Copper

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This chapter reviews events in the Canadian copper industry in 2002 and provides some outlook for the Canadian industry and prices. The electronic version of this chapter is available at www.nrcan.gc.ca/mms/cmy/content/2002/25.pdf.

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SUMMARY

RECENT WORLD COPPER DATA

	2001	2002 (p)
	(Mt)	
Mine production	13.659	13.566
Primary refined production	13.684	13.429
Secondary refined production	1.902	1.891
Total refined production	15.586	15.32
Usage (consumption)	14.807	15.069
Refined stocks at year-end	2.109	2.212

Source: International Copper Study Group, ICSG Copper Bulletin, May 2003.
(p) Preliminary.

2002 LME PRICES FOR GRADE A COPPER

	Cash	3 Month	15 Month	27 Month
		(US$/t)		
Average	1 557	1 576	1 634	1 669
Minimum	1 690	1 710	1 763	1 790
Maximum	1 421	1 445	1 515	1 560

Source: Calculated from London Metal Exchange (LME) daily data available at www.lme.co.uk/2628.html (note conditions of use).
Notes: Cash ask price = settlement price. Refer to Figure 11 for a graph of copper prices for the period 1989 to 2002. For a definition of Grade A copper, see LME web site at www.lme.co.uk/2314.asp. For copper brands listed on the LME, go to www.lme.co.uk/2319.asp. The average value of the Canadian dollar in 2002 was US$0.6369 (see www.bankofcanada.ca/en/exchange-look.htm for daily and other rates).

RECENT CANADIAN DATA

	2001	2002 (p)
	(tonnes)	
Copper mine production	633 500	600 200
Reported copper mine production (rounded to nearest 1000 t)	618 000	602 000
Copper refined production	567 700	494 300
Copper domestic shipments	257 200	257 100
Copper refined imports	8 000	11 600
Apparent copper usage	265 200	268 700

Source: Natural Resources Canada (except company reports), see http://mmsd1.mms.nrcan.gc.ca/mmsd/data/2002/02mtly12.pdf.
Notes: NRCan data are rounded to the nearest 100 t except for reported copper mine production, which is rounded to nearest 1000 t. Use = domestic shipments + refined imports. Reported copper mine production is taken from company reports and is a mixture of copper in concentrates produced and payable copper in concentrates, depending upon the company.

CONTENTS

VALUE ADDED

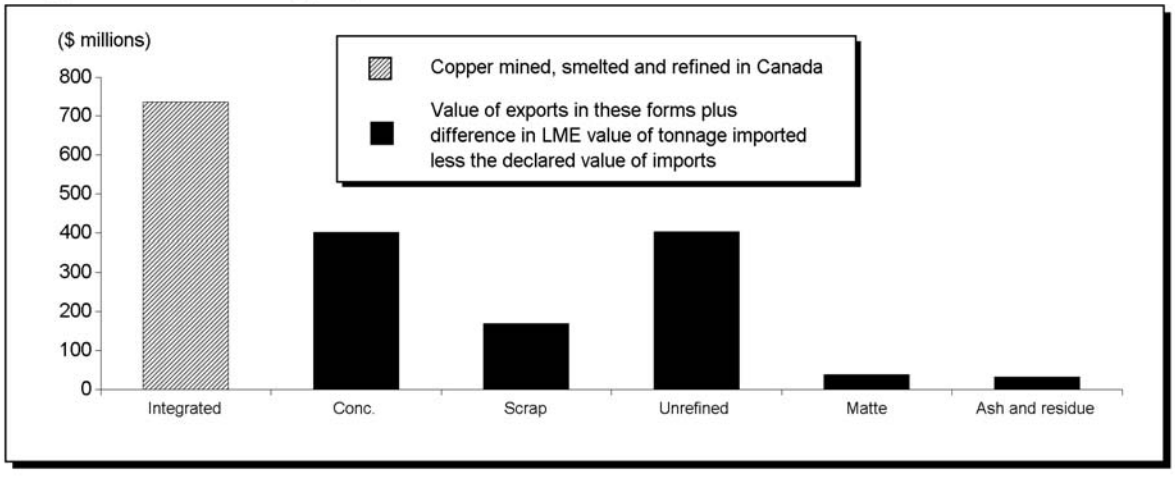
The "value added" of the Canadian copper industry up to refined metal was approximately $1800 million in 2002. This value reflects the value of the production and processing of materials originating in Canada, the value of intermediate exports, and the value added of raw materials imported for treatment in Canada. Such raw materials include:

- copper in concentrates (H.S. 2603);
- copper in ash and residues (H.S. 2629.30);
- copper in waste and scrap (H.S. 7404);
- unrefined copper (H.S. 7402) such as precipitates; and
- copper in mattes (H.S. 7401).

The data are not complete enough for an exact calculation. For example, some of the waste and scrap imported is brass and bronze, which has a higher value than copper, so using the tonnage of scrap imports valued at the London Metal Exchange (LME) settlement price for Grade A copper would undervalue the final value of the products made from the imports (i.e., brass scrap is imported to make brass, not to be put into a copper smelter to recover the copper values). Offsetting this is the inaccuracy in some tonnage data; only the gross weights of most imports are recorded and, as such, the contained metal may not be equal to the gross weight of the imports. For example, the copper contained in ash and residue may be much less than the gross tonnage and so a valuation of the potential products by multiplying the gross weight of the copper ash and residue imports by the copper value overvalues these imports. However, such ashes and residues may contain precious metals, which have a unit value many times that of copper. Thus, the value-added data are illustrative of actual value added.

One can see that the greatest contribution to value added occurs from the copper mined and processed in Canada; this material accounts for over 40% of copper's total value added. Concentrates traded account for about one quarter of the total value added – this includes the value of copper concentrates exported and the difference between the declared value of the concentrate imports and the value of the copper produced from these imports. Unrefined copper is similar to copper concentrates, accounting for about one quarter of copper's total value added of $1800 million.

Figure 1
Copper, Value Added (1) by Source, 2002



Sources: Statistics Canada; Bank of Canada exchange rate; London Metal Exchange price for Grade A copper.
(1) Approximate value.

CANADIAN DEVELOPMENTS

The Canadian primary copper industry is in reality a number of distinct copper industries. Some mines[a] produce copper as a co-product[b] of another metal such as nickel, zinc or gold, and some mines produce copper as a by-product[c] of other metals. Some copper mines sell their output in the form of copper concentrate to custom smelters in Canada or overseas. Some of the smelters process feed from their own mines/mills. Others supplement their corporate feed with purchased concentrates; one (the Horne smelter) processes almost entirely material purchased from other companies. Smelters that purchase concentrate are known as custom smelters. Each of these groups reacts differently to changing market conditions. In the case of smelting and refining, for example, the mines selling copper concentrates get paid a price related to the world price for refined copper, usually the LME price,[d] less the "treatment charges and refining charges" (TCRCs).[e] TCRCs are the amounts charged by smelters and refineries that purchase copper concentrates and process these concentrates to refined copper. The treatment charge is the amount charged to smelt the concentrate; the refining charge is the amount charged to refine the anode or blister copper to a high-purity copper cathode, the form that most copper users want. TCRCs are set by market forces – when there is a surplus of copper concentrates compared to the smelting and refining capacity, then TCRCs rise. When there is a shortage of copper concentrates relative to smelting and refining capacity, as was the case in 2002 for example, then TCRCs fall. Smelters try to operate at high rates of utilization in order to keep their unit costs low, staying competitive relative to other smelters. But eventually, if TCRCs are low for an extended period of time, then some smelters close because they are uncompetitive. A case in point is the Gaspé smelter, which closed permanently in 2002.

If copper prices are low for an extended period, then some mines that are losing money will close. In addition, there will be less investment in new copper mine capacity because of the projected poor returns on investment. Together these factors reduce the supply of copper concentrates, which changes the supply-demand balance and leads to lower TCRCs as smelters compete for scarcer supplies of concentrate feed. When copper prices rise, mines may re-open or new ones may start up; as the amount of copper in concentrates increases, the TCRCs will increase.

The share of the LME price that is retained by smelters and refineries is variable; it varies from a low of about 20% of LME prices up to 35%. From a graph published by AME Mineral Economics in February 2002,[1] the smelter/refinery share of LME prices appears to have generally trended downward from 1975 to about 1988. After this period, the fluctuation became more erratic, but peaked at over 30% of LME in 1998 before dropping back to about 25% of LME prices as of early 2002.

In Canada, there are concentrate sellers that benefit from low TCRCs. There are also custom smelters, such as Noranda Inc., that benefit from high TCRCs. One might describe Inco Limited, a very large integrated copper producer, as presently being largely unconcerned about TCRCs as Inco does not sell or buy appreciable amounts of copper concentrates. However, this will change by 2006 when Voisey's Bay is expected to come into production; at that time, Inco plans to sell the majority of the copper produced by the project to custom smelters.

The production of copper in Canada is associated with the production of other metals (and sulphuric acid). There is no Canadian copper mine whose revenue from its domestic operations is derived entirely from copper. The role of other metals in Canadian copper production in terms of value and production was estimated for 2002 production and the result is presented in graphical form in Figure 2.

Canadian copper production and processing is a net earner of foreign exchange, earning a net of $965 million; total exports in 2002 were $2205 million and total imports were $1240 million. Figure 3 shows the imports and exports of three groups of copper products and the associated trade balances for each group. The three groupings of products are:

- concentrates, anode copper, and refined copper;
- semi-fabricated items, including alloys of copper and ingots; and
- fabricated items.

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a The author's use of the term "mine" includes the concentrator or mill associated with the mine. At present, all copper mined in Canada is crushed and milled in a process in which much of the waste is removed from the mine ore. The output from the mill is termed a "concentrate" or higher-grade material. The concentrate is used as feed to copper smelters. A short description in English of the flotation process can be found at http://60centuries.copper.org/modern/modern02_a.html. The location of the description of the smelting and refining process is available in English at http://60centuries.copper.org/modern/modern03_a.html.

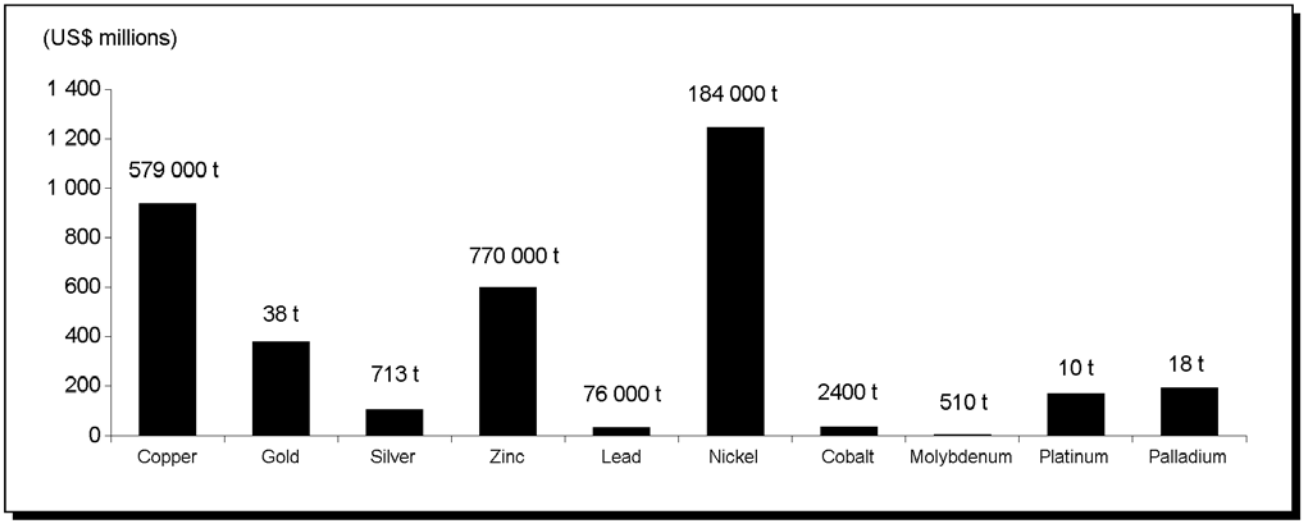
b When copper is a co-product, it is an important, but not the principal, source of revenue from the mine output.

c When copper is a by-product, it is a relatively insignificant source of revenue from the mine output and changes in the copper price are unlikely to result in major changes to the mine operating plans.

d LME prices are set daily in the United Kingdom.

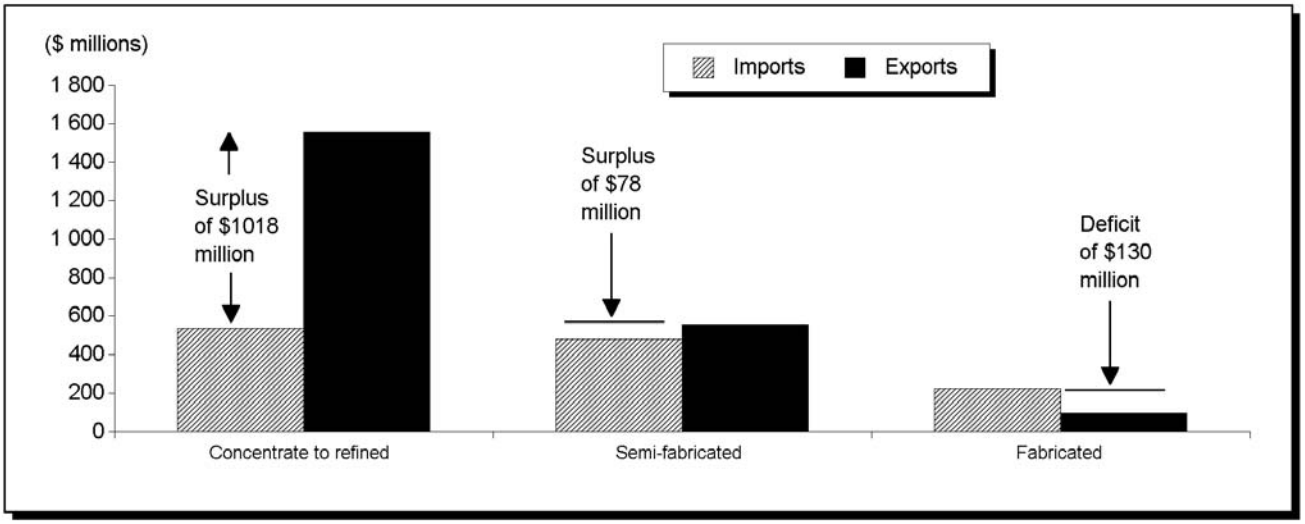
e Freight, insurance, payment for contained metals such as gold and silver, penalties for deleterious impurities, price escalation factors, etc., are also calculated but, for the sake of simplicity, these are ignored here.

Figure 2
Value (1) and Quantity (2) of Metals Recovered with Copper Mined in Canada, 2002



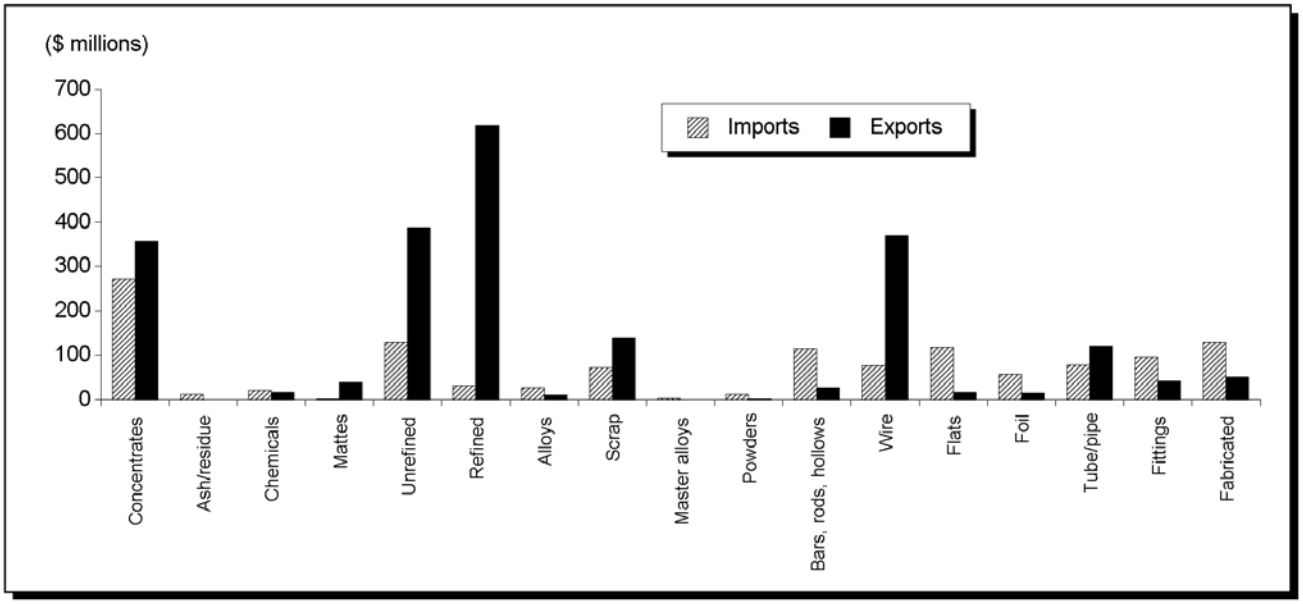
Sources: Company reports; author's criteria for grouping; average metal prices for 2002.
(1) Value is approximate as companies may report metal in concentrate, payable metal, or deliveries. (2) Approximate amount of metal in concentrate.

Figure 3
Canadian Copper Trade by Processing Stage, 2002



Sources: Natural Resources Canada; Statistics Canada.

Figure 4
Canadian Copper Trade, by Product Type, 2002



Sources: Natural Resources Canada; Statistics Canada.

These groupings can be broken down into more detail that shows the relative trade balances for the detailed trade classifications. These are presented in Figure 4.

More detailed trade data are shown in Table 1, which lists trade by Harmonized System (H.S.) code and by country of destination for products and origin for imports.

The most important net trade earnings (export revenues less import revenues) generated by copper and copper alloy products were in the following groupings:[f]

- refined copper $587 million
- copper and alloy wire $294 million
- copper anodes and matte $258 million
- concentrates $85 million
- recyclables $66 million

The groupings of copper and copper alloy items for which Canada has a significant negative trade balance (export revenues less import revenues) are shown below:

- flat products (sheet, plate strips) $100 million
- bars, rods and hollow sections $88 million
- fabricated products $78 million
- fittings $52 million

[f] Only groups generating over $50 million were shown in this table and the subsequent table.

CANADIAN PRODUCTION SUMMARY

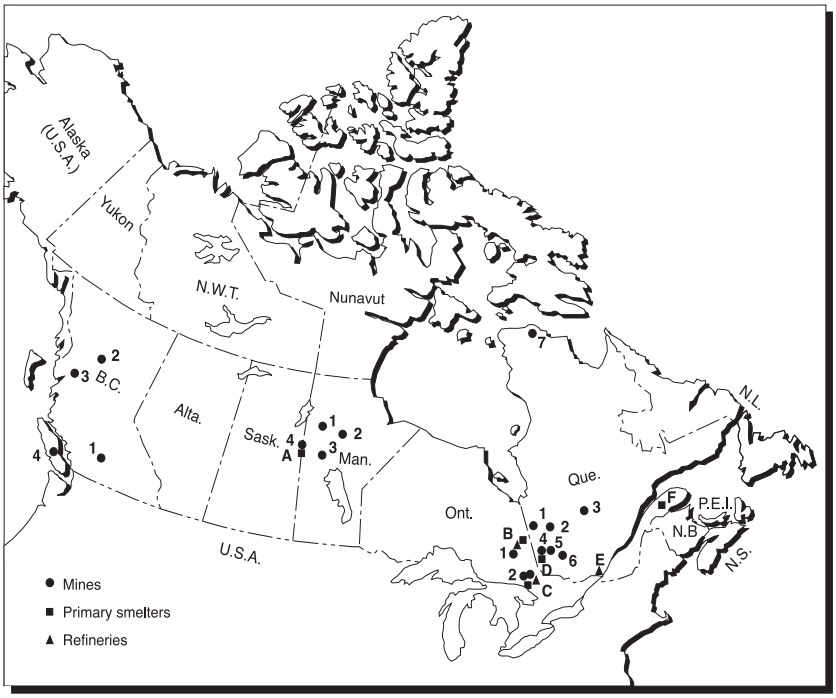
The locations of Canadian mines and prospective producers are shown in Figure 5.

Canadian production of copper in concentrates was 600 200 t[g] (633 500 t)[h] as prices continued to languish between US$1421 and US$1690/t (US64¢ and 77¢/lb). Refined production declined to 567 700 t (579 700 t), reflecting the shortage of refinery feed due to the closure of a smelter and a strike at another smelter during 2002. Domestic shipments of refined copper remained nearly unchanged at 257 100 t (257 200 t). The reader can refer to monthly data for 2002 and 2001 by referring to the publication *Production of Canada's Leading Minerals*, Table 3, at http://mmsd1.mms.nrcan.gc.ca/mmsd/data/2002/02mtly12.pdf.

Existing and future Canadian copper production is affected both by copper prices and by the prices of other co-product and by-product metals. The present low prices of copper and other associated metals are not sufficient to maintain Canadian copper output at current levels to the end of the decade. The author projects that in six to eight years Canadian copper mine output will be less than

[g] Data are rounded to the nearest 100 t.
[h] Data in parentheses indicate a comparable period in 2001.

Figure 5
Copper Producers in Canada, 2002



Numbers refer to locations on map above.

MINES

BRITISH COLUMBIA

1. Highland Valley Copper
2. Northgate Exploration Limited (Kemess)
3. Imperial Metals Corporation (Huckleberry)
4. Boliden AB (Myra Falls)

SASKATCHEWAN

Hudson Bay Mining and Smelting Co., Limited (Flin Flon)

MANITOBA

1. Hudson Bay Mining and Smelting Co., Limited (Ruttan mine)
2. Inco Limited (Thompson mine)
3 Hudson Bay Mining and Smelting Co., Limited (Chisel North mine)
4. Hudson Bay Mining and Smelting Co., Limited (Flin Flon area mines including Konuto Lake)

ONTARIO

1. Falconbridge Limited (Kidd Creek mines, Timmins)
2. Falconbridge Limited (Sudbury area) Inco Limited (Sudbury area)

QUEBEC

1. Les Mines Selbaie
2. Noranda Inc. (Bell-Allard mine)
3. Campbell Resources Inc. (Joe Mann mine) Inmet Mining Corp. (Troilus mine)
4. Breakwater Resources Ltd. (Bouchard-Hébert mine)
5. Agnico-Eagle Mines Limited (La Ronde mine) Barrick Gold Corporation (Bousquet mine)
6. Aur Resources, Inc., Novicourt Inc., Teck Cominco Limited (Louvicourt mine)
7. Falconbridge Limited (Raglan mine)

NEW BRUNSWICK

Noranda Inc. (Brunswick mine)

PRIMARY SMELTERS

A. Hudson Bay Mining and Smelting Co., Limited (Flin Flon)
B. Falconbridge Limited (Timmins)
C. Inco Limited (Sudbury area) Falconbridge Limited (Sudbury area)
D. Noranda Inc. (Noranda)
F. Noranda Inc. (Murdochville) - closed April 2002

REFINERIES

B. Falconbridge Limited (Timmins)
C. Inco Limited (Sudbury area)
E. Noranda Inc. (Montréal-East)

1 Highland Valley Copper is a partnership of Teck Cominco Limited and BHP Billiton Plc.

current output as insufficient new mines are expected to be developed to replace the output from Canadian copper mines that are expected to exhaust their reserves by the end of the decade.

There are three types of copper mines in Canada: copper mines, co-product copper producers, and by-product copper producers.

Copper Mines

Canadian "copper mines" are those mines at which copper generates the main source of revenue. At such operations, while other metals can be important sources of revenues, such revenues are generally not a decisive factor in either maintaining the mine operation or in a decision to close the mine. The Louvicourt, Highland Valley Copper, and Hucklebery mines are examples of such operations.

Co-Product Copper Mines

In other mines, copper revenues, while significant, are not the principal source of revenue for the operation. Copper prices in such operations are a factor in making new investment decisions or, in the case of periods of low prices, in deciding whether to shut the operations temporarily. But the price of another metal or metals may earn more revenues than copper and these metals can therefore be more important than copper in the decision-making process. Examples of such operations would likely include the Myra Falls, Bouchard-Hébert, and Selbaie mines.

By-Product Copper Mines

At some mines, copper production is a relatively minor component in the revenue stream. For such operations, the price of copper is much less important in the decision-making process and such mines could continue to produce copper even at very low copper prices. Conversely, much higher copper prices may not make enough of a difference in revenue to make increased mine production a profitable investment. Examples of such operations may include the LaRonde, Joe Mann, Lac des Iles, and Brunswick mines.

New mine development continues to be restrained by low prices for copper and zinc. The major greenfield[i] mine development scheduled will be Voisey's Bay, a nickel-copper-cobalt deposit in Newfoundland and Labrador. This project is scheduled to commence shipping concentrate in 2006. A number of mines face exhaustion of reserves; the Bousquet gold mine closed in 2002 and Selbaie is expected to close in late 2003.

Production vs. Shipments

Canadian statistics include a report of "mine production" (which is actually mill or concentrator production) and is the total amount of copper produced in concentrates by Canadian mines. However, Canadian statistics also include a "production" figure, which is actually the total amount of copper contained in concentrates that is shipped from the mine site in a year. This measure of production is less widely used and is not consistent with the definitions used by the International Copper Study Group (ICSG); Canadian "mine production" data are consistent with the ICSG definition.

The reader needs to be careful to verify which definition is being used in Canadian statistics when viewing a particular table. For example, the record of "Mineral Production of Canada, by Province" presented at http://mmsd1.mms.nrcan.gc.ca/mmsd/production/2002/02pprod.pdf actually shows preliminary **shipment** data for 2002 and not the production of copper in concentrate for 2002.

Preliminary shipment data are estimated prior to the end of the year in question. Mine production data (noted above) are reported by producers after the month of production. Hence, at the time of writing, the 2002 production data are more accurate than the estimated preliminary shipment data are. Revisions to both the shipment data and the mine production data are completed in the subsequent year. Historically, Canadian statistical series show mine shipment data. Such data are useful to show the relative copper output between provinces.

The preliminary estimate for 2002 shipments of copper in concentrates was 577 000 t (less than the over 600 000 t of copper in concentrates reported as being produced in 2002). The production data are usually higher than shipments as production relates to the total content of copper in concentrates produced whereas the shipment data relate to the estimated recoverable copper in concentrates shipped. In certain instances, material produced at the end of one year may not be shipped until the next year, causing a further difference between the data series.

Companies may show production data that report the total amount of copper contained in the concentrates produced in a year or the "payable production" may be shown. The latter reflects the amount of copper for which the mine is paid by the custom smelter. The deduction reflects the inability of the smelters to achieve 100% recoverability of the copper in the feed material. For some operations that report payable production, it is possible to calculate the production of copper contained if one knows the tonnage of ore processed, the copper grade of the material processed, and the recovery factor at the mill.

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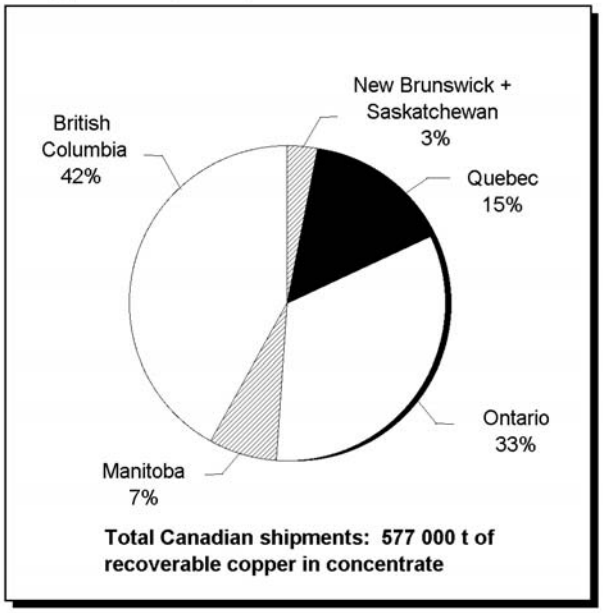
[i] A "greenfield" project is a project developed at an entirely new site; a "brownfield" project is an expansion at an existing or former production site.

Figure 6
Copper Output by Province, 2002



Source: Natural Resources Canada.

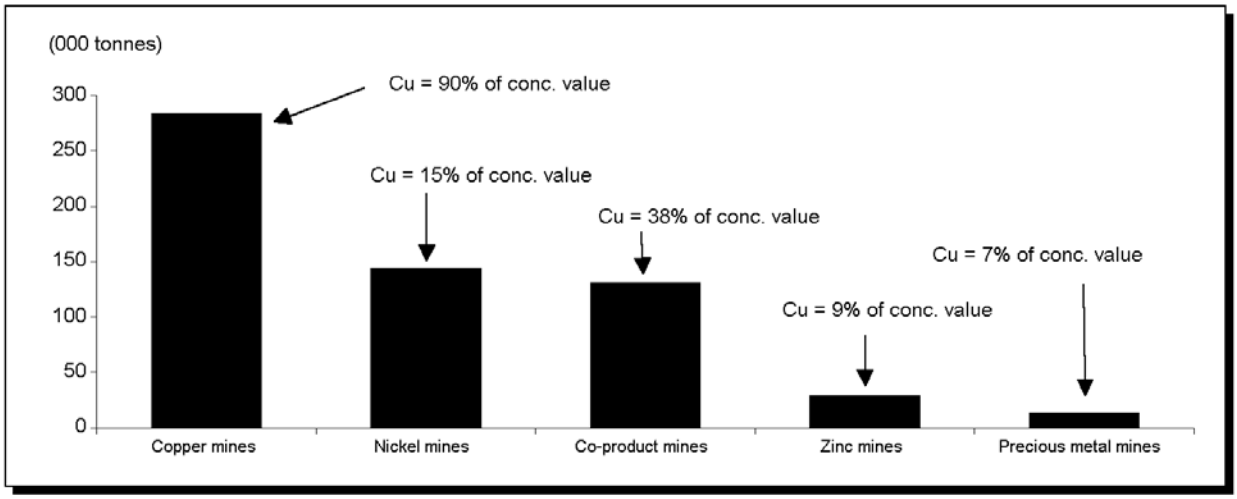
Using the shipment data, the largest producing provinces are British Columbia, with 42% of total copper shipments, and Ontario, with 33%. The majority of the B.C. output is from copper mines that also produce other by-products such as gold and molybdenum. The Ontario copper production comes in the form of by-product copper from the Sudbury Basin nickel operations and from the Kidd copper-zinc operations at Timmins (see Figure 4).

CANADIAN PRODUCTION FACILITIES

The web sites for Canadian copper producers and for companies that are prospective producers are shown in Table 3. Table 3 also presents the locations on the Internet where documents of publicly traded companies are filed with Canadian Securities Administrators. The System for Electronic Document Analysis and Retrieval, or SEDAR, presents data for public access.

Index of Canadian Producers by Company Name

Figure 7
Canadian Copper Production, by Type of Mine, 2002



Sources: Company reports; author's criteria for grouping; average metal prices for 2002.
Notes: Total copper shown in graph equals 579 000 t. The total value of metals (copper, nickel, cobalt, etc.) in concentrates is estimated at US$3.3 billion. In addition, there is about US$325 million in platinum group metals production from Inco and Falconbridge from their worldwide sources that is not included in the graph. Conc. value = the sum of tonnage of each metal in concentrate multiplied by the average market price for that metal in 2002.

Agnico-Eagle Mines operates the LaRonde mine near Val-d'Or, Quebec, and is the operator of the **Louvicourt Joint Venture** (see below). Agnico-Eagle expanded its mill to 6350 t/d (7000 st/d) at its LaRonde operation in early October.[2] LaRonde is a gold operation that produces by-product silver, zinc and copper. Deep drilling during the year showed promising gold and copper values, and the company accelerated the development of drifts to allow further drilling. Agnico-Eagle was evaluating a number of options to mine ore below the Penna shaft (shaft depth is 2250 m or 7380 ft),[3] the deepest in the Western Hemisphere; one of the options is to sink a new shaft to 3050 m (10 000 ft).[4] Production increased with the new mill start-up and with higher grades. Production in 2003 is expected to be even higher as the new mill should be utilized for the entire year. The production data in 2002 and 2001 were:[5]

LARONDE MINE

	2001	2002
Millions of tonnes milled	1.57	1.78
Copper grade (%)	0.21	0.34
Copper recovery (%)	60.4	72.0
Contained copper (t)	2 140	4 630
Payable copper (t)	1 860	4 050
Payable zinc (t)	57 300	49 000
Payable gold (kg)	7 300	8 090
Payable silver (t)	78.5	96.2

Notes: Except for % figures, data are rounded to three significant digits. Contained copper is calculated.

Aur Resources Inc. is the operator of the Louvicourt mine (see below for details), a joint venture between Aur Resources (30%), Novicourt Inc. (45%) and Teck Cominco Limited (25%). This mine is expected to be depleted in mid-2005 at which time Aur hopes to have its Duck Pond project in production. Details about the Louvicourt mine are presented below.

Boliden AB redomiciled its operations in Sweden from Canada in late 2001.[6] Boliden owns the mine at Myra Falls through its subsidiary, Boliden Westmin (Canada) Limited.[7] Myra Falls is located on Vancouver Island in British Columbia. The latter company operates the underground zinc-copper mine, which has by-product gold and silver production. The Myra Falls operation consists of two underground mines and a mill; the H-W mine is located at a depth of 300-600 m and the Battle/Gap mine, with its higher zinc grade, is located about 2 km horizontally away from the shaft at a depth of 700-900 m. The ore from the two mines is hoisted in a 715-m shaft. The 1.4-Mt/y mill utilizes rod and ball mills and flotation to produce a zinc concentrate and a copper-gold concentrate, as well as a separate gold concentrate. The concentrates are trucked 90 km to the port at Campbell River for shipping to smelters, principally in Japan.[8] Zinc concentrates are sent to South Korea and Japan with some sales elsewhere. The mine reserves are sufficient for about eight years of future production,[9] or until about 2010.

Production at Myra Falls in 2002 was lower than in 2001 because the mine had been shut from December 2001 to the end of March 2002[10] following a write-down of 1.2 billion SEK[11] (or about US$120 million). Boliden was able to increase efficiency and reduce costs by 20% at the operation and, by the end of 2002, Boliden was making a profit from the Myra Falls operation.[12] Part of the cost reduction came from employees who voted to link wages to metal price trends, resulting in a 10% wage cut in 2002.[13] The number of Canadian employees at Boliden decreased from 432 at the end of 2001 to 363 at the end of 2002.[14]

Production from Myra Falls in 2001 and 2002 was:[15]

MYRA FALLS MINE

	2001	2002
Copper (t)	13 200	6 780
Zinc (t)	57 900	50 400
Gold (kg)	632	618
Silver (t)	12.1	18.7

Notes: Metal values are rounded to three significant digits. Metal tonnages are assumed to be payable.

Breakwater Resources Ltd. has two underground zinc-copper mines in Quebec: the Langlois mine and the Bouchard-Hébert mine. The Langlois mine did not operate in 2002; further details on this mine can be found in the "Projects and Mines on Standby in 2002" section of this chapter (below).

Breakwater's Bouchard-Hébert underground zinc mine (formerly known as the Mobrun mine) is located about 30 km away from Rouyn-Noranda (where Noranda's

Horne copper smelter is located). As well as zinc, the mine produces by-product gold, copper and silver. The copper concentrate grades 16-17% copper. A semi-autogenous (SAG) mill with conventional flotation processing is used in the concentrator.[16] During 2002, the upper sections of the mine were worked where the zinc grade is higher but the copper and precious metal grades are lower.[17] Capital expenditures of less than $2 million were incurred in 2002, as in 2001, but no additional capital expenditures are planned for the life of the mine.[18] The mine is slated to close in 2005 unless additional reserves are added.[19] Breakwater anticipates re-opening the Langlois mine to replace production from the exhaustion of the Bouchard-Hébert mine.[20]

The production data from the Bouchard-Hébert mine in 2002 and 2001 are shown below:[21]

BOUCHARD-HÉBERT MINE

	2001	2002
Millions of tonnes milled	1.04	1.05
Copper grade (%)	0.80	0.70
Copper recovery (%)	16.5	16.1
Contained copper (t)	6 930	6 060
Contained zinc (t)	41 200	51 200
Contained gold (kg)	886	626
Contained silver (t)	17.5	13.9

Notes: Data are rounded to three significant digits.
Contained copper is calculated.

A description of the Bouchard-Hébert mine and its geology can be found in Breakwater's Preliminary Prospectus, February 18, 2002, pp. 21-30, obtainable at www.sedar.com/csfsprod/data29/filings/00413572/00000003/C%3A%5CSEDAR%5CFILINGS%5CSR KTR2.pdf.

Barrick Gold Corporation produced some by-product copper from its Bousquet gold mine in Quebec.[22] Barrick reported that this mine was closed in 2002,[23] as had been previewed, and did not release copper production data for the mine. Human Resources Development Canada reported early in 2002 that the Bousquet mine would be closed in November 2002 and that 300 jobs would be lost.[24] Barrick's web site is located at www.barrick.com.

Campbell Resources Inc. operates the Joe Mann mine, an underground gold-copper mine, through its wholly owned subsidiary, **Meston Resources Inc.**.[25] Located about 65 km from Chibougamau, Quebec, the mine had been suspended due to a combination of ground control problems, dilution and low prices; the suspensions were from October 1999 to April 2000 and again from November 2001[26] to April 1, 2002.[27] The plan that brought the mine back into production was based upon an operating rate of 945 t/d, five days a week, to produce 2 t/y of gold, about 685 kg/y of silver and 558 t/y of copper (either in concentrates or as payable copper).[28] In addition, workers accepted wage reductions linked to the price of gold. The mine shaft is capable of hoisting 1815 t/d based upon a 12-hour hoist day.[29] The mine is scheduled to produce 408 t of copper in 2003[30] with the mine going to a five-day-per-week schedule in early 2003.[31] Ore is trucked to the Campbell mill located about 65 km from the Joe Mann mine.[32] The 3175-t/d mill has three circuits for metals recovery – gravity, flotation and cyanide are all used. Some of the gold is contained in the copper concentrate, which is railed to Noranda's Horne smelter.[33] During 2003, a technique of thermal fragmentation will be introduced in order to more efficiently mine narrow gold-bearing veins where dilution would make traditional methods uneconomic.[34]

Production in 2001 and 2002 (converted from the Imperial unit of measurement to the International System units) was:[35]

JOE MANN MINE

	2001	2002
Tonnes milled	–	122 000
Copper grade (%)	–	26
Contained copper (t)	–	300
Copper produced (t)	–	228
Gold produced (kg)	–	1 010

– Nil.
Notes: Data are rounded to three significant digits.
Contained copper is calculated. Production data are assumed to be "payable" values.

Noranda Inc. is the most significant copper producer in Canada. It also owns 59.5% of Falconbridge Limited (as of December 31, 2002), a company that produces a large amount of copper as a by-product of nickel from the company's Sudbury operations and as copper from the company's Kidd operations in Timmins, Ontario. Noranda's Canadian Copper and Recycling business unit consists of:

- the Kidd Creek mining operations at Timmins, Ontario;
- the Horne smelter at Rouyn-Noranda, Quebec;
- the Gaspé smelter (now permanently closed);
- the Kidd metallurgical complex, consisting of a copper smelter and copper refinery (as well as a zinc refinery, acid plant and recovery facilities for minor metals); and
- the CCR refinery in Montréal-East.

The details of Noranda's non-Falconbridge operations are shown below.

Noranda has direct interests in many copper production facilities in Canada, including nine mines,[j] three smelters (of which one closed in 2002), and two refineries. In addition, the company has significant copper production facilities in foreign countries.[k]

Falconbridge is owned 59.5% by Noranda.[36] In Canada, Falconbridge has nickel-copper production facilities as well as copper-zinc production facilities. These are detailed separately below.

Falconbridge's smelter in Sudbury, Ontario, takes concentrate produced from the company's mines located in Sudbury (four mines) and northern Quebec (one mine), plus material that is recovered from recyclables (1800 t of copper were recovered from recyclables in 2001). The mines ship their ore to a central mill at Strathcona where most of the ore is processed into a bulk nickel-copper-cobalt concentrate. In addition, however, some high-grade copper material is recovered separately as copper concentrate and shipped to Falconbridge's Kidd operations for recovery (see below). The bulk nickel-copper-cobalt concentrate from the Sudbury mines is sent to the company's smelter, located at Falconbridge, Ontario, about 85 km from the Strathcona mill. This concentrate is smelted to a nickel-copper-cobalt matte and shipped to the Nikkelverk refinery in Kristiansand, Norway, for final refining.[37]

The copper in bulk nickel-copper concentrates and copper contained in recyclable materials is smelted at Falconbridge's electric smelter in the Sudbury Basin. In 2001, Falconbridge recycled 537 t of copper at its Sudbury smelter.[38] The smelter output was:[39]

FALCONBRIDGE SMELTER OUTPUT

	2001	2002
	(tonnes)	
FALCONBRIDGE SMELTER OUTPUT		
Copper in matte		
Sudbury origin	8 890	11 200
Raglan origin	7 160	6 620
Custom origin	1 840	2 740
Nickel in matte		
Sudbury origin	24 500	28 200
Raglan origin	26 900	25 200
Custom origin	3 440	4 400
Cobalt in matte		
Sudbury origin	590	691
Raglan origin	419	370
Custom origin	779	894
Sulphuric acid	225 000	247 000

Notes: Metal values are rounded to three significant digits. Custom nickel is nickel from recyclable feeds.

While Falconbridge's electric smelter has operated below capacity for the last couple of years due to a shortage of feed, in the fourth quarter the smelter operated at a record rate of 72 000 t/y of nickel in matte compared to its previous rated capacity of 65 000 t/y of nickel in matte.[40] The smelter has a feed capacity of 130 000 t/y of matte.[41] The smelter's acid plant converts sulphur dioxide from exhaust gas to sulphuric acid, which is sold. The capacity of this acid plant is about 300 000 t/y.[42] In February, the province issued a new order limiting the annual emission of sulphur dioxide from Falconbridge's smelter to 66 000 t/y effective December 31, 2006 (down from the previous limit of 100 000 t/y), and reducing ground-level concentrations to 0.34 ppm effective April 2002. In 2001, the smelter emitted 29 600 t of sulphur dioxide, less than 30% of the allowable limit.

Falconbridge has permission from the Province of Ontario to export nickel-copper matte from Canada with a recoverable content of 100 million lb (or about 45 360 t) of refined nickel annually; this permission lasts until December 31, 2009.[43] The permission has been renewed a number of times in the past and can be renewed again in the future.

Falconbridge's copper production in Canada from nickel operations in 2001 and 2002 is shown below:[44]

FALCONBRIDGE INO

	2001	2002
SUDBURY MINES		
Millions of tonnes milled	1.95	2.30
Copper grade (%)	1.35	1.56
Copper recovery (%)	87	87
Contained copper in nickel-copper conc. (t)	8 850	9 380
Contained copper in copper conc. (t)	14 000	21 700
Contained nickel (t)	25 200	27 800
Contained copper (kg)	630	690
Contained gold+silver+platinum group metals (kg)	..	..
RAGLAN MINE		
Millions of tonnes milled	0.96	0.87
Copper grade (%)	0.91	0.97
Copper recovery (%)	79	77
Contained copper (t)	6 920	6 500
Contained nickel (t)	24 600	24 600
Contained copper (kg)	318	386
Contained gold+silver+platinum group metals (kg)	..	..

INO = Integrated nickel operations; .. Not available.
Notes: Data are rounded to three significant digits. Recovery of copper is calculated from tonnes milled and head grade.

[j] Bell-Allard, Brunswick and Kidd Creek (considered as one mining complex), Sudbury (4), Raglan, and Louvicourt.
[k] For example, Antamina, Colahuasi, Lomas Bayas and Atlonorte.

Fed from the copper production from the nickel operations located in Canada, Falconbridge produces refined copper at its plant in Norway. The Falconbridge Nikkelverk Aktieselskap A/S operation is located in Kristiansand in southern Norway. There Falconbridge recovers nickel, cobalt, gold, silver, platinum group metals and sulphuric acid by treating the matte with a chlorine leach and electrowinning. Nikkelverk supplements the feed from the Sudbury smelter by tolling, principally from BCL Limited in Botswana. Finally, Nikkelverk can process certain recyclable materials as well. The capacity of Nikkelverk is 40 000 t/y of copper, 85 000 t/y of nickel, and 4500 t/y of cobalt.[45] This could be increased, if market conditions and feed supply warrant, to 60 000 t/y of copper, 100 000 t/y of nickel and 5000 t/y of cobalt.[46] Nikkelverk's production in 2001 and 2002 was:[47]

FALCONBRIDGE REFINERY OUTPUT

	2001	2002
Refined copper (t)		
Sudbury origin	7 140	11 100
Raglan origin	7 820	6 740
Custom origin	11 800	12 800
Refined nickel (t)		
Sudbury origin	22 100	27 200
Raglan origin	29 400	24 300
Custom origin	16 800	17 100
Refined cobalt (t)		
Sudbury origin	496	621
Raglan origin	439	344
Custom origin	2 379	3 030
Platinum group metals (kg)	7 280	11 000
Sulphuric acid (t)	86 400	89 900

Notes: Metal values are rounded to three significant digits.
Refinery is located in Norway.

The Kidd operations of Falconbridge consist of two independent divisions: the Kidd Mining Division, site of the company's underground mines producing copper, zinc and silver; and the Kidd Metallurgical Division, located about 25 km southwest of the mine, where the company mills the ore, smelts the copper concentrate, refines the anode copper, and refines the zinc concentrate. It also produces by-product cadmium, indium and sulphuric acid. Silver and other by-products contained in the electro-refinery tank house slimes are sent to Noranda's CCR Division for recovery. The nearly 700 workers at the Kidd metallurgical site represented by Local 599 of the National Automobile, Aerospace and Agricultural Implement Workers Union of Canada (CAW-Canada) signed a three-year labour agreement with Falconbridge in September[48] that replaced the agreement that expired on September 30.[49] Falconbridge is working with Noranda's Horne smelter and CCR refinery to coordinate operations and feed procurement and to pool technical resources[50] in order to reduce costs.

Ore is produced from three mines at the Kidd mining site: the No. 1, No. 2 and No. 3 mines. These mines divide the orebody up into three horizontal slices like thick layers of a cake. Mine No. 1 extends from surface to 790 m, Mine No. 2 extends from 790 m to 1400 m, and Mine No. 3 extends from 1400 m to 2070 m.[51] Mine D, under development, will produce from a zone located at a depth of 2070-3110 m.[52] By year-end 2002, about 40% of the $640 million project had been completed.[53]

Mine No. 3 was brought into production in late 2001.[54] The development of Mine D was accelerated in 2001 after ground control problems in existing mining areas;[55] ongoing work in 2002 included shaft-sinking and ramp development. A new ventilation system for Mine D and the existing mine operation was installed and started up in the third quarter.[56] Mine D is scheduled to begin production in late 2004; the $650 million project will extend the life of the Kidd mine to 2024 by allowing mining of 10 Mt of reserves, access to 14 Mt of resources,[57] and the mine to return to its production level of 2.4 Mt/y of ore.[58]

Mine production at Kidd in 2001 and 2002 was:[59]

KIDD MINE PRODUCTION

	Tonnes	Copper Grade	Zinc Grade	Silver
		(%)	(%)	(g/t)
2001				
Mine No. 1	703 000	1.80	6.75	78
Mine No. 2	281 000	4.05	0.25	22
Mine No. 3	993 000	2.11	5.98	61
2002				
Mine No. 1	992 000	1.80	7.78	92
Mine No. 2	216 000	2.87	0.99	27
Mine No. 3	1 110 000	2.11	5.89	78

The copper concentrate is smelted at the Kidd metallurgical site in a Mitsubishi continuous smelter with a capacity of 150 000 t/y of blister copper (copper in anodes),[60] along with the copper concentrate produced at the separate circuit in the Strathcona mill (see above) and the custom concentrates, which include imported copper in concentrate.[61]

In addition, the smelter processes copper concentrates from Falconbridge's Collahuasi mine in Chile[62] and from Minera Escondida Limitada,[63] also located in Chile. Production in 2001 and 2002 was:[64]

KIDD METALLURGICAL DIVISION

	2001	2002
Millions of tonnes milled	1.95	2.24
Copper grade (%)	2.31	2.12
Copper recovery (%)	94	95
Contained copper (t)	42 300	45 400
Contained zinc (t)	81 700	104 000
Contained silver (t)	89	114
Anode copper (t)		
from Kidd mine	46 000	44 500
from Falconbridge INO	8 430	23 100
from custom feed	77 600	76 500
Cathode copper (t)		
from Kidd mine	41 800	47 000
from Falconbridge INO	8 430	23 100
from custom feed	77 600	76 500
Zinc in Kidd concentrate (t)	81 700	104 000
Refined zinc (t)	140 000	145 000
Sulphuric acid (t)	514 000	584 000

Notes: Metal values are rounded to three significant digits. Copper recovery rate and contained copper are calculated. Metal production and metal in concentrates are rounded to three significant digits. Custom material = copper in imported concentrates plus domestic and imported scrap. Zinc and silver contents of custom material are not shown.

In addition, the Kidd refinery sends anode slimes containing substantial quantities of silver to Noranda's CCR refinery and to third-party refineries.[65] Refined output for 2003 was reported by Falconbridge in its 2002 Annual Report at 132 000 t of copper and 145 000 t of zinc.[66]

Highland Valley Copper is owned 63.9% by Teck Cominco Limited, 33.6% by BHP Billiton Plc, and 2.5% by Highmont Mining Company.[67] The open-pit mine is located about 80 km southwest of Kamloops, British Columbia. The 136 000-t/d concentrator produces a copper concentrate and a molybdenum concentrate using SAG mills and conventional flotation technology.[68] The concentrate is relatively high grade due to a significant percentage of bornite in the ore. The mine was closed for four months during 1999 and it resumed work after negotiating a power contract tying power rates to copper prices and after signing a collective agreement with workers that reduces wages if copper prices fall below US67¢/lb and that increases wages if prices rise above US79¢/lb; the labour agreement contract with the workers expires on September 30, 2003.[69] Bargaining for the new labour contract is planned to commence in mid-2003.[70]

During 2002, there were reports that BHP Billiton was considering selling its share of Highland Valley Copper.[71] The A V Birla Group was reported to have been in negotiations with BHP Billiton, but no official confirmation was given by either company.[72] In August, after 18 months of public review, Highland Valley Copper received a permit from the Province of British Columbia to divert groundwater into a creek; the drainage will help stabilize the pit walls enabling the mine to stay in operation until 2009.[73] Ore reserves at the end of 2002 were sufficient for six years of current operations,[74] namely to the end of 2008. The production for 2001 and 2002 was:[75]

HIGHLAND VALLEY COPPER MINE

	2001	2002
Millions of tonnes milled	48.90	49.90
Copper grade (%)	0.43	0.41
Copper recovery (%)	89.4	88.7
Contained copper (t)	187 000	181 000
Payable molybdenum (t)	. .	2 500
Payable silver (t)	. .	62.2
Payable gold (kg)	. .	457

. . Not available.
Note: Data are rounded to three significant digits.

At the end of 2002, the **Hudson Bay Bay Mining and Smelting Co., Limited (HBMS)** operations of **Anglo American plc** consisted of four mines, a mine under development, two mills, a copper smelter, and a zinc pressure leach refinery. The main operations are centred on the Manitoba/Saskatchewan border. The principal mines were Konuto, Chisel North (a zinc mine), Callinan, Trout Lake, and the new 777 mine. All facilities are in Manitoba except for the Konuto and Callinan mines, which are located in Saskatchewan close to the border with Manitoba.[76] As announced in October 2001, the company's Ruttan mine and mill in the town of Leaf Rapids, Manitoba, were closed on June 26, 2002;[77] the closure resulted in the layoff of about 350 workers.[78]

In 1999, HBMS announced a US$240 million expansion, which included the Chisel North mine in Snow Lake, Manitoba, the 777 mine at Flin Flon, an expansion of the Flin Flon mill, and an expansion of the zinc plant.[79] The 777 shaft was sunk in July 2002 to a depth of 1540 m[80] and was equipped by year-end 2003. Lateral development at the 777 mine is planned during 2003 and full production

of 1 Mt/y from the new mine is anticipated in August 2004.[81] The 777 mine should extend the life of the operations to 2016.[82] The mineable reserves and resources of the 777 orebody were estimated at 14.2 Mt grading 2.53% copper and 5.09% zinc.[83]

The current cost estimate of the expansion is US$276 million.[84] The Flin Flon metallurgical facilities also process purchased concentrates; the copper concentrates have been sourced both domestically and internationally but, in the past couple of years, have only been sourced domestically.

During 2002, HBMS operated the Ruttan, Konuto, Callinan and Chisel North mines; the former closed in mid-year as noted, while the latter is a zinc mine with no copper. The Konuto and Callinan mines are both located in Saskatchewan, close to the Manitoba border.[85] From its own mines, HBMS produced 42 900 t of copper compared to 102 100 t of zinc.[86] In addition to copper and zinc production, gold and silver are recovered from the company's mines and from purchased concentrates. The production in 2001 and 2002 is shown below:[87]

HBMS, ALL PROPERTIES

	2001	2002
Millions of tonnes milled	3.56	3.00
Copper grade (%)	1.50	1.70
Copper in concentrates (t)	53 100	42 900
Copper in anodes (t)	79 500	83 400
Zinc in concentrates (t)	78 400	102 000
Refined zinc production (t)	88 400	108 000
Gold produced (kg)	2 150	1 840
Silver produced (t)	37.7	38.4

Notes: Data are rounded to three significant digits. Copper in anodes includes copper from custom concentrate. Gold and silver production is assumed to be payable. Zinc, gold and silver production is assumed to include metal from purchased concentrates.

Imperial Metals Corporation is a new corporation; it was formed in 2002 after the former Imperial Metals Corporation was reorganized into two distinct businesses, one to focus on energy and one to focus on mining.[88] The natural gas and oil assets were renamed IEI Energy Inc. and the mining assets were transferred to the new Imperial Metals Corporation effective January 1, 2002.[89] Imperial Metals' mining assets include a 50% interest in the Huckleberry mine (see below), an open-pit copper-molybdenum mine, and the Mount Polley mine, which is an open pit copper-gold operation that has been closed since September 2001 due to low metal prices[90] (see Projects section below).

Huckleberry Mines Ltd., owned 50% by Imperial Metals Corporation and 50% by the "Japan Group," is the operator of the Huckleberry mine. The Japan Group consists of Mitsubishi Materials Corporation, Dowa Mining Co., Ltd., Furukawa Co. Ltd., and Marubeni Corporation. The Japan Group initially had a 40% interest earned by providing US$60 million in financing in 1996. This was increased to 50% in mid-1999.[91]

In 2002, Imperial Metals continued discussions with lenders about restructuring fixed payments due under existing loans to payments that could be made when and as cash were to be available over the course of the remaining mine life.[92] The company reported that the payment date for all deferred principal and interest charges has been rescheduled to June 30, 2003, to provide time for a restructuring agreement to be negotiated. If negotiations fail, then Imperial Metals' interest in the mine could be foreclosed.[93] The deferred principal and interest payable on June 30 amounts to $64 million, which Huckleberry Mines Ltd. will be unable to pay. The financial obligations of Huckleberry Mines are non-recourse to Imperial Metals.[94]

The Main Zone pit was mined out in April after having commenced in November 1999. The mining has been subsequently sourced entirely from the East Zone pit. This pit had been redesigned based upon a long-term copper price of US85¢/lb, down from the earlier design, which used a price of US$1.00/lb. The ore is judged adequate to maintain production through 2007. Molybdenum recovery from the East Zone pit is much lower than from the Main Zone pit and lower molybdenum production is expected for the rest of the mine life.[95] The East Zone probable reserves also contain gold and silver values, but production data for these metals have not been released.[96] Using the average reserve grade and a recovery of 88%, copper production would average about 32 000 t/y of copper in concentrates over the remaining life of the mine.

Huckleberry's copper concentrate is trucked to Stewart, British Columbia, and then shipped to Japan; the molybdenum concentrates are trucked to Vancouver for sale.[97] The production data in 2002 and 2001 are shown below:[98]

HUCKLEBERRY MINE

	2001	2002
Millions of tonnes milled	7.42	7.42
Copper grade (%)	0.52	0.53
Copper recovery (%)	94	88
Copper production (t)	36 400	35 000
Molybdenum production (t)	888	507

Note: Data are rounded to three significant digits.

Inco Limited operates mines, mills, smelters and refineries in Sudbury, Ontario; Port Colborne, Ontario; and Thompson, Manitoba. The company produces copper as a by-product of its nickel operations. In addition, cobalt, gold, silver, platinum group metals, selenium, tellurium, sulphuric acid and liquid SO_2 are also produced at Inco's Canadian facilities. The majority of the copper produced in Inco's Canadian facilities is from the Sudbury mines; 94% of the total copper output in 2002 came from Sudbury ores while only 1% came from Thompson ores. The remaining 5% of the copper produced may have come from recyclable materials, likely also containing nickel. Inco no longer smelts copper concentrate from Thompson ores in Thompson, but sends the concentrate to Sudbury for smelting.[99]

A bulk nickel-copper concentrate is produced in Sudbury at the Clarabelle mill in Copper Cliff, Ontario. The concentrate is sent to two flash smelters and then to convertors; the Bessemer matte is slowly cooled over a period of days to allow the copper and nickel to separate. The cooled matte is then crushed and ground and, through both magnetic and conventional separation, the copper concentrate is removed and sent to Inco's MK Convertor. The copper concentrate is then smelted in a series of stages; the copper is cast into anodes and refined at Inco's copper refinery in Copper Cliff.[100] Production of refined copper was 113 116 t in 2002, compared to 116 255 t in 2001, and below the targeted 125 000 t for 2002 due to various problems in the Ontario Division, including ground instability.[101] About 3% of Inco's sales in 2002 were derived from purchased materials.[102]

Inco does not publish its mine concentrate grades or its recoveries in its financial publications. However, data on the percentage of copper, cobalt and precious metals from the Ontario and Manitoba ores are shown in the company's 10-K reports.[103] The Cobalt Development Institute reports Inco's total cobalt production.[104] Inco's estimated production of finished metals derived from Canadian sources and imported concentrates was:[105]

INCO, ONTARIO AND MANITOBA

	2001	2002
Tonnes mined (Mt)	9.48	9.66
Copper grade (%)	1.37	1.28
Nickel grade (%)	1.75	1.64
Copper refined from Ontario and Manitoba mines (t)	109 000	106 000
Nickel produced in Ontario and Manitoba mines net of purchased feed (t)	128 000	130 000
Cobalt from Ontario and Manitoba mines (t)	1 250	1 290

Note: Metal values are rounded to three significant digits.

During 2001 and 2002, Inco purchased nickel feed that was processed in its Canadian operations. The tonnages of nickel derived from these sources amounted to about 16 800 t in 2001 and 17 200 t in 2002.[106]

Also in 2001 and 2002, Inco's deliveries of gold and silver from non-toll refined sources are reported. These deliveries exceed the gold and silver production from Canadian mines by the amount of gold and silver in purchased recyclables and primary feed, data which are not released. The deliveries of platinum group metals, gold and silver were:[107]

INCO, PLATINUM GROUP METALS, GOLD AND SILVER DELIVERIES

	2001	2002
Platinum group metals deliveries (kg)	12 600	13 400
Gold deliveries (kg)	2 360	2 210
Silver deliveries (t)	49.7	48.8

Notes: Non-toll refined sources. Data are rounded to three significant digits.

The composition of Inco's 2002 platinum group metals production was shown in a presentation to the investment community in February 2003 as 52% palladium, 44% platinum and 4% rhodium plus ruthenium and iridium.

INCO, COMPOSITION OF PLATINUM GROUP METALS PRODUCTION

	2001	2002
	(kg)	
Platinum	5 500	5 880
Palladium	6 410	7 000
Rhodium	404	404
Ruthenium	124	31.1
Iridium	156	93.3
Total	12 600	13 400

Note: Totals do not add due to independent rounding to three significant digits.

Drilling of the 170 orebody at the McCreedy/Lower Coleman mine in 2002 added 1.6 Mt grading 7.7% copper, 1.0% nickel, and 15.9 g/t of precious metals (platinum, palladium and gold) to ore reserves; additional drilling is planned in 2003.[108]

Inco's forecast copper production for 2003 is 114 000 t, of which 46% is forecast to be produced in the first half of the year.[109]

Inmet Mining Corporation operates its wholly owned[110] open-pit Troilus gold mine 175 km north of Chibougamau, Quebec; it produces by-product copper. In the first nine months of 2002, gold accounted for 82% of the value of the metal production.[111] The ore grades 1.1 g/t gold and 0.2% copper; mill recovery was 92% for copper in 2001.[112] The operation produces a copper concentrate and gold doré. The copper concentrate is sold under long-term contract to an unnamed third-party smelter.[113] The Troilus mill has been expanded every year since production began in 1977.[114]

Improvements in the mill in 2002 and 2001 allowed a higher throughput, which reduced cash costs significantly.[115] In 2001, the mine processed higher-grade ore and stockpiled lower-grade ore to be processed at the end of the mine life, which in 2002 was expected to be 2006.[116] (Note: Inmet announced revalued ore reserves at Troilus in March 2003, putting the final year of production back to 2010 because of in-fill drilling to better delineate reserves and because of improved operational efficiencies.)[117] A bulk sampling program from the J-4 deposit was begun in late 2002 to determine the economics of mining; J-4 was targeted as the source of ore from 2004 to 2006.[118]

Increased mill throughput at Troilus reduced the production costs per tonne as the mill throughput went from less than 11 000 t/d in 1998 to 15 000 t/d in 2001. In 2002, mill throughput increased by over 4% to 5.7 Mt (equivalent to nearly 15 700 t/d per calendar day).[119] Reduced costs were a significant factor in allowing the increase in reserves noted above, which will extend the mine life to 2010.

The production of the by-product copper in concentrate in 2001 and 2002 was 7800 t and 6800 t, respectively.[120] It appears that, with the ore grades and recovery factors, the tonnages above represent payable copper and not copper contained in concentrate; using reported 2001 data of 5.49 Mt milled at 0.2% copper and 92% copper recovery in the mill, the tonnage of copper contained in concentrates would have amounted to about 10 100 t.[121]

Production in 2001 and 2002 was:[122]

TROILUS MINE

	2001	2002
Millions of tonnes milled	5.49	5.73
Copper grade (%) (e)	0.16	0.13
Copper recovery (%)	92	90
Copper production (t)	7 800	6 800
Contained gold (kg)	5 060	5 130

(e) Estimated.
Notes: Data for gold production and tonnes milled are rounded to three significant digits. Copper grade is estimated using recovery, ore tonnage and copper production; stated grades for 2001 and 2002 were 0.2% and 0.1%, respectively. Copper production is available only to nearest 100 t.

The reserves for year-end 2002, as revalued in the March 2003 announcement, were 42.5 Mt grading 0.9 g/t gold and 0.09% copper (proved plus probable), compared to the pre-revision year-end 2002 total of 22.6 Mt grading 0.9 g/t gold and 0.1% copper.[123]

The **Louvicourt mine** is a copper mine producing by-product zinc, silver and gold that is owned jointly by Novicourt Inc. (45%), Aur Resources Inc. (30%) and Teck Cominco Limited (25%).[124] Noranda Inc. had a beneficial interest of 62.1% in Novicourt in 2002, up from 61.4% in 2001.[125] There are no full-time employees of Novicourt; Noranda supplies the administrative, accounting and other corporate services under an agreement between the two companies. Novicourt is represented on the management board of Louvicourt by Noranda appointees. Novicourt sells its 45% share of zinc and copper concentrates to Noranda at terms and conditions similar to those negotiated by Aur and Teck Cominco for their respective shares of output.[126]

Difficult ground conditions were experienced in 2002 as the mine continued to deplete its reserves.[127] In January, a ground fall of about 100 000 t of ore and backfill in an active production area resulted in increased ground support costs and the postponement of mining higher-grade ore.[128] The mine produces separate copper and zinc concentrates. In addition to the copper and by-product zinc, the mine also obtains revenue from gold and silver contained in the concentrate. The production data in 2002 and 2001 are shown below:[129]

LOUVICOURT MINE

	2001	2002
Millions of tonnes milled	1.57	1.48
Copper grade (%)	3.40	3.10
Copper recovery (%)	96.90	96.80
Contained copper (t)	51 700	44 900
Contained zinc (t)	17 700	20 000
Contained silver (t)	28	23
Contained gold (kg)	1 040	865

Note: Data are rounded to three significant digits.

Louvicourt is expected to close by mid-2005 following exhaustion of economic reserves,[130] and ore production is scheduled to decline as the mine depletes its reserves. The mill is scheduled to operate at 3800 t/d in the first half of 2003 (compared to 4069 t/d in 2002 and 4304 t/d in 2001); in June, the mill rate will drop to 3000 t/d.[131] The head grade for the ore in 2003 is budgeted at 3.2% copper, 1.7% zinc, 24.4 g/t silver, and 0.73 g/t gold. Production in 2003 is budgeted at 37 600 t of copper contained in concentrate; by-product zinc production is scheduled to be 16 300 t, with silver forecast at 19.7 t and gold at 600 kg.[132]

Noranda Inc., as noted above, owns a majority share in Falconbridge Limited, whose operations were noted above. Brascan Corporation and associated companies own about 40% of Noranda common shares.[133] The copper operations of the non-Falconbridge facilities are detailed below. In June, Noranda and Falconbridge announced that certain copper activities would be rationalized, thereby jointly saving about $10 million.[134]

In 2002, Noranda's copper was derived from:

- two wholly owned[135] zinc operations, the Brunswick and Bell-Allard mines and mills, which produce by-product copper (Brunswick also produces refined lead at its smelter);
- two copper-zinc producers, the Louvicourt mine and mill (detailed above, in which Noranda is a part owner through a Noranda subsidiary), and the Kidd operations of Falconbridge Limited (detailed above) consisting of a mine complex, a mill, a copper smelter and refinery, an acid plant, and minor metal recovery facilities;
- nickel-copper operations (five mines, two mills, a smelter, and an acid plant) of Falconbridge in Sudbury and in northern Quebec (detailed above), which produce by-product copper;
- the Gaspé smelter;
- the Horne smelter; and
- the CCR refinery.

The Bell-Allard zinc mine is located 10 km from the town of Matagami, Quebec. Bell-Allard began operation in 2000 with five years of reserves,[136] using the Mattagami mill, located 2 km from the mine, to process ore. The conventional flotation mill produces a zinc concentrate and a copper concentrate that are sent to the CEZ refinery and the Horne smelter, respectively.[137,138] The Bell-Allard mine is scheduled to close in the fourth quarter of 2004. The nearby Perseverance zinc property (see Project section below), with copper by-product, will not come into production before the closure of Bell-Allard.[139] The tonnages mined in 2002 and 2001 were 669 000 t and 774 000 t,[140] respectively. Production at the Bell-Allard mine in 2001 and 2002 was:[141]

BELL-ALLARD MINE

	2001	2002
Millions of tonnes milled	0.77	0.67
Contained copper (t)	8 640	7 260
Contained zinc (t)	88 800	84 800
Contained silver (t)	12.30	10.20
Contained gold (kg)	?	?

Notes: Data are rounded to three significant digits. Gold is reported in reserves, but gold production is not shown by the company.

The Brunswick mine is located about 25 km from Bathurst, New Brunswick. This zinc mine also produces lead and by-product copper and silver. Copper concentrate from Brunswick is sent to the Horne smelter.[142] The mine produced its one hundred millionth tonne of ore in March 2003.[143] The Brunswick lead smelter will cease operating on a continuous basis from mid-2003 forward and will operate for eight months per year.[144] Two shafts provide access to the five mining levels to a depth of 1.1 km. Over 1 Mt of reserves were lost in 2002 due to poor ground conditions when a re-evaluation of mining plans was completed.[145]

Production in 2001 and 2002 was:[146]

BRUNSWICK MINE

	2001	2002
Millions of tonnes milled	3.60	3.49
Contained copper (t)	8 530	8 920
Contained zinc (t)	277 000	304 000
Contained lead (t)	76 200	83 100
Contained silver (t)	194	219

Note: Data are rounded to three significant digits.

The mine's reserves are expected to last until late 2008, assuming a mining rate of between 9000 and 10 000 t/d.[147]

The metallurgical processing plants of Noranda's Canadian Copper and Recycling business unit, which are not part of Falconbridge (see above), consist of:

- the Gaspé smelter (now permanently closed) at Murdochville, Quebec;
- the Horne smelter at Rouyn-Noranda, Quebec; and
- the CCR refinery in Montréal-Est.

In November 2001, Noranda had announced that its Gaspé smelter would close in April 2002 for a period of at least six months.[148] The mine at Gaspé had been closed in 1999 as reserves had been depleted 46 years after opening.[149] In late March 2002, Noranda announced that the closure of Gaspé by April 30, 2002, would be permanent.[150] The last casting of anode copper from the smelter was on April 27, 2002.[151] Copper anode production in 2001 had been 108 673 t.[152] The smelter is being dismantled and the company is remediating the plant site.[153] Production at the Gaspé smelter in 2001 and 2002 was:[154]

GASPÉ SMELTER

	2001	2002
Feed material (t)	327 000	100 000
of which recycled was (t)	21 000	2 000
Anode copper (t)	109 000	29 600
Sulphuric acid (t)	220 000	75 000

Note: Data are rounded to three significant digits, except for recycled feed, which is rounded to nearest 1000 t.

At the Horne smelter, workers belonging to the union *Syndicat des travailleurs de la Mine Noranda* went on strike on June 24 after the union and company were unable to agree upon the terms of a new labour contract. The previous contract had expired on February 28, 2002.[155] Noranda management personnel kept the smelter operating at a reduced rate, producing 147 020 t of copper anodes in 2002 compared to 188 145 t in 2001. Further talks between the union representing the 500 workers and the company did not result in an agreement. Noranda said that the smelter was running at 70% of capacity in November.[156] The smelter can process 850 000 t/y of material.[157] The Horne smelter produced 510 000 t of sulphuric acid in 2002, compared to 591 000 t in 2001.[158] The strike was not settled by the end of 2002. Production at the Horne smelter in 2001 and 2002 was:[159]

HORNE SMELTER

	2001	2002
Feed material (t)	841 000	734 000
of which recycled was (t)	75 000	45 000
Anode copper (t)	188 000	147 000
Sulphuric acid (t)	591 000	510 000

Note: Data are rounded to three significant digits, except for recycled feed, which is rounded to nearest 1000 t.

The CCR copper refinery is located in Montréal-Est, Quebec, on Montréal Island. This refinery handles copper anode from the Horne and Gaspé smelters, as well as anode from Noranda Inc.'s Altonorte smelter in Chile.[160] Altonorte is being expanded to 290 000 t/y of anode copper (it produced 147 000 t in 2002) recovered from third-party mines located in Chile. The US$170 million expansion[161] affords Noranda the opportunity to obtain new anode copper for Noranda's CCR refinery, compensating for the loss of the Gaspé smelter output.

As well as processing copper concentrates, the Horne smelter, with its Noranda reactor, can process complex and recyclable materials containing copper, gold, silver and platinum group metals. For example, scrap electrical wires are a source of copper. Used electronics are a source of gold, silver and platinum group elements. These materials are sent in the anode copper to the CCR refinery for final separation into their elemental forms.

The continued closure of the Gaspé smelter and the reduced output from the Horne smelter meant that Noranda's CCR refinery near Montréal, Quebec, produced 24% less refined copper in 2002 than in 2001. During the last quarter, the CCR work force was reduced by 15% due to increased efficiencies resulting from modernization.[162] Production at CCR in 2001 and 2002 was:[163]

CCR REFINERY

	2001	2002
Refined copper (t)	323 000	244 000
Refined silver (t)	1 340	1 260
Refined gold (t)	38.4	32.0

Note: Data are rounded to three significant digits.

CCR's production of selenium, tellurium and nickel sulphate is not disclosed.[164]

NorFalco LLC, owned 65% by Noranda Inc. and 35% by Falconbridge Limited, is part of Noranda's zinc business unit. NorFalco came into being when Noranda redeemed the 50% interest of E.I. du Pont de Nemours and Company in Noranda Dupont LLC, jointly owned by Dupont and Noranda until mid-2001. NorFalco purchases all of the sulphuric acid produced by Noranda and Falconbridge in North America for resale to customers. Sales in 2002 were about 2.1 Mt of sulphuric acid. The U.S. Department of Justice is investigating complaints that NorFalco, Falconbridge and Noranda conspired with others to artificially fix the price of sulphuric acid. These allegations have been denied. As of year-end 2002, the Department of Justice had not decided to bring charges or to terminate the investigation.[165]

North American Palladium Ltd. operates the Lac des Iles open-pit palladium mine 85 km north of Thunder Bay, Ontario. The concentrate also contains important amounts of by-product platinum, gold, copper and nickel. The mine was expanded in 2001 to 15 000 t/d and the company built a new mill to replace the older 2400-t/d mill. A secondary crushing circuit was completed in early 2002 in an attempt to increase the throughput to design capacity. However, in September, the company discovered that the primary crusher had sustained damage and it remained offline through the end of the year, so the old crusher was brought back on-line and crushing services were temporarily contracted. A program of refining mill recoveries

continued throughout the year. The concentrate is sent to Inco and Falconbridge in Sudbury for smelting and refining. Production of payable copper in 2002 was 2400 t, up from 1390 t in 2001.[166] Drilling during 2002 further defined the mineralization; this led to a feasibility study for an underground mine, which is scheduled to be completed in May 2003.[167] A new crusher has been purchased and the target installation date is mid-2003.[168]

LAC DES ILES MINE

	2001	2002
Millions of tonnes milled	2.66	4.85
Copper grade (%)	0.04	0.05
Contained copper (t)	1 420	2 400
Contained nickel (t)	724	1 250
Contained gold (kg)	299	499
Contained palladium (kg)	3 830	6 820
Contained platinum (kg)	313	597

Note: Data are rounded to three significant digits.

Northgate Exploration Limited owns 95% of Kemess Mines Ltd., which owns the Kemess South mine in British Columbia; Royal Oak Ventures, Inc. owns the remaining 5%.[169] Brascan Financial Corporation owns 36% of B.C. Pacific Capital Corporation, which in turn owns 41.59% of Northgate Exploration Limited.[170]

The equipment fleet in the 48 000-t/d open-pit gold-copper mine[171] includes two electric cable shovels, a loader and thirteen off-highway trucks;[172] the second cable shovel and the thirteenth haul truck were commissioned in 2002.[173] Kemess produced an annual record 33 000 t of copper and 8.78 t of gold in 2002, even with a lower average grade (0.236% copper and 0.724 g/t gold compared to 0.251% copper and 0.855 g/t gold in 2001) by milling 17.3 Mt in 2002 compared to 15.4 Mt in 2001.[174] As well, the increased recoveries obtained through the use of column flotation cells contributed to the higher output.[175] The mill was able to operate at 49 500 t/d for the second half of the year.[176] The copper concentrate produced at Kemess grades 20-25% copper with 50-150 g/t gold.[177] The three-year concentrate sales contract with Noranda Inc. ends on December 31, 2004.[178]

In June, a new three-year labour agreement was signed with 300 employees represented by the International Union of Operating Engineers, Local 115.[179] In 2002, Northgate was able to reduce the treatment and refining charges it paid by US7.5¢/lb, or US$165/t.[180]

During the year, exploration in the East and Central Cirque areas allowed an upgrade of resources from the inferred to indicated categories.[181] In 2002, 22 000 m of diamond drilling was completed.[182] Exploration work in 2003 at the Nugget Zone, located 1.3 km from the Kemess North pit outline, is targeted at locating a high-grade core in the inferred resources of 87 Mt grading 0.16% copper and 0.38 g/t gold.[183]

During the year, Northgate entered into a strategic alliance with Doublestar Resources Ltd. and Procon Mining and Tunnelling Ltd., who may develop the Sustut copper deposit located 65 km from the Kemess mine. The three companies undertook a feasibility study of the Sustut deposit, which has total resources of 5.9 Mt grading 1.87% copper and 6.11 g/t silver in the southeast zone; the feasibility study is due for completion in the first quarter of 2003.[184] The ore from Sustut would be milled at Northgate's Kemess operation.[185]

A new pit plan for Kemess South was completed during the year that reduced the stripping ratio from 1.2:1 to 1.05:1.[186] Northgate changed its tailings dam construction techniques, replacing non-acid-generating waste rock from the mine with a coarse de-pyritized fraction from the tailings. The savings on the 7-km haul distance and the reduction in the dam height resulted in a cost savings of over US$20 million over the life of Kemess South.[187] The new column flotation cells, which increased copper and gold recoveries, are projected to result in additional revenues of US$10 million yearly over the next six years.[188] Research work is expected to be completed that could allow, if successful, installation of a flash flotation process in the mill by the end of 2003; this would increase gold recovery by 2% by early removal of the gold from the milling before it is lost.[189] About two thirds of the revenue in the concentrates produced in 2002 was from the gold while the remaining one third was from copper; some silver is contained in the concentrates but no details were released in the company's annual report.

Production in 2003 was forecast by the company at 35 150 t of copper and 9144 kg of gold,[190] which, with a stripping ratio of 1.7:1, would result in the mining of 50 Mt of ore and waste.[191] Kemess South is expected to exhaust its reserves by the end of 2008[192] and the company is studying the Kemess North project (see below). The average production of Kemess South over the remaining mine life is projected at 9000 kg of gold and 34 000 t of copper.[193] The mine concentrate contains an unstated amount of minor by-product silver[194] for which the mine apparently receives credit.

Production from Kemess South in 2001 and 2002 was:[195]

KEMESS SOUTH MINE

	2001	2002
Millions of tonnes milled	15.40	17.30
Copper grade (%)	0.25	0.24
Copper recovery (%)	77	81
Contained copper (t)	30 100	33 100
Contained silver (t)	. .	. .
Contained gold (kg)	8 620	8 780

. . Not available.
Note: Data are rounded to three significant digits.

The Selbaie mine is owned 100% by BHP Billiton Plc through **Les Mines Selbaie.**[196] It is located approximately 400 km north of Montréal, Quebec, close to the border with Ontario. The proven ore reserves at mid-2002 amounted to 6.2 Mt grading 0.3% copper, 1.22% zinc, 22 g/t silver and 0.24 g/t gold, including stockpiled feed.[197] The mine's reserves at mid-year 2002 were 6.2 Mt, equivalent to 1.5 years at the 2002 milling rate,[198] namely until the end of 2003, assuming uninterrupted operations. The recovery of copper varied between 88.5% and 95.1% for the period July 2001 to June 2002, with zinc recovery at 73.5%, silver recovery at 63.5% and gold recovery at 65.6%.[199] Mine production in 2001 and 2002 was:[200]

SELBAIE MINE

	2001	2002
Millions of tonnes milled	3.83	4.08
Copper grade (%)	0.39	0.32
Copper in ore milled (%)	14 800	13 100
Copper recovery	–	–
Payable copper (t)	8 010	10 000
Payable zinc (t)	34 400	33 400
Payable silver (t)	51	68
Payable gold (kg)	865	597

– Nil.
Notes: Data are rounded to three significant digits. Copper grade and copper in ore are calculated.

CANADIAN PROJECTS AND MINES ON STANDBY IN 2002

Space and time preclude a review of all projects, mines on standby, and exploration programs in Canada. The selection of the following mines and projects does not imply that those discussed below are more or less advanced than others not included in this Copper chapter.

Index by Deposit Name

Aur Resources Inc. completed the purchase of the **Duck Pond** copper-zinc deposit in Newfoundland and Labrador in March. Duck Pond is intended to replace Aur's output from its share of the Louvicourt mine, which is expected to close by mid-2005. Aur expects to decide in the first half of 2003 whether to proceed with the development of Duck Pond. The company has obtained all environmental permits and releases from the Province of Newfoundland and Labrador and expects to obtain a last release from Fisheries and Oceans Canada by mid-2003. Assuming a decision to proceed is made in mid-2003, Aur plans to incur capital expenditures of about $48 million in 2003 and 2004, and $6 million in 2005, in order to have the property in production by mid-2005. Aur expects to produce over a 10-year period about 16 000 t/y of copper contained in concentrates plus by-products of about 28 000 t/y of zinc, 18.7 t/y of silver and 110 kg/y of gold.[201] The mine is expected to start as an open pit but to move underground by the second year of operation.[202] Additional details about the Duck Pond deposit, contained in the December 6, 2001 press release, are available at www.sedar.com/csfsprod/data28/filings/00408518/00000001/m%3A%5CDec_07%5CToronto%5Caur12 06.pdf.

Breakwater Resources Ltd.'s **Langlois** mine spent 2002 on a care-and-maintenance basis. The mine was closed after problems in an ore pass in November 2000 and low zinc prices.[203] A feasibility study was completed in mid-2001 that recommended an increased cut-off grade and a mining rate of 450 000 t/y. A plan to mine 16 000 t of copper in concentrates from the mining of 2.9 Mt of ore over eight years was envisaged based upon a zinc price of US50¢/lb. (The LME cash settlement price for zinc averaged US$798/t, or US36.2¢/lb, for the month of December 2002.)[204]

A drilling program was started in the fourth quarter to better delineate reserves and to upgrade resources into reserves. Over 7900 m will be drilled at a cost of $650 000, of which the Quebec government will pay $255 000. After drilling is completed, a new feasibility study will be completed in the first half of 2003. A description of the mine and geology can be found in Breakwater's Preliminary Prospectus, February 18, 2002, pp. 64-77, available at www.sedar.com/csfsprod/data29/filings/00415187/00000003/C%3A%5CSEDAR%5CFILINGS%5CSR KTR2.pdf.

Campbell Resources Inc. is participating in the development of the **Copper Rand** mine in order to bring it into production in the second quarter of 2004. Campbell's subsidiary, MSV Resources Inc., owns 26% of Corporation Copper Rand Inc., which owns the Copper Rand mine and the Cedar Bay property.[205] Campbell has an option to increase its ownership to 50% of Copper Rand and has the right of first refusal on the remaining 50% of the company.[206] The Copper Rand mill has a capacity of 2700 t/d; after recovering gold by a gravity circuit, conventional flotation will be used to make a copper-gold concentrate.[207] The mine is being developed with the financial assistance of various Quebec-owned corporations.[208] The mine development, including deepening of the shaft to 1265 m, was completed by mid-year. A 1160-m decline is planned,[209] of which 240 m were excavated by year-end.[210] The overall cost of the mine development, including work on the hoist and mill, is estimated at $53.3 million.[211] Investissement Québec provided a loan facility of $22 million to CCR; this is guaranteed by a subsidiary of Campbell.[212]

Initial production is planned at a rate of 31 750 t per month of ore. This is to be increased to 40 800 t per month over the 4.75-year life of the mine.[213] The revised feasibility study of April 1999 noted reserves and resources equal to 2.4 Mt grading 1.70% copper and 3 g/t gold.[214] Commercial production is forecast to begin in April 2004 at an initial rate of 7260 t/y of copper and about 1550 kg/y of gold.[215] At 98.2% recovery for copper, the inventory noted would contain an estimated 40 000 t of recoverable copper; mined over the planned 4.75 years, annual production would average about 8400 t.

DRC Resources Corporation holds claims directly and under option at the site of the former copper producer, Afton Mines Ltd., which closed in 1988 after mining 27 Mt and producing 204 700 t of copper and 14 t of gold.[216] The property is close to a main paved highway, natural gas, electrical power and water. It is located about 10 km from Kamloops, British Columbia.[217] DRC received a report on its **Afton** copper-gold project in British Columbia in April 2002. This report recommended a $1.1 million drilling program at the deposit. In the December quarterly report, the company summarized the indicated mineral resources as:[218]

- Main Zone: 34 Mt grading 1.55% copper, 1.1 g/t gold, 0.125 g/t palladium and 3.42 g/t silver; and
- Northeast Zone: 1.1 Mt grading 1.02% copper, 0.86 g/t gold, 0.10 g/t palladium and 5.49 g/t silver.

Drilling in 2002 totaled 38 850 m.[219] In its December 2002 quarterly report, the company noted that it had engaged consultants to complete a prefeasibility study for the property.[220] The company has a deadline in late 2009 to bring the property into production at a minimum of 500 t/d of mill throughput or the mineral claims may revert to the optioners.[221]

Expatriate Resources Ltd. owns and participates in a number of copper properties in Canada. These include: the Ice deposit in the **Finlayson/Box** property and the Wolverine deposit in the Yukon, the Tillex property in Ontario, and the Yava deposit in Nunavut.[222]

The Wolverine JV properties are owned 60.6% by Expatriate and 39.4% by Atna Resources Ltd. The claims in the Finlayson Lake area were studied by AGRA Simons Ltd. in 2000, which was followed by metallurgical investigations. Expatriate understands that smelters prefer a blend of Wolverine and Kudz Ze Kayah ores as the Wolverine ores alone contain significant concentrations of selenium.[223] The Kudz Ze Kayah deposit was returned to Teck Cominco Limited after Expatriate failed to make a payment in 2001.[224] The combined reserves of Wolverine and Kudz Ze Kayah total 14.5 Mt grading 0.97% copper, 7.23% zinc, 1.53% lead, 184.5 g/t silver and 1.39 g/t gold. Of this amount, 11.1 Mt are from Kudz Ze Kayah and 3.5 Mt are from Wolverine. Wolverine by itself has a copper grade of 1.37% copper.[225] Expatriate plans to evaluate the joint development of its Logan zinc-silver pitable deposit in combination with the Wolverine deposit[226] in order to blend Wolverine's high-selenium ores to acceptable levels.

The Ice property in the Yukon has an indicated mineral resource of 4.6 Mt grading 1.48% copper, of which the company reported that 3.4 Mt were of near-surface mineralization.[227] The Yava property in Nunavut was acquired by Expatriate in 2001. A resource of 1.1 Mt grading 4.96% zinc, 1.03% copper, 1.60% lead, 117 g/t silver and 0.3 g/t gold was estimated in 1976 for Brascan Resources Limited. Infrastructure is needed to develop the property.[228]

Falconbridge expects to decide by mid-2003 whether to develop the **Montcalm** deposit, located near Timmins, Ontario. In the third quarter of 2000, Falconbridge signed a letter of intent with Outokumpu Mines Inc. for the right to earn a 50% interest by expending $24.5 million. At that time, the undiluted mineral resource was estimated to be 7.75 Mt grading 1.48% nickel and 0.7% copper, and production of 6000 t/y of nickel in concentrate was forecast.[229] In the June quarter of 2001, Falconbridge

purchased the deposit for $14 million. At that time, the company estimated that the deposit, at 5 Mt, could sustain an output of 750 000 t/y of ore to produce 8000 t/y of nickel.[230]

Falconbridge has also had encouraging results with its exploration of the **Nickel Rim South** property in the Sudbury Basin. At the end of 2002, the inferred resource as defined by surface drilling was 6.3 Mt grading 3.4% copper with 1.7% nickel, 2.2 g/t platinum, 2.5 g/t palladium and 1.5 g/t gold.[231] Located at a depth of about 1600 m, the resource was outlined by a drilling program during 2001 and 2002. A decision is expected in 2003 whether to proceed with an underground exploration program.[232] Such a program would involve shaft sinking unless Falconbridge and Inco could come to an arrangement whereby the former could use the nearby Victor shaft; Victor was indefinitely deferred once the Voisey's Bay project was given the go-ahead in 2002.

Imperial Metals Corporation's **Mount Polley** mine remained on standby throughout 2002. Operations at the 100%-owned copper-gold open-pit mine/mill were suspended in September 2001 due to low metal prices. During 2002, ongoing research was directed at increasing copper recovery from copper oxide mineralization with the help of the federal government's Industrial Research Assistance Program. The company reported indications that the recovery rate could be boosted from 11% for the highly oxided material from the Springer pit using conventional flotation up to 78% using a leaching technique. This would have the effect of increasing the planned output from the Springer pit from 54 400 t/y to about 81 600 t/y of copper[233] once the Mount Polley mine were to restart. The Springer pit area has been logged and the access roads have been completed.[234]

The Springer pit would be the major source of feed when the mine re-opens. Probable ore reserves at Mount Polley as of September 30, 2001 (and currently), totaled 31.9 Mt grading 0.356% copper and 0.337 g/t gold, with a 17.5% oxide ratio, distributed as:[235]

Pit	Tonnes	Cu Grade	Oxide Ratio	Gold
		(%)	(%)	(g/t)
Cariboo	52 700	0.298	10.2	0.505
Bell	5 515 700	0.311	2.9	0.338
Springer	26 341 000	0.366	20.6	0.366

Note: Tonnes are rounded to nearest 100 tonnes.

Additional work on the copper oxide leaching is planned for 2003; depending upon the results of the column testing, the ore reserves could be re-evaluated to take the higher recovery from the oxide ores into account. In addition to this work, more exploration is planned for 2003. The Springer pit has not yet been fully defined at depth.[236]

Inco reached agreement with various parties and announced that it would proceed with the development of **Voisey's Bay** (see below for details of agreements). Preparatory development of infrastructure began during the year, both at Voisey's Bay and at Argentia, the future site of a pilot plant for a new hydrometallurgical process being developed by Inco to process the nickel-cobalt concentrate from Voisey's Bay. Copper concentrate will be separately produced from the nickel-cobalt concentrate at the mill. The copper concentrate will be sold, rather than processed at Inco's smelters, which face emission limits for sulphur dioxide. In later years when the hydrometallurgical plant is assumed to be operational, the projected annual production rate of copper will be 31 750 t of copper in copper concentrate and about 6800 t of copper contained in nickel concentrates.[237]

Initially, the nickel-cobalt concentrate will be sent to Inco's facilities in Ontario and Manitoba for processing. Following development of the hydrometallurgical process, the Province and the company expect that a commercial hydrometallurgical plant will be constructed at Argentia to process the Voisey's Bay nickel-copper output.[238]

Inco 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 June 2002. In May 2002, Inco's subsidiary, Voisey's Bay Nickel Company Limited (VBNC), had reached separate agreements with two Aboriginal groups; the agreements were ratified by the two Aboriginal groups 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/00485302/00000001/e%3A%5CINCO%5C2002%5C8Koct8.pdf.

Information from the provincial government is available through links located at 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 large write-down of the carrying value of the asset.

Briefly, the agreements include:[l]

- 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 during 2003-2006 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 the 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 the 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% nickel 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% nickel 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% nickel 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% nickel.
- 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-apeca.gc.ca/e/media/press/press.shtml?1813.

Inmet owns 100% of the **Izok Lake** zinc-copper property in Nunavut. Izok's indicated resources are 16.5 Mt grading 2.2% copper, 11.4% zinc and 60 g/t silver.[239] A feasibility study of the project was completed in 1994.[240] The project requires infrastructure in order for the concentrates to be shipped to markets. The Bathurst Inlet Port and Road (BIPR) project, estimated to cost about $215 million, envisaged a 210-km all-weather road connecting a port on Bathurst Inlet with the eastern shore of Contwoyto Lake; an 80-km road would then proceed from the other shore of Contwoyto Lake to the Izok Lake project site, with the two road sections being connected by an ice road in the winter and barges in the summer. The BIPR would require environmental approval before proceeding. The proponents, who include the Kitikmeot Corporation, an Inuit company, favour an environmental review by the Nunavut Impact Review Board, a public government body. The opponents favour a more detailed review that would include funding for interveners. The Minister of Indian and Northern Affairs Canada is to decide the nature of the review, requested in July 2002. In December, the proponents informed regulators that the 80-km road to Izok Lake would be dropped from the plans because Izok Lake would not be developed at current low zinc prices.[241]

[l] 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.

Minto Exploration Ltd. holds 100% of the **Minto** project, located about 250 km northwest of Whitehorse, Yukon, on the west side of the Yukon River. The deposit consists of in-situ geologic reserves of 8.8 Mt grading 1.73% copper, 0.48 g/t gold and 7.5 g/t silver. The mining plan calls for open pitting of 6.5 Mt grading 2.13% copper, 0.62 g/t gold and 9.3 g/t silver over an initial life of 11 years. The mine is intended to produce an average of 13 400 t/y of copper plus 5.35 t/y of silver and nearly 360 kg/y of gold contained in 35 000 t/y of concentrates. As of 1999, the capital cost was estimated at $27.3 million, including working capital.[242]

Minto is owned by ASARCO Incorporated. In 1996, Minto and ASARCO agreed to advance the Minto project; ASARCO agreed to spend up to US$25 million to develop the property in return for a 70% share in the venture. As of year-end 2002, ASARCO had spent US$8.5 million to support the project, which had been suspended in March 1988.[243]

Noranda Inc.'s **Perseverance** property is located very close to Noranda's Bell-Allard mine near Matagami, Quebec. A feasibility study of the Perseverance property has been completed. Noranda owns a 90% interest and Société de développement de la Baie James owns the remaining 10%.[244] In December 2002, Noranda announced that, because of low zinc prices, it would delay the development of the nearby Perseverance zinc deposit. That deposit consists of three high-grade zinc zones: Perserverance, Equinox and Perseverance West, which also contain an average of 1.24% copper. The delay will mean a minimum 15-month interval between the closure of the Bell-Allard mine in the fourth quarter of 2004 and the possible start-up of the Perseverance operation.[245]

Northgate Exploration Limited targeted mid-2003 for completion and release of its prefeasibility study of the **Kemess North** project begun in December 2002. Kemess North is intended to replace production from Kemess South, which is expected to exhaust its reserves by the end of 2008. A feasibility study of the project is expected to begin in mid-2003, subject to board approval. Alternate methods of transporting the ore from Kemess North to the existing concentrator are being studied, including a 5-km tunnel for a conveyor. Some of the cost savings are being investigated in the studies, including higher ore throughput and lower-cost tailings disposal. Because the Kemess North ore is not as hard, the Kemess South mill is expected to be able to handle 75 000 t/d. Also, some tailings from the Kemess North mine may be deposited in the former Kemess South pit. At the end of 2002, the capital cost estimate for the Kemess North project was US$150 million, equally divided between pre-stripping costs and the ore transport infrastructure. A start-up date of 2009 was shown in the company's 2002 Annual Report. Northgate is investigating scheduling the pre-stripping during 2006 when the waste-to-ore ratio drops significantly at Kemess South[246] (e.g., the stripping ratio is expected to be 1.7:1 in 2003, but only averages 1.05:1 over the period 2003-08). During 2003, Northgate plans to upgrade the resources at Kemess North to reserve status.[247]

The **Sudbury Basin Joint Venture** (SBJV) is owned 75% by FNX Mining Company Inc. and 25% by Dynatec Corporation.[248] (FNX was known as Fort Knox Gold Resources Inc. until June 20, 2002.)[249] FNX manages the exploration and Dynatec will manage mine development and operation.[250] The SBJV reached an agreement with Inco in January 2002 to purchase five properties from Inco, subject to certain conditions. For example, if a new deposit is discovered with more than 272 000 t of contained nickel, Inco has a right to reacquire a 51% interest in the property. Inco and the SBJV have an off-take agreement for production from the properties, subject to various conditions.[251] A synopsis of the agreement with Inco is available on the Internet at www.fnxmining.com/fnx/inco291201.pdf.

The joint venture began a $14 million work program over 16 months, including drilling, development work, and various engineering and geological studies. The initial $14 million program was within the context of a total expenditure of $30 million over 52 months.[252] The properties involved are the McCreedy West mine, the Levack mine, the Victoria mine, the Kirkwood mine and the Norman North platinum group metals-copper-nickel mineralized zone.[253] The SBJV completed 108 000 m of exploration drilling in nine months in 2002.[254]

Future production from these locations would be sent to Inco for milling, smelting and refining, subject to available capacity at Inco facilities. In its 2002 Annual Report, Dynatec stated that the $14 million work program had been completed ahead of schedule and that the partners expected to spend the required $30 million by the end of 2003, two years ahead of the deadline.[255] Dynatec also stated that initial production was expected from the McCreedy West mine in the June quarter of 2003.[256] The SBJV's exploration budget in 2003 is $24.5 million.[257] Resource estimates for some of the properties contained in the FNX Mining Company Inc. annual information form and annual report for 2002 are shown in Tables 1 and 2 (i.e., the mineral resources tables, page A-37) of the document found at www.sedar.com/csfsprod/data38/filings/00542790/00000001/g%3A%5CSedar%5CFNXMin%5CAIF20 03%5CAIFDec312002.pdf.

Appendix A of the 2002 annual information form for FNX Mining Company Inc. shows historical production and provides descriptions of the former Inco properties under consideration; this report can be found on the SEDAR site at the location noted immediately above.

Redcorp Ventures Ltd.'s subsidiary, Redfern Resources Ltd., owns the **Tulsequah** project in northwestern British Columbia,[258] located 100 km from Atlin, British

Columbia, and 65 km northeast of Juneau, Alaska. The claims are located adjacent to the Canada-U.S. boundary.[259] In British Columbia, a Project Approval Certificate (PAC) was required in order to proceed with construction of the mine. Originally, the company had received its PAC in March 1998 after a three-year environmental assessment review. The PAC was challenged by the Taku River Tlingit First Nation and the B.C. Supreme Court quashed the PAC. Redfern appealed and the B.C. Court of Appeal upheld the appeal and, in January 2002, remitted the project back to the B.C. ministers for a new decision about the PAC. In December 2002, Redfern again received its PAC allowing the company to proceed with the project.[260] Cominco Ltd. operated two mines at the site from 1951 to 1957, producing just over 900 000 t of ore.[261]

Redfern announced that it intended to proceed with a drilling program to further define the current resource. Concurrently the company will seek financing, including potential partners, for development of the project.[262] An existing reserve estimate shows 7.6 Mt grading 6.63% zinc, 1.31% copper, 1.24% lead, 105 g/t silver and 2.5 g/t gold.[263] A feasibility study was completed predicated on a 2500-t/d mill, taking 900 000 t/y of ore feed[264] from an underground mine, using conventional flotation techniques to produce a lead concentrate, a zinc concentrate, and a copper concentrate. A gold concentrate will be produced by gravity means. The copper concentrate would contain an estimated 10% lead by weight.[265] The estimated payable outputs from the operation (contained metal contents should be higher) were: 10 400 t/y of copper, 52 600 t/y of zinc, 4990 t/y of lead, 75.3 t/y of silver, and 1.84 t/y of gold.[266] Capital costs were estimated at $148 million,[267] but these are to be updated in a revised feasibility study that will also take into account drilling to be done in 2003. The company will complete some additional environmental work required by Fisheries and Oceans Canada.[268]

In 2002, Getty Copper Corporation (name changed to Getty Copper Inc. in January 2003) continued exploration at its **Getty North** and associated properties in the Highland Valley, British Columbia, near the Highland Valley mine owned by Teck Cominco Limited and BHP Billiton Plc (see above). Getty commissioned a study of the properties, and a technical review, done in December 2002 and modified in February 2003, was released.[269] The report stated that only the Getty North deposit had sufficient exploration to allow a resource estimate.[270] Using a cut-off grade of 0.1% copper, the indicated oxide resource was 6.8 Mt grading 0.522% copper and the sulphide zone drill-indicated resource was 27.6 Mt grading 0.410% copper.[271] In April, Getty announced that it had commissioned a scoping study by Innovat Limited of continuous vat leaching, producing possible alternative forms of copper, including copper sulphate crystals, as an alternative to SX/EW (solvent extraction and electrowinning) heap leach.[272]

Gibraltar Mines Limited is owned 100% by Taseko Mines Limited. Gibraltar was bought from Boliden Westmin (Canada) Limited in 1999.[273] Gibraltar is located 65 km from the town of Williams Lake, British Columbia. The open-pit operation ran from 1972 to 1998, when it was closed due to low prices and placed on care and maintenance.

In 2001, Gibraltar Mines Limited, Gibraltar Engineering Services Limited Partnership (GESL), and Cominco Engineering Services Ltd. (CESL) concluded a memorandum of understanding to jointly evaluate the potential for a hydrometallurgical copper refinery at the **Gibraltar** mine.[274] In addition to sulphide copper mineralization, there are in-pit oxide zones that would be processed by SX/EW.[275] Gibraltar supplemented its conventional flotation process with the leaching of low-grade ore and electrowinning of the leachate produced. A total of 38 430 t of electrowon copper was produced from October 1986 until the SX/EW plant was shut down.[276]

A scoping study completed in August 2000 projected capital costs of $95 million for a copper refinery and $25 million to restart the mine, which included costs to modify the concentrator and to complete six months of preproduction stripping at the Pollyanna pit. That study showed an internal rate of return of 18.4% and "no apparent fatal flaws."[277] In 2001, Bateman Engineering Pty of Australia was engaged to undertake an "engineering feasibility-level cost study for the construction and operation of a hydrometallurgical copper refinery utilizing CESL technology at the Gibraltar mine." A capital cost of $109.5 million and an operating cost of US14.7¢/lb were estimated for a refinery producing 30 000 t/y of LME-grade copper from 130 000 t/y of copper concentrates grading 24% copper.[278] Further work was ongoing through 2002 funded by GESL and CESL on a 50:50 basis. Most of the work examining the feasibility of building a copper refinery at Gibraltar using the CESL-developed process was completed by mid-2002; however, a decision to proceed is dependent upon higher copper prices and other factors.[279]

Total sulphide resources are 743 Mt grading 0.287% copper and 0.008% molybdenum at a cut-off grade of 0.2% copper. In addition, there are 16.4 Mt grading 0.2% copper of oxide and leachable copper resources.[280] In-pit sulphide measured and indicated resources amount to 208 Mt grading 0.311% copper and 0.010% molybdenum, which are located in the Pollyanna zone, the Connector zone and the Granite Lake zone.[281] In-pit leachable copper measured plus indicated "inventory" amount to 18.1 Mt grading 0.146% copper and 0.10% molybdenum located in the Pollyanna pit and the PGE Connector pit.[282]

During 2002, Gibraltar and the Cariboo Regional District of south-central British Columbia agreed to the construc-

tion and operation of an 80-year landfill utilizing waste rock areas not required for future mining operations; Gibraltar will construct, operate and maintain the landfill on a fee-for-service basis. The landfill construction will begin in mid-2003 and operations will commence in October 2003.[283]

Taseko's **Prosperity** project is located about 200 km from Williams Lake, British Columbia. After a number of studies, Taseko decided in 2002 to study in more detail an option of mining at a rate of 70 000 t/d based upon 491 Mt grading 0.22% copper and 0.43 g/t gold. Further work showed a 16-year mine life producing 188 885 t/y (dry) concentrate grading 24.5% copper, 38.8 g/t gold and 89 g/t silver that would be trucked to Vancouver, British Columbia, and then shipped to overseas smelters. Thus, annual production would be about 46 300 t of copper with by-product production of 7.3 t of gold and 16.8 t of silver. Taseko decided to focus its attention on the Gibraltar project, and the level of activity on the Prosperity project declined accordingly after 2000.[284]

USE OF COPPER IN CANADA

Canadian copper use is not surveyed on an annual basis. Apparent use can be calculated by adding the imports of refined copper to the reported domestic shipments of copper producers. For 2002, as noted earlier, these data were: 11 600 t of refined imports plus 257 100 t of producers' domestic shipments (8000 t and 257 200 t respectively in 2001). A recent survey was instituted to measure the recycling of copper in Canadian copper and copper alloy facilities.

Various sources of information exist on the Internet for those wishing to find additional information about copper use in Canada; these web sources are detailed in subsequent paragraphs.

The **Canadian Copper & Brass Development Association** (CCBDA) assists copper and copper alloy users on many matters, including technical information. Its web site contains technical information that can be ordered online for such topics as alloy castings, tubing, forgings, etc. Technical assistance and library services are also available. The membership consists of both users and producers of copper. Companies making wire, tubes, rod, plumbing fixtures, castings and forgings are among those that are members of the CCBDA. The association's web site can be found at www.ccbda.org.

The CCBDA web site also provides links to other copper development associations. There is information:

- in French at www.cuivre.org and at www.copperbenelux.org; and
- in English at www.copper.org (United States), www.copperinfo.com (international), www.copper.org.sg (South-East Asia), www.procobreperu.org/home.htm (Peru), www.indiancopper.org (India), and www.jcda.or.jp (Japan).

Information is also available in other languages, including Finnish, Danish, Dutch, German, Greek, Italian, Japanese Norwegian, Portuguese, Spanish and Swedish through links shown at www.copperinfo.com/professionals/index.shtml#CRIF.

The **Canadian Association of Recycling Industries** is the national organization of recycling industries, of which metal recycling, and copper recycling in particular, is an important component. The Association represents companies through the entire chain of recycling from scrap collection to processing and utilization (www.cari-acir.org).

The **Canadian Foundry Association** (CFA) is the national association of foundries in Canada, formed in 1975. Its members include brass and bronze foundries. Its site contains a membership list with links to the members' web sites (click on "Member Profiles"). The CFA web site is located at www.foundryassociation.ca.

The **Canadian Die Casters Association** represents companies in Canada engaged in pressure die casting. Its site contains information about members and links to web sites (click on "Member Profiles" in left frame). Companies seem to publicize their use of aluminum, zinc and magnesium rather than that of copper. The CDCA web site is located at www.diecasters.ca.

Industry Canada maintains a web site that allows searches for companies engaged in semi-fabrication of metals and fabrication metals, including copper and copper alloys. The Canadian Company Capabilities (CCC) data base can be searched using terms such as "copper," "brass" or "bronze." The site is located at http://strategis.ic.gc.ca/cgi-bin/allsites/search/basic/viewhits?lang=e&file=R317907.

A search of companies having in their product/service description the words "brass," "bronze" or "copper" showed the following number of "hits":

- brass: 249 companies
- bronze: 126 companies
- copper: 306 companies

The CCC search narrowed to "Primary Metal Manufacturing" is located at http://strategis.ic.gc.ca/SSG/mm01798e.html.

Industry Canada has compiled information about Canadian metal casters; the reporting culminated in interviews with companies in early 2000. A report about metal casting can

be accessed on the Internet at http://strategis.ic.gc.ca/epic/internet/intrm-crt.nsf/vwapj/Metalcasting_TRM.pdf/$FILE/Metalcasting_TRM.pdf. The reader can go to Appendix A of this report to view the names and the metals handled by Canadian casters. In an earlier web page, searching and sorting by criteria was possible. Using that capability, the data showed that 72 of the 239 casters reported some capability with copper casting. These copper users were distributed as:

Province	Number
Ontario	36
British Columbia	17
Alberta	8
Nova Scotia	6
Manitoba	2
Quebec	2
Prince Edward Island	1
Total	72

By clicking on the links to Appendix A at the bottom of the web page noted immediately above, the reader may view companies by geographic groupings showing company name and location.

WORLD COPPER REVIEW

Space and time do not permit a review of events in the world copper industry. A brief outlook is prepared by the Minerals and Metals Sector of Natural Resources Canada each year and the latest one done, dated November 2002, is available on the Internet at www.nrcan.gc.ca/mms/pdf/nfo/nfo02/copp-e.pdf.

Bloomsbury Minerals Economics Ltd (www.bloomsburyminerals.com/BME.htm) has written a succinct analysis of how the present copper market evolved. With permission from Bloomsbury, it is reproduced here (the views expressed in this analysis are entirely those of Bloomsbury):

> "In the late 1980s, there was an unexpected change in the trend growth rate of copper consumption. It accelerated suddenly, by 1.5% per annum, from under 2% per annum to a new rate of over 3%. Copper producers were initially very cautious in accepting this as anything more than a short-term phenomenon. However, the new trend did endure and, as a result, the period from mid-1987 to mid-1996 showed a tendency towards shortages of copper (occasionally exacerbated by market manipulation) and high prices. High prices benefited miners directly, but smelters and refiners also flourished. High long-term contract charges for custom smelting and refining were made possible by both the buoyant price environment and the discipline and dominance of two major buying blocs: Japan for custom concentrates and western Europe for blister.
>
> "Encouraged by what seemed like an endless boom both in volume and prices, mines invested in new capacity that, from 1996, totally overwhelmed the market. Meanwhile, smelting and refining capacity grew dramatically outside the traditional custom processing centres of Japan and western Europe. With the down-side apparently limited by the strong discipline shown by the established major blocs, and with volume growth looking assured, new smelters and refineries were built in India and China and major expansions were launched in South Korea and Mexico. Competition intensified and, over a period from mid-1996 to mid-1999, first prices for refined copper, and then custom processing margins on copper concentrates and blister, collapsed.
>
> "By the third quarter of 1999, exchange stocks had risen to very high levels and over 750 000 tonnes per year (t/y) of mine capacity had been shut down, some of it permanently, but most kept on care-and maintenance. A similar amount of smelter capacity was shut down, as was over 500 000 t/y of refining capacity. These cutbacks and closures returned the refined copper market to balance in late 1999 and then led to a large deficit in 2000. Although it was clear that trend consumption had increased further in the late 1990s (to almost 4% p.a.) and even though a boom in the copper-intensive high-tech sector also benefited copper, exchange stocks that had been built up over 1997-99 still overhung the market to some extent and prices rose only modestly in 2000. Then, in 2001, copper suffered along with other metals from a severe downturn in demand in high-tech sectors as well as old-economy industries, which drove the market back into surplus."

To put copper in context, it is the third-ranking metal produced and used in the world, behind aluminum and steel. Total copper production in 2002 was reported at 15.3 Mt, of which about 12%, or 1.9 Mt, was produced from recycled sources (see also World Copper Data on page 1 of this chapter).[285] In comparison, the world crude steel production in 2002 was over 900 Mt,[286] derived from primary and recycled feed materials. Aluminum is the second most produced metal with primary refined production reported by the International Aluminium Institute (IAI) at over 21.2 Mt in 2002[287] with an estimated further 2.2 Mt produced from purchased or tolled scrap.[288] However, not all countries report to the IAI. NRCan's aluminum specialist estimates that world primary plus secondary production in 2002 was in the order of 34 Mt, of

which about 26 Mt was primary production (see the Aluminum chapter in the 2002 *Canadian Minerals Yearbook*).

The relative quantities of the world production of major metals in 2002 are presented below:

Metal	Million Tonnes
Steel	900
Aluminum	26
Copper	15
Zinc	10
Lead	6
Nickel	1

Sources: IISI, IAI, ICSG, ILZSG, INSG.

APPLICATIONS

Copper is used in many applications. Due to its high electrical conductivity, a prime application of copper is wire and cable used to carry power and signals. The high conductivity means good efficiency, and good corrosion resistance means that copper is a very good electrical conductor. High conductivity means a smaller cross-section for wires relative to other metals, which is important for small motors, hand tools, and crowded conduit spaces. However, in long-distance transmission lines, the heavier density of copper relative to conductivity means that aluminum is preferred to copper as the current-carrying metal for such lines.

Copper also has a high thermal conductivity that makes it a leading competitor for heat exchangers such as automotive radiators and for solar heating. More information about the applications of copper can be found on the web site of various copper development organizations. An extensive review of applications is available at www.copperinfo.com/cproducts/index.shtml.

The **International Copper Study Group** (ICSG) based in Lisbon sells detailed statistics on world copper production, use and trade. Details are available on its web site at www.icsg.org.

The United States Geological Survey (USGS) is another source of detailed information about the world copper industry. The copper information available includes yearly reviews, monthly articles, and an annual summary. The copper portal for the USGS is located at http://minerals.usgs.gov/minerals/pubs/commodity/copper.

Copper use is generally measured at the semi-fabrication stage. If copper products are made into wires, tubes, etc., that are principally copper and copper alloys, these imports and exports can be tracked. But once incorporated into fabricated items such as electronics, ships, aerospace goods, transformers, motors, etc., then it is difficult to track the ultimate destination of copper. Imagine a customs broker being asked to declare the copper content of imported motor vehicles or of imported CD players. Therefore, a calculation showing the "consumption per capita" ignores the ultimate user/consumer of the metals in question by focusing on the available data collected at the semi-fabrication stage.

For example, using statistics of the ICSG, which show that the Danish use of copper was only 100 t in 2002, one might presume that the Danish society is relatively copper-free. Danish copper usage since 1998 shows that total usage for 1998 to 2002 in those five years amounted to 500 t.[289] One could calculate the average per capita Danish copper use as just over 50 mg of copper daily (population of 5.37 million[290]). This is equivalent to a monthly usage of less than the copper content of an old-style single Canadian penny (the penny was a 2.5-g coin, of which 98% by weight was copper, during the period 1982-96.)[291]

However, the Danes have modern enterprises and accommodations with electrical wiring, copper tubing, electric motors, etc. Danes import and use copper in automotive vehicles, aircraft, ships, electronics, and electrical goods such as household appliances, electrical generators, all types of electrical motors, and refrigeration and air conditioning units, which are not counted in the calculated "use" of copper in Denmark.

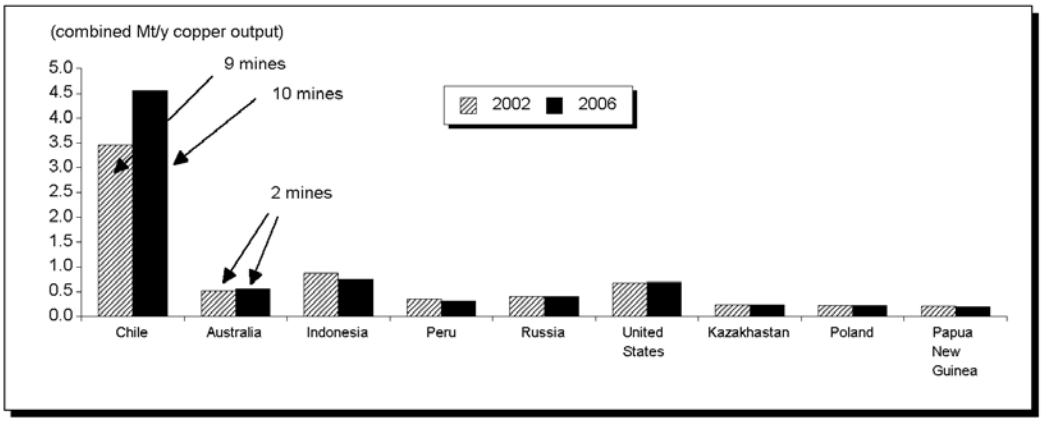
Thus, calculations of copper usage or copper "consumption" for individual countries or groups of countries may be misleading. A better but less specific figure is the calculated world copper usage, which was about 2.4 kg per capita in 2002.[292]

PRODUCTION

The ICSG and USGS web sites noted above are sources of information about world production of copper. In addition to these sources, major international copper-producing companies in the world have web sites with detailed production and financial information. The corporate sites also contain descriptions of operations. Web sites for some major producers are shown in Table 5 so that the reader can obtain more information. Refer to Table 3 for a list of Canadian companies involved with copper production or development.

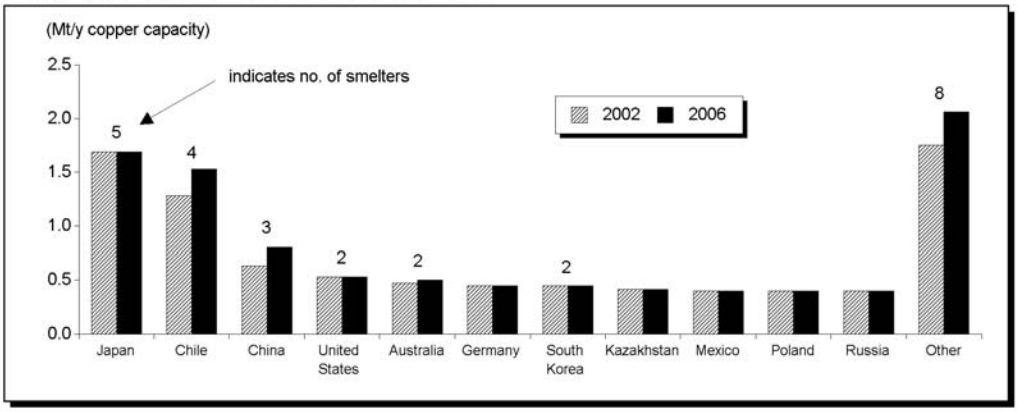
All else being equal, large production facilities have a cost advantage over smaller facilities. Economies of scale allow large plants to remain competitive in times of low

Figure 8
Large (1) Copper Mines in 2002 and 2006



Source: International Copper Study Group, *Directory of Copper Mines and Plants*.
(1) There are 19 mines with a capacity of at least 200 000 t/y of copper in concentrate in 2002.
Note: One mine for all countries unless indicated otherwise.

Figure 9
Large (1) Copper Smelters in 2002 and 2006



Source: International Copper Study Group, *Directory of Copper Mines and Plants*, April 2003.
(1) There are 31 smelters with a capacity of at least 200 000 t/y in 2002.
Notes: "Other" = 8 smelters in 7 countries (Spain, India, Peru, Sweden, Indonesia, Zambia and Bulgaria). One smelter for each country unless indicated otherwise.

prices. The high proportion of production from "large facilities" is illustrated in the following sections about "mining," "smelting" and "refining."

Mining

In 2002, 19 facilities in 9 countries had capacities of at least 200 000 t/y of copper in concentrates (including SXEW production).[m] Together these facilities accounted for 46% of world mine capacity (see Figure 8). Chile had 9 operations in the top 19 in 2002 and is projected to have 10 by 2006. Only Australia and the United States have two such facilities; all remaining countries have only a single producer of major rank.

Smelting

In 2002, 25 facilities in 15 countries had capacities of at least 200 000 t/y of copper in anodes (see Figure 9).

[m] SXEW = solvent extraction and electowinning. This method is not currently employed in Canada but is being studied by Taseko Mines, amongst others. The ore from the mine is exposed to an acidic carrier such that the copper is dissolved. The copper is recovered in an electrowinning process, somewhat akin to a refining process. SXEW skips the smelting stage. Phelps Dodge Corporation is to commence testing hydrometallurgy to process chalcopyrite in 2003; SXEW operations typically use copper oxide ore as feed material.

Together these facilities accounted for 53% of world smelter capacity in 2002. The copper-using countries dominated the large smelter industry. Japan had five facilities with a total capacity of nearly 1.7 Mt/y. Chile, a copper producer, was second with nearly 1.3 Mt/y; however, China and the United States were third and fourth with large facilities having combined capacities of 630 000 t/y and 530 000 t/y, respectively. Only six countries had more than one large smelting facility (capacity of at least 200 000 t/y).

A list of world copper smelters in 2002 is available from the USGS at http://pubs.usgs.gov/of/2003/of03-075/CSTable.html.

Refining

In 2002, 29 facilities in 11 countries had refineries with capacities of at least 200 000 t/y (see Figure 10). These refineries accounted for 49% of world refinery capacity in 2002. The refinery capacities also include electrowinning production capacity. Chile has a combined electro-refining and electrowinning capacity of 1.8 Mt/y. Japan was second with an electrorefining capacity of 1.25 Mt/y while the United States was third with a combined large electro-refining and electrowinning facility total of 1.1 Mt/y. Only six countries had more than one large facility with a capacity of at least 200 000 t/y.

PRICES

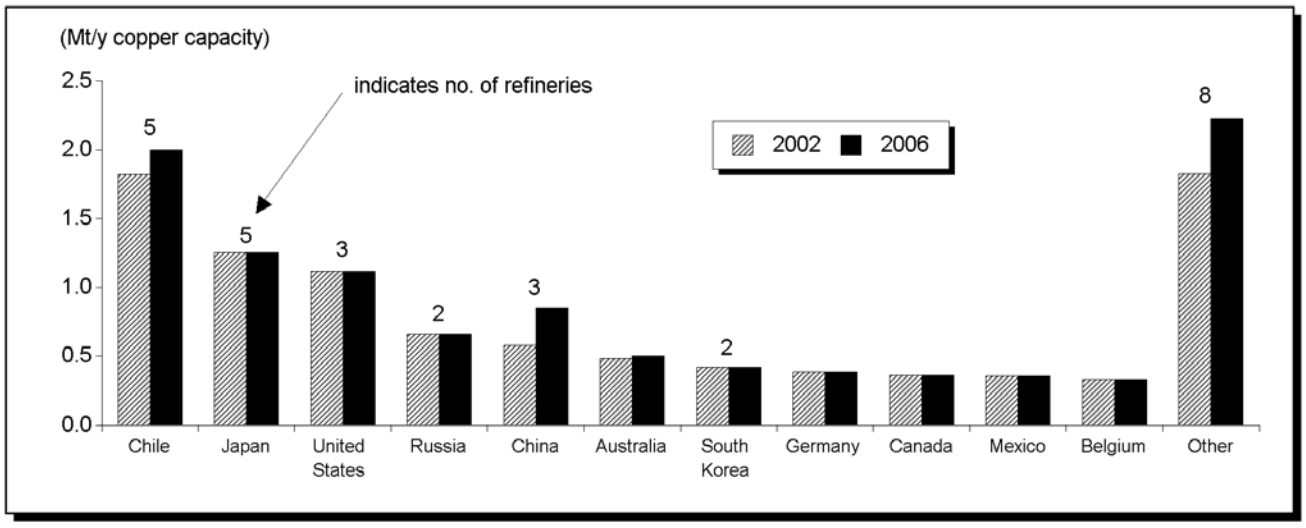
As noted on page 1 of this chapter, the London Metal Exchange (LME) settlement price for copper averaged US$1577/t for Grade A copper in 2002. Copper inventories on the LME increased from just under 800 000 t at the end of 2001 to over 855 000 t at the end of 2002. Total copper stocks, or the sum of the exchange stocks of the LME, the COMEX[n] and Shanghai, increased from a total of over 1.135 Mt at the end of 2001 to over 1.29 Mt at the end of 2002.[293]

Figure 11 shows LME cash settlement copper prices and a running 90-day historical average for 2001 and 2002. Figure 12 shows the same price series for the period 1989 to 2002, which puts the lower prices since late 1997 into a historical context.

The price graphs show prices in current prices, not adjusted for inflation. Inflation has very little to do with determining copper prices, which are more related to the

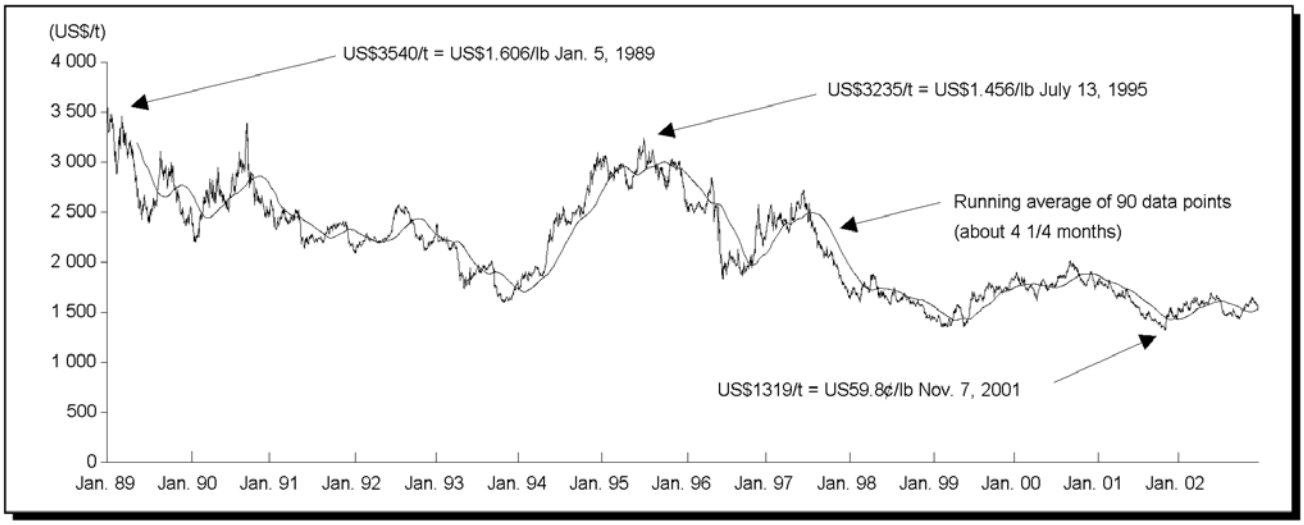
[n] COMEX data are available through links on a web page found at www.nymex.com/jsp/markets/cop_pre_agree.jsp. COMEX is a division of the New York Mercantile Exchange, Inc. (source: www.nymex.com/media/metalshedge.pdf).

Figure 10
Large (1) Copper Refineries in 2002 and 2006



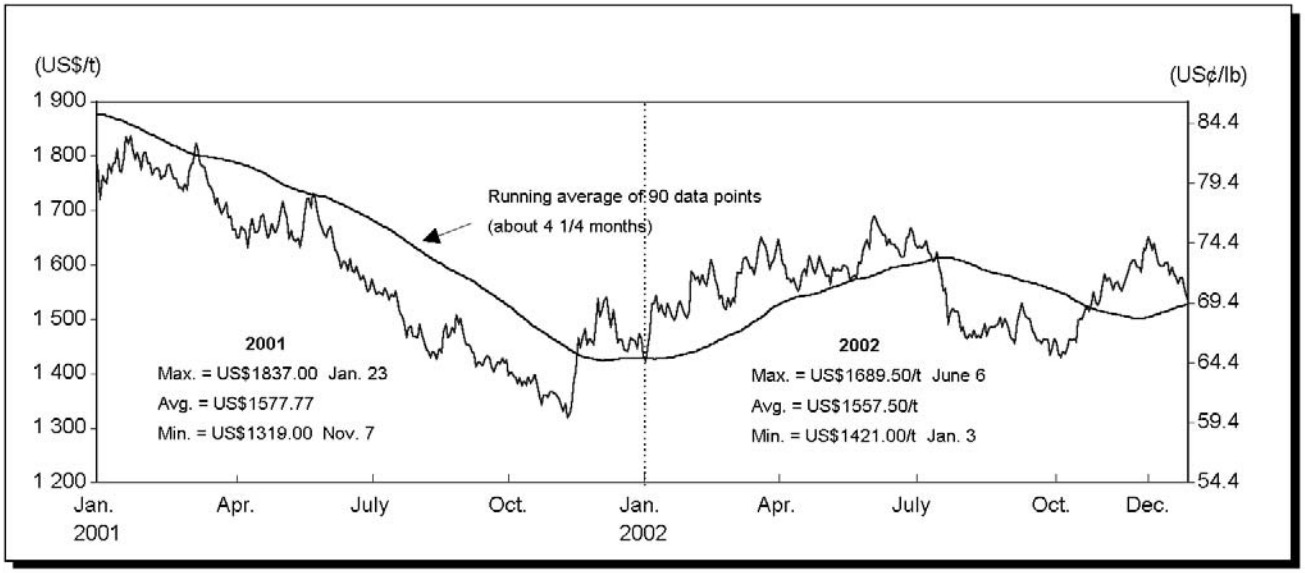
Source: International Copper Study Group.
(1) There are 33 refineries with a capacity of at least 200 000 t/y in 2002.
Notes: "Other" = 8 refineries in 8 countries (Peru, Spain, Zambia, Sweden, Brazil, Indonesia, Iran and India). One refinery for each country unless indicated otherwise.

Figure 11
LME Grade A Copper Daily Cash Settlement Price, 1989-2002
4 1/4 Month Running Average



Sources: London Metal Exchange; *Metal Bulletin*; International Copper Study Group.

Figure 12
LME Daily Cash Settlement Copper Price, 2001 and 2002



Sources: London Metal Exchange; *Metal Bulletin*; International Copper Study Group.

supply-demand balance and the expectation for future supply-demand balance. The price for copper received by producers normally is somewhat higher than the LME prices because of a premium associated with brand, form of the copper, location of delivery point, etc.[o] Inco Limited's realized price for copper in 2002 was US$1629/t, compared to the LME average of US$1559.50/t. The reference premium for Europe is based upon the Codelco premium, which was US$38/t established in late 2002,[294] or US1.7¢/lb. Canadian copper consumers typically purchase copper based upon the reference COMEX price plus a premium for delivery point, brand, etc.

Treatment Charges and Refining Charges

Treatment charges and refining charges (TCRCs) declined through the year as low copper prices led to declining copper production. The low TCRCs, and the expectation of continuing low TCRCs, led to the closure of the Gaspé smelter in Murdochville, Quebec, by Noranda Inc. Conversely, the low TCRCs benefited Canadian mines that sell copper concentrates.

During 2002, a number of smelters in Asia entered into two agreements to increase their negotiating power when purchasing copper concentrates.

The China United Copper Co. Ltd. was formed by five large copper smelters in China and China Minmetals Group who together accounted for an estimated 80% of Chinese copper concentrate imports and for about 70% of Chinese copper smelter output. Chinese mines provided about half the concentrate smelted in China in 2002 and this was projected to decrease to below 40% by 2010.[295]

Nippon Mining & Metals Co., Ltd. and Mitsui Mining & Smelting Co. Ltd. modified the business activities of their joint company, Pan Pacific Copper Co., Ltd. Pan Pacific Copper was formed to market copper and sulphuric acid produced by the two owners. In May, the companies announced that Pan Pacific Copper would also handle the procurement of copper concentrates for both companies in place of the joint company that they set up in 2002 to handle concentrate procurement; United Copper Resources Co., Ltd. Consequently, United Copper Resources was dissolved.[296]

Counterbalancing some of the effects of the new smelter purchasing groupings, the various producers reduced production in response to prospects for lower copper prices. Mine production in 2002 declined from the 2001 peak of over 11 Mt to the 2000 output level.[297]

As prices failed to increase, reductions in production, such as the decision to mine low-grade ore in times of low prices at the Escondida operation in Chile, thereby reducing production by 80 000 t/y (announced in November 2001),[298] the closure of 90 000 t/y of sulphide output at the Tintaya mine in Peru (also announced November 2001),[299] Codelco's cutback of 106 000 t (announced in 2001), and Codelco's decision announced in November to reduce sales by 200 000 t in 2003,[300] together reduced the amount of available copper and of copper concentrate. To take advantage of lower unit costs resulting from high capacity utilization, smelters had to offer, as illustrated below, lower TCRCs in order to try to attract sufficient feed material to run at high levels of throughput.

As TCRCs declined over the year, the lower TCRCs were termed a "catastrophe" by one unnamed European smelter, quoted in a report in early 2003 by *Metal Bulletin*. The same source reported a smelter's comments that the European smelters had grown accustomed to treatment charges of $80-$90/t (and, by implication, refining charges of US8¢-9¢/lb). This led to (European) complaints that smelters in India had an advantage due to duties on cathode and that the Chinese smelters had an advantage because of a decision to eliminate the value-added tax on copper concentrate imports.[301] One analyst was reported in mid-year 2002 as saying that with the Indian import duties, custom smelters in India could make money at TCRCs of even US$10/t and US1¢/lb.[302] However, apparently belying this claim, Hindustan Copper Ltd. had to re-issue a tender for 40 000 t of copper concentrates in May when TCRCs fell below US$40/t and US4¢/lb.[303]

In January, P.T. Freeport Indonesia Company[p] (owned by Freeport-McMoRan Copper & Gold Inc.) and the Japanese Smelter Pool reportedly negotiated TCRCs at US$70/t and 7¢/lb. This rate was 10% lower compared to a year earlier, mainly due to a shortage of concentrates. In addition, the charges on the contained gold were reduced, which in effect reduced TCRCs to the equivalent of US$68-$69/t and US6.8¢-6.9¢/lb.[304] At this time, spot TCRCs in India were said to be about US$48/t and US4.8¢/lb. A week later, it was reported that Ok Tedi Mining Limited had settled contracts with Japanese smelters for the same terms while selling spot material at US$48/t and US4.8¢/lb.[305]

In February, the Escondida mine and Mitsubishi Corporation settled for TCRCs reported to be US$68/t and US6.8¢/lb. This too represented a 10% decrease compared to the mid-2001 terms negotiated at US$76/t and US7.6¢/lb. By early April, the benchmark TCRCs in Japan were reduced slightly to US$68.5/t and US6.85¢/lb,

[o] Noranda described it as a "premium negotiated above the COMEX or LME settlement price based on product form and quality, packaging, delivery terms, supply commitments, delivery location and availability of product" (Annual Information Form, 2002, p. 10).

[p] In the words of Freeport-McMoRan Copper & Gold Inc. Annual Report, 2002, "the world's single largest producer and supplier of custom copper concentrate."

some US$2.50/t and 0.25¢/lb above TCRCs outside of Japan.[306] In May, as noted above, Hindustan Copper Ltd. had to re-tender a bid for copper concentrates when prices were below US$40/t and US4¢/lb.

In late June, Escondida negotiated mid-year terms with Japanese smelters at the rate of US$64/t and US6.4¢/lb. This deal was similar to that negotiated with the Ok Tedi mine by Mitsubishi Mining and United Copper Resources, the negotiating arm of Nippon Mining and Mitsui. The settlement was termed a decrease of $4/4¢ on previous agreements made at the start of 2002.[307] These deals came a week after an agreement reported between the PASAR (Philippine Associated Smelting and Refining Corporation) smelter in the Philippines and the Ok Tedi mine for US$61.5 and US6.15¢/lb, which included lower gold charges as negotiated earlier in the year.[308] By January 2003, it was reported that Birla Copper had contracted for 2003 at a combined TCRC of US11¢-13¢/lb compared to US15¢-16¢/lb in 2002,[309] equivalent to a decline from about US$62.50 and US6.25¢/lb to about US$47.50/t and US4.75¢/lb, or a decline of nearly 25%.

OUTLOOK

Canadian copper producers continued to face difficult times in 2002 due to the continued low prices. At some Canadian mines that produce copper, the prices of other metals are more important than copper prices in determining the profitability of the operation. Thus, not all mines in Canada that produce copper make decisions based upon the same criteria when considering new investments or whether to shut down in times of low copper prices.

The author divided the copper product from Canadian mines into categories by importance of type of metal produced. These groupings[q] were:

- copper mines: copper accounts for most of the metal value in the concentrates produced;
- zinc mines: zinc accounts for most of the metal value in the concentrates produced;
- nickel mines: nickel accounts for most of the metal value in the concentrates produced;
- precious metals mines: gold, silver, and, in one case, platinum group metals account for most of the metal value in the concentrates produced;
- co-product mines: copper accounts for more than 20% but less than 50% of metal value in concentrate produced.

The amounts of copper produced by these groupings of industry and copper's percentage of the total concentrate value has been presented in Figure 7 (note that the groupings are the author's groupings and that other groupings are possible). The following groupings were used:

- copper mines
- nickel mines
- co-product mines
- zinc mines
- precious metals mines

The "**copper mines**" evaluate mine operation principally according to copper prices; these are judged to be the Highland Valley Copper, Huckleberry and Louvicourt mines, which produce about 45% of Canadian copper and for which copper accounts for about 90% of the value of metals in concentrate produced at these mines in total.

The "**nickel mines**" evaluate mine operation principally according to nickel prices; these are judged to be Falconbridge's mines in the Sudbury Basin, the Raglan mine, and Inco's mines in the Sudbury Basin and in Manitoba, all of which produce about 25% of Canadian copper and for which copper accounts for about 15% of the value of metals in concentrate produced at these mines in total.

The "**co-product mines**" are operations in which copper is an important component of the total value of metal in concentrate (over 20% of the total value) but is not the determining factor in evaluating the mine operations (for these mines copper amounts to less than half the total value). The co-product mines are judged to be the Kidd, Kemess, Hudson Bay, and Selbaie mines, which produce about 23% of Canadian copper and for which copper accounts for about 38% of the value of the metals in concentrate produced at these mines in total. Some co-product mines have most of their revenue associated with zinc and some gold.

The "**zinc mines**" evaluate mine operation principally according to zinc prices; these are judged to be the Brunswick, Bell-Allard, Myra Falls, and Bouchard-Hébert mines, which produce about 5% of Canadian copper and whose copper accounts for about 38% of the value of metals in concentrate produced at these mines in total.

The "**precious metals mines**" evaluate mine operation principally according to the gold and palladium prices;

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[q] The values of metals in concentrates do not necessarily reflect the revenue obtainable from these metals as varying proportions of the metals are recoverable for sale. Also, the data were compiled from company reports in which most companies reported metals contained in concentrates, but some reported payable quantities and one reported only deliveries of metals. The metal for which smelters pay is less than the contained quantity. For these reasons, the grouping is general but is believed to be indicative of the decision criteria of mines producing copper in Canada.

these are judged to be the Troilus, Bousquet,[r] Joe Mann, LaRonde, and Lac des Iles mines, which produce about 2% of Canadian copper and whose copper accounts for about 7% of the value of metals in concentrate produced at these mines in total.

The price of copper is of different importance to each of the above "types" of mines. For the "copper mines," the price of copper is of prime importance in evaluations of operations, expansion, new investments at the operation, and for decisions on whether or not to shut down in times of low copper prices. In contrast, for the "precious metals mines" and "zinc mines," copper prices are relatively insignificant for the evaluation of the operations, expansion decisions, new investments at the operation, and decisions on whether or not to shut down when the mine faces difficult economic conditions. The postponement of the development of the Perserverance deposit would not likely be reversed even if the copper price were to rise by 50% so long as the zinc price remains depressed as the orebody contains 16% zinc plus precious metals, but only 1.24% copper.

A higher copper price, of say US$1/lb, by itself would likely not result in a decision to expand output at the precious metals mines or at the zinc mines because the increased revenue would be small in proportion to total revenue. Hence, the copper production from zinc and precious metals mines is relatively insensitive to the price of copper. In contrast, copper produced at the country's "copper mines" is very sensitive to copper prices.

Many costs for Canadian producers, such as labour and supplies, are in Canadian currency. Revenues such as the LME copper price or the price at which concentrates are sold are denominated in U.S. currency. The period from late 1997 to late 2002 was a period of some relief for Canadian producers as they benefited from a lower-valued Canadian currency. Monthly average exchange rates since 1990 are shown in Figure 13. While there has been a rebound from the record low of January 2002 of US62.49¢ per Canadian dollar, the low copper prices and the appreciating Canadian currency together mean the mines face tough times.

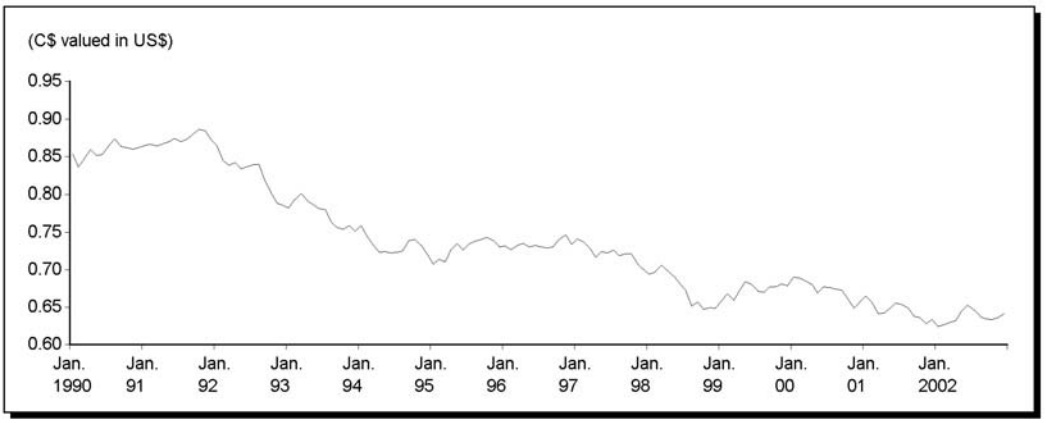
The outlook for Canadian copper production capacity to 2007 is shown in Figure 14. Projections beyond 2007 would show a significant decrease due to the expected closure of Highland Valley Copper late in the decade, which will reduce Canadian copper production by between 150 000 and 200 000 t/y of copper in concentrates. If copper prices remain low, below US90¢/lb for the remainder of the decade, prospects are dim that new projects will make up for the expected depletion of existing producers and allow Canadian copper production to be maintained at present levels.

The opening of new mines in Canada involves obtaining many approvals. A major project in Canada is subject to federal and provincial approval processes.[s] The decisions can be challenged in court. There are also outstanding land claims by Aboriginal groups that increase uncertainty about investment decisions. Depending upon the location

[r] Data for Bousquet production are not released and are not included in the calculations shown above; however, it was judged to be a gold mine and not a copper mine.

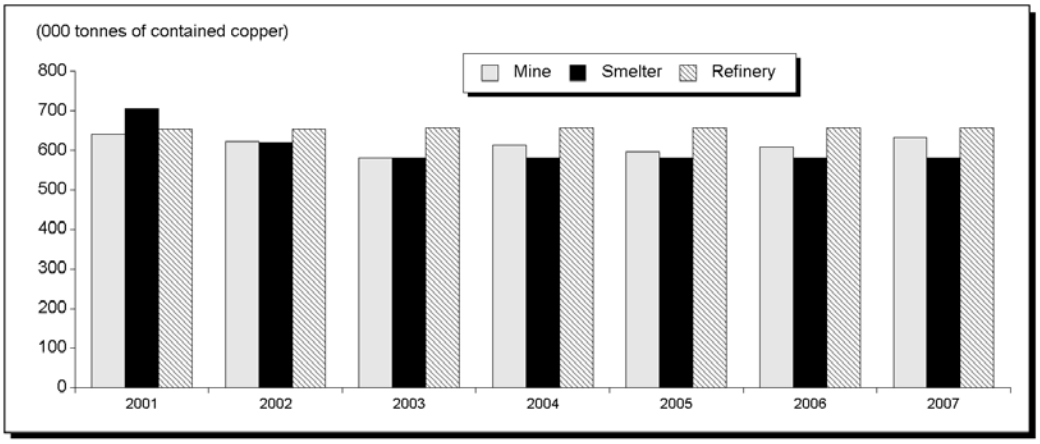
[s] Refer to www.ceaa-acee.gc.ca/index_e.htm for more details.

Figure 13
Monthly Average Exchange Rates, 1990-2002



Source: Bank of Canada noon rates (www.bankofcanada.ca/en/exchange-avg.htm).

Figure 14
Canadian Copper Capacity, 2001-07



Source: International Copper Study Group, *Directory of Copper Mines and Plants*, April 2003, using data supplied by companies to Natural Resources Canada.
Note: Data reflect the closure of the Gaspé smelter in 2002.

of a new project, some producers need to negotiate Impact and Benefit Agreements with Aboriginal groups.[t]

The copper industry in many of the developing nations may be affected by the outcome of the Extractive Industries Review by the World Bank. If the World Bank either withdraws or reduces its lending role to projects in developing countries or if it imposes onerous lending conditions, then the investment and insurance costs for new projects in these countries may increase significantly. The net effect could be to decrease the competitiveness of projects in developing countries relative to developed countries such as Canada. For more details, the reader can refer to the World Bank web site at www.eireview.org/eir/eirhome.nsf.

Copper recycling in Canada is an important factor in maintaining the competivity of Canadian copper smelters. Canadian industry imports a significant amount of copper and associated metals such as platinum group metals, silver and gold. These feeds supplement conventional concentrates and the metals in the scrap are important sources of revenues. For example, Noranda Inc.'s Horne smelter has an advantage because it is particularly flexible in terms of the feed material – both in physical form and in the ability to treat complex feeds (see details above of the recycled outputs in 2001 and 2002 of the Horne and Gaspé smelters).

However, the ability of Canadian industry to match terms by U.S. competitors for materials arising from U.S. sources is hindered by the regulations governing the import and export of recyclables that have a potental to generate a leachate if buried in landfill. The *Canadian Environmental Protection Act* (CEPA) was amended in 1999. During 2002, a series of consultations took place on how to: change regulations that could facilitate access to recyclable materials, be consistent with Canada's international obligations, and reflect the policy direction in the amended CEPA that clearly differentiates between wastes for final disposal and recyclables. If new regulations put Canadian smelters on more of an even footing with respect to regulatory approvals of the U.S. destinations for recyclables, this action will contribute to removing barriers to recycling in Canada.

FURTHER INFORMATION – CANADIAN INDUSTRY

Much more information is available about copper supply, demand, and uses, as well as the health and environmental aspects of copper. Good sources of information for production are the web sites of those companies that produce copper. The list of web sites of companies with Canadian mines and projects is shown below. Securities information is available from SEDAR,[u] and the reader should be sure to use the **entire** URL address (which is quite lengthy). Many of these companies also have substantial copper production facilities outside of Canada and details about those facilities can be found in the Annual Information Forms filed yearly (similar to a 10-K form filed in the

[t] An example is Voisey's Bay Nickel (see www.vbnc.com/iba.asp).

[u] System for Electronic Document Analysis and Retrieval, a registered trademark of the Canadian Securities Administrators, located on the Internet at www.sedar.com.

United States) and the annual reports also filed with securities regulators. The list of corporate web sites and SEDAR locations for these companies' documents is located in Table 3.

Canadian monthly data for mine production, shipments, refinery output and domestic shipments by Canadian producers can be found in three file formats at http://mmsd1.mms.nrcan.gc.ca/mmsd/ data/default_e.asp.

Additional information about the Canadian copper industry is available from a number of commercial sources, many displaying free information. Some of these sites include:

- *Canadian Mining News* (information in English, French, German, Spanish, Italian and Portuguese, located at www.canadianminingnews.com); and
- The *Goldsheet Mining Directory* is an extensive source of information about Canadian and other mining companies operating in Canada and abroad. It offers links to corporate web sites, associations and other sources of information, including government departments. A weekly update service showing new sites added is also available. The web site is located at www.goldsheetlinks.com.

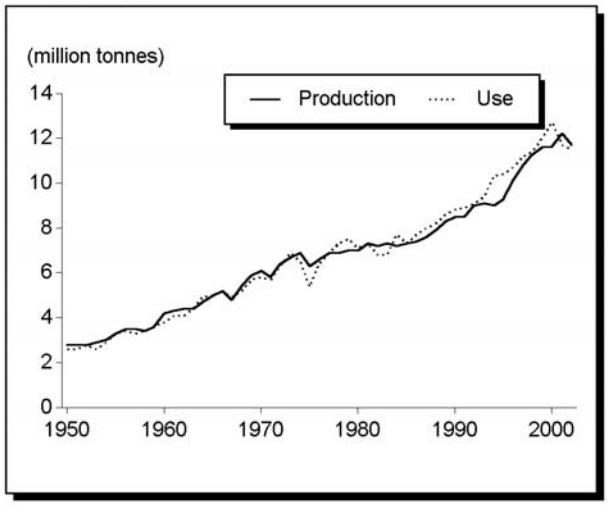
OTHER SOURCES OF COPPER INFORMATION

For copper production outside of Canada, Table 4 shows the countries and web sites of major producers.

Production, trade, and capacity data are published by the ICSG, a group consisting of 25 countries serviced by a secretariat in Lisbon, Portugal. Various publications are sold. The ICSG *Copper Bulletin* is a monthly publication, sold for US$100 or 100 euros per issue (price in non-member countries is 50% higher) (current as of the May 2003 issue). Yearly subscriptions are available. In addition, the Group sells a *Directory of Copper Mines and Plants* spanning a five-year period. The April 2003 issue price was 400 euros. Details of these and other publications are available at www.icsg.org in the "Publications" section.

Long-term data are available from the World Bureau of Metal Statistics (WBMS). The WMBS is a private company that holds the copyright for *METALLSTATISTIK*, the renowned data series formerly published by Metallgeschellshaft AG. This publication series contains production data back to 1900, as well as trade and price data. The 89th edition for the period 1991 to 2001 is sold for £420, 720 euros or US$840 (per web site, June 2003). The WBMS also publishes *World Metal Statistics* monthly, quarterly and yearly. The WBMS web site is located at www.world-bureau.com.

Figure 15
Historical Western World Copper Data, 1995-2002



Source: World Bureau of Metal Statistics.

Figure 15[v] shows the historical data for copper production and usage in the Western World from 1950 to 2002.

The historical use of copper appears to fall into two more regular growth periods (determined by the author):

- 1950 to 1973, a period for which a 4.33%/y growth rate curve can be fitted to the data; and
- 1982 to 2002, a period for which a 3.13%/y growth rate curve can be fitted to the data.

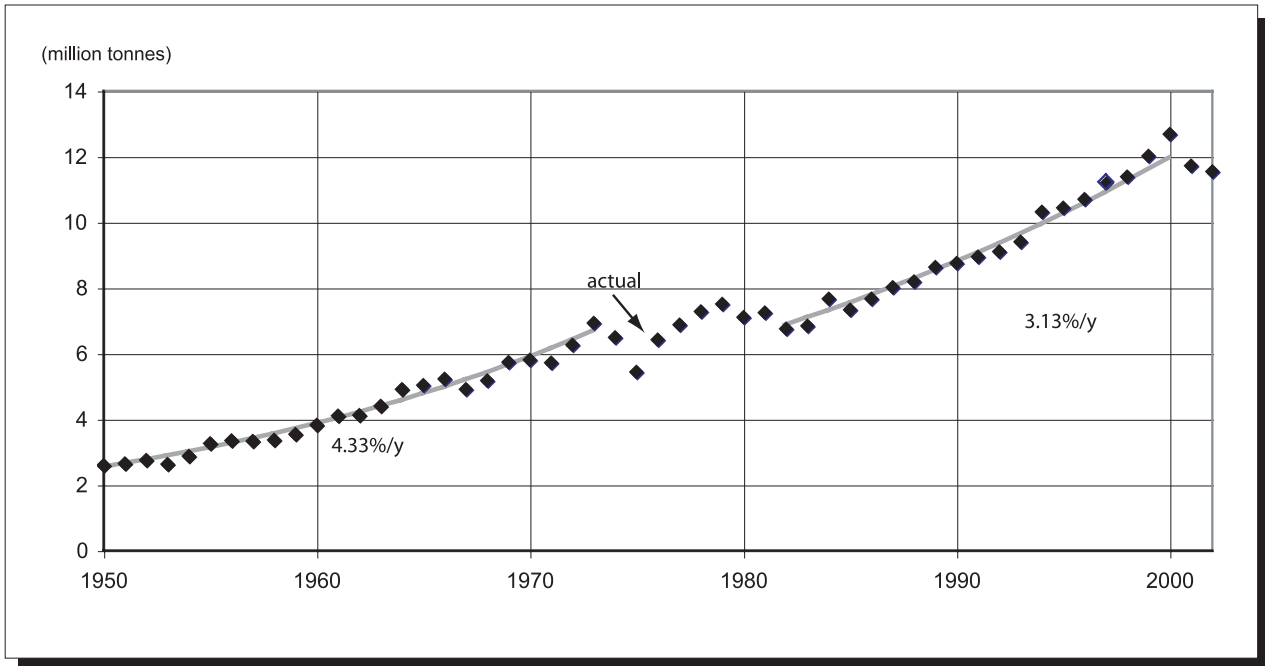
These periods are separated by a time when the demand for copper was more volatile, suggesting that growth during this time was not similar to the two periods noted above. The data from 2000 onwards look suspiciously like demand may be entering into another period of instability when growth in copper usage does not fall into a pattern described by exponential growth. These observations are illustrated in Figure 16, which shows the actual WBMS data and the curves fitted by the author for selected periods.

The **International Copper Association** (ICA) maintains a web site with information about:

- **copper products** - building products, consumer and electronic items, transportation, agriculture, industrial applications, and machinery and future applications;

[v] Produced with the kind assistance of WBMS.

Figure 16
World Copper Use and Growth Rates, 1950-2002



Source: World Bureau of Metal Satistics for actual data; regressions by author.

- **energy efficiency** - air conditioners and refrigerators, copper bus bars, motors, power cables, solar energy, transformers, and case studies;
- **health and nutrition** - aquatic life, biological importance, copper deficiency, copper research, information flow project, drinking water, good health with copper, how much do we need?, plant and animal health, pregnancy and infants, public health benefits, quick facts, ICA research;
- **environment** - climate change mitigation, copper research information flow project, energy conservation, natural presence, recycling, sustainability, ICA research; and
- **about copper** - copper alloys, copper exchanges, copper markets, copper mining, copper products.

The web site for the International Copper Association is located at www.copperinfo.com/index4.shtml.

One of the more interesting destinations from the ICA site is an online history of copper. This site provides material of interest to students and others seeking an overview of the history of copper. This can be found at http://60centuries.copper.org.

Information about copper use is available from the **International Wrought Copper Council** (IWCC). The publication *World Trade in Copper and Copper Alloy Semi-Manufactures, 2001* is sold containing data for 21 countries for 2001 and the three previous years. The cost is £450 for non-members. The *Survey of Capacities of Copper Mines, Smelters, Refineries, and Copper Wire Rod Plants,* April 2002, covering 1999 to 2007, is sold for £250 to non-members. The site has links to member companies and organizations. The IWCC site is located at www.coppercouncil.org.

The USGS publishes monthly and annual data as well as detailed geographic reviews. The copper portal is located at http://minerals.usgs.gov/minerals/pubs/commodity/copper.

Historical statistics for copper and for other metals and minerals in the United States are available in pdf, html and spreadsheet format from a general listing available at http://minerals.usgs.gov/minerals/pubs/of01-006.

Specifically, the copper data in the three formats are found at:

- pdf format – http://minerals.usgs.gov/minerals/pubs/of01-006/copper.pdf
- spreadsheet format – http://minerals.usgs.gov/minerals/pubs/of01-006/copper.xls
- html format – http://minerals.usgs.gov/minerals/pubs/of01-006/copper.html

Historical world information compiled by the USGS about mine, smelter and refinery production by country for the years 1986-90 can be found at:

- mine – http://minerals.usgs.gov/minerals/pubs/commodity/copper/stat/tbl12.txt
- smelter – http://minerals.usgs.gov/minerals/pubs/commodity/copper/stat/tbl13.txt
- refinery – http://minerals.usgs.gov/minerals/pubs/commodity/copper/stat/tbl14.txt

The USGS historical copper consumption data in the United States for the years 1970-90 are available for five consuming sectors: wire-rod mills, brass mills, chemical plants, ingotmakers, and foundries. These data can be found at http://minerals.usgs.gov/minerals/pubs/commodity/copper/stat/tbl5.txt.

CONVERSIONS

Conversion between metric and imperial units is available on the Internet at www.worldwidemetric.com/metcal.htm and conversions relating to precious metals, which are often measured in troy ounces, are located on the Internet at www.goldcalculator.com/index_files/page0033.htm and www.hallmark-gemstones.com/metalinfo.html.

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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 November 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.

NOTE TO READERS

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EU MFN	Japan WTO (1)
2603.00	Copper ores and concentrates						
2603.00.00.10	Copper content	Free	Free	Free	Free	Free	Free
2825.50	Copper oxides and hydroxides	Free	Free	Free	Free	3.2%	4.8%
28.33	Sulphates; alums; peroxosulphates (persulphates)						
	Other sulphates:						
2833.25	Of copper						
2833.25.10	Cupric sulphate	Free	Free	Free	Free	3.2%	3.9%
2833.25.90	Other copper sulphates	5.5%	Free	Free	Free	3.2%	3.9%
74.01	Copper mattes; cement copper (precipitated copper)						
7401.10	Copper mattes	Free	Free	Free	Free	Free	Free
7401.20	Cement copper (precipitated copper)	Free	Free	Free	Free	Free	Free
7402.00	Unrefined copper; copper anodes for electrolytic refining	Free	Free	Free	Free	Free	Free-3%
74.03	Refined copper and copper alloys, unwrought						
	Refined copper:						
7403.11	Cathodes and sections of cathodes	Free	Free	Free	Free	Free	Free-3%
7403.12	Wire bars	Free	Free	Free	Free	Free	Free-3%
7403.13	Billets	Free	Free	Free	Free	Free	Free-3%
7403.19	Other	Free	Free	Free	Free	Free	Free-3%
	Copper alloys:						
7403.21	Copper-zinc base alloys (brass)	Free	Free	Free	Free	Free	Free
7403.22	Copper-tin base alloys (bronze)	Free	Free	Free	Free	Free	Free-3%
7403.23	Copper-nickel base alloys (cupro-nickel) or copper-nickel-zinc base alloys (nickel-silver)	Free	Free	Free	Free	Free	Free-3%
7403.29	Other copper alloys (other than master alloys of heading no. 74.05)	Free	Free	Free	Free	Free	Free-3%
7404.00	Copper waste and scrap	Free	Free	Free	Free	Free	Free
7405.00	Master alloys of copper	Free	Free	Free	Free	Free	3%
74.06	Copper powders and flakes	Free	Free	Free	Free	Free	3%
74.07	Copper bars, rods and profiles of refined copper	Free-3%	Free	Free	Free	4.8%	3%
74.08	Copper wire of refined copper	Free-3%	Free	Free	Free	4.8%	3%
74.09	Copper plates, sheets and strip of a thickness exceeding 0.15 mm	Free	Free	Free	Free	4.8%	3%
74.10	Copper foil (whether or not printed or backed with paper, paperboard, plastics or similar backing materials) of a thickness (excluding any backing) not exceeding 0.15 mm	Free	Free	Free	Free	5.2%	3%
74.11	Copper tubes and pipes	2-2.5%	Free	Free	Free	4.8%	3%
74.12	Copper tube or pipe fittings (for example, couplings, elbows, sleeves)	3%	Free	Free	Free	5.2%	Free
7413.00	Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated	3%	Free	Free	Free	Free-5.2%	3%
74.14	Cloth (including endless bands), grill and netting, of copper wire; expanded metal of copper	3%	Free	Free	Free	4.3%	Free
74.15	Nails, tacks, drawing pins, staples (other than those of heading no. 83.05) and similar articles, of copper or of iron or steel with heads of copper; screws, bolts, nuts, screw hooks, rivets, cotters, cotter-pins, washers (including spring washers) and similar articles, of copper	Free-3%	Free	Free	Free	3-4%	Free
7416.00	Copper springs	3%	Free	Free	Free	4%	Free
7417.00	Cooking or heating apparatus of a kind used for domestic purposes, non-electric and parts thereof, of copper	3%	Free	Free	Free	4%	Free
74.18	Table, kitchen or other household articles and parts thereof, of copper; pot scourers and scouring or polishing pads, gloves and the like, of copper; sanitary ware and parts thereof, of copper	3%	Free	Free	Free	3%	Free
74.19	Other articles of copper	Free-9.5%	Free-5%	Free	Free	3%	Free

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); *Customs Tariff Schedules of Japan,* 2003.
(1) WTO rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, COPPER PRODUCTION AND TRADE, 2001 AND 2002

Item No.		2001		2002 (p)	
		(tonnes)	($000)	(tonnes)	($000)
MINE PRODUCTION (1)		683 531	–	600 187	–
SHIPMENTS (2)					
	Newfoundland and Labrador	–	–	–	–
	Prince Edward Island	–	–	–	–
	Nova Scotia	–	–	–	–
	New Brunswick	9 048	22 611	8 994	22 116
	Quebec	98 014	244 937	86 716	231 235
	Ontario	182 336	455 658	189 756	466 611
	Manitoba	38 872	97 142	37 758	92 847
	Saskatchewan	10 796	26 979	10 080	24 787
	Alberta	–	–	–	–
	British Columbia	275 245	687 838	243 729	599 328
	Yukon	–	–	–	–
	Northwest Territories	–	–	–	–
	Total	614 312	1 535 165	577 033	1 418 923
	Refinery output	567 720	..	495 140	..
EXPORTS					
2603.00.10	Copper ores and concentrates				
	Copper content				
	Japan	(a) 382 576	279 052	(b) 167 962	185 757
	China	(a) 111187	84 743	(b) 59 307	63 098
	South Korea	(a) 64154	49 887	(b) 23 197	46 145
	India	(a) 21433	16 754	(b) 16 281	32 171
	Other countries	(a) 50 662	43 900	(b) 16 206	28 570
	Total	630 012	474 336	282 953	355 741
	(Note: Canadian copper concentrate data as shown by Statistics Canada are believed to be incorrect for 2000, 2001 and 2002. Data for those years appear to show the tonnage of copper concentrate shipments and not the tonnes of copper contained in concentrates. This results in a serious over-estimation of the copper exports from Canada. An attempt will be made to reconstruct the trade data for these years; a provisional correction based only upon unit value has been shown for 2002. Therefore, the numbers reported above based upon official data should be considered incorrect.)				
2604.00.00.10, 2607.00.00.10, 2608.00.00.10, 2616.10.00.10	Other ores and concentrates				
	Copper content				
	Finland	4 050	2 673	–	–
2620.30	Copper ash and residues				
	United States	43	106	64	155
	Germany	–	–	20	34
	Total	43	106	84	189
2825.50	Copper oxides and hydroxides	...	1	–	–
2833.25	Copper sulphates				
	United States	5 601	7 241	5 939	7 799
	Cuba	...	...	–	–
	Total	5 601	7 241	5 939	7 799
7401.10	Copper mattes				
	Norway	16 031	34 655	18 971	37 838
	Other countries	21	48	–	–
	Total	16 052	34 703	18 971	37 838
7401.20	Copper mattes; cement copper (precipitated copper)				
	Japan	–	–	3 438	322
	United States	–	–	...	4
	Total	–	–	3 438	326
7402.00	Copper anodes				
	United States	80 108	364 768	84 118	387 596

TABLE 1 (cont'd)

Item No.		2001		2002 (p)	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7403.11 to 7403.19	Refined copper and copper alloys, unwrought				
	United States	270 328	706 128	234 538	594 156
	Colombia	3 747	17 732	2 747	13 195
	United Kingdom	23 812	64 445	702	1 916
	Dominican Republic	316	1 505	98	479
	Other countries	10 694	28 766	33	191
	Total	308 897	818 576	238 118	609 937
7403.21 to 7403.29	Copper alloys and other copper alloys				
	United States	2 737	8 827	3 059	10 065
	Other countries	8	59	6	16
	Total	2 745	8 886	3 065	10 081
7404.00	Copper waste and scrap				
	United States	56 447	110 866	52 621	113 670
	China	8 539	12 978	13 771	17 533
	Germany	1 672	2 997	1 052	1 635
	India	1 423	2 277	1 016	1 479
	South Korea	594	825	556	1 133
	Taiwan	309	608	477	988
	Hong Kong	138	265	411	607
	Other countries	1 123	2 072	1 294	1 497
	Total	70 245	132 888	71 198	138 542
7405.00	Master alloys of copper				
	United States	–	–	–	–
7406.10 to 7406.20	Copper powders and flakes				
	United States	33	237	282	678
	Taiwan	24	259	23	232
	Other countries	23	196	25	239
	Total	80	692	330	1 149
7407.10 to 7407.29	Copper bars, rods and profiles of refined copper				
	United States	6 630	29 348	5 539	24 562
	Chile	161	725	129	590
	Other countries	46	244	29	152
	Total	6 837	30 317	5 697	25 304
7408.11 to 7408.29	Copper wire of refined copper and of copper alloys				
	United States	112 831	323 017	131 632	369 048
	Argentina	4	62	25	164
	Other countries	14	132	82	336
	Total	112 849	323 211	131 739	369 548
7409.11 to 7410.22	Copper plates, sheets, strip and foil of refined copper and of copper alloys				
	United States	11 278	56 534	4 695	19 830
	Taiwan	350	1 571	203	779
	Thailand	964	3 519	198	682
	Hong Kong	...	...	77	432
	Saudi Arabia	534	2 397	94	253
	Australia	157	725	47	246
	Other countries	2 418	9 802	103	405
	Total	15 701	74 548	5 417	22 627

TABLE 1 (cont'd)

Item No.		2001		2002 (p)	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7411.10 to 7411.29	Copper tubes and pipes of refined copper and of copper alloys				
	United States	18 203	110 002	18 852	115 929
	Singapore	43	324	45	307
	Netherlands	529	3 307	38	253
	United Kingdom	130	984	31	224
	Australia	74	728	28	200
	Other countries	283	1 956	143	797
	Total	19 262	117 301	19 137	117 710
7412.10 to 7412.20	Copper tube and pipe fittings of refined copper and of copper alloys				
	United States	..	37 714	..	36 561
	France	..	969	..	483
	Germany	..	1 612	..	457
	Sweden	..	815	..	356
	Spain	..	3 403	..	140
	Other countries	..	3 836	..	626
	Total	..	48 349	..	38 623
7413.00	Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated				
	United States	1 013	6 012	722	5 900
	Other countries	21	63	41	409
	Total	1 034	54 424	763	6 309
7414, 7415, 7416, 7419	Other items of copper				
	United States	..	40 292	..	34 026
	Other countries	..	934	..	2 916
	Total	..	41 226	..	36 942
	Total exports		2 566 260		2 479 731
IMPORTS (3)					
2603.00.00.10	Copper ores and concentrates				
	Copper content				
	Chile	(a) 106 849	206 436	(b) 51 600	105 019
	United States	(a) 29 468	65 525	(b) 16 510	47 417
	Peru	(a) 19 516	31 061	(b) 22 414	41 981
	Belgium	–	–	(b) 10 055	25 107
	Portugal	(a) 14 573	23 371	(b) 10 340	17 502
	Argentina	(a) 17 258	36 451	(b) 6 813	13 519
	Other countries	(a) 31 869	65 740	(b) 9 959	19 793
	Total	219 533	428 584	127 691	270 338
	(Note: Canadian copper concentrate data as shown by Statistics Canada are believed to be incorrect for 2000, 2001 and 2002. Data for those years appear to show the tonnage of copper concentrate shipments and not the tonnes of copper contained in concentrates. This results in a serious over-estimation of the copper exports from Canada. An attempt will be made to reconstruct the trade data for these years; a provisional correction based only upon unit value has been shown for 2002. Therefore, the numbers reported above based upon official data should be considered incorrect. Imports shown as originating in Belgium likely originated in another country.)				
2604.00.00.10, 2607.00.00.10, 2608.00.00.10, 2616.10.00.10	Other ores and concentrates				
	Copper content				
	United States	285	502	192	313
	Mexico	129	246	–	–
	Total	414	748	192	313
2620.30	Copper ash and residues				
	Portugal	–	–	13 404	4 739
	United States	6 880	9 958	2 686	4 586
	Sweden	923	1 753	557	1 552
	Spain	1 213	339	19	286
	Other countries	893	540	526	324
	Total	9 909	12 590	17 192	11 487

TABLE 1 (cont'd)

Item No.		2001		2002 (p)	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
2825.50	Copper oxides and hydroxides	1 390	3 894	1 281	3 715
2833.25	Copper sulphates	19 145	15 888	18 851	17 055
2836.99.10.20	Copper carbonates	..	4	..	8
2836.99.90.10	Other copper carbonates	6	13	9	19
2837.19.00.10	Copper cyanides	47	298	35	210
3212.90.90.12	Pigments based on copper or copper alloy powders and flakes	19	222	9	109
7401.10	Copper mattes	2	6	100	367
7401.20	Copper mattes; cement copper (precipitated copper)	145	295	177	549
7402.00	Copper anodes	30 562	67 171	58 487	129 263
7403.11 to 7403.19	Refined copper and copper alloys, unwrought				
	Refined copper	7 993	22 863	11 569	31 053
7403.21 to 7403.29	Refined copper and copper alloys, unwrought				
	Other copper alloys	8 495	29 702	7 260	27 096
7404.00	Copper waste and scrap				
	United States	72 401	128 765	39 119	67 629
	Cuba	781	1 346	1 257	1 823
	United Kingdom	169	564	270	1 085
	Japan	...	...	323	983
	Haiti	171	334	217	394
	Other countries	17 563	28 845	162	236
	Total	91 085	159 854	41 348	72 150
7405.00	Master alloys of copper	310	1 328	485	2 034
7406.10 to 7406.20	Copper powders and flakes	2 043	10 456	2 159	10 734
7407.10 to 7407.29	Copper bars, rods and profiles of refined copper				
	United States	30 277	100 680	32 731	103 912
	Poland	2 928	6 092	1 308	2 925
	South Korea	2 023	3 699	953	1 304
	New Zealand	220	866	248	920
	Other countries	2 305	8 031	1 563	5 029
	Total	37 753	119 368	36 803	114 090
7408.11 to 7408.29	Copper wire of refined copper and of copper alloys	24 734	82 197	22 712	76 351
7409.11 to 7409.90, 7410.11 to 7410.22	Copper and copper alloy plates, sheets, strip and foil	37 265	211 764	27 875	172 525
7411.10	Pipes and tubes, refined copper	8 145	38 564	9 869	43 887
7411.21	Pipes and tubes, copper-zinc base alloys	4 658	22 937	4 740	25 085
7411.22	Pipes and tubes, copper-nickel base alloys or copper-nickel-zinc base alloys	414	2 726	402	2 834
7411.29	Plates and tubes, copper alloys, n.e.s.	2 338	14 332	852	4 894
7412.10	Fittings, pipe or tube, of refined copper	954	12 317	1 273	15 227
7412.20	Fittings, pipe or tube, copper alloys	5 619	71 789	6 569	79 668
7413.00	Stranded wire, cable, plaited bands and the like, of copper, not electrically insulated	8 402	34 772	8 632	31 711

TABLE 1 (cont'd)

Item No.		2001		2002 (p)	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
7414.20	Endless bands of copper wire for machinery	..	357	..	227
7414.90	Cloth, grill and netting of copper wire and expanded metal of copper	213	916	180	851
7415.10	Nails, tacks, drawing pins, staples and similar articles of copper or of iron or steel with copper heads	154	913	179	1 072
7415.21	Copper washers, including spring washers	275	1 685	434	3 055
7415.29	Articles of copper, not threaded, n.e.s., similar to those of headings 7415.10 and 7415.21	954	5 012	904	4 802
7415.31	Copper screws, for wood	34	208	–	–
7415.32 (4)	Screws, bolts and nuts of copper, excluding wood screws	1 220	6 213	–	–
7415.33 (4)	Screws, bolts and nuts of copper, excluding wood screws	–	–	1 457	6 316
7415.39	Articles of copper, threaded, n.e.s., similar to bolts, nuts and screws	684	3 628	895	4 513
7416.00	Copper springs	..	483	..	935
7419.10	Chain and parts thereof of copper	62	394	58	427
7419.91	Articles of copper, not further worked than cast, moulded, stamped or forged	3 262	25 568	3 920	26 043
7419.99	Articles of copper, n.e.s.	..	49 320	..	48 815
	Total imports		1 459 379		1 239 833

Sources: Natural Resources Canada; Statistics Canada.
– Nil; **. .** Not available or not applicable; **. . .** Amount too small to be expressed; n.e.s. Not elsewhere specified; (p) Preliminary.
(a) Data believed to be tonnage of concentrates and not tonnes of copper in concentrate. (b) Tonnage of concentrates adjusted by unit value and may not reflect tonnes of copper in concentrates.
(1) Copper contained in concentrates produced. (2) Anode copper recovered in Canada from domestic concentrates plus exports of payable copper in concentrate and matte. (3) Imports from "other countries" may include re-imports from Canada. (4) HS code changed from 7415.32 to 7415.33 as of 2002.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, COPPER PRODUCTION, TRADE[1] AND USE, 1975, 1980 AND 1985-2002

	Production		Exports			Imports	Use (3)
	Shipments (2)	Refinery Output	Concentrates and Matte	Refined	Total	Refined	Refined
			(tonnes)				
1975	733 826	529 197	314 518	320 705	635 223	10 908	196 106
1980	716 363	505 238	286 076	335 022	621 098	13 466	208 590
1985	738 637	499 626	320 619	280 033	600 652	19 131	222 466
1986	698 527	493 445	341 390	306 822	648 212	20 901	225 586
1987	794 149	491 124	381 126	288 800	669 926	16 583	231 288
1988	758 478	528 723	348 404	268 680	617 084	4 659	236 280
1989	704 432	515 216	348 739	321 690	670 429	4 408	213 046
1990	771 433	515 835	374 875	335 941	710 816	2 611	180 605
1991	780 362	538 339	348 080	377 985	726 065	2 321	159 170
1992	761 694	539 302	346 842	385 761	732 603	8 916	156 132
1993	709 650	561 580	319 840	408 364	728 204	21 155	185 565
1994	590 784	549 869	237 554	388 568	626 122	(r) 19 594	(r) 199 350
1995	700 843	572 616	(r) 274 493	(r) 434 693	(r) 709 186	(r) 24 176	(r) 189 550
1996	652 499	559 200	409 577	384 338	793 915	28 700	218 280
1997	647 779	560 582	515 547	381 476	897 023	22 602	224 777
1998	690 762	562 261	450 867	355 825	806 692	18 685	246 212
1999	581 583	548 563	(r) 355 838	294 106	(r) 649 944	(r) 16 475	(r) 266 505
2000	621 889	551 393	(a) 693 016	288 335	981 351	11 874	272 075
2001 (p)	614 312	567 720	(a) 650 114	308 897	1 217 834	7 993	265 209
2002 (p)	577 033	495 140	(a) 301 924	238 118	797 064	11 569	272 042

Sources: Natural Resources Canada; Statistics Canada.
(p) Preliminary; (r) Revised.
(a) Data believed to be tonnage of concentrates and not tonnes of copper in concentrate. (b) Tonnage of concentrates adjusted by unit value and may not reflect tonnes of copper in concentrates.
(1) 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) From 1975 to 1988, anode copper recovered in Canada from domestic concentrate plus exports of payable copper in concentrates and matte. Starting in 1989 to date, recoverable copper in concentrate shipped, except for 2000, 2001 and 2002 (see notes a and b). (3) Producers' domestic shipments of refined copper plus imports of refined shapes.

TABLE 3. CORPORATE INTERNET AND SEDAR SITES

Company	Web Site Address	SEDAR Site Address
Agnico Eagles Mines Limited	www.agnico-eagle.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00000834&lang=EN
Aur Resources Inc.	www.aurresources.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00002420&lang=EN
Barrick Gold Corporation	www.barrick.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00000923&lang=EN
Billiton Metals Canada Inc.	(see BHP Billiton Plc)	(no location found)
Boliden Westmin (Canada) Limited	www.boliden.ca/index.htm	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00017238&lang=EN
Breakwater Resources Ltd.	www.breakwater.ca	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00002929&lang=EN
Callinan Mines Limited	www.callinan.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00008418&lang=EN
Campbell Resources Inc.	www.ressourcescampbell.com/en/index.html	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00001579&lang=EN
DRC Resources Corporation	www.drcresources.com/s/Home.asp	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00004818&lang=EN
Expatriate Resources Ltd.	www.expatriateresources.com/start.htm	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00005621&lang=EN
Falconbridge Limited	www.falconbridge.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00000376&lang=EN
Getty Copper Corporation	www.gettycopper.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00002550&lang=EN
Highland Valley Copper	(see Teck Cominco Limited and BHP Billiton Plc)	(see Teck Cominco Limited)
Hudson Bay Mining and Smelting Co., Ltd.	(see Anglo American plc)	(no location found - not a publicly traded company in Canada)
Imperial Metals Corporation	www.imperialmetals.com/s/Home.asp	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00017753&lang=EN
Inco Limited	www.inco.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00001084&lang=EN
Inmet Mining Corporation	www.inmetmining.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00003181&lang=EN
Minto Explorations Limited	(discontinued)	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00005603&lang=EN
MSV Resources Inc.	(not found)	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00002877&lang=EN
Noranda Inc.	www.noranda.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00004438&lang=EN
North America Palladium Ltd.	www.napalladium.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00003026&lang=EN
Northgate Exploration Ltd.	www.northgateexploration.ca	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00001913&lang=EN
Novicourt Inc.	(not found)	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00001886&lang=EN
Placer Dome Inc.	www.placerdome.com/index.jsp	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00002304&lang=EN
Redcorp Ventures Ltd.	www.redcorp-ventures.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00014660&lang=EN
Taseko Mines Limited	www.tasekomines.com/tko/Home.asp	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00003212&lang=EN
Teck Cominco Limited	www.teckcominco.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00001787&lang=EN
Voiseys Bay Nickel Company Limited	www.vbnc.com and www.inco.com	www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&issuerNo=00001084&lang=EN

Source: Natural Resources Canada.
Note: SEDAR = System for Electronic Document Analysis and Retrieval (see www.sedar.com).

TABLE 4. FOREIGN COPPER PRODUCERS

Country	Company	Web Site Address
Australia	M.I.M. Holdings Limited	www.mim.com.au
	WMC Resources Ltd	www.wmc.com
Belgium	Umicore Group	www.um.be
Brazil	Companhia Vale do Rio Doce (CVRD)	www.vale.com.br
Chile	Antofagasta Holdings	www.aminerals.cl
	Corporación Nacional del Cobre de Chile	www.codelco.com
	Compañía Minera Doña Inés de Collahuasi	www.collahuasi.cl
	Empresa Nacional de Minerià (ENAMI)	www.enami.cl
	Minera Escondida Limitada	www.escondida.cl
China	Jiangxi Copper Company Limited	www.jxcc.com/english/engfgs/enindex.htm
	Jinchuan Group Limited	www.jnmc.com/default.asp
	Yunnan Copper Industrial Corp. Ltd.	www.yunnan-copper.com/ehtml/copper.html
India	Birla Copper	www.birlacopper.com
	Hindustan Copper Ltd. (HCL)	www.hindustancopper.com
	Sterlite Industries (India) Limited	www.sterlite.com/metal/copper1.html
Indonesia	Freeport-McMoRan Copper & Gold Inc.	www.fcx.com
Japan	Dowa Mining Co., Ltd.	www.dowa.co.jp
	Furukawa Electric Co., Ltd.	www.furukawa.co.jp/english/index.htm
	Mitsubishi Materials Corporation	www.mmc.co.jp/english/top_e.html
	Mitsubishi Group	www.mitsubishi.or.jp/e/contents/contents_2.html
	Mitsui & Co., Ltd.	www.mitsui.co.jp/tkabz/english/index.html
	Nippon Mining & Metals Co., Ltd.	www.nikko-metal.co.jp
	Nittetsu Mining Co., Ltd.	www.nittetsukou.co.jp
	Onahama Smelting and Refining Co., Ltd.	http://group.mmc.co.jp/osr/eng
	Dowa Mining Co., Ltd.	www.dowa.co.jp/english/index.htm
	Sumitomo Metal Mining Co., Ltd.	www.smm.co.jp/index_E.html
Kazakhstan	Zhezkazkantsvetmet *	www.samsungamerica.com/metal.asp
Korea	LG-Nikko Copper Inc.	www.lgnikko.com/eng/#
Mexico	Grupo México S.A. de C.V.	www.gmexico.com/indexi.html
Peru	Centromín Peru S.A.	www.centromin.com.pe
	Southern Peru Copper Corporation	www.southernperu.com/pages/home.htm
PNG	Ok Tedi Mining Limited	www.oktedi.com
Phillipines	Phillipine Associated Smelting & Refining Corp.	www.pasar.net.ph
Poland	KGHM Polska Miedz S.A.	www.kghm.pl/en/index.php
Rumania	Pidrop smelter	www.um.be
Russia	MMC Norilsk Nickel	www.nornik.ru/index.jsp?lang=E
United Kingdom	Anglo American plc	www.angloamerican.co.uk
	BHP Billiton Plc	www.bhpbilliton.com
	Rio Tinto plc	www.riotinto.com
United States	ASARCO Incorporated	www.asarco.com
	Kennecott Utah Copper Corporation	www.kennecott.com
	Phelps Dodge Corporation	www.phelpsdodge.com

* Zhezkazhants is owned by Samsung Deutschland GmbH.

TABLE 5. COPPER AND COPPER-NICKEL SMELTERS IN CANADA, 2002

Company and Location	Product	Rated Annual Capacity (1)	Feed Material	Remarks
Falconbridge Limited Falconbridge, Ontario	Copper-nickel matte	20 000 t/y	Nickel-copper concentrates	Copper-nickel concentrate processed in fluid bed roasters and an electric furnace; 1800-t/d sulphuric acid plant treats roaster gases. Matte from the smelter is refined in Norway.
Inco Limited Sudbury, Ontario	Molten "blister" copper, nickel sulphide and nickel sinter for the company's refineries; nickel oxide sinter for market, soluble nickel oxide for market	135 000 t/y	Bulk nickel-copper concentrates, scrap	Oxygen flash furnace for smelting of nickel-copper concentrate; converters for production of nickel-copper Bessemer matte. Production of matte followed by matte treatment, flotation, separation of copper and nickel sulphides, then by roasting to make nickel oxides for refining and marketing. Oxygen flash conversion of copper sulphide to semi-blister followed by pyrorefining to blister copper. Copper is refined at Inco's nearby refinery in Sudbury.
Falconbridge Limited Timmins, Ontario	Molten "blister" copper	140 000 t/y	Copper concentrates, scrap	Mitsubishi-type smelting, separation and converting furnaces. Hazelett continuous cast anodes. Incremental expansion increased capacity to 140 000 t/y in 1999.
Noranda Inc. Horne smelter Rouyn-Noranda, Quebec	Copper anodes	200 000 t/y	Copper concentrates, scrap	New continuous converter commissioned in 1997.
Hudson Bay Mining and Smelting Co., Limited Flin Flon, Manitoba	Copper anodes	90 000 t/y	Copper concentrates	Five roasting furnaces, one reverberatory furnace and two converters. Modernization planned but delayed indefinitely.
Total capacity December 2002		585 000 t/y		
Noranda Inc. Gaspé smelter Murdochville, Quebec	Copper anodes	Closed April 2002, capacity was 135 000 t/y	Copper concentrates	Green charge reverberatory furnace, three converters, one rotary anode furnace and an acid plant.
Thus, total capacity in January 2002 was		620 000 t/y		

Source: Data were provided by the companies listed.
(1) Copper in matte, blister and anode.

TABLE 6. COPPER REFINERIES IN CANADA, 2002

Company and Location	Rated Annual Capacity	Remarks
	(tonnes)	
CCR refinery Noranda Inc. Montréal-Est, Quebec	360 000	Refines anodes from Noranda's Horne and Gaspé smelters, and also from purchased scrap and anode scrap. Precious metals, selenium and tellurium are recovered from slimes. Modernization program completed in July 1999 raised capacity to 360 000 t/y.
Inco Limited Copper Cliff, Ontario	140 000	Casts and refines anodes from molten converter copper from the Copper Cliff smelter and also refines purchased scrap. Gold, silver, selenium and tellurium cake are recovered from anode slimes. Recovers and electrowins copper from Copper Cliff nickel refinery residue. Annual capacity is a function of copper content in concentrates produced.
Inco Limited Copper Cliff, Ontario	9 000	Electrowinning plant processes copper-bearing fluids.
Falconbridge Limited Timmins, Ontario	145 000	Refines anodes from the Kidd Creek smelter. Incremental expansion increased capacity to 147 000 t/y in 2000.
Total	654 000	
Taseko Mines Limited McLeese Lake, British Columbia	2 000	Dissolved copper-in-solution from heap leaching operations is treated in a solvent extraction plant and then electrowinned to produce copper cathode. Production suspended in December 1998. Operation sold to Taseko Mines Limited in April 1999. Studies under way for 30 000-t/y hydrometallurgical plant.

Source: Data for active facilities were provided by the companies listed in early 2003, and data for Taseko Mines were taken from the 2002 Annual Information Form.

TABLE 7. MONTHLY COPPER PRICES, 2001 AND 2002

	LME Grade A (1)		COMEX HG (2)	
	2001	2002	2001	2002
	(US$/t rounded to nearest $1)			
January	1 788	1 504	1 845	1 538
February	1 766	1 562	1 718	1 513
March	1 739	1 605	1 765	1 643
April	1 664	1 590	1 682	1 612
May	1 682	1 596	1 694	1 544
June	1 608	1 648	1 600	1 680
July	1 525	1 590	1 531	1 595
August	1 464	1 480	1 485	1 495
September	1 426	1 479	1 442	1 422
October	1 377	1 484	1 393	1 440
November	1 428	1 582	1 457	1 448
December	1 472	1 596	1 495	1 596

Source: International Copper Study Group, *ICSG Copper Bulletin*, December 2001, July 2002 and May 2003.
Notes: (1) Settlement price. (2) 1st position.

TABLE 8. YEARLY AVERAGE COPPER PRICES,[1] 1980-2002

	LME
	(current US¢/lb)
1980	2 182.6
1981	1 743.5
1982	1 477.1
1983	1 592.8
1984	1 376.1
1985	1 416.5
1986	1 374.2
1987	1 780.2
1988	2 601.5
1989	2 845.8
1990	2 660.2
1991	2 337.9
1992	2 280.6
1993	1 912.6
1994	2 307.2
1995	2 930.2
1996	2 293.9
1997	2 276.2
1998	1 653.8
1999	1 572.9
2000	1 813.4
2001	1 577.8
2002	1 557.5

Source: International Copper Study Group.
(1) Grade A, Cash.