Canadian Reserves of Selected Major Metals, and Recent Production Decisions

Alan Reed

The author is with the Minerals and Metals Sector, Natural Resources Canada.
Telephone: (613) 995-9071
E-mail: areed@nrcan.gc.ca

RESERVES OF SELECTED MAJOR METALS

Levels of Canadian reserves of gold, nickel and zinc in ores were all slightly higher in December 1995 compared with the revised figures for 1994. However, Canadian reserves of copper, lead, silver and molybdenum decreased during 1995 (Table 1).

Given the new production decisions announced during 1996 and those expected in 1997 and beyond, the high level of mineral deposit appraisal activity that is taking place, and the large number of projects that have advanced to the production feasibility stage, reserve levels for most of the major metals appear likely to increase again in the foreseeable future.

Reserves Policy

Canadian reserves are estimated from information contained in annual and other corporate reports, and from the responses of mining companies to the annual Federal-Provincial Survey of Mines and Concentrators.

Reserves reported here include only metal contained in material that is classified by companies as "proven" or "probable" (or their equivalents) at producing mines and in deposits that are firmly committed to production (Table 2). Metal contained in mineral resources classified by companies as "possible" (or its equivalents) is not included in national totals, nor is metal contained in deposits that have not advanced beyond the deposit appraisal phase (Figure 1). When available, only metal contained in mineable ore is included in Canadian totals so as to exclude losses inherent in the mining process. Every effort is made to achieve, from year to year, consistency in the reserves reported here; however, consistency ultimately depends on industry practice that has evolved over the years. Imperial units reported by companies have been converted to metric units and the results have been rounded to the appropriate number of significant digits.

Reserves by Commodity

Gold

There were almost 1540 t of gold contained in Canadian mine reserves in December 1995. This represents a 1.8% increase compared with revised totals for December 1994.

The gold reserves of eight projects, for which production decisions were announced during 1995, were added to Canadian totals at year-end (Table 3). The largest single gross addition, 62 t of gold, resulted from the inclusion of reserves from the Pamour pit expansion and the Matachewan mine of Royal Oak Mines Inc. in Ontario. The announced re-opening of the Bissett (San Antonio) mine at Bissett in Manitoba by Rea Gold Corporation added 25.1 t of gold to the reserves, and the production decision at Viceroy Resource Corporation's Brewery Creek heap leach project in the Klondike district of the Yukon Territory added a further 25 t. Smaller additions were provided by the production decisions at the Beaufor mine (Aurizon Mines Ltd., 5.1 t of gold) and the Bell Allard mine (Noranda Mining and Exploration Inc., 2.4 t of gold) in Quebec; the Bralorne mine (Bralorne-Pioneer Gold Mines Ltd., 4.6 t of gold) in British Columbia; the Photo Lake mine (Hudson Bay Mining and Smelting Co., Limited, 2.5 t of gold) in Manitoba; and the Rambler mine tailings vat leach project (Electra Mining Consolidated Ltd., 1.6 t of gold) in Newfoundland.

Silver

Canadian reserves of silver decreased slightly during 1995 to almost 19 073 t, about 0.4% lower than the previous year's level. This decrease is due to slightly lower reserves in deposits where silver is a minor constituent. There were no new production decisions on silver deposits in 1995.

Zinc

Canadian reserves of zinc increased to about 14.7 Mt at year-end, up by about 1.4% compared to the

Figure 1
Generalized Model of the Process of Mineral Resource Development and Mining

PHASES	MINERAL RESOURCE ASSESSMENT	MINERAL EXPLORATION					MINERAL DEPOSIT APPRAISAL				DEVELOPMENT OF MINE COMPLEX	MINERAL PRODUCTION	ENVIRON-MENTAL RESTORATION
	MRA	EX-1	EX-2	EX-3	EX-4	EX-5	DA-1	DA-2	DA-3	DA-4	MC	MP	ER
STAGES	Surveys, research, synthesis.	Exploration planning.	Regional reconnaissance and surveys.	Prospecting and ground survey of anomalies.	Verification of anomalies and showings.	Discovery and delimitation.	Deposit definition.	Project engineering.	Project economics.	Feasibility study. Production decision.	Construction of plant and infra-structure. Mine preparation.	Production, marketing, new development.	Mine closure. Site reclamation and restoration.
OBJECTIVES	Supply informa-tion and tools required to develop the mineral potential of the nation for economic bene-fit, in the perspective of sustained development.	Select target commodities. Establish exploration objectives and strategies. Select target areas.	Find regional and more local-ized anomalies. Select significant targets.	Acquire proper-ties. Confirm presence, exact location and characteristics of anomalies.	Acquire addi-tional properties as required. Verify and con-firm anomalies. Find mineral showings.	Discover, con-firm and delimit a mineral deposit of economic interest. Evalu-ate technical and economic poten-tial in a prelimi-nary fashion.	Define the grade, limits, internal distribution, controls and the mineralogy-processing parameters of a mineral deposit. Acquire data to support engi-neering planning.	Establish tech-nical feasibility. Prepare realistic plans, schedules, investment-cost and operating-cost estimates for all aspects of a project.	Establish para-meters for economic and financial evaluation.	Ensure validity of project data, assumptions and evaluation results. Decide whether or not to undertake a mining project at this time. Obtain the required permits. Obtain financing.	Complete mine development and construction on schedule and within budget. Ensure efficient and timely mine and concentrator start-up.	Achieve planned rate and speci-fications of commercial production on schedule and within budget. Achieve mine profitability, company survival and sustained development.	Restore mine site to an environmentally acceptable condition.
EVALUATION METHODS	Geoscientific, mineral and economic sur-veys, research, compilations and synthesis by governments, research institutes and universities.	Metal and mineral market research. Review of geological and ore deposit information for various areas. Review legal and political context. Use of deduction and intuition.	Satellite imagery, aerial photo-graphy and airborne geophysics. Prospecting, geology and geochemistry. Appraisal, rating and selection of anomalies.	Ground-based geological, geo-chemical and geophysical prospecting and surveys. Review and selection of significant anomalies.	Geological mapping and other surveys. Trenching and sampling. Review of results and selection of targets.	Stripping, trench-ing, detailed mapping, sampl-ing, drilling and down-hole geo-physics. Prelimi-nary deposit inventory and evaluation. Environmental characterization and site surveys.	Detailed map-ping, sampling and drilling on surface or from underground. Systematic mineral processing tests. Detailed environ-mental and site surveys.	Pilot tests and engineering studies. Design and cost estimation for mining, ore concentration, metal extraction, infrastructure, protection of the environment and restoration.	Market, price, cost and other financial studies. Technical, environmental, economic, financial, social and political risk analysis.	Exhaustive due diligence review of geological, engineering, environmental, economic, legal and site data. Evaluation of profitability, risks and up-side factors of a project.	Project and quality manage-ment methods. Training program for personnel and detailed start-up plan.	Production management using continuous quality improve-ment methods. Exploration, appraisal and development of new ore zones, both on-property and off-property.	Mine closure and decommission-ing. Environ-mental restora-tion and monitoring.
RESULTS	Geoscientific, mineral and economic data-bases, maps and models.	Exploration projects.	Regional anomalies.	Local anomalies.	Mineral showings.	Mineral deposit.	Deposit appraisal project.			Mining project.	Mining plant.	Mineral production.	Restored site.
FEASIBILITY STUDIES						Expected margin of error of estimates at the 90% confidence level: ±100%	±60%	±40%	±20%	±10%		±5%	Full compliance
INVESTMENT AND RISK	Moderate	Low but increasing investment. Very high, but decreasing risk of failure and financial loss.					Much larger and increasing investment. High, but decreasing risk of failure.				Large industrial investment. Low to moderate industrial risk.		
MINERAL INVENTORY	Undelimited mineral resources						Delimited mineral resources				Ore reserves		Delimited mineral resources
	Speculative	Hypothetical				Inferred	Indicated and measured				Proven and probable		

Sources: Modified by D.A. Cranstone, A. Lemieux and M. Vallée, February 25, 1994, from M. Vallée, 1992, *Guide to the Evaluation of Gold Deposits*, CIM Special Volume 45, p. 4, and *SOQUEM Annual Report*, 1976-77, pp. 4-5. Revised by M. Vallée March 8, 1996.

previous year. The largest contributors to the 1995 increase were the Bell Allard and Isle Dieu Mattagami mines of Noranda Mining and Exploration Inc. in Quebec, and the Pick Lake deposit of Inmet Mining Corporation at Winston Lake in Ontario. Reserves decreased at most of the other zinc-producing mines in Canada. The most notable reductions occurred at Cominco Ltd.'s Polaris mine on Little Cornwallis Island in the Northwest Territories, and at the Sullivan mine in Kimberley, British Columbia. Operations at these two mines are at an advanced stage and, as a consequence, reserves have been falling gradually for several years. Sullivan has been in operation since 1909, and Polaris since 1982.

The Geco mine owned by Noranda Mining and Exploration Inc. in Ontario closed after nearly 40 years of production.

Lead

Canadian reserves of lead decreased by approximately 5.2% in 1995, largely as a result of production not being replaced at the Sullivan and Polaris mines.

The only mines to report a net increase in lead reserves during 1995 were the Heath Steele-Stratmat (Noranda Mining and Exploration Inc., New Brunswick), Isle Dieu Mattagami (Noranda Mining and Exploration Inc., Quebec), and Myra Falls (Westmin Resources Ltd., British Columbia) mines. These increases were relatively modest.

Copper

In December 1995, Canadian reserves of copper were estimated at about 9.3 Mt, or down by about 3% from a revised figure of about 9.5 Mt a year earlier. This reduction is largely because production was not replaced at some of the larger mines, and because of the closure of the Geco mine in Ontario and the Island Copper and Goldstream mines in British Columbia.

New production decisions were announced in 1995 for the Raglan deposits in Quebec by Falconbridge Limited, for the Bell Allard mine in Quebec by Noranda Mining and Exploration Inc., for the Pick Lake deposit in Ontario by Inmet Mining Corporation, and for the Photo Lake mine in Manitoba by Hudson Bay Mining and Smelting Co., Ltd. Deep drilling at the Highland Valley mine near Kamloops, British Columbia, found 200 Mt of possible ore that may become mineable reserves in the future. Highland Valley is owned by Cominco Ltd., Highmont Mining Company, Rio Algom Limited and Teck Corporation.

Molybdenum

Canadian reserves of molybdenum stood at 129 000 t in December 1995, or about 12.8% lower than in the previous year. The decrease occurred because 1995 production was only partially replaced by new-found ore, and because the Island Copper mine in British Columbia closed due to the depletion of its ore reserves.

At the end of 1995 there were only three Canadian mines, all located in British Columbia, producing ore containing molybdenum. These were Placer Dome's Endako mine, which produces only molybdenum, and the Highland Valley mine and the Gibraltar mine that produce molybdenum as a co-product of copper mining.

Nickel

In December 1995, there were some 5.8 Mt of nickel contained in Canadian mine reserves, up by approximately 9% from the levels of 1994. This increase is largely due to the production decision announced by Falconbridge Limited for the Raglan deposits in the Ungava region of Quebec.

Inco Limited had some 4.9 Mt of nickel in Canadian reserves at the end of 1994, or more than 80% of the national total. Inco appears to have replaced all of the 135 000 t of nickel that it mined in the Sudbury area of Ontario during 1995 and to have added about 150 000 t to its total reserves in Ontario. At Thompson, Manitoba, Inco's production of 34 000 t of nickel does not appear to have been replaced in 1995. Considerable potential remains for additions to reserves in both of these provinces.

The development of the copper-nickel-cobalt deposits at Voisey's Bay in Labrador will make major additions to Canada's mineable reserves of these metals in the near future.

Canadian Reserves by Province and Territory

Three provinces (Ontario, British Columbia and New Brunswick) held dominant positions in terms of Canada's proven and probable mineable reserves of major metals in December 1995 (Table 4). Ontario had 72% of the nickel, 55% of the gold and 47% of the copper, plus 20% of the silver and 12% of the zinc. British Columbia had 100% of the molybdenum, 31% of the copper and 25% of the silver, plus 15% of the lead, 10% of the zinc and 8% of the gold. New Brunswick had 57% of the lead, 36% of the zinc and 32% of the silver, plus 2% of the copper and 3% of the gold. Quebec had 20% of the zinc, 19% of the gold, 15% of the copper, 8% of the nickel and 14% of the silver. Manitoba had 21% of the nickel, 6% of the copper and 5% of the gold, plus 4% of the copper and 2% of the silver. The Yukon Territory had 21% of the lead, 9% of the zinc, 6% of the silver and 3% of the gold. The Northwest Territories had 7% of the zinc, 6% of the lead and 6% of the gold.

Canadian Reserves by Industry

Canadian mines are, to a large extent, polymetallic, a complexity that the Standard Industrial Classification (SIC) tends to oversimplify (Table 5).

Current mine reserves of gold in Canada are distributed through the various SIC classes as follows: gold mines, 83%; copper and copper-zinc mines, 6%; nickel-copper mines, 5%; and zinc-lead-silver mines, 5%. Current mine reserves of silver in Canada are distributed through the various SIC classes as follows: gold mines, 18%; copper and copper-zinc mines, 30%; nickel-copper mines, 10%; and zinc-lead-silver mines, 42%. Current mine reserves of copper in Canada are distributed through the various SIC classes as follows: gold mines, 2%; copper and copper-zinc mines, 54%; nickel-copper mines, 41%; and zinc-lead-silver mines, 3%. Current mine reserves of nickel in Canada are contained entirely in the SIC class of nickel-copper mines. Current mine reserves of lead in Canada are contained in the SIC classes as follows: copper and copper-zinc mines, 4%; and zinc-lead-silver mines, 96%. Current mine reserves of zinc in Canada are contained in the SIC classes as follows: copper and copper-zinc mines, 39%; and zinc-lead-silver mines, 61%. Current mine reserves of molybdenum in Canada are contained in the SIC classes as follows: copper and copper-zinc mines, 37%; and molybdenum mines, 63%.

Apparent Life of Canadian Reserves

The apparent life (life index) of mine reserves is usually calculated by dividing the total amount of metals remaining in mine reserves at the end of a given year by the corresponding amount of metals contained in the ores produced during that year. Similar calculations are often applied at the national level.[1]

At the national level, life indices are but a very rough measure of the expected life of aggregate mine reserves, and they are often misleading unless abnormal situations are recognized. Life indices based on proven and probable reserves do not make allowances for inferred extensions to reserves at current mines, gross additions that will accrue to current reserves from the likely development, in the foreseeable future, of known orebodies for which a production decision has yet to be made, or expected changes in production rates. Furthermore, life indices tend to overstate the apparent life of reserves when, for example, annual production is abnormally low due to strikes, cutbacks or suspensions at large establishments, or when significant increases in capacity resulting from new production decisions will be coming on stream, but only several years hence.

The apparent life indices for the major metals in Canada at the end of 1995 were 27 years for nickel, 12 years for copper, 12 years for zinc, 12 years for lead, 12 years for silver, 10 years for molybdenum, and 9 years for gold.

Reserve Trends

Reserves at most mines change slightly from year to year. It is usually a small number of mining operations with large changes in reserves that affect the overall direction of national trends.[2]

Canadian reserves of copper, lead, molybdenum, nickel, silver and zinc have declined steadily since the early 1980s. In contrast, gold reserves increased substantially until 1988, before starting a gradual decline (Figure 2, Table 6). In 1994, these trends were partially reversed by increases in the Canadian reserves of zinc, gold and silver. In 1995, Canadian reserves of zinc and gold continued to increase, while those of silver declined very slightly. Canadian reserves of nickel increased substantially in 1995, but reserves of copper, lead and molybdenum continued their gradual decline.

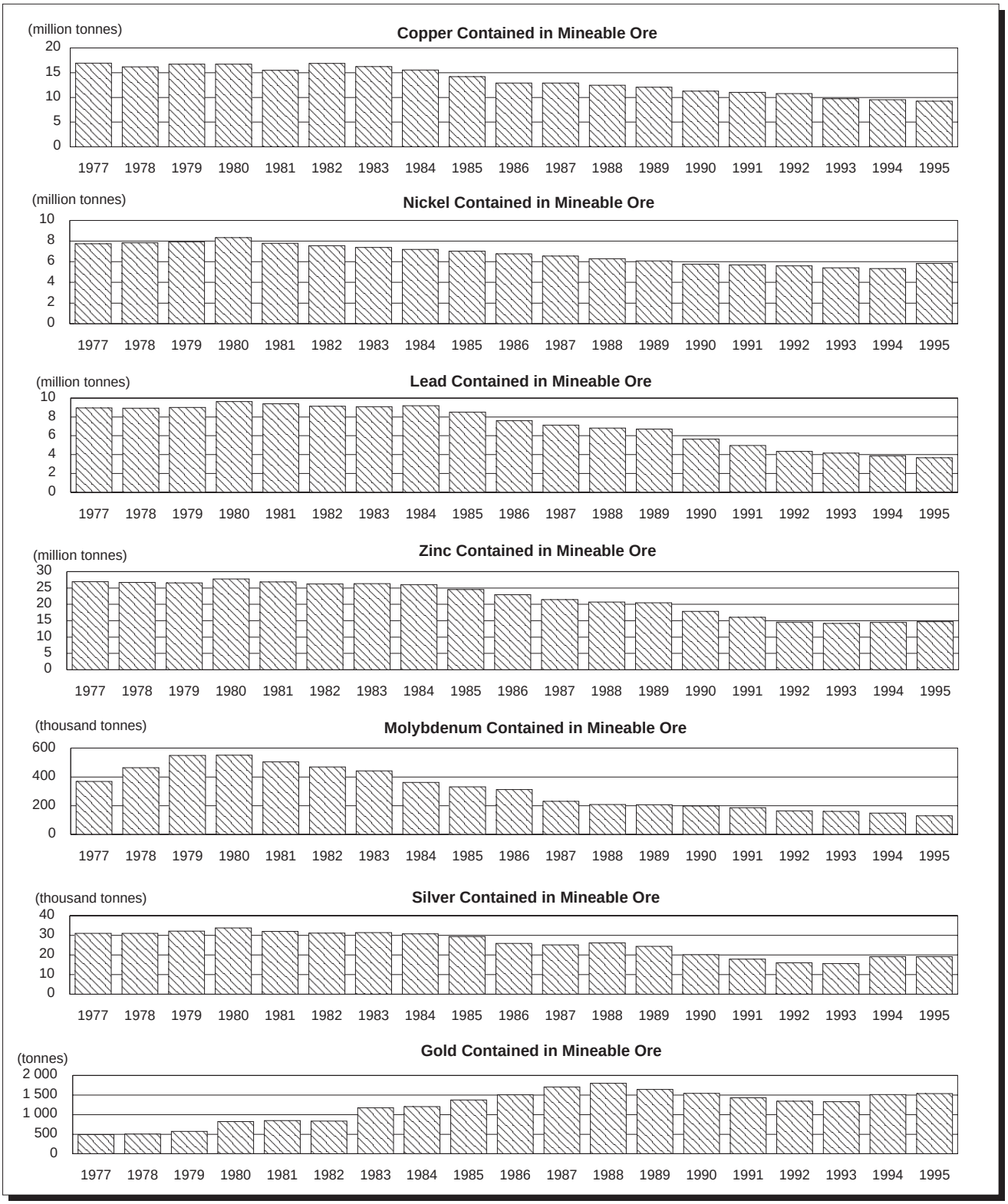
The annual aggregate change in Canadian reserves is the net result of three main factors affecting individual mines (Figure 3): additions to reserves, deletions to reserves, and production. Additions to reserves are the result of new discoveries; of new geological, metallurgical, production or other information; of a decrease in production costs; or of a rise in commodity prices, all of which increase the quantity of mineral resources that are profitable to mine. Deletions to reserves are the result of new geological, metallurgical, production or other information; of increases in costs; or of decreases in commodity prices, all of which reduce the quantity of mineral resources previously counted in mine reserves that are now expected to be mined at a profit. Production is normally the main factor reducing the reserves at individual mines.

However, in practice, there are considerably more factors that influence reserve levels at individual mines. For example, temporary suspensions of production maintain mine reserves, a situation that occurred in the Yukon during 1994 because production at both the Faro mine and the Sa Dena Hess mine was suspended. As well, strategic decisions, such as focussing on long-term exploration programs at mine sites rather than on developing additional ore immediately, can result in decreases in reserves in the short term, but in large increases in reserves in the longer term.

RECENT PRODUCTION DECISIONS

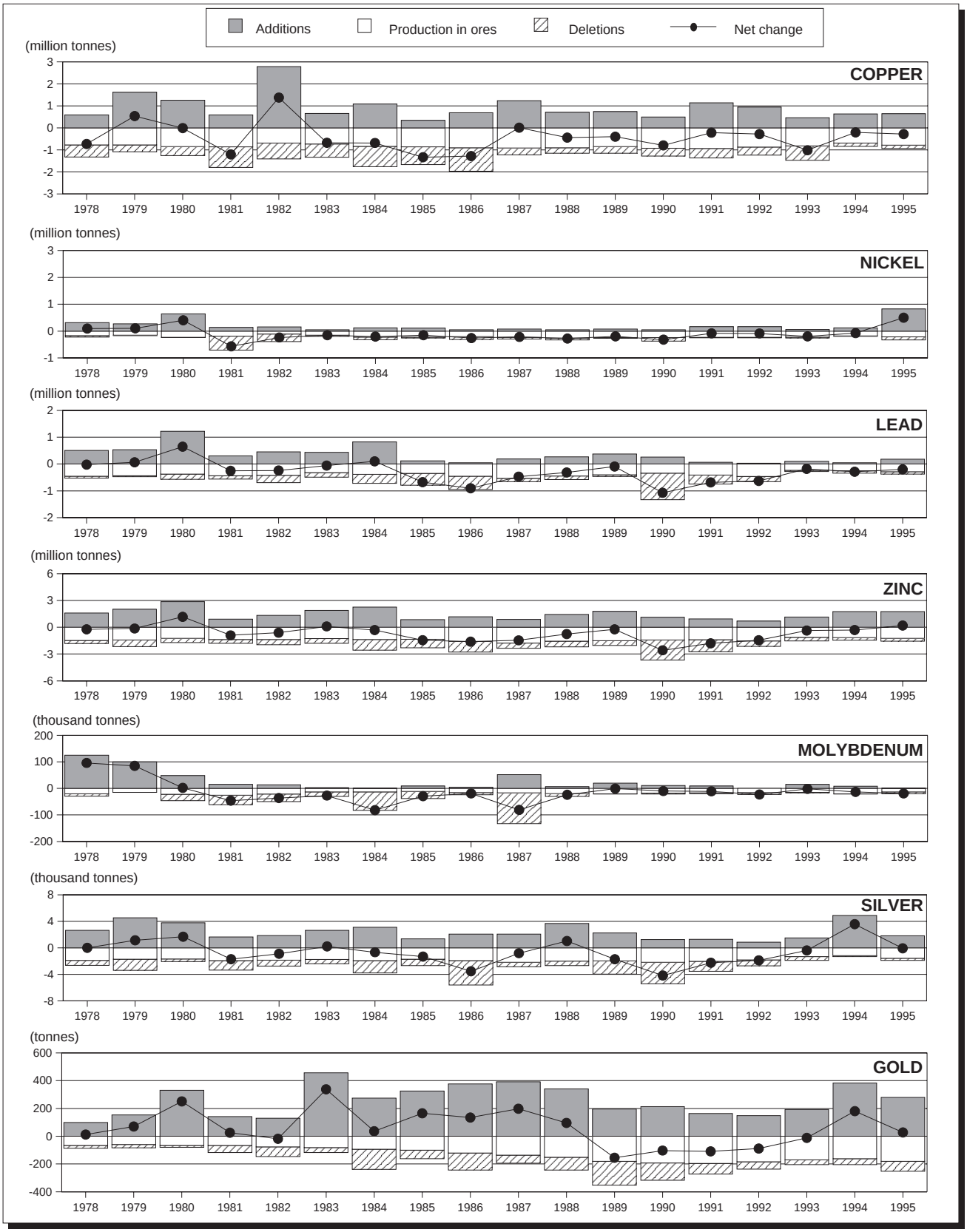
Apart from the likely additions to reserves that will result from development and exploration currently taking place at existing mines or from discoveries made elsewhere, production decisions announced during 1996 will maintain Canadian reserves of some metals at close to their current levels, if not increase them somewhat over the next few years.

Figure 2
Canadian Reserves of Selected Major Metals, 1977-95
Metal Contained in Proven and Probable Mineable Ore in Operating Mines and Deposits Committed to Production, as at December 31 of Each Year



Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.
Note: This series was revised during 1996.

Figure 3
Main Components of Change in Canadian Reserves of Selected Major Metals, 1978-95



Source: Natural Resources Canada.

Several criteria need to be met for a project to be considered here to have reached the production decision stage. In general, there needs to have been a positive production feasibility study, all of the necessary permits must have been obtained, financing must have been arranged, and directors must have approved construction.

During 1996, thirteen precious-metal and five base-metal production decisions were announced in Canada (Table 7). Several production decisions are expected during 1997 and in subsequent years, which is reflected in the higher levels of mine investment expected in the foreseeable future in Canada.[3] The Voisey's Bay deposit of Inco Limited in Labrador is scheduled to begin producing concentrate in late 1999 and refined nickel in early 2000, but is not included in the production decisions of 1996 because not all of the necessary permits and agreements were in place at that time.

OUTLOOK

During 1995, the mine reserves of gold, zinc and nickel increased to maintain the recovery that began in 1994. The rate of decline of the mine reserves of other metals slowed, and it appears likely that future production decisions to be made concerning a number of advanced projects currently being investigated will result in increases in the mine reserves of most of the metals in the next few years.

The Voisey's Bay nickel-copper-cobalt deposit has established reserves in the Ovoid zone of 32 Mt grading 2.83% nickel, 1.68% copper and 0.12% cobalt. The Eastern Deeps zone has an indicated resource of 50 Mt grading 1.36% nickel, 0.67% copper and 0.09% cobalt, and it is estimated that the property contains an inferred resource of 150 Mt. If these figures are confirmed, the Ovoid zone will increase Canada's nickel reserves by about 15%, and the Eastern Deeps zone will add a further 11%.

REFERENCES

1 An analysis of the life index of Canadian reserves of copper, nickel, lead, zinc, molybdenum, silver and gold as of December 1994 and based on 1994 metal production rates in ores can be found in André Lemieux, "Canadian Reserves of Selected Major Metals, Recent Production Decisions, Mine Investment, and Deposits Promising for Future Production" in the 1994 edition of the *Canadian Minerals Yearboo*k, Natural Resources Canada, Ottawa, pp. 4.4 and 4.5.

2 The distribution of net changes in mine-by-mine reserves of Canadian gold mines during 1988 can be found in André Lemieux, "Canadian Reserves, Mine Investment, New Projects and Promising Deposits" in the 1989 edition of the *Canadian Minerals Yearbook*, Energy, Mines and Resources Canada, Ottawa, p. 5.25.

3 An analysis of mine investment in Canada over the interval 1969-95 can be found in André Lemieux, "Canadian Reserves of Selected Major Metals, Recent Production Decisions, Mine Investment, and Deposits Promising for Future Production" in the 1994 edition of the *Canadian Minerals Yearbook*, Natural Resources Canada, Ottawa, pp. 4.5-4.13.

Note: Information in this review was current as of February 14, 1997.

TABLE 1. MAIN COMPONENTS OF CHANGE DURING 1995 IN CANADIAN RESERVES OF SELECTED MAJOR METALS

Metal	Units	Revised Opening Metal Balance, January 1995	Metal in Ore Mined During 1995	Metal Apparently Written Off During 1995	Metal in New Reserves Found During 1995	Net Change During 1995	Closing Metal Balance, December 1995	% Change During 1995
Copper	000 t	9 533	–781	–151	649	–283	9 250	–3.0
Nickel	000 t	5 334	–212	–119	829	498	5 832	+9.3
Lead	000 t	3 861	–288	–89	176	–201	3 660	–5.2
Zinc	000 t	14 514	–1 235	–316	1 750	198	14 712	+1.4
Molybdenum	000 t	148	–13	–7	1	–19	129	–12.8
Silver	t	19 146	–1 656	–314	1 806	–73	19 073	–0.4
Gold	t	1 513	–180	–72	279	+27	1 540	+1.8

Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.
Note: May not balance due to rounding.

TABLE 2. TONNAGES AND GRADES OF OPERATIONS INCLUDED IN CANADIAN RESERVES OF SELECTED MAJOR METALS, AS AT DECEMBER 31, 1995

Tonnages classified by companies as "possible" are not included where they are reported separately from proven and probable tonnages, nor are tonnages for deposits for which there is no firm production decision. Data reported in imperial units were converted to metric units and rounded to the corresponding number of significant digits. Confidential data have been suppressed from the details of this report.

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
NEWFOUNDLAND								
Hope Brook Underground								
Royal Oak Mines Inc.								
Mineable	2 221 000	..					..	3.
Rambler								
Ming Minerals Inc.								
Ming West	134 000	5.29					15.	2.1
Rambler (Tailings Vat Leach)								
Electra Mining Consolidated Ltd.								
Raymo Processing Ltd.								
Proven	1 148 000							1.4
NEW BRUNSWICK								
Brunswick No. 12 Underground								
Noranda Mining and Exploration Inc.								
Proven mineable	55 035 000	0.32		3.64	9.11		104.	..
Heath Steele-Stratmat								
Noranda Mining and Exploration Inc.								
Proven mineable	1 943 000	0.81		2.03	7.16		74.4	
Probable mineable	2 001 000	0.94		1.82	6.77		82.6	
QUEBEC								
Beaufor								
Aurizon Mines Ltd.								
Louvem Mines Inc.								
Proven-probable	573 000						..	8.95
Bell Allard								
Noranda Mining and Exploration Inc.								
N/S	3 200 000	1.5			13.77		43.44	0.765
Bouchard-Hébert (Mobrun 1100 Lens)								
Audrey Resources Inc.								
Proven-probable	10 452 000	0.83			4.31		40.5	1.3
Bousquet No. 1								
Barrick Gold Corporation[1]								
..	..						..	..
Bousquet No. 2								
Barrick Gold Corporation[1]								
..	..	..					..	..
Casa Berardi Est								
Golden Knight Resources Inc.								
TVX Gold Inc.								
Proven-probable-possible mineable	990 233						..	6.
Casa Berardi Ouest								
Golden Knight Resources Inc.								
TVX Gold Inc.								
Proven-probable-possible mineable	1 325 783						..	5.5
Chimo								
Cambior inc.								
Proven	438 000						0.2	4.5
Copper Mountain Oxide								
Noranda Mining and Exploration Inc.								
Probable mineable	19 152 000	0.44					..	
Copper Rand								
MSV Resources Inc.								
Proven	1 315 100	1.6					..	2.5
Probable	87 770	2.04					..	1.3
Donald J. Laronde (Dumagami)								
Agnico-Eagle Mines Limited								
Proven	2 451 080	0.78					21.3	6.2
Probable	2 958 610	0.54					57.3	5.8

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
QUEBEC (cont'd)								
Doyon								
Barrick Gold Corporation								
Cambior inc.								
Proven and probable	4 756 000							5.5
Eastmain								
MSV Resources Inc.								
..	..	..					..	..
Francoeur								
Richmont Mines Inc.								
Proven and probable	800 000						..	6.82
Gonzague Langlois (Grevet)								
Cambior inc.								
Proven-probable-possible	10 653 000	0.46			8.41		37.	0.1
Isle Dieu Mattagami								
Noranda Mining and Exploration Inc.								
..	..	..		..	..		..	..
Joe Mann								
Campbell Resources Inc.								
Probable geological	306 000	0.26					..	9.02
Proven geological	746 000	0.28					..	8.85
Joubi-Dubuisson								
Western Quebec Mines Inc.								
Proven Joubi-Dubuisson	29 910						..	4.29
Probable Joubi-Dubuisson	104 620						..	5.69
Kiena								
Placer Dome Canada Limited								
Proven-probable	3 671 000						..	4.8
Louvicourt								
Aur Resources Inc.								
Novicourt Inc.								
Teck Corporation								
Mineable	14 000 000	3.7			1.5		29.	0.86
Mouska								
Cambior inc.								
Proven and probable	193 000						..	8.71
Murdochville Townsite								
Noranda Mining and Exploration Inc.								
Proven E zone	2 780 000	2.88					14.	..
Probable E zone	965 000	4.12					20.	..
Needle Mountain Open Pit								
Noranda Mining and Exploration Inc.								
..	..	..						
Needle Mountain Underground								
Noranda Mining and Exploration Inc.								
Proven	150 000	1.56					5.1	..
Norita East								
Noranda Mining and Exploration Inc.								
..	..	..		..	..		..	..
Portage								
MSV Resources Inc.								
Proven	275 010	1.77					..	4.8
Probable	4 580	1.89					..	4.42
Raglan								
Falconbridge Limited								
Proven mineable	4 488 000	0.88	3.41					
Probable mineable	8 834 000	0.87	3.06					
Selbaie (Detour) A1 Open Pit								
Billiton Metals Canada Inc. (Gencor Ltd.)								
..	..	..		..	..		..	..
Sigma No. 1								
Placer Dome Canada Limited[2]								
..	..						..	..

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
QUEBEC (cont'd)								
Sigma No. 2								
Placer Dome Canada Limited[2]								
..	..						..	..
Silidor								
Battle Mountain Gold Company								
Cambior inc.								
Proven	384 000						..	4.8
Probable	233 000						..	4.5
Sleeping Giant								
Aurizon Mines Ltd.								
Cambior inc.								
Proven mineable	180 000						..	9.9
Probable mineable	446 000						..	9.9
Troilus (Lac Frotet)								
Inmet Mining Corporation								
Proven-probable mineable	43 600 000	0.12					1.36	1.35
ONTARIO								
Campbell								
Placer Dome Canada Limited								
Proven-probable	4 500 000						..	18.
Cheminis								
Northfield Minerals Inc.								
..	..						..	..
Craig								
Falconbridge Limited[3]								
..	..	..	..				..	..
David Bell								
Homestake Canada Inc.								
Teck Corporation								
Proven-probable	5 400 000						..	11.
Detour Lake								
Placer Dome Canada Limited								
Proven-probable	3 191 000						..	4.9
Dome (including Paymaster)								
Placer Dome Canada Limited								
Proven-probable	33 808 000						..	3.
Eagle River								
River Gold Mines Ltd.								
Proven and probable	1 053 000						..	13.
Fraser								
Falconbridge Limited[3]								
..	..	..	..				..	
Golden Giant								
Battle Mountain Gold Company								
Proven mineable	8 815 000						..	11.
Probable mineable	1 135 000						..	14.
Golden Patricia								
Barrick Gold Corporation								
Proven-probable	93 000						..	13.8
Holloway								
Battle Mountain Gold Company								
Teddy Bear Valley Mines Ltd.								
Proven mineable	1 998 000						..	7.75
Probable mineable	3 768 000						..	6.2
Holt-McDermott								
Barrick Gold Corporation								
Proven-probable	2 805 000						..	8.06

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
ONTARIO (cont'd)								
Hoyle Pond								
Kinross Gold Corporation								
Proven and probable	1 664 000						..	12.5
Inco Ontario Division								
Inco Limited[4]								
..	..	..	..				..	..
Kerr Addison								
AJ Perron Gold Corp.								
Proven-probable	410 810						..	3.98
Kidd Creek No. 1								
Falconbridge Limited[5]								
..	..	..		..	..		..	
Kidd Creek No. 2								
Falconbridge Limited[5]								
..	..	..		..	..		..	
Kidd Creek No. 3								
Falconbridge Limited[5]								
..	..	..		..	..		..	
Lac-des-Îles (palladium-platinum)								
North American Palladium Ltd.								
Sheridan Platinum Group, The								
Probable Roby and C zones	8 100 000	..	..					..
Lake Shore (tailings)								
Kinross Gold Corporation								
Proven	334 000							2.4
Probable	103 000							2.1
Lindsley (Thayer Lindsley)								
Falconbridge Limited[5]								
..	..	..	..	..			..	..
Lockerby								
Falconbridge Limited[5]								
..	..	..	..				..	..
Macassa								
Kinross Gold Corporation								
Proven-operating area	1 000 000							10.
Proven no. 3 shaft pillar	224 000							15.
Probable	141 000							20.
Red Lake (Arthur W. White)								
Goldcorp Inc.								
Proven	901 000						..	11.
Probable	1 323 000						..	12.
Redstone								
Black Hawk Mining Inc.								
Proven mineable	55 287		2.57					
Probable	118 076		3.67					
Royal Oak Ontario Division								
Royal Oak Mines Inc.								
Mineable	46 924 000						..	1.7
Strathcona								
Falconbridge Limited[5]								
..	..	..	..				..	..
Williams								
Homestake Canada Inc.								
Teck Corporation								
Proven-probable	33 353 000						0.3	5.14
Winston Lake (includes Pick Lake)								
Inmet Mining Corporation								
Proven-probable	1 300 000	0.91			15.50		35.62	0.65

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
MANITOBA								
Bissett (San Antonio)								
Rea Gold Corporation								
Mineable	2 900 000						..	8.64
Callinan								
Hudson Bay Mining and Smelting Co., Limited								
..	..	..			..		..	..
Chisel Lake North								
Hudson Bay Mining and Smelting Co., Limited								
..	..	..			..		..	..
Chisel Lake Underground								
Hudson Bay Mining and Smelting Co., Limited								
..	..	..		..	..		..	
Inco Manitoba Division								
Inco Limited[4]								
..	..	..	..				..	..
Keystone								
Black Hawk Mining Inc.								
Granduc Mining Corporation								
Mineable Farley Lake	1 449 000						..	3.91
Mineable Burnt Timber	198 500							2.8
New Britannia (Nor-Acme/Snow Lake)								
High River Gold Mines Ltd.								
TVX Gold Inc.								
Mineable	3 921 000						..	6.41
Photo Lake								
Hudson Bay Mining and Smelting Co., Limited								
..	..	..			..		..	..
..	..	..			..		..	..
Ruttan								
Hudson Bay Mining and Smelting Co., Limited								
..	..	..			..		..	..
Trout Lake								
Hudson Bay Mining and Smelting Co., Limited								
..	..	..			..		..	..
Westarm								
Hudson Bay Mining and Smelting Co., Limited								
..	..	..			..		..	..
SASKATCHEWAN								
Contact Lake								
Cameco Corporation								
Uranerz Exploration and Mining Limited								
Mineable Contact Lake	624 000						..	7.5
Seabee								
Claude Resources Inc.								
..	..						..	..
BRITISH COLUMBIA								
Afton								
Teck Corporation								
Mineable	5 800 000	0.46					..	0.3
Bralorne								
Bralorne-Pioneer Gold Mines Ltd.								
International Avino Mines Ltd.								
Proven-probable	432 577						..	11.

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
BRITISH COLUMBIA (cont'd)								
Endako								
Placer Dome Canada Limited								
Proven-probable	104 840 000					0.077		
Eskay Creek								
Prime Resources Group Inc.								
Proven and probable	1 020 000						2 860.	64.32
Gilbraltar Dumps (biological leach cathode)								
Gibraltar Mines Limited								
..	..	..						
Gibraltar Open Pit								
Gibraltar Mines Limited								
Proven Gilbraltar	148 600 000	0.301				0.009	..	
Probable Gibraltar	13 800 000	0.251				0.008	..	
Highland Valley								
Cominco Ltd.								
Highmont Mining Company								
Rio Algom Limited								
Teck Corporation								
Measured-indicated	504 000 000	0.420				..	..	..
Myra Falls								
Westmin Resources Limited								
Proven-probable mineable H-W	11 150 379	1.6		..	6.1		27.5	1.5
Nickel Plate Open Pit								
Homestake Mining Company								
Proven-probable	850 000						..	2.7
Premier								
Westmin Resources Limited								
Proven-probable geological	95 000						85.7	8.2
QR (Quesnel River)								
Kinross Gold Corporation								
Proven and probable	1 287 000						..	4.35
Similco								
Princeton Mining Corporation								
Oriole reserves	2 652 000	0.437					..	..
Virginia - low strip reserves	1 305 000	0.420					..	..
Salvage from mined pits	1 020 000	0.403					..	..
Ingerbelle, Phase I	7 824 000	0.310					..	..
Snip								
Cominco Ltd.								
Prime Resources Group Inc.								
Measured-indicated	347 000						..	26.6
Sullivan								
Cominco Ltd.								
Measured-indicated	10 800 000			4.5	8.0		26.	
YUKON TERRITORY								
Brewery Creek (heap leach)								
Viceroy Resource Corporation								
Defined ore	17 136 000						0.7	1.46
Faro								
Anvil Range Mining Corporation								
Proven Vangorda	1 005 000			3.60	4.40		47.	0.93
Stockpiled	2 598 000			..	..		17.9	0.19
Probable Grum	23 138 000			2.74	4.54		45.9	0.69
Sa Dena Hes (Mount Hundere)								
Cominco Ltd.								
Teck Corporation								
Measured and indicated ore	1 400 000			2.5	10.2		43.9	

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
NORTHWEST TERRITORIES								
Colomac								
Royal Oak Mines Inc.[6]								
..	..						..	..
..	..						..	..
Con								
Miramar Mining Corporation								
Proven-probable	3 469 000						..	11.
Giant Open Pit - Giant Underground								
Royal Oak Mines Inc.[6]								
..	..						..	..
..	..						..	..
Lupin								
Echo Bay Mines Ltd.								
..	..						..	..
..	..						..	..
Nanisivik								
Nanisivik Mines Ltd.								
..	..			..	..		..	
..	..			..	..		..	
Polaris								
Cominco Ltd.								
Pine Point Mines Limited								
Measured-indicated	5 850 000			3.5	13.8			
Ptarmigan-Tom								
Treminco Resources Ltd.								
..	..						..	..

Source: Natural Resources Canada, based on published company reports.
.. Not available in published reports or estimated by author. N/S Not specified.
1 Barrick Gold Corporation reports combined ore reserves at the Bousquet complex (including Bousquet No. 1 and No. 2) as 6 912 000 t with a grade of 7.2 g/t. **2** Placer Dome Inc. reports combined ore reserves for Sigma No. 1 and Sigma No. 2 as 3 578 000 t with a grade of 3.9 g/t. **3** Falconbridge Limited reports total Sudbury Division ore reserves as 25 539 000 t with a grade of 1.55% copper and 1.67% nickel. **4** Inco Limited reports total Canadian ore reserves as 340 Mt with a grade of 1.43% nickel and 0.96% copper. **5** Falconbridge Limited reports total Kidd Creek Division ore reserves as 27 039 000 t with a grade of 2.79% copper, 5.53% zinc and 69 g/t silver. **6** Royal Oak Mines Inc. reports total Northwest Territories Division ore reserves as 13 355 000 t with a grade of 3.57 g/t gold.
Notes: One tonne (t) = 1.1023113 short tons. One gram per tonne (g/t) = 0.02916668 troy ounces per short ton.

TABLE 3. PRODUCTION DECISIONS ADDED TO CANADIAN RESERVE TOTALS AS AT DECEMBER 31, 1995

Project	Operators and Major Partners	Province	Metals
Rambler	Ming Minerals Inc.	Nfld.	Copper, silver, gold
Rambler (Tailings Vat Leach)	Electra Mining Consolidated Ltd and Raymo Processing Ltd.	Nfld.	Gold
Beaufor	Aurizon Mines Ltd. and Louvem Mines Inc.	Que.	Gold, silver
Raglan	Falconbridge Limited	Que.	Nickel, copper
Bell Allard	Noranda Mining and Exploration Inc.	Que.	Zinc, copper, silver, gold
Redstone	Black Hawk Mining Inc.	Ont.	Nickel
Bissett (San Antonio)	Rea Gold Corporation	Man.	Gold
Photo Lake	Hudson Bay Mining and Smelting Co., Limited	Man.	Copper, zinc, silver, gold
Bralorne	Bralorne-Pioneer Gold Mines Ltd. and International Avino Mines Ltd.	B.C.	Gold, silver
Brewery Creek	Viceroy Resource Corporation	Yukon	Gold, silver

Source: Natural Resources Canada, based on company reports.

TABLE 4. CANADIAN RESERVES OF SELECTED MAJOR METALS BY PROVINCE AND TERRITORY, AS AT DECEMBER 31, 1995

Metal Contained in Proven and Probable Mineable Ore[1] in Operating Mines[2] and Deposits Committed to Production

Metal	Units[3]	Nfld.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	B.C.	Y.T.[5]	N.W.T.	Canada[6]
Copper	000 t	9	–	215	1 358	4 388	402	–	2 877	–	–	9 250
Nickel	000 t	–	–	–	423	4 171	1 238	–	–	–	–	5 832
Lead	000 t	–	–	2 074	31	54	8	–	530	755	207	3 660
Zinc	000 t	–	–	5 284	2 978	1 698	897	–	1 540	1 308	1 007	14 712
Molybdenum	000 t	–	–	–	–	–	–	–	129	–	–	129
Silver	t	3	–	6 010	2 657	3 885	435	1	4 748	1 223	112	19 073
Gold[4]	t	9	–	40	288	841	83	10	129	42	97	1 540

Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.
– Nil or less than one unit.
[1] No allowance is made for losses in milling, smelting and refining. Excludes material classified as "possible." Includes "geological reserves" for some mines that do not report mineable ore. [2] Includes metal in mines where production has been suspended temporarily. [3] One tonne (t) = 1.1023113 short tons = 32 150.746 troy ounces. [4] Excludes metal in placer deposits because reserves data are generally unavailable. [5] Includes the Sa Dena Hes (Mount Hundere) mine where production was suspended in December 1992. [6] May not balance due to rounding at the provincial level.

TABLE 5. CANADIAN RESERVES OF SELECTED MAJOR METALS BY INDUSTRY, AS AT DECEMBER 31, 1995
Metal Contained in Proven and Probable Mineable Ore[1] in Operating Mines[2] and Deposits Committed to Production

		Gold Mines	Copper, Copper-Zinc Mines	Nickel-Copper Mines	Zinc-Lead-Silver Mines	Molybdenum Mines	Miscellaneous Metal Mines	
	SIC no.[5]	0611	0612	0613	0614	0615	0619	Canada[6]
	(Units[3])							
Copper	000 t	138	4 995	3 809	302	–	6	9 250
Nickel	000 t	–	–	5 826	–	–	6	5 832
Lead	000 t	–	131	2	3 528	–	–	3 660
Zinc	000 t	–	5 803	–	8 909	–	–	14 712
Molybdenum	000 t	–	48	–	–	81	–	129
Silver	t	3 419	5 754	1 879	8 020	–	–	19 073
Gold[4]	t	1 285	98	84	71	–	2	1 540

Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.
– Nil or less than one unit.
[1] No allowance is made for losses in milling, smelting and refining. Excludes material classified as "possible." Includes "geological reserves" for some mines that do not report mineable ore. [2] Includes metal in mines where production has been suspended temporarily. [3] One tonne (t) = 1.1023113 short tons = 32 150.746 troy ounces.
[4] Excludes metal in placer deposits because reserves data are generally unavailable. [5] SIC Standard Industrial Classification. [6] May not balance due to rounding at the SIC level.

TABLE 6. CANADIAN RESERVES OF SELECTED MAJOR METALS AS AT DECEMBER 31 OF EACH YEAR, 1977-95[a]
Metal Contained in Proven and Probable Mineable Ore[1] in Operating Mines[2] and Deposits Committed to Production

Year	Copper	Nickel	Lead	Zinc	Molybdenum	Silver	Gold[3]
	(000 t)	(000 t)	(000 t)	(000 t)	(000 t)	(t)	(t)
1977	16 914	7 749	8 954	26 953	369	30 991	493
1978	16 184	7 843	8 930	26 721	464	30 995	505
1979	16 721	7 947	8 992	26 581	549	32 124	575
1980	16 714	8 348	9 637	27 742	551	33 804	826
1981	15 511	7 781	9 380	26 833	505	32 092	851
1982	16 889	7 546	9 139	26 216	469	31 204	833
1983	16 214	7 393	9 081	26 313	442	31 425	1 172
1984	15 530	7 191	9 180	26 000	361	30 757	1 208
1985	14 201	7 041	8 503	24 553	331	29 442	1 373
1986	12 918	6 780	7 599	22 936	312	25 914	1 507
1987	12 927	6 562	7 129	21 471	231	25 103	1 705
1988	12 485	6 286	6 811	20 710	208	26 122	1 801
1989	12 082	6 092	6 717	20 479	207	24 393	1 645
1990	11 261	5 776	5 643	17 847	198	20 102	1 542
1991	11 040	5 691	4 957	16 038	186	17 859	1 433
1992	10 755	5 605	4 328	14 584	163	15 974	1 345
1993	9 740	5 409	4 149	14 206	161	15 576	1 333
1994	9 533	5 334	3 861	14 514	148	19 146	1 513
1995	9 250	5 832	3 660	14 712	129	19 073	1 540

Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.
[a] This series was revised during 1996.
[1] No allowance is made for losses in milling, smelting and refining. Excludes material classified as "possible." Includes "geological reserves" for some mines that do not report mineable ore. [2] Includes metal in mines where production has been suspended temporarily. [3] Excludes metal in placer deposits because reserves data are generally unavailable.
Note: One tonne (t) = 1.1023113 short tons = 32 150.746 troy ounces.

TABLE 7. PRODUCTION DECISIONS ANNOUNCED IN CANADA DURING 1996

Companies	Projects	Metals	Start-Up Year	Incremental Capital Cost
				($ millions)
Roycefield Resources Ltd.	New 100 000-t/y Beaver Brook antimony mine and concentrator, Gander area, Newfoundland	Antimony	1997	20.
Richmont Mines Inc.	New 46 000-oz/y Nugget Pond underground mine, Baie Verte area, Newfoundland	Gold	1997	15.
Ming Minerals Inc.	New 32 000-oz/y Stog'er Tight mine, Baie Verte area, Newfoundland	Gold	October 1996	. .
Breakwater Resources Ltd.	Reactivation of the Caribou underground mine, and reactivation, at 3000-t/d, of the Caribou concentrator and new Restigouche open-pit mine, Bathurst area, New Brunswick	Zinc, lead, silver, gold	1997	60.
MSV Resources Inc. and Corner Bay Minerals Inc.	New 200 000-t/y Corner Bay mine, Chibougamau area	Copper	1997	16.
TVX Gold Inc. and Golden Knight Resources Inc.	Production from the Principal Zone, Casa Berardi mine, Quebec	Gold, silver	September 1996	. .
Noranda Mining and Exploration Ltd.	Re-opening of Mine Gallen open-pit mine (West MacDonald), Rouyn-Noranda, Quebec	Zinc	1997	9.
River Gold Mines Ltd. and VenCan Gold Corporation	New 15 000-20 000-oz/y Edwards mine, Wawa area, Ontario	Gold	1997	. .
Glimmer Resources Inc. and Exall Resources Limited	New 600-t/d Hislop-Beatty mine, Timmins area, Ontario	Gold	1997	. .
Royal Oak Mines Inc.	New 100 000-oz/y Matachewan mine, northeastern Ontario	Gold	1998	. .
Placer Dome Canada Inc. and TVX Gold Inc.	New 190 000-oz/y Musselwhite mine, Pickle Lake area, northwestern Ontario	Gold	1997	190.
Madsen Gold Corporation	Re-opening of Madsen underground mine, Red Lake area, northwestern Ontario	Gold	1997	. .
Waddy Lake Resources Inc. and Golden Rule Resources Ltd.	New 45 000-oz/y Komis mine, La Ronge area, Saskatchewan	Gold	1996	9.8
Royal Oak Mines Inc.	New 50 000-t/d Kemess South mine, Toodoggone River area, British Columbia	Gold, copper	1998	390.
Imperial Metals Corporation and Sumitomo Corporation	New Mount Polley open-pit mine and 18 000-t/d concentrator, Williams Lake area, British Columbia	Gold, copper	1997	123.5
Princeton Mining Corporation	New 16 500-t/d Huckleberry open-pit mine, Houston area, British Columbia	Copper, gold, silver, molybdenum	1997	135.
B.Y.G. Natural Resources Inc.	New 700-t/d (50 000-oz/y) Mount Nansen open-pit mine, Carmacks area, Yukon	Gold, silver	1996	. .
Echo Bay Mines	New Ulu underground mine, Lupin area, Northwest Territories	Gold, silver	1998	. .

Source: Natural Resources Canada, based on company reports.
. . Not available.