

Canadian Reserves of Selected Major Metals, and Recent Production Decisions

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RESERVES OF SELECTED MAJOR METALS

Canadian reserves of gold, molybdenum and copper in ores increased during 1996. Gold reserves were higher than at any time since the peak year of 1988. However, reserves of nickel, lead and zinc decreased during 1996, while reserves of silver were maintained at approximately the same level as at the end of 1995 (Table 1).

Generally declining metal prices during 1996 caused many mining companies to make their ore reserve calculations at year-end based upon lower metal prices than they had used at the end of 1995. This resulted in reductions of ore reserves at many producing mines. In the cases of copper, gold and molybdenum, the announcement of production decisions for three major new mines in British Columbia (Huckleberry, Mount Polley and Kemess South) was sufficient to overcome the general reductions in Canadian ore reserves.

In Canada during 1997, there were no announcements of new production decisions for the seven metals reviewed in this chapter. Given that metal prices continued to fall during 1997, it is probable that Canadian ore reserve levels for the major metals will continue to decline in the immediate future. The Voisey's Bay nickel-copper-cobalt deposit in Labrador is not presently included in Canadian reserves because there are several major issues to be resolved before production can begin. When a production decision is made, it will result in major increases in the reserves of nickel and copper.

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, which 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 1724 t of gold contained in Canadian mine reserves in December 1996. This represents an increase of 12% compared to revised totals for December 1995.

The gold reserves of 12 projects, for which production decisions were announced during 1996, were added to Canadian totals at year-end (Table 3). The largest single gross addition, 120 t of gold, resulted from the inclusion of reserves from the proposed Kemess South open-pit mine of Royal Oak Mines Inc. in British Columbia. The announced re-opening of the Aquarius mine at Timmins, Ontario, by Echo Bay Mines Ltd. added 40 t of gold to the reserves,¹ and the reserves at Royal Oak Mines Inc.'s Ontario division increased by 38 t. The production decision at the Musselwhite mine of Placer Dome Inc. in Ontario added 37 t; the Mount Polley mine of Imperial Metals Corporation in British Columbia added 34 t; and the Madsen mine of Madsen Gold Corporation in Ontario added 10 t. Smaller additions were provided by the production decisions at the Golden Bear mine (North American Metals Corporation, 7.75 t of gold) and 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	ENVIRONMENTAL 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 infrastructure. Mine preparation.	Production, marketing, new development.	Mine closure. Site reclamation and restoration.
OBJECTIVES	Supply information and tools required to develop the mineral potential of the nation for economic benefit, in the perspective of sustained development.	Select target commodities. Establish exploration objectives and strategies. Select target areas.	Find regional and more localized anomalies. Select significant targets.	Acquire properties. Confirm presence, exact location and characteristics of anomalies.	Acquire additional properties as required. Verify and confirm anomalies. Find mineral showings.	Discover, confirm and delimit a mineral deposit of economic interest. Evaluate technical and economic potential in a preliminary fashion.	Define the grade, limits, internal distribution, controls and the mineralogy-processing parameters of a mineral deposit. Acquire data to support engineering planning.	Establish technical feasibility. Prepare realistic plans, schedules, investment-cost and operating-cost estimates for all aspects of a project.	Establish parameters 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 specifications 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 surveys, 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 photography and airborne geophysics. Prospecting, geology and geochemistry. Appraisal, rating and selection of anomalies.	Ground-based geological, geochemical 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, trenching, detailed mapping, sampling, drilling and down-hole geophysics. Preliminary deposit inventory and evaluation. Environmental characterization and site surveys.	Detailed mapping, sampling and drilling on surface or from underground. Systematic mineral processing tests. Detailed environmental 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 management methods. Training program for personnel and detailed start-up plan.	Production management using continuous quality improvement methods. Exploration, appraisal and development of new ore zones, both on-property and off-property.	Mine closure and decommissioning. Environmental restoration and monitoring.
RESULTS	Geoscientific, mineral and economic databases, 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.

Huckleberry mine (Princeton Mining Corporation, 5.6 t of gold) in British Columbia; the Edwards mine (VenCan Gold Corporation, 6.5 t of gold) and the Glimmer mine (Exall Resources Limited, 5.5 t of gold) in Ontario; the Nugget Pond mine (Richmont Mines Inc., 4.8 t of gold) in Newfoundland; and the Mount Nansen mine (B.Y.G. Natural Resources Inc., 3.6 t of gold) in the Yukon.

Silver

Canadian reserves of silver were maintained at about the same level as at the end of 1995, about 19 000 t. There were no new production decisions on silver deposits in 1996.

Zinc

Canadian reserves of zinc decreased to about 13.7 Mt at year-end, down by about 7% compared to the previous year. The production decision at the Caribou mine of Breakwater Resources Ltd. in New Brunswick added 446 000 t of zinc to the reserves, and the production decision at the Gallen mine of Noranda Metallurgy in Quebec added 50 000 t, but these were insufficient to counterbalance the reductions in reserves at most of the producing zinc mines. Of the established zinc-producing mines, only Nanisivik (Nanisivik Mines Ltd., +128 000 t) in the Northwest Territories, and Callinan (+45 000 t) and Ruttan (+32 000 t) of Hudson Bay Mining and Smelting Co., Ltd. in Manitoba, increased their reserves. At the LaRonde gold mine in Quebec, the discovery of a new zinc-rich ore zone added 120 000 t to the zinc reserves. The largest reductions in reserves occurred at Faro (Anvil Range Mining Corporation) in the Yukon, Chisel Lake North (Hudson Bay Mining and Smelting Co., Ltd.) in Manitoba, Polaris (Cominco Ltd.) in the Northwest Territories, Brunswick No. 12 (Noranda Mining and Exploration Inc.) in New Brunswick, Sullivan (Cominco Ltd.) in British Columbia, and Sa Dena Hes (Teck Corporation) in the Yukon.

Lead

Canadian reserves of lead decreased by approximately 5% in 1996, largely as a result of production not being replaced, and downward reassessments of reserves at Faro (Anvil Range Mining Corporation) and Sa Dena Hes (Teck Corporation) in the Yukon and at Sullivan (Cominco Ltd.) in British Columbia.

The only mines to report a net increase in lead reserves during 1996 were Nanisivik (Nanisivik Mines Ltd., +128 000 t) in the Northwest Territories and Caribou (Breakwater Resources Ltd., +240 000 t) in New Brunswick.

Copper

In December 1996, Canadian reserves of copper were estimated at about 9.7 Mt, or up by about 4.5% from

a year earlier. This increase is the result of production decisions at Huckleberry (Princeton Mining Corporation, +464 000 t), Kemess South (Royal Oak Mines Inc., +449 000 t), and Mount Polley (Imperial Metals Corporation, +200 000 t) in British Columbia. All of the existing copper-producing mines suffered reductions of their reserves as they were unable to find sufficient new reserves to replace those consumed by mine production.

Molybdenum

Canadian reserves of molybdenum stood at 144 000 t in December 1996, or about 12% higher than in the previous year. The increase occurred because 1996 production was replaced by newfound ore at existing molybdenum mines, and because the production decision at Huckleberry (Princeton Mining Corporation) in British Columbia added 13 000 t of molybdenum to the Canadian total.

Nickel

In December 1996, there were some 5.6 Mt of nickel contained in Canadian mine reserves, down by approximately 4% from the levels of 1995. This decrease is largely due to the decline in reserves at the Sudbury Integrated Nickel Operations of Falconbridge Limited. At the Raglan deposit in Quebec, which began production in 1997, Falconbridge increased its nickel reserves by 35 000 t or about 8%.

Inco Limited had some 4.9 Mt of nickel in Canadian reserves at the end of 1996, or more than 80% of the national total. Inco appears to have replaced about one third of the nickel that it mined in Canada during 1996. However, 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 1996 (Table 4).

Ontario had 70% of the nickel, 52% of the gold and 43% of the copper, plus 18% of the silver and 12% of the zinc.

British Columbia had 100% of the molybdenum, 39% of the copper and 28% of the silver, plus 12% of the lead, 10% of the zinc and 17% of the gold.

New Brunswick had 65% of the lead, 40% of the zinc and 34% of the silver, plus 2% of the copper and 2% of the gold.

Quebec had 21% of the zinc, 16% of the gold, 13% of the copper, 8% of the nickel and 13% of the silver.

Manitoba had 22% of the nickel, 4% of the zinc and 4% of the gold, plus 4% of the copper and 2% of the silver.

The Yukon had 16% of the lead, 7% of the zinc, 5% of the silver and 3% of the gold.

The Northwest Territories had 7% of the zinc, 6% of the lead and 5% 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, 78%; copper and copper-zinc mines, 14%; nickel-copper mines, 4%; and zinc-lead-silver mines, 4%.

Current mine reserves of silver in Canada are distributed through the various SIC classes as follows: gold mines, 22%; copper and copper-zinc mines, 28%; nickel-copper mines, 8%; and zinc-lead-silver mines, 42%.

Current mine reserves of copper in Canada are distributed through the various SIC classes as follows: gold mines, 1%; copper and copper-zinc mines, 58%; nickel-copper mines, 38%; and zinc-lead-silver mines, 3%.

Current mine reserves of molybdenum in Canada are contained in the SIC classes as follows: copper and copper-zinc mines, 43%; and molybdenum mines, 57%.

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 various SIC classes as follows: copper and copper-zinc mines, 3%; and zinc-lead-silver mines, 97%.

Current mine reserves of zinc in Canada are contained in the SIC classes as follows: gold mines, 1%; copper and copper-zinc mines, 37%; and zinc-lead-silver mines, 62%.

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.²

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 1996 were 25 years for nickel, 13 years for copper, 12 years for molybdenum, 11 years for silver, 10 years for zinc, 9 years for lead, and 7 years for gold.

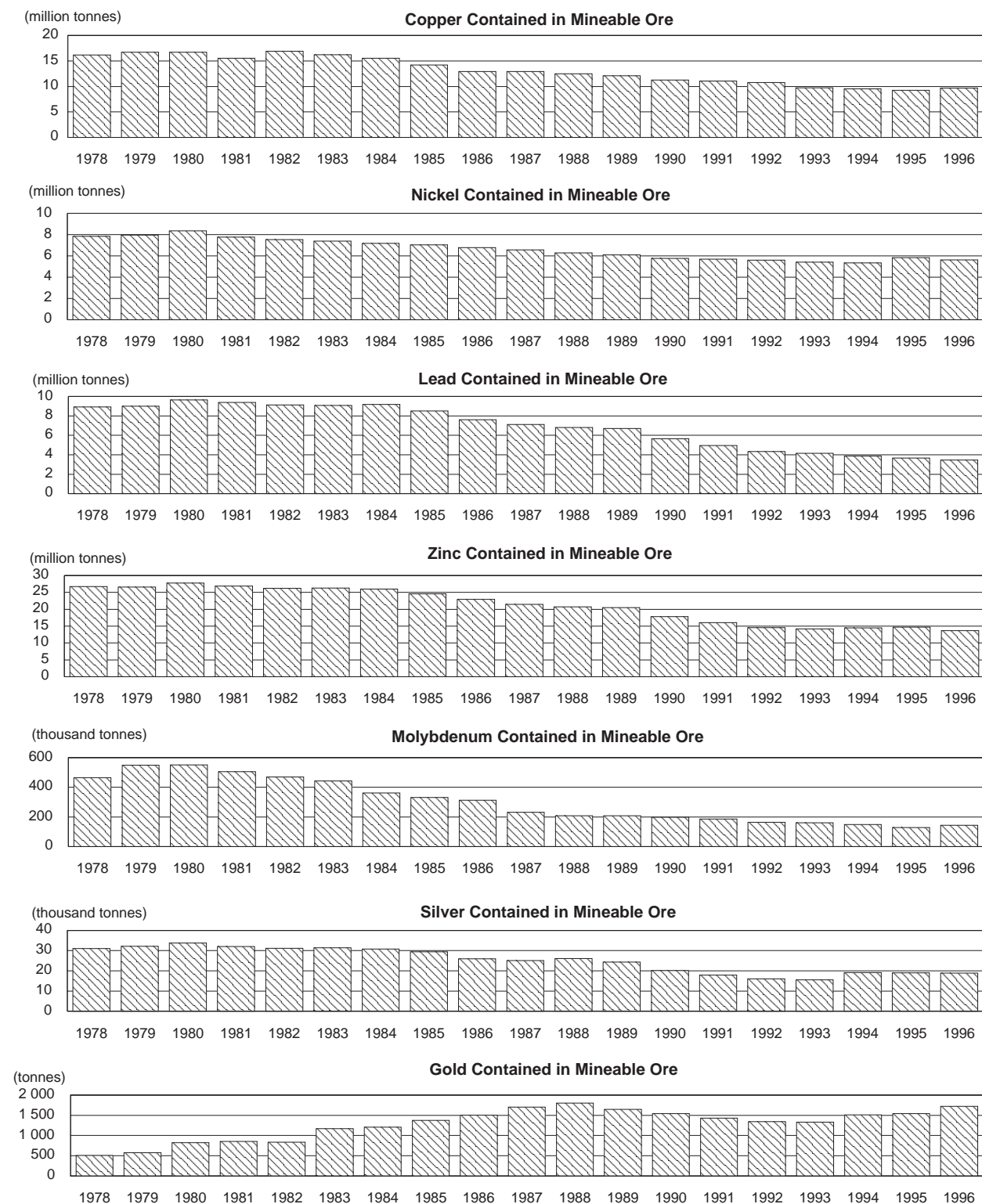
Reserve Trends

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.³

Figure 2 and Table 6 show how Canadian reserves of copper, nickel, lead, zinc, molybdenum and silver have declined steadily since the early 1980s. In contrast, gold reserves increased substantially until 1988 before starting a gradual decline. In 1994, these trends began to be arrested or reversed. This reversal started with increases in Canadian reserves of zinc, gold and silver in 1994, followed by increases in Canadian reserves of zinc, gold and nickel in 1995, and increases in Canadian reserves of gold, nickel and molybdenum in 1996. Canadian reserves of gold in 1996 were higher than in any year since the peak year of 1988.

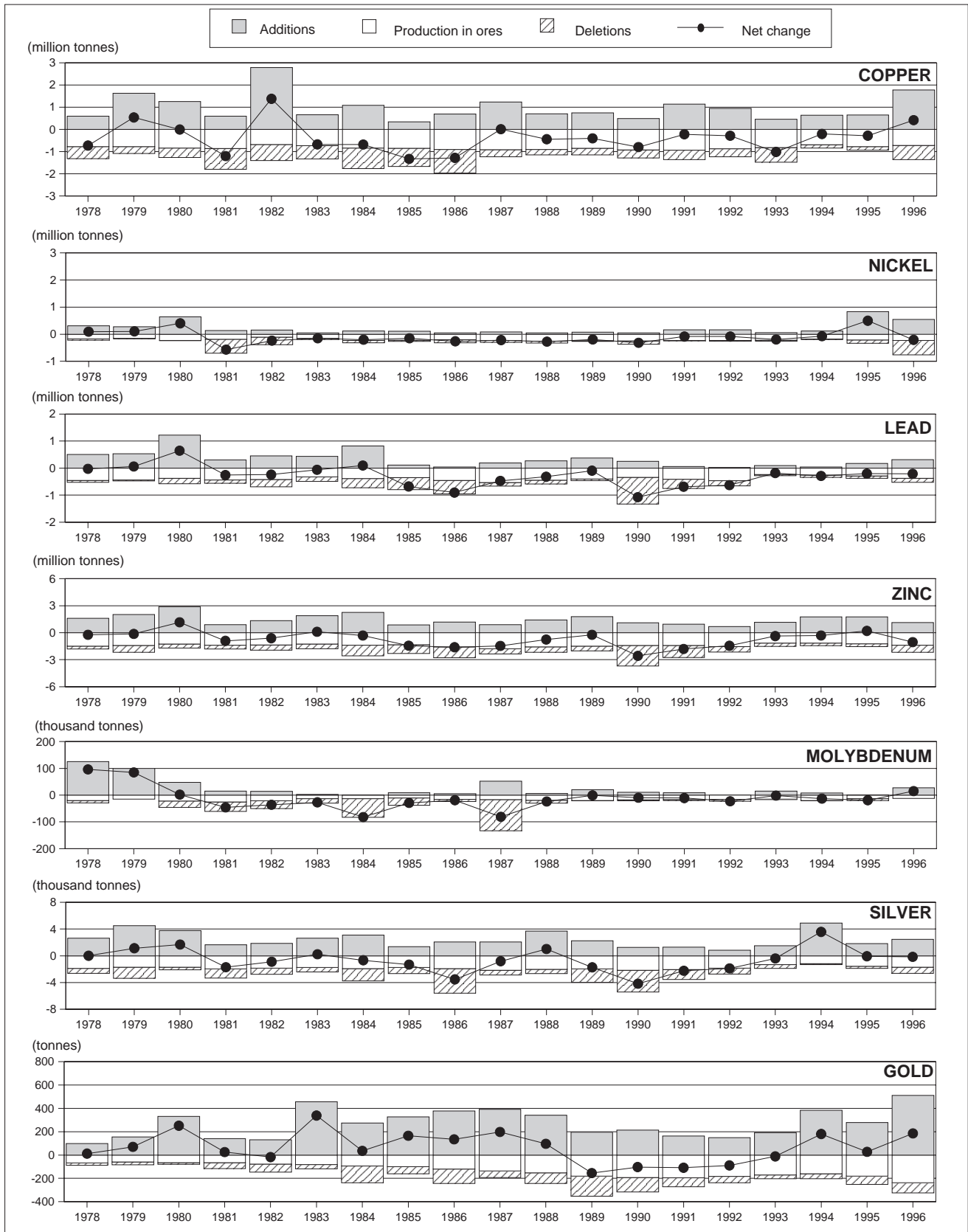
The annual aggregate change in Canadian reserves is the net result of three main factors affecting individual mines (Figure 3): additions to reserves, deletions to reserves, and production. Additions to reserves are the result of new discoveries; of new geological, metallurgical, production or other 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 but, in 1996, declining metal prices were a significant factor in the reduction of ore reserves at producing mines.

Figure 2
Canadian Reserves of Selected Major Metals, 1978-96
 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, 1978-96



Source: Natural Resources Canada.

RECENT PRODUCTION DECISIONS

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 1997, there were no new production decisions announced for precious-metal or base-metal deposits in Canada. This is an unprecedented occurrence in the recent history of Canadian mining, and it indicates the severity of the effect of declining metal prices.

Inco Limited's Voisey's Bay deposit in Labrador is scheduled to begin production in late 2000, but is not included as a 1997 production decision because not all of the necessary permits and agreements were in place at that time.

OUTLOOK

Given that there were no new production decisions announced in 1997, and that some of the new projects previously announced in 1996 were deferred or cancelled during 1997, it is highly probable that mine reserves of precious metals and base metals will decline in 1997.

At the Voisey's Bay nickel-copper-cobalt deposit, Inco had established reserves and resources of 116 Mt at the end of 1997. If these figures are confirmed, Voisey's Bay will increase Canada's nickel reserves by about 28% and its copper reserves by about 9%.

ENDNOTES

¹ Echo Bay Mines subsequently announced that construction at Aquarius would be postponed pending higher gold prices.

² 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 Yearbook*, Natural Resources Canada, Ottawa, pp. 4.4 and 4.5.

³ 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.

Note: Information in this review was current as of February 14, 1998.

TABLE 1. MAIN COMPONENTS OF CHANGE DURING 1996 IN CANADIAN RESERVES OF SELECTED MAJOR METALS

Metal	Units	Revised Opening Metal Balance, January 1996	Metal in Ore Mined During 1996	Metal Apparently Written Off During 1996	Metal in New Reserves Found During 1996	Net Change During 1996	Closing Metal Balance, December 1996	% Change During 1996
Copper	000 t	9 250	-722	-639	1 778	417	9 667	+4.5
Nickel	000 t	5 832	-227	-532	550	-209	5 623	-3.6
Lead	000 t	3 660	-373	-149	312	-210	3 450	-5.7
Zinc	000 t	14 712	-1 401	-779	1 128	-1 052	13 660	-7.2
Molybdenum	000 t	129	-12	-	27	15	144	+11.6
Silver	t	19 073	-1 705	-909	2 451	-162	18 911	-0.8
Gold	t	1 539	-238	-86	510	185	1 724	+12.0

Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.

- Nil.

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, 1996

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	642 000	..					..	3.1
Nugget Pond Richmont Mines Inc. Mineable	390 000							12.2
NEW BRUNSWICK								
Brunswick No. 12 Underground Noranda Mining and Exploration Inc. Proven	52 259 000	0.33		3.70	9.23		105.	..
Caribou Breakwater Resources Ltd. Proven and probable	6 200 000			3.9	7.2		97.	
Heath Steele Noranda Mining and Exploration Inc. Proven	1 096 000	1.03		1.91	5.65		72.48	
Probable	2 090 000	0.86		1.60	6.70		72.48	
QUEBEC								
Beaufor Aurizon Mines Ltd. Louvem Mines Inc. Proven and probable	768 200						..	7.78
Bell Allard Noranda Mining and Exploration Inc. N/S	3 200 000	1.5			13.77		43.44	0.765
Bouchard-Hébert (Mobrún 1100 Lens) Cambior inc. Proven-probable	9 204 000	0.84			4.41		39.7	1.3
Bousquet No. 2 Barrick Gold Corporation Proven and probable	3 924 000	..					..	8.5
Copper Mountain Oxide Noranda Mining and Exploration Inc. Probable mineable	19 152 000	0.44						
Copper Rand MSV Resources Inc. ..	..	..					..	..
Doyon Barrick Gold Corporation Cambior inc. Mineable	10 268 000						..	5.76
Francoeur Richmont Mines Inc. Proven and probable	963 000						..	6.69
Gallen Noranda Metallurgy Proven	750 000	0.10			6.64		27.	0.93
Isle Dieu Mattagami Noranda Mining and Exploration Inc. Proven	362 000	0.94			17.23		80.6	0.31
Probable	3 172 000	1.5			13.77		43.5	0.621
Joe Mann Campbell Resources Inc. Proven and probable	879 000	0.25					..	8.54

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
QUEBEC (cont'd)								
Joubi-Dubuisson								
Western Quebec Mines Inc.								
Proven	22 815						..	4.382
Probable	56 875						..	6.55
Kiena								
Placer Dome Canada Limited								
Proven and probable	3 358 000						..	4.502
Langlois (Grevet)								
Cambior inc.								
Proven and probable	10 106 000	0.44			8.07		35.79	0.1
LaRonde (Dumagami)								
Agnico-Eagle Mines Limited								
Proven	2 050 561	..					..	7.
Probable	2 757 989	..			..		..	6.2
Louvicourt								
Aur Resources Inc.								
Novicourt Inc.								
Teck Corporation								
Proven	6 377 000	3.82			1.58		28.61	0.93
Probable	6 094 000	3.45			1.46		29.24	0.62
Mouska								
Cambior inc.								
..
Murdochville Townsite								
Noranda Mining and Exploration Inc.								
Proven E Zone	2 753 000	3.28					15.9	
Needle Mountain Open Pit								
Noranda Mining and Exploration Inc.								
Proven	74 000	1.51					5.28	
Portage								
MSV Resources Inc.								
Proven	165 200	1.74					..	3.98
Raglan								
Falconbridge Limited								
Proven and probable	14 431 000	0.88	3.17					
Selbaie (Detour) A1 Open Pit								
Billiton Metals Canada Inc. (Gencor Ltd.)								
..
Sigma No. 1								
Placer Dome Canada Limited								
Proven and probable	1 724 000						..	4.9
Sigma No. 2								
Placer Dome Canada Limited								
..
Silidor								
Battle Mountain Gold Company								
Cambior inc.								
Proven and probable	120 000							5.18
Sleeping Giant								
Aurizon Mines Ltd.								
Cambior inc.								
Mineable	577 580							11.2
Troilus (Lac Frotet)								
Inmet Mining Corporation								
Proven-probable mineable	49 600 000	0.12					1.37	1.37
ONTARIO								
Aquarius								
Echo Bay Mines Ltd.								
Proven and probable	19 710 000							2.
Campbell								
Placer Dome Canada Limited								
Proven and probable	4 429 000						..	15.7

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
ONTARIO (cont'd)								
David Bell								
Homestake Canada Inc.								
Teck Corporation								
Mineable	5 500 000						..	9.63
Detour Lake								
Placer Dome Canada Limited								
Proven and probable	1 921 000						..	4.7
Dome (including Paymaster)								
Placer Dome Canada Limited								
Proven and probable	30 050 000						..	2.8
Eagle River								
River Gold Mines Ltd.								
Proven and probable								
..
Edwards								
River Gold Mines Ltd.								
VenCan Gold Corporation								
Drill indicated	394 000							16.5
Falconbridge Sudbury Integrated Nickel Operations								
Falconbridge Limited								
Proven	14 206 835	1.53	1.63					
Probable	9 944 000	1.53	1.63					
Glimmer								
Exall Resources Limited								
Glimmer Resources Inc.								
Mineable	499 500							11.14
Golden Giant								
Battle Mountain Gold Company								
Proven and probable	9 154 027						..	9.9
Golden Patricia								
Barrick Gold Corporation								
Proven and probable	40 000						..	12.7
Holloway								
Battle Mountain Gold Company								
Teddy Bear Valley Mines Ltd.								
Proven and probable	5 651 000						..	6.9
Holt-McDermott								
Barrick Gold Corporation								
Proven and probable	3 298 000						..	6.89
Hoyle Pond								
Kinross Gold Corporation								
Proven	807 000						..	12.31
Probable	734 000						..	9.521
Inco Ontario Division								
Inco Limited ¹								
..
Kidd Creek No. 1								
Falconbridge Limited ²								
..	
Kidd Creek No. 2								
Falconbridge Limited ²								
..	
Kidd Creek No. 3								
Falconbridge Limited ²								
..	
Lac-des-Îles (palladium-platinum)								
North American Palladium Ltd.								
Probable Roby Zone	6 000 000	..	..					..
Probable C Zone	2 100 000	..	..					..
Macassa								
Kinross Gold Corporation								
Proven	1 069 000						..	13.04
Proven no. 3 shaft pillar	251 000						..	14.37
Probable	217 000						..	14.76

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
ONTARIO (cont'd)								
Madsen								
Madsen Gold Corporation								
Proven and probable	1 064 722							9.46
Musselwhite								
Placer Dome Canada Limited								
TVX Gold Inc.								
Proven and probable	6 640 000							5.60
Red Lake (Arthur W. White)								
Goldcorp Inc.								
Proven above 30 level	695 000						..	12.
Proven below 30 level	30 000						..	10.
Proven HG below 30 level	5 000						..	34.
Probable above 30 level	875 000						1.	11.
Probable below 30 level	184 000						..	10.
Probable HG below 30 level	98 000						..	46.3
Royal Oak Ontario Division								
Royal Oak Mines Inc.								
Mineable	72 832 000						..	1.7
Williams								
Homestake Canada Inc.								
Teck Corporation								
Mineable	32 200 000						0.65	5.01
Winston Lake (includes Pick Lake)								
Inmet Mining Corporation								
Proven and probable	1 100 000	0.85			14.76		..	..
MANITOBA								
Bissett (San Antonio)								
Rea Gold Corporation								
Proven and probable mineable	2 120 000						..	8.201
Callinan								
Hudson Bay Mining and Smelting Co., Limited ³								
..
Inco Manitoba Division								
Inco Limited ¹								
..
Keystone								
Black Hawk Mining Inc.								
Mineable	1 471 100						0.3	4.399
New Britannia (Nor-Acme/Snow Lake)								
High River Gold Mines Ltd.								
TVX Gold Inc.								
Proven and probable	3 772 000						..	4.598
Photo Lake								
Hudson Bay Mining and Smelting Co., Limited ³								
..
Ruttan								
Hudson Bay Mining and Smelting Co., Limited ³								
..
Trout Lake								
Hudson Bay Mining and Smelting Co., Limited ³								
..
Westarm								
Hudson Bay Mining and Smelting Co., Limited ³								
..

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
SASKATCHEWAN								
Contact Lake								
Cameco Corporation								
Uranerz Exploration and Mining Limited								
Proven (Bakos)	212 000						..	7.289
Probable (Bakos)	91 000						..	7.13
Seabee								
Claude Resources Inc.								
Mineable	962 675						..	9.861
BRITISH COLUMBIA								
Afton								
Teck Corporation								
Mineable	1 217 290	0.49					..	..
Bralorne								
Bralorne-Pioneer Gold Mines Ltd.								
International Avino Mines Ltd.								
Mineable	432 577						..	11.
51B FW mineable	111 000						..	13.
Endako								
Nissho Iwai Corp.								
Proven and probable	124 887 000					0.066		
Eskay Creek								
Prime Resources Group Inc.								
Proven and probable	1 267 000						2 720.	59.3
Gibraltar Dumps (biological leach cathode)								
Gibraltar Mines Limited								
Proven and probable	3 039 000	0.197						
Gibraltar Open Pit								
Gibraltar Mines Limited								
Proven and probable	142 543 999	0.303				0.009	..	
Golden Bear								
North American Metals Corporation								
Mineable	1 519 000							5.102
Highland Valley								
Cominco Ltd.								
Highmont Mining Company								
Rio Algom Limited								
Teck Corporation								
Proven and probable	496 000 000	0.419				0.0079	..	..
Huckleberry								
Mitsubishi-Dowa-Furukawa-Marubeni								
Princeton Mining Corporation								
Mineable proven and probable	90 373 000	0.513				0.014	2.8	0.062
Kemess South								
Royal Oak Mines Inc.								
Mineable	200 000 000	0.224						0.62
Mount Polley								
Imperial Metals Corporation								
Sumitomo								
Mineable (proven, probable and possible)	82 324 000	0.3						0.418
Myra Falls								
Westmin Resources Limited								
Proven and probable	9 098 407	1.5		..	6.6		28.6	1.4
Premier								
Westmin Resources Limited								
Proven and probable	350 000				1.6			7.2
QR (Quesnel River)								
Kinross Gold Corporation								
Proven	525 000						..	4.029
Probable	1 049 000						..	3.97

TABLE 2 (cont'd)

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
BRITISH COLUMBIA (cont'd)								
Snip								
Cominco Ltd.								
Prime Resources Group Inc.								
Proven and probable	335 000					..	24.7	
Sullivan								
Cominco Ltd.								
Measured	8 800 000		4.4	8.0		24.		
Table Mountain (Erickson Creek)								
Cusac Gold Mines Ltd.								
..	
YUKON TERRITORY								
Brewery Creek (heap leach)								
Viceroy Resource Corporation								
Proven	17 100 000					..	1.4	
Faro								
Anvil Range Mining Corporation								
Grum & Vangorda	20 767 000		2.61	4.28		43.5	0.741	
Mount Nansen								
B.Y.G. Natural Resources Inc.								
Brown-McDade Open Pit	201 179					68.9	7.2	
Brown-McDade Open Pit LG	116 982					20.	2.	
Brown-McDade Underground	297 781					56.9	6.9	
NORTHWEST TERRITORIES								
Colomac								
Royal Oak Mines Inc. ⁴								
..	
Con								
Miramar Mining Corporation								
Proven	810 312					..	11.7	
Probable	2 400 581					..	11.3	
Giant								
Royal Oak Mines Inc. ⁴								
..	
Lupin								
Echo Bay Mines Ltd.								
Proven and probable	1 430 000						9.63	
Nanisivik								
Nanisivik Mines Ltd.								
Proven and probable	4 050 000		0.5	8.1		37.		
Polaris								
Cominco Ltd.								
Pine Point Mines Limited								
Measured-indicated	4 400 000		4.0	13.9				
Ptarmigan-Tom								
Treminco Resources Ltd.								
Proven	3 000					..	..

Source: Natural Resources Canada, based on published company reports.

.. Not available in published reports or estimated by author; N/S Not specified.

¹ Inco Limited reports total Canadian ore reserves, including substantial reserves at Voisey's Bay, as 401 Mt with a grade of 1.56% copper and 1.02% nickel. ² Falconbridge Limited reports total Kidd Creek Division ore reserves as 28 202 000 t with a grade of 2.38% copper, 6.02% zinc and 68 g/t silver. ³ Hudson Bay Mining and Smelting Co. Ltd. reports total reserves of 24.1 Mt with a grade of 1.45% copper and 3.21% zinc. ⁴ Royal Oak Mines Inc. reports total Northwest Territories Division reserves as 7 370 000 t with a grade of 4.49 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, 1996

Project	Operators and Major Partners	Province	Metals
Nugget Pond	Richmont Mines Inc.	Nfld.	Gold
Caribou	Breakwater Resources Ltd.	N.B.	Zinc, lead, silver
Gallen	Noranda Metallurgy	Que.	Zinc, copper, silver, gold
Aquarius	Echo Bay Mines Ltd.	Ont.	Gold
Edwards	VenCan Gold Corporation River Gold Mines Ltd.	Ont.	Gold
Glimmer	Exall Resources Limited Glimmer Resources Inc.	Ont.	Gold
Musselwhite	Placer Dome Inc. TVX Gold Inc.	Ont.	Gold
Madsen	Madsen Gold Corporation	Ont.	Gold
Golden Bear	North American Metals Corporation	B.C.	Gold
Huckleberry	Mitsubishi-Dowa-Furukawa-Marubeni Princeton Mining Corporation	B.C.	Copper, molybdenum, silver, gold
Mount Polley	Imperial Metals Corporation Sumitomo	B.C.	Gold, copper
Kemess South	Royal Oak Mines Inc.	B.C.	Gold, copper
Mount Nansen	B.Y.G. Natural Resources Inc.	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, 1996

Metal Contained in Proven and Probable Mineable Ore¹ in Operating Mines² and Deposits Committed to Production

Metal	Units ³	Nfld.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	B.C.	Yukon	N.W.T.	Canada ⁵
Copper	000 t	0.4	—	199	1 211	4 130	353	—	3 773	—	—	9 667
Nickel	000 t	—	—	—	458	3 956	1 210	—	—	—	—	5 623
Lead	000 t	—	—	2 228	18	49	—	—	417	542	196	3 450
Zinc	000 t	—	—	5 472	2 880	1 584	590	—	1 306	889	940	13 660
Molybdenum	000 t	—	—	—	—	—	—	—	144	—	—	144
Silver	t	0.2	—	6 333	2 364	3 471	358	0.5	5 275	948	163	18 911
Gold ⁴	t	7	—	40	281	898	65	12	300	44	77	1 724

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) = 1,102,311.3 short tons = 32 150.746 troy ounces. ⁴ Excludes metal in placer deposits because reserves data are generally unavailable. ⁵ May not balance due to rounding at the provincial level.

TABLE 5. CANADIAN RESERVES OF SELECTED MAJOR METALS BY INDUSTRY, AS AT DECEMBER 31, 1996
Metal Contained in Proven and Probable Mineable Ore¹ in Operating Mines² and Deposits Committed to Production

SIC no. ⁵	Gold Mines	Copper, Copper-Zinc Mines	Nickel-Copper Mines	Zinc-Lead-Silver Mines	Molybdenum Mines	Miscellaneous Metal Mines	Canada ⁶	
	0611	0612	0613	0614	0615	0619		
	(Units ³)							
Copper	000 t	107	5 599	3 680	276	—	5	9 667
Nickel	000 t	—	—	5 619	—	—	4	5 623
Lead	000 t	—	97	—	3 353	—	—	3 450
Zinc	000 t	133	5 120	—	8 407	—	—	13 660
Molybdenum	000 t	—	62	—	—	82	—	144
Silver	t	4 071	5 349	1 529	7 962	—	—	18 911
Gold ⁴	t	1 337	242	75	67	—	1	1 724

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, 1977-96^a

Metal Contained in Proven and Probable Mineable Ore¹ in Operating Mines² 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
1996	9 667	5 623	3 450	13 660	144	18 911	1 724

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.