Canadian Mineral Exploration and Discovery Analysis

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CANADA'S STANDING AS AN EXPLORATION TARGET

In 1999, exploration and deposit appraisal expenditures for non-petroleum minerals in Canada totaled $504.3 million. Canada remained one of the world's top exploration targets (second after Australia) in terms of mineral exploration expenditures that year. Exploration and deposit appraisal for 2000 totaled $473 million (a preliminary total gathered early in 2000). The decline in exploration expenditures in Canada is typical of the decline in exploration expenditures worldwide. The Metals Economics Group's (MEG) survey[1] (data gathered later in 2000) indicates that the United States continued to hold third position in 2000. The relative rankings of these top three countries have remained unchanged since 1992 (Figure 1). Although the MEG study is the only one to look at exploration spending worldwide, it does not adequately account for exploration expenditures in countries such as China and the various countries that have resulted from the breakup of the former Soviet Union. This is because MEG surveys only exploration expenditures by the "Western" companies exploring in these countries, so its survey results are indicative of only part of the exploration there. The value of China's mineral production is at least six times that of Canada, at least five times that of Australia, and more than 50% higher than that of the United States (Table 1). For this reason, it is likely that the magnitude of China's mineral exploration effort actually exceeds that in any of Australia, Canada or the United States. The MEG survey, which is conducted yearly, underwent a major change in its methodology in the 2000 edition. The

Figure 1
Top Three Country Destinations of Mineral Exploration Capital from Worldwide Sources, 1975-2000

	Rank		
Year	First	Second	Third
2000	Australia	**Canada**	United States
1999	Australia	**Canada**	United States
1998	Australia	**Canada**	United States
1997	Australia	**Canada**	United States
1996	Australia	**Canada**	United States
1995	Australia	**Canada**	United States
1994	Australia	**Canada**	United States
1993	Australia	**Canada**	United States
1992	Australia	**Canada**	United States
1991	**Canada**	Australia	United States
1990	**Canada**	Australia	United States
1989	**Canada**	Australia	United States
1988	**Canada**	Australia	United States
1987	**Canada**	Australia	United States
1986	**Canada**	Australia	United States
1985	**Canada**	Australia	United States
1984	**Canada**	Australia	United States
1983	**Canada**	Australia	United States
1982	**Canada**	Australia	United States
1981	**Canada**	Australia	United States
1980	Australia	**Canada**	United States
1979	Australia	United States	**Canada**
1978	Australia	United States	**Canada**
1977	United States	**Canada**	Australia
1976	**Canada**	United States	Australia
1975	United States	**Canada**	Australia

Source: Natural Resources Canada, based on official Canadian and Australian statistics and the best available data for the United States.
Notes: Australian expenditures were 6.5% higher than those for Canada in 1983 and 3.3% higher in 1991; however, correcting the reported Australian totals for substantial mine development expenditures, which are not included in Canadian statistics, ranks Canada first in 1983 and 1991. Complete data are not available for the former Soviet Union and China.

[1] *Corporate Exploration Strategies*, published by Metals Economics Group, Halifax, Nova Scotia, September 2000.

exploration budget cutoff was reduced from US$2.9 million in 1999 to US$100 000 in 2000. This cutoff reduction should have largely corrected the previous consistent substantial underestimation by MEG of the real levels of annual exploration spending in Canada and Australia that had resulted from the omission of the exploration expenditures of several hundred active companies in these countries.

RECENT MINERAL EXPLORATION AND DISCOVERY ACTIVITY AND RESULTS ACROSS CANADA

Some Canadian exploration highlights in 2000 include:

In Newfoundland, Thundermin Resources Inc. and Queenston Mining Inc. drilled the Duck Pond and Boundary Pond deposits, originally discovered in 1987. Resources at Duck Pond are 6.2 Mt grading 3.4% copper, 6.2% zinc, 1.0% lead, 63 g/t silver and 0.8 g/t gold. The deposits are under option from Noranda Inc. Metallurgical tests have been carried out and a recently completed feasibility study indicates that the project is economically viable.

In Quebec, Noranda Inc. discovered the Perseverance zinc deposit (5 Mt grading 16.8% zinc, 1.3% copper, 34 g/t silver and 0.4 g/ gold, in three deposits) near its mining operation at Matagami. Perseverance will add seven years to the life of the Matagami operation. On the Raglan nickel-copper property, Falconbridge Limited discovered a new ore lens at the West Boundary Zone, 15 km east of the concentrator, the eighth deposit discovered by Falconbridge on the property since 1995.

At Sudbury, Ontario, where more than 10 nickel-copper deposits have been found since 1990, Inco Limited announced the discovery of a new deposit at Pump Lake. Drilling has indicated 3.5 Mt grading 1.5% nickel, 1.0% copper and 1.5 g/t combined platinum-palladium-gold with ongoing drilling expected to increase this resource.

Exploration by North American Palladium Ltd. continues to increase ore reserves at the Lac des Iles mine in northwestern Ontario where mill capacity has recently been increased from 2400 t/d to 15 000 t/d. At the end of 2000, measured and indicated resources had increased to 145.7 Mt grading 1.57 g/t palladium, 0.17 g/t platinum, 0.12 g/t gold, 0.06% copper and 0.05% nickel with a further 19.7 Mt classified as inferred. This tonnage contains 8.4 million troy oz of palladium. The orebody remains open to the east, west and at depth. Further increases in reserves and resources are expected.

Metallurgical work and a pre-feasibility study on the Big Whopper pegmatite deposit of Avalon Ventures Ltd., discovered northwest of Kenora, Ontario, in 1997, which contains 13.8 Mt grading 1.34% Li_2O and 0.30% Rb_2O and is open at depth, indicate that selective flotation can recover more than 90% of the petalite in a concentrate with an average grade of 4.4% Li_2O and an exceptionally low iron content (less than 0.02% Fe_2O_3). In addition to petalite, the flowsheet also provides for the recovery of separate concentrates of rubidium-potassium-feldspar, albite, spodumene, mica, tantalum and tin. The pre-feasibility study indicated that the project (mineable by open pit) will yield a discounted cash flow rate of return of 39.5%. The company plans to proceed with a full feasibility study at a cost of $5.0 million. The “Big Whopper” is one of only four such large petalite-pegmatite deposits in the world. Drilling is in progress on a separate tantalum-bearing lepidolite dyke on the property.

An initial 300-t bulk sample taken by De Beers Canada Exploration Inc. from the Victor kimberlite, located to the west of James Bay in Ontario, yielded diamonds valued at US$154/ct, with a kimberlite value of US$50/t.

In Manitoba, kimberlite indicator mineral dispersal trains have been found by provincial geological survey geologists in the Superior province (of Archean age), in the northeastern part of Manitoba to the north and south of Knee Lake, and near the Echimamish River. This has led to the acquisition of 60 to 70 exploration permits by more than 20 companies, including De Beers and BHP Diamonds Inc. The permits covered an area of 31 000 km^2 as of mid-April 2001. Detailed exploration, including drilling, is under way on some of these permit areas.

In Saskatchewan, one year after commencement of production at the McArthur River mine, Cameco Corporation announced that proven and probable reserves at the mine, the world’s largest and highest grade uranium mine, have been increased by more than 50% to 394.5 million lb of U_3O_8 in ore grading an average 21.18% U_3O_8. The increase is based on drilling done during 1999-2000 together with results of the initial year of production. Cameco continued to drill a property at La Rocque Lake where high-grade uranium intersections were first reported in 1999. Results of this work have not yet been released.

Exploration of Foran Mining Corporation’s McIlvena Bay zinc-copper deposit continues. Indicated and inferred resources for this deposit now stand at 14.5 Mt grading 0.91% copper, 6.08% zinc, 0.40% lead, 0.45 g/t gold and 23.70 g/t silver, plus another 12.1 Mt grading 1.81% copper, 0.54% zinc, 0.63 g/t gold and 12.47 g/t silver. The deposit is open downplunge and to the northeast.

Diamonds continue to be the principal exploration target in the Northwest Territories, which is expected to produce diamonds at a rate of $1.5 billion

annually by 2004 (see Diamond Exploration Highlights below for additional information).

In Nunavut, the Naartok gold deposit was discovered on the Hope Bay gold property, bringing the number of known gold deposits on that property to four. A $10 million exploration program is being carried out on the Hope Bay property where more than $85 million has been spent on exploration to date. At the Meadowbank gold project, to the north of Baker Lake, the Vault gold deposit was discovered, the fifth deposit to be discovered and outlined on that property in five years.

DIAMOND EXPLORATION HIGHLIGHTS

Exploration for diamonds continues at a substantial number of properties in Labrador, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, the Northwest Territories and Nunavut (Figure 2). This chapter only describes properties that have been demonstrated to have diamond contents and values that appear to have promising economic potential.

Ekati Diamond Mine, Northwest Territories

Diamond exploration of the Ekati mine property continues to result in the discovery of additional diamond-bearing kimberlite pipes. During the summer of 2000, 11 additional pipes were discovered for a total of 136 pipes confirmed on the property at year-end. Ninety-seven of these pipes are in the core zone claim block, and thirty-nine are in the outlying buffer zone. Exploration is ongoing.

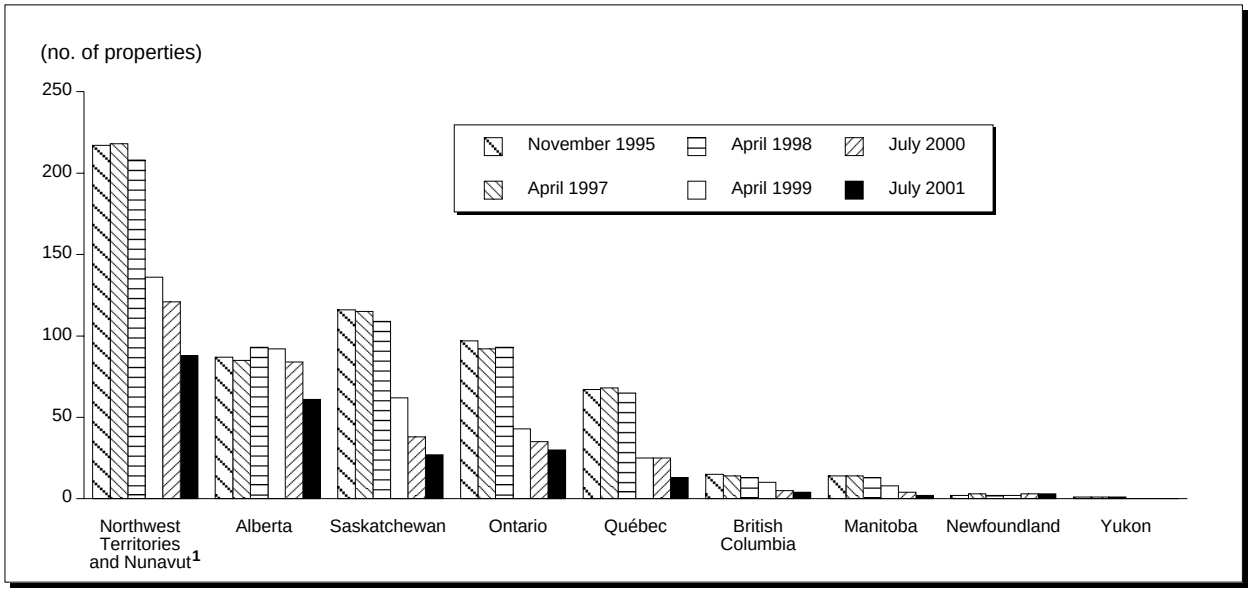
In addition to the previously approved mining plans for the Panda, Misery, Koala, Fox and Sable pipes, the mine plan has been amended to include the Koala North, Pigeon and Beartooth pipes.

The Pigeon pipe has a surface area of about 2 ha and is reported to contain a kimberlite ore reserve of 5.3 Mt to a depth of 200 m, at a waste-to-ore stripping ratio of 9.7 to 1. The Beartooth pipe has a surface area of 1 ha, with reserves of 1.4 Mt to a depth of 155 m, at a 12-to-1 stripping ratio.

Results from drill samples collected early in 2000 are as follows:

Pipe	Dry Tonnes	Total Carats Recovered (>1 mm)	Average Grade (ct/t)
Wolverine	130.8	8.59	0.07
Zach	63.3	11.30	0.18
Cougar	74.3	0.72	0.01
Lynx	168.5	140.74	0.83

Figure 2
Regional Distribution of Diamond Exploration and Deposit Appraisal Properties, 1995-2001



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1995-97 and InfoMine db for 1998-2001, Robertson Info-Data Inc., Vancouver, British Columbia, and used under licence.

[1] In July 2001 (2000), there were 78 (112) diamond exploration properties in the Northwest Territories and 10 (9) in Nunavut, for a total of 88 (121) properties in the two territories.

Diamond valuations were not carried out on the diamonds from the Wolverine, Zach and Cougar pipes because of the low diamond recoveries.

The diamonds from the Lynx pipe have been valued at US$139/ct. An additional bulk sample from the Lynx pipe, weighing approximately 150 t, was taken during the first quarter of 2001.

The kimberlites discovered during the summer of 2000 include the following:

Pipe	Sample weight	Total Carats Recovered	Grade
	(kg)	(>1 mm)	(ct/t)
Kodiak	81.7	0.87	10.6
Pegasus	29.1	0.33	1.1
Wildebeest	35.0	0.032	0.9

Diavik Project, Northwest Territories

On December 19, 2000, the final decision was made to develop the Diavik diamond mining project. Construction is in progress at an estimated total cost of $1.3 billion. Initial production is expected in the first half of 2003. The Diavik project plan calls for a two-year production ramp-up period after which 1.5 Mt of kimberlite are expected to be processed annually. Diamond production is anticipated to average approximately 6 Mct/y. The Diavik mine will yield a total of 101.5 Mct of diamonds at an average value of US$63/ct over a 20-year mine life.

Exploration of the Diavik property continued in 2000.

Snap Lake Project, Northwest Territories

De Beers has acquired the Snap Lake diamond deposit at a cost of $379 million by taking over Winspear Diamonds Inc. (67.76% owner of the deposit) and purchasing the 32.24% interest that was owned by Aber Diamond Corporation. Indicated ore reserves are 22.8 Mt at a mineable grade of 1.65 ct/t. A further 20 Mt are classified as inferred. The diamond value is about US$100/ct. De Beers continues exploration and bulk sampling of the Snap Lake deposit. Exploration and economic studies confirm that the site will support a 3000-t/d underground mine. Phase one will employ up to 450 people during construction and 350 people during an anticipated mine life of over 20 years. De Beers estimates that production could begin early in 2004 provided that permits are issued allowing construction to begin at the end of 2002.

Jericho Property, Nunavut

Tahera Corporation has a feasibility study on the Jericho JD/OD1 kimberlite pipe. The study indicates that approximately 3.0 Mct of diamonds can be produced over an eight-year mine life. Open-pit mining would mine a cumulative 1.9 Mt of reserves for the first four years, to be followed by the mining of 614 000 t of reserves from underground, from a decline. Additional diamondiferous kimberlite resources may be converted to reserves, which could extend the life of the mine beyond eight years.

Tahera continues to explore for kimberlite pipes in the Jericho area and is attempting to obtain financing for the proposed diamond mine. Estimated resources for the JD/OD1 kimberlite are as follows:

Indicated Resources	Tonnage	Recovered Grade	Recovered Carats	Value
	(Mt)	(ct/t)	(000s)	(US$/t)
North - Upper Lobe	0.603	0.77	467	46.20
North - Lower Lobe	0.908	0.71	647	42.60
Central Lobe	2.156	1.42	3 062	109.34
Total indicated	3.667	1.14	4 176	82.50
Inferred resources	3.401	0.52	1 757	31.54
Total resources	7.068	0.84	5 933	57.98

Victor Kimberlite, Ontario

De Beers has discovered 18 kimberlite pipes on its property in the James Bay Lowlands, some 90 km west of Attawapiskat, Ontario. Sixteen of these kimberlites are diamondiferous. The site was originally discovered in 1980, but it was not until 1999 that encouraging results were obtained from the Victor kimberlite. A bulk sample of approximately 7000 t was extracted from the Victor kimberlite (the largest of the 18 pipes with an area of approximately 15 ha) in early 2000 using a 24-inch-diameter reverse circulation drill to a depth of 200 m below surface, and from two near-surface trenches. The drill program was to be carried over into the winter of 2000/01. Results of an initial 300-t bulk sample, released by De Beers, yielded diamonds valued at US$154/ct for a kimberlite value of US$50/t. Results for the larger bulk sample have not yet been released.

De Beers reports that the results of the bulk sampling program, and of the evaluation of the diamonds recovered, are expected to be available in late 2001 or early 2002 and will be used to determine whether the site will advance to a full mine feasibility study. A team of De Beers' mining engineers is currently working on a desktop study.

Gahcho Kué Project, Northwest Territories

This project, formerly known as the AK claims, and later as the Kennady Lake property, is a joint venture between De Beers Canada Exploration Inc. (51%), Mountain Province Diamonds Inc. (44.1%) and Camphor Ventures Inc. (4.9%). De Beers has the right to earn up to a 60% interest in the AK and CJ properties by taking the project to commercial production. De Beers indicates that the intention of a drilling project during the winter of 2000/01 was to determine whether it is possible to increase diamond revenues for the site by the approximately 15% that is needed to move the project to the feasibility stage. In this bulk sampling program, which cost $8 million to $10 million, De Beers plans to recover 1000-1250 ct from each of the Hearne and 5034 kimberlites. De Beers considers these kimberlites to be the most prospective of the kimberlites discovered thus far on the property and the pipes which, to date, have returned the highest values in terms of revenue per tonne.

De Beers recovered approximately 307 t from the Hearne pipe and 550 t from the 5034 pipe. Although fewer holes were drilled than had been planned because of unseasonably warm winter weather, the quantity of diamonds expected to be recovered is expected to be adequate for evaluation and modeling purposes.

De Beers is to carry out exploration drilling on other parts of the AK claims during the summer of 2001 with the drilling targets to be based on geophysical targets and indicator mineral sampling.

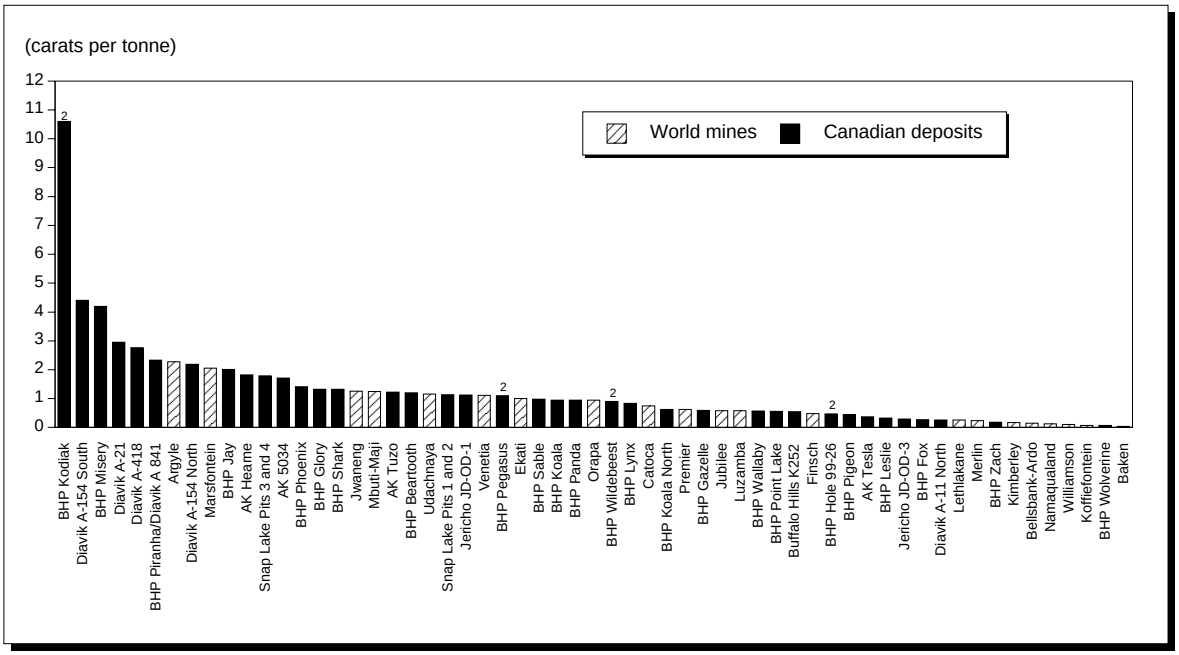
Buffalo Hills Property, Alberta

In March 2000, Ashton Mining of Canada Inc. discovered the K252 kimberlite. The area of this kimberlite is approximately 2 ha. A 1.28-t sample of volcaniclastic kimberlite yielded 0.85 ct of diamonds larger than 0.8 mm, using a square aperture screen, or 0.66 ct/t. The largest diamond was a colourless composite crystal weighing 0.36 ct. This is the most encouraging of the 35 kimberlites discovered on the Buffalo Hills property to the end of 2000. In March 2001, Ashton took a 22.8-t mini-bulk sample from the K252 kimberlite that yielded 12.54 ct of diamonds larger than 0.8 mm in size, or 0.55 ct/t. If the 4.0 t of mudstone from intervals in the kimberlite breccia are included, the 26.8 t of material recovered have a combined grade of 0.47 ct/t. The largest diamond recovered was a 0.94-ct composite crystal while the second largest was a colourless 0.65-ct stone. The next six diamonds have weights that range from 0.17 to 0.28 ct.

Ashton plans a program of geotechnical studies and financial analysis to identify preliminary economic thresholds for diamond content and value. The company states that this would be followed by delineation drilling and the collection of a larger sample.

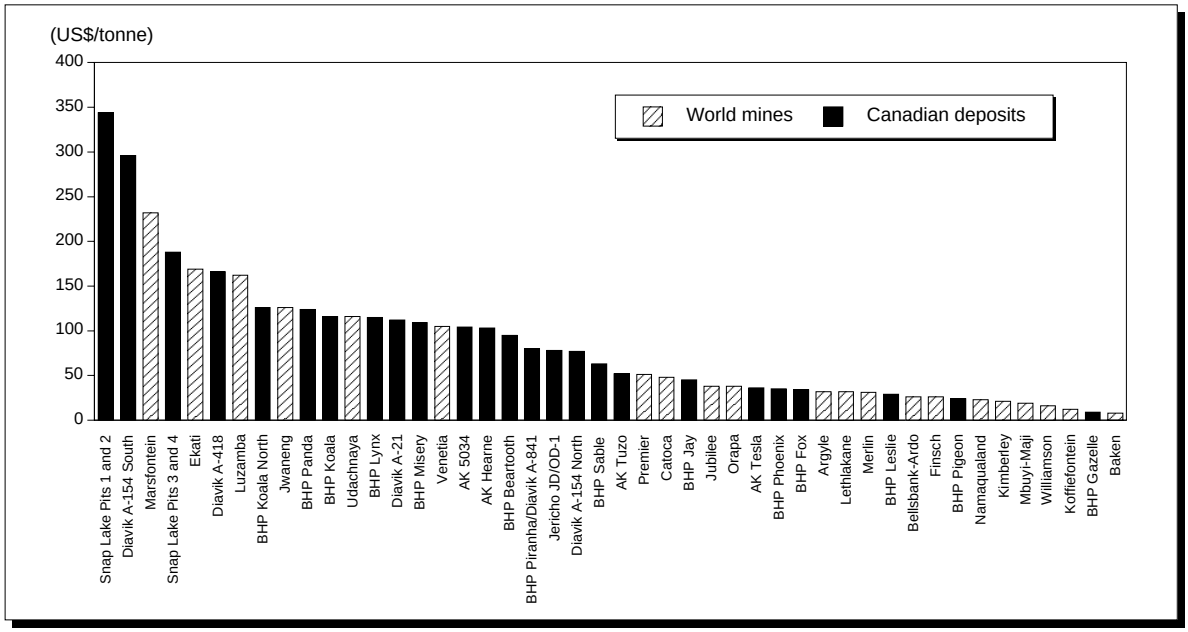
Notes: (1) Information in this review was current as of May 31, 2001. (2) This and other reviews, including previous editions, are available on the Internet at http://www.nrcan.gc.ca/mms/cmy/index_e.html.

Figure 3
Recoverable Diamond Grades From World Diamond Mines[1] and Canadian Diamond Deposits



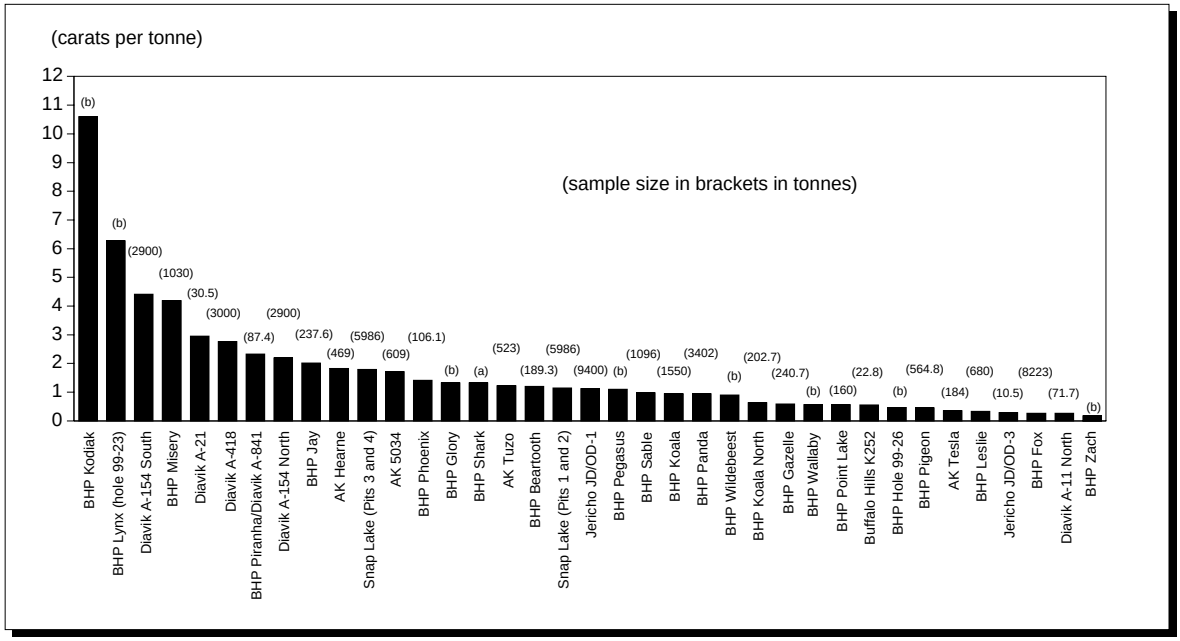
Source: Natural Resources Canada, based on published data.
[1] Grades of world diamond mines are 1999 production grades. [2] Based on a sample weight of a fraction of a tonne of drill core.

Figure 4
Recoverable Diamond Values for World Diamond Mines[1] and Canadian Diamond Deposits



Source: Natural Resources Canada, based on published data.
[1] Values for world diamond mines are 1999 production grades.

Figure 5
Grades of Selected Canadian Diamond Deposits



Source: Natural Resources Canada, based on published data.
(a) Sample size not available. (b) Based on samples of only a fraction of a tonne of drill core.

TABLE 1. THE WORLD'S TOP 25 MINERAL PRODUCERS IN 1996

Rank	Country	Production Value
		(US$ billions)
1	China	78.7[a]
2	United States	58.6
3	South Africa	18.0
4	Australia	16.9
5	Russia	16.5[a]
6	**Canada**	14.6
7	India	14.5
8	Brazil	9.9
9	Germany	9.4
10	Japan	9.2
11	Chile	9.2
12	Mexico	7.0
13	Poland	6.7
14	Indonesia	6.1
15	South Korea	5.3
16	Italy	5.2
17	Peru	4.8
18	United Kingdom	4.5
19	Spain	4.4
20	Turkey	4.2
21	Kazakhstan	3.5
22	Iran	3.2
23	Ukraine	3.2
24	France	3.2
25	North Korea	2.5

Source: Natural Resources Canada (compiled by author).
[a] Totals for China and Russia exclude most construction minerals.

TABLE 2. SELECTED DATA ON CANADA'S MOST PROMISING DIAMOND DEPOSITS

Pipe	Total Tonnes Sampled	Total Carats Recovered	Average Grade	Average Value	Average Value
			(ct/t)	(US$/ct)	(US$/t)
EKATI MINE AND BUFFER ZONE PROPERTIES					
Panda	3 402	3 244	0.95	130	124
Misery	1 030	4 313	4.19	26	109
Koala	1 550	1 465	0.95	122	116
Koala North	201.7	126.58	0.63	200[a]	126
Fox	8 223	2 199	0.27	125	34
Leslie	680	233	0.33	89	29
Pigeon (original sample)	154	60	0.39	51	20
Pigeon (1998 sample)	564.8	251.31	0.45	54	24
Jay	237.6	476.8	2.01	22.50	45
Sable	1 096	1 070	0.98	64	63
Beartooth	189.3	227.09	1.20	79	95
Point Lake	160	90+	0.56	..	..
Phoenix (98-C)	106.1	149.2	1.41	25	35
Shark	..	..	1.32	..	..
Gazelle	240.7	141.4	0.59	15	9
Glory	0.2438	..	1.32	..	..
Wallaby	0.1208	..	0.57	..	..
Piranha (= A841) (straddles boundary of Buffer claims and Diavik property)	87.4	203.44	2.33	30	80
Lynx	168.5	140.74	0.83	139	115
Hole 99-26	0.1736	0.082	0.47	..	..
Wolverine	130.8	8.59	0.07	..	..
Zach	63.3	11.30	0.18	..	..
Kodiak	.0817	0.87	10.6	..	..
Pegasus	.291	0.33	1.1	..	..
Wildebeest	.0350	0.032	0.9	..	..
DIAVIK PROPERTY					
A-154 South	2 900	12 800	4.41	67	296
A-154 North	71.72	156.81	2.19	35	77
A-418	3 000	8 275	2.76	56	166
A-21	30.5	90	2.95	38	112
A-11 North	29	7.6	0.26	..	..
JERICHO PROPERTY					
JD/OD-1	9 400	10 539	1.12	70[c]	78[c]
JD/OD-3 (first sample)	10.53	7.34	0.697[b]	..	..
JD/OD-3 (second sample)	35.9	10.41	0.29	..	..
AK PROPERTY					
5034 (1999 bulk sample)	609	1044	1.71	63	104
Hearne	469	856	1.82	44	103
Tuzo	469	540	1.03	43	52
Tesla	..	..	0.37	96	36
Tesla (1999 bulk sample)	184	64	0.35	..	..
SNAP LAKE PROPERTY					
Snap Lake Dike (Pits 1 and 2)	199.7	226.7	1.14	301	344
Snap Lake Dike (Pits 3 and 4)	5 985.7	10 708.1	1.789	105	188
BUFFALO HILLS PROPERTY					
K252 (kimberlite only)	22.8	12.54	0.55	..	..
K252 (including mudstone)	26.8	12.60	0.47	..	..

Source: Natural Resources Canada, based on company data.
.. Not available.
a Approximately 77% of the value is due to three gem-quality stones 3.26 to 5.41 ct in size. **b** Includes a single 3.6-ct stone; if this stone is excluded, the grade is 0.25 ct/t. **c** Values have been revised to include stones larger than 10.8 ct that had been omitted in previously published values.