Canada's Rank in World Mining

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INTRODUCTION

For years, Canada has consistently been one of the world's major non-petroleum mineral-producing countries. Until now, there has been no way of knowing Canada's exact ranking in the world production hierarchy or the ranking of any of the world's other major mineral producers.

In 1998, an initial ranking of the world's mineral-producing countries and other jurisdictions in terms of their 1996 value of production of non-petroleum minerals was undertaken. In mid-2001, a decision was made to partially repeat this analysis for 1998, the most recent year for which mineral production statistics for the world's countries (and other mineral-producing jurisdictions) were then readily available. To determine the top 25 countries in 1998, rankings of production values were calculated for the top 30 countries from 1996. Also, production tonnages in 1998 of the major commodities produced by those countries that had ranked 31 to 40 in 1996 were compared with 1996 tonnages to ensure that there had been no major production increases that might have moved any of them into the top 25 in 1998.

SOURCES OF PRODUCTION DATA

Two principal sources of mineral commodity production data were used in this analysis: the British Geological Survey (BGS) publication entitled *World Mineral Statistics 1992-96* and a subsequent edition, *World Mineral Statistics 1995-99*, and the U.S. Geological Survey's (USGS) *Minerals Yearbook*, Volume III for 1996 (and subsequently the one for 1998).

The BGS publication provides annual data concerning production of some 70 metals, ores, industrial minerals, coal, petroleum and natural gas for all of the world's countries and other mineral-producing jurisdictions (French Guiana, New Caledonia and Netherlands Antilles). Most of the tonnages published by the BGS are internationally approved statistics that have been discussed and accepted by the International Consultative Group on Nonferrous Metals Statistics. The BGS does not cover all mineral commodities. For example, it does not cover most of the mineral commodities used for construction purposes, such as cement, lime, aggregates and dimension stone, nor does it cover gemstones other than diamonds, or many of the industrial mineral commodities, such as sodium carbonate, sodium sulphate, mineral pigments, abrasive minerals, peat, pumice and silica.

The production of commodities not covered by the BGS was obtained from USGS country reports. For both 1996 and 1998, production statistics for the United States were obtained from the USGS's *Minerals Yearbook*, Volume I.

COUNTRY OF ORIGIN OF BY-PRODUCT COMMODITIES

Certain elements (cadmium, mercury, rhenium, germanium, selenium, tellurium, silver, gold, other precious metals, and possibly cobalt) are not necessarily recovered in metallic form in the countries where they are mined, but are recovered instead at smelters/refineries in countries with little or no mine production of metals. The actual mine sources of such metals are located in the mining countries from which the concentrates have been imported. In the concentrates, the recovered metals may have been present only in trace quantities that were neither analyzed for nor paid for in purchasing those concentrates. Because the actual origin of these metals is not known in any quantitative fashion, "mine" production of such by-products has been assigned by the BGS to the countries in which the smelters or refineries are located. For example, neither Belgium nor the Netherlands have any metal mines, yet 1996 "mine" production of cadmium from zinc plants located in those countries was 1580 t in Belgium and 603 t in the Netherlands. Similarly, Japanese cadmium production of 2344 t and German cadmium production of 950 t probably came chiefly from imported zinc concentrates. The 250 t of selenium reported as being produced by Belgium, the 58 t of selenium credited to Japan, and the 40 t of tellurium reported as being Japanese production were also recovered chiefly from imported copper concentrates. Similarly, the 2 t of germanium recovered in Japan and unknown quantities of gold and silver recovered as by-products in various countries have all been recovered from concentrates that originated in other countries.

MINERAL COMMODITY VALUES

Introduction

There are several methods by which the annual value of a country's mineral production can be calculated and compared. One method is to obtain official government statistics concerning mineral production value for all mineral commodities for each and every of the world's many countries, quoted in the currencies of each country, and then use average annual currency exchange rates (difficult or almost impossible to obtain for many countries) to transform all of these into a single currency, such as U.S. dollars. There are several problems with such an approach.

First, one must locate the sources of such production statistics (tonnages and values) for all of the world's countries, which would be difficult. Second, there would also be language translation-related difficulties. Third, countries have various ways of calculating production values – some use mine-gate production values, such as the value of copper concentrates f.o.b. (free on board) a mine, while others use more highly processed values, such as the market value of the refined copper produced, and still others use export values that include the cost of shipping minerals to a seaport and loading them onto a ship (f.o.b.). Fourth, converting production values in domestic currencies into an internationally valued currency such as the U.S. dollar can create problems, especially if currency exchange rates are at controlled official rates of exchange that have little relationship to the real value of the currency. Fifth, varying exchange rates are another difficulty. For example, between January 1997 and August 1999, the value of the Canadian dollar declined from US$0.7415 to US$0.6513, which would have resulted in an apparent decline in the value of Canada's mineral production of some 12%, even if the volume of Canadian mineral production tonnages had remained constant.

Approach Used in This Analysis

In this analysis, a standard set of mineral commodity prices was applied worldwide to the tonnage of production of each mineral in each country. For some commodities in certain countries, this methodology may have yielded values of production considerably in excess of official production values, but it has provided an appropriate and workable method of comparing the mineral production of all the world's countries, which is why it has been used here.

Mineral Commodity Prices

There are a variety of different price quotes available for most mineral commodities, e.g., for concentrates at the mine (which exclude the costs of shipping, smelting and refining), and one or more metal market prices, such as the London Metal Exchange (LME) price or the New York Commodity Exchange prices (which are not exactly the same) for most refined metals (both of which include the costs of smelting and refining).

Some prices, such as LME prices, are for metal physically located in LME warehouses at various world locations with removal and shipping costs being the responsibility of the purchaser. North American producer prices generally include the costs of shipment to the customer in railway carload lots.

Many of the so-called "industrial minerals" come in differing grades or degrees of fineness of grind. The degree of fineness can range from crude lump material to material ground to minus 400 mesh, or finer. Generally, the finer the grind, the higher the price. They can be "bulk" (unpackaged), or packaged in bags or in drums, with the packaged forms more expensive than bulk quantities. Prices for various grades and fineness of grind differ, and prices can be quoted f.o.b. a railway car, a truck at the mine, or a ship at an ocean port; delivered to a foreign port, c.i.f. (cost, insurance and freight included in the price); at a foreign port f.a.s. (free alongside ship); f.o.t. (free on truck), delivered to the purchaser in a domestic or foreign country; and so on.

Many industrial minerals come in differing degrees of purity, sometimes expressed in percentages, such as graphite 92/95% C, 85/90% C; fluorspar, metallurgical grade 85% CaF_2, acidspar 97% CaF_2; phosphate 75-77% BPL (bone phosphate of lime), 70-72% BPL; manganese, battery grade 78-85% MnO_2, chemical grade 74-84% MnO_2; and so on.

Coal prices are generally quoted either f.o.b. a mine or f.o.b. an appropriate ocean port.

COMMODITY PRICES USED IN THIS ANALYSIS

In this analysis, for metal prices, LME prices have generally been used for the metals that are traded on the LME, rather than producer prices (which include shipping costs); London market prices have been used for gold, platinum, palladium; and dealer prices have been used for the specialty metals such as cadmium, mercury, and the less common precious metals such as rhodium, iridium, ruthenium and osmium. For the various industrial minerals, prices f.o.b. a mine or plant have been used where such prices were available. If this was not possible, prices f.o.b. producing countries have been used.

For coal, prices for clean coal f.o.b. mine have been used, rather than f.o.b. an ocean port. The intent has been to eliminate or at least minimize the inclusion of freight costs for shipping the mineral commodity from where it is produced to the consumer.

PRICE SOURCES

Introduction

There is no one source for the prices of all mineral commodities. Metals such as aluminum, copper, gold, nickel, platinum, palladium, tin, zinc and others are traded daily on metal exchanges, such as the LME, so that daily metal exchange prices can be averaged to provide approximate annual average prices. For the major metals, annual average prices are available from the weekly publication *Platts Metals Week*. For a very few rare metals, annual averages have had to be calculated using data concerning prices and dates of price changes reported in *Metal Bulletin*. Prices for many of the industrial minerals appear monthly in the periodical *Industrial Minerals*, so that the 12 monthly prices quoted in this publication can be averaged to yield approximate annual average prices. There is generally more than one price quote for a particular mineral commodity, obtainable from several world sources, and sometimes for different degrees of purity or different grades. For some of these minerals, such as talc and wollastonite, the price is higher for more finely ground material. Asbestos has multiple grades with widely different prices, based chiefly on fibre length. In general, prices applicable to bulk lump or coarsely ground industrial minerals have been used rather than those for finely ground minerals, and also prices as close to the mine mouth as possible have been used in order to eliminate freight costs. Where two prices for apparently similar material differ, or where a price range is all that is available, an average of the two prices, or of the lower and upper prices of a price range, has usually been used.

Prices for construction materials, such as cement, lime, sand, gravel, crushed rock aggregates and the like, are not generally available from published sources. Furthermore, sand, gravel and crushed rock aggregate prices are generally based on a price f.o.b. the pit or quarry plus a charge for delivery that is dependent on the distance these commodities have to be transported to the consumer. The source for prices used in the present analysis for such construction materials has been the USGS publication *Mineral Commodity Summaries 1997*, published in February 1997, which lists the estimated 1996 U.S. production of each commodity and average U.S. prices in that year in dollars per metric tonne. Similarly, prices for 1998 were obtained from *Mineral Commodity Summaries 1999*. These prices have been applied to the production of all countries.

Prices for salt, asbestos and gypsum were obtained from the 1996 and 1998 editions of the *Canadian Minerals Yearbook*. For uranium, the 1996 and 1998 "restricted prices" were obtained from Natural Resources Canada's Energy Sector. In the case of iron ore, the U.S. f.o.b. mine prices given in the USGS's *Mineral Commodity Summaries* were inappropriate because they were more than double the world iron ore price. The iron ore prices used are based on the f.o.b. mine value of iron ore shipments from Canadian mines to customers in Europe (the Japanese tend to squeeze iron ore prices down below world averages so that the price of sales to Europe is more appropriate).

There is wide variation in world sulphur prices. Canadian sulphur is produced by the removal of H_2S gas from "sour" natural gas. After the deduction of freight costs to the port of Vancouver, some of that sulphur has a negative value at the producing plant stockpile, i.e., it is not worth shipping so it remains in the stockpile until higher prices make shipment worthwhile. The price for sulphur f.o.b. a U.S. mine or plant (US$38/t in 1996) has been used. This exceeds the average Canadian price f.o.b. Vancouver, a price that includes rail freight to Vancouver. During 1996, the f.o.r. (free on rail) Alberta producing plant price for liquid sulphur was in the range of US$2-$15/t.

Coal prices suitable for this analysis are difficult to obtain. Many producers tend to consider the prices at which they sell their coal to be confidential and have agreements with their customers that require price confidentiality. Shipping costs, coal rank and the heat content type of coal (metallurgical versus steam), and sulphur content are only some of the important factors. An example of the influence of shipping costs is provided by the price of marketable bituminous coal produced in Nova Scotia; in 1996, this coal sold at an average mine-mouth price equivalent to US$42.60/t when the mine-mouth price of comparable coal in the U.S. Appalachians was only US$24.00/t. The Nova Scotia producers were able to command the higher price because the price difference was roughly equal to the cost of hauling U.S. coal by rail to an ocean port and then by ship to Nova Scotia.

Similarly, coal used at Manitoba Hydro's two thermal power-peaking plants is chiefly sub-bituminous coal hauled by rail from Montana, with freight costs roughly double the mine-mouth price paid for the coal in Montana. Lignite coal could easily be obtained from less distant mines in southeastern Saskatchewan, but the lignite has a considerably lower heat content and also a higher per-tonne price, so it is less economical than the coal from mines in Montana. The most important factors to consider in the purchase of coal are: 1) delivered cost per BTU or per kilogram calorie; 2) the sulphur content of the coal; and 3) the suitability of the coal for the planned use.

In some countries, coal production costs are highly subsidized by governments so these costs can be as much as several times the world market price for comparable coal. To use subsidized prices in comparing mineral production values seems inappropriate, so they have not been used in this analysis.

The definition of exactly what coals constitute anthracite, bituminous, sub-bituminous, lignite and brown coal appears to depend to a considerable extent on the particular expert who defines them. Although anthracite is a higher rank coal (90-97% carbon by one definition) than bituminous coal (85-90% carbon by the same set of definitions), the higher hydrocarbon content in bituminous coals also provides combustion heat, so there is little difference in heat content and, as a result, little difference in the market prices of anthracite and bituminous coal. Therefore, in the present analysis, the same price has been used for both anthracite and bituminous coal. Useable price information for “brown coal” has been impossible to obtain, so an arbitrary assumption has been made that it has a price of US$1.00/t lower than the price of lignite. Similarly, for peat fuel, used in a few countries, an arbitrary price that is US$2.00/t lower than the price of lignite has been used.

The following are the average coal prices in U.S. dollars (f.o.b. mine) compiled for 1996 from all available sources and used in this analysis. Coal is widely available from North American coal mines at such prices, but neither brown coal nor peat fuel are produced in North America.

Type	Price
	(US$/t)
Bituminous and anthracite	24.00
Sub-bituminous	8.50
Lignite	7.00
Brown coal	6.00
Peat fuel	5.00

As there did not appear to have been any significant change in coal prices in 1998 from the 1996 prices, the same prices were used for the 1998 analysis.

Prices Used for the 1998 Production Ranking Analysis

For 1996, having to find and then average monthly and even daily prices for many mineral commodities was extremely time consuming. To shorten the task for 1998, published prices for such commodities at mid-year were used instead of annual price averages.

THE WORLD’S TOP 25 MINING COUNTRIES IN 1996 AND 1998

Table 1 lists the world’s top 25 mining countries in 1996 and 1998, giving the calculated U.S. dollar value for the 1996 and 1998 non-petroleum mineral production of each country.

On first reflection, some of the world’s major mineral-producing countries might not have been thought of as being major mining countries. This is because they are not significant mine producers of metals. Such countries include Germany, Japan, South Korea, Italy, the United Kingdom and France. These countries are important producers of non-petroleum minerals chiefly because of their large production of construction materials, the industrial minerals and, in some cases, coal used mostly for electric power generation and/or steel-making.

The production value ranking of countries changed from 1996 to 1998, not only because of higher or lower production of individual mineral commodities, but also because of the effects of changes from year to year in the prices of the mineral commodities that each country produces. It cannot be concluded that the volume of mineral production of individual countries has been higher or lower because production values, or country rankings, have changed from one year to the next. Because most construction materials are missing from the Chinese and Russian production value totals (presumably because the USGS has not been able to obtain these data), the actual value of China’s total mineral production is considerably higher than shown in Table 1. Similarly, the value of Russia’s total mineral production, including the missing construction materials, would almost certainly place Russia third in the world in terms of mineral production value, behind the United States but ahead of South Africa.

Uncertainties Concerning Production Statistics and Mineral Commodity Prices

Some of the production statistics and some of the prices that have been used in the analysis are not accurate final data. The BGS's 1996 production tonnages for some commodities, in some countries, were reported as being nil in the 1992-96 BGS report yet, with hindsight, the 1995-99 report indicates that there was production of some of those minerals in some of those countries during 1996. There were a considerable number of such omissions in the 1992-96 report. In many other cases, the production tonnages for some minerals in some countries for 1996 that were published in the 1992-96 BGS report have been subject to major revisions in the 1995-99 report. Similarly, many tonnages published by the BGS are reported as being estimates and there is no way to know the accuracy of those estimates.

Similar omissions and subsequent revisions for some mineral commodities, in certain countries, are found in the USGS production statistics. Especially in the case of nonmetallic mineral commodities, various countries report their production of certain commodities in ambiguous ways, for example, it is not clear whether reported tonnages of stone are of high-value dimension stone or of low-value crushed rock aggregate. In some cases, higher-value and lower-value forms of a commodity are combined in a single reported tonnage for a country, for example, a kaolin tonnage totaled together with a tonnage of common clay. This sort of reporting has forced a certain number of interpretations of which commodity price value to use. In general, in such cases, the price of the lower-valued commodity was used for the entire production tonnage reported, even though an unknown portion of the reported tonnage must have been higher-valued material.

There are also other statistical difficulties. For example, the BGS reports total carats of diamond production for all diamond-producing countries. Some of these diamonds are low-value industrial diamonds and the remainder are high-value, gem-quality diamonds. There is no way to know what average prices to apply to the BGS data to come up with a total value of each country's diamond production. The diamond production values were World Diamond Council estimates for the years 1997 and 1999, which had to be used in this analysis as proxies for the values of 1996 and 1998 diamond production, respectively, because the 1996 and 1998 values could not be found.

Another difficulty is the various grades of tonnages of the iron ore and the manganese ore that are produced in different countries. Those grades must be taken into account in ore value calculations. The BGS reported manganese grades for 1996 but not for 1998. The BGS did not report iron ore grades for either year, but a United Nations compilation of iron ore grades was available for 1996; that compilation has now been discontinued. So, with the unavailability of better data, the assumption was made that, in 1998, the grades of both iron ore and manganese ore production were identical to those for 1996.

Some data are incomplete, or unavailable, in certain of the USGS reports. For example, in the case of China, statistics concerning the production of construction materials are far from complete. The only Chinese construction materials production statistics reported by the USGS are those for cement and gypsum. There are no data for Chinese production of sand and gravel, crushed rock aggregates, dimension stone, or for common clay used for the manufacture of bricks and the like. A country with a population as exceptionally large as that of China must have a production value of these construction materials that totals several tens of billions of U.S. dollars annually, an amount that must exceed the value of Canada's production of all the non-petroleum mineral commodities combined.

Russia is the other country in the top 25 for which production statistics are not readily available for the construction materials (sand and gravel, crushed rock aggregates, dimension stone and common clay); the value of Russian production is therefore also significantly understated in the current analysis.

In addition, there are inaccuracies in the prices quoted for some of the nonmetallic mineral commodities covered by the USGS's *Mineral Commodity Summaries*. In recent editions, prices for some mineral commodities have been subjected to major revisions that go back several years. This means that a significant number of the prices that were used to calculate 1996 production values may have been incorrect; it was not feasible to go back and revise all the production value calculations for 1996. Similarly, it is possible that such revisions to 1998 prices may be made by the USGS in the future.

In conclusion, the country production value totals reported in Table 1 are only approximations.

Value of Mineral Production per Capita (Table 2), and per Square Kilometre (Table 3)

Values of mineral production can be measured in ways other than the total value of production for each country (or other mineral-producing jurisdiction), such as in terms of values in dollars per capita and/or per square kilometre.

Production values per capita for the world's top 25 mineral-producing countries in 1996 are presented in Table 2. Of those 25 countries, Australia (US$928 per capita) ranked first, Canada (US$488 per capita) ranked third, and India (US$16 per capita) ranked twenty-fifth. There were another 70 countries/jurisdictions that had per-capita mineral production values lower than that of India.

Production values per square kilometre for the world's top 25 mineral-producing countries in 1996 were also calculated. Of the top 25 mineral-producing nations, Canada ranked twenty-second from the top (Table 3) with a value of mineral production per square kilometre of only US$1465, compared to South Korea with a production value of US$53 434 per square kilometre. Four countries/jurisdictions not among the world's top 25 mining countries (Nauru, Christmas Island, New Caledonia, and Belgium), have per-square-kilometre production values even higher than that of South Korea.

Canada's rank of twenty-second in terms of the value of production per square kilometre is a rank relative to those of only the world's top 25 mineral-producing countries. However, when all of the world's 189 countries and other non-country jurisdictions are considered, in 1996, Canada was a surprisingly low ninety-first from the top in terms of value of mineral production per square kilometre. There were 90 countries or jurisdictions in which the production value per square kilometre exceeded that in Canada.

Notes: (1) Information in this review was current as of December 31, 2000. (2) This and other reviews, including previous editions, are available on the Internet at http://www.nrcan.gc.ca/mms/cmy/index_e.html

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TABLE 1. VALUE OF NON-PETROLEUM MINERAL PRODUCTION OF THE WORLD'S TOP 25 PRODUCERS OF NON-PETROLEUM MINERALS IN 1996 AND 1998

1996			1998		
Rank	Country	Value	Rank	Country	Value
	(US$ millions)			(US$ millions)	
1	China[1]	78 749	1	China[1]	80 208
2	United States	58 626	2	United States	56 715
3	South Africa	17 991	3	South Africa	17 192
4	Australia	16 809	4	Russia[1]	17 039
5	Russia[1]	16 510	5	Australia	16 311
6	Canada	14 617	6	India	15 728
7	India	14 491	7	Canada	12 843
8	Brazil	9 910	8	Germany	10 226
9	Germany	9 390	9	Brazil	10 060
10	Japan	9 212	10	Japan	8 808
11	Chile	9 157	11	Chile	8 169
12	Mexico	6 977	12	Poland	7 260
13	Poland	6 704	13	Indonesia	6 722
14	Indonesia	6 050	14	Mexico	6 566
15	South Korea	5 290	15	Italy	6 416
16	Italy	5 233	16	Turkey	6 066
17	Peru	4 773	17	United Kingdom	4 397
18	United Kingdom	4 506	18	South Korea	4 338
19	Spain	4 426	19	Peru	3 856
20	Turkey	4 233	20	Spain	3 798
21	Kazakhstan	3 497	21	Iran	3 647
22	Iran	3 159	22	Ukraine	3 460
23	Ukraine	3 157	23	Kazakhstan	3 315
24	France	3 153	24	France	3 262
25	North Korea	2 467	25	North Korea	3 065

Sources: Natural Resources Canada.
[1] Totals for China and Russia exclude most construction materials because those data could not be obtained. The correct rank of Russia was almost certainly third in both 1996 and 1998, ahead of South Africa and Australia.

TABLE 2. VALUE OF NON-PETROLEUM MINERAL PRODUCTION PER CAPITA OF THE 25 COUNTRIES WITH THE HIGHEST VALUE OF NON-PETROLEUM MINERAL PRODUCTION IN 1996

Rank	Country	Production Value Per Capita
		(US$)
1	Australia	928
2	Chile	642
3	Canada	488
4	South Africa	409
5	United States	222
6	Kazakhstan	205
7	Peru	202
8	Poland	174
9	South Korea	117
10	Germany	115
11	Spain	112
12	Russia[1]	111
13	North Korea	103
14	Mexico	98
15	Italy	91
16	United Kingdom	77
17	Japan	74
18	Turkey	69
19	China[1]	64
20	Brazil	61
21	Ukraine	61
22	France	54
23	Iran	46
24	Indonesia	30
25	India	16

Sources: Natural Resources Canada.
[1] Production values for China and Russia exclude most construction materials because those data could not be obtained. Actual production values per capita are higher than indicated here.

TABLE 3. VALUE OF NON-PETROLEUM MINERAL PRODUCTION PER SQUARE KILOMETRE OF THE 25 COUNTRIES WITH THE HIGHEST VALUE OF NON-PETROLEUM MINERAL PRODUCTION IN 1996

Rank	Country	Production Value Per Square Kilometre
		(US$)
1	South Korea	53 434
2	Germany	26 303
3	Japan	24 370
4	Poland	21 419
5	North Korea	20 388
6	United Kingdom	18 520
7	Italy	17 352
8	South Africa	14 747
9	Chile	12 096
10	Spain	8 764
11	China[1]	8 283
12	United States	6 255
13	France	5 712
14	Turkey	5 434
15	Ukraine	5 229
16	India	4 707
17	Peru	3 714
18	Mexico	3 563
19	Indonesia	3 176
20	Australia	2 187
21	Iran	1 917
22	Canada	1 465
23	Kazakhstan	1 287
24	Brazil	1 164
25	Russia[1]	997

Sources: Natural Resources Canada.
[1] Production values for China and Russia exclude most construction materials because those data could not be obtained. Actual production values per square kilometre are higher than indicated here.