

Platinum Group Metals

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The term “platinum group metals” (PGMs) refers to six closely related metals generally found together: platinum (Pt), palladium (Pd), rhodium (Rh), ruthenium (Ru), iridium (Ir) and osmium (Os). These “noble” metals possess unusual qualities such as high melting points and chemical inertness and, most importantly, exceptional catalytic properties, even under conditions of severe temperature and corrosion. The principal uses for these metals are for catalysts, electronics and jewellery. First categorized as a precious metal in 1751, all six elements were once thought to be one single metal until platinum and later palladium and rhodium were separated from their ores in the early 1800s. PGMs are commonly associated with ores of nickel and copper.

South Africa is the world’s leading platinum producer and the second largest palladium producer after Russia, where production is concentrated in the Norilsk region. All of South Africa’s production is sourced from the Bushveld Igneous Complex, which hosts the world’s largest resource of PGMs. In addition to platinum and palladium, these mines also produce rhodium, ruthenium, iridium, gold, silver, nickel, copper and cobalt as by-products. In Canada, the Sudbury Basin in Ontario is the most important region for the production of PGMs. Toronto-based Inco Limited is the largest PGMs producer outside of South Africa and Russia.

The principal uses for platinum and rhodium are in catalysts, especially autocatalysts, which account for about 40% of industrial demand for platinum and for over 80% of demand for rhodium in market economy countries. Electrical, autocatalyst and dental uses account for about 90% of the demand for palladium. Europe leads in industrial demand for both platinum and palladium, ahead of both Japan and North America.

The prices of platinum and palladium are determined daily in a number of markets; London, New York and Tokyo are the principal markets for platinum and palladium. Johnson Matthey Plc issues prices daily for platinum, palladium, rhodium, iridium and ruthenium. Various publications list prices for rhodium.

The average London prices for the principal PGMs in 2003 were (in US\$/troy oz):

Platinum	691.86
Palladium	200.61
Rhodium	530.27
Iridium	93.07
Ruthenium	35.04

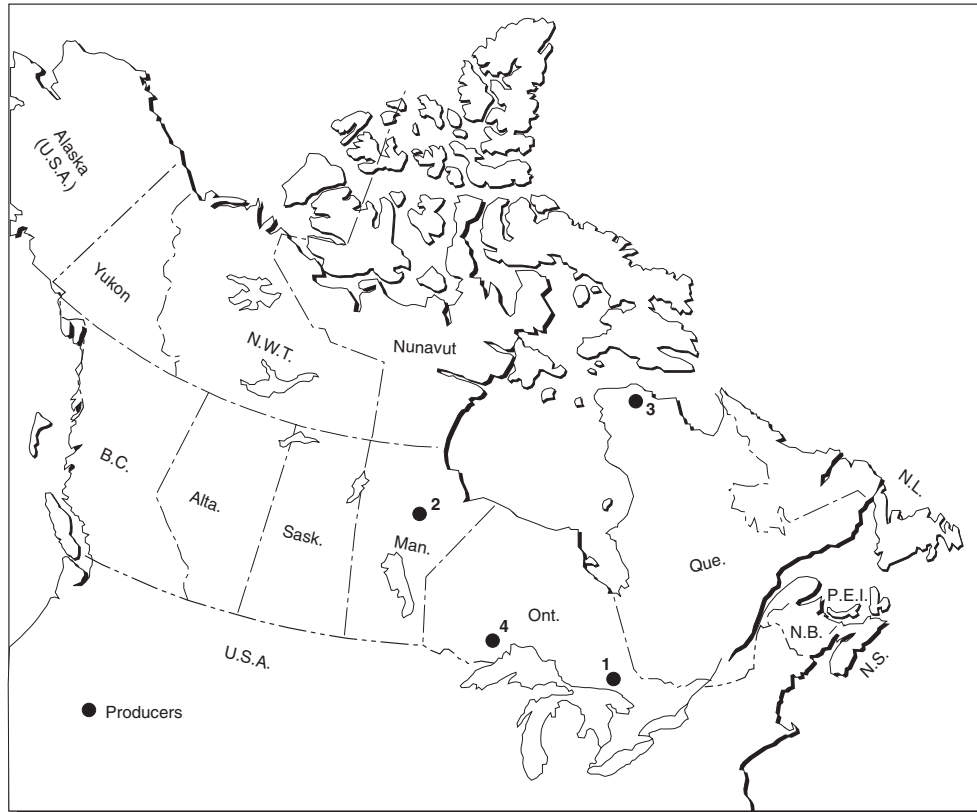
CANADIAN DEVELOPMENTS

Primary PGMs output in Canada declined from 24.4 t in 2002 to 18.5 t in 2003 largely as a result of the interruption in production during a three-month strike at Inco’s facilities in Sudbury.

In addition to primary PGMs output, Canadian nonferrous metals producers recover considerable amounts of PGMs by recycling domestic and imported post-consumer materials. Obsolete autocatalysts, industrial catalysts, electronics, telecommunications equipment, and other post-consumer materials are the main sources of post-consumer items that contain sufficient PGMs to warrant recovery.

Canada has one producer with PGMs as the principal product and two producers of by-product PGMs. North American Palladium Ltd. operates the Lac des Iles open-pit PGMs mine west of Thunder Bay in northern Ontario. Inco Limited and Falconbridge Limited recover PGMs as by-products of their nickel-copper operations. Inco’s Sudbury, Ontario, operation is the source of the majority of Canada’s primary PGMs output, with a small portion of Inco’s PGMs coming from its Manitoba operations. Falconbridge recovers PGMs from its nickel mine at Raglan in northern Quebec. Ontario accounts for the vast majority of primary PGMs production in Canada (Figure 1).

Figure 1
Platinum Group Metals in Canada, 2003



Numbers refer to locations on map above.

PRODUCERS

1. Falconbridge Limited (Fraser, Lindsley, Onaping-Craig, Lockerby)
1. Inco Limited (Copper Cliff North, Copper Cliff South, Crean Hill, Creighton, Froid, Little Stobie, McCreedy East, Levack/McCreedy West, Garson, Stobie)
2. Inco Limited (Thompson, Birchtree)
3. Falconbridge Limited (Raglan)
4. North American Palladium Ltd. (Lac des Iles)

WEB SITE

- www.falconbridge.com
- www.inco.com
- www.inco.com
- www.falconbridge.com
- www.napalladium.ca

Both Inco and Falconbridge ship contained PGMs to refining facilities in Europe for final recovery. Falconbridge sends its PGMs, contained in a copper-nickel matte, to the company's Nikkelverk refinery in Norway. These contained PGMs in the matte are not reported in Canadian export data. Nikkelverk also processes primary materials from other primary and secondary sources.

Inco's platinum refinery in Acton, United Kingdom, processes both primary and secondary materials, and also toll refines PGMs. Most of Inco's PGMs are produced

from Ontario ores and the company expects production of 400 000 troy oz in 2004. Inco is developing one orebody, the 170 orebody at the Coleman mine, and the Creighton Deep area to meet future PGMs production targets to maintain PGMs production at the 400 000 troy oz level beyond 2004.

In 2003, drilling at Falconbridge's Nickel Rim South deposit increased estimated inferred mineral resources to 11.7 Mt grading 1.6% nickel, 3.7% copper, 2.0 g/t platinum, 2.3 g/t palladium and 0.7 g/t gold. The Nickel Rim

South deposit is located near Falconbridge's existing infrastructure in Sudbury and is expected to enter production in late 2008 or early 2009.

Canada's PGMs mine operated by Lac des Iles Mines Ltd. is located 80 km northwest of Thunder Bay, Ontario. The operation began mining in December 1993. North American Palladium Ltd., formerly Madeleine Mines Ltd. until June 1993, owns Lac des Iles, which itself was incorporated in 1991. The Lac des Iles deposit contains one of the largest open-pit bulk-mineable palladium reserves in the world. The processing operation has a design capacity of 15 000 t/d that produces, by flotation, a palladium-rich concentrate that also contains economically recoverable credits for platinum, gold, copper, nickel and cobalt. The concentrate is delivered to the Sudbury operations of Falconbridge Limited and Inco Limited for smelting, and is further processed at their respective European operations for refining.

According to company reports, mine production in 2003 totaled 14.6 Mt, or 39 895 t/d, containing 4.4 Mt of ore grading 2.48 g/t palladium. Total mine production decreased from the 46 793 t/d recorded in 2002 as a result of continued crusher problems during the first six months and longer haulage distances attributable to increased pit depth and tailings dam construction. Although mine production was lower in 2003, palladium production from the Lac des Iles mill reached a new record of 288 703 oz in 2003 as a result of higher palladium feed grade and, particularly during the second half of the year, higher mill throughput and mill operating time. Ore processed in 2003 totalled 5 159 730 t, or 14 136 t, per calendar day at an average palladium head grade of 2.3 g/t palladium and an average palladium recovery of 75.5%. Other metal production in 2003 included 23 742 oz of platinum, 23 536 oz of gold, 7 142 674 lb of copper and 4 070 785 lb of nickel.

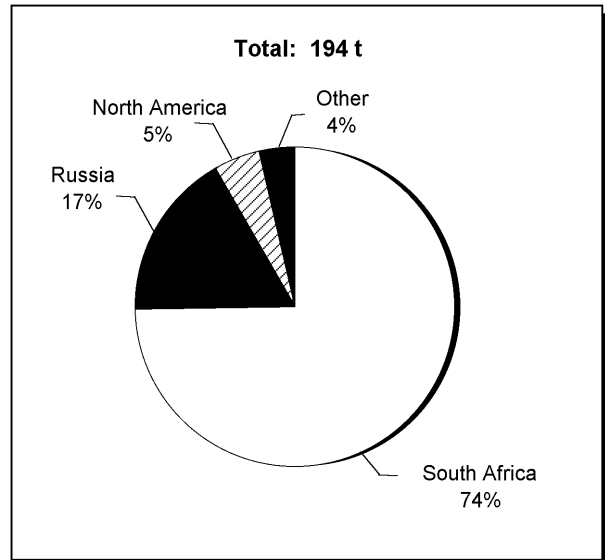
A feasibility study that was completed in 2003 confirmed the viability for an underground mining operation. Integration of underground development and open-pit mining will greatly increase production over the expected mine life. Construction of the initial underground mine infrastructure is under way and first production is expected during the third quarter of 2005.

In addition to primary production, both Inco and Falconbridge recover PGMs from scrap and secondary materials, including autocatalysts. At the Horne smelter in Quebec, Noranda Inc. processes electronics and telecommunications equipment to obtain significant amounts of palladium and platinum.

WORLD DEVELOPMENTS

South Africa and Russia are the leading producers of PGMs. The United States and Canada are the third and fourth largest producers of primary PGMs, but their com-

Figure 2
World Platinum Production, 2003



Source: Johnson Matthey Plc.

bined output is less than 10% of world PGMs production. Japan, Zimbabwe, Australia, Colombia, Finland and Poland each produced less than 1% of world PGMs production in 2002. Primary PGMs are also produced in the People's Republic of China, associated with the approximately 40 000 t/y of nickel production from the Jinchuan Nickel Corporation.

Platinum Supply

Primary platinum supplies increased 4% in 2003, mostly as the result of a 5% rise in output from South African mines and a 6.7% rise in Russian output. Primary output was estimated at 194.1 t, compared to 185.7 t in 2002.

In addition, Johnson Matthey estimated that 20 t of platinum were recovered from the recycling of autocatalysts in 2003, up from 17.6 t in 2002.

South Africa

South Africa is the largest platinum producer, delivering 138.4 t to markets in 2002 and an estimated 145.3 t in 2003. South Africa's PGMs output is derived almost exclusively from three reefs located in the Bushveld Complex, namely the Merensky Reef, the UG2 Reef and the Plat Reef. The Bushveld Complex accounts for more than 80% of the world's PGMs resources. In addition to the PGMs from the Bushveld Complex, minor amounts of PGMs (less than 0.5% of total production) are recovered from the processing of copper ores at the Palabora mine and the gold deposits of the Witwatersrand Basin.

Anglo American Platinum Corporation Limited (Anglo Platinum) (74.8% held by Anglo American plc of South Africa Ltd.) is the world's largest primary producer of platinum. Anglo Platinum owns and operates six mines in South Africa. Elsewhere in the world, Anglo Platinum conducts exploration at the River Valley project in the Sudbury district of Ontario (via a joint venture with Pacific North West Capital of Vancouver, who manages the project) and at Agnew Lake, also in the Sudbury area (via an agreement with Pacific North West and New Millennium Metals Corporation). The company also has a joint venture with Eurasia Mining Plc to evaluate properties in the Vissim district of the Ural Mountains near Yekaterinenburg in Russia.

In 2003, Anglo Platinum reached 71.5 t of refined platinum, up from 69.9 t in 2002. Increased costs, the increasing strength of the South African rand, and the relatively weak prices for palladium and rhodium led to a re-evaluation of the company's long-term expansion program. The company will delay the development of several projects, including mines at Twickenham and Der Brochen in the Bushveld Complex and the planned expansion of a new tailings treatment plant. The revised plan is for the company to reach 90 t of production by 2006, down from the original target of 105 t.

Impala Platinum Holdings Limited (Implats) produced about 53 t of platinum in 2003. Implats operates mines in South Africa (Bushveld Complex) and Zimbabwe. Construction continued on the company's Marula Platinum mine, which is being commissioned on the eastern limb of the Bushveld Complex. Once completed, it is expected that the mine will have a production capacity of 3.1 t of platinum annually. The surface infrastructure has been commissioned and full production is scheduled for the 2005 financial year.

Mining at the Crocodile River UG2 mine was suspended in November 2003 after difficulties were encountered while trying to convert to underground mining. Difficult geological conditions, coupled with rising costs, weak palladium and rhodium prices, and the strong rand, all contributed to the decision to suspend operations.

Northam Platinum Limited is South Africa's fourth largest platinum producer with output of about 10 t of PGMs annually, of which about 6 t is platinum. The company is listed as a broadly based black empowerment company and operates a platinum mine at the upper end of the western limb of the Bushveld Complex.

Toronto-based SouthernEra Resources Limited produced 1.76 t of PGMs plus gold in 2003. The mine is expected to reach its target ore production rate of 5 t/y PGMs by the third quarter of 2004. A feasibility study on phases 2 and 3 of the Messina project is expected to be completed in mid-2004.

Russia

Russia is the second largest producer of platinum, accounting for about 15% of the world supply. Information related to PGMs production, sales and reserves is considered to be a state secret in Russia. In November 2003, Russian President Vladimir Putin signed into law a bill that would relax the restrictions on information related to PGMs in Russia. Further approvals are expected, however, before information can be made available sometime towards the end of 2004. Government stocks and sales will remain secret.

MMC Norilsk Nickel is Russia's largest producer of PGMs, producing platinum, palladium and other PGMs from its Siberian nickel-copper operations and lesser amounts from its copper-nickel mines in the Kola Peninsula. It is estimated that Norilsk produced some 20 t of platinum in 2003. In addition to the platinum produced by Norilsk, there is some placer recovery of alluvial platinum deposits in Russia. At sites ranging from the Urals to the Kamchatka Peninsula, placer operations recover in the order of 5-7 t/y of platinum.

United States

In the United States, Stillwater Mining Company, the only producer of PGMs in the United States, decreased its production from 4.4 t in 2002 to 4.2 t in 2003. While PGMs production overall was 5% below the projected target for the year, the company improved its mine productivity in the fourth quarter and managed to reduce its total consolidated cash costs to US\$283/oz. In addition, the company successfully ramped up mine production at its East Boulder mine to 1250 t/d of ore. Norilsk Nickel, through its wholly owned subsidiary Norimet Limited, acquired a 50.8% interest in Stillwater in June 2003 and subsequently increased its holdings to 55.5% of the company in September.

Zimbabwe

Zimbabwe continued its emergence as an important producer in the PGMs world. Platinum production almost doubled in 2003 to reach a total of 4.4 t as production at the Mimosa and Ngezi mines continued to expand.

Platinum Recycling

Platinum and other PGMs are recovered from a variety of post-consumer scrap and other sources. Used industrial catalysts, electronic scrap, jewellery sweepings, autocatalysts and telecommunications equipment are important sources of PGMs. In Johnson Matthey's extensive reviews of the PGMs industry, demand in each sector except autocatalysts is net of recycling, thus indicating the primary metal requirements.

Primary Palladium Supply

The primary palladium supply to market economy countries increased in 2003, ahead of demand, resulting in weaker prices for 2003. Unlike platinum, Russia is the world's leading producer of palladium and Russian supplies surged to 91.8 t in 2003, up from 60 t in 2002. Overall, the total primary palladium supply was up by 23% to 200 t in 2003 compared to 163.3 t in 2002.

In addition to the primary supply, Johnson Matthey estimates that 12.8 t of palladium were recovered from the recycling of motor vehicle catalysts in 2003, an increase of 11% over 2002. Secondary palladium is recovered from nonferrous metals facilities in Finland, Belgium, South Africa, Sweden, Japan, the United States and Canada.

Primary Rhodium Supply

The supply of primary rhodium to markets increased in 2003 by 17% to an estimated 22.4 t. South Africa is the world's largest rhodium producer accounting for roughly 75% of the total supply. Russia is the second most important producer at 19% of the total supply. In addition to the primary supply, an estimated 3.8 t of rhodium were recovered from autocatalysts in 2003.

MARKET DEMAND

PGMs are used in a wide variety of applications in their pure form, in alloys with other PGMs, or in alloys with other metals. The diversity of their uses reflects their varied and unique attributes. The qualities of PGMs include:

- chemical inertness,
- resistance to corrosion,
- high-temperature oxidation resistance,
- very good ability to catalyze chemical reactions,
- high melting point,
- high strength at elevated temperatures,
- low coefficient of thermal expansion,
- stable thermo-electric properties,
- good mechanical durability, and
- stable electrical contact resistance.

The four largest industrial markets for platinum and palladium in 2003 were electrical, 38.5 t; autocatalysts, 175 t; jewellery, 83.7 t; and dental (palladium only), 22.6 t.

An additional 0.5 t of platinum was removed from available supply by investments. Net stock changes resulted in 8.7 t of platinum coming out of stocks while 37 t of palladium went into stocks.

Platinum Demand

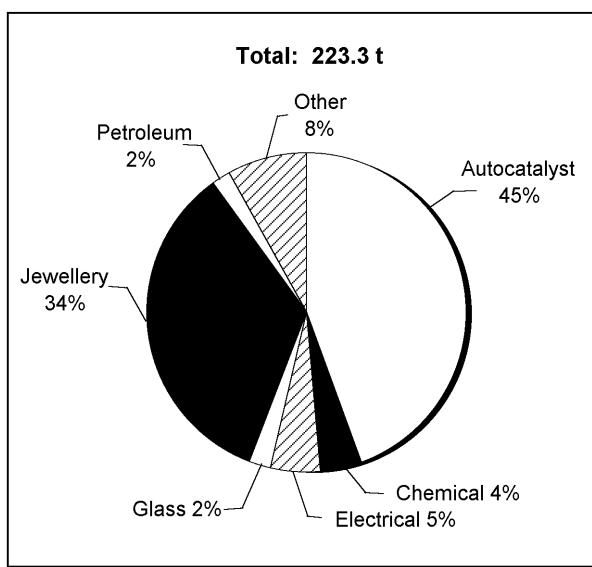
Europe is the world's leading industrial user of platinum, taking about 27% of industrial demand. Industrial demand

in Japan and North America accounts for 20% and 19%, respectively, of total industrial demand in 2003.

Japan is a distinctly different market from Europe and North America with a different pattern of platinum demand. In Japan, the major use for platinum is in jewellery. Japanese jewellers accounted for 50% of the 41 t of Japanese industrial demand in 2003. In Europe, autocatalysts are the largest market use of platinum, accounting for 70% of net industrial demand. Autocatalysts and jewellery together account for about 76% of industrial platinum demand.

Other industrial uses include glass-making and use in the chemical and petroleum industries.

Figure 3
World Platinum Demand by Application, 2003



Source: Johnson Matthey Plc.

Autocatalysts

Automobile emission limits were first legislated in the United States in the late 1960s. The emission limits were progressively tightened and oxidation catalysts were required to meet air pollution control limits. By 1983 all new light-duty gasoline-powered vehicles in the United States were fitted with three-way catalysts. In the autocatalyst, platinum efficiently transforms hydrocarbons (HC) and carbon monoxide (CO) in the exhaust gases to more benign substances, while rhodium is most efficient at handling oxides of nitrogen (NO_x). Palladium can handle all three pollutants, but less efficiently than either platinum or rhodium.

Other countries have adopted emission controls modelled on those of California. Canadian emission regulations

were implemented in 1987. European regulations required new cars with gasoline engines to have catalytic scrubbers as of 1993. Industrializing nations have also introduced regulations as their motor vehicle density increased. The demand for autocatalysts is forecast to continue to rise as regulations ratchet down emission limits and as the number of jurisdictions regulating emissions increases.

The composition of autocatalysts varies according to prices for the various PGMs, the composition of the fuel, the regulated limits, and the service life of components. Southeast Asia and other areas with gasolines that have significant amounts of sulphur or lead inhibit the use of catalysts richer in less expensive palladium. In North America, for example, Ford Motor Company opted to equip most of its vehicles with palladium-rich autocatalysts. In Europe, moves to palladium-richer catalysts for gasoline engines have been somewhat offset by the need for platinum catalysts to control emissions from diesel engines.

Clean Diesel Technologies Inc. patented a platinum fuel additive for use with diesel fuels. The platinum additive reduces hydrocarbon, carbon monoxide and particulate emissions. The platinum in the additive is not recoverable.

Jewellery

In 1996, the last year that a PGMs review was published in the *Canadian Minerals Yearbook*, Japanese jewellers consumed more platinum (46 t) than did the total net demand for autocatalysts in market economy countries (45.1 t). By 2003, however, the situation had changed dramatically. Overall demand for platinum by the jewellery sector peaked in 1999 at 89.6 t and fell to 75.9 t in 2003. In Japan, demand has fallen almost every year since 1996 to reach 20.7 t in 2003.

Other Uses for Platinum

All other uses of platinum are relatively minor compared to autocatalysts and jewellery. Chemical uses and petroleum refining make use of platinum to increase the speed and efficiency of chemical reactions. The electronics industry uses platinum in substrates in the manufacture of computer hard disks. The glass industry uses platinum in the manufacture of glass fibres, drawing on platinum's corrosion resistance and strength.

One minor application that currently shows promise for increased future demand is the manufacture of fuel cells. Fuel cells generate power by combining oxygen and hydrogen, yielding water and energy as products. Various technologies are being investigated; the two most popular technologies are the phosphoric acid fuel cell (PAFC) and the proton exchange membrane fuel cell (PEMFC). The catalyst used in fuel cells is usually made of platinum powder thinly coated onto carbon paper or cloth to facilitate the reaction of the oxygen and the hydrogen in the cell.

Investment Offtake

Net purchases of platinum bars and coins by investors fell in 2003 as higher prices resulted in increased sales of products back to Japanese dealers and reduced demand for bullion coins in the United States. Platinum bars and coins are used as a form of investment to hedge against inflation or as a means to speculate against platinum prices. However, as platinum is also an industrial metal like silver, material previously taken off the market for investment can later appear as feed for industrial demand. In 2003, investment demand fell to just 0.5 t, down from 2.5 t in 2002.

Palladium Demand

Japan's dominance as the leading consumer of palladium has eroded in the last couple of decades. In the late 1980s, Japan consumed about 50% more palladium than did North America and about 2.5 times more than Europe. By 2003, the estimated share of demand by Japan at 41 t was slightly less than that of North America (46.7 t) and Europe (44 t).

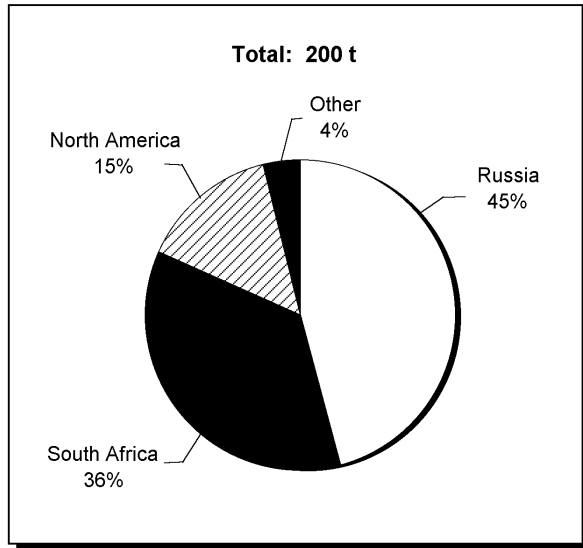
Similar to platinum, the pattern of Japanese demand for palladium differs from that in Europe and North America. In Japan, the major use for palladium in 2003 was in autocatalysts (16.8 t) followed closely by dental applications (12.6 t) and electrical applications (6.8 t). In North America, just over half of the industrial demand for palladium is accounted for by use in autocatalysts, while in Europe autocatalysts account for 80% of total demand.

On a worldwide basis, autocatalysts are by far the leading market sector for palladium (58%). The net industrial demand by sector (excluding investment offtake) in 2003 was estimated at 27.8 t for electrical, 22.6 t for dental, 94.9 t for autocatalysts, 7.8 t for jewellery, 7.8 t for chemical and 2.8 t for other uses.

Palladium usage in the electrical sector has increased along with the rapidly rising demand for electronic goods such as personal computers, mobile phones and video cameras. The newer generations of electronic equipment also use more multi-layered ceramic capacitors (MLCC) that contain palladium. While nickel has made limited inroads into this use, palladium still provides superior performance and ease of manufacture. Declining palladium contents in individual components have been somewhat offset by increased MLCC use.

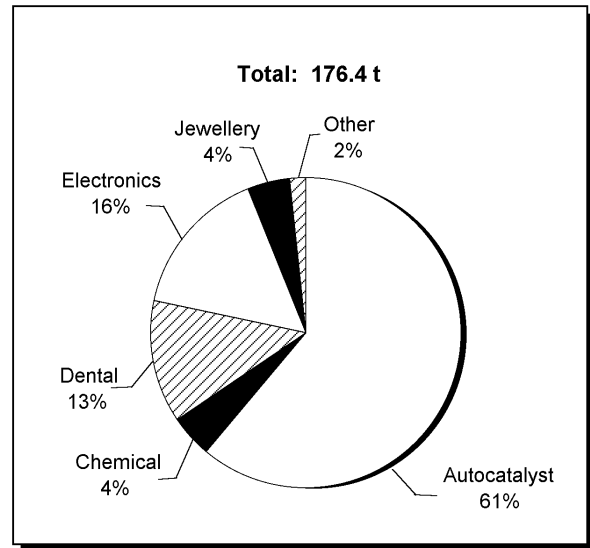
The third largest use for palladium is in dental alloys, orthodontic devices and prosthodontic devices. Other industrial uses for palladium include industrial catalytic applications, pharmaceutical and nitric acid production, petroleum refining, and jewellery.

Figure 4
World Palladium Production, 2002



Source: Johnson Matthey Plc.

Figure 5
World Palladium Demand by Application, 2003



Source: Johnson Matthey Plc.

Rhodium Demand

Tighter restrictions on the permissible levels of NOx in automotive exhausts continue to drive the demand for rhodium in autocatalysts. Autocatalysts now account for over 86% of the rhodium used. Small amounts of rhodium are used in the chemical (6%), electrical (1%) and glass (5%) industries. In these applications, rhodium is used with other PGMs to produce an alloy with enhanced physical or catalytic properties.

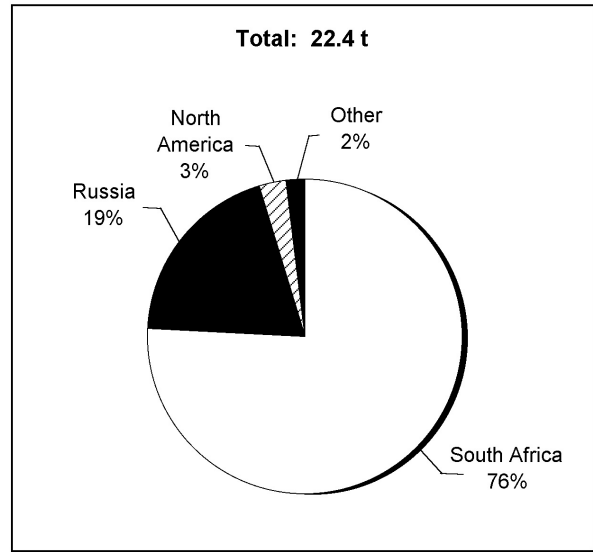
Demand for Other PGMs

The demand for ruthenium and iridium is much lower than that for platinum or palladium. Estimated demand in 2003 for ruthenium was 15.4 t and for iridium was about 3.2 t. Demand data for osmium are not available.

Ruthenium has a variety of uses. In 2003, demand for ruthenium for use in chemical process catalysts increased by 40% to 4.4 t. Most of the increase was due to the expansion of acetic acid manufacturing capacity using an iridium-ruthenium catalyst. Electronic demand for ruthenium also benefited from the increased use of ruthenium in hard disk drives. By adding a thin layer of ruthenium to the magnetic coating of the hard disk, the data storage density of the disk can be substantially increased.

Demand for iridium is split between electronics, electrochemical and chemical applications. Iridium-ruthenium alloys have been used instead of ruthenium for electrodes in chlor-alkali plants. Iridium has also displaced rhodium catalysts used to make acetic acid. Other uses include minor amounts in autocatalysts used with direct fuel-

Figure 6
World Rhodium Production, 2003



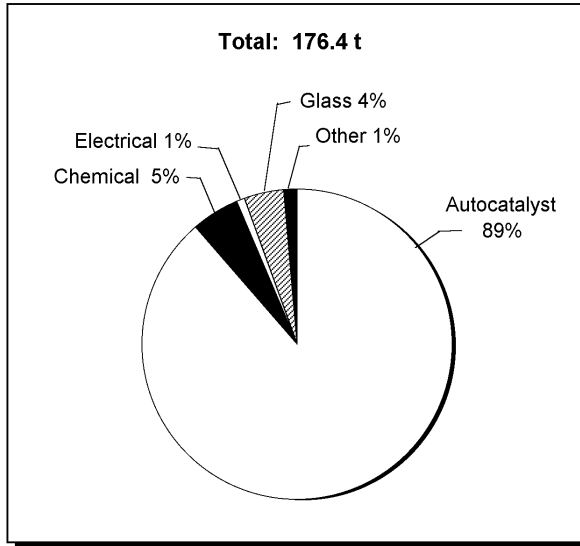
Source: Johnson Matthey Plc.

injection engines and in electrolytic cells to produce sodium chlorate.

Osmium metal is lustrous, bluish white, extremely hard, and brittle, even at high temperatures. It has the highest melting point and lowest vapour pressure of the PGMs. The metal is very difficult to fabricate in its metallic state

and is therefore processed into osmium powder. It is usually alloyed with other PGMs to produce very hard alloys such as fountain pen tips, instrument pivots, and electrical contacts. A 90/10 platinum/osmium alloy is used in implants such as pacemakers and replacement heart valves.

Figure 7
World Rhodium Demand by Application, 2003



Source: Johnson Matthey Plc.

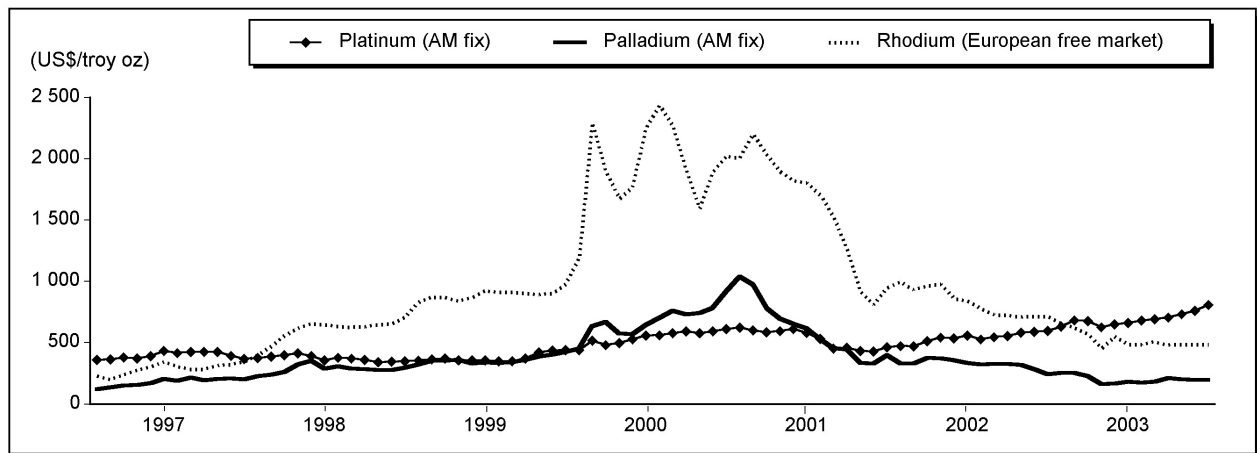
PRICES

Platinum prices continued their upward trend that began in 2002. The average price for London a.m. and p.m. fixings was up 28% in 2003 to US\$691.86/oz. Unlike platinum prices, the other PGMs did not perform as well. Palladium prices fell 41% to an average US\$200.61/oz, rhodium was down 37% to US\$530.27/oz, iridium dropped 68% to US\$93.07/oz, and ruthenium was down 47% to US\$35.04/oz.

OUTLOOK

Canadian PGMs production is largely a function of nickel production but, over time, nickel producers can shift the PGMs-to-nickel ratio. A large proportion of Canada's PGMs production is produced as the by-product of other metals. Autocatalysts are expected to remain a dependable market for PGMs in the medium to long term. The market for emissions control technology will grow as vehicle numbers increase, emission limits decrease, and the service life of components is extended. While gasoline and diesel engines will continue to be used in most motor vehicles, the use of PGMs, especially platinum and rhodium, in autocatalysts will remain a secure source of demand. Some increased efficiencies in PGMs use in autocatalysts can be expected but, as of yet, no substitutes appear to be sufficiently advanced to threaten the use of PGMs in autocatalysts. There is room for inter-PGMs substitution as low lead and low sulphur levels in gasolines permit the substitution of platinum by palladium in some catalysts.

Figure 8
Prices for Platinum, Palladium and Rhodium, 1997-2003



Source: The London Platinum and Palladium Market.

However, as the use of autocatalysts becomes more widespread, increasing amounts of PGMs will be recovered from scrapped vehicles. Once the population of vehicles equipped with PGMs catalysts is sufficiently large and widespread, then the rate of demand for primary PGMs will slow. Primary PGMs would then be needed only to make up for losses in recycling, for net new internal combustion vehicle registrations, and for increased PGM loadings per vehicle to meet new standards.

Due to the narrow production base for PGMs, their prices are more volatile than those of the major industrial base metals such as iron and steel, copper or aluminum. The most significant factors affecting prices are whether labour or political events interfere with PGMs output in Russia or South Africa, the size of the Russian PGMs stockpile and the degree to which it will be drawn down, and the rate of economic growth worldwide, which affects demand for PGMs.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 64. (2) Information in this review was current as of August 31, 2004. (3) Some differences are noted in some data from independent sources. Readers are cautioned to confirm these data. (4) Lorraine Ralph and others in the Minerals and Metals Statistics Division created Tables 1 and 2 and provided input into other tables and figures. (5) This and other reviews, including previous editions, are available on the Internet at www.nrcan.gc.ca/mms/cmy/com_e.html.

NOTE TO READERS

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TARIFFS

Item No.	Description	Canada			United States	EU	Japan
		MFN	GPT	USA	Canada	Conventional Rate (1)	WTO (2)
26.16	Precious metal ores and concentrates						
2616.90.00.30	Platinum group	Free	Free	Free	Free	Free	Free
71.10	Platinum, unwrought or in semi-manufactured forms, or in powder form	Free	Free	Free	Free	6%	Free
7110.11	Platinum: Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.21	Palladium: Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.29	Other	Free	Free	Free	Free	Free	Free
7110.31	Rhodium: Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.39	Other	Free	Free	Free	Free	Free	Free
7110.41	Iridium, osmium and ruthenium: Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.49	Other	Free	Free	Free	Free	Free	Free
71.12	Waste and scrap of precious metal or of metal clad with precious metal						
7112.92	Of platinum, including metal clad with platinum but excluding sweepings containing other precious metals	Free	Free	Free	Free	Free	Free
71.15	Other articles of precious metal or of metal clad with precious metal						
7115.90.10.20	Crucibles of platinum	Free	Free	Free	Free	3%	Free
7115.90.10.30	Other of platinum	7.5%	5%	Free	Free	3%	Free

Sources: Canadian *Customs Tariff*, effective January 2004, Canada Border Services Agency; *Harmonized Tariff Schedule of the United States*, 2004; Official Journal of the European Union (October 30, 2003 Edition); *Customs Tariff Schedules of Japan*, 2003.

(1) The customs duties applicable to imported goods originating in countries that are Contracting Parties to the General Agreement on Tariffs and Trade or with which the European Community has concluded agreements containing the most-favoured-nation tariff clause shall be the conventional duties shown in column 3 of the Schedule of Duties. (2) WTO rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. PLATINUM GROUP METALS, SHIPMENTS AND TRADE, 2001-03

		2001		2002		2003	
		(grams)	(\$000)	(grams)	(\$000)	(grams)	(\$000)
SHIPMENTS (1)							
	Quebec	x	x	x	x	x	x
	Ontario	x	x	x	x	x	x
	Manitoba	x	x	x	x	x	x
	Total	20 694 169	651 922	24 371 767	502 424	18 513 737	269 901
		(kg)	(\$000)	(kg)	(\$000)	(kg)	(\$000)
EXPORTS							
2616.90.83	Precious metal ores and concentrates; platinum group metal content						
	United Kingdom	7 433	205 304	7 053	154 864	451	8 709
	South Korea	-	-	-	-	10	305
	United States	3 398	13 730	566	2 614	-	-
	Total	10 831	219 034	7 619	157 478	461	9 014
7110.11	Platinum unwrought or in powder form						
	United States	53	1 421	35	929	39	1 087
	Other countries	-	-	14	390	36	800
	Total	53	1 421	49	1 319	75	1 887
7110.19	Platinum in other semi-manufactured forms						
	United States	618	16 974	487	13 774	401	12 720
	United Kingdom	-	-	-	-	-	6
	Total	618	16 974	487	13 774	401	12 726
7110.21	Palladium unwrought or in powder form						
	United States	3 451	89 078	2 087	29 265	1 914	19 845
	United Kingdom	125	3 185	-	-	87	661
	Total	3 576	92 263	2 087	29 265	2 001	20 506
7110.29	Palladium in other semi-manufactured forms						
	United States	52	1 210	5	151	2	26
7110.39	Rhodium in other semi-manufactured forms						
	United States	10	549	-	-	-	-
	Japan	-	-	2	62	-	-
	Total	10	549	2	62	-	-
7110.41	Iridium, osmium and ruthenium unwrought or in powder form						
	United States	-	-	9	19	-	-
7112.20	Waste and scrap of platinum, including metal clad with platinum, except sweepings containing other precious metals						
	China	1	9	-	-	-	-
	Germany	17 505	2 214	-	-	-	-
	United Kingdom	3 630	464	-	-	-	-
	United States	1 188	18 612	-	-	-	-
	Total	22 324	21 299	-	-	-	-

TABLE 1 (cont'd)

		2001		2002		2003	
		(kg)	(\$000)	(kg)	(\$000)	(kg)	(\$000)
EXPORTS (cont'd)							
7115.90	Other; articles of precious metal or of metal clad with precious metal; crucibles of platinum						
	United States	134	1 346	7	108	41	748
	Other	3	14	–	–	200	18
	Total	137	1 360	7	108	241	766
	Total exports	37 601	354 110	10 265	202 176	3 181	44 925
IMPORTS (2)							
2616.90.00.30	Precious metal ores and concentrates; platinum group metal content						
	South Africa	–	–	1 000	57	16	243
	United States	–	6	–	1	1	12
	Total	–	6	1 000	58	17	255
7110.11	Platinum unwrought or in powder form						
	South Africa	751	18 788	961	25 993	1 757	46 267
	United States	2 376	54 208	1 961	41 772	983	20 843
	United Kingdom	401	10 776	677	17 279	678	18 302
	Belgium	532	13 900	248	6 451	2 325	10 457
	Other countries	304	7 515	64	1 387	258	7 147
	Total	4 364	105 187	3 911	92 882	6 001	103 016
7110.19	Platinum in other semi-manufactured forms						
	United States	404	8 281	409	9 134	643	14 172
	Switzerland	34	588	40	774	192	2 584
	Japan	2	74	89	2 417	26	815
	Other countries	75	2 028	42	1 129	40	992
	Total	515	10 971	580	13 454	901	18 563
7110.21	Palladium unwrought or in powder form						
	United States	3 052	73 281	2 666	47 880	2 071	20 153
	Russia	148	3 310	279	3 211	1 633	14 880
	South Africa	344	10 143	730	13 178	1 176	11 776
	United Kingdom	513	18 716	1 938	33 064	1 233	9 610
	Belgium	496	17 632	387	6 117	631	6 647
	Norway	221	7 869	146	2 981	138	1 205
	Other countries	15	285	39	723	9	73
	Total	4 789	131 236	6 185	107 154	6 891	64 344
7110.29	Palladium in other semi-manufactured forms						
	United States	765	15 124	697	10 769	716	9 994
	Germany	299	4 419	55	956	162	2 604
	Switzerland	137	2 084	240	4 181	121	1 430
	Russia	24	325	46	746	26	251
	Netherlands	25	408	15	270	8	118
	Other countries	483	24 679	3	53	2	40
	Total	1 733	47 039	1 056	16 975	1 035	14 437
7110.31	Rhodium unwrought or in powder form						
	South Africa	11	983	–	–	75	2 209
	Belgium	5	449	4	148	5	112
	United States	–	8	1	8	–	7
	Russia	36	99	–	–	–	–
	United Kingdom	4	359	–	–	–	–
	Total	56	1 898	5	156	80	2 328

TABLE 1 (cont'd)

		2001		2002		2003	
		(kg)	(\$000)	(kg)	(\$000)	(kg)	(\$000)
IMPORTS (cont'd)							
7110.39	Rhodium in other semi-manufactured forms						
	United States	2	61	4	96	6	171
	Other countries	1	31	1	11	–	32
	Total	3	92	5	107	6	203
7110.41	Iridium, osmium and ruthenium unwrought or in powder form						
	Japan	–	–	–	–	13	108
	United States	5	38	6	69	3	29
	United Kingdom	9	62	10	73	–	–
	Other countries	9	73	1	4	–	–
	Total	23	173	17	146	16	137
7110.49	Iridium, osmium and ruthenium in other semi-manufactured forms						
	United States	293	3 896	11	111	35	388
	United Kingdom	1	6	–	5	13	136
	Other countries	10	120	7	80	2	26
	Total	304	4 022	18	196	50	550
7112.20	Waste and scrap of platinum, including metal clad with platinum, except sweepings containing other precious metals						
	United States	2 246 389	27 819	–	–	–	–
	Other countries	86	90	–	–	–	–
	Total	2 246 475	27 909	–	–	–	–
7115.90.10.20	Other; articles of precious metal or of metal clad with precious metal; crucibles of platinum						
	United States	1 633	66 938	1 010	33 877	1 245	39 387
	Other countries	8	538	2	194	1	388
	Total	1 641	67 476	1 012	34 071	1 246	39 775
7115.90.90.30	Other; of platinum						
	United States	51	769	41	590	36	800
	Other countries	113	1334	1	23	16	69
	Total	164	2 103	42	613	52	869
	Total imports	2 260 067	398 112	13 831	265 812	16 295	244 477

Sources: Natural Resources Canada; Statistics Canada.

– Nil; x Confidential.

Notes : (1) Mineral production (shipments) figures for iridium, palladium, platinum, ruthenium and rhodium include recoverable metal in concentrates shipped. Quantities are valued using average New York dealer prices or London Metal Exchange prices depending on the metal. (2) Imports from "other countries" may include re-imports from Canada.

Note: Numbers may not add to totals due to rounding.

TABLE 2. PRINCIPAL PLATINIUM GROUP METALS PRICES, 1997-2003

Month	Platinum AM Fix	Palladium AM Fix	Rhodium European Free Market
	(US\$/troy oz)	(US\$/troy oz)	(average US\$/troy oz in warehouse)
1997			
January	359.44	121.14	229.66
February	364.68	135.80	199.81
March	379.68	149.24	238.75
April	371.03	153.67	276.17
May	389.59	171.33	302.50
June	431.36	204.26	344.46
July	415.51	187.78	305.63
August	425.48	214.68	285.68
September	424.97	191.18	284.09
October	423.76	205.13	315.94
November	392.91	208.43	321.61
December	367.01	198.87	344.46
Average	395.69	178.46	288.49
1998			
January	375.27	226.21	398.93
February	386.49	236.60	472.00
March	398.80	262.41	556.88
April	413.78	320.78	620.00
May	389.40	354.47	656.47
June	356.02	287.32	648.46
July	377.75	306.72	634.62
August	369.94	287.88	627.29
September	359.86	283.14	631.73
October	342.64	277.26	645.58
November	346.75	277.21	652.12
December	350.45	297.06	706.43
Average	371.83	284.30	602.57
1999			
January	354.70	321.65	829.17
February	364.81	351.70	874.64
March	370.48	353.21	869.56
April	357.99	361.93	840.38
May	355.67	329.74	865.78
June	356.69	337.36	923.33
July	349.48	331.77	911.73
August	349.80	340.12	910.91
September	372.18	361.50	905.77
October	422.60	387.14	893.64
November	435.14	401.48	902.31
December	440.80	424.60	976.67
Average	377.63	358.59	890.21
2000			
January	440.75	451.68	1 192.33
February	517.24	636.29	2 291.00
March	480.74	667.44	1 896.56
April	498.28	572.17	1 673.65
May	526.76	570.91	1 768.83
June	559.68	646.64	2 248.13
July	560.48	702.12	2 431.79
August	577.96	759.71	2 270.45
September	592.91	728.24	1 909.17
October	579.27	739.43	1 595.54
November	593.50	783.84	1 893.27
December	610.76	917.11	2 023.50
Average	545.32	682.34	1 926.33

TABLE 2 (cont'd)

Month	Platinum AM Fix (US\$/troy oz)	Palladium AM Fix (US\$/troy oz)	Rhodium European Free Market (average US\$/troy oz in warehouse)
2001			
January	622.14	1 039.95	2 008.33
February	601.48	975.25	2 200.00
March	585.75	782.32	2 033.33
April	595.00	696.21	1 894.79
May	609.86	655.48	1 825.00
June	579.74	614.12	1 802.78
July	531.91	526.09	1 704.17
August	451.02	455.45	1 525.68
September	458.10	445.00	1 265.00
October	432.17	335.40	916.07
November	429.61	328.39	808.59
December	461.99	399.79	947.92
Average	529.03	602.82	1 527.29
2002			
January	473.05	330.03	998.00
February	471.35	331.28	930.00
March	512.35	374.40	963.33
April	541.45	370.19	977.69
May	534.68	356.86	861.88
June	557.22	334.81	842.14
July	526.24	322.52	781.00
August	545.38	324.43	730.00
September	555.30	327.38	725.91
October	580.93	316.57	712.37
November	588.45	285.81	715.00
December	596.60	242.65	715.00
Average	540.13	336.89	841.16
2003			
January	629.57	254.55	658.75
February	682.40	253.25	625.00
March	676.52	225.86	570.00
April	625.30	163.10	455.00
May	649.90	167.35	550.00
June	662.31	179.50	485.00
July	682.20	173.30	485.00
August	692.80	181.60	508.75
September	705.14	210.86	483.50
October	732.28	201.61	484.55
November	760.38	197.05	487.81
December	808.48	197.91	485.00
Average	692.51	200.82	527.57

Sources: The London Platinum and Palladium Market; *Metal Bulletin*.

TABLE 3. WORLD PLATINUM GROUP METALS PRODUCTION, 1997-2002

	1997	1998	1999	2000	2001	2002
(kilograms metal content)						
PALLADIUM						
World Total	143 744	152 400	157 758	165 017	177 977	182 769
Total Europe	70 230	70 212	75 187	84 037	85 037	84 037
Total Africa	55 920	58 463	58 506	56 184	62 972	65 324
Total America	15 295	18 774	17 895	19 272	24 310	27 608
Total Asia	1 899	4 151	5 354	4 712	4 830	5 000
Total Oceania	400	800	816	812	828	800
Russia (e)	70 000	70 000	75 000	84 000	85 000	84 000
South Africa	55 675	56 608	58 164	55 818	62 601	64 244
United States (e)	8 430	10 600	9 800	10 300	12 100	14 800
Canada (e)	6 865	8 174	8 095	8 972	12 210	12 808
Japan	1 899	4 151	5 354	4 712	4 830	5 000
Zimbabwe	245	1 855	342	366	371	1 080
Australia (e)	400	800	816	812	828	800
Serbia and Montenegro (e)	50	50	25	25	25	25
Poland	–	12	12	12	12	12
Finland (e)	180	150	150	–	–	–
PLATINUM						
World Total	154 664	159 254	163 633	160 516	180 102	184 853
Total Africa	116 206	119 213	121 783	114 964	130 826	135 296
Total Europe	30 070	30 530	32 526	35 467	36 535	35 525
Total America	7 395	8 828	8 497	9 132	12 017	13 332
Total Asia	693	533	737	782	550	500
Total Oceania	300	150	90	171	174	200
South Africa	115 861	116 483	121 304	114 459	130 307	133 796
Russia (e)	30 000	30 000	32 000	35 000	36 000	35 000
Canada (e)	4 379	5 177	5 129	5 683	7 733	8 242
United States (e)	2 610	3 240	2 920	3 110	3 610	4 390
Zimbabwe	345	2 730	479	505	519	1 500
Colombia	406	411	448	339	674	700
Finland (e)	60	500	500	441	510	500
Japan	693	533	737	782	550	500
Australia (e)	300	150	90	171	174	200
Poland	–	20	21	21	20	20
Serbia and Montenegro (e)	10	10	5	5	5	5
OTHER PLATINUM GROUP METALS						
World Total	39 187	41 220	51 396	51 282	51 132	57 121
Total Africa	25 095	27 039	37 048	36 533	35 881	41 841
Total Europe	13 500	13 500	13 700	14 100	14 500	14 500
Total America	592	681	648	649	751	780
South Africa	25 068	26 862	37 011	36 493	35 839	41 721
Russia (e)	13 500	13 500	13 700	14 100	14 500	14 500
Canada (e)	592	681	648	649	751	780
Zimbabwe	27	177	37	40	42	120
TOTAL PLATINUM GROUP METALS						
World Total	337 595	352 875	372 787	376 815	409 211	424 742
Total Africa	197 221	204 715	217 337	207 681	229 679	242 461
Total Europe	113 800	114 242	121 413	133 604	136 072	134 062
Total America	23 282	28 284	27 040	29 053	37 078	41 719
Total Asia	2 592	4 684	6 091	5 494	5 380	5 500
Total Oceania	700	950	906	983	1 002	1 000
South Africa	196 604	199 953	216 479	206 770	228 747	239 761
Russia (e)	113 500	113 500	120 700	133 100	135 500	133 500
Canada (1)	11 836	14 033	13 872	15 304	20 694	21 829
United States (e)	11 040	13 840	12 720	13 410	15 710	19 190
Japan	2 592	4 684	6 091	5 494	5 380	5 500
Zimbabwe	617	4 762	858	911	932	2 700
Australia (e)	700	950	906	983	1 002	1 000
Colombia	406	411	448	339	674	700
Finland (e)	240	650	650	441	510	500
Poland	–	32	33	33	32	32
Serbia and Montenegro (e)	60	60	30	30	30	30

Sources: Natural Resources Canada; U.S. Geological Survey.

– Nil; (e) Estimated.

(1) Recoverable metals in concentrates shipped per NRCan. Breakdown calculated based on estimates per USGS.

**TABLE 4. CANADA, PLATINUM
METALS SHIPMENTS, 1980-2003**

	Quantity	Value
	(kg)	(\$000)
1980	12 776	159 088
1981	11902	136 186
1982	7 105	82 253
1983	6965	79 180
1984	10 369	133 467
1985	10 534	141 396
1986	12 190	193 730
1987	10 930	181 849
1988	12 541	190 914
1989	9 870	141 730
1990	11 123	189 423
1991	11 123	150 155
1992	11 311	130 204
1993	11 819	123 610
1994	13 422	144 538
1995	16 068	181 996
1996	13 934	141 620
1997	11 836	134 242
1998	14 033	214 883
1999	13 872	250 466
2000	15 304	478 460
2001	20 694	651 923
2002	24 372	502 425
2003 (p)	18 514	269 901

Sources: Natural Resources Canada;
Statistics Canada.

(p) Preliminary.