Platinum Group Metals

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INTRODUCTION

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 the Russian Federation.

The principal uses for platinum and rhodium are in catalysts, especially autocatalysts, which account for about 40% of industrial demand for platinum and 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 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 prices for the principal PGMs for 2003 and 2004 as reported by Johnson Matthey plc were (in US$/troy oz):

	2003	2004	% Change
Platinum	691.86	845.75	22
Palladium	200.61	230.03	15
Rhodium	530.27	981.73	85
Iridium	93.07	186.32	100
Ruthenium	35.04	64.68	85

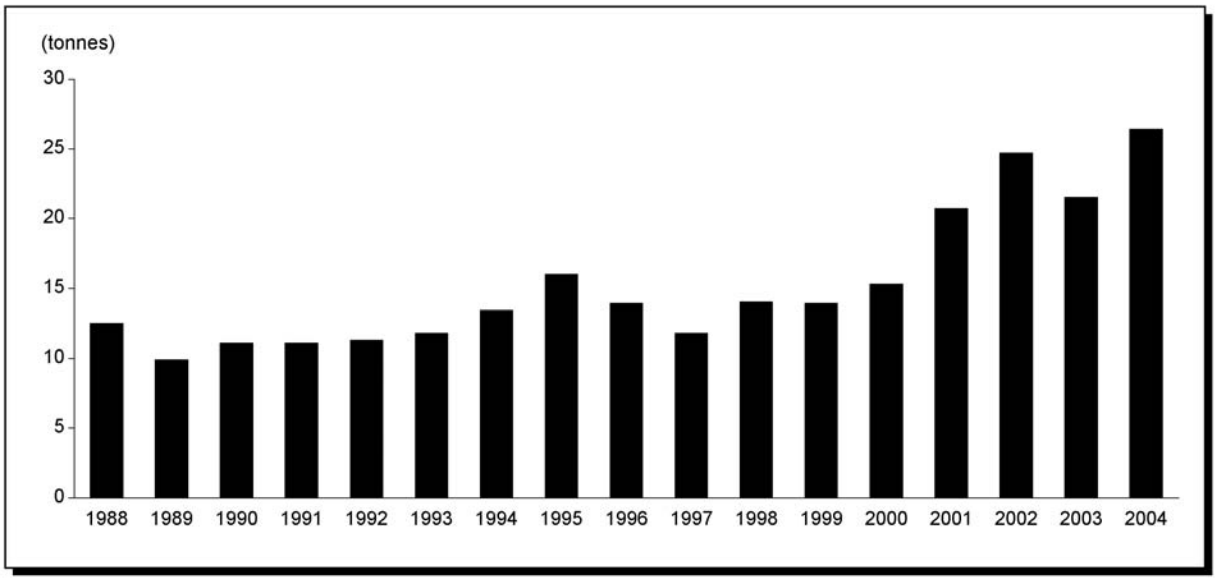
CANADIAN DEVELOPMENTS

Primary PGMs output in Canada increased from 21.5 t in 2003 to 26.4 t in 2004, largely as a result of the return to normal operations following an interruption in production during a three-month strike at Inco's facilities in Sudbury in 2003 (Figure 1).

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 three producers of by-product PGMs (Figure 2). 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

Figure 1
Canadian Platinum Group Metals Shipments, 1988-2004



Source: Natural Resources Canada.

recover PGMs as by-products of their nickel-copper operations. In addition, late in 2003, the Sudbury Joint Venture (SJV) started production at several properties formerly held by Inco. The joint venture is a project between FNX Mining Company Inc. (75%) and Dynatec Corporation (25%), which acts as the operator. Ore from the SJV operations is trucked to Inco's Clarabelle mill for processing and the SJV is paid for the value of the metal content. 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 sourced from its Manitoba operations. Falconbridge recovers PGMs from its nickel mine at Raglan in northern Quebec (mostly palladium) as well as from its Sudbury operations. Ontario accounts for the vast majority of primary PGMs production in Canada.

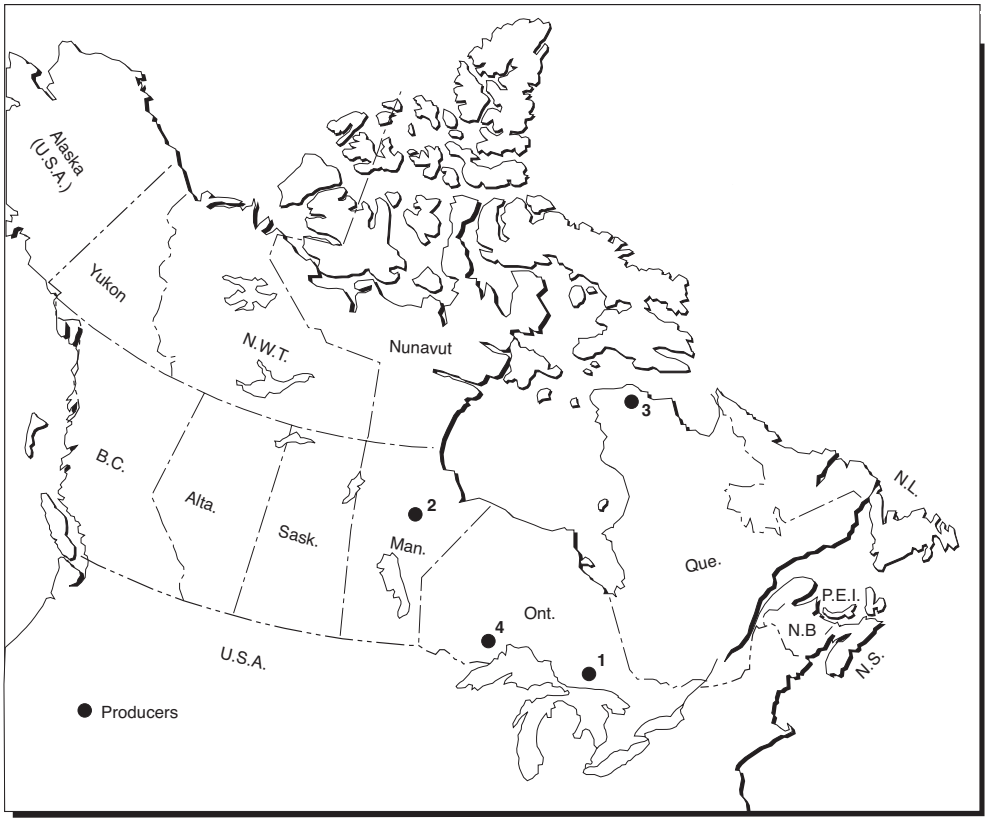
Both Inco and Falconbridge ship contained PGMs to refining facilities in Europe for final recovery. Falconbridge sends its PGMs, contained in a copper-nickel matte, to the company's Nikkelverk refinery in Norway. These contained PGMs in the matte are not reported in Canadian export data. Nikkelverk also 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 produced 13.1 t (422 000 troy oz) in 2004 from Inco source material. Inco continued exploration work in 2004 at its 170 footwall high-grade precious metal deposit at the McCreedy/Coleman mine. As of December 31, 2004, the probable ore reserves in the 170 deposit were estimated at 1.5 Mt grading 1.0% nickel, 7.4% copper and 14.5 g/t combined platinum, palladium and gold. Exploration drilling was conducted at the McCreedy/Coleman mine on the down-dip extension of the 153 footwall high-grade precious metals deposit. The 153 orebody is currently being mined, and proven and probable ore reserves were estimated at 3.1 Mt grading 1.2% nickel, 12.1% copper and 12.2 g/t combined platinum, palladium and gold at year-end 2004.

Canada's only 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 known as 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, the mine produced a record amount of ore in 2004, which in turn resulted in increased metal production. The mine produced some 16.9 Mt of ore, or 46 038 t/d, containing 4.6 Mt of ore grading 2.6 g/t palladium. Palladium production from the Lac des Iles mill reached a new record of 9.6 t (308 931 oz) in 2004.

Figure 2
Platinum Group Metals in Canada, 2004



Numbers and letters refer to locations on map above

PRODUCERS	WEB SITE
1. Falconbridge Limited (Fraser, Lindsley, Onaping-Craig, Lockerby)	www.falconbridge.com
1. Inco Limited (Copper Cliff North, Copper Cliff South, Crean Hill, Creighton, Frood, Little Stobie, McCreedy East, Levack/McCreedy West, Garson, Stobie)	www.inco.com
2. Inco Limited (Thompson, Birchtree)	www.inco.com
3. Falconbridge Limited (Raglan)	www.falconbridge.com
4. North American Palladium Ltd. (Lac-des-Iles)	www.napalladium.ca

Other metal production in 2004 included 0.8 t (25 128 oz) of platinum, 0.8 t (25 679 oz) of gold, 3554 t (7 836 183 lb) of copper and 1960 t (4 320 970 lb) of nickel. A second crushing facility was added to the mine in the fourth quarter of the year; it is expected to improve efficiencies and reduce costs.

A feasibility study that was completed in 2004 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 started in May. By year-end, all surface facilities were installed, the portal and decline were well established, and work had started on the ventilation raise and secondary escape. First production is expected during the fourth 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.

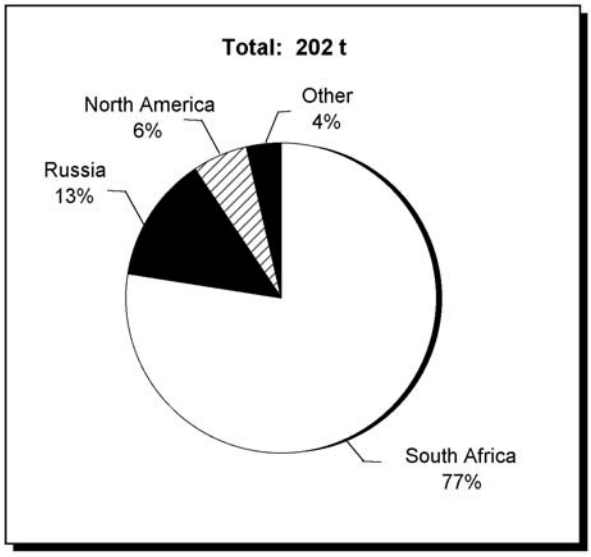
WORLD DEVELOPMENTS

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 combined 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 2004. Primary PGMs are also produced in China, associated with the approximately 40 000 t/y of nickel production from the Jinchuan Nonferrous Metals Corporation Limited.

Platinum Supply

Primary platinum supplies increased by 9.3 t in 2004, mostly as a result of rises in output from South African mines and a return to more normal rates of production in Canada following the strike at Inco in 2003 (Figure 3). In addition to primary sources, Johnson Matthey estimated that 22 t of platinum were recovered from the recycling of autocatalysts in 2004.

Figure 3
World Platinum Production, 2004



Source: Johnson Matthey Plc.

South Africa

South Africa is the largest platinum producer delivering 156.5 t to markets in 2004. 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 from the gold deposits of the Witwatersrand Basin.

Anglo Platinum Limited (74.8% held by Anglo American plc) 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 Corp. of Vancouver, who manages the project) and at Agnew Lake, also in the Sudbury District (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 2004, Anglo Platinum produced 76.2 t of refined platinum, up from 71.8 t in 2003 despite a wage strike in October and repairs to the Polokwane smelter. The company is seeking to further increase production by an additional 6% in 2005. Equivalent refined production from the mines managed by Anglo Platinum and its joint-venture partners increased by 3.9%, mainly as the result of additional production from the Western Limb Tailings Retreatment operation and the Modikwa platinum mine. In addition, the Kroondal platinum mine venture, jointly owned with Aquarius Platinum (South Africa) Limited, contributed some 2.3 equivalent refined tonnes, which were sold in concentrate to Impala Platinum Holdings Limited (Implats).

Implats has four mining operations: Impala Platinum and Marula Platinum, located on the Bushveld Complex in South Africa, and Zimplats and Mimosa Platinum, located on the Great Dyke in Zimbabwe. Implats produced about 34 t of platinum in 2004, up 5% over last year, despite a 10-day work stoppage over wages in October. Marula Platinum is one of the first operations to have been developed on the relatively under-exploited eastern limb. The metallurgical plant and surface infrastructure were delivered on schedule; however, the development of underground mining operations is significantly behind schedule, largely as the result of an inappropriate mining method and unexpected geological conditions. As a result, production for 2004 was severely affected with only 0.4 t of platinum in concentrate being produced, compared with planned full production of 3.1 t. A new plan has been developed to limit the dilution and improve the mine grade.

By the end of the 2004 financial year, Implats had increased its holding in Zimbabwe Platinum Mines Ltd. (Zimplats), which is listed on the Australian Stock Exchange, to 83.44%. Implats and Zimplats hold 30% and 70%, respectively, in Makwiro Platinum Mines (Private) Limited, giving Implats an effective holding of 88.4% in

the Makwiro mine and metallurgical complex in Zimbabwe. Mimosa Platinum is located on the southern part of the Great Dyke in Zimbabwe and is wholly owned by Mimosa Investments, based in Mauritius. Mimosa Investments is in turn jointly owned by Implats and Aquarius Platinum Limited. The mine completed an expansion program in 2004 to reach a production level of 2.1 t/y.

Following the suspension of mining at the Crocodile River UG2 mine in November 2003, Implats sold its 83.2% interest in Barplats Investments Limited in May 2004. The new owners of Barplats resumed production at Crocodile River in July.

Toronto-based SouthernEra Resources Limited acquired an additional 18.4% of the Messina mine in June and, by September, the company had split into two separately listed companies to better reflect the product mix between platinum and diamonds. SoutherEra's platinum and gold assets, including the Messina mine, were transferred to the newly listed Southern Platinum Corp., while the diamond assets were transferred to SouthernEra Diamonds Inc. Overall, platinum production at Messina increased in 2004 to reach 1.2 t.

Russia

Russia is the second largest producer of platinum, accounting for about 15% of the world's supply. Information related to PGMs production, sales and reserves is considered to be a state secret in Russia. In February 2004, the Russian State Duma voted in favour of relaxing restrictions on information related to PGMs in Russia. Further approvals are required, however, before the information can be made available to the public, now expected sometime in 2005. At year-end 2004, stocks and sales information remained a state 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 26 t of platinum in 2004. In addition to the platinum produced by Norilsk, there is some placer recovery from alluvial platinum deposits in Russia. At sites ranging from the Urals to the Kamchatka Peninsula, it is estimated that placer operations recover in the order of 5-7 t of platinum annually.

United Kingdom

Inco reported that it had achieved the highest level of annual platinum production in the company's history at the Acton refinery, located in the west end of London. The Acton facility also achieved its third highest Inco-sourced production level for PGMs during the year. Acton is a major refiner of PGMs, as well as gold and silver. In addition to processesing primary mining concentrates from Inco's mines in Canada, it also processes secondary materials, such as recycled spent catalysts and electronic scrap.

United States

Stillwater Mining Company is the only primary producer of PGMs in the United States. Lower-grade ore and lower mill throughput, together with a one-week strike at the company's Stillwater mine, contributed to an overall 0.2-t decrease in U.S. production to 4.0 t in 2004. Milling rates at the company's East Boulder mine increased in 2004; however, production was still lower than had been expected for the year.

Zimbabwe

Zimbabwe continued its emergence as an important producer in the PGMs world. Platinum production increased by 5% in 2004 to reach a total of 4.5 t as production at the Mimosa and Ngezi mines continued to rise. Future expansions are in question given the current economic and political uncertainty in the country, including the future of proposed black economic empowerment legislation.

Platinum Recycling

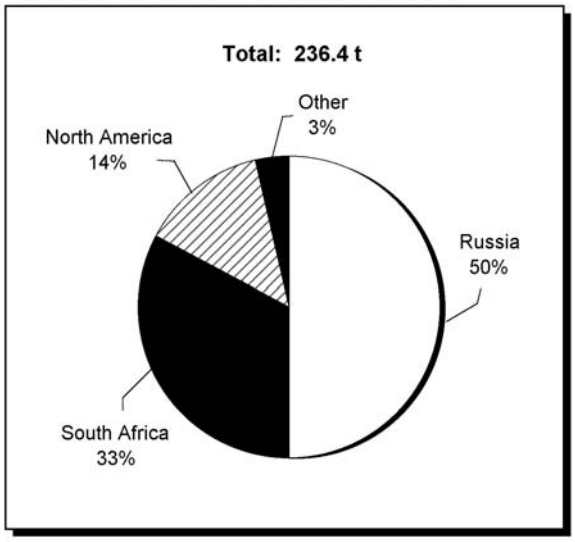
Platinum and other PGMs are recovered from a variety of post-consumer scrap and other sources. Used industrial catalysts, electronic scrap, jewellery sweepings, autocatalysts, and telecommunications equipment are important sources of PGMs. In Johnson Matthey's extensive reviews of the PGMs industry, 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 once again ran ahead of demand for the second year in a row in 2004. While demand rose an impressive 22% in 2004, primarily driven by the rapid development of palladium jewellery manufacturing in China and strong growth in autocatalysts and electronics, palladium supply kept pace and even exceeded demand by over 31 t. Russia is the world's leading producer of palladium and Russian supplies surged to 118.2 t in 2004, up from 91.8 t in 2003 (Figure 4). Overall, the total primary palladium supply reached 237 t in 2004, compared to 201 t in 2003.

In addition to the primary mine supply, Johnson Matthey estimates that 16.5 t of palladium were recovered from the recycling of motor vehicle catalysts in 2004. Secondary palladium is recovered from nonferrous metal facilities in Finland, Belgium, South Africa, Sweden, Japan, the United States and Canada.

Figure 4
World Palladium Production, 2004

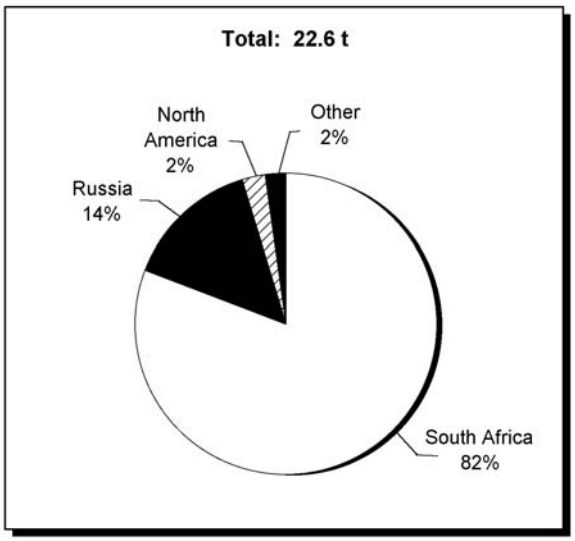


Source: Johnson Matthey Plc.

Primary Rhodium Supply

The supply of primary rhodium to markets increased slightly in 2004 to an estimated 22.6 t. South Africa was the world's largest rhodium producer, accounting for roughly 80% of the total supply (Figure 5). Russia was the second most important producer at 14% of the total supply. In addition to the primary supply, an estimated 4.4 t of rhodium were recovered from autocatalysts in 2004.

Figure 5
World Rhodium Production, 2004



Source: Johnson Matthey Plc.

MARKET DEMAND FOR PGMS

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 2004 were electrical, 38.9 t; autocatalysts, 227.7 t; jewellery, 97 t; and dental (palladium only), 26.4 t.

An additional 1.2 t of platinum were removed from available supply by investments in 2004. Net stock changes resulted in 2.5 t of platinum coming out of stocks, while 31.7 t of palladium went into stocks.

Platinum Demand

Europe is the world's leading industrial user of platinum, taking about 32% of industrial demand. Industrial demand in Japan and North America accounted for 21% and 16%, respectively, of total industrial demand in 2004.

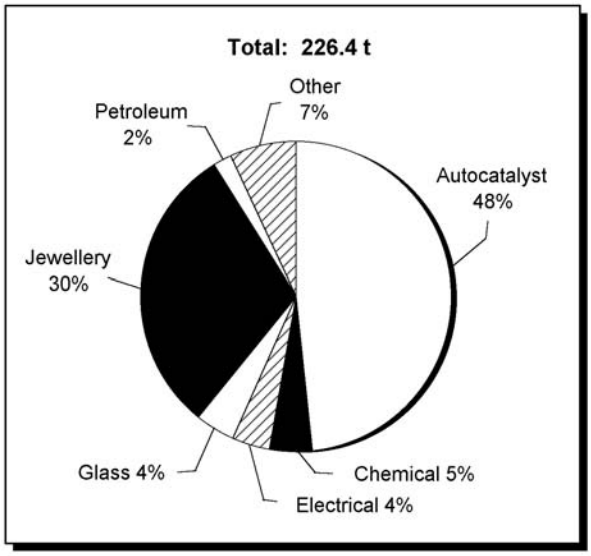
Traditionally, Japan has had a distinctly different market from Europe and North America with a different pattern of platinum demand. In Japan, the major use for platinum has been in jewellery, but demand in this sector has declined significantly over the past five years from 73% of demand in 1999 to just 43% (18.4 t) in 2004. For the first time, autocatalyst demand in Japan equalled that of jewellery. In Europe and North America, autocatalysts are the largest market use of platinum, accounting for 80% and 74% of net industrial demand, respectively. Taken together, autocatalysts and jewellery account for about 87% of total world industrial platinum demand (Figure 6).

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

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

Figure 6
World Platinum Demand by Application, 2004



Source: Johnson Matthey Plc.

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.

Jewellery

Platinum jewellery demand fell more than 12% in 2004 to reach 68.4 t, its lowest level since 1998. The decline in demand was due to the rise in platinum prices, which in turn led to a decrease in purchases by Chinese manufacturers. Retail sales were also down in Japan and North America as a result of the higher prices. The one region to register increased platinum jewellery sales was Europe, where strong growth in the United Kingdom led the way to a 7% rise in demand to 6.4 t.

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.

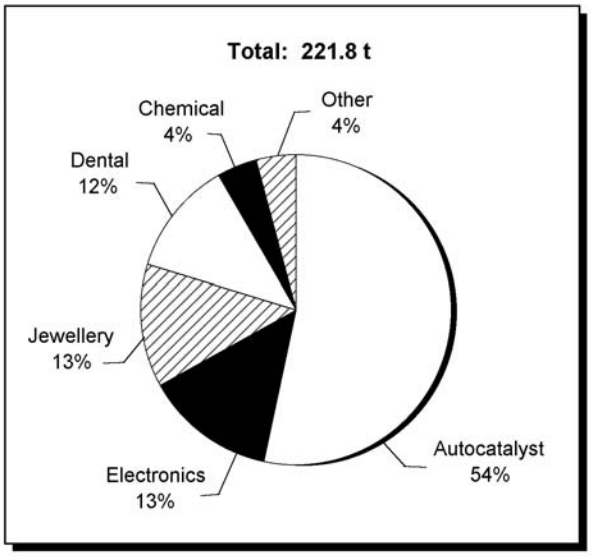
One minor application that currently shows promise for increased future demand is the manufacture of fuel cells. Fuel cells generate power by combining oxygen and hydrogen, yielding water and energy as products. Various technologies are being investigated; the two most popular technologies are the phosphoric acid fuel cell (PAFC) and the proton exchange membrane fuel cell (PEM). 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.

Palladium Demand

North America was the leading region for palladium demand in 2004 where demand rose to 57.9 t, up 17% over 2003, led primarily by demand in the autocatalyst sector. 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 2004 was in autocatalysts (21 t) followed by dental applications (16.2 t) and electrical applications (7 t). In North America, two-thirds of the industrial demand for palladium is accounted for by use in autocatalysts, while in Europe autocatalysts accounted for 86% of total demand.

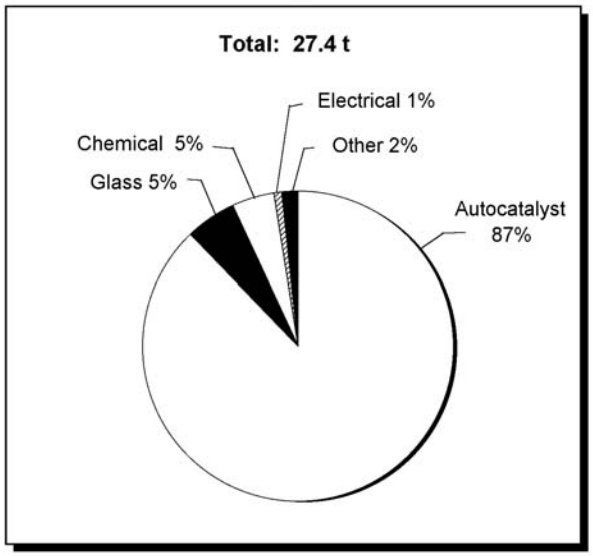
On a worldwide basis, according to reports by Johnson Matthey, autocatalysts are, by far, the leading market sector for palladium (58%). The sectorial net industrial demand (excluding investment offtake) in 2004 was estimated at 29.7 t for electrical, 26.4 t for dental, 118.5 t for autocatalysts, 28.6 t for jewellery, 9.5 t for chemical and 9 t for other (Figure 7).

Figure 7
World Palladium Demand by Application, 2004



Source: Johnson Matthey Plc.

Figure 8
World Rhodium Demand by Application, 2004



Source: Johnson Matthey Plc.

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.

Rhodium Demand

Tighter restrictions on the permissible levels of NO_x in automotive exhausts continue to drive the demand for rhodium in autocatalysts. Autocatalysts now account for over 87% of the rhodium used. Small amounts of rhodium are used in the chemical (5%), electrical (1%) and glass industries (5%). In these applications, rhodium is used with other PGMs to produce an alloy with enhanced physical or catalytic properties. Total demand for rhodium in 2004, including the amount recovered from autocatalysts, was 27.4 t (Figure 8).

Demand for Other PGMs

The demand for ruthenium and iridium is much lower than that for platinum or palladium. Estimated demand in 2004 for ruthenium was 21 t and for iridium was estimated at about 3.6 t. Demand data for osmium are not available.

Ruthenium has a variety of uses. In 2004, demand for ruthenium for use in chemical process catalysts fell back to 3.8 t after the significant increase seen in 2003. Demand in the electronics sector benefited from the increased use of ruthenium in hard-disk drives. Data storage density can be substantially increased by adding a thin layer of ruthenium to the magnetic coating of a hard disk. Demand for electronic applications increased to 12.1 t in 2004, representing over 57% of the total demand for ruthenium.

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-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.

PRICES

Platinum prices continued their upward trend that began in 2002. The fall in the value of the U.S. dollar that fuelled speculative demand for gold and most other commodities in 2004 carried over into the prices for the PGMs as well. The average price for London a.m. and p.m. fixings was up 22% in 2004 to reach US$845.75/troy oz. Prices for all the other PGMs rose as well, reversing the mostly downward trend seen in 2003. Palladium prices were up 15% to an average US$230.03/troy oz, rhodium was up 85% to US$981.73/troy oz, iridium rose 100% to US$186.32/troy oz, and ruthenium was up 85% to US$64.68/troy oz (Figures 9 and 10).

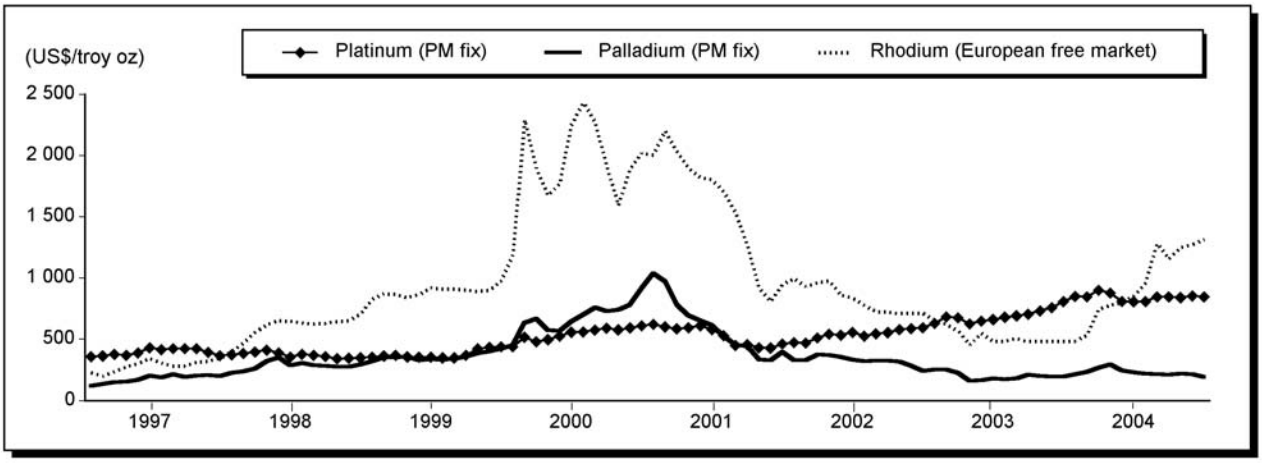
OUTLOOK

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.

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 PGM 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.

Figure 9
Prices for Platinum, Palladium and Rhodium, 1997-2004

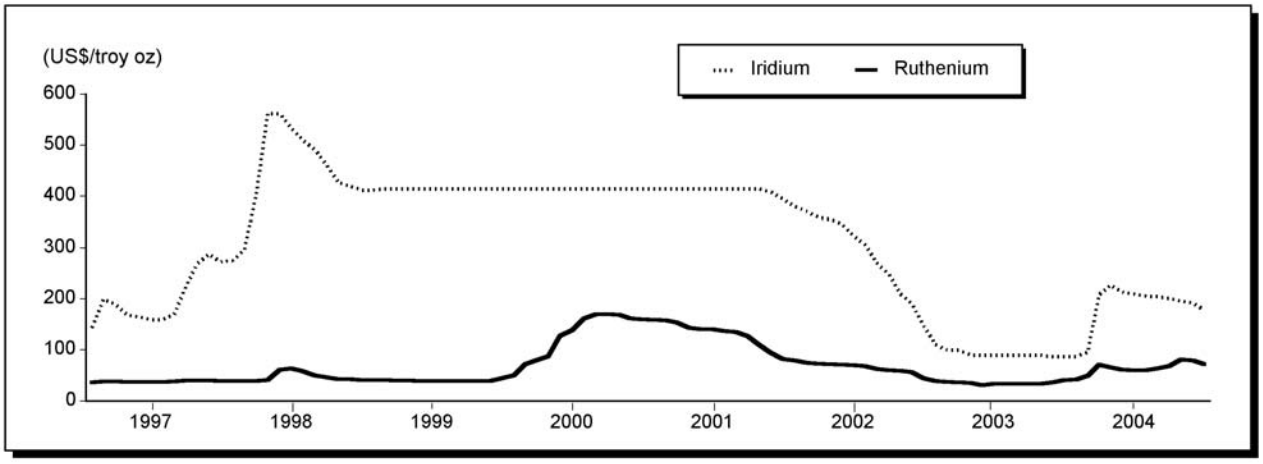


Sources: The London Platinum and Palladium Market; Metal Bulletin Plc.

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 July 25, 2005. (3) 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

Figure 10
Prices for Iridium and Ruthenium, 1997-2004



Source: Metal Bulletin Plc.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EU Conventional Rate (1)	Japan WTO (2)
26.16	Precious metal ores and concentrates						
2616.90.00.30	Platinum group metal content	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
	Platinum:						
7110.11	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.19	Other	Free	Free	Free	Free	Free	Free
	Palladium:						
7110.21	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.29	Other	Free	Free	Free	Free	Free	Free
	Rhodium:						
7110.31	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.39	Other	Free	Free	Free	Free	Free	Free
	Iridium, osmium and ruthenium:						
7110.41	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
7115.90.90.30	Other of platinum	7%	5%	Free	Free	3%	Free

Sources: Canadian *Customs Tariff*, effective January 2005, Canada Border Services Agency; *Harmonized Tariff Schedule of the United States,* 2005; *Official Journal of the European Union* (October 30, 2004 Edition); *Customs Tariff Schedules of Japan, 2004.*
(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 . CANADA, PLATINUM GROUP METALS PRODUCTION, 2002-04

	2002		2003		2004 (p)	
	(g)	($000)	(g)	($000)	(g)	($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	24 371 767	502 424	21 528 438	316 813	26 364 198	463 676

Sources: Natural Resources Canada; Statistics Canada.
(p) Preliminary; x Confidential.
(1) Mineral production (shipments) figures for irridium, 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.
Note: Numbers may not add to totals due to rounding.

TABLE 2. PLATINUM GROUP METALS, TRADE, 2002-04

		2002		2003		2004 (p)	
		(kg)	($000)	(kg)	($000)	(kg)	($000)
EXPORTS							
2616.90.83	Precious metal ores and concentrates; platinum group metal content						
	South Korea	–	–	10	305	10	414
	United Kingdom	7 053	154 864	451	8 709	–	–
	United States	566	2 614	–	–	–	–
	Total	7 619	157 478	461	9 014	10	414
7110.11	Platinum unwrought or in powder form						
	United Kingdom	–	–	–	–	119	1 307
	United States	35	929	39	1 087	28	938
	France	–	–	16	211	32	482
	Japan	14	390	20	589	–	–
	Total	49	1 319	75	1 887	179	2 727
7110.19	Platinum in other semi-manufactured forms						
	United States	487	13 774	401	12 720	422	14 829
	Other countries	–	–	–	6	2	60
	Total	487	13 774	401	12 726	424	14 889
7110.21	Palladium unwrought or in powder form						
	United States	2 087	29 265	1 914	19 845	2 287	28 936
	United Kingdom	–	–	87	661	645	5 933
	Total	2 087	29 265	2 001	20 506	2 932	34 869
7110.29	Palladium in other semi-manufactured forms						
	United States	5	151	2	26	87	1 027
7110.31	Rhodium unwrought or in powder form						
	United States	–	–	–	-	...	4
	Other countries	...	...	...	...	–	–
	Total	...	...	...	...	...	4
7110.39	Rhodium in other semi-manufactured forms						
	Japan	2	62	–	–	–	–
7110.41	Iridium, osmium and ruthenium unwrought or in powder form						
	United States	9	19	–	–	5	22

TABLE 2 (cont'd)

		2002		2003		2004 (p)	
		(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	7	108	40	722	22	281
	Other countries	–	–	200	18	. . .	19
	Total	7	108	240	740	22	300
	Total exports	10 265	202 176	3 180	44 899	3 659	54 252
IMPORTS (1)							
2616.90.00.30	Precious metal ores and concentrates; platinum group metal content						
	South Africa	. . .	1	1	12	. . .	. . .
	United States	1 000	57	16	243	–	–
	Total	1 000	58	17	255	. . .	. . .
7110.11	Platinum unwrought or in powder form						
	United Kingdom	677	17 279	678	18 302	1 377	39 128
	Other countries	3 234	75 603	5 323	84 714	2 747	77 432
	Total	3 911	92 882	6 001	103 016	4 124	116 560
7110.19	Platinum in other semi-manufactured forms						
	United States	409	9 134	643	14 172	446	12 800
	Other countries	171	4 320	258	4 390	178	6 375
	Total	580	13 454	901	18 562	624	19 175
7110.21	Palladium unwrought or in powder form						
	United States	2 666	47 880	2 071	20 153	1 165	6 326
	Other countries	3 519	59 274	4 820	44 191	232	2 302
	Total	6 185	107 154	6 891	64 344	1 397	8 628
7110.29	Palladium in other semi-manufactured forms						
	United States	697	10 769	716	9 994	2 119	26 383
	Other countries	359	6 206	319	4 443	7 539	44 321
	Total	1 056	16 975	1 035	14 437	9 658	70 704
7110.31	Rhodium unwrought or in powder form						
	United States	1	8	. . .	7	. . .	3
	Belgium	4	148	5	112	–	–
	South Africa	–	–	75	2 209	–	–
	Total	5	156	80	2 328	. . .	3
7110.39	Rhodium in other semi-manufactured forms						
	United States	4	96	6	171	9	215
	Other countries	1	11	. . .	32	2	47
	Total	5	107	6	203	11	262
7110.41	Iridium, osmium and ruthenium unwrought or in powder form						
	Japan	–	–	13	108	73	662
	United States	6	69	3	29	26	274
	Other countries	11	77	. . .	. . .	. . .	. . .
	Total	17	146	16	137	99	936
7110.49	Iridium, osmium and ruthenium in other semi-manufactured forms						
	United States	11	111	35	388	7	71
	Other countries	7	85	15	162	7	81
	Total	18	196	50	550	14	152

TABLE 2 (cont'd)

		2002		2003		2004 (p)	
		(kg)	($000)	(kg)	($000)	(kg)	($000)
IMPORTS (cont'd)							
7115.90.10.20	Other; articles of precious metal or of metal clad with precious metal; crucibles of platinum						
	United States	1 010	33 877	1 245	39 390	1 177	44 626
	Other countries	2	194	1	388	9	567
	Total	1 012	34 071	1 246	39 778	1 186	45 193
7115.90.90.30	Other; of platinum						
	United States	41	590	35	765	24	453
	Other countries	1	23	5	41	2	38
	Total	42	613	40	806	26	491
	Total imports	13 831	265 812	16 283	244 416	17 139	262 104

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; (p) Preliminary; x Confidential.
(1) Imports from "other countries" may include re-imports from Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 3. CANADA, PLATINUM METALS SHIPMENTS, 1988-2004

	Quantity	Value
	(kg)	($000)
1988	12 541	190 914
1989	9 870	141 729
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	134 241
1998	14 033	214 883
1999	13 872	250 466
2000	15 304	478 459
2001	20 694	651 922
2002	24 372	502 424
2003	21 528	316 813
2004 (p)	26 364	463 676

Sources: Natural Resources Canada; Statistics Canada.
(p) Preliminary.

TABLE 4. PRINCIPAL PLATINIUM GROUP METALS PRICES, 1998-2004

Month	Platinum AM Fix	Palladium AM Fix	Rhodium European Free Market
	(US$/troy oz)	(US$/troy oz)	(average US$/troy oz in warehouse)
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
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

TABLE 4 (cont'd)

Month	Platinum AM Fix	Palladium AM Fix	Rhodium European Free Market
	(US$/troy oz)	(US$/troy oz)	(average US$/troy oz in warehouse)
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
2004			
January	850.95	215.60	487.33
February	846.10	234.65	537.13
March	899.33	268.33	744.44
April	881.85	296.50	778.75
May	809.58	245.93	797.81
June	807.16	228.96	853.89
July	809.32	220.57	957.22
August	846.83	215.67	1 281.25
September	847.98	211.21	1 155.56
October	844.21	218.23	1 250.00
November	854.18	213.96	1 273.13
December	850.62	191.88	1 315.63
Average	845.99	229.84	952.68

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

TABLE 5. WORLD PLATINUM GROUP METALS PRODUCTION, 1998-2003

	1998	1999	2000	2001	2002	2003
	(kilograms of metal content)					
PALLADIUM						
World Total	152 400	149 758	152 017	164 952	174 752	181 243
Total Europe	70 212	67 187	71 037	72 037	73 037	74 032
Total Africa	58 463	58 506	56 184	62 972	66 187	75 928
Total America	18 774	17 895	19 272	24 310	29 100	24 863
Total Asia	4 151	5 354	4 712	4 805	5 618	5 600
Total Oceania	800	816	812	828	810	820
Russia (e)	70 000	67 000	71 000	84 000	85 000	84 000
South Africa	56 608	58 164	55 818	55 818	62 601	64 244
United States (e)	10 600	9 800	10 300	10 300	12 100	14 800
Canada (e)	8 174	8 095	8 972	8 972	12 210	12 808
Japan	4 151	5 354	4 712	4 712	4 830	5 000
Zimbabwe	1 855	342	366	366	371	1 080
Australia (e)	800	816	812	812	828	800
Serbia and Montenegro (e)	50	25	25	25	25	25
Poland	12	12	12	12	12	12
Finland (e)	150	150	–	–	–	–
PLATINUM						
World Total	159 254	163 633	159 516	179 343	186 850	204 782
Total Africa	119 213	121 783	114 964	130 826	136 102	155 422
Total Europe	30 530	32 526	34 467	35 535	35 533	36 525
Total America	8 828	8 497	9 132	12 017	14 253	11 860
Total Asia	533	737	782	791	762	750
Total Oceania	150	90	171	174	200	225
South Africa	116 483	121 304	114 459	130 307	133 796	151 022
Russia (e)	30 000	32 000	34 000	35 000	35 000	36 000
Canada (e)	5 177	5 129	5 683	7 733	9 202	6 990
United States (e)	2 730	479	505	519	2 306	4 400
Zimbabwe	3 240	2 920	3 110	3 610	4 390	4 170
Colombia	533	737	782	791	762	750
Finland (e)	411	448	339	674	661	700
Japan	500	500	441	510	508	500
Australia (e)	150	90	171	174	200	225
Poland	20	21	21	20	20	20
Serbia and Montenegro (e)	10	5	5	5	5	5
OTHER PLATINUM GROUP METALS						
World Total	41 220	51 096	51 282	51 132	57 571	65 615
Total Africa	27 039	37 048	36 533	35 881	42 201	50 354
Total Europe	13 500	13 400	14 100	14 500	14 500	14 600
Total America	681	648	649	751	870	661
South Africa	26 862	37 011	36 493	35 839	41 721	49 594
Russia (e)	13 500	13 400	14 100	14 500	14 500	14 600
Canada (e)	177	37	40	42	480	760
Zimbabwe	681	648	649	751	870	661
TOTAL PLATINUM GROUP METALS						
World Total	352 875	364 487	362 815	395 427	419 173	451 640
Total Africa	204 715	217 337	207 681	229 679	244 490	281 704
Total Europe	114 242	113 113	119 604	122 072	123 070	125 157
Total America	28 284	27 040	29 053	37 078	44 223	37 384
Total Asia	4 684	6 091	5 494	5 596	6 380	6 350
Total Oceania	950	906	983	1 002	1 010	1 045
South Africa	199 953	216 479	206 770	228 747	239 761	273 374
Russia (e)	113 500	112 400	119 100	121 500	122 500	124 600
Canada (1)	14 033	13 872	15 304	20 694	24 372	18 514
United States (e)	13 840	12 720	13 410	15 710	19 190	18 170
Japan	4 762	858	911	932	4 729	8 330
Zimbabwe	4 684	6 091	5 494	5 596	6 380	6 350
Australia (e)	950	906	983	1 002	1 010	1 045
Colombia	411	448	339	674	661	700
Finland (e)	650	650	441	510	508	500
Poland	32	33	33	32	32	32
Serbia and Montenegro (e)	60	30	30	30	30	25

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.