



2005 Minerals Yearbook

PLATINUM-GROUP METALS

PLATINUM-GROUP METALS

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In 2005, Stillwater Mining Company (SMC) (Billings, MT) was the only domestic mine producer of platinum-group metals (PGMs) from its Stillwater Mine near Nye, MT, and its East Boulder Mine south of Big Timber, MT. SMC was majority owned by Mining and Metallurgical Company (MMC) Norilsk Nickel (Moscow, Russia). SMC produced 17,200 kilograms (kg) of PGMs in 2005, 3% less than the 17,700 kg that it produced in 2004 (Stillwater Mining Company, 2006, p. 4).

In 2005, the domestic automobile industry continued to be the major consumer of PGMs. Autocatalysts accounted for approximately 87% of rhodium consumption, 71% of palladium consumption, and 52% of platinum consumption.

Production

Primary.—During 2005, the Stillwater Mine produced 9,110 kg of palladium and 2,730 kg of platinum. The decrease in production at the Stillwater Mine was caused by a reallocation of resources to development rather than mine production. Production from the East Boulder Mine was 4,200 kg of palladium and 1,180 kg of platinum (Stillwater Mining Company, 2006, p. 4-6, 9). Palladium and platinum production for SMC were down by 2.5% and 3.1%, respectively, compared with those of 2004. SMC defined mine production as the quantity of PGMs contained in concentrate at the time it was shipped to the smelter. The company milled 1.16 million metric tons (Mt) of ore from the mines, slightly more than in 2004. In 2005, the average mill head grade for the mines declined to 16.5 grams per metric ton (g/t) combined palladium and platinum from 17.1 g/t in 2004 (Stillwater Mining Company, 2006, p. 1).

SMC processed ore from the mines through a flotation concentrator adjacent to the mine shaft. The mill had a recovery rate for PGMs of 92%. The flotation concentrate, 1.5% of the original ore on a dry weight basis, was filtered and transported to the company's metallurgical complex in Columbus, MT.

At the SMC metallurgical complex, the concentrates from both mines are processed first at the precious metal smelter. The concentrate, which contains 1 to 2 kilograms per metric ton (kg/t) PGMs, is fed into an electric arc furnace (EAF) along with spent autocatalysts and limestone. The resulting matte, which contains 6 to 8 kg/t PGMs, is granulated and fed into a top-blown rotary converter (TBRC). The furnace slag is shipped back to the Stillwater Mine mill to capture more of the PGMs. The TBRC produces matte that contains 12 to 19 kg/t PGMs that is granulated and transported to the refinery. The slag from the TBRC is returned to the EAF for further treatment. The smelter has an offgas processing facility that captures more than 99.7% of the sulfur dioxide (SO₂) produced by the smelter and produces gypsum cake that is sold to a local agricultural supply wholesaler.

The refinery has several circuits that further process the smelter matte to produce PGM filter cake, nickel sulfate hexahydrate crystals, and copper cathodes. The PGM filter cake contains 60% to 65% PGMs and is shipped to Johnson Matthey plc (London, United Kingdom) facilities in the United States and to Heraeus Precious Metal Management, Inc. (New York, NY) for further refining.

SMC's proven and probable reserves are contained in the J-M Reef, a 45-kilometer-long ore body in the Beartooth Mountain Range in south-central Montana. At the end of 2005, the company had a total proven and probable reserve of 750,000 kg (24.1 million troy ounces) of palladium and platinum, with a metal ratio of 3.5 to 1 palladium to platinum. In 2005, the proven reserves increased by 33% compared with 2004 proven reserves owing to the completion of diamond drilling program in 2005 (Stillwater Mining Company, 2006, p. 17).

PolyMet Mining Corp. (Vancouver, British Columbia, Canada) announced that it had purchased an ore processing facility in northeastern Minnesota. The former taconite plant was to be used for processing NorthMet project ore from northeastern Minnesota, which includes cobalt, copper, gold, nickel, and PGMs. If a mine is developed, it would be the first combined base- and precious-metal mine in the State of Minnesota and the third PGM mine in the United States (PolyMet Mining Corp., 2005).

Secondary.—In 2005, recovery and recycling of autocatalysts provided a growing secondary source of PGMs. The strength of the price of platinum in 2005, which averaged \$900 per troy ounce, helped support the profitability of the recovery and recycling businesses. The global recovery of platinum from autocatalysts rose by 12% in 2005, reaching 24,000 kg, with recovery increasing in Europe and North America. In North America, recovery of platinum from catalytic converters rose by more than 2,000 kg in 2005 to an estimated 15,000 kg of platinum. Japan, however, recovered 36% less platinum from scrapped autocatalysts in 2005; this could be attributed to the exporting of used cars and a reduced number of end-of-life vehicles (Kendal, 2006, p. 20-23).

Global palladium recovered from autocatalysts in 2005 was 20,000 kg, an increase of 19% compared with that of 2004. In Europe, a combination of higher palladium loading on autocatalysts plus the greater number of autocatalysts being recycled led palladium recovery to increase by 50% to 5,000 kg compared with that of 2004. Palladium recovery in North America increased by 13% to 12,000 kg. In Japan, recovery of palladium dropped to 900 kg, a 25% decrease compared with recovery in 2004. As with platinum, the reason for this drop was the exporting of used automobiles (Kendal, 2006, p. 32-35).

In 2005, global recovery of rhodium slipped slightly to 4,000 kg. Increased recoveries in Europe and North America were

more than offset by a decrease in recovery in Japan (Kendal, 2006, p. 40).

SMC's recycling program processed 190 metric tons (t) or 9 metric tons per day of spent catalysts from automobiles and from oil refineries in 2005, 27% more than in 2004. SMC's goal was to double the amount of scrap material processed. Adding more scrap material to the smelter adds little to the overall operating cost of production and increases the grade of the matte (Stillwater Mining Company, 2006, p. 8).

Consumption

In 2005, global platinum sales were about 208,000 kg, a 2% increase compared with that of 2004. Increased use of platinum in catalytic converters was partially offset by a decrease in platinum demand from the jewelry industry owing to the increase in the price for that metal. Increased sales of diesel cars in Europe, rising light vehicle (passenger and light trucks) output, and tighter emission regulations combined to increase the consumption of platinum in autocatalysts to 119,000 kg, about a 9% increase compared with that of 2004. Palladium global sales also increased in 2005 to 219,000 kg, a 7% increase compared with those of 2004. The increase was driven by the rapid growth of palladium jewelry production in China and growth in the use of palladium in autocatalysts and electronics (Kendal, 2006, p. 2-10).

In 2005, U.S. apparent consumption of refined platinum was estimated to be about 89,600 kg, and apparent domestic palladium consumption was estimated to be 126,000 kg.

Palladium.—Worldwide consumption of palladium rose to 218,000 kg in 2005, a 7% increase compared with consumption in 2004. Palladium used in jewelry continued to increase, rising by 54% to 44,500 kg in 2005 compared with 2004 consumption. China, which accounted for most of the growth, consumed about 37,000 kg, 83% of the world consumption of palladium for jewelry manufacture. The majority of the remaining palladium consumption for jewelry was by Japanese jewelry manufactures, with some consumption in Europe and the United States (Kendal, 2006, p. 8-11, 32-39).

Palladium consumption for the production of autocatalysts remained relatively unchanged in 2005. There was a large increase in demand from auto makers in China, Japan, and the Republic of Korea that was offset by a drop in production of gasoline light vehicles in Europe and the United States (Kendal, 2006, p. 32).

Palladium consumption in dental alloys remained stable at 26,300 kg, with Japan as the major consumer. The chemical industry consumed 9,950 kg in 2005, a 3% increase compared with that of 2004. The main uses of palladium in the chemical industry were as catalysts in manufacturing bulk chemicals, including purified terephthalic acid (PTA). In 2005, much of the increased consumption was owing to construction of new PTA capacity in several countries, including Brazil, China, and Mexico. PTA ultimately is used in the production of polyester fibers and polyethylene terephthalate (PET). The electronics industry increased its consumption of palladium by 5% in 2005 to 30,000 kg. Most of the palladium used in the electronics industry was for multilayer ceramic capacitors for uses in all types of electronic goods (Kendal, 2006, p. 37-39).

Platinum.—Growth in the diesel-powered light vehicle sector in Europe continued to be the major reason for the increase in consumption of platinum in autocatalysts. In 2005, European automakers consumed 61,000 kg of platinum, an increase of 8,700 kg. Sales of diesel vehicles continued to rise, and about one-half of all new light vehicles in Western Europe was diesel. Although the rate of economic growth in Europe slowed in 2005, new European Stage IV emissions requirements and the introduction of catalyzed soot filters led to the increasing platinum loading on diesel autocatalysts. Soot filters are not required under European Stage IV emission regulation; however, some countries have adopted soot filters because of public concern.

The use of platinum in China and Japan also increased. In China, the consumption of platinum used in autocatalysts jumped to 3,500 kg in 2005 from 2,300 kg in 2004 owing to increased production of light vehicles and more stringent emission regulations. Japan saw an increase in consumption of platinum for autocatalysts owing to increased automobile production and increased emission regulations on light vehicles and heavy-duty diesel vehicles. In North America, the demand for platinum increased slightly despite the drop in light vehicle production in 2005 (Kendal, 2006, p. 5).

In 2005, global consumption of platinum in jewelry dropped by 9% compared with consumption in 2004, to 61,000 kg, the lowest level since 1995, largely as a result of high and volatile prices. A 13% decrease in purchases of metal by Chinese jewelry manufacturers in 2005 compared with purchases in 2004 was attributed to the higher price of platinum. With the large price surge, many jewelers also reduced their inventories of platinum jewelry, which led to a reduction of platinum jewelry on display. Retail demand for platinum jewelry also suffered losses to palladium and white gold jewelry. In Europe, however, sales remained stable owing to a growth in the platinum bridal jewelry market in the United Kingdom (Kendal, 2006, p. 5-6).

Global use of platinum in chemical catalysts rose by 3% in 2005 to 10,400 kg compared with that of 2004. Consumption of platinum-base catalysts for the production of silicon increased owing to increased silicon manufacturing capacity in Asia. The purchases of platinum by the petroleum refining industry increased to 15,000 kg in 2005 because of increased refining capacity. The global use of platinum in electronics increased by 20% to 11,000 kg in 2005. Growth in the sales of computer hard disks accounted for much of the growth in consumption, with greater production of PGM-bearing thermocouples and other electronics adding to the increase in consumption (Kendal, 2006, p. 6).

Platinum consumed in the production of liquid crystal display (LCD) glass and other glasses increased in 2005 by 22% to 11,000 kg compared with that of 2004 with most of the increased consumption coming from increased capacity in the LCD industry in Asia. Consumption in other end uses, such as anticancer drugs, coatings on turbine engines, medical components, oxygen sensors in automobiles, and spark plugs, increased slightly, while consumption of platinum in dental alloys decreased slightly in 2005. Consumption of platinum-base catalysts used in offroad equipment and stationary emissions controls remained about the same at 600

kg. Worldwide consumption of platinum coins and small bars remained unchanged in 2005; however, there was a net return of about 500 kg of large platinum bars in Japan to the investment market (Kendal, 2006, p. 26-27). U.S. Mint sales of platinum American Eagle Bullion coins remained unchanged in 2005 (U.S. Mint, 2006¹).

Other PGMs.—Global rhodium consumption in 2005 rose by 11% to 25,000 kg compared with that of 2004. A majority of this was used in the production of autocatalysts. Other uses of rhodium were, in descending order, LCD glass manufacturing, chemicals, electrical applications, and jewelry (Kendal, 2006, p. 40).

Global consumption of ruthenium increased by 17% to 24,500 kg in 2005. A 30% increase in ruthenium consumption in electronics was partially offset by a drop in chemical uses. Electrochemical and other end-use demand remained unchanged. Some of the uses for ruthenium in electronics are conductive paste used in resistor components, hard disks, and plasma display panels. Consumption of iridium, which is used in similar industries as ruthenium, increased to 3,860 kg in 2005, a 3% increase compared with 2004 consumption (Kendal, 2006, p. 41).

Prices

According to Platts Metals Week, the 2005 annual average price of palladium was \$203.54 per troy ounce, which was a 13% decrease compared with that of 2004. Prices had increased in 2004 after trending down since 2000 when the price had averaged \$692 per troy ounce. The average annual platinum price in 2005 reached \$899.51 per troy ounce, a more than 6% increase compared with the average annual 2004 price. As for the other PGMs, the iridium 2005 annual price decreased by 9% compared with the 2004 price, the rhodium 2005 annual price increased by 110%, and the ruthenium 2005 annual price increased by 16%.

Palladium.—The price of palladium began the year at \$184 per troy ounce and remained near the \$200 per troy ounce level for much of the year. In October, the price started a climb that peaked on December 9 at \$297 per troy ounce and promptly dropped to \$255 per troy ounce at yearend.

Platinum.—The price of platinum began the year at \$858 per troy ounce and remained below the \$900 per troy ounce level for the first half of the year. In August, the price of platinum rose above the \$900 per troy ounce level for 2 weeks before falling back under \$900 per troy ounce. After 2 weeks of price fluctuations just below the \$900 per troy ounce level, the price began a climb, reaching \$1,019 per troy ounce on December 12, the highest price in nearly 25 years. The price quickly fell to \$968 per troy ounce by yearend.

Rhodium.—The price of rhodium reached a 14-year high of \$3,110 per troy ounce on November 17. This was a 139% increase compared with the January 3 price of \$1,300 per troy ounce. The price had been increasing since early 2004 when the price was \$500 per troy ounce. The price increase was attributed to the declining availability of the metal. With less metal for

sale from Russia and increasing consumption from automobile, chemical production, and glass there was less material available. Speculation reportedly also played a part in the increase in prices.

Other PGMs.—The price of iridium began the year at \$170 per troy ounce and decreased to \$145 per troy ounce on February 18 where it remained until early April. The price began a slow climb and ended the year at \$195 per troy ounce. The price of ruthenium followed a similar trend to that of iridium, starting the year at \$67 per troy ounce and dropping to \$55 per troy ounce on February 17. The price began to rise in early March to end the year at \$87 per troy ounce.

Trade

In 2005, the U.S. net import reliance as a percentage of apparent consumption was estimated to be 89% for refined palladium and 96% for refined platinum. Imports of refined palladium in 2005 increased by 10% to 139,000 kg from 127,000 kg in 2004, with three countries accounting for about 85% of refined palladium imports in 2005—Russia (46%), South Africa (23%), and the United Kingdom (15%). A large portion of the Russian imports was shipments from Norilsk Nickel to SMC as part of a purchase agreement. Imports of platinum, including waste, scrap, and coins, increased by 23% in 2005 to 106,000 kg from 86,400 kg in 2004, with four countries accounting for 72% of imports of platinum in 2005—South Africa (38%), the United Kingdom (17%), Canada (10%), and Germany (7%). Other refined PGM imports were up by 13% in 2005 compared with those of 2004. South Africa accounted for 60%, Germany accounted for 19%, and the United Kingdom accounted for 16% of other PGM imports in 2005. The United States exported 45,600 kg of platinum (48,400 kg in 2004), 27,000 kg of palladium (31,500 kg in 2004), 1,070 kg of other PGM (1,090 kg in 2004), and 615 kg of rhodium (314 kg in 2004).

World Industry Structure

In 2005, world mine production of PGMs increased by about 5% to 515,000 kg compared with 492,000 kg in 2004 (table 5). South Africa, the world's leading producer of PGMs, accounted for 61% of total mine production in 2005, Russia accounted for 28%, Canada accounted for 4%, and the United States accounted for 3%. South Africa, which accounted for 78% of world platinum production, increased its output of platinum by 6% in 2005 to 169,000 kg. Global output of palladium climbed to 222,000 kg, with Russia and South Africa accounting for 44% and 38%, respectively, of the total. South Africa dominated the world's mine production of other PGMs with 77% of the total.

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Canada.—North American Palladium Ltd. (Toronto, Ontario, Canada) produced about 5,510 kg of palladium and 586 kg of platinum in 2005 at the Lac des Iles Mine compared with 9,610 kg of palladium and 782 kg of platinum in 2004. Lower ore grade, poor mill availability, and a drop in recoveries led to the

¹A reference that includes a section mark (§) is found in the Internet Reference Cited section.

41% decrease in PGM production (North American Palladium Ltd., 2006, p. 1-5). The rest of Canada's PGM production was a byproduct of nickel mining in the Sudbury and Raglan areas. Inco Limited (Toronto) and Falconbridge Limited (Toronto) were the main producers of byproduct PGM. In 2005, Inco produced 13,000 kg of PGMs and, although Falconbridge did not release data for PGM production, nickel production dropped in 2005 (Kendal, 2006, p. 18).

Madagascar.—Jubilee Platinum plc (London) increased the pace of exploration (comprising reconnaissance, geochemical soil sampling, trenching, and geophysics) on its three copper-nickel-PGM properties—Ambodilafa, Lanjanina, and Londokomanana, (Jubilee Platinum plc, 2006).

Russia.—In 2005, Russia accounted for 44% of global mine production of palladium, 21% of other PGM production, and 14% of platinum production. Despite the importance of the Russian PGM mining industry to the world market, information on production, reserves, and sales have historically been difficult to obtain because such data were considered to be confidential under Russian law. In late 2003, a bill to declassify PGM data (with the exception of Government stocks and sales) was enacted. Although the bill was to take effect in February 2004, the publication of PGM data was delayed by regulatory procedures (O'Neil, 2004). In 2005, however, Norilsk disclosed that it produced 97,400 kg of palladium and 23,400 kg of platinum. Micon International conducted an independent audit of the deposits on the Taimyr Peninsula and as of December, reported reserves of 2,540 t of PGM (1,930 t of palladium, 497 t of platinum, and 112 t of other PGM) (MMC Norilsk Nickel, 2006, p. 1, 13, 98).

Serbia and Montenegro.—RTB BOR Grupa Rudarsko Topioninarski Basen BOR D.O.O. in Serbia, which previously recovered palladium and platinum from copper ores and was the country's only producer of PGMs, closed in 2005 (Walter Steblez, Serbia and Montenegro country specialist, U.S. Geological Survey, oral commun., June 14, 2006).

South Africa.—South Africa accounted for 78% of platinum, 38% of palladium, and 61% of all PGMs produced worldwide in 2005. In 2005, South African production of PGMs was up by 9% compared with that of 2004; palladium production rose by 8%, platinum production rose by 6%, and other PGM production rose by 21%.

PGM production by Anglo Platinum Limited (Johannesburg, South Africa) was 127,000 kg in and accounted for 41% of the total South African PGM production in 2005. Platinum production was unchanged compared with 2004 production, but palladium production was up by 3% and that of other PGM was up by more than 30%. The primary reasons for the increase in PGM production were the two pool and share agreements (P&SA) with Aquarius Platinum Limited (Johannesburg). The first P&SA was at the Kroondal Platinum Mine, and in July, Anglo and Aquarius signed the second P&SA for the Marikana operations. The P&SAs allow the companies to pool their assets while retaining ownership and sharing the proceeds equally. Production arising from Kroondal is sold to Impala Platinum Limited (Implats) (Johannesburg) under a volume-based concentrate offtake agreement. The commitment in terms of this agreement was expected to be met from the shafts already

in production at commencement of the second P&SA and was expected to be fully met during 2007 at current production rates. Additional production arising from the expansion made possible by the P&SA will be smelted and refined by Anglo, which had several potential new projects in South Africa and was expected to remain the leading producer of PGMs in the world (Anglo Platinum Limited, 2006, p. 1-10, 51-55).

Refined production of PGMs from Implats increased by 6% to 36,000 kg compared with production in 2004. The increase was owing to a 7% increase in mill throughput, but was offset slightly by lower grade ore (Impala Platinum Holdings Limited, 2006).

Northam Platinum Limited (Johannesburg) processed 17% more ore in 2005 than in 2004. The main reason for the increase was that production in 2004 had been reduced by a fire, which had closed the mine for about 6 weeks (Kendal, 2006, p. 15).

In June, Lonmin Plc (London) purchased Southern Platinum (Toronto) for \$190 million. This purchase added the Limpopo division (formally Messina Platinum Ltd. when under Southern Platinum Corp.). In 2005, Lonmin produced 30,000 kg of platinum, up by 4% compared with platinum production in 2004 (Kendal, 2006, p. 14-15).

On November 29, Aquarius announced the first shipment of concentrates from the Everest Platinum Mine in South Africa. The mine produced 220 kg of PGMs in 2005, and Aquarius expected the open pit and underground mine near the town of Lydenburg on the eastern limb of the South African Bushveld Complex to produce 7,000 kg of PGMs in 2006 (Aquarius Platinum Limited, 2006, p. 1-8).

African Rainbow Minerals' Limited (ARM) (Sandton, South Africa) platinum division had several joint ventures operating in South Africa—Modikwa Platinum Mine, 50% jointly owned with Anglo; Nkomati Nickel Mine, 50% with LionOre Mining International Ltd. (Toronto); and Two Rivers Platinum Mine, a project in which ARM held 55% and Implats 45%. The Two Rivers Project was expected to start up in the second half of 2006 and was projected to produce 6,500 kilograms per year (kg/yr) of PGMs (African Rainbow Minerals Limited, 2006, p. 43-45).

A bankable feasibility study was completed on Ridge Mining plc's (London) Blue Ridge Mine in November. The mine was projected to start up in mid-2006 and had a projected capacity of 3,890 kg/yr of PGMs (Ridge Mining plc, 2006).

Zimbabwe.—In 2005, Zimplats Holdings Limited (Harare, Zimbabwe), which owned Zimbabwe's Hartley Complex, produced 2,700 kg of platinum and 2,240 kg of palladium which was unchanged compared with production in 2004. The introduction of underground mining lowered the amount of ore milled; this was offset, however, by an increase in ore grade (Zimbabwe Platinum Mines Limited, 2006).

Implats, which owns 86.9% of Zimplats, announced that it had increased PGM production by 9% at the Mimosa, Zimbabwe, 50-50 joint venture with Aquarius, compared with production in 2004. In 2005, Mimosa produced 2,240 kg of platinum, 1,680 kg of palladium, and 170 kg of rhodium. Implats and Aquarius announced that an upgrade of the concentrator, planned for mid-2006, could increase the annual output of platinum to 2,690 kg (Kendal, 2006, p. 19).

Although Zimbabwe has proven to be a popular site for exploration and mining of PGMs, much of the refining takes place in South Africa. A recent proposal by the Government of Zimbabwe could result in the Government taking a substantial stake in foreign-owned domestic mining operations. Although further upgrades to capacity and the possibility of building new refineries in Zimbabwe were investigated in 2005, the proposal from the Government caused foreign investors to become reluctant to invest in new operations (Kendal, 2006, p. 19).

Current Research and Technology

In 2005, there were numerous technological advances that required PGMs. Many of these were associated with fuel cells, medical devices, nanotechnology, and pharmaceuticals. It was unknown how these new technologies would affect the consumption of PGMs or the patterns of PGMs consumption.

Outlook

An increase in diesel car sales in Europe can be expected to cause a strong increase in the use of platinum in the region in 2006 and beyond. Stricter emissions regulation in China, Europe, Japan, and other parts of the world is also expected to lead to higher average platinum loadings on catalysts, especially on light-duty diesel vehicles, as particulate matter emissions become more closely controlled. In the United States, thrifting to reduce platinum loadings in catalysts is continuing at most manufacturers and is likely to lead to a reduction in the use of platinum in autocatalysts. The price differential of more than \$600 per troy ounce between palladium and platinum has led to the assumption that automobile manufacturers will change PGM ratios in gasoline-engine vehicle's catalytic converters in favor of palladium, causing automotive industry use of palladium to increase in the short term. Average loading levels on autocatalysts are expected to increase in Europe and Japan at the expense of platinum as more stringent particulate emission standards are introduced. Since U.S. automobile manufacturers sharply drew down their palladium stocks during 2005, purchases of palladium by U.S. automobile manufacturers are likely to increase. Also, many U.S. automobile manufacturers had yet to make the switch because of the historically high and volatile prices. A shift toward greater use of palladium in preference to platinum on gasoline-vehicle autocatalysts by a number of manufacturers is also likely to provide a modest increase in palladium use in Asia and Europe. In Europe, however, production of gasoline fueled automobiles is expected to decline while sales of diesel engines continue to rise, which will partially offset some of the expected growth from switching to palladium, as will further thrifting by all catalyst producers. In the electronics sector, component sales are expected to increase. Increased demand for palladium, however, will be somewhat offset by a combination of miniaturization and substitution of nickel and silver for palladium in multilayer ceramic capacitors. The sale of platinum jewelry is expected to drop worldwide, assuming the price continues to be high and white gold and palladium are used as substitutes.

There was a believed to be a supply shortfall of platinum in 2005, but supplies of platinum are expected to increase significantly from new mines opening in South Africa. However, since the growth in supply is expected to be about the same as the projected growth in demand, a supply deficit is expected to continue. As for palladium there was a perceived oversupply of palladium in the world in 2005. However, a supply deficit could develop as production of palladium will most likely remain flat or decline and demand is expected to grow.

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TABLE 1
 SALIENT PLATINUM-GROUP METALS STATISTICS¹

		2001	2002	2003	2004	2005
United States:						
Mine production:						
Palladium, Pd content: ²						
Quantity	kilograms	12,100	14,800	14,000	13,700	13,300
Value	thousands	\$237,000	\$162,000	\$91,400	\$102,000	\$87,100
Platinum, Pt content: ²						
Quantity	kilograms	3,610	4,390	4,170	4,040	3,920
Value	thousands	\$61,900	\$76,500	\$93,100	\$110,000	\$113,000
Refinery production:						
Palladium, Pd content:						
Quantity	kilograms	9,790	5,700	7,250	5,480	5,470
Value	thousands	\$192,000	\$62,200	\$47,300	\$41,000	\$35,800
Platinum, Pt content:						
Quantity	kilograms	15,000	15,200	17,000	16,700	16,100
Value	thousands	\$258,000	\$265,000	\$379,000	\$456,000	\$466,000
Imports for consumption, refined:						
Iridium, Ir content	kilograms	3,110	2,100	2,200	3,230	3,010
Osmium, Os content	do.	77	36	53	75	39
Palladium, Pd content	do.	160,000	117,000	105,000	127,000	139,000
Platinum, includes waste, scrap, and coins, Pt content	do.	84,200	84,700	88,500	86,400	106,000
Rhodium, Rh content	do.	12,400	8,630	12,000	13,200	13,600
Ruthenium, Ru content	do.	8,170	9,890	15,900	18,800	23,200
Exports, refined:						
Iridium, osmium, and ruthenium, gross weight	do.	252	94	145	1,090 ^r	1,070
Palladium, Pd content	do.	36,800	42,700	22,300	31,500 ^r	27,000
Platinum, Pt content	do.	29,300	27,800	22,200	20,000 ^r	20,700
Rhodium, Rh content	do.	982	349	479	314 ^r	615
Stocks, National Defense Stockpile, December 31:						
Iridium, Ir content	do.	784	784	562	501	189
Palladium, Pd content	do.	16,300	5,870	1,170	568	--
Platinum, Pt content	do.	3,680	649	649	649	261
Price, average:						
Iridium ³	dollars per troy ounce	\$415.25	\$294.62	\$93.02	\$185.33	\$169.51
Palladium ⁴	do.	\$610.71	\$339.68	\$203.00	\$232.93	\$203.54
Platinum ⁴	do.	\$533.29	\$542.56	\$694.44	\$848.76	\$899.51
Rhodium ⁴	do.	\$1,600.00	\$838.88	\$530.28	\$983.24	\$2,060.00
Ruthenium ³	do.	\$130.67	\$66.33	\$35.43	\$64.22	\$74.41
Employment		1,620	1,580	1,540	1,580	1,620
World, mine production, PGM content	kilograms	410,000 ^r	430,000 ^r	465,000 ^r	492,000 ^{r, c}	515,000 ^c

^cEstimated. ^rRevised. -- Zero.

¹Data are rounded to three significant digits, except prices.

²Source: Stillwater Mining Co., 2005 annual report, p. 4.

³Price data are annual averages of daily Engelhard unfabricated quotations published in Platts Metals Week.

⁴Price data are annual Engelhard unfabricated quotations published in Platts Metals Week.

TABLE 2
U.S. IMPORTS FOR CONSUMPTION OF PLATINUM, BY COUNTRY¹

Country	Grain and nuggets		Sponge		Other unwrought		Other		Waste and scrap		Coins	
	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)
2004	376	\$9,520	68,800	\$1,830,000	6,710	\$178,000	4,550	\$105,000	5,870	\$82,000	12	\$345
2005:												
Australia	--	--	--	--	--	--	1,470	42,300	3,610	2,000	5	176
Austria	--	--	--	--	1	10	(2)	3	--	--	--	--
Azerbaijan	--	--	2	52	--	--	--	--	--	--	--	--
Belgium	--	--	1,540	42,900	1	33	(2)	10	--	--	--	--
Brazil	--	--	604	17,500	--	--	1	20	(2)	7	--	--
Canada	10	313	--	--	2	43	333	9,610	10,500	20,000	3	95
Chile	--	--	--	--	--	--	--	--	353	6,100	--	--
China	--	--	--	--	--	--	(2)	4	63	2,040	1	24
Colombia	60	1,700	11	286	104	2,860	--	--	296	2,100	--	--
Dominican Republic	--	--	--	--	--	--	--	--	21	245	--	--
El Salvador	--	--	--	--	--	--	--	--	--	--	--	--
France	--	--	--	--	1	9	1	13	319	452	--	--
Germany	--	--	3,750	108,000	264	6,050	3,830	55,300	79	274	--	--
Greece	--	--	--	--	(2)	2	--	--	--	--	--	--
Hong Kong	--	--	--	--	--	--	--	--	3	108	1	21
India	2	55	40	745	2	54	--	--	--	--	--	--
Ireland	--	--	--	--	--	--	6	152	--	--	--	--
Israel	--	--	--	--	(2)	3	--	--	--	--	1	9
Italy	51	1,350	412	12,300	598	16,300	300	7,000	--	--	--	--
Japan	--	--	314	8,860	121	2,990	253	6,770	1,580	18,600	--	--
Jordan	--	--	--	--	--	--	--	--	12	133	--	--
Korea, Republic of	--	--	--	--	93	2,790	(2)	5	5,280	18,000	--	--
Malaysia	--	--	--	--	--	--	--	--	1,090	16,700	--	--
Mauritius	--	--	--	--	--	--	(2)	3	--	--	--	--
Mexico	--	--	--	--	--	--	--	--	2,480	22,000	--	--
Netherlands	--	--	--	--	--	--	15	205	--	--	(2)	16
Norway	--	--	704	20,200	--	--	--	--	--	--	--	--
Philippines	--	--	--	--	--	--	1	10	2,420	1,430	--	--
Russia	--	--	3,820	107,000	186	5,040	95	2,550	--	--	--	--
Saudi Arabia	--	--	--	--	--	--	--	--	6	5	--	--
Singapore	--	--	--	--	(2)	4	--	--	30	829	--	--
South Africa	137	3,870	40,000	1,130,000	33	993	36	672	--	--	--	--
Spain	--	--	--	--	--	--	--	--	--	--	--	--
Suriname	--	--	--	--	--	--	--	--	(2)	8	--	--
Sweden	--	--	--	--	1	18	--	--	--	--	--	--
Switzerland	1	14	739	21,700	2	56	85	1,640	--	--	9	127

See footnotes at end of table.

TABLE 2—Continued
U.S. IMPORTS FOR CONSUMPTION OF PLATINUM, BY COUNTRY¹

Country	Grain and nuggets		Sponge		Other unwrought		Other		Waste and scrap		Coins	
	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)
2005—Continued:												
Taiwan	(2)	\$2	--	--	--	--	--	--	--	--	--	--
Thailand	--	--	--	--	--	--	--	--	215	\$5,840	--	--
United Kingdom	97	2,700	16,200	\$466,000	333	\$10,800	589	\$17,400	738	21,600	3	\$103
Total	358	10,000	68,200	1,940,000	1,740	48,000	7,020	144,000	29,100	138,000	23	571

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Less than 1/2 unit.

Source: U.S. Census Bureau; data adjusted by the U.S. Geological Survey.

TABLE 3
U.S. IMPORTS FOR CONSUMPTION OF PLATINUM-GROUP METALS, BY COUNTRY¹

Country	Unwrought palladium		Palladium, other		Iridium ²		Unwrought osmium		Unwrought ruthenium		Rhodium ³	
	Quantity, Pd content (kilograms)	Value (thousands)	Quantity, Pd content (kilograms)	Value (thousands)	Quantity, Ir content (kilograms)	Value (thousands)	Quantity, Os content (kilograms)	Value (thousands)	Quantity, Ru content (kilograms)	Value (thousands)	Quantity, Rh content (kilograms)	Value (thousands)
2004	106,000	\$786,000	20,700	\$145,000	3,230	\$18,000	75	\$421	18,800	\$35,900	13,200	\$397,000
2005:												
Austria	--	--	13	44	--	--	--	--	--	--	--	--
Azerbaijan	1	6	--	--	--	--	--	--	--	--	--	--
Belgium	2,330	14,300	119	1,100	--	--	--	--	--	--	720	33,500
Canada	1,610	13,200	--	--	--	--	--	--	--	--	(4)	3
Chile	40	299	--	--	--	--	--	--	--	--	--	--
China	270	1,860	--	--	--	--	4	22	--	--	--	--
Dominican Republic	--	--	2	9	--	--	--	--	--	--	--	--
France	--	--	47	176	--	--	--	--	--	--	(4)	2
Germany	1,670	12,200	562	2,700	403	2,110	4	55	6,360	15,700	833	48,100
Ireland	--	--	--	--	1	9	--	--	--	--	--	--
Israel	--	--	--	--	--	--	--	--	--	--	9	590
Italy	1,720	9,990	787	5,190	--	--	--	--	--	--	74	4,330
Japan	1,980	8,660	1,470	1,740	--	--	--	--	32	78	17	1,120
Korea, Republic of	--	--	--	--	--	--	--	--	--	--	16	1,310
Norway	6,120	37,100	12	343	--	--	--	--	--	--	7	446
Russia	54,600	342,000	9,680	52,600	--	--	21	203	108	185	915	54,900
Singapore	--	--	--	--	--	--	--	--	60	120	78	5,000
South Africa	32,400	190,000	--	--	1,150	5,950	10	83	14,700	30,900	7,800	474,000
Spain	15	92	--	--	--	--	--	--	--	--	--	--
Switzerland	1,160	9,330	1,570	9,450	--	--	--	--	280	558	--	--
Thailand	--	--	--	--	--	--	--	--	--	--	1	25
United Kingdom	20,200	137,000	945	6,370	1,450	8,650	--	--	1,610	2,240	3,110	198,000
Total	124,000	776,000	15,200	79,700	3,010	16,700	39	362	23,200	49,800	13,600	821,000

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Unwrought and other forms of iridium.

³Unwrought and other forms of rhodium.

⁴Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 4
U.S. EXPORTS OF PLATINUM-GROUP METALS, BY COUNTRY¹

Country	Palladium		Platinum		Platinum, waste and scrap		Iridium, osmium, ruthenium		Rhodium	
	Quantity, Pd content	Value	Quantity, Pt content	Value	Quantity, Pt content	Value	Quantity, gross weight	Value	Quantity, Rh content	Value
	(kilograms)	(thousands)	(kilograms)	(thousands)	(kilograms)	(thousands)	(kilograms)	(thousands)	(kilograms)	(thousands)
2004	31,500 †	\$143,000 †	20,000	\$377,000 †	28,400 †	\$520,000 †	1,090 †	\$8,800 †	314 †	\$7,900 †
2005:										
Argentina	5	35	131	3,440	--	--	--	--	--	--
Australia	343	2,520	529	15,500	--	--	--	--	--	--
Austria	2	9	28	483	--	--	--	--	--	--
Belarus	61	117	--	--	--	--	--	--	--	--
Belgium	140	748	37	1,020	73	695	1	7	(2)	10
Bermuda	1	7	--	--	--	--	--	--	--	--
Bolivia	(2)	7	--	--	--	--	--	--	(2)	8
Brazil	608	4,180	371	8,650	10	162	(2)	13	--	--
Bulgaria	19	40	--	--	--	--	--	--	--	--
Cambodia	--	--	(2)	5	--	--	--	--	--	--
Canada	3,160	20,900	858	20,100	2,040	19,400	4	22	121	7,040
Chile	--	--	552	8,430	--	--	--	--	--	--
China	276	1,390	547	9,290	16	149	14	248	1	47
Colombia	22	161	3	54	--	--	--	--	(2)	8
Costa Rica	1	7	--	--	--	--	--	--	--	--
Cyprus	--	--	(2)	4	--	--	(2)	5	--	--
Czech Republic	--	--	3	43	--	--	--	--	--	--
Denmark	86	539	3	49	--	--	--	--	--	--
Dominican Republic	11	69	(2)	5	--	--	--	--	--	--
Ecuador	--	--	1	11	--	--	--	--	--	--
Estonia	2	9	--	--	--	--	--	--	--	--
Finland	11	95	7	114	--	--	--	--	--	--
France	543	2,810	93	1,260	--	--	7	41	--	--
Germany	3,750	14,500	2,190	47,400	1,460	16,100	77	620	78	6,040
Greece	--	--	2	31	--	--	--	--	--	--
Guatemala	--	--	--	--	--	--	--	--	(2)	7
Haiti	3	17	--	--	--	--	--	--	--	--
Hong Kong	570	2,230	786	18,900	--	--	224	1,350	2	329
Hungary	1	3	1	10	--	--	--	--	--	--
Iceland	9	56	1	24	--	--	--	--	--	--
India	9	31	21	380	6	231	(2)	9	6	1,090
Indonesia	--	--	(2)	9	--	--	--	--	--	--
Ireland	74	150	98	1,990	--	--	3	17	--	--
Israel	759	2,090	2	48	--	--	6	34	--	--
Italy	205	1,380	1,770	51,800	3	91	--	--	10	583
Japan	2,150	12,600	5,840	126,000	1,660	44,000	179	1,220	58	4,450
Korea, Republic of	346	962	99	2,300	56	472	4	52	--	--
Kuwait	5	41	(2)	15	--	--	--	--	--	--
Lebanon	21	54	--	--	--	--	--	--	(2)	4
Liechtenstein	5	45	1	11	--	--	--	--	--	--
Malaysia	21	138	57	685	--	--	360	2,340	--	--
Mexico	47	375	389	8,050	--	--	20	137	4	581
Netherlands	97	637	52	849	--	--	--	--	--	--
New Zealand	47	366	6	94	--	--	--	--	--	--
Norway	68	777	31	487	--	--	--	--	--	--
Philippines	1	14	14	211	--	--	--	--	--	--
Poland	3	14	1	20	--	--	--	--	--	--
Qatar	1	11	--	--	--	--	--	--	--	--
Romania	1	8	6	103	--	--	--	--	--	--

See footnotes at end of table.

TABLE 4—Continued
U.S. EXPORTS OF PLATINUM-GROUP METALS, BY COUNTRY¹

Country	Palladium		Platinum		Platinum, waste and scrap		Iridium, osmium, ruthenium		Rhodium	
	Quantity, Pd content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, Pt content (kilograms)	Value (thousands)	Quantity, gross weight (kilograms)	Value (thousands)	Quantity, Rh content (kilograms)	Value (thousands)
2005—Continued:										
Russia	--	--	2	\$34	--	--	--	--	--	--
Saint Kitts and Nevis	4	\$6	--	--	--	--	--	--	--	--
Saudi Arabia	3	27	4	46	--	--	--	--	--	--
Singapore	57	296	15	304	--	--	30	\$143	(2)	\$21
Slovakia	--	--	5	119	--	--	--	--	--	--
Slovenia	8	20	--	--	--	--	--	--	--	--
South Africa	25	147	863	15,200	--	--	--	--	--	--
Spain	301	1,460	7	105	--	--	--	--	--	--
Suriname	--	--	5	67	--	--	--	--	--	--
Sweden	30	324	70	1,110	1	\$6	--	--	--	--
Switzerland	642	5,230	1,380	19,200	--	--	(2)	9	(2)	32
Taiwan	3,660	9,550	857	21,000	--	--	92	514	279	4,940
Thailand	203	763	109	1,480	--	--	(2)	11	2	302
Turkey	5	35	6	118	--	--	--	--	--	--
United Arab Emirates	1	7	1	26	--	--	--	--	(2)	55
United Kingdom	8,560	33,700	2,830	60,600	19,600	401,000	53	394	54	3,340
Uruguay	33	181	--	--	--	--	--	--	--	--
Vietnam	--	--	1	21	--	--	--	--	--	--
Total	27,000	122,000	20,700	447,000	24,900	482,000	1,070	7,190	615	28,900

¹Revised. -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Less than ½ unit.

Source: U.S. Census Bureau; data adjusted by the U.S. Geological Survey.

TABLE 5
PLATINUM-GROUP METALS: WORLD PRODUCTION, BY COUNTRY^{1,2}

(Kilograms)

Country ³	2001	2002	2003	2004 ^e	2005 ^e
Palladium:					
Australia ⁴	828	810	820 ^c	830	840
Botswana ^c	900	1,300	2,200	2,500	1,900
Canada	8,972 ^r	12,210 ^r	12,808 ^r	18,551 ^{r,5}	15,000
Japan ⁶	4,805	5,618	5,500 ^c	5,300 ^r	5,200
Poland ^{e,7,8}	12	12	12	12	12
Russia ^c	96,000 ^r	96,000 ^r	97,000 ^r	97,000 ^r	97,400
Serbia and Montenegro ^c	25	25	20	20	--
South Africa	62,601	63,758 ^r	70,946 ^r	78,455 ⁵	84,908 ⁵
United States ⁹	12,100	14,800	14,000	13,700 ⁵	13,300 ⁵
Zimbabwe	371	1,943	3,449 ^r	3,564 ⁵	3,879 ⁵
Total	187,000^r	196,000^r	207,000^r	220,000^r	222,000
Platinum:					
Australia ^{e,4}	174	200	225	230	240
Botswana ^c	200	300	500	500	300
Canada	7,733 ^r	9,202 ^r	6,990 ^{r,c}	7,813 ^{r,5}	6,400
Colombia	674	661	828 ^{r,c}	1,209 ^{r,5}	1,082 ^p
Finland	510	508	461 ^{r,c}	705 ^r	800
Japan ⁵	791	762	770 ^c	750 ^r	730
Poland ^{e,6,7}	20	20	20	20	20
Russia ^c	27,000 ^r	27,000 ^r	28,000 ^r	28,000 ^r	30,000
Serbia and Montenegro ^c	5	5	5	5	--
South Africa	130,307	132,897 ^r	148,348 ^r	159,862 ^{r,5}	168,749 ⁵
United States ⁹	3,610	4,390	4,170	4,040 ⁵	3,920 ⁵
Zimbabwe	519	2,306	4,270 ^r	4,438 ⁵	4,834 ⁵
Total	172,000^r	178,000^r	195,000^r	208,000^r	217,000
Other platinum-group metals:					
Canada ^c	720	700	799	800	800
Russia ^c	14,500	14,500	15,000 ^r	15,000 ^r	15,500
South Africa	37,005 ^r	39,986 ^r	46,856 ^r	48,265 ^{r,5}	58,218 ⁵
Zimbabwe	42	480	851 ^r	809 ⁵	862 ⁵
Total	52,300^r	55,700^r	63,500^r	64,900^r	75,400
Grand total	410,000^r	430,000^r	465,000^r	492,000^r	515,000

^cEstimated. ^pPreliminary. ^rRevised. -- Zero.

¹World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Table includes data available through April 29, 2006. Platinum-group metal (PGM) production by Germany, Norway, and the United Kingdom is not included in this table because the production is derived wholly from imported metallurgical products and to include it would result in double counting.

³In addition to the countries listed, China, Indonesia, and the Philippines are believed to produce PGM, and several other countries may also do so, but output is not reported quantitatively, and there is no reliable basis for the formulation of estimates of output levels. A part of this output not specifically reported by country is, however presumably included in this table credited to Japan.

⁴PGM recovered from nickel ore that is processed domestically. PGM in exported nickel ore are extracted in the importing countries, such as Japan, and are believed to be included in the production figures for those countries.

⁵Reported figure.

⁶Production derived entirely from imported ores.

⁷Based on official Polish estimates.

⁸Estimates based on reported platinum and palladium-bearing final (residual) slimes and then average Pt and Pd content from electrolytic copper refining.

⁹A very small quantity of byproduct platinum and palladium produced from gold-copper ores was excluded.