



# 2007 Minerals Yearbook

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## PLATINUM-GROUP METALS

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# PLATINUM-GROUP METALS

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In 2007, Stillwater Mining Co. (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. MMC Norilsk Nickel (Moscow, Russia) was the majority owner of SMC. SMC produced 16,700 kilograms (kg) of PGMs in 2007, nearly 11% less than the 18,700 kg that it produced in 2006 (Stillwater Mining Co., 2008, p. 1). Defense National Stockpile Center (2008) (DNSC) reported PGM sales results under Basic Ordering Agreement DLA-Iridium-003. In 2007, DNSC sales took place in January, February, March, August, and September and for the calendar year, sales were 94 kg of iridium and no platinum, which left 18 kg of iridium and 261 kg of platinum in the stockpile. Palladium stocks were exhausted in 2004 (table 1).

In 2007, the automobile industry continued to be the major consumer of PGMs. Autocatalysts accounted for approximately 85% of rhodium consumption, 53% of platinum consumption, and 57% of palladium consumption on a global basis (Jollie, 2008, p. 52-56).

## Production

**Primary.**—During 2007, the Stillwater Mine produced 8,520 kg of palladium and 2,640 kg of platinum, 13% and 10% less, respectively, in 2007 relative to production in 2006. PGM production from the East Boulder Mine was 5,540 kg (4,320 kg of palladium and 1,210 kg of platinum), which was a 7% decrease in palladium production and a 9% decrease in platinum production compared with that of 2006. Palladium and platinum production for SMC were down by 11% and 10%, respectively, compared with production in 2006. Production of rhodium in 2007 was 124 kg, unchanged from production in 2006 (Stillwater Mining Co., 2008, p. 44-45). The company milled 1.17 million metric tons (Mt) of ore from the mines, a 9% drop relative to that of 2006. The production shortfall at the Stillwater Mine was attributed to a shortage of skilled miners. SMC has implemented an aggressive program to recruit and train local Montana residents as miners and has experienced positive results thus far. In addition, there was a 7-day work stoppage during bargaining activities for the new 4-year labor agreement, which was subsequently ratified. At the East Boulder Mine, a transition from bulk mining to more selective methods resulted in a temporary decrease in production. SMC's proven and probable reserves are contained in the J-M Reef, an ore body that occurs within the layered igneous rocks of the Stillwater Complex. At yearend 2007, the company reported a total proven and probable reserve of 658,000 kg of palladium and platinum, with a palladium to platinum ratio that ranges from 3.49 to 1 at the Stillwater Mine to 3.6 to 1 at the East Boulder Mine (Stillwater Mining Co., 2008, p. 21).

In 2007, exploration continued at several sites in the United States. The most advanced project was PolyMet Mining Corp.'s (Vancouver, British Columbia, Canada) NorthMet Mine in the Duluth Complex in northeast Minnesota. Mine startup and initial production were expected in late 2008 or early 2009 (PolyMet Mining Corp., 2008). Franconia Minerals Corp. (Spokane, WA) continued exploring the Birch Lake project, also located in the Duluth Complex. The copper-nickel-PGM project includes three inferred underground resources—Birch Lake, Maturi, and Spruce Road. Preliminary economic assessment showed that a combined Birch Lake-Maturi operation would have an average annual production of 2,100 kg of palladium and 1,000 kg of platinum during a mine life of 26 years. The project was in the feasibility-study phase with a production target of 2011 (Franconia Minerals Corp., 2008, p. 2). Nevoro, Inc. (Toronto, Ontario, Canada), acquired 100% of the common shares of Aurora Metals (BVI) Ltd. (Vancouver, British Columbia, Canada), which in turn had 221 claims totaling 1,853 hectares in the Stillwater Complex. Exploration by Nevoro has focused on PGM-bearing chromitites, and drilling was planned to continue in 2008 (Nevoro, 2008). Beartooth Platinum Corp. (Toronto, Ontario, Canada) also continued exploration for PGM in the chromitites of the Stillwater Complex (Beartooth Platinum Corp., 2008). SMC invested in Pacific North West Capital Corp. (Vancouver, British Columbia, Canada) in order to take part in further options for PGM production in North America, with one such project at Goodnews Bay, AK (Stillwater Mining Co., 2008, p. 14). In Alaska, Pure Nickel, Inc. (Toronto, Ontario, Canada) continued exploration of the nickel-copper-cobalt-PGM MAN property located 265 kilometers (km) south-southeast of Fairbanks. Pure Nickel also developed an exploration program at the Salt Chuck Mine, an historic copper mining area containing palladium-bearing copper sulfide mineralization (Pure Nickel, Inc., 2008, p. 34-36, 59-63).

**Secondary.**—In 2007, recycling of autocatalysts provided a substantial secondary source of PGMs. The global recovery of platinum from autocatalysts rose by 3% in 2007, reaching 27,700 kg, with recovery increasing in Europe by nearly 16%, but remaining unchanged relative to 2006 quantities in the rest of the world. In North America, recovery of platinum from catalytic converters remained at an estimated 18,000 kg of platinum, which represented roughly 65% of global autocatalyst recycled material (Jollie, 2008, p. 26).

About 31,100 kg of palladium was recovered from autocatalysts globally in 2007, an increase of 24% compared with that of 2006. Palladium recovery in Europe increased by 33% to 9,330 kg, and that in North America increased by 21% to 18,800 kg relative to that in 2006. Nearly 61% of global recycled palladium came from North America (Jollie, 2008, p. 34-35). In 2007, global recovery of rhodium from

autocatalysts increased by 7% to 5,690 kg, owing to the large price jump and increased rhodium content of scrapped three-way, or gasoline, catalytic converters (Jollie, 2008, p. 42).

SMC's recycling program recovered 11,600 kg of PGMs in 2007, up nearly 8% as compared with that of 2006. The sale of the recycled material was \$326.4 million in 2007, which was up 21% from the 2006 sales value (Stillwater Mining Co., 2008, p. 16).

## Consumption

In 2007, global platinum sales totaled 246,000 kg, a 7% increase compared with sales in 2006. Platinum use in the autocatalyst sector grew owing to stricter emission standards and to the growth in production of light-duty diesel vehicles in Europe. Many of the vehicles now have a platinum-based oxidation catalyst as well as a platinum-coated particulate filter, thus increasing the average platinum loading per vehicle. However, the partial replacement of platinum by palladium in autocatalysts led to lower platinum consumption. Automakers have largely removed platinum from three-way, or gasoline catalysts and have increased substitution of less-expensive palladium for as much as 25% of the platinum in diesel engines.

Investment demand increased as a result of a new investment vehicle known as exchange-traded funds (ETFs) that were launched for platinum in May 2007. ETFs, which exist in other commodities such as gold and silver, are essentially paper investments that are backed by platinum bullion and allow investment without investors having to take physical delivery of the metal (Jollie, 2008, p. 5).

Palladium global sales increased to 244,000 kg, a 6% increase compared with 230,000 kg in 2006. The increase was driven partly by increased substitution of palladium for platinum in catalytic converters, for both gasoline and diesel engines. Purchases for investment increased substantially owing to the introduction of two palladium ETFs.

In 2007, U.S. apparent consumption of refined platinum was estimated to be about 156,000 kg, a 156% increase from the apparent consumption of 2006 of 72,700 kg (revised). The large increase was a result of increased imports of platinum waste and scrap from Germany, Jordan, and the Republic of Korea. Apparent domestic palladium consumption was estimated to be about 84,100 kg, a 5% increase from the 80,500 kg (revised) of 2006.

**Palladium.**—Palladium use in autocatalysts increased by 11% globally to 138,000 kg in 2007 compared with 2006 consumption. Demand in Europe rose by only 1% because of a decline in the market share of gasoline vehicles. In the rest of the world, gasoline vehicles are dominant and can use a palladium- or platinum-based autocatalyst. Demand in North America rose to 51,000 kg, a 17% increase relative to that of 2006, despite the economic slowdown and drop in vehicle purchases. The Chinese passenger car market is now the second ranked in the world, and palladium consumption there was 25% higher in 2007 than in 2006. Palladium demand for autocatalysts in the rest of the world increased by 12% to 24,000 kg (Jollie, 2008, p. 6-7, 32-35).

On a global basis, palladium consumption by the jewelry industry declined by 26% in 2007 compared with that of 2006. The drop was largely a result of decreased consumption in China, by far the leading user of palladium for jewelry, at nearly 68% of world consumption in that sector. Consumption in China dropped to 15,500 kg of palladium, 34% lower than that of 2006. In contrast, the much smaller markets in Europe and North America showed increases in palladium usage in jewelry. Consumption in Europe was 1,400 kg of palladium, a 13% increase relative to that of 2006, and consumption in North America was 1,560 kg, a 25% increase relative to that of 2006 (Jollie, 2008, p. 35-36).

World palladium consumption in dental alloys increased by 466 kg to 19,800 kg in 2007, with roughly 43% of the global consumption from Japan and about 42% from North America. The chemical industry consumed 11,500 kg of palladium in 2007, a 16% decrease from that in 2006. The global decrease was the result of a 43% drop in usage by the chemical industry in Europe relative to usage in 2006. In the chemical industry, palladium is mainly used as a catalyst in manufacturing bulk chemicals, including purified hydrogen peroxide, nitric acid, purified terephthalic acid, and vinyl acetate monomer, the latter of which is a component of many resins and plastics. The electronics industry increased its consumption of palladium for the sixth consecutive year. Consumption was up by 7% in 2007, to 40,000 kg, as compared with that of 2006. More than one-half of the palladium used in the electronics industry was for multilayer ceramic capacitors, which are widespread in circuitry used in all types of electronic goods. Large amounts of palladium were also used in hybrid integrated circuits. Use of palladium in other applications increased by 12% in 2007 compared with that of 2006. Such uses included petroleum refining catalysts and gas sensors (Jollie, 2008, p. 36-38).

Palladium use in investment products increased to 8,090 kg in 2007 from 1,560 kg in 2006. This dramatic increase was the result of the launch of two palladium ETFs, one in London and the other in Switzerland (Jollie, 2008, p. 7).

**Platinum.**—Global use of platinum in the autocatalyst sector increased by 8% to 131,000 kg in 2007 compared with that in 2006. Consumption in Europe was about 64,700 kg of platinum in 2007, nearly unchanged from that of 2006, and accounted for nearly one-half of the global total each year. The proportion of light-duty diesel vehicles in Europe rose to 53% of all light-duty vehicles. Consumption in this sector for North America increased by 32% in 2007 relative to that of 2006. Light-duty vehicle production fell in North America in 2007, but the platinum consumption in the autocatalyst sector increased because of stricter emission standards for medium- and heavy-duty trucks. In Japan, platinum demand in the autocatalyst sector increased by about 2%. In China, where almost all cars are gasoline-powered, use of platinum for autocatalysts in 2007 rose to 6,690 kg, a 39% increase relative to consumption in 2006. This increase was as a result of tighter emission standards as well as increased vehicle production. Consumption of platinum for autocatalysts also increased in other areas of the world including India, Russia, and South America (Jollie, 2008, p. 24-26).

In 2007, global consumption of platinum in jewelry dropped for the fifth consecutive year to the lowest level in 16 years, as a result of high and volatile prices. Consumption in this sector was 49,300 kg of platinum, a 3% drop compared with that of 2006. Consumption in North America decreased slightly, and consumption in Japan dropped by 22% in 2007 relative to consumption in 2006. Consumption in China increased by 3%. China remained by far the leading consumer in this sector; at 24,300 kg, it accounted for nearly one-half of global consumption. In Europe, platinum consumption in the jewelry industry was 6,530 kg, an increase of 8% compared with that in 2006 (Jollie, 2008, p. 27-29).

Global use of platinum in the chemical sector decreased slightly in 2007, to 12,100 kg compared with that of 2006 as a result of thriftiness. The purchases of platinum by the petroleum refining industry increased by 14% to 6,400 kg in 2007, because of increased refining capacity in most regions of the world. The global consumption of platinum in electronics increased by 18%, to 13,200 kg in 2007, as compared with that of 2006, owing to increases in computer hard drive manufacturing. The amount of platinum used per disk had risen to increase memory capacity. Platinum consumed in the production of liquid crystal display (LCD) glass and other glasses increased in 2007 by 6%, to 13,400 kg compared with that of 2006, primarily as a result of increased capacity in the Asian LCD industry. Consumption in other end uses remained unchanged at 15,200 kg. Demand in the dental sector fell, and there was evidence of recycling and thriftiness in the spark plug sector, as a result of increasing price. A large growth in platinum investment took place in 2007 as a result of the introduction of two ETFs. By yearend 2007, the two funds contained 6,070 kg of platinum (Jollie, 2008, p. 30-31). In 2007, the U.S. Mint sales of platinum American Eagle Bullion coins decreased by 33% to 281 kg from 421 kg in 2006 owing to the large increase in price of the coins (U.S. Mint, 2008).

**Other PGMs.**—Global rhodium consumption in 2007 rose by 2% to 26,600 kg compared with that of 2006. A majority of rhodium use, 81% in 2007, was in the production of autocatalysts. In 2007, increased consumption in autocatalysts in China, much of Asia, and North America outweighed the effect of thriftiness in three-way catalytic converters. Demand for rhodium in the autocatalyst sector decreased in Europe in 2007 relative to that in 2006 owing to the continued growth in the market share of light-duty diesel vehicles. Rhodium consumption in this sector also decreased in Japan owing to the use of metal from inventory. Use of rhodium in the glass manufacturing sector decreased slightly in 2007 as compared with use in 2006. Although increased furnace capacity by the LCD glass manufacturing industry outweighed the decrease in cathode-ray tube glass manufacturing plants, the high rhodium price led to the use of alloys with lower rhodium contents. Consumption of rhodium in the chemical sector rose by 31% to 1,990 kg in 2007 owing to construction of new facilities, including oxoalcohol plants in Asia. Demand from the electrical sector as well as other applications was unchanged from that of 2006, at 995 kg (Jollie, 2008, p. 42-43).

Global consumption of ruthenium dropped by 32% to 35,600 kg in 2007 relative to that in 2006. Ruthenium consumption

decreased in the hard disk industry as a result of thriftiness and increased recycling. Ruthenium use in chip resistors remained flat in 2007; its use in paste for flat-panel displays fell as a result of thriftiness, and its use in the chemical sector fell to 3,140 kg in 2007, a 55% decrease compared with that in 2006. Global consumption of iridium decreased to 3,700 kg in 2007, a 9% drop compared with 2006 consumption, reflecting a 27% decrease of iridium use in catalysts in the chemical sector. In contrast, there was an increase in use of iridium in spark plugs in the aerospace and automotive industries (Jollie, 2008, p. 43).

## Prices

According to Platts Metals Week, the 2007 annual average prices of palladium and platinum increased by 11% and 14%, respectively, compared with the 2006 annual average prices. As for the other PGMs, the 2007 iridium annual price increased by 27%, the 2007 rhodium annual price increased by 36%, and the ruthenium 2007 annual price increased by 197% compared with the 2006 prices (table 1).

**Iridium.**—In January, the price of iridium was \$400 per troy ounce; it rose to \$450 per troy ounce in February as a result of speculative buying, where it remained for the rest of the year.

**Palladium.**—Palladium price began the year at \$337 per troy ounce and rose to \$385 per troy ounce by late April following news of the launch of two new ETFs. The price stayed relatively level through July and then dropped steeply to \$322 per troy ounce by late August in response to Nissan's announcement that it could reduce PGM loadings in autocatalysts, and to global economic events. The palladium price rose to \$382 per troy ounce in October, driven by rises in oil and gold prices. The price again slid throughout November to \$346 per troy ounce owing to lack of investment interest; the price then rose throughout December and finished the year at \$370 per troy ounce.

**Platinum.**—In 2007, the platinum price reached its alltime highest annual average of \$1,308 per troy ounce. Platinum price began the year at \$1,138 per troy ounce, and then dropped slightly to \$1,122 in early January. The price then began to rise owing to news of delays in Russian shipments as a result of new export regulations. Global economic problems, fueled partly by the subprime mortgage crisis, resulted in a gradual price rise during the next several months. In September, concerns over platinum supply disruptions from South Africa resulted in a steepening of the price rise; a series of record high prices were reached during the next 3 months. By yearend, the platinum price was \$1,547 per troy ounce, a 35% rise from that at the year's start.

**Rhodium.**—The rhodium price began the year at \$5,550 per troy ounce, but immediately began an upward climb because of supply suspension from Russia as a result of export license issues. The price climbed to \$6,525 in mid-April as a result of heavy purchasing and supply concerns. The price was volatile until late July, when it dipped to \$5,970 per troy ounce. The price then rose gradually, reached \$6,350 in early November, then shot up to \$6,800 in late November. The price continued increasing and ended the year at \$6,850 per troy ounce.

**Ruthenium.**—Ruthenium prices were erratic in 2007 reflecting variations in industrial purchasing. Prices started the year at \$610 per troy ounce, rose to \$870 by mid-February, and then dropped precipitously to \$375 per troy ounce in mid-July. Prices rose to a new peak of \$580 per troy ounce in late October, then dropped to finish the year at \$415 per troy ounce.

## Foreign Trade

In 2007, the U.S. net import reliance as a percentage of apparent consumption was estimated to be 85% for refined palladium and 98% for refined platinum. Imports of refined palladium in 2007 decreased by 5% to 113,000 kg from 119,000 kg in 2006, with three countries accounting for about 83% of refined palladium imports in 2007—Russia (43%), South Africa (21%), and the United Kingdom (19%). Imports of platinum, including waste, scrap, and coins, increased by 59% in 2007 to 181,000 kg, from 114,000 kg in 2006, with four countries accounting for 75% of imports of platinum in 2006—Germany (26%), South Africa (25%), the Republic of Korea (15%), and the United Kingdom (9%). Other refined PGM imports were up by 26% in 2007 compared with those of 2006. Three countries accounted for 89% of the imports of other PGM in 2007—South Africa (49%), Germany (25%), and the United Kingdom (15%) (tables 2 and 3).

Exports of PGMs in 2007 increased from those in 2006, with the exception of palladium, which fell by 21% (table 4).

## World Review

In 2007, world mine production of PGMs decreased slightly to 509,000 kg compared with 513,000 kg in 2006 (table 5). South Africa, the world's leading producer of PGMs, accounted for 61% of total mine production in 2007, Russia accounted for 27%, and Canada and the United States each accounted for 4%. In 2007, platinum production from South Africa totaled 166,000 kg, which represented 79% of world platinum production and a slight drop relative to South African production in 2006. Global output of palladium dropped to 219,000 kg, with Russia and South Africa accounting for 44% and 38%, respectively, of the total. World production of other PGMs (iridium, osmium, ruthenium, and rhodium) in 2007 increased 3% as compared with that of 2006. South Africa was the dominant producer, accounting for 75% of the global total production.

**Australia.**—An updated bankable feasibility study was being conducted by Platinum Australia Ltd. (West Perth) at the Pantom PGM Project in Western Australia. Platinum Australia had completed a feasibility study on the project in 2003 but concluded it was not economical at that time. Increased metal prices since then have led to a reevaluation, including metallurgical test work, and completion of the study is expected in the first half of 2008 (Platinum Australia Ltd., 2008, p. 4-13).

**Botswana.**—In 2007, MMC Norilsk Nickel acquired LionOre Mining International Ltd. (Toronto, Ontario, Canada) and LionOre's Tati Nickel Mine, which produced 1,680 kg of palladium and 280 kg platinum in 2007 (MMC Norilsk Nickel, 2008, p. 139).

**Canada.**—North American Palladium Ltd. (NAP) (Toronto) produced about 8,900 kg of palladium and 760 kg of platinum in 2007 at the Lac des Iles Mine, an increase of 20% relative to that of 2006 following the first full year of underground mining. NAP assessed the economic viability of extending the open pit mine, which could increase the mine life by 2 to 3 years. NAP completed a mineral resource assessment of its Shebandowan West Project, located roughly 100 km southwest of its Lac des Iles operations; production might begin in late 2009. Assessment continued on the offset high-grade zone at the Lac des Iles Mine and was expected to be completed in the second quarter of 2008 (North American Palladium Ltd., 2008, p. 5-20).

In the Sudbury region, Marathon PGM Corporation (Toronto) continued its assessment of the Marathon PGM-copper property and announced updated estimates of indicated and inferred resources of 70,000 kg of palladium and 21,000 kg of platinum. Production estimates were 6,220 kilograms per year (kg/yr) of PGM and gold. Marathon, in a joint venture with Gossan Resources Ltd. (Winnipeg), conducted drilling at the Bird River Project, Manitoba, and results indicate open pit potential for PGM and base metals (Marathon PGM Corp., 2008, p. 1-6). Canadian Royalties Inc. (Montreal) completed a feasibility study for the nickel-copper-PGM Nunivak Nickel Project (formerly known as the Raglan South Nickel Project) in the Raglan area of Quebec (Canadian Royalties Inc., 2008, p. 2-12) and planned to assess the viability of establishing an open pit mine and ore treatment facility. Xstrata plc (Zug, Switzerland) continued to produce PGM as byproducts from nickel mining operations at Sudbury, although production figures were not released. The company was developing new mines at Fraser Morgan and Nickel Rim South, with the latter expected to start operations in 2009 and likely to produce significant PGM (Jollie, 2008, p. 23).

Vale Inco (Toronto) produced 5,941 kg of palladium and 4,354 kg of platinum as byproducts of its nickel operations at Sudbury. Vale has a new nickel project at the Totten Mine in the Sudbury area, which is expected to produce 2,550 kg/yr of platinum, gold, and silver starting in the first half of 2011 (Vale Inco, 2008, p. 33, 40).

**Finland.**—NAP and Gold Fields Ltd. (Johannesburg, South Africa) continued with development of the Arctic Platinum project located in northern Finland, about 60 km south of Rovaniemi. The project consists of several advanced-stage PGM deposits. NAP completed a scoping study and commissioned a feasibility study (North American Palladium Ltd., 2008, p. 19-20).

**India.**—The exploration 70-30 joint venture between Platinum Mining Corp. of India plc (PMCI) (London, United Kingdom) and Ferro Alloys Corp. (FACOR) (Orissa, India) hit a major setback. The goal of the joint venture was to develop the FACOR-operated Boula Chromite Mine, situated in the Eastern Indian State of Orissa, into a PGM mine. In August, the Indian Government ordered suspension of mining activities at the Boula Mine because they asserted the mine was in a designated wildlife zone. Chromite mining was allowed to resume following dispute by FACOR, but PMCI has decided to defer its PGM exploration program at Boula pending resolution of the dispute. PMCI was looking into other options for platinum mining and acquired 20% of the share capital of Majormatic 167

(Proprietary) Ltd., which was granted prospecting rights over the Naboom platinum deposit in South Africa. PMCI planned to start a drilling program at the Naboom platinum deposit in January 2008, with drilling expected to be completed in March 2008 (Platinum Mining Corp. of India plc, 2008).

**Russia.**—In 2007, Russia accounted for 44% of global mine production of palladium, 27% of other PGM, and 13% of platinum production. MMC Norilsk Nickel produced 94,800 kg of palladium and 22,600 kg of platinum, which were decreases of 4% and 3%, respectively, compared with production in 2006. Reported reserves for the deposits on the Taimyr Peninsula and the Kola Peninsula as of December were 2,500 t of PGM (1,970 t of palladium, 516 t of platinum, and 15 t of other PGM) (MMC Norilsk Nickel, 2008, p. 8, 60). Russia's alluvial platinum production was 5,750 kg of platinum, slightly higher than the 5,600 kg of platinum produced in 2006 (Jollie, 2008, p. 22).

**South Africa.**—South Africa accounted for 78% of platinum, 75% of other PGMs, and 40% of palladium produced worldwide in 2007. In 2007, South African production of platinum dropped relative to that of 2006 as a result of various problems, including safety-related mine closures, labor unrest, problems retaining skilled workers, and geological issues. The world's leading PGM producer, Anglo Platinum Ltd. (Johannesburg) produced 78,000 kg of platinum and 43,700 kg of palladium in 2007, a drop of 12% for platinum and 10% for palladium relative to production in 2006. Rhodium production was 10,300 kg in 2007, approximately the same as that of 2006. Production from Anglo Platinum's wholly owned mines was as follows: the Rustenburg Section produced 20,700 kg of platinum, a 20% drop from 2006 production; the Amandelbult Section produced 17,900 kg of platinum, 3% less than that in 2006; Mogalakwena (formerly PPRust) produced 5,090 kg; 15% less than that in 2006; Lebowa Platinum Mines produced 2,900 kg of platinum, 11% less than that in 2006; and Twickenham Phase I production was 289 kg of platinum, a 45% increase from 2006 production. Anglo Platinum joint-ventures production was as follows: the Union Section, 85% owned with the Bakgatla-Ba-Kgafela Traditional Community, produced 9,600 kg of platinum, a 2% drop from that in 2006; Bafokeng-Rasimone Platinum Mine, a 50-50 joint venture with Royal Bafokeng Resources (Pty.) Ltd., produced 6,000 kg of platinum, an 11% drop from that in 2006; and Modikwa Platinum Mine, a 50-50 joint venture with African Rainbow Minerals Ltd. (ARM) (Sandton), produced 3,660 kg of platinum, a decrease of 13% relative to that in 2006. Anglo Platinum had two pool and share agreements (P&SAs) with Aquarius Platinum South Africa. At the Kroondal Platinum Mine, production dropped by 5% to 4,050 kg of platinum. The second P&SA is the Marikana Platinum Mine, which continued its ramp up in 2007 and produced 722 kg of platinum, an increase of 81% from 2006 levels. The Marikana ramp up was expected to continue until it reaches steady-state production of 2,300 kg/yr of platinum during 2010. The Mototolo Platinum Mine, a 50-50 joint venture with XK Platinum Partnership, which consists of Xstrata and Kasigo Platinum Venture (Pty.) Ltd., had its first full year of production in 2007, with a reported 2,960 kg of platinum produced. The Western Limb Tailings Retreatment plant produced 1,410 kg of platinum, a 41% increase from 2006 production (Anglo Platinum Ltd., 2008, p. 38-79).

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Impala Platinum's refined production of platinum was 32,800 kg, a 6% drop compared with that of 2006. Production from its majority-owned Marula operation was 2,022 kg of platinum and 2,084 kg of palladium, increases of 63% and 68%, respectively, from 2006 production. Marula was still in the ramp-up stage, and full production of 4,040 kg/yr was expected in 2010. Implats acquired 100% of African Platinum plc (Afplats) (London, United Kingdom), which represented a 74% stake in the Leeuwkop project. Mine development was underway, and full production of 5,000 kg/yr of platinum was expected by 2013. Two Rivers Platinum, a joint venture with ARM (55%) and Implats (45%), produced 2,370 kg of platinum in 2007. The mine is still ramping-up production, and production capacity of 6,840 kg/yr of PGMs was expected to be reached in 2008 (Impala Platinum Holdings Ltd., 2008, p. 44-45).

In 2007, Northam Platinum Ltd. (Johannesburg) reported sales of 6,610 kg of platinum and 3,010 kg of palladium, decreases of about 4% and 12%, respectively, compared with sales in 2006. Rhodium sales increased to 877 kg in 2007 from 749 kg in 2006 (Northam Platinum Ltd., 2008, p. 10).

Lonmin plc (London, United Kingdom) reported production of 21,600 kg of platinum and 9,910 kg of palladium, a drop of 13% and 14%, respectively, relative to 2006 production. Rhodium production fell to 2,750 kg, a 23% decrease relative to that of 2006. Mining continued at the Pandora Joint Venture, of which Lonmin has a 42.5% interest, along with Anglo Platinum (42.5%), Mvelaphanda Resources Ltd. (Sandton) (7.5%), and Bapo Ba Mogale tribe (7.5%). Lonmin completed its acquisition of the Akanani project and continued with drilling to define the mineral resource estimate (Lonmin plc, 2008).

Aquarius announced that production from its wholly owned Everest Mine was 2,940 kg of platinum, 1,630 kg of palladium, and 483 kg of rhodium during 2007, its first full year of production. Aquarius has two P&SAs with Anglo Platinum, at the Kroondal and Marikana Mines. Production from the Kroondal Mine was nearly unchanged from that in 2006 at 8,210 kg of platinum, 3,950 kg of palladium, and 1,430 kg of rhodium. Production during 2007 from the Marikana Mine was 2,520 kg of platinum, 1,170 kg of palladium, and 397 kg of rhodium, increases of more than 50% for each metal relative to that of 2006. Production from the Chromite Tailings Retreatment Plant, a joint-venture project between Aquarius (50%), GB Mining and Exploration Ltd. (Johannesburg) (25%), and Sylvania South Africa Ltd. (West Perth, Australia) (25%), was 140 kg of platinum, 51 kg of palladium, and 39 kg of rhodium, increases of 195%, 17%, and 29%, respectively, relative to 2006 production (Aquarius Platinum Ltd., 2008, p. 18-27).

ARM platinum division had several joint ventures in South Africa—Modikwa Platinum Mine, 50% jointly owned with Anglo Platinum; Nkomati Nickel Mine, 50% with MMC Norilsk Nickel, following MMC Norilsk Nickel's acquisition of LionOre in June 2007; and Two Rivers Platinum Mine, a project in which ARM held 55% and Implats 45%. Production from Modikwa was 8,530 kg of PGM, and from Nkomati, production was 1,430 kg of PGM, both reported on a 100% basis. Each was 7% lower than 2006 production. Two Rivers produced 5,730 kg of PGM during 2007, its first full year of operation. In 2007, the

Nkomati phase 2 large-scale expansion project was undertaken and was expected to extend the life of the mine by 18 years to 2027. Two new open pits were planned, with construction to begin in early 2008 (African Rainbow Minerals Ltd., 2008, p. 18-27).

Eastern Platinum Ltd. (Vancouver, British Columbia, Canada) acquired an additional 5%, for a total of 74%, of Barplats Investments Ltd.'s (Gauteng, South Africa) Crocodile River Mine. Eastern Platinum changed its fiscal yearend from June 30 to December 31 effective July 2007. Production was 1,740 kg of platinum for the 6 months ending December 31, 2007, a 15% increase from that in 2006 (Eastern Platinum Ltd., 2008).

Xstrata purchased Eland Platinum Holdings Ltd. (Bryanston, South Africa) resulting in acquisition of the Elandsfontein Platinum Mine. Production from Elandsfontein along with the first full year production from the Mototolo joint venture (with Anglo Platinum) was 2,590 kg of PGM, a large increase from the 301 kg of PGM produced by Xstrata in 2006. Expansion at Elandsfontein Mine was planned for 2008 with potential production of 18,700 kilograms per month (kg/mo) of PGMs, during a mine life of 50 years (Xstrata plc, 2008, p. 57-58).

A feasibility study was completed on Sheba's Ridge Mine, a joint venture between Ridge Mining plc (London, United Kingdom) and Anglo Platinum, at the end of 2007. Results were expected to be announced in 2008. Development of the Blue Ridge project began in January 2007, and annual production was expected to be 2,330 kg of platinum, 1,090 kg of palladium, 404 kg of rhodium, 684 kg of ruthenium, and 78 kg of iridium, with a mine life of more than 18 years (Ridge Mining plc, 2008, p. 3-8).

Platinum Australia Ltd. had two projects in South Africa. The Smokey Hills project, located in the Bushveld Complex, was in the development phase, and was close to completing formal permitting. The Smokey Hills Project has a resource of 31,000 kg of platinum, palladium, rhodium, and gold and is planned to produce 3,000 kg/yr of those metals. A bankable feasibility study was underway at the Kalahari Platinum Project, for which Platinum Australia entered into a joint-venture agreement with ARM. The Kalahari Platinum Project is planned as an open pit mine initially, with production forecast of 6,000 to 9,000 kg/yr of platinum, palladium, and rhodium.

**Zimbabwe.**—In 2007, production from Impala's Mimosa Mine was 2,430 kg of platinum, 1,850 kg of palladium, and 190 kg of rhodium, increases of 7%, 2%, and 9%, respectively, relative to production in 2006. Mimosa's Wedza Phase V expansion was successful in increasing underground production. The expansion also included increased concentrator capacity to 175,000 metric tons per month (t/mo) from 150,000 t/mo and was expected to raise production of PGM in concentrate to 6,065 kg/yr. In 2007, production from Impala's Zimplats Mine was 3,000 kg of platinum, 2,440 kg of palladium, and 264 kg of rhodium, which were increases of 8%, 9%, and 9%, respectively, compared with 2006 production. At the Zimplats-managed Ngezi Mine, the conversion from open cast to underground mining continued. Portal 2 was in operation; full production from portal 1 was expected in October 2008; and production from portal 4 was planned for 2010 (Impala Platinum Holdings, Ltd., 2008, p. 47-53).

Anglo Platinum's Unki project, located near Gweru, was planned as a 120,000-t/mo operation, with potential for increasing the mine and concentrator capacity. Although development was ahead of schedule, the project was still subject to certain Zimbabwean and South African regulatory and fiscal approvals, and negotiations were ongoing with the Zimbabwean Government (Anglo Platinum Limited, 2008, p. 95).

## Outlook

The unexpected decrease in PGM supply in 2007 from South Africa, the world's leading producer, had major repercussions for the PGM industry because it has resulted in a supply deficit. With aboveground PGM stocks limited, supply shortages may continue for the near future although the global economic slowdown could result in lowered demand for industrial metals such as the PGM.

The primary end use for palladium, platinum, and rhodium is the automotive industry; therefore, the outlook for that industry will have the greatest impact on the consumption and prices of these PGM. A slowdown in automobile demand in Europe and the United States has been offset by rising demand in other areas of the world such as China, India, and Russia. Therefore, an overall increase in demand for PGM in that sector is expected. The increase in diesel car market share in Europe can be expected to cause an increase in the use of platinum in the region in 2008 and beyond. Stricter emissions regulations in China, Europe, Japan, and other parts of the world is also expected to lead to higher average PGM loadings on catalysts, especially on light-duty diesel vehicles, as particulate matter emissions become more closely controlled. In the heavy-duty diesel sector, there has been increased use of platinum-based aftertreatment to meet legislation requirements, and this is expected to increase platinum demand in that sector. Average palladium 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. 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 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.

On the supply side, platinum production is expected to decrease or remain level from South Africa through 2008, although it could increase after that. Supply from Zimbabwe is unpredictable because of the volatile political situation in that country. The consumption of minor PGM is expected to increase, especially ruthenium and rhodium, which could lead to a supply deficit. Production from South Africa will be dependent on several issues including timelines for new projects and ramp ups, stability of power supplies, availability and retention of skilled workers, quick resolution of labor disputes, and increased safety records.

The launch of two ETFs in 2007 has also impacted the PGM industry by removing metal from the market. Investment in these funds started slowly, but accelerated as the year went on and as PGM prices increased. Based on this, investment in these funds is likely to continue, and may increase the deficit in platinum and palladium supplies.

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TABLE 1  
SALIENT PLATINUM-GROUP METALS STATISTICS<sup>1</sup>

		2003	2004	2005	2006	2007
United States:						
Mine production:						
Palladium, Pd content: <sup>2</sup>						
Quantity	kilograms	14,000	13,700	13,300	14,400	12,800
Value	thousands	\$91,400	\$102,000	\$87,100	\$150,000	\$148,000
Platinum, Pt content: <sup>2</sup>						
Quantity	kilograms	4,170	4,040	3,920	4,290	3,860
Value	thousands	\$93,100	\$110,000	\$113,000	\$158,000	\$162,000
Refinery production:						
Palladium, Pd content:						
Quantity	kilograms	7,250	5,480	5,220	5,660	7,410
Value	thousands	\$47,300	\$41,000	\$34,100	\$58,700	\$85,100
Platinum, Pt content:						
Quantity	kilograms	17,000	16,700	6,360	6,870	8,930
Value	thousands	\$379,000	\$456,000	\$184,000	\$253,000	\$375,000
Imports for consumption, refined:						
Iridium, Ir content	kilograms	2,200	3,230	3,010	2,800	3,410
Osmium, Os content	do.	53	75	39	56	23
Palladium, Pd content	do.	105,000	127,000	139,000	119,000	113,000
Platinum, includes waste, scrap, and coins, Pt content	do.	88,500	86,400	106,000	114,000	181,000
Rhodium, Rh content	do.	12,000	13,200	13,600	15,900	16,600
Ruthenium, Ru content	do.	15,900	18,800	23,200	36,000	48,700
Exports, refined:						
Iridium, osmium, and ruthenium, gross weight	do.	145	1,090	1,080	3,390	8,190
Palladium, Pd content	do.	22,300	31,500	27,000	53,100	41,800
Platinum, Pt content	do.	22,200	20,000	20,700	45,500	28,900
Rhodium, Rh content	do.	479	314	615	1,600	2,210
Stocks, National Defense Stockpile, December 31:						
Iridium, Ir content	do.	562	501	189	111	18
Palladium, Pd content	do.	1,170	568	--	--	--
Platinum, Pt content	do.	649	649	261	261	261
Price, average:						
Iridium <sup>3</sup>	dollars per troy ounce	93.02	185.33	169.51	349.45	444.43
Palladium <sup>4</sup>	do.	203.00	232.93	203.54	322.93	357.34
Platinum <sup>4</sup>	do.	694.44	848.76	899.51	1,144.42	1,308.44
Rhodium <sup>4</sup>	do.	530.28	983.24	2,059.73	4,561.06	6,203.09
Ruthenium <sup>3</sup>	do.	35.43	64.22	74.41	193.09	573.74
Employment		1,540	1,580	1,620	1,720	1,630
World, mine production, PGM content	kilograms	466,000	481,000	504,000 <sup>f</sup>	513,000 <sup>f</sup>	509,000 <sup>c</sup>

<sup>c</sup>Estimated. <sup>f</sup>Revised. do. Ditto. -- Zero.

<sup>1</sup>Data are rounded to three significant digits, except prices.

<sup>2</sup>Source: Stillwater Mining Co., 2007 annual report, p. 44.

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

<sup>4</sup>Price data are annual Engelhard unfabricated quotations published in Platts Metals Week.

TABLE 2  
U.S. IMPORTS FOR CONSUMPTION OF PLATINUM, BY COUNTRY<sup>1</sup>

Country	Grain and nuggets		Sponge		Other unwrought		Other		Waste and scrap		Coins	
	Pt content (kilograms)	Value (thousands)	Pt content (kilograms)	Value (thousands)	Pt content (kilograms)	Value (thousands)	Pt content (kilograms)	Value (thousands)	Pt content (kilograms)	Value (thousands)	Pt content (kilograms)	Value (thousands)
2006	234	\$7,320	58,100	\$2,070,000	4,670 <sup>1</sup>	\$164,000 <sup>1</sup>	8,540	\$233,000	39,400	\$233,000	65	\$881
2007:												
Argentina	--	--	--	2,820	81		--	--	17	283	--	--
Australia	--	--	--	12	(2)	2,950	125,000		241	9,950	1	16
Austria	--	--	--	--	--	(2)	4		--	--	--	--
Bahamas, The	--	--	--	--	--	--	--		1	33	--	--
Belgium	--	--	1,670	67,200	--	--	251		51	19	--	--
Bolivia	--	--	--	--	--	--	--		26	25	--	--
Brazil	13	957	225	9,780	--	--	55		1,310	22,500	--	--
Canada	16	587	4	174	1	32	20,400		1,610	17,400	44	625
Chile	--	--	--	--	--	--	--		555	20,000	--	--
China	--	--	--	--	--	--	--		2,370	2,350	--	--
Colombia	--	--	--	20,300	563		--		127	4,140	--	--
Czech Republic	3	84	--	--	--	--	--		5	339	--	--
Dominican Republic	--	--	--	--	--	--	--		1	46	--	--
Egypt	--	--	--	--	--	--	--		(2)	16	--	--
France	--	--	--	1,160	24	83			200	5,900	--	--
Germany	80	2,330	1,800	71,700	207	6,900	103,000		39,900	185,000	(2)	17
Greece	--	--	--	--	--	--	--		40	1,510	--	--
Guatemala	--	--	--	--	--	--	(2)	12	--	--	--	--
Hong Kong	--	--	--	--	--	--	--		2,440	7,740	--	--
India	--	--	25	1,050	--	--	--		--	--	--	--
Ireland	--	--	--	--	--	--	3	28	--	--	--	--
Israel	--	--	--	--	--	--	--		2	110	--	--
Italy	19	780	1,010	42,500	24	1,060	28,400		(2)	3	--	--
Japan	2	50	693	28,800	187	4,310	1,290		1,430	73,200	--	--
Jordan	--	--	--	--	--	--	--		10,900	3,840	--	--
Korea, Republic of	--	--	--	29,200	699		283		26,400	9,110	--	--
Malaysia	--	--	--	--	--	--	--		72	3,080	--	--
Mexico	--	--	21	1,040	31	1,080	431		102	4,130	--	--
Morocco	--	--	--	--	--	--	--		4	10	--	--
Netherlands	--	--	--	4	(2)	2	33		--	--	--	--
Netherlands Antilles	--	--	--	--	--	--	--		(2)	12	--	--
Norway	--	--	800	32,200	--	--	--		--	--	--	--
Philippines	--	--	--	--	--	--	--		50	1,270	--	--
Poland	--	--	--	--	--	--	90		--	--	--	--
Qatar	--	--	--	--	--	--	--		74	27	--	--
Russia	--	--	782	30,700	--	--	--		--	--	--	--

See footnotes at end of table.

TABLE 2—Continued  
U.S. IMPORTS FOR CONSUMPTION OF PLATINUM, BY COUNTRY<sup>1</sup>

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)
2007—Continued:												
Saudi Arabia	--	--	--	--	--	--	--	--	1,070	\$42,000	--	--
Singapore	--	--	--	--	--	--	--	--	109	7,000	--	--
South Africa	488	\$15,300	42,900	\$1,680,000	759	\$30,500	541	\$20,800	--	--	--	--
Switzerland	--	--	278	10,900	735	24,900	328	12,500	--	--	--	--
Taiwan	--	--	--	--	75	614	--	--	1,440	10,500	--	--
Thailand	--	--	--	--	(2)	9	--	--	13	145	--	--
United Arab Emirates	--	--	--	--	--	--	--	--	4	51	--	--
United Kingdom	1	20	15,700	651,000	549	21,800	499	17,400	487	13,100	13	\$306
Venezuela	--	--	--	--	--	--	--	--	9,730	806	--	--
Total	622	20,100	65,900	2,620,000	3,940	145,000	10,200	330,000	101,000	446,000	58	964

<sup>1</sup>Revised. -- Zero.

<sup>2</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>3</sup>Less than ½ 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 COUNTRY<sup>1</sup>

Country	Unwrought palladium		Palladium, other		Iridium <sup>2</sup>		Osmium <sup>2</sup>		Ruthenium <sup>2</sup>		Rhodium <sup>2</sup>	
	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)
2006	100,000	\$967,000	19,000	\$141,000	2,800	\$30,100	56	\$487	36,000	\$187,000	15,900	\$1,920,000
2007:												
Belgium	4,020	43,700	232	2,740	--	--	--	--	155	2,580	2,130	305,000
Canada	1,200	20,600	347	4,440	25	317	--	--	156	219	(3)	12
China	330	2,690	9	351	(3)	10	8	50	47	870	--	--
Denmark	--	--	2	9	--	--	--	--	--	--	--	--
France	--	--	1	5	--	--	--	--	--	--	--	--
Germany	2,030	21,500	301	3,570	629	2,980	10	70	15,400	212,000	1,020	147,000
Hong Kong	56	675	--	--	11	146	--	--	49	992	--	--
Ireland	--	--	--	--	1	10	--	--	--	--	--	--
Italy	1,510	17,400	7	96	63	319	--	--	188	2,600	179	31,100
Japan	1,650	11,400	417	4,250	(3)	4	--	--	209	2,040	--	--
Korea, Republic of	--	--	--	--	--	--	--	--	--	--	149	2,910
Mexico	9	93	19	146	--	--	--	--	--	--	13	254
Netherlands	--	--	--	--	--	--	--	--	--	--	(3)	2
Norway	5,370	57,600	93	1,140	--	--	--	--	--	--	81	16,100
Russia	39,900	452,000	8,950	97,000	--	--	--	--	1,640	22,500	1,220	228,000
Singapore	--	--	--	--	--	--	--	--	804	11,100	6	1,240
South Africa	23,500	252,000	309	3,560	1,330	17,700	5	69	23,100	317,000	9,280	1,460,000
Spain	94	127	--	--	--	--	--	--	--	--	--	--
Switzerland	281	3,080	650	8,220	--	--	--	--	--	--	63	12,600
Syria	--	--	(3)	7	--	--	--	--	--	--	--	--
Taiwan	295	957	--	--	--	--	--	--	209	3,910	--	--
Thailand	--	--	1	10	--	--	--	--	--	--	--	--
United Kingdom	21,200	237,000	248	3,220	1,350	20,500	(3)	3	6,730	78,800	2,470	447,000
Total	101,000	1,120,000	11,600	129,000	3,410	41,900	23	192	48,700	655,000	16,600	2,650,000

-- Zero.

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

<sup>2</sup>Unwrought and other forms.

<sup>3</sup>Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 4  
U.S. EXPORTS OF PLATINUM-GROUP METALS, BY COUNTRY<sup>1</sup>

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)
2006	53,100	\$402,000	45,500	\$1,170,000	29,400	\$594,000	3,390	\$35,800	1,600	\$108,000
2007:										
Argentina	2	24	112	4,770	--	--	--	--	--	--
Australia	528	5,380	284	11,100	5	51	1	23	2	40
Austria	--	--	135	2,910	--	--	--	--	--	--
Bahrain	1	3	--	--	--	--	--	--	--	--
Belarus	97	353	--	--	--	--	--	--	--	--
Belgium	458	4,560	179	5,430	7,130	29,700	4	28	4	772
Bolivia	--	--	--	--	--	--	--	--	(2)	28
Brazil	967	2,990	98	2,760	21	489	(2)	7	--	--
Bulgaria	24	54	(2)	4	--	--	--	--	--	--
Cambodia	--	--	1	45	--	--	--	--	--	--
Canada	4,520	38,500	1,540	34,300	2,940	25,000	74	1,560	18	3,350
Chile	--	--	18	397	(2)	4	(2)	6	--	--
China	2,480	26,100	2,180	64,100	77	734	84	2,170	384	75,900
Colombia	31	416	3	77	--	--	--	--	--	--
Costa Rica	16	58	(2)	3	--	--	--	--	(2)	4
Cyprus	--	--	--	--	--	--	(2)	6	--	--
Czech Republic	22	115	--	--	--	--	--	--	(2)	21
Denmark	84	979	2	66	--	--	--	--	--	--
Dominican Republic	2	16	2	44	--	--	--	--	--	--
Egypt	--	--	23	245	--	--	--	--	--	--
El Salvador	2	3	--	--	--	--	--	--	--	--
Finland	4	107	6	174	--	--	--	--	(2)	6
France	607	3,690	55	1,100	1	8	40	746	--	--
Germany	3,270	19,500	3,510	89,200	24,400	283,000	261	3,420	193	27,100
Greece	10	72	1	9	--	--	--	--	--	--
Guatemala	2	9	(2)	3	--	--	--	--	1	25
Haiti	4	26	--	--	--	--	--	--	--	--
Hong Kong	538	6,220	326	8,380	6	64	855	19,300	119	19,800
Hungary	1	4	(2)	5	--	--	--	--	--	--
Iceland	8	100	(2)	12	--	--	--	--	--	--
India	6	68	267	5,930	--	--	4	92	3	349
Ireland	494	3,770	348	6,960	--	--	3	16	4	481
Israel	2,190	6,470	7	149	--	--	--	--	--	--
Italy	736	5,730	623	25,500	3	33	33	532	53	3,610
Jamaica	--	--	(2)	7	--	--	--	--	--	--
Japan	6,800	75,200	6,810	229,000	6,070	119,000	1,550	29,700	1,420	269,000
Kenya	1	3	--	--	--	--	--	--	--	--
Korea, Republic of	51	529	192	3,680	--	--	1	20	--	--
Kuwait	4	74	--	--	--	--	--	--	--	--
Lebanon	3	21	(2)	5	--	--	--	--	--	--
Liechtenstein	1	22	(2)	10	--	--	--	--	--	--
Malaysia	10	81	3	83	(2)	1	442	12,300	--	--
Malta and Gozo	2	6	--	--	--	--	--	--	--	--
Mexico	121	580	102	2,110	--	--	10	288	5	927
Monaco	17	336	--	--	--	--	--	--	--	--
Morocco	5	42	6	76	--	--	--	--	--	--
Netherlands	22	281	42	1,010	--	--	(2)	4	--	--
Netherlands Antilles	--	--	--	--	--	--	(2)	7	--	--
New Zealand	87	1,260	4	138	--	--	--	--	--	--
Norway	36	587	139	2,300	--	--	--	--	--	--

See footnotes at end of table.

TABLE 4—Continued  
U.S. EXPORTS OF PLATINUM-GROUP METALS, BY COUNTRY<sup>1</sup>

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)
2007—Continued:										
Oman	1	\$10	--	--	--	--	--	--	--	--
Panama	--	--	--	--	--	--	--	--	(2)	\$5
Philippines	3	51	15	\$384	--	--	--	--	--	--
Poland	2	46	8	152	--	--	--	--	--	--
Qatar	3	31	--	--	--	--	--	--	--	--
Romania	11	106	5	117	--	--	--	--	--	--
Russia	--	--	92	3,840	--	--	--	--	--	--
Saudi Arabia	24	271	1	17	--	--	--	--	--	--
Singapore	55	640	122	2,230	--	--	2,040	\$34,000	(2)	31
Slovakia	37	57	--	--	--	--	--	--	--	--
Slovenia	6	24	--	--	--	--	--	--	--	--
South Africa	54	145	2,890	39,200	--	--	1	14	(2)	11
Spain	192	1,330	12	206	2	\$18	--	--	--	--
Swaziland	1	6	--	--	--	--	--	--	--	--
Sweden	7	120	19	459	--	--	--	--	--	--
Switzerland	2,150	23,500	1,940	43,600	--	--	16	95	--	--
Taiwan	2,480	10,300	2,510	56,000	--	--	911	20,300	2	85
Thailand	164	1,190	66	1,410	--	--	--	--	--	--
Trinidad and Tobago	2	15	(2)	6	--	--	--	--	--	--
Turkey	2	44	2	27	--	--	--	--	--	--
United Arab Emirates	22	184	2	59	--	--	--	--	(2)	42
United Kingdom	12,300	55,700	4,220	113,000	13,700	466,000	1,860	20,800	1	221
Uruguay	10	98	1	13	--	--	--	--	--	--
Venezuela	6	38	1	10	--	--	1	5	--	--
Vietnam	9	114	12	253	1	6	--	--	--	--
Zambia	--	--	(2)	4	--	--	--	--	--	--
Total	41,800	298,000	28,900	763,000	54,400	924,000	8,190	145,000	2,210	401,000

-- Zero.

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

<sup>2</sup>Less than ½ unit.

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

TABLE 5  
PLATINUM-GROUP METALS: ESTIMATED WORLD PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Kilograms)

Country <sup>3</sup>	2003	2004	2005	2006	2007
<b>Palladium:</b>					
Australia <sup>4</sup>	820	800	550 <sup>r</sup>	600 <sup>r</sup>	600
Botswana	2,200	2,500	1,900	2,000	2,000
Canada	12,808 <sup>s</sup>	12,000	10,415 <sup>r,5</sup>	10,493 <sup>r,5</sup>	10,500 <sup>p</sup>
Japan <sup>6</sup>	5,500	5,300	5,400	5,400	5,500
Poland <sup>7,8</sup>	10 <sup>r</sup>	10 <sup>r</sup>	10 <sup>r</sup>	10 <sup>r</sup>	10
Russia	97,000	97,000	97,400	98,400	96,800
Serbia	8 <sup>r,9</sup>	8 <sup>r,9</sup>	8 <sup>r,9</sup>	8 <sup>r</sup>	8
South Africa	70,946 <sup>s</sup>	76,403 <sup>s</sup>	82,961 <sup>s</sup>	86,265 <sup>r,5</sup>	86,460 <sup>p,5</sup>
United States <sup>10</sup>	14,000	13,700 <sup>s</sup>	13,300 <sup>s</sup>	14,400 <sup>s</sup>	12,800 <sup>s</sup>
Zimbabwe	3,449 <sup>s</sup>	3,564 <sup>s</sup>	3,879 <sup>s</sup>	4,022 <sup>r,5</sup>	4,200
<b>Total</b>	<b>207,000</b>	<b>211,000</b>	<b>216,000<sup>r</sup></b>	<b>222,000<sup>r</sup></b>	<b>219,000</b>
<b>Platinum:</b>					
Australia <sup>4</sup>	225	200	111 <sup>r</sup>	112 <sup>r</sup>	130
Botswana	500	500	300	300	300
Canada	6,990	7,000	6,075 <sup>r,5</sup>	6,120 <sup>r</sup>	6,200 <sup>p</sup>
Colombia	828	1,209 <sup>s</sup>	1,082 <sup>s</sup>	1,438 <sup>r,5</sup>	1,400
Ethiopia	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	3 <sup>r</sup>	3
Finland	461	705	800	800	800
Japan <sup>6</sup>	770	750	760	760	770
Poland <sup>7,8</sup>	20	20	20	20	20
Russia	28,000	28,000	29,000	29,000	27,000
Serbia	1 <sup>r,9</sup>	1 <sup>r,9</sup>	1 <sup>r,9</sup>	1 <sup>r</sup>	1
South Africa	148,348 <sup>s</sup>	153,239 <sup>s</sup>	163,711 <sup>s</sup>	168,125 <sup>r,5</sup>	165,833 <sup>p,5</sup>
United States <sup>10</sup>	4,170	4,040 <sup>s</sup>	3,920 <sup>s</sup>	4,290 <sup>s</sup>	3,860 <sup>s</sup>
Zimbabwe	4,270	4,438 <sup>s</sup>	4,834 <sup>s</sup>	4,998 <sup>r,5</sup>	5,300
<b>Total</b>	<b>195,000</b>	<b>200,000</b>	<b>211,000<sup>r</sup></b>	<b>216,000<sup>r</sup></b>	<b>212,000</b>
<b>Other platinum-group metals:</b>					
Canada	1,730	7,164 <sup>s</sup>	5,000	6,265 <sup>r,5</sup>	3,500 <sup>p</sup>
Russia	15,000	15,000	15,500	15,600	14,500
South Africa	46,856 <sup>s</sup>	46,759 <sup>s</sup>	56,309 <sup>s</sup>	53,138 <sup>r,5</sup>	58,626 <sup>s</sup>
Zimbabwe	851 <sup>s</sup>	809 <sup>s</sup>	862 <sup>s</sup>	864 <sup>r,5</sup>	1,500
<b>Total</b>	<b>64,400</b>	<b>69,700</b>	<b>77,700</b>	<b>75,900<sup>r</sup></b>	<b>78,100</b>
<b>Grand total</b>	<b>466,000</b>	<b>481,000</b>	<b>504,000<sup>r</sup></b>	<b>513,000<sup>r</sup></b>	<b>509,000</b>

<sup>p</sup>Preliminary. <sup>r</sup>Revised. -- Zero.

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

<sup>2</sup>Table includes data available through April 29, 2008. 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.

<sup>3</sup>In addition to the countries listed, China, Indonesia, and the Philippines are thought 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.

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

<sup>5</sup>Reported figure.

<sup>6</sup>Production derived entirely from imported ores.

<sup>7</sup>Based on official Polish estimates.

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

TABLE 5—Continued  
PLATINUM-GROUP METALS: ESTIMATED WORLD PRODUCTION, BY COUNTRY<sup>1,2</sup>

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<sup>9</sup>Montenegro and Serbia formally declared independence in June 2006 from each other and dissolved their union.

<sup>10</sup>A very small quantity of byproduct platinum and palladium produced from gold-copper ores was excluded.