



2016 Minerals Yearbook

PLATINUM-GROUP METALS [ADVANCE RELEASE]

PLATINUM-GROUP METALS

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In 2016, the United States was the world's fourth-leading producer of palladium and the fifth-leading producer of platinum. Stillwater Mining Co. (SMC) (Billings, MT), the only domestic mine producer of platinum-group metals (PGMs), recovered PGMs from its Stillwater Mine southwest of Nye, MT, and its East Boulder Mine south of Big Timber, MT. Domestic production of palladium and platinum was 13,100 kilograms (kg) and 3,890 kg, increases of 4% and 6%, respectively, from that of 2015 (Stillwater Mining Co., 2017, p. 48). Recycling has become a significant source of PGMs as well, accounting for about 23% of the total global supply of palladium, platinum, and rhodium in 2016 (CPM Group, 2017, p. 7, 113, 179).

Most of the world's supply of primary PGMs came from South Africa and Russia, which accounted for 56% and 24%, respectively, of global primary PGM production. World mine production of PGMs totaled 473,000 kg, a slight decrease from that of 2015 (table 5).

The annual average prices for palladium, platinum, rhodium, and ruthenium decreased by 11%, 6%, 27%, and 12%, respectively, compared with those of 2015, and the iridium price increased by 8% (table 1).

In 2016, the automobile industry continued to be the major consumer of PGMs. Catalytic converters, also referred to as autocatalysts, accounted for approximately 84% of global rhodium consumption, 67% of palladium consumption, and 46% of platinum consumption (CPM Group, 2017, p. 33, 132, 197).

The PGMs consist of iridium, osmium, palladium, platinum, rhodium, and ruthenium. The PGMs occur together in nature, but economic deposits are rare. PGMs are produced from deposits that are mined primarily for PGMs and are also produced as byproducts of nickel-copper mines.

Legislation and Government Programs

The Defense Logistics Agency Strategic Materials, U.S. Department of Defense, reported no PGM sales from U.S. Government stockpiles in 2016; 15 kg of iridium and 261 kg of platinum remained in the stockpile. In addition, 0.12 kg of platinum-group-metal alloys—palladium-cobalt wire—and 0.56 kg of platinum-group-metal compounds were added to the stockpile in late 2014 and early 2015, respectively.

Production

Primary.—During 2016, U.S. palladium and platinum mine production was 13,100 kg and 3,890 kg, respectively, increases of 4% and 6%, respectively, compared with those of 2015 (table 1), and mine production of rhodium was 103 kg, 6% more than that in 2015. The Stillwater Mine produced 7,790 kg of palladium and 2,380 kg of platinum, slight and 4% increases, respectively, compared with production in 2015. The East Boulder Mine produced 5,280 kg of palladium and 1,510 kg of platinum,

increases of 8% and 9%, respectively, compared with 2015 production. SMC milled 1.17 million metric tons (Mt) of ore from the Stillwater and East Boulder Mines, 6% more than that of 2015. In 2016, the Stillwater Mine processed an average of 1,773 metric tons per day (t/d) of ore, 4.6% less than 2015, having a combined mill-head grade of 17 grams per metric ton (g/t) PGMs and a PGM mill recovery of 93%, the same as that in 2015. In 2016, the East Boulder Mine processed an average of 1,592 t/d of ore, 10.4% more than in 2015, having a combined mill-head grade of 14 g/t PGMs and a PGM mill recovery rate of about 90%, slightly less than that in 2015. The concentrates from the mines were smelted and then processed at the base-metals refinery at SMC's facilities in Columbus, MT, producing a PGM-rich filter cake. Final refining of PGMs was done by Johnson Matthey plc. Refined metal from SMC's mine production was sold to Tiffany & Co. and Johnson Matthey plc (Stillwater Mining Co., 2017, p. 18–21, 48).

At yearend 2016, SMC reported proven and probable reserves at its Montana mines of 41.4 Mt of ore having an average grade of 16 g/t PGMs, a palladium-to-platinum ratio of about 3.6 to 1, and about 659,000 kg of contained palladium and platinum. These reserves are contained in the J-M Reef, an ore body within the layered mafic and ultramafic igneous rocks of the Stillwater Complex. SMC reported progress on its Blitz development project, a mine expansion project adjacent to the Stillwater Mine. The Blitz project would ultimately consist of two parallel underground drifts that would extend about 7,000 meters eastward from the Stillwater Mine. A new portal and decline from surface was permitted in 2015. Construction of the decline commenced in the third quarter of 2016. The mine expansion infrastructure was expected to be complete in 2018. The Graham Creek project, a second expansion project located west of the East Boulder Mine and completed during the second quarter of 2014, continued to ramp up and contributed to the overall increase in production of the East Boulder Mine in 2016. On December 9, 2016, SMC began talks about a potential merger with Sibanye Gold Ltd. (Stillwater Mining Co., 2017, p. 7, 16, 23).

In 2016, PGM exploration continued in the Duluth Complex of Minnesota. Twin Metals Minnesota LLC (St. Paul, MN) continued to pursue the development of its Twin Metals Minnesota copper-nickel-PGM project. The Twin Metals project, planned as an underground mine, included three deposits in close proximity—the Birch Lake, Maturi, and Spruce Road deposits. On December 15, 2016, Twin Metals was notified that the relevant U.S. authorities had denied renewal of two of its long-held mining leases. Twin Metals was pursuing legal avenues seeking to secure its rights to the two Federal mining leases (Twin Metals Minnesota LLC, 2016).

PolyMet Mining Corp. (Canada) continued the permitting process to begin to construct and operate the NorthMet project in northeastern Minnesota. The NorthMet project was planned

as an open pit mine, and ore was to be processed at the nearby Erie Plant facilities, originally used to process iron ore (PolyMet Mining Corp., 2017, p. 6–7).

Secondary.—In 2016, PGMs were recycled from three main sources—catalytic converters, electronics, and jewelry. Globally, more than 121,000 kg of secondary PGMs was recovered, accounting for approximately 23% of the global supply of PGMs (CPM Group, 2017, p. 7, 113, 179).

Catalytic converters were the predominant source of secondary PGMs. An estimated 55,300 kg of PGMs was recovered from catalytic converters in the United States, which was about 51% of the world total; about 35,800 kg was recovered in Western Europe; about 13,200 kg in Japan; and 4,220 kg in China (CPM Group, 2017, p. 31, 122, 190).

Globally, about 77,400 kg of palladium was recovered from secondary sources in 2016. Of the total, 66,400 kg of palladium was recovered from catalytic converters (slightly more than in 2015), 13,600 kg from electronics (slightly less than in 2015), and 700 kg from jewelry (7% less than in 2015) (CPM Group, 2017, p. 127).

Globally, about 39,700 kg of platinum was recovered from secondary sources including about 34,600 kg from recycled catalytic converters, essentially unchanged from that of 2015. About 1,520 kg of platinum was recovered from electronics recycling in 2016, which was slightly less than the amount recovered in 2015. About 3,570 kg of platinum was recovered from the jewelry industry globally in 2016, essentially unchanged from that of 2015. In 2016, recovery of rhodium from catalytic converters increased by 5% to 7,450 kg (CPM Group, 2017, p. 29, 190).

SMC reported that its recycling program processed 20,800 kg of PGMs from spent catalytic converters and other industrial sources in 2016, a 21% increase compared with that of 2015. Of the total recycled, SMC toll-refined 7,100 kg of PGMs, an 11% increase from that in 2015; the remainder was material purchased for its own accounts. In 2016, SMC sold 7,560 kg, 4,040 kg, and 902 kg, respectively, of recycled palladium, platinum, and rhodium, which were increases of 23%, 10%, and 21%, respectively, compared with amounts sold in 2015 (Stillwater Mining Co., 2017, p. 8, 9).

Consumption

Palladium.—Apparent domestic palladium consumption, defined as mine production plus imports minus exports, was 76,000 kg, a slight increase from that in 2015.

Global palladium consumption was about 291,000 kg in 2016, slightly more than that in 2015. About 67% of palladium was used by the catalytic converter industry, about 13% by the electronics industry, and about 8% and 5% by the dental and chemical industries, respectively. About 5% of palladium was used in the jewelry industry and the remainder was used in other industries and as investment (CPM Group, 2017, p. 132).

In 2016, global palladium use in catalytic converters reached an alltime high for the seventh consecutive year, increasing slightly to 195,000 kg, owing to an increase in the market share of gasoline engines in Europe, which use palladium in catalytic converters; a greater number of vehicles sold in developed economies; and a tightening of emission standards globally.

The pace of growth, however, decreased compared with recent years because of a slowdown in growth of the United States auto market and weakness in auto demand in Japan. North America was the leading autocatalyst-consuming region and accounted for 32% of global consumption of palladium in catalytic converters (61,500 kg), essentially unchanged from that of 2015. The United States accounted for about 79% of the North American consumption in this category (CPM Group, 2017, p. 129, 132).

Palladium consumption in catalytic converters in Western Europe increased for the third consecutive year to 35,100 kg, an alltime high and 6% more than that of 2015, owing to an increase in auto sales, a decreased market share of diesel vehicles, and the substitution of palladium for platinum in diesel vehicles. Consumption by China's catalytic converter industry was 40,300 kg, 11% more than that of 2015 owing partly to a Government subsidy for small automobiles as well as increasing demand for gasoline-powered vehicles. Consumption by Japan was 22,500 kg, slightly less than that of 2015. Palladium consumption in catalytic converters in the rest of the world decreased by 5% to 35,300 kg (CPM Group, 2017, p. 129–134).

Global palladium consumption by the jewelry industry, which declined for the seventh consecutive year, was 13,800 kg, a slight decrease from that of 2015 and the lowest level since 2002 partly owing to a lack of marketing of palladium jewelry. China remained the leading user of palladium for jewelry, accounting for 32% of world consumption in that industry. However, demand in China's jewelry industry decreased slightly relative to that of 2015. Consumption in Europe was 2,020 kg of palladium, slightly higher than that in 2015; consumption in North America and Japan was 2,080 kg and 3,200 kg, respectively, both slightly less than in 2015. Consumption in the rest of the world increased slightly to about 2,080 kg (CPM Group, 2017, p. 136).

World palladium consumption in dental alloys was 22,600 kg in 2016, essentially unchanged from consumption in 2015. Japan and North America accounted for about 35% and 31%, respectively, of the global palladium consumption in this industry. The chemical industry used 15,100 kg of palladium in 2016, slightly less than that in 2015. In the chemical industry, palladium was used as a catalyst in manufacturing bulk chemicals, including hydrogen peroxide, nitric acid, terephthalic acid, and vinyl acetate monomer, which in turn were used to produce many resins, plastics, and polyester and polyethylene terephthalate for use in textiles and packaging. Consumption of palladium by the electronics industry was 38,600 kg in 2016, slightly less than that of 2015, representing the first decline since 2012 (CPM Group, 2017, p. 135).

The palladium investment sector was a net seller of palladium in 2016. Holdings in exchange-traded products (ETPs), decreased to about 52,600 kg at yearend 2016, a 26% decrease from holdings at yearend 2015 (CPM Group, 2017, p. 146).

Platinum.—In 2016, U.S. apparent consumption of refined platinum, defined as mine production plus imports minus exports, excluding waste and scrap, was 32,200 kg, slightly more than 31,900 kg in 2015.

In 2016, global platinum use, excluding investments, totaled 219,000 kg, slightly more than that of 2015. About 45% of the total was used in catalytic converters, about 33% by

the jewelry industry, about 9% in chemicals and petroleum refining, and about 3% in electronics. The remainder was used in other industries including glass manufacturing and the medical and biomedical industries. Worldwide use of platinum in the catalytic converter industry was 101,000 kg, about 2% higher than that in 2015, largely owing to increased sales of large commercial vehicles that are typically powered by diesel engines that use platinum in their catalytic converters. In Europe, about 37,800 kg of platinum was used in catalytic converters, which was 5% more than that in 2015. Although market share of diesel passenger vehicles declined to about 50% in Europe, this region remained the leading consumer of platinum for catalytic converters and accounted for about 38% of total global consumption. Consumption of platinum in catalytic converters in the United States in 2016 was 23,300 kg, essentially unchanged from that in 2015, which accounted for about 23% of global consumption. In Japan, platinum consumption in catalytic converters decreased slightly in 2016 from that in 2015 to 18,000 kg largely as a result of decreased demand for commercial vehicles. In China, consumption of platinum in catalytic converters increased by 6% to 12,000 kg. In the rest of the world, consumption of platinum in catalytic converters decreased by 5% in 2016 from that in 2015 to 9,520 kg (CPM Group, 2017, p. 31–41).

In 2016, global consumption of platinum in the jewelry industry was essentially unchanged compared with that in 2015 at 72,400 kg. Consumption in the United States was 2,240 kg, 6% more than that in 2015. Consumption in China decreased slightly to 55,400 kg and accounted for 76% of global consumption. Consumption in Europe (France, Germany, and the United Kingdom) was 1,310 kg, slightly more than that in 2015; consumption in Japan was 8,800 kg, slightly more than that in 2015; and consumption in the rest of the world increased by 14% to 4,730 kg (CPM Group, 2017, p. 33).

Global use of platinum in chemicals and petroleum refining was 19,700 kg in 2016, slightly less than that of 2015. The leading use for platinum in chemical production was for catalysts used in the production of silicones and other chemicals, such as terephthalic acid used in the production of polyester fabric and plastic containers. Worldwide consumption of platinum in electrical applications was 5,970 kg in 2016, essentially unchanged from that of 2015 (CPM Group, 2017, p. 33).

Consumption of platinum for dental and medical applications was 1,120 kg, which was 3% less than that in 2015. Consumption in other end uses was slightly more than that of 2015 at 16,800 kg. These other uses included platinum used in glassmaking equipment (CPM Group, 2017, p. 33).

Purchases of platinum by the investment sector increased to 19,300 kg in 2016, 38% more than that in 2015, largely owing to increased purchasing of platinum bars by Japanese investors. Platinum holdings in ETPs globally totaled 85,100 kg at yearend 2016, slightly more than that at yearend 2015 (CPM Group, 2017, p. 94; Johnson Matthey plc, 2017, p. 1).

Other PGMs.—Global consumption of iridium was 7,710 kg in 2016, slightly less than that of 2015. Use in electrical applications increased by 25% to 3,110 kg; use in the electrochemical applications was 1,430 kg, 19% less than 2015; use in chemical production was 715 kg, 15% more than that

in 2015; and use in other applications was 2,490 kg, a 15% decrease from that in 2015 (Johnson Matthey plc, 2017, p. 47).

Global rhodium consumption in 2016 was a record-high 31,900 kg, slightly more than that of 2015, and the seventh consecutive year that global rhodium consumption increased. Most rhodium use, about 85% in 2016, was in the production of catalytic converters. In 2016, rhodium use in catalytic converters was 27,000 kg, slightly more than that in 2015. Use of rhodium in glass manufacturing increased slightly to 1,290 kg. Consumption of rhodium in chemical production decreased slightly to 1,590 kg in 2016; use in electronics was 1,360 kg, slightly less than that in 2015; and use in other applications was 645 kg, 6% less than that in 2015 (CPM Group, 2017, p. 191–197).

Global consumption of ruthenium decreased by 13% to 30,900 kg in 2016 from that in 2015. Consumption of ruthenium in electrical applications was 13,800 kg, 3% less than that in 2015; electrochemical use was 4,630 kg, 6% more than that in 2015; use in chemical production was 7,710 kg, 38% less than that in 2015; and consumption in other applications increased by 3% to 4,790 kg (Johnson Matthey plc, 2017, p. 48).

Prices

According to Platts Metals Daily, in 2016, the Engelhard annual average prices for platinum, palladium, ruthenium, and rhodium decreased by 6%, 11%, 12%, and 27%, respectively; the price for iridium increased by 8% from 2015 (table 1).

Iridium.—The annual average iridium price in 2016 was \$586.90 per troy ounce, which was 8% higher than that in 2015. The iridium price began the year at \$525 per troy ounce, where it remained until late June. The price then increased at a consistent pace to \$700 per troy ounce in mid-November, where it remained until yearend.

Palladium.—The annual average palladium price in 2016 was \$617.39 per troy ounce, which was 11% less than that in 2015. Palladium prices began 2016 at \$553 per troy ounce, fluctuated in a wide range until late June, and then increased to \$734 per troy ounce in mid-August. The price then decreased to \$617 per troy ounce in late October, increased to the year's high of \$774 per troy ounce in late November, and then decreased, ending the year at \$680 per troy ounce.

Platinum.—In 2016, the annual average platinum price was \$989.52 per troy ounce, which was 6% less than that of 2015, continuing a downward trend that began in 2012, after a record high of \$1,725 per troy ounce in 2011. Platinum began the year at \$895 per troy ounce, decreased to \$816 per troy ounce in late January, and then generally followed an upward trend, reaching the year's high of \$1,184 per troy ounce on August 10. The price then generally decreased for the rest of the year, ending the year at \$903 per troy ounce. Platinum prices generally followed gold prices in response to global economic conditions.

Rhodium.—The annual average rhodium price in 2016 was \$696.84 per troy ounce, which was 27% less than that in 2015. The rhodium price began the year at \$660 per troy ounce and generally trended upward until late March to \$750 per troy ounce, where it remained around that level until early May. The price then decreased to a low of \$625 per troy ounce in August and then generally increased, with some fluctuation, ending the year at \$765 per troy ounce. The rhodium annual average price

in 2016 was below that for platinum, continuing the trend that began in 2012.

Ruthenium.—The annual average ruthenium price in 2016 was \$42 per troy ounce, which was 12% less than that of 2015, continuing a downward trend that began in 2010. The ruthenium price began the year at \$42 per troy ounce where it remained until yearend.

Foreign Trade

In 2016, the U.S. net import reliance as a percentage of apparent consumption, calculated excluding trade data for waste and scrap, was estimated to be 83% for refined palladium and 88% for refined platinum. Imports for consumption of refined palladium in 2016 totaled 80,400 kg, a 6% decrease from those of 2015. Three countries accounted for about 81% of refined palladium imports in 2016—Russia and South Africa (35% each) and the United Kingdom (11%). Imports for consumption of platinum excluding waste and scrap decreased slightly in 2016 to 42,300 kg from 42,700 kg in 2015. Excluding waste and scrap, the leading sources of platinum imports in 2016 were South Africa (43%), Germany (19%), and Italy (9%). Imports for consumption of rhodium increased slightly compared with those in 2015 to 10,700 kg; imports of osmium, iridium, and ruthenium respectively increased by 238%, 28%, and slightly. Two countries accounted for 80% of the imports of iridium, osmium, rhodium, and ruthenium in 2016—South Africa (57%) and the United Kingdom (23%) (tables 2, 3). Imports of platinum waste and scrap totaled 159,000 kg in 2016, a 29% increase from the amount imported in 2015.

About 17,500 kg of palladium was exported in 2016, a 24% decrease as compared with 2015. Exports of platinum, excluding waste and scrap, decreased by 3%, and exports of waste and scrap increased by 11% compared with those in 2015. Exports of rhodium increased by 5% compared with exports in 2015, and combined exports of iridium, osmium, and ruthenium decreased by 6% during the same time period (table 4).

World Review

In 2016, world mine production of PGMs decreased slightly to 473,000 kg from 478,000 kg in 2015 (table 5). South Africa accounted for 56% of total PGM mine production in 2016; Russia, 24%; Canada, 7%; Zimbabwe, 6%; the United States, 4%; and other countries, 3%. In 2016, world platinum mine production decreased slightly. South Africa produced 133,000 kg of platinum, which was 70% of world platinum production and 4% less than 2015 production. Russia accounted for 12% of global platinum mine production in 2016; Zimbabwe, 8%; Canada, 7%; and the United States, 2%. Global mine production of palladium in 2016 decreased by 3% to 212,000 kg, with Russia and South Africa accounting for 38% and 36%, respectively, of global production; Canada, 10%; and the United States and Zimbabwe, 6% each. World mine production of other PGMs (iridium, osmium, rhodium, and ruthenium) increased by 8% in 2016 compared with that of 2015, and South Africa accounted for 77% of global production.

Canada.—North American Palladium Ltd. produced 4,650 kg of palladium and 318 kg of platinum from its Lac des Isles

Mine in Ontario, decreases of 10% and 17%, respectively, compared with production in 2015. The decreases were a result of unfavorable ground conditions as the mine transitioned to the sublevel shrinkage mining method (North American Palladium Ltd., 2017, p. 3–4).

Vale S.A. (Brazil) produced 10,000 kg of palladium and 5,160 kg of platinum as byproducts of its nickel operations at Sudbury, Ontario, a decrease of 6% and an increase of 8%, respectively, from production in 2015. Glencore plc (Switzerland) produced PGMs as byproducts from its nickel mining operations at Sudbury and at the Raglan Mine in Quebec. In 2016, Glencore produced 5,380 kg of palladium, 2,800 kg of platinum, and 187 kg of rhodium at its Eland and jointly owned Mototolo Mines. These represent increases of 10%, 18%, and 20%, respectively, relative to 2015 (Glencore plc, 2017, p. 63; Vale S.A., 2017, p. 51).

Russia.—In 2016, PJSC MMC Norilsk Nickel produced 79,400 kg of palladium and 19,300 kg of platinum at its two production assets in Russia—Kola MMC on the Kola Peninsula and the Polar Division on the Taymyr Peninsula. Production was slightly less for palladium and essentially unchanged for platinum compared with 2015 production (PJSC MMC Norilsk Nickel, 2017).

South Africa.—Production of palladium and platinum decreased by 8% and 4%, respectively, in 2016 compared with 2015. The world's leading PGM producer, Anglo American Platinum Ltd. (Amplats), reported primary equivalent refined platinum production from its mining operations of 52,500 kg in 2016, an 8% decrease compared with that in 2015. In 2016, Amplats also produced from its mining operations 33,900 kg of palladium, a decrease of 12% compared with 2015, and 7,060 kg of rhodium, essentially unchanged from 2015. Amplats continued with its restructuring plan and completed the sale of its Rustenburg mining and concentrating operations to Sibanye Gold Ltd. in November 2016. The sale included the Bathopele, Siphumelele, and Thembelani mining operations (which include the integrated Khuseleka and Khomanani mining operations); two concentrating plants; a chromium-recovery plant; and the Western Limb Tailings Retreatment plant. As part of the deal, Sibanye was to sell all concentrates back to Amplats through the end of 2018. Starting January 1, 2019, Sibanye and Amplats would enter a toll treatment arrangement whereby Amplats would smelt and refine concentrate produced from the Rustenburg mines for a period of 2 to 8 years. Going forward, Amplats planned to focus on lower cost mechanized mining operations (Anglo American Platinum Ltd., 2016; 2017, p. 33; CPM Group, 2017, p. 14–15).

Production at Impala Platinum Holdings Ltd.'s South African mining operations in 2016 was about 13,400 kg of palladium and 24,700 kg of platinum, which were each 3% less than 2015 production. Lonmin plc (United Kingdom) produced 10,100 kg of palladium and 21,900 kg of platinum in 2016, each 11% less than the amounts produced in 2015 (CPM Group, 2017, p. 13, 116).

Zimbabwe.—In 2016, both palladium and platinum production increased by 19% compared with 2015 (table 5). Zimplats Holdings Ltd. continued to redevelop the Bimha Mine following its collapse in 2014. Return to full production was on schedule and expected to take place in April 2018. Zimplats

was also finalizing plans to develop a new shaft to replace production from the oldest mines, with first production expected in 2021 (CPM Group, 2017, p. 17).

Outlook

Palladium, platinum, and rhodium are used primarily in catalytic converters in automobiles to decrease harmful emissions; therefore, the performance of the gasoline and hybrid automobile industry, which requires catalytic converters, will have the greatest impact on future consumption of these PGMs. Global automobile production is expected to increase, particularly in emerging markets, such as China and India, as well as in developed markets in Europe and the United States; therefore, an overall increase in demand for PGMs in catalytic converters is expected.

PGM production levels from South Africa are expected to increase slightly; however, production levels will remain vulnerable to problems in the South African mining industry, including work stoppages caused by labor disputes and safety issues, and ongoing restructuring of the platinum mining industry, including closure of unprofitable mines. Supply from Zimbabwe is expected to increase owing to ongoing mine expansions but is subject to political stability. Recycling of platinum and palladium is expected to increase, particularly from automotive catalysts, although the quantity of material available for recycling is very price sensitive. As metal prices increase, recycling becomes more profitable and, thus, more material is available for supply; conversely, a decrease in metal prices leads to reduced recycling and reduced material availability from recycling.

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TABLE 1
SALIENT PLATINUM-GROUP METALS STATISTICS¹

		2012	2013	2014	2015	2016
United States:						
Mine production:²						
Palladium, Pd content:						
Quantity	kilograms	12,300	12,600	12,400	12,500	13,100
Value	thousands	\$257,000	\$295,000	\$324,000	\$280,000	\$259,000
Platinum, Pt content:						
Quantity	kilograms	3,670	3,720	3,660	3,670	3,890
Value	thousands	\$184,000	\$178,000	\$163,000	\$125,000	\$124,000
Refinery production:						
Palladium, Pd content:						
Quantity	kilograms	21,000	23,900	23,700	19,800	23,200
Value	thousands	\$438,000	\$561,000 ^r	\$617,000 ^r	\$442,000 ^r	\$460,000
Platinum, Pt content:						
Quantity	kilograms	16,600	19,100	18,900	19,200	17,300
Value	thousands	\$831,000	\$915,000 ^r	\$845,000 ^r	\$615,000 ^r	\$551,000
Imports for consumption, refined:						
Iridium, Ir content	kilograms	1,240 ^r	1,740 ^r	1,960 ^r	1,010	1,300
Osmium, Os content	do.	130	77	322	8	27
Palladium, Pd content	do.	80,100	83,100	92,900 ^r	85,300 ^r	80,400
Platinum, includes waste, scrap, and coins, Pt content	do.	172,000	116,000	157,000 ^r	166,000 ^r	201,000
Rhodium, Rh content	do.	12,800	11,100	11,100	10,600	10,700
Ruthenium, Ru content	do.	10,200	15,400 ^r	11,000 ^r	8,230	8,410
Exports, refined:						
Iridium, osmium, and ruthenium, gross weight	do.	1,640	1,330 ^r	887 ^r	781	736
Palladium, Pd content	do.	32,200	25,900	22,100 ^r	23,000	17,500
Platinum, Pt content	do.	9,160 ^r	11,100 ^r	14,800	14,400	14,000
Rhodium, Rh content	do.	1,040	1,220	433 ^r	759 ^r	794
Stocks, National Defense Stockpile, December 31:						
Iridium, Ir content	do.	18	18	15	15	15
Platinum, Pt content	do.	261	261	261	261	261
Price, average:³						
Iridium	dollars per troy ounce	1,066.23	826.45	556.19	544.19	586.90
Palladium	do.	649.27	729.58	809.89	694.99	617.39
Platinum	do.	1,555.39	1,489.57	1,387.89	1,056.09	989.52
Rhodium	do.	1,274.98	1,069.10	1,174.23	954.90	696.84
Ruthenium	do.	112.26	75.63	65.13	47.63	42.00
Employment		1,660	1,770	1,620	1,440	NA
World, mine production, platinum-group-metal content	kilograms	447,000 ^r	461,000 ^r	390,000 ^r	478,000 ^r	473,000

^rRevised. do. Ditto. NA Not available.

¹Table includes data available through February 27, 2018. Data are rounded to three significant digits, except prices.

²Source: Stillwater Mining Co., 2017, Form 10-K—2016: U.S. Securities and Exchange Commission, p. 18–21.

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

TABLE 2
U.S. IMPORTS FOR CONSUMPTION OF PLATINUM, BY COUNTRY OR LOCALITY¹
(Kilograms, platinum content, and thousand dollars)

Country or locality	Grain and nuggets		Sponge		Other unwrought		Other		Waste and scrap		Coins	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
2015	820	24,100	30,000	1,040,000	4,700	166,000	5,960	197,000	123,000	899,000	1,210	43,500
2016:												
Algeria	--	--	--	--	--	--	--	--	204	6,820	--	--
Australia	--	--	--	--	--	--	50	50	881	24,200	192	6,320
Austria	--	--	--	--	10	367	10	367	--	--	146	4,600
Belgium	--	--	653	22,100	--	--	2	41	84	3,010	--	--
Brazil	--	--	--	--	--	--	4	98	6,310	34,700	--	--
Canada	39	1,260	--	--	(2)	10	170	5,560	31,200	77,500	441	15,600
Chile	--	--	--	--	--	--	--	--	322	11,400	--	--
China	--	--	--	--	472	15,500	41	1,890	3,530	26,100	(2)	3
Colombia	(2)	3	--	--	919	27,800	--	--	149	3,730	--	--
Czechia	--	--	--	--	6	180	231	7,490	2	135	--	--
France	--	--	47	1,520	--	--	103	3,820	1,090	37,600	--	--
Germany	7	117	1,800	61,500	687	24,900	5,300	165,000	3,330	146,000	69	2,510
Italy	--	--	3,930	124,000	--	--	4	76	2,750	53,000	--	--
Japan	--	--	64	2,090	272	8,380	22	726	2,580	61,000	--	--
Korea, Republic of	--	--	555	17,200	--	--	(2)	14	98	2,660	--	--
Luxembourg	--	--	--	--	--	--	--	--	147	3,950	--	--
Macau	--	--	--	--	--	--	--	--	967	213	--	--
Malaysia	--	--	--	--	--	--	--	--	800	11,300	--	--
Malaysia	--	--	--	--	--	--	--	--	1,270	35,400	--	--
Mexico	2	68	--	--	39	1,240	--	--	--	--	--	--
Norway	--	--	1,200	38,700	--	--	14	451	--	450	--	--
Pakistan	--	--	--	--	--	--	--	--	2,260	--	--	--
Russia	--	--	623	19,700	--	--	(2)	5	--	--	(2)	7
Saudi Arabia	--	--	--	--	--	--	--	--	1,050	34,600	--	--
Singapore	--	--	--	--	302	10,900	62	2,460	2,520	69,900	--	--
South Africa	367	11,000	15,900	498,000	2,000	63,700	157	5,260	--	--	--	--
South Africa	--	--	114	4,850	148	5,020	2,320	80,000	6	8	61	2,370
Switzerland	--	--	148	4,450	--	--	--	--	683	13,100	--	--
Taiwan	--	--	--	--	--	--	--	--	249	8,190	--	--
United Arab Emirates	--	--	--	--	--	--	--	--	95,500	135,000	13	384
United Kingdom	1	23	2,410	76,900	101	3,100	150	4,770	--	--	--	--
Uruguay	--	--	--	--	--	--	--	--	176	360	--	--
Uruguay	2	80	--	--	18	657	6	229	794	20,200	2	97
Total	419	12,600	27,400	871,000	4,970	161,000	8,610	279,000	159,000	821,000	924	31,900

¹Revised. -- Zero.

²Table includes data available through February 27, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

³Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 3
U.S. IMPORTS FOR CONSUMPTION OF PLATINUM-GROUP METALS, BY COUNTRY OR LOCALITY¹

Country or locality	Unwrought palladium		Palladium, other		Iridium ²		Osmium ²		Ruthenium ²		Rhodium ²	
	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)
2015	75,700 [†]	\$1,650,000	9,600	\$228,000	1,010	\$17,400	8	\$59	8,230	\$14,600	10,600	\$336,000
2016:												
Austria	--	--	284	6,300	--	--	--	--	--	--	--	--
Belgium	1,380	21,500	--	--	--	--	--	--	282	564	395	9,140
Brazil	399	3,600	--	--	--	--	--	--	--	--	--	--
Canada	257	9,120	3,160	85,800	--	--	--	--	--	--	13	333
China	--	--	--	--	2	50	27	159	--	--	111	3,640
France	--	--	7	238	--	--	--	--	--	--	--	--
Germany	681	9,040	888	23,500	137	2,880	--	--	704	1,380	303	7,090
Hong Kong	16	51	--	--	--	--	--	--	--	--	--	--
India	--	--	15	314	--	--	--	--	--	--	--	--
Italy	3,610	74,100	97	1,610	1	23	--	--	--	--	288	6,640
Japan	1,010	8,400	6	69	131	2,640	--	--	--	--	--	--
Korea, Republic of	1,640	28,300	3	47	--	--	--	--	--	--	595	11,800
Mexico	--	--	13	149	1	10	--	--	--	--	--	--
Norway	2,260	43,600	--	--	--	--	--	--	--	--	54	1,190
Russia	21,400	433,000	6,680	133,000	1	15	--	--	30	57	1,010	21,100
South Africa	26,900	537,000	828	16,100	827	13,700	--	--	4,380	7,830	6,500	138,000
Switzerland	49	1,010	196	4,450	(3)	3	--	--	--	--	--	--
United Kingdom	8,500	169,000	120	2,890	196	3,650	--	--	3,010	4,630	1,410	30,800
Other	(3)	3	1	23	--	--	--	--	--	--	1	15
Total	68,100	1,340,000	12,300	275,000	1,300	23,000	27	159	8,410	14,500	10,700	230,000

[†]Revised. -- Zero.

¹Table includes data available through February 27, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

²Unwrought and other forms.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 4
U.S. EXPORTS OF PLATINUM-GROUP METALS, BY COUNTRY OR LOCALITY¹

Country or locality	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)
2015	23,000	\$458,000	14,400	\$469,000 [†]	246,000	\$886,000	781 [†]	\$13,800	759	\$25,800
2016:										
Argentina	1	6	85	2,640	--	--	--	--	--	--
Australia	86	1,390	126	4,120	(2)	5	72	995	--	--
Austria	8	56	(2)	8	1	40	1	6	(2)	7
Belgium	1	26	(2)	3	2,730	13,300	--	--	(2)	8
Brazil	88	1,750	42	1,330	--	--	--	--	1	25
Canada	1,990	33,700	210	7,210	99	261	2	28	(2)	46
Cayman Islands	6	27	28	854	--	--	--	--	1	99
Chile	5	81	62	2,510	--	--	--	--	--	--
China	2,840	48,600	114	2,340	10	275	25	382	314	8,050
Colombia	48	667	1	30	--	--	--	--	--	--
Costa Rica	33	272	28	336	--	--	2	15	--	--
Czechia	20	167	15	532	--	--	3	79	--	--
Denmark	27	232	(2)	6	--	--	--	--	--	--
Dominican Republic	3	4	17	467	--	--	--	--	--	--
Finland	23	78	(2)	28	--	--	--	--	--	--
France	331	2,950	42	1,400	--	--	14	180	--	--
Germany	2,860	44,500	4,220	131,000	4,730	71,000	128	2,190	406	9,580
Hong Kong	785	11,000	89	2,670	111	70	100	1,270	5	126
India	261	4,440	657	21,600	269	8,120	60	633	14	325
Ireland	248	1,410	197	5,920	--	--	3	14	--	--
Israel	1,060	5,300	12	345	--	--	(2)	3	--	--
Italy	221	4,390	148	5,170	1,170	1,670	--	--	16	339
Japan	495	6,850	913	27,900	223,000	163,000	34	753	18	381
Korea, Republic of	1,460	23,300	441	12,700	46	943	8	120	1	60
Laos	--	--	29	919	--	--	--	--	--	--
Luxembourg	2,400	50,500	1,530	49,800	1	20	--	--	--	--
Mexico	147	2,340	1,010	18,500	3	59	12	57	(2)	47
Netherlands	14	73	(2)	59	34	595	--	--	--	--
New Zealand	27	555	(2)	47	--	--	4	18	--	--
Norway	19	373	(2)	13	--	--	--	--	--	--
Peru	21	86	--	--	--	--	--	--	--	--
Saudi Arabia	34	347	--	--	--	--	--	--	--	--
Singapore	28	435	1,460	46,200	2	47	--	--	17	437
Slovakia	--	--	51	680	--	--	--	--	--	--
South Africa	2	6	--	--	1,420	13,900	--	--	--	--
Spain	15	114	--	--	--	--	--	--	--	--
Switzerland	102	1,900	473	15,700	4,930	84,400	4	85	--	--
Taiwan	1,360	16,700	41	1,400	--	--	14	166	2	42
Thailand	139	2,650	108	3,480	--	--	--	--	1	28
United Arab Emirates	10	81	1	10	--	--	11	208	--	--
United Kingdom	220	3,850	1,830	54,600	34,400	344,000	238	4,070	(2)	3
Uruguay	14	377	2	121	--	--	--	--	--	--
Vietnam	3	38	18	585	--	--	--	--	--	--
Other	31	276	12	336	--	--	1	8	--	--
Total	17,500	272,000	14,000	423,000	273,000	702,000	736	11,300	794	19,600

[†]Revised. -- Zero.

¹Table includes data available through February 27, 2018. Data 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.

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

(Kilograms, platinum-group-metal content)

Country or locality ³	2012	2013	2014	2015	2016
Palladium:					
Australia ^{e,4}	550 ^r	600 ^r	600 ^r	600 ^r	590
Botswana	2,613	1,742 ^r	1,120 ^r	1,200 ^{r,e}	-- ^e
Canada ^e	13,800 ^r	15,700 ^r	19,300 ^r	20,400 ^r	21,000
Finland	1,100 ^e	1,100 ^e	902	2,400	2,000 ^e
Japan ⁵	8,052	6,239	6,969	7,073 ^r	7,172
Poland ⁶	23 ^r	30	51 ^r	55 ^{r,e}	20 ^e
Russia ^e	81,700 ^r	80,200 ^r	82,700 ^r	81,000	79,400
Serbia	22	25 ^r	23 ^r	31 ^r	-- ^e
South Africa	74,738	76,008	58,410	82,691	76,273
United States ⁷	12,300	12,600	12,400	12,500	13,100
Zimbabwe ^e	8,140 ^r	10,200 ^r	10,100	10,100 ^r	12,000
Total	203,000^r	204,000	193,000	218,000^r	212,000
Platinum:					
Australia ^{e,4}	160 ^r	170 ^r	170 ^r	170 ^r	90
Botswana	435	280 ^r	190 ^r	250 ^{r,e}	-- ^e
Canada ^e	7,870 ^r	8,900 ^r	11,000 ^r	11,600 ^r	12,600
Colombia	1,460	1,836	1,135 ^r	861 ^r	700
Ethiopia ^e	--	--	--	5	5
Finland	429	946	1,060	1,030	700 ^e
Japan ⁵	1,735	1,963	1,724	1,864 ^r	2,033
Poland ⁶	39 ^r	51 ^r	86 ^r	90 ^{r,e}	30 ^e
Russia ^e	26,500	25,200 ^r	24,300 ^r	23,800 ^r	23,000
Serbia	3	2 ^r	3	4 ^r	4 ^e
South Africa	128,590	137,024	93,991	139,125	133,241
United States ⁷	3,670	3,720	3,660	3,670	3,890
Zimbabwe ^e	10,500	13,100 ^r	12,500	12,600	14,900
Total	181,000^r	193,000^r	150,000^r	195,000^r	191,000
Other platinum-group metals:					
Canada ^e	800 ^r	900 ^r	1,100 ^r	1,200 ^r	1,510
Russia ^e	8,200 ^r	8,300 ^r	8,200 ^r	7,600	11,500
South Africa	51,010	51,156	36,043	53,699	54,139
Zimbabwe	2,090 ^r	2,678	2,667	2,612 ^r	3,130 ^e
Total	62,100^r	63,000^r	48,000^r	65,100^r	70,300
Grand total	447,000^r	461,000	390,000^r	478,000^r	473,000

^eEstimated. ^rRevised. -- Zero.

¹Table includes data available through November 7, 2017. All data are reported unless otherwise noted. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Platinum-group-metal (PGM) production by Germany, Norway, Switzerland, and the United Kingdom was not included, because the production was derived wholly from imported metallurgical products and to include it would result in double counting.

³In addition to the countries and (or) localities listed, China, Indonesia, and the Philippines are thought to have produced PGMs. Several other countries and (or) localities may also have done so, but output was not reported quantitatively. Additionally, there was no reliable basis for estimating output. A part of this output, not specifically reported by country or locality, is presumably included in this table and credited to Japan.

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

⁵Production derived entirely from imported ores.

⁶Official Polish estimates are based on reported platinum- and palladium-bearing final (residual) slimes and the average platinum and palladium content from electrolytic copper refining.

⁷Byproduct platinum and palladium produced from gold-copper ores were excluded.