

PLATINUM-GROUP METALS

By Robert G. Reese

Six metals, (platinum, palladium, rhodium, iridium, ruthenium, and osmium) make up the platinum group metals (PGM). Of the six metals, platinum and palladium are the most important commercially. PGM's are used as catalysts in the automotive, chemical, and petroleum industries. Other applications for the PGM's include the electrical and electronic, dental and medical, and jewelry industries.

Although generally found together, minable deposits of the PGM's are very rare. Often, PGM production occurs as a byproduct of some other metal, usually nickel or copper. Worldwide, the major PGM producing regions include the Republic of South Africa, Russia, Canada, the United States, and Colombia.

Identified world PGM resources at yearend 1994 were estimated at 100 million kilograms (kg). The reserve base was estimated at 66 million kg and reserves at 56 million kg. Of the reserve base and the reserves, the Republic of South Africa had nearly 90% of each; Russia had 9% and 11% respectively; and the United States had 1% and 0.4% respectively.

In the United States, the Stillwater Mine in Montana accounts for nearly all domestic PGM production. The remaining domestic PGM production occurs as a byproduct at some copper refining operations. Production at the Stillwater Mine consists primarily of palladium and platinum.

In 1994, the Stillwater Mining Co., operator of the Stillwater Mine, became a publicly traded and financed company. Of the original partners, Stillwater Mining redeemed Chevron Corp.'s 50% interest in the mine with proceeds from a private placement of common stock and notes. In December, Stillwater Mining closed its first public stock offering, and used a portion of the proceeds from this sale to redeem the notes issued in the earlier private placement.

At the same time as the public offering, Manville Corp., the mine's other founding partner, reduced its holding in Stillwater Mining from 50% to 27% through a secondary stock offering.

Production at the Stillwater Mine declined in 1994 despite increased ore production. In 1993, the Stillwater Mine produced nearly 2,050 kg of platinum and 6,780 kg of palladium, while in 1994, the mine produced 1,960 kg and nearly 6,440 kg of platinum and palladium, respectively.¹ Company officials

attributed the lower production to lower ore grades mined in 1994. During the year, the company adopted a plan to increase ore production at Stillwater from 336,000 metric tons per year to more than 660,000 tons per year by mid-1997. As part of this plan, the company began construction of a new 530-meter shaft in October.

The Stillwater Mining Co. concentrates and smelts the ore from the Stillwater Mine locally. The resulting PGM-bearing matte is shipped to Belgium for refining. In the United States, secondary PGM's were refined by about 20 firms, mostly on the East and West coasts. PGM were sold by at least 90 processors and dealers, largely in the Northeast.

Historically, the U.S. Bureau of Mines developed data on industry held stocks, refinery production, and consumption of PGM's from a voluntary survey of domestic refiners. Continued low response rates by industry to the Bureau's canvass have resulted in a decision to not publish these data for 1994. Beginning in 1995, the Bureau will combine the three separate surveys for gold, silver, and PGM into a single annual survey of precious metal refiners. It is hoped that by reducing the burden for industry, the response rate will improve, and that publication of quality data can be resumed.

The average dealer price for platinum increased from \$370 per ounce for 1993 to \$401 per ounce for 1994. Similarly, the average dealer price for palladium increased from \$120 for 1994 to \$142 for 1993. For 1994, average dealer prices for the remaining PGM'S were iridium, \$30; osmium, \$400; rhodium, \$717; and ruthenium, \$12. In 1993, the average prices were \$47, \$400, \$1,066, and \$13 per ounce for iridium, osmium, rhodium, and ruthenium respectively.

Total accountable platinum stocks at yearend 1994 increased by 340 kg over those of yearend 1993. The increased holdings were in stocks held by futures exchanges, which at yearend 1994 were 3,860 kg of platinum. Stocks of palladium held by futures exchanges also increased, from 1,150 kg at yearend 1993 to 1,980 kg at yearend 1994. Other accountable stocks of PGM's include those held by the Federal Government in the National Defense Stockpile. These stocks remained unchanged from the previous year, and at yearend 1994

consisted of 14,100 kg of platinum, 39,300 kg of palladium, and 920 kg of iridium.

Outlook

Demand for PGM is expected to continue to grow worldwide, given the strong demand for a cleaner environment. Many countries already require the use of catalytic converters for controlling emissions from gasoline-powered automobiles, and other countries are expected to adopt these requirements. Although both platinum and palladium are used in catalytic converters, in the short-term, platinum is expected to remain the dominant metal, owing primarily to the need to use up to three times as much palladium to obtain the desired emissions reduction. Domestically, the demand for PGM is also expected to grow as increasingly stringent standards for automobile emissions are adopted.

¹Stillwater Mining Co. 1994 Annual Report, 56 pp.

TABLE 1
U.S. IMPORTS FOR CONSUMPTION AND EXPORTS OF PLATINUM GROUP METALS IN 1994 1/

(Kilograms)

| Country | Ores and concentrates | Waste and scrap | Refined | | | | | | |
|---------------------------|-----------------------|-----------------|---------------|---------------|---------------|--------------|------------|-----------|--------------|
| | | | Platinum | Palladium | Rhodium | Iridium | Osmium | Ruthenium | |
| Imports | | | | | | | | | |
| Australia | -- | 4 | 927 | -- | -- | -- | -- | -- | |
| Belgium | -- | 10 | 1,850 | 10,200 | 150 | -- | -- | -- | |
| Brazil | -- | 2 | 232 | 374 | -- | -- | -- | -- | |
| Canada | -- | 148 | 1,150 | 1,700 | -- | (2/) | -- | (2/) | |
| Chile | -- | -- | -- | 54 | -- | -- | -- | -- | |
| China | -- | 108 | 33 | 1,250 | -- | -- | -- | -- | |
| Colombia | -- | 2 | 2,430 | -- | -- | -- | -- | -- | |
| Estonia | -- | 11 | -- | 46 | -- | -- | -- | -- | |
| Finland | -- | 10 | -- | 22 | -- | -- | -- | -- | |
| France | -- | 381 | 132 | 137 | 8 | -- | -- | -- | |
| Germany | -- | 19 | 1,210 | 3,220 | 181 | 227 | 3 | 471 | |
| Hong Kong | -- | 163 | 15 | -- | -- | -- | 6 | -- | |
| India | -- | -- | -- | 91 | -- | -- | -- | 300 | |
| Ireland | -- | -- | (2/) | 249 | 53 | (2/) | -- | -- | |
| Italy | -- | -- | 302 | 500 | 44 | -- | -- | -- | |
| Japan | -- | 53 | 259 | 4,260 | 88 | 1 | -- | 15 | |
| Korea, Republic of | -- | 379 | -- | -- | -- | -- | -- | -- | |
| Mexico | 6 | 9 | 23 | 12 | 3 | 2 | -- | -- | |
| Netherlands | -- | 361 | 73 | 55 | 45 | -- | -- | (2/) | |
| Norway | -- | -- | 481 | 1,270 | 17 | -- | -- | -- | |
| Russia | -- | -- | 4,000 | 35,500 | 1,590 | -- | -- | -- | |
| South Africa, Republic of | -- | -- | 39,100 | 22,900 | 4,880 | 557 | 46 | 8,720 | |
| Switzerland | -- | -- | 869 | 1,140 | 154 | 65 | -- | 259 | |
| Taiwan | -- | 280 | (2/) | 324 | -- | -- | -- | -- | |
| United Kingdom | -- | 1,260 | 3,410 | 9,270 | 614 | 73 | -- | 116 | |
| Other | -- | 22 | 29 | 4 | -- | 1 | -- | (2/) | |
| Total | 6 | 3,220 | 56,500 | 3/ | 92,500 | 7,820 | 926 | 55 | 9,880 |
| Exports | | | | | | | | | |
| Australia | -- | -- | 99 | 124 | -- | -- | -- | -- | |
| Belgium | -- | 20,900 | 2,670 | 5,480 | 60 | -- | -- | -- | |
| Brazil | -- | -- | 17 | -- | -- | -- | -- | -- | |
| Canada | 1 | 1,520 | 1,130 | 1,120 | 8 | 3 | 4/ | -- | |
| China | -- | 1 | -- | 100 | 4 | 1 | 4/ | -- | |
| Denmark | -- | -- | 3 | 24 | -- | -- | -- | -- | |
| Finland | -- | -- | 42 | 1 | -- | -- | -- | -- | |
| France | 156 | 4 | 202 | 728 | -- | 2 | 4/ | -- | |
| Germany | -- | 802 | 1,810 | 1,480 | 135 | 17 | 4/ | -- | |
| Greece | -- | -- | 1 | 11 | -- | -- | -- | -- | |
| Hong Kong | -- | 3 | 20 | 14 | -- | 12 | 4/ | -- | |
| Ireland | -- | -- | 568 | 327 | 64 | -- | -- | -- | |
| Israel | -- | -- | 274 | 249 | -- | -- | -- | -- | |
| Italy | -- | 495 | 2 | 470 | -- | 1 | 4/ | -- | |
| Japan | -- | 8,770 | 3,770 | 5,640 | 267 | 2 | 4/ | -- | |
| Korea, Republic of | 27 | -- | 1,170 | 651 | -- | -- | -- | -- | |
| Malaysia | -- | -- | 610 | -- | -- | -- | -- | -- | |
| Mexico | -- | -- | 717 | 3,280 | 1 | 1 | 4/ | -- | |
| Netherlands | -- | -- | 90 | 2,660 | -- | -- | -- | -- | |
| New Zealand | -- | -- | -- | 26 | 1 | 1 | 4/ | -- | |
| Norway | -- | -- | 4 | 69 | -- | -- | -- | -- | |
| Singapore | -- | -- | 3 | 861 | -- | -- | -- | -- | |
| South Africa, Republic of | (5/) | -- | -- | 203 | 15 | -- | -- | -- | |
| Spain | 5 | -- | 4 | 23 | -- | -- | -- | -- | |
| Sweden | 5 | 232 | 52 | 307 | -- | -- | -- | -- | |
| Switzerland | 7 | 186 | 1,150 | 836 | -- | -- | -- | -- | |
| Taiwan | -- | -- | 113 | 2,590 | -- | 1 | 4/ | -- | |
| Turkey | -- | -- | -- | -- | -- | -- | -- | -- | |
| United Kingdom | (5/) | 9,180 | 956 | 2,560 | 237 | 24 | 4/ | -- | |
| Other | 1 | 1 | 9 | 65 | (2/) | 3 | 4/ | -- | |
| Total | 202 | 42,100 | 15,500 | 29,900 | 791 | 68 | | | |

1/ Data rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

3/ Of this amount, 2,140 kilograms was in the form of platinum coins.

4/ Includes osmium and ruthenium.

5/ Data withheld pending verification by the Bureau of the Census.

TABLE 2
PLATINUM-GROUP METALS: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Kilograms)

| Country 3/ | 1990 | 1991 | 1992 | 1993 | 1994 e/ |
|-------------------------------------|----------------|----------------|-------------------|-------------------|----------------|
| Platinum: | | | | | |
| Australia e/ 4/ | 100 | 100 | 100 | 100 | 100 |
| Canada e/ 5/ | 5,040 | 4,680 | 4,800 | 5,000 r/ | 6,000 |
| Colombia | 1,320 | 1,600 | 1,960 | 1,720 r/ | 1,800 |
| Ethiopia e/ | 2 | 1 | 1 | 1 | 1 |
| Finland e/ | 60 | 60 | 60 | 60 | 60 |
| Japan 6/ | 1,430 | 988 | 629 | 661 r/ | 700 |
| Russia e/ 7/ | XX | XX | 28,000 | 20,000 | 15,000 |
| Serbia and Montenegro 8/ | XX | XX | 19 r/ | 15 r/ e/ | 15 |
| South Africa, Republic of e/ 5/ | 87,800 | 88,900 | 94,900 | 109,000 r/ | 102,000 |
| U.S.S.R. e/ 7/ 9/ | 31,000 | 30,000 | XX | XX | XX |
| United States e/ 10/ | 1,810 | 1,730 | 1,840 | 1,800 | 2,000 |
| Yugoslavia 8/ 11/ | 21 | 22 | XX | XX | XX |
| Zimbabwe | 21 | 19 | 9 | 4 r/ | 10 |
| Total | 129,000 | 128,000 | 132,000 | 138,000 r/ | 128,000 |
| Palladium: | | | | | |
| Australia e/ 4/ | 400 | 400 | 400 | 400 | 400 |
| Canada e/ 5/ | 5,270 | 6,440 | 5,800 | 6,000 r/ | 7,000 |
| Finland e/ | 100 | 100 | 100 | 100 | 100 |
| Japan 6/ | 1,050 | 1,050 | 986 | 1,180 r/ | 1,200 |
| Russia e/ 7/ | XX | XX | 70,000 | 50,000 | 40,000 |
| Serbia and Montenegro 8/ | XX | XX | 130 r/ | 125 r/ e/ | 125 |
| South Africa, Republic of e/ 5/ | 38,300 | 38,000 | 41,000 | 48,000 r/ | 44,000 |
| U.S.S.R. e/ 7/ 9/ | 84,000 | 82,000 | XX | XX | XX |
| United States e/ 10/ | 5,930 | 6,050 | 6,470 | 6,500 | 6,400 |
| Yugoslavia 8/ 11/ | 130 | 155 r/ | XX | XX | XX |
| Zimbabwe | 31 | 30 | 19 | 11 r/ | 20 |
| Total | 135,000 | 134,000 | 125,000 | 112,000 r/ | 99,200 |
| Other Platinum-group Metals: | | | | | |
| Canada e/ 5/ | 1,400 | 586 | 1,310 | 1,440 r/ | 1,970 |
| Russia e/ 7/ | XX | XX | 6,000 | 4,000 | 3,000 |
| South Africa, Republic of e/ 5/ | 15,800 | 16,000 | 17,000 | 19,000 r/ | 18,000 |
| U.S.S.R. e/ 7/ 9/ | 10,000 | 9,500 | XX | XX | XX |
| Total | 27,200 | 26,100 | 24,300 | 24,400 r/ | 23,000 |
| Grand total | 291,000 | 288,000 | 282,000 r/ | 275,000 r/ | 250,000 |

e/ Estimated. r/ Revised. XX Not applicable.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Table includes data available through May 4, 1995. Platinum-group metal 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.

3/ In addition to the countries listed, China, Indonesia, Papua New Guinea, and the Philippines are believed to produce platinum-group metals, 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. However, a part of this output not specifically reported by country is presumably included in this table credited to Japan.

4/ Platinum-group metals recovered from nickel ore processed domestically. Platinum-group metals extracted from exported ores are believed to be included in the production figures for Japan, and may be included in figures for other receiving countries.

5/ Country reports only total of platinum-group metals produced. Figures for constituent metals are U.S. Bureau of Mines estimates.

6/ Production derived entirely from imported ores.

7/ All production in the U.S.S.R. for 1990-91 came from Russia.

8/ All production in Yugoslavia for 1990-91 came from Serbia and Montenegro.

9/ Dissolved in Dec. 1991.

10/ Estimates for the Stillwater Mine, from published sources. A very small quantity of byproduct platinum and palladium produced from gold-copper ores was excluded.

11/ Dissolved in Apr. 1992.