

## Russia, Palladium, and Semiconductors

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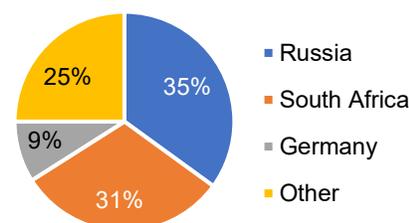
*Palladium is critical to the U.S. economy and national security. Russia is the largest supplier of the metal to the United States. When the war in Ukraine began in February 2022 and sanctions against Russia were imposed, many reports highlighted how reliant the western world is on palladium from Russia. This executive briefing briefly describes palladium and its uses, including semiconductor production; expands on Russia's role in the palladium supply chain; and discusses the effect Russian supply has on pricing.*

**Palladium:** Palladium is a member of the platinum group metals (PGM), a collection of rare precious metals.<sup>1</sup> Like other PGMs, palladium has a high melting point, is corrosion resistant, and is a key material in certain industrial processes.<sup>2</sup> The most common application is in automotive catalytic converters, where it helps to decrease pollution. Palladium is also a critical input for certain stages of semiconductor manufacturing. It is primarily used in the metal connections attaching chips to circuit boards and in the junctions between the chips and other metals.

Palladium is typically sourced as a byproduct or from recycling operations due to its low concentration in commercially significant ores. All primary commercial sources are tied to other mining operations, typically nickel and copper mining. Palladium is initially extracted as an impure concentrate, which is subsequently refined to higher purities at other facilities. In the United States, one company (Sibanye-Stillwater in Montana) produces palladium concentrates and an initial refined product, but that material is exported to the United Kingdom for further refining into commercial grades. Total U.S. output averages 14,000 kilograms per year, which represents only about 16 percent of total U.S. palladium consumption in 2021.<sup>3</sup>

**Palladium, Russia, and Prices:** Most of the PGMs produced today are sourced from mineral deposits in the Noril'sk-Talnakh area of Russia and from South Africa.<sup>4</sup> The composition of ore deposits vary widely from country-to-country: Russia produces about three times as much palladium as platinum, while South Africa produces twice as much platinum as palladium. Over several decades, Russia built a palladium stockpile, although the true amount in the stockpile has never been known. Approximately two-fifths of the global palladium supply, and over one-third of 2021 U.S. imports, is sourced from Russia (figure 1). As of 2022, one Russian mining company (MMC Norilsk Nickel PJSC, the world's largest nickel producer) produces about 40 percent of Russian palladium.

**Figure 1:** Country Sources of 2021 U.S. Palladium Imports



Source: USGS "[Platinum-Group Metals](#)," January 2022.

Palladium prices were relatively stable in the decades prior to the 2000s but have since undergone several spikes (figure 2). The first noticeable price increase, in the latter half of the 1990s, while due in part to the tech boom, was primarily attributable to Russian implications that it was not going to sell any of its

<sup>1</sup> Precious metals have a perceived scarcity and high economic value. Platinum, iridium, osmium, rhodium, and ruthenium are other PGMs.

<sup>2</sup> PGMs, including palladium, do not have adequate substitutes for their various applications.

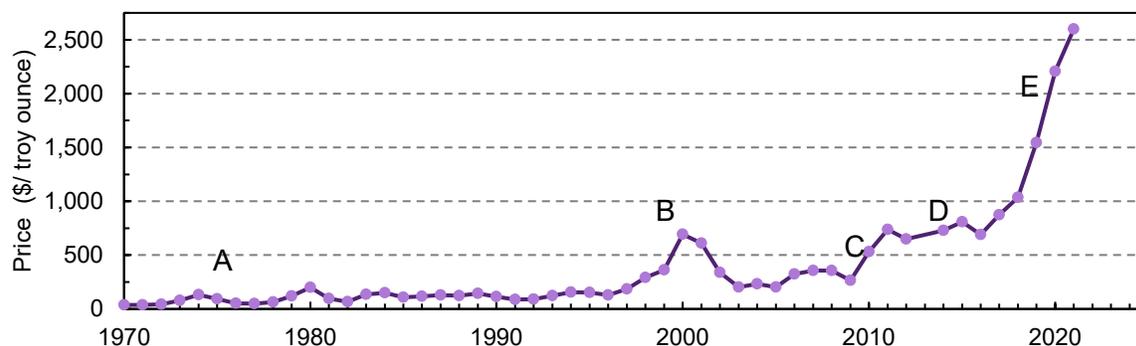
<sup>3</sup> As a precious metal, palladium is often traded in Troy ounces, where 1 kilogram equals 31.1507 troy ounces.

<sup>4</sup> Significant development did not begin until the 1960s when industrial demands for PGMs increased.

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palladium reserves.<sup>5</sup> Russia eventually did sell from its reserves, causing prices to fall. In 2011, speculation over reports that Russian reserves would be depleted over the succeeding three years drove palladium prices back up to similar highs, which were maintained for several years. Further speculation in 2019 that the Russian palladium stockpile was again facing imminent depletion contributed to the subsequent rapidly rising prices. These events detail how integral Russia is to the global palladium market and how even its rumored developments affect the global price. Despite reports of Russian palladium depletion, Russia has consistently exported over 80 million kilograms annually since 2016 (figure 3).

**Figure 2:** Price of Palladium in dollars per troy ounce, 1970–2021

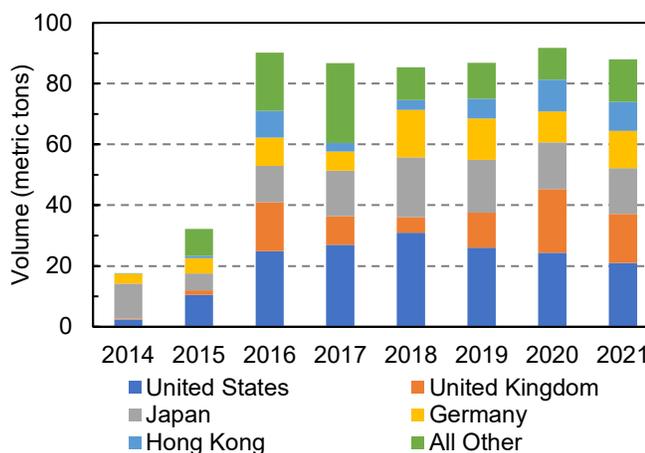


Source: Compiled based on USGS, “[Metal Prices in the United States Through 2010](#),” March 5, 2013; USGS, “[Platinum-Group Metals](#),” January 2016; USGS “[Platinum-Group Metals](#),” January 2022.

Notes: (A) widespread introduction of catalytic converters U.S. automobile market; (B) shortfall of palladium supplies from Russia; (C) speculation over Russian palladium reserves; (D) occupation of Crimea; (E) COVID-19 pandemic.

**Outlook:** Palladium prices have continued to climb throughout the Russian war with Ukraine. As of March 2022, no sanctions have been announced on palladium. However, in February 2022 the White House did issue a warning to certain industries, including semiconductor manufacturers, to diversify their supply chains for certain key materials, such as palladium. Even without sanctions, securing supplies from Russia will likely be difficult as palladium is primarily shipped via airfreight and several countries have closed airspace to Russian planes. Reportedly, many western companies are attempting to diversify their supply away from Norilsk Nickel. The full extent of the palladium supply disruption will depend on the overall course of the ongoing conflict.

**Figure 3:** Russian exports of palladium, 2014–2021



Source: Official exports statistics from Russia under HS heading 7110.21 and 7110.29, as reported by national statistical authorities in the Global Trade Atlas database, accessed March 24, 2022.

Sources: USGS, “[Platinum-Group Elements](#),” 2017; USGS, “[Fact Sheet 2014–3064](#),” July 25, 2014; USGS, “[U.S. Geological Survey Releases 2022](#),” February 22, 2022; Loferski, “[Platinum-Group Metals](#),” 2012; Quinio, “[Oil Ban Talk](#),” March 7, 2022; MacDonald, “[This Russian Metals Giant](#),” March 7, 2022; Touryalai, “[A Russian State Secret](#),” October 21, 2010; White, “[A Mismanaged Palladium Stockpile](#),” February 6, 2022; Rapoza, “[What Russia Means to Palladium Prices](#),” February 3, 2012; Reuters, “[Russia Could Hit U.S. chip industry](#),” February 11, 2002; Warwick, “[Palladium Spot Price](#),” March 3, 2022.

<sup>5</sup> Some firms secured supplies when prices were high and some, like Ford, incurred billion dollar-level losses.

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