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Washington, DC 20548

April 30, 2019

The Honorable Tom Udall
Ranking Member
Subcommittee on Interior, Environment, and Related Agencies
Committee on Appropriations
United States Senate

Hardrock Mining: Trends in U.S. Reliance on Imports for Selected Minerals

Dear Senator Udall:

Hardrock minerals, such as copper, play an important role in the U.S. economy, contributing to multiple industries, including transportation, defense, aerospace, electronics, energy, agriculture, construction, and health care. Over the past six decades, many of these minerals have been sourced increasingly from outside the United States, according to the U.S. Geological Survey (USGS), an agency within the Department of the Interior (Interior).¹

USGS reports annually on the United States’ dependence on imports of non-fuel mineral commodities—referred to as minerals—to meet domestic consumption. It does so by calculating the net import reliance as a percentage of apparent U.S. consumption,² also known as the net import reliance percentage.³ A mineral’s net import reliance percentage equals the amount of imports minus the amount of exports of that mineral, expressed as a percentage of domestic consumption of the mineral.⁴ Specifically:

$$\text{Net import reliance percentage} = \frac{\text{Imports} - \text{exports} + \text{adjustments in stocks}}{\text{Apparent consumption}} \times 100$$

This percentage represents how reliant on the import of a particular mineral the United States is, taking into account what is imported and exported. For example, a net import reliance percentage of 60 for a particular mineral indicates that 60 percent of apparent U.S. consumption is met through net imports—that is, imports minus exports, accounting for adjustments in

¹USGS provides statistics on the worldwide supply, demand, and consumption of mineral commodities essential to the nation’s economy and national security, among other things. These data do not include information on whether these minerals were produced from federal lands, according to agency officials.

²Apparent consumption is met by domestic production, plus imports minus exports, plus adjustments for changes in government and industry stocks. Adjustments in stocks refers to changes in the amount of material held in inventories. Decreases in stocks contribute to net import reliance, whereas stock increases reduce net import reliance.

³To develop these data, USGS collects production data through monthly, quarterly, and annual USGS mineral industry surveys and import and export data from the U.S. Census Bureau and other sources. The authority for USGS to collect such data is found in the National Materials and Minerals Policy, Research and Development Act of 1980. This act, among other things, directs the Secretary of the Interior to collect and analyze mineral data and restricts the disclosure of nonaggregated data and information.

⁴The calculation also takes into account changes in domestic stockpiles of the mineral.

domestic stocks. The remaining 40 percent of apparent U.S. consumption is met by U.S. domestic production. A net import reliance percentage less than zero indicates that the United States was a net exporter of that particular mineral in that year, and a net import reliance of 100 means the United States is completely reliant on imports to meet its domestic consumption.

According to USGS officials, the net import reliance percentage is one factor in determining whether a mineral is considered to be critical, as that percentage can help identify the potential for supply disruption of a particular mineral; however, the net import reliance percentage does not take into account information about the economic or strategic risk of relying on imports for a particular mineral. For example, although a net import reliance percentage greater than 50 percent is considered to be high, it should not always be construed to pose a potential supply risk, according to USGS officials. Specifically, if the import source for a particular mineral is a nation with whom the United States has reliable trade relations, the risk of a supply disruption is lessened.

In December 2017, the President issued an executive order that emphasizes the importance of understanding the United States' reliance on imports of certain minerals that are vital to national security and economic prosperity.⁵ These minerals are referred to as critical minerals. Using the definition of a critical mineral established in Executive Order 13817, Interior published a list of 35 minerals designated as critical minerals on May 18, 2018.⁶

You asked us to provide updated information on import trends for hardrock minerals from our prior report.⁷ This report describes trends in U.S. net import reliance percentages for 15 hardrock minerals from 1990 through 2017.

To conduct this work, we analyzed USGS's net import reliance percentage data for the following 15 hardrock minerals from 1990 through 2017—the most recently available data at the time of our review: barite, copper, fluor spar, gold, gypsum, lead, magnesium compounds, magnesium metal, nickel, palladium, perlite, platinum, silver, tungsten, and zinc. We previously reported on the net import reliance percentages of these minerals in 2008. In selecting the minerals for that report, we interviewed officials from Interior's Bureau of Land Management and the U.S. Department of Agriculture's Forest Service to identify hardrock minerals produced on federal land.⁸ We also reviewed reports on hardrock mining, including from the National Academy of

⁵Executive Order 13817 of Dec. 20, 2017, *A Federal Strategy To Ensure Secure and Reliable Supplies of Critical Minerals*, 82 Fed. Reg. 60835 (Dec. 26, 2017). The order directs the Department of the Interior, in coordination with the Department of Defense and in consultation with the heads of other relevant executive departments and agencies, to publish a list of critical minerals, which the order defines as "a mineral identified by the Secretary of the Interior to be (i) a non-fuel mineral or mineral material essential to the economic and national security of the United States, (ii) the supply chain of which is vulnerable to disruption, and (iii) that serves an essential function in the manufacturing of a product, the absence of which would have significant consequences for our economy or our national security."

⁶83 Fed. Reg. 23295 (May 18, 2018). The dependency of the United States on foreign sources creates a strategic vulnerability for both its economy and military to adverse foreign government action, natural disaster, and other events that can disrupt supply of these key minerals, according to this federal register notice.

⁷See GAO, *Hardrock Mining: Information on State Royalties and Trends in Mineral Imports and Exports*, [GAO-08-849R](#) (Washington, D.C.: July 21, 2008). In addition, we previously examined federal agency efforts to manage supply risks associated with critical minerals in *Advanced Technologies: Strengthened Federal Approach Needed to Help Identify and Mitigate Supply Risks for Critical Raw Materials*, [GAO-16-699](#) (Washington, D.C.: Sept. 7, 2016).

⁸The Forest Service participates with the Bureau of Land Management in managing hardrock minerals on federal lands. The Forest Service has principal responsibility for use and protection of surface resources on National Forest System lands, and to ensure such lands are reclaimed to support ongoing land uses. See generally, 36 C.F.R. Part

Sciences. To examine trends for this report, we analyzed USGS data to determine which hardrock minerals had net import reliance percentages that generally increased, generally decreased, remained generally constant, or fluctuated with no long-term discernable trend. We also interviewed USGS officials about their perspectives on the context for and implications of trends. To assess the reliability of these data, we reviewed agency documents on the data and interviewed knowledgeable USGS officials. We found the data to be sufficiently reliable for our purposes.

We conducted this performance audit from November 2018 to April 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

In Summary

From 1990 through 2017, trends in net import reliance percentages have varied for 15 hardrock minerals, based on our analysis of USGS data. Specifically, for this time period, the net import reliance percentages generally increased for six of the 15 hardrock minerals (copper, magnesium compounds, magnesium metal, perlite, silver, and zinc); generally decreased for four minerals (gypsum, palladium, platinum, and tungsten); remained generally constant for two minerals (fluorspar and gold); or fluctuated with no long-term discernable trend for the remaining three minerals (barite, lead, and nickel). Our analysis of USGS data over this time period also shows:

- The net import reliance percentages have averaged over 50 percent from 1990 through 2017 for eight of the 15 minerals we examined (barite, fluorspar, nickel, palladium, platinum, silver, tungsten, and zinc).
- Six of the 15 hardrock minerals are included on Interior’s list of critical minerals to the United States: barite, fluorspar, magnesium metal, palladium, platinum, and tungsten. Of these, four (barite, fluorspar, palladium, and platinum) had average net import reliance percentages of over 50 percent for at least the last 10 years covered by our review—2008 through 2017.
 - Although barite has fluctuated since 1990, it consistently had a net import reliance percentage greater than 70 since 2000. This mineral is used in oil and gas drilling and radiation shielding, among other applications. China is the top producer and supplier of this mineral to the United States, according to a USGS report.⁹
 - The United States has relied entirely on imports of fluorspar to meet apparent consumption since 1997. Fluorspar is used to make chemicals for aluminum production, semiconductor manufacturing, and uranium processing, among other things. Mexico is the primary supplier to the United States for this mineral,

228, Subpart A. Management of hardrock mineral resources is governed by Bureau of Land Management regulations at 43 C.F.R. Group 3800.

⁹A producer of a mineral refers to a country that produces or mines that mineral. Supplier refers to the country that supplies the mineral to the United States or another country. For some minerals, these are different countries.

although China is the leading producer of it worldwide, according to a USGS report.

- Magnesium metal is used in the aerospace, defense, and transportation sectors, among others. Magnesium metal has had an average net import reliance percentage of 41 from 2008 through 2017. China is the top producer of magnesium metal worldwide, and Israel and Canada are the top suppliers to the United States, according to a USGS report.
- Platinum and palladium have had average net import reliance percentages of 77 and 59, respectively, from 2008 through 2017, although the net import reliance percentages for both of these have been generally decreasing since the early-2000s. These minerals are used for catalytic converters for automobiles, fuel cells, and electronics, among other things. South Africa is the top producer of platinum and the second largest producer of palladium worldwide and the top supplier of these minerals to the United States, according to a USGS report.
- The net import reliance percentage for tungsten, which is used for cutting and drilling tools, jet engines, and cellular phones, has been generally decreasing since 1990, although the percentage has started increasing again in 2017, according to USGS officials. China is both the top producer and supplier of this to the United States, according to a USGS report.
- The United States has been a net exporter of gold in every year except 2004.
- While there was no discernable trend for lead overall, the net import reliance percentage has steadily increased since 2008. Although lead is still being mined domestically, the United States is becoming more reliant on imported refined lead because of the closure of the last lead smelter in 2013, according to USGS officials.

See enclosure 1 for more detailed information on the net import reliance percentages for these 15 hardrock minerals.

Agency Comments

We provided a draft of this product to the Department of the Interior for comment. USGS provided technical comments, which we incorporated as appropriate.

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As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the appropriate congressional committees, the Secretary of the Interior, the Director of the U.S. Geological Survey, and other interested parties. In addition, the report will be available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or fennella@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report were Elizabeth Erdmann (Assistant Director), William Gerard, Kelsey Kennedy, Gwen Kirby, Leslie Kaas Pollock, Anne Rhodes-Kline, Oliver Richard, and Jack Wang.

Sincerely yours,

A handwritten signature in black ink that reads "Anne-Marie Fennell". The signature is written in a cursive style with a large initial "A" and a long horizontal line extending from the end of the name.

Anne-Marie Fennell
Director, Natural Resources and Environment

Enclosure

Enclosure 1: Data on Net Import Reliance Percentages

Table 1 provides the net import reliance percentages for 15 hardrock minerals for the years 1990 through 2017.

Table 1: U.S. Net Import Reliance as a Percentage of U.S. Apparent Consumption for 15 Hardrock Minerals, 1990 through 2017

| Year | Barite ^a | Copper | Fluorspar ^a | Gold | Gypsum | Lead | Magnesium Compounds | Magnesium Metal ^a | Nickel | Palladium ^a | Perlite | Platinum ^{a,b} | Silver | Tungsten ^a | Zinc ^c |
|------|---------------------|--------|------------------------|----------------|--------|------|---------------------|------------------------------|--------|------------------------|---------|-------------------------|-----------------|-----------------------|-------------------|
| 1990 | 71 | 3 | 89 | E | 36 | 3 | 15 | E | 64 | NA ^d | 5 | NA ^d | NA ^e | 81 | 41 |
| 1991 | 66 | E | 88 | E | 31 | 6 | 18 | E | 61 | NA ^d | 5 | NA ^d | NA ^e | 91 | 24 |
| 1992 | 52 | 2 | 91 | E | 31 | 10 | 24 | E | 59 | NA ^d | 6 | NA ^d | NA ^e | 86 | 61 |
| 1993 | 72 | 7 | 89 | E | 31 | 15 | 35 | E | 63 | NA ^d | 7 | NA ^d | NA ^e | 81 | 67 |
| 1994 | 64 | 13 | 91 | E | 31 | 19 | 41 | E | 64 | NA ^d | 6 | NA ^d | NA ^e | 95 | 71 |
| 1995 | 65 | 7 | 91 | E | 30 | 17 | 43 | E | 60 | NA ^d | 6 | NA ^d | NA ^e | 90 | 71 |
| 1996 | 70 | 14 | 99 | E | 29 | 17 | 31 | E | 59 | NA ^d | 11 | NA ^d | NA ^e | 89 | 69 |
| 1997 | 76 | 13 | 100 | E | 28 | 14 | 34 | 16 | 56 | NA ^d | 12 | NA ^d | E | 84 | 70 |
| 1998 | 80 | 14 | 100 | E | 28 | 18 | 44 | 25 | 64 | 90 | 14 | 94 | 43 | 77 | 71 |
| 1999 | 66 | 27 | 100 | E | 25 | 20 | 41 | 38 | 63 | 92 | 12 | 96 | 39 | 65 | 74 |
| 2000 | 84 | 37 | 100 | E | 27 | 13 | 48 | 43 | 56 | 84 | 17 | 78 | 43 | 66 | 72 |
| 2001 | 86 | 22 | 100 | E | 27 | 8 | 39 | 44 | 52 | 88 | 18 | 92 | 49 | 64 | 73 |
| 2002 | 78 | 37 | 100 | E | 27 | E | 46 | 55 | 52 | 82 | 26 | 91 | 60 | 69 | 75 |
| 2003 | 77 | 40 | 100 | E | 25 | E | 46 | 53 | 45 | 82 | 30 | 91 | 65 | 63 | 70 |
| 2004 | 78 | 43 | 100 | 8 | 28 | E | 52 | 61 | 49 | 83 | 28 | 92 | 54 | 73 | 72 |
| 2005 | 84 | 42 | 100 | E | 27 | E | 54 | 60 | 48 | 84 | 24 | 93 | 72 | 68 | 67 |
| 2006 | 81 | 38 | 100 | E | 27 | E | 55 | 53 | 50 | 75 | 32 | 90 | 67 | 67 | 77 |
| 2007 | 85 | 37 | 100 | E | 28 | E | 49 | 47 | 17 | 73 | 33 | 91 | 64 | 67 | 73 |
| 2008 | 80 | 31 | 100 | E | 25 | E | 54 | 50 | 32 | 79 | 26 | 89 | 61 | 60 | 72 |
| 2009 | 78 | 21 | 100 | E ^f | 17 | 13 | 40 | 33 | 22 | 62 | 26 | 95 | 58 | 68 | 77 |
| 2010 | 75 | 32 | 100 | E ^f | 12 | 13 | 50 | 38 | 41 | 49 | 24 | 91 | 65 | 63 | 73 |
| 2011 | 76 | 34 | 100 | E ^f | 12 | 19 | 49 | 33 | 48 | 64 | 27 | 89 | 66 | 40 | 74 |
| 2012 | 81 | 36 | 100 | E ^f | 12 | 19 | 54 | <30 ^g | 49 | 57 | 22 | 73 | 54 | 39 | 71 |
| 2013 | 71 | 34 | 100 | E | 12 | 26 | 57 | <50 ^g | 47 | 60 | 20 | 67 | 59 | 41 | 75 |
| 2014 | 79 | 31 | 100 | E | 11 | 34 | 60 | <50 ^g | 58 | 65 | 19 | 67 | 63 | >25 ^g | 81 |
| 2015 | 78 | 31 | 100 | E | 11 | 31 | 66 | <50 ^g | 52 | 53 | 20 | 69 | 71 | >25 ^g | 81 |
| 2016 | 83 | 29 | 100 | E | 11 | 33 | 51 | <50 ^g | 45 | 53 | 28 | 66 | 68 | >25 ^g | 84 |
| 2017 | >75 ^g | 33 | 100 | E | 12 | 40 | 47 | <25 ^g | 59 | 45 | 23 | 68 | 62 | >50 ^g | 85 |

Legend: E = the United States was a net exporter for this mineral; NA = not available.

Source: U.S. Geological Survey (USGS). | GAO-19-434R

Notes: Net import reliance as a percentage of apparent consumption is calculated as the amount of imported material minus exports of that material, plus adjustments for changes in the amount of that material held in stockpiles domestically, as expressed as a percentage of domestic consumption. Net import reliance information for 1990 through 2013 is based on the most accurate data available 5 years after the given year, whereas information for 2014 through 2017 is based on the most accurate data available in 2018 and may be estimated based on partial data.

^aThe mineral is considered to be a critical mineral, as defined by Executive Order 13817, and identified in 83 Fed. Reg. 23295.

^bBeginning in 2016, the platinum data series was revised to include imports of waste and scrap in the calculation.

^cBeginning in 1992, the zinc data series was revised from "all zinc forms" to "refined zinc metal" in the calculation.

^dPrior to the Mineral Commodity Summaries 1996 report, values for platinum group metals, which include palladium and platinum, were reported collectively. Starting in the Mineral Commodity Summaries 2001 report, USGS published net import reliance figures for palladium and platinum separately, starting with data dating back to 1998.

^eThe United States is a net importer of silver; however, changes in unreported investor stocks preclude calculations of a meaningful net import reliance percentage.

^fThere was no net import reliance percentage for gold reported in these years. The United States has been a net exporter; however large unreported investor stock changes preclude calculation of a meaningful net import reliance percentage.

^gThe net import reliance as a percentage of apparent consumption cannot be published for that mineral in a particular year because doing so will potentially disclose proprietary company data. For those years, a net import reliance percentage is calculated using actual data and then is published using a greater than or less than value so that only an aggregated range of possible values is disclosed.

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