Meeting the Mineral Needs of the United States

A recent report points out where the United States is most dependent on mineral imports and highlights some ways for reducing this dependence.

Stacks of aluminum ingots, ready for transport. Roughly 60% of aluminum used in the United States is imported. A recent U.S. Geological Survey report shows where the United States is most dependent on mineral imports and suggests ways to reduce this dependence. Credit: Leonid Eremeychuk/iStock/Getty Images Plus/Getty Images

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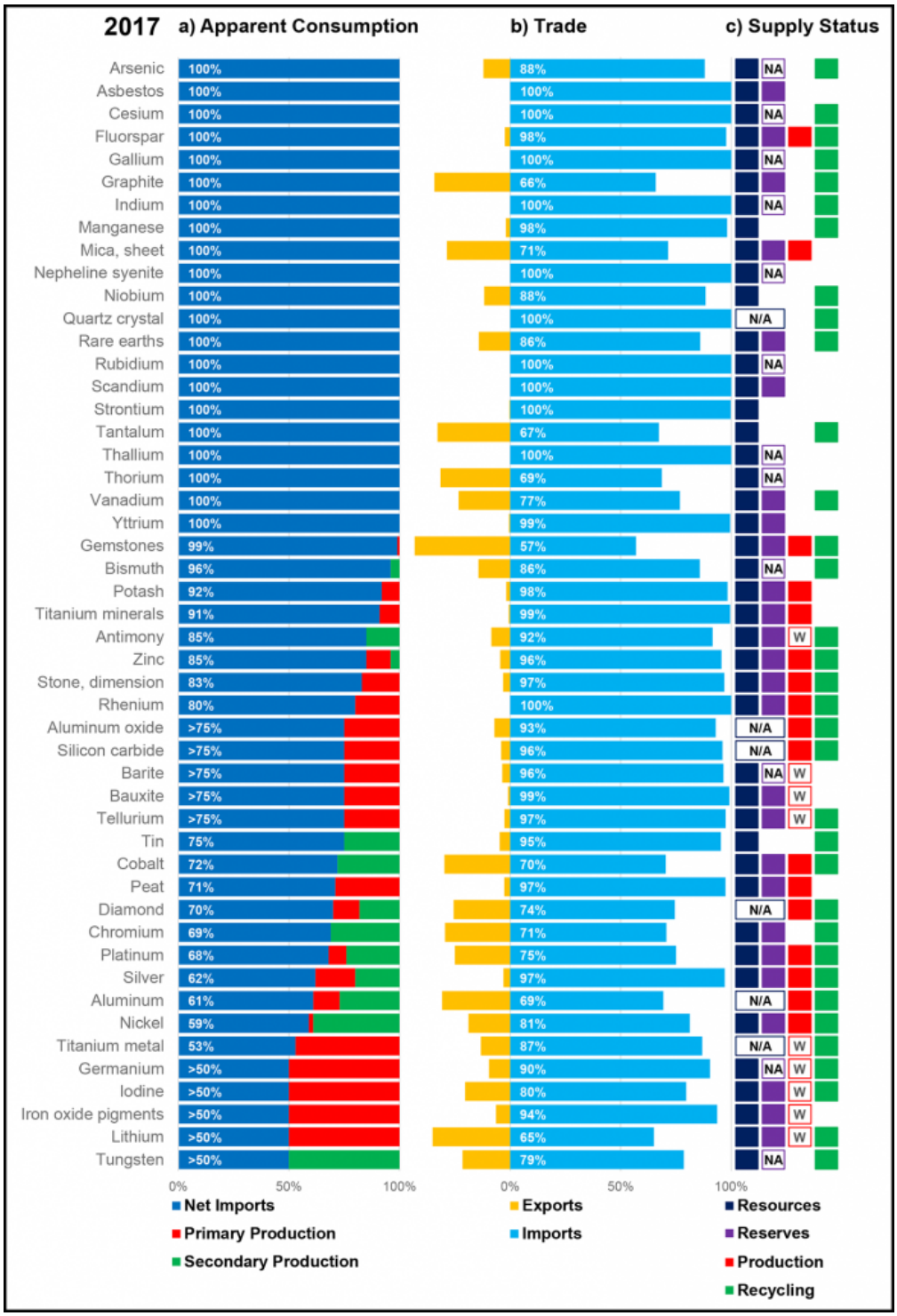
The United States relies on mineral resources of all kinds: iron and aluminum for automotive parts, rare earth elements for consumer electronic devices, and titanium pigments for paints and coatings, to name

only a few. The United States can produce enough of some of these mineral commodities to meet domestic demand, but for others it relies on imports from around the world. Political instability and competition from other nations could disrupt the flow of imported minerals, leaving U.S. markets to deal with shortages and high prices. Thus, it is necessary to keep track of what is imported and how much and from whom.

On 20 December 2017, the White House issued Executive Order 13817 (https://www.federalregister.gov/documents/2017/12/26/2017-27899/a-federal-strategy-to-ensure-secure-and-reliable-supplies-of-critical-minerals), entitled "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals," citing the reliance of the United States on imports for certain mineral commodities vital to economic and national security interests. The order states that increased domestic exploration, production, recycling, and processing will reduce reliance on imports. And import reliance is one of many factors that determine the risks communities would face if foreign supplies were disrupted [*Fortier et al.,* 2015].

In 2017, the United States relied on imports for more than half its supply of 50 mineral commodities. The U.S. Geological Survey's National Minerals Information Center (https://minerals.usgs.gov/minerals/pubs/nmic/) compiles and publishes production, consumption, and net import reliance data for more than 90 nonfuel minerals and materials. By combining production, trade, and consumption data into a single statistic for each commodity, net import reliance provides a method to evaluate the status of the U.S. mineral supply.

Here the key components that determine net import reliance are described to better illustrate the role of the domestic mineral industry, natural resources, and international trade relations. Although other factors, such as geographic production concentration and the availability of alternatives, are important, reducing net import reliance is one way to mitigate supply risk.



(https://eos.org/wp-content/uploads/2018/07/mineral-commodity-import-export-consumption-resources-reserves-production-f01.png)

Fig. 1. Data for 2017 for apparent consumption, trade, and supply status of mineral commodities for which the United States is at least 50% import reliant. (a) Net imports, primary production, and secondary production are shown as a percentage of domestic consumption. (b) Imports and exports are shown as a percentage of total U.S. trade. (c) The status of U.S. supply is shown as a series of

boxes. Solid boxes indicate that a mineral commodity is produced or recycled domestically and whether domestic reserves and resources exist. Open boxes indicate that data are withheld (W), not available (NA), or not applicable (N/A). Note that iron oxide pigments (natural and synthetic) are combined because statistics are not reported separately. Credit: *U.S. Geological Survey* [2018]. Click image for larger version.

Of the more than 90 individual mineral commodities analyzed in 2017, the United States relied on imports for more than half its supply of 50 mineral commodities [*U.S. Geological Survey,* 2018]. Mineral commodities for which the United States was greater than 50% import reliant are shown in Figure 1. Mineral commodities for which the United was less than 50% import reliant (e.g., lead or copper) or a net exporter (e.g., molybdenum) are not shown.

What Is Net Import Reliance?

Net import reliance measures the dependence of the United States on imports to meet domestic consumption. This figure is the difference between imports and exports of mineral commodities, adjusting for changes in industry and government stocks.

“Stock adjustments” refer to changes in the amount of material held in inventories. Decreases in stocks contribute to net imports, whereas stock increases reduce net imports. Negative net imports indicate that the United States was a net exporter. For all other mineral commodities, net imports contribute to the total quantity consumed by the United States. This total quantity, referred to as “apparent consumption,” is the sum of primary production, secondary production, and net imports.

Primary production refers to material mined, refined, or manufactured domestically, whereas secondary production refers to material recovered from recycling of scrap. Net import reliance (NIR) is the percentage of domestic apparent consumption that comes from net imports.

Although the general form of the NIR equation is used consistently across mineral commodities, data on domestic production, industry stocks, or rates of recycling may not be available for each individual commodity. The relationships among the variables used to calculate NIR are shown in Figure 2, which showcases how the apparent consumption of refined zinc is dominated by imports.

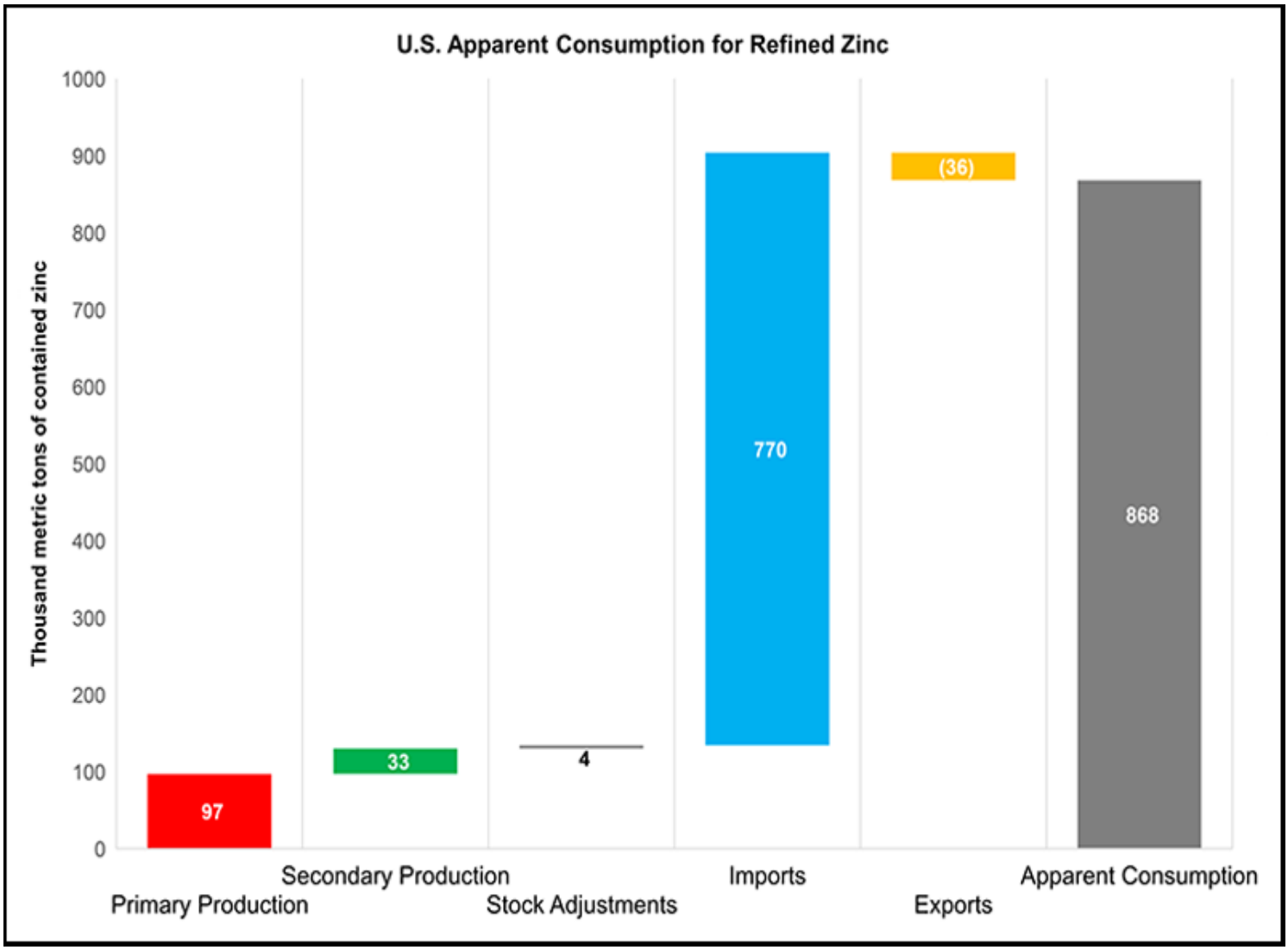


Fig. 2. A waterfall diagram illustrates the relationship between the components of U.S. apparent consumption of refined zinc, including primary and secondary production, stock adjustments, imports, and exports.

Consumption and Trade

Three sources meet domestic demand for mineral commodities:

primary production
secondary production
net imports

The United States depends entirely on imports for 21 mineral commodities. For 19 of these commodities, including cesium, rubidium, and tantalum, no domestic production takes place (NIR is 100%). Minimal quantities of fluorspar (https://minerals.usgs.gov/minerals/pubs/commodity/fluorspar/) and sheet mica (https://minerals.usgs.gov/minerals/pubs/commodity/mica/) are produced domestically as by-products of limestone and feldspar (https://minerals.usgs.gov/minerals/pubs/commodity/feldspar/) mining, respectively.

For mineral commodities with less than 100% import reliance, primary and secondary productions satisfy the remaining portion of apparent consumption. In some cases, primary production data are withheld to avoid disclosing proprietary information; in these cases, approximate NIR values are used.

Imports and exports include raw materials, such as ores and concentrates; metals; chemicals; and certain semimanufactured products. Materials embedded in finished consumer products are not considered in traditional net import reliance statistics. Exports of mineral commodities with no domestic production represent imported material that underwent a transformation process in the United States. For example, although gallium (https://minerals.usgs.gov/minerals/pubs/commodity/gallium/) is not produced domestically, low-grade primary gallium imports are refined into high-purity gallium at a facility in Utah, some of which is then exported in the form of light-emitting diodes (LEDs), integrated circuits, and other products.

U.S. Supply Status

The domestic components of supply consist of primary production and recycling. Primary production refers to the mining of ore from reserves, the economic subset of identified resources. In Figure 1, a primary production box indicates that a mineral commodity is produced domestically, even if production data are withheld or excluded from apparent consumption.

A recycling box indicates that a mineral commodity is currently recycled in the United States. Quantitative estimates of the contribution of recycling to apparent consumption are not available for several mineral commodities. For example, gallium arsenide semiconductors are recycled as new scrap (distinct from postconsumer scrap) but are not included as secondary production of gallium or arsenic (https://minerals.usgs.gov/minerals/pubs/commodity/arsenic/).

Resources are defined as naturally occurring concentrations of material in Earth's crust where economic extraction is currently or potentially feasible. Although resources of many mineral commodities occur in the United States, resources of some mineral commodities are insignificant or currently considered subeconomic (e.g., domestic identified resources of manganese, tantalum, and tin).

Reserves represent the portion of identified resources that could be economically extracted or produced at the time of determination. Reserves are dynamic and dependent on continued exploration or changing economic conditions such as commodity prices and extraction costs. Reserves and resource terminology are not applicable to manufactured products such as silicon carbide, aluminum, and aluminum oxide.

By examining the components of apparent consumption, trade, and supply alongside net import reliance, a few general trends become apparent. Reserves, production, recycling, exports, and by-product recovery each contribute to the overall import reliance picture.

Domestic Reserves

In general, the United States does not lack mineral resources, but not all resources will become reserves and not all reserves will lead to production.

A common misconception is that the United States must import mineral commodities because no domestic resources exist. In general, the United States does not lack mineral resources. For example, it has resources of 43 mineral commodities with high NIR.

Reserves, on the other hand, are related to domestic production. Of the 26 mineral commodities with reserves estimates, 19 are produced domestically. Seven mineral commodities with domestic reserves lack domestic primary production: asbestos, chromium, graphite, rare earths, scandium, vanadium, and yttrium.

Domestic reserves data are not available for 12 mineral commodities: arsenic, barite, bismuth, cesium, gallium, germanium, indium, nepheline syenite, rubidium, thallium, thorium, and tungsten. Reserves estimates are not typically conducted for by-products and minor constituents of a mineral deposit. Of the 12 mineral commodities for which reserves data are not available, eight are by-products that are not recovered domestically.

The United States lacks domestic reserves of five commodities: manganese, niobium, strontium, tantalum, and tin. Reclassifying resources as reserves requires considerable investment and effort to conduct exploration and economic feasibility analysis. Therefore, not all resources will become reserves, and not all reserves will lead to production. Reserves that may result in production include graphite (https://minerals.usgs.gov/minerals/pubs/commodity/graphite/) projects under development in Alaska and Alabama and a niobium (https://minerals.usgs.gov/minerals/pubs/commodity/niobium/) project under development in Nebraska.

Domestic Production

In general, mineral commodities with domestic reserves are also produced domestically. Several factors determine whether mineral commodities are produced, including market conditions, comparative advantage among countries, environmental and social issues (https://eos.org/research-spotlights/natural-resource-exploitation-could-reach-new-depths), and other economic forces.

For example, although domestic reserves exist, asbestos has not been mined since 2002. U.S. demand decreased as a result of health and liability issues, and 100% of asbestos apparent consumption is met through imports. Under different market conditions or regulatory policies, the United States could resume mining asbestos or other mineral commodities because reserves are available. Similarly, an increase in rare earth prices in 2011 led to the classification of reserves in California, but the subsequent

fall in prices hindered domestic production. For any commodity, individual deposits are subject to similar market forces.

Several by-product mineral commodities have neither primary production nor reserve estimates. In polymetallic ore deposits, mining operations target a specific mineral commodity, but the potential by-products are not recovered. For example, germanium, gallium, and indium are, in some cases, unrecovered constituents of zinc ore produced in the United States. Similarly, lead ores contain bismuth, but lead ores are no longer processed in the United States. In other cases, the primary mineral commodity is not mined domestically, and therefore, there is no by-product recovery. For example, cesium (https://minerals.usgs.gov/minerals/pubs/commodity/cesium/) and rubidium are produced as by-products of lithium (https://minerals.usgs.gov/minerals/pubs/commodity/lithium/) minerals in pegmatites mined globally, but U.S. lithium production is from brine operations.

Increasing production of any mineral commodity is limited by economic factors and accessibility (https://eos.org/articles/surveying-alaskan-minerals-from-afar). For most mineral commodities, extraction costs for deposits in the United States in comparison with other countries are a factor in determining whether they are mined domestically. The overall financial attractiveness of a potential venture depends on all of the costs and risks (e.g., regulatory or political uncertainty) associated with the project.

For by-product mineral commodities, extraction and recovery costs control the economic viability of production. For example, sheet mica is produced as a by-product of feldspar (https://minerals.usgs.gov/minerals/pubs/commodity/feldspar/) mining in North Carolina but in such limited quantity compared with imports that NIR is essentially 100%. Despite limited production, the United States may be less susceptible to potential supply disruptions for mineral commodities with existing domestic mines and processing facilities compared to commodities without domestic production. Furthermore, as demand for a by-product commodity increases, companies may be willing to increase by-product production with little additional cost if recovery capability exists at domestic plants.

Domestic Recycling

Domestic recycling increases domestic supply and decreases demand for imported primary materials. Domestic recycling has a twofold effect on net import reliance: It increases domestic supply and decreases demand for imported primary materials. Secondary production contributes to the domestic supply of 12 mineral commodities (aluminum, antimony, bismuth, chromium, cobalt, diamond, nickel, platinum, silver, tin, tungsten, and zinc).

Postconsumer scrap represents a significant unconventional “resource” for certain mineral commodities. For example, the United States does not mine chromium, but recycling of stainless steel scrap reduces

net import reliance for chromium to 69%. Similarly, antimony, bismuth, cobalt, and tin all lack domestic primary production, but secondary production reduces their NIR values.

Several other mineral commodities are known to be recycled, but secondary production statistics may be limited or not available because of how material is reprocessed. Although some materials degrade during recycling, increased efficiency in the collection and processing of recyclable materials would further reduce NIR and allow the United States to recover waste and scrap that would otherwise be exported.

Role of Exports

Exports of mineral commodities occupy an important role in the U.S. economy, even when the United States is a net importer. Of the 50 mineral commodities analyzed, only 10 lack exports.

Exports contribute to the U.S. economy because imported raw materials and intermediate product forms may undergo transformative processing or manufacturing in the United States that adds value to their products. For example, the United States imports bauxite (https://minerals.usgs.gov/minerals/pubs/commodity/bauxite/) (an aluminum ore) and produces aluminum (https://minerals.usgs.gov/minerals/pubs/commodity/aluminum/) metal. NIR for bauxite exceeds 75%, but NIR for aluminum is 61%.

Lack of By-Product Recovery

Many mineral commodities with greater than 50% NIR are produced exclusively as by-products, and their production is contingent upon the production of other mineral commodities. Exploration efforts often do not focus on by-product minerals for a number of reasons. By-product minerals occur in very low concentrations, have limited impact on the economic feasibility of a project, and are traded in small quantities on opaque markets.

Therefore, reserve estimates for by-products are limited and incomplete because producers do not routinely report information for by-product minerals, particularly if there are no plans to recover them. Comprehensive geologic exploration programs encompassing broad geographic areas and detailed mineralogical investigation would help identify domestic resources, reserves, and potential mining opportunities for by-product and minor metals.

Producers may be aware of potential by-products but choose not to recover them.
In other cases, producers may be aware of potential by-products but choose not to recover them. This could be due to a lack of economic viability or processing infrastructure or because of the mineral composition of the ore. For example, zinc concentrates mined in Alaska and Washington contain germanium, but these concentrates are exported to Canada for processing and germanium recovery.

Other by-products that could potentially be recovered from domestically mined ores include arsenic, bismuth, gallium, indium, rhenium, and vanadium.

NIR could be reduced for many commodities, such as tellurium in copper ore, if unrecovered constituents were separated from gangue (economically worthless material associated with an ore deposit) and produced as by-products, instead of being lost as waste. Research on mineral processing technologies and marginal costs of recovery may improve the economic viability of by-product commodities.

Assessing and Reducing Risk

Net import reliance is a conceptual tool that can be applied to any mineral commodity. Increased geologic exploration, economic assessment, production, processing, by-product recovery, and recycling can contribute to reducing NIR.

The significance of NIR as an indicator of supply risk depends on a variety of factors, including the utility, substitutability, production cost, market size, and price for each particular mineral commodity. Comprehensive assessments are needed to fully understand the supply risk of individual commodities.

Reducing net import reliance may reduce supply risk; however, evaluation of supply risk should consider several factors in conjunction with NIR, such as trade relations with import source countries, changes in material demand, the availability of substitutes, and the importance of a mineral commodity to the U.S. economy. For example, the risks associated with relying on imports for rare earths may outweigh the costs of developing a secure domestic supply, whereas for other commodities, such as asbestos, continued import reliance is likely.

Thus, ensuring that the United States has adequate mineral supplies to meet its needs involves many interacting factors, such as the dynamic balance between imports and exports and the economics of developing domestic resources. However, a metric like NIR can help untangle some economic complexities and pinpoint how to best mitigate risks from supply disruptions to the mineral resources needed for modern society.

References

Fortier, S. M., et al. (2015), Comparison of U.S. net import reliance for nonfuel mineral commodities—A 60-year retrospective (1954–1984–2014), *U.S. Geol. Surv. Fact Sheet 2015-3082,* 4 pp., https://doi.org/10.3133/fs20153082 (https://doi.org/10.3133/fs20153082).

U.S. Geological Survey (2018), Mineral commodity summaries 2018, 202 pp., Reston, Va., https://doi.org/10.3133/70194932 (https://doi.org/10.3133/70194932).

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