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SUMMARY

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Linda R. Rowan
Analyst in Natural Resources and Earth Sciences

According to a National Research Council report, a *critical mineral* is a nonfuel mineral that is essential for use and faces considerable supply chain vulnerabilities. For example, silicon is essential for manufacturing computer chips; lithium is essential for manufacturing batteries; and rare earth elements are essential for manufacturing magnets, batteries, phosphors, and catalysts used in such products as wind turbines, electric vehicles, screens/touchscreens, and petroleum refining. Demand for these components in the health care, transportation, power generation, consumer electronics, defense, and refining and manufacturing sectors is projected to grow in the next decade, likely leading to increased demand for critical mineral resources.

A supply chain includes extraction, processing, component development, and end-use technology. Recycling or reuse is possible at any step of the supply chain. The supply chain may be vulnerable if it lacks diversity or capacity. Some factors that may limit diversity include extraction or processing of some critical minerals in only a few locations. Factors that may limit capacity include reserve locations, technical challenges, export quotas, environmental impacts, geopolitical volatility, market volatility, and capital requirements.

In 2020 and 2021, Congress passed legislation that addressed critical mineral policies, defined *critical mineral* in statute, and specified criteria for developing a critical minerals list (CML). Section 7002 of the Energy Act of 2020 (Division Z of P.L. 116-260) directed the Secretary of the Interior, acting through the Director of the U.S. Geological Survey (USGS), to identify critical minerals and develop a CML.

Pursuant to the Energy Act of 2020, a *critical mineral* is any mineral, element, substance, or material designated as critical by the Secretary of the Interior acting through the Director of the USGS because it is essential to the economic and national security of the United States, has a vulnerable supply chain, and serves an essential function in manufacturing a product. The USGS published a final list of 50 critical minerals in February 2022; the USGS is prioritizing these 50 critical minerals in its assessment of potential domestic resources and other research.

Congress is considering whether the definition of a critical mineral, the methodology for developing a CML, and the 2022 CML are sufficient to advance critical mineral resources development per national minerals policy and contribute to identifying supply chain risks. Legislation introduced in the 118th Congress would amend the definition, methodology, and CML.

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Overview

According to a National Research Council report, critical minerals are both essential in use and subject to supply risks.[1] The report noted that critical minerals are essential for certain products and services.[2] For example, silicon, gallium, and germanium may be essential for manufacturing certain types of *semiconductors*.[3] Lithium, cobalt, and nickel may be essential for manufacturing certain types of batteries used in electric vehicles and other products. Some *rare earth elements* (REEs) may be essential for manufacturing touchscreens in electronic products and magnet-based motors that drive large wind turbines, electric vehicles, and other products.[4] Demand for semiconductors (i.e., computer chips), batteries, touchscreens, magnet-based motors, and other products is projected to grow in the next decade, leading to increased demand for critical minerals.[5]

According to the U.S. Department of Energy (DOE), a generic supply chain—which includes extraction, processing, components, end-use technology, and recycling and reuse—provides a useful context to consider geologic, technical, environmental, political, and economic factors that impact supply risk.[6] **Figure 1** shows the stages of a generic supply chain with risks, opportunities, and policies related to one or more stages or to the entire chain. According to DOE, a specific supply chain for a specific mineral may show different details for each stage and may show that materials may be reclaimed at different stages of the supply chain and reused either upstream or downstream, depending on the mineral.[7] *Extraction* is the removal of *mineral resources* from the

[1] Supply risks may be (1) geologic—whether the resource exists in nature, (2) technical—whether the resource can be extracted and processed, (3) environmental and social—whether the resource can be extracted and processed in an environmentally and socially acceptable way, (4) political—whether governments influence resource availability through policies and actions, and (5) economic—whether the resource can be extracted and processed at a cost that users are willing to pay. National Research Council (NRC), *Minerals, Critical Minerals, and the U.S. Economy*, 2008, (hereinafter, NRC, *Critical Minerals*, 2008). See p. 8 for a further description of supply risks and p. 238 for a short description of the report's use of the term *critical mineral*.

[2] *Essential*, as discussed in the report, means the chemical and physical properties of a mineral, such as metallurgical, chemical, catalytic, electrical, magnetic, or optical properties, that make it difficult or impossible to find a substitute that can provide a similar function at a comparable cost. NRC, *Critical Minerals*, 2008, pp. 7, 43-47.

[3] *Semiconductor chips*—also known as *computer chips, microchips,* or *integrated circuits*—are tunable electrical conductivity wafers fabricated with miniature resistors, transistors, capacitors, or diodes. For more information about semiconductors, see CRS Report R47508, *Semiconductors and the Semiconductor Industry*, by Manpreet Singh, John F. Sargent Jr., and Karen M. Sutter.

[4] Rare earth elements (REEs) include scandium, yttrium, and 15 elements that are called the lanthanide series on the periodic table. The lanthanides range from atomic number 57 (lanthanum) to 71 (lutetium). U.S. Geological Survey (USGS), "Rare-Earth Elements," https://www.usgs.gov/publications/rare-earth-elements; USGS, "Rare Earths Statistics and Information," https://www.usgs.gov/centers/national-minerals-information-center/rare-earths-statistics-and-information; and Bradley S. Van Gosen, Philip L. Verplanck, and Poul Emsbo, *Rare Earth Element Mineral Deposits in the United States*, USGS, Circular 1454, version 1.1, April 2019, https://doi.org/10.3133/cir1454 (hereinafter, Van Gosen, Verplanck, and Emsbo, *Rare Earth Element Mineral Deposits*, 2019).

[5] White House, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth*: *100-Day Reviews Under Executive Order 14017*, June 2021, https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf (hereinafter, White House, *Building Resilient Supply Chains*, 2021); U.S. Department of Energy (DOE), *Critical Materials Assessment*, July 2023, https://www.energy.gov/sites/default/files/2023-07/doe-critical-material-assessment_07312023.pdf (hereinafter, DOE, *Critical Materials Assessment*, 2023); and International Energy Agency, "The Role of Critical Minerals in the Clean Energy Transition," https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

[6] DOE, *Critical Materials Strategy*, December 2010 (hereinafter, DOE, *Critical Materials Strategy*, 2010), pp. 11-12.

[7] Ibid., p. 12.

surface or subsurface via mining.[8] Mineral resources may be extracted either as major products, where the mineral resource is directly processed to extract the desired materials, or as coproducts or *byproducts* of other mining operations.[9] The U.S. Geological Survey (USGS) notes that many mineral resources are extracted as byproducts. The USGS tracks domestic and global product and byproduct extraction for minerals listed in the USGS Mineral Commodity Summaries.[10] According to DOE, byproduct extraction may create complex relationships between the availability and extraction costs of different materials, which may cause supply chains and market prices to vary in ways not captured by supply and demand relationships.[11]

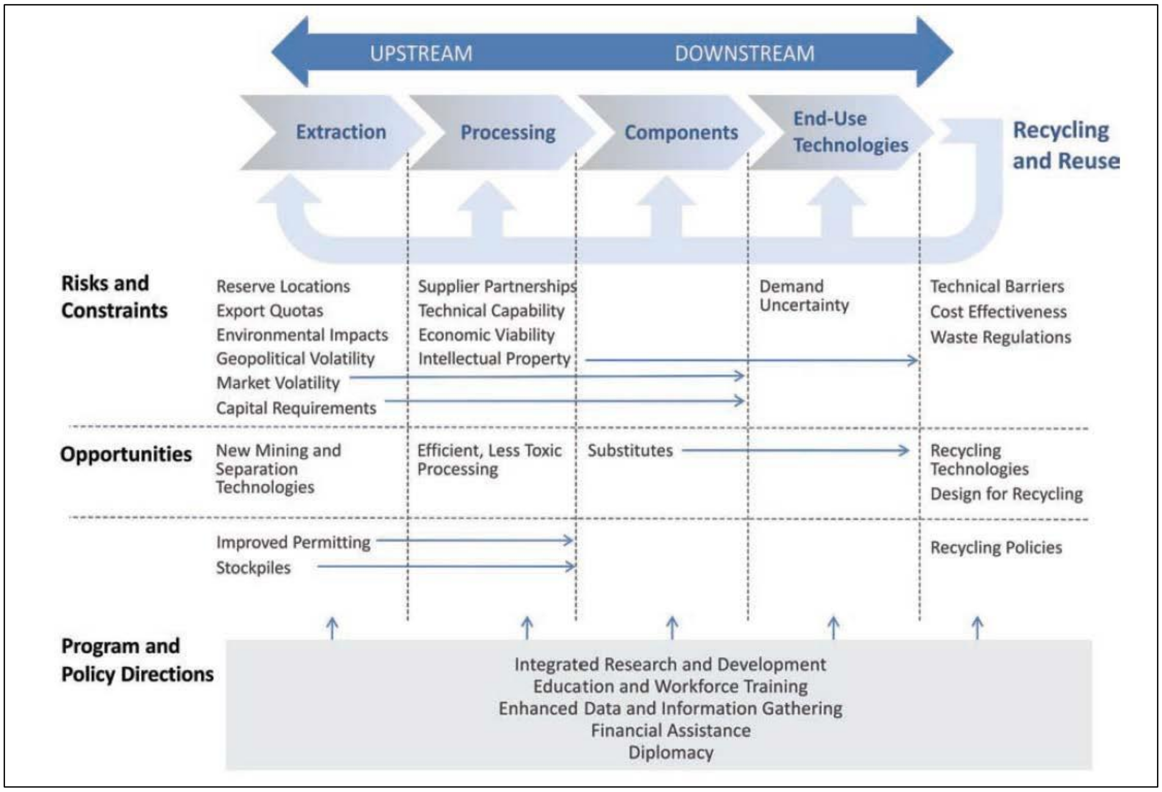
[8] The USGS geologic description of a *mineral* is "as a naturally occurring inorganic element or compound having an orderly internal structure and a characteristic chemical composition, crystal form, and physical properties." The USGS defines *resource* regarding minerals, including fuel minerals, as "a concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible." The USGS considers *extraction* to include underground, surface (or open pit), or placer (extraction from sediments, such as river channels or beach sands) mining. USGS, *Mineral Commodity Summaries 2023*, 2023, p. 205, https://doi.org/10.3133/mcs2023 (hereinafter, USGS, *MCS*, 2023). USGS, "What Is the Difference Between a Rock and a Mineral?," https://www.usgs.gov/faqs/what-difference-between-rock-and-mineral; USGS, "How Do We Extract Minerals?," https://www.usgs.gov/faqs/how-do-we-extract-minerals. For more details about certain critical mineral resources and their extraction, processing, and primary uses, see Klaus J. Schulz et al., *Critical Mineral Resources of the United States—Economic and Environmental Geology and Prospects for Future Supply*, USGS Professional Paper 1802, December 2017, https://doi.org/10.3133/pp1802 (hereinafter, USGS, *Critical Mineral Resources,* 2017).

[9] The USGS defines *byproduct* as "those whose production is dependent on that of another commodity." Nedal T. Nassar and Steven M. Fortier, *Methodology and Technical Input for the 2021 Review and Revision of the U.S. Critical Minerals List*, USGS, USGS Open-File Report 2021-1045, 2021, p. 7, https://doi.org/10.3133/ofr20211045 (hereinafter, USGS, *Methodology and Technical Input*, 2021).

[10] USGS, "Mineral Commodity Summaries," https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries. The USGS publishes summaries every year, and the number of minerals summarized may vary from year to year.

[11] DOE, *Critical Materials Assessment*, 2023.

Figure 1. Supply Chain and Risks, Opportunities, and Policies



Source: U.S. Department of Energy (DOE), *Critical Materials Strategy*, December 2010, Figure 9-1.

Notes: DOE's strategy focused on critical materials for energy uses, including critical minerals. The generic supply chain in this figure shows recycling and reuse only at the end of the chain; however, a supply chain for a specific mineral may show materials being reclaimed at one or more other stages and reused either upstream or downstream, depending on the mineral and the available technology. *Processing* is the separation and refining of mineral resources to obtain a desired composition or purity. *Components* refers to using the processed materials to manufacture component parts for the end-use technology. The *end-use technology* may be a product or service.

A mineral's criticality may change over time as technology advances and other factors lead to changing supply and demand. Two examples highlight changing mineral criticality related to changing and emerging technologies.

- Production and demand for REEs was lower in the 1960s-1970s (when the United States was a major producer) than in the 1980s-1990s, when REEs became more essential for evolving technology, such as electronics and magnet-based motors (**Figure 2**).[12] China increased its REEs production beginning in the mid-1980s, became a major producer of REEs in the mid-1990s, and now dominates production. The recent dominance of China as the top producer of REEs may lead to supply chain risks that may impact the U.S. economy and

[12] Gordon B. Haxel, James B. Hedrick, and Greta J. Orris, "Rare Earth Elements—Critical Minerals for High Technology," USGS, USGS Factsheet 087-02, 2002, https://pubs.usgs.gov/fs/2002/fs087-02/fs087-02.pdf; and Van Gosen, Verplanck, and Emsbo, *Rare Earth Element Mineral Deposits*, 2019.

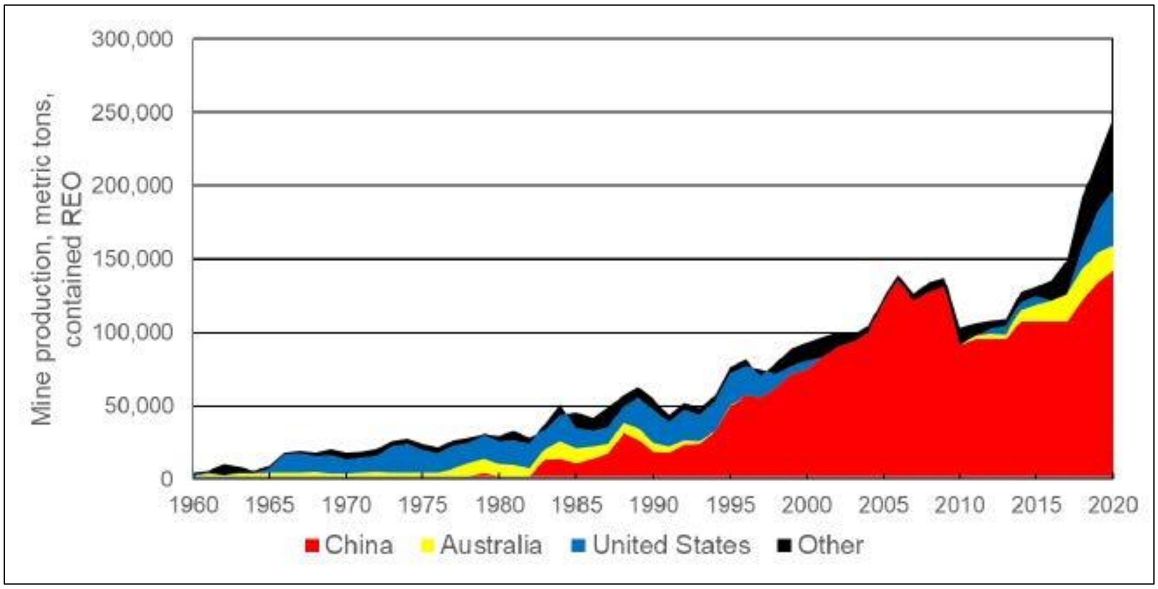
national security.[13] The increase in production of REEs over time also highlights the growing demand for REEs for different products and services.

- A growing number of different critical minerals are essential as components for computer chips (i.e., semiconductors) due to advances in chip technology.[14] In the 1980s, 12 minerals or elemental components, including some critical minerals, were identified as essential for computer chips. In the 2000s to present, more than 60 minerals or elemental components, including more critical minerals, are identified as essential for computer chips.[15] Today, tunable electrical conductivity wafers most commonly are composed of silicon, silicon carbide, germanium, gallium arsenide, or gallium nitride.

Change in the criticality of a mineral due to evolving technology highlights the need to repeatedly analyze supply chain risks over short time periods (such as one year or five years).[16]

Figure 2. Global Production of Rare Earth Elements

(1960 to 2020)



Source: White House, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews Under Executive Order 14017*, June 2021, https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf. The data for this graph are from the U. S. Geological Survey (USGS). See also Gordon B. Haxel, James B. Hedrick, and Greta J. Orris, "Rare Earth Elements—Critical Minerals for High Technology," USGS Factsheet 087-02, 2002, https://pubs.usgs.gov/fs/2002/fs087-02/fs087-02.pdf; and Bradley S. Van Gosen, Philip L. Verplanck, and Poul Emsbo, *Rare Earth Element Mineral Deposits in the United States*, USGS, Circular 1454, Version 1.1, April 2019, https://doi.org/10.3133/cir1454

Notes: *Mine production* refers to the extraction of a mineral resource and is most often quantified in the weight of material mined in metric tons over a specified time period. A metric ton is a unit of weight equivalent to 1,000 kilograms (about 2,204.6 pounds). REO = rare earth oxide.

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[13] For more information, see CRS In Focus IF11259, *Trade Dispute with China and Rare Earth Elements*, by Karen M. Sutter; CRS Report R46915, *China's Recent Trade Measures and Countermeasures: Issues for Congress*, by Karen M. Sutter; and CRS Report R46618, *An Overview of Rare Earth Elements and Related Issues for Congress*, by Brandon S. Tracy.

[14] USGS, *MCS*, 2023; USGS, *Critical Mineral Resources*, 2017; and NRC, *Critical Minerals*, 2008.

[15] NRC, *Critical Minerals*, 2008, Figure 2.2.

[16] DOE, *Critical Materials Strategy*, 2010.

Besides changes in mineral criticality, supply chains may be vulnerable if they lack diversity and capacity (**Figure 1**).[17] Extraction or processing of some critical minerals in a few locations limits diversity. For example, in 2019, 60% or more of lithium, cobalt, and graphite resources were extracted in Australia, Congo, and China, respectively, and 60% or more of lithium and cobalt were processed in China (**Figure 3**).[18] China has been a top producer of many REEs since the mid-1990s (**Figure 2**).[19] Factors that may limit extraction capacity include reserve locations limitations, technical challenges to extracting the critical mineral, export quotas, environmental impacts, geopolitical volatility, market volatility, and capital requirements.[20]

[17] NRC, *Critical Minerals*, 2008.

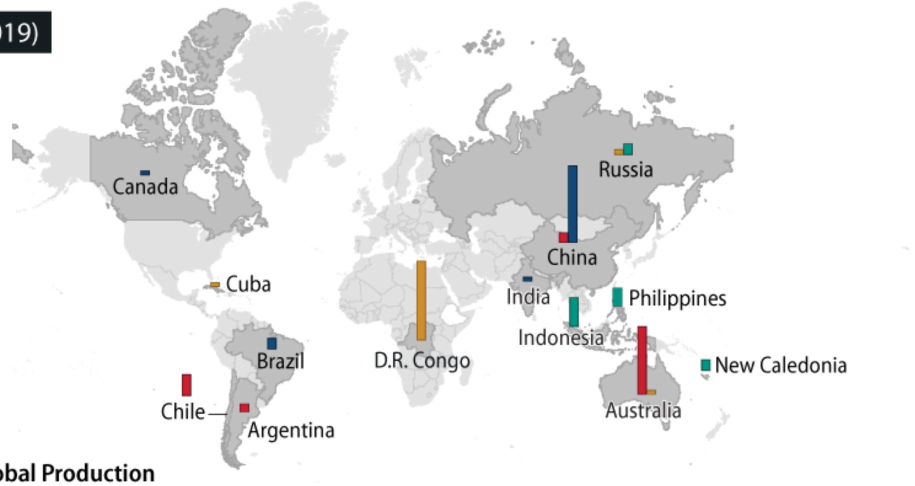
[18] White House, *Building Resilient Supply Chains*, 2021, Figure 13. The National Renewable Energy Laboratory analyzed mining data from USGS, *Mineral Commodity Summaries 2019,* https://www.usgs.gov/centers/nmic/meneral-commodity-summaries, and refining data from analysis and refining data from BloombergNEF Battery Metals Database, accessed on March 7, 2021.

[19] White House, *Building Resilient Supply Chains*, 2021; and Van Gosen, Verplanck, and Emsbo, *Rare Earth Element Mineral Deposits*, 2019.

[20] The USGS defines *reserves* as "that part of the reserve base that could be economically extracted or produced at the time of determination" and *reserve base* as "the in-place demonstrated (measured plus indicated) resource from which reserves are estimated," USGS, *MCS*, 2023, p. 206. Some reserve locations may have limited extraction capacity because they are remote or located on land where mining is restricted, among other reasons.

Figure 3. Top Producers and Refiners of Critical Minerals for Batteries in 2019

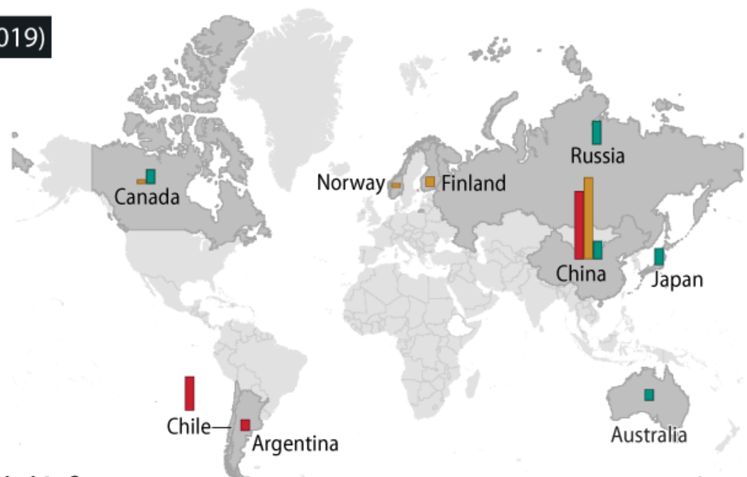
Mining (2019)



Percent of Global Production

	Lithium	Cobalt	Nickel	Graphite
	60% - Australia	70% - D.R. Congo	26% - Indonesia	68% - China
	19% - Chile	5% - Russia	16% - Philippines	10% - Brazil
	9% - China	4% - Cuba	10% - New Caledonia	4% - Canada
	7% - Argentina	4% - Australia	10% - Russia	4% - India
Total metric tons	**84,700**	**128,700**	**2,133,000**	**930,000**

Refining (2019)



Percent of Global Refinement

	Lithium	Cobalt	Class 1 Nickel
	60% - China	72% - China	21% - Russia
	30% - Chile	9% - Finland	16% - China
	10% - Argentina	4% - Canada	15% - Japan
	—	4% - Norway	13% - Canada
Total metric tons	**66,100**	**162,900**	**1,171,300**

Source: Modified by CRS. White House, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews Under Executive Order 14017*, June 2021, tps://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf, Figure 13, p. 121.

Notes: *Mine production* refers to the extraction of a mineral resource and is most often quantified in the weight of material mined in metric tons over a specified time period. A metric ton is a unit of weight equivalent to 1,000 kilograms (about 2,204.6 pounds). *Total metric tons* refer to the total global amount of production in 2019 and the total global amount of refinement in 2019 in the top and bottom tables, respectively. The percentages given in the tables may not sum to 100% for each mineral because not all producers or refiners are listed. The total metric tons for each mineral for global production may not equal the total metric tons for each mineral for global refinement because production and refinement are different processes involving different materials and these steps potentially may occur in different years. Class 1 Nickel is 99.8% pure nickel. Australia refined about 10% of class 1 nickel, which is shown on the map. As the fifth top refiner, Australia is not listed under the heading Percent of Global Refinement in the figure, which shows the top four refiners for Class I Nickel.

DOE noted opportunities to reduce supply chain risks, such as technological innovations in extraction, processing, substitution, and recycling, as well as more efficient permitting, more stockpiling, and more recycling policies (**Figure 1**).[21] According to DOE, federal programs and policies could support integrated research and development, education and workforce training, enhanced data and information gathering (i.e., analysis), financial assistance, and diplomacy to reduce risks, advance opportunities, and secure a sustainable critical mineral supply chain.[22]

In 2016, the Subcommittee on Critical and Strategic Mineral Supply Chains of the National Science and Technology Council (NSTC) submitted a progress report to Congress on an interagency assessment of critical minerals, including the development of a screening methodology and the initial results of the application of the methodology.[23] The report identified 17 potentially critical minerals and noted the next step was to develop a prioritized list of a subset of the 17 minerals for further investigation. In 2017, the Trump Administration issued an executive order (E.O. 13817) that defined *critical mineral* and directed the Secretary of the Interior, in coordination with the Secretary of Defense and in consultation with the heads of other relevant executive departments and agencies, to publish a list of critical minerals.[24] The Secretary of the Interior published a list of 35 critical minerals and the methodology for determining them in the *Federal Register* in May 2018.[25] In 2020, the Trump Administration issued E.O. 13953 declaring a national emergency to deal with the threat of the nation's undue reliance on critical minerals from foreign adversaries, such as China.[26] E.O. 13953 noted that the U.S. imported more than half of its annual consumption for 31 of the 35 critical minerals on the 2018 list and has no domestic production for 14 of the 35 listed critical minerals. E.O. 13953 directed the Secretary of the Interior to adjust the listing criteria based on an amended definition of *critical mineral* and to update the list on a regular basis.

[21] NRC, *Critical Minerals*, 2008; and DOE, *Critical Materials Strategy*, 2010.

[22] DOE, *Critical Materials Strategy*, 2010.

[23] National Science and Technology Council (NSTC), *Assessment of Critical Minerals: Screening Methodology and Initial Application*, Subcommittee on Critical and Strategic Mineral Supply Chains of the Committee on Environment, Natural Resources, and Sustainability, March 2016, https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/NSTC/csmsc_assessment_of_critical_minerals_report_2016-03-16_final.pdf (hereinafter, NSTC, *Assessment of Critical Minerals*, 2016), among other reports on critical minerals. An "early warning screening" approach for material supply problems was first included as a U.S. policy goal in the National Materials and Minerals Policy, Research, and Development Act of 1980 (P.L. 96-479).

[24] Executive Order 13817, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals," 82 *Federal Register* 60835-60837, December 26, 2017 (hereinafter, E.O. 13817).

[25] Department of the Interior (DOI), "Final List of Critical Minerals 2018," 83 *Federal Register* 23295-23296, May 18, 2018, https://www.federalregister.gov/documents/2018/05/18/2018-10667/final-list-of-critical-minerals-2018 (hereinafter, DOI, "Final List of Critical Minerals 2018").

[26] Executive Order 13953, "Addressing the Threat to the Domestic Supply Chain from Reliance on Critical Minerals from Foreign Adversaries and Supporting the Domestic Mining and Processing Industries," 85 *Federal Register* 62539-62544, October 5, 2020 (hereinafter, E.O. 13953).

In 2020, Congress changed and added to the national materials and minerals policy through passage of the Energy Act of 2020 (Division Z of P.L. 116-260). [27] In addition, the act directed certain executive departments and federal agencies to change or start critical materials and minerals initiatives to advance national policies. Section 7002 of the Energy Act of 2020 defined the term *critical mineral*. Under the authority of the Energy Act of 2020, the USGS aims to identify critical minerals based on supply chain risks and develop and update a critical minerals list (CML).[28] In addition, the legislation directs the USGS to conduct research and assessment of critical mineral resources in the United States as well as a supply chain analysis to produce annual reviews and multiyear forecasts of the production, consumption, and recycling patterns of critical minerals.[29]

In February 2021, the Biden Administration issued E.O. 14017 directing the federal government to undertake a comprehensive 100-day review of the supply chains of four critical products—semiconductors, large capacity batteries, critical minerals and materials, and pharmaceuticals and active pharmaceutical ingredients—to identify vulnerabilities, assess risks, and develop strategies to promote resilience.[30] In June 2021, the federal government completed a 100-day review and recommended more than 70 actions to promote resilience.[31]

In June 2021, Congress, via the Infrastructure Investment and Jobs Act (IIJA; P.L. 117-58), authorized and appropriated funds for a national mineral research, mapping, and assessment initiative called Earth Mapping Resources Initiative (Earth MRI), to be coordinated with existing USGS programs. Under the authority of the Energy Act of 2020, the USGS aims to prioritize resource assessments on the most critical of the critical minerals on the CML.[32] In addition, Section 40210 of IIJA codified the NSTC Critical Minerals Subcommittee's efforts to coordinate federal science and technology efforts for supply chain resiliency.[33]

In June 2023, the Biden Administration issued a report card describing actions taken on most of the recommendations in the 100-day review, including actions taken through enacted legislation, such as the Energy Act of 2020 and the IIJA.[34] On November 27, 2023, the Biden Administration announced new actions to secure supply chains, including critical mineral supply chains.[35] Since

[27] More specifically, Section 7002 of the Energy Act of 2020 (Division Z, Title VII, Critical Minerals, of the Consolidated Appropriations Act, 2021,P.L. 116-260).

[28] Some amendments are consistent with some of the recommendations in the NRC, *Critical Minerals*, 2008; DOE, *Critical Materials Strategy*, 2010; NSTC, *Assessment of Critical Minerals*, 2016; E.O. 13871; and E.O. 13953, among other executive branch efforts on critical minerals.

[29] CRS Report R48005, *Critical Mineral Resources: The U.S. Geological Survey (USGS) Role in Research and Analysis*, by Linda R. Rowan.

[30] Executive Order 14017, "America's Supply Chains," 86 *Federal Register* 11849, February 24, 2021, https://www.federalregister.gov/documents/2021/03/01/2021-04280/americas-supply-chains.

[31] White House, *Building Resilient Supply Chains*, 2021.

[32] 30 U.S.C. §1606(d).

[33] CriticalMinerals.gov, "Statutory Authority," https://criticalminerals.gov/statutory-authority/. The Subcommittee on Critical and Strategic Mineral Supply Chains was renamed the Critical Minerals Subcommittee in 2019. Department of Commerce (DOC), *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*, 2019, https://www.commerce.gov/sites/default/files/2020-01/Critical_Minerals_Strategy_Final.pdf.

[34] White House, "Two Years of Building Stronger Supply Chains and a More Resilient Economy," https://www.whitehouse.gov/wp-content/uploads/2023/06/Supply-Chain-Report-Card.pdf.

[35] White House, "FACT SHEET: President Biden Announces New Actions to Strengthen America's Supply Chains, Lower Costs for Families, and Secure Key Sectors," https://www.whitehouse.gov/briefing-room/statements-releases/2023/11/27/fact-sheet-president-biden-announces-new-actions-to-strengthen-americas-supply-chains-lower-costs-for-families-and-secure-key-sectors/, (hereinafter, White House, *America's Supply Chains,* 2023).

then, the Critical Minerals Subcommittee has established a website, CriticalMinerals.gov, that summarizes federal science and technology efforts for critical mineral supply chain resiliency.[36]

This CRS report summarizes changes to national materials and minerals policy, provides an overview of the definition of the term *critical mineral* and the development of a CML, and discusses the CML's impact on policy and federal initiatives. Some in Congress have called for changes to the definition of *critical mineral* and the CML, whereas others in Congress would use the critical mineral designation or the CML to amend minerals policy through legislation introduced in the 118th Congress. This report raises considerations for Congress about whether the critical mineral designation and the CML may help to identify and mitigate supply chain risks.

National Materials and Minerals Policy

Congress reiterated a national policy for materials and minerals in the National Materials and Minerals Policy, Research, and Development Act of 1980 (1980 Act; P.L. 96-479): "It is the continuing policy of the United States to promote an adequate and stable supply of materials necessary to maintain national security, economic well-being and industrial production with appropriate attention to a long-term balance between resource production, energy use, a healthy environment, natural resources conservation, and social needs."[37]

The 1980 Act defined *materials* and called for the President, through the Executive Office of the President, to coordinate with responsible agencies and departments to carry out the following measures:[38]

> (1) identify materials needs and assist in the pursuit of measures that would assure the availability of materials critical to commerce, the economy, and national security;
>
> (2) establish a mechanism for the coordination and evaluation of Federal materials programs, including those involving research and development so as to complement related efforts by the private sector as well as other domestic and international agencies and organizations;

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[36] CriticalMinerals.gov, "CriticalMinerals.gov," https://criticalminerals.gov/. The website was called for in White House, *America's Supply Chains*, 2023.

[37] 30 U.S.C. §§1601 et seq. The National Materials and Minerals Policy, Research, and Development Act of 1980 (1980 Act; P.L. 96-479) states: "Nothing in this Act shall be interpreted as changing in any manner or degree the provisions of and requirements of the Mining and Minerals Policy Act of 1970, as amended (30 U.S.C. §21a)." The 1970 act established in law a national mining and minerals policy:

> The Congress declares that it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in (1) the development of economically sound and stable domestic mining, minerals, metal and mineral reclamation industries, (2) the orderly and economic development of domestic mineral resources, reserves, and reclamation of metals and minerals to help assure satisfaction of industrial, security and environmental needs, (3) mining, mineral, and metallurgical research, including the use and recycling of scrap to promote the wise and efficient use of our natural and reclaimable mineral resources, and (4) the study and development of methods for the disposal, control, and reclamation of mineral waste products, and the reclamation of mined land, so as to lessen any adverse impact of mineral extraction and processing upon the physical environment that may result from mining or mineral activities.

[38] These measures apply to *materials* as defined in the 1980 Act (30 U.S.C. §1601 (b)(2)):

> substances, including minerals, of current or potential use that will be needed to supply the industrial, military, and essential civilian needs of the United States in the production of goods or services, including those which are primarily imported or for which there is a prospect of shortages or uncertain supply, or which present opportunities in terms of new physical properties, use, recycling, disposal or substitution, with the exclusion of food and of energy fuels used as such.

> (3) establish a long-range assessment capability concerning materials demands, supply and needs, and provide for the policies and programs necessary to meet those needs;
>
> (4) promote a vigorous, comprehensive, and coordinated program of materials research and development consistent with the policies and priorities set forth in the National Science and Technology Policy, Organization, and Priorities Act of 1976 (42 U.S.C. 6601 et seq.);
>
> (5) promote cooperative research and development programs with other nations for the equitable and frugal use of materials and energy;
>
> (6) promote and encourage private enterprise in the development of economically sound and stable domestic materials industries; and
>
> (7) encourage Federal agencies to facilitate availability and development of domestic resources to meet critical materials needs.

Section 7002(b) of the Energy Act of 2020 amended the 1980 Act to define *critical material*, define *critical mineral*, and amend or add specific critical mineral measures.[39] Measures (3) and (7) were amended to read as follows:

> (3) establish an analytical and forecasting capability for identifying critical mineral demand, supply, and other factors to allow informed actions to be taken to avoid supply shortages, mitigate price volatility, and prepare for demand growth and other market shifts;
>
> (7) facilitate the availability, development, and environmentally responsible production of domestic resources to meet national material or critical mineral needs;

New measures (8)-(13) added by the Energy Act of 2020 are the following:

> (8) avoid duplication of effort, prevent unnecessary paperwork, and minimize delays in the administration of applicable laws (including regulations) and the issuance of permits and authorizations necessary to explore for, develop, and produce critical minerals and to construct critical mineral manufacturing facilities in accordance with applicable environmental and land management laws;
>
> (9) strengthen—
>
> (A) educational and research capabilities at not lower than the secondary school level; and
>
> (B) workforce training for exploration and development of critical minerals and critical mineral manufacturing;
>
> (10) bolster international cooperation through technology transfer, information sharing, and other means;
>
> (11) promote the efficient production, use, and recycling of critical minerals;
>
> (12) develop alternatives to critical minerals; and
>
> (13) establish contingencies for the production of, or access to, critical minerals for which viable sources do not exist within the United States.

[39] 30 U.S.C. §§1601 et seq. The Energy Act of 2020 retains the definition of *materials* from the 1980 Act.

Definition of Critical Mineral

Sections 7002(a) and (c) of the Energy Act of 2020 defined *critical mineral* as any mineral, element, substance, or material designated as critical by the Secretary of the Interior, acting through the Director of the USGS using three criteria.[40] The criteria are as follows:[41]

> (i) essential to the economic or national security of the United States;
>
> (ii) the supply chain of which is vulnerable to disruptions (including restrictions associated with foreign political risk, abrupt demand growth, military conflict, violent unrest, anti-competitive or protectionist behaviors, and other risks throughout the supply chain); and
>
> (iii) serve an essential function in the manufacturing of a product (including energy technology-, defense-, currency-, agriculture-, consumer electronics-, and healthcare-related applications), the absence of which would have significant consequences for the economic or national security of the United States

The definition excluded *mineral fuels*;[42] water, ice, or snow; and common varieties of sand, gravel, stone, pumice, cinders, and clay. In addition, the Secretary of the Interior acting through the Director of the USGS may designate any mineral, element, substance, or material as a critical mineral that another federal agency determines to be strategic and critical to the defense or national security of the United States.[43] Furthermore, the act directs the Secretary of the Interior, acting through the Director of the USGS, to consult with the Secretaries of Defense, Commerce, Agriculture, and Energy and the United States Trade Representative in designating critical minerals.[44]

2022 Critical Minerals List

Section 7002(c) of the Energy Act of 2020 requires the Secretary of the Interior, acting through the Director of the USGS, to develop a CML and to update the list at least every three years, if not more often.[45] The USGS may prioritize in its national resource assessment minerals it places on the CML.[46] The USGS may consider such criticality in planning research and other initiatives.

The USGS developed a methodology to determine which minerals should be designated as critical and may update this methodology as needed (see "USGS Methodology").[47] The USGS

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[40] 30 U.S.C. §1606(a)(3).

[41] 30 U.S.C. §1606(c)(4)(A).

[42] *Mineral fuels* include oil, gas, coal, oil shale, and uranium under the Mining and Minerals Policy Act of 1970 (30 U.S.C. 21(a)). The uranium mining and processing supply chain has been evaluated elsewhere (DOE, *Nuclear Energy*, U.S. Department of Energy Response to Executive, February 2022, https://www.energy.gov/sites/default/files/2022-02/Nuclear%20Energy%20Supply%20Chain%20Report%20-%20Final.pdf) and issues regarding the availability and reliability of nuclear fuel are addressed in a separate section of the Energy Act of 2020 (P.L. 116-260, Title II, "Nuclear").

[43] 30 U.S.C. §1606(c)(4)(B). See NRC, *Critical Minerals*, 2008, for a discussion of critical mineral versus strategic minerals and for a history of U.S. policy regarding strategic versus critical minerals. See also USGS, *Critical Mineral Resources*, 2017, Appendix A1, for a history of strategic versus critical minerals beginning with World War I.

[44] 30 U.S.C. §1606(c)(4)(C).

[45] 30 U.S.C. §1606(c)(4)(A).

[46] 30 U.S.C. §1606 (d)(5) allows the Secretary of the Interior to complete resource assessments for the most critical minerals on the CML first. CRS Report R48005, *Critical Mineral Resources: The U.S. Geological Survey (USGS) Role in Research and Analysis*, by Linda R. Rowan.

[47] 30 U.S.C. §1606 (c). As noted in the "Overview," the USGS with other agencies began working on a methodology as (continued...)

published for public comment a draft list and methodology in a November 9, 2021, *Federal Register* notice and a final list (hereinafter 2022 CML) and methodology in a February 24, 2022, *Federal Register* notice.[48]

The 2022 CML of 50 critical minerals includes

> aluminum, antimony, arsenic, barite, beryllium, bismuth, cerium, cesium, chromium, cobalt, dysprosium, erbium, europium, fluorspar, gadolinium, gallium, germanium, graphite, hafnium, holmium, indium, iridium, lanthanum, lithium, lutetium, magnesium, manganese, neodymium, nickel, niobium, palladium, platinum, praseodymium, rhodium, rubidium, ruthenium, samarium, scandium, tantalum, tellurium, terbium, thulium, tin, titanium, tungsten, vanadium, ytterbium, yttrium, zinc, and zirconium.[49]

The 2022 CML includes nickel and zinc and excludes helium, potash, rhenium, strontium, and uranium compared to the 2018 list.[50]

USGS Methodology

The USGS developed a methodology for designating critical minerals that consists of three possible evaluations based on whether enough data exist for a fully quantitative analysis:[51]

> 1. A quantitative evaluation of supply risk wherever sufficient data were available using three indicators:
>
> > (A) a net import reliance indicator of the dependence of the U.S. manufacturing sector on foreign supplies,
> >
> > (B) an enhanced production concentration indicator which focuses on production concentration outside of the United States, and
> >
> > (C) weights for each producing country's production contribution by its ability or willingness to continue to supply the United States.
>
> 2. a semi-quantitative evaluation of whether the supply chain had a single point of failure, or
>
> 3. a qualitative evaluation when other evaluations were not possible.

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a member of the Subcommittee on Critical and Strategic Mineral Supply Chains of the NSTC. NSTC, *Assessment of Critical Minerals*, 2016.

[48] USGS, "2021 Draft List of Critical Minerals," 86 *Federal Register* 214, November 9, 2021, https://www.govinfo.gov/content/pkg/FR-2021-11-09/pdf/2021-24488.pdf (hereinafter, USGS, "2021 Draft List"); and USGS, "2022 Final List of Critical Minerals," 87 *Federal Register* 10381-10382, February 24, 2022, https://www.govinfo.gov/content/pkg/FR-2022-02-24/pdf/2022-04027.pdf (hereinafter, USGS, "2022 Final List").

[49] USGS, "U.S. Geological Survey Releases 2022 List of Critical Minerals," https://www.usgs.gov/news/national-news-release/us-geological-survey-releases-2022-list-critical-minerals. The USGS considers all uses of critical minerals in its assessments. Others, such as DOE, may consider only energy uses in their assessments.

[50] The USGS included uranium on the 2018 list and considered only uranium's nonfuel uses. The 2018 list grouped more than a dozen minerals into two mineral groups, REEs and platinum group elements (PGEs), whereas the 2022 CML ungrouped these minerals and listed them individually. This accounts in part for the shorter list of minerals in 2018 compared with the 2022 CML. REEs and PGEs have similar physical and chemical properties and tend to occur together in nature. PGEs include a cluster of minerals with similar atomic numbers across two rows of the periodic table, ruthenium (atomic number = 44), rhodium (45), and palladium (46) and osmium (76), iridium (77), and platinum (78). USGS, "Platinum-Group Elements," https://www.usgs.gov/publications/platinum-group-elements. In some descriptions, PGEs are referred to as platinum group metals. USGS, "Platinum-Group Metals," https://www.usgs.gov/centers/national-minerals-information-center/platinum-group-metals-statistics-and-information. DOI, "Final List of Critical Minerals 2018"; and USGS, "2022 Final List."

[51] USGS, "2022 Final List."

The USGS published a technical report that explains the methodology for designating the minerals on the 2022 CML in more detail.[52]

Quantitative Analysis

For 54 minerals that had enough data in 2018 for a quantitative assessment, the USGS analyzed each mineral's supply risk based on trade exposure, economic vulnerability, and disruption potential factors (see textbox on "Recency Weighted Supply Risk Score").[53] **Figure 4** displays the relative vulnerability of a mineral's supply chain to trade exposure, economic vulnerability, or disruption potential for 54 mineral commodities using production and refinement data for 2018. Such a scatter plot allows the three factors and supply risk to be shown in two dimensions, such that the relative importance of each factor on each mineral's supply risk may be compared. In addition, each mineral's criticality can be compared to that of other minerals. The trade exposure factor is based on the U.S. net import reliance on the mineral; the size of the circles for each mineral in **Figure 4** corresponds to normalized trade exposure from 0 to 1, where the larger the circle the greater the trade exposure (i.e., the higher the net import reliance). The economic vulnerability factor is based on high expenditures for commodities in industries with low operating profits where the industries have a higher economic importance for the U.S. economy; the normalized economic vulnerability increases along the vertical axis from a low of 0.0 to a high of 1.0 in **Figure 4**. The disruption potential factor is based on the producing country's share of the global mineral production and its willingness to continue to supply the mineral; the normalized disruption potential factor increases along the horizontal axis from a low of 0.0 to a high of 1.0 in **Figure 4**. Each mineral's normalized supply risk score, which is a combination of these three factors, is displayed by color shading, where the darkest blue represents a low risk of 0.0 and the darkest red represents the highest risk of 1.0.

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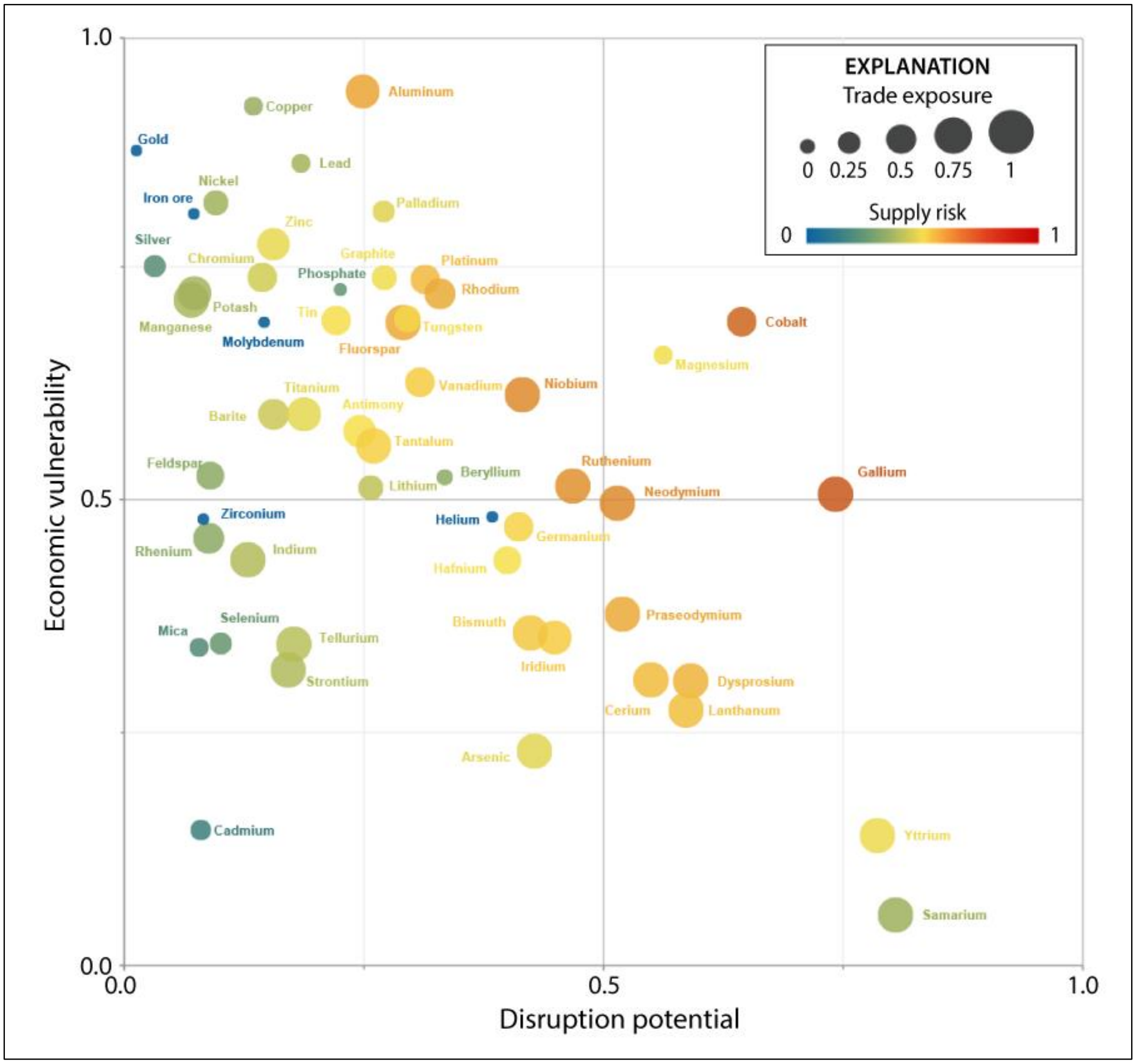
[52] USGS, *Methodology and Technical Input,* 2021.

[53] These three analyses map to the three criteria listed in USGS, "2022 Final List." The supply risk score and the three factors were normalized to values between 0.0 and 1.0, where 0.0 is low risk and 1.0 is high risk. Ibid., Table 1.

Figure 4. Mineral Commodity Supply Risk

(2018 data)



Source: Nedal T. Nassar and Steven M. Fortier, *Methodology and Technical Input for the 2021 Review and Revision of the U.S. Critical Minerals List*, USGS, USGS Open-File Report 2021-1045, 2021, https://pubs.er.usgs.gov/publication/ofr20211045.

Notes: The figure includes the 54 mineral commodities quantitatively assessed by the USGS for their supply risk based on extraction and processing data for 2018. Thirty-nine of these mineral commodities are on the 2022 critical minerals list (CML). The plot does not include cesium, erbium, europium, gadolinium, holmium, lutetium, rubidium, scandium, terbium, thulium, and ytterbium, which are on the 2022 CML. The USGS assessed these minerals qualitatively. The size of the circles corresponds to trade exposure; the larger the circle, the higher the trade exposure risk (see the explanation in the figure). The vertical and horizontal lines inside the plot denote 0.25, 0.50, 0.75 values on the vertical and horizontal axes to guide readability. The circle plotted for gallium is near the 0.5 horizontal line for economic potential and near the 0.75 vertical line for disruption potential.

Ranking the Minerals by Supply Risk Score

The USGS aims to prioritize critical mineral resource initiatives using the ranked criticality of the minerals on the 2022 CML.[54] **Figure 5** shows each mineral's annual supply risk score from 2007 to 2018, where enough data are available, and the supply risk changes over this period for most minerals.[55] Because supply risk may change, the USGS calculated a recency weighted supply risk score for the more recent years, 2015-2018, to capture recent trends in supply and demand. The USGS designated 36 (out of 54) quantified minerals, each with a recency weighted supply risk score of 0.4 or greater to the 2022 CML (see textbox, "Recency Weighted Supply Risk Score" and **Figure 5**). The five highest supply risk minerals by recency weighted supply risk score were gallium (0.67), niobium (0.66), cobalt (0.65), neodymium (0.65), and ruthenium (0.63). **Figure 5** also shows the leading producing and in some cases refining country for each mineral. China was the leading producer for 24 and the leading refiner for 9 of the 36 critical minerals with a quantified supply risk score.

Recency Weighted Supply Risk Score

The supply risk for each quantitatively evaluated critical mineral was normalized to a number between 0.0 and 1.0, with 1.0 being the highest supply risk. The supply risk was calculated for each year between 2007 to 2018 where enough annual data were available for each mineral. Then a recency weighted supply risk score was calculated for 2015-2018, with more weight given to the most recent years. This was done to capture more recent trends in each mineral's supply chain.

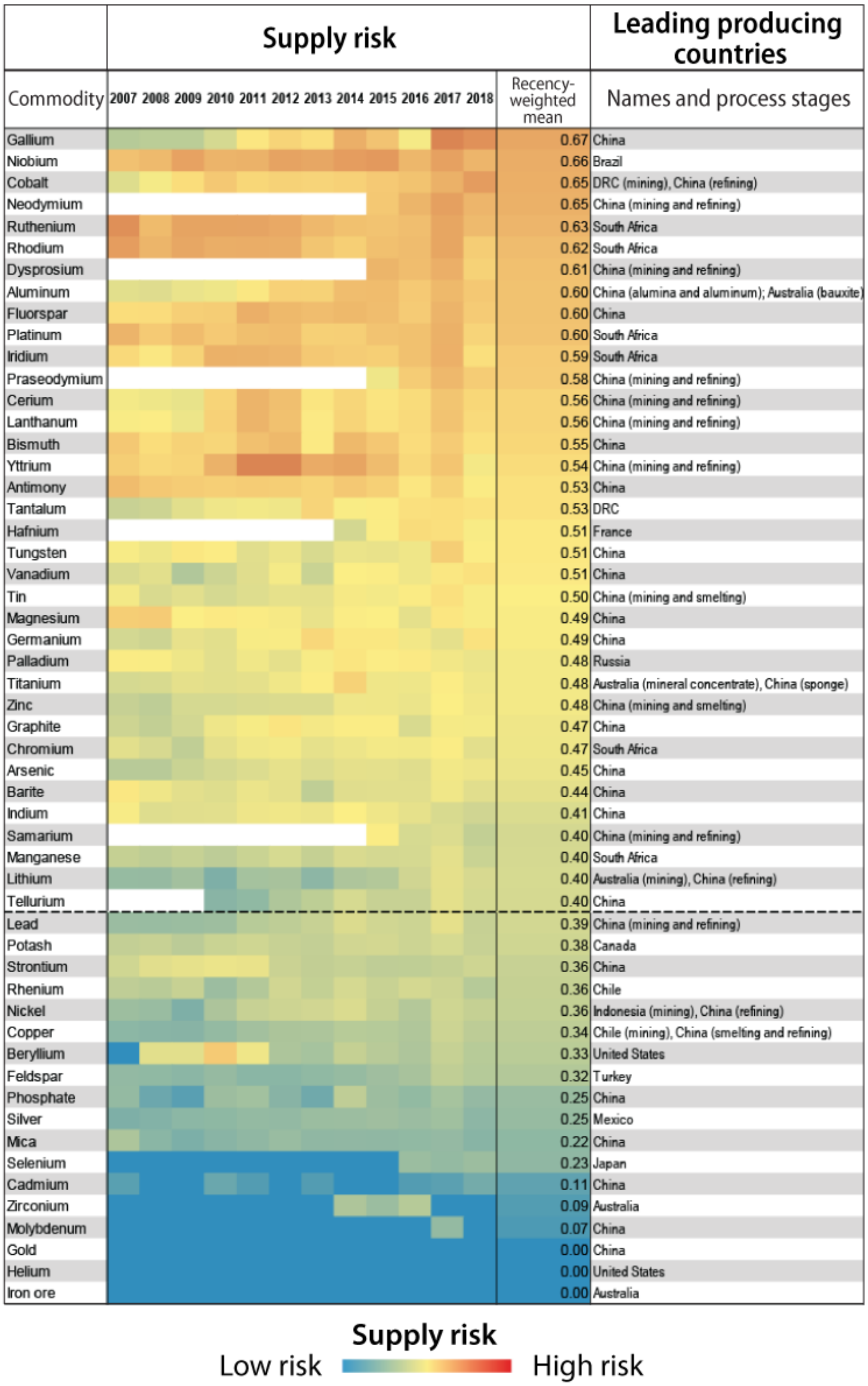
The U.S. Geological Survey (USGS) determined a recency weighted supply risk score threshold of 0.4 for designating a mineral critical and placing the mineral on the critical minerals list. The threshold of 0.4 is based on combining the thresholds for three factors: economic vulnerability, trade exposure, and disruption potential. The USGS used the following thresholds for each factor: 0.2 for economic vulnerability, 0.4 for trade exposure, and 0.5 for disruption potential.

Source: Nedal T. Nassar and Steven M. Fortier, *Methodology and Technical Input for the 2021 Review and Revision of the U.S. Critical Minerals List*, USGS, USGS Open-File Report 2021-1045, Figure 3 and p. 7.

[54] Under the authority of the Energy Act of 2020.

[55] The annual supply risk for 2018 for the 54 minerals is shown in **Figure 4**. For some minerals, there was not enough data for a quantitative assessment in some years. In these cases, no score is shown with color shading in **Figure 5**. For example, no annual supply risk score is shown for neodymium from 2007 to 2014.

Figure 5. Mineral Supply Risk and Leading Producing Countries



Source: Modified by CRS. Nedal T. Nassar and Steven M. Fortier, *Methodology and Technical Input for the 2021 Review and Revision of the U.S. Critical Minerals List*, U.S. Geological Survey, USGS, USGS Open-File Report 2021-1045, 2021, https://doi.org/10.3133/ofr20211045.

Notes: The minerals above the dotted line are on the 2022 critical minerals list (CML) because they have a higher supply chain risk (red to yellow shading) based on a *recency* weighted mean supply chain risk score of 0.4 or greater. In addition, beryllium, nickel, and zirconium are on the 2022 CML because they have a single point of failure on their supply chain. Cesium, erbium, europium, gadolinium, holmium, lutetium, rubidium, scandium, terbium, thulium, and ytterbium are on the 2022 CML; however, these minerals were assessed qualitatively and are not listed here because they do not have a recency weighted mean supply chain risk score. The annual supply chain risk is calculated for each year from 2007 to 2018 for each mineral, as shown above. If there are not enough data to calculate the annual risk, the box is white. A recency weighted mean supply risk score was calculated using the USGS quantitative methodology for each mineral using production and processing (i.e., refining) data from 2015 to 2018 (see textbox "Recency Weighted Supply Risk Score"). Recency weighted means that the score for the most recent year, 2018, was given a higher weight, whereas past years until 2015 were given a lower weight. DRC = Democratic Republic of Congo.

Semi-Quantitative Analysis

Beryllium, nickel, and zirconium had recency weighted supply risk scores less than 0.4 (**Figure 5**) but are included on the 2022 CML because they each have a single point of failure on their supply chains.

Qualitative Analysis

USGS included 11 minerals on the 2022 CML based on a qualitative assessment: cesium, erbium, europium, gadolinium, holmium, lutetium, rubidium, scandium, terbium, thulium, and ytterbium.[56] The lack of a quantitative assessment for every mineral may make it difficult to establish priority for research for critical minerals that do not have a risk score.[57]

Byproduct List

Section 7002(c) of the Energy Act of 2020 required the Secretary of the Interior, acting through the Director of the USGS, to publish in the *Federal Register* two lists—a CML and a list of critical minerals recovered as *byproducts*;[58] The Secretary of the Interior published one list combining information about primary and byproduct production.[59] The USGS created a combined list primarily because the production source does not impact the supply risk ranking methodology.[60] Where possible, the USGS identifies byproducts and the host product for a mineral; such information may help with strategies to reduce supply chain vulnerabilities for a particular mineral.[61]

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[56] The United States is 100% net import reliant for these mineral commodities and has been for many years. USGS, *Methodology and Technical Input*, 2021, p. 12.

[57] The USGS gathers data and information for more than 90 minerals and materials on a regular basis and prepares annual to monthly reports on events, trends, and issues for each mineral commodity. USGS, *MCS*, 2023; and USGS, "National Minerals Information Center," https://www.usgs.gov/centers/national-minerals-information-center.

[58] A *byproduct* refers to a commodity recovered from the extraction and/or processing of a primary commodity. See 30 U.S.C. §1606 (a)(1): "The term ''byproduct' means a critical mineral—(A) the recovery of which depends on the production of a host mineral that is not designated as a critical mineral; and (B) that exists in sufficient quantities to be recovered during processing or refining."

[59] USGS, "2022 Final List"; USGS, Methodology and Technical Input, 2021, Figure 3 and pp. 7-8; and CRS Report R48005, *Critical Mineral Resources: The U.S. Geological Survey (USGS) Role in Research and Analysis*, by Linda R. Rowan.

[60] USGS, *Methodology and Technical Input*, 2021.

[61] Ibid. In addition, the USGS identifies products and byproducts for mineral commodities where the data are available, including for some critical minerals, in the annual USGS Mineral Commodity Summaries. USGS, "Mineral Commodity Summaries," https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries.

Minerals Excluded from the List

Some public comments to the 2021 draft CML and the 2022 CML called for the USGS to include copper, helium, phosphate, potash, lead, silver, or uranium as critical minerals.[62] The USGS does not include these minerals on the 2022 CML because the minerals do not fit the criteria for criticality based on the USGS methodology. Uranium, a fuel mineral, is excluded from consideration by the Energy Act of 2020.[63] Some public comments about the draft methodology called for the USGS to change its quantitative or qualitative methodology, which might impact the minerals included on the list. The USGS stated that it did not find any technical flaws in the methodology that would warrant changes.[64]

Comparing the 2022 Critical Minerals List to DOE's 2023 Critical Materials List

Pursuant to Section 7002(a)(2) of the Energy Act of 2020, DOE prepared and published in the *Federal Register* a 2023 DOE Critical Materials List.[65] The 2023 DOE Critical Materials List includes two materials, electrical steel and silicon carbide, and 16 critical minerals that have supply chain risks and are essential for energy technologies either for the short term (from 2020 to2025) or for the medium term (from 2025 to 2035; see **Figure 6**).[66] The 2023 DOE Critical Materials List includes "aluminum, cobalt, copper, dysprosium, electrical steel (grain-oriented electrical steel, non-grain-oriented electrical steel, and amorphous steel), fluorine, gallium, iridium, lithium, magnesium, natural graphite, neodymium, nickel, platinum, praseodymium, terbium, silicon, and silicon carbide."[67]

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[62] USGS, "2021 Draft List"; and USGS, "2022 Final List."

[63] USGS, "2022 Final List."

[64] Ibid.

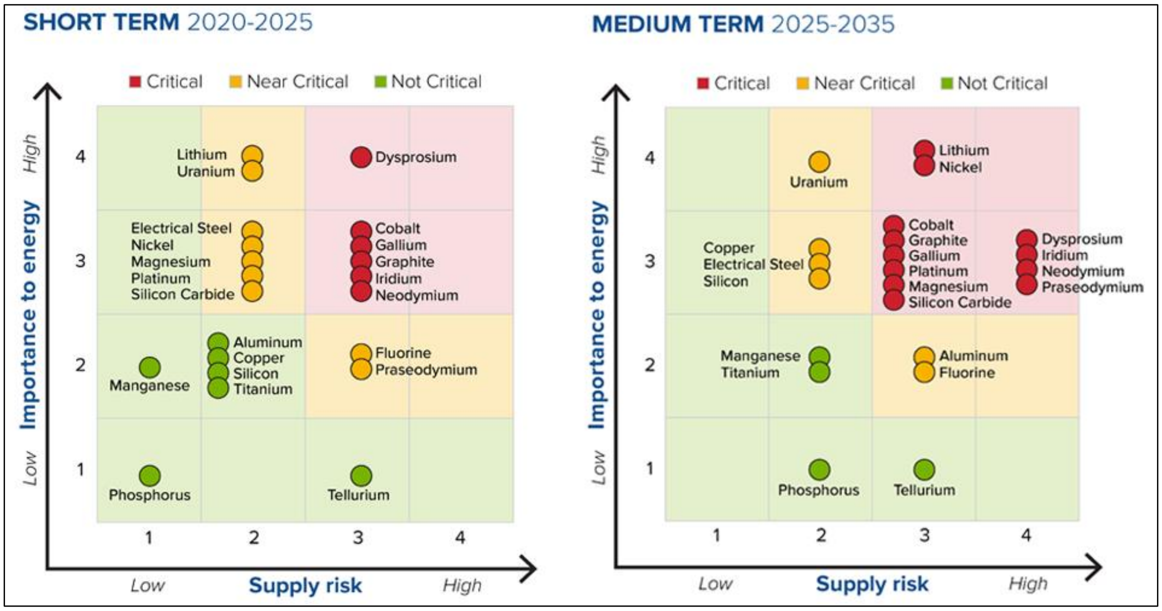
[65] 30 U.S.C. §1606(a)(2). Section 7002(a)(2) of the Energy Act of 2020 defines *critical materials* as

> (A) Any non-fuel mineral, element, substance, or material that the Secretary of Energy determines (i) has high risk for supply chain disruption; and (ii) serves an essential function in one or more energy technologies, including technologies that produce, transmit, store, and conserve energy [referred to here as a critical material for energy]; or (B) a critical mineral [as designated by the Secretary of the Interior].

[66] DOE interprets energy technologies to be clean energy technologies as described in the DOE Critical Minerals and Materials Vision and Strategy. DOE, "Notice of Final Determination on 2023 DOE Critical Materials List," 88 *Federal Register* 51792-51798, August 4, 2023, https://www.federalregister.gov/documents/2023/08/04/2023-16611/notice-of-final-determination-on-2023-doe-critical-materials-list (hereinafter, DOE, "Determination on 2023 DOE Critical Materials List"). DOE, *Critical Minerals and Materials: U.S. Department of Energy's Strategy to Support Domestic Critical Mineral and Material Supply Chains (FY2021-F Y2031)*, https://www.energy.gov/sites/prod/files/2021/01/f82/DOE%20Critical%20Minerals%20and%20Materials%20Strategy_0.pdf.

[67] DOE, "Determination on 2023 DOE Critical Materials List." DOE notes that the 2023 list is based on an updated analysis and methodology of previous critical materials strategy reports published in 2010, 2011, and 2019. DOE, *Critical Materials Assessment*, 2023.

Figure 6. DOE Critical Materials, 2020-2035



Source: DOE, *Critical Materials Assessment*, July 2023, https://www.energy.gov/sites/default/files/2023-07/doe-critical-material-assessment_07312023.pdf

Notes: Aluminum, copper, and silicon are not considered critical (red) in the short term (left); however, DOE included these minerals on the 2023 DOE Critical Materials List because they become near critical (yellow) in the medium term (right). Uranium, a fuel mineral, is considered in the Critical Materials Assessment and is plotted here but is not included on the 2023 DOE Critical Materials List. Terbium is included on the list but not shown on this graph, because there is not enough quantitative data to plot its importance and risk, according to DOE.

The 2023 DOE Critical Materials List is based on a different criteria and methodology than the 2022 CML, even though the two lists are often compared.[68] Comparing **Figure 4** with **Figure 6** illustrates the different factors considered in the USGS and DOE assessments based on the definitions of critical mineral and critical material in federal statute. For example, DOE evaluated only some materials for some energy technologies, as determined by DOE's evaluation of criticality.[69] DOE's assessment considers the global economy using DOE or International Energy Agency scenarios of future supply and demand of certain energy technologies to achieve certain sustainable development goals for time periods of 5-10 years.[70]

The 2022 CML includes 36 other critical minerals that are not listed on the 2023 DOE Critical Materials List and excludes 2 minerals (copper and silicon) that are listed on the 2023 DOE

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[68] DOE notes its list was developed independently of the 2022 CML but complements the 2022 CML by providing a global perspective of demand for critical materials for clean energy technologies from now to 2035. DOE, *Critical Materials Assessment*, 2023, pp. x and xiii. For lists from USGS, DOE, and Department of Defense, see CriticalMinerals.gov, "Critical Minerals Lists," https://criticalminerals.gov/critical-minerals-lists/.

[69] According to DOE, it established criteria and a methodology to assess critical materials for energy technologies because it would not be possible to evaluate the 118 elements on the periodic table. The updated assessment considered 38 materials used by nine technologies and ranked 23 of these materials to be critical enough for a more detailed evaluation. The nine technologies are broadly described by DOE as vehicles, stationary storage, hydrogen electrolyzers, solar energy, wind energy, nuclear energy, electric grid, solid state lighting, and microchips. DOE, *Critical Materials Assessment*, 2023.

[70] For example, DOE considers the International Energy Agency's Net-Zero Emissions Scenario, Sustainable Development Scenario, and Announced Pledge Scenarios. DOE, *Critical Materials Assessment*, 2023; and International Energy Agency, "Global Energy and Climate Model," https://www.iea.org/reports/global-energy-and-climate-model.

Critical Materials List. The 2023 DOE Critical Materials List includes only terbium of the 11 critical minerals on the 2022 CML, for which only a qualitative assessment was possible. The 2022 CML considers critical minerals that are essential for all technologies, not just energy technologies, which accounts in part for the additional critical minerals on the 2022 CML. One reason that DOE includes copper and silicon is because DOE's assessments are forward-looking and consider what minerals and materials it projects will be critical in 2020-2025 and 2025-2035 for energy technologies (**Figure 6**).[71]

In comparison, the USGS calculated supply risk on an annual basis from 2007 to 2018 and calculated a weighted recency supply risk score for 2015-2018 (see textbox on "Weighted Recency Supply Risk Score" and **Figure 5**).[72] The USGS noted that the more recent data were used and weighted because they more accurately reflect recent trends in supply and demand. According to the USGS, its analysis does not consider data from 2019 to 2023 because there are not enough data for a quantitative assessment; this may limit the ability of the 2022 CML to capture the trends in supply and demand from 2019 to 2023.

Congressional Considerations

Stakeholders in the 118th Congress are considering whether the definition of *critical mineral*, the methodology for developing a CML, and the 2022 CML are sufficient to inform national materials and minerals policy. For example, legislation introduced in the 118th Congress would amend the definition of critical mineral or the CML methodology, primarily to include other minerals such as copper, phosphate, potash, or uranium.[73] In particular, stakeholders and some Members of Congress have asked the USGS to add copper to the CML.[74] The USGS responded that copper did not fit the criteria based on the USGS methodology.[75] The 2023 DOE Critical Materials List includes copper and silicon as critical materials for energy technologies in the future. The differences between the two lists have raised further questions about which minerals should be considered critical.

In addition, the Department of Defense (DOD) assesses the supply chain risks for materials needed on an emergency basis for more than 250 strategic and critical materials.[76] DOD considers

[71] USGS, "2022 Final List"; USGS, *Methodology and Technical Input*, 2021; and DOE, *Critical Materials Assessment*, 2023.

[72] The USGS relied on annual evaluations for each mineral for 2007-2018, except for minerals where annual data were not available. See **Figure 5** for data gaps and for the annual supply risk score for each year. The analysis stopped at 2018 because that is the most recent year for which the USGS had complete annual data for quantitative assessments. USGS, *Methodology and Technical Input*, 2021.

[73] For example, H.R. 3514, H.R. 3885, and H.R. 4059. Also, H.R. 6395 would amend the Energy Act of 2020 and would require the Secretary to consult with the Secretary of Health and Human Services regarding critical mineral designations.

[74] Ian Littlewood, *Add Copper to the Critical Mineral List Now*: *Copper's Updated Critical Mineral Supply Chain Calculations*, Copper Development Association Inc., https://copper.org/copperiscritical.org/report/CDA_Copper_Critica_lMinerals_full_report.pdf; and Krysten Sinema, "Sinema & Colleagues Urge Administration to Designate Copper as a Critical Mineral in Interest of National Security," https://www.sinema.senate.gov/sinema-colleagues-urge-administration-designate-copper-critical-mineral-interest-national-security/.

[75] Hannah Northey, "USGS Rejects Push to Make Copper a 'Critical' Mineral," *E&E News PM*, May 23, 2023, https://subscriber.politicopro.com/article/eenews/2023/05/23/usgs-rejects-push-to-make-copper-a-critical-mineral-00098416. See also a link to a letter from the USGS to Senators Krysten Sinema, Mark Kelly, Joe Manchin III, Joe Braun, Raphael Warnock, and Mitt Romney available at https://subscriber.politicopro.com/eenews/f/eenews/?id=00000188-4953-d998-ab8f-fb5f223b0000.

[76] See White House, *Building Resilient Supply Chains*, 2021, pp. 151-204, for an overview of Department of Defense (continued...)

critical minerals that come from mining a natural resource to be a subset of strategic and critical materials and defines *strategic and critical materials* as materials that "would be needed to supply the military, industrial, and essential civilian needs of the United States during a national emergency, and (B) are not found or produced in the United States in sufficient quantities to meet such need."[77]

Members may consider whether the various purposes for which different federal departments construct their lists are sufficient to inform national materials and minerals policy and to what extent the departments should coordinate their efforts to identify critical minerals and critical materials.[78]

Some stakeholders question whether a critical mineral definition and a CML are necessary. Legislation introduced in the 118th Congress would remove the term *critical* and use a broader definition of *mineral* to include more minerals related to current policies and authorities for mineral resources development.[79]

Some in Congress have called for the USGS to complete an annual critical minerals outlook, as directed by the Energy Act of 2020, to identify potential supply chain risks in advance, so critical mineral resource development or other actions might be accelerated.[80] The Subcommittee on Energy and Mineral Resources of the House Natural Resources Committee held a hearing in September 2023 on *Examining the Methodology and Structure of the U.S. Geological Survey's Critical Minerals List*. The hearing discussed which minerals to define as critical and the importance of the USGS providing a critical minerals outlook.[81]

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assessments of critical and strategic materials, how critical minerals are part of these assessments, and some selected short lists of fewer than 60 critical materials. For a history of strategic versus critical minerals policy, see USGS, *Critical Mineral Resources*, 2017, Appendix A1. For descriptions of lists from USGS, DOE, and Department of Defense, see CriticalMinerals.gov, "Critical Minerals Lists," https://criticalminerals.gov/critical-minerals-lists/.

[77] 50 U.S.C. §98 (h)(3)(1) and CRS Report R47833, *Emergency Access to Strategic and Critical Materials: The National Defense Stockpile*, by Cameron M. Keys.

[78] For a table listing the status of federal government actions to promote stronger supply chains, see White House, "Two Years of Building Stronger Supply Chains and a More Resilient Economy," https://www.whitehouse.gov/wp-content/uploads/2023/06/Supply-Chain-Report-Card.pdf.

[79] For example, H.R. 1 and H.R. 1335 would remove *critical* from some federal statutes enacted under the Energy Act of 2020 and the Infrastructure Investment and Jobs Act (P.L. 117-58). These bills would define *mineral* more broadly using the definition from the Mining Law of 1872. Section 301 of H.R. 1335 states, "The term 'mineral' means any mineral of a kind that is locatable (including, but not limited to, such minerals located on 'lands acquired by the United States,' as such term is defined in section 2 of the Mineral Leasing Act for Acquired Lands) under the Act of May 10, 1872 (Chapter 152; 17 Stat. 91)."

[80] 30 U.S.C. §1606 (j). See "Comparing the 2022 Critical Minerals List to DOE's 2023 Critical Materials List," and CRS Report R48005, *Critical Mineral Resources: The U.S. Geological Survey (USGS) Role in Research and Analysis*, by Linda R. Rowan.

[81] U.S. Congress, House Committee on Natural Resources, Subcommittee on Energy and Mineral Resources, *Examining the Methodology and Structure of the USGS's Critical Minerals List*, 118th Cong., 1st sess., September 13, 2023, https://naturalresources.house.gov/calendar/eventsingle.aspx?EventID=414780.

Author Information

Linda R. Rowan
Analyst in Natural Resources and Earth Sciences

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