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Critical Mineral Resources: The U.S. Geological Survey (USGS) Role in Research and Analysis

The U.S. Geological Survey (USGS) is a lead federal science agency responsible for mineral resources research and analysis, where *resource* refers to a naturally occurring concentration of a mineral on the surface or in the subsurface that is currently or potentially economically extractable. Pursuant to the Energy Act of 2020 (Division Z of P.L. 116-260), 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 research and analysis identifies critical mineral resources to inform decisionmakers who aim to ensure a secure and sustainable supply chain. The USGS developed a list of 50 critical minerals in 2022 and aims to prioritize these minerals in its resource assessments. Section 7002 of the Energy Act of 2020 directed the Secretary of the Interior, acting through the Director of the USGS, to conduct a national assessment; add a review of production, consumption, and recycling patterns to annual mineral commodity summaries; and complete an annual outlook of future production, consumption, and recycling of critical minerals.

The Infrastructure Investment and Jobs Act (IIJA; P.L. 117-58) authorized and appropriated funds for the Earth Mapping Resources Initiative (Earth MRI) to accelerate mineral resources research, mapping, and assessment, with prioritization of critical mineral resources. Earth MRI is to integrate other USGS programs, including a Mineral Deposit Database, the National Cooperative Geologic Mapping Program, the National Geological and Geophysical Data Preservation Program (NGGDPP), and the 3D Elevation Program to advance research and mapping. In addition, the USGS is identifying potential sources of critical minerals in mine waste and potential critical mineral resources through analysis of samples archived by the NGGDPP.

According to a review in the USGS Mineral Commodity Summaries 2024, the United States was 100% net import reliant for 12 of the 50 critical minerals on the 2022 critical minerals list and more than 50% net import reliant for an additional 29. In 2023, China was the leading producer for 29 of the 50 critical minerals on the 2022 critical minerals list. Reliance on critical minerals from other countries and China’s dominance in producing and refining them raises concerns about critical mineral supply chain disruptions in the United States. Earth MRI has more than 100 ongoing or completed projects to research, map, and assess potential critical mineral resources in the United States. The USGS with partners is providing Earth MRI results and access to legacy mining and minerals information through accessible geospatial databases. The USGS aims to complete a five-year outlook for some critical minerals in the first half of 2024, to forecast supply chain risks in support of mitigating such risks before they might impact the U.S. economy and national security.

Congress may consider whether recent authorizations, policy directives, and appropriations for the USGS are sufficient for the agency’s role in identifying and researching domestic critical mineral resources. Congress may also consider whether domestic and international analyses are sufficient to identify and mitigate supply chain risks.

One hundred thirty-six bills, amendments, or resolutions related to critical minerals have been introduced in the 118th Congress as of March 20, 2024. Some measures would address the definition of *critical mineral* in federal statute (30 U.S.C. §1606(a)(3); e.g., H.R. 1 and H.R. 1335). Other measures would use the definition of *critical mineral* to support domestic or international mineral resources development through directing research and education, mining and refining, environmental stewardship, or international cooperation on critical mineral resources (e.g., H.R. 1704, H.R. 2685, H.R. 4977, S. 458, and S. 912).

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Introduction

According to a National Research Council report, critical minerals are *essential* for certain products and services and subject to *supply chain risks*.¹ For example, 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.² A general description of a supply chain typically includes extraction, processing, components, end-use technology, and recycling and reuse.³ *Extraction* is the removal of mineral resources from the surface or subsurface via mining.⁴ 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.⁵ Demand for products and services that rely on critical minerals is expected to increase in the next decade or so, causing concern about supply chain

¹ *Essential*, as discussed in a National Research Council (NRC) report, means the chemical and physical properties of a mineral, such as metallurgical, chemical, catalytic, electrical, magnetic, and/or optical properties, that make it difficult or impossible to find a substitute that can provide a similar function at a comparable cost. *Supply chain 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. NRC, *Minerals, Critical Minerals, and the U.S. Economy*, 2008, pp. 6, 8, and 36 (hereinafter, NRC, *Critical Minerals*, 2008).

² *Rare earth elements* include scandium, yttrium, and 15 elements that are called the lanthanide series. The lanthanides range from atomic number 57 (lanthanum) to atomic number 71 (lutetium). U.S. Geological Survey (USGS), “Rare Earths Statistics and Information,” <https://www.usgs.gov/centers/national-minerals-information-center/rare-earths-statistics-and-information>; USGS, “Rare-Earth Elements,” <https://www.usgs.gov/publications/rare-earth-elements>; 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>. See also 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).

³ According to the U.S. Department of Energy (DOE), a specific supply chain for a specific mineral may show different specific 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. For example, the refinement steps for rare earth element oxides produced in mines may include refinement from oxide to metal and then refinement from metal to metal alloys or magnetic powders. The metal alloys or magnetic powders are then distributed to manufacturers to make components. U.S. DOE, *Critical Materials Strategy*, December 2010 (hereinafter, DOE, *Critical Materials Strategy*, 2010), p. 11-12.

⁴ 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* with regard to 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>; and USGS, “How Do We Extract Minerals?” <https://www.usgs.gov/faqs/how-do-we-extract-minerals>. For more details about certain critical mineral resources, especially their geology and global distribution, extraction, processing, environmental considerations, 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>.

⁵ The USGS defines *byproduct* as a commodity “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, Open-File Report 2021-1045, 2021, p. 7, <https://doi.org/10.3133/ofr20211045>.

risks disrupting the U.S. economy and national security.⁶ One strategy to identify and mitigate supply chain risks is research, assessment, and analysis of critical mineral resources.⁷

The U.S. Geological Survey (USGS), an agency within the Department of the Interior, aims to research and assess domestic mineral resources and analyze global supply and demand of mineral resources.⁸ Beginning in 2013, the USGS began research and assessment of 23 mineral commodities deemed critical minerals to inform decisionmaking to ensure a secure and sustainable supply of mineral commodities.⁹ The report noted that the United States was 100% net import reliant on foreign sources for 12 mineral commodities, more than 50% net import reliant for an additional 50 mineral commodities and that no country can be self-sufficient for all of its mineral commodity needs. In addition, the USGS began to designate some mineral resources as critical mineral resources as part of their work on the Subcommittee on Critical and Strategic Mineral Supply Chains of the National Science and Technology Council (NSTC).¹⁰ The Trump Administration through Executive Order (E.O.) 13817 defined *critical mineral*, directed the Secretary of the Interior to publish a list of critical minerals, and directed the Secretary of Commerce with other executive branch agencies to develop a plan to improve the topographic, geologic, and geophysical mapping of the United States and to make the resulting data electronically accessible, among other tasks.¹¹

⁶ White House, *Building Resilient Supply Chains*, 2021; U.S. 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>.

⁷ DOE, *Critical Materials Strategy*, 2010, and 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 (hereinafter, DOC, *Federal Strategy, Critical Minerals*, 2019).

⁸ USGS, “Mineral Resources Program,” <https://www.usgs.gov/programs/mineral-resources-program>, and USGS, “National Minerals Information Center, About” <https://www.usgs.gov/centers/national-minerals-information-center/about>. Mineral resources research and assessment has been part of the USGS mission since it was formed by The Organic Act of March 3, 1879, for “classification of the public lands, and examination of the geological structure, mineral resources, and products of the national domain.” USGS, “Mineral Resources Program, About” <https://www.usgs.gov/programs/mineral-resources-program/about>. Assessment is part of the research endeavor and seeks to determine whether the resource may be economically extracted based on the types of minerals, the concentration of the minerals, a geologic model of the size and structure of the deposit, and related details based on research and associated geologic mapping.

⁹ The report considers the global and domestic resource position for 23 mineral commodities. The report explains the criteria for designating some mineral commodities as critical mineral resources. USGS, *Critical Mineral Resources*, 2017. According to the USGS, the 2017 report is in part an update to a 1973 report that considered the domestic resource position of 65 mineral commodities or commodity groups with some mention of global resource positions. USGS, *United States Mineral Resources*, USGS Professional Paper 820, 1973, <https://doi.org/10.3133/pp820>.

¹⁰ 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). The subcommittee was renamed the Critical Minerals Subcommittee. DOC, *Federal Strategy, Critical Minerals*, 2019. CRS Report R47982, *Critical Mineral Resources: National Policy and Critical Minerals List*, by Linda R. Rowan.

¹¹ Executive Order (E.O.) 13817, “A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals,” 82 *Federal Register* 60835-60837, December 26, 2017. CRS Report R47982, *Critical Mineral Resources: National Policy and Critical Minerals List*, by Linda R. Rowan.

The Secretary of the Interior published a list of 35 critical minerals in 2018.¹² The Secretary of Commerce published a federal strategy to improve mapping, among other tasks, in 2019.¹³ In addition, pursuant to E.O. 13817, the USGS organized a critical mineral resource mapping initiative within the Mineral Resources Program (MRP), and Congress funded the initiative in FY2019.¹⁴

Congress codified some components of executive branch initiatives and orders in legislation enacted in 2020 and 2021. The enacted legislation directed certain USGS research and analysis activities for critical mineral resources. Section 7002 of the Energy Act of 2020 (Division Z of P.L. 116-260) defined critical mineral and directed the Secretary of the Interior, acting through the Director of the USGS, to publish and update a critical minerals list (CML), to research and assess domestic critical mineral resources, and to analyze global supply and demand.¹⁵ In federal statute, 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.¹⁶ In June 2021, the Infrastructure Investment and Jobs Act (IIJA; P.L. 117-58) established 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.¹⁷

The USGS published a final list of 50 critical minerals in a February 24, 2022, *Federal Register* notice.¹⁸ 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 2022 CML.¹⁹

In February 2021, the Biden Administration issued E.O. 14017 that directed 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.²⁰ In June 2021, the federal government completed its

¹² 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>.

¹³ DOC, *Federal Strategy, Critical Minerals*, 2019.

¹⁴ USGS, “Earth Mapping Resources Initiative (Earth MRI), About,” <https://www.usgs.gov/special-topics/earth-mri/about>. See also USGS, *Budget Justifications and Performance Information Fiscal Year 2020*, p. 49, and USGS, *Budget Justifications and Performance Information Fiscal Year 2019*, pp. 55-59.

¹⁵ CRS Report R47982, *Critical Mineral Resources: National Policy and Critical Minerals List*, by Linda R. Rowan.

¹⁶ 30 U.S.C. §1606. Other minerals may be designated critical minerals if another federal agency deems them to be strategic and critical to the defense or national security of the United States.

¹⁷ USGS, “Bipartisan Infrastructure Law: Critical Minerals,” <https://www.usgs.gov/special-topics/bipartisan-infrastructure-law-investments/science/bipartisan-infrastructure-law-1>.

¹⁸ 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”). CRS Report R47982, *Critical Mineral Resources: National Policy and Critical Minerals List*, by Linda R. Rowan.

¹⁹ 30 U.S.C. §1606(d).

²⁰ E.O. 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>. In addition, E.O. 14017 called for assessments and strategies to strengthen supply chains in six industrial sectors. These reports were completed in February 2022. White House, “Executive Order on America’s Supply Chains: A Year of Action and Progress,” <https://www.whitehouse.gov/wp-content/uploads/2022/02/Capstone-Report-Biden.pdf>.

100-day review and recommended more than 70 actions to promote resilience, including actions pursuant to IIJA and some other laws.²¹

In June 2023, the Biden Administration issued a report card describing actions taken on some of the recommendations in the 100-day review, including actions taken through enacted legislation, such as Earth MRI pursuant to IIJA.²²

This report describes USGS critical mineral resources research and analysis activities pursuant to the Energy Act of 2020 and IIJA. Also noted are initiatives that the USGS is coordinating with the Department of Energy (DOE), the Department of Labor (DOL), and the National Science Foundation (NSF).²³ The report raises considerations for Congress regarding federal efforts to research and assess critical mineral resources and to analyze supply chain risks.

USGS Research of Critical Mineral Resources

Sections 7002(d) and (j) of the Energy Act of 2020 direct the USGS to conduct a national assessment; add an annual review of production, consumption, and recycling patterns to the USGS annual mineral commodity summaries; and complete an annual outlook for critical minerals on the 2022 CML.²⁴ Section 7002(i) directs the Secretaries of the Interior and Energy, in consultation with the Director of the NSF, to establish a Critical Materials Information Portal.²⁵ Sections 7002(g) and (h) direct the Secretary of the Interior to consult and coordinate research and analysis with DOE-led critical materials initiatives.²⁶ Furthermore, Section 7002(k) calls for a workforce assessment, a curriculum study, and a competitive grant program for domestic critical minerals-related research and development, education, and training.²⁷ The Energy Act of 2020 authorized \$50 million annually for FY2021–FY2029 for the Secretary of the Interior to carry out Section 7002.

The USGS MRP within the USGS Energy and Minerals Mission Area leads the research and assessment activities to provide information about the known and undiscovered critical mineral

²¹ White House, *Building Resilient Supply Chains*, 2021.

²² White House, “Two Years of Building Stronger Supply Chains and a More Resilient Economy,” June 2023, <https://www.whitehouse.gov/wp-content/uploads/2023/06/Supply-Chain-Report-Card.pdf>.

²³ Sections 7002(g-i) of the Energy Act of 2020 direct DOE to carry out certain critical materials initiatives, often in coordination with other federal agencies. Section 7002(k) directs the National Science Foundation (NSF) and the Department of Labor (DOL) to coordinate with the USGS on education and workforce initiatives related to critical minerals. These coordinated initiatives are briefly mentioned for comparison or to describe coordination with the USGS but are not discussed in detail in this report.

²⁴ 30 U.S.C. §1606(d) and 30 U.S.C. §1606(j).

²⁵ According to the USGS, DOE is coordinating with NSF and the USGS to establish a portal. Personal correspondence between CRS and USGS.

²⁶ 30 U.S.C. §1606(i).

²⁷ 30 U.S.C. §1606(k). The education and workforce activities are specifically related to critical mineral exploration, development, assessment, production, manufacturing, recycling, forecasting, education, and research. There is no mention of critical materials or materials science and no calls for DOE to consult or coordinate on these initiatives. Regarding the curriculum study, the USGS with NSF and the Department of Labor held an education and workforce workshop on January 23-24, 2024, that was coordinated and hosted by the National Academies of Sciences, Engineering, and Medicine. National Academies, *Building Capacity to Meet Current and Future Challenges and Needs Facing the U.S. Mineral Resources Workforce: A Workshop*, https://www.nationalacademies.org/event/41017_01-2024_building-capacity-to-meet-current-and-future-challenges-and-needs-facing-the-us-mineral-resources-workforce-a-workshop. Regarding the grant program, DOL and DOI are awaiting appropriations as authorized to establish an education and workforce grant program. Personal correspondence between CRS and USGS.

resources in the United States.²⁸ The national assessment called for in the Energy Act of 2020 is a focused research and assessment initiative on critical minerals using the existing activities of MRP, including activities that are coordinated with other USGS programs.²⁹

The Energy Act of 2020 requires the USGS to complete a national assessment of each critical mineral before December 27, 2024.³⁰ The assessment is to identify known critical mineral resources and estimate the amount of undiscovered critical mineral resources in the United States. The USGS is to work with state (including state geological surveys), local, academic, industry, and other entities to conduct this national assessment. Besides using existing public and private information (including exploration histories), the Secretary of the Interior may carry out surveys and field work, including drilling, remote sensing, geophysical surveying, topographic and geologic mapping, and geochemical sampling and analysis, to complete the national assessment. The Secretary of the Interior is to make the data and metadata for the national assessment publicly and electronically accessible.

In 2021, the IJIA authorized or amended authorities for some activities that may support critical mineral measures under the authority of the Energy Act of 2020. Section 40201 of the IJIA established the USGS Earth MRI. The USGS programs and activities that have some focus on critical mineral resource initiatives are described below and include the primary USGS programs on research of critical mineral resources as called for in Section 7002(d) of the Energy Act of 2020 and Section 40201 of IJIA.

Mineral Resources Program

The two primary functions of MRP are (1) research and assessment of mineral resources and (2) mineral supply and demand analysis.³¹ MRP research and assessment provides information for land-use planners and decisionmakers about where mineral commodities are known or suspected to occur in the Earth's crust, about the estimated quantity and quality of those deposits, and about how they interact with the environment. MRP leads the critical mineral measures being implemented by the USGS pursuant to the Energy Act of 2020 and IJIA. Some of these measures continue the mineral resources work of the MRP with a focus on critical minerals.

The Biden Administration on November 27, 2023, announced new actions to secure supply chains, including critical mineral supply chains, at the inaugural meeting of the White House Council on Supply Chain Resilience.³² In particular, the USGS is to map and develop geospatial

²⁸ USGS Mineral Resources Program “Critical Mineral Resources,” <https://www.usgs.gov/programs/mineral-resources-program/science/critical-mineral-resources>.

²⁹ Mineral resources research and assessment has been part of the USGS mission since it was formed by The Organic Act of March 3, 1879, for “classification of the public lands, and examination of the geological structure, mineral resources, and products of the national domain.” Assessment is part of the research endeavor and seeks to determine whether the resource may be economically extracted based on the types of minerals, the concentration of the minerals, a geologic model of the size and structure of the deposit, and related details based on research and associated geologic mapping.

³⁰ 30 U.S.C. §1606(d). This includes minerals designated as critical minerals in Section 7002(c) and allows for additional assessments of minerals subsequently designated as critical minerals. In addition, the Secretary of the Interior shall report to Congress on the status of geological surveying of federal lands for any mineral commodity for which the U.S. is dependent on a foreign country for more than 25% of U.S. supply.

³¹ USGS, “Mineral Resources Program,” <https://www.usgs.gov/programs/mineral-resources-program>.

³² 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).

databases of certain global critical mineral resources (i.e., similar to the domestic database, see “USMIN Mineral Deposit Database”) and seek a federal statistical unit from the U.S. Chief Statistician for an “official minerals statistics.”³³ Related Biden Administration actions call for the DOE and Department of Defense (DOD) to continue research and analysis of critical minerals (as part of broader critical material initiatives) for energy and defense purposes, respectively. DOE is to develop an assessment tool that accounts for raw materials, manufacturing, workforce, and logistics considerations for energy technology. DOD is to develop a supply chain assessment tool for suppliers of defense weapons. In addition, the NSTC Critical Minerals Subcommittee launched a CriticalMinerals.gov website to “highlight cross-governmental supply chain efforts.”³⁴

Earth Mapping Resources Initiative

Knowing where mineable critical mineral resources exist depends, in part, on knowing the geology:

- how the rocks and minerals formed (such as from a volcanic eruption),
- the geochemical composition (such as a high concentration of lithium),
- the geophysical properties (such as density and magnetic properties), and
- the geologic structure (such as multilayer, folded, faulted, on the surface, or extending into the subsurface).

Earth MRI, managed by the MRP, acquires new geologic maps, geophysical and geochemical surveys, and lidar data to understand the geology of areas in the United States with the potential for hosting critical mineral resources.³⁵ The USGS initially requested and Congress funded critical mineral resources mapping in FY2019 pursuant to Interior Secretarial Order 3359 and E.O. 13817.³⁶ In March 2019, the USGS published a report describing which areas of the United States may host some critical minerals so that Earth MRI projects could focus on these areas.³⁷

³³ White House, *America’s Supply Chains*, 2023. The USGS has asked the Office of Management and Budget to designate the National Minerals Information Center as a principal statistical unit of the federal government. White House, “Statistical Programs & Standards,” <https://www.whitehouse.gov/omb/information-regulatory-affairs/statistical-programs-standards/>.

³⁴ White House, *America’s Supply Chains*, 2023. CriticalMinerals.gov, “CriticalMinerals.gov,” <https://criticalminerals.gov/>. Section 40210 of IIA codified the Critical Minerals Subcommittee. CriticalMinerals.gov, “Statutory Authority,” <https://criticalminerals.gov/statutory-authority/>.

³⁵ USGS, “Earth Mapping Resources Initiative (Earth MRI),” <https://www.usgs.gov/special-topics/earth-mri>.

³⁶ DOI Secretarial Order 3359, https://www.doi.gov/sites/doi.gov/files/uploads/so_criticalminerals.pdf, and E.O. 13817, “A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals,” 82 *Federal Register* 60835-60837, December 20, 2017. For a summary of the first steps to implementing Earth MRI, see Warren C. Day, *The Earth Mapping Resources Initiative (Earth MRI): Mapping the Nation’s Critical Mineral Resources*, USGS, Fact Sheet 2019-3007, 2019, <https://doi.org/10.3133/fs20193007>. DOI, *Budget Justifications and Performance Information Fiscal Year 2019: U.S. Geological Survey* [Greenbook], <https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/s3fs-public/atoms/files/FY2019%20USGS%20Budget%20Justification%20%28Greenbook%29.pdf>, p. 55.

³⁷ Since 2019, the USGS has posted revisions to some components of this report, with the most recent revision in July, 2022. USGS, *Focus Areas for Data Acquisition for Potential Domestic Sources of Critical Minerals*, Open-File Report 2019–1023, <https://doi.org/10.3133/ofr20191023A>. Work on this report started with the 2018 list of critical minerals (DOI, “Final List of Critical Minerals 2018”) and does not include all the minerals on the 2018 list or on the 2022 critical minerals list (CML) (USGS, “2022 Final List” and “National Minerals Information Center: Annual Review and Multiyear Forecasts”). The study considers potential sources of antimony, barite, beryllium, chromium, fluorspar, hafnium, helium, magnesium, manganese, potash, uranium, vanadium, and zirconium in the states and Puerto Rico. The study considers potential sources of aluminum, cobalt, graphite, lithium, niobium, platinum group elements, rare earth elements, tantalum, tin, titanium, and tungsten in most states, except Hawaii, and Puerto Rico. Helium, potash, (continued...)

Section 40201 of the IIJA authorized Earth MRI to accelerate USGS efforts for mineral resources research and mapping with an emphasis on mapping critical mineral resources. Pursuant to IIJA authority, Earth MRI is to incorporate the research and mapping from existing USGS programs, including the USMIN Mineral Deposit Database, the National Cooperative Geologic Mapping Program (NCGMP), the National Geological and Geophysical Data Preservation Program (NGGDPP), 3D Elevation Program (3DEP), and other data sources (see below for more details about each program). The USGS plans to use existing agreements or enter into new agreements with state geological surveys to carry out Earth MRI. Section 40201 of the IIJA authorized total appropriations of \$320 million for Earth MRI for FY2022–FY2026, to remain available until expended. Title VI of Division J of the IIJA appropriated \$64 million annually for FY2022–FY2026 for Earth MRI.

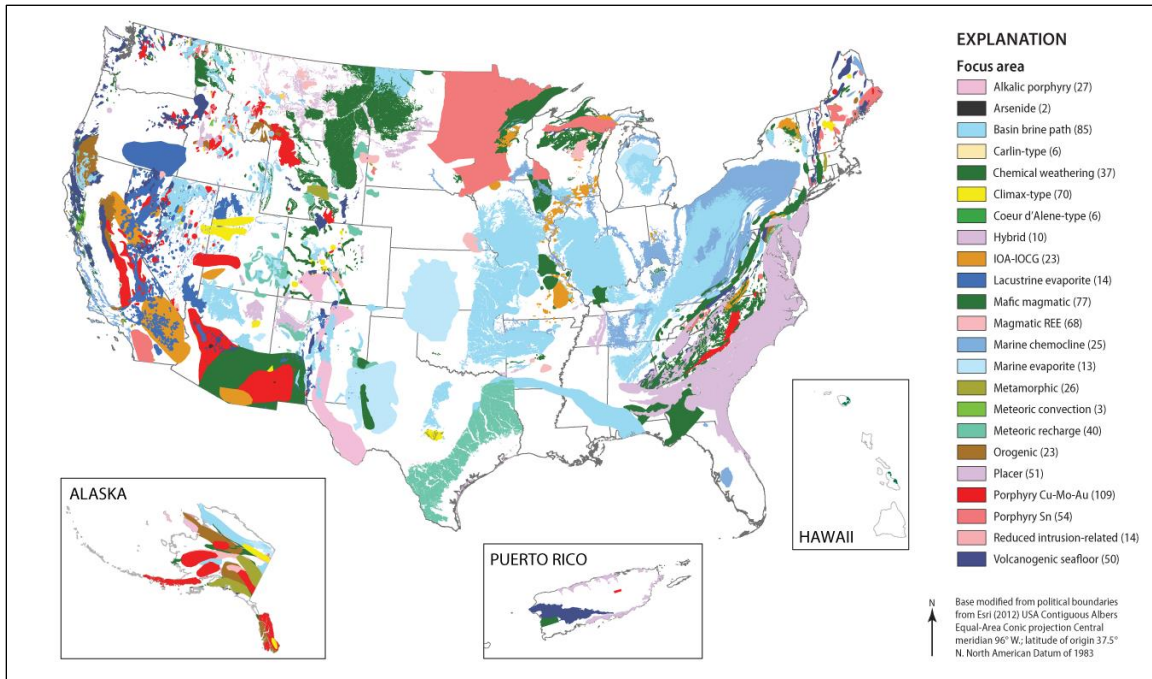
The IIJA directed the USGS to create a “comprehensive national modern surface and subsurface mapping and data integration effort” that emphasizes the recoverable critical minerals in a surface or subsurface deposit within 10 years of enactment. The USGS states that it intends to complete the national assessment pursuant to the IIJA deadline instead of the four-year deadline required by the Energy Act of 2020.³⁸ The USGS compiled a national map of currently identified potential critical mineral resources to prioritize Earth MRI activities (**Figure 1**).³⁹

and uranium are included in this USGS study because they were on the 2018 list. Helium, potash, and uranium are not on the 2022 CML.

³⁸ Personal correspondence between CRS and USGS.

³⁹ Jane M. Hammarstrom et al., *National Map of Focus Areas for Potential Critical Mineral Resources in the United States*, U.S. Geological Survey, USGS Fact Sheet 2023-3007, February 2023, <https://doi.org/10.3133/fs20233007>.

Figure I. National Map of Potential Critical Mineral Resources



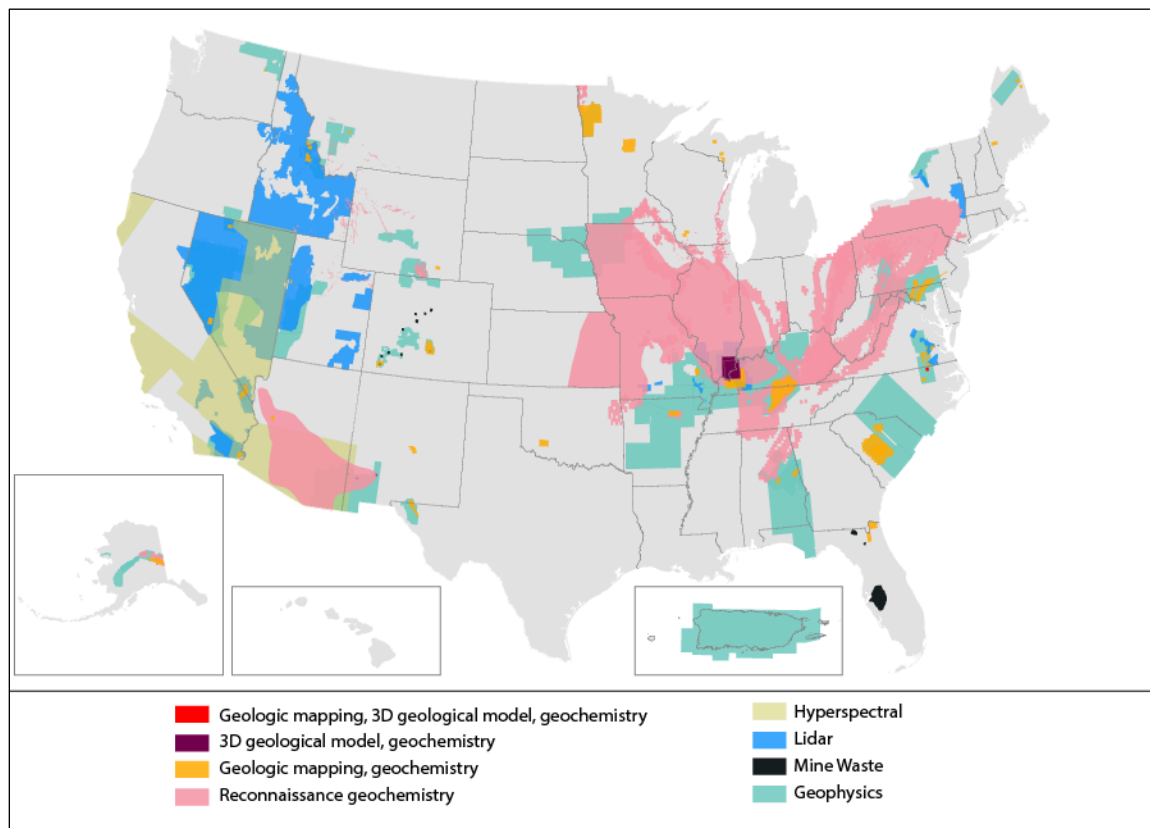
Source: Jane M. Hammarstrom et al., *National Map of Focus Areas for Potential Critical Mineral Resources in the United States*, U.S. Geological Survey, USGS Fact Sheet 2023–3007, February 2023, <https://doi.org/10.3133/fs20233007>.

Notes: The maps show about 800 focus areas for 23 types of mineral systems that could host one or more critical mineral resources in the states and Puerto Rico. A mineral system describes a general way that a mineral resource may form, such as from a volcanic eruption. In the figure key, the numbers in parentheses indicate the number of focus areas identified in the United States for each mineral system.

One hundred sixteen projects in Earth MRI were completed or are in progress as of June 1, 2023. **Figure 2** shows the spatial distribution of these projects.⁴⁰

⁴⁰ USGS, “Earth MRI Acquisitions Viewer,” <https://ngmdb.usgs.gov/emri/#3/40/-96>.

Figure 2. Earth Mapping Resources Initiative Acquisitions
(Map of Earth MRI Projects Completed or in Progress as of June 1, 2023)



Source: CRS prepared this map by accessing data from the Earth MRI Acquisitions Viewer (<https://ngmdb.usgs.gov/emri/#3/40/-96>) on June 1, 2023. The interactive Earth MRI Acquisitions Viewer provides a map of the projects plus links to more data about each project.

Notes: The colors show the different types of projects completed or in progress by the U.S. Geological Survey (USGS) in partnership with state geological surveys and others. 3D = three-dimensional, lidar = light detection and ranging. *Hyperspectral* means remote sensing and mapping with sensors that sample many bandwidths in and near the visible light wavelength portion of the electromagnetic spectrum. Lidar images topography, which may indirectly identify a particular type of rock or mineral, whereas hyperspectral identifies rocks or minerals with high concentrations of certain elements, such as iron.

Earth MRI has identified potential critical mineral resources in the United States. Two examples of recent discoveries highlight some of the techniques used to understand the geology.

1. A new REE-niobium-zirconium deposit of volcanic origin has been identified at Pennington Mountain in northern Maine using airborne magnetic and radiometric surveys.⁴¹ A radiometric instrument attached to an aircraft sampled a large area of more than 3,700 square miles for high concentrations of uranium, thorium, and potassium. The survey detected a small area (less than 10 square miles) with a high concentration of thorium. Additional ground-based radiometric surveys, geochemical measurements of rock samples, and some more detailed geologic

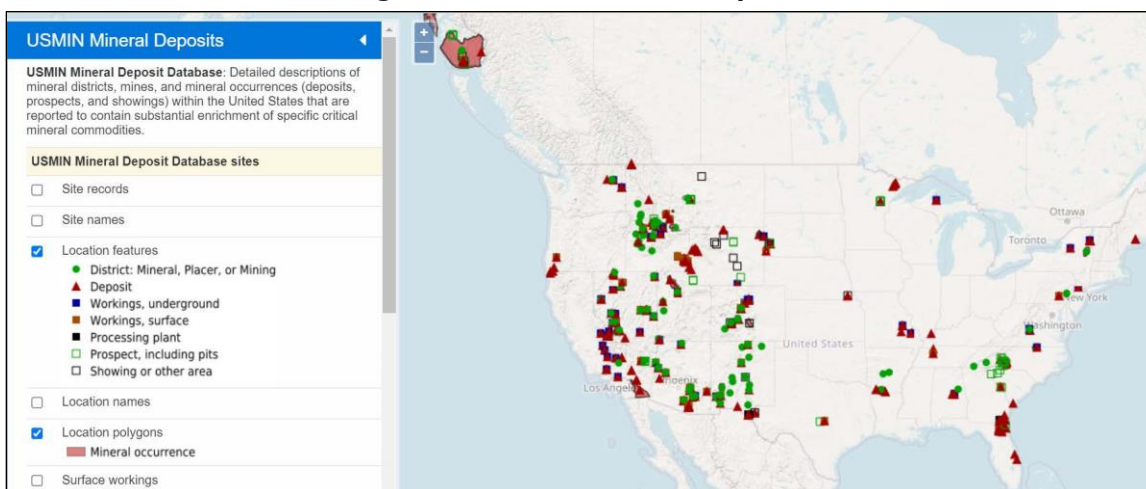
⁴¹ USGS, “Scientists Discover Significant Critical Minerals Potential in Northern Maine,” November 10, 2022, <https://www.usgs.gov/news/national-news-release/scientists-discover-significant-critical-minerals-potential-northern>.

- mapping further located potential mineable REEs with concentrations similar to concentrations found in mines in Australia and China.⁴²
2. Gallium, another potential critical mineral resource, has been discovered through an Earth MRI project in mines, mine waste, and related mineral deposits near Bauxite, Arkansas.⁴³ Laboratory analyses of samples from these locations detected higher than average concentrations of gallium and niobium. Such concentrations may indicate economically mineable deposits.

USMIN Mineral Deposit Database

Knowing where mines and potentially mineable mineral deposits are located may help to develop a national assessment of known and potential critical mineral resources. MRP maintains the USMIN Mineral Deposit Database, a national scale, geospatial database of the most important mines, mineral deposits, and mineral districts of the United States, according to the USGS (Figure 3). The IJIA requires that the USMIN Mineral Deposit Database be integrated with Earth MRI and that the data be publicly accessible;⁴⁴ the current data collection is available online. Figure 3 shows the status of the database as of November 28, 2023.

Figure 3. USMIN Mineral Deposits



Source: USGS, “USMIN Mineral Deposits,” at <https://mrdata.usgs.gov/deposit/map-us.html#home>.

Notes: Screenshot of the USMIN Mineral Deposits interactive, online geospatial database, accessed on November 28, 2023. Each symbol refers to a mineral district, mine, or mineral occurrence within the United States. Clicking on a symbol links to more data about the deposit. The map is centered on the contiguous United States, and only a small part of Southeast Alaska is shown. Not shown are the rest of Alaska, Hawaii, and U.S. territories.

⁴² Chunzang Wang et al., “A Recently Discovered Trachyte-Hosted Rare Earth Element-Niobium-Zirconium Occurrence in Northern Maine, USA,” *Economic Geology*, vol. 118, no. 1 (January 2023), <https://doi.org/10.5382/econgeo.4993>.

⁴³ Bradley S. Van Gosen and LaDonna M. Choate, Reconnaissance Study of the Major and Trace Element Content of Bauxite Deposits in the Arkansas Bauxite Region, Saline and Pulaski Counties, Central Arkansas, USGS, Open-File Report 2021–1073, 2021, <https://doi.org/10.3133/ofr20211073>.

⁴⁴ USGS, “USMIN Mineral Deposit Database,” <https://www.usgs.gov/centers/gggsc/science/usmin-mineral-deposit-database>.

National Cooperative Geologic Mapping Program

According to the USGS, NCGMP researches, produces, and maintains geologic maps and three-dimensional geologic framework models of areas in the United States to support the responsible use of land, water, energy, and minerals and to mitigate geologic hazards.⁴⁵ The maps show the rocks and minerals on the surface. The models show how the rocks and minerals on the surface may have formed and how the formations may extend on the surface or into the subsurface.

Established by the National Geologic Mapping Act of 1992 (P.L. 102-285) in partnership with the Association of American State Geologists, the federal, state, and university partners develop geologic maps and models organized within the National Geologic Map Database.⁴⁶ Section 40202 of the IIJA amended P.L. 102-285 so that NCGMP includes mapping potential critical minerals from abandoned mine land and mine waste components. IIJA extended the authorization of appropriations for NCGMP of \$64 million annually to FY2031.

National Geological and Geophysical Data Preservation Program

According to the USGS, NGGDPP preserves and makes accessible the nation's geoscience collections, including rock samples, subsurface and surface data, and maps, for their use in research and natural resource development.⁴⁷ Through the program, the USGS, other Department of the Interior agencies that have samples and data, and state agencies that elect to be part of the program maintain and update their collections. Section 351 of the Energy Policy Act of 2005 (P.L. 109-58) authorized three goals for the NGGDPP: (1) archive geologic data, (2) establish a national catalog of the archived data, and (3) provide assistance for archiving data.⁴⁸ Section 40203 of the IIJA added a fourth goal to the NGGDPP to provide for the preservation of samples to identify geochemical signatures from critical mineral ore bodies in order to understand their origin. Section 7002(l) of the Energy Act of 2020 reauthorized appropriations of \$5 million per year for FY2021–FY2029 for NGGDPP. Section 41003 of the IIJA authorized appropriations and Title VI of Division J of IIJA appropriated \$8.7 million for FY2022 and \$5 million annually for FY2023–FY2025 for NGGDPP.

3D Elevation Program

According to USGS, 3DEP acquires nationwide lidar data to provide a national baseline of consistent high-resolution topographic elevation data—bare earth and 3D point clouds (**Figure**

⁴⁵ USGS, “National Cooperative Geologic Mapping Program (NCGMP) Mission Overview,” <https://www.usgs.gov/programs/national-cooperative-geologic-mapping-program/national-cooperative-geologic-mapping>.

⁴⁶ 43 U.S.C. §31a. USGS, “National Geologic Map Database,” https://ngmdb.usgs.gov/ngmdb/ngmdb_home.html, and USGS, “History and Evaluation of the NCGMP,” <https://www.usgs.gov/programs/national-cooperative-geologic-mapping-program/history-and-evaluation-ncgmp>.

⁴⁷ USGS, “National Geological and Geophysical Data Preservation Program,” <https://www.usgs.gov/programs/national-geological-and-geophysical-data-preservation-program>

⁴⁸ 42 U.S.C. §15908(b). The three goals from the Energy Policy Act of 2005 are

(1) to archive geologic, geophysical, and engineering data, maps, well logs, and samples; (2) to provide a national catalog of such archival material; and (3) to provide technical and financial assistance related to archival material.

4).⁴⁹ The topographic data assist in identifying critical mineral resources in the United States.⁵⁰ In particular, the lidar data increase the spatial precision of the geologic mapping to more accurately define the surface extent of a deposit and may help to identify any structures, such as faults or folds, that may impact the model of the subsurface extent of the deposit. 3DEP was established in the National Landslide Preparedness Act (P.L. 116-323), which authorized \$40 million for 3DEP for each FY2021–FY2024.⁵¹ The USGS maintains an interactive map of the status of 3DEP data collection in the United States (**Figure 5**). In addition, the USGS is adding interactive tools, such as LidarExplorer, to allow users to access and visualize lidar data online using cloud processing capabilities.⁵²

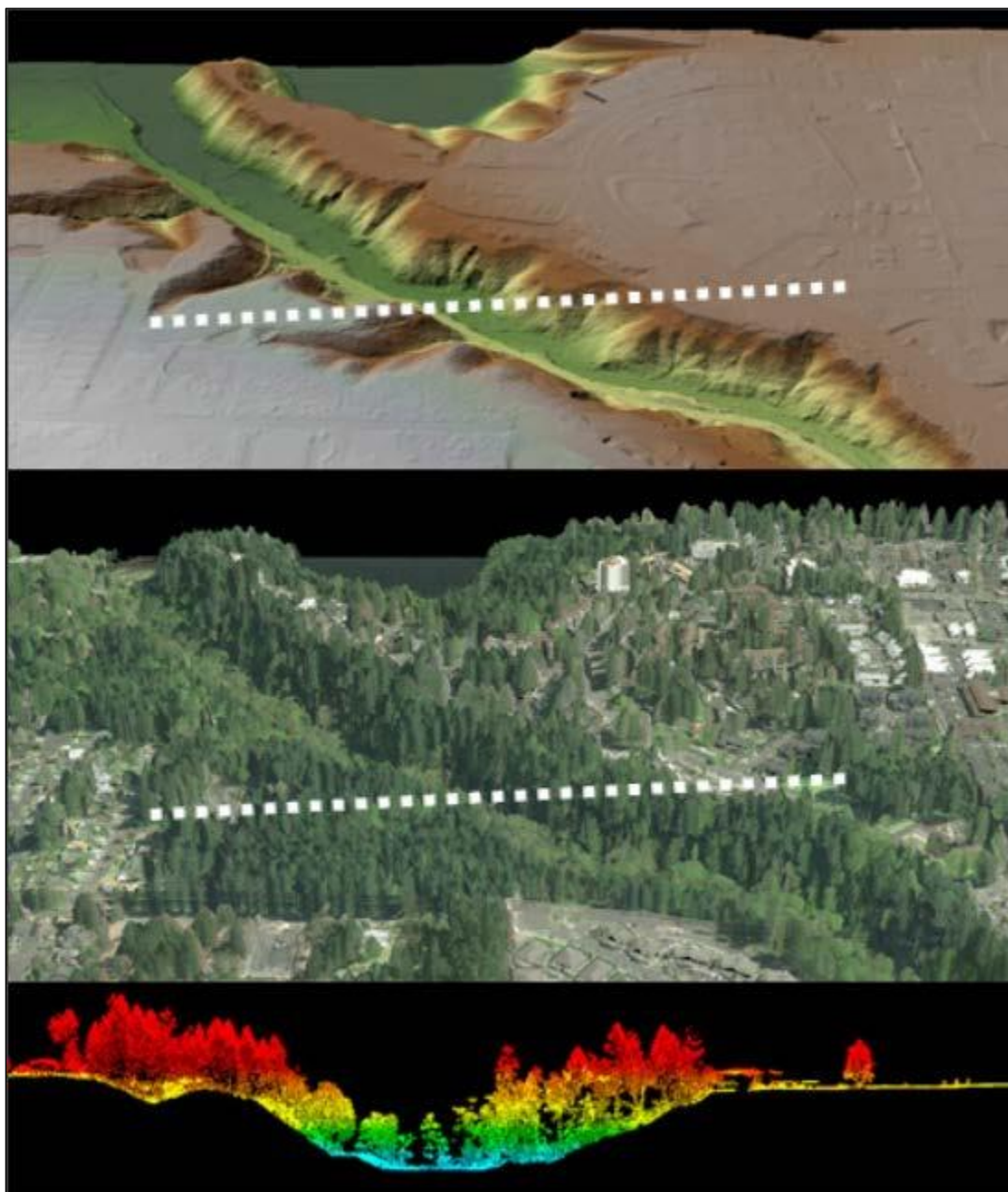
⁴⁹ USGS, “3D Elevation Program,” <https://www.usgs.gov/3d-elevation-program>. *Lidar* means light detection and ranging, which is used to create high-resolution models of ground elevation with a vertical accuracy of 10 centimeters (4 inches). It is a remote sensing technology using a laser scanner, a global positioning system (GPS), and an inertial navigation system (INS) mounted on an aircraft. The laser scanner transmits brief pulses of light (wavelengths in or near the visible light bands of the electromagnetic spectrum) to the ground surface. Those pulses are reflected or scattered back, and their travel time is used to calculate the distance between the laser scanner and the ground. Lidar data are initially collected as a “point cloud” of individual points reflected from everything on the surface, including structures and vegetation. The USGS produces a “bare earth” Digital Elevation Model (DEM) by removing structures and vegetation. The USGS intends to replace older DEMs (with a spatial resolution of 10 meters or about 32 feet) of the topography of the United States and its territories with lidar DEMs (with a spatial resolution of 1 meter or about 3 feet). USGS, “What Is Lidar Data and Where Can I Download It?” <https://www.usgs.gov/faqs/what-lidar-data-and-where-can-i-download-it>.

⁵⁰ USGS, “Earth MRI: Partnering to Map Potential Critical Mineral Deposits,” <https://www.usgs.gov/special-topics/earth-mri/science/earth-mri-partnering-map-potential-critical-mineral-deposits>.

⁵¹ 43 U.S.C. §3104(a).

⁵² USGS, “LidarExplorer,” <https://apps.nationalmap.gov/lidar-explorer/#/>. For more information about other 3DEP data, see USGS, “About 3DEP Products & Services,” <https://www.usgs.gov/3d-elevation-program/about-3dep-products-services>.

Figure 4. Examples of Lidar Bare Earth and Point Cloud Data
(Region in Olympia, Washington)

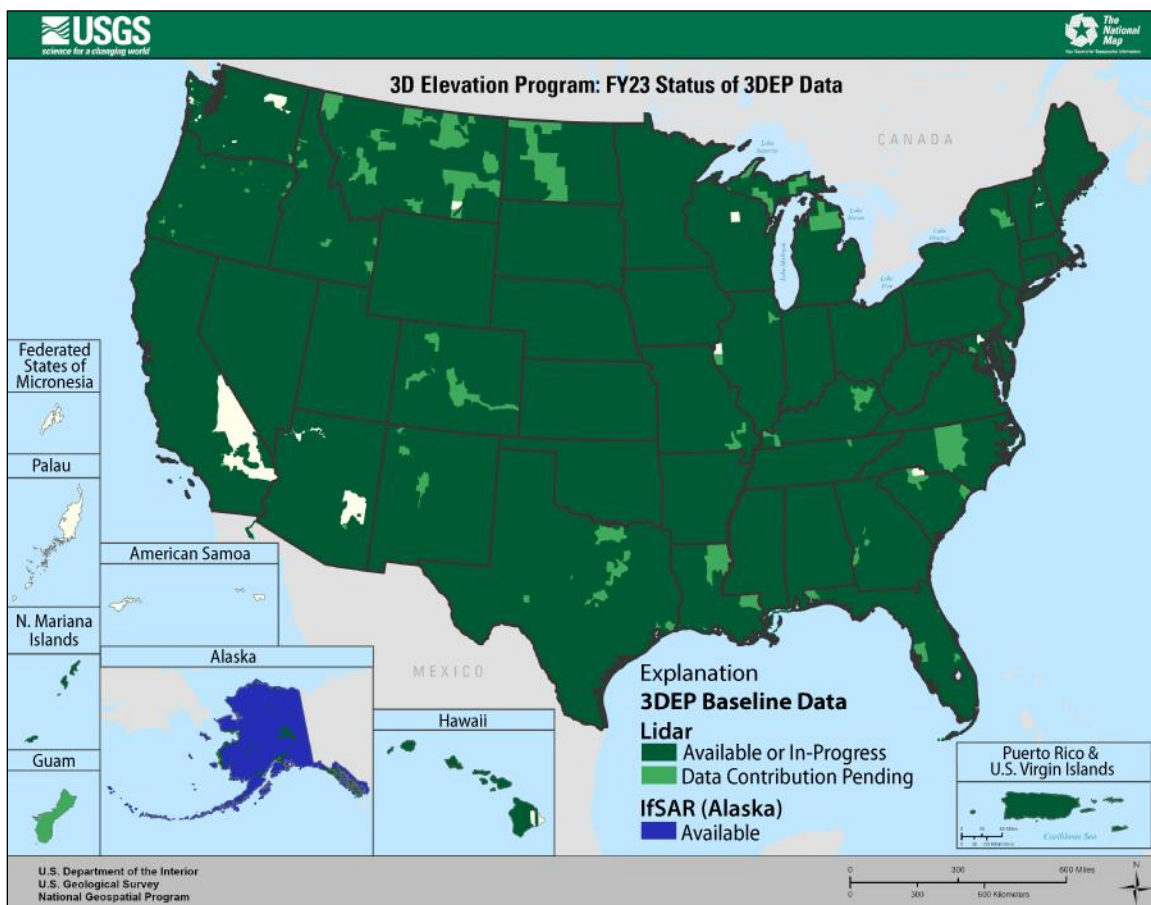


Source: Vicki Lukas and Vanessa Baez, *3D Elevation Program—Federal Best Practices*, U.S. Geological Survey, USGS Fact Sheet 2020-3062, 2020, <https://doi.org/10.3133/fs20203062>.

Notes: Top: bare earth digital elevation model from lidar (color shading shows elevation from low [green shades] to high [brown shades]) for a region in Olympia Washington. Middle: colorized point cloud data of the same region as the top (colors are estimated based on what a person might see in this region). Bottom: lidar point cloud profile of the vegetation (color shading shows elevation from low [blue shades] to high [red shades]) along the white dotted line shown in the upper images. A bare earth lidar model removes any structures or vegetation to show the bare earth topography (top). A point cloud lidar model may include some (bottom image) or all (middle image) structures and vegetation above the bare earth, depending on what data an analyst

wants to consider. The 3D Elevation Program collects point cloud data and for the nationwide topographic map, removes all structures and vegetation to create bare earth topography for the United States and its territories.

Figure 5. FY2023 Status of 3DEP Data



Source: USGS, “FY23 Status of 3DEP Quality Data,” <https://www.usgs.gov/media/images/fy23-status-3dep-quality-data>.

Notes: The USGS and partners have collected or are in the process of collecting lidar data in the green shaded areas on the maps. The maps are current as of November 13, 2023. The USGS and partners collected mostly interferometric synthetic aperture radar (IfSAR) data to generate digital elevation topographic maps of Alaska (blue shaded areas). IfSAR is the mapping technology of choice in Alaska because it works in cloud cover, extreme weather conditions, rugged terrain, and remote locations. IfSAR spatial resolution ranges from about 10 to 20 meters (about 30 to 60 feet). Some higher resolution lidar data (about 1 to 5 meters, or 3 to 16 feet) are available or are still being collected in some areas of Alaska (green shaded areas). USGS, “3D Elevation Program,” <https://www.usgs.gov/3d-elevation-program>.

USGS Analysis of Critical Minerals Supply Chain Risks

Section 7002(j) of the Energy Act of 2020 directs the Secretary of the Interior, acting through the Director of the USGS, to analyze, review, and forecast critical mineral supply chain risks to

evaluate existing critical mineral policies and inform future actions.⁵³ The statute requires the USGS to publish a review of critical mineral production, consumption, and recycling patterns in the annual USGS Mineral Commodity Summaries. The review is to include domestic production, consumption, market prices or other price data, recycling, substitutes, and supply chain risk assessments for each critical mineral. In addition, the review is to discuss international production, consumption, market prices or other price data, recycling, and substitutes for each critical mineral.

The statute requires the USGS to publish an “Annual Critical Minerals Outlook.”⁵⁴ The outlook should include projected domestic production, consumption, recycling, substitutes, and supply chain risk assessments for each critical mineral. In addition, there should be a discussion of “reasonably foreseeable international trends associated with the discovery, production, consumption, use, costs of production, and recycling of each critical mineral as well as the development of alternatives to critical minerals.”⁵⁵

National Minerals Information Center: Annual Review and Multiyear Forecasts

The National Minerals Information Center (NMIC) within MRP conducts mineral supply and demand analysis, including data collection, analysis, and dissemination that describes past domestic and international production and consumption of about 100 selected mineral commodities for approximately 180 countries (**Figure 6**).⁵⁶ Fifty of the mineral commodities are critical minerals on the 2022 CML.⁵⁷ Pursuant to Section 7002(c) of the Energy Act of 2020, the USGS published a final list and methodology in a February 24, 2022, *Federal Register* notice.⁵⁸

The 2022 CML 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.

⁵³ 30 U.S.C. §1606 (j)(1). “The Secretary (acting through the Director of the [USGS]) or a designee of the Secretary, in consultation with the Energy Information Administration, academic institutions, and others ... shall conduct and publish” the analysis and forecast.

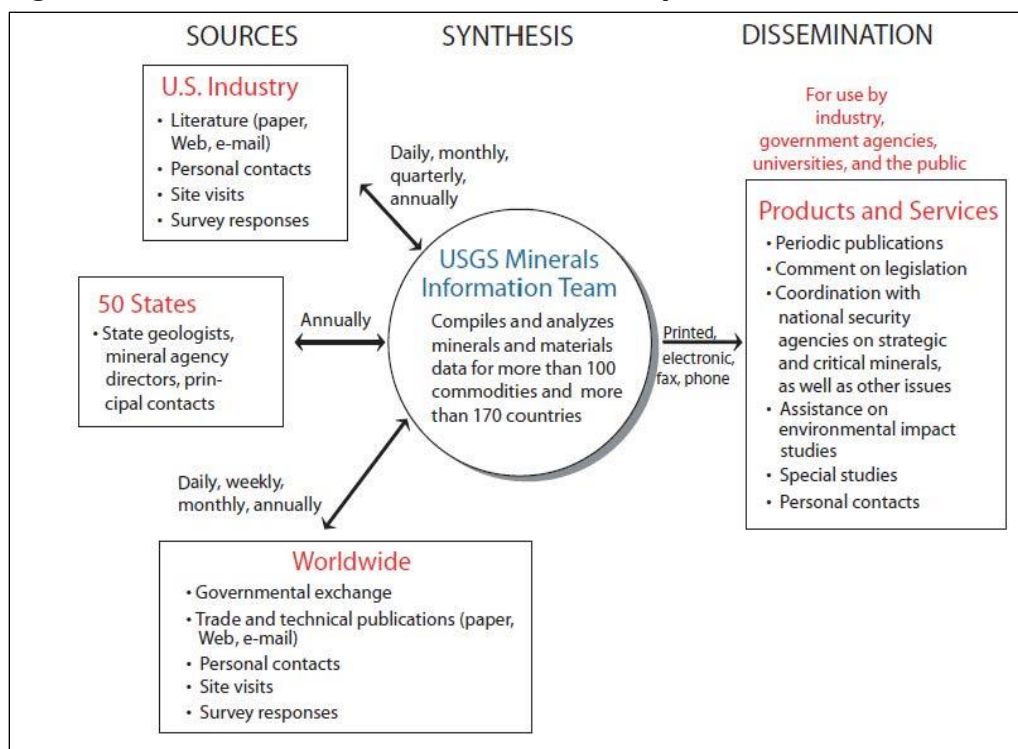
⁵⁴ 30 U.S.C. §1606 (j)(1)(B).

⁵⁵ 30 U.S.C. §1606 (j)(1)(B)(vi).

⁵⁶ USGS, “National Minerals Information Center,” <https://www.usgs.gov/centers/national-minerals-information-center>. The number of minerals and the number of countries included in analyses may vary over time or based on the type of USGS product. A mineral information function and some staff from the Bureau of Mines were transferred to the USGS when the Bureau of Mines was abolished in 1995 and closed in 1996. John A. Breslin, *One Hundred Years of Federal Mining Safety and Health Research*, Centers for Disease Control and Prevention, Information Circular 9520, February 2010, <https://www.cdc.gov/niosh/mining/userfiles/works/pdfs/2010-128.pdf>. The USGS has some Bureau of Mines analyses. USGS, “How Can I Find U.S. Bureau of Mines Publications?” <https://www.usgs.gov/faqs/how-can-i-find-us-bureau-mines-publications>.

⁵⁷ 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>. CRS Report R47982, *Critical Mineral Resources: National Policy and Critical Minerals List*, by Linda R. Rowan.

⁵⁸ 30 U.S.C. §1606 (c). USGS, “2022 Final List.”

Figure 6. USGS Minerals Information: Sources, Synthesis, and Dissemination

Source: National Research Council, *Minerals, Critical Minerals, and the U.S. Economy*, 2008, Figure 5.1.

Notes: The information in this figure was provided to the National Research Council by the USGS in 2007.

The Energy Act of 2020 directs the Secretary of the Interior, acting through the Director of the USGS, to report on the critical minerals on the 2022 CML in the NMIC's annual Mineral Commodity Summaries and to produce an Annual Critical Minerals Outlook.⁵⁹ The USGS added a review of critical mineral commodities starting with the 2022 Mineral Commodity Summaries.⁶⁰ The review considers critical mineral production, consumption, and recycling patterns around the world.⁶¹ The USGS calculates a net import reliance of the United States on certain mineral commodities (**Figure 7**), which is based on a global analysis of mineral commodities and is part of the USGS methodology for evaluating mineral criticality.⁶² In 2023, according to the USGS, the United States was 100% net import reliant for 12 and more than 50% net import reliant for an additional 29 of the 50 critical minerals on the 2022 CML. **Figure 7** shows the major producing countries that the United States relies on for certain select minerals. China is a major producer for some critical minerals, leading to concerns about supply chain disruptions, particularly related to geopolitical tensions.⁶³

⁵⁹ 30 U.S.C. §1606 (j).

⁶⁰ USGS, "Mineral Commodity Summaries 2022," <https://pubs.usgs.gov/publication/mcs2022>.

⁶¹ USGS, "Mineral Commodity Summaries," <https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries>. Additional critical mineral reviews are available in mineral commodity summaries posted in 2023 and 2024.

⁶² The net import reliance is a primary factor used in the USGS quantitative methodology for the CML. CRS Report R47982, *Critical Mineral Resources: National Policy and Critical Minerals List*, by Linda R. Rowan.

⁶³ Fabian Villalobos et al., *Time for Resilient Critical Material Supply Chain Policies*, RAND Corporation, 2022, <https://doi.org/10.7249/RRA2102-1>.

Figure 7. Net Import Reliance and Major Import Sources for Select Minerals (2023)¹

Commodity	Net import reliance as a percentage of apparent consumption in 2023	Leading import sources (2019–22) ²
ARSENIC, all forms	100	China, ³ Morocco, Malaysia, Belgium
ASBESTOS	100	Brazil, Russia
CESIUM	100	Germany
FLUORSPAR	100	Mexico, Vietnam, China, South Africa
GALLIUM	100	Japan, China, Germany, Canada
GRAPHITE (NATURAL)	100	China, ³ Mexico, Canada, Madagascar
INDIUM	100	Republic of Korea, Canada, Belgium
MANGANESE	100	Gabon, South Africa, Australia, Georgia
MICA (NATURAL), sheet	100	China, Brazil, India, Belgium
NIOBIUM (COLUMBIUM)	100	Brazil, Canada
RUBIDIUM	100	China, Germany, Russia
SCANDIUM	100	Japan, China, Germany, Philippines
STRONTIUM	100	Mexico, Germany, China
TANTALUM	100	China, ³ Germany, Australia, Indonesia
YTTRIUM	100	China, ³ Germany, France, Republic of Korea
GEMSTONES	99	India, Israel, Belgium, South Africa
ABRASIVES, fused aluminum oxide	>95	China, ³ Canada, Brazil, Austria
NEPHELINE SYENITE	>95	Canada
RARE EARTHS, ⁴ compounds and metals	>95	China, ³ Malaysia, Japan, Estonia
TITANIUM, sponge metal	>95	Japan, Kazakhstan, Saudi Arabia, Ukraine
BISMUTH	94	China, ³ Republic of Korea, Belgium, Mexico
POTASH	91	Canada, Russia, Belarus
STONE (DIMENSION)	87	Brazil, China, ³ Italy, Turkey
DIAMOND (INDUSTRIAL), stones	84	India, South Africa, Russia, Congo (Kinshasa)
PLATINUM	83	South Africa, Switzerland, Germany, Belgium
ANTIMONY, metal and oxide	82	China, ³ Belgium, India, Bolivia
ZINC, refined	77	Canada, Mexico, Peru, Republic of Korea
BARITE	>75	India, China, ³ Morocco, Mexico
BAUXITE	>75	Jamaica, Turkey, Guyana, Australia
IRON OXIDE PIGMENTS, natural and synthetic	75	China, ³ Germany, Brazil, Canada
TITANIUM MINERAL CONCENTRATES	75	South Africa, Madagascar, Australia, Canada
CHROMIUM, all forms	74	South Africa, Kazakhstan, Russia, Canada
PEAT	74	Canada
TIN, refined	74	Peru, Bolivia, Indonesia, Malaysia
ABRASIVES, silicon carbide	73	China, ³ Brazil, Canada, Netherlands
SILVER	69	Mexico, Canada, Poland, Switzerland
COBALT	67	Norway, Canada, Finland, Japan
GARNET (INDUSTRIAL)	67	South Africa, Australia, China, ³ India
RHENIUM	60	Chile, Canada, Germany, Kazakhstan
ALUMINA	59	Brazil, Australia, Jamaica, Canada
VANADIUM	58	Canada, Brazil, Austria, Russia
NICKEL	57	Canada, Norway, Finland, Russia
DIAMOND (INDUSTRIAL), bort, grit, and dust and powder	56	China, ³ Republic of Korea, Ireland, Russia
MAGNESIUM COMPOUNDS	52	China, ³ Israel, Canada, Brazil
GERMANIUM	>50	Belgium, China, Canada
IODINE	>50	Chile, Japan
MAGNESIUM METAL	>50	Canada, China, ³ Israel, Taiwan
SELENIUM	>50	Philippines, Mexico, Germany, Canada
TUNGSTEN	>50	China, ³ Germany, Bolivia, Vietnam
SILICON, metal and ferrosilicon	<50	Brazil, Russia, Canada, Norway
COPPER, refined	46	Chile, Canada, Mexico
ALUMINUM	44	Canada, United Arab Emirates, Bahrain, Russia
PALLADIUM	37	Russia, South Africa, Italy, Canada
LEAD, refined	35	Canada, Mexico, Republic of Korea, Australia
MICA (NATURAL), scrap and flake	28	China, Canada, India, Finland
PERLITE	26	Greece, China, Mexico
LITHIUM	>25	Argentina, Chile, China, Russia
TELLURIUM	>25	Canada, Germany, Philippines, Japan
SALT	25	Canada, Chile, Mexico, Egypt
BROMINE	<25	Israel, Jordan, China ³
ZIRCONIUM, ores and concentrates	<25	South Africa, Australia, Senegal, Russia
CEMENT	22	Turkey, Canada, Greece, Mexico
VERMICULITE	20	South Africa, Brazil, Zimbabwe

Source: USGS, *Mineral Commodity Summaries, 2024*, 2024, <https://pubs.usgs.gov/publication/mcs2024>.

Notes: Some of the minerals listed here are on the 2022 critical minerals list.

¹ According to the USGS, “Not all mineral commodities covered in this publication are listed here. Those not shown include mineral commodities for which the United States is a net exporter (abrasives, metallic; beryllium; boron; cadmium; clays; diatomite; gold; helium; iron and steel scrap; iron ore; kyanite; lime; molybdenum; rare earths, mineral concentrates; sand and gravel, industrial; soda ash; titanium dioxide pigment; wollastonite; zeolites; and zinc, ores and concentrates) or less than 20% net import reliant (feldspar; gypsum; iron and steel; iron and steel slag; nitrogen (fixed)—ammonia; phosphate rock; pumice; sand and gravel, construction; stone, crushed; sulfur; and talc and pyrophyllite). For some mineral commodities (hafnium; mercury; quartz, high-purity and industrial cultured crystal; thallium; and thorium), not enough information is available to calculate the exact percentage of import reliance.”

² Countries are “listed in descending order of import share” in 2019-2022.

³ China includes Hong Kong.

⁴ Rare Earths include cerium, dysprosium, erbium, europium, gadolinium, holmium, lanthanum, lutetium, neodymium, praseodymium, samarium, terbium, thulium, and ytterbium.

Section 7002(j) of the Energy Act of 2020, directs the USGS to publish an “Annual Critical Minerals Outlook,” and the forecast is to consider 1-year, 5-year, and 10-year periods.⁶⁴ The USGS aims to publish a five-year outlook for bauxite, cobalt, copper, iron ore, lithium, nickel, palladium, platinum, and tin in the first half of 2024.⁶⁵ According to the USGS, additional five-year outlooks will be published for a different set of minerals in 2025 and so forth, until every mineral on the 2022 CML has a five-year outlook. The USGS plans to update each five-year outlook about every five years.⁶⁶

Appropriations

In addition to annual appropriations for USGS programs related to critical minerals, Title VI of Division J of the IJA appropriated \$64 million annually for FY2022–FY2026 for Earth MRI and \$8.7 million for FY2022 as well as \$5 million annually for FY2023–FY2025 for NGGDPP.⁶⁷ P.L. 117-169 (commonly known as the Inflation Reduction Act of 2022) appropriated \$23.5 million for 3DEP.⁶⁸

The President’s Budget Request for FY2024 provides \$1,785.509 million for USGS, an increase of \$288.331 million above the FY2023 enacted level of \$1,497.178 million.⁶⁹ The request provides \$93.360 million for MRP and notes that the \$22.505 million increase above the FY2023 enacted level of \$70.855 million is to support critical mineral resources research and analysis. The request provides \$368.611 million for Core Science Systems, a \$84.004 million increase over the FY2023 enacted level of \$284.607 million. None of the increase is requested for 3DEP, NCGMP, or NGGDPP within Core Science Systems.

The Consolidated Appropriations Act, 2024 (P.L. 118-42) provides \$1,455.434 million for the USGS. The Committees provide \$68.729 million for MRP and the FY2023 enacted level of

⁶⁴ 30 U.S.C. §1606 (j).

⁶⁵ Personal correspondence between CRS and USGS. The USGS did not designate copper or iron ore as critical minerals, and they are not on the 2022 CML; however, the USGS aims to include them in their first five-year outlook. Bauxite is a heterogeneous material composed of aluminum hydroxide minerals and other minerals. Bauxite is converted to alumina, and alumina is reduced to produce aluminum metal. Bauxite is also a component in abrasives, cement, chemicals, proppants, refractories, and as a slag adjuster in steel mills. USGS, “Bauxite and Alumina Statistics and Information,” <https://www.usgs.gov/centers/national-minerals-information-center/bauxite-and-alumina-statistics-and-information>.

⁶⁶ Personal correspondence between CRS and USGS.

⁶⁷ Appropriations for each fiscal year for Earth MRI and NGGDPP may remain available for two additional fiscal years. CRS In Focus IF12152, *U.S. Geological Survey (USGS): Supplemental Appropriations*, by Anna E. Normand and Linda R. Rowan. See also USGS, “Initial Spend Plan,” 2022, https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/s3fs-public/media/files/USGS%20BIL%20Spend%20Plan_FINAL.pdf.

⁶⁸ The funding was provided in FY2022 to remain available through FY2031.

⁶⁹ In addition, the USGS received supplemental appropriations of \$64.0 million for Earth MRI and \$5.0 million for the National Geological and Geophysical Data Preservation Program and \$41.0 million in 2023 emergency supplemental from P.L. 117-328. The total enacted budget for FY2023 with supplemental appropriations for USGS was \$1,607.631 million. CRS In Focus IF12152, *U.S. Geological Survey (USGS): Supplemental Appropriations*, by Anna E. Normand and Linda R. Rowan, and USGS, *Budget Justifications and Performance Information Fiscal Year 2024, 2023*, <https://www.doi.gov/sites/doi.gov/files/fy2024-usgs-greenbook.pdf-508.pdf> (hereinafter, USGS, *Budget FY2024*).

funding for Earth MRI and critical mineral mapping efforts in Alaska.⁷⁰ The Committees encourage the USGS to develop comprehensive geologic mapping of lithium resources and recovery, especially in areas in the United States with large concentrations of lithium resources. The Committees do not specify annual appropriations for NMIC within MRP.

The Committees provide \$273.221 million for Core Science Systems and the FY2023 enacted level of funding for 3DEP.⁷¹ The Committees do not specify annual appropriations for NCGMP and NGGDPP within Core Science Systems.

Congressional Considerations

Congress may consider whether USGS research and analysis is sufficient to identify and help to reduce supply chain risks for critical mineral resources. The increasing demand for critical mineral resources for existing and emerging technologies and the U.S. net import reliance on most critical minerals has raised concerns about supply chain risks (**Figure 7**).⁷² Such risks have increased congressional interest in U.S. activities to promote domestic and international critical mineral resources development. Legislation introduced in the 118th Congress would further address critical mineral policies and activities to help to reduce supply chain risks.⁷³

Congress may consider whether USGS research and analysis activities to inform supply chain risks and associated policies are meeting congressional expectations as specified in the Energy Act of 2020 and the IIJA. In the Energy Act of 2020 and the IIJA, the USGS is directed to conduct research to complete a national assessment of domestic critical mineral resources by 2024 and 2031, respectively. The USGS aims to complete the assessment by 2031.⁷⁴ In the Energy Act of 2020, the USGS is directed to review critical mineral production, consumption, and recycling patterns in the annual Mineral Commodity Summaries and forecast values for these patterns in an “Annual Critical Minerals Outlook” for 1-year, 5-year, and 10-year periods. The USGS includes a review of critical minerals in the annual Mineral Commodity Summaries.⁷⁵ The USGS aims to complete a five-year outlook for some critical minerals in the first half of 2024.⁷⁶ Some Members of Congress have emphasized the importance of the USGS completing these outlooks as soon as possible to mitigate supply chain risks.⁷⁷

⁷⁰ Senate, Division E – Department of the Interior, Environment, and Related Agencies Appropriations Act, 2024, *Congressional Record*, vol. 170 (March 5, 2024), pp. S1679–S1680, <https://www.congress.gov/118/crec/2024/03/05/170/39/CREC-2024-03-05.pdf>.

⁷¹ *Ibid.*

⁷² DOE, *Critical Materials Assessment*, 2023, and White House, *Building Resilient Supply Chains*, 2021, among others.

⁷³ One hundred thirty-six bills, amendments, or resolutions related to critical minerals have been introduced in the 118th Congress as of March 20, 2024. Some measures would address the definition of *critical mineral* in federal statute (30 U.S.C. §1606(a)(3); e.g., H.R. 1 and H.R. 1335). Other measures would use the definition of *critical mineral* to support domestic or international mineral resources development through directing research and education, mining and refining, environmental stewardship, or international cooperation on critical mineral resources (e.g., H.R. 1704, H.R. 2685, H.R. 4977, S. 458, and S. 912).

⁷⁴ See “USGS Research of Critical Mineral Resources.”

⁷⁵ The first review was published in the Mineral Commodity Summaries, 2022. USGS, “Mineral Commodity Summaries,” <https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries>.

⁷⁶ See “National Minerals Information Center: Annual Review and Multiyear Forecasts.”

⁷⁷ 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>. CRS Report R47982, *Critical Mineral Resources: National Policy and Critical Minerals List*, by Linda R. Rowan.

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