National Map of Focus Areas for Potential Critical Mineral Resources in the United States

The U.S. Geological Survey (USGS) launched the Earth Mapping Resources Initiative (Earth MRI) to modernize the surface and subsurface geologic mapping of the United States, with a focus on identifying areas that may have the potential to contain critical mineral resources. EarthMRI can inform strategies to ensure secure and reliable domestic critical mineral supplies for the United States as mandated by Executive Order 13817 (White House, 2017) and the Infrastructure and Jobs Act of 2021 (Public Law 117–58, 135 Stat. 529).

Earth MRI is a collaborative effort between the USGS and the State geological surveys as represented by the Association of American State Geologists to identify, prioritize, and acquire new geoscience data for geographic areas, or focus areas, across the Nation that have potential to host critical mineral resources (Day, 2019; U.S. Geological Survey, 2022). Mapping of focus areas was based on a framework of mineral systems and their associated mineral deposit types that could possibly host critical minerals (Hofstra and Kreiner, 2020). Using readily available geologic, geophysical, geochemical, and mineral deposit data, teams of USGS scientists worked with representatives of State geological surveys in a series of workshops to outline focus areas that contain evidence of key features for one or more mineral systems. These areas can be used to guide future efforts to collect new geologic, geophysical, geochemical, and topographic data that focus on critical minerals through Earth MRI.

This fact sheet contains maps of focus areas and information about an important critical mineral (lithium) and the mineral systems and focus areas related to it (figs. 1, 2, 3).

Mineral Systems and Deposit Types

The mineral systems framework (table 1) implemented for Earth MRI defines a hierarchical relationship among the geologic factors that control the generation and preservation of mineral deposits (Hofstra and Kreiner, 2020). Mineral systems host mineral deposits that are genetically related in both time and space.

Focus Areas

More than 800 focus areas were identified based on geologic evidence of a mineral system for 23 mineral system types in Alaska, the conterminous United States, Hawaii, and Puerto Rico (Dicken and others, 2022). Figure 2 is the first national map to show all the focus areas. By choosing subsets of the data in Dicken and others (2022), users can generate maps showing focus areas for some or all of the 23 mineral systems.

Focus areas for Alaska were delineated using statewide geological, geochemical, geophysical, and mineral occurrence data and previously published prospectivity analyses (Karl and others, 2016; Kreiner and Jones, 2020; Kreiner and others, 2022). Evidence of other focus areas includes known mining districts and mineral belts, areas of historical mining of critical minerals, areas of recent mineral exploration, and, in some cases, the mapped extent of rock types that may contain critical minerals, such as phosphorites or clays with known or potential elevated concentrations of rare earth elements (Hammarstrom and others, 2020, 2022). All of these focus areas are serving as an initial broad screening tool for targeting areas for new geologic, geochemical, topographic, and geophysical mapping and data acquisition through Earth MRI.

Lithium

Lithium (Li) is an important critical mineral used extensively in the growing market for rechargeable batteries and the green economy, yet in 2021, there was only a single domestic lithium producer (Jaskula, 2022). The focus areas identified through Earth MRI indicate that there are areas within the United States with lithium potential that, if developed, could lead to increased domestic lithium supply.

Figure 1. Photograph of giant white spodumene crystals in a pegmatite in New England. Spodumene is an important source of lithium for use in electric vehicle batteries (Jaskula, 2022). Photograph by John Mars, U.S. Geological Survey.

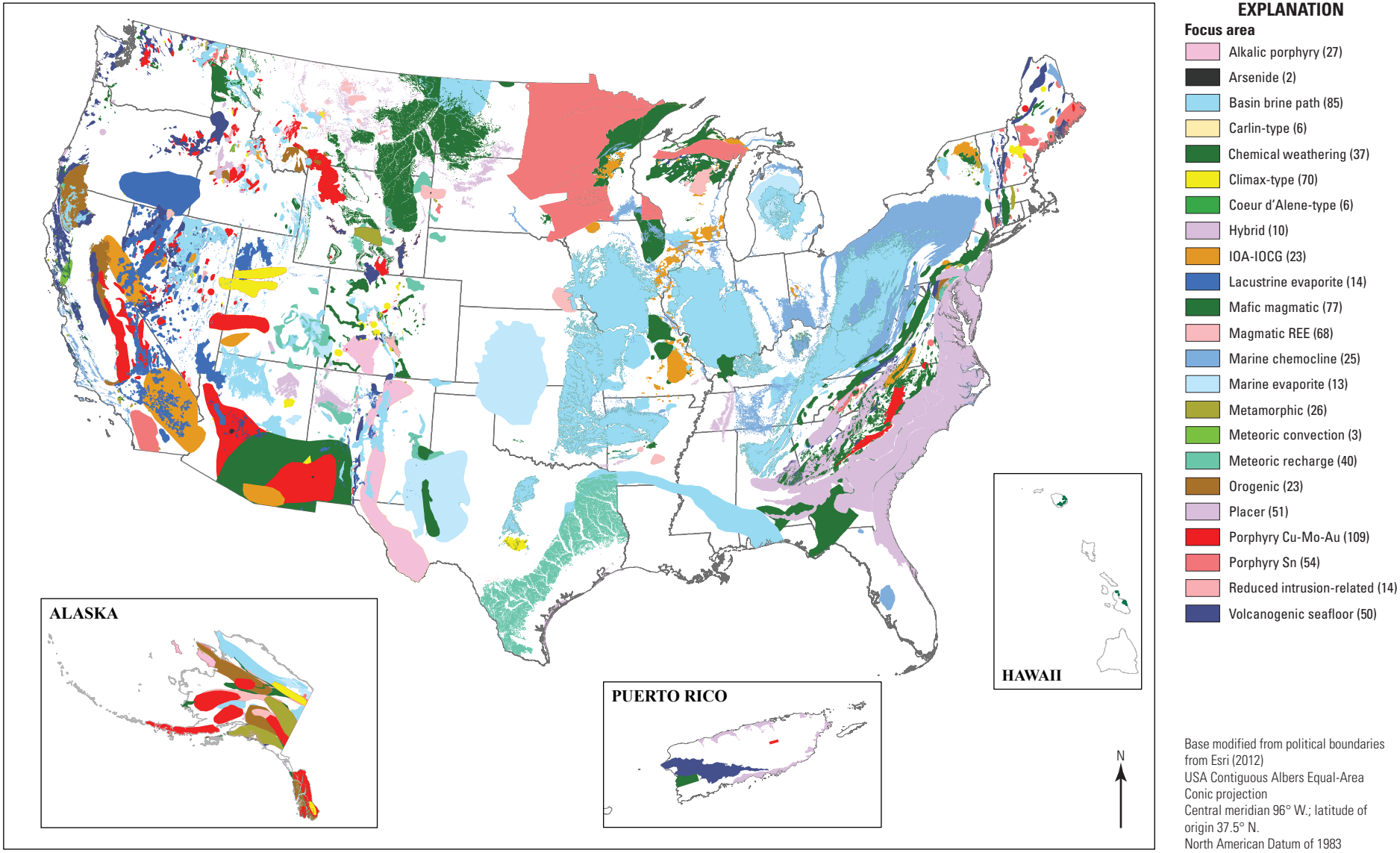

Figure 2. Maps showing focus areas for 23 mineral systems that could host critical mineral resources in the United States and Puerto Rico. Numbers in parentheses in the explanation refer to the numbers of focus areas for each mineral system. Data from Dicken and others (2022), which provides the extent of individual focus areas.

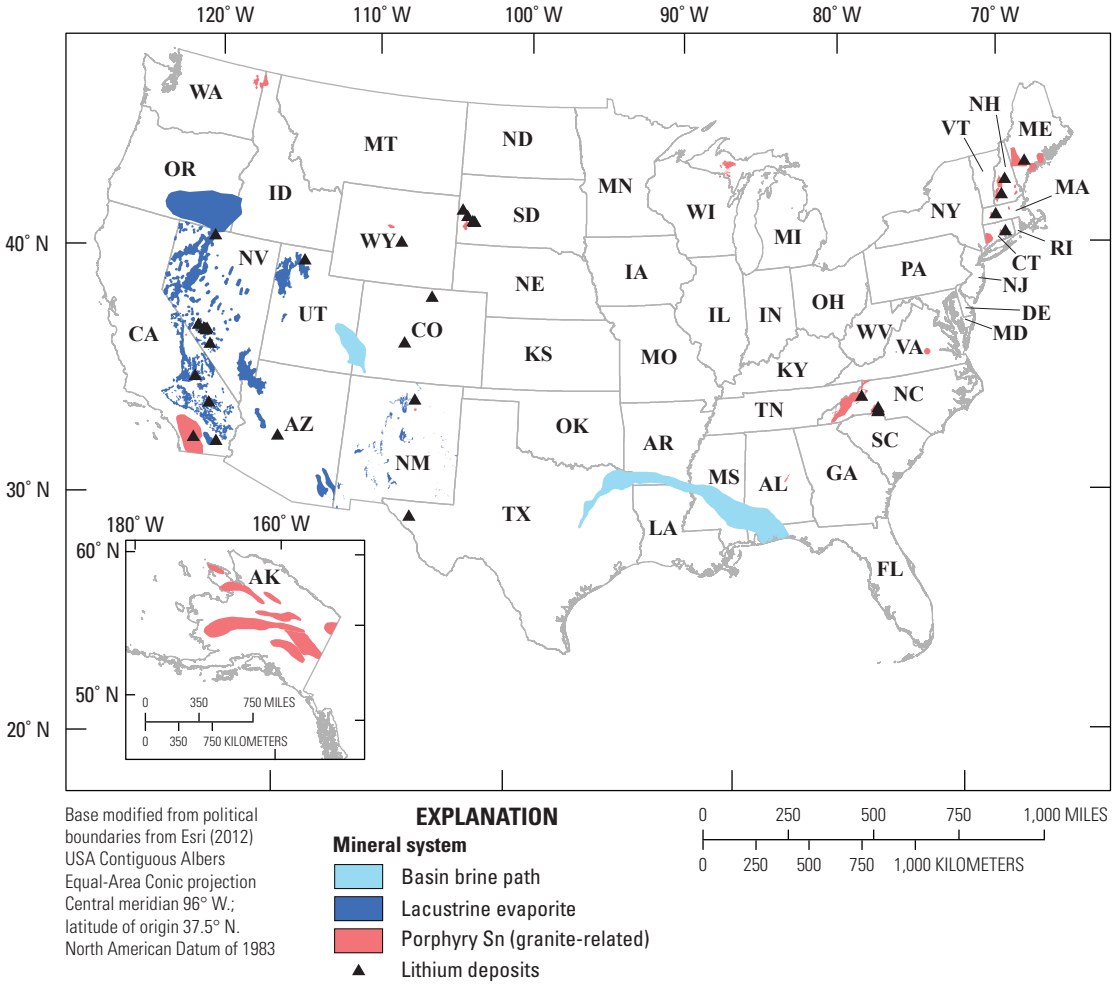

Figure 3. Maps of the conterminous United States and Alaska showing the distribution of three mineral systems that could host lithium and locations of known lithium deposits (Karl and others, 2019). Sn, tin. Data from Dicken and others (2022).

Table 1. Example of a mineral system, related mineral deposit types, principal commodities, and accompanying critical minerals.

[Mafic magmatic systems form in large igneous provinces related to mantle plumes or meteorite impacts. PGE, platinum-group elements. See Hofstra and Kreiner (2020) for the complete mineral system and deposit type table]

Mafic magmatic mineral system		
Deposit type	**Principal commodities**	**Critical minerals**
Chromite	Chromium	Chromium
Iron-titanium oxide	Iron, phosphorus, titanium, vanadium	Titanium, vanadium
Nickel-copper-PGE sulfide	Cobalt, copper, gold, nickel, PGE, selenium, silver, tellurium	Cobalt, nickel, PGE, tellurium
PGE (low sulfide)	PGE	PGE

Figure 3 shows the distribution of focus areas for lithium within three different mineral systems: (1) as the mineral spodumene in pegmatites associated with granites in porphyry tin systems such as those along the Appalachians in North Carolina and Maine (figs. 1, 2, 3), (2) in clays and evaporites in dried lake beds (salars) in the western United States (fig. 3, lacustrine evaporite system), and (3) dissolved in brines, such as the Smackover Formation in Texas, Arkansas, and Mississippi (fig. 3, basin brine path system). Any new data acquired through Earth MRI could be integrated with existing data to evaluate the lithium potential for these focus areas.

References Cited

Day, W.C., 2019, The Earth Mapping Resources Initiative (Earth MRI)—Mapping the Nation's critical mineral resources (ver. 1.2, September 2019): U.S. Geological Survey Fact Sheet 2019–3007, 2 p., accessed May 15, 2020, at https://doi.org/10.3133/fs20193007.

Dicken, C.L., Woodruff, L.G., Hammarstrom, J.M., and Crocker, K.E., 2022, GIS, supplemental data table, and references for focus areas of potential domestic resources of critical minerals and related commodities in the United States and Puerto Rico: U.S. Geological Survey data release, accessed November 15, 2022, at https://doi.org/10.5066/P9DIZ9N8.

Hammarstrom, J.M., Dicken, C.L., Day, W.C., Hofstra, A.H., Drenth, B.J., Shah, A.K., McCafferty, A.E., Woodruff, L.G., Foley, N.K., Ponce, D.A., Frost, T.P., and Stillings, L.L., 2020, Focus areas for data acquisition for potential domestic resources of 11 critical minerals in the conterminous United States, Hawaii, and Puerto Rico—Aluminum, cobalt, graphite, lithium, niobium, platinum-group elements, rare earth elements, tantalum, tin, titanium, and tungsten (ver. 1.1, July 2022): U.S. Geological Survey Open-File Report 2019–1023–B, 67 p., accessed December 5, 2022, at https://doi.org/10.3133/ofr20191023B.

Hammarstrom, J.M., Dicken, C.L., Woodruff, L.G., Andersen, A.K., Brennan, S., Day, W.C., Drenth, B.J., Foley, N.K., Hall, S., Hofstra, A.H., McCafferty, A.E., Shah, A.K., and Ponce, D.A., 2022, Focus areas for data acquisition for potential domestic resources of 13 critical minerals in the conterminous United States and Puerto Rico—Antimony, barite, beryllium, chromium, fluorspar, hafnium, helium, magnesium, manganese, potash, uranium, vanadium, and zirconium: U.S. Geological Survey Open-File Report 2019–1023–D, 66 p., accessed November 15, 2022, at https://doi.org/10.3133/ofr20191023D.

Hofstra, A.H., and Kreiner, D.C., 2020, Systems-deposits-commodities-critical minerals table for the Earth Mapping Resources Initiative (ver. 1.1, May 2021): U.S. Geological Survey Open-File Report 2020–1042, 26 p., accessed November 15, 2022, at https://doi.org/10.3133/ofr20201042.

Jaskula, B.W., 2022, Lithium: U.S. Geological Survey Mineral Commodity Summaries 2022, p. 100–101, accessed November 29, 2022, at https://doi.org/10.3133/mcs2022.

Karl, N.A., Mauk, J.L., Reyes, T.A., and Scott, P.C., 2019, Lithium deposits in the United States: U.S. Geological Survey data release, accessed November 15, 2022, https://doi.org/10.5066/P9ZKRWQF.

Karl, S.M., Jones, J.V., III, and Hayes, T.S., eds., 2016, GIS-based identification of areas that have resource potential for critical minerals in six selected groups of deposit types in Alaska: U.S. Geological Survey Open-File Report 2016–1191, 99 p., 5 app., 12 pls., scale 1:10,500,000, accessed December 15, 2018, at https://doi.org/10.3133/ofr20161191.

Kreiner, D.C., and Jones, J.V., III, 2020, Focus areas for data acquisition for potential domestic resources of 11 critical minerals in Alaska—Aluminum, cobalt, graphite, lithium, niobium, platinum group elements, rare earth elements, tantalum, tin, titanium, and tungsten (ver. 1.1, July 2022): U.S. Geological Survey Open-File Report 2019–1023–C, 20 p., accessed November 15, 2022, at https://doi.org/10.3133/ofr20191023C.

Kreiner, D.C., Jones, J.V., III, and Case, G.N., 2022, Alaska focus area definition for data acquisition for potential domestic sources of critical minerals in Alaska for antimony, barite, beryllium, chromium, fluorspar, hafnium, magnesium, manganese, uranium, vanadium, and zirconium: U.S. Geological Survey Open-File Report 2019–1023–E, 19 p., accessed November 15, 2022, at https://doi.org/10.3133/ofr20191023E.

U.S. Geological Survey, 2022, 2022 final list of critical minerals: Federal Register, v. 87, no. 37, p. 10381–10382, accessed December 5, 2022, at https://www.federalregister.gov/documents/2022/02/24/2022-04027/2022-final-list-of-critical-minerals.

White House, 2017, A Federal strategy to ensure secure and reliable supplies of critical minerals—Executive Order 13817 of December 20, 2017: Federal Register, v. 82, no. 246, document 2017–27899, p. 60835–60837, accessed February 14, 2018, at https://www.federalregister.gov/documents/2017/12/26/2017-27899/a-federal-strategy-to-ensure-secure-and-reliable-supplies-of-critical-minerals.

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