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MBMG
Montana Bureau of Mines and Geology

Critical Commodity Research in Western Montana

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Introduction

Prospectors in Montana have long recognized the association between metallic mineral deposits and crystalline igneous rocks. Gold strikes at Grasshopper Creek (1862), Alder Gulch (1863), and Last Chance Gulch (1864) drew swarms of prospectors into southwestern Montana. Modern exploration is now driven by the demand for domestic sources of the critical commodities needed for high-tech applications, the green economy, and national security. The Montana Bureau of Mines and Geology (MBMG) is actively partnering with the U.S. Geological Survey (USGS) in projects that aim to improve the understanding of critical commodity occurrences throughout western Montana and the shared border with Idaho. In 2019, the USGS launched its Earth-Mapping Resources Initiative (E-MRI) and began to compile information related to critical commodity resources throughout the Nation. The scope of projects ranges from preserving historic mine site data, to quadrangle geologic mapping and sampling in regions of historic mining, to defining large regions of the State where geophysical surveys will add significant information about the upper crust that will aid future commodity exploration. The MBMG is committed to sustainable and responsible development of Montana's mineral resources.

Data Preservation

The MBMG archives and preserves historic data and geologic samples, including sample collections that have important specimens of critical commodities. Ongoing projects include preservation of the Anaconda Research Collection and the Butte Stope Books, development of a new specimen repository, rescue of historic collections, and generation of new geochemistry data on existing samples. The important collections of Dr. Robert Chadwick and Dr. Todd Feeley contain around 6,000 samples that are currently in storage at Montana State University. Many of these samples are of current interest to critical commodity research and would be difficult to replace.

The Philipsburg Mining District in southwest Montana (fig. 1), one of Montana's top historic Ag producers, is a great target for evaluating critical commodity potential and archiving rock samples from a region of reported occurrences (e.g., Cu, Ag, W, Mo, Pb, Zn, Au). This E-MRI data preservation project will photograph and create metadata for 200 samples from the Philipsburg District, and submit sample splits to the USGS for bulk geochemical analyses. Remaining samples will be permanently archived by the MBMG for future researchers. This project presents an opportunity for MBMG and USGS professionals to collaborate with Montana Tech students and professors, and the public availability of these data will be of great interest to mining companies and the general public.

A portion of the Data Preservation archives.

Geologic Mapping

The USGS Earth-MRI program supports mapping of 7.5' quadrangles that contain important mineral districts and potential sources of critical commodities. The MBMG has recently completed an E-MRI project at the Elkhorn 7.5' quadrangle, and will be commencing work at the Radersburg, Giant Hill, Alta, and Horse Creek Pass 7.5' quadrangles in 2023.

2020–2022: Elkhorn 7.5' Quadrangle (Completed)

Geologic Mapping in the Bull Mountains–Elkhorn Mining District, Montana

The Elkhorn district is 35 miles (50 km) northeast of Butte (fig. 1) and produced over $15 million in ore from Ag-Pb-Zn (±Au) carbonate replacement and skarn deposits; tourmaline-bearing breccia pipes and an unmined porphyry Mo (Cu) system also exist in the area (Brown and others, 2019). USGS critical elements, including arsenic (As), bismuth (Bi), antimony (Sb), manganese (Mn), zinc (Zn), and possibly platinum group elements (PGEs) and tungsten (W), are associated with these types of magmatic-hydrothermal ore deposits.

2023–2026: Alta and Horse Creek Pass 7.5' Quadrangles

Geologic Mapping in the Sheep Creek–Mineral Hill REE-Nb District, Montana–Idaho

The Sheep Creek–Mineral Hill mineral belt extends in a northwest direction from Idaho into Montana (fig. 1) and hosts rare earth element (REE) and niobium (Nb)-bearing carbonatite deposits of unknown age and origin. This E-MRI project collaborates with the Idaho Geological Survey (IGS) to study the occurrence, age, mineralogy, and

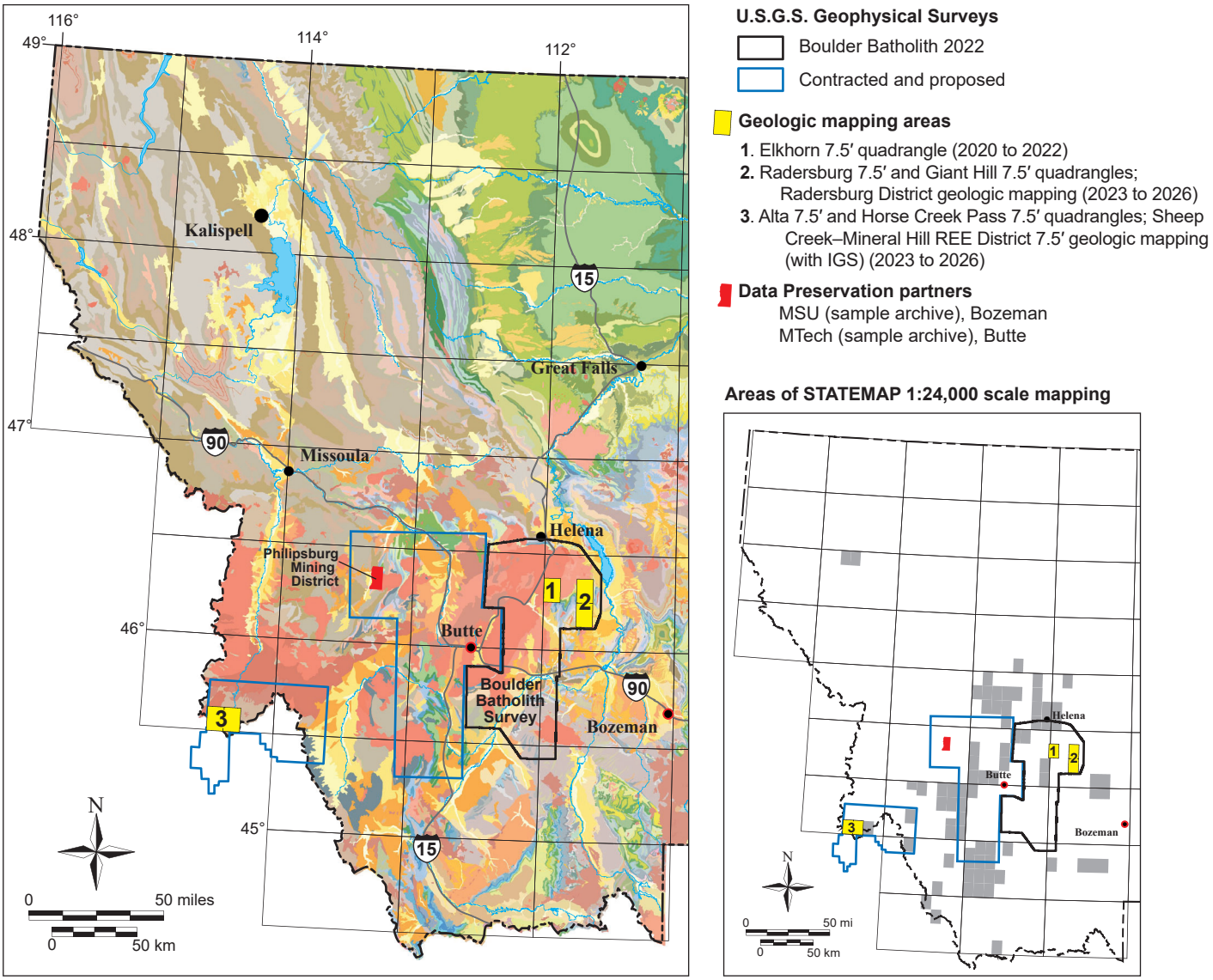

Figure 1. Map showing locations of completed and proposed USGS geophysical surveys, E-MRI 7.5' quadrangle geologic mapping, E-MRI data preservation projects, and completed USGS STATEMAP quadrangle geologic maps (inset).

View of the Elkhorn Mining District and the peaks, looking north.

geochemistry of REE and Nb-bearing carbonatites in the Alta and Horse Creek Pass 7.5' quadrangles.

2023–2026: Radersburg and Giant Hill 7.5' Quadrangles

Geologic mapping in the Radersburg and Park Districts

The Radersburg and Giant Hill 7.5' quadrangles occur within the eastern intrusive contact zone between the Late Cretaceous Boulder Batholith and older, predominately sedimentary rocks that are capped by the Late Cretaceous Elkhorn Mountains Volcanics sequence (fig. 1; Klepper and others, 1957). The east flank of the Elkhorn Mountains is part of the Elkhorn Mountains volcanic field, which hosts polymetallic epithermal veins, porphyry Cu-Mo prospects, skarns (Cu-Au), and Pb-Zn±Ag carbonate replacement deposits (Pardee and Schrader, 1933; Reed, 1951, Klepper and others, 1971). These deposit types may contain critical commodities such as REEs, Ge, Ga, In, V, Mo, Mn, W, Bi, P, U, As, Sb, and Te (fig. 2; Hofstra and Kreiner, 2020). Two historic mining districts are present in the study area; the Radersburg (Lone Mountain, Cedar Plains) District, and the Park (Indian Creek) District.

Geophysical Surveys

Boulder Batholith Regional Geophysical Survey (Flown 2022)

This high-resolution magnetic and radiometric survey was acquired in 2022 in Montana (fig. 1). The Late Cretaceous Boulder Batholith and co-magmatic Elkhorn Mountains Volcanics (EMV) are located along the Continental Divide in southwest Montana and together are a rare and well-preserved example of continental arc magmatism. A plethora of precious and base metal mineral deposits, and related critical minerals, are documented within the Boulder Batholith–EMV magma system, including two world-class Cu-Mo porphyry systems at Butte, Montana. Precious and base metal lodes, vein systems, breccia pipes, Mo-Cu porphyries, and skarns are documented within the volcanic and intrusive rocks of the Boulder Batholith region, including the largest gold mine (Golden Sunlight mine) and copper mine (Butte mining district) in the State. This survey also captures the eastern margin of the Boulder Batholith, which contains skarn and carbonate replacement deposit types along the intrusive contacts. This region has potential for the critical minerals As, Sb, Te, Bi, Sn, Ga, and W, and potentially Re, U, REE, Zr, Hf, Nb, Ta, Be, Li, Co, and Ga.

Butte Extension Regional Geophysical Survey (Fly in 2023)

This high-resolution magnetic and radiometric survey is planned for acquisition in FY 2023 in Montana, including parts of Beaverhead, Deer Lodge, Granite, Jefferson, Madison, Powell, and Silver Bow Counties (fig. 1). The survey is funded by the USGS Earth Mapping Resource Initiative and is designed to meet complementary needs related to geologic mapping, earthquake hazards, and mineral resource research. The survey footprint extends coverage over the Boulder Batholith and the famous Butte mining district, in addition to the historic Philipsburg and Hecla mining districts. The survey will use a helicopter to collect magnetic and radiometric data along east–west flight lines spaced 200 m apart and flown 100–300 m above ground.

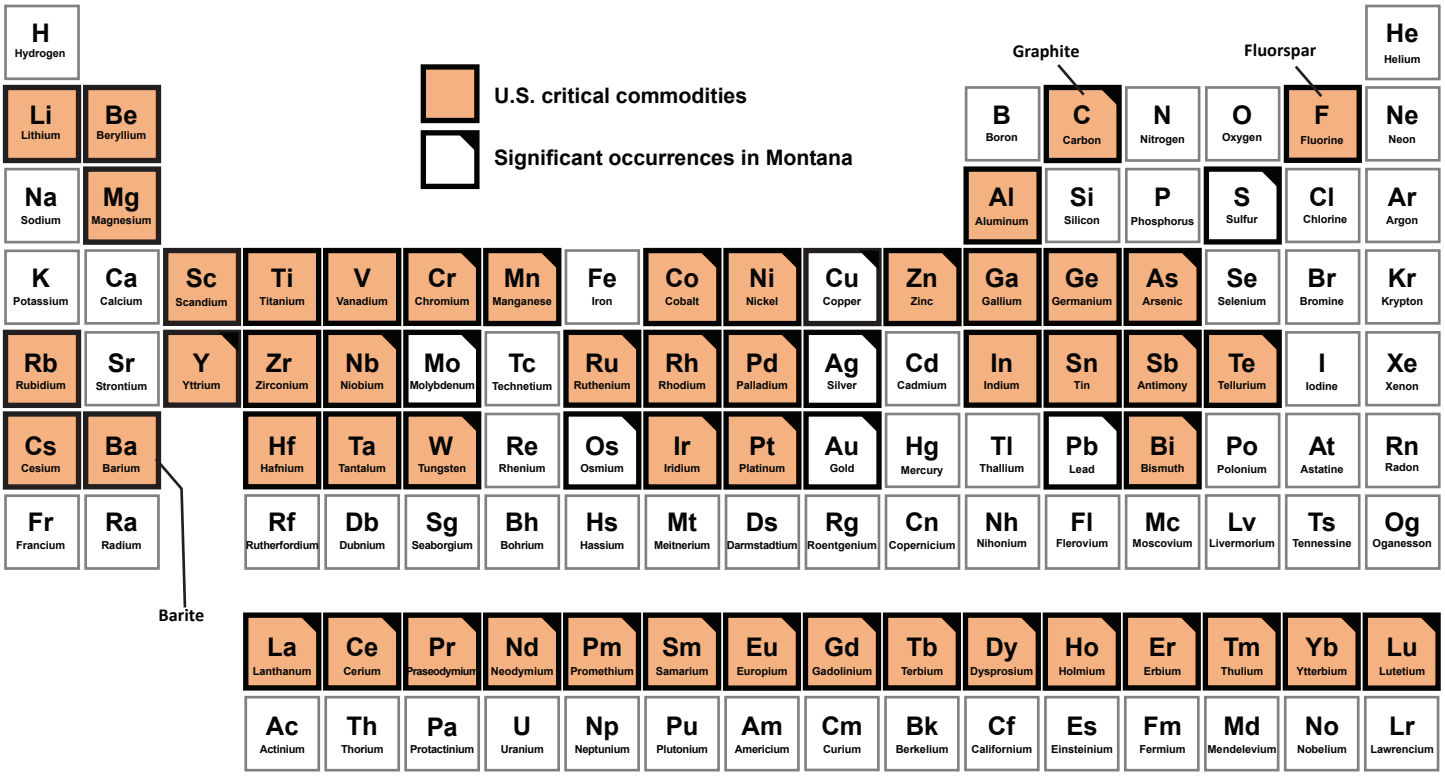

Figure 2. The periodic table of the elements, with critical commodities and resources in Montana highlighted.

Headframe rising above the fog in Butte, Montana.

The airborne geophysical survey will provide valuable information about the geology below the ground surface. This new information will be combined with geologic mapping and sampling by the Montana Bureau of Mines and Geology to develop an improved understanding of the fundamental geologic framework underpinning the mining districts, which will help industry determine the potential for undiscovered critical minerals including As, Sb, Te, Bi, Sn, Ga, and W, and potentially Re, U, REE, Zr, Hf, Nb, Ta, Be, Li, Co, and Ga, and associated co- and by-product commodities (base, precious, and industrial minerals).

Workforce Development

E-MRI and MBMG projects include support for student employees and collaboration with graduate student researchers at Montana Tech to provide fieldwork, analytical, GIS, and data science experience for the next generation of geoscientists. Experience with critical commodities is already considered a key qualification for exploration and mining jobs, and the U.S. is projected to see increased demand for economic geologists in the next 10 years.

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About the MBMG

Established in 1919, the Montana Bureau of Mines and Geology (MBMG) continues to fulfill its mandate to collect and publish information on Montana's geology to promote orderly and responsible development of the energy, groundwater, and mineral resources of the State. A non-regulatory state agency, the MBMG provides extensive advisory, technical, and informational services on the State's geologic, mineral, energy, and water resources. The MBMG is increasingly involved in studies of the environmental impacts to land and water caused either by past practices in hard-rock mining or by current activities in agriculture and industry. The Montana Bureau of Mines and Geology is the principal source of Earth science information for the citizens of Montana. More information is available at mbmg.mtech.edu.