Critical Mineral: Bismuth

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Overview

Bismuth (Bi) is a chemical element included on the U.S. Geological Survey's Final 2025 List of Critical Minerals. Elemental Bi is a brittle and dense metal. It is a pinkish silver color that readily tarnishes to an iridescent patina. The metal has applications in specialty electronics (solders and transistors), alloys, and in many cases as a non-toxic replacement for lead (Pb), stomach medicines, and catalysts.

Unusual for a heavy metal or metalloid, Bi is not very toxic. This encourages its substitution for Pb, a metal it otherwise shares many properties with. Pb poisoning from hunting ammunition entering the food chain and from solder leaching from landfills has encouraged swapping Pb for Bi in bullets and solder, respectively.

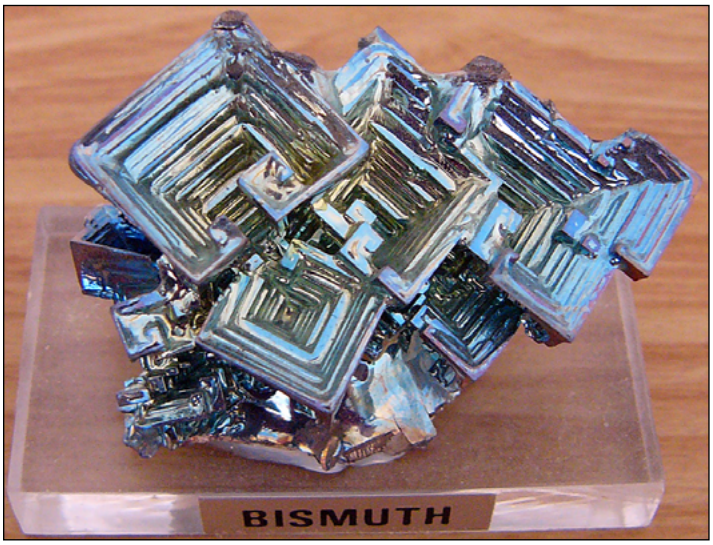

Figure 1. A lab-grown crystal of elemental Bi showing the characteristic hopper growth habit and iridescent tarnish. Photo by Philippe Giabbanelli (CC-BY-3.0).

Supply

Most Bi production is a byproduct of Pb smelting. Mines with Bi as the primary product are very rare. China leads world production for Bi with 14 kt (thousand metric tonnes) in 2025. South Korea was the next highest at 1 kt. The U.S. has not produced refined Bi since 1997.

Pricing for Bi sharply increased in 2025 to $20/lb from ~$3–5/lb in the past few years. Bi-bearing ores typically contain 0.1 to 0.6 wt.% Bi. The effective grade depends on the mineralogy of the deposit and if other commodities are produced. Bi can occur in discrete Bi minerals, and as impurities in other minerals such as in galena (a Pb-sulfide).

Figure 2. Bi-subsalicylate suspensions are a common treatment for indigestion and diarrhea. The pink color is due to food dyes and not the Bi compound. Photo by Carolyn Franks, from Adobe Stock.

Mineralogy

When it occurs in discrete minerals, Bi is commonly found as bismuthinite (Bi_2S_3), native Bi, or bismite (Bi_2O_3). Over 25 other Bi minerals occur, but these are rather rare. Bi can occur in minerals combined with other commodities such as copper (Cu), gold (Au), silver (Ag), Pb, tellurium (Te), or tungsten (W).

Nominally Bi-free minerals such as galena, tetrahedrite, tennantite, or bornite can have significant substitutional Bi. Additional critical minerals that can be associated with Bi are tin (Sn), zinc (Zn), antimony (Sb), cobalt (Co), nickel (Ni), arsenic (As), fluorspar (CaF_2), and barite ($BaSO_4$).

Figure 3. A sample of oxidized Au-Bi ore with 4 g/t Au and 1.25 wt.% Bi from a historic mine dump in Powell County, Montana. Photo by Adrian Van Rythoven, MBMG.

Aside from Au, other non-critical minerals that can occur with Bi are molybdenum (Mo), cadmium (Cd), and selenium (Se).

Most occurrences of Bi mineralization are associated with granitic intrusions. Specifically, these deposits are skarns, carbonate replacement, porphyry, greisen, pegmatite, or polymetallic sulfide veins. Deposits less commonly associated with Bi-mineralization are orogenic gold, arsenide vein, sediment-hosted copper, iron-oxide copper gold, and volcanogenic massive sulfide types.

Deposits in Montana

Most occurrences of Bi in Montana formed with the Rocky Mountains. These are associated with granitic intrusions and are skarns, carbonate replacement deposits, or more generic polymetallic sulfide veins. These all have primary commodities of interest such as Ag, Au, W, Zn, Pb, or Cu.

Most Bi occurrences can be loosely grouped as polymetallic sulfide vein type. These are fairly common in Deer Lodge, Jefferson, Park, and Sanders Counties. Other such occurrences are in Flathead, Granite, Lewis and Clark, Madison, Missoula, Silver Bow, and Powell Counties. Skarn-hosted Bi is common in Beaverhead County. Bi has also been reported at skarn deposits in Deer Lodge, Broadwater, Granite, Jefferson, Lewis and Clark, and Powell Counties. Carbonate replacement deposits are the least common occurrence for Bi and are limited to Beaverhead, Granite, and Jefferson Counties.

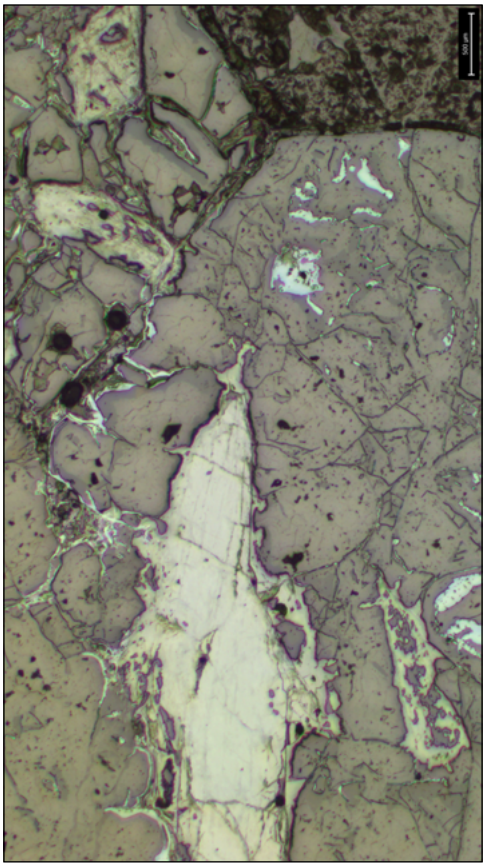

Figure 4. A photomicrograph (reflected light) of a thin section from the sample shown in figure 3. The medium gray mass is beyerite: $Ca(BiO)_2(CO_3)_2$. Photo by Adrian Van Rythoven, MBMG.

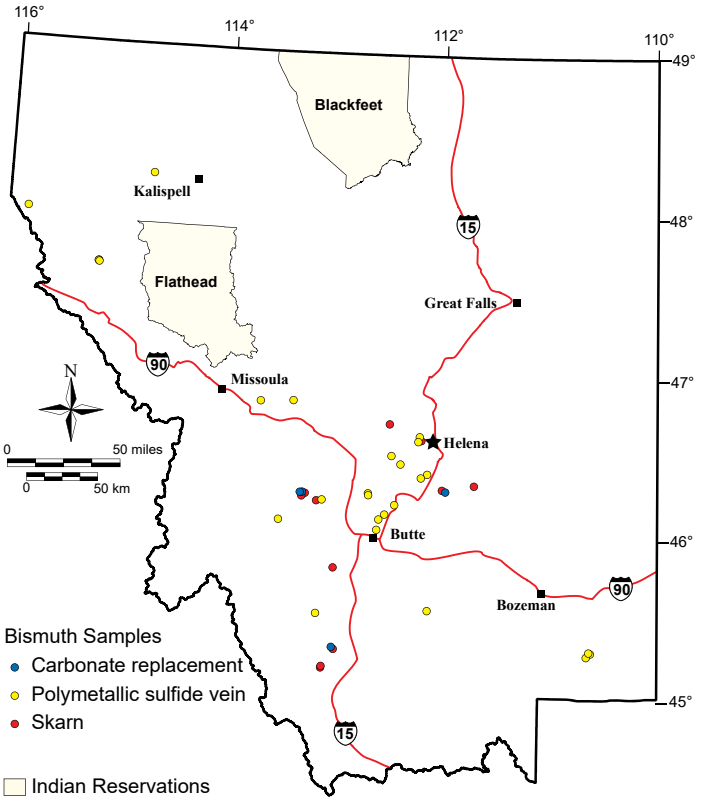

Figure 5. A map of western Montana displaying known Bi occurrences by deposit type.

Outlook in Montana

There are no companies specifically prospecting for Bi in Montana. However, active exploration for Ag, Au, Sb, Cu, and W has the potential to also find Bi in Montana.

Researchers at the MBMG are sampling legacy mine sites across the State in order to assess their economic potential for critical minerals, including Bi. Government efforts to document the critical mineral content of mine waste, especially older (legacy) waste, is a recent initiative. The appeal of this initiative is fourfold: (1) secure domestic supply chains for critical minerals, (2) lower mining impacts on the landscape as the material is already fragmented and at the surface, (3) increase employment for legacy mining communities, and (4) rehabilitate legacy mine sites that cause pollution.

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.