

Critical Mineral: Gallium

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Overview

Gallium (Ga) is a chemical element that is included on the United States Geological Survey's 2022 Critical Minerals list. Ga is a soft, silvery, metal that melts at 85.6°F (29.8°C). The metal is commonly compounded with arsenic, nitrogen, or phosphorous to create semiconductor materials that are used in specialty circuits. Other applications include diodes, lasers, and synthetic gemstones.



Figure 1. Crystallized Ga metal. Photo by Maxim Bilovitskiy (CC-BY-SA-4.0).



Figure 2. A sample of Ga metal in a plastic bag, melted to liquid state by the heat of a hand. Photo by GOKLuLe (CC-BY-SA-3.0).

Supply

Ga is primarily sourced as a byproduct from smelting other critical minerals: aluminum (Al) or zinc (Zn). The average grade of Ga in Al or Zn ores is 0.005%. Recycling is also an important source of Ga.

China is the top producer of Ga-bearing ore. Russia is a very distant second place producer. China, Canada, Japan, Slovakia, and the United States are the top refiners of Ga. Although the United States does have considerable Al

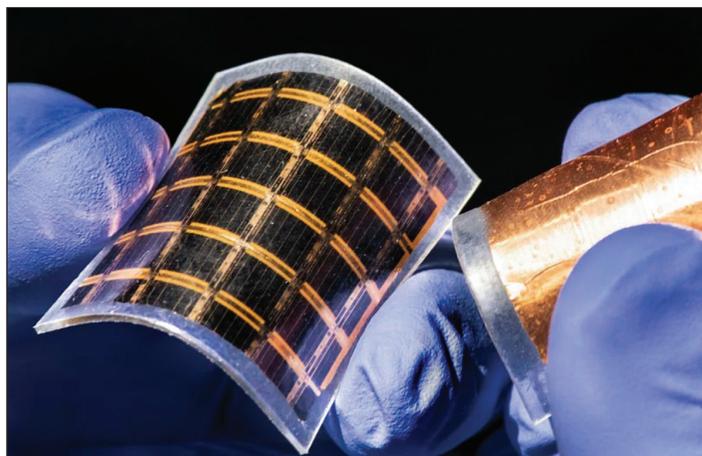


Figure 3. Flexible Ga-arsenide (GaAs) solar cells. Photo by U.S. Department of Energy (CC0 1.0)

smelting capacity, it does not have significant Al reserves, and most domestic Ga resources are in Zn ores. No Ga is currently recovered from domestic ores in the United States. Domestic Ga consumption in 2022 was 18 tonnes. Ga metal prices ranged from \$380 to \$510 per kg in 2022. Price fluctuations are driven by global supply/demand for Ga and affect the economics of any deposit, but as Ga is typically a byproduct of Al or Zn mining, the price for the main product of any mine is the dominant factor.

Mineralogy

Ga occurs as a trace component of bauxite (Al-oxyhydroxides, an Al ore), and sphalerite (Zn-sulfide, a Zn ore). Bauxite forms from tropical weathering of feldspar-rich rocks. Sphalerite deposits are also sources of Ga, including Mississippi Valley-type, skarn, sedimentary exhalative, stratiform sediment-hosted, and polymetallic vein deposits.



Figure 4. A specimen of sphalerite from the Ruby Mine, Jefferson County, Montana. Photo by Dr. Steven Quane, MBMG.

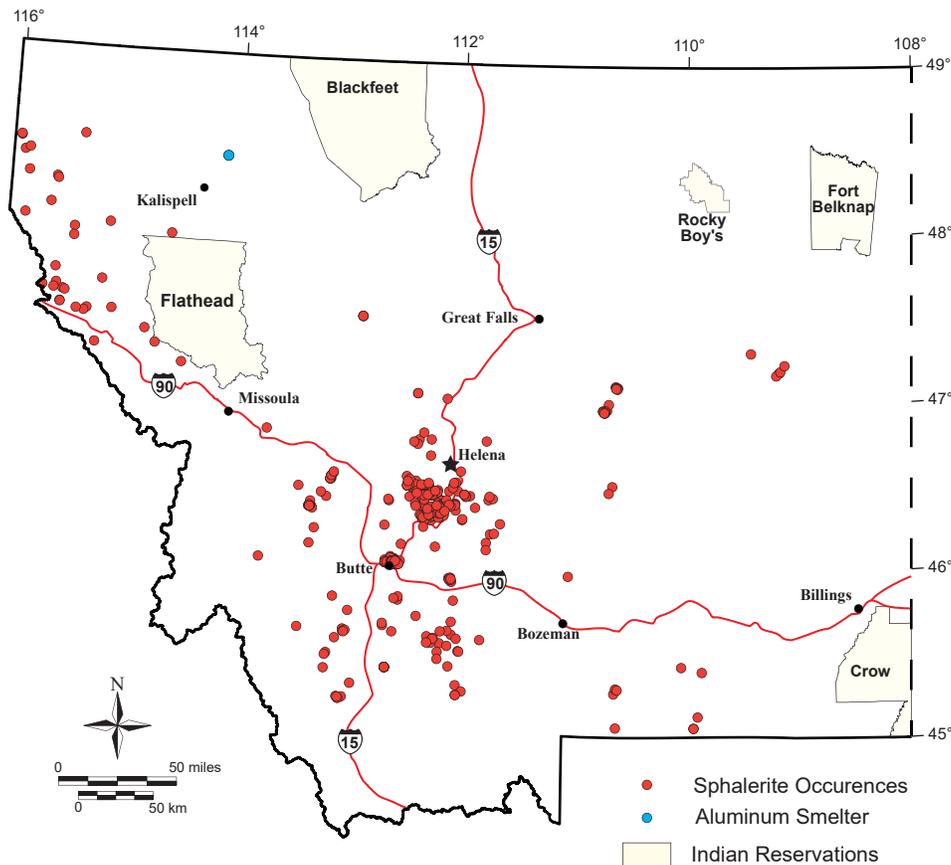


Figure 5. A map of western Montana displaying known sphalerite occurrences and the former Al smelter.

Aside from Zn, other critical minerals that can occur with Ga in sphalerite are germanium (Ge) and indium (In). Critical minerals that can occur alongside sphalerite are arsenic (As), barite (BaSO_4), bismuth (Bi), cobalt (Co), tellurium (Te), and antimony (Sb).

Deposits in Montana

Western Montana has a large variety of sphalerite-bearing skarn and polymetallic vein deposits that could present potential Ga resources. In the Butte District alone (Silver Bow County), there are dozens of former polymetallic sulfide mines with reported sphalerite production. However, the currently operating Continental Pit is a porphyry-type deposit that is not typically associated with Zn (or Ga). Similarly, the historic mines of the Philipsburg District (Granite County) are prospective for Ga mineralization.

Other places with the potential for Ga mineralization are sediment-hosted deposits in Lincoln, Sanders, and Meagher Counties. Former gold–silver mines in Jefferson and Broadwater Counties are also prospective for Ga.

Outlook in Montana

No Ga-specific mineral exploration, development, or mining is underway in Montana. Current mineral exploration and development in the State that could reasonably produce Ga includes examination of underground prior mine workings in the Butte district and development of mines

in the northwestern part of the State. While primarily a copper (Cu) development, the Black Butte project in Meagher County has many sphalerite occurrences peripheral to the main Cu deposits. These have yet to be evaluated for Ga or other related critical minerals.

Although there are no bauxite deposits in Montana, there is a decommissioned (ca. 2015) Al smelter in Flathead County.

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.