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MBMG
Montana Bureau of Mines and Geology

# Critical Mineral: Indium

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## Overview

Indium (In) is a chemical element that is included on the United States Geological Survey's 2022 Critical Minerals list. In is a silvery, very soft metal that is used in a variety of applications. The most common use for In is with tin (Sn) as In-Sn-oxide (ITO) in liquid crystal displays (LCD). It is also used for solders in electronics, in photovoltaic cells, and in some semiconductors.

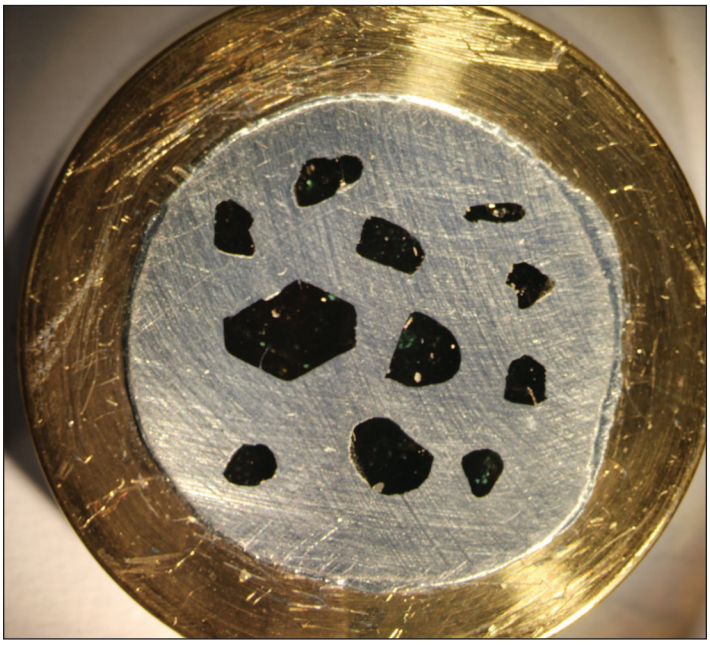

*Figure 1. A 1-inch-wide (2.54 cm) steel sample mount filled with In metal that has diamond crystals pressed in. The very malleable In metal holds the samples in place while providing an electrically conductive sample for ion-beam analysis of carbon isotopes in the crystals. The surface of the sample mount is sputtered with a very thin film of Au, also to aid conductivity. Photo by Adrian Van Rythoven.*

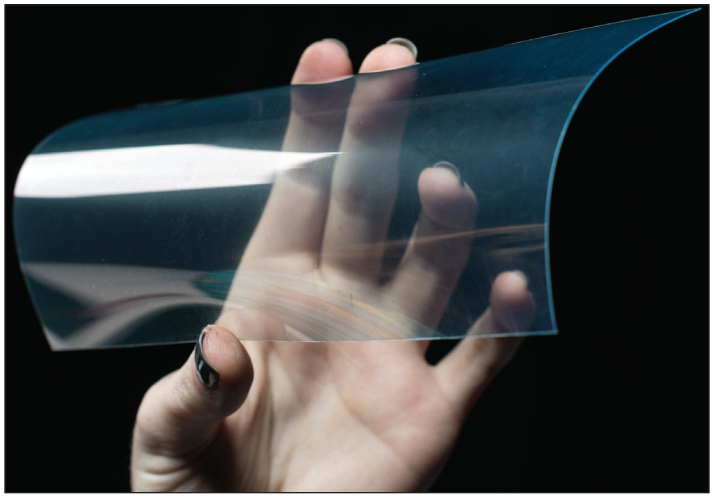

*Figure 2. A plastic sheet with ITO coating for use in electronics displays. Photo by J.M. De Cristofaro (CC-BY-NC-SA 2.0).*

## Supply

China, South Korea, Japan, and Canada were the top In refiners in 2022. The U.S. has not produced any appreciable In for the past few years, and imported 160 tonnes (t) in 2022. Recycled In is also a supply source. Pricing for In in 2022 averaged $250 per kg. Ore grades range from about 0.0001 to 0.19 wt.% In.

## Mineralogy

As a rare metal, In ore minerals exist, but are uncommon. Most In is in zinc (Zn) sulfide minerals (primarily sphalerite) as an impurity. Other base metal sulfides (e.g., stannite, chalcopyrite) may also have appreciable In. Most In mined is produced as a byproduct from Zn mines. The U.S. produces a fairly large amount of Zn from mines in Alaska and Tennessee, but also has Zn reserves in many more states. Worldwide, no mines exist with In as the main product.

Most American Zn (and thus potential In) deposits are Mississippi Valley-type. Other deposit types include skarns, sedimentary exhalative, stratiform sediment-hosted, carbonate-replacement, and polymetallic vein. Polymetallic vein and skarn deposits typically are the two types with the highest grades of In. Aside from Zn, other critical minerals that can occur with In in these deposits are germanium (Ge), gallium (Ga), bismuth (Bi), barite ($BaSO_4$), cobalt (Co), tellurium (Te), antimony (Sb), tin (Sn), and arsenic (As).


*Figure 3. A specimen of dark gray sphalerite with small, silvery pyrite encrustations, from Butte mine workings, Silver Bow County, Montana. Photo by Steve Quane, MBMG.*

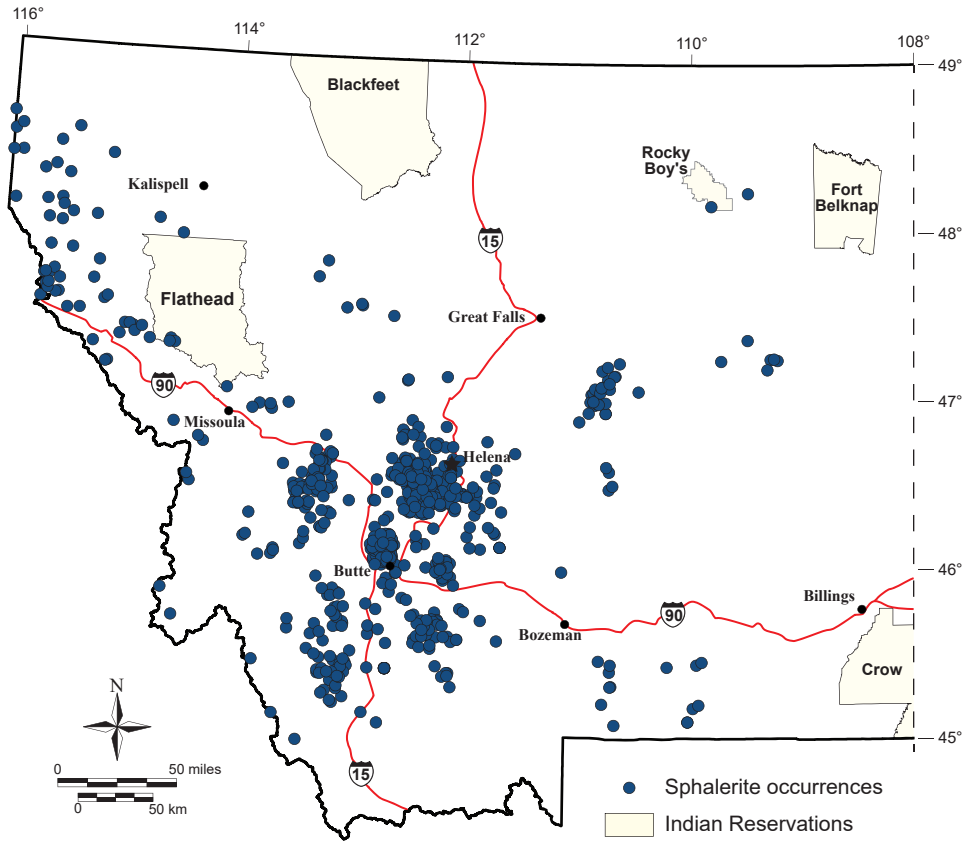


*Figure 4. A map of western Montana displaying known sphalerite occurrences (and thus potential In).*

## Deposits in Montana

Occurrences of In mineralization in Montana are restricted to the western half of the State. Historic Zn mining was prevalent around Butte (Silver Bow County) and Philipsburg (Granite County). The currently operating Continental mine in Butte is a porphyry-type deposit and not particularly Zn-rich, suggesting low In potential.

Other places with the potential for economic In mineralization are sediment-hosted deposits in Lincoln, Sanders, and Meagher Counties. A variety of magmatism-associated gold (Au), silver (Ag), lead (Pb), copper (Cu), and/or Zn deposits also occur in Beaverhead, Broadwater, Lewis and Clark, Jefferson, Madison, Mineral, and Cascade Counties.

## Outlook in Montana

Unflooded historic workings around Butte are currently being reevaluated for Zn and other metals, including In. While primarily a Cu development, the Black Butte project in Meagher County has many sphalerite (a Zn, and thus potential In, ore) occurrences peripheral to the main Cu deposits.

### 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.