Critical Mineral: Tungsten

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Overview

Tungsten (W) is a chemical element that is included on the United States Geological Survey's 2022 Final List of Critical Minerals.

W is a brittle, very hard, very dense, grayish white metal. It has the highest melting point and tensile strength of any pure metal. It is also rather unreactive. These and other rare properties create many applications for W compounds.

W-carbide is the largest application, used for machine tools, munitions, surgical instruments, neutron reflectors, and other specialty hardware. Steel alloys are the second largest application (e.g., in rockets or jet turbines). There are also some W-bearing chemicals of use (e.g., ceramics or catalysts).

Figure 1. An 80 gram, 1.3 x 3 cm cylinder of refined metallic W. The surface of the cylinder is slightly oxidized. Photo by Hi-Res Images of Chemical Elements (CC-BY-3.0).

Supply

China is the world's largest W producer by a large margin, with 64 kt (thousand metric tonnes) produced in 2023. Vietnam (3.5 kt), Russia (2 kt), and North Korea (1.7 kt) were the other top four producers in the same year. China also has the most reserves (2,300 kt), followed by Australia (570 kt), Russia (400 kt), and Vietnam (74 kt). No domestic reserves exist. Most domestic resources are found in Alaska, Arizona, Idaho, Montana, Nevada, and New Mexico.

Domestic W production has been minimal for decades, with zero production since 2016. In 2023, total imports were 11.5 kt; 27 % of this was from China. The U.S. Defense Logistics Agency holds a strategic stockpile of W ore with approximately 130 t of contained W metal. This is about 1% of annual domestic imports.

Globally, most W is mined from skarn (contact metamorphism) or related greisen (hydrothermally altered granite) deposits. Grades for deposits are typically 0.2 to 1.1 wt.% W. Pricing for W metal was about US$49,000/t in late 2024.

Mineralogy

Scheelite ($CaWO_4$) is the primary ore mineral for W. Another possible ore is wolframite: $(Fe,Mn)WO_4$. Although these are not sulfide minerals, many W deposits also have associated sulfides minerals such as pyrite, chalcopyrite, sphalerite, galena, or pyrrhotite. Sulfide minerals can have the potential to produce acid rock drainage.

Other critical minerals associated with W mineralization are antimony (Sb), arsenic (As), beryllium (Be), fluorspar (CaF_2), manganese (Mn), tantalum (Ta), tin (Sn), and zinc (Zn). Other associated non-critical minerals are copper (Cu), gold (Au), lead (Pb), molybdenum (Mo), and rhenium (Re).

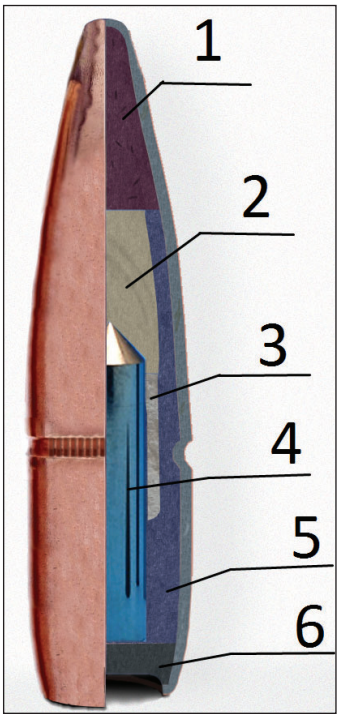

Figure 2. A schematic of a Raufoss Mk 211 12.7 x 99 mm (0.50 BMG) NATO round. #4 points to the armor-piercing W-carbide core. This round can penetrate 16 mm of steel plate at 400 m when shot from a Barrett M82 or Browning M2. Photo by Talifero (CC-BY-SA-3.0).

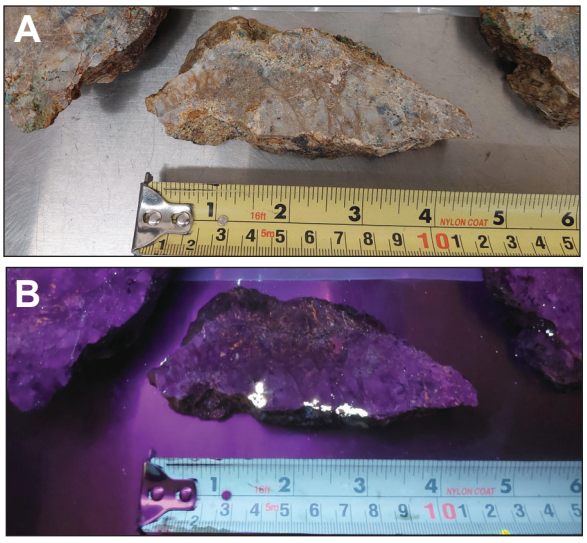

Figure 3. A cut sample of scheelite mineralization in skarn from the Blue Copper Prospect under (A) regular light, and (B) short-wave ultraviolet light. The scheelite fluoresces blue-white under UV light. Photo by Adrian Van Rythoven.

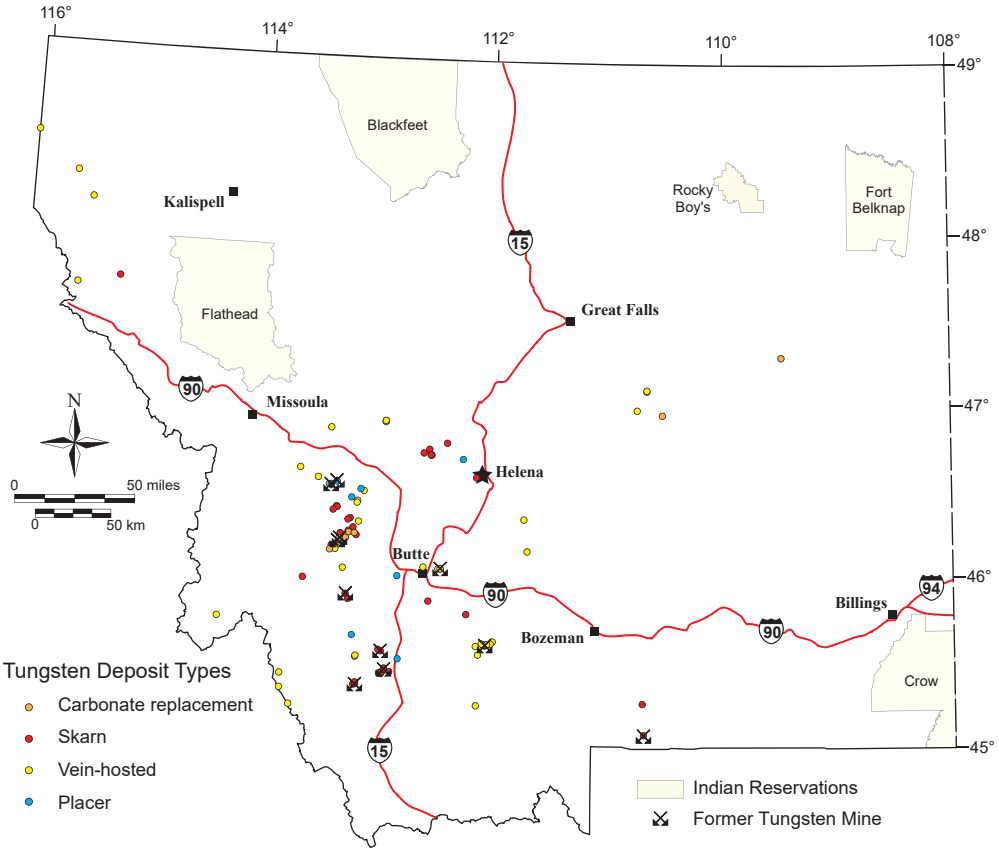

Figure 4. A map of Montana displaying known W occurrences by deposit type. Also shown are deposits that produced W.

Both skarn and greisen deposits form when (typically granitic) magma intrudes the crust, cools, and solidifies into plutons.

Deposits in Montana

Montana had produced W from about nine mines. Most of these operated during the early 1900s. The most productive was the Calvert Mine (Beaverhead County). This was the last Montana W mine to close in 1966. Other important producers were the Trigger and Browns Lake Mines. Other mines typically had W as a byproduct.

Most of Montana's reported W prospects, including the mines, occur in a north–south strip through Granite, Deer Lodge, and Beaverhead Counties. The majority of these are skarn-type deposits, but W is noted in some carbonate replacement-type, and some that can be generically described as 'vein'-type (possibly greisen) as well. A few placer deposits are also noted to host some W, typically with Au. Other counties with noted W mineralization are Broadwater, Cascade, Fergus, Jefferson, Lewis and Clark, Lincoln, Madison, Park, Powell, Sanders, and Silver Bow.

Outlook in Montana

The only active exploration project of significance to contain W is the Blue Copper Prospect in Snowshoe Gulch, Powell County. Although a Cu-Au prospect, there is significant scheelite mineralization in the skarns that constitute the prospect.

Mine waste piles at the Calvert and other abandoned W mines have been found to have notable W content (>1 wt.% W). Other mine or smelter waste piles, not necessarily those from W production, contain elevated W (up to 0.1 wt.%) along with other metals (e.g., As, Cu, and Zn).

Researchers at the MBMG are sampling legacy mine sites across the State in order to assess their economic potential for critical minerals. 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 and domestic supply chains for critical minerals, (2) lower mining impacts on the landscape as the material is already fragmented and at surface, (3) increased employment for legacy mining communities, and (4) rehabilitation of legacy mine sites that cause pollution.

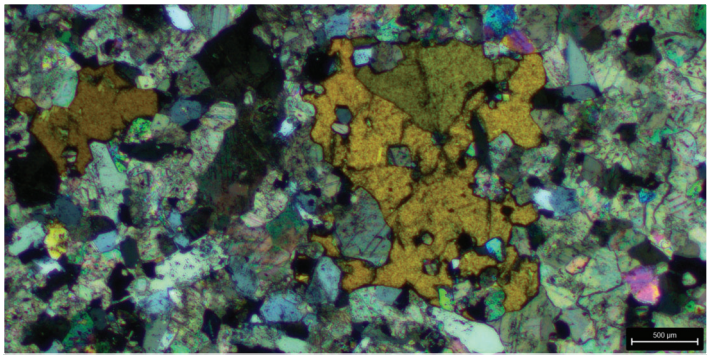

Figure 5. A cross-polarized transmitted photomicrograph of larger scheelite (orange) surrounded by calcite (pastel) and quartz (gray) in ore from the Old Bonanza Mine, Deer Lodge County. Photo by Adrian Van Rythoven.

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.