Critical Mineral: Fluorspar

Adrian Van Rythoven

April 2025

https://doi.org/10.59691/EIJP2397

Overview

Fluorite, or fluorspar when considered as a commodity, is an industrial mineral included on the U.S. Geological Survey's 2022 Final List of Critical Minerals. Fluorspar is a halide mineral, specifically calcium fluoride (CaF_2). It comes in a variety of translucent colors, forms fairly soft cubic crystals, and cleaves into octahedra. Most varieties are fluorescent under ultraviolet light.

Depending on the purity of a fluorspar concentrate, there are a variety of applications. The most valuable (>97 wt.% CaF_2) is acid-grade, used to make hydrofluoric acid and derivative chemicals. It is also necessary for aluminum and uranium refining. The next is ceramic-grade (85–97 wt.% CaF_2), used for ceramics and specialty glasses. The least valuable, but easiest to produce, is metallurgical-grade (65–85 wt.% CaF_2), added as flux for steelmaking, or used in cement.

Lithium hexafluorophosphate ($LIPF_6$) is the key electrolyte salt in lithium ion batteries. The fluorine in $LiPF_6$ typically comes from fluorspar.

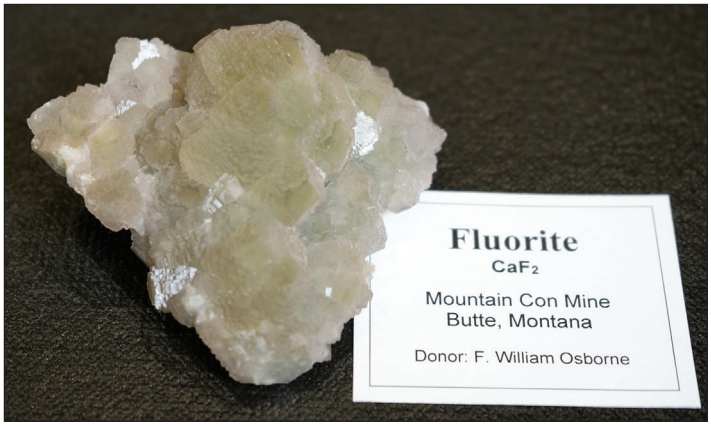

Figure 1. A sample of fluorite (fluorspar), about 4 in wide, from the Mountain Con Copper Mine, Silver Bow County, Montana. Specimen from the Montana Tech Mineral Museum, donated by F. William Osborne. Photo by Steve Quane, MBMG.

Supply

China has the largest fluorspar reserves at 86 Mt (million metric tonnes), followed by Mexico (68 Mt), South Africa (41 Mt), and Mongolia (34 Mt). China also produced the most in 2024 (5.9 Mt), followed by Mexico and Mongolia at 1.2 Mt each.

The U.S. has negligible production or reserves of fluorspar. It is 100% import reliant. However, fluorosilicic acid byproduct from domestic phosphate production is substituted for fluorspar in some applications.

Fluorspar pricing in 2024 ranged from $400/t for metallurgical grade to $470/t for acid grade.

Figure 2. A photo of the Finkl Steel Mill operations near Chicago, Illinois. Low-grade fluorspar (metallurgical fluorspar) is added as a flux to help iron ore melt and to remove impurities. The white bags in the foreground likely hold fluorspar. Photo by Payton Chung (CC-BY-2.0).

Mineralogy

Fluorspar deposits are common as veins or replacement beds. Fluorspar can be found in igneous, metamorphic, or sedimentary settings. Carbonate replacement, epithermal, carbonatite, greisen, skarn, pegmatite, and generic hydrothermal vein/breccia deposits can occur.

Other critical minerals found in these deposits are the rare earth elements (REEs), tantalum (Ta), niobium (Nb), tungsten (W), lithium (Li), tin (Sn), barite ($BaSO_4$), zirconium (Zr), scandium (Sc), zinc (Zn), indium (In), cesium (Cs), germanium (Ge), gallium (Ga), and hafnium (Hf).

Figure 3. A 3.7 V Li-ion battery. Fluorine from fluorspar is used to create the Li-bearing electrolyte in many types of Li-ion batteries. Photo by Emilio J. Rodriguez Posada (CC-BY-SA-4.0).

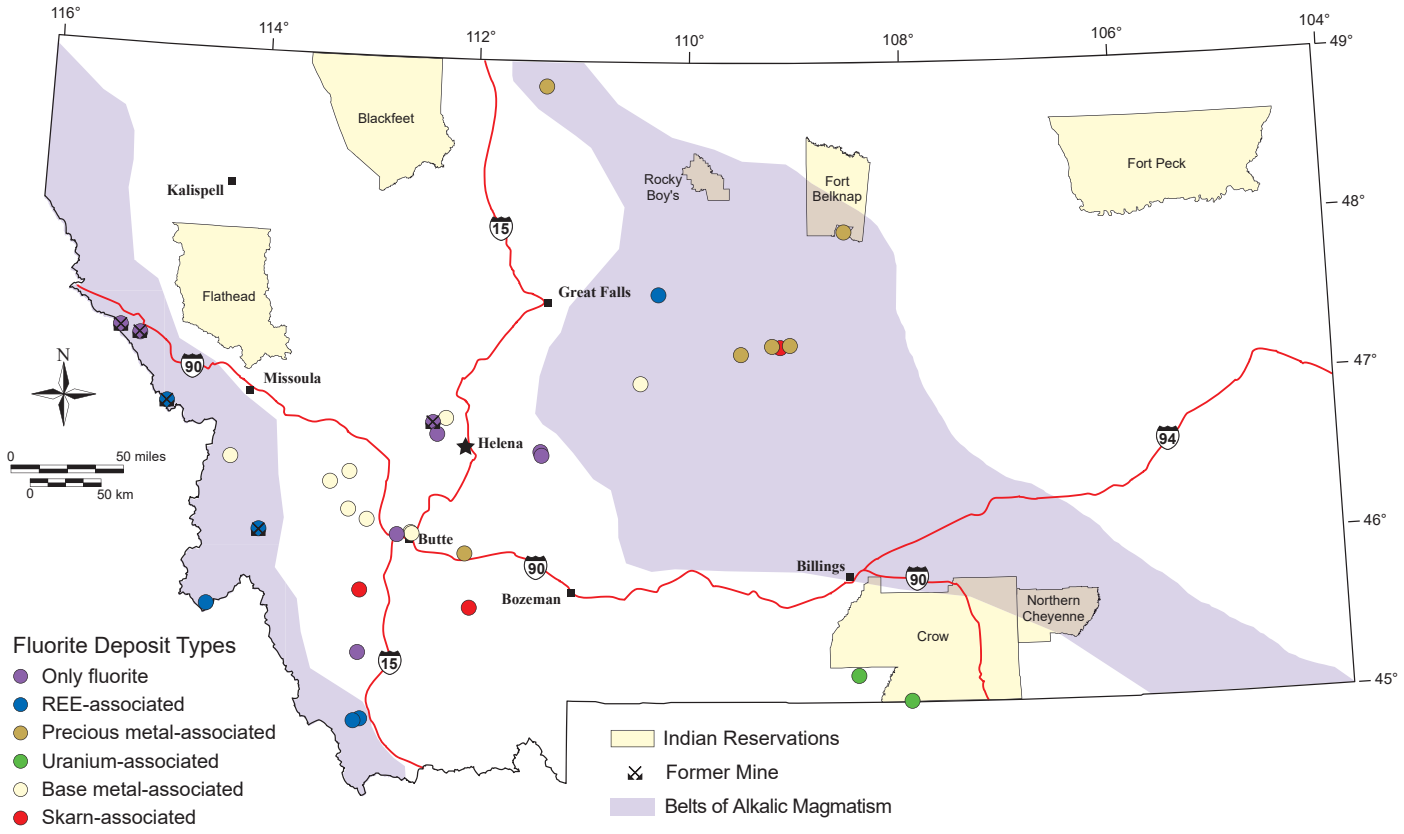

Figure 4. A map of Montana displaying known fluorspar occurrences with their associated metals, including former mines, and the two belts of alkalic magmatism.

As fluorspar is so common, mineralogy is important to the deposit's economics. Deposits with fluorspar crystals that are easy to physically separate from impurities and concentrate are more valuable.

Deposits in Montana

Fluorspar is a common mineral, but it needs to occur in high concentrations and amounts to be considered a fluorspar deposit. Fluorspar-dominant deposits are fairly abundant throughout southwestern Montana. Most fluorspar in Montana is associated with other metals.

Historic U deposits in the Pryor Mountains (Carbon County) have associated fluorspar. The base metal veins of Deer Lodge, Granite, Silver Bow, Lewis and Clark, and Judith Basin Counties have significant associated fluorspar. True skarn-hosted fluorspar is also found in in areas with base metals. The highest concentrations of fluorspar deposits are in the State's two belts of alkalic magmatism. Most of these are REE-associated, although the Central Montana Alkalic Belt also has many gold (Au)-associated fluorspar deposits.

There is significant past production of fluorspar in Montana. Primarily it was from REE or fluorspar-only deposits in the western part of the State. The fluorspar and REE mines at Snowbird (Mineral County) and Crystal Mountain (Ravalli County) were known for extremely high-purity production.

Outlook in Montana

No fluorspar-specific production or exploration is ongoing in Montana. REE or other metals-related mineral exploration may result in future fluorspar discoveries.

Researchers at the MBMG are sampling legacy mine sites across the State to assess their economic potential for critical minerals, including fluorspar. 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.

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.