

Mapping Arsenide Five-element Veins in the Black Hawk District by Integrating Historic Records With GPS, LiDAR, Geochemistry, and Geophysical Surveys

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Arsenide five-element vein deposits are mineralogically and texturally complex, moderate-temperature, hydrothermal, structurally controlled, Ag-Co-Ni-Bi-As carbonate vein systems with local minor elements (U, Pb, Zn, Sb, Hg). There are many subtypes or variations of this deposit type. These deposits are being re-evaluated worldwide due to the quantities of critical minerals that these deposits host, especially Co and Ni. The elements forming most five-element veins have different chemical properties and are not normally found together, which highlights the need for specific hydrothermal processes leading to the formation of this elemental association. These deposits contain high-grade silver (1000s g/t Ag) but are low tonnage (<1 Mt) and low in gold and copper. Mapping of these systems is fundamental to understanding their origin, yet few district-scale geologic maps exist.

The Black Hawk district (Burro Mountains), New Mexico is one of the few localities of five-element veins in the U.S. It is estimated that 1,286,000 oz Ag was produced from the district from 1883-1960. Several geologic maps have been produced over the years, but recent mapping includes the integration of historic records with geologic mapping using GPS, LiDAR, geochemical mapping, radiometric surveys, and geophysical surveys (IP, electromagnetic methods, USGS Earth MRI radiometric and magnetic surveys). The veins are mapped as uranium, silver, carbonate, and quartz. Older tungsten veins are found in the southern part of the district that are not related. Mapping has shown epithermal textures such as bladed quartz after calcite (indicative of boiling) and brecciation are common in the higher levels of the system. Uranium minerals are common in the subsurface of productive veins (Black Hawk, Alhambra, Rose), but only a few veins at the surface are radioactive (Granda, BLHK573, 590). Magnetic surveys indicate the veins are found along the eastern edge of a magnetic-high, attributed to the Twin Peaks monzonite (75 Ma).