

Hydrothermal Footprint of the Radersburg Cu–Au Porphyry, Montana: Integrating Mineralogical, Geochemical and Geophysical Data

Joseph Clevenger¹, Eric Anderson², Kyle Eastman³

¹Oregon State University, Corvallis, United States, ²US Geological Survey, Denver, United States, ³Montana Bureau of Mines and Geology, Butte, United States

In 1978-1980 Exxon Minerals Co. discovered the ~78 Ma Radersburg porphyry Cu-Au deposit among late Cretaceous satellite plutons of the Boulder batholith. ~200m of 0.1-0.2wt% Cu and ~0.2g/t Au occur in zones of biotite-K-feldspar alteration containing aplitic quartz-chalcopryrite-pyrite-magnetite veins below <300m of Cenozoic sediments. This porphyry type deposit lies <1 km south of the historic Au-Ag-Cu Keating and Ohio-Keating veins, which had a relatively large production of >220,000 oz of Au prior to 1948.

Bulk-rock geochemical analyses, gamma-ray spectra, and airborne magnetic and radiometric surveys over a ~4km x 2.5km surface area identify the central Keating Hill 800m² zone containing productive quartz-calcite-pyrite-chalcopryrite-gold veins, which is characterized by K-addition as muscovite and K-feldspar (up to 4.5-6.5 wt% K with K/Al molar ratios of 0.4-0.62). In this zone, country rock plagioclase-hornblende has been replaced by K-feldspar-pyrrhotite which is bounded on east, north, and west by chlorite-albite ± epidote alteration. Both alteration styles are cut by auriferous pyrite-calcite-quartz veins with muscovite ± chlorite selvages.

Muscovite compositions from 2200nm absorption features in the SWIR spectral range calibrated by EMPA illustrate a similar concentric zonation. Where muscovite alteration cuts Keating Hill, long wavelength alunoceladonitic phengite (~2209-2212nm) is formed. Beyond this region, mica wavelengths grade outward to distal short-wavelength (~2203-2195nm) compositions with vein local long-wavelength micas.

Bi, Te, and Rb are maximally enriched at Keating Hill and along a central north-south corridor, correlating with the highest relative Au enrichments and long wavelength mica occurrence. Elevated Sb and Li enrichments align with mapped zones of pyrite>pyrrhotite and short wavelength muscovite, while As is regionally elevated (vs. ~1 ppm crustal abundance) with maxima local to mineralized veins.

Airborne geophysical anomalies map the hydrothermal system, but geochemistry and SWIR analyses provide necessary detail for understanding causative sources. Together, these data can be used in exploration for similar buried deposits.