

Geophysical Mapping of Porphyry Copper Systems in the Boulder Batholith, Southwest Montana

Eric Anderson¹, Snir Attia¹, John Dilles², Marak Reed³, Kyle Eastman^{4,5}, Christopher Gammons⁴

¹US Geological Survey, Denver, United States, ²Oregon State University, Corvallis, United States, ³University of Oregon, Eugene, United States, ⁴Montana Technological University, Butte, United States, ⁵Montana Bureau of Mines and Geology, Butte, United States

The Earth Mapping Resources Initiative (EarthMRI) has conducted extensive airborne magnetic and radiometric surveys across the United States, generating foundational geophysical datasets essential for advancing mineral system mapping. This study presents results from recent surveys, supplemented by regional compilations and ground-based measurements of magnetic susceptibility and gamma-ray spectra, focusing on porphyry systems at Butte and within the Boulder batholith of southwest Montana.

Magnetic susceptibility measurements and magnetic anomaly highs within a compilation of upward continued magnetic data delineate the batholith and indicate the predominance of magnetite-series granitoids. Radiometric data indicate elevated near-surface concentrations of potassium, thorium, and uranium in the extensive Butte Granite, also confirmed by ground-based gamma-ray spectrometry. Within the Butte district, two well-known porphyry systems contain extensive potassic alteration, separated by a zone of intense sericitic alteration. These hydrothermal systems exhibit shells of magnetite-rich rock up to 2 km in diameter and more than 200 m thick at varying depths up to 600 m. Aeromagnetic data map a 10 km-wide, 350 nT magnetic low over the hydrothermal systems, with minimal evidence of magnetite-rich zones. Magnetic susceptibility measurements outside these zones indicate substantial destruction of primary magnetite, while radiometric data suggest increased uranium and decreased thorium concentrations in the altered Butte Granite.

The Corbin-Wickes deposit located 75 km northeast of Butte, identified through limited drilling and outcropping stockwork veins, is similarly characterized by magnetite-destructive hydrothermal alteration in the Butte Granite as indicated by magnetic susceptibility measurements and a 200 nT magnetic low, coincident with decreased thorium and uranium. Additional areas with similar magnetic and radiometric character within mapped Butte Granite may be indicative of prospective ground for porphyry copper systems. The integration of these geophysical datasets provides valuable insight into the mineralogical and alteration processes within the Boulder batholith, supporting ongoing efforts to map porphyry copper systems.