

Discharge of Hydrothermal Fluids from a Magma Chamber and Concomitant Formation of a Stratified Breccia Zone at the Questa Porphyry Molybdenum Deposit, New Mexico

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Abstract

The fluorine-rich Questa porphyry Mo deposit, New Mexico, comprises several orebodies with different mineralization styles, including thick veins (decimeter- to meter-scale), thin veinlets (millimeter-scale), and very unusual breccia bodies. In the Goat Hill orebody, a $>6 \times 10^6$ -m³ breccia body hosts 30 to 40 percent of the contained Mo and has an elongated lens shape. It is ≤ 100 m thick, 200 m wide, and 650 m long, and is located above and southward of an aplitic stock apex. Based on detailed core relogging, the breccia body was divided into seven facies, five of which define a breccia stratigraphy on a longitudinal section. Differences between breccia facies in terms of matrix paragenesis, fragment alteration, and breccia textures can be explained by the evolution of a magmatic-hydrothermal fluid away from its source, different intensities of water-rock interaction, and different breccia-forming processes. Breccia formation was initiated when premineral dikes and surrounding andesitic country rocks were hydraulically fractured by ore-forming fluids evolved from crystallizing water-saturated magma. Fractures propagated from the stock apex along preexisting volcanic bedding or a fracture zone dipping gently toward the north. Oxygen isotope geothermometry indicates that the breccia matrix precipitated at temperatures near 550°C. The isotopic composition of this matrix is $\delta D = -138$ to -110 per mil (phlogopite) and $\delta^{18}O = 6.8$ to 10.3 per mil for quartz, and 2.8 to 5.7 per mil for phlogopite. At 550°C, the calculated water composition is $\delta^{18}O = 5.1$ to 8.6 per mil and $\delta D = -121$ to -93 per mil. The isotopic study confirms that breccia-forming water had little to no meteoric component, as evidenced by the aplite matrix in the breccia and the proximity with the source intrusion. The interpretation that magmatic fluids were dominant in ore-forming processes is in contrast with some other Mo systems that show involvement of significant meteoric water.

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