

Halo Veins at the Copper Creek Copper Porphyry Deposit, Arizona: Evidence for Copper Introduction Near the Ductile-Brittle Transition

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Located northeast of Tucson in southern Arizona, Copper Creek is a major undeveloped copper porphyry project comprising a combined open pit and underground measured and indicated mineral resource of 421.9 million metric tonnes grading 0.45% Cu, 0.008% Mo, and 1.1 g/t Au. The deposit is hosted by the ~62-61 Ma Copper Creek igneous complex, which has been emplaced into the ~63 Ma Gloy Hole Volcanics. Copper mineralization at Copper Creek includes several texturally distinct ore types, including copper sulfides within halo veins and cement in hydrothermal breccias.

Many halo veins contain infills of euhedral quartz crystals that exhibit zoning patterns in cathodoluminescence similar to those in B vein quartz in typical porphyry deposits. Fluid inclusion assemblages in the quartz show textural evidence for postentrapment modification, which is typical for B vein quartz formed near the ductile-brittle transition. In some halo veins, the alteration halos surround a central hairline fracture that contains no quartz or sulfide minerals. In other veins, centerlines are infilled by chalcopyrite and pyrite. Where quartz occurs in contact with the sulfide minerals, the quartz has irregular grain boundaries, demonstrating that sulfide deposition occurred at conditions of retrograde quartz solubility.

The observations suggest that there is a progression from halo veins containing quartz to veins where there is only a central hairline fracture with no infill, and veins where the centerline is occupied only by sulfide minerals. This can be explained by cooling of a low- to moderate-salinity (<10-15 wt.% NaCl) single-phase magmatic-hydrothermal fluid from temperatures above ~450°C to those where retrograde solubility occurs but sulfide precipitation was still inhibited, to temperatures where copper sulfides precipitate. The observations suggest that copper mineralization at Copper Creek was not a high-temperature process and may have occurred by the same magmatic-hydrothermal fluids that precipitated the sulfide cement in the hydrothermal breccias.