

Vein Mineralogy and Microtextures of Miocene Intermediate-sulfidation Epithermal Veins in the Tonopah District, Nevada

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The Tonopah mining district, located in southwestern Nevada, comprises numerous Miocene intermediate-sulfidation epithermal vein deposits and was a major historic producer of silver and gold. Microtextural evidence suggests that quartz in the veins formed via a maturation process of a noncrystalline silica precursor, not as a primary mineral precipitate from the hydrothermal liquids. Characteristic textures include fine-grained mosaic quartz with interlocking grain boundaries, polygonal quartz, flamboyant quartz with radiating arrays of inclusions, feathery quartz showing splintery domains, and large prismatic quartz grains hosting recrystallization fronts defined by pseudoprimary inclusions. Optical cathodoluminescence reveals complex internal zoning patterns in prismatic quartz crystals that are inconsistent with crystal growth in open spaces. These microtextural observations suggest that the crystals grew in a gel-like matrix with neighboring crystals competing for space during conversion of the noncrystalline silica to quartz. The quartz hosts ore minerals that commonly have delicate, multi-branching shapes resembling dendrites that also originally formed in the noncrystalline silica matrix, and were subsequently enveloped and modified by quartz during maturation of the matrix, resulting in grain coarsening and migration of ore minerals along quartz grain boundaries. Re-equilibration of ore minerals during the waning of hydrothermal activity and related cooling is indicated by the formation of myrmekitic intergrowths of aguilarite and galena from an originally homogeneous Ag-Pb-Se-S phase, and by the inversion of cubic silver sulfide. These microtextures suggest that the initial deposition of noncrystalline silica along the walls of the intermediate-sulfidation epithermal veins at Tonopah, and the growth of the ore mineral dendrites within the silica matrix, occurred rapidly at far-from-equilibrium conditions, requiring supersaturation of solutes in the hydrothermal liquids. It is proposed that these conditions were the result of vigorous boiling of the hydrothermal liquids hundreds of meters below the paleosurface.