

Origin and Significance of Postore Dissolution Collapse Breccias Cemented with Calcite and Barite at the Meikle Gold Deposit, Northern Carlin Trend, Nevada

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Abstract

The final event in a complicated hydrothermal history at the Meikle gold deposit was gold deficient but caused extensive postore dissolution of carbonate, collapse brecciation, and precipitation of calcite and barite crystals in the resulting cavities. Although previously interpreted to be part of the Carlin-type hydrothermal system, crosscutting relationships and U-Th-Pb geochronology constrain this hydrothermal event to late Pliocene time (ca. 2 Ma), nearly 36 Ma after ore formation. Mineralogic, fluid inclusion, and stable isotope data indicate that postore hydrothermal fluids were reduced, H₂S-rich, unevolved meteoric waters ($\delta^{18}\text{O} = -17\text{‰}$) of low temperature (ca. 65°C). The $\delta^{18}\text{O}$ values of barite and calcite indicate that these minerals were in isotopic equilibrium, requiring that barite SO₄ was derived from the oxidation of reduced sulfur; however, preexisting sulfides in breccia cavities were not oxidized. The $\delta^{34}\text{S}$ (15‰) values of barite are higher than those of local bulk sulfide and supergene alunite indicating that SO₄ was not derived from supergene oxidation of local sulfide minerals. The 15 per mil $\delta^{34}\text{S}$ value suggests that the H₂S in the fluids may have been leached from sulfur-rich organic matter in the local carbonaceous sedimentary rocks. A reduced H₂S-rich fluid is also supported by the bright cathodoluminescence of calcite which indicates that it is Mn rich and Fe poor. Calcite has a narrow range of $\delta^{13}\text{C}$ values (0.3–1.8‰) that are indistinguishable from those of the host Bootstrap limestone, indicating that CO₂ in the fluid was from dissolution of the local limestone. These data suggest that dissolution and brecciation of the Bootstrap limestone occurred where H₂S-rich fluids encountered more oxidizing fluids and formed sulfuric acid (H₂SO₄). Intense fracturing in the mine area by previous structural and hydrothermal events probably provided conduits for the descent of oxidized surface water which mixed with the underlying H₂S-rich waters to form the dissolving acid. The surface-derived fluid apparently contained sufficient oxygen to produce H₂SO₄ from H₂S but not enough to alter pyrite to Fe oxide. Although H₂S is an important gold-transporting ligand, the temperature was too low to transport a significant amount of gold.

The presence of analogous calcite- and barite-lined cavities in other Carlin-type deposits suggests that the generation (and oxidation) of H₂S-rich meteoric waters was a common phenomenon in north-central Nevada. Previous sulfur isotope studies have also shown that the Paleozoic sedimentary rocks were the principal source of H₂S in Devonian sedimentary exhalative-type, Jurassic intrusion-related, Eocene Carlin-type, and Miocene low-sulfidation gold deposits in the region. The similar sulfur source in all of these systems suggests that basin brines, magmatic fluids, and meteoric waters all evolved to be H₂S-rich ore fluids by circulation through Paleozoic sedimentary rocks. Thus, although not directly related to gold mineralization, the recent hydrologic history of the deposit provides important clues to earlier ore-forming processes that were responsible for gold mineralization.

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