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Genesis of the World-Class Dashui Gold Deposit in the West Qinling Orogen, China: Constraints from Petrography, Whole-rock Geochemistry, and Mineral Inclusion Composition

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The Dashui gold deposit, with proven reserves of >100 t @ 10 g/t (locally having bonanza ore grades of 1000 g/t), is one of the largest high-grade gold deposits in the West Qinling Orogen, China. Gold ores of this deposit are mainly composed of very fine-grained hematite, microcrystalline quartz, and carbonate. Rare sulfides are common as are ore minerals predominant in other gold deposits over the West Qinling orogen. The distinct mineral assemblages at Dashui has led to a prevailing supergene origin for its formation. Here, we present new geological and mineralogical evidence to suggest a primary origin.

Orebodies are of dendritic, lenticular, or cystic shapes and are mainly hosted in the Lower Triassic limestone and dolomitic limestone, with minor ores in granodioritic dykes that intruded the Triassic sedimentary rocks at 215.36 ± 0.87 Ma. Gold mineralization is closely associated with extensively silicified carbonate breccias that form breccia pipes in high-grade ore zones. The breccias are generally angular to sub-angular, range in size from several millimeters to centimeters, and are frequently cemented by multiple generations of hydrothermal iron-rich silica and calcite. Fragments of hydrothermal silica and calcite are not uncommon and hydrothermally cemented, suggesting multiple brecciation events. Based on field relation and petrographic evidence, gold mineralization and ore-related hydrothermal alteration can be divided into three stages: microcrystalline quartz-hematite stage (I), calcite-hematite stage (II), and calcite stage (III), with gold mostly being deposited in stage I. This main ore-stage is characterized by replacement of carbonate by microcrystalline silica (30–80 μm) and hematite (2–3 μm), typically marked by irregular carbonate residues surrounded by euhedral microcrystalline quartz. Integrated FE-SEM and XRD analysis has revealed fine-grained hematite, kaolinite, apatite, monazite, native gold, and some unknown minerals within euhedral microcrystalline quartz. Stage II features hematite-interlayered calcite, with microcrystalline quartz variably present in the growth zones of calcite. The latest stage is marked by coarse-grained calcite veins surrounding or cutting the orebodies.

Bulk chemical analysis of gold ores reveals that SiO_2 (0.33–87.44 wt %) is positively correlated with Au (R = 0.47; R refers to correlation coefficients) but negatively correlated with CaO (R = -0.99). The results are consistent with petrographic observations, further confirming that gold mineralization is genetically associated with silicification, hematitization, and decarbonization of the host carbonate. Minor, fine-grained pyrite is locally developed in stage I microcrystalline quartz and yields LA–ICP–MS Au signal intensities significantly higher than the background, which have positive correlations to elevated S, As, Hg, Tl, and Ag signals. This observation indicates that minor gold was deposited in As-rich pyrite. Taken together, we suggest that the Dashui gold deposit formed from acidic, Si- and Fe-rich, and oxidized fluids that replaced carbonate to form microcrystalline quartz, hematite, native gold, and locally minor As-rich pyrite. As such, Dashui can be best classified as a Carlin-like gold deposit or simply an epithermal gold deposit.