Trace Element Compositions of the Daqiao Sediment-Hosted Gold Deposit, Western Qinling Orogen, China: Implications for Ore Genesis

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The western Qinling orogen in central China hosts numerous sediment-hosted gold deposits that account for ca. 20% of known gold resources in China. These deposits have been commonly considered to be orogenic and/or Carlin-like varieties. Although most deposits have been intensively studied in the last three decades, issues on the source of gold and ore genesis remain hotly debated. The recently discovered Daqiao gold deposit has a proven reserve of 140 t gold at an average grade of 3 to 4 g/t. Gold mineralization is hosted in weakly metamorphosed clastic rocks of the lower Triassic Daheba Formation. They are intruded by numerous granodiorite dikes at 215.0 ± 1.1 to 211.5 ± 1.5 Ma, constrained by laser ablation ICP-MS (LA-ICPMS) zircon U-Pb dating. Gold mineralization is largely localized in dilational hinges of anticlines and interlayered fracture zones, in areas that have been intensely silicified. The ore-related silicification is dominated by massive microcrystalline quartz overprinted by drusy quartz. Less significant alteration minerals include sericite, kaolinite, and calcite.

Gold ores contain 3.6 ppm Au, 11.8 ppm Ag, 512 ppm As, 262 ppm Sb, 60 ppm Tl, 62 ppm U, 22.7 ppm Se, and 31.8 ppm V. The Au-Ag-As-Sb-Tl-U-Se-V assemblages are consistent with those typical of sediment-hosted gold deposits elsewhere. Compositions of gold ores are confirmed by LA-ICPMS spot analysis of pyrite and marcasite, the predominant ore minerals in the Daqiao deposit. Pyrite commonly consists of euhedral core that is enclosed by colloidal rims with oscinatory zoning, whereas marcasite occurs as coarse euhedral grains or irregular aggregates. Pyrite core is depleted in most trace elements with an average of 786 ppm As, 0.69 ppm Sb, 0.31 ppm Tl, 0.59 ppm Bi. Trace elements are significantly higher in the rims, with 0.2–136.7 ppm Au, 1454–38584 ppm As, 0.9–177.4 ppm Ag, 7.2–10623 ppm Sb, 332-5000 ppm Tl, 0.1-70.7 ppm Se, 108-3475 ppm Hg and 3.5-20.5 ppm V. Aggregates of fine-grained marcasite contain 22.5 ppm Au, 2499 ppm As, 6.6 ppm Ag, 1286 ppm Sb, 312 ppm Tl and 507 ppm Hg on average, whereas paragenetically later coarse-grained marcasite has less abundant trace elements, with 0.03 ppm Au, 96 ppm As, 257 ppm Sb, 30 ppm Tl, 11.3 ppm Hg and 16 ppm W. All spot analyses plot below the Au solubility limit line of arsenian pyrite, indicating that Au is mostly present as solid solution. Paleozoic organic- and pyrite-rich carbonaceous black shales in western Qinling orogen have elevated trace elements identified in the Daqiao gold deposit, including 130 ppb Au and unusually high As (1500 ppm), Ag (1035 ppm), U (10 ppm), V (1138 ppm), Mo (52 ppm), Pb (136 ppm) and Zn (239 ppm).

We therefore suggest that gold and other trace elements in the Daqiao gold deposit were mostly likely sourced from the Paleozoic carbonaceous black shales that underlie the Triassic host rocks and released gold, sulfur, arsenic, and other metals during the Triassic collisional metamorphism throughout the orogen. Nevertheless, the late Triassic magmatic intrusions cannot be ruled out as a potential source of gold taking into account the close temporal relationship between gold ores and granitic dikes in the mine.