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Genesis of the Taolegai Intermediate-Sulfidation Epithermal Au Deposit in the Northern Margin of Alxa: Evidence from Ore Geology, Fluid Inclusions, *In-situ* Sericite Rb-Sr Dating, Zircon U-Pb Dating, and Sulfur Isotopes

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The Taolegai gold deposit is situated at the northern margin of the Alxa Block within the Central Asian Orogenic Belt (CAOB). Mineralization is predominantly controlled by open structures and hosted within Permian monzogranite (256 ± 1 Ma, LA-ICP-MS zircon U-Pb) and older K-feldspar granite. Wall rocks proximal to ore veins exhibit a medium- to low-temperature hydrothermal alteration assemblage consisting of sericite, calcite, epidote, and chlorite. The paragenetic sequence comprises three distinct phases: a quartz-pyrite stage, a base metal sulfide stage, and a calcite-quartz stage. Fluid inclusion microthermometry reveals that the ore-forming fluids correspond to an H_2O-NaCl system characterized by medium to low temperatures (120–330 °C) and low to moderate salinities (1.0–11.9 wt% NaCl equiv.). In situ $\delta^{34}S$ values of pyrite show a narrow variation from +2.60 ‰ to +5.07 ‰ (average +4.27 ‰), suggesting a sulfur origin from a relatively homogeneous magmatic source. Evidence from fluid inclusions and sulfur isotopes indicates that fluid boiling and the mixing of magmatic fluids with meteoric water are the primary drivers of ore precipitation. In situ Rb-Sr dating of syn-mineralization sericite constrains the timing of mineralization, yielding an isochron age of 210 ± 5 Ma. These findings demonstrate that Taolegai is an intermediate sulfidation (IS) epithermal deposit genetically linked to concealed Late Triassic magmatism.

