

Magmatic-Hydrothermal Origin of the Labuzaika Gold Deposit, Western Qinling Orogen, China

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The Labuzaika gold deposit is located in the Xiahe-Hezuo district, western Qinling orogen, China, with a proven reserve of about 50 t gold. Gold mineralization is hosted in the Dewulu quartz diorite pluton (238.4 ± 1.9 Ma). A high ilmenite/magnetite ratio (up to 9:1) of the pluton indicates low oxygen fugacity for the magmas. The Dewulu pluton was emplaced into Carboniferous to Permian clastic and carbonate rocks forming hornfels and marbles in areas proximal to the intrusion. Two Au skarn orebodies occur at the contact between the Dewulu pluton and Permian carbonate. They are characterized by garnet, diopside, tremolite, actinolite, chlorite, quartz, ankerite, arsenopyrite, loellingite, chalcopyrite, pyrrhotite, and Au-Ag-Bi-Te assemblages.

Auriferous sulfide-quartz-carbonate veins and sheeted veinlets account for over 80% of total gold resources of the deposit. These were localized in a number of N-striking faults. A number of dioritic dikes that intruded the Dewulu quartz diorite pluton are crosscut by auriferous veins. The veins consist of quartz, arsenopyrite, pyrite, galena, sphalerite, boulangerite, freibergite, bournonite, and calcite, with minor amounts of stibnite, tourmaline, and sericite. The veins have halos of quartz, sericite, calcite, and pyrite alteration. Gold occurs as electrum and kustelite inclusions in boulangerite, freibergite and bournonite, or as microfracture infillings in arsenopyrite.

Fluid inclusions in quartz from the skarns are characterized by pure CO₂-CH₄ gaseous inclusions, and three-phase CO₂-CH₄ rich, aqueous inclusions that have homogenization temperature ranging from 248° to 349°C. The arsenopyrite-loellingite-pyrrhotite assemblages, combined with abundant CH₄ in ore fluids, indicate a reduced gold skarn system. Assimilation of carbonaceous black shales, which are widely distributed in the western Qinling orogen, in ore-related magmas and/or fluids could have been the cause for the reduced nature of the magmatic-hydrothermal system, as partly confirmed by the negative $\delta^{34}\text{S}$ values (-1.6 to -5.7‰) of arsenopyrite and chalcopyrite. Quartz from the gold veins host abundant two-phase aqueous fluid inclusions that have total homogenization temperatures ranging from 216° to 338°C and salinities of 1.8 to 11.7 wt % NaCl equiv. Microthermometric measurements and Raman spectroscopic analyses revealed significant amounts of CO₂ and CH₄ in the vapor phase.

Two mineralized dioritic dikes have zircon U-Pb ages ranging from 233.7 ± 1.6 to 231.6 ± 1.6 Ma. Sericite separates from an auriferous sulfide-quartz-calcite vein yielded an ⁴⁰Ar/³⁹Ar plateau age of 228.2 ± 1.5 Ma (2σ). Therefore, gold mineralization postdated the emplacement of the dioritic dikes and the Dewulu quartz diorite pluton. Ore-forming fluids have calculated $\delta^{18}\text{O}_{\text{SMOW}}$ of 7.8 to 10.7‰, based on the oxygen isotope data of quartz grains from auriferous veins at 300°C. The $\delta^{34}\text{S}$ values of arsenopyrite and pyrite are between 2.4 to 6.9‰. The oxygen and sulfur isotope data are best interpreted as indicating a magmatic origin for the ore fluids.