

Intrusion-Hosted Mineralization in the Charters Towers Goldfield, North Queensland: New Isotopic and Fluid Inclusion Constraints on the Timing and Origin of the Auriferous Veins

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Abstract

Auriferous quartz sulfide veins of the Charters Towers goldfield are mainly hosted in oxidized I-type granitoids of the Ravenswood batholith. K-Ar and Ar-Ar isotope age data of hydrothermal muscovite from alteration envelopes of veins at Charters Towers and the Hadleigh Castle mine (~40 km east of Charters Towers) are indistinguishable within error, suggesting broadly synchronous gold deposition between 410 and 404 Ma and across a significant segment of the Ravenswood batholith. Published geochronological data indicate that several granitoid bodies were emplaced into the Ravenswood batholith at the time of gold mineralization. Despite their association in space and time with igneous rocks, the gold deposits lack an obvious causative intrusion. Moreover, published lead isotope studies indicate that the lead in the ore was not acquired from any of the exposed intrusions. A distal origin of the ore-forming fluids also may be inferred from nitrogen isotope values of hydrothermal sericite, suggesting wall-rock interaction with metamorphic fluids or fluids that were in equilibrium with metamorphic rocks during the paragenetic stage of pyrite and arsenopyrite deposition (stage II). Veins of the Charters Towers goldfield contain three different types of fluid inclusions, which are distinguishable by petrography and microthermometry. This study is the first to report saline fluid inclusions in sphalerite (18.9–28.3 wt % NaCl equiv) and vein quartz (20.9–24.7 wt % NaCl equiv), trapped during the stage of gold deposition (stage III). The range of temperatures and salinities, particularly of the saline inclusions in sphalerite, could indicate mixing between hotter, more saline fluids (e.g., deep-seated magmatic) and cooler, more dilute solutions (e.g., modified meteoric) as the cause of gold deposition. The geological and geochemical data are not compatible with derivation of fluids, metals, and ligands from individual plutons. Similarity of host rocks, ore element associations, alteration assemblages, structural controls, and tectonic settings strongly suggest that the auriferous veins of the Charters Towers goldfield belong to a group of granitoid-hosted lode gold deposits that are generally classified as orogenic.

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