

Fluid Inclusion, Trace Element, and Isotopic Characteristics of Mineralization-Associated Hydrothermal Barite in the Cloncurry IOCG District, Northwest Queensland

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Hydrothermal barite is a common yet rarely studied gangue component of Australian Proterozoic iron oxide-Cu-Au deposits in the Gawler Craton, South Australia, and the Cloncurry district, Northwest Queensland. However, the Cloncurry district is unique among IOCG districts for hosting both barite-rich deposits, which include the E1 Group and Monakoff, as well as barite-bearing deposits such as Ernest Henry and Starra. Abundant barite is also associated with some subeconomic chalcopyrite mineralization hosted in the Corella Formation near the Snake Creek Anticline (SCA) south of Cloncurry. While the presence of barite clearly indicates the contribution of oxidized-sulfur-bearing fluids to mineralization, it also requires a substantial Ba source and/or concentrating mechanism—the delineation of which may contribute to the understanding of IOCG fluid sources. Presented here is a comparison of fluid inclusion, trace element, and sulfur isotope data from barite in a regionally significant IOCG deposit: the E1 Group (also elevated in REE), and mineralized but subeconomic hydrothermal barite outcroppings in the vicinity of the SCA.

Both deposits and subeconomic barite-chalcopyrite occurrences in the Cloncurry district are proximal to long-lived, regional structures, including the Ernest Henry, E1, Monakoff, and Starra shear zones associated with their respective Cu-Au deposits, and the Cloncurry fault <1 km from the SCA localities. Barite occurs either as vein/dilational void infill or as fine-grained (<0.5 mm) replacement. Barite is paragenetically late in all cases, and may be associated with calcite, quartz, fluorite, chalcopyrite, hematite and anhydrite. At E1 barite formed in the latest Cu-Au mineralization stage along with calcite, fluorite, and chalcopyrite, and is characterized by 1 mm - >10 cm vein infill and layer-controlled alteration (~0.5 mm grain size). Barite collected from around SCA is hosted in large (~50 cm) veins that also contain calcite and minor chalcopyrite, and crosscut hydrothermal magnetite-quartz breccias.

E1 Group barite hosts a main population of NaCl-CaCl₂-rich, liquid-vapor inclusions with final ice melting (T_m) between -23° and -11°C, and liquid homogenization (T_h) mainly >150°C, which are cut by trails of single-phase and liquid-vapor inclusions too small for analysis. Barite samples from the SCA show similar composition and T_h , but are characterized by one population with T_m between -30° and -16°C, and another population with T_m between -15° and 0°C. Laser ablation ICP-MS trace-element analysis of barite indicates that HREE concentrations are depleted in both systems. Total REE concentrations in E1 barite, with the exception of La, are an order of magnitude higher than those in SCA barite. The discrepancy in La relative to other REEs in the SCA barite may indicate that fluid in both systems was REE-bearing. In-situ SHRIMP sulfur isotope analysis of E1 and SCA barite shows a distinct difference between deposit-grade systems like E1 ($\delta^{34}S_{CDT}$ varies between +16.4 and +27.7‰) and Starra ($\delta^{34}S_{CDT} = +30‰$), and the subeconomic SCA system ($\delta^{34}S_{CDT} +1.3$ to +5.1‰), suggesting a separate sulfur source for strongly and weakly mineralized hydrothermal barite. Further study is necessary to ascertain if the differing sulfur sources influence the degree of copper and REE concentration.