Sulfur Isotope Fingerprints of Sediment-Hosted Copper Deposits in Mt Isa Western Succession, Australia

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The genesis of sediment-hosted copper deposits in the Mt Isa Western Succession has been extensively debated, particularly regarding the syngenetic vs epigenetic models. One way to potentially clarify such models is to track the evolution of sulfur isotopic fingerprints of sulfide minerals. Here we present sulfur isotopes for the Mammoth sediment-hosted deposits from SHRIMP-SI, in addition to data from Lady Annie, Lady Loretta, and Mt Isa (from the literature). Based on our paragenetic study, pyrite formed at several stages, mainly during diagenesis (syn-diagenetic pyrite) and afterwards (epigenetic pyrite), two events distinguishable by sulfur isotopes. The median values of sulfur isotopes for Mammoth, Lady Annie, Lady Loretta, and Mt Isa syn-diagenetic pyrite are -4 ‰, 27‰, 11‰, and 5‰, respectively and median values of sulfur for Mammoth, Lady Annie, Lady Loretta, and Mt Isa epigenetic pyrite are -11‰, 20‰, 6‰, and 10‰, respectively. The ore-bearing copper sulfides such as chalcopyrite and bornite yield sulfur isotopes closer to the epigenetic pyrites than the syn-diagenetic pyrites, indicating ore precipitation under reducing conditions, which supports the epigenetic model. Syn-digenetic pyrite with enriched sulfur isotopes is interpretated to have formed from sulfate-reducing bacteria while epigenetic pyrite and copper sulfides with moderate to depleted sulfur isotopes are linked to copper-rich hydrothermal fluids. The distinctive depleted sulfur isotopes of both syn-diagenetic and epigenetic pyrite at Mammoth are interpreted as due to fluid-host-rock interaction, as Mammoth is the only copper deposit in the region hosted by silicious sandstone while others are hosted by dolomitic shales.