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Variation of sulfur isotopes in indium-rich tin deposits (Baal Gammon and Isabel) of Herberton Mineral Field, Queensland, Australia

AVISH KUMAR[1], IOAN SANISLAV[1], LAURE A.J. MARTIN[2] AND PAUL DIRKS[1]

[1]James Cook University
[2]The University of Western Australia
Presenting Author: avish.kumar@my.jcu.edu.au

Indium is a critical metal with increasing demand in the manufacture of solar panels, LCDs, and touchscreens. Indium-rich tin deposits of the Herberton Mineral Field, such as those occurring at Baal Gammon and Isabel, are related to the fractionated granites of northeast Queensland that formed during the Carboniferous-Permian. Two phases of mineralization were recognized at Baal Gammon and Isabel. At Baal Gammon, the first phase consists of cassiterite mineralization in the UNA Porphyry and at Isabel, the first phase consists of cassiterite that occurs in polymetallic veins. The second phase consist of sulfides mineralization. At Baal Gammon, it consists mainly of chalcopyrite and pyrrhotite deposited as massive to semi-massive sulfides, veins, and breccia infill. The Isabel deposit consists of two types of polymetallic veins based on ore mineralogy; type 1 veins consist of sphalerite cross-cut by chalcopyrite and pyrrhotite, and type 2 veins consist of sphalerite and galena. The Sn and the sulfides mineralization are cross-cut by a later phase of quartz-feldspar porphyry and overlain by volcanic rocks. To investigate the sources of sulfur, sulfur isotopes (^{34}S, ^{33}S and ^{32}S) were analyzed through in-situ secondary-ion mass spectrometry (SIMS) on chalcopyrite-pyrrhotite pair from three different locations at Baal Gammon and from one polymetallic vein at Isabel. At Baal Gammon, the $\delta^{34}S$ in chalcopyrite from the massive sulfides hosted by the UNA Porphyry range from 1.5‰ to 1.7‰, whereas the $\delta^{34}S$ in chalcopyrite from the massive sulfides occurring at the contact between the younger porphyry and the UNA Porphyry varies from 2.07‰ to 2.09‰. The $\delta^{34}S$ in chalcopyrite in the polymetallic veins of the Isabel deposit varies from 0.9‰ to 1.4‰. Small variations in $\delta^{34}S$ signature from different parts of the Baal Gammon and Isabel deposits indicate a closed to a partially open magmatic system that operated during the evolution of Sn-Cu mineralization. This variation in the sulfur isotope could be due to remobilization and or kinetic fractionation that occurred during a later magmatic episode. Sulfur isotope fractionation between chalcopyrite and pyrrhotite was minimum at Baal Gammon but some fractionation was observed in the polymetallic veins of Isabel.