# The Cairn Hill Magnetite-Sulfide Deposit, Mount Woods Inlier, South Australia: Ore Genesis and Spatial-Temporal Relationships with Iron Oxide Copper-Gold Systems in the Gawler Craton

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The Cairn Hill Fe-(Cu-Au) deposit is located within the 1.6 Ga Olympic Cu-Au province of the Gawler craton, South Australia. The deposit strikes E-W over a distance of 1.3 km and is up to 40 m wide. It is characterized by two mineralized zones: the North and South lodes, coincident with subsidiary structures within the transpressional Cairn Hill shear zone, and concordant with the strike of the encompassing magnetic anomaly. Progressive exhumation resulted in temperature and pressure decreases under high fluid pressure, causing the Cairn Hill shear zone to cross the brittle-ductile transition, as evidenced by late brecciation and veining. This occurred relatively late in the hydrothermal-metamorphic evolution, resulting in a contractional duplex in a restraining bend, suggestive of a positive flower structure providing an optimal conduit for hydrothermal fluid flow. Early Na-Ca alteration has affected the host rocks predominantly characterized by albite + scapolite + diopside ± actinolite/titanite. Extensive K-Fe metasomatism has affected the host rocks overprinted by localized zones of intense, texturally destructive high-temperature magnetite-biotite alteration. Associated hypogene iron mineralization predominantly consists of magnetite, with extensive zones of a superimposed, texturally complex sulfide assemblage (pyrite-pyrrhotite-chalcopyrite).

The Cairn Hill deposit is hosted by an upper-amphibolite quartzofeldspathic orthogneiss and Mesoproterozoic (1600–1575 Ma) Hiltaba-equivalent Balta suite granites and granodiorites. U-Pb zircon SHRIMP dating of a representative host rock and crosscutting foliated granitic dike constrain the timing of mineralization between ~1587 and ~1514 Ma, respectively. Thermochronological analysis of hornblende and muscovite intergrowths within the magnetite ore using laser step-heating $^{40}Ar/^{39}Ar$ methods on mineral separates constrain the cooling history from >500° to <300°C of the Cairn Hill deposit between ~1492 and ~1462 Ma, respectively. The relatively high temperature of formation and the magnetite-dominant mineral paragenesis support the notion that Cairn Hill is a deep-level, magnetite-rich end-member IOCG system.

The Gawler craton is best known for its hematite breccia-dominant IOCG deposits, which include Olympic Dam, Prominent Hill, and Carrapateena. However, with our new data on the Cairn Hill deposit and the discovery in the last 5 years of Cu-Au deposits or prospects with skarn character such as Hillside and Punt Hill, it is becoming increasingly clear that the Olympic Cu-Au province includes within it iron oxide-associated Cu-Au deposits across the entire spectrum of IOCG mineralization. Therefore, regions of the Gawler craton that expose crustal levels prohibitively deep for hematite-breccia deposit formation may have the potential to host magnetite-dominant Cu-Au mineralization, opening up a potentially new exploration search space within the Gawler craton.