Copper - Gold Exploration in the Middleback Ranges; Source(s) of Fluids and Metals.

Thesis submitted by

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ABSTRACT

The Moola Prospect of the Middleback Ranges, South Australia is an epigenetic, hypothermal copper-gold prospect that displays several clear genetic affinities with IOCG deposits/prospects in the Gawler Craton, although from this study alone classification of the mineralisation is imprudent. A broad study on the mineral paragenesis and geochemistry of the deposit was carried out on a single drill core provided by OneSteel, the holder of the tenement encompassing the Moola Prospect. The mineralisation, characterised by pyrite + chalcopyrite, hematite and magnetite, is hosted by the Palaeoproterozoic metavolcanic / volcaniclastic, Myola Volcanics and an unnamed, undated fine-grained microgranite that intrudes the Myola Volcanics. This unnamed, undated microgranite, displays geochemical and petrological similarities with the Myola Volcanics from which it's thought to be partial derived from its anatexis; likely being a Wertigo Granite equivalent. Four alteration assemblages were observed in the Moola Prospect drill core and placed into the following paragenic sequence; Na (Ca-Fe) characterised by the formation of albite; sericite replacing K-feldspar and plagioclase and alteration increasing towards sericite veining; chlorite with alteration increasing towards chlorite-mica±epidote veins; late stage quartz, quartz-carbonate, carbonate flooding, that hosts mineralisation. Ore mineral paragenesis occurs in an overlapping sequence; the first mineral precipitated was magnetite that was later extensively martitised, with hematite followed by pyrite and minor heamatite + pyrite, pyrite + chalcopyrite, then chalcopyrite. Later supergene alteration altered the chalcopyrite to native copper and malachite. Sphalerite precipitation couldn't be constrained from petrological evidence alone. Iron oxide and sulphide chemistry, and sulphur isotopes from the sulphides support this paragenesis, and constrains precipitation of sphalerite between the pyrite only and chalcopyrite only phases. Iron oxide chemistry also revealed the presence of illmentite in the core, however could only constrain illmentite precipitation as, coeval to after haematite precipitation. Sulphur isotopes revealed evidence for an additional late stage pyrite precipitation, after the chalcopyrite only phase. Bulk rock composition was quite variable with some altered samples showing strong enrichments of Fe_2O_3, SiO_2, CaO, K_2O, Na_2O SO_3, MnO, P_2O_5 and MgO. Strong enrichment of CaO and/or SiO_2 in some of the altered samples, but not others, suggests that the quartz-carbonate alteration represented by this geochemical signature is sporadic in nature. Depletion in SiO_2 in some of the altered samples could also represent the consumption of silica during the Na-Ca-Fe alteration event. Enrichment of SO_3 in the altered samples likely directly represents alteration related to the precipitation of sulphide ore minerals. Trace element and rare earth element compositional changes from alteration shows enrichments of Cu, U, Pb, Li, B, Mn and V likely relating to alteration associated with mineralisation. εNd (1590Ma) values of the Moola Prospect together with εNd (1590Ma) versus whole rock Cu concentration and Co: Ni ratios of pyrite, indicates a crustal derived, with minor mantle input for the sources of metals. Sulphur isotopes and trace element whole rock geochemistry indicates a primitive/ magmatic fluid source is responsible for alteration and/ or mineralisation.