Metals and fluids in IOCG systems of the Gawler Craton: constraints from Nd, O, H and S isotopes.

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The involvement of mantle-derived rocks in hydrothermal processes at the U-rich Olympic Dam iron oxide copper-gold (IOCG) deposit has been well documented [1]. Compared to Olympic Dam, the origin of metals and fluids from the low grade IOCG prospects from the eastern Gawler Craton, South Australia, has received scant attention.

Whole rock neodymium isotopic compositions were determined for mineralised and hydrothermally altered rocks from low grade Cu-Au prospects and for barren host rocks in the Olympic Dam district and Mt Woods Inlier. Weakly Cu-mineralised magnetite-rich alteration from five prospects yield εNd (1590 Ma) values of -4.1 to -5.8, whereas overprinting hematitic alteration has εNd values of -3.3 to -9.1. These compositions overlap with values from barren host rocks, and are consistent with a dominantly crustal source for Nd. The evidence of hydrothermal input of Nd (and inferred co-transported Cu) from primitive mantle sources has been missing at these prospects.

Sulfur in sub-economic mineralization has $\delta^{34}S_{pyrite, chalcopyrite}$ values of either -5 to 2‰ or 5 to 10‰. These ranges are consistent with sulfur sourced from igneous or metasedimentary rocks, respectively, but are more positive than $\delta^{34}S$ values for Olympic Dam sulfides (-10 to -5‰) [2]. The observed variations result from the complex interplay between different sulfur sources and the variable redox state of fluids. Calculated isotopic compositions of waters in equilibrium with minerals of the magnetite-rich alteration in sub-economic mineralised systems are 7.7 to 12.8‰ ($\delta^{18}O$) and -15 to -21‰ (δD). The only available $\delta^{18}O$ and δD fluid values for overprinting hematite-chlorite-sericite assemblages in low grade prospects are 4.7-9.8‰ and -9‰, respectively. These isotopic ranges can be explained by fluid re-equilibration with felsic igneous and metasedimentary rocks at low water-to-rock ratios prior to their arrival at the sites of mineralization. The effects of meteoric waters are less evident in these systems compared to Olympic Dam [3].

Our data suggest that the environment and processes leading to the formation of the giant Olympic Dam deposit and its sub-economic counterparts were quite different, including the affinity of the productive IOCG systems to the mantle-derived rocks, and particular hydrological regimes defining the sources, flow paths, and oxidation state of fluids.

References

[1] Johnson and McCulloch (1995). [2] Eldridge and Danti (1994). [3] Oreskes and Einaudi (1992).