Multiple fluid events and metal mobility associated with formation of IOCG-type mineralisation in Gawler Craton

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The Gawler Craton, in South Australia, is host to the giant Olympic Dam deposit and a number of other economic to subeconomic iron oxide-copper-gold (IOCG) prospects including Prominent Hill, Oak Dam, Wirrda Well, Acropolis, Punt Hill, and Carrapateena. Several genetic models have been proposed for the formation of IOCG mineralisation in the Craton, but little is known about the source of metals and sulfur, and mechanisms of their transport and deposition.

Geologic and petrographic studies on IOCG prospects in the Olympic Dam district (Emmie Bluff, Canegrass, Cocky Swamp and Dromedary Dam) indicate several stages of fluid activity. Subeconomic Cu-Au mineralsiation at these prospects is associated with the hematite-chlorite-sericite alteration with chalcopyrite commonly replacing pre-existing pyrite. With the use of cutting-edge Synchrotron X-ray Fluorescence Microscopy and Field Emission Gun Scanning Electron Microscopy it was shown for the first time that subeconomic IOCG mineralisation in the Gawler Craton was affected by a late fluid event, which resulted in partial dissolution of Cu mineralisation and transport of Cu in the form of chloride complexes. Patchy chlorite associated with the late alteration of chalcopyrite hosts a previously undescribed in IOCG rocks Cu-Cl phase. This Cu-Cl phase is interpreted to be a by-product of chalcopyrite partial dissolution and contains minor Zr, Y and U. The fluids must therefore have been rich in chlorine to mobilise Cu, and probably fluorine, as they were carrying relatively immobile Zr, Y and U which become mobile in the presence of fluoride complexes. This might be an indication of remobilisation and re-deposition of Cu along with other metals elsewhere in the district and could have implications for a possible metal source for the nearby Cu-Au deposits.

Understanding the role of Phanerozoic and active tectonics in generating geothermal resources in central Australia

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Central Australia has a significant potential for geothermal development. Recent He and C isotope studies of volatiles from artesian waters suggest mantle-derived fluid reservoirs as a source of the geothermal resources [1], rather than radioactive heat production in the basement granitic rocks as widely believed. In conjunction with isotopic data of the volatiles, our structural geological field observations suggest that geothermal systems in central Australia preferentially occur in areas of deformation-enhanced permeability and deep mantle fluid production. To this end, we performed comprehensive isotopic dating studies (Rb–Sr, Ar–Ar and U-series) to understand the role of Phanerozoic and neotectonic deformations in permeability production and stable isotope tracing to determine the source of fluids in the geothermal reservoirs. Isotopic dating results and stable isotope geochemistry of hydrothermal minerals in basement rocks are interpreted as indicating that Cretaceous extensional tectonic events controlled the thermal history of central-eastern Australian basins and distribution of fracture zones allowing recent uprise of hot mantle fluids. Areas affected by Cretaceous tectonics are characterised by significantly high temperatures (>250°C) at 5 km depth [2] and distinctive geophysical anomalies [3]. Our field studies show that pre-existing faults were reactivated neotectonically and controlled the formation of late Quaternary carbonate vein and breccia deposits, which formed as hydro-fractures during CO_2-rich fluid overpressure, analogous to similar deposits in seismically active geothermal systems worldwide [4]. $\delta^{13}C$ values of the carbonates are consistent with CO_2 derived from a mantle source. High precision U-series dating of carbonate veins suggests that the release of the pressurised CO_2 occurred intermittently from 35.9 ± 0.15 ka to 1.2 ± 0.02 ka, possibily in association with mantle degassing in response to seismicity.

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