Generation of Paired Cu-Au Mineral Systems Within a Suprasubduction Zone Setting in Eastern Proterozoic Australia

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Eastern Proterozoic Australia is well endowed with mineral deposits, including paired ca. 1.60-1.57 Ga IOCG and porphyry-epithermal Cu-Au mineralisation in the Gawler Craton, the generation of which is conjectural. We propose an alternative suprasubduction zone model for eastern Proterozoic Australia where the spatial and temporal distribution of mineral systems in the Gawler Craton was dictated by the evolution and chemistry of the fluids/melts derived from the subducting slab (Tiddy and Giles, 2020: Ore Geol. Rev. 122, 103483). The model draws upon modern geological analogues including the Late Cretaceous to Early Eocene Laramide Orogeny (western USA) and genesis of Cretaceous IOCG and Cu-porphyry deposits in the Chilean Coastal Cordillera.

A flat-slab subduction geometry prevailed from ca. 1.604-1.595 Ga. Anhydrous, F-rich, S-poor melts were produced and interacted with the subcontinental lithospheric mantle (SCLM). Progressive eclogitisation and densification of the frontal oceanic slab resulted in slab steepening from ca. 1.595 Ga, causing sudden upwelling of hot asthenosphere and further slab melting and SCLM metasomatism. Mafic melts were emplaced into the lower crust and underwent assimilation-fractional crystallisation processes, eventually forming the dominantly A-type Hiltaba Suite granites and Gawler Range Volcanics that were emplaced in the upper crust and are associated with IOCG mineralisation. Further slab steepening and slab retreat is evidenced by the present-day progressive westerly to southwesterly younging direction of the ca. 1.595-1.575 Ga Hiltaba Suite and saw development of an asthenospheric wedge and a return to a normal subduction geometry. Heat introduced from the asthenospheric wedge caused dehydration of the downgoing slab to produce hydrous, S-rich fluids that interacted with the asthenosphere to generate oxidised, S-rich partial melts related to porphyry/epithermal mineralisation. Therefore, within this suprasubduction zone model, mineralisation style is dictated by whether downgoing slab melts (anhydrous, F-rich, S-poor: IOCG) or slab fluids (hydrous, S-rich: porphyry/epithermal) interacted with the SCLM.