Role of Low Metamorphic Grade Sedimentary Successions in the Eastern Gawler Craton and on the Formation of Iron Oxide-Copper-Gold Mineralization in the Olympic Cu-Au Province, Gawler Craton

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Early Mesoproterozoic A- to I-type and mafic magmatism was the primary thermal driver for mineralization within the Olympic Cu-Au Province, Gawler craton. Magmatism of this age is present across the Gawler craton and the Curnamona province to the east, yet hematite-rich iron oxide-copper-gold (IOCG) deposits are apparently restricted to a north-south belt along the eastern margin of the Gawler craton. What are the controls on the location of this mineral province? One control is the variation in oxidation state of early Mesoproterozoic granites; granites in the eastern Gawler craton are, on average, more oxidized than those in more westerly regions of the craton. This would have been a factor that influenced the incompatible element composition of magmatic fluids derived from these magmas. Potentially, a more significant factor in the formation of the IOCG deposits is the nature of the rocks into which those magmas were intruded.

Most of the western, southern, and northern Gawler craton underwent amphibolite-granulite facies metamorphism either during a ca. 2465–2410 Ma event (Sleafordian orogeny), a ca. 1730 to 1690 Ma event (Kimban orogeny) or both. The eastern Gawler craton and Curnamona province, in contrast remained unaffected by these orogenic events. Potentially evaporate-bearing sedimentary successions including the ca. 1750 Ma Wallaroo Group and ca. 1710–1640 Ma Willyama Supergroup, were therefore largely unmetamorphosed prior to the early Mesoproterozoic magmatic and metallogenic event. There is a spatial partitioning of Paleoproterozoic orogenesis into regions of the western, southern and northern Gawler craton, and a broad spatial correlation between rocks of low metamorphic grade and the belt of IOCG mineralization. An implication of this recognition is that regions of the western Curnamona Province, contain similar low metamorphic grade geology and Cu-Au deposits, and could be considered an eastern extension of the Olympic Cu-Au Province.

Sedimentary, metamorphic, and magmatic fluids have been implicated in the formation of many IOCG deposits, in the Olympic Cu-Au Province and other IOCG provinces globally. In the Olympic Cu-Au province, low metamorphic grade rocks containing formation waters and porosity likely provided a more fertile geochemical environment into which high-temperature, A-type and mafic magmas and their associated hydrothermal cells were emplaced and developed with the required fluid chemistry to precipitate Cu-Au-U-REE–bearing minerals. Arguably, given that the majority of early Mesoproterozoic granites on the Gawler craton are high-temperature, A-type and hence relatively dry, without a voluminous sedimentary fluid component, it is possible that the widespread regional alteration systems and sites of extraordinary metal endowment within this IOCG belt could not have formed.