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Palaeo- to Mesoproterozoic Evolution of the Gawler Craton, Australia: Geochronological, geochemical and isotopic constraints

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Abstract

The Gawler Craton, South Australia, consists of late Archaean to early Mesoproterozoic igneous and supracrustal lithologies which preserve a deformation history lasting the duration of the Palaeoproterozoic. Understanding the evolution of the Gawler Craton is of significance in global supercontient reconstructions as it preserves evidence for earliest Palaeoproterozoic collisional orogenesis (*c*. 2460-2430 Ma) and, in conjunction with the North Australian Craton and Antarctica, has often been correlated to the western margin of Laurentia. In addition, the Gawler Craton is also host to the world-class Olympic Dam Fe-oxide-Cu-Au-U type-deposit (world's fourth-largest Cu and largest U deposit) and related Fe-oxide-Cu-Au-U and Cu-Au mineralising systems. Despite the various geologically and economically important characteristics of the Gawler Craton there has traditionally been a poor understanding of the tectonothermal evolution of the Gawler Craton, in particular for the Palaeoproterozoic. This study addresses and refines the Palaeo- to Mesoproterozoic tectonothermal evolution of the Gawler Craton. This is done using geochemical, geochronological and isotopic analytical techniques to better understand selected supracrustal and igneous lithologies in the Gawler Craton and the orogenic events which have affected them.

Largely unexposed metasedimentary lithologies of the northern Gawler Craton record multiple deformation events but have previously been virtually unconstrained with respect to their timing of protolith deposition and the age of deformation/metamorphism. New geochronological data demonstrate these metasedimentary lithologies were deposited during the time period ~1750-1730 Ma before being metamorphosed and deformed during the Kimban (1730-1690 Ma) and Kararan (1570-1545 Ma) Orogenies. Detrital zircon geochronology and isotopic and geochemical characteristics of the sampled metasedimentary lithologies suggest a relatively similar protolith sedimentary succession was deposited across a large extent of the northern Gawler Craton. Detritus for the sedimentary protolith does not appear to have been sourced from the Gawler Craton. Instead the protolith it is more consistent with a North Australian Craton provenance suggesting a proximity between the northern Gawler Craton and North Australian Craton at the time of protolith deposition.

The newly defined presence of the Palaeoproterozoic Kimban Orogeny in the northern Gawler Craton demonstrates the Kimban Orogeny to be a major, high-grade, craton-wide orogenic event. This finding contradicts previous suggestions that the northern Gawler Craton was accreted to the proto-Gawler Craton during the later Mesoproterozoic Kararan Orogeny. In addition, previous reconstruction models for the Palaeo- to early Mesoproterozoic often cite the felsic Tunkillia Suite (1690-1670 Ma), western and central Gawler Craton, as representing arc magmatism prior to the subsequent amalgamation of the Gawler Craton during the Kararan Orogeny. New geochemical and isotopic data for the Tunkillia Suite have allowed for re-examination of the tectonic setting for the petrogenesis of the Tunkillia Suite. Contrary to previous suggestions (based upon discrimination diagrams), the mineralogy, geochemistry and isotopic characteristics of the Tunkillia Suite are not consistent with arc-magmatism. Instead the Tunkillia Suite is interpreted to represent a late- to post-tectonic magmatic suite generated during the waning stages of the Kimban Orogeny. This petrogenesis further highlights the importance of the Kimban Orogeny as a fundamental tectonothermal event in the evolution of the Gawler Craton.

Subsequent to the Kimban Orogeny, the Gawler Craton was thought to undergo a period of subduction-related magmatism (St Peter Suite) prior to the anorogenic magmatism of the voluminous felsic Gawler Range Volcanic (GRV) and Hiltaba Suite magmatism (1595-1575 Ma). New geochronological data for the ms-bi-gt-bearing peraluminous Munjeela Suite (1590-1580 Ma) have demonstrated the Hiltaba/GRV event was accompanied by significant crustal anatexis not associated with the Hiltaba/GRV magmatism. The Munjeela Suite and metasedimentary enclaves within it demonstrate that the Gawler Craton was likely to be undergoing compressive deformation and crustal thickening sometime during the petrogenesis of the Hiltaba/GRV magmatism. This suggests the Hiltaba/GRV magmatism did not occur in an anorogenic setting as previously proposed.

The findings of this study are incorporated into a revised tectonothermal evolution of the Gawler Craton. This is used to discuss previous reconstruction models for Proterozoic Australia and provide a new reconstruction model of Australia and Antarctica during the Palaeoproterozoic. Important facets of the proposed model are links to the Archaean-Early Palaeoproterozoic Sask Craton in the Trans-Hudson Orogen, Laurentia, and the joint evolution of the North Australian and Gawler Cratons throughout the entire Palaeoproterozoic.

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'you might have to think
of how you got started
sitting in your little room'

Publications and Selected Conference Abstracts

Peer Reviewed Journal Articles

Payne, J.L., Hand, M., Barovich, K.M. and Reid, A., *In review*. A Global context for the Paleoproterozoic evolution of the Mawson Continent. IGCP 509 'Palaeoproterozoic Earth' Special Issue, Geological Society of London Special Publication.

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Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by any other person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

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