

Liebig-aged (*c.* 1640 Ma) magmatism and
metamorphism in *c.* 1760 Ma crust in the
Warumpi and southern Aileron Province, central
Australia: a case for revising the tectonic
framework of Proterozoic Australia

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LIEBIG-AGED (*c.* 1640 Ma) MAGMATISM AND METAMORPHISM IN *c.* 1760 Ma CRUST IN THE WARUMPI AND SOUTHERN AILERON PROVINCE, CENTRAL AUSTRALIA: A CASE FOR REVISING THE TECTONIC FRAMEWORK OF PROTEROZOIC AUSTRALIA

LIEBIG-AGED TECTONISM IN THE WARUMPI & AILERON PROVINCES

1 ABSTRACT

The southern margin of the North Australian Craton (NAC) has been suggested to represent a long-lived (*c.* 1860 to 1600 Ma) active margin that preserves a cryptic record of the growth and assembly of the Australian continent. The Warumpi Province is juxtaposed against the southern Aileron Province, and has been interpreted as exotic to the NAC, though the timing of collision between the Warumpi Province and the southern Aileron Province is contentious. U-Pb zircon and monazite LA-ICP-MS geochronology from granulite facies metapelites and granitic gneisses along the southern margin of the Aileron Province and northern margin of the Warumpi Province, has shown it is characterised by *c.* 1780-1740 Ma magmatic rocks and *c.* 1640-1615 Ma magmatic and metamorphic rocks. The evidence for these events is preserved in kilometre-scale migmatitic boudins and low-strain zones enveloped by pervasive E-W trending higher strain belts. The overprinting high strain fabrics are Grenvillian age and constrained to *c.* 1175-1070 Ma. Phase equilibria modelling on a garnet-sillimanite-cordierite metapelite dated at *c.* 1616 Ma, from a low-strain domain within the southern Aileron Province, indicates that peak metamorphic conditions were ~7-8 kbar and between 740-900 °C, and were associated with a down-pressure or decompressional *P-T* history. A metamorphic monazite age of *c.* 1620 Ma was also preserved in a granitic gneiss located in an older, low-strain domain. The presence of the *c.* 1760 Ma and *c.* 1640 Ma timelines in both the Warumpi and Aileron Provinces calls into question the proposed exotic nature of the Warumpi Province. A speculative interpretation is that the Liebig-aged metamorphism and magmatism, seemingly associated with relatively shallow orientated, low strain fabrics, represents a period of extension rather than collision.

KEYWORDS

Proterozoic Australia, Aileron Province, Warumpi Province, southern Arunta region, North Australian Craton, U-Pb zircon geochronology, U-Pb monazite geochronology

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2 LIST OF FIGURES & TABLES

Table 1 Summary of major tectonic events that have created and shaped the Arunta region.

Table 2 Summary of samples analysed in this study; including grid reference, lithological unit, rock type and structural setting.

Table 3 Summary of U-Pb monazite and zircon geochronology, listed in order of increasing age.

Table 4 Summary of new and existing geochronological data in the southern Aileron/Warumpi provinces used to compile Figure 16.

Figure 1 Simplified geological map of study area with respect to Arunta region, central Australia.

Figure 2 Geological map of the primary study region demonstrating the distribution of major lithologies and geological structures within southern Aileron Province and Warumpi Province.

Figure 3 Aerial photograph demonstrating key structural relationships (field area, with low-strain boudins and high-strain E-W belts highlighted).

Figure 4 Field photographs showing the two dominant structural domains present in the field area.

Figure 5 Photomicrographs of key petrological relationships.

Figure 6 Microprobe elemental maps for Mn, Mg, Fe and Ca for a garnet grain from metapelitic sample RBN-18.

Figure 7 Calculated *P-T* pseudosection for sample RBN-18.

Figure 8-10 Concordia plots and representative backscatter electron (BSE) images showing the results of U-Pb monazite geochronology for this study.

Figure 11-14 Concordia plots, age spectra plots and representative cathodoluminescence (CL) images showing the results of U-Pb zircon geochronology for this study.

Figure 15 Th/U ratios versus age scatter plots for all relevant U-Pb zircon geochronology samples.

Figure 16 Spatial distribution of geochronological data collected from the southern Aileron and Warumpi Provinces shown against a TMI image to highlight the regional geological structure.

Figure 17 Schematic demonstrating the postulated extensional tectonic setting at *c.* 1615 Ma.