Paper Number: 2278

New insights into the Palaeoproterozoic tectonothermal evolution of the northeastern sector of the Aileron Province, central Australia

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The Aileron Province in central Australia preserves a succession of Palaeoproterozoic metamorphic and igneous rocks at the southern margin of the North Australian Craton. The 150 km east–west trending northeastern sector of the Aileron Province comprises major tectonic areas separated by shear and fault zones, including the Jervois Range area in the east and the Mopunga Range area in the west. Both areas record evidence for sediment deposition in a high-thermal-gradient extensional environment such as a back arc basin, contemporaneous intrusion of bimodal igneous rocks, and metamorphism. Metamorphism in the Mopunga Range area resulted in migmatite formation and the accumulation of associated felsic magmas, whereas metamorphism in the Jervois Range area was entirely subsolidus. This submission presents an integrated field, petrologic, U–Pb SHRIMP zircon and U–Pb LA-ICP-MS monazite study to constrain the pressure–temperature–time–deformation (*P–T–t–D*) histories of the Jervois Range and Mopunga Range areas and interpret the tectonothermal history of the northeastern sector of the Aileron Province. Pseudosections were constructed for multiple samples of metapelitic and metaigneous rock from each major tectonic area, and chronologic data from the same samples, as well as deformational relationships were integrated using structural, petrologic, and chemical tools in order to constrain the *P–T–t–D* evolution of each tectonic area.

The extensional back arc basin preserved in the northeastern sector of the Aileron Province was active until after ca. 1790 Ma, as evidenced by zircon maximum depositional ages of metasedimentary rocks in the Jervois Range area. The still-active sedimentary basin was intruded by syndepositional bi-modal magmas of continental arc affinity, including up to kilometre-scale mafic and felsic plutons emplaced between ca. 1790 Ma and 1780 Ma. The influx of magma into the active sedimentary basin provided a heat source that initiated regional high-thermal-gradient metamorphism and likely resulted in hydrothermal fluid flow and related syngenetic base metal mineralisation. Metapelitic schists in the Jervois Range area contain cordierite and andalusite porphyroblasts interpreted to have grown during prograde metamorphism at temperatures between 550 and 650 °C and pressures between 0.15 and 0.3 GPa. A $^{207}Pb/^{206}Pb$ age of 1789 ± 10 Ma (2σ) for monazite included in cordierite cores with internal foliation records the beginning of metamorphism and deformation. Monazite included in andalusite grown due to heat from the magmatism records a $^{207}Pb/^{206}Pb$ age of 1770 ± 6 Ma (2σ), suggesting the initial period of high-thermal-gradient metamorphism lasted at least 20 m.y. The extensive high-temperature metamorphism and continuing igneous intrusion resulted in crustal-scale thermal weakening, progressive regional deformation, and subsequent strain localisation in an extensional setting. Normal movement along major fault and shear zones led to an isothermal increase in pressure in the Jervois Range area to >0.4 GPa at ca. 1760–1750 Ma, as indicated by $^{207}Pb/^{206}Pb$ ages of monazite interpreted to have grown during this progressive deformation. The cessation of deformation after ca. 1750 Ma resulted in slow, dominantly-isostatic cooling and decompression of the regional system between ca. 1730 and 1710 Ma, and resulted in the crystallisation of undeformed granites. Crustal fluid flow initiated by metamorphism and magmatic crystallisation was focused in the evolving regional and local structures, leading to extensive alteration, epigenetic mineralisation, and hydrothermal brecciation zones as late as ca. 1690 Ma.

In the Mopunga Range area, the ca. 1790–1780 Ma igneous–sedimentary package was metamorphosed to supersolidus conditions and preserves a network of former melt-bearing veins showing pathways from sites of melt generation to melt accumulation in felsic igneous plutons. The timing and duration of supersolidus metamorphism is being tested; however, partial melt generated during migmatite formation in the Mopunga Range area is interpreted to have migrated to, and accumulated in plutons that crystallised between ca. 1730 and 1700 Ma.