150 Myr of episodic metamorphism, magmatism and intraplate deformation catalysed by rehydration and localised weakening of the deep crust

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The intraplate Alice Springs Orogen, central Australia, is characterised by fluid-rock systems that systematically vary in their depth, structural style, fluid sources and magnitude of alteration and deformation. Despite being part of a laterally-continuous anastomosing shear belt, however, the timing of metamorphism, magmatism and deformation associated with fluid-rock interaction is strongly diachronous. Ages obtained from amphibolite-facies schists and associated pegmatite suites span 150 Myr from 450–300 Ma, and are linked to multiple prograde thermal cycles that attest to a prolonged and episodic history of rehydration and reworking. This represents a remarkable natural laboratory to investigate the contribution of metasomatic processes to intraplate orogenesis through space and time.

We focus on kilometre-scale shear zones and voluminous pegmatite intrusions of the Strangways and Harts Ranges, which represent extensive zones of mid-crustal rehydration and localised lithospheric weakening that transect Palaeoproterozoic granulite facies protoliths. Garnet Sm-Nd and monazite, xenotime and zircon U-Pb ages, along with garnet major and trace element zoning profiles, indicate that periods of prograde metamorphism and pegmatite emplacement occurred at c. 450 Ma, c. 420 Ma, c. 380 Ma, c. 360 Ma, c. 330 Ma and c. 300 Ma. Calculated P–T mineral equilibria models indicate that each prograde metamorphic episode reached similar peak P–T conditions, ranging between 6.5–6.9 kbar and 575–660 °C. Garnet core compositions indicate that its growth initiated at elevated P–T conditions, and petrographically the samples show no evidence of relict phases or preserved mineral reaction textures. Combined, these factors suggest that the protolith did not undergo low-temperature retrogression prior to prograde metamorphism, but rather that metamorphism resulted from fluid-rock interaction at near peak P–T conditions. Palaeozoic reworking was thus catalysed by episodic hydrous input into the metastable Palaeoproterozoic granulite protolith, causing a profound effect on the dynamics of basement reactivation.