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120 Myr of episodic metamorphism and intraplate deformation catalysed by rehydration and localised weakening of the deep crust

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Kilometre-scale amphibolite facies shear zones of the Strangways Range, central Australia, represent extensive zones of mid-crustal rehydration and localised lithospheric weakening that transect Palaeoproterozoic granulite facies protoliths. Garnet Sm-Nd and monazite U-Pb ages, along with garnet major and trace element zoning profiles, indicate that periods of prograde metamorphism occurred at c. 450 Ma, c. 380 Ma and c. 330 Ma during the intraplate Alice Springs Orogeny. 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. That is, Palaeozoic recrystallisation and reworking was catalysed by episodic hydrous input into the metastable Palaeoproterozoic granulite protolith.

The timing of metamorphism in the shear zones is coeval with established periods of orogenesis in central Australia and along the convergent margin of the Australian plate during the mid-Palaeozoic evolution of east Gondwana. Given the concurrence of accretionary deformation at both the continental margin and in the continental interior, it is plausible that the development of rheologically weak fluid-catalysed mineral assemblages in the mid-crust critically focused strains driven by in-plane stresses generated at the plate margin. In such a scenario, the episodic availability and metasomatic effects of deep crustal fluids controlled the spatial pattern of intraplate deformation in central Australia. Nevertheless, the source of these fluids remains enigmatic. Preliminary oxygen and hydrogen stable isotope data indicates that they are characterised by a distinct shift to isotopically heavy values, perhaps reflecting outgassing of a hydrated mantle reservoir or dewatering of buried sedimentary sequences derived from adjacent sedimentary basins.