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Microstructural variation in the transport direction of a large-scale mid-crustal thrust (Woodroffe Thrust, Central Australia)

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The over ∼600 km long E-W trending mid-crustal Woodroffe Thrust is one the most prominent structures of a range of large-scale shear zones that developed in the Musgrave Ranges region in Central Australia. During the Petermann Orogeny around 550 Ma the Woodroffe Thrust placed 1.2 Ga granulites onto similarly-aged amphibolite and granulite facies gneisses along a south-dipping plane with a top-to-north shear sense. Due to late-stage open folding of the thrust plane, a nearly continuous N-S profile of 60 km length in the direction of thrusting could be studied for variation in microstructure.

The regional P/T variations in the mylonitized footwall (600 to 500 ºC at $\sim$ 0.8 GPa from S to N) indicate that the original angle of dip was shallow ($\sim 10^{\circ}$) towards the south. Along the profile, evidence for fluid-present conditions are effectively absent in the more southerly areas and only present on a local scale in the north, characterizing the regional conditions to be “dry”. This is indicated by: 1) only rare syntectonic quartz veins in the footwall; 2) very little sericitization of plagioclase; 3) breakdown of plagioclase to kyanite + garnet, rather than kyanite + clinozoisite; and 4) variable presence of hydrothermally introduced calcite. These changes in P/T conditions and fluid availability are associated with corresponding changes in mineral assemblage and microstructure. Mylonitized dolerites consists of a syn-kinematic assemblage (decreasing modal amounts from left to right) of Pl + Cpx + Grt + Ky + Rt + Ilm $\pm$ Opx $\pm$ Amp $\pm$ Qz in the central/southern areas and Pl + Bt + Amp + Chl + Ilm $\pm$ Kfs $\pm$ Mag $\pm$ Ap in the north. The amount of newly grown garnet decreases towards the north and garnet is generally absent in the northernmost exposures of the Woodroffe Thrust. Mylonitized felsic granulites and granitoids consist of syn-kinematic assemblages of Qz + Pl + Kfs + Grt + Cpx + Ky + Ilm + Rt $\pm$ Bt $\pm$ Amp $\pm$ Opx $\pm$ Ap in the south and Qz + Pl + Kfs + Bt + Czo + Grt + Ilm $\pm$ Mag + Ttn $\pm$ Ms $\pm$ Amp $\pm$ Ap in the north. Plagioclase and K-feldspar dynamically recrystallized (grainsize < 10 μm) along the entire 60 km N-S transect, but with an increasing degree in the more southern exposures. Over the entire area dynamically recrystallized quartz aggregates in mylonites show polygonal, strain-free, equigranular grains, with a morphology indicating SGR recrystallization, under temperatures usually considered typical for GBM, which could potentially be due to the relatively “dry” conditions. Quartz grainsizes are on average 24 μm and 44 μm in the southern and northern areas, respectively. The increase in grain size towards the north correlates well with the increasing influx of fluids, but is in contrast to the trend of higher metamorphic grade towards the south. This suggests that fluid, rather than temperature, may be the main factor controlling the rheology of such “dry” middle crust.