Geophysical Research Abstracts
Vol. 16, EGU2014-5009, 2014
EGU General Assembly 2014

Strain localization on different scales and the importance of brittle precursors during deformation in the lower crust (Davenport Shear Zone, Central Australia)

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High strain rocks in the Musgrave Ranges (Central Australia) provide a rather unique insight into the development of lower crustal shear zones during the 550 Ma Petermann Orogeny, allowing common models for lower crustal deformation to be critically evaluated. The observed structures in the study area are, from south to north: (1) The Mann Fault, which is poorly exposed but evident on airborne geomagnetic maps. This regional scale fault with a component of dextral shear shows a step-over resulting in the formation of a pull-apart basin. (2) The Davenport Shear Zone, accommodating the horizontal extension in a 7 km wide WNW-ESE-trending mylonitic zone developed under subeclogitic, lower crustal conditions. This high strain zone is bounded to the north by a more than 50 km long, continuous, sheared dolerite dyke. North of this dyke, the ∼1200 Ma Musgravian fabric is still preserved, only slightly rotated and typically N-S trending. (3) The Woodroffe Thrust, marking the northern boundary of the Musgrave Ranges, brings these lower crustal rocks on top of amphibolite facies units, with a top-to-north sense of movement.

Strain in the Davenport Shear Zone is very heterogeneously distributed, with localization and partitioning from the kilometre down to the millimetre scale. Pseudotachylyte is commonly associated with dykes, especially on the boundaries, and is often sheared. The orientation of sheared dykes and localized shear zones is typically at a high angle to either side of the shortening direction, resulting in a variable sense of shear and a major component of flattening, with a nearly horizontal extension direction. Detailed outcrop-scale mapping shows that compositional inhomogeneities, such as quartz veins, are generally not exploited, even when favourably oriented for shear reactivation. Ultramylonitic shear zones are sometimes only a few millimetres wide but extend for several metres and are generally oblique to the background foliation. Pseudotachylyte often predates or is coeval with localized shearing and fracturing clearly played a major role in the nucleation of mesoscale discrete shear zones. In order to constrain the conditions of pseudotachylyte formation, and to establish whether they developed under lower crustal subeclogitic conditions, garnet-bearing sheared pseudotachylytes were sampled for geothermobarometric analysis.