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In-situ Geochronology and Mineral Growth Episodes: a Tale of Proterozoic to Palaeozoic Shearzone Activity from the Strangways Metamorphic Complex, Central Australia

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One of the most difficult tasks both in geochronological and in geodynamic studies is providing time constraints on the activity of shearzones in metamorphic terrains (initiation of the shearzone and/or multiple activity). The use of minerals with low closure temperatures and also isochron methods are both fraught with difficulties, because the results most likely record only the last phase of activity or suffer from incomplete equilibration. It is an unresolved debate / issue in the Arunta Block whether exhumation of the Proterozoic granulite facies rocks started in the Proterozoic and was episodic until final thrusting and nappe stacking occurred in the Palaeozoic, or if it was confined to the Palaeozoic. Evidence for Proterozoic shearzone activity from Ar-Ar dating is inconclusive because of the possibility of inheritance / incomplete resetting. An example from the Strangways Metamorphic Complex (SMC) in the Arunta Block provides evidence for several growth episodes of minerals with high closure temperatures (zircon, xenotime, monazite), interpreted to be related to activity of the shearzone. Granulite facies metamorphism in the SMC has been dated at 1715-1730 Ma based on U-Pb zircon ages of two sets of syn-metamorphic orthopyroxene-bearing veins and monazite U-Pb ages from metasediments (Möller et al, 1999a). A staurolite-corundum-biotite-chlorite-rutile shearzone from the central SMC is interpreted as the product of Si-loss of a granulite facies garnet-bearing metasediment. Zircon cores, probably detrital material, are pre-metamorphic at about 1800 Ma. The first influx of fluids is interpreted to have caused Si-loss in the metasediment (possibly related to the fluid event which produced the well-known silica undersaturated sapphirine bearing pods in the SMC), leading to garnet breakdown and formation of corundum and large (several hundred micron), low U, low Th xenotime with concentric zoning. These yield Proterozoic chemical U-Th-Pb ages, of about 1600 Ma, some occur as inclusions in staurolite, occasionally together with U-rich, huttonitic monazite. The earliest Palaeozoic mineral growth recognised are polycrystalline overgrowths on zircon (containing minute xenotime inclusions) dated by SHRIMP at 443 ±6 Ma (Möller et al., 1999b) also found as inclusions in staurolite. Many zircons are cracked and the cracks filled by xenotime, characterised by high U contents. This generation of xenotime also forms distinct overgrowths on the polycrystalline zircon rims and on the Proterozoic xenotime. This may be one of the first studies reporting 'inheritance' in xenotime. Large, weakly zoned monazite are never found as inclusions in staurolite, but occur aligned in the chlorite matrix. They have been dated by Laser-ICP-MS at ca. 385 Ma (Möller et al, 1999b), within error identical to the age obtained by chemical U-Th-Pb dating with the electron microprobe. This late monazite growth is possibly related to breakdown of biotite to chlorite, interpreted to have occurred with a phase of shearzone activity. High-precision U-Pb TIMS ages are obtained on single monazite grains after drilling them from thin-sections using a Medenbach microdrill. There are thus at least three events of mineral growth which can be linked to enhanced fluid activity and therefore most likely to shearzone activity: in the late Early Proterozoic, at the Silurian-Ordovician boundary, and in the Devonian; which indicate that this shearzone had a long history of activity and reactivation. Textural observations linked with in-situ geochronology on minerals with high closure temperatures are the methods which can provide the clues to unravel such complex shear-zone histories.

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