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Fractured garnet as an indicator of lower crustal seismicity (Musgrave Ranges, Central Australia)

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The Davenport Shear Zone in the Musgrave Ranges, Central Australia, is a lower crustal shear zone developed under sub-eclogitic metamorphic conditions (ca. 650 °C, 1.2 GPa), with the general absence of newly grown hydrous minerals indicating effectively "dry" conditions. In this shear zone, mutually overprinting mylonites and pseudotachylytes can be found. Pseudotachylytes form by frictional melting during seismic slip and are therefore indicative of seismogenic fault zones. In close proximity to pseudotachylyte veins, relict garnets from a previous granulite facies metamorphism are fractured, often in a conjugate manner. These garnets preserve evidence for calcium diffusion both on the rims and along fractures, interpreted to reflect breakdown of the anorthite component of plagioclase to kyanite + Ca-rich garnet during mylonitisation associated with the Davenport Shear Zone. Diffusion patterns at the rims are offset by fractures, but are also present along the fractures themselves, indicating elevated temperatures above 600 °C during fracturing. Fractures are filled with mainly biotite and kyanite. EBSD (electron backscatter diffraction) data shows a relative rotation of individual garnet fragments, typically of around 20°. Furthermore, some garnet fragments show internal zones of misorientation on the order of 5°, which potentially results from crystal plastic behavior. In these zones, diffusion is strongly enhanced compared to the fractures or rims of the garnet. The grain size of dynamically recrystallized quartz in the same sample is in the range of 50-100 μm, indicating differential stresses on the order of 10's of MPa. In contrast, brittle fracture of garnet under dry conditions at pressures of 1.2 GPa would require much higher differential stress levels, on the order of 1 GPa. These high stresses are interpreted to be transient and to reflect repeated lower crustal seismicity, as indicated by the multiple generations of pseudotachylyte.