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Pure and Simple Shear Partitioning at Microscale revealed by Quartz Fabric in the South Tibetan Detachment, Zanskar, NW India

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In order to better understand how deformation is partitioned in polymineralic and banded granitic rocks within a large scale shear zone, we investigated quartz microstructures and the c-axis crystallographic preferred orientation (CPO) distribution in mylonitic orthogneiss samples, cropping out in the normal shear zone that marks the South Tibetan Detachment (STD) in Zanskar, NW India. Mylonitic orthogneiss comprise Qtz + Plg + Kfs + Bi + Mu ± Grt ± Trm and were deformed at amphibolite facies conditions (∼650°C at 5kbars). The quartz fabric was analysed using a Fabric Analyser G50 and the quantitative analysis have been done using MATLAB™ PolyLX Toolbox. In the field and in micro-scale, rocks record asymmetric deformation characteristic of normal shearing. Bulk quartz CPO fabric from sections of the same thin section reveal a variety of slip systems (from <a> rhomb to <c> prism) and either bulk pure shear or simple shear. The question then is what controls the slip system and the shear component during deformation of these granitic rocks. In order to answer this, we defined different domains in each sample based on compositional layering and detailed the fabric and the CPO distribution within them. The domains typically are: (1) quartz-rich domain (>95% quartz), (2) quartz (60-80%) and biotite-rich domain, (3) quartz (60-80%) and muscovite-rich domain, and (4) quartz (50%), two micas and feldspars domain. Quartz in quartz-rich domain shows extensive recrystallization by grain boundary migration, deformation in simple shear regime with a strong c-axis CPO with maxima perpendicular to the shear band boundaries. Biotite and muscovite in domains 2 and 3 form an interconnected network wrapping around the less strained quartz grains that undergo pure shear as indicated by their CPO. In domain 4 quartz and biotite form a network around large plagioclase and K-feldspar porphyroblasts. Both feldspars reveal intragranular cracks filled with recrystallized quartz. Quartz CPO here reveals pure shear deformation with symmetric cross girdle. Quartz in pure quartz domains shows basal <a> slip system and with increasing proportions of biotite the <c> prism slip is activated.

This study indicates that the slip system behaviour of quartz in polymineralic rocks is controlled by the position of quartz grains in the aggregate, the mineral proportions of different mineral phases and most importantly their connectivity. Presence of micas resulted in strong grain-scale strain partitioning that left quartz as a relatively strong phase which then underwent coaxial strain deformation, in contrast to micas that deformed in simple shear. Furthermore, deformation partitioning has a major effect on the evolution of quartz CPO, because the quartz grains in mica-rich domains remained dispersed and less strained. In contrast to domains where quartz is the controlling phase, where quartz is highly strained and records CPO indicative of non-coaxial deformation. In feldspar-rich bands quartz seems to be protected by large feldspar grains and is generally less strained under coaxial strain.