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Do local kinematics have an effect on the recrystallized grain size piezometer?

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The quartz recrystallized grain size piezometer was determined by axial shortening experiments on Black Hills quartzite in Griggs type triaxial deformation apparatus (Stipp & Tullis, 2003). The analysis of general shear experiments on Black Hills quartzite (Heilbronner & Kilian, 2017) reveal a striking discrepancy between both experimental setups; at a given differential stress, recrystallized grains are much larger in the general shear experiments than in axial shortening.
A major difference between both sets of experiments is, that the finite grain volume of quartz in the general shear experiments almost entirely consists of recrystallized grains while the here investigated axial shortening experiments have fractions of recrystallized grains in the range of 15 to 30% in the high stress experiments and up to 60% in the low stress experiments. Quartz in the general shear experiments developed a moderate to strong crystallographic preferred orientation (CPO) while, apart from a Dauphiné-induced ordering of poles to {10-11} and {01-11}, no overall significant CPO developed in the axial shortening experiments.
Based on the analysis of the EBSD data of Cross et al. (2017), we observed that the dispersion axes of large quartz grains in the axial shortening experiments correspond to the global kinematic reference frame. The dispersion axes of the fraction of small, recrystallized grains depend on the local kinematics between the porphyroclasts. Slip transparency indicates that boundaries between the largest grains are rather hard while recrystallized grains can accommodate strain induced by crystal plastic slip more effectively and homogeneously.
These results suggest that recrystallized grains in the axial shortening experiments, at least in those with low fractions of recrystallized grains, correspond to a material deforming at a rate higher than the imposed shortening rate while the axial load is predominantly supported by the porphyroclasts. In contrast, recrystallized grains in general shear experiments deform at the imposed (global) rate and derived stresses correspond on average to the deforming zone. Due to strain and strain rate inhomogeneities in the latter experiments, however, there is a systematic variation in recrystallized grain size across the general shear zone. We compare these local microstructural variations and discuss their significance for the recrystallized grain size piezometer calibration.