Geophysical Research Abstracts
Vol. 18, EGU2016-8731-4, 2016
EGU General Assembly 2016

BHQ revisited (1) - Looking at grain size

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Black Hills Quartzite (BHQ) has been used extensively in experimental rock deformation for numerous studies. Coaxial and general shear experiments have been carried out, for example, to define the dislocation creep regimes of quartz (Hirth & Tullis, 1992), to determine the effect of annealing (Heilbronner & Tullis, 2002) or to study the development of texture and microstructure with strain (Heilbronner & Tullis, 2006). BHQ was also used to determine the widely used quartz piezometer by Stipp & Tullis (2003).

Among the microstructure analyses that were performed in those original papers, grain size was usually determined using CIP misorientation images. However, the CIP method (= computer-integrated polarization microscopy, details in Heilbronner and Barrett, 2014) is only capable of detecting the c-axis orientation of optically uniaxial materials and hence is only capable of detecting grain boundaries between grains that differ in c-axis orientation.

One of the puzzling results we found (Heilbronner & Tullis, 2006) was that the recrystallized grain size seemed to depend on the crystallographic preferred orientation of the domain. In other words the grain size did not only depend on the flow stress but also on the orientation of the c-axis w/r to the shear direction. At the time, no EBSD analysis (electron back scatter diffraction) was carried out and hence the full crystallographic orientation was not known. In principle it is therefore possible that we missed some grain boundaries (between grains with parallel c-axes) and miscalculated our grain sizes.

In the context of recent shear experiments on quartz gouge at the brittle-viscous transition (see Richter et al., this conference), where EBSD is used to measure the recrystallized grain size, we wanted to re-measure the CIP grain sizes of our 2006 samples (deformed in regime 1, 2 and 3 of dislocation) in exactly the same way. In two companion posters we use EBSD orientation imaging to repeat, refine and expand the microstructure and texture analysis of Heilbronner & Tullis (2006). Here, in poster (1), we focus on the recrystallized grain size with the aim of (a) comparing CIP- and EBSD derived grain size measurements, (b) of comparing the recrystallized grain size of coaxially deformed and sheared BHQ and (c) in order to confirm that the quartz piezometer indeed depends on texture, and (d) to test if it also depends on the type of deformation (irrotational versus rotational deformation).

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