Geophysical Research Abstracts
Vol. 16, EGU2014-14680, 2014
EGU General Assembly 2014

Force chain forming quartz in an ultramylonite

Rüdiger Kilian (1), Luiz F. G. Morales (2), and Max Peters (3)

(1) Geological Institute, University Basel, Switzerland, (2) Helmholtz Zentrum, GFZ Potsdam, Germany, (3) Institute of Geological Sciences, University Bern, Switzerland

Polymineralic ultramylonites often show microstructures indicative of grain size sensitive creep with dissolution precipitation or diffusion accommodated grain boundary sliding. Typically phases show an anticorrelated distribution, the grain size is small and a crystallographic preferred orientation is absent. The latter observation is usually thought to originate from rigid body rotation of grains because flow dominated by diffusion creep operates at differential stresses, which are too low to activate crystal-plastic mechanisms.

Here, we present quartz texture measurements from a natural ultramylonite, deformed under upper amphibolite facies conditions from the Nordmannvik Nappe, Upper Allochton of the Norwegian Caledonides. The ultramylonite has a mean grain size $< 10\ \mu$m (eq. diameter) and shows a very homogeneous microstructure with an anticorrelated phase distribution with quartz (50 vol%), separated by a matrix of biotite, white mica, plagioclase and titanite while garnet forms porphyroclasts. Quartz occurs either as isolated grains or in "one grain" thick, small clusters. Two types of clusters can be distinguished: foliation parallel clusters and oblique clusters with a long axis at a small angle to the inferred shortening direction, the latter being prominent in the most homogeneous ultramylonite.

Quartz shows a weak but non-random texture. In the foliation parallel clusters a [c]-axis maximum is elongated around the y-direction towards the normal of the foliation, <a>-axes form point maxima at a small angle to the lineation, very similar to textures found in high temperature quartz mylonites (e.g. Pennacchioni et al., 2010). In the foliation oblique clusters, the [c]-axes form a very broad maximum around the y-direction and <r> axes show three distinct, close to orthogonal maxima close to x,y,z-directions, rotated about 10-15° antithetically around the y-direction. Isolated quartz grains also show a weak texture of this type. Quartz grains contain low angle boundaries, some of which can be interpreted as subgrain boundaries, mainly related to prism-a and rhomb-a slip, suggesting the activation of crystal-plastic processes. Alternative texture forming processes (e.g. growth textures) are also discussed.

The texture in the foliation parallel clusters is thought to be an inherited texture from lower strain stages in the ultramylonite, as it is mostly present in the least deformed parts of the ultramylonite. However, we suggest that the texture formed in the foliation oblique clusters is related to a dynamic formation of force chains between quartz grains, where differential stresses become high enough for plastic yielding. The presence of force chains questions whether ultramylonites necessarily need to possess a linear viscous rheology, even if microstructures would indicate a diffusion creep mechanism.

Pennacchioni G., Menegon L., Leiss B., Nestola F., Bromiley G., 2010: Development of crystallographic preferred orientation and microstructure during plastic deformation of natural coarse?grained quartz veins. Journal of Geophysical Research, Vol. 115, B12405