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LPO-Development in Quartz: Experiments on Natural Single Crystals

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Experiments have been carried out to investigate lattice preferred orientation (LPO) development in quartz single crystals. Cylindrical samples of natural single crystals of Brazilian quartz were axially deformed in a Griggs solid medium deformation apparatus in the ductile deformation field. The experiments were performed at a temperature of 800°C, a confining pressure of 1.2 GPa, strain rates in the range 0.7-$1.1 \cdot 10^{-6}$ s^{-1}, with ~1 vol% added water. First results were obtained on three crystals deformed in O^{+} orientation (shortening direction at 45° to the c-axis and 45° to the a-axis) to 11, 14 and 22% bulk finite strain. The LPO was measured optically with a universal stage. Three different mechanisms of LPO development were observed:

1. *Reorientation by glide along deformation lamellae* - In areas deformed to low finite strains (typically less than ~10%), the c-axis rotated up to an amount of ~20° towards the shortening direction. This occurred in areas where abundant sub-basal deformation lamellae developed. The areas are diffuse and elongated, approximately parallel to the c-axis. Rotation could have taken place by glide along the sub-basal lamellae.

2. *Reorientation by sliding of fragments along fractures* - At higher strains, zones of new grains and 'subgrains' (50-500 μm) locally developed. These (sub)grains are interpreted as being fracture-fragments developed by cataclastic deformation. They are mostly elongated parallel to the shortening direction, parallel to the dominant fracture orientation. The *c*-axes rotated in various directions away from the original orientation, in directions distinctly different from the above lamellar glide, towards and also away from the shortening direction.

3. *Reorientation by nucleation of small new grains* - Within the areas of presumed cataclastic deformation, small, new, sub-euhedral grains (40-80 μm) grew locally. The *c*-axes of these small grains are almost exclusively oriented at a high angle (~60 to 90°) to the *c*-axes orientation of the surrounding (sub)grains. These grains have nucleated in this orientation and grown by grain boundary migration. Why new grains develop in this specific orientation is not well understood.

The present results illustrate how different mechanisms act together to produce a final LPO in quartz in experiments and, maybe, in nature. For further understanding of these mechanisms and the specific LPO development, experiments are being carried out to diffferent amounts of strain and analysed using EBSD.