Geophysical Research Abstracts
Vol. 13, EGU2011-13351-3, 2011
EGU General Assembly 2011

Quantitative Neutron and X-ray texture analysis of Quartz mylonites - a comparative study

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We investigated five mylonitic quartz veins from the Adamello pluton (southern Alps, Italy) which accumulated different amounts of shear deformation in the range between 4.5 to over 15. All quartz mylonites consist of a fine grained (35-40 μm grainsize) dynamically recrystallized aggregate and show a strong crystallographic preferred orientation (CPO or texture), dominated by a strong Y-maximum of c-axis, whose intensity is expected to strengthen with increasing strain. The CPO has been measured by different texture diffraction methods at the Neutron Material Science Diffractometer STRESS-SPEC at the research reactor FRM II in Garching near Munich and with an x-ray diffractometer optimized for geological sample material located at the University of Göttingen.

The high penetration capabilities of neutrons allowed the texture determination of the complete cubic quartz sample volume of about 4 cm^3. In contrast, 90% of the x-ray CuKα radiation detected from the sample in reflection geometry has penetration depths of up to 45 μm in quartz (Wenk 1998). Applying a beam diameter of about 7 mm by means of a glass fibre polycapillary results in a measured sample volume of 1.73 mm^3. Combining the measurements of three orthogonal sample directions, the measured sample volume sums up to 5.19 mm^3. Due to the defocussing effect in X-ray diffraction, a correction function derived from randomly oriented powder samples has to be applied and only incomplete pole figures (tilt angle 75°) could be obtained. To obtain complete pole figures, we (1) combined the measurements of three orthogonal sample sections and (2) applied the WIMV-algorithm (e.g. Wenk et al 1998) as an orientation distribution function (ODF) to recalculate complete pole figures. For a quantitative comparison with the X-ray data, the WIMV-algorithm was also applied on the neutron diffraction data to also obtain a quantitative texture analysis.

The experimental and recalculated pole figures of the three orthogonal sample directions measured by X-ray are very similar between the individual directions. This proves a high texture homogeneity and a reliable defocussing correction. Consequently the added experimental pole figures from the three sample directions show a very good agreement as well. The comparison between the X-ray and neutron pole figures shows in general a good accordance. Minor differences are related to grain statistics, small sample heterogeneities and minor effects from the defocusing correction. From the geological view these are negligible. Furthermore, this study shows that the STRESS-SPEC neutron diffractometer, although optimized for material science applications is well suitable for the measurement of geological samples, when critical grain-size/volume ratios are not exceeded.

References:

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