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# Deformation of dry quartz in shear zones

Rüdiger Kilian (1), Renée Heilbronner (1), and Holger Stünitz (2)

(1) University Basel, Department of Geosciences, Basel, Switzerland (ruediger.kilian@unibas.ch), (2) Geological Institute, University Tromsø, Norway

The Permian Truzzo granite in the Penninic Tambo nappe is subjected to heterogeneous Alpine deformation at amphibolite facies conditions. Small scale shear zones develop in undeformed volumes of granite which still exhibit magmatic structures. Along the strain gradient associated with the shear zones, magmatic quartz recrystallizes dynamically and forms polycrystalline aggregates. The quartz microstructure is dominated by grain boundary migration and only minor subgrain rotation recrystallization. The dynamically recrystallized grain size ranges between 100 to 750 $\mu$m, which is consistent with recrystallization at relatively low differential stresses.

Fourier-Transform-Infrared (FTIR) spectroscopy reveals very low water contents (< 100 mol ppm H) in the interior of recrystallized grains (in the form of discrete OH peaks and very little broad band absorption), comparable with those values reported for dry Brazil quartz. Primary magmatic quartz grains contain fluid-inclusion-rich areas with a broad absorption band and high water concentrations. Recrystallized grains are dry, and fluid inclusion trails are clearly postkinematic. Primary magmatic quartz grains contain sub-micron-sized white mica inclusions which are expelled during grain boundary migration and are not present in the recrystallized grains. This permits a clear distinction of recrystallized and left-over magmatic grains. These measurements present the first data on strictly intragranular water contents of dynamically recrystallized quartz.

EBSD measurements at the FTIR-sites reveal the formation of subgrain boundaries consistent with the activity of the basal <a> and the prism [c] slip systems. Deformation experiments suggest that monocrystalline as well as polycrystalline dry quartz is extremely strong and does not deform at any realistic time scale at the inferred low differential stresses. Only deformation experiments on wet polycrystalline quartz have produced flow laws that can be extrapolated to natural conditions, which yield satisfying results.

While recrystallized quartz grains remain dry, water must have been present during deformation, as is indicated by synkinematic biotite growth, ease of diffusion-related processes and the drainage of primary fluid inclusions from the magmatic quartz grains during recrystallization. This suggests that the weakening effect of water on quartz aggregates is at least in parts related to grain boundary (recovery) processes and is not exclusively explained by an increase of the dislocation density or accelerated glide or climb.