Geometry and crystallography of sutured grain boundaries in dynamically recrystallized quartz

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Physical properties of crystalline material, such as strength, fluid permeability, reactivity, susceptibility to weathering, or resistance to cracking, are strongly affected by grain as well as phase boundaries. In contrast to such importance, knowledge about the nature of these boundaries and about the effects of physical parameters is comparatively low. 'Simple' polarizing microscope studies on quartz from metamorphic rocks already reveal the discrepancy between the generally straight appearance of boundary segments and common models of 'curved' grain boundaries. In addition, the fractal geometry of sutured quartz grain boundaries and their usefulness for determining deformation temperatures have been shown. Combined electron backscatter diffraction (EBSD) and universal stage measurements provide crystallographic orientations of grain-boundary segments in relation to both neighbouring quartz grains. Strikingly, most stable, i.e. low-energy, orientations are not controlled by low-index or by coincidence site lattice orientations but preferentially occupy rhombohedral, trapezohedral and bypiramidal orientations, i.e., orientations in a ca. 25-50° girdle to the *c*-axis (Kuntcheva et al., 2006; Liebl et al., 2007). With temperature increase from ca. 350°C to ca. 700°C during regional metamorphism, grain-boundary-segment orientations increasingly concentrate in this girdle. Orientations parallel to the basal plane as well as to the prism planes are significantly under-represented. Effects of strain or duration of post-deformation annealing are not recognizable. Effects of water fugacity, short-term high-T annealing, and distance of grain-boundary migration are under investigation. Measurements on samples from contact aureoles are presented. In general, temperature appears as most important parameter for migration and stabilization of grain boundaries. In addition, grain boundaries have to be considered not as isolated objects but as (meta-stable) grain-boundary networks with complex geometrical dependencies and the capability for self-organization. Steps towards 3d investigations will be presented.

References

Kuntcheva B, Kruhl JH, Kunze K (2006) Crystallographic orientations of high-angle grain boundaries in dynamically recrystallized quartz: First results. Tectonophysics 421: 331-346

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