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# Crystallographically controlled crystal-plastic deformation of zircon in shear zones

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Plastically-deformed zircons from various types of strained natural metamorphic rocks have been investigated in-situ by electron backscatter diffraction analysis (EBSD), allowing crystallographic orientation mapping at high spatial resolution.
Plastic deformation often forms under the control of grain-internal heterogeneities. At the crystal structure scale deformation is controlled by the physical anisotropy of the lattice. Three most common slip systems in zircon are [100]{010}, [010]{001} and [001]{010} (Leroux et. al., 1999; Reddy et. al., 2007). They are genetically connected with the main zircon crystallographic directions: [001] (c-axis), [100] and [010] (a and b axes). Atomic models show weak planes normal to these directions that preferably evolve to glide planes in the deforming crystal. The visualization of seismic (elastic) properties of zircon with the MATLAB toolbox MTEX shows a similar pattern. The slowest S-wave velocities are observed in directions parallel to [100], [010] and [001] crystallographic directions. The highest Young's modulus values lie in the same directions.
In natural zircon grains, the common slip systems are preferably activated when zircon is hosted by rheologically comparatively weaker phases or a fine-grained matrix. In these cases zircon behaves as a rigid clast. During progressive deformation high deviatoric stresses together with high strain rates concentrate at crystal tips, as shown by numerical modeling. Softer host phases allow more degrees of freedom for zircon to be deformed according to its crystallographic and internal properties. These conclusions are supported by the misorientation axes density distribution maps, derived with MTEX. Deformed zircon hosted by a relatively soft phase (mostly biotite) develops a crystallographic preferred orientation (CPO), which has not been documented for zircon before. At the same time deformation of zircon hosted by a rheologically stronger matrix causes the activation of less common slip systems, screw dislocations or the development of brittle deformation. In this case the internal deformation is mainly controlled by the host phase microstructural arrangement.
Crystal lattice distortions of zircon such as plastic deformation features may facilitate intragranular material transport. Enhanced mobility of trace elements or radiogenic isotopes influences isotopic systems used for geochronology. In-situ microstructural study of plastically deformed accessory zircon grains allows linking different stages of high-grade regional metamorphism and deformation. Understanding of zircon deformation mechanisms and their effects on the distribution of trace elements and isotopic systems is important for deriving the age of deformation events.

References:

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