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New Perspectives for In-Situ Rock Deformation and Recrystallisation Analysis - POWTEX Neutron Diffractometer at FRM II Garching, Germany

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For the investigation of fabric development in mono- and polyphase rocks and their deformation kinematics the quantitative analysis of the crystallographic preferred orientation (CPO) is a common tool. Furthermore, bulk texture measurements also allow the quantitative characterisation of the anisotropic physical properties of rocks. As neutrons have large penetration capabilities of several cm in geological sample materials neutron diffraction is a strong tool for geoscientific texture analysis.
The new POWTEX (POWder and TEXture) Diffractometer at the neutron research reactor FRM II in Garching, Germany is designed as a high-intensity ($\sim$1 x 10^7 n/cm^{2}s) time-of-flight diffractometer. The combination of high flux, the utilization of wavelength frames (TOF) and the large detector coverage (9.8 sr) allow fast and effective texture measurements. As the cylindrical detector provides sufficient angular resolution also for sharp recrystallisation textures, POWTEX offers unique possibilities for in-situ time-resolved texture measurements during deformation and recrystallisation experiments on rock materials as large sample environments can be placed inside the detector system.
The in-situ deformation apparatus is a new design to minimize shadowing effects inside the cylindrical detector and is operated by a uniaxial spindle drive with a maximum axial load of 250 kN. The HT deformation experiments will be carried out in uniaxial compression or extension and an upgrade to triaxial deformation conditions is envisaged. The apparatus can alternatively be used for ice deformation by inserting a cryostat cell for temperatures down to 77 K with a triaxial apparatus allowing also simple shear experiments. Strain rates range between 10^{-8} and 10^{-3} s^{-1} reaching to at least 50 % axial strain. The deformation apparatus is designed for continuous long-term deformation experiments and can be exchanged between in-situ and ex-situ placements during continuous operation inside and outside the neutron detector. For the in-situ recrystallisation analysis the specially designed rotatable furnace reaches temperatures of up to 1800° C and allows a quantitative 3D analysis of the recrystallisation by the stereological calculation of the measured textures as shown by Klein et al. 2009 for synchrotron experiments.
References:
Klein, H. (2009). Principles of highly resolved determination of texture and microstructure using high-energy synchrotron radiation. Adv. Eng. Mat. 11, 452-458.