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New perspectives for Neutron Diffraction in Geoscience - A new High-Intensity Texture and Powder Diffractometer at FRM-II, Garching Germany

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n recent years, neutron texture diffraction has become a routine tool in geoscience for the quantitative analysis of the crystallographic preferred orientation (CPO). Quantitative texture analysis is e.g. involved in the research fields of fabric development in mono- and polyphase rocks, deformation histories and kinematics during mountain building processes and the characterization of flow kinematics in lava flows. Especially for the quantitative characterization of anisotropic physical properties of both rock and analogue materials, bulk texture measurements of sometimes larger sample volumes are necessary. This is easily achievable by neutron diffraction due to the high penetration capabilities of the neutrons. The resulting geoscientific need for increased measuring time at neutron diffraction facilities with the corresponding technical characteristics and equipment will in future be satisfied by a new high-intensity diffractometer, which will be built at the neutron research reactor FRM-II in Garching, Germany. It will be built by a consortium of chemistry and geoscience groups from the RWTH Aachen, Forschungszentrum Jülich and the University of Göttingen, who will also operate the instrument. The main focuses of this instrument will be on serving the international Geoscience and Chemistry communities in the fields of texture and powder diffraction.

The FRM-II currently offers the unique chance to build up a new diffractometer in the Eastern Experimental Hall. The diffractometer will be optimized to high intensities (flux) with an equivalent sufficient resolution for polyphase rocks. Therefore,

this instrument will have a special focus on fast and time-resolved measurements with equivalent experimental sample environments for texture and powder diffraction. This will allow short measuring times especially for texture measurements with the resulting possibility for measurements of larger geological sample series. This is often necessary as geological material can be quite heterogeneous in complex geological situations. As geological material is often composed by fairly coarse-grained mineral phases, the instrument will be equipped with a fully automated sample goniometer for large sample volumes. Furthermore a broad range of d-values (0.5 to 15 Å) will be measurable for minerals with low crystallographic symmetries.

The uniqueness of this instrument is the combination of a high-intensity diffractometer with different sample environments for in situ-static and deformation experiments (stress, strain and annealing/recrystallisation) and UHP/UHT experiments. A LP/LT or atmospheric-P deformation rig for in situ-deformation experiments on ice, halite or rock analogue materials is planned, to allow in situ-measurements of the texture development during deformation and annealing. Additionally a uniaxial HT/MP deformation apparatus is also designated, as well as an uniaxial stress frame for in situ stress investigations is planned to conduct simultaneous measurements of stress, elastic or plastic deformation and texture. Other sample environments for geoscientific application will be HP/HT furnaces and pressure cells for powder diffraction and a HT/HP-autoclave for glass and melt experiments combined with radiography for investigations on shear viscosities, shear instabilities and phase separations in melts. Furthermore the diffractometer will be built in combination with a high-pressure multi anvil up to 25 GPa and 2500 K built by the University of Bayreuth.

The concept is complementary to the texture diffractometer in Dubna, Russia and the stress diffractometer STRESS-SPEC at Garching. For powder diffraction the diffractometer will be complementary to the existing high-resolution powder diffractometer SPODI at the FRM-II. It will offer the possibility of short, high-intensity parametric powder diffraction measurements in dependency of temperature, electrical, magnetic and stress fields due to the higher flux at the sample. The optimization to high-intensities and therefore short measuring times will also allow time-resolved measurements of kinetic reactions even of small sample volumes.