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The anisotropy of geomaterial granite

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Abstract. Granites appear to be isotropic, which qualifies them as suitable crystalline host rocks for nuclear waste repository sites. However, despite their optical appearance, granites show a primary structural anisotropy (Bouchez, 1997) that evolved during emplacement and crystallization of the melt. The major processes involved are magmatic flow and oriented crystal growth (Müller et al., 2011). Hypothetically, it is expected that different tectonic environments, i.e. different orientations of the stress tensor, cause significant differences in the primary anisotropy, which is expressed by the crystallographic preferred orientation (CPO) of the rock-forming minerals. It is likely that primary anisotropic petrophysical properties control the orientation of post-magmatic structural features like extensional fractures and thus shape potential fluid pathways.

We present the first results of a systematic study of felsic plutonites, i.e. the GAME project (Gefüge, Textur- und Anisotropie-Messungen von potenziell für die Endlagerung geeigneten Graniten zur Charakterisierung möglicher Fluidwegsamkeiten). The samples of syn-Variscan felsic plutons from two sites (Erzgebirge and Fichtelgebirge) represent different tectonic settings during intrusion: extension and compression. Furthermore, they depict different stages of fractionation of the peraluminous granite suites. The CPOs were analysed using the neutron time-of-flight (ToF) texture diffractometer SKAT (Keppler et al., 2014; Ullemeyer et al., 1998) and EBSD (electron backscatter diffraction). Using scanning electron microscope (SEM) automated mineral liberation analysis (Schulz et al., 2020), modal mineral compositions are quantified. This enables us to model primary or "intrinsic" petrophysical properties for these granites based on the elastic stiffness tensor of the individual rock-forming minerals (Mainprice et al., 2011). Main- and trace-element geochemical data (ICP-AES and ICP-MS) allow for a characterization of the different magmatic settings of the samples.

All granites show distinct preferred orientations of rock-forming minerals. The quartz textures, for example, exhibit similar CPOs, with point maxima of the positive rhombs in combination with small circles to crossed-girdle c-axis distributions. However, the orientation with respect to the geographic reference system strongly varies. We will discuss the CPOs in relation to the stress tensor orientation during emplacement of the felsic plutons and compare the primary anisotropy with the post-magmatic fracture patterns of the particular granites.

References

Bouchez, J. L.: Granite is never isotropic: An introduction to AMS studies of granitic rocks, in: Granite: From Segregation of Melt to Emplacement Fabrics, edited by: Bouchez, J. L., Hutton, D. H. W., and Stephens, W. E., Springer, ISBN 0-7923-4460-X, 1997.

Keppler, R., Ullemeyer, K., Behrmann, J. H., and Stipp, M.: Potential of full pattern fit methods for the texture analysis of geological materials: implications from texture measurements at the recently upgraded neutron time-of-flight diffractometer SKAT, J. Appl. Crystallogr., 47, 1520–1534, https://doi.org/10.1107/s1600576714015830, 2014.

Mainprice, D., Hielscher, R., and Schaeben, H.: Calculating anisotropic physical properties from texture data using the MTEX open-source package, Geol. Soc. Lond. Spec. Publ., 360, 175–192, https://doi.org/10.1144/sp360.10, 2011.

Müller, A., Leiss, B., Ullemeyer, K., and Breiter, K.: Lattice-preferred orientations of late-Variscan granitoids derived from neutron diffraction data: implications for magma em-

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placement mechanisms, Int. J. Earth Sci., 100, 1515–1532, https://doi.org/10.1007/s00531-010-0590-6, 2011.

Schulz, B., Sandmann, D., and Gilbricht, S.: SEM-Based Automated Mineralogy and Its Application in Geo- and Material Sciences, Minerals, 10, 1004, https://doi.org/10.3390/min10111004, 2020.

Ullemeyer, K., Spalthoff, P., Heinitz, J., Isakov, N. N., Nikitin, A. N., and Weber, K.: The SKAT texture diffractometer at the pulsed reactor IBR-2 at Dubna: experimental layout and first measurements, Nucl. Instrum. Meth. A, 412, 80–88, 1998.