The anisotropy of geomaterial granite

Franz Müller1, Peter Hallas2, and Uwe Kroner1

1Institut für Geologie, TU Bergakademie Freiberg, Bernhard-von-Cotta Str. 2, 09599 Freiberg, Germany
2Thüringer Landesamt für Umwelt, Bergbau und Naturschutz, Außenstelle Weimar, Dienstgebäude 2, Carl-August-Allee 8–10, 99423 Weimar, Germany

Correspondence: Franz Müller (f.mueller@geo.tu-freiberg.de)

Received: 31 March 2023 – Accepted: 25 May 2023 – Published: 6 September 2023

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

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-
