Pressure-solution creep as a source for strain localisation during late emplacement of granite: The case of Naxos (Greece)

Estelle Ledoux (1), Jacques Précigout (2), and Laurent Arbaret (2)

(1) Unité Matériaux et Transformations (UMET), UMR 8207, CNRS, Université de Lille 1, Lille, France, (2) Institut des Sciences de la Terre d’Orléans (ISTO), UMR 7327, CNRS-BRGM, Université d’Orléans, Orléans, France

Strain localisation is a fundamental process that largely contributes to the dynamics of the lithosphere. This includes the development of shear bands and large-scale strain gradients in granitic plutons at near solidus to sub-solidus conditions, the source(s) of which remains unresolved. Here we focus on quartz-rich shear bands that developed within the granodiorite of Naxos emplaced below the north-Cycladic detachment (Aegean arc, Greece). Based on detailed microstructures, we document 1) a well-defined prismatic slip lattice preferred orientation (LPO), 2) a fabric strength that weakens with decreasing size of recrystallized grains, 3) local phase mixing of fine-grained feldspar and quartz without any LPO, and 4) the occurrence of four-grain junctions where strain has localized. Evidence of strain-related myrmekite and fluid inclusions also indicate the presence of fluids during deformation. Whereas prismatic slip LPO results from dislocation creep, the three other points suggest a significant contribution of grain-size-sensitive creep, including grain boundary sliding (GBS). Such a mixed rheology has been already documented for natural quartzite (Tokle et al., 2019) and during experiments (Fukuda et al., 2018; Richter et al., 2018), but it still remains unexplained. Based on available flow laws (Gratier et al., 2009; Hirth et al., 2001), we here attribute this peculiar rheology to long-term feedbacks between dislocation creep and fluid-assisted pressure-solution creep, so that quartz aggregates stabilize at conditions that involve equal contribution of these two processes. Because pressure-solution creep is highly sensitive to grain size, partly owing to GBS, it provides a suitable alternative to account for the occurrence of strain localisation in granitic rocks.

References