Geophysical Research Abstracts
Vol. 16, EGU2014-13703, 2014
EGU General Assembly 2014

The brittle-viscous-plastic evolution of shear bands in the South Armorican Shear Zone

Zita Bukovská (1), Petr Jeřábek (1), Luiz F.G. Morales (2), Ondrej Lexa (1), and Ralf Milke (3)

(1) Charles University in Prague, Faculty of Science, Albertov 6, 128 43 Prague 2, Czech Republic (zita.bukovska@natur.cuni.cz), (2) GFZ Helmholtz Center Potsdam, Telegrafenberg, 14473 Potsdam, Germany, (3) Free University Berlin, Institute for Geosciences, Malteserstrasse 74-100, 12249 Berlin, Germany

Shear bands are microscale shear zones that obliquely crosscut an existing anisotropy such as a foliation. The resulting S-C fabrics are characterized by angles lower than 45° and the C plane parallel to shear zone boundaries. The S-C fabrics typically occur in granitoids deformed at greenschist facies conditions in the vicinity of major shear zones. Despite their long recognition, mechanical reasons for localization of deformation into shear bands and their evolution is still poorly understood. In this work we focus on microscale characterization of the shear bands in the South Armorican Shear Zone, where the S-C fabrics were first recognized by Berthé et al. (1979).
The initiation of shear bands in the right-lateral South Armorican Shear Zone is associated with the occurrence of microcracks crosscutting the recrystallized quartz aggregates that define the S fabric. In more advanced stages of shear band evolution, newly formed dominant K-feldspar, together with plagioclase, muscovite and chlorite occur in the microcracks, and the shear bands start to widen. K-feldspar replaces quartz by progressively bulging into the grain boundaries of recrystallized quartz grains, leading to disintegration of quartz aggregates and formation of fine-grained multiphase matrix mixture. The late stages of shear band development are marked by interconnection of fine-grained white mica into a band that crosscuts the original shear band matrix. In its extremity, the shear band widening may lead to the formation of ultramylonites. With the increasing proportion of shear band matrix from $\sim$1% to $\sim$12%, the angular relationship between S and C fabrics increases from $\sim$30° to $\sim$40°.
The matrix phases within shear bands show differences in chemical composition related to distinct evolutionary stages of shear band formation. The chemical evolution is well documented in K-feldspar, where the albite component is highest in porphyroclasts within S fabric, lower in the newly formed grains within microcracks and nearly absent in matrix grains in the well developed C bands. The chemical variation between primary and secondary new-formed micas was clearly identified by the Mg-Ti-Na content.
The microstructural analysis documents a progressive decrease in quartz grain size and increasing interconnectivity of K-feldspar and white mica towards more mature shear bands. The contact-frequency analysis demonstrates that the phase distribution in shear bands tends to evolve from quartz aggregate distribution via randomization to K-feldspar aggregate distribution. The boundary preferred orientation is absent in quartz-quartz contacts either inside of outside the C bands, while it changes from random to parallel to the C band for the K-feldspar and and K-feldspar-quartz boundaries.
The lack of crystallographic preferred orientation of the individual phases in the mixed matrix of the C planes suggests a dominant diffusion-assisted grain boundary sliding deformation mechanism. In the later stages of shear band development, the deformation is accommodated by crystal plasticity of white mica in micaceous bands. The crystallographic and microstructural data thus indicate two important switches in deformation mechanisms, from (i) brittle to Newtonian viscous behavior in the initial stages of shear band evolution and from (ii) Newtonian viscous to power law in the later evolutionary stages. The evolution of shear bands in the South Armorican Shear Zone thus document the interplay between deformation mechanisms and chemical reactions in deformed granitoids.