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Mineralogically triggered strain localization: inferences from ductile paired shear zones (Tauern Window, Eastern Alps)

Sylvia Duprat-Oualid (1,2,3), Bernhard Grasemann (1), Benjamin Huet (1), Philippe Yamato (2,3), and Gerlinde Habler (4)

(1) Department of Geodynamics and Sedimentology, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria (sylvia.duprat.oualid@gmail.com), (2) Universite´ de Rennes 1, Ge´osciences Rennes, 35042 Rennes Cedex, France, (3) CNRS UMR 6118, 35042 Rennes Cedex, France, (4) Department of Lithospheric Research, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria

Lithosphere is mainly constituted by polyphase rocks whose mineralogical, structural and textural characteristics control the spatial distribution of strain, and so, its effective mechanical strength. Variations in local mineralogical compositions may lead to drastic changes in the local microstructures and texture leading, by mechanical feedback processes, to strain hardening or weakening. Understanding these small-scale relations between the petrological characteristics, the rheological properties and the development of progressive deformation is thus of fundamental importance for understanding the strength of rocks at large-scale, especially the mechanical behavior of plates boundaries.

We acknowledge the importance of brittle precursors for the localization of strain in the viscous deforming part of the crust. In this study, we focus in centimeter-wide paired ductile shear zones shaped nearby along on both sides of ep-grt-qtz veins within a late Variscan metagranodiorite of the “Zentralgneis” in the Tauern Window (Berlinerhütte, Zillertal, Austria). The paired shear zones, underlined by biotite bands, localized at some centimeters away from the veins associated with a metasomatic domain, within the relatively undeformed host rock. According to their spatial orientations, they exhibit different intensities of shearing (from incipient linking of biotites to anastomosing ultra-mylonitic bands) and thus can be explored as successive strain domains of a shear zone developing in space and time.

Here, we present a combination of high-resolution petro-chemical section across the paired shear zones with microstructural and textural measurements in order to constrain mineral reactions and deformation processes associated with the development of localized shear zones. Whole rock chemical analyzes combined with continuous mineralogical mapping revealed small chemical variations induced by fluid-rock interactions in the vicinity of the veins. Although macroscopically indistinguishable, these small chemical variations cause rheological heterogeneities, which in turn control the initialization of the localized strain pattern. Electron backscatter diffraction data constrain the texture of the different phases helping to determine deformation mechanisms and mapping of relative strain intensities. The present study highlights the importance of combining high-resolution petrological, microstructural and textural data in order to understand the complex feedbacks between chemical reactions and localizing strain at micro- and macro-scales.