Geophysical Research Abstracts
Vol. 19, EGU2017-4892, 2017
EGU General Assembly 2017

Formation of seismically-induced non-cohesive high-temperature cataclasites in the granitoid middle crust: An alternative to pseudotachylites?

Marco Herwegh (1), Philip Wehrens (2), Alfons Berger (1), and Max Peters (3)

(1) Institute of Geological Sciences, Bern University, Bern, Switzerland (marco.herwegh@geo.unibe.ch), (2) Swisstopo, Bern, Switzerland, (3) Institute of Applied Geosciences - Division of Geothermal Research, KIT, Karlsruhe, Germany

Pseudotachylites are interpreted as classic indicators for the occurrence of paleo-seismic events in the middle crust, where deformation and associated friction at seismic strain rates result in localized melting. In this study, we investigate the evolution of deformation in the granitic middle crust, i.e. at the frictional-viscous transition, using the central Aar massif (Swiss Alps) as a natural study area. The Aar massif is highly dissected in 3D by a large number of fault zones occurring at multi-scales (tens ok km down to mm), which originated at depths of 18-20 km, but were reactivated over and over again during exhumation. While the formation of cataclasites and fault gouges in the youngest active domains of the faults can simply be attributed to late low-temperature deformation, we also found evidences for high-temperature ultracataclasis and gouge formation in the precursor ductile shear zones. Within mylonitic domains, ultrafine-grained polymineralic layers occur, which branch of the mylonitic layering along very discrete fracture networks into the less deformed host rock. These microfabrics are mineralized and/or overgrown by biotite (T>400°C). In addition, epidote veins developed indicating fracturing and precipitation; the veins becoming folded at some locations. We suggest that these ultrafine-grained aggregates formed at seismic strain rates under the presence of fluid. This may occur in an initial stage of strain localization or during cyclic deformation behavior within already existing mylonitic shear zones. Ultracataclasis and loss of cohesion in granitic mylonites at such elevated temperatures must be related to strain rate weakening, an elevated pore fluid pressure and seismic tumbling, where the non-cohesive aggregates were injected at high rates into the surrounding host rock. Moreover, owing to lubrication of grain boundaries by fluids and efficient heat dissipation, friction-induced melting was prevented and no pseudotachylite was formed. In subsequent stages of slow interseismic deformation, the ultrafine-grained non-cohesive polymineralic aggregates bands gained again cohesion during grain coarsening and were overprinted in a ductile manner often obliterating the short-lived ultracataclastic deformation. Because of this high-temperature overprinting, but also the subsequent low-temperature strain localization, the preservation potential of such seismic high-temperature strain gages is rather low in nature. For this reason, the relevance of the formation of non-cohesive fault gouges at high-temperature shearing in granitoid crust might have been underestimated so far representing an important alternative to the formation of friction-induced pseudotachylites.