Geophysical Research Abstracts
Vol. 17, EGU2015-10069, 2015
EGU General Assembly 2015

Frictional-viscous transition in simulated calcite fault gouge sheared at 550°C

Berend Antonie Verberne, André R. Niemeijer, Johannes H. P. de Bresser, and Christopher J. Spiers
Utrecht University, High Pressure & Temperature Laboratory, Faculty of Geosciences, Utrecht, Netherlands
(bartverberne16@hotmail.com)

Understanding the strength and slip stability of fault rocks throughout the frictional-viscous transition is important for understanding the mechanisms controlling seismogenesis. We report ring shear experiments on simulated calcite fault gouge (median grain size ∼20 μm), consisting of i) tests performed at an effective normal stress (σneff) of 50 MPa at constant sliding velocities (v) of 0.1 and 100 μm/s, and ii) σneff-stepping tests at constant v = 0.1 and 10 μm/s, using sequentially increased σneff values within the range from 30 to 140 MPa. Each test was performed wet at a fixed temperature of 550°C, and sheared gouges recovered from constant σneff tests were used for microstructure analyses. Our results show that samples sheared at σneff = 50 MPa, at v = 0.1 μm/s, have a steady-state shear strength (τss) of ∼46 MPa, and are characterized by a microstructure consisting of 10 to 30 μm sized elongated grains embedded in a matrix of ∼1 to 5 μm sized polygonal grains. By contrast, samples sheared at σneff = 50 MPa at v = 100 μm/s, showed τss ≈ 38 MPa, and a microstructure consisting of a matrix of 1 to 40 μm sized angular to sub-rounded grains cut by a sharply-defined, 30 to 40 μm wide, boundary-parallel shear band composed of ∼0.3 to 1 μm sized polygonal grains, characterized by strong, uniform, birefringence colours, and uniform extinction, suggestive of a crystallographic preferred orientation (CPO). Plots of shear strength against σneff, showed a clear deviation from linearity for σneff-stepping tests conducted at 0.1 μm/s, whereas for those conducted at 10 μm/s, the τ- σneff dependence was well-described with a straight line. Our results suggest that, in experiments conducted at low slip rates (v = 0.1 μm/s), the shear strain was accommodated by pervasive, frictional-viscous flow, whereas for samples sheared at high rates (v > 10 μm/s), this occurred via localized, frictional slip. Using a recent microphysical model involving a competition between dilatant granular flow vs. creep-controlled compaction, we show that the latter may correspond with a regime of potentially seismogenic, velocity weakening slip, as opposed to stable, velocity strengthening shear for tests performed at v = 0.1 μm/s.