Geophysical Research Abstracts
Vol. 12, EGU2010-10139, 2010
EGU General Assembly 2010

Mechanical Behaviour of Phyllosilicate-Rich Faults

Cristiano Collettini (1), André Niemeijer (2), Cecilia Viti (3), and Chris Marone (4)

(1) Dipartimento di Scienze della Terra Università degli Studi di Perugia, Italy, (2) Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy., (3) Dipartimento di Scienze della Terra Università degli Studi di Siena, Italy., (4) Department of Geosciences and Energy Institute Center for Geomechanics, Geofluids, and Geohazards, Penn State University, USA

A number of observations indicate that phyllosilicate-rich faults are widespread within the brittle crust. Here, we report on laboratory experiments designed to investigate the frictional behavior of 1) intact foliated solid rocks sheared in their in-situ geometry and 2) powders obtained from crushing and sieving the samples used in the solid experiments; 3) powders obtained from non foliated samples. The samples were collected from the Zuccale low-angle normal fault (Italy) and are characterised by different amounts of phyllosilicates (from 60 to 10 % of talc, smectite biotite and chlorite) plus calcite, hornblende and tremolite. Friction of powders, at room humidity and temperature, is in the range 0.27-0.62 and it is controlled by the abundance of weak phyllosilicates (talc and smectite). Over a range of normal stresses from 10 to 150 MPa and sliding velocities from 1 to 300 μm/s, the powdered material with a) 60% of phyllosilicates exhibits velocity strengthening behaviour associated to calcite grain rotation and translation in a phyllosilicate-rich groundmass; b) $<$ 40% of phyllosilicates exhibits an evolution, with increasing sliding velocity, from velocity strengthening to velocity weakening associated to grain size reduction and localization along B and Y shear planes. Friction of solid samples (20-35% of phyllosilicates) is in the range 0.35-0.25 and for each normal stress solid rocks have a friction coefficient 0.2-0.3 lower than powders with identical mineralogical composition. In addition, the solid samples become more and more velocity strengthening with increasing sliding velocity.

Field observations along exhumed and phyllosilicate-rich faults worldwide suggest that phyllosilicates-rich strands bound lenses of stronger and non foliated lithologies. Within this fault structure fault creep and aseismic slip along weak and phyllosilicate-rich foliated surfaces (velocity strengthening behaviour) might increase stress on lenses of stronger materials (velocity weakening behaviour) from which a rupture can nucleate. In this view, some crustal faults can behave as weak structures over long timescales (millions of years) and be intermittently seismogenic on shorter timescales.