Geophysical Research Abstracts,
Vol. 11, EGU2009-12262, 2009
EGU General Assembly 2009

Experimental investigations of mechanical healing of a simulated fault gouge

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In order to investigate the effect of fast healing from mechanical perturbations on the frictional behavior of fault surfaces, slide-hold-slide (SHS) experiments are often run in which holds are preceded by a rapid reduction of the shear stress, that triggers an increase of shear strength when resuming shear (i.e. The Tightening-up effect of unloading or Tu-effect). We present laboratory investigation where we explore the role of slip and stress perturbations before resuming the general loading of the frictional interface. Tests are performed with the Annular Simple Shear Apparatus (Navier/CERMES, Ecole des Ponts ParisTech, France) for studying such mechanical healing of a simulated fault gouge. A 100mm thick annular sample of siliceous sand (0.6mm diameter) is submitted to shear by the mean of a rotating cylinder in a semi-Couette geometry. We show that rather than small shear stress perturbations, small back-slips are responsible for significant restrengthening of the interface. Shear stress perturbations that do not lead to any significant inelastic back-slips, however, do not lead to restrengthening. A robust linear relationship between the amount of the back-slip and the strength increase is surprisingly obtained. This result suggests that small perturbations of the contact status in the granular assembly of gouge particles have a major influence on the fault restrengthening. Small displacements might have a much larger effect on the force chain transfer than stress perturbations.