The Chinese University of Hong Kong
Earth System Science Programme

Fault Weakening (Hardening?) Processes – Some Natural and Experimental Examples

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Abstract

The apredictability of seismic rupture along mature faults reflects, to a significant degree, the heterogeneity of slip behavior within a fault/fault zone. Direct examination of features presumed (hoped?) to be concomitant with active seismic cycles is the motivation for fault drilling programs over the past 20 years including Nojima (1995 Kobe), Chelungpu (1999 Chi-Chi), Longmenshan (2008 Wenchuan), Japan trench (Tohoku-oki 2013), San Andreas (SAFOD), Alpine Fault NZ (DFDP). These projects extend over a range of fault behaviour from locked to creeping segments, as well as discrete rupture, as well as comprising different tectonic settings. In general, an issue of much current interest is elucidation of the processes (e.g. melting, amorphization, fluidization) and products (e.g. melts, gels, nanoparticles) of slip that induce a velocity weakening state associated with rupture. Notwithstanding the amount of research invested in this problem, there remain contradictions as to what is happening on the fault plane. In this presentation, observations of micromechanical phenomena from various of the aforementioned cores are compared with the larger data base from exhumed upper crustal faults, and experimental studies examining the formation of discrete slip surfaces at both slow and very fast velocities in rotary shear. Utilizing transmission electron microscopy (TEM), slip zones are seen to be extremely narrow (i.e. ~ μm-scale) for events as different as the Tohoku-oki earthquake and gouge deformed by slow rotary shear. The self-contradictory nature of geometric similitude and mechanical origin has not been satisfactorily resolved. Is it that any particular path to velocity weakening simply reflects optimization of energy dissipation and the particulars of material deformation are the most efficacious mediators?

~ All are Welcome! ~

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