Solid Earth Physics Seminar, Harvard University

Tuesday, 8 December 2015, 2:30 pm (not the usual time!)
EPS Faculty Lounge, 4th Floor, Hoffman Lab, 20 Oxford Street

Is fault geometry important for earthquake mechanics?

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Abstract:

Faults are characterized by complex zones of deformed rock that repeatedly shear during faulting events. The majority of the overall displacement on faults in the upper crust is localized along rough slip-surfaces. Earthquakes are assumed to be a direct result of slip on these existing discontinuities. The presence of gouge and cataclasite zones indicates that the fault surface itself evolves through wear production. For each slip event, wear is generated from the rock across the fault plane, which consequently modifies the geometry of the slip-surface. Quantifying the non-planarity of fractures is therefore assumed to be essential for evaluating and modeling faulting in natural environments. Yet, previous experimental measurements suggest that under tectonic loading the maximum friction value does not depend on the surface roughness. Here we present field and experimental measurements which focus on the relationship between geometrical evolution, resistance to shear and wear generation during faulting. Our experimental setup is based on direct shear tests with slip-surface that are: a) rough, b) include multiscale geometrical irregularities, c) initially interlocked and d) sheared along distances which are comparable to their roughness magnitudes. Therefore, we simulate a typical case of natural faulting which has rarely been addressed in previous experiments. We show that surface roughness value decreases with slip amount but increases with increasing normal stress. Power spectral densities values of topography profiles measured parallel to the slip orientation found to be well fitted by a power-law curve, with typical power value of 2.6 which is corresponded to Hurst exponent of 0.8, assuming self-affine roughness. Wear-loss and roughness evolution are both correlated to the mechanical work applied during the experiments. Deformation associated with shearing rough interlocked surfaces spreads beyond the surface zone and widens with the increasing normal stress. Therefore, damage location and intensity during natural faulting is predicted to be strongly affected by the initial roughness and by the normal stress.