The effect of frictional properties in subduction zones on earthquake triggerability

Award: 07-42242 (December 2007)

H. Savage[1], E. Brodsky[1]

[1]*University of California, Santa Cruz*

The frictional properties of faults affect whether a fault will fail seismically, yet our knowledge of fault friction remains concentrated on the laboratory scale. This fellowship aims to use results from laboratory experiments on small faults to investigate the systematics of seismicity in natural fault settings. The initial laboratory work has expanded our knowledge of the relation between fault stability and frictional properties. Specifically, we have learned that the critical slip distance, which depends on fault architecture such as the presence or absence of a gouge layer, affects whether or not a fault will be triggered by transient stresses such as seismic waves. The wave amplitude at which triggering commences is a function of layer thickness modulated by interseismic creep (see figure). In order for the fault to be triggered, the displacement amplitude of the wave must exceed the critical slip distance. However if the fault can creep aseismically, a smaller wave can trigger seismicity. In the absence of interseismic creep, triggering thresholds would scale directly with the critical slip distance.

Variations in seafloor topography and sediment cover result in variations of seismogenic zone thickness. We are investigating whether the triggering thresholds in subduction zones scale with seismogenic zone thickness in a manner similar to the laboratory experiments. We are using both triggering thresholds from remote earthquakes as well as aftershock productivity from local events to determine the triggerability of different subduction zones.

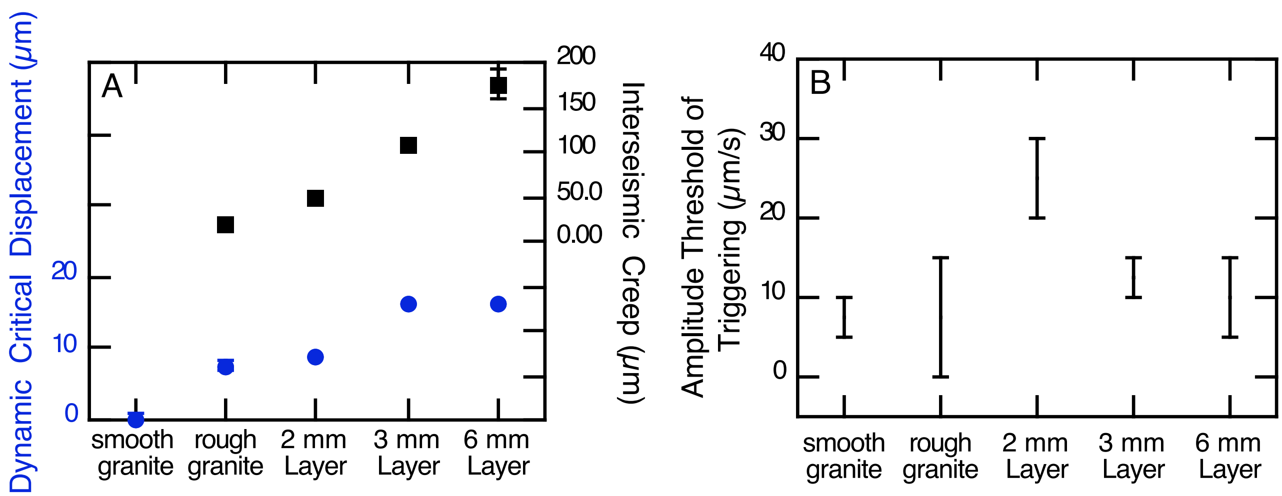

Figure: A) The critical slip distance required to sufficiently weaken a fault for dynamic failure increases with layer thickness. However, the amount of creep occurring interseismically increases with layer thickness as well. B) Laboratory experiments on bare granite surfaces show that the absence of a gouge layer makes a fault most susceptible to triggering, and that the thinner layers are least susceptible to the stabilizing effects of gouge. We interpret this as a result of the competing effects of increasing critical displacement (stabilization) and increasing aseismic creep (destabilization).