The Upper Transition From Seismic To Aseismic Faulting on Subduction Megathrusts

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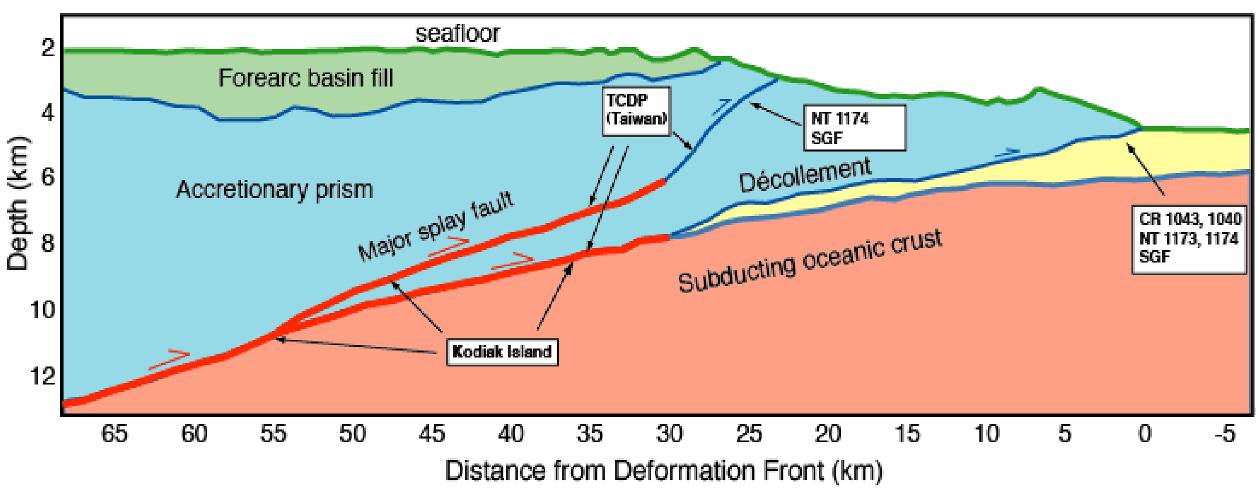
The updip transition from seismic to aseismic faulting along subduction plate boundaries is one of the most important unsolved problems in fault mechanics. We are conducting a comprehensive laboratory-based investigation of the mechanisms that determine the stability transition. We are working with an unparalleled suite of samples from ODP drilling, field sampling of exhumed faults, and synthetic fault gouge that provide direct analogs for portions of active subduction zones. Samples and conditions span depth and temperature conditions straddling the transition in slip behavior (see Figure). Laboratory measurements of hydrologic, frictional, and elastic properties are being conducted under carefully controlled conditions that span the upper regions of the world's subduction zones. We are testing the two main hypotheses for the upper stability transition: the clay mineral hypothesis and the lithification hypothesis. Our experiments show that hydration state has a strong effect on the frictional properties of clay-rich fault gouge. As water content is increased from 0-20.0 wt%, the friction rate parameter a-b becomes increasingly positive. Variation in a-b decreases dramatically as normal stress increases. If our experimental results can be applied to natural faults, our results indicate that the onset of shallow seismicity in subduction zones is more complicated than a simple transition from smectite to illite clay. This also follows from the results of our previously funded SEIZE project, which demonstrated that the smectite-illite transformation itself does not cause a transition to velocity-weakening behavior.



Saffer, D. M., Frye, K. M., Marone, C, and Mair, K. (2001), Laboratory Results Indicating Complex and Potentially Unstable Frictional Behavior of Smectite Clay, Geophysical Research Letters, 28, 2297-2300.

Saffer, D. M., and C. Marone (2003), Comparison of smectite and illite frictional properties: application to the updip limit of the seismogenic zone along subduction megathrusts, Earth and Planetary Science Letters, 215, 219-235.