Monday, April 8, 2019

Live Oak Room • Norris Conference Center • 816 Town and Country Blvd #210
Social Hour 5:30–6:30 p.m.
Dinner 6:30–7:30 p.m.

Cost: $40 Preregistered members; $45 non-members/walk-ups

To guarantee a seat, pre-register on the HGS website & pre-pay by credit card.
Pre-registration without payment will not be accepted.
Walk-ups may pay at the door if extra seats are available.

If you are an Active or Associate Member who is unemployed and would like to attend this meeting, please call the HGS office for a discounted registration cost. We are also seeking members to volunteer at the registration desk for this and other events.

Melodie French
Rice University

Rice Night – Come early for lots of student posters in addition to the speaker!

What Experiments Are Teaching Us About Subduction Megathrust Slip

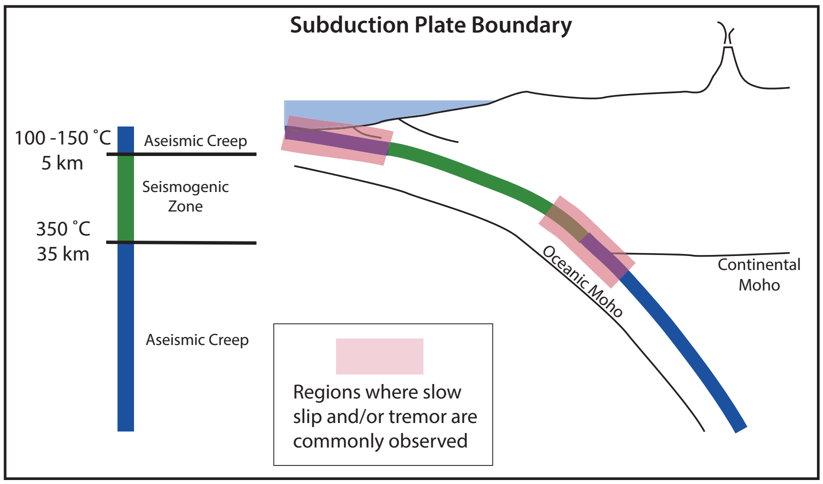

Figure 1. *Modified after similar diagrams by Chris Scholz (1988, 1998, 2002) to reflect the occurrence of slow slip and tremor in subduction zones. The subduction plate boundary has long been known to exhibit shallow (~5 to 10 km) and deep (~35 to 45 km) transitions between creep and seismogenic fault slip. However, enhanced geophysical instrumentation has revealed more subtle behavior, slow slip and tremor, within ~10 km of these transitions. These phenomena have implications for tsunami-genesis at the shallow transition and earthquake triggering at the deep transition. We do not yet know what causes these slip modes to occur.*

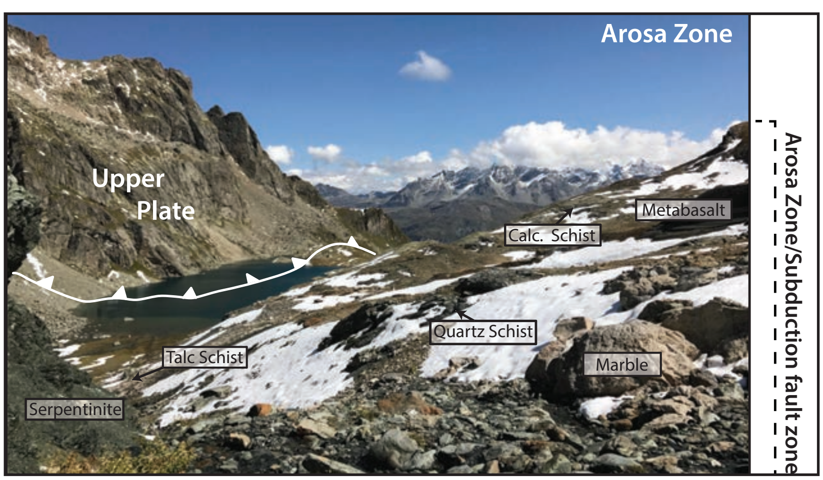

Figure 2. *A field exposure of the Arosa Zone in the Central Alps, where megathrust rocks are exhumed from ~35-40 km depth. The megathrust commonly experiences slow slip and tremor at these depths, and one or more of the many rock types present are thought to control this slip behavior.*

Earthquakes are created by slip along faults kilometers beneath the surface, but not all faults produce earthquakes. We have long known that faults may be seismogenic or slowly, steadily creeping, and physical models explain these behaviors well. Over the past two decades, advancements in seismic and geodetic monitoring technologies led to the discovery that faults regularly slip at rates intermediate between steady creep and co-seismic. These newly discovered phenomena are called "slow slip" and "tremor", and they challenge our understanding of how faults slip.

Slow slip and tremor are primarily observed along subduction plate boundary megathrusts (**Figure 1**), leading to interest in how they may influence seismic hazards and what they may reveal about the physical conditions of the plate boundary at depth. Despite the fact that slow slip and tremor characteristics differ between subduction zones and along a single megathrust, there are consistent patterns emerging on where and under what conditions they are observed. For instance, slow slip occurs over a wide range of temperatures and pressure, but is primarily observed near spatial transitions between seismogenic and creeping parts of the fault zone. There is also reason to believe that one or more of the rock types that exist along the subduction plate boundary may have material properties that result in these "intermediate" slip modes (**Figure 2**). This is because these slip phenomena are most commonly observed in subduction zones, but have also been observed along some strike slip fault segments that were formerly ancient subduction plate boundaries. Finally, there is a growing body of evidence that pore fluid pressures are high near the megathrust where slow slip and tremor occur.

HGS General Dinner Meeting *continued on page 15* continued from page 13

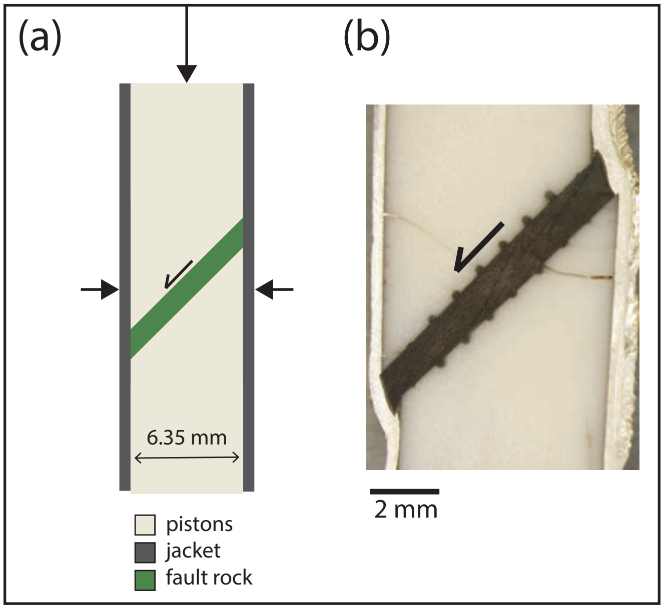

Figure 3. *(a) A cross-section diagram showing the experimental configuration used to test fault rocks. (b) A photograph of an actual deformed sample cut to reveal a cross-section.*

Whether a fault slips destructively, aseismically, or slowly is, in part, a function of the micro-scale properties of the rocks within the fault zone. My group uses high pressure deformation experiments to reproduce the micro-scale processes that occur within fault zones, and micro-mechanical models to relate these processes to geophysically observed slip. We are particularly interested in how the physical properties of megathrust rocks and extrinsic variables like fluid pressure and temperature together control how fault rock deforms, and thus how it slips.

In this presentation, I will review what we know about the phenomena of slow slip and tremor, including where they occur and how they have challenged our old models of faulting. I will discuss hypotheses for what may cause these modes of slip and what their occurrence might tell us about the conditions along the plate boundary at depths up to 50 km. Finally, I will show how deformation experiments in my group are being conducted to test and refine hypotheses for causes of slow slip and tremor. ■

Biographical Sketch

Melodie French is an Assistant Professor in the Department of Earth, Environmental, and Planetary Sciences at Rice University. She joined the faculty at Rice in January 2017, and built a laboratory to study the physical properties of rocks, including fault rocks. She received her BA in physics from Oberlin College, MS in Geology from the University of Wisconsin, and PhD in Geophysics from Texas A&M University. Melodie was an NSF Postdoctoral Fellow at the University of Maryland prior to arriving at Rice.