Harvard University, Solid Earth Physics Seminar
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4th Floor Faculty Lounge, Hoffman Laboratory, 20 Oxford St.

Physico-chemical Effects of Dehydration Reactions during Nucleation and Seismic Slip: Experiments and Theory

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Abstract: The hydrous minerals contained within the subducted oceanic crust are thought to play a great role in subduction zones, in particular during their dehydration. In this presentation, I discuss the possible roles of dehydration reactions in the changes in physical and mechanical properties of rocks, and their potential of triggering earthquakes.

The first part of the presentation describes experimental results obtained during dehydration test performed on gypsum in a triaxial apparatus. During drained tests performed under isotropic pressure, P and S wave velocities decrease drastically at the onset of dehydration. Importantly, the Vp/Vs ratio also decreases. The dehydration reaction was also accompanied by bursts of AEs. Focal mechanism analysis of the largest AEs showed they had a large volumetric component in compaction, confirming that AEs are related to pore closure and/or collapse. These experiments indicate that the signature of dehydration reactions in subduction zones might be more subtle than the commonly observed elevated apparent Vp/Vs ratio.

In a second part, I present a theoretical model of thermo-hydro-mechanical and chemical couplings during nucleation and seismic slip. This model indicates that the endothermic character of dehydration reactions is responsible for a strong thermal buffering of the plane, even if the slip rate is high. In addition, the stability analysis shows that dehydration reactions can destabilize a normally (i.e. when no reaction occurs) stable fault, which can potentially lead to an earthquake.

Finally, a series of high-velocity friction tests on gypsum is described. These experiments demonstrate the possibility of thermal buffering of the fault plane during rapid slip.