[JJ] Evening Poster | S (Solid Earth Sciences) | S-SS Seismology

[S-SS15]Fault Rheology and Earthquake Physics

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The goal of this session is to integrate theoretical, experimental, observational, and numerical perspectives from various fields such as seismology, geodesy, geology, mineralogy, and so on, to define what is known about earthquake source processes and the physical and chemical elementary processes of faulting. This session welcomes studies that address such issues as pre-, co-, and post-seismic processes, the rheology of seismogenic faults and fault rocks, laboratory experiments on elementary processes, numerical models based on frictional laws, and estimates of the stress field in the seismogenic zones. We also welcome studies on fault-zone drilling projects and in situ stress measurements.

[SSS15-P08]Numerical friction experiments on macroscopic frictio law of a heterogeneous fault element

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Keywords:Friction law, Numerical experiment, Earthquake sequence simulation

The friction law of a fault is one of the main ingredients of modeling of fault behaviors including a large earthquake and its recurrence. It is usually studied in laboratory experiments for cm-scale specimens, and one of the prominent problems is its direct applicability to large-scale behaviors. Small repeating earthquakes (repeaters) may be a realization of heterogeneous frictional property on faults, which were modeled by rate-weakening patches embedded in a rate-strengthening fault [e.g., Chen and Lapusta, 2009]. After the 2011 Tohoku-oki earthquake, so many repeaters were found in the Tohoku subduction zone [e.g., Kato and Igarashi, 2012]. But it is quite difficult to numerically resolve all of them in a large-scale simulation of the whole subduction zone, which is demanded for potential disaster mitigation. Therefore, it is important to investigate a spatiotemporally coarse-grained friction law of a fault region including unstable inclusions. We hypothesized that each point on a fault obeys the cm-scale friction law (the rate-state friction law in the aging law formulation) with sub-mm state evolution distance L, and assumed a rate-weakening circular patch (80 m diameter) which generates repeating events. We set 256 m periodicity along the fault, and conducted dynamic earthquake sequence simulations [e.g., Liu and Lapusta, 2009] by driving the system by far field stress τ$_0$ and observing averaged slip on the fault. Those simulations can be seen as numerical friction experiments with controlling the shear stress and observing the slip rate.

The macroscopic steady-state can be explained by a logarithmic law, with the frictional resistance slightly smaller and the rate-dependency slightly more rate-strengthening than the spatial average of the friction law assumed for each point on the fault. The transient behavior on a positive step in τ$_0$ can be explained by the aging law with significantly longer L and smaller a- and b-values. The optimum parameters and estimation errors do not intersect for different amount of the stress step, indicating that the macroscopic friction law takes a different form from the aging law.