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Stress triggering with modified rate- and state-dependent friction law

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Rate- and state-dependent friction law (RSF) has been recently revised by Nagata et al. [2012]: its frictional parameters were replaced by experimentally corrected values in the constitutive equation and a shear stress weakening effect was incorporated in the state evolution equation. It can quantitatively simulate any kinds of rock friction data observed in hold-slide tests and velocity-step tests. Based on the revised RSF, we here re-investigated the mechanics of frictional slip on earthquake faults responsible for stress triggering because they might be wrongly inferred from the earlier flawed RSFs such as the slowness law.

Seismicity is considered as a sequence of earthquake nucleation events, which are controlled by loading history and fault frictional property. Dieterich [1994] modeled aftershock seismicity, a major part of earthquake clustering, based on the derived RSF. In his modeling, he consider an accelerating process of the slip on a fault caused by a spontaneous stress step and analytically derived time to instability. However, the aftershock productivity and duration predicted are much lower and much longer than those of observation.

Here we reconstruct the aftershock model by using the revised RSF recently proposed in order to examine how the defects in the original model are modified. Analytic derivation of the time to instability is not available in the revised RSF and we have to simulate slip acceleration process of fault population and measure the time from a stress step to instability.

Our simulation results show that the aftershock productivity with the revised RSF is around 2.0 times larger than the original, and the durations are 3 times shorter (stress step :10MPa). Our reconstruction with the revised RSF can not fill the gap between the theory and observation.

Keywords: aftershock, rate- state-dependent friction, triggering