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THERMAL PRESSURIZATION IN 3 – D DYNAMIC SPONTANEOUS RUPTURE MODELS WITH COHESIVE ZONE

We simulate an earthquake rupture through a 3 - D Finite Difference algorithm using the traction – at – split - nodes fault boundary condition. The dynamic rupture propagation is governed by an assigned constitutive law, which controls the breakdown processes within the cohesive zone.

Our numerical procedure allows the use either of time - and slip - weakening or rate - and state - dependent (R & S) friction laws. Seismic slip on faults produces temperature perturbations. Fault heating is controlled by the mechanical properties of the fault surface and by the rheological properties of the gouge layer. We model the temperature evolution on the fault through the heat flow equation and we couple these thermal variations with the fluid pressure changes by using the Darcy's law for fluid flow in porous media and the continuity equation of fluid mass in a solid. We assume that the increase of temperature does not change the adopted R & S constitutive parameters during the dynamic instability. In a first set of simulations, we consider a constant porosity within the slip zone and we model the temporal variations of effective normal stress by considering the Terzaghi law. Subsequently, we use the evolution equation for the state variable proposed by Linker and Dieterich (1992), which accounts for normal stress variations. In this way we model the state variable evolution as a function of the constitutive parameters and the effective normal stress changes. Finally, we link this constitutive model with the evolution law for porosity proposed by Segall and Rice (1995).

The goal of this study is to investigate dynamic fault weakening caused by shear heating and thermal pressurization of pore fluids. We show how these phenomena may complicate the dynamic traction evolution and affect dynamic fault strength.

Our simulations reveal that the effect of frictional heating and temperature increase strongly depend on the thickness of the slip zone. Thus, our 3 - D simulations confirm that thermal pressurization is a viable mechanism to explain earthquake ruptures.