DYNAMICS OF SLOW AND FAST EARTHQUAKES AND THE EFFECT OF DAMAGE AROUND THE FAULT BY ANALYZING ENERGY VARIATION

Navid KHEIRDAST*, *Michelle ALMAKARI*, *Harsha S. BHAT*, *Ankit GUPTA

Laboratoire de Géologie de l'ENS (UMR 8538),
École normale superieure, PSL university, Paris, France

contact: khairdast@gmail.com

Stress and displacements in fault zones evolve due to complex mechanical interactions between fractures that span a multitude of length scales in the damage zones surrounding mature faults. In such systems, mechanical energy is stored due to tectonic loading. However, when (micro)fractures are unable to bear the tectonic loads, they host unstable slips, or earthquakes, that dissipate the stored energy in the bulk of rocks across a multiscale rupture magnitude. In this study, we design a fracture-network surrounding a main rough fault, the length and density of fractures follow observationally verified statistical distribution. Frictional strength on each fracture is rate dependent. We run quasi-dynamic seismic cycle simulation for this fault networks. The results show both slow and fast earthquakes on the main fault, as well as tremor-like behavior in the damaged zone, simultaneous with the slow instabilities on the main fault. Given off-faults at different orientations, we study under which conditions ruptures tend to advance slowly. The study of the change in the system's potential energy due to an infinitesimal advancement of slip on the main fault, and computing the share of the main and off-faults in this process, introduces the concept of a generalized force that drives the rupture, wherein off-faults might increase or decrease this generalized force. This force is balanced with the surface resistance against rupture slip, which is dictated by the friction law. We discuss how the rate dependency of friction, translated in terms of instability length increase, balances with the generalized rupture driving force, and how off-faults affect rupture speed by applying a generalized force opposite to the one applied by the rupture on the main fault.