SIMULATIONS OF EARTHQUAKE CYCLES IN CO-EVOLVING FAULT DAMAGE ZONES CONTROLLED BY DAMAGE RHEOLOGY

Peng ZHAI [1], ***Yihe HUANG*** [1], ***Chao LIANG*** [2]

[1] Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, USA
[2] Institute for Disaster Management and Reconstruction (IDMR), Sichuan University, Chengdu, China

contact: pengzhai@umich.edu

Both short-term coseismic off-fault damage, as evidenced by pulverized rocks, and long-term fault growth during the interseismic period have been suggested to contribute to the fault zone formation. Previous numerical models simulate off-fault plastic yielding either in a single dynamic seismic event or in the context of seismic cycles. However, the co-evolution of fault damage zones and seismic cycles are not yet well understood. Here we simulate the damage evolution of fault damage zones and earthquake cycles together in a 2D anti-plane strike-slip seismic cycle model constrained by the continuum brittle damage framework and rate-state friction law.

Because damage accumulation rate depends on fault slip rate, we consider the coseismic damage accumulation rate to be 6 orders of magnitude larger than the interseismic one. This also generates a coseismic velocity drop of 0.1%-4% as observed by seismic imaging in active fault zones. Damage mainly occurs during the short-term coseismic rupture phase and concentrates at shallow depths as a flower structure, in which an distributed damaged area surrounds a localized, highly damaged fault core. We also find that coseismic damage can be significantly amplified by a pre-existing low-velocity zone (LVZ). As the initial velocity contrasts of fault damage zones increase from 10%-40%, we observe larger coseismic damage and longer recurrence intervals of simulated earthquakes. Moreover, the amount of coseismic damage also depends on the hypocenter depth. Deeper events result in larger coseismic damage distributed in a wider area, which also attenuates more slowly with depth.