The probability of earthquake rupture termination on nonplanar faults

*So Ozawa[1], Ryosuke Ando[1], Eric M. Dunham[2]

1. Graduate School of Science, the University of Tokyo, 2. Department of Geophysics, Stanford University

Fault bends are known to arrest rupture propagation in many earthquakes. A global compilation of surface rupture traces by Biasi & Wesnousky (2017) indicates that the passing probability of a rupture at a fault bend decreases with increasing the bend angle. To elucidate the mechanical control of rupture arrests in fault bends, here we perform long-term earthquake sequence simulations on a fault that includes restraining and releasing bends, which are often seen in natural strike-slip faults. We use a stress relaxation method to avoid a pathological stress buildup due to the fault curvature.

A comprehensive parameter study shows that the probability of rupture arrests on the fault bend is primarily controlled by the angle of the bend and agrees with empirical laws obtained from historical earthquakes (Biasi & Wesnousky, 2017). The rupture termination can be understood by the concept of energy balane. A rupture tends to stop when the energy release rate becomes smaller or the fracture enegy (dissipation of energy due to inelastic processes such as friction) becomes larger. Both restraining and releasing bends are not optimally oriented from the stress field and have smaller available energy that drives the rupture progapation. Also, a large normal stress at restraining bends cause higher energy dissipation during rupture. This idea explains the difference of the location of the rupture arrest and the parameter dependence of passing probabilities between restraining and releasing bends. Additionally, the spatial heterogeneity of long-term slip rates is consistent with a natural example of restraining bends. Finally, we discuss the similarity and difference of our geometrical barriers and other types of rupture barriers, such as non-uniform frictional properties on the fault.

Keywords: Nonplanar fault, Numerical simulation

