Dynamic rupture on two fault segments with an ”inactive” area

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It is possible that two ”active” segments with an ”inactive” area where no dislocation remains on ground surface connect under the surface and rupture simultaneously. We simulate dynamic ruptures on such two fault segments. The inactive area is assumed to be under low initial shear stress and to have long critical displacement (Dc). Varying the length and depth of the inactive area, we investigate rupture propagation and jump to the second segment. The aspect ratio of the inactive area affects rupture processes, especially rupture jump and direction on the second segment. For fault geometry in which a rupture cannot jump across a discontinuity without the inactive area or jump to a shallow portion, a rupture can jump to the deep portion and propagates horizontally.

We put two vertical strike-slip segments parallel to each other and an inactive area between the segments in a 3-D, semi-infinite, homogeneous, isotropic, and linear elastic medium. The length and width of segments are 30 km and 15 km, respectively. The segments reach the free surface. We consider two models for offset: a ”no-offset” model and a ”offset” model. In the no-offset model, two segments and an inactive area between them compose a plane. In the offset model, on the other hand, two segments are discontinuous with an inactive overlap. Initial normal stress depends on depth, and frictional coefficients are uniform on the segments. Initial shear stress depends on depth in more than 1 km deep area, and it is uniform (4 MPa) in less than 1 km deep area and the inactive area. Dc is 0.4 m in more than 1 km deep area, 1 m in less than 1 km deep area, and 4 m in the inactive area. We use a finite-difference method by Kase and Kuge (2001) with slip-weakening friction law.

In the no-offset model, a rupture cannot jump across more than 5 km long and 15 km deep inactive area. The rupture prefers jumping to the shallow portion. In cases that the inactive area is less than 12 km in depth, the rupture propagates through the active area under the inactive area, which is consistent with the previous study in homogeneous stress condition (Dan et al., 2007). In the offset model, a short length and a lower depth less than 10 km of the inactive area lead to rupture jump to a deep portion on the second segment, although two segments do not connect even under the inactive area. For fault geometry in which a rupture cannot jump across a discontinuity without the inactive area or jump to a shallow portion, a rupture can jump to the deep portion and propagates horizontally. Our results imply that the depth-dependent stress condition and the inactive area produce a realistic rupture process.