

Dynamic Simulation of Branch Fault Formation Considering Mixed Mode Rupture: Comparison with Natural Examples

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We investigate the formation process of wing-crack like sequentially occurring branch faults. Such branch faults are found in field examples of exhumed fault rocks [e.g., Di Toro et al., 2005, *Nature*] and laboratory examples formed during dynamic rupture propagation [e.g., Griffith et al., 2009, *Geology*]. Recent theoretical studies suggested that the angles and lengths of branch faults reflect dynamic rupture processes of main faults, which the branches are grown from, and the rupture velocities [Rice et al., 2005, *BSSA*] and the length [Ando and Yamashita, 2007, *JGR*] of the main faults can be estimated by using these geometrical parameters. In fact, Di Toro et al. (2005) used the theory and the model of Rice et al. (2005) to infer the condition for exhumed branches filled by pseudotachylite. However, these physical models lack some ingredients such as actual dislocations due to branching [Rice et al., 2005] or the mixed mode rupture [Ando and Yamashita, 2007]. In this study we extend the numerical simulation method developed by Ando and Yamashita (2007) using the boundary integral equation method (BIEM) in order to deal with the mode I rupture as well as the previously implemented mode II. We perform the spontaneous rupture simulation to track the self-chosen fault growth path under various conditions of model parameters including the rupture velocity, the frictional coefficients and the stress angle. The results are compared with the field example of the extension cracks branched from the 1-mm-thick ultracataclasite, which are found in the Late Cretaceous Shimanto accretionary complex in eastern Kyushu, southwest Japan. The extension cracks having the length of a few mm exhibit a peak in the distribution of the branch angles around 60 degrees from the ultracataclasite, which is much higher than the numerical prediction only considering the mode II with the Coulomb criterion, 30 degrees.

Keywords: branch fault, wing crack, fault zone, dynamic rupture, accretionary complex, simulation