S148-P016 **Room: Poster Session Hall** **Time: May 20**

Comparison of the fracture energy between inland and subduction-zone earthquake

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Rupture Velocity is one of the most important source parameters. It is controlled by the fracture energy. Tinti et al. [2005] and Mai et al. [2006] estimated the fracture energy of some inland earthquakes and indicated that the fracture energy scales with the seismic moment according to a power law with exponent of 1/2-2/3. Kimura et al. [2008] evaluated the fracture energy of the 1978 and 2005 Miyagi-oki earthquakes, which are interplate events in a subduction zone, and indicated that the fracture energy of these earthquakes are about 10% of the value predicted from the empirical relation of Mai et al. [2006]. We think that the discrepancy would be partially caused by the aspect ratio of the fault plane. The aspect ratio is different between inland and subduction-zone earthquakes even when the seismic moment is same because of the difference of the width of the seismogenic zone. We examine this effect on the fracture energy by numerical simulations.

We constructed four simple fault models with the ratio of length to width of 1, 2, 4, and 6 in an infinite homogeneous medium. In all the models, we assumed the slip-weakening models with constant stress drop and rupture velocity. The assumed rupture velocity is 80 % of the shear-wave velocity. To simulate the dynamic rupture stably, the value of D_C was assumed to increase with the distance from the rupture nucleation point, and we calculated the fracture energy from the assumed D_C values and strength excess values obtained from the dynamic rupture simulations.

We compared the average fracture energy among four fault models and obtained the following results. In the case that the aspect ratio of the fault plane is one, the fracture energy scales with the seismic moment according to a power law with exponent 1/3. On the other hand, in the case that only the length of the fault varies and the width is constant, the fracture energy also scale with the seismic moment, but the exponent of the power law is 1/2, or larger. Consequently, the fracture energy of the fault model with the aspect ratio of six is about 1.7 times larger than the square fault model when the seismic moments of two models are same. Therefore, the strike-slip fault with large aspect ratio like inland earthquakes will require larger fracture energy than the square fault, such as subduction-zone events.