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地震時の高速破壊すべりに対する付加体堆積物の応答性
Frictional response of sediments to earthquake ruptures: Insight from friction experiments on samples from NantroSEIZE

向吉 秀樹 [2*], 廣瀬 丈洋 [1], 谷川 亘 [1], 多田井 修 [2], 林 為人 [1]
Mukoyoshi Hideki[2*], Takehiro Hirose[1], Wataru Tanikawa[1], Tadai Osamu[2], Weiren Lin[1]

[1] 海洋研究開発機構　高知コア研究所, [2]（株）マリン・ワーク・ジャパン
[1]JAMSTC/Kochi, [2]Marine Works Japan

In order to evaluate the frictional response of sediments against rapid sliding associated with rupture propagation along faults in the accretionary prism, we have conducted friction experiments on clay-rich sediments from IODP Expedition 316, Nankai Trough. Recent high-velocity friction experiments demonstrated that frictional resistance of simulated faults increases rapidly at the onset of sliding of over slip distance of more than several centimeters (the initial frictional barrier), that is followed by prolonged slip-weakening (e.g. Sone & Shimamoto, 2009). The sediments from the Nankai trough also exhibit similar mechanical behaviors at slip velocity of 1.3 m/s and normal stress of 1.0 MPa. In this study special attention is paid to the initial frictional barrier at the onset of rapid sliding, as it may be a significant factor controlling how earthquake ruptures propagate from the depth into the shallow accretionary prisms.

In the experiments, we slid a simulated fault gouge at a constant slip rate of 0.1 mm/s and then suddenly increase slip rate to 1.3 m/s with different acceleration of from 0.13 to 13 m/sˆ2. In all runs, friction coefficient is 0.6-0.7 at slip rate of 0.1 m/s and then increases by 2-10% over distance of several centimeters as a fault starts accelerate. Amplitude of the initial frictional barrier and hardening distance seem to depend on acceleration. When a simulated fault overcomes the initial barrier, friction coefficient gradually decreases with slip toward the steady-state value of 0.1˜0.2. In order to evaluate whether the initial barrier can affect rupture propagation, we estimate a ratio of the frictional work consumed on fault during the initial hardening stage to the frictional work during the slip weakening. The ratio is about ˜0.01 at acceleration of 0.13 m/sˆ2, but tends to increase with acceleration to ˜0.1 at 13 m/sˆ2. The result suggests that as the rupture speed increases, the effect of initial frictional barrier at the onset of rapid faulting could not be negligible; large initial barrier may arrest the rupture propagation. The effect of initial barrier must be incorporated into the analysis of earthquake rupture propagation in subduction zones.
Keywords: fault, friction, NantroSEIZE, Expedition 316, earthquake