High-velocity frictional strength across the Tohoku-Oki megathrust determined from surface drilling torque

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High-velocity frictional strength is one of the primary factors controlling earthquake faulting. The Japan Trench Fast Drilling Project drilled through the shallow plate-boundary fault, where displacement was ~50 m during the 2011 Tohoku-Oki earthquake. To determine downhole frictional strength, we analyzed the surface drilling torque data acquired at rotation rates equivalent to seismic slip rates (0.8-1.3 m/s). The results show a clear contrast in high-velocity frictional strength across the plate-boundary fault: the apparent friction coefficient of frontal prism sediments (hemipelagic mudstones) in the hanging wall is 0.1-0.3, while that of the underthrust sediments (mudstone, laminar pelagic claystone, and chert) in the footwall increases to 0.2-0.4. The apparent friction coefficient of the smectite-rich pelagic clay in the plate-boundary fault is 0.08-0.19, which is consistent with that determined from high-velocity (1.1-1.3 m/s) friction experiments. This suggests that surface drilling torque is useful in obtaining downhole frictional strength.

Keywords: frictional strength, drilling torque, Japan Trench Fast Drilling Project