Thermal and pressure effect on frictional property of smectite: application to the plate boundary earthquakes of Nankai

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Along subduction thrust faults, the transformation from smectite to illite at 100-150 °C plays a key role to define the updip limit of the seismogenic zone. If this hypothesis is correct, it is required that smectite exhibits velocity strengthening behavior at in-situ effective normal stress (σeff) and ~100-150 °C. Here we report results of friction experiments on gouges of pure Na-montmorillonite at σeff of 10-70 MPa, a pore fluid pressure of 10 MPa, at temperatures of 25-150 °C, and sliding velocities of 0.03-3 µm/s, using an oil-medium triaxial testing machine. We found that the coefficient of friction (µ) ranges from 0.056 to 0.120. At temperatures of 20 to 60 °C, µ systematically decreased with increasing σeff, while at 90-120 °C, it increased with increasing σeff. With increasing σeff, the velocity dependence of friction (a-b) became negative at 25-90 °C and positive at 120 °C. Therefore, we suggest that smectite friction promotes stable slip along the decollement at the shallow Nankai subduction zone.

Keywords: subduction thrust fault, decollement, aseismogenic zone, smectite, laboratory experiment, velocity dependence of friction