Frictional properties of the Nankai Trough accretionary mud samples collected from 1000-3000 mbsf at IODP Site C0002

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We conducted triaxial friction experiments on the Nankai Trough accretionary mud samples collected from 1000-3000 mbsf (meters below seafloor) at IODP Site C0002 off Kii Peninsula, at confining pressures of 44-83 MPa, pore water pressures of 32-50 MPa and temperatures of 51-98°C equivalent to their in situ conditions, and at axial displacement rates (V_{axial}) changed stepwise among 0.1, 1 and 10 μm/s, in order to investigate their frictional properties changing with depth.
XRD analyses of tested mud samples revealed that the content of total clay minerals tends to increase with depth from ~30 to ~60 wt%, while that of smectite tends to decrease with depth from ~30 to ~20 wt%. Thus, the smectite fraction in total clay minerals decreases with depth from ~0.75 to ~0.3. Because the temperature at 3000 mbsf reaches ~100°C, this decrease in smectite fraction with depth is likely due to the progress of smectite dehydration with increasing temperature.
Friction experiments of tested mud samples revealed that the steady-state friction coefficient (μ_{ss}) has a negative correlation with the content of total clay minerals. μ_{ss} at V_{axial} = 1 μm/s tends to decrease with depth from ~0.5 to ~0.3, according to the increasing content of total clay minerals with depth. Although shallower samples exhibited a clear increase in μ_{ss} when V_{axial} was increased and vice versa, i.e., velocity strengthening, a few deeper samples exhibited a decrease in μ_{ss} when V_{axial} was increased and vice versa, i.e., velocity weakening. Velocity dependence of steady-state friction ($d\mu_{ss}/d\ln V_{sliding}$, where $V_{sliding}$ is sliding velocity) has a positive correlation with the smectite fraction in total clay minerals. Because the latter decreases with depth, $d\mu_{ss}/d\ln V_{sliding}$ also tends to decrease with depth. $d\mu_{ss}/d\ln V_{sliding}$ values are relatively large (>0.002) and positive at depths shallower than 2000 mbsf, implying stable faulting at these depths. In contrast, $d\mu_{ss}/d\ln V_{sliding}$ values are relatively small (≤0.002) and locally negative at depths deeper than 2000 mbsf, implying conditionally stable faulting including slow slip events at these depths.

Keywords: friction, mudstone, accretionary prism, Nankai Trough

