

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 $\mu\text{m/s}$, 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 $V_{\text{axial}} = 1 \mu\text{m/s}$ 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 ($d\mu_{\text{ss}}/d\ln V_{\text{sliding}}$, where V_{sliding} is sliding velocity) has a positive correlation with the smectite fraction in total clay minerals. Because the latter decreases with depth, $d\mu_{\text{ss}}/d\ln V_{\text{sliding}}$ also tends to decrease with depth. $d\mu_{\text{ss}}/d\ln V_{\text{sliding}}$ values are relatively large (>0.002) and positive at depths shallower than 2000 mbsf, implying stable faulting at these depths. In contrast, $d\mu_{\text{ss}}/d\ln V_{\text{sliding}}$ 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.

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