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Mechanical properties of the shallow Nankai Trough accretionary sediments

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We report the results of triaxial compression and friction experiments of mudstone, sandstone and tuff samples, which are cored from the shallow (1000-1500 mbsf) Nankai Trough accretionary prism at Sites C0002 and C0009 of IODP Expeditions 315 and 319, at confining pressures, pore water pressures and temperatures close to their in situ conditions.

Triaxial compression experiments at these conditions and an axial displacement rate of 10 micron/s reveal that failure strength is 300 MPa for a sandstone sample, 48 MPa for a tuff sample, 20 MPa for a silty mud sample, and 14 MPa for a clayey mud sample. Another silty mud sample did not fail, and deformed ductilely at strength of ˜15 MPa. The sandstone sample is strongly lithified by being cemented by calcite and dolomite, which makes this sample's failure strength very high. The ductilely deformed silty mud sample seems not lithified enough to fail. Failure strength of the other three samples shows a negative correlation with the content of clay minerals, i.e. it increases with decreasing content of clay minerals.

Friction experiments at these conditions and axial displacement rates changed stepwise among 0.1, 1 and 10 micron/s reveal that frictional strength, too, has a negative correlation with the content of clay minerals; steady-state friction coefficient is $>$0.8 for the sandstone sample with ˜5 wt% clays, ˜0.7 for the tuff sample with ˜15 wt% clays, ˜0.55 for the silty mud samples with ˜30 wt% clays, and ˜0.25 for the clayey mud sample with ˜40 wt% clays. Slip-dependent frictional behavior also shows a correlation with the content of clay minerals; sandstone sample, tuff and silty mud samples, and clayey mud sample exhibit slip-hardening, quasi steady-state slip, and slip-softening, respectively. All samples showed an increase in friction when sliding velocity was increased or vice versa, i.e., velocity strengthening. We also found that the velocity dependence of friction has a correlation with the content of clay minerals, suggesting an increasing contribution of flow with increasing amount of clay minerals.

Thus the mechanical properties of shallow accretionary sediments differ basically according to the content of clay minerals, which would have important implications for deformation and faulting in the shallow Nankai Trough accretionary prism.

Keywords: fracture experiment, permeability, velocity dependent of friction