Public Abstract

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Title:Permeability, clay mineralogy, and microfabric of sediments from IODP Expedition 348, Site C0002, Nankai Trough accretionary prism, offshore southwest Japan

One of the main objectives of the Integrated Ocean Drilling Program (IODP) Expedition 348 was to characterize the variations of lithology and structure in the deep interior of the Nankai Trough accretionary complex beneath the Kumano forearc basin, offshore SW Japan. One objective for this study is to document the hydrogeologic properties of different lithologies within the accretionary prism. Specifically, I focus on thin interbeds of fine-grained turbidites and evaluate their relation between sediment microstructure and permeability. In addition, I document the clay mineral assemblages and diagenetic reaction progress. Those results have implications for evaluating factors that control the updip aseismic-seismic transition in fault-slip behavior along the megathrust fault system.

I conducted constant-flow permeability tests on four whole-round (WR) specimens collected from 2174.98 to 2209.64 mbsf. The samples were trimmed parallel to the WR core axis and tested at isotropic effective stresses of 0.28 MPa (40 psi) and 0.55 MPa (80 psi). The specimens are mainly clayey siltstone, with thin interbeds of silty turbidites. Intrinsic permeability (k) values range from 3.80 × 10-18 to 2.66 × 10-17 m2. Environmental scanning electron microscopy shows that the arrangement of grain fabric is random and does not vary significantly among the specimens tested.

A comparison of permeability data from Hole C0002P with data from other sites of Nankai Trough, as well as data from other subduction zones, indicates that samples from Nankai Trough conform to global trends. Permeability decreases with decreasing porosity and increasing depth. Data from Hole C0002P, however, are similar to data from mud and mudstone in shallow intervals of Sites C0002 and C0004, which indicates permeability is higher than expected within the deep interior of accretionary prism. The higher permeability values at deeper depth could have been influenced by high density of microfractures, coarser grain size, and lab testing under relatively low confining pressures. Moreover, the very steep bedding dips within the cored interval of turbidites would also favor vertical fluid migration through the accretionary prism, good drainage of pore fluids, and retention of near-hydrostatic pore pressures. If similar conditions and rock properties extend all the way down to the megasplay fault, it could result in increases of effective normal stress and shear strength.

Additionally, 41 cuttings samples (1190.5 - 1990.5 mbsf) from Hole C0002F, and 23 samples adjacent to WR samples (2163 - 2216.8 mbsf) from Hole C0002P were analyzed by the X-ray diffraction (XRD). Results for the clay-size fraction show that smectite is the most abundant clay mineral within the accretionary prism. In Hole C0002F, the expandability of illite/smectite (I/S) mixed-layer clays has an average value of 70%, and the average illite percentage in I/S is 26%. In Hole C0002P, the average expandability of I/S is 69%, and the percentage of illite in I/S varies from 13% to 54%, with an average of 41%.

The XRD results are consistent with data from coeval (late Miocene) mudstones in the Nankai accretionary prism and the Shikoku Basin. Values of illite crystallinity (~0.4-0.7) show that detrital source rocks during the late Miocene had been subjected to advanced levels of diagenesis and incipient greenschist-facies metamorphism, consistent with rock units currently exposed in the Outer Zone of SW Japan. The smectite-to-illite reaction has initiated at the depths sampled in Hole C0002F, and reaction progress has advanced further at the depths cored in Hole C0002P. Linear projection of the diagenetic gradient to greater depths indicates that the smectite-to-illite reaction probably goes to completion near the megasplay fault (~5200 mbsf). Exhaustion of clay dehydration would be expected to reduce the potential for build-up of fluid

overpressures, thereby increasing values of effective normal stress within the seismogenic zone.