The Nankai Trough Seismogenic Zone Experiment: Highlights from the World of Sedimentology and Lithostratigraphy

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The Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) is arguably the largest and most comprehensive project in the long history of marine geology. The NanTroSEIZE transect extends offshore SW Japan from the Kumano (forearc) Basin across the inner and outer accretionary prisms of Nankai Trough into the subduction inputs of Shikoku Basin. Guided by a 3-D seismic reflection survey, the Integrated Ocean Drilling Program (IODP) has sampled successfully at 13 sites. Riser drilling at IODP Site C0002 has already reached depths of more than 3050 meters below seafloor (mbsf), thereby achieving the world's record for scientific ocean drilling. Upcoming IODP Expedition 358 will attempt to deepen that hole to ~5200 mbsf. The ultimate goal is to penetrate the damage zone of the megasplay fault at seismogenic depths.

This presentation will focus on three of the more significant highlights of NanTroSEIZE from the perspective of sedimentology and lithostratigraphy. (1) Sedimentary facies units across the Shikoku Basin are unusually diverse, particularly when compared to such examples as Japan Trench and Costa Rica. The facies vary significantly in 3-D, and the boundaries are diachronous. That spatial and temporal heterogeneity is especially noteworthy for the uppermost hemipelagic-pyroclastic facies, as well as older Miocene turbidite units (Kyushu and Zenisu Fans). The 3-D complexity of facies architecture is a response to both basement topography and the surrounding margin's complicated tectonic history. This lithostratigraphic reality is important to consider when reconstructing the growth history of the Nankai accretionary prism, not to mention its 3-D permeability structure. (2) Clay mineral assemblages from nearly all environments of deposition define a progressive decrease in detrital smectite over time, especially over the last 10 million years. On average, contents of smectite within bulk mudstone decrease by 3 weight-% for every 1 Myr decrease in age. The main driver in changing suspended sediment influx was uplift and denudation of diverse parent rocks across the Outer Zone of Japan, which resulted in a gradual shift from middle Miocene erosion of weathered volcanic rocks (smectite-rich) to late Miocene and Plio-Pleistocene erosion of deeper-seated plutons and meta-sedimentary strata of the Shimanto Belt (illite- and chlorite-rich). The ability to predict smectite content as a function of age within various domains of the accretionary prism is valuable when assessing frictional properties and volumetric fluid production via smectite-to-illite diagenesis. The hanging wall of the megasplay fault, for example, differs fundamentally in its fluid-production potential from the frontal accretionary prism, as well as recently subducted, smectite-rich, Shikoku Basin sediments. (3) There is one exception to the above-mentioned trend. A large mismatch exists between clay mineral assemblages in Miocene mudstones from the inner accretionary prism (Sites C0001 and C0002) versus those in coeval mudrocks of the Shikoku Basin (Sites C0011 and C0012). That first-order compositional disparity invalidates the assumption of continued subduction and accretion of Philippine plate sediments. Instead, Miocene accretion near the NanTroSEIZE transect was probably caused by subduction of the Pacific plate prior to a northeastward migration of the trench-trench-trench triple junction. The earlier phase of Pacific plate subduction (old and cold) carries important implications for the thermal evolution of the margin.

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