NanTroSEIZE Stage 3 Fact Sheet

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NanTroSEIZE Plate Boundary Deep Riser – 348 & Beyond

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Summary of Planned Operations

IODP Site C0002 is the deep centerpiece of the NanTroSEIZE Project (Tobin and Kinoshita, 2006), intended to access the plate interface fault system at a location where it is believed to be capable of seismogenic locking and slip, and to have slipped coseismically in the 1944 Tonankai earthquake (e.g. Ichinose et al., 2003). This zone also coincides with the location where a cluster of very low frequency (VLF) seismic events occurred in 2004 – 5 (Ito and Obara, 2006) and the first tectonic tremor recorded in an accretionary prism setting has been found (Obana and Kodaira, 2009).

The just-completed IODP Expedition 338 was intended to drill and case that hole to 3600 mbsf in preparation for later deepening. Due to operational difficulties, that depth target was not achieved. In Hole C0002F, the wellhead is in place and a 20-inch casing string is cemented to 856 mbsf. The hole was drilled and left in an uncased, open-hole condition to 2005.5 mbsf.

The objective of the upcoming planned NanTroSEIZE operations are to extend Hole C0002F to ~5200 mbsf, crossing and sampling the main fault plane reflector (the "megasplay" fault) and installing casing to that depth. This drilling campaign will be divided into 2 phases, Expedition 348 and a follow-up expedition. These expeditions will share data and samples between the different phases, as part of one "greater science party". They will also have access to data and cuttings samples from IODP Expedition 338 Hole C0002F. The two phases will be organized accordingly:

(A) In the first phase, Expedition 348, now slated to take place from August 2013 through January 2014, the NanTroSEIZE Project intends to deepen that hole, installing casing to ~ 3600 (or 4400) mbsf in two (or 3) casing strings. LWD operations, cuttings collection and analysis, and limited coring below 2000 mbsf will be attempted. Also planned during Exp. 348 is the installation of a riserless permanent LTBMS/CORK-type observatory at Site C0010, replacing the temporary GeniusPlug observatory with a permanent observatory.

(B) Early in 2015, the second phase expedition is planned to further drill, log and sample C0002F starting from the bottom of the casing installed during Expedition 348 (3600 or 4400 mbsf) and advancing across the prominent plate boundary reflector known as the "mega-splay fault" (Figs F1 & F2) at estimated depth of 4500 – 5200 mbsf. The main objective is to

log and sample the hanging wall, the presumed fault zone, and ~200 meters of the footwall of this structure, which is believed to be the main active detachment zone of the plate boundary within the accretionary prism. Additional key objectives include conducting a 3D two-ship Vertical Seismic Profile (3D-VSP) at the 3600 mbsf level before advancing deeper, to image the mega-splay in unprecedented detail; and also drilling through the lower accretionary prism interval with LWD and cuttings analysis. Finally, the hole is to be cased and suspended in a condition that will permit future return for further operations.

Operations in 2013 – 2014 for Expedition 348 include:

- Employing riser drilling technique, re-opening the hole from 856 – 2000 mbsf, then drilling ahead with logging-while-drilling (LWD) data recovery, continuous cuttings recovery and mud gas analysis to ~3600 mbsf.
- Coring of about one hundred meters at a depth to be determined within the interval from 2000 – 3600 mbsf within the inner accretionary prism.
- Re-occupation of Hole C0010A to install a riserless borehole observatory and recover the temporary monitoring unit (GeniusPlug).

The second phase drilling program (early 2015) will also include:

- Reaching and sampling the megasplay fault.
- As comprehensive a suite of wireline logging, downhole stress, pore pressure, and permeability tests as available time and budget allow.
- A three-dimensional vertical seismic profile (3D-VSP), to be acquired by airgun shooting from a 2nd ship with an array of clamped geophones in the C0002F borehole.

Further background information about the NanTroSEIZE transect and the goals for ultradeep drilling can be found in Tobin and Kinoshita (2006), Tobin et al. (2009), Kinoshita et al. (2009), Moore et al. (2009), Exp. 319 Scientists, 2010a, and Underwood et al., 2010.

Primary plan: Site C0002 Riser Operations and Science & C0010 Riserless Observatory

The primary drilling plan for Expedition 348 is to extend Hole C0002F through riser drilling with the drilling vessel *Chikyu* to approximately 3600 mbsf (the actual depth will be determined by drilling conditions and time available). The hole will be suspended at the 11 ¾-inch casing (or 9 5/8 inch casing if 4400 mbsf reached) set point (Fig. F2), after casing is installed and cemented into place. On Expedition 326 in 2010, the wellhead was installed and a 20-inch casing string was cemented in place to 856 mbsf. During Exp. 338, the interval from 856 – 2005 mbsf was drilled in preparation for casing, but the hole had to be suspended with weighted mud in open hole conditions down to 2005.5 mbsf.

The entire upper 2000 m section at Site C0002 was previously logged with a comprehensive LWD program during Expeditions 314 (Shipboard Scientific Party, 2009a) and 338, and

intervals down to 1120 mbsf have been cored during Expeditions 315 (S.S.P., 2009b) and 338. The Kumano forearc basin sedimentary package composes the interval from 0 – 940 mbsf, and it is underlain by the “inner wedge” deformed accretionary wedge package. The seismic reflection character of the entire zone from ~940 mbsf to the megasplay reflector at ~5200 mbsf exhibits virtually no coherent reflectors indicative of intact stratal packages, in contrast to the outer accretionary wedge seaward of the mega-splay fault system (Fig. F2; also see Moore et al., 2009). This seismic character is thought to indicate that the inner wedge is a complexly-deformed zone, perhaps best characterized as a subduction mélange or proto-mélange. The anticipated lithology is Miocene age hemipelagic mudstones and turbidites with volcanic ash throughout this entire interval. Accordingly, the main research objectives for this interval are to sample the interior of the accretionary complex in the midslope region beneath the Kumano forearc basin with both cores and drill cuttings, to perform downhole stress orientation/magnitude, pore pressure, permeability, and collect an extensive suite of LWD logs to characterize the formation.

The interval from 856 mbsf to 2005 mbsf will be reamed/re-drilled and cased with no significant new scientific data collection planned. After the casing is established at either the current TD of 2005 or to 2300 mbsf, the interval to 3600 mbsf will be drilled with a suite of LWD,tools except for intervals to be cored. During this riser drilling, mud return will allow for a comprehensive program of drill cuttings and mud gas analysis, as was performed during Expedition 338. Coring (100 m) is also planned to sample the inner wedge, at depth to be determined. If conditions are good, it may be possible to extend the hole to 4400 mbsf and set 9 5/8-inch casing at that TD (Fig. F3). After coring this open-hole interval, Hole C0002F will be suspended for future re-occupation, re-entry and further deepening to the planned plate boundary target during the 2014 – early 2015 time window.

The second phase expedition will resume with sampling and measurements in the deeper accretionary prism and across the megasplay fault. The objective is to extend Hole C0002F through riser drilling to advance with continuous coring across the fault and into the footwall to approximately 5200 mbsf, the estimated megasplay fault (Fig. F3). The main target for coring and log acquisition is the lowermost ~100 m of the hanging wall, the fault zone itself, and ~100 meters of the footwall, expected to be dominated by brittle fault zone structures and complex lithologic architecture typical of large offset plate boundary fault zones. We will prioritize the taking of the maximum number of cores possible in this zone, but may be limited by time constraints.

In summary, Hole C0002F drilling on Expedition 348 and its 2015 follow-up will therefore access a subduction plate boundary fault system and its wall rocks at likely seismogenic depths for the first time anywhere, testing hypotheses for the mechanics and geological/geochemical evolution of these megathrust faults, as well as determining the

cause of the prominent seismic reflector. Additionally, it will shed light on the nature of accretionary prism formation and evolution, underplating processes, and other open questions in active margin tectonics. At the end of this project, the borehole will be suspended for possible future re-entry.

Scientific Staffing Needs

Scientists with interest and expertise in fault zone structure and mechanics, accretionary complex evolution, state of stress in a plate boundary setting, physical and hydrological properties and their evolution, pore fluid geochemical properties and processes, core-log-seismic integration (CLSI) in structurally-complex settings, and deep subsurface biology are invited to apply. A shipboard party size of ~13 scientists at a time for each of two approximately 8-week periods is anticipated, for both Expedition 348 and the 2015 follow-on, requiring ~ 50 scientists in total over the two expeditions in 2013 & 2015. Applicants for the entire Stage 3 project are being solicited, and the staffing invitations will be according to shipboard requirements as the detailed operations plan develops. Shipboard duties will likely include structural geology, physical properties and *in situ* stress, log and CLSI analysis, sedimentology/lithostratigraphy, micropaleontology, paleomagnetism, microbiology, and analysis of porewater and gas geochemistry (organic and inorganic).

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Figure F1. Map of NanTroSEIZE region, with all Stage 1, 2, & 3 drilling sites indicated. The box represents the region with 3D seismic data (Hole C0002F is indicated by the black diamond; Red Circles indicate Stage 1 & 2 Sites). The black stars indicate the 1944 & 1946 earthquake epicenters.

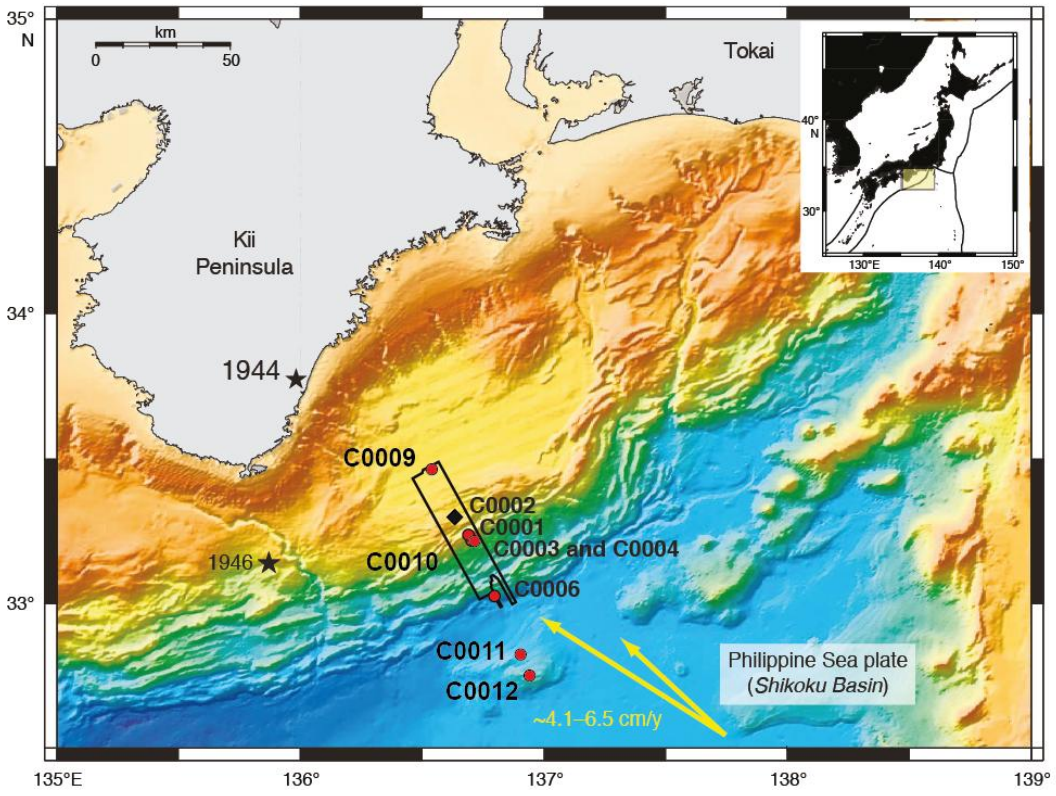

Figure F2. InLine 2529 extracted from the 3D seismic volume, showing Hole C0002F, in relation to Stage 1 Sites C0001, C0003 and C0004. The dashed extension below the colored boxes indicates the future planned Oceanic Plate Basement interception at ~7000 mbsf. The Red, Yellow, Green, and Blue boxes indicate the 20 inch casing to 856 mbsf, and the planned casing set points for 13-3/8, 11-3/4, and 9-5/8 inch casing, at 2300, 3600, and 4400 mbsf, respectively. The target depth for Expedition 348 is ~5200 mbsf, with open hole coring (black) beyond the planned 9-5/ inch casing shoe position.

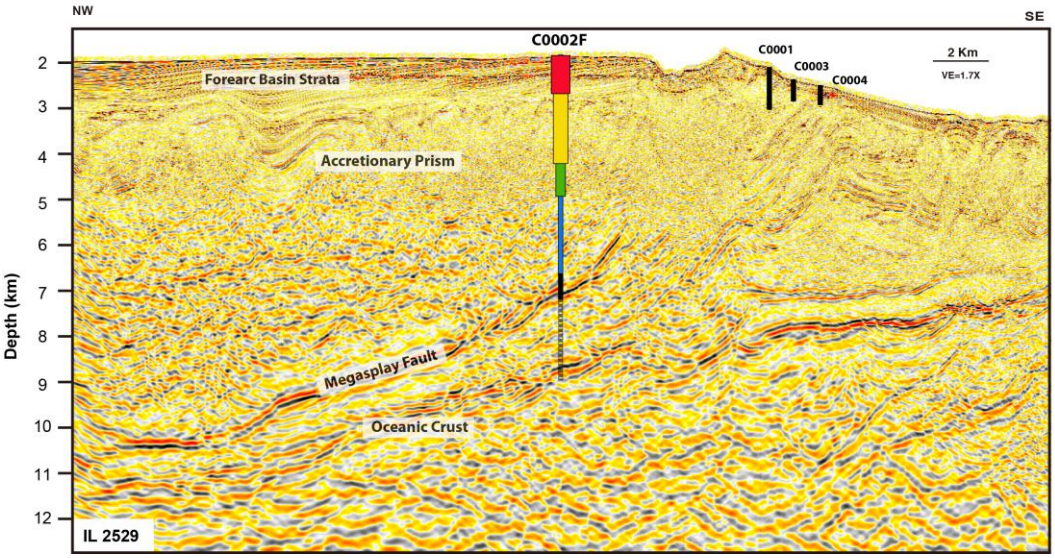

Figure F3. A schematic for the planned operations at Hole C0002F. The ultimate TD of Hole C0002F is planned for ~5200 meters below seafloor, with the megasplay reflector depth (green dashed line) assumed at ~5000 mbsf. The IODP Exp 348 targets are: (1) 13-3/8 inch casing shoe at 2300 mbsf, (2) 11-3/4 inch casing shoe depth at ~3600 mbsf (shown in red), (3) 9 5/8 inch casing to ~4400 mbsf (red/black striped). Open hole coring (blue) will extend below the planned casing depth. Future operations include deepening the hole (9-5/8 inch casing option, in black) to the top of oceanic crust (blue dashed line), and coring. BSR = bottom simulating reflector. Previously drilled and cased sections are depicted in green.