Integrated Ocean Drilling Program
Expedition 316 Scientific Prospectus

NanTroSEIZE Stage 1:
NanTroSEIZE Shallow Megasplay and Frontal Thrusts

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This IODP *Scientific Prospectus* is based on precruise Science Advisory Structure panel discussions and scientific input from the designated Co-Chief Scientists on behalf of the drilling proponents. During the course of the cruise, actual site operations may indicate to the Co-Chief Scientists, the Operations Superintendent, and the Expedition Project Manager that it would be scientifically or operationally advantageous to amend the plan detailed in this prospectus. It should be understood that any proposed changes to the science deliverables outlined in the plan presented here are contingent upon approval of the CDEX Science Operator Science Manager in consultation with IODP-MI.

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Abstract

Integrated Ocean Drilling Program (IODP) Expedition 316 is part of the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) complex drilling project (CDP). This coordinated, multiplatform, and multiexpedition drilling project is designed to investigate fault mechanics and seismogenesis along subduction megathrusts through direct sampling, in situ measurements, and long-term monitoring in conjunction with allied laboratory and numerical modeling studies. The primary goals for Expedition 316 are to drill and core two proposed sites, NT1-03B and NT2-01B. Site NT1-03B will be drilled and cored to a total depth (TD) of 950 meters below seafloor (mbsf), and Site NT2-01B will be drilled and cored to a total depth of 1000 mbsf. Hole C at Site NT2-01B will also be fitted with a reentry cone and cased to TD in preparation for cross-hole hydrologic experiments and installation of monitoring equipment planned for future operations.

Expedition 316 is intended to comprehensively evaluate the deformation, inferred depth of detachment, structural partitioning, and fault zone physical characteristics at the frontal thrust (proposed Site NT1-03B) and at the shallow portion of the megasplay system (proposed Site NT2-01B). Critical data to be collected include physical properties of the fault zone and surrounding wall rocks, diagenetic, chemical, and other evidence for fluid flow, and age determination of material above and below both fault systems in order to begin to estimate transport histories and fluid flow response in different areas of the forearc. These data will be collected through complete coring and laboratory measurement and downhole measurements (in situ temperature measurements and wireline logging) whose exact composition will depend on the results of logging-while-drilling (LWD) operations during Expedition 314 (LWD Transect).

These operations and data will constrain accumulation and release of strain and the relationships between pore pressure, fault slip, strain, and fluid flow in the near field of the shallow megasplay and the frontal thrust. Taken together, these operations will constrain the long-term slip behavior of the megasplay and frontal thrust fault systems, and document rock properties and in situ conditions within a deep forearc basin and the interior of an accretionary prism.

In this *Scientific Prospectus* we present the scientific background and objectives, drilling operations designed to achieve them, contingency strategies, and coordinated NanTroSEIZE Stage 1 research planning for sharing Stage 1 samples and data.

Schedule

The operations schedule for Expedition 316 is derived from the original Integrated Ocean Drilling Program (IODP) drilling Proposals 603-CDP3, 603A-Full2, 603B-Full2, 603C-Full, and 603D-Full2 (available at **www.iodp.org/NanTroSEIZE**).

Following ranking by the IODP Scientific Advisory Structure, the IODP Operations Task Force charged the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) Project Management Team (PMT) with formulating a strategy for achieving the overall scientific objectives in these proposals. The resulting overarching goals and multistage implementation strategy is described in Tobin and Kinoshita (2006a, 2006b). For the first stage of the NanTroSEIZE project, the IODP Operations Committee scheduled three *Chikyu* (**www.jamstec.go.jp/chikyu/eng/Expedition/index.html**). These three expeditions will be implemented as a single science program.

Expedition 316 is scheduled for the *Chikyu*, operating under contract with the Japanese Implementing Organization, Center for Deep Earth Exploration (CDEX) and will begin directly following the completion of IODP Expedition 315 (Megathrust Riser Pilot, *Chikyu*) in mid-December 2007. At the time of publication, the ship schedule has not been completely finalized. Refer to **www.iodp.org/expeditions** for more information. For the current detailed schedule, see **www.iodp.org**. Details on the *Chikyu* can be found at **www.jamstec.go.jp/chikyu**. A total of 49.5 days including 9.5 days of contingency time will be available for the drilling, coring, downhole measurements, logging, and casing operations described in this report.

Introduction

Subduction zones account for 90% of global seismic moment release, generating damaging earthquakes and tsunamis with potentially disastrous effects on heavily populated coastal areas (e.g., Lay et al., 2005). Understanding the processes that govern the strength, nature, and distribution of slip along these plate boundary fault systems is a crucial step toward evaluating earthquake and tsunami hazards. More generally, characterizing fault behavior at all plate boundary types through direct sampling, near-field geophysical observations, and measurement of in situ conditions at depths of coseismic slip is a fundamental and societally relevant goal of modern earth science.

To this end, several recent and ongoing drilling programs have targeted portions of active plate boundary faults either that have slipped coseismically during large earthquakes or that nucleate smaller events. These efforts include the San Andreas Fault Observatory at Depth (Hickman et al., 2004), the Taiwan-Chelungpu Drilling Project (Ma, 2005), and IODP NanTroSEIZE drilling (Tobin and Kinoshita, 2006a, 2006b).

The NanTroSEIZE project is a multiexpedition, multiplatform, multistage IODP complex drilling program focused on understanding the mechanics of seismogenesis and rupture propagation along subduction plate boundary faults. The drilling program outlines a coordinated effort to sample and instrument the plate boundary system at several locations offshore the Kii Peninsula (Fig. **F1, F2**) with the main objectives of understanding (Tobin and Kinoshita, 2006a, 2006b)

- The aseismic–seismic transition of the megathrust fault system,
- Processes of earthquake and tsunami generation, and
- The hydrologic behavior of the plate boundary.

The drilling program will evaluate a set of core hypotheses through a combination of riser and riserless drilling, long-term observatories, and associated geophysical, laboratory, and numerical modeling efforts. The following hypotheses are paraphrased from the original proposals and outlined in Tobin and Kinoshita (2006a, 2006b):

1. Systematic, progressive material and state changes control the onset of seismogenic behavior on subduction thrusts.
2. Subduction megathrusts are weak faults.
3. Plate motion is accommodated primarily by coseismic frictional slip in a concentrated zone (i.e., the fault is locked during the interseismic period).
4. Physical properties of the plate boundary system change with time during the earthquake cycle.
5. A significant, laterally extensive fault system (the "megasplay" fault; Park et al., 2002) slips in discrete events that may include tsunamigenic slip during great earthquakes. It remains locked during the interseismic period and accumulates strain.

Sediment-dominated subduction zones such as the East Aleutian, Cascadia, and Nankai margins are characterized by repeated occurrences of great earthquakes of ~M 8.0 (Ruff and Kanamori, 1983). Although the causative mechanisms are not well understood (e.g., Byrne et al., 1988; Moore and Saffer, 2001; Saffer and Marone, 2003), the updip limit of the seismogenic zones at these margins is thought to correlate with a topographic break along the outer rise (e.g., Byrne et al., 1988; Wang and Hu, 2006). Accretionary prisms in these subduction zones are separated into two parts by this outer rise (Wang and Hu, 2006; Kimura et al., 2007), and the inner and outer wedges are located above the seismogenic plate boundary and aseismic décollement, respectively.

At Nankai, high-resolution images of the outer rise from seismic reflection profiles clearly document a large out-of-sequence thrust (OOST) fault system (the "megasplay" fault after Park et al., 2002) that branches from the plate boundary décollement within the coseismic rupture zone of the 1944 Tonankai M 8.2 earthquake (Fig. **F2A**). Several lines of evidence indicate that the megasplay system is active and may accommodate an appreciable component of plate boundary motion. However, the partitioning of strain between the lower plate interface (the décollement zone) and the megasplay system and the nature and mechanisms of fault slip as a function of depth and time on the megasplay are not understood. As stated in the fifth hypothesis above, one of the first-order goals in characterizing the seismogenic zone along the Nankai Trough—and which bears on understanding subduction zone megathrust behavior globally—is to document the role of the megasplay fault in accommodating plate motion and to characterize its mechanical and hydrologic behavior.

Stage 1 of the NanTroSEIZE program includes three coordinated riserless drilling expeditions to drill several sites across the continental slope and rise offshore the Kii Peninsula, within the inferred coseismic slip region of the 1944 Tonankai M 8.2 earthquake (Figs. **F1B, F2B**) (Tobin and Kinoshita, 2006a, 2006b). The first of these will be a LWD expedition that will serve as a geophysical baseline for all of the Stage 1 drilling sites (Expedition 314: LWD Transect; *Chikyu*) to define physical properties, lithostratigraphy, and structural information in advance of coring operations. This will be followed by a coring expedition (Expedition 315: Megasplay Riser Pilot; *Chikyu*) aimed at sampling the materials and characterizing in situ conditions within the accretionary wedge to 1 km below seafloor at proposed Site NT2-03. This site will also serve as a pilot hole for later Stage 2 riser drilling targeting the megasplay fault at ~3–3.5 km below seafloor. These expeditions and their scheduled operations are summarized in Figure **F2.**

Expedition 316 (Shallow Megasplay and Frontal Thrusts) on the *Chikyu* targets two shallow fault zones: (1) the frontal thrust near the trench (proposed Site NT1-03B) and (2) the older accretionary prism and megasplay fault (proposed Site NT2-01B). These operations are aimed at sampling two major thrust fault systems at relatively shallow depths where they are accessible to riserless drilling. The first is the main frontal thrust at the seaward edge of the accretionary wedge (Figs. **F3, F4**). Based on seismic data and submersible studies, this thrust is thought to have placed moderately consolidated, ~2 Ma clastic rocks over weak and unlithified late Quaternary trench section clastic sediments (Ashi et al., 2002). The scientific objectives of drilling at proposed Site NT1-03B are to clarify the following:

- The function of the frontal thrust with respect to large earthquakes,
    - Do great earthquakes trigger slip along this fault plane, and if so, are they tsunamigenic?
    - Does the frontal thrust generate low-frequency events or does it creep during the interseismic period?
- The relationship between fluid behavior and slip and deformation, and
- The evolution of the frontal thrust from its birth to death.

These objectives will be accomplished by complete coring and a suite of downhole measurements of the 950 m of planned borehole along with the LWD logs from Expedition 314. The investigations undertaken onboard and postcruise will include the following:

- Comprehensive characterization of deformation at macro, meso, and microscopic scales;
- Evaluation of the geophysically inferred depth of detachment;
- Structural partitioning at the frontal thrust;
- Physical properties of the fault zone and surrounding wall rocks; and
- Diagenetic, chemical, and other evidence for fluid flow on the frontal thrust.

Later stages of drilling may target deeper intervals at this site, depending on what is discovered in Stage 1.

Operations at proposed Site NT2-01B will target the shallow portion of the megasplay fault system, just seaward of the break in slope marking the boundary between the inner and outer accretionary wedge (Figs. **F5, F6**). The scientific objectives of drilling at proposed Site NT2-01B are as follows:

- To clarify the character and behavior of the shallow portion of the megasplay;
    - Is it an active blind fault or an inactive fault?

    - Is there evidence for past seismogenic slip, supporting contention that the megasplay is the primary candidate for the source of great earthquakes and tsunamis?
- To clarify the slip and deformation mechanisms in the stable region above the (inferred) unstable seismogenic fault;
- To clarify the relationship between fluid behavior, slip, and deformation along the megathrust; and
- To clarify the evolutionary development of the splay fault.

Coring and downhole measurement will be carried out in similar fashion as that at proposed Site NT1-03B and will be used to obtain samples of the fault rock and wall rock and characterize them as completely as possible in conjunction with logging data (from Expedition 314 and possibly from Expedition 316). The drilling will penetrate numerous subfaults and zones of deformation before reaching the splay fault. Drilling is planned to penetrate 200 m below the splay fault to characterize deformation in the footwall. Thus, operations are planned based on a total depth (TD) of 1000 mbsf. If the targeted splay fault is at greater depth than expected and time allows, drilling and coring will proceed to a maximum of 1200 mbsf. Work on this expedition, including the installation and cementation of casing, will lead to subsequent installation of a monitoring system in later stages of the NanTroSEIZE complex drilling project.

Background

Geological setting

The Nankai Trough is formed by subduction of the Philippine Sea plate to the northwest beneath the Eurasian plate at a rate of ~4.1 cm/y. (Seno et al., 1993). The convergence direction is approximately normal to the trench, and sediments of the Shikoku Basin are actively accreting at the deformation front. The Nankai Trough is among the most extensively studied subduction zones in the world, and great earthquakes during the past 3000 or more years are well documented in historical and archeological records (e.g., Ando, 1975). The Nankai Trough has been selected as a focus site for studies of seismogenesis by both IODP and the U.S. MARGINS initiative, based on the wealth of geological and geophysical data available, a long historical record of great (M > 8.0) earthquakes, and direct societal relevance of understanding tsunamis and earthquakes that have had, and will have, great impact on nearby heavily populated coastal areas.

The Kumano Basin region, off the Kii Peninsula (Fig. **F1A, F1B**), was chosen based on three criteria: (1) the updip end of the seismogenic zone must be definable based on slip in past great earthquakes, (2) seismic imaging must present clear drilling targets, and (3) deep targets must be within the operational limits of riser drilling by the *Chikyu* (i.e., maximum of 2500 m water depth and 7000 mbsf). In the Kumano Basin, the seismogenic zone lies at ~6000 mbsf (Nakanishi et al., 2002). Slip inversion studies suggest that only here did past coseismic rupture clearly extend shallow enough for drilling (Ichinose et al., 2003; Baba and Cummins, 2005), and an updip zone of large slip (asperity) has been identified and targeted (Fig. **F1B**). Coseismic slip during events like the 1944 Tonankai M 8.2 earthquake likely occurred on the megasplay fault rather than on the décollement beneath it, though slip on either plane is permissible given the available data. The megasplay fault, therefore, is a primary drilling target equal in importance to the basal décollement zone.

The region offshore the Kii Peninsula on Honshu Island has been identified as the best location for seismogenic zone drilling for several reasons. First, the rupture area of the most recent great earthquake, the 1944 Tonankai M 8.2 event, is well constrained by recent seismic and tsunami waveform inversions (e.g., Tanioka and Satake, 2001; Kikuchi et al., 2003). A horizon of significant coseismic slip is reachable by drilling with the *Chikyu*. Second, the region offshore the Kii Peninsula is generally typical of the Nankai margin in terms of heat flow and sediment on the incoming plate. This is in contrast to the area offshore Cape Muroto where previous Deep Sea Drilling Project and Ocean Drilling Program (ODP) drilling has focused and where both local stratigraphy associated with basement topography and anomalously high heat flow have been documented (Moore, Taira, Klaus, et al., 2001; Moore et al., 2005). Third, ocean bottom seismometer campaigns and onshore high-resolution geodetic studies (though of short duration) indicate significant interseismic strain accumulation (e.g., Miyazaki and Heki, 2001; Obana et al., 2001).

As noted above, the megasplay, a large OOST, branches from the master décollement ~50 km landward of the trench along the drilling transect and forms the trenchward boundary of the Kumano Basin, a forearc basin filled by turbiditic sediments with a maximum thickness of ~2000 m. A pronounced continuous ridge of topography extending >120 km along strike is evident in swath-bathymetric and multichannel seismic data and is likely related to splay fault slip. Remotely operated vehicle (ROV) and submersible surveys reveal a very steep slope on both sides of the ridge, suggesting recent activity (Ashi et al., 2002, unpubl. data). This fault has been termed a megasplay because it differs markedly from other OOSTs in several respects:

- It is continuous along strike, is associated with a significant break in seafloor slope, and is a strong seismic reflector, suggesting that it is a first-order structural element of the margin.
- Significant long-term slip is documented by sequence boundaries and progressive landward tilting of strata in the Kumano Basin as observed in seismic reflection data (Fig. **F2**).
- The megasplay separates rocks with significantly higher seismic velocity on its landward side from rocks of lower seismic velocity toward the trench, suggesting that it represents a major mechanical discontinuity (Nakanishi et al., 2002).
- It is geographically coincident with the updip termination of slip during the 1944 Tonankai M 8.2 event, as inferred from tsunami (Tanioka and Satake, 2001) and seismic (Kikuchi et al., 2003) waveform inversions, and recent structural studies indicate that it may have experienced coseismic slip (e.g., Park et al., 2002).

Mechanical arguments further suggest that the megasplay is the primary coseismic plate boundary near the updip terminus of slip (e.g., Kame et al., 2003; Wang and Hu, 2006).

Subduction zones like the Nankai Trough, on which great earthquakes (M > 8.0) occur, are especially favorable for study because the entire width (dip extent) of the seismogenic zone ruptures in each great event, so the future rupture area is perhaps more predictable than for smaller earthquakes. The Nankai Trough region is among the best-studied subduction zones in the world. It has a 1300 y historical record of recurring and typically tsunamigenic great earthquakes, including the 1944 Tonankai M 8.2 and 1946 Nankaido M 8.3 earthquakes (Ando, 1975; Hori et al., 2004). The rupture area and zone of tsunami generation for the 1944 event are now reasonably well understood (Ichinose et al., 2003; Baba et al., 2005). Land-based geodetic studies suggest that the plate boundary thrust here is strongly locked (Miyazaki and Heki, 2001). Similarly, the relatively low level of microseismicity near the updip limits of the 1940s earthquakes (Obana et al., 2001) implies significant interseismic strain accumulation on the megathrust; however, recent observations of very low frequency (VLF) earthquake event swarms apparently taking place within the accretionary prism in the drilling area (Obara and Ito, 2005) demonstrate that interseismic strain is not confined to slow elastic strain accumulation.

The outer accretionary wedge seaward of the 1944 earthquake seismogenic zone is characterized by strongly deformed fold-and-thrust belts above the aseismic plate boundary. Similar spatial and geometric relationships are commonly observed at other accretionary prisms (Plafker, 1972). The mechanical relationship between great earthquake slip in seismogenic zones and slip and deformation in the outer wedge is not well understood. However, Wang and Hu (2006) have proposed that the forearc region can be described as a "dynamic critical wedge," and recent discoveries of low-frequency events within the accretionary wedge (Ito and Obara, 2006) suggest that deformation and slip may occur episodically as both high-frequency postseismic events or as much lower frequency, "slower" interseismic events. These factors contribute to both the evolution of the margin architecture and to the behavior of the system today (e.g., Park et al., 2002) (Figs. **F2, F7, F8**).

Seismic studies and site survey data

A significant volume of site survey data has been collected in the drilling area over many years, including multiple generations of two-dimensional seismic reflection (e.g., Park et al., 2002), wide-angle refraction (Nakanishi et al., 2002), passive seismicity (e.g., Obara et al., 2004), heat flow (Yamano et al., 2003), side-scan sonar, and swath bathymetry and submersible and ROV dive studies (Ashi et al., 2002). In 2006, Japan and the United States conducted a joint three-dimensional (3-D) seismic reflection survey over a ~11 km × 55 km area, acquired by PGS Geophysical, an industry service company. This 3-D data volume is the first deep-penetration, fully 3-D marine survey ever acquired for basic research purposes and has been used to refine selection of drill sites and targets in the complex megasplay fault region, define the regional structure and seismic stratigraphy, analyze physical properties of the subsurface through seismic attribute studies, and assess drilling safety. Further, these data will be used in conjunction with physical properties and geophysical data obtained from core analyses and both wireline logging and LWD to allow extensive and high-resolution integration of core, logs, and seismic data. The supporting site survey data for the NanTroSEIZE Stage 1 expeditions are archived at the IODP-MI Site Survey Data Bank (**ssdb.iodp.org**).

Scientific objectives

Operations at proposed Site NT1-03B will penetrate the frontal thrust, and those at proposed Site NT2-01B will target the shallow portion of the megasplay fault system, just seaward of the break in slope marking the boundary between the inner and outer accretionary wedge (Figs. **F3, F4**). At both sites, drilling will continue sufficiently far into the footwall sediments to fully characterize them. The overall scientific objectives at Sites NT1-03B and NT2-01B are to understand the following:

- The nature of slip along the frontal thrust and splay fault as related to large earthquakes:
    - Are earthquakes along the frontal thrust triggered by larger events within the seismogenic zone and are they tsunamigenic?
    - Is the megasplay an active blind thrust or an inactive fault?
    - What is the character of interseismic activity; locked, creeping, or producing VLF earthquakes?
- The evolution of the frontal thrust and splay fault:
    - What are the physical and chemical characteristics of the rocks outside, adjacent to, and within the fault zones?
    - How do these characteristics influence the behavior of these faults, and how do they reflect the history of fault zone development?
    - What are the relative and absolute age-depth relationships across the fault zones, and can slip histories and total displacements be inferred from these data?

Structural observations of cores, particularly in and surrounding the fault zone, will be of primary importance in characterizing the nature of slip and the past evolution of the splay fault. These observations will be integrated with imaging using the computed tomography scanner and downhole visualization logs collected during Expedition 314 (LWD Transect) and wireline logging. Core descriptions and physical property observations will characterize the consolidation state of the hanging wall and footwall and yield insight into the displacement history along the splay fault and the fluid response to fault slip. The shipboard physical property measurements will help ground-truth data from Expedition 314 (LWD Transect) and wireline logging. Age determinations above and below the fault will be extremely important to estimate displacement.

A further scientific objective is to understand the relationship between fluid behavior and slip and deformation:

- How do fluid pressure and consolidation state influence fault zone slip?
- Do fault zones provide conduits for fluid flow from depth?

Geochemical observations will provide important information on fluid flow within and surrounding the fault zones. For example, detailed characterization of veins can yield information on past fluid flow, whereas pore fluid anomalies along the fault zone are potential indicators of recent fluid flow. Temperature measurements, through in situ probes and wireline logging, provide information on background thermal gradient, which controls diagenetic reactions and can indicate areas of very rapid fluid flow from depth. Estimation of pore pressure is important to the scientific objectives; although in situ probe measurements have not yet been developed for the *Chikyu*, porosity will provide an indirect constraint. In addition, geotechnical tests on cores will provide data on consolidation state.

Drilling strategy, operations plan, and downhole measurements

To achieve the scientific objectives, our primary operations at proposed Sites NT1-03B and NT2-01B will be to core and obtain downhole in situ formation measurements. Our operations plan and time estimate is shown in Table **T1.** Coring will progress from the hydraulic piston coring system (HPCS) to the extended shoe coring system (ESCS) to the rotary core barrel (RCB) to obtain the highest quality, most complete core samples. Formation temperature measurements (third-generation advanced piston corer temperature tool [APCT-3] and Davis-Villinger Temperature Probe [DVTP]) will be conducted during coring operations. Following coring, we may run downhole wireline logging measurements, with the specific package of logging tools to be determined based on the results of Expedition 314, the LWD component of the Stage 1 operation. Currently, all wireline logging operations for Expedition 316 are contingency only and will only be run if there are significant problems with LWD operations.

Operations plan

The operations plan and time estimate (see Table **T1**) are based on formations and depths inferred from seismic and regional geological interpretations without benefit of prior drilling in this immediate area. We have also based our plans on information from the landward ODP Leg 190 and 196 Sites 1175, 1176, and 1178, which are located >200 km west-southwest. Expedition 314 on the *Chikyu* will conduct LWD operations at proposed Sites NT1-03B and NT2-01B prior to Expedition 316. The LWD holes drilled at each site will be referred to as Hole A in all cases. We will use these operations and data to guide the operations described below. Our expedition plans to conduct operations in one hole (B) at Site NT1-03B (Fig. **F4**) (a second hole, C, is available as an alternate if the scientific target is not attained) and two holes (B and C) at Site NT2-01B (Fig. **F6**). An abbreviated list of primary sites, holes, drilling depths, and contingency plans can be found in **"Site summaries."**

Proposed Site NT1-03B

Hole B

Hole B will be cored with the HPCS to refusal (~250 mbsf) and then with the ESCS to either (1) refusal, (2) significant problems with core quality, or (3) TD (~950 mbsf). We will conduct formation temperature measurements during HPCS coring (advanced piston corer temperature tool; APCT-3 if available) at a target spacing of every third core. Temperature probe measurements (DVTP or equivalent) will be taken during ESCS coring approximately every third core. If TD is reached in Hole B and LWD operations in Hole A were successful, the objectives of this site will have been reached, and Hole C (see below) operations will be cancelled.

Hole C

If the target objective is *not* reached in Hole B because of ESCS refusal or poor core quality/recovery, Hole C will be drilled to reach the objective. Hole C will be drilled without coring to ~10 m above the TD of Hole B, where RCB coring will start and continue to a total target depth of 950 mbsf, assuming hole conditions permit. After the hole is conditioned, loaded with mud, and the bit is released in the hole, we may conduct wireline logging if LWD operations were unsuccessful. The specifications of the logging runs will depend on whether LWD operations in Hole A were successfully conducted during Expedition 314 at this site. If LWD operations were successful and the full planned suite of measurements were taken, there will no wireline runs. If LWD operations were unsuccessful because of poor borehole conditions, it is unlikely that hole conditions will allow successful wireline logging. However, if LWD operations did not reach this site because of time limitations or were not successful because of mechanical issues, there will be a logging run with density, porosity, natural gamma radiation, and electrical resistivity (triple combination [triple combo]) and a second wireline logging run with sonic velocity, resistivity imaging, and gamma radiation. In addition, a vertical seismic profile (VSP) will be conducted. Side wall formation pressure and fluid sampling tools are under consideration. To better understand the temperature regime seaward of the seismogenic zone and to observe active fluid circulation, open-hole mud temperature measurements during logging will be important.

Proposed Site NT2-01B

Hole B

Hole B will be cored with the HPCS to refusal and then with the ESCS to refusal or 600 mbsf. Depending on core quality and recovery, we may switch to RCB in Hole B before refusal. We will conduct formation temperature measurements during HPCS coring (APCT-3 or equivalent) at a target spacing of every third core. Temperature probe measurements (DVTP or equivalent) will be taken during ESCS coring approximately every third core. TD for Hole B is 600 mbsf, and all operations in Hole B will cease once that depth is reached.

Hole C

Prior to drilling at Hole C, a jet-in test will be conducted to determine shallow subseafloor conditions. This will be followed by installation of a reentry cone and 20 inch surface casing to 60 mbsf. Hole C will be drilled without coring to ~10 m above the TD of Hole B, where RCB coring will start and continue to a total target depth of 1000 mbsf, assuming hole conditions permit. After the hole is conditioned, loaded with mud, and the bit is released in the hole, we may conduct wireline logging if LWD operations were unsuccessful. The specifications of the logging runs will depend on whether LWD operations were successfully conducted during Expedition 314 at this site.

If LWD operations were successful and the full planned suite of measurements were taken, there will be no wireline runs. If LWD operations were unsuccessful because of poor borehole conditions, it is unlikely that hole conditions will allow successful wireline logging. If LWD operations did not reach this site because of time limitations or were not successful because of mechanical issues, there will be a logging run with density, porosity, natural gamma radiation, and electrical resistivity (triple combo); a second wireline logging run with sonic velocity, resistivity imaging, and gamma radiation; and a VSP will be conducted. Side wall formation pressure and fluid sampling tools are under consideration. To better understand the temperature regime seaward of the seismogenic zone and to observe active fluid circulation, open-hole mud temperature measurements during logging will be important. Following wireline logging, Hole C will be opened to a diameter of 17-1/2 inch and 13-3/8 inch casing will be run to the TD of the hole and cemented.

If observations during the LWD operations (Expedition 314) or in Hole A indicate difficult hole conditions, a contingency plan is to install and cement 13-3/8 inch casing to a shallower depth determined by specific hole conditions and requirements. Drilling and coring will continue below the casing, and 9-5/8 inch casing will be installed and cemented into place after TD has been reached.

Future observatory plans

Tentative plans for future observatory work at Site NT2-01B Hole C include return to the borehole to perforate the casing and cement at three intervals: (1) above, (2) within, and (3) below the splay fault for pore pressure monitoring. These intervals will be identified using information from Expeditions 314 (LWD transect) and 316. After conducting packer tests within each interval to determine formation permeability, a CORK-II type installation will be used to hydraulically isolate the intervals with packers inside the casing. A thermistor string or self-contained temperature loggers will provide in situ temperature and temperature changes through time at these three intervals and shallower portions of the borehole, and potentially long-term chemical sampling can be conducted (with OsmoSamplers or equivalent). Additional future stage work will add a paired borehole at this site for cross-hole hydrogeologic testing and strainmeters/seismometer.

Contingency

Substantial risks to fully achieving our scientific objectives include (1) lack of data about hole conditions or formation properties, (2) seafloor conditions including slope (Fig. **F9**), and (3) potential problems with the Kuroshio Current (Fig. **F10**). There are minor risks associated with seafloor infrastructure (Fig. **F11**) and gas hydrate occurrence (Fig. **F12**); however, these factors have been well characterized and pose little or no risk. To mitigate any risks, we have devised a contingency strategy, as described below (Fig. **F13**). It is important to note that this contingency plan is based on our current state of knowledge at the time of writing this *Scientific Prospectus* and may be modified based on continuing NanTroSEIZE Project Management Team (NT-PMT) discussions, on continuing processing and interpretation of 3-D seismic data, and actual NanTroSEIZE Stage 1 operations. This contingency plan also reflects the linked objectives of multiple NanTroSEIZE Stage 1 expeditions by inclusion of “global” Stage 1 riserless coring objectives that would achieve overarching NanTroSEIZE and Stage 1 objectives.

Proposed Site NT1-03

Proposed Site NT1-03B is the primary choice of locations to achieve the frontal thrust objectives. This site has an estimated seafloor slope of 10°, and estimated depth to the frontal thrust is ~600 mbsf. Drilling conditions and data from Expedition 314 (LWD transect) will be used to decide the final drilling strategy at Site NT1-03. The primary plan is to drill with no reentry cone or casing if LWD indicates hole conditions are good. If Expedition 314 results indicate unstable hole conditions or if poor hole conditions are encountered at Hole B in this expedition, drilling in Site NT1-03B Hole C could use a reentry cone and case shallow unstable zones if time allows. Additional contingencies include moving to alternate Sites NT1-03A (second choice) or NT1-03C (third choice). Site NT1-03A has an estimated seafloor slope of 12°, which is at the limit for installation of a reentry cone and surface casing. If a reentry cone and casing are deemed necessary to achieve the objectives at this site, this alternative may not be acceptable unless camera or submersible survey identifies a suitably flat location.

An additional uncertainty exists in the estimated depth of the frontal thrust resulting from potential inaccuracies in the velocity model. If the fault zone is shallower than expected, drilling may stop above the 950 mbsf nominal TD. If the fault zone is deeper than expected, additional drilling may be needed if time allows.

Proposed Site NT2-01

If LWD in Hole A (Expedition 314) or drilling in Hole B (Expedition 316) indicates unstable hole conditions, the contingency plan for Hole C, as discussed above, is to install 13-3/8 inch casing, drill and core, then install 9-5/8 inch casing. A strong Kuroshio Current could make casing operations difficult. In this case, a potential strategy would be to drill and RCB core as far as possible without a reentry cone and casing.

An additional uncertainty exists in the estimated depth of the splay fault resulting from potential inaccuracies in the velocity model. If the splay fault is shallower than expected, drilling may stop above the 1000 mbsf nominal TD. If the fault zone is deeper than expected, additional drilling may be needed if time allows.

If currents or hole conditions do not allow operations at Sites NT1-03 or NT2-01 or if we complete our objectives with sufficient time, we will proceed to coring at any remaining “global” Stage 1 riserless contingency sites. These global contingency sites were identified by the NT-PMT as important toward achieving overall scientific objectives of NanTroSEIZE Stage 1 drilling and will serve as common contingency sites for all of the Stage 1 expeditions. Coring at these contingency sites will follow in the order described as follows, beginning with the first site not already drilled during contingency operations during previous Stage 1 expeditions. Operations at all of these sites may require casing depending on hole conditions.

- Deepening of Site NT1-03. This would consist of drilling without coring to ~10 m above the previous total depth of Site NT1-03 and RCB coring as time and conditions allow. Spot coring of the frontal thrust or other targets to provide additional core material would be considered, depending on core recovery during earlier drilling.
- Coring and wireline logging of Site NT2-04. This site penetrates Kumano Basin sediments to document the history of deposition in the basin related to slip on the splay fault system.
- Drilling, coring, and wireline logging at Site NT1-04. This site will provide additional information about physical properties, pore water geochemistry, and hydrogeology of turbidites within the Shikoku Basin beneath rapidly deposited trench-wedge turbidites at a location between Sites NT1-03 and NT1-07.
- Drilling, coring, and wireline logging at Site NT1-02. This site will document subduction inputs at a site along strike from Site NT1-01 to characterize along-strike variability.

Sampling and data sharing strategy

NanTroSEIZE Stage 1 expeditions are a single coordinated science program

To maximize the science return, the three Stage 1 expeditions will be implemented as a single science program with samples and data shared across all three expeditions. This presents unique opportunities and challenges to ensure overall NanTroSEIZE project success, individual expedition success, and realization of each individual participant's scientific objectives.

We have not finalized all of the details, processes, and mechanisms for sample and data sharing, but members of the management structure (IODP-MI, SAS, NT-PMT, Co-Chief Scientists, CDEX, and USIO) are committed to working with the scientific participants to ensure effective and efficient implementation of the overall science plan.

Three key points related to overall research planning are as follows:

1. *Specialty Coordinators.* Unlike traditional stand-alone ODP-IODP legs and expeditions, unusual amounts of coordination and collaboration must occur among science parties across the three Stage 1 expeditions. Specialty Coordinators will be responsible for facilitating these essential collaborations. The NT-PMT has identified six specific research areas that require special effort over the project's duration. These include (a) lithostratigraphy and sedimentary petrology, (b) structural geology, (c) geotechnical properties and hydrogeology, (d) geochemistry, (e) log-seismic integration, and (f) paleomagnetism and biostratigraphy. Specialty Coordinators will provide technical and scientific guidance to each science party and facilitate cross-expedition collaborations among the science parties to achieve NanTroSEIZE Stage 1 objectives.
2. *Community samples.* As usual, individual scientists will collect samples for shipboard analyses and their postcruise research. In addition, however, we intend to collect substantial numbers of "community" archive samples, especially whole-round (WR) cores. In some cases, these community samples will augment and/or provide redundancy for those requested by shipboard scientists. The goal is to preserve samples for a wide range of overall science objectives over the duration of the NanTroSEIZE project.
3. *Sample clusters.* To ensure achievement of Stage 1 and overall NanTroSEIZE scientific objectives, it will be essential to co-locate suites of essential data types. This must be done with appropriate and consistent sample spacing throughout each site's stratigraphic succession and across all Stage 1 sites.

Research plan proposals (sample and data requests)

Shipboard and shore-based researchers should refer to the IODP Sample, Data, and Obligations Policy (**www.iodp.org/program-policies**). This document outlines the policy for distributing IODP samples and data and defines the obligations that sample and data recipients incur.

A coordinated Stage 1 research plan covering all samples and data is required well in advance of the first expedition that is scheduled to start in September 2007. Scientists must submit their research plans using the Sample/Data Request form available at **www.iodp.org/access-data**. This will be required much earlier for the NanTroSEIZE Stage 1 expeditions to ensure coordination among the three Stage 1 expeditions. The coordinated Stage 1 research plan will be developed prior to the first NanTroSEIZE Stage 1 expedition with substantial involvement and interaction of Stage 1 expedition Co-Chief Scientists, science participants, and Specialty Coordinators. We expect all of the individual expedition participants to honor expedition-specific as well as cross-expedition objectives and priorities. Substantial collaboration and cooperation will be required.

Access to data and core samples for specific research purposes, both during each expedition and during the subsequent 1 y moratorium, must be approved by the Sample Allocation Committee (SAC) for that particular expedition. The moratorium for NanTroSEIZE Stage 1 will extend 1 y from the completion of the last of the three Stage 1 expeditions, or if a significant postcruise sampling party is required, 1 y following the completion of the sampling party.

The SAC is composed of the Co-Chief Scientists, Staff Scientist, and IODP Curator on shore, and curatorial representatives in place of the curator on board ship. For NanTroSEIZE Stage 1, there is a SAC for each expedition. All three SACs will contribute to the overall coordinated research planning effort. The six Specialty Coordinators will also contribute to this process as project-wide representatives of their respective disciplines.

Based on research (sample and data) requests submitted, the SAC will work with the scientific party, other Stage 1 SACs, and Specialty Coordinators to formulate a formal expedition-specific sampling and data-sharing plan for shipboard and postcruise activities. This plan will be subject to modification depending upon the actual material/data recovered and collaborations that may evolve between scientists before and during the Stage 1 expeditions. Modifications to the sampling plan during the expedition require the approval of the SAC.

All sample frequencies and sizes must be justified on a scientific basis and will depend on core recovery, the full spectrum of other requests, the expedition objectives, and project-wide NanTroSEIZE objectives. Success will require substantial amounts of cross-expedition collaboration, integration of complementary data sets, and consistent methods of analysis.

When critical intervals are recovered, there may be considerable demand for samples from a limited amount of cored material. These intervals (e.g., highly deformed fault zone) may require special handling, a higher sampling density, reduced sample size, or continuous core sampling for a set of particular high-priority research objectives. The SAC may require an additional formal sampling plan before critical intervals are sampled.

All sampling to acquire ephemeral data types or achieve essential sample preservation will be conducted during the expedition. Sampling for individual scientists postcruise research may be conducted during the expedition or may be deferred to postcruise. The working plan will be based on the coordinated Stage 1 research plan to be developed prior to the first Stage 1 expedition. Following Expedition 316 and all NanTroSEIZE Stage 1 expeditions, cores will be delivered to the IODP Core Repository at Kochi University, Japan.

Cruise-specific sampling

The unique nature of the NanTroSEIZE project requires some adaptation of existing IODP policies and procedures. As scientists develop their individual research plans for core samples and data, they should refer to this expedition's scientific objectives (see above), the other Stage 1 expeditions, as well as the overarching Stage 1 *Scientific Prospectus* (Tobin and Kinoshita, 2006a).

We anticipate an extensive sampling program to achieve research objectives within most disciplines. When possible, our goal will be to make as many measurements as possible on common (or nearly co-located) samples, thus reducing the amount of material removed from the core and maximizing our ability to correlate different data types. These sample clusters (e.g., pore water, carbon carbonate, moisture and density, bulk X-ray diffraction, clay X-ray diffraction, and bulk chemistry) will also improve our ability to complete routine complementary postcruise analyses. Substantial whole-round core sampling will be conducted to obtain appropriate samples for ephemeral shipboard analyses and to appropriately preserve samples for postcruise research. Such whole-round samples are especially important for geotechnical and rock mechanical tests (e.g., permeability, consolidation, triaxial, ring-shear, etc.). Because different laboratories employ different protocols and have different capabilities and limitations (e.g., elevated temperature, stress ranges, and strain rates), there are no rigorous standardized approaches for many of the critical measurements. This, combined with a need for comprehensive characterization of core materials over the broadest possible range of experimental conditions, requires a coordinated sampling approach. Experience further shows that it is impossible to identify all of the critical sampling intervals before the cores are split. Therefore, not only will whole-round samples be extracted for individual scientist's research, we will also to build a community archive. The community whole-round specimens will be stored at the repository (Kochi) and released to scientists only after they file appropriate sample requests. These samples will be used primarily to ensure that there are no critical gaps in sample characterization with respect to both spatial sample distribution and scientific data types generated, for interlaboratory calibration, redundancy, and quality assurance/ quality control (QA/QC).

Community labs for postexpedition analyses

Whereas many analyses can and will be conducted at sea, others require state-of-the-art instrumentation that is only available onshore. We are particularly concerned about stable isotopic measurements that depend upon dedicated instruments not found at all universities and government laboratories. For example, we expect to collect pore waters to measure at least Sr, B, Li, O, H, Cl, and C stable isotopic compositions. It is doubtful that any individual scientist has the onsite capability to make all of the measurements listed above. Issues regarding QA/QC become significant. To get the most consistent and reliable data for all Stage 1 expeditions, the NT-PMT has proposed that all samples for each category of geochemical analysis go to a single laboratory. Several laboratories (to be determined) will have to be involved. For example, one laboratory might measure O, H, and C isotopes, whereas another might measure Cl isotopes or Li. The choice of a particular laboratory (and analytical technique) will be reached by consensus of the inorganic geochemists who sail on the Stage 1 coring expeditions, mediated by the Specialty Coordinator in geochemistry and approved by the expedition SAC. We anticipate that data generated from each laboratory will be shared by all members of the Stage 1 scientific party for use as defined by the approved research plans.

References

Ando, M., 1975. Source mechanisms and tectonic significance of historical earthquakes along the Nankai Trough, Japan. *Tectonophysics,* 27(2):119–140. **doi:10.1016/0040-1951(75)90102-X**

Ashi, J., Kuramoto, S., Morita, S., Tsunogai, U., Goto, S., Kojima, S., Okamoto, T., Ishimura, T., Ijiri, A., Toki, T., Kudo, S., Asai, S., and Utsumi, M., 2002. Structure and cold seep of the Nankai accretionary prism off Kumano—outline of the off Kumano survey during YK01-04 Leg 2 cruise. *JAMSTEC J. Deep Sea Res.,* 20:1–8.

Baba, T., and Cummins, P.R., 2005. Contiguous rupture areas of two Nankai Trough earthquakes revealed by high-resolution tsunami waveform inversion. *Geophys. Res. Lett.,* 32(8):L08305. **doi:10.1029/2004GL022320**

Baba, T., Cummins, P.R., and Hori, T., 2005. Compound fault rupture during the 2004 off the Kii Peninsula earthquake (M 7.4) inferred from highly resolved coseismic sea-surface deformation. *Earth, Planets Space,* 57(3):167–172.

Byrne, D.E., Davis, D.M., and Sykes, L.R., 1988. Loci and maximum size of thrust earthquakes and the mechanics of the shallow region of subduction zones. *Tectonics,* 7:833–857.

Hickman, S., Zoback, M., and Ellsworth, W., 2004. Introduction to special section: preparing for the San Andreas Fault Observatory at depth. *Geophys. Res. Lett.,* 31(12):L12S01. **doi:10.1029/2004GL020688**

Hori, T., Kato, N., Hirahara, K., Baba, T., and Kaneda, Y., 2004. A numerical simulation of earthquake cycles along the Nankai Trough in southwest Japan: lateral variation in frictional property due to the slab geometry controls the nucleation position. *Earth Planet. Sci. Lett.,* 228(3–4):215–226. **doi:10.1016/j.epsl.2004.09.033**

Ichinose, G.A., Thio, H.K., Somerville, P.G., Sato, T., and Ishii, T., 2003. Rupture process of the 1944 Tonankai earthquake (M_s 8.1) from the inversion of teleseismic and regional seismograms. *J. Geophys. Res.,* 108(B10):2497. **doi:10.1029/2003JB002393**

Ito, Y., and Obara, K., 2006. Very low frequency earthquakes within accretionary prisms are very low stress-drop earthquakes. *Geophys. Res. Lett.,* 33(9):L09302. **doi:10.1029/2006GL025883**

Kame, N., Rice, J.R., and Dmowska, R., 2003. Effects of prestress state and rupture velocity on dynamic fault branching. *J. Geophys. Res.,* 108(B5):2265. **doi:10.1029/2002JB002189**

Kikuchi, M., Nakamura, M., and Yoshikawa, K., 2003. Source rupture processes of the 1944 Tonankai earthquake and the 1945 Mikawa earthquake derived from low-gain seismograms. *Earth, Planets Space,* 55(4):159–172.

Kimura, G., Kitamura, Y., Hashimoto, Y., Yamaguchi, A., Shibata, T., Ujiie, K., and Okamoto, S., 2007. Transition of accretionary wedge structures around the up-dip limit of the seismogenic subduction zone. *Earth Planet. Sci. Lett.,* 225(3–4):471–484. **doi:10.1016/j.epsl.2007.01.005**

Lay, T., Kanamori, H., Ammon, C.J., Nettles, M., Ward, S.N., Aster, R.C., Beck, S.L., Bilek, S.L., Brudzinski, M.R., Butler, R., DeShon, H.R., Ekström, G., Satake, K., and Sipkin, S., 2005. The great Sumatra-Andaman earthquake of 26 December 2004. *Science,* 308(5725):1127–1133. **doi:10.1126/science.1112250**

Ma, K., 2005. Slip zone and energetic of a large earthquake from seismological modeling and fault core of TCDP. *Eos, Trans. Am. Geophys. Union,* 86(52):T43D-02. (Abstract)

Miyazaki, S., and Heki, K., 2001. Crustal velocity field of southwest Japan: subduction and arc-arc collision. *J. Geophys. Res.,* 106(B3):4305–4326. **doi:10.1029/2000JB900312**

Moore, G.F., Taira, A., Klaus, A., et al., 2001. *Proc. ODP, Init. Repts.,* 190: College Station, TX (Ocean Drilling Program). **doi:10.2973/odp.proc.ir.190.2001**

Moore, J.C., and Saffer, D., 2001. Updip limit of the seismogenic zone beneath the accretionary prism of southwest Japan: an effect of diagenetic to low-grade metamorphic processes and increasing effective stress. *Geology,* 29(2):183–196. **doi:10.1130/0091-7613(2001)029<0183:ULOTSZ>2.0.CO;2**

Nakanishi, A., Takahashi, N., Park, J.-O., Miura, S., Kodaira, S., Kaneda, Y., Hirata, N., Iwasaki, T., and Nakamura, M., 2002. Crustal structure across the coseismic rupture zone of the 1944 Tonankai earthquake, the central Nankai Trough seismogenic zone. *J. Geophys. Res.,* 107(B1):2007. **doi:10.1029/2001JB000424**

Obana, K., Kodaira, S., Mochizuki, K., and Shinohara, M., 2001. Micro-seismicity around the seaward updip limit of 1946 Nankai earthquake dislocation area. *Geophys. Res. Lett.,* 28(12):2333–2336. **doi:10.1029/2000GL012794**

Obara, K., Hirose, H., Yamamizu, F., and Kasahara, K., 2004. Episodic slow slip events accompanied by nonvolcanic tremors in southwest Japan subduction zone. *Geophys. Res. Lett.,* 31:L23602. **doi:10.1029/2004GL020848**

Obara, K., and Ito, Y., 2005. Very low frequency earthquakes excited by the 2004 off the Kii Peninsula earthquakes: a dynamic deformation process in the large accretionary prism. *Earth, Planets Space,* 57(4):321–326.

Park, J.-O., Tsuru, T., Kodaira, S., Cummins, P.R., and Kaneda, Y., 2002. Splay fault branching along the Nankai subduction zone. *Science,* 297(5584):1157–1160. **doi:10.1126/science.1074111**

Plafker, G., 1972. Alaskan earthquake of 1964 and Chilean earthquake of 1960: implications for arc tectonics. *J. Geophys. Res.,* 77(5):901–925.

Ruff, L., and Kanamori, H., 1983. Seismic coupling and uncoupling at subduction zones. *Tectonophysics,* 99(2–4):99–117. **doi:10.1016/0040-1951(83)90097-5**

Saffer, D.M., and Marone, C., 2003. Comparison of smectite- and illite-rich gouge frictional properties: application to the up-dip limit of the seismogenic zone along subduction megathrusts. *Earth Planet. Sci. Lett.,* 215(1–2):219–235. **doi:10.1016/S0012-821X(03)00424-2**

Seno, T., Stein, S., and Gripp, A.E., 1993. A model for the motion of the Philippine Sea plate consistent with NUVEL-1 and geological data. *J. Geophys. Res.,* 98:17941–17948.

Tanioka, Y., and Satake, K., 2001. Detailed coseismic slip distribution of the 1944 Tonankai earthquake estimated from tsunami waveforms. *Geophys. Res. Lett.,* 28(6):1075–1078. **doi:10.1029/2000GL012284**

Tobin, H., and Kinoshita, M., 2006a. NanTroSEIZE: the IODP Nankai Trough seismogenic zone experiment. *Sci. Drill.,* 2:23–27. **doi:10.2204/iodp.sd.2.06.2006**

Tobin, H.J., and Kinoshita, M., 2006b. Investigations of seismogenesis at the Nankai Trough, Japan. IODP Sci. Prosp., NanTroSEIZE Stage 1. **doi:10.2204/iodp.sp.nantroseize1.2006**

Wang, K., and Hu, Y., 2006. Accretionary prisms in subduction earthquake cycles: the theory of dynamic Coulomb wedge. *J. Geophys. Res.,* 111(B6):B06410. **doi:10.1029/2005JB004094**

Yamano, M., Kinoshita, M., Goto, S., and Matsubayashi, O., 2003. Extremely high heat flow anomaly in the middle part of the Nankai Trough. *Phys. Chem. Earth,* 28(9–11):487–497. **doi:10.1016/S1474-7065(03)00068-8**

Table T1. Operation plan and time estimate for Expedition 316. (**See table notes.** Continued on next page.)

Hole	PTD (mbsf)	Water depth (m)	Total (mbsl)	Operation	Estimated days	Number of cores
Proposed Site NT1-03						
B	600	3955	4555	Move to site, preparation for drilling (BHA, etc.)	1.0	
				RIH HPCS/ESCS	0.5	
				Core with HPCS/ESCS to 600 mbsf: - HPCS and ESCS to PTD; if cannot reach PTD, go to Hole C - Require core orientation - Hole size: 11-7/16 inch - Temperature measurement every 50 m by APCT-3 or DVTP (0.5 days)	5.5	63
				POOH, lay out HPCS/ESCS	1.0	
				Total drilling days:	8.0	
C	950	3955	4905	Move to Hole C, RIH RCB	0.5	
				Drill to 600 mbsf by RCB: - If Hole A <PTD, start core at Hole A refusal depth (take overlapping cores in Hole C) - Limit progress to 400 m per day to maintain good hole - Hole size: 9-7/8 inch	1.5	
				Core with RCB to 950 mbsf: - Take 400 m of core by RCB - Take overlapping core of Hole B - Penetration rate: 100 m per day	3.5	37
				Displace with weighted mud, POOH, lay out RCB assembly	1.0	
				Total drilling days:	6.5	
Proposed Site NT2-01						
B	600	2391	2991	Move to site (13 nmi), RIH HPCS/ESCS assembly	1.0	
				Core with HPCS/ESCS to 600 mbsf: - HPCS/ESCS to PTD; if cannot reach PTD, go to Hole C - Require core orientation - Hole size: 11-7/16 inch - Temperature measurement every 50 m by APCT-3 or DVTP	5.5	64
				POOH, lay out HPCS/ESCS assembly	0.5	
				Retrieve guidehorn	0.5	
				Total drilling days:	7.5	

Table T1 (continued).

Hole	PTD (mbsf)	Water depth (m)	Total (mbsl)	Operation	Estimated days	Number of cores
C	1000	2391	3391	Move to Hole C, set riserless wellhead with 20 inch casing	2.0	
				Install guidehorn	0.5	
				RIH RCB assembly	0.5	
				Drill with RCB to 600 mbsf: - If Hole B <PTD, take core from Hole A refusal depth - Limit progress to 400 m per day to maintain good hole - Hole size: 9-7/8 inch	1.5	
				Core with RCB to 1000 m - Take 400 m core by RCB - Take overlapping core of Hole A - Penetration rate: 100 m per day	4.0	43
				POOH	0.5	
				RIH hole opener	0.5	
				Open hole to 17-1/2 inch (penetration rate: 400 m per day)	2.5	
				Wiper trip, spot high-viscosity mud, POOH stand-back hole opener	1.0	
				Run 13-3/8 inch casing	1.0	
				Cement with POOH running tool	0.5	
				Retrieve guidehorn, etc.	1.0	
				Total drilling days:	15.5	
				Expedition 316 total drilling days:	37.5	
				Transit between base and location:	0.5	
				Equipment and fuel supply before expedition:	0.0	
				Equipment discharge after expedition:	2.0	
				Total operation days (without contingency):	40.0	
				Contingency (including weather and equipment downtime):	9.5	
				Expedition 316 total operation days:	49.5	

Notes: PTD = proposed total depth. HPCS = hydraulic piston coring system, ESCS = extended shoe coring system, RCB = rotary core barrel, BHA = bottom-hole assembly. RIH = run in hole, POOH = pull out of hole. DVTP = Davis-Villinger Temperature Probe, APCT-3 = third-generation advanced piston corer temperature tool.

Figure F1. A. Nankai Trough off southwestern Japan is the locus of subduction of the Philippine Sea plate (PSP) beneath Honshu and Shikoku islands. Yellow arrow = convergence direction between PSP and Japan. Rupture zones of the last two great subduction earthquakes (1944 and 1946) are also shown. Stars = epicenter locations for earthquake nucleation. Red dashed line = Kumano Basin drilling area. In inset, EP = Eurasian plate, PP = Pacific plate, NAP = North American plate. (Continued on next page.)

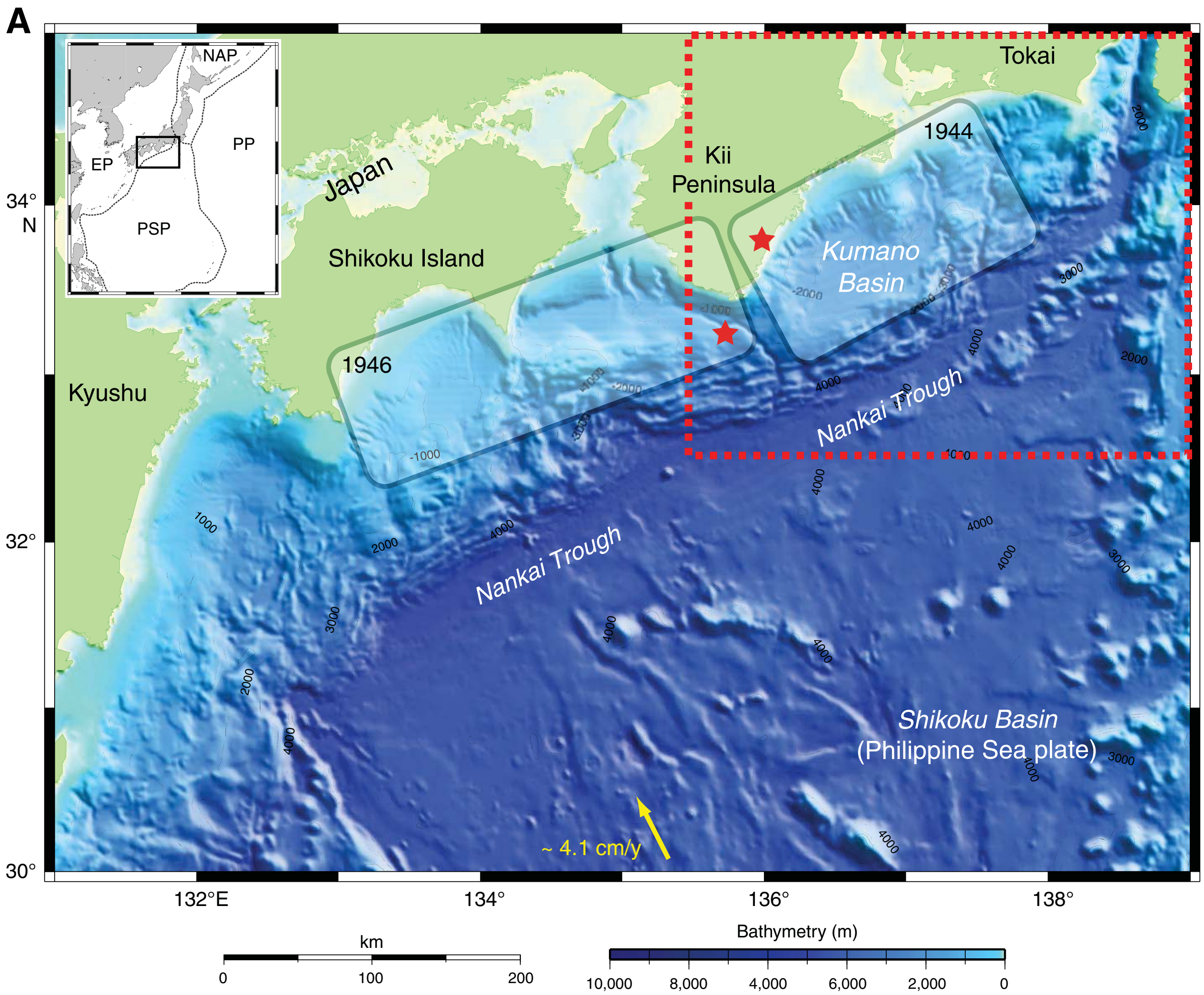


Figure F1 (continued). B. Bathymetric map of Kumano Basin region, with all multichannel seismic profile locations and planned Stage 1 drill sites (primary and alternates). Expedition 316 will occupy proposed Sites NT1-03 and NT2-01. Portions of Line 5 and Line L (thick black line) shown in Figures F2 and F3, respectively. White barbed line = position of deformation front of accretionary prism, yellow arrow = convergence vector between Philippine Sea plate and Japanese Islands (Eurasian plate), red dots = planned future riser drilling sites, yellow and orange dots = riserless sites.

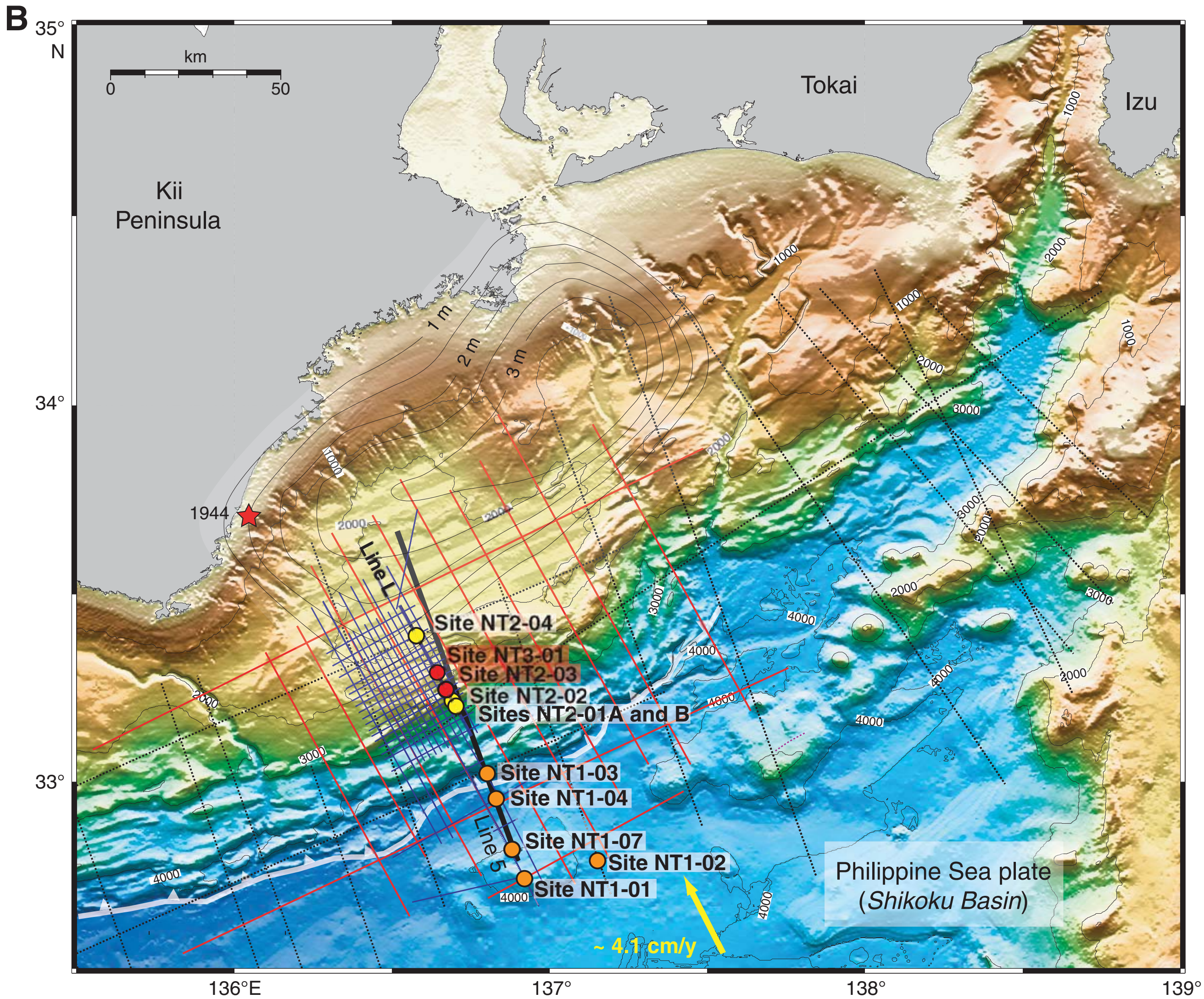


Figure F2. A. Uninterpreted seismic Line KR0108-5 (prestack, depth migration) showing the structure of the Nankai Trough accretionary prism in the area selected for drilling operations (from Park et al., 2002). Location of Line KR0108-5 is shown in Figure **F1B. B.** Interpretation of Line KR0108-5 showing locations of Stage 1 sites proposed for logging while drilling, coring, and downhole measurement/CORK installation, after Tobin and Kinoshita (2006b). Black rectangles = total depth planned for Stage 1, empty rectangles = planned total depth for future operations. The extent of coseismic rupture in the 1944 M 8.1 Tonankai great earthquake determined from tsunami (Tanioka and Satake, 2001) and seismic (Kikuchi et al., 2003) waveform inversions are shown above the seismic line by red and blue arrows, respectively. (Continued on next page.)

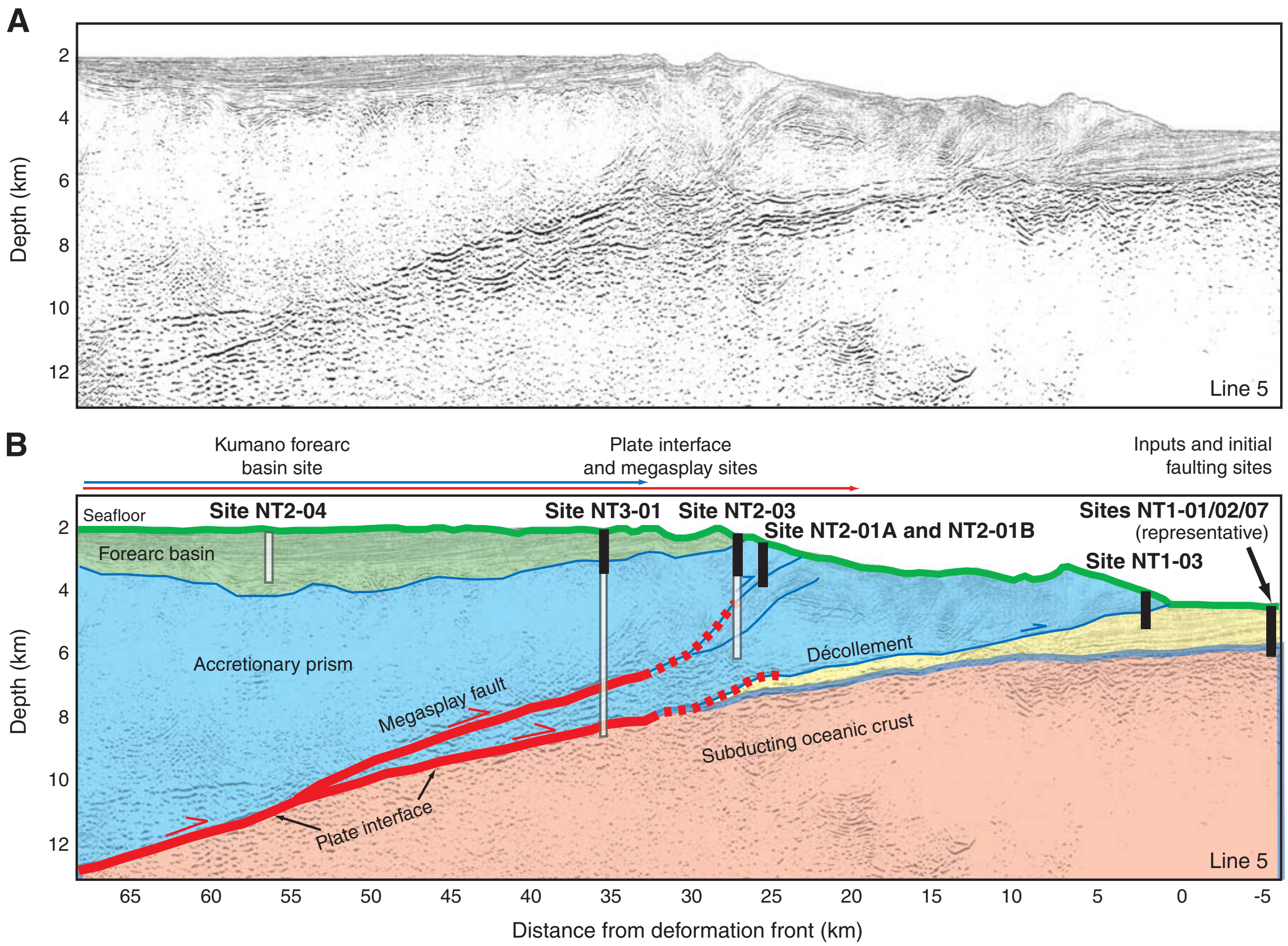
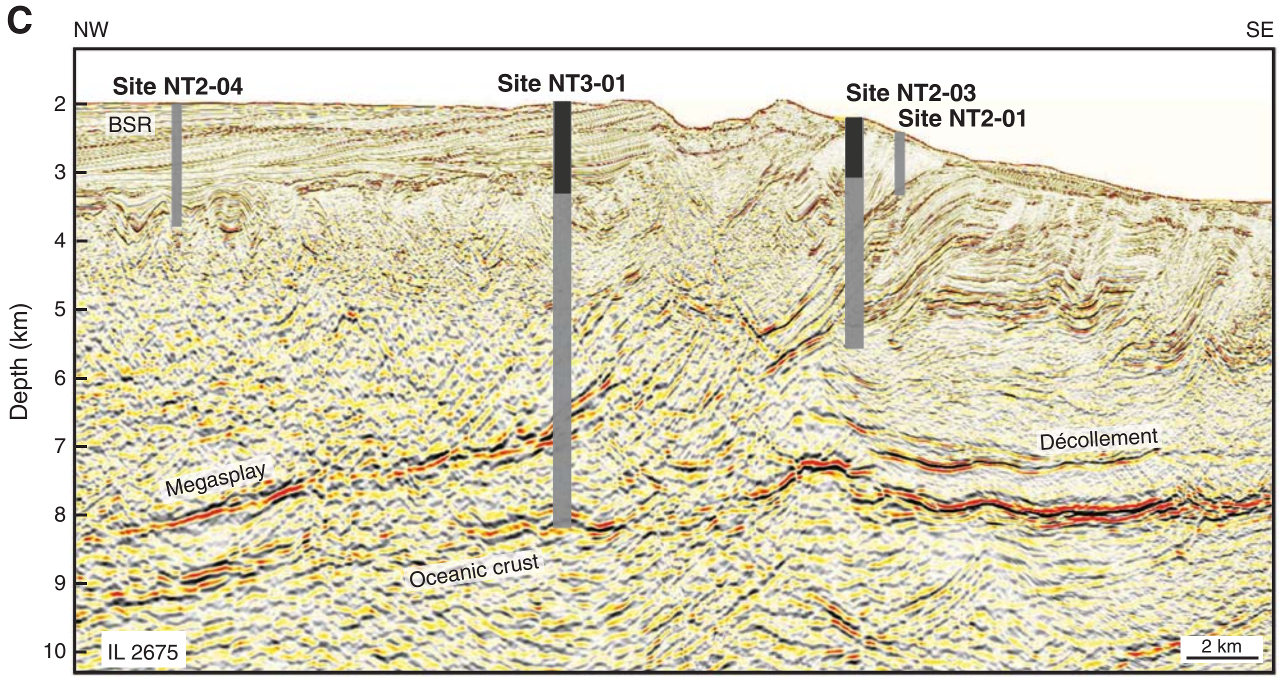


Figure F2 (continued). Drill sites (Fig. F1B) shown overlain on (**C**) uninterpreted depth migrated seismic three-dimensional Inline 2675 (vertical exaggeration [V.E.] = 2) and (**D**) IFREE Line 95 (V.E. = 4.6). Black rectangles = total depth planned for Stage 1, empty rectangles = planned total depth for future operations.



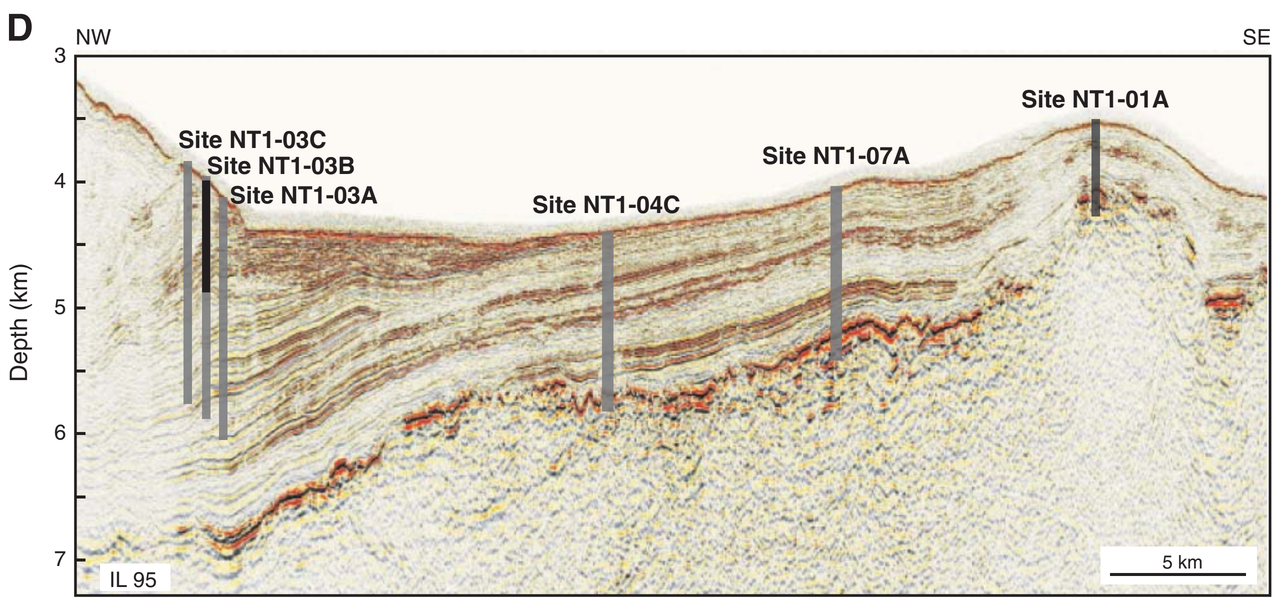


Figure F3. Bathymetry and site locations for proposed Holes NT1-03A, NT1-03B, and NT1-03C. Hole NT1-03B is the primary and Holes NT1-03A (first choice) and NT1-03C (second choice) are alternates.

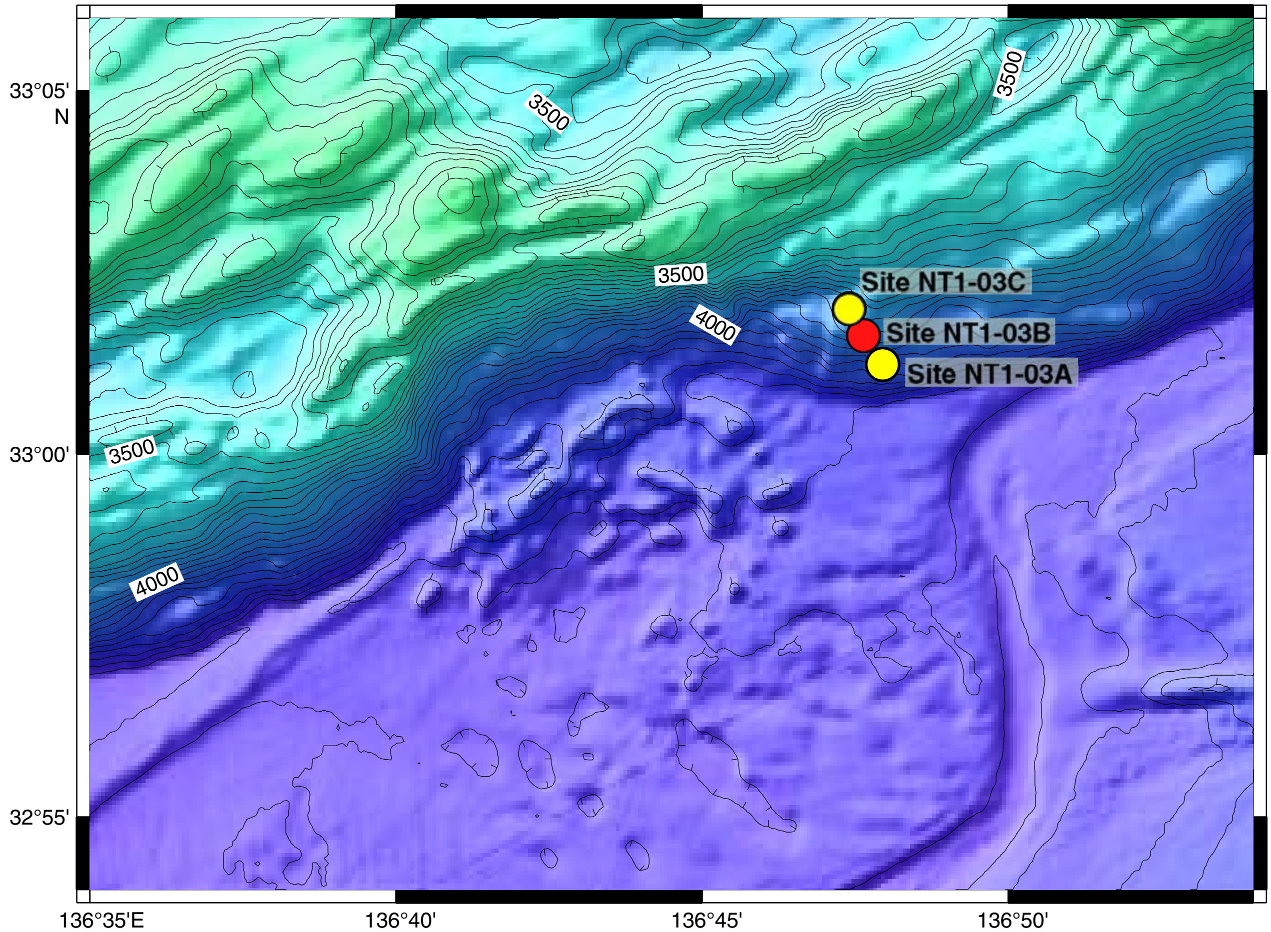


Figure F4. High-resolution, time-migrated three-dimensional seismic profiles through proposed Site NT1-03. Three holes are shown; Hole NT1-03B has been designated as the primary target, Hole NT1-03A is the first choice alternate, and Hole NT1-03C is the last choice. Thick black lines represent scheduled drilling depth targets for Expedition 316 and thinner black lines represent approved depths for deeper drilling, as they constitute a scientifically valuable target and represent a viable contingency site for all operations. All three holes penetrate the package of bright reflectors interpreted to represent the frontal thrust at ~6 s two-way traveltime (interpreted to be ~850 mbsf and deepening toward the backarc). Hole NT1-03B was chosen to mitigate the risks associated with steep seafloor slopes found at the location of Hole NT1-03A, and so avoiding the significantly deeper required total depth in Hole NT1-03C. Vertical exaggeration = 2.5.

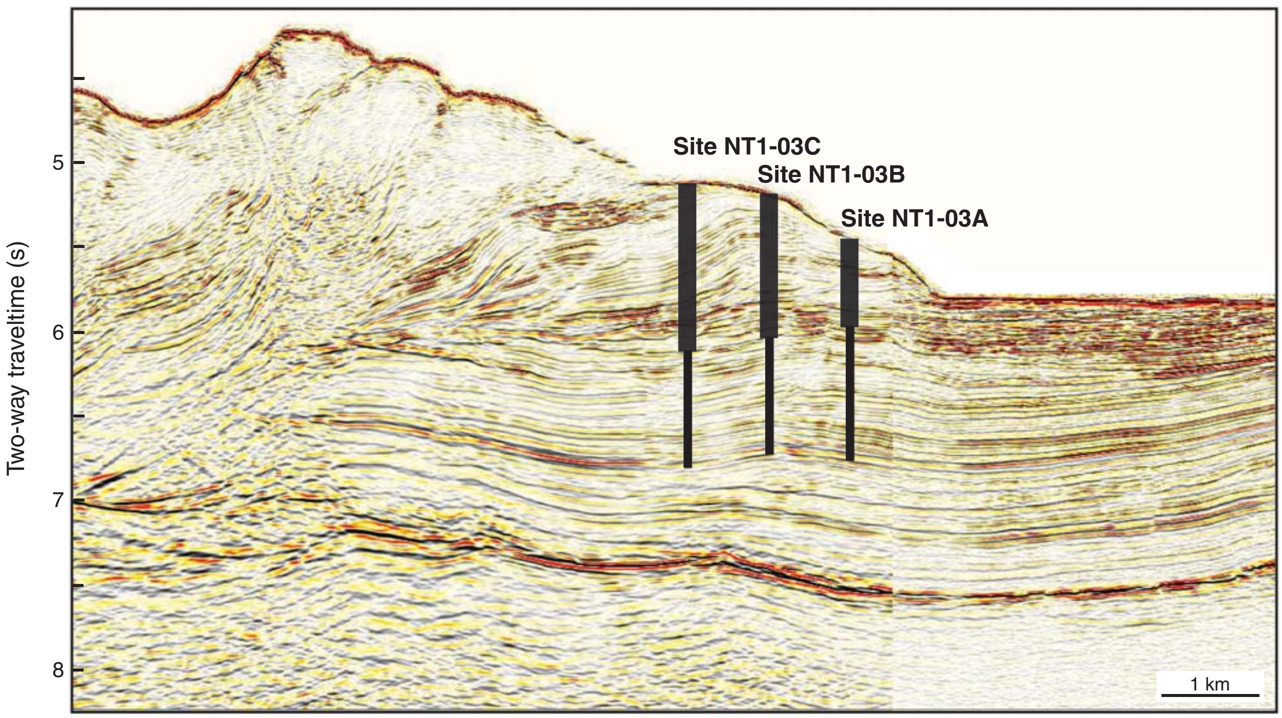


Figure F5. Bathymetry, drill sites, and location of high-resolution three-dimensional seismic survey (gray box). Red dots = Holes NT2-01B and NT1-03B, red lines = seismic lines used for this *Scientific Prospectus*.

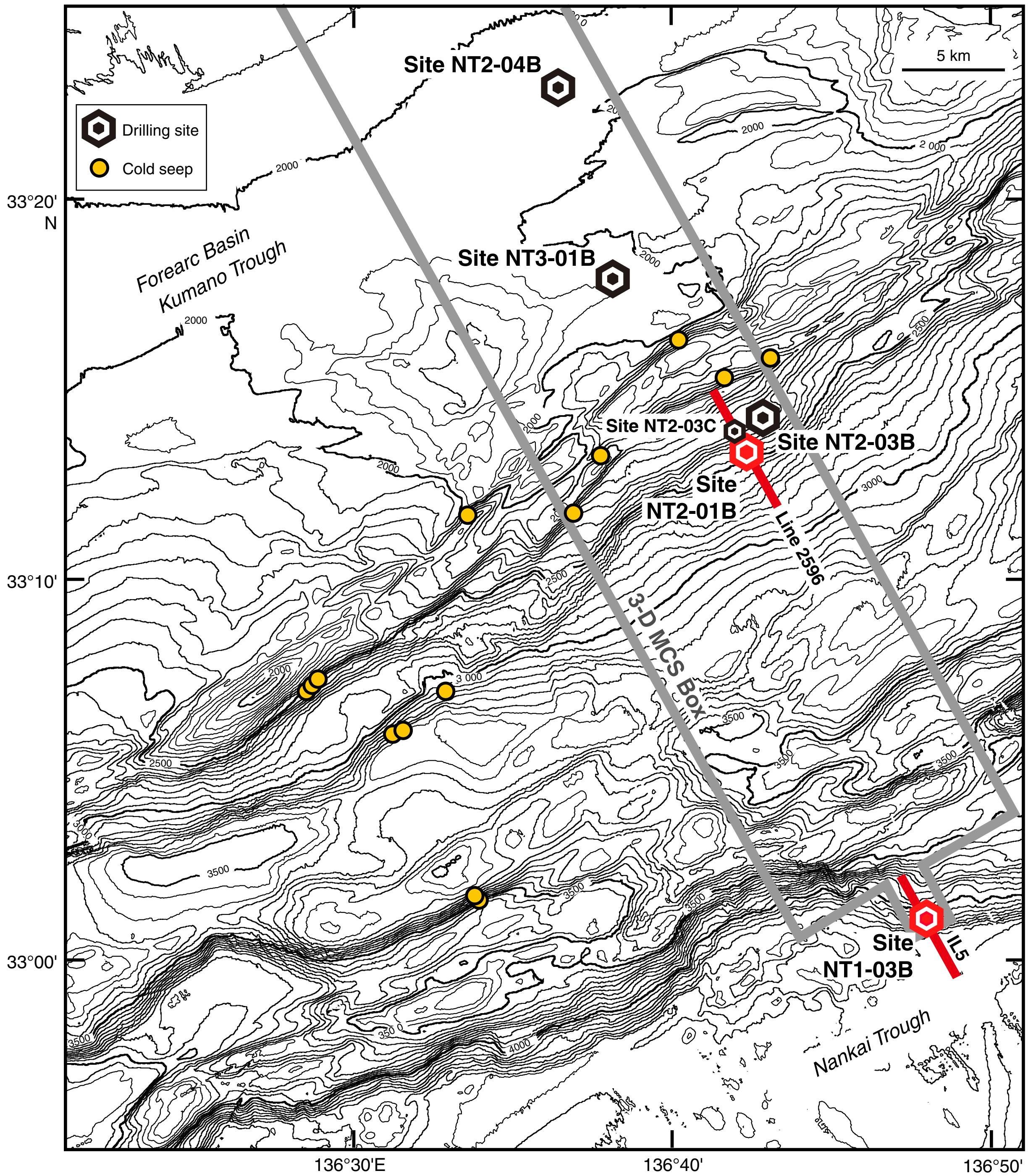


Figure F6. High-resolution, time-migrated three-dimensional seismic profile through proposed Sites NT2-01 and NT2-03. Holes NT2-01B and NT2-03C will be drilled and cored, with Hole NT2-01B designated as the primary target. Casing will be installed in Hole NT2-03C. Gray lines = scheduled drilling depth targets for Expedition 316. The primary target zone is the package of bright reflectors interpreted to represent the shallow megasplay at ~4 s two-way traveltime (interpreted to be ~600–800 mbsf). Vertical exaggeration = 2.2.

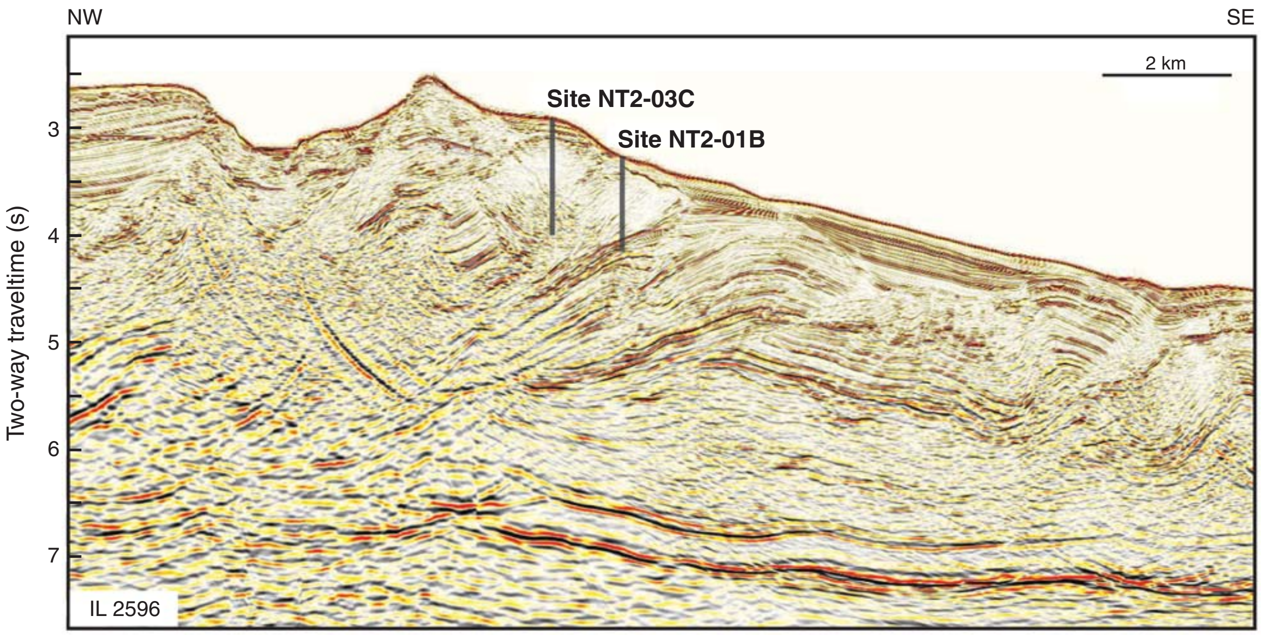


Figure F7. Conceptual model of forearc basin development at the seaward edge of the Kumano Basin based on the seismic reflection data. Basin formation and development is significantly governed by megasplay fault activity. Dashed line = inactive thrust fault, dotted lines = sequence boundaries, black arrows = direction of coseismic slip, blue arrows = up lift associated with the fault slip.

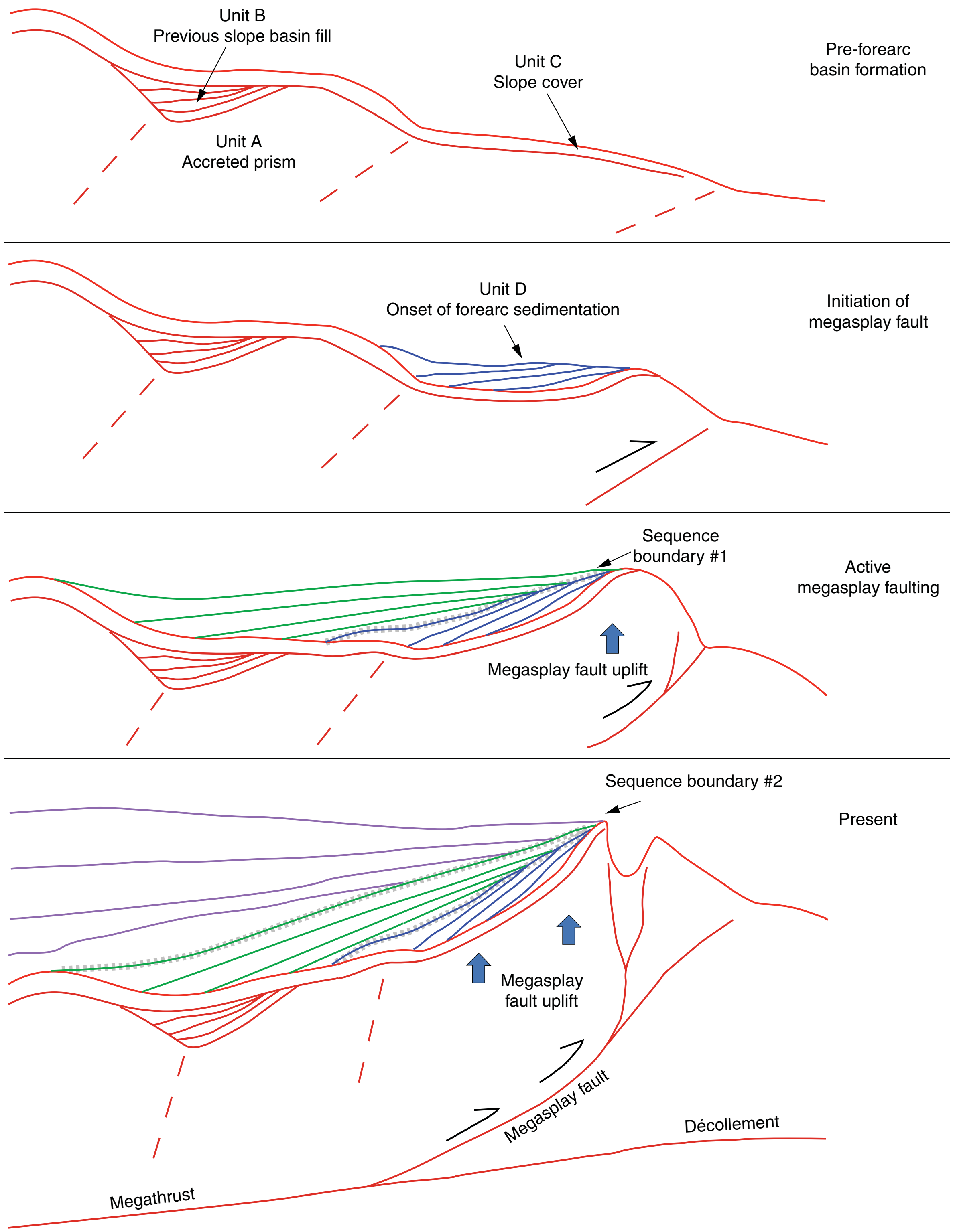


Figure F8. Locations of very low frequency earthquakes in the Nankai Trough in 2003–2004 (Obara and Ito, 2005). The events ranged in magnitude from 3.5 to 4.4 and were characterized by dominantly low frequency (10 s period) energy, with essentially no higher frequency component (Obara and Ito, 2005; Ito and Obara, 2006). Focal mechanisms and locations for the events off the Kii Peninsula are consistent with reverse faulting within the accretionary wedge. White circles = proposed drilling locations.

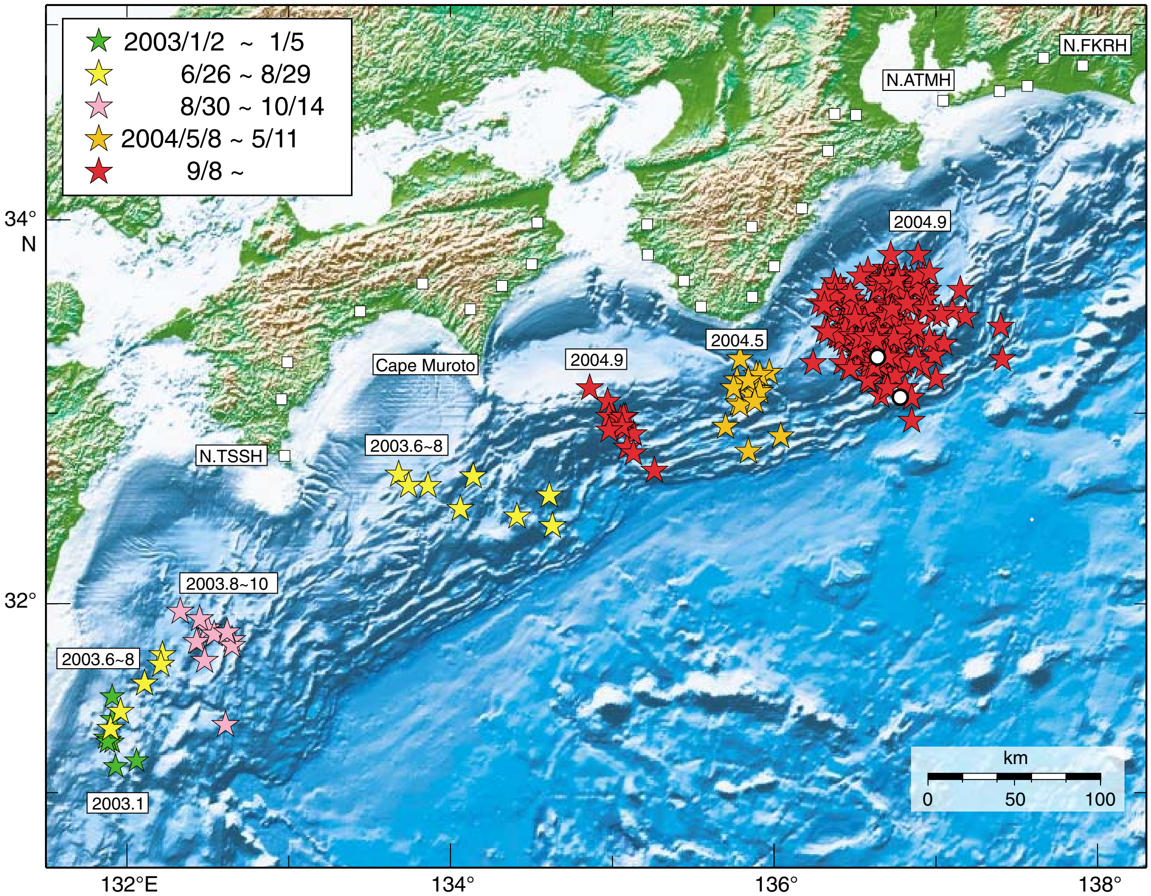


Figure F9. High-resolution bathymetric data collected by deep-tow sidescan sonar over the Kumano Basin and forearc slope showing the roughness and steepness of the proposed drill sites. Areal coverage does not include sites in the trench or reference sites on the Philippine Sea plate (Sites NT1-03, NT1-04, NT1-02, and NT1-07).

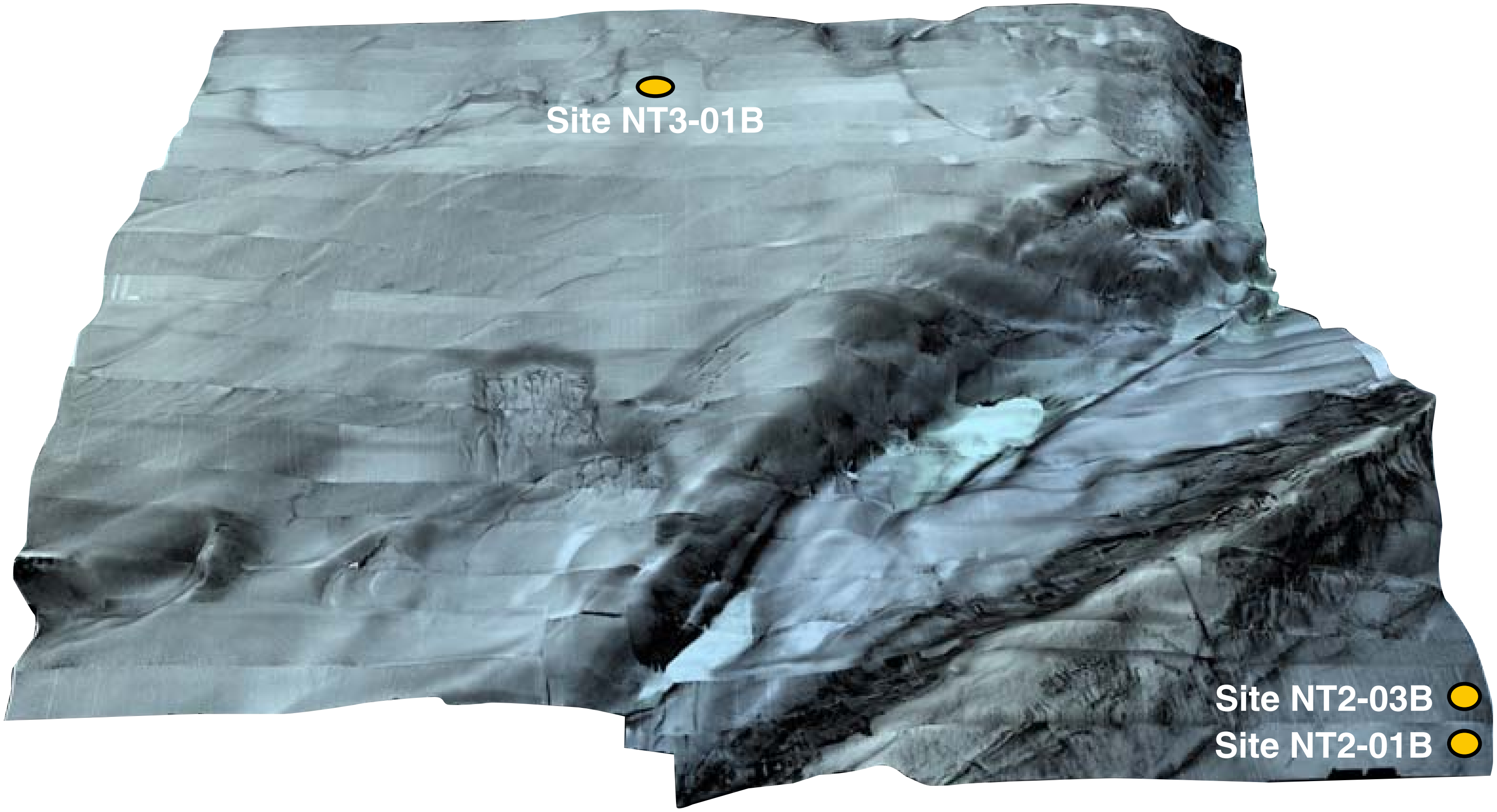


Figure F10. Recent meteorological and oceanographic data showing the path of the strong northeasterly Kuroshio Current (pink arrow) and the paths of the subsidiary and seasonal currents in the area (small red arrows) Risks associated with drilling in high currents in nonriser mode are much less than in riser mode onboard *Chikyu*; however, some operations such as casing, wellhead installation, and others may be effected. Alternate sites and contingency plans were made with this in mind.

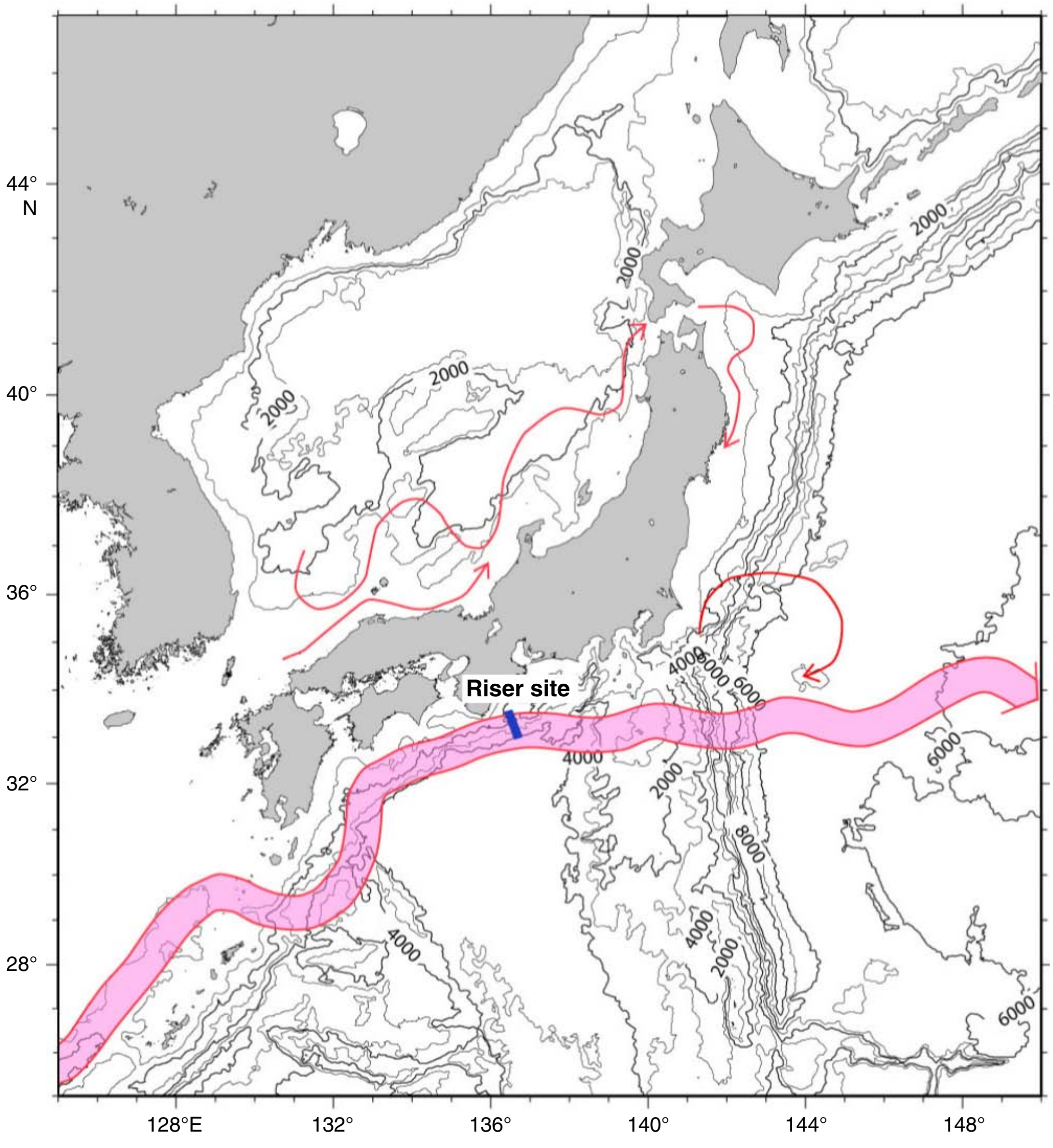


Figure F11. Last known locations of deep-water infrastructure communications cables on the seafloor (red lines). Industry and governmental sources were queried as to the locations and of location. Sites were chosen so as to keep the drilling vessel >1× the water depth distance away from any cables in order to prevent any interruption or breakage. All sites are well within safe criteria.

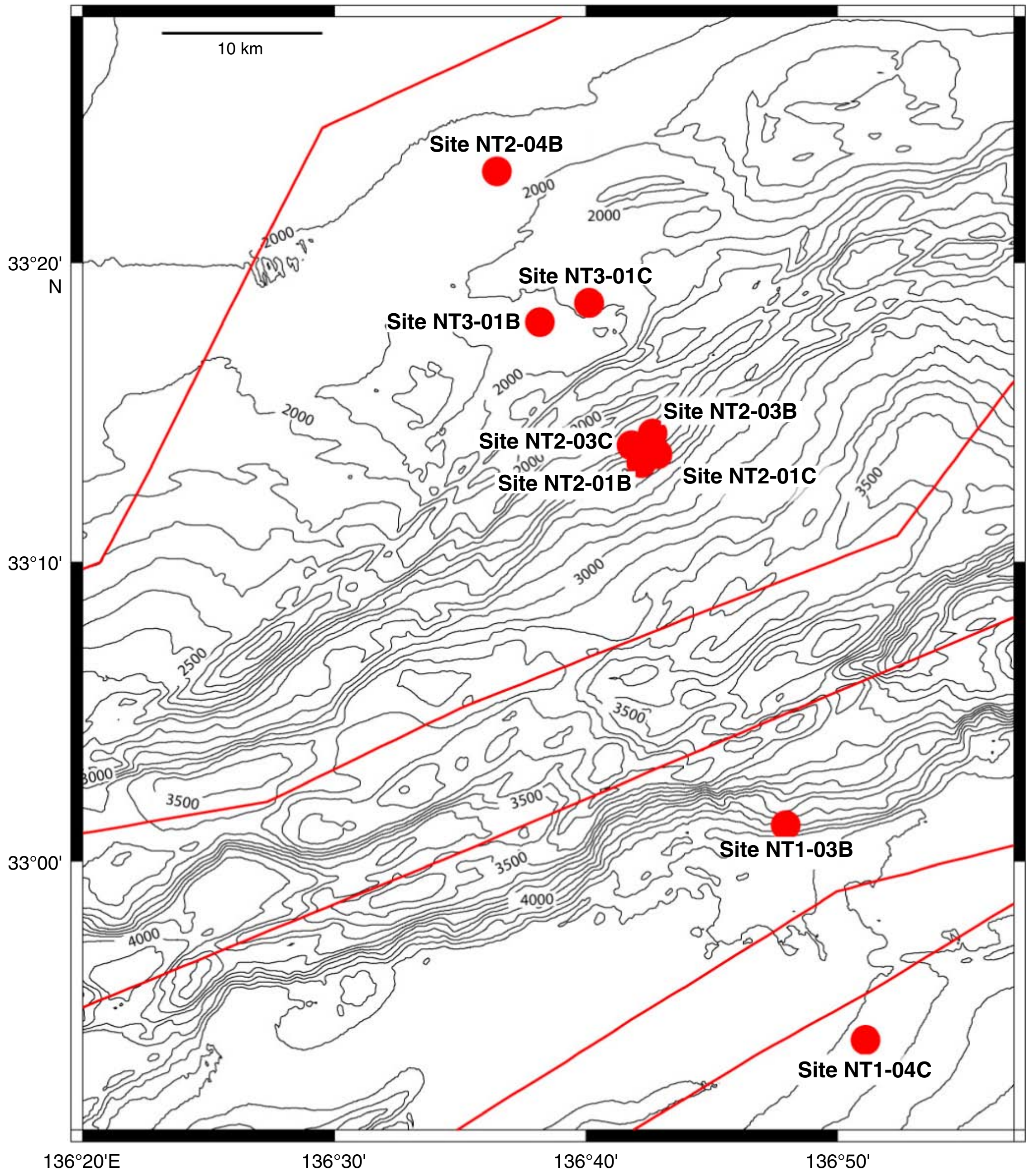


Figure F12. (**A**) Amplitude analysis and (**B**) subseafloor structure and relief investigations of bottom simulating reflectors. Investigations of offset well data were carried out in parallel with data analysis. Three-dimensional seismic data were interpreted to identify and account for any risks that may be posed by the presence of methane hydrates and/or free gas in the shallow subsurface. All investigations indicate that there is little or no risk posed by hydrate deposits in this area.

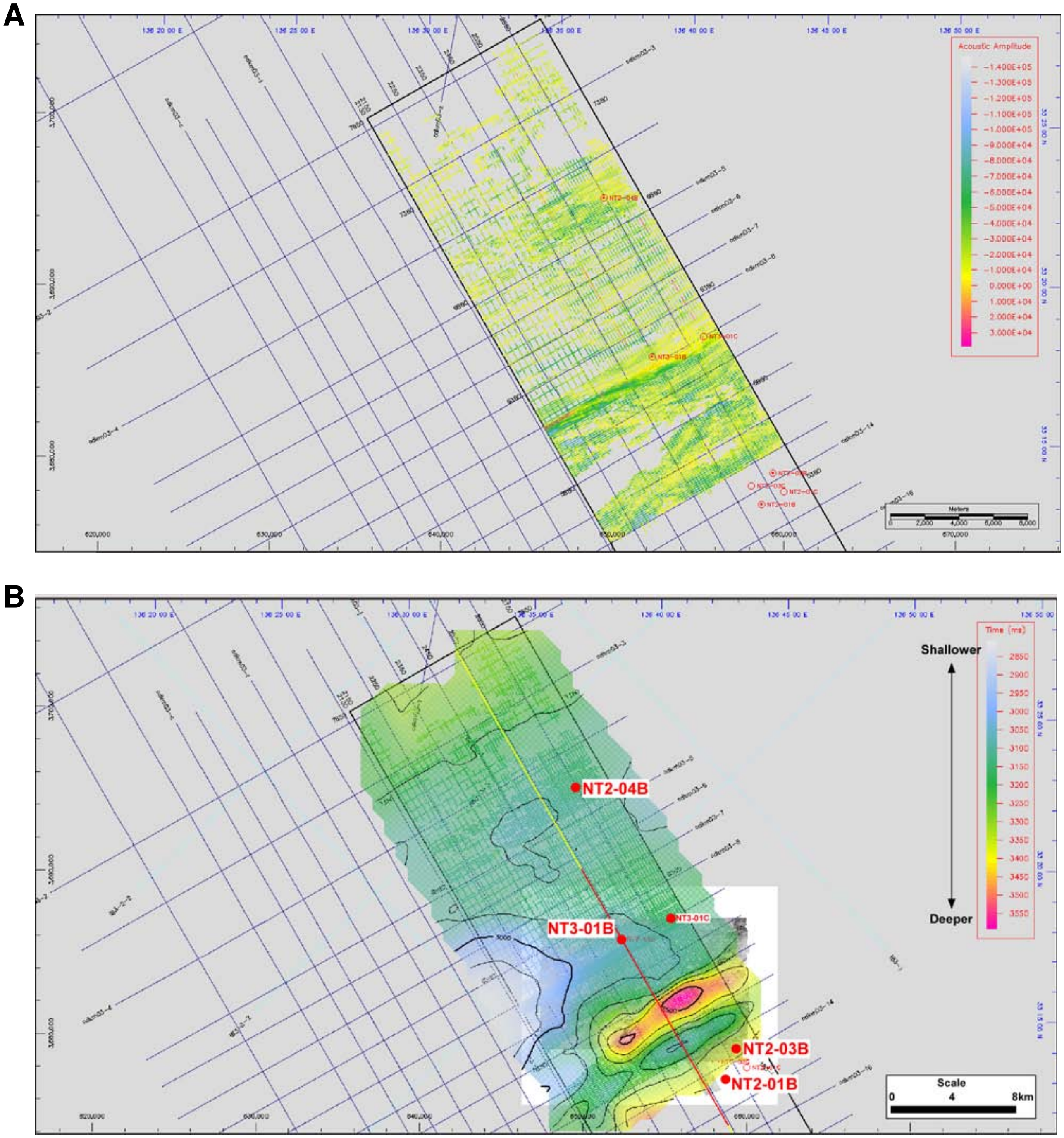
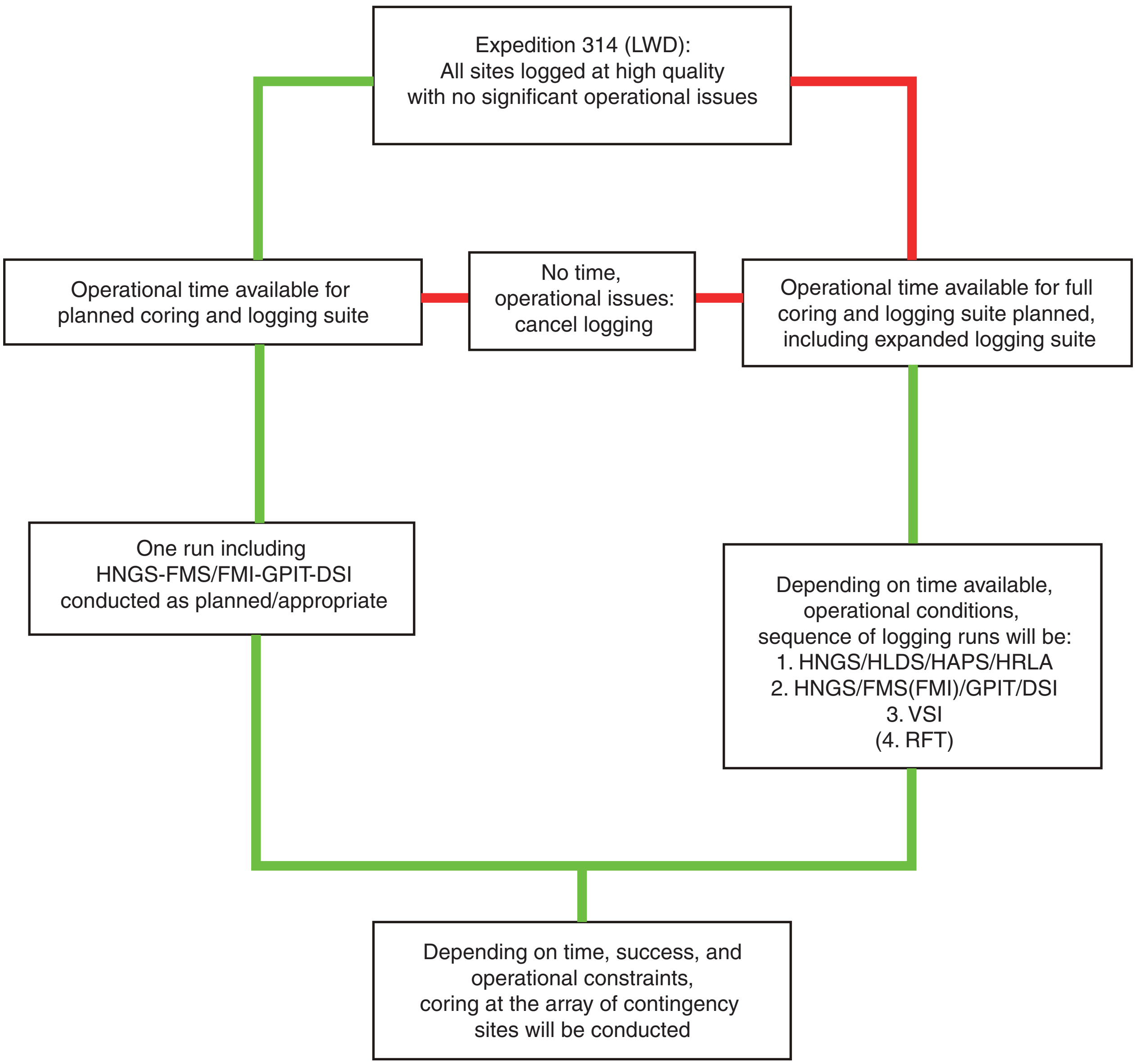


Figure F13. Generalized decision tree for logging and contingency operations depending on the success of logging-while-drilling (LWD) operations, the time available for simple and/or complex wireline operations, the operational constraints on wireline operations, and the time and operational constraints on drilling/coring at contingency sites. Green lines = successful operations, or "go," red lines = unsuccessful operations, or "stop." HNGS = Hostile Environment Gamma Ray Sonde, FMS = Formation MicroScanner, FMI = Formation MicroImager, GPIT = General Purpose Inclinometer Tool, DSI = Dipole Sonic Imager, HLDS = Hostile Environment Litho-Density Sonde, HAPS = Hostile Accelerator Porosity Sonde, HRLA = High-Resolution Laterolog Array, VSI = Vertical Seismic Imager, RFT = retrievable formation tester.



Site summaries

Proposed Site NT1-01A

Priority:	Primary: • *Chikyu* Expedition 314 (LWD) Alternate: • Other Stage 1 expeditions
Position:	32°44.8878′N, 136°55.0236′E
Water Depth (m):	3610
Target drilling depth (mbsf):	600 m sediment (Stage 1)
Approved maximum penetration (mbsf):	800; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	Extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track maps (Figs. **AF1, AF4**) • Line odkm 03-AB SP 2795 (Fig. **AF2**) • CrossLine odkm 03-22 SP 1685 (Fig. **AF3**) • IFREE 3-D Inline 95 (Fig. **AF5, AF6**)
Objective (see text for full details):	Reference site: • Penetrate entire sedimentary section and into oceanic crust • Document lithologic, hydrologic, thermal, and geotechnical properties of subduction inputs • Log-seismic integration
Drilling, coring, and downhole measurement program:	*Chikyu* Expedition 314: Hole A: MWD/LWD
Anticipated lithology:	0–600 mbsf: Shikoku Basin hemipelagic sediments 600–800 mbsf: volcaniclastic sediments and basalt

Site summaries (continued)

Proposed Site NT1-02A

Priority:	Alternate to proposed Site NT1-07A
Position:	32°47.4996′N, 137°9.2784′E
Water depth (m):	4210
Target drilling depth (mbsf):	830 (730 m sediment + 100 m basement)
Approved maximum penetration (mbsf):	720; EPSP, December 2005; permission to penetrate to 930 mbsf being requested of EPSP
Survey coverage:	Extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track map (Fig. **AF7**) • Lines odkm 03-22 (Fig. **AF8**) and odkm 03-103-1 (Fig. **AF9**) • CrossLine KR9806-1 (Fig. **AF10**)
Objective (see text for full details):	Core and conduct downhole measurements throughout the entire Shikoku Basin section and uppermost portion of the underlying oceanic crust
Drilling, coring, and downhole measurement program:	See **NT1-07A**
Anticipated lithology:	0–730 mbsf: Shikoku Basin hemipelagic sediments and turbidites 730 mbsf: volcaniclastic sediments and basalt

Site summaries (continued)

Proposed Site NT1-03A

Priority:	Alternate for proposed Site NT1-03B
Position:	33°01.23258′N, 136°47.94852′E
Water depth (m):	3955
Target drilling depth (mbsf):	600 sediment (Stage 1)
Approved maximum penetration (mbsf):	1800; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	Extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track maps (Figs. **AF11, AF4**) • Lines odkm 03-K SP 2435 (Fig. **AF12**) and 95 (Fig. **AF5**) • CrossLine KR9806-12 (Fig. **AF13**) • IFREE 3-D Inline (Fig. **AF14**)
Objective (see text for full details):	Characterize incoming sedimentary sequence (lithologic, hydrologic, thermal, geotechnical, geochemical properties) Document early phases of deformation Verify location of frontal décollement Although penetration to basement is desirable, a more important goal is to sample as much of the lower Shikoku Basin as possible.
Drilling, coring, and downhole measurement program:	See **NT1-03B**
Anticipated lithology:	0–20 mbsf: hemipelagics 200–400 mbsf: uplifted trench turbidites ~400 mbsf: frontal thrust 400–830 mbsf: trench wedge turbidites 830–1050 mbsf: upper Shikoku Basin hemipelagics and volcanic ash 1050–2700 mbsf: lower Shikoku Basin hemipelagics and turbidites

Site summaries (continued)

Proposed Site NT1-03B

Priority:	Primary: • *Chikyu* Expedition 314 (LWD) • *Chikyu* Expedition 316 (Thrust Faults)
Position:	33°1.635′N, 136°47.639′E
Water depth (m)	3832
Target drilling depth (mbsf):	950 sediment (Stage 1)
Approved maximum penetration (mbsf):	1800; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	CDEX 2006 3-D MCS survey; extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track map (Fig. **AF15**) • CDEX/IFREE 3-D inline (Fig. **AF16**)
Objective (see text for full details):	Penetrate the toe of the Nankai accretionary prism to: • Characterize incoming sedimentary sequence (lithologic, hydrologic, thermal, geotechnical, geochemical properties) • Document early phases of deformation • Verify location of frontal décollement Although penetration to basement is desirable, a more important goal is to sample as much of the lower Shikoku Basin as possible.
Drilling, coring, and downhole measurement program:	*Chikyu* Expedition 314 (LWD): • Pilot hole - MWD • Hole A - MWD/LWD to TD *Chikyu* Expedition 316 (Thrust Faults): Hole B (if TD cannot be achieved, start Hole C): • APC/XCB • Core orientation • Downhole temperature measurements Hole C: • Drill without coring to depth of Hole B • RCB core to TD • Wireline logging as contingency if Expedition 314 LWD is not accomplished
Anticipated lithology:	0–20 mbsf: hemipelagics and volcanic ash 20–600 mbsf: uplifted trench turbidites ~600 mbsf: frontal thrust 600–1100 mbsf: trench wedge turbidites 1100–1400 mbsf: upper Shikoku Basin hemipelagics and volcanic ash 1400–2800 mbsf: lower Shikoku Basin hemipelagics and turbidites

Site summaries (continued)

Proposed Site NT1-03C

Priority:	Alternate for proposed Site NT1-03B
Position:	33°2.000′N, 136°47.403′E
Water depth (m):	3790
Target drilling depth (mbsf):	950 sediment (Stage 1)
Approved maximum penetration (mbsf):	1800; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	CDEX 2006 3-D MCS; extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track map (Fig. **AF15**) • CDEX/IFREE 3-D inline (Fig. **AF16**)
Objective (see text for full details):	Penetrate the toe of the Nankai accretionary prism to: • Characterize incoming sedimentary sequence (lithologic, hydrologic, thermal, geotechnical, geochemical properties) • Document early phases of deformation • Verify location of frontal décollement Although penetration to basement is desirable, a more important goal is to sample as much of the lower Shikoku Basin as possible.
Drilling, coring, and downhole measurement program:	See **NT1-03B**
Anticipated lithology:	0–200 mbsf: hemipelagics and slumped trench material 200–850 mbsf: uplifted trench turbidites ~850 mbsf: frontal thrust 850–1290 mbsf: trench wedge turbidites 1290–1550 mbsf: upper Shikoku Basin hemipelagics and volcanic ash 1550–2920 mbsf: lower Shikoku Basin hemipelagics and turbidites

Site summaries (continued)

Proposed Site NT1-04C

Priority:	Alternate for proposed Site NT1-07A
Position:	32°54.000′N, 136°51.110′E
Water depth (m):	4355
Target drilling depth (mbsf):	1400 (1300 m sediment)
Approved maximum penetration (mbsf):	1500; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	IFREE 3-D 2006 seismic survey; extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track map (Fig. **AF4**) • IFREE 3-D Inline 95 (Figs. **AF5, AF17**) • IFREE 3-D Crossline 1151 (Fig. **AF18**) • 2-D KR Line 0211 (Fig. **AF19**)
Objective (see text for full details):	Reference site: • Penetrate entire sedimentary section and into oceanic crust • Complete characterization of Shikoku Basin strata and upper igneous basement where basement topography is relatively flat • Document lithologic, hydrologic, thermal, geotechnical, and geochemical properties of subduction inputs • Log-seismic integration
Drilling, coring, and downhole measurement program:	See **NT1-07A**
Anticipated lithology:	0–400 mbsf: upper Shikoku Basin hemipelagics and volcanic ash 400–800 mbsf: lower Shikoku Basin hemipelagics and volcanic ash 800–1200 mbsf: lower Shikoku Basin hemipelagics and turbidite sands >1200 mbsf: volcaniclastic sediments and basalt

Site summaries (continued)

Proposed Site NT1-07A

Priority:	Primary: • *Chikyu* Expedition 314 (LWD) Alternate: • Other Stage 1 expeditions
Position:	32°49.7300′N, 136°52.8900′E
Water depth (m):	4062
Target drilling depth (mbsf):	1200 m sediment (stop at basement contact)
Approved maximum penetration (mbsf):	1400; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	Extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track maps (Figs. **AF20, AF4**) • Line odkm 03-101 SP 2524 (Fig. **AF21**) • IFREE 3-D InLine 95 (Figs. **AF5, AF22**)
Objective (see text for full details):	Reference site: • Penetrate entire sedimentary section • Complete characterization of Shikoku Basin strata and upper igneous basement where basement topography is relatively flat and the lower Shikoku Basin sand facies is well-developed • Document lithologic, hydrologic, thermal, geotechnical, and geochemical properties of subduction inputs • Log-seismic integration
Drilling, coring, and downhole measurement program:	*Chikyu* Expedition 314 (LWD): Hole A - MWD/LWD to basement contact
Anticipated lithology:	0–400 mbsf: upper Shikoku Basin hemipelagics and volcanic ash 400–800 mbsf: lower Shikoku Basin hemipelagics and volcanic ash 800–1200 mbsf: lower Shikoku Basin hemipelagics and turbidite sands >1200 mbsf: volcaniclastic sediments and basalt

Site summaries (continued)

Proposed Site NT2-01B

Priority:	Primary: • *Chikyu* Expedition 314 (LWD) • *Chikyu* Expedition 316 (Thrust Faults)
Position:	33°13.3200′N, 136°42.2000′E
Water depth (m):	2391
Target drilling depth (mbsf):	1000 m sediment
Approved maximum penetration (mbsf):	1200; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	CDEX 2006 3-D MCS; extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track map (Fig. **AF23**) • 3-D Inline 2596 (Figs. **AF24, AF25**) • 3-D Crossline 5375 (Fig. **AF26**)
Objective (see text for full details):	Characterization of active splay fault and fluid flow regime by core sampling, logging, crosshole experiments and long-term monitoring Focus on mechanical and hydrological properties (e.g., strength, pore pressure, permeability, porosity), fluid budget, origin of the fluid, detection of episodic flow Borehole long-term observatory for hydrogeological properties and crosshole testing planned for future stages
Drilling, coring, and downhole measurement program:	*Chikyu* Expedition 314 (LWD): Hole A - MWD/LWD to 1000 m *Chikyu* Expedition 316 (Thrust Faults): Hole B: • Jet-in test • APC/XCB coring and downhole measurements (temperature, core orientation) Hole C: • Install reentry cone and casing • RCB coring to TD • Case hole to TD • Wireline logging only as contingency in case *Chikyu* Expedition 314 LWD is not successful
Anticipated lithology:	0–100 mbsf: slope sediments 100–610 mbsf: accretionary prism (deformed, compacted turbidites) ~610 mbsf: megasplay fault 610–910 mbsf: younger slope sediments >910 mbsf: older accretionary prism sediments and rocks

Site summaries (continued)

Proposed Site NT2-01C

Priority:	Alternate for proposed Site NT2-01B
Position:	33°13.7035′N, 136°43.0353′E
Water depth (m):	2304
Target drilling depth (mbsf):	1000 m sediment
Approved maximum penetration (mbsf):	1200; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	CDEX 2006 3-D MCS; extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**) Track map (Fig. **AF23**) 3-D Crossline 5375 (Fig. **AF26**) 3-D InLine 2675 (Figs. **AF27, AF28**)
Objective (see text for full details):	Characterization of active splay fault and fluid flow regime by core sampling, logging, crosshole experiments and long-term monitoring. Focus on mechanical and hydrological properties (e.g., strength, pore pressure, permeability, porosity), fluid budget, origin of the fluid, detection of episodic flow Borehole long-term observatory for hydrogeological properties and crosshole testing is planned for future stages
Drilling, coring, and downhole measurement program:	See **NT2-01B**
Anticipated lithology:	0–100 mbsf: slope sediments 100–610 mbsf: accretionary prism (deformed, compacted turbidites) ~610 mbsf: megasplay fault 610–910 mbsf: younger slope sediments >910 mbsf: older accretionary prism sediments and rocks

Site summaries (continued)

Proposed Site NT2-03B

Priority:	Primary: • *Chikyu* Expedition 314 (LWD) • *Chikyu* Expedition 315 (Megasplay Riser Pilot)
Position:	33°14.30′N, 136°42.65′E
Water depth (m):	2178
Target drilling depth (mbsf):	1000 m
Approved maximum penetration (mbsf):	1250; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	CDEX 2006 3-D MCS; extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track map (Fig. **AF23**) • 3-D Inline 2675 (Figs. **AF27, AF28**) • 3-D Crossline 5475 (Fig. **AF29**)
Objective (see text for full details):	Sample forearc basin sediments and deformed prism Preparatory site for 3.5 km deep Stage 2 riser site (Stage 2 will characterize megasplay fault zone system by intersecting it at intermediate depth of 3.5 km) Integration with proposed Sites NT2-01A and NT3-01 is essential
Drilling, coring, and downhole measurement program:	*Chikyu* Expedition 314 (LWD): • Pilot hole using MWD • Hole A - MWD/LWD to 1000 m *Chikyu* Expedition 315 (Megasplay Riser Pilot): Hole B: • Jet-in test • APC/XCB coring and downhole measurements (temperature, core orientation) Hole C: • Install reentry cone and 20 inch casing • Drill without coring to depth of Hole B • RCB core to TD • Wireline logging (DSI, VSP) • Deploy reentry cone and 13-3/8 inch casing if required to achieve TD • Wireline logging only as contingency in case *Chikyu* Expedition 314 LWD is not successful Hole D: • Initiate riser drill hole • Install 36 inch conductor casing • Drill 26 inch hole to 700 mbsf • Install and cement 20 inch casing
Anticipated lithology:	0–210 mbsf: slope sediments 210–800 mbsf: accretionary prism (deformed, compacted turbidites)

Site summaries (continued)

Proposed Site NT2-03C

Priority:	Alternate for proposed Site NT2-03B
Position:	33°13.9075′N, 136°41.811′E
Water depth (m):	2145
Target drilling depth (mbsf):	1000 m sediment
Approved maximum penetration (mbsf):	1250; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	CDEX 2006 3-D MCS; extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track map (Fig. **AF23**) • 3-D InLine 2596 (Fig. **AF28**) • 3-D CrossLine 5475 (Fig. **AF29**)
Objective (see text for full details):	Sample forearc basin sediments and deformed prism Preparatory site for 3.5 km deep Stage 2 riser site (Stage 2 will characterize megasplay fault zone system by intersecting it at intermediate depth of 3.5 km) Integration with proposed Sites NT2-01A and NT3-01 is essential.
Drilling, coring, and downhole measurement program:	See **NT2-03B**
Anticipated lithology:	0–210 mbsf: slope sediments 210–800 mbsf: accretionary prism (deformed, compacted turbidites)

Site summaries (continued)

Proposed Site NT2-04B

Priority:	Alternate for proposed Site NT3-01B
Position:	33°23.05′N, 136°36.46′E
Water depth (m):	2000
Target drilling depth (mbsf):	1400 m sediment
Approved maximum penetration (mbsf):	1400; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	CDEX 2006 3-D MCS; extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track map (Fig. **AF30**) • 3-D InLine 2645 (Fig. **AF31, AF32**) • 3-D CrossLine 6980 (Fig. **AF33**)
Objective (see text for full details):	Total history of the splay fault system is depicted by integrating the results from proposed Site NT3-01 as a reference for this site.
Drilling, coring, and downhole measurement program:	See **NT3-01B**
Anticipated lithology:	0–1039 mbsf: slope basin sediments; rapidly deposited sand/silts/clays ~420 mbsf: bottom-simulating reflector 1039–1400 mbsf: older accreted prism

Site summaries (continued)

Proposed Site NT3-01B

Priority:	Primary: • *Chikyu* Expedition 314 (LWD) Alternate for all other Stage 1 expeditions
Position:	33°18.020′N, 136°38.180′E
Water depth (m):	1966
Target drilling depth (mbsf):	1400
Approved maximum penetration (mbsf):	1400; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	CDEX 2006 3-D MCS; extensive survey data outlined in Proposal 603C-Full (**www.iodp.org/nantroseize-downloads**) • Track map (Fig. **AF30**) • 3-D InLine 2529 (Figs. **AF34, AF35**) • 3-D CrossLine 6225 (Fig. **AF36**)
Objective (see text for full details):	Determine splay fault history and nature of prism below basin sediments Preparatory site for deep (~5.5–6.0 km) riser drilling
Drilling, coring, and downhole measurement program:	*Chikyu* Expedition 314 (LWD): • Hole A - MWD/LWD • 9-5/8 inch casing to 1000 mbsf as required
Anticipated lithology:	0–1039 mbsf: slope basin sediments; rapidly deposited sand/silts/clays ~420 mbsf: bottom-simulating reflector 1039–1400 mbsf: older accreted prism

Site summaries (continued)

Proposed Site NT3-01C

Priority:	Alternate for proposed Site NT3-01B
Position:	33°18.650′N, 136°40.120′E
Water depth (m):	2046
Target drilling depth (mbsf):	1400
Approved maximum penetration (mbsf):	1400; approved by CDEX and TAMU safety panels based on EPSP Jan 2007 recommendation
Survey coverage:	CDEX 2006 3-D MCS; extensive survey data outlined in Proposal 603A-Full2 (**www.iodp.org/nantroseize-downloads**): • Track map (Fig. **AF30**) • 3-D InLine 2700 (Figs. **AF37, AF38**) • 3-D CrossLine 6190 (Fig. **AF39**)
Objective (see text for full details):	Core and conduct downhole measurements throughout the entire forearc basin section and uppermost portion of the underlying prism Determine splay fault history and nature of prism below basin sediments Preparatory site for deep (~5.5–6.0 km) riser drilling
Drilling, coring, and downhole measurement program:	See **NT3-01B**
Anticipated lithology:	0–1039 mbsf: slope basin sediments; rapidly deposited sand/silts/clays ~420 mbsf: bottom-simulating reflector 1039–1400 mbsf: older accreted prism

Figure AF1. Track map, Site NT1-01A.

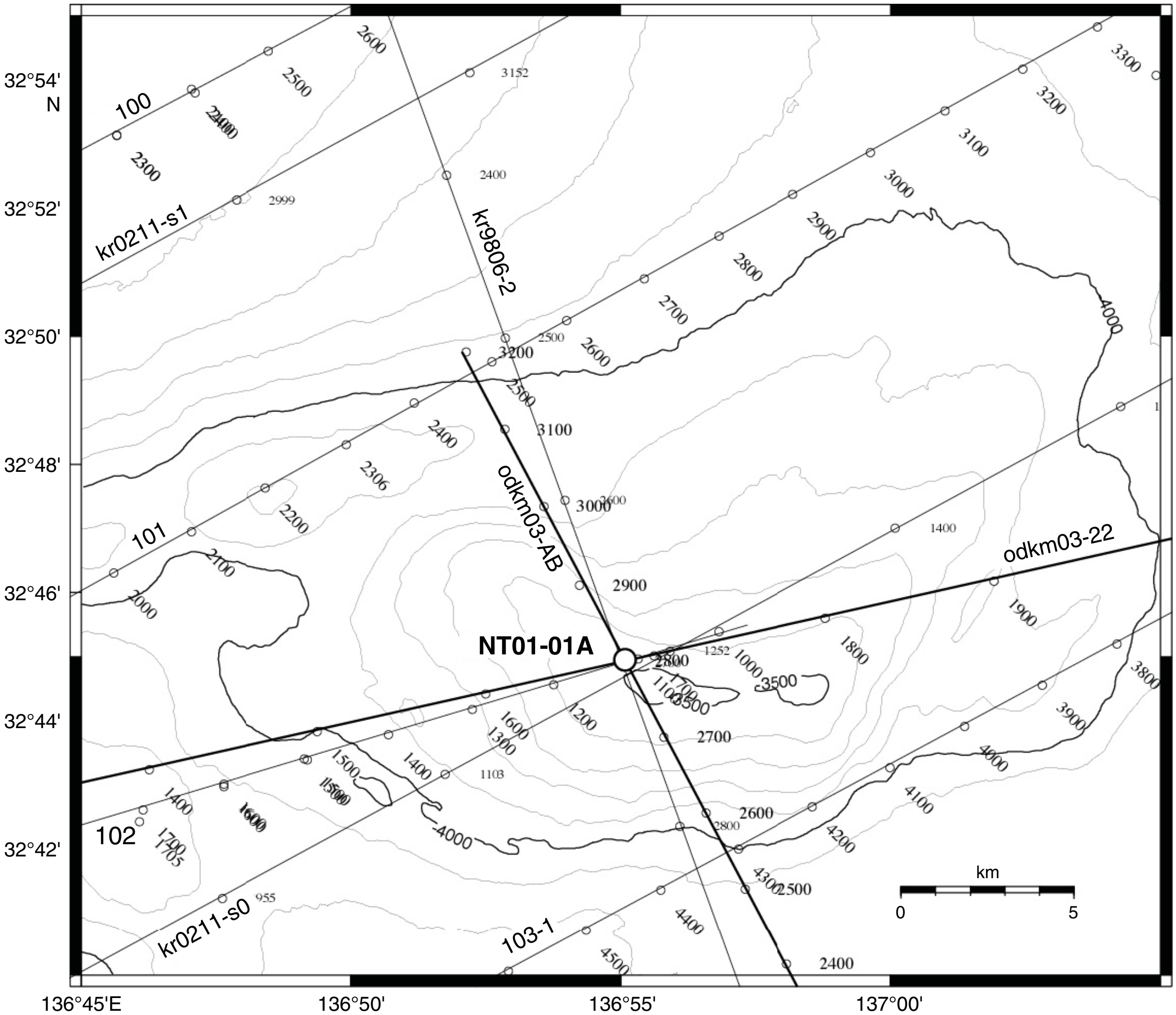


Figure AF2. Line ODKM03-AB.

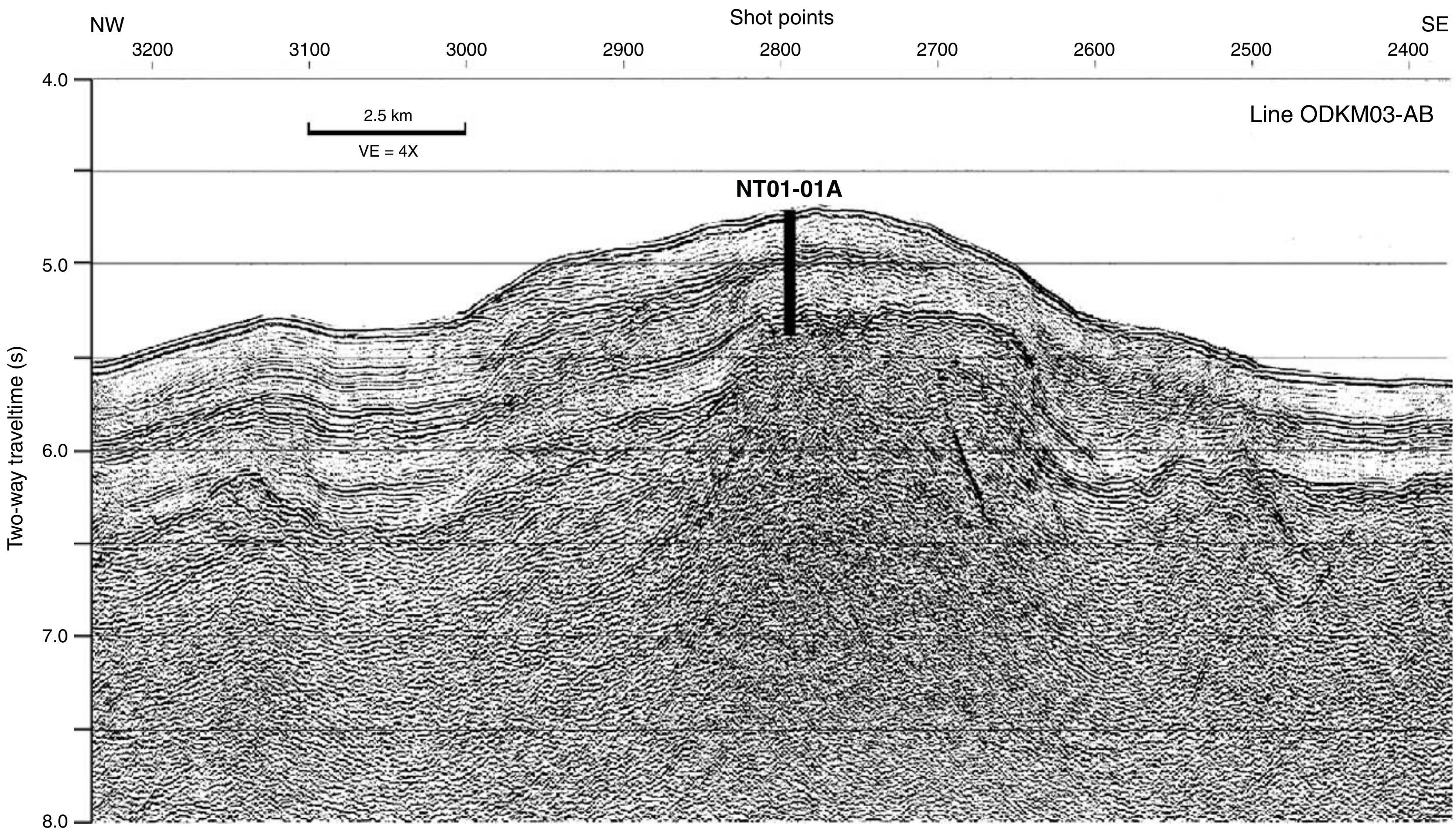


Figure AF3. Line ODKM03-22.

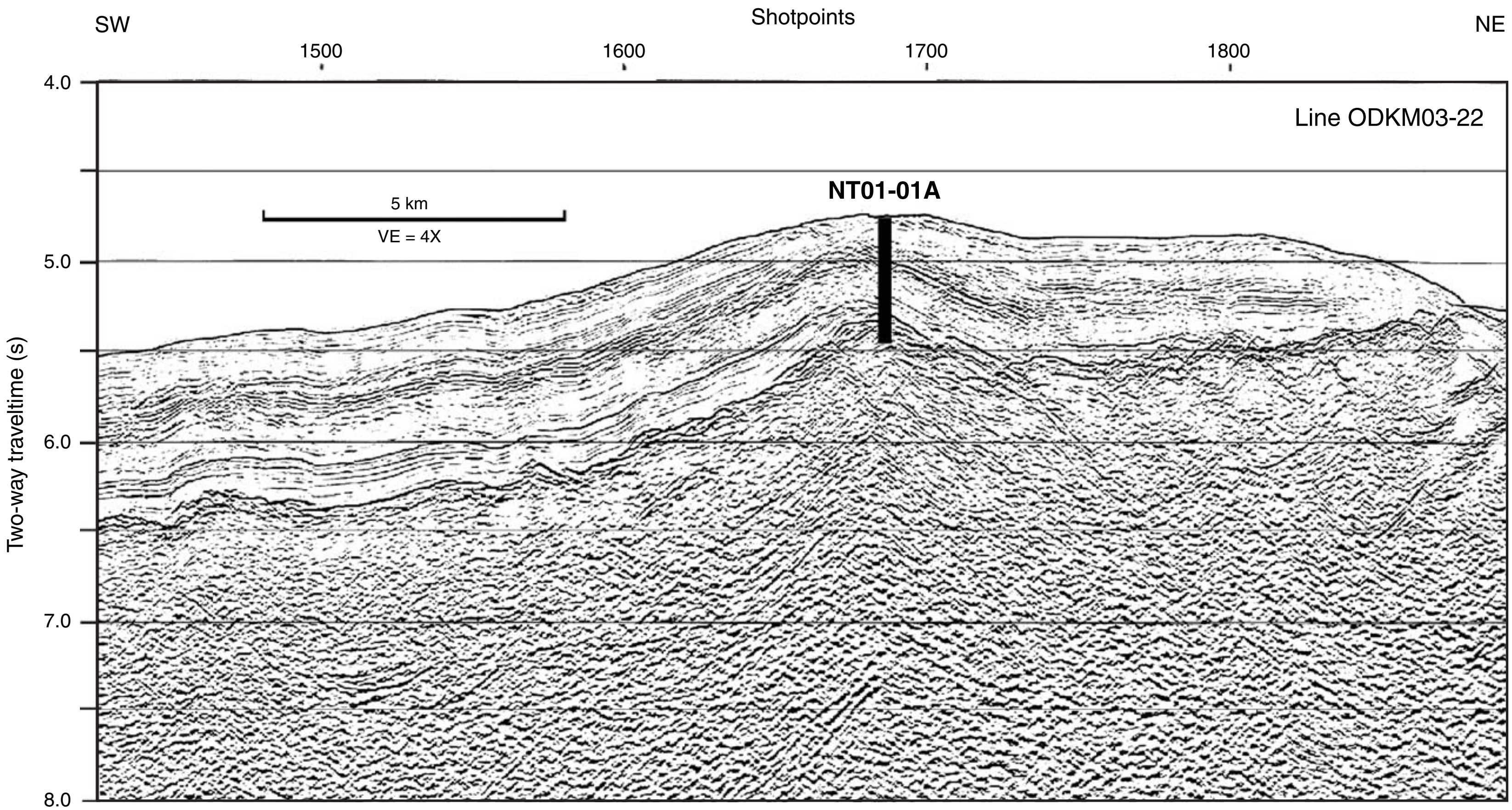


Figure AF4. Track map, Site NT1-04C.

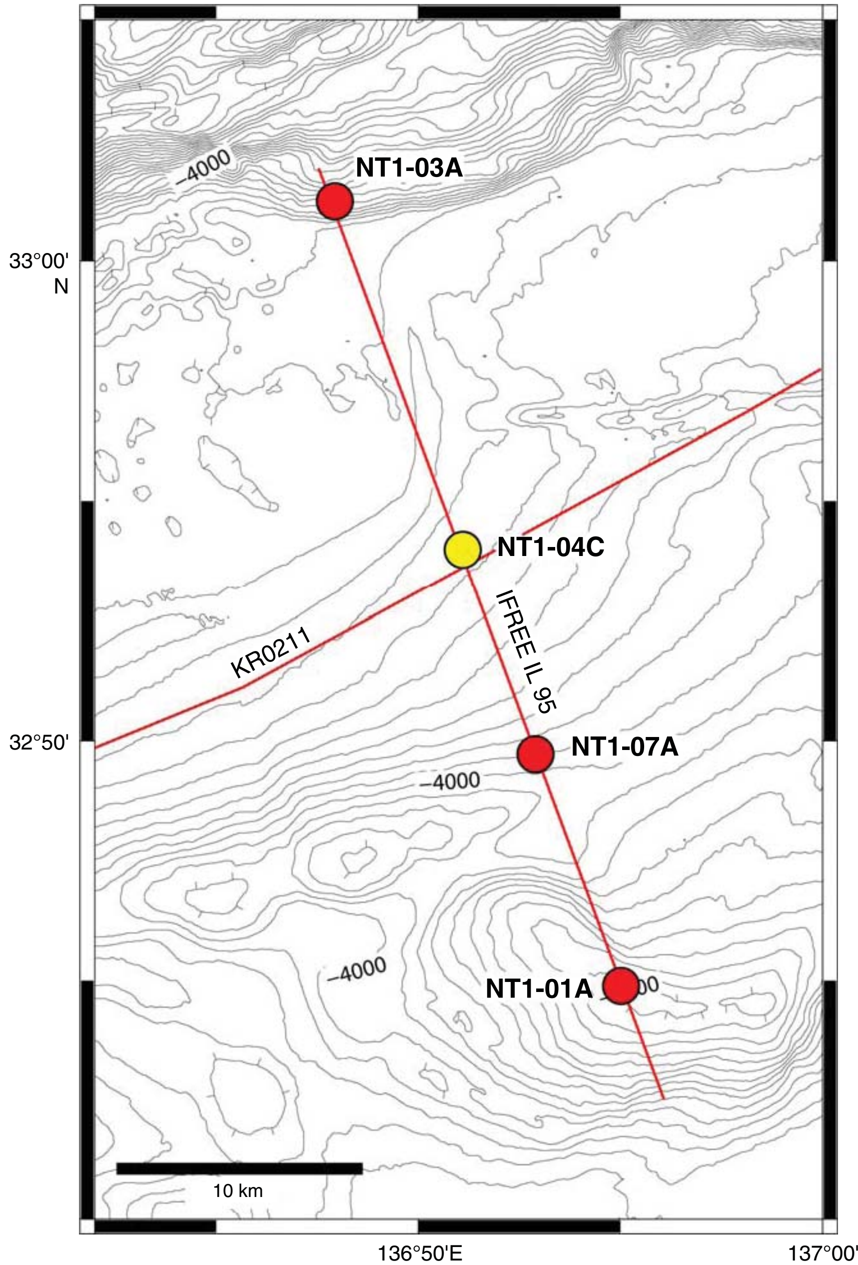


Figure AF5. Inline 95.

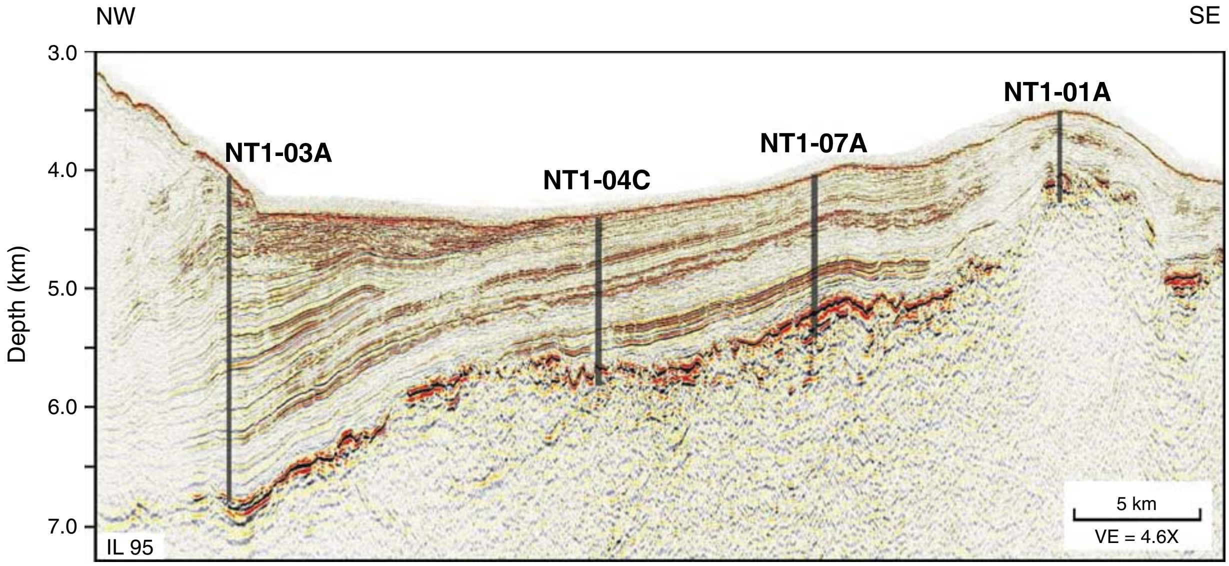


Figure AF6. Inline 95.

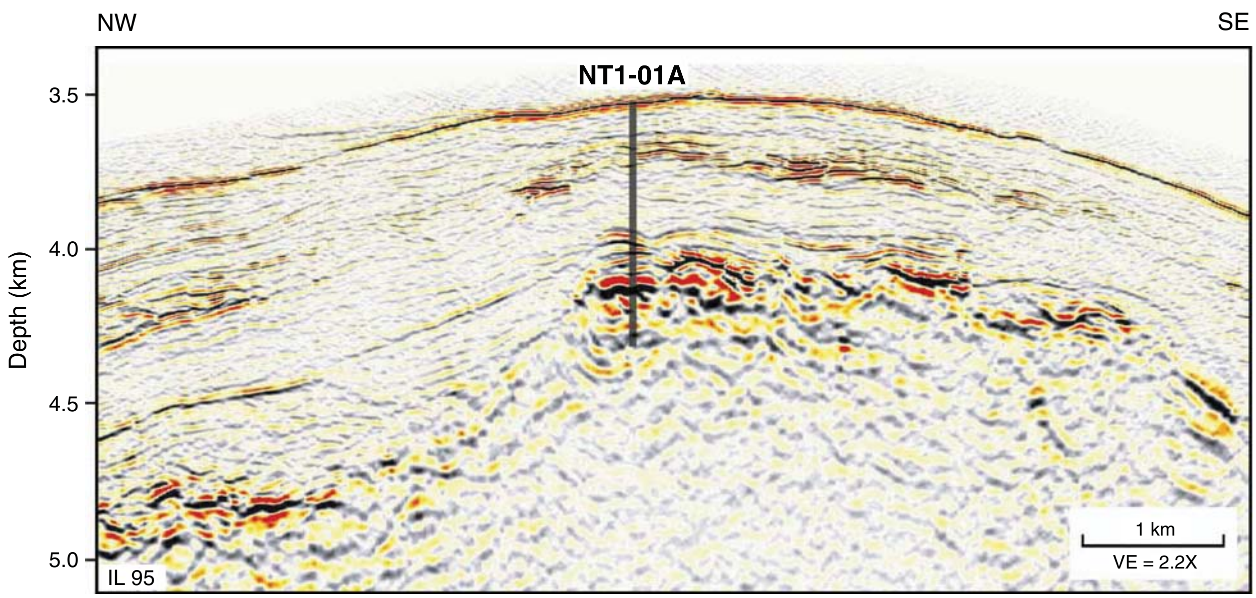


Figure AF7. Track map, Site NT1-02A.

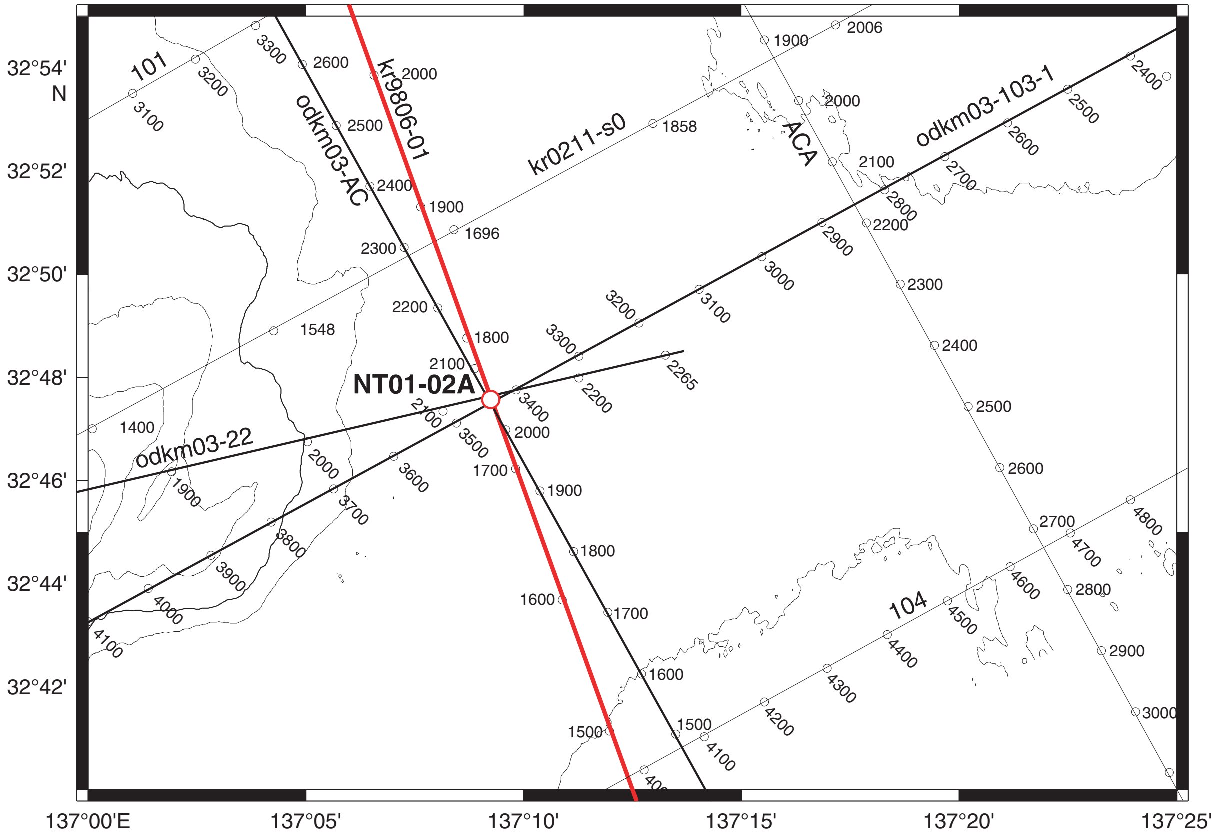


Figure AF8. Line ODKM03-22.

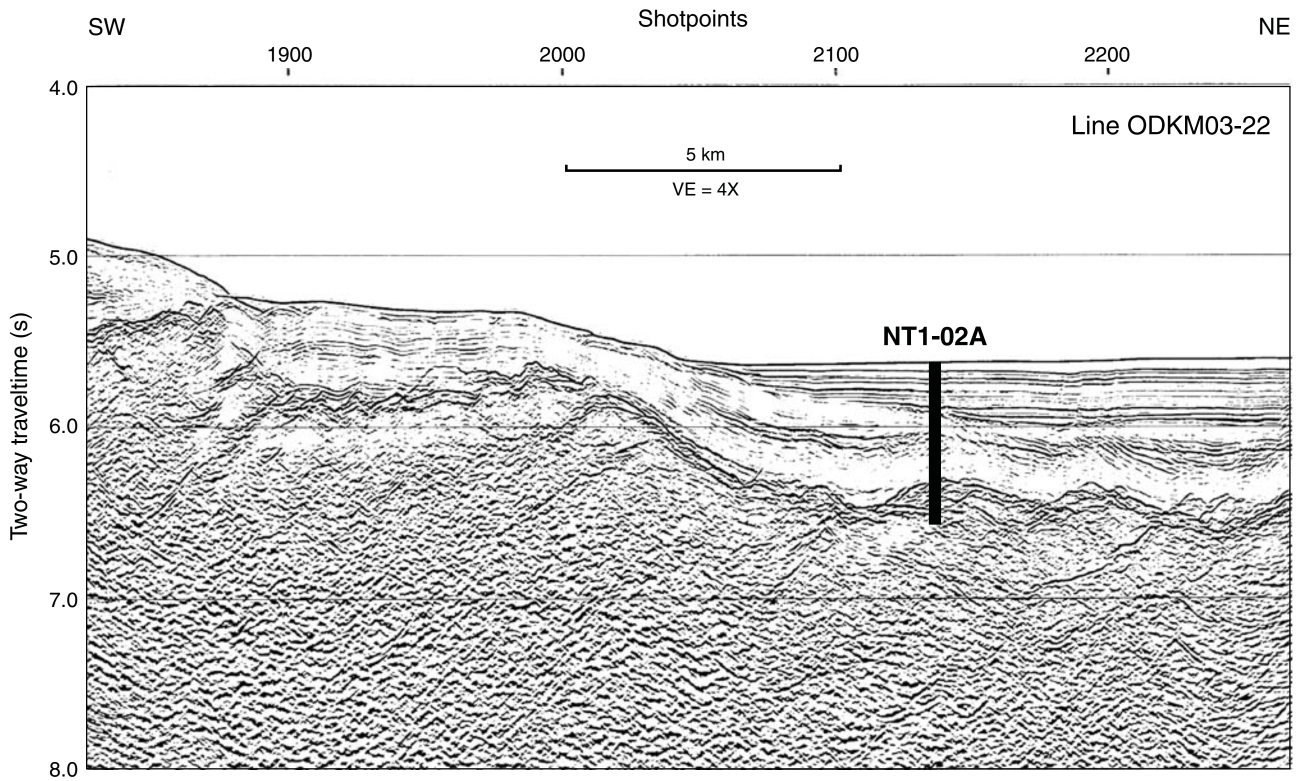


Figure AF9. Line ODKM03-103-1.

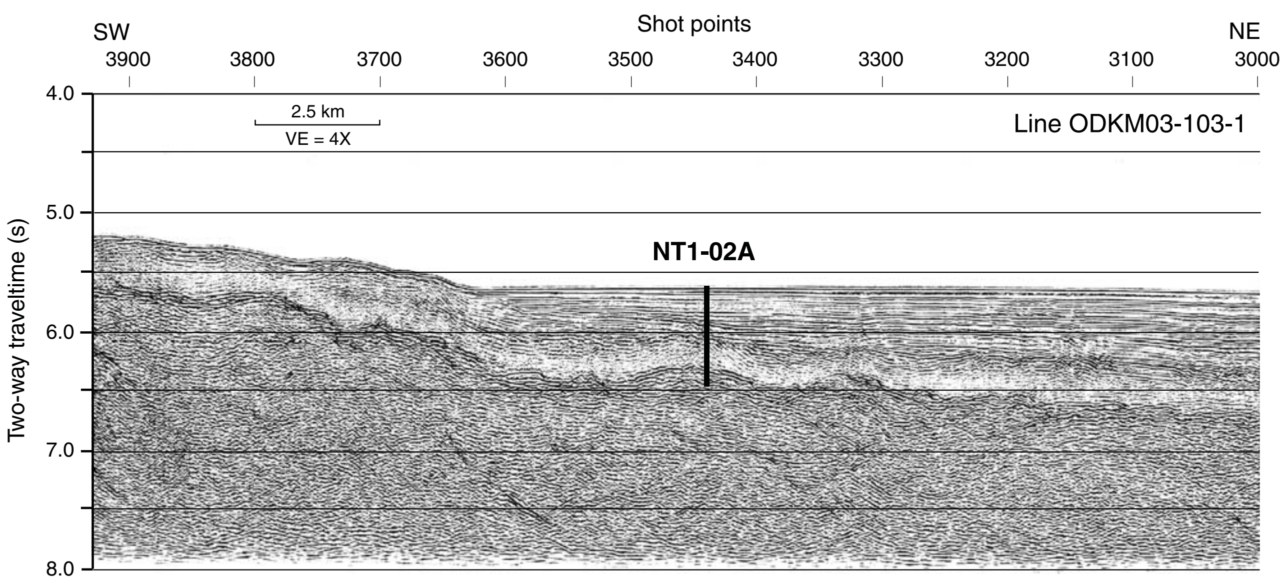


Figure AF10. Line KR9806-1.

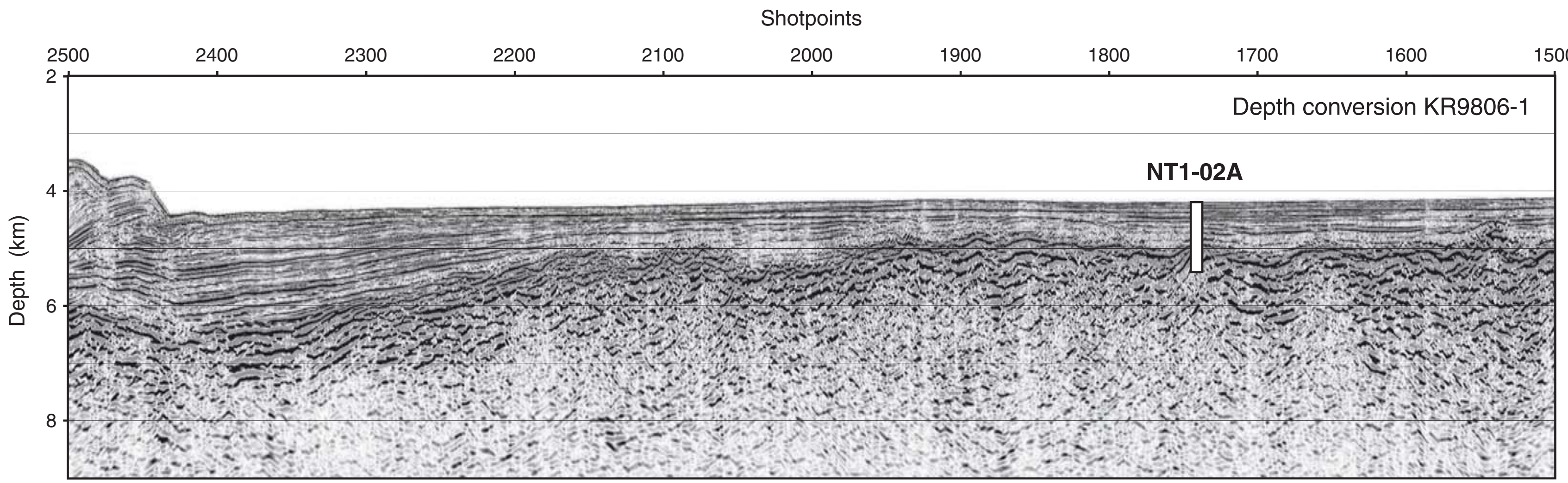


Figure AF11. Track map, Site NT1-03A.

Figure AF12. Line ODKM03-K.

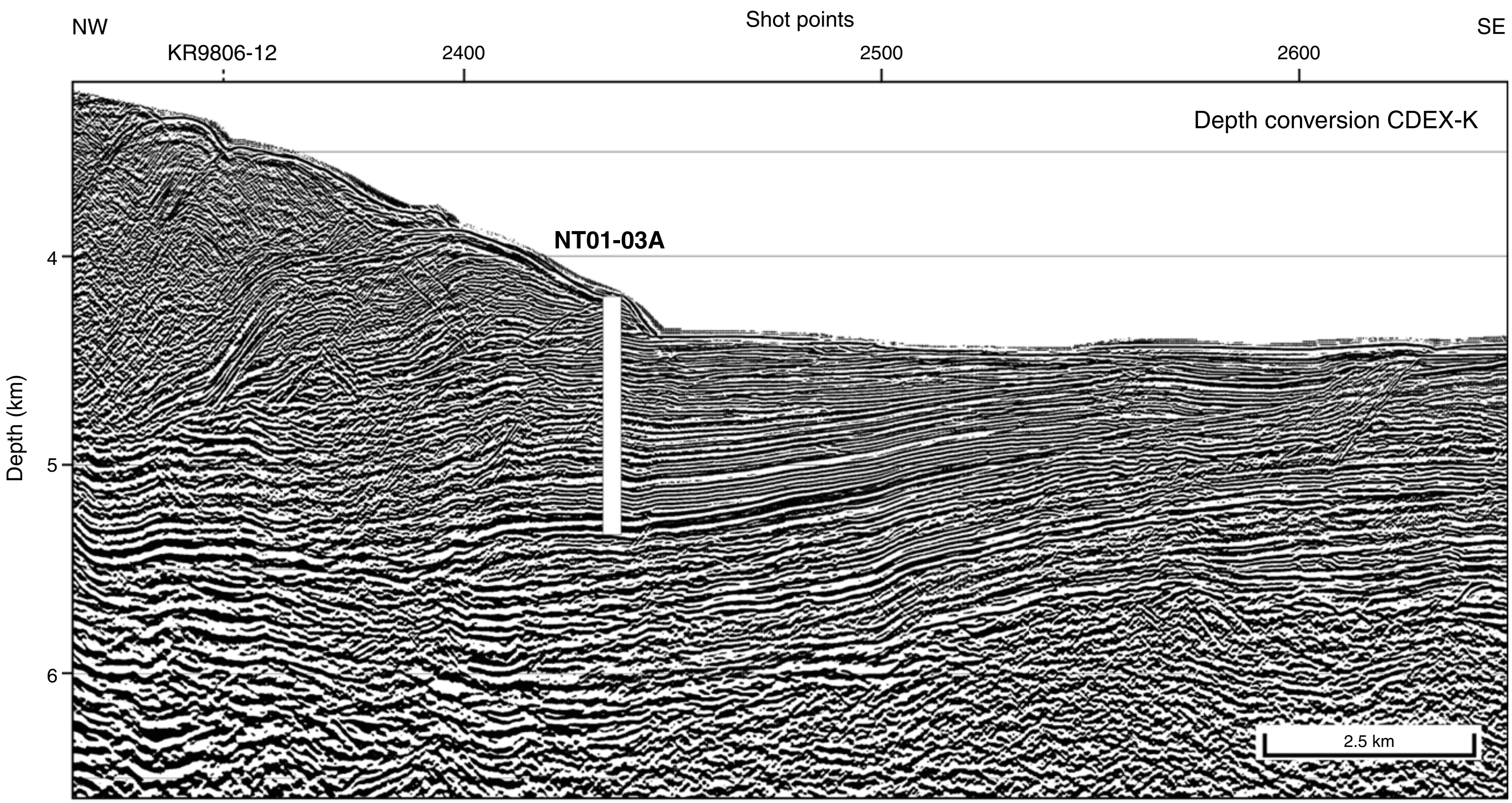


Figure AF13. Line KR9806-12.

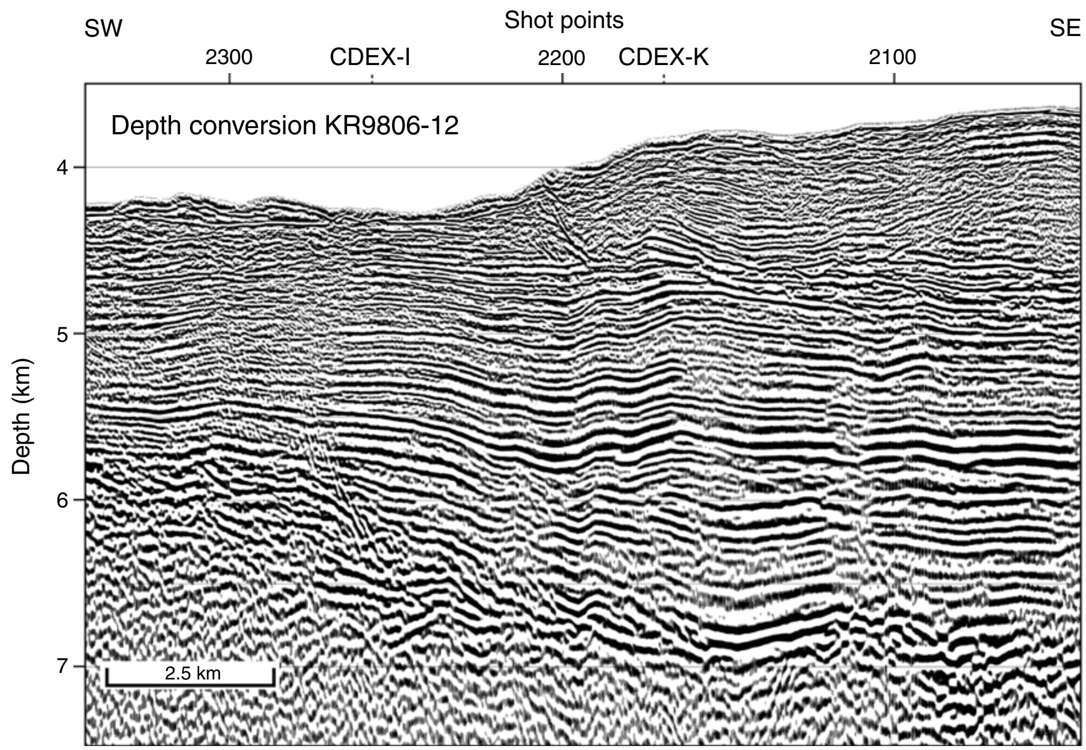


Figure AF14. Inline.

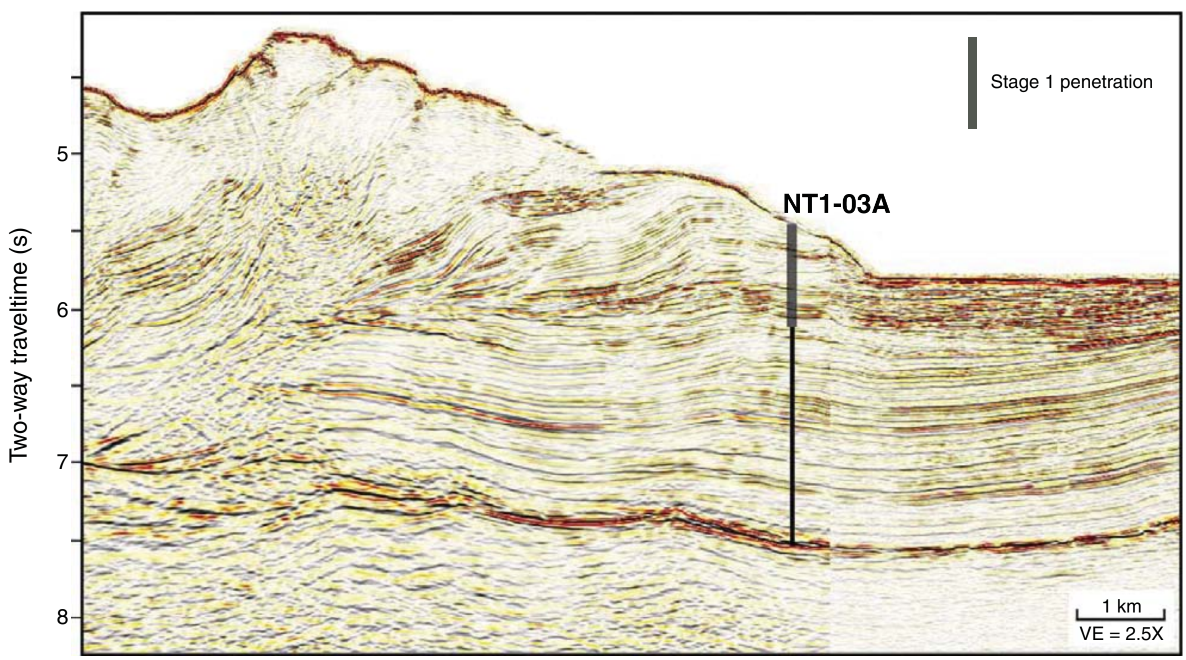


Figure AF15. Site map, NT1-03.

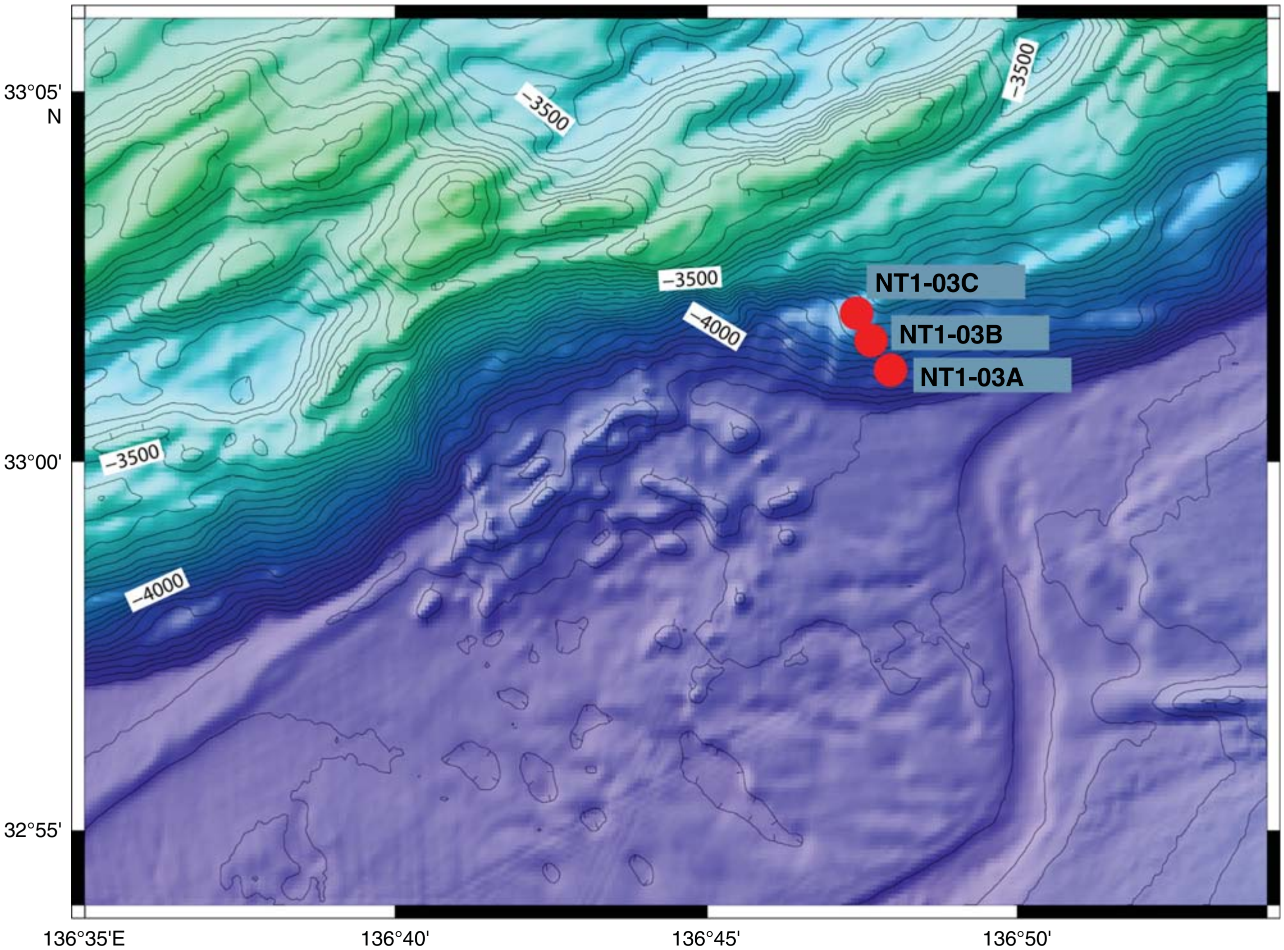


Figure AF16. Inline.

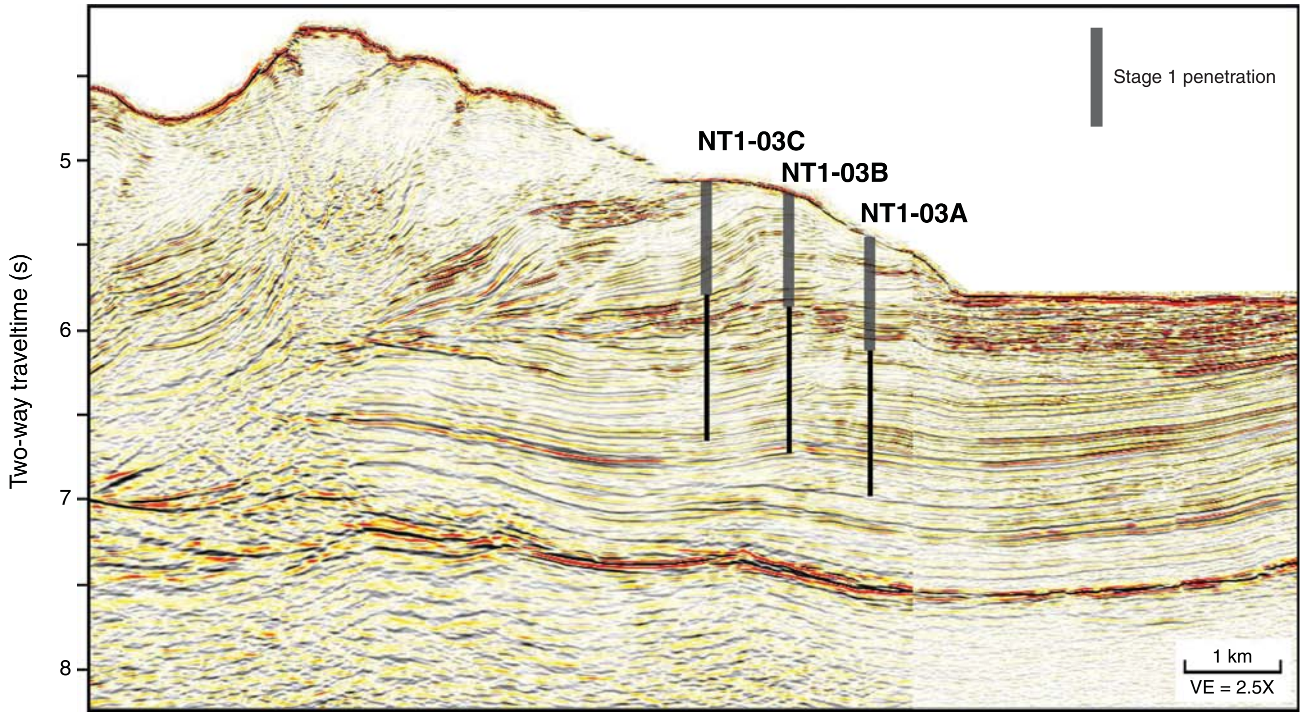


Figure AF17. Inline 95.

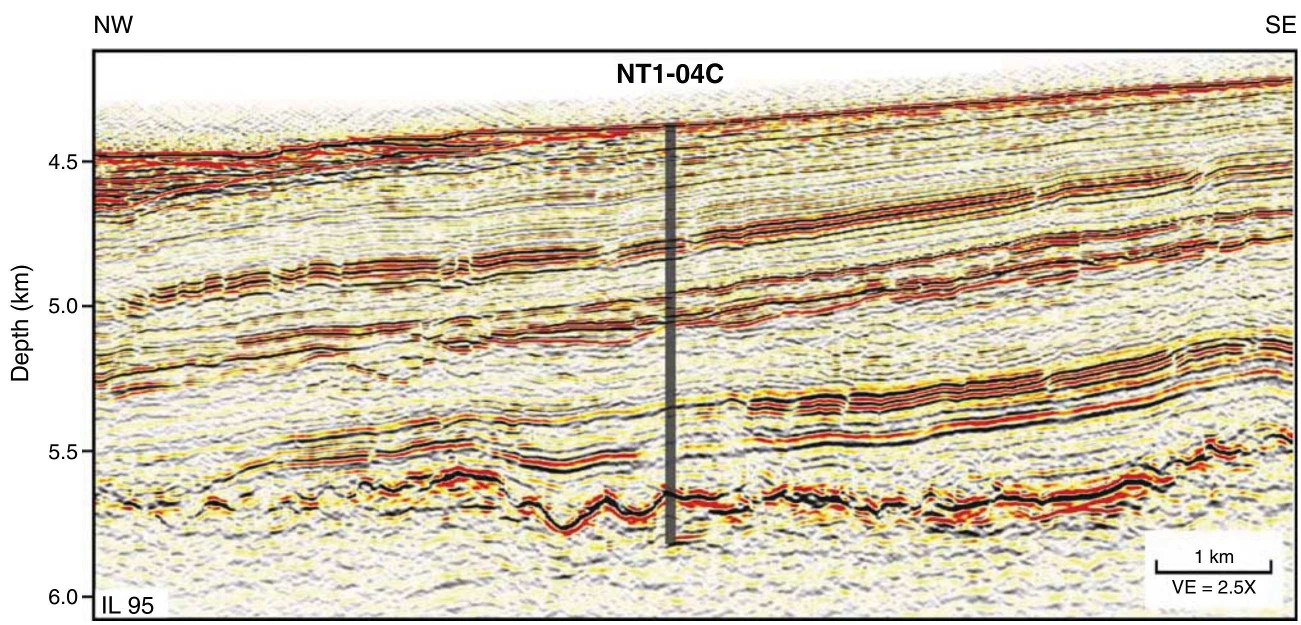


Figure AF18. Line 1151.

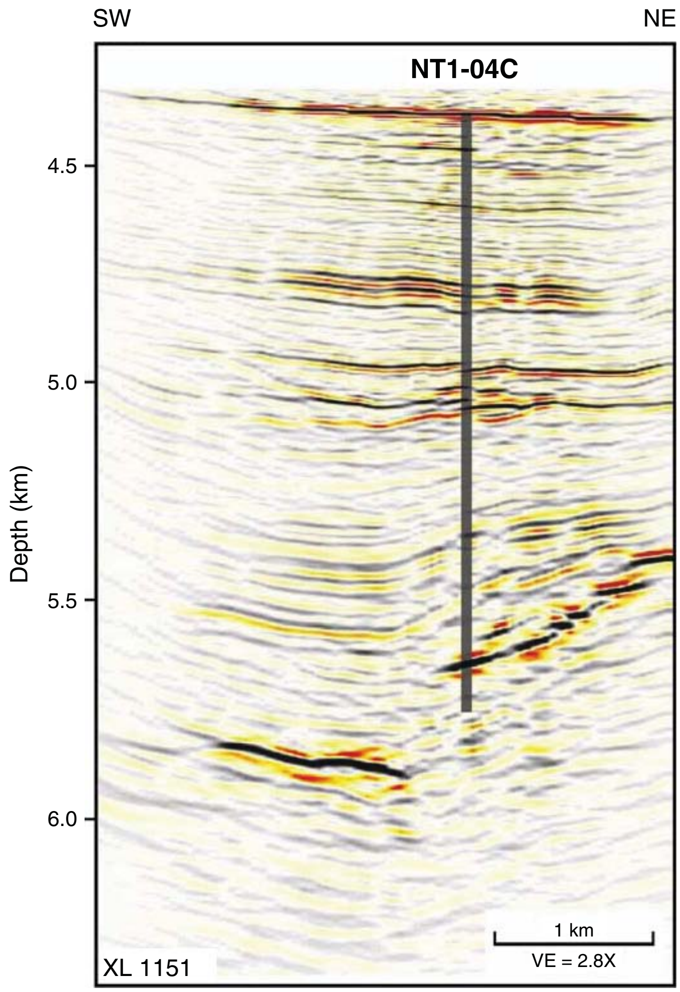


Figure AF19. Line KR0211.

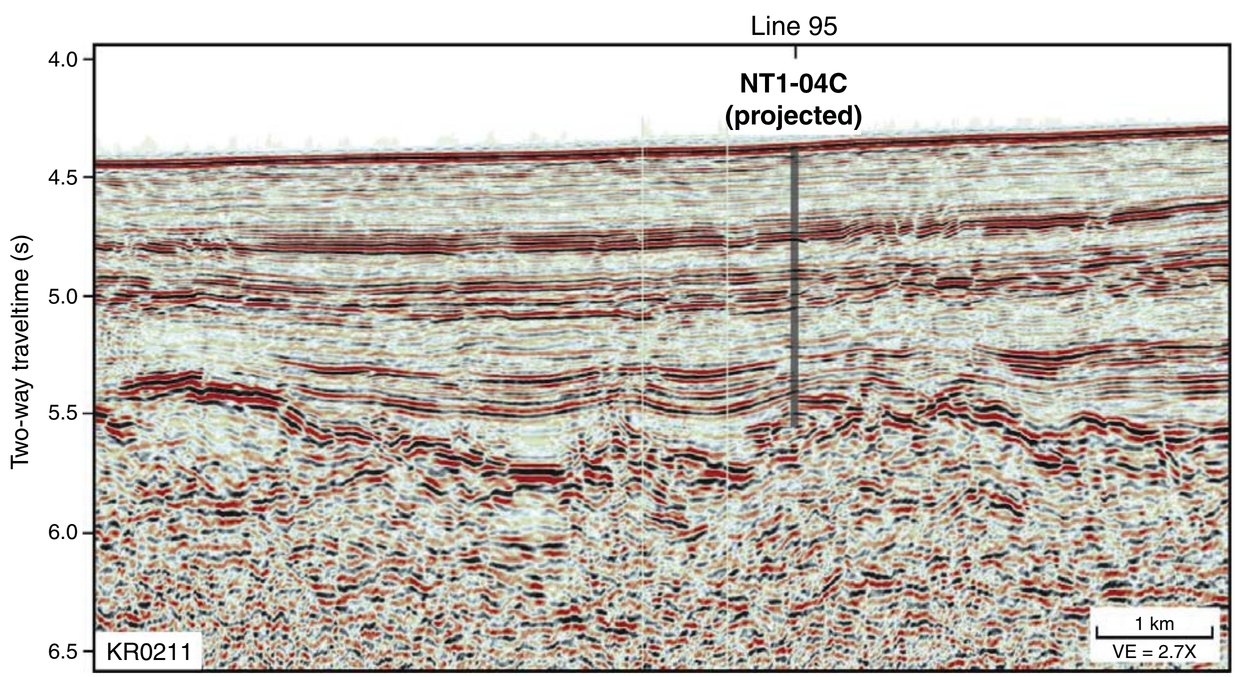


Figure AF20. Track map, Site NT1-07A.

Figure AF21. Line ODKM 03-101.

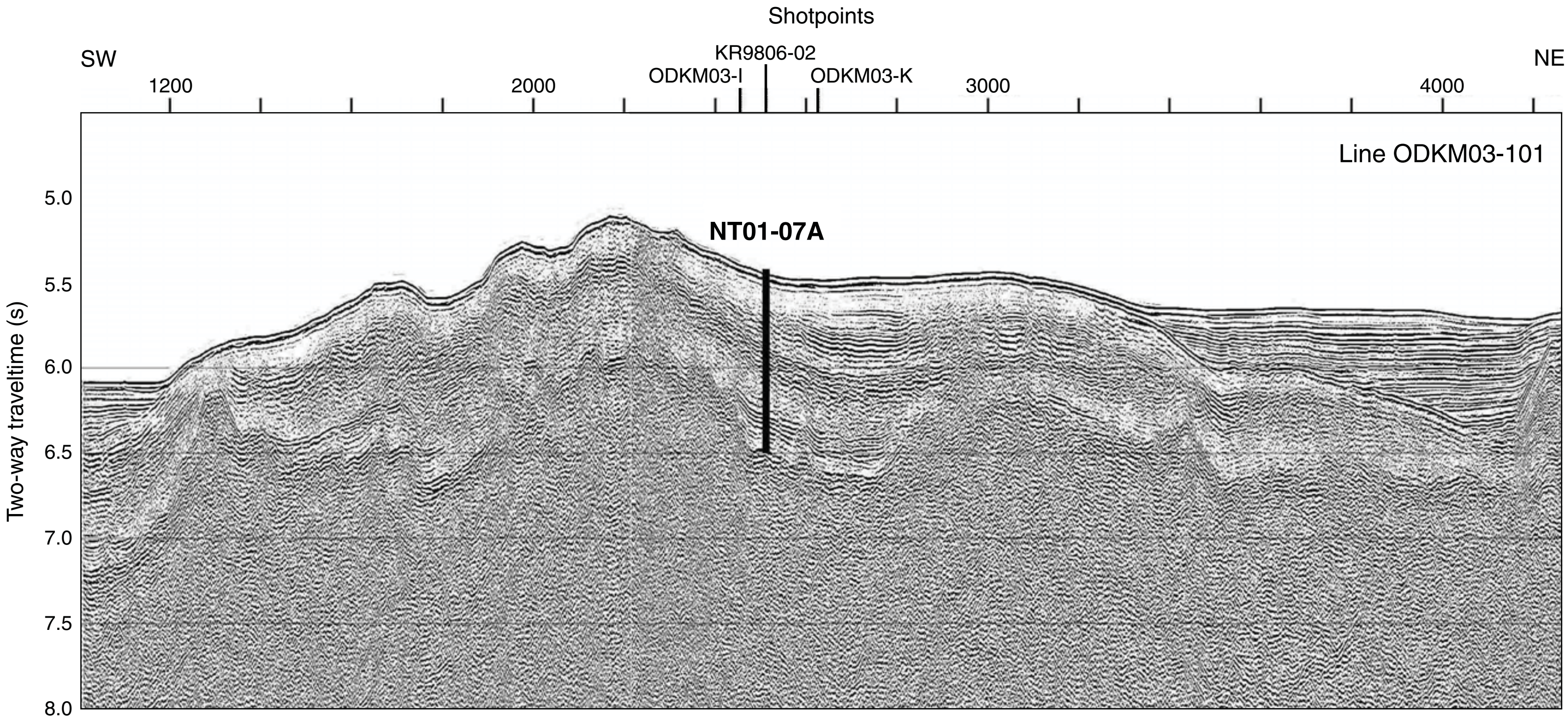


Figure AF22. Inline 95.

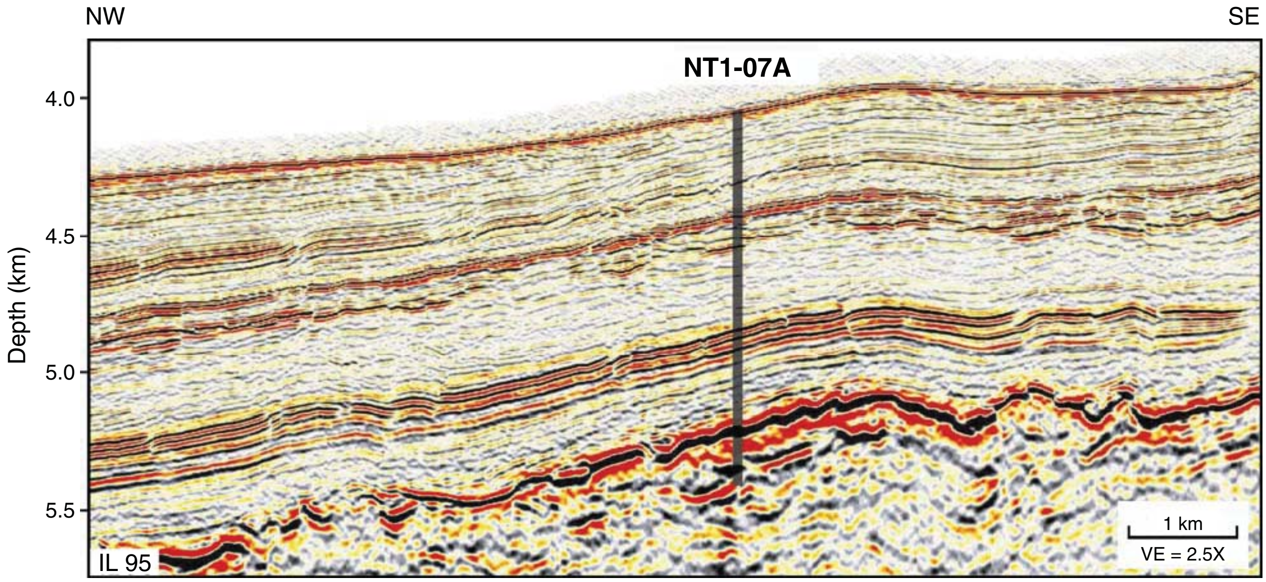


Figure AF23. Track map, Sites NT2-01 and 03.

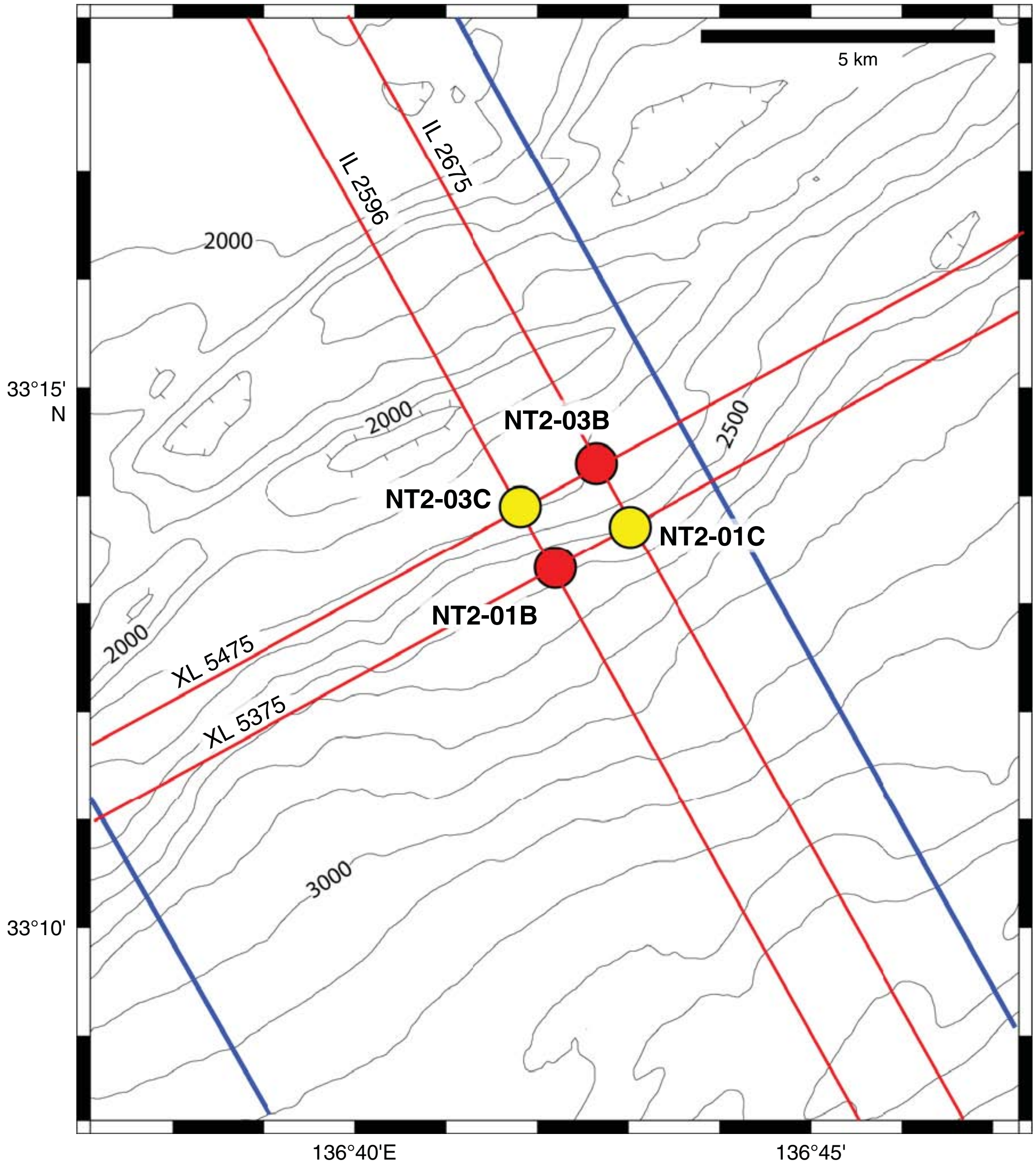


Figure AF24. Inline 2596.

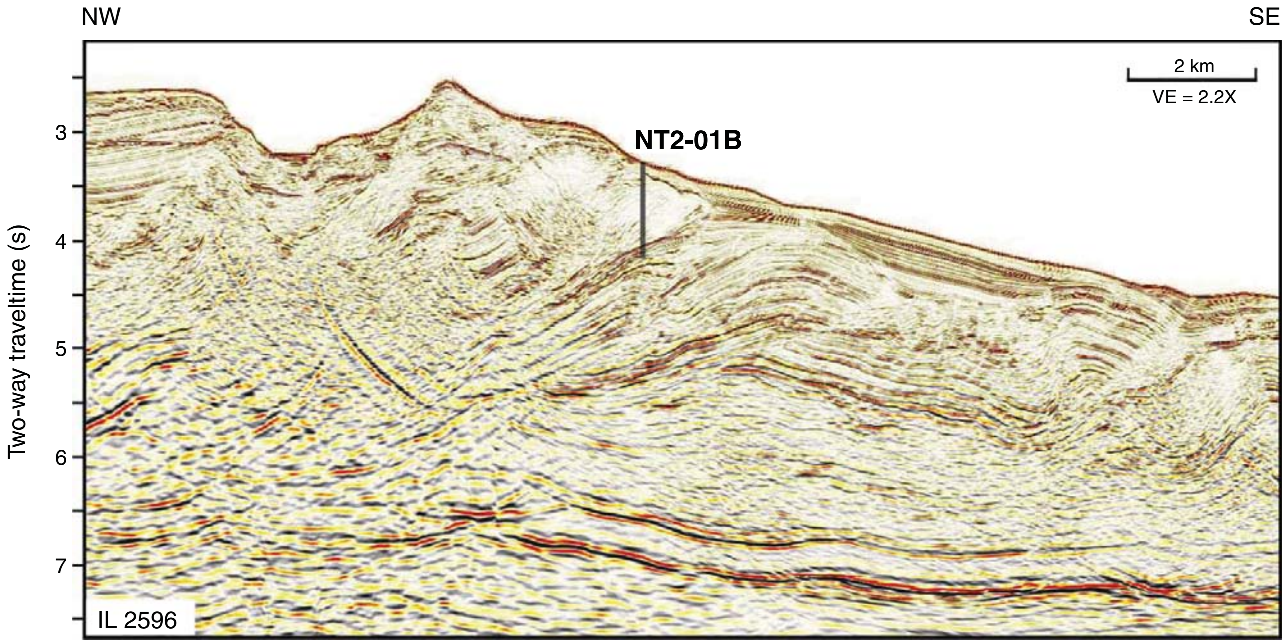


Figure AF25. Inline 2596.

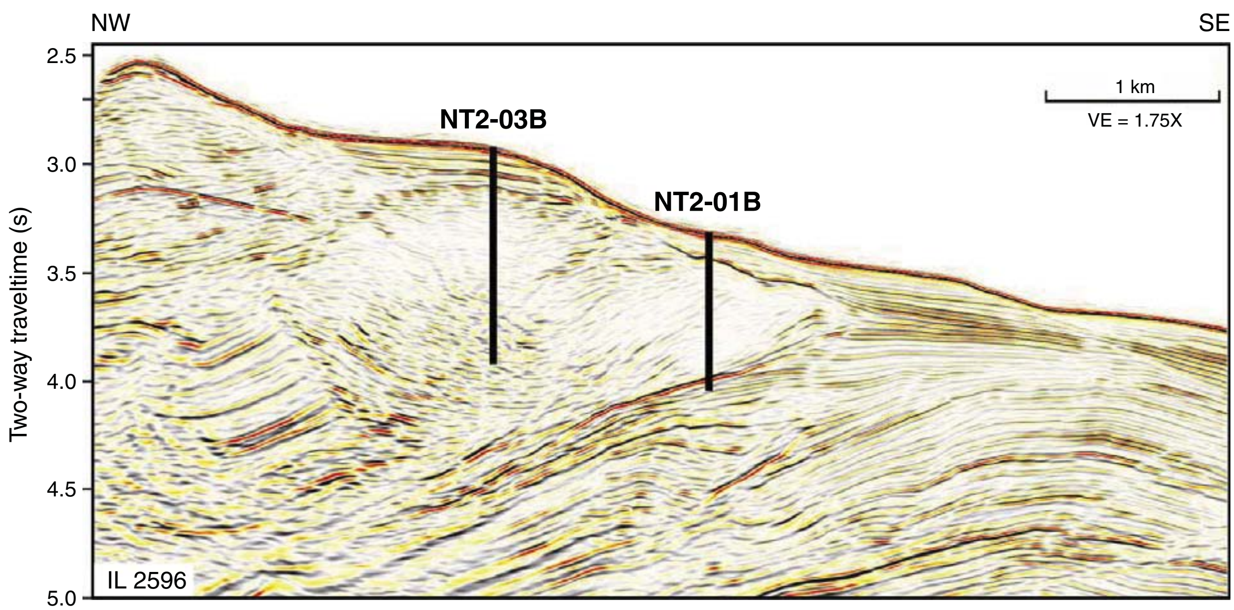


Figure AF26. Crossline 5375.

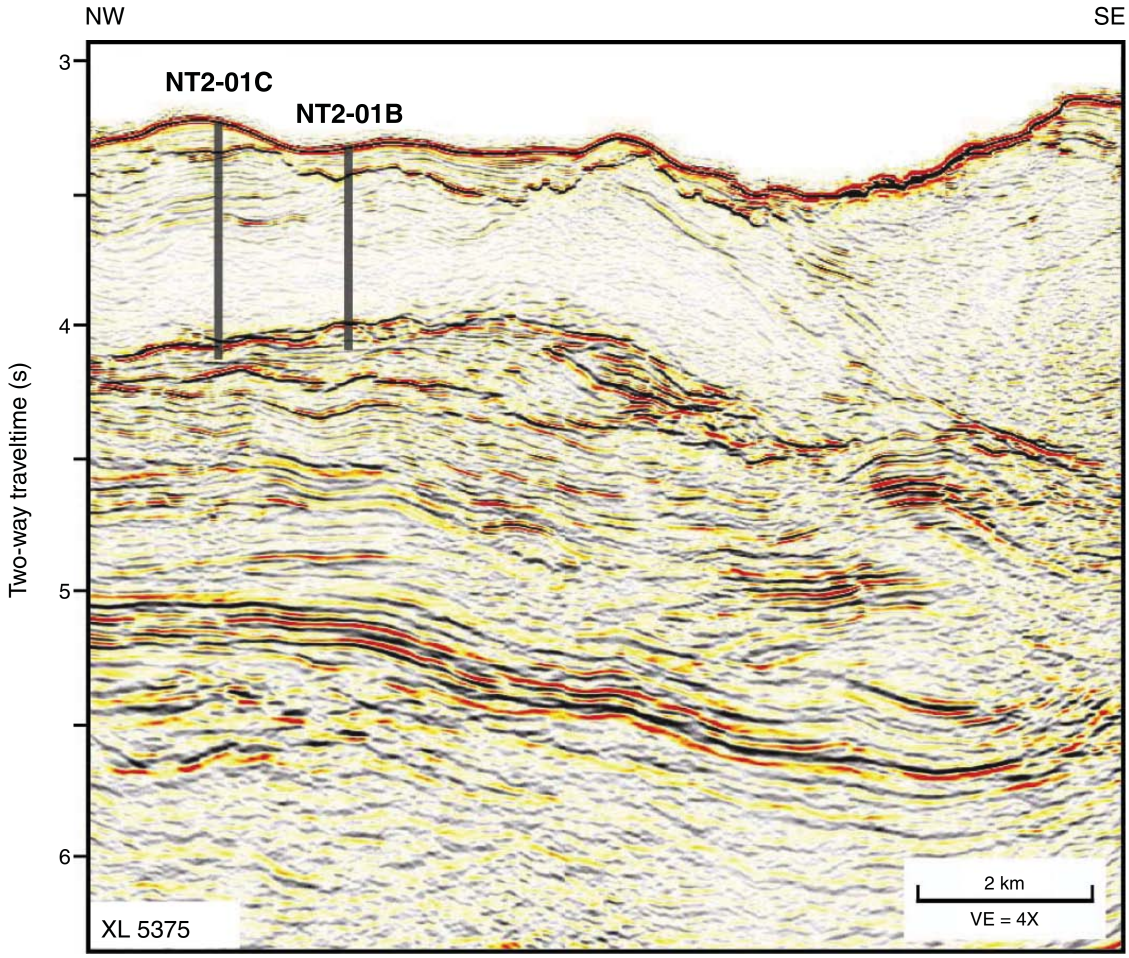


Figure AF27. Inline 2675.

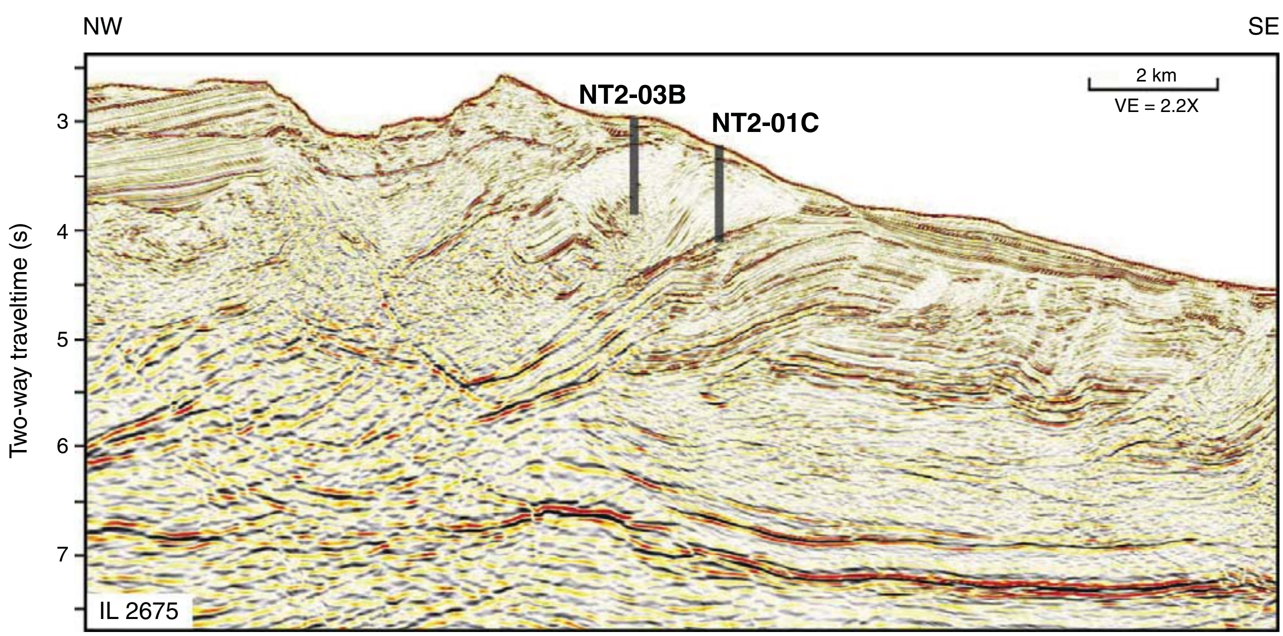


Figure AF28. Inline 2675.

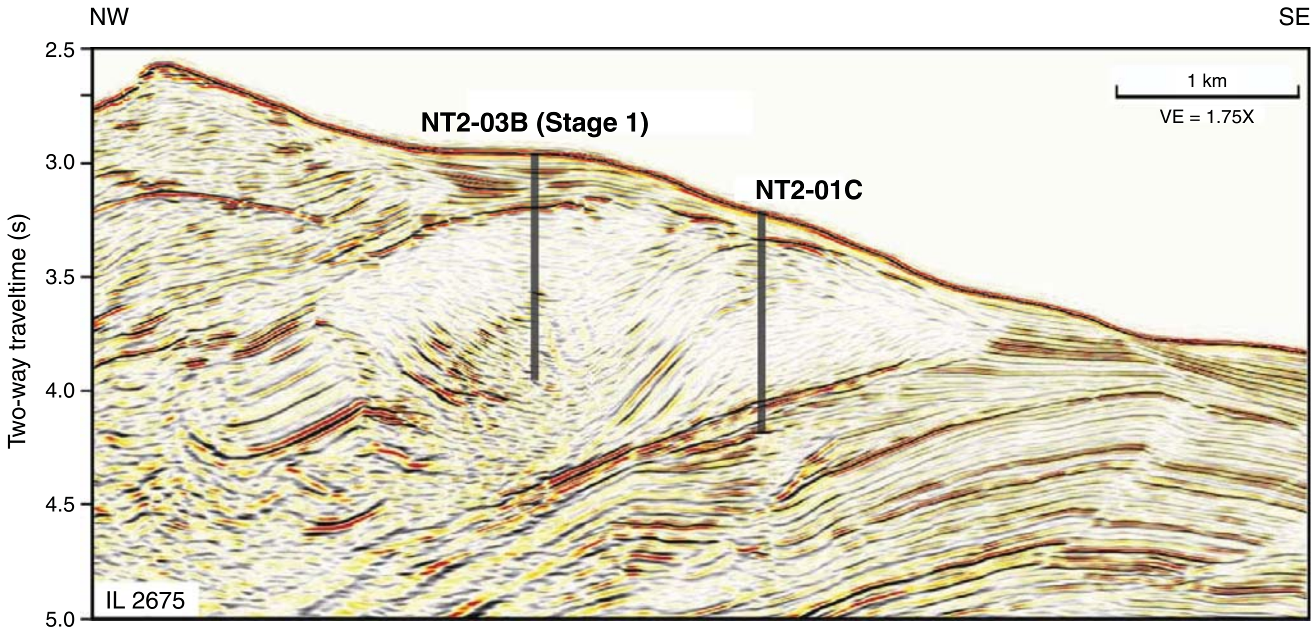


Figure AF29. Crossline 5475.

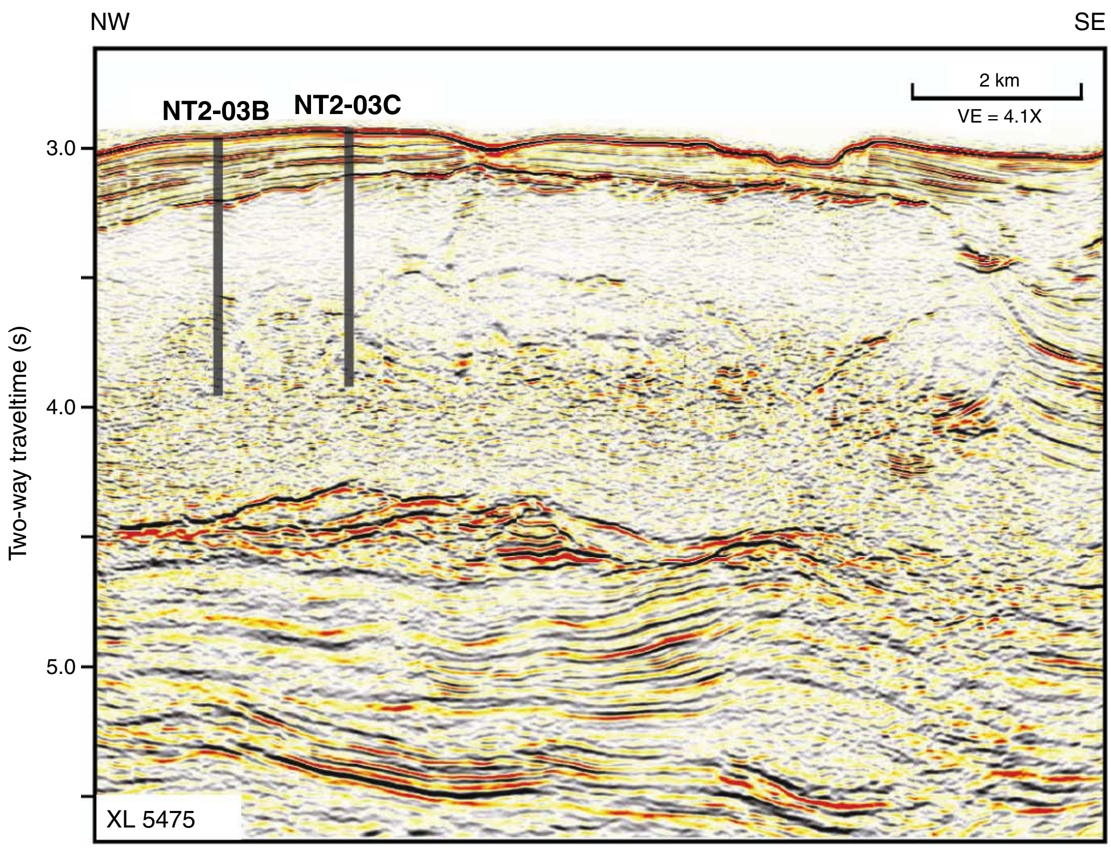


Figure AF30. Track map, Site NT3-01.

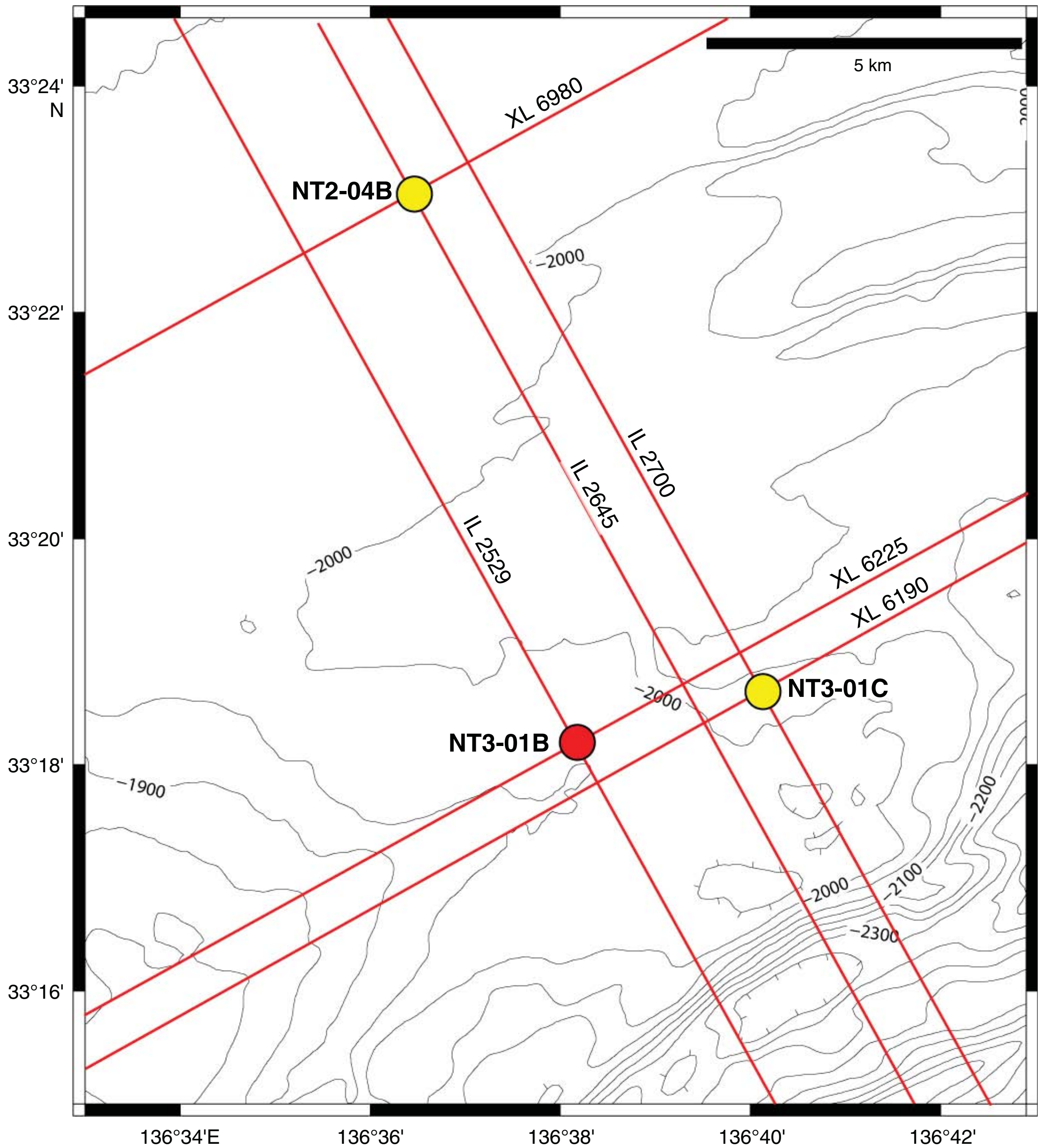


Figure AF31. Inline 2645.

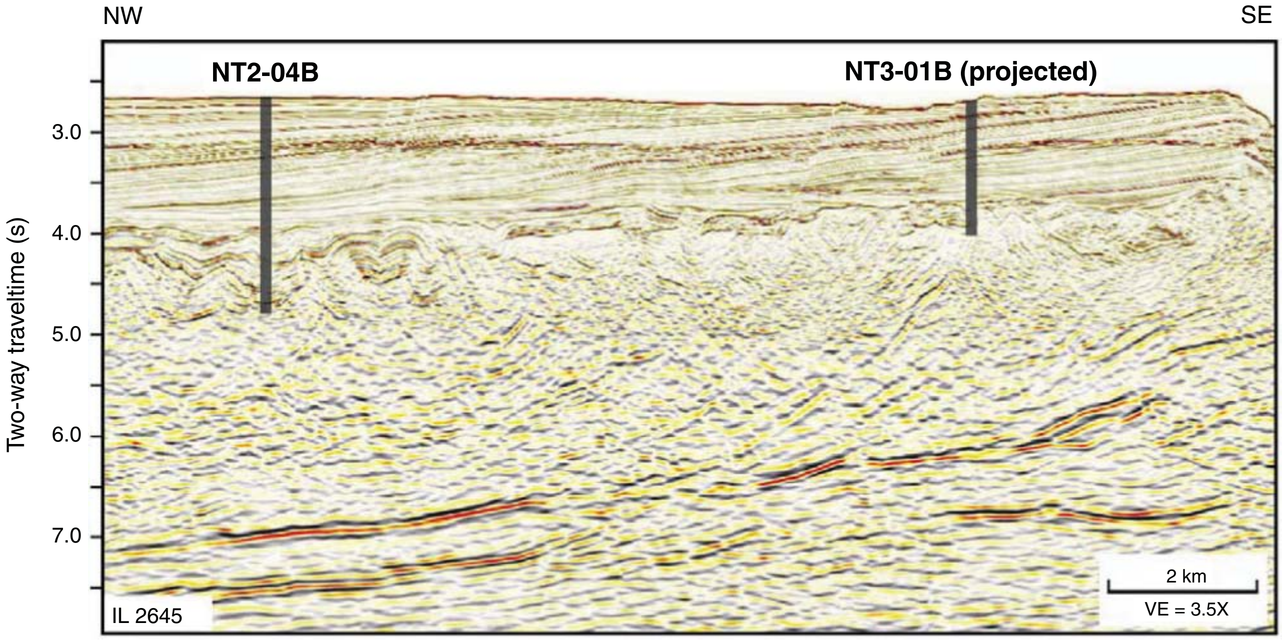


Figure AF32. Inline 2645.

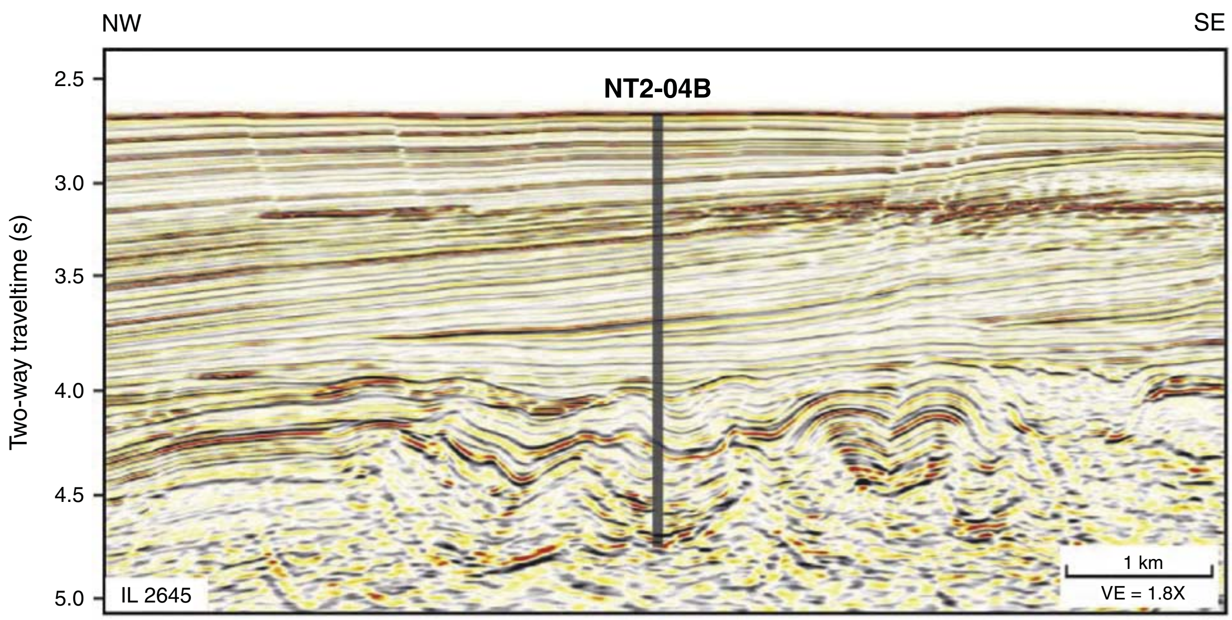


Figure AF33. Crossline 6980.

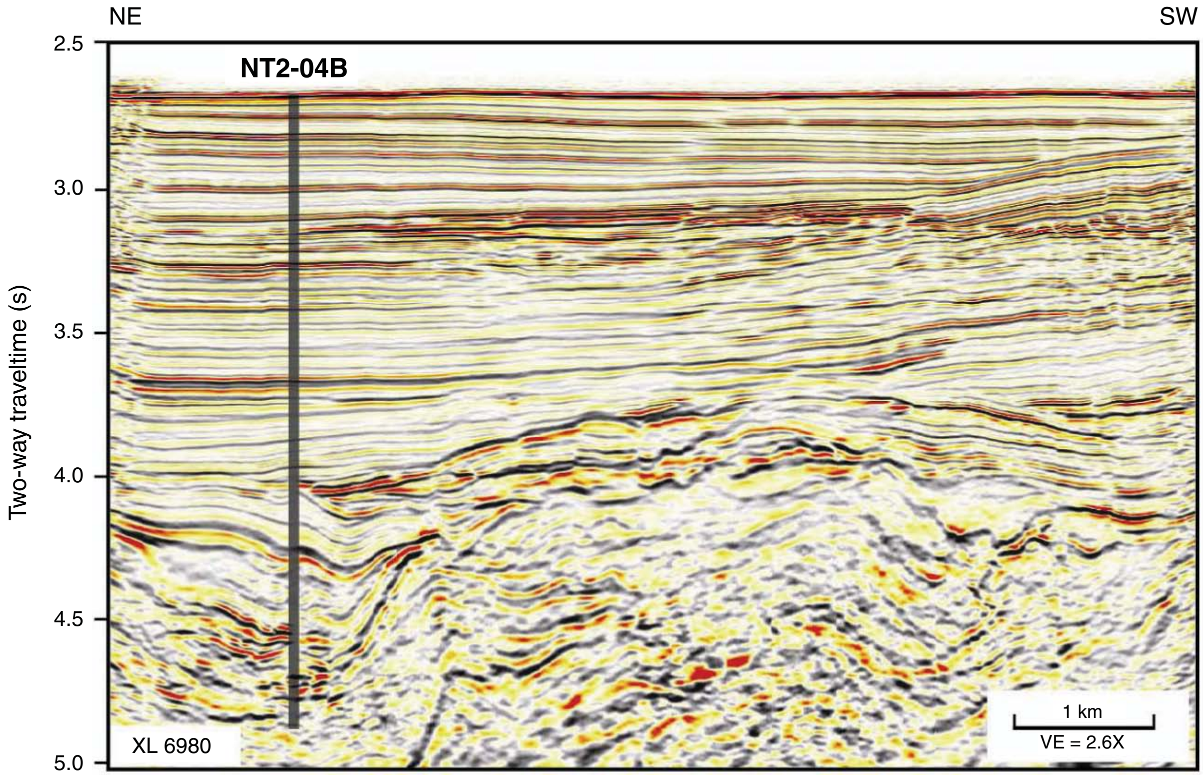


Figure AF34. Inline 2529.

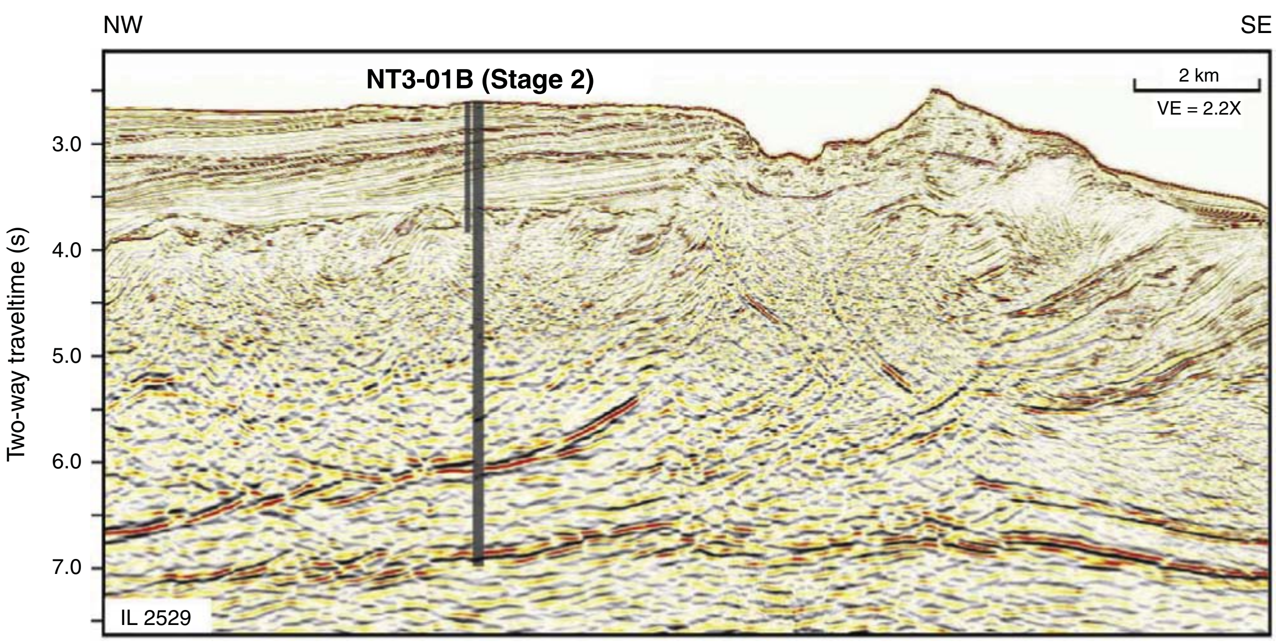


Figure AF35. Inline 2529.

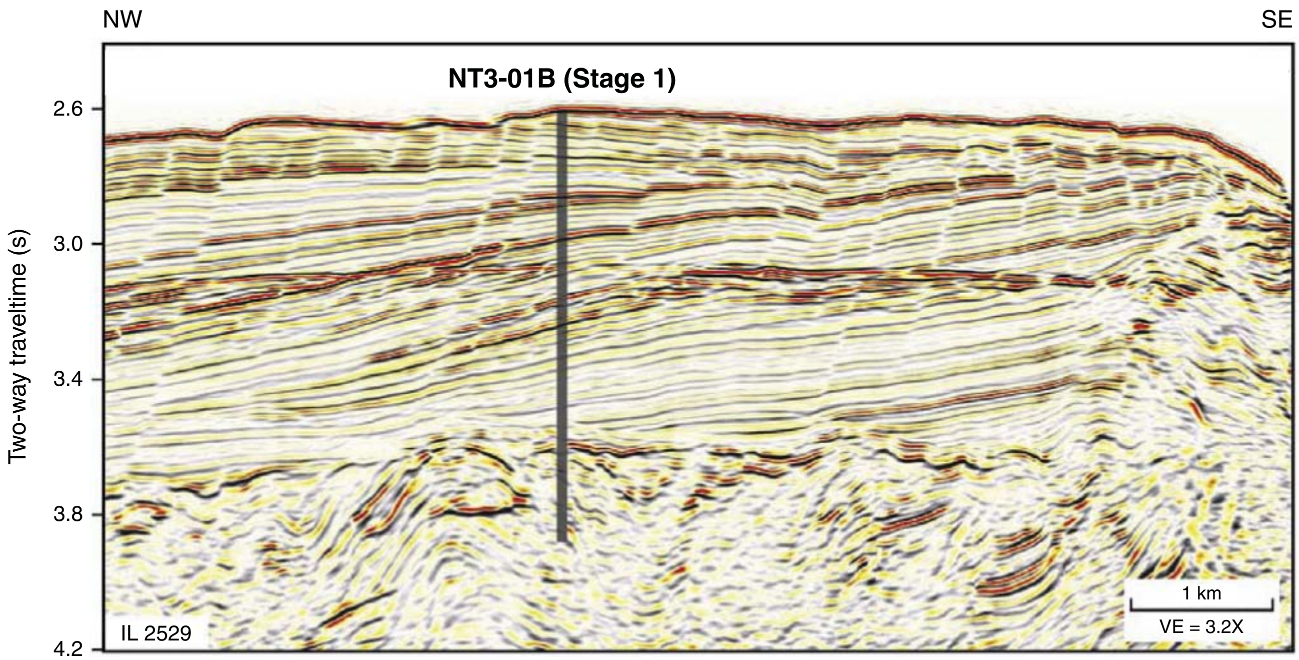


Figure AF36. Crossline 6225.

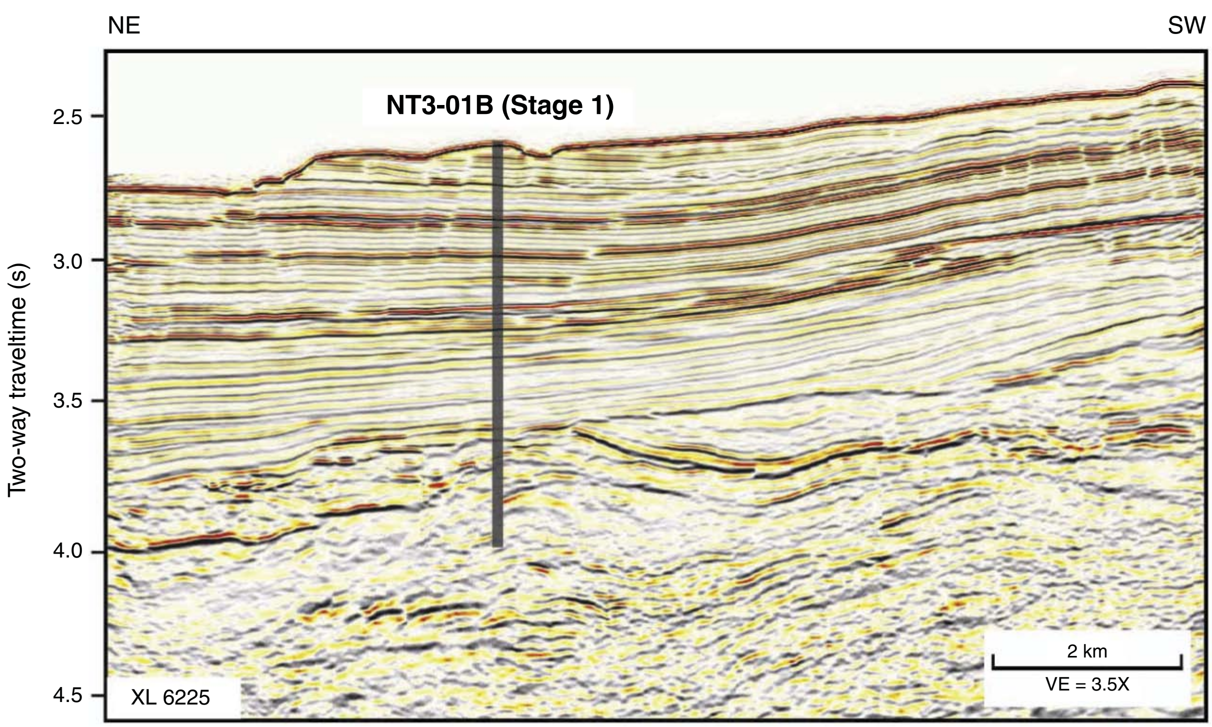


Figure AF37. Inline 2700.

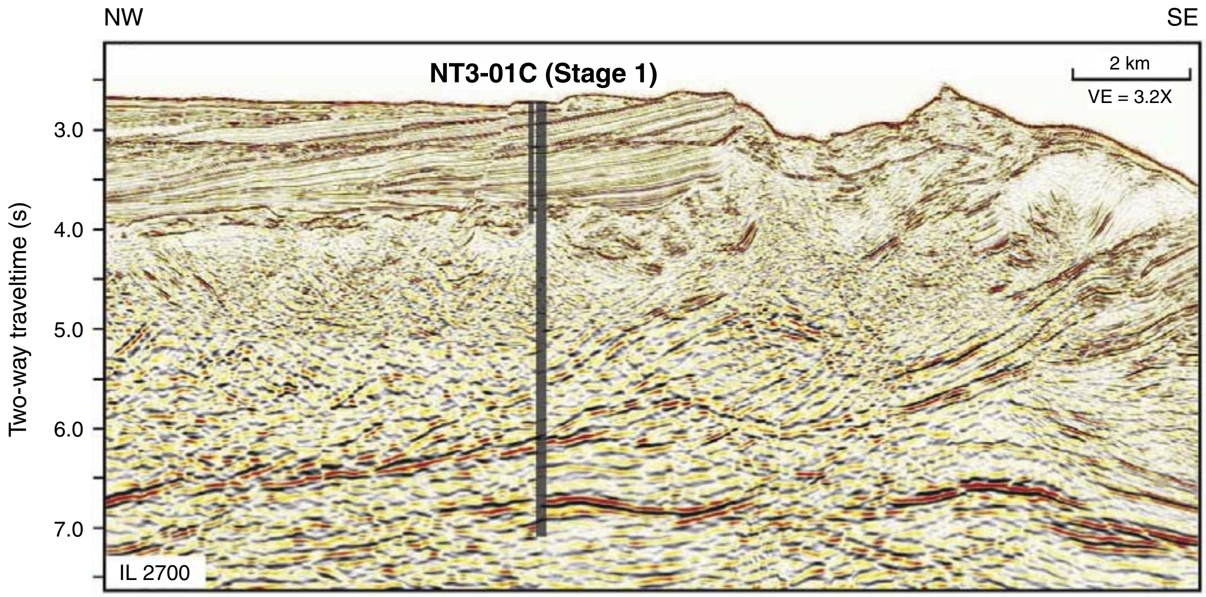


Figure AF38. Inline 2700.

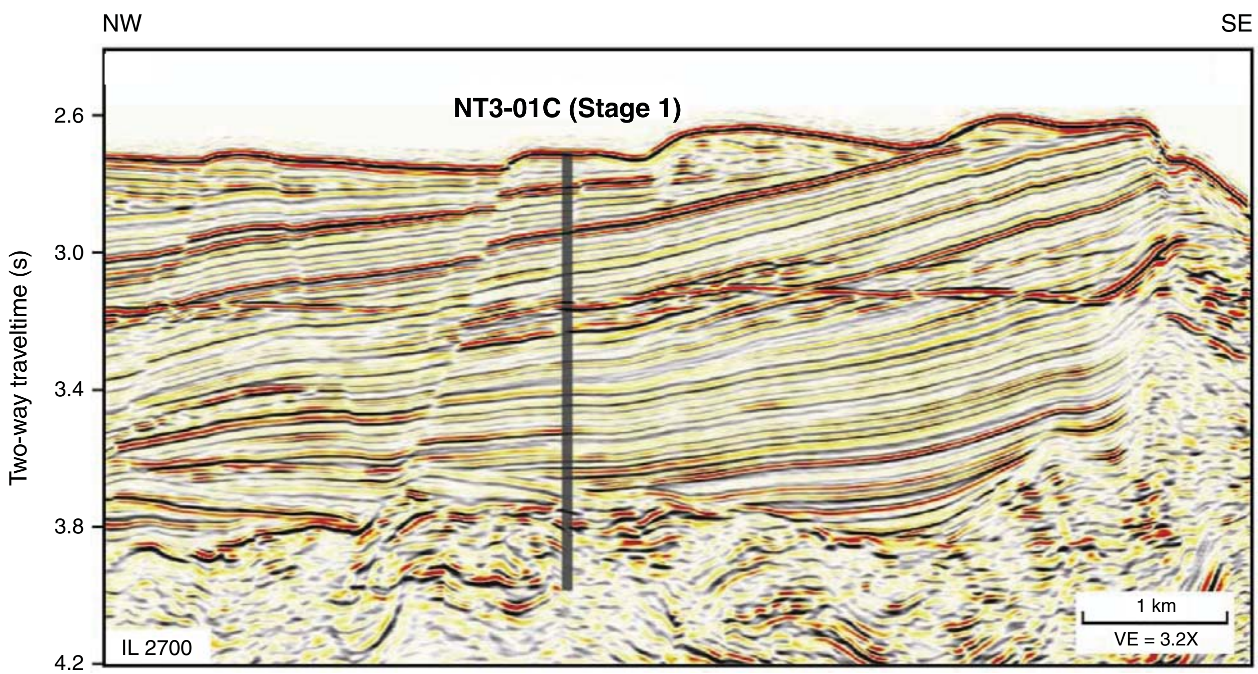
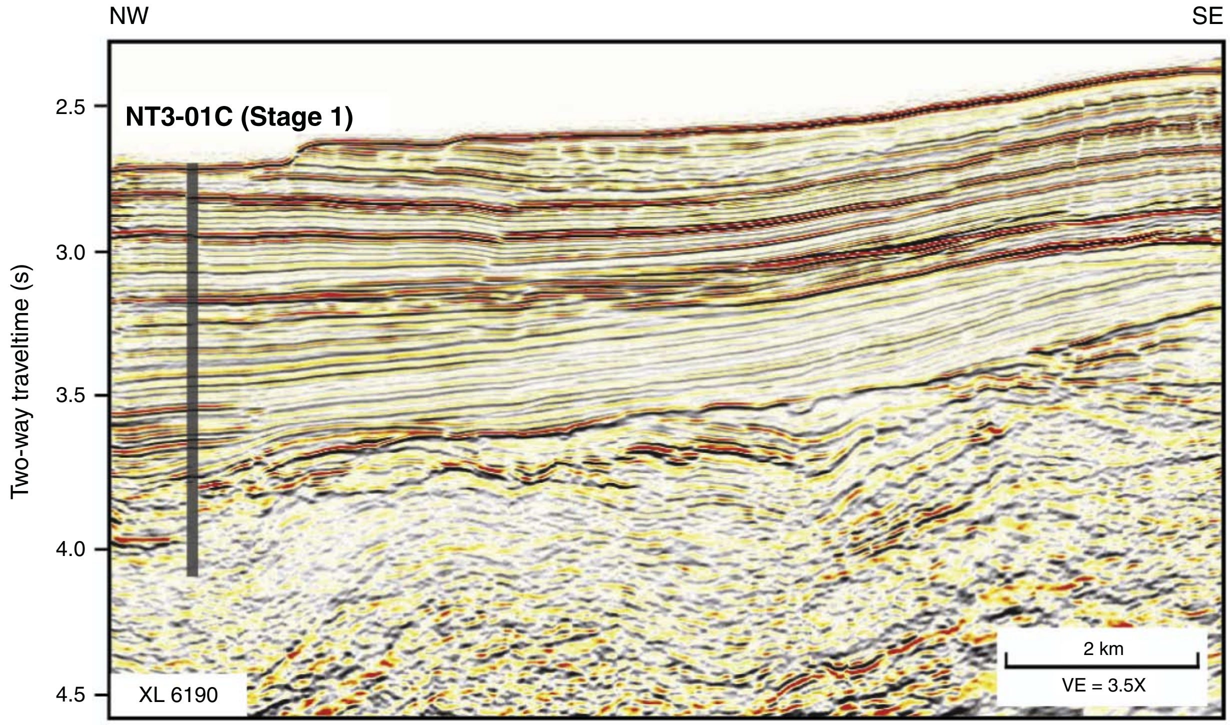


Figure AF39. Crossline 6190.



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