# IODP Proposal Cover Sheet

JTRACK

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| Title | Tracking the Tsunamigenic slips Across and Along the Japan Trench (JTRACK): Investigating a new paradigm in tsunamigenic megathrust slip with very deep water drilling using the D/V Chikyu |
| Proponents | S. Kodaira, J. Mori, J. Sample, M. Strasser, *. JTRACK working group (21 others), |
| Keywords | Tsunami, Earthquake, Subduction, Paleoseismology, Fault |
| Area | Japan Trench |

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## Abstract


We propose JTRACK, a collection of targeted scientific objectives that can be addressed during short expeditions requiring the D/V Chikyu, to investigate the super-earthquake cycle and conditions facilitating periodic slip-to-trench deformation along the Japan Trench. The 2011 Tohoku-oki earthquake and tsunami has caused us to re-evaluate models for seismic behavior of shallow portions of subduction zones. Successful coring, and observatory emplacement and retrieval during Expedition 343/343T (JFAST) demonstrated that the Chikyu is a viable and required platform for drilling in water depths required by our scientific objectives.

We propose a multidisciplinary approach of coring and downhole measurements, coupled with shore-based studies, along three trench-normal transects. The transects target zones of likely rupture and tsunami generation related to the 2011 Tohoku-oki earthquake (central transect), 1896 Meiji-Sanriku earthquake (northern), and 1677 Enpo Boso earthquake (southern). These transects would seek to characterize fault structures and mechanical and fluid properties along major slip zones, including a reference site on the incoming plate. A fourth trench-parallel transect would include a series of relatively shallow holes to investigate the superquake cycle of the Japan Trench. The proposed objectives can be accomplished by a series of short expeditions, and significant constraints on the tsunamic hazard can be realized before all transects are completed.

Coring from IODP 343/343T, and ODP Legs 56/57, high-resolution seismic reflection data, repeat bathymetric surveys, and nearby OBS installations provide regional context and baseline data. Each transect would consist of 4-5 drill sites chosen to penetrate and sample important faults, including the megathrust, to understand the nature of the weak clay layer sampled at C0019 and whether that material may facilitate tsunamigenic earthquakes along the entire margin. We also need to constrain patterns of fluid movement and pressures to understand how much overpressuring might contribute to slip, and what times may be required to rebuild overpressures. One site will be collocated with Site C0019 to leverage results from JFAST. Measurements and sampling will be completed to characterize physical/chemical properties, changes in stress state, and the record of seismo-turbidites in the trench related to very large earthquakes. A reference site will be chosen far from influences of the deformation front. Very deep-water sites in the trench will be selected to penetrate major thrusts recognized on seismic data, and to sample separate sub-basins for seismo-turbidite record. Prism sites will be chosen where water depths allow for use of underwater cameras and submersibles for return sampling




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## Scientific Objectives

JTRACK proposes to investigate processes leading to catastrophic, tsunamigenic earthquake and the history of such events along the margin. Our specific objectives are to:

A. Sample a reference section on the incoming plate as a baseline for comparison with sediments in the prism and plate-boundary décollement;
B. Continuously core the fault zone in multiple locations to determine representative fault rock properties by structural analysis and laboratory experiments;
C. Investigate the role of fluids in slip along a transect with geochemical and physical property data from continuous cores;
D. Characterize the prism stress state from borehole and sediment property measurements, and geodetic monitoring; and
E. Construct a great earthquake chronology from a trench-axis drilling transect.

Specific questions this project would address are:
How does the presence of a weak, velocity-weakening pelagic clay layer in the incoming plate influence the seismic behavior of the plate boundary?
Is there thermal evidence for repeated, large slip at shallow depths on the plate boundary décollement?
Are there differences in fault characteristics in regions that rupture in tsunamigenic'earthquakes compared to great earthquakes?
What rock properties control the earthquake coseismic and postseismic deformation?
What is the strength of the shallow part of the megathrust?
How does the state of stress, as controlled by the megathrust, change along strike and in the margin-normal direction?
What are the fluid flow patterns in the fault system?

## Non-standard measurements technology needed to achieve the proposed scientific objectives.

## Proposed Sites

| Site Name | Position (Lat, Lon) | Water Depth (m) | Penetration (m) | | | Brief Site-specific Objectives |
|---|---|---|---|---|---|---|
| | | | Sed | Bsm | Total | |
| JTS-02A | 36.6586, 143.1637 | 7110 | 1350 | 0 | 1350 | Inner trench slope drilling in possible tsunami source area of 1677 Enpo Boso earthquake. Investigate fault rock properties of shallow mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging, core measurements (objective D) |
| JTS-01A | 36.6343, 143.2166 | 7590 | 620 | 0 | 620 | Trench axis drilling in possible tsunami source area of 1677 Enpo Boso earthquake. Seismoturbidite record from shallowest section(objective E). Deeper interval for understanding deformation of trench sediments and shallowest mega splay fault. Investigate fault rock properties of shallowest mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging, core measurements (objective D). |

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| JTN-03A | 39.8764, 144.2465 | 7230 | 950 | 0 | 950 | Inner trench slope drilling in estimated tsunami source area of 1896 Meiji-Sanriku earthquake. Investigate fault rock properties of shallow mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging, core measurements (objective D) |
| JTN-02A | 39.8724, 144.3024 | 7325 | 560 | 0 | 560 | Trench axis drilling in estimated tsunami source area of 1896 Meiji-Sanriku earthquake. Seismoturbidite record from shallowest section (objective E). Deeper interval for understanding deformation of trench sediments and shallowest mega splay fault. Investigate fault rock properties of shallowest mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging and core measurements (objective D). |
| JTN-01A | 39.8689, 144.3552 | 7260 | 480 | 0 | 480 | Near trench drilling around estimated tsunami source area of 1896 Meiji-Sanriku earthquake. Seismoturbidite record from upper 100 m (objective E). Deeper interval for another reference section on the incoming plate for comparison with sediments in the prism and plate boundary decollement (objective A). |
| JTC-03A | 37.9383, 143.9133 | 6900 | 850 | 0 | 850 | Inner trench slope drilling in the large slip area of 2011 Tohoku-oki earthquake. Investigate fault rock properties of shallow mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging and core measurements (objective D). Observatory for fault zone pore pressure monitoring (objective C). |
| JTC-02A | 37.9308, 143.9645 | 7400 | 500 | 0 | 500 | Trench axis drilling in the large slip area of 2011 Tohoku-oki earthquake. Seismoturbidite record from Upper 100 meters (objective E). Deeper interval for understanding deformation of trench sediments and shallowest mega splay fault. Investigate fault rock properties of shallowest mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging and core measuremens (objective D). |
| JTC-01A | 37.918, 144.0507 | 6995 | 300 | 0 | 300 | Acquire undeformed incoming sediments which can be compared to ODP Sites 436 and 437. This is a reference section on the incoming plate as a baseline for comparison with sediments in the prism and plate boundary decollement (objective A). |


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***Tracking Tsunamigenic Slips Across and Along the Japan Trench (JTRACK): Investigating a new paradigm in tsunamigenic megathrust slip with very deep water drilling using the D/V Chikyu***

List of Proponents

| Proponent | Affiliation | Expertise |
|---|---|---|
| Shuichi Kodaira* | JAMSTEC-IFREE | geophysics |
| Jim Mori* | Kyoto University | seismology, hazards |
| Jim Sample* | Northern Arizona University | geochemistry, tectonics |
| Michael Strasser* | ETH Zurich | sedimentology, tectonics |
| Demian Saffer | Pennsylvania State University | hydrogeology |
| Kohtaro Ujiie | University of Tsukuba | structural geology |
| Takehiro Hirose | JAMSTEC-Kochi | physical properties |
| Jamie Kirkpatrick | Colorado State University | structural geology |
| Weiren Lin | JAMSTEC-Kochi | rock mechanics |
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| Ken Ikehara | Geological Survey of Japan | sedimentology |
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| Chris Goldfinger | Oregon State University | tectonics, paleoseismology |
| Toshiya Kanamatsu | JAMSTEC-IFREE | sedimentology |
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| Jan Behrmann | GEOMAR | tectonics, rock mechanics |
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| Achim Kopf | MARUM | tectonics, rock mechanics |
| Tim Byrne | University of Connecticut | tectonics, structural geology |
| Saneatu Saito | JAMSTEC-IFREE | geophysics, well logging |
| Greg Moore | University of Hawaii | geophysics |

*primary proponents

## 1. INTRODUCTION

Among the global efforts to understand and mitigate earthquake hazards, investigations and resources for understanding the effects of tsunamis have been relatively few, compared to the many studies of strong earthquake shaking. Yet worldwide over the last decade, nearly a third of the loss of human life from earthquakes is attributed to tsunamis (~247,000 from tsunamis and ~535,000 from earthquake shaking for 2002 to 2012). Since understanding processes and

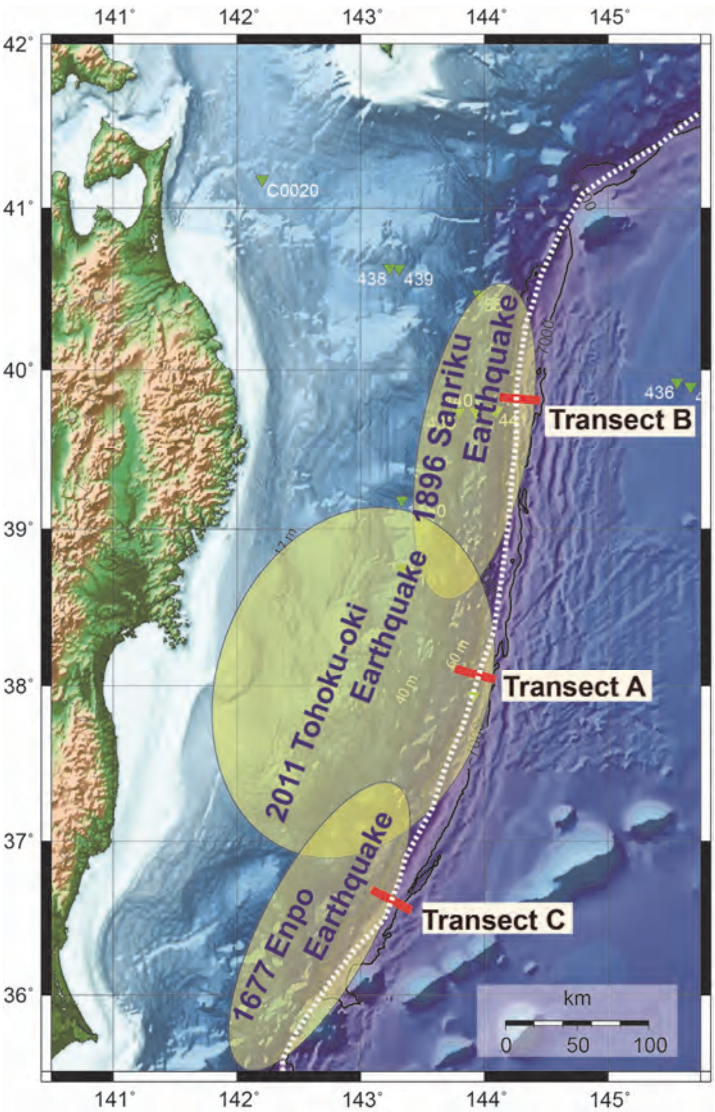



**Fig. 1**. Schematic figure showing location of historic very large earthquakes and proposed drilling transects. Transect A, B and C are proposed at an up-dip end of the fault zone of the 2011 Tohoku-oki earthquake (M=9.0), 1896 Sanriku Earthquake (M=8.2) and 1677 Enpo earthquake (M=8.0), respectively. Green triangles indicate previous sites of deep sea drilling. White broken line indicates the trench axis. The 1896 Sanriku earthquake occurred at the northern part of the Japan Trench and generated large tsunamis with maximum run-ups of more than 30 m. This earthquake is classified as a typical tsunami earthquake, which generates anomalously large tsunamis than what is expected from its seismic waves. Based on a tsunami wave inversion, the tsunami source of this earthquake is estimated to be very close to the Japan Trench and the fault strike is parallel to the trench axis [18]. The historic literature describes large tsunamis ( 4 – 10 m) along the coastline from the Kanto to Tohoku region, following an earthquake that occurred on November 4, 1677 (the Enpo earthquake) [19]. The fault zone of this earthquake is not well determined [19], but a tsunami source model proposed by the Central Disaster Prevention Council of Japan suggests the fault zone extended from the southern end of the Japan Trench to off-shore of Fukushima along the Japan Trench. (www.bousai.go.jp/kaigirep/chuobou/senmon/nihonkaiko_chisimajishin/10/pdf/siryou2_3_11.pdf)

properties that control fault slip behavior and deformation along subduction plate boundaries is one of the main IODP research targets, the tsunami investigations of JTRACK have the potential to make important scientific contributions to IODP and societal contributions to hazard mitigation. JTRACK will focus on a well-instrumented margin that is part of the recent global surge in great earthquakes (Fig. 1). We propose separate central, northern, and southern drilling transects across trench strike linked to slip zones that may be the cause of major tsunami in 2011, 1896, and 1677, respectively. In addition, a trench-parallel transect could efficiently capture the record of great earthquakes in the sedimentary record to complement findings from the other transects. We have structured the scientific objectives so that individual, stand-alone goals can be reached by short, targeted drilling operations. The short expeditions are close to the Japanese coastline and designed to fit into opportune openings in the D/V *Chikyu* schedule.

The Tohoku-oki earthquake (Mw 9.0), had a huge amount of fault slip to the trench and produced a gigantic tsunami generated by the seafloor deformation [1, 2]. Similar events, such as the 1896 Sanriku earthquake and ensuing giant tsunami, have occurred along this margin in the past (Fig. 1). This history indicates a need to revise the widely accepted conceptual model that in a seismogenic subduction zone, the shallow portion of the megathrust is slipping largely aseismicly. The Tohoku-oki earthquake further demonstrated that the short instrumental and historical records are inadequate to characterize the complex and multi-scale seismic behavior of subduction zones, including the occurrence of proposed "superquakes" with very long recurrence intervals [3, 4].

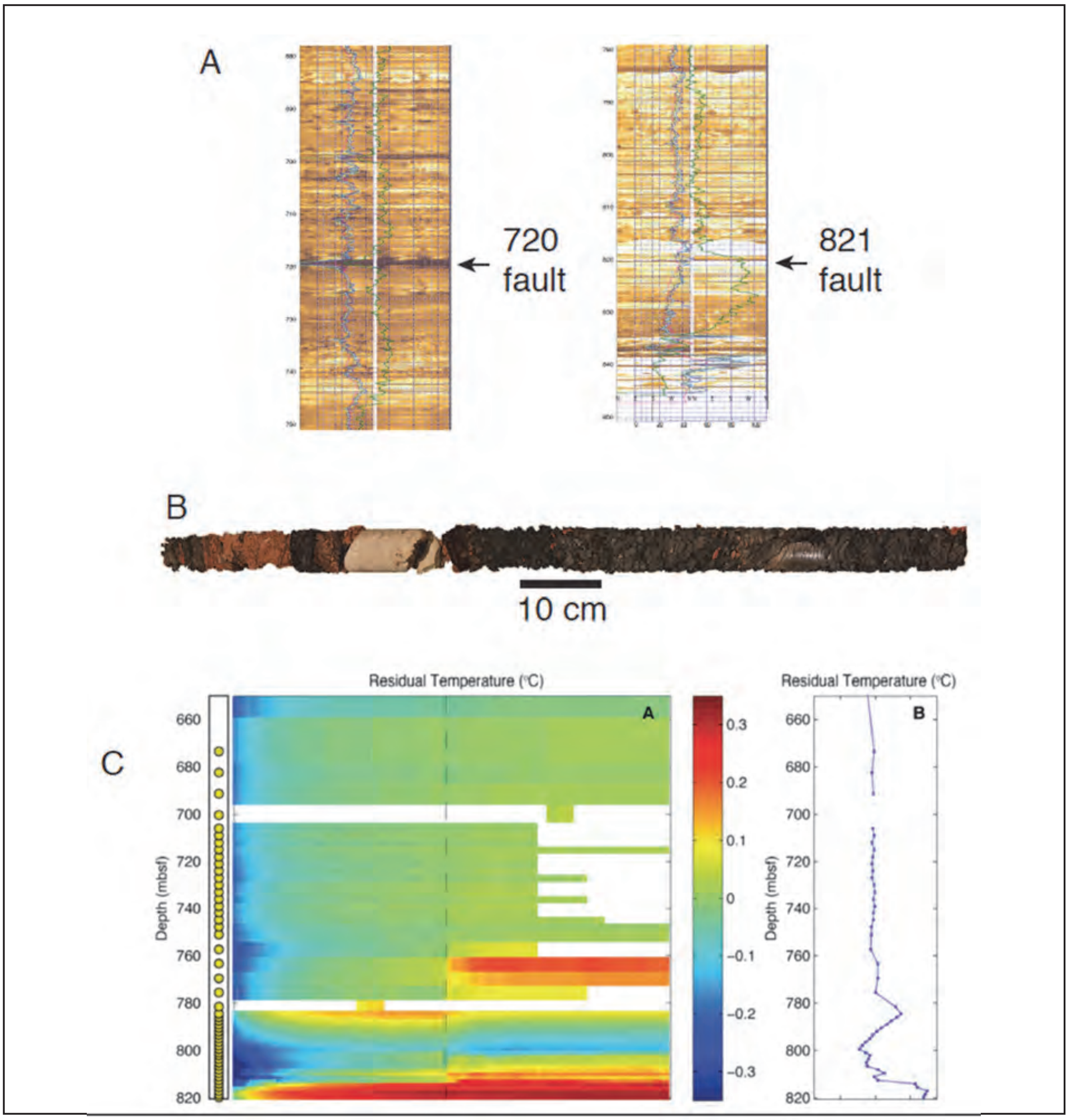
The 2011 Tohoku-oki earthquake is the first event whose entire activity was recorded by a modern dense geophysical network located close to the rupture zone. Bathymetric surveys show direct evidence for >50 m of lateral and 10 m of vertical motion reaching the trench and substantial deformation in trench sediments. Although the region of greatest slip is situated in very deep water (typically > 6500 m), in JFAST the capabilities of D/V *Chikyu* were extended to use logging-while-drilling to locate the fault, collect samples at intervals across two fault zones, and install a temperature observatory during the Japan Trench Fast Drilling Project (JFAST; IODP Expedition 343/343T) (Fig.2; [5]). Taking advantage of this gained experience, JTRACK proposes boreholes in the Japan Trench region with the following new scientific goals:

1. Understand the variations of physical and chemical properties of sediments and fluids of the near-trench megathrust that enable huge fault displacements and generate very large tsunamis; and
2. Develop and implement new methods for determining the recurrence of giant tsunamigenic earthquakes in the sediment record of the trench fill.

## 2. RATIONALE FOR NEW JAPAN TRENCH DRILLING

From Expedition 343/343T and supporting geophysical and geological data, we learned fundamental characteristics about large slip to the trench: 1) the co-seismic displacement reached all the way to the trench axis; 2) the co-seismic megathrust slip was confined to a narrow (<5 m) zone of a very weak clay layer on the Pacific Plate [6-8]; 3) there is no evidence yet that fluid overpressure contributed to slip; 4) trench-fill sediments are deformed by trenchward movement of the overriding block; and 5) turbidities from previous earthquakes are preserved in the trench fill and might provide a paleoseismic record.

However, there remain critical unanswered questions and the Japan Trench presents an unparalleled opportunity to fully characterize a system that can generate large, destructive tsunamis. The research proposed here will also help us to understand which other margins have similar tsunami hazards. JTRACK is proposed to accomplish the following specific objectives:




A) Sample a reference section on the incoming plate as a baseline for comparison with sediments in the prism and plate-boundary décollement;

B) Continuously core the fault zone in multiple locations to determine representative fault rock properties by structural analysis and laboratory experiments;

C) Investigate the role of fluids in slip along a transect with geochemical and physical property data from continuous cores;

D) Characterize the prism stress state from borehole and sediment property measurements, and geodetic monitoring; and

E) Construct a great earthquake chronology from a trench-axis drilling transect.

Lessons learned about operations in deep water from JFAST now make this comprehensive drilling program at the Japan Trench margin feasible. Also, an operational advantage of this project is that it can be accomplished during several expeditions of short duration, as opportunities for ship time arise.

## 3. WHAT WILL WE LEARN FROM TRENCH AXIS DRILLING IN THE JAPAN TRENCH

### ***3.1. Structural observations of interseismic and dynamic deformation characteristics of large-slip megathrusts (addresses objectives A,B,C,D)***

Fundamental questions regarding the structure, composition and mechanical behavior of the plate boundary décollement can be addressed by the scientific drilling proposed here.

- How does the presence of a weak, velocity-weakening pelagic clay layer in the incoming plate influence the seismic behavior of the plate boundary? Limited sampling of this clay occurred during JFAST (Fig.2), but constraints on the spatial distribution and degree of lithification of the pelagic clay on the Pacific plate near the trench requires integrated seismic surveys and coring at reference sites. Coring through the shallow megathrust landward of the trench will show how the pelagic clay in the incoming plate controls both the evolution of the megathrust architecture and the coseismic response of the fault.

- Is there thermal evidence for repeated, large slip at shallow depths on the plate boundary décollement? Modeling of temperature data imply the slip zone could have reached 1250°C ([7] Fig.2). Detection of frictional heat in the rock record can be accomplished by systematic sampling of cores from the fault for clay mineralogy, trace element mobility, and organic thermal maturity measurements

- Are there differences in fault characteristics in regions that rupture in 'tsunamigenic' earthquakes compared to great earthquakes? Direct observation of the slip zones in cores of the 2011 Tohoku-oki and 1896 Meiji-Sanriku earthquakes would allow the coseismic processes and magnitude of shear resistance in each to be evaluated. Additionally, structural characterization of the broader zone of deformation associated with the décollement would help constrain the long-term strength of the fault associated with each section of the margin.

### ***3.2. Experimental determination of fault- and wall-rock dynamic physical properties (objectives A, B, C, D, E)***

Shorebased laboratory experiments will help to answer questions about deformation arising from the drilling expeditions.

- What rock properties control the earthquake coseismic and postseismic deformation? Post-cruise geomechanical experiments using recovered core samples are a critical complement to shipboard measurements and seismic reflection observations for understanding coseismic and postseismic deformation, and fault-zone architecture. Experimental data will be compared with down-hole patterns in shipboard physical property measurements (porosity, strength, thermal conductivity, P-wave velocity, electrical resistivity, mineralogy) that might control the mechanical behavior of the megathrust. Frictional parameters were measured in JFAST [8], but important fluid information was lacking. Permeability measurements are necessary to constrain the likelihood of fluid flow and possible maintenance of excess fluid pressures, which directly control effective stress condition in the fault zone. Measurements of shear strength and consolidation history are important constraints on slope failure, and can be used to connect submarine landslides to paleoseismicity.

### ***3.3. Hydrogeological constraints on role of fluids in slip (objectives A, C)***

The JTRACK project will constrain the role of fluids and fluid overpressuring in slip during tsunami-generating earthquakes in the Japan Trench.

- What are the fluid flow patterns in the fault system? Understanding fluids is an important complement to structural, physical property, and geophysical measurements to constrain the location of faults since they are possible co-seismic conduits. Hydrogeological studies will utilize physical property measurements (e.g., permeability), as well as shipboard and shorebased geochemical measurements of interstitial waters and sediments for evidence of diagenetic influences on physical properties and to constrain fluid sources as local or exotic. With a systematic, high-resolution IW sampling program we can determine flow patterns related to the fault structure and whether fluids contribute to overpressuring.

- What are the microbiological responses to faulting? From JFAST samples, elevated hydrogen implies inorganic generation of hydrogen by high coseismic temperatures, which may promote increased biological activity. Geochemical and biochemical analyses will investigate new hypotheses relating microbiological activity to earthquake faulting.

### *3.4. Stress state: spatial-temporal stress distribution and variation in Japan Trench (objectives A, D)*

Drilling offers an opportunity to measure directly the current stress condition as it varies with location. Three separate transects will allow us to capture stress state at various times in the evolution of the megaquake cycle. We propose to make multiple stress measurements in different boreholes for which hole stability and physical properties are examined using a suite of geophysical logging techniques.

- What is the strength of the shallow part of the megathrust? –The target of this drilling project is the near-trench region of the megathrust and we wish to compare this with the average strength of the plate interface, which is very low [9].

- How does the state of stress, as controlled by the megathrust, change along strike and in the margin-normal direction?

Stress determinations to answer both of these questions will involve i) analyses of borehole damage such as breakout and/or drilling induced tensile fractures from resistivity images (i.e. Logging While Drilling), ii) on-site hydraulic fracturing tests at several depths and iii) study of anelastic strain recovery of core samples. We also plan to infer paleo-stress by analyzing minor faults observed in core samples and borehole images. The proposed drilling plan will also provide a rare opportunity to compare information from some of the new boreholes with JFAST results [10] to constrain stress variations over a timescale of years [11].

## *3.5. Great earthquake record from Japan trench seismoturbidites (objectives A, E)*

A record of seismo-turbidites recovered from trench-axis drilling will help answer several questions related to the seismic cycle at the Japan Trench.

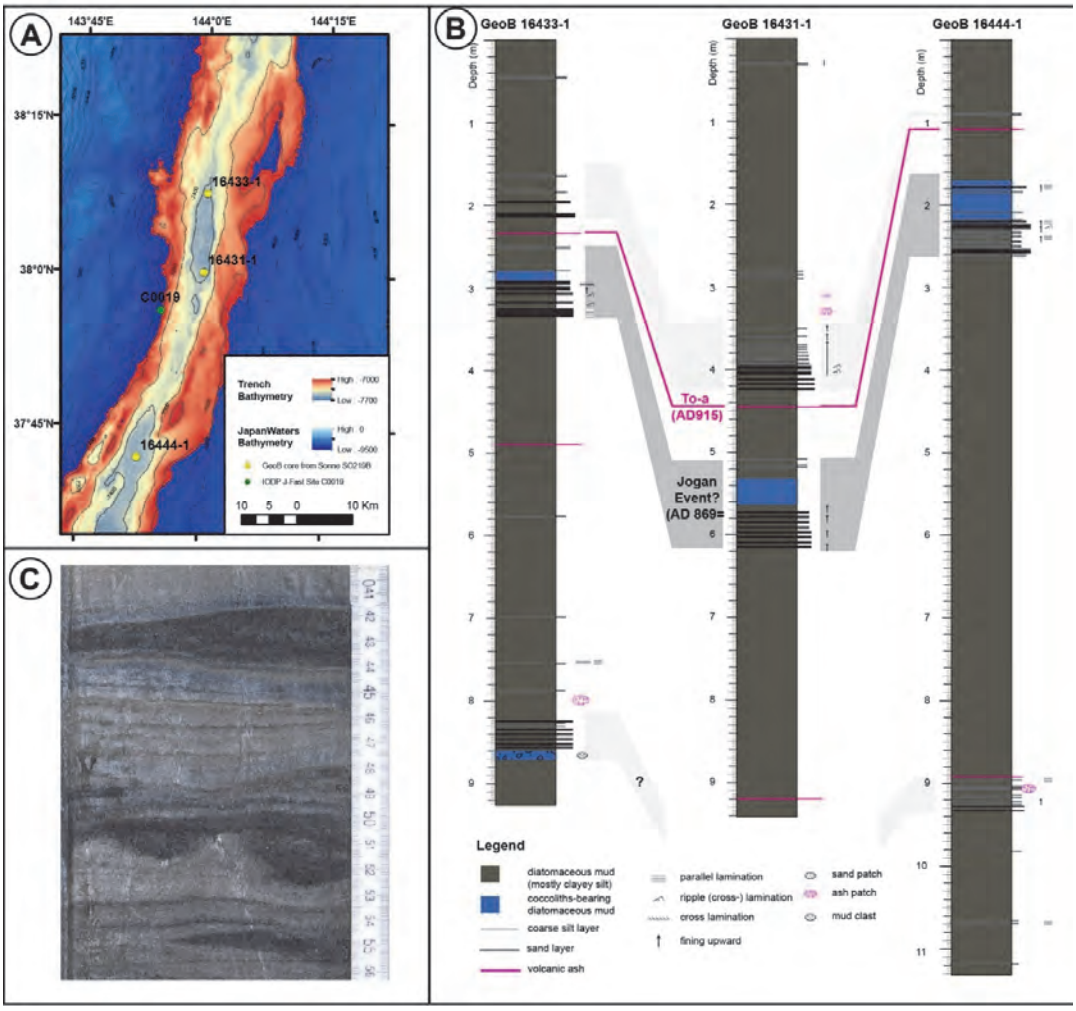



**Fig. 4.** Compilation of paleo-seismology constraints from gravity cores in separated trench-floor basins A: map showing core locations and detailed bathymetry structure in the trench. B) Positive correlation of dated ash layers and turbidite sequences related to past eathquakes. C) Core image showing example of turbidite sequence interpreted as seismo-turbidite (Figure modified after [13]).

- What is the history of great tsunami-producing earthquakes? We will investigate the hypothesis that the Japan Trench has a megaquake super-cycle not recoverable in instrumental and historical data. Coring of trench floor deposits in separated trench-floor basins will reconstruct the temporal-spatial distribution of gravity flow deposits. High-resolution age control will be established using mulitproxy Bayesian age models tied to tephrachronology and radiocarbon dating of individual organic compounds. Positive turbidite correlation between isolated sites will support a common (seismic) source [12], since no correlation would be expected between sites with no physical connection. The selected drill sites are isolated from terrestrial turbidite sources, and lie in water too deep to be affected by storms or tsunami. Evaluation of the entire spatio-temporal distribution of the turbidite record in the trench will distinguish between earthquakes and local slope instability triggers. In addition positive correlation may be established between the turbidite record and onshore tsunami deposits, which would provide independent evidence for an unprecedented paleo-earthquake record.

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Sedimentary cores (up to 10 m length) from research cruises Sonne SO219A and Mirai MR12-E01 demonstrate the high preservation potential of seismo-turbidites, and document at least three turbidite units that correlate to previous mega-earthquakes (Fig.3; [13]). JTRACK will further investigate and extend this earthquake record back in time with and along strike with deeper holes. Complementary data from piston coring of the Quaternary record will be used to spatially extend the more recent history.

**STRUCTURAL SETTING AND AVAILABLE SITESURVEY DATA**

The Japan Trench is one of the most well imaged subduction seismogenic zones, on the basis

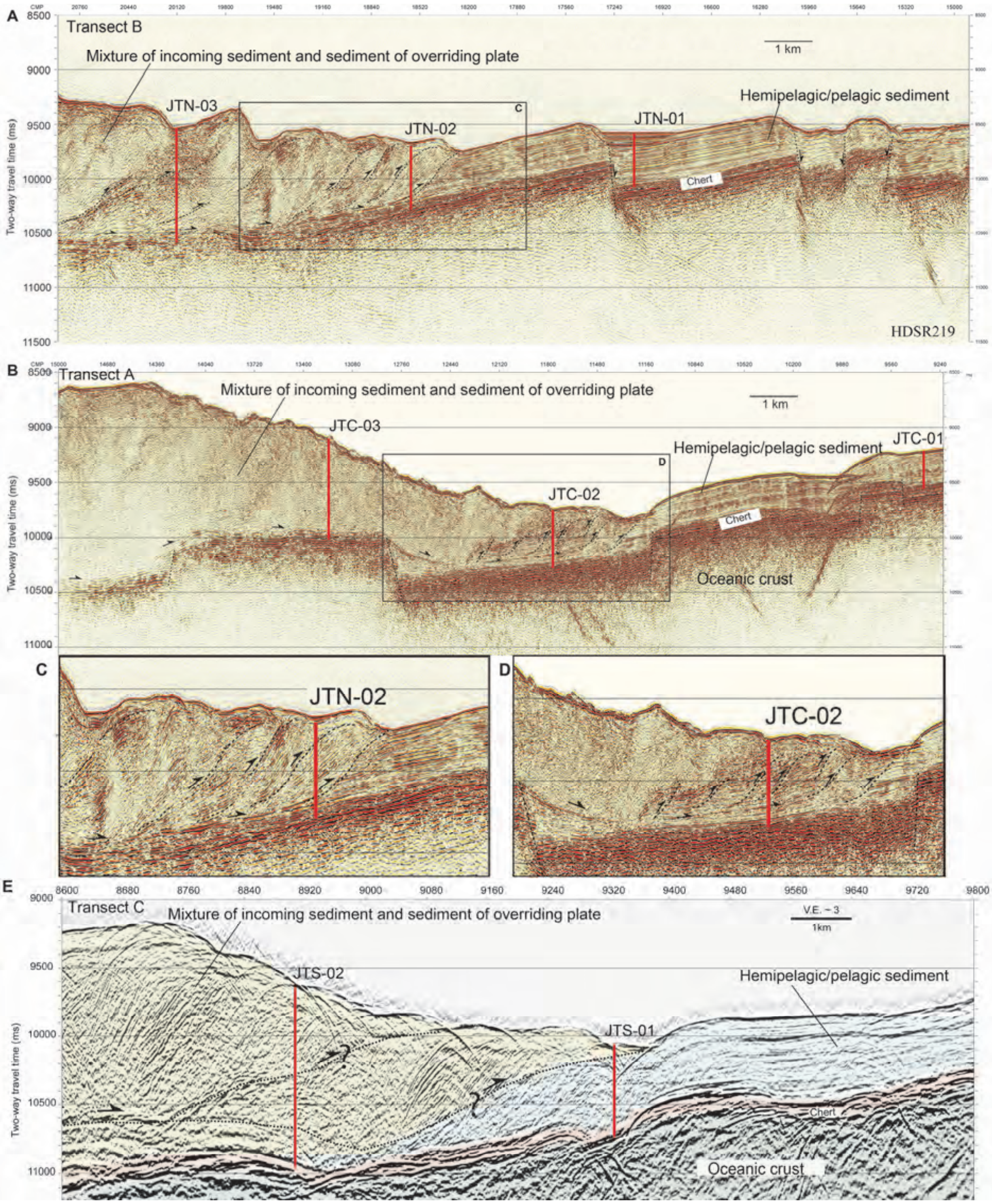


**Fig.4 A**, **B** Tentative proposed sites and a high resolution seismic section of Transect B and Transect A, respectively. JTC03 is located at the JFAST drilling site. **C, D** Enlarged sections of areas outlined in **A** and **B** respectively. **C** Tentative proposed sites and a conventional MCS seismic section of Transect C. JAMSTEC plan to acquired high resolution seismic data along this profile in 2014-2015. Final locations of drilling sites will be selected after detailed processing and interpretation of the high resolution seismic data.

of extensive seismic surveys conducted since the early 1970s [14]. Since the late 1990s, combined seismic reflection and refraction surveys using ocean bottom seismometers have been conducted to cover the entire region of the Japan Trench to image the detailed structures. The structures are divided horizontally into five areas: the deep-sea terrace, the upper, middle, and lower slope, and the trench axis. Previous seismic studies as well as ocean drilling results show that the upper plate beneath the deep-sea terrace and upper slope consists of an older (Cretaceous to Neogene) continental framework, and that incoming oceanic sediment consists of a Neogene hemipelagic mudstone resting on a carbonate- and chert-rich Cretaceous pelagic sequence. Beneath the deep-sea terrace, the subducting oceanic crust is clearly imaged down to about 10 km. Seaward of the deep-sea terrace, the upper slope is characterized by a highly reflective zone above the subducting oceanic crust and normal faults that cut the topmost sediments as well as a part of the acoustic basement, which is interpreted as a Cretaceous unconformity. The highly reflective zone, which is about 2 km thick and seems to thin towards the land, consists of a series of reflectors that are subparallel to the subducting oceanic basement. Within this well resolved detailed structure, JTRACK is targeting the lower slope and trench axis regions (Fig.4).

After the 2011 Tohoku earthquake, JAMSTEC acquired MCS data as well as high resolution seismic reflection data in the largest slip zone (Fig. 5). Some of those profiles were shot along the previous profile shot before the earthquake. From those data, deformation structures formed by the Tohoku-oki earthquake are imaged in the trench axis, and it is suggested that these remarkable structures formed as a result of compression during coseismic slip on the shallow plate interface, implying that fault rupture during the Tohoku-oki earthquake did reach the seafloor at the trench axis (Fig.4). The seismic surveys in the Japan Trench by JAMSTEC are still ongoing and high-resolution seismic data are planned along the entire Japan Trench axis region (Fig. 5). In addition to the seismic data, all available multibeam bathymetric have been complied by the JCG and JAMSTEC, and new data will be acquired along the planned high resolution seismic data.

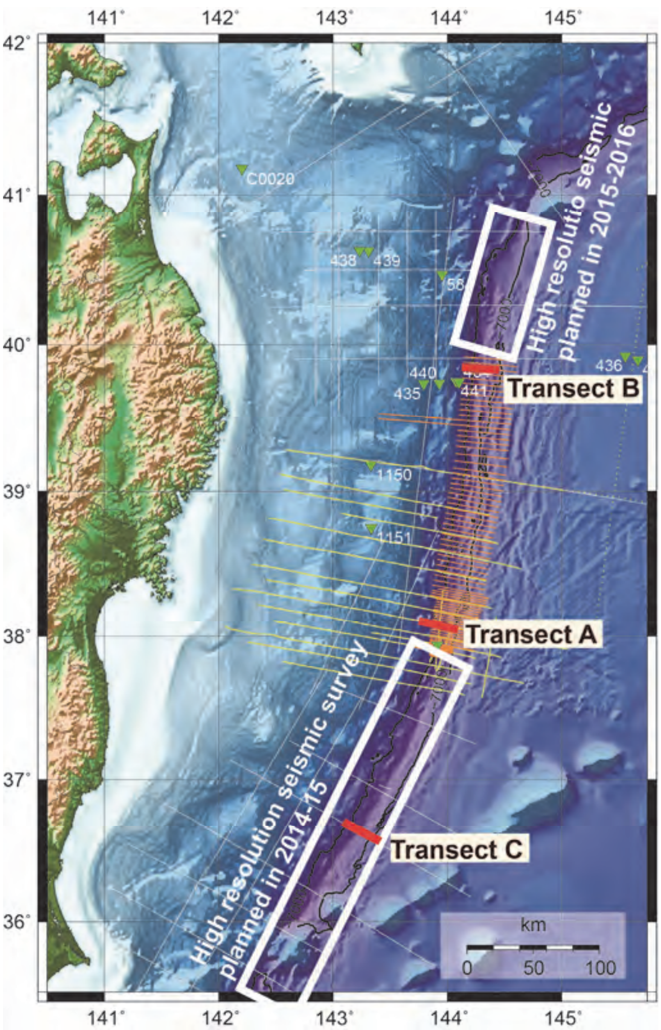


**Fig.5.** Seismic profiles acquired by JAMSTEC since 1997. Specification data of seismic system used are following. Profiles run before the earthquake (thin white lines) were acquired using the following parameters: 12,000 cu. inches non-tuned air gun array, 3,000-4,500 m long 120-168 ch. streamer cable, yellow broken lines, 7,800 tuned airgun array and 6000 m long 444 ch. streamer cable. Parameters for profiles acquired after the earthquake: 7,800 tuned airgun array and 6000 m long 444 ch (thin yellow lines), and 320 – 380 cu. inch cluster gun array with 37.5 m shot interval and 1,200 m long 192 ch with 6.25 m channel interval streamer cable (high resolution profiles-orange lines). Green triangles indicate previous sites of deep sea drilling. White rectangles indicate areas of planned high resolution seismic survey. JAMSTEC plan to acquire the high resolution seismic data in 2014-2015 and 2015-2016 at the southern part and the northern part of the Japan Trench, respectively.

## DRILLING PLAN

To achieve the primary objectives described above, we propose a drilling plan along three transects across strike that include logging-while-drilling (LWD) and coring (Fig.4). Faulting related to the 1896 Sanriku tsunamigenic earthquake will be investigated in a northern transect. A central transect will build on results from JFAST related to the 2011 Tohoku earthquake and include installation of casing and a existing pore pressure observatory fabricated originally for

Expedition 343. A reference site will be drilled seaward of the central transect to acquire undeformed incoming sediments which can be compared to ODP Sites 436 and 437. Along a southern transect the trench seismoturbidite related to potentially several large tsunamigenic earthquakes (e.g., 1677 Enpo Boso event) will be addressed. All three transects will contribute to understanding possible variations in earthquake supercycles related to changing megathrust slip characteristics along the Japan trench.

Trench drilling at each transect will target the upper 100 meters of the seismoturbidite record, with one hole to penetrate deeper target structures. For the shallow sites, giant piston coring from a mission specific platform (R/V Marion Dufresne or R/V Knorr) is not currently a potential option because those research vessels are currently not equipped with enough cable to operate in up to 8 km water depth, but *D/V Chikyu* is a viable platform for retrieving the necessary cores in deep water. An along-trench drilling transect in very-deep water of 100-m-deep holes will provide information to extend the megaquake record further back in time.

At each drill site on the inner trench slope, we anticipate drilling a first hole with an LWD string, to include MWD measurements. The MWD measurements will provide essential information about hole conditions. Annular pressure while drilling (APWD), in particular, may also yield important qualitative information about in situ fluid pressure and permeability (e.g., [15]). The LWD data will help to define key horizons that are top-priority coring targets, and select intervals for observatory monitoring. Logging data may also provide additional information about in situ permeability architecture, and wellbore failure features that can be used to define both the orientations of horizontal stresses and their magnitudes, in conjunction with core physical property measurements (e.g., [16, 10]). Sonic logging will provide a key tie between core-scale measurements and seismic reflection data, needed to extrapolate information away from boreholes.

Following LWD at each inner-trench-slope site, a second hole (or holes if needed) will be drilled for coring. If time permits, we anticipate continuous coring; if time is limited, the highest priority coring targets will be identified on the basis of the LWD data (e.g., [5]). To maximize core quality and recovery, coring holes outboard of the trench will be spudded using hydraulic piston coring to refusal, and then switched to rotary core barrel if needed. At all sites, use of a short coring stroke (~3-5 m) in key intervals might be required to maximize core recovery and quality. An intensive coring program is essential to achieving the science objectives of the project, through standard shipboard characterization of cores, and by providing samples for post-expedition experimental studies.

At the observatory Site, a short independent expedition can install casing in the LWD hole, and a pore pressure observatory will be deployed. In a screened section spanning the décollement, pore pressure will be measured by transducers at the wellhead, via hydraulic lines extending downward to the monitored interval (e.g. [17]). Formation fluids across the screened interval can also be sampled at the wellhead by valve operation during ROV visits. The components of the observatory and a wellhead originally designed for deployment at Site C0019 have been fabricated and are currently available. The observatory will provide direct measurement of *in situ* pore fluid pressure at the fault zone; continuous monitoring will allow estimation of *in situ* hydraulic properties through analysis of the tidal loading response, and will record hydraulic transients associated with tectonic events. Finally, the observatory will also allow access for future active perturbation experiments and fluid sampling.

Table 1. List of objectives from JFAST and in proposed JTRACK.

| Objective | JFAST objective | New JTRACK objective | Realized during JFAST? | Comments |
|---|---|---|---|---|
| Characterize stress state before and after 2011 | √ | | Y | |
| Measure temperature to characterize dynamic friction | √ | | Y | |
| Characterize structures and textures in slip zone | √ | | N | Work is ongoing, but core recovery was insufficient to determine if slip zone was sampled |
| Experiments on fault materials to characterize physical properties | √ | | ? | Work is ongoing, but core recovery was insufficient to determine if slip zone was sampled |
| Continuous core sampling for physical and chemical properties of sediment and interstitial waters | √ | | N | <7% cored; potential that several important faults were missed; not enough core material available near main fault for IW geochemistry |
| Reference site on incoming plate | | √ | n/a | No nearby reference site |
| Continuously core the fault zone in multiple locations | | √ | n/a | Determine representative fault rock properties by structural analysis and laboratory experiments to characterize megathrust variability |
| Across-trench characterization of sediment properties and IW geochemistry with continuous coring of the upper and lower plates | | √ | n/a | Needed to identify other possible fault horizons and constrain role of fluid pressures in fault slip |
| Along-trench drilling of sediment record | | √ | n/a | Will constrain frequency and magnitude of large, |

| | | | | |
|---|---|---|---|---|
| | | | | tsunamigenic EQs, and superquake cycle |
| Pressure observatory | √ | √ | N | Not installed during 343 due to time; can be used to examine post-EQ fault recovery, and sample fluids in time series from fault zone |
| | | | | |

Y = yes, N = no, ? = uncertain without further work, n/a = not applicable

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# IODP Site Summary Forms:

## Form 1 – General Site Information

1 - Pre a

## Section A: Proposal Information

| | |
|---|---|
| Title of Proposal: | Tracking the Tsunamigenic slips Across and Along the Japan Trench (JTRACK): Investigating a new paradigm in tsunamigenic megathrust slip with very deep water drilling using the D/V Chikyu |
| Date Form Submitted: | 2013-09-27 14:50:58 |
| Site Specific Objectives with Priority (Must include general objectives in proposal) | Acquire undeformed incoming sediments which can be compared to ODP Sites 436 and 437. This is a reference section on the incoming plate as a baseline for comparison with sediments in the prism and plate boundary decollement (objective A). |
| List Previous Drilling in Area: | DSDP Leg 56/57, 87, ODP Leg 186, IODP Expedition 343 |

## Section B: General Site Information

| | | | |
|---|---|---|---|
| Site Name: | JTC-01A | Area or Location: | Japan Trench |
| If site is a reoccupation of an old DSDP/ODP Site, Please include former Site# | none | Jurisdiction: | Japanese EEZ |
| Latitude: | Deg: 37.918 | Distance to Land: (km) | 250 |
| Longitude: | Deg: 144.0507 | | |
| Coordinate System: | WGS 84 | | |
| Priority of Site: | Primary: yes Alt: | Water Depth (m): | 6995 |


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## Section C: Operational Information

| | Sediments | Basement |
|---|---|---|
| Proposed Penetration (m): | 300 | 0 |
| | Total Sediment Thickness (m) 450 | |
| | | Total Penetration (m): 300 |
| General Lithologies: | diatomaceous mud/mud stones, pelagic clay, chert | basalt |

**Coring Plan: (Specify or check)**

HPCS/EPCS/ESCS to refusal, then RCB to TD

APC ☒ XCB ☐ MDCB ☐ PCS ☐ RCB ☒ Re-entry ☐

**Wireline Logging Plan:**

| Standard Measurements | | Special Tools | | | |
|---|---|---|---|---|---|
| WL | ☒ | Magnetic Susceptibility | ☐ | | |
| LWD | ☒ | Magnetic Field | ☐ | Formation Image (Acoustic) | ☐ |
| Porosity | ☒ | Borehole Temperature | ☐ | Formation Fluid Sampling | ☐ |
| Density | ☒ | Nuclear Magnetic Resonance | ☒ | Formation Temperature & Pressure | ☐ |
| Gamma Ray | ☒ | Geochemical | ☐ | VSP | ☐ |
| Resistivity | ☒ | Side-Wall Core Sampling | ☐ | Others: | |
| Sonic (Δt) | ☒ | | | | |
| Formation Image (Res) | ☒ | | | | |
| Check-shot (upon request) | ☒ | | | | |

Max. Borehole Temp.: °C

Mud Logging: (Riser Holes Only)

Cuttings Sampling Intervals

from m to m m intervals

from m to m m intervals

*Basic Sampling Intervals: 5m*

Estimated Days: Drilling/Coring: 6 Logging: 3 Total On-site:

Observatory Plan: *Longterm Borehole Observation Plan/Re-entry Plan*

**Potential Hazards/ Weather:**

| | | | | | | Preferred weather window |
|---|---|---|---|---|---|---|
| Shallow Gas | ☐ | Complicated Seabed Condition | ☐ | Hydrothermal Activity | ☐ | April to October is preferable because of strong wind in the late autumn and winter |
| Hydrocarbon | ☐ | Soft Seabed | ☐ | Landslide and Turbidity Current | ☐ | |
| Shallow Water Flow | ☐ | Currents | ☐ | Gas Hydrate | ☐ | |
| Abnormal Pressure | ☐ | Fracture Zone | ☐ | Diapir and Mud Volcano | ☐ | |
| Man-made Objects (e.g., sea-floor cables, dump sites) | ☐ | Fault | ☐ | High Temperature | ☐ | |
| $H_2S$ | ☐ | High Dip Angle | ☐ | Ice Conditions | ☐ | |
| $CO_2$ | ☐ | Sensitive marine habitat (e.g., reefs, vents) | none | | | |
| Other: | none | | | | | |


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# IODP Site Summary Forms:

## Form 1 – General Site Information

1 - Pre a

## Section A: Proposal Information

| | |
|---|---|
| Title of Proposal: | Tracking the Tsunamigenic slips Across and Along the Japan Trench (JTRACK): Investigating a new paradigm in tsunamigenic megathrust slip with very deep water drilling using the D/V Chikyu |
| Date Form Submitted: | 2013-09-27 14:50:58 |
| Site Specific Objectives with Priority (Must include general objectives in proposal) | Trench axis drilling in the large slip area of 2011 Tohoku-oki earthquake. Seismoturbidite record from Upper 100 meters (objective E). Deeper interval for understanding deformation of trench sediments and shallowest mega splay fault. Investigate fault rock properties of shallowest mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging and core measuremens (objective D). |
| List Previous Drilling in Area: | DSDP Leg 56/57, 87, ODP Leg 186, IODP Expedition 343 |

## Section B: General Site Information

| | | | |
|---|---|---|---|
| Site Name: | JTC-02A | Area or Location: | Japan Trench |
| If site is a reoccupation of an old DSDP/ODP Site, Please include former Site# | none | Jurisdiction: | Japanese EEZ |
| Latitude: | Deg: 37.9308 | Distance to Land: (km) | 250 |
| Longitude: | Deg: 143.9645 | | |
| Coordinate System: | WGS 84 | | |
| Priority of Site: | Primary: yes Alt: | Water Depth (m): | 7400 |


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## Section C: Operational Information

| | Sediments | Basement |
|---|---|---|
| Proposed Penetration (m): | 500 | 0 |
| | Total Sediment Thickness (m) 550 | |
| | | Total Penetration (m): 500 |
| General Lithologies: | mud/mudstones, pelagic clay, chert | basalt |

**Coring Plan: (Specify or check)**

HPCS/EPCS/ESCS to refusal, then RCB to TD

APC ☒ XCB ☐ MDCB ☐ PCS ☐ RCB ☒ Re-entry ☐

**Wireline Logging Plan:**

| Standard Measurements | | Special Tools | | | |
|---|---|---|---|---|---|
| WL | ☒ | Magnetic Susceptibility | ☐ | | |
| LWD | ☒ | Magnetic Field | ☐ | Formation Image (Acoustic) | ☐ |
| Porosity | ☒ | Borehole Temperature | ☐ | Formation Fluid Sampling | ☐ |
| Density | ☒ | Nuclear Magnetic Resonance | ☒ | Formation Temperature & Pressure | ☐ |
| Gamma Ray | ☒ | Geochemical | ☐ | VSP | ☐ |
| Resistivity | ☒ | Side-Wall Core Sampling | ☐ | Others: | |
| Sonic ($\Delta t$) | ☒ | | | | |
| Formation Image (Res) | ☒ | | | | |
| Check-shot (upon request) | ☒ | | | | |

Max. Borehole Temp.: °C

Mud Logging: (Riser Holes Only)

Cuttings Sampling Intervals

from m to m m intervals

from m to m m intervals

*Basic Sampling Intervals: 5m*

| Estimated Days: | Drilling/Coring: 9 | Logging: 4 | Total On-site: |
|---|---|---|---|

Observatory Plan: *Longterm Borehole Observation Plan/Re-entry Plan*

**Potential Hazards/ Weather:**

| | | | | | |
|---|---|---|---|---|---|
| Shallow Gas | ☐ | Complicated Seabed Condition | ☐ | Hydrothermal Activity | ☐ |
| Hydrocarbon | ☐ | Soft Seabed | ☐ | Landslide and Turbidity Current | ☐ |
| Shallow Water Flow | ☐ | Currents | ☐ | Gas Hydrate | ☐ |
| Abnormal Pressure | ☐ | Fracture Zone | ☐ | Diapir and Mud Volcano | ☐ |
| Man-made Objects (e.g., sea-floor cables, dump sites) | ☐ | Fault | ☒ | High Temperature | ☐ |
| $H_2S$ | ☐ | High Dip Angle | ☐ | Ice Conditions | ☐ |
| $CO_2$ | ☐ | Sensitive marine habitat (e.g., reefs, vents) | none | | |
| Other: | none | | | | |

Preferred weather window: April to October is preferable because of strong wind in the late autumn and winter

# IODP Site Summary Forms:

## Form 1 – General Site Information

1 - Pre a

## Section A: Proposal Information

| | |
|---|---|
| Title of Proposal: | Tracking the Tsunamigenic slips Across and Along the Japan Trench (JTRACK): Investigating a new paradigm in tsunamigenic megathrust slip with very deep water drilling using the D/V Chikyu |
| Date Form Submitted: | 2013-09-27 14:50:58 |
| Site Specific Objectives with Priority (Must include general objectives in proposal) | Inner trench slope drilling in the large slip area of 2011 Tohoku-oki earthquake. Investigate fault rock properties of shallow mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging and core measurements (objective D). Observatory for fault zone pore pressure monitoring (objective C). |
| List Previous Drilling in Area: | DSDP Leg 56/57, 87, ODP Leg 186, IODP Expedition 343 |

## Section B: General Site Information

| | | | |
|---|---|---|---|
| Site Name: | JTC-03A | Area or Location: | Japan Trench |
| If site is a reoccupation of an old DSDP/ODP Site, Please include former Site# | C0019 | Jurisdiction: | Japanese EEZ |
| Latitude: | Deg: 37.9383 | Distance to Land: (km) | 250 |
| Longitude: | Deg: 143.9133 | | |
| Coordinate System: | WGS 84 | | |
| Priority of Site: | Primary: yes Alt: | Water Depth (m): | 6900 |

## Section C: Operational Information

| | Sediments | Basement |
|---|---|---|
| Proposed Penetration (m): | 850 | 0 |
| | Total Sediment Thickness (m) 1000 | |
| | | Total Penetration (m): 850 |
| General Lithologies: | mud/mudstones, pelagic clay, chert | basalt |

**Coring Plan:**
**(Specify or check)**

HPCS/EPCS/ESCS to refusal, then RCB to TD

**APC** [x] XCB [ ] MDCB [ ] PCS [ ] RCB [x] Re-entry [ ]

**Wireline Logging Plan:**

| Standard Measurements | | Special Tools | | | |
|---|---|---|---|---|---|
| WL | [x] | Magnetic Susceptibility | [ ] | | |
| LWD | [x] | Magnetic Field | [ ] | Formation Image (Acoustic) | [ ] |
| Porosity | [x] | Borehole Temperature | [ ] | Formation Fluid Sampling | [ ] |
| Density | [x] | Nuclear Magnetic Resonance | [x] | Formation Temperature & Pressure | [x] |
| Gamma Ray | [x] | Geochemical | [ ] | VSP | [ ] |
| Resistivity | [x] | Side-Wall Core Sampling | [ ] | Others: | |
| Sonic (Δt) | [x] | | | | |
| Formation Image (Res) | [x] | | | | |
| Check-shot (upon request) | [x] | | | | |

Max. Borehole Temp.: °C

**Mud Logging:** (Riser Holes Only)

Cuttings Sampling Intervals

from m to m m intervals

from m to m m intervals

*Basic Sampling Intervals: 5m*

**Estimated Days:** Drilling/Coring: 15 Logging: 4 Total On-site:

**Observatory Plan:**

*Longterm Borehole Observation Plan/Re-entry Plan*

Pore pressure observatory will be deployed. In a screened section spanning the décollement, pore pressure will be measured by transducers at the wellhead, via hydraulic lines extending downward to the monitored interval. Formation fluids across the screened interval

**Potential Hazards/ Weather:**

| | | | | | |
|---|---|---|---|---|---|
| Shallow Gas | [ ] | Complicated Seabed Condition | [x] | Hydrothermal Activity | [ ] |
| Hydrocarbon | [ ] | Soft Seabed | [ ] | Landslide and Turbidity Current | [ ] |
| Shallow Water Flow | [ ] | Currents | [ ] | Gas Hydrate | [ ] |
| Abnormal Pressure | [ ] | Fracture Zone | [ ] | Diapir and Mud Volcano | [ ] |
| Man-made Objects (e.g., sea-floor cables, dump sites) | [ ] | Fault | [x] | High Temperature | [ ] |
| $H_2S$ | [ ] | High Dip Angle | [ ] | Ice Conditions | [ ] |
| $CO_2$ | [ ] | Sensitive marine habitat (e.g., reefs, vents) | none | | |
| Other: | none | | | | |

Preferred weather window: April to October is preferable because of strong wind in the late autumn and winter

# IODP Site Summary Forms:

## Form 1 – General Site Information

1 - Pre a

## Section A: Proposal Information

| | |
|---|---|
| Title of Proposal: | Tracking the Tsunamigenic slips Across and Along the Japan Trench (JTRACK): Investigating a new paradigm in tsunamigenic megathrust slip with very deep water drilling using the D/V Chikyu |
| Date Form Submitted: | 2013-09-27 14:50:58 |
| Site Specific Objectives with Priority (Must include general objectives in proposal) | Near trench drilling around estimated tsunami source area of 1896 Meiji-Sanriku earthquake. Seismoturbidite record from upper 100 m (objective E). Deeper interval for another reference section on the incoming plate for comparison with sediments in the prism and plate boundary decollement (objective A). |
| List Previous Drilling in Area: | DSDP Leg 56/57, 87, ODP Leg 186, IODP Expedition 343 |

## Section B: General Site Information

| | | | |
|---|---|---|---|
| Site Name: | JTN-01A | Area or Location: | Japan Trench |
| If site is a reoccupation of an old DSDP/ODP Site, Please include former Site# | none | | |
| Latitude: | Deg: 39.8689 | Jurisdiction: | Japanese EEZ |
| Longitude: | Deg: 144.3552 | Distance to Land: (km) | 200 |
| Coordinate System: | WGS 84 | | |
| Priority of Site: | Primary: yes Alt: | Water Depth (m): | 7260 |

## Section C: Operational Information

| | Sediments | Basement |
|---|---|---|
| Proposed Penetration (m): | 480 | 0 |
| | Total Sediment Thickness (m) 590 | |
| | | Total Penetration (m): 480 |
| General Lithologies: | mud/mudstones, pelagic clay, chert | basalt |

**Coring Plan: (Specify or check)**

HPCS/EPCS/ESCS to refusal, then RCB to TD

**APC** ☒ XCB ☐ MDCB ☐ PCS ☐ RCB ☒ Re-entry ☐

**Wireline Logging Plan:**

| Standard Measurements | | Special Tools | | | |
|---|---|---|---|---|---|
| WL | ☒ | Magnetic Susceptibility | ☐ | | |
| LWD | ☒ | Magnetic Field | ☐ | Formation Image (Acoustic) | ☐ |
| Porosity | ☒ | Borehole Temperature | ☐ | Formation Fluid Sampling | ☐ |
| Density | ☒ | Nuclear Magnetic Resonance | ☒ | Formation Temperature & Pressure | ☐ |
| Gamma Ray | ☒ | Geochemical | ☐ | VSP | ☐ |
| Resistivity | ☒ | Side-Wall Core Sampling | ☐ | Others: | |
| Sonic (Δt) | ☒ | | | | |
| Formation Image (Res) | ☒ | | | | |
| Check-shot (upon request) | ☒ | | | | |

Max. Borehole Temp.: °C

Mud Logging: (Riser Holes Only)

Cuttings Sampling Intervals

from m to m m intervals

from m to m m intervals

*Basic Sampling Intervals: 5m*

Estimated Days: Drilling/Coring: 11 Logging: 4 Total On-site:

Observatory Plan: *Longterm Borehole Observation Plan/Re-entry Plan*

**Potential Hazards/ Weather:**

| | | | | | | Preferred weather window |
|---|---|---|---|---|---|---|
| Shallow Gas | ☐ | Complicated Seabed Condition | ☐ | Hydrothermal Activity | ☐ | April to October is preferable because of strong wind in the late autumn and winter |
| Hydrocarbon | ☐ | Soft Seabed | ☐ | Landslide and Turbidity Current | ☐ | |
| Shallow Water Flow | ☐ | Currents | ☐ | Gas Hydrate | ☐ | |
| Abnormal Pressure | ☐ | Fracture Zone | ☐ | Diapir and Mud Volcano | ☐ | |
| Man-made Objects (e.g., sea-floor cables, dump sites) | ☐ | Fault | ☒ | High Temperature | ☐ | |
| $H_2S$ | ☐ | High Dip Angle | ☐ | Ice Conditions | ☐ | |
| $CO_2$ | ☐ | Sensitive marine habitat (e.g., reefs, vents) | none | | | |
| Other: | none | | | | | |


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# IODP Site Summary Forms:

## Form 1 – General Site Information

1 - Pre a

## Section A: Proposal Information

| | |
|---|---|
| Title of Proposal: | Tracking the Tsunamigenic slips Across and Along the Japan Trench (JTRACK): Investigating a new paradigm in tsunamigenic megathrust slip with very deep water drilling using the D/V Chikyu |
| Date Form Submitted: | 2013-09-27 14:50:58 |
| Site Specific Objectives with Priority (Must include general objectives in proposal) | Trench axis drilling in estimated tsunami source area of 1896 Meiji-Sanriku earthquake. Seismoturbidite record from shallowest section (objective E). Deeper interval for understanding deformation of trench sediments and shallowest mega splay fault. Investigate fault rock properties of shallowest mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging and core measurements (objective D). |
| List Previous Drilling in Area: | DSDP Leg 56/57, 87, ODP Leg 186, IODP Expedition 343 |

## Section B: General Site Information

| | | | |
|---|---|---|---|
| Site Name: | JTN-02A | Area or Location: | Japan Trench |
| If site is a reoccupation of an old DSDP/ODP Site, Please include former Site# | | | |
| Latitude: | Deg: 39.8724 | Jurisdiction: | Japanese EEZ |
| Longitude: | Deg: 144.3024 | Distance to Land: (km) | 200 |
| Coordinate System: | WGS 84 | | |
| Priority of Site: | Primary: yes; Alt: | Water Depth (m): | 7325 |

# Section C: Operational Information

| | Sediments | Basement |
|---|---|---|
| Proposed Penetration (m): | 560 | 0 |
| | Total Sediment Thickness (m) 650 | |
| | | Total Penetration (m): 560 |
| General Lithologies: | mud/mudstones, pelagic clay, chert | basalt |

**Coring Plan: (Specify or check)**

HPCS/EPCS/ESCS to refusal, then RCB to TD

**APC** ☒ XCB ☐ MDCB ☐ PCS ☐ RCB ☒ Re-entry ☐

Wireline Logging Plan:

| Standard Measurements | | Special Tools | | | |
|---|---|---|---|---|---|
| WL | ☒ | Magnetic Susceptibility | ☐ | | |
| LWD | ☒ | Magnetic Field | ☐ | Formation Image (Acoustic) | ☐ |
| Porosity | ☒ | Borehole Temperature | ☐ | Formation Fluid Sampling | ☐ |
| Density | ☒ | Nuclear Magnetic Resonance | ☒ | Formation Temperature & Pressure | ☐ |
| Gamma Ray | ☒ | Geochemical | ☐ | VSP | ☐ |
| Resistivity | ☒ | Side-Wall Core Sampling | ☐ | Others: | |
| Sonic (Δt) | ☒ | | | | |
| Formation Image (Res) | ☒ | | | | |
| Check-shot (upon request) | ☒ | | | | |

Max. Borehole Temp.: °C

Mud Logging: (Riser Holes Only)

Cuttings Sampling Intervals

from m to m m intervals

from m to m m intervals

*Basic Sampling Intervals: 5m*

Estimated Days: Drilling/Coring: 11 Logging: 4 Total On-site:

Observatory Plan: *Longterm Borehole Observation Plan/Re-entry Plan*

Potential Hazards/ Weather:

| | | | | | | Preferred weather window |
|---|---|---|---|---|---|---|
| Shallow Gas | ☐ | Complicated Seabed Condition | ☐ | Hydrothermal Activity | ☐ | April to October is preferable because of strong wind in the late autumn and winter |
| Hydrocarbon | ☐ | Soft Seabed | ☐ | Landslide and Turbidity Current | ☐ | |
| Shallow Water Flow | ☐ | Currents | ☐ | Gas Hydrate | ☐ | |
| Abnormal Pressure | ☐ | Fracture Zone | ☐ | Diapir and Mud Volcano | ☐ | |
| Man-made Objects (e.g., sea-floor cables, dump sites) | ☐ | Fault | ☒ | High Temperature | ☐ | |
| $H_2S$ | ☐ | High Dip Angle | ☐ | Ice Conditions | ☐ | |
| $CO_2$ | ☐ | Sensitive marine habitat (e.g., reefs, vents) | none | | | |
| Other: | none | | | | | |

# IODP Site Summary Forms:

## Form 1 – General Site Information

1 - Pre a

## Section A: Proposal Information

| | |
|---|---|
| Title of Proposal: | Tracking the Tsunamigenic slips Across and Along the Japan Trench (JTRACK): Investigating a new paradigm in tsunamigenic megathrust slip with very deep water drilling using the D/V Chikyu |
| Date Form Submitted: | 2013-09-27 14:50:58 |
| Site Specific Objectives with Priority (Must include general objectives in proposal) | Inner trench slope drilling in estimated tsunami source area of 1896 Meiji-Sanriku earthquake. Investigate fault rock properties of shallow mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging, core measurements (objective D) |
| List Previous Drilling in Area: | DSDP Leg 56/57, 87, ODP Leg 186, IODP Expedition 343 |

## Section B: General Site Information

| | | | |
|---|---|---|---|
| Site Name: | JTN-03A | Area or Location: | Japan Trench |
| If site is a reoccupation of an old DSDP/ODP Site, Please include former Site# | none | | |
| Latitude: | Deg: 39.8764 | Jurisdiction: | Japanese EEZ |
| Longitude: | Deg: 144.2465 | Distance to Land: (km) | 200 |
| Coordinate System: | WGS 84 | | |
| Priority of Site: | Primary: yes Alt: | Water Depth (m): | 7230 |


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## Section C: Operational Information

| | Sediments | Basement |
|---|---|---|
| Proposed Penetration (m): | 950 | 0 |
| | Total Sediment Thickness (m) 1100 | |
| | | Total Penetration (m): 950 |
| General Lithologies: | mud/mudstones, pelagic clay, chert | basalt |

**Coring Plan: (Specify or check)**

APC to refusal, then XCB to TD

APC ☒ XCB ☐ MDCB ☐ PCS ☐ RCB ☒ Re-entry ☐

**Wireline Logging Plan:**

| Standard Measurements | | Special Tools | | | |
|---|---|---|---|---|---|
| WL | ☒ | Magnetic Susceptibility | ☐ | | |
| LWD | ☒ | Magnetic Field | ☐ | Formation Image (Acoustic) | ☐ |
| Porosity | ☒ | Borehole Temperature | ☐ | Formation Fluid Sampling | ☐ |
| Density | ☒ | Nuclear Magnetic Resonance | ☒ | Formation Temperature & Pressure | ☒ |
| Gamma Ray | ☒ | Geochemical | ☐ | VSP | ☐ |
| Resistivity | ☒ | Side-Wall Core Sampling | ☐ | Others: | |
| Sonic (Δt) | ☒ | | | | |
| Formation Image (Res) | ☒ | | | | |
| Check-shot (upon request) | ☒ | | | | |

Max. Borehole Temp.: °C

**Mud Logging:** (Riser Holes Only)

Cuttings Sampling Intervals

from m to m m intervals

from m to m m intervals

*Basic Sampling Intervals: 5m*

**Estimated Days:** Drilling/Coring: 16 Logging: 5 Total On-site:

**Observatory Plan:** *Longterm Borehole Observation Plan/Re-entry Plan*

**Potential Hazards/ Weather:**

| | | | | | | Preferred weather window |
|---|---|---|---|---|---|---|
| Shallow Gas | ☐ | Complicated Seabed Condition | ☐ | Hydrothermal Activity | ☐ | April to October is preferable because of strong wind in the late autumn and winter |
| Hydrocarbon | ☐ | Soft Seabed | ☐ | Landslide and Turbidity Current | ☐ | |
| Shallow Water Flow | ☐ | Currents | ☐ | Gas Hydrate | ☐ | |
| Abnormal Pressure | ☐ | Fracture Zone | ☐ | Diapir and Mud Volcano | ☐ | |
| Man-made Objects (e.g., sea-floor cables, dump sites) | ☐ | Fault | ☒ | High Temperature | ☐ | |
| $H_2S$ | ☐ | High Dip Angle | ☐ | Ice Conditions | ☐ | |
| $CO_2$ | ☐ | Sensitive marine habitat (e.g., reefs, vents) | none | | | |
| Other: | none | | | | | |


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# IODP Site Summary Forms:

## Form 1 – General Site Information

1 - Pre a

## Section A: Proposal Information

| | |
|---|---|
| Title of Proposal: | Tracking the Tsunamigenic slips Across and Along the Japan Trench (JTRACK): Investigating a new paradigm in tsunamigenic megathrust slip with very deep water drilling using the D/V Chikyu |
| Date Form Submitted: | 2013-09-27 14:50:58 |
| Site Specific Objectives with Priority (Must include general objectives in proposal) | Trench axis drilling in possible tsunami source area of 1677 Enpo Boso earthquake. Seismoturbidite record from shallowest section(objective E). Deeper interval for understanding deformation of trench sediments and shallowest mega splay fault. Investigate fault rock properties of shallowest mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging, core measurements (objective D). |
| List Previous Drilling in Area: | DSDP Leg 56/57, 87, ODP Leg 186, IODP Expedition 343 |

## Section B: General Site Information

| | | | |
|---|---|---|---|
| Site Name: | JTS-01A | Area or Location: | Japan Trench |
| If site is a reoccupation of an old DSDP/ODP Site, Please include former Site# | none | | |
| Latitude: | Deg: 36.6343 | Jurisdiction: | Japanese EEZ |
| Longitude: | Deg: 143.2166 | Distance to Land: (km) | 200 |
| Coordinate System: | WGS 84 | | |
| Priority of Site: | Primary: yes Alt: | Water Depth (m): | 7590 |


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## Section C: Operational Information

| | Sediments | Basement |
|---|---|---|
| Proposed Penetration (m): | 620 | 0 |
| | Total Sediment Thickness (m) 760 | |
| | | Total Penetration (m): 620 |
| General Lithologies: | mud/mudstones, pelagic clay, chert | basalt |

**Coring Plan: (Specify or check)** HPCS/EPCS/ESCS to refusal, then RCB to TD

**APC** ☒ XCB ☐ MDCB ☐ PCS ☐ RCB ☒ Re-entry ☐

**Wireline Logging Plan:**

| Standard Measurements | | Special Tools | | | |
|---|---|---|---|---|---|
| WL | ☒ | Magnetic Susceptibility | ☐ | | |
| LWD | ☒ | Magnetic Field | ☐ | Formation Image (Acoustic) | ☐ |
| Porosity | ☒ | Borehole Temperature | ☐ | Formation Fluid Sampling | ☐ |
| Density | ☒ | Nuclear Magnetic Resonance | ☒ | Formation Temperature & Pressure | ☐ |
| Gamma Ray | ☒ | Geochemical | ☐ | VSP | ☐ |
| Resistivity | ☒ | Side-Wall Core Sampling | ☐ | Others: | |
| Sonic (Δt) | ☒ | | | | |
| Formation Image (Res) | ☒ | | | | |
| Check-shot (upon request) | ☒ | | | | |

Max. Borehole Temp.: °C

Mud Logging: (Riser Holes Only)

Cuttings Sampling Intervals

from m to m m intervals

from m to m m intervals

*Basic Sampling Intervals: 5m*

| Estimated Days: | Drilling/Coring: 11 | Logging: 4 | Total On-site: |
|---|---|---|---|

Observatory Plan: *Longterm Borehole Observation Plan/Re-entry Plan*

**Potential Hazards/ Weather:**

| | | | | | | |
|---|---|---|---|---|---|---|
| Shallow Gas | ☐ | Complicated Seabed Condition | ☒ | Hydrothermal Activity | ☐ | Preferred weather window: April to October is preferable because of strong wind in the late autumn and winter |
| Hydrocarbon | ☐ | Soft Seabed | ☐ | Landslide and Turbidity Current | ☐ | |
| Shallow Water Flow | ☐ | Currents | ☐ | Gas Hydrate | ☐ | |
| Abnormal Pressure | ☐ | Fracture Zone | ☐ | Diapir and Mud Volcano | ☐ | |
| Man-made Objects (e.g., sea-floor cables, dump sites) | ☐ | Fault | ☒ | High Temperature | ☐ | |
| $H_2S$ | ☐ | High Dip Angle | ☐ | Ice Conditions | ☐ | |
| $CO_2$ | ☐ | Sensitive marine habitat (e.g., reefs, vents) | none | | | |
| Other: | none | | | | | |


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# IODP Site Summary Forms:

## Form 1 – General Site Information

1 - Pre a

## Section A: Proposal Information

| | |
|---|---|
| Title of Proposal: | Tracking the Tsunamigenic slips Across and Along the Japan Trench (JTRACK): Investigating a new paradigm in tsunamigenic megathrust slip with very deep water drilling using the D/V Chikyu |
| Date Form Submitted: | 2013-09-27 14:50:58 |
| Site Specific Objectives with Priority (Must include general objectives in proposal) | Inner trench slope drilling in possible tsunami source area of 1677 Enpo Boso earthquake. Investigate fault rock properties of shallow mega splay (objective B) and role of fluids in slip (objective C). Determine the stress state from logging, core measurements (objective D) |
| List Previous Drilling in Area: | DSDP Leg 56/57, 87, ODP Leg 186, IODP Expedition 343 |

## Section B: General Site Information

| | |
|---|---|
| Site Name: | JTS-02A |
| If site is a reoccupation of an old DSDP/ODP Site, Please include former Site# | none |
| Latitude: | Deg: 36.6586 |
| Longitude: | Deg: 143.1637 |
| Coordinate System: | WGS 84 |
| Priority of Site: | Primary: yes Alt: |

| | |
|---|---|
| Area or Location: | Japan Trench |
| Jurisdiction: | Japanese EEZ |
| Distance to Land: (km) | 200 |
| Water Depth (m): | 7110 |


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## Section C: Operational Information

| | Sediments | Basement |
|---|---|---|
| Proposed Penetration (m): | 1350 | 0 |
| | Total Sediment Thickness (m): 1550 | |
| | | Total Penetration (m): 1350 |
| General Lithologies: | mud/mudstones, pelagic clay, chert | basalt |

**Coring Plan: (Specify or check)**

HPCS/EPCS/ESCS to refusal, then RCB to TD

APC [x] XCB [ ] MDCB [ ] PCS [ ] RCB [x] Re-entry [ ]

**Wireline Logging Plan:**

| Standard Measurements | | Special Tools | | | |
|---|---|---|---|---|---|
| WL | [x] | Magnetic Susceptibility | [ ] | | |
| LWD | [x] | Magnetic Field | [ ] | Formation Image (Acoustic) | [ ] |
| Porosity | [x] | Borehole Temperature | [ ] | Formation Fluid Sampling | [ ] |
| Density | [x] | Nuclear Magnetic Resonance | [x] | Formation Temperature & Pressure | [x] |
| Gamma Ray | [x] | Geochemical | [ ] | VSP | [ ] |
| Resistivity | [x] | Side-Wall Core Sampling | [ ] | Others: | |
| Sonic (Δt) | [x] | | | | |
| Formation Image (Res) | [x] | | | | |
| Check-shot (upon request) | [x] | | | | |

Max. Borehole Temp.: °C

**Mud Logging: (Riser Holes Only)**

Cuttings Sampling Intervals

from m to m m intervals

from m to m m intervals

*Basic Sampling Intervals: 5m*

**Estimated Days:** Drilling/Coring: 22 Logging: 7 Total On-site:

**Observatory Plan:** *Longterm Borehole Observation Plan/Re-entry Plan*

**Potential Hazards/ Weather:**

| | | | | | |
|---|---|---|---|---|---|
| Shallow Gas | [ ] | Complicated Seabed Condition | [x] | Hydrothermal Activity | [ ] |
| Hydrocarbon | [ ] | Soft Seabed | [ ] | Landslide and Turbidity Current | [ ] |
| Shallow Water Flow | [ ] | Currents | [ ] | Gas Hydrate | [ ] |
| Abnormal Pressure | [ ] | Fracture Zone | [ ] | Diapir and Mud Volcano | [ ] |
| Man-made Objects (e.g., sea-floor cables, dump sites) | [ ] | Fault | [x] | High Temperature | [ ] |
| $H_2S$ | [ ] | High Dip Angle | [ ] | Ice Conditions | [ ] |
| $CO_2$ | [ ] | Sensitive marine habitat (e.g., reefs, vents) | none | | |
| Other: | none | | | | |

Preferred weather window: April to October is preferable because of strong wind in the late autumn and winter