

# IODP Proposal Cover Sheet

Japan Trench Tsunamigenesis

835 - Full

|            |   |      |              |
|------------|---|------|--------------|
| Title      | 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 |      |              |
| Proponents | S. Kodaira, J. Sample, M. Strasser, K. Ujiie, J. Kirkpatrick, P. Fulton, J. Mori, *. JTRACK working group (30 others),  |      |              |
| Keywords   | Tsunami, Earthquake, Subduction, Paleoseismology, Fault   | Area | Japan Trench |

## Contact Information

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## Abstract

Understanding the huge slip and associated devastating tsunami of the 2011 Tohoku-oki earthquake is a high priority challenge for IODP with important societal impacts. JTRACK investigates spatial and temporal aspects of physical, hydrological, and chemical properties of the fault zone to elucidate key factors that can control large (and small) slip on the megathrust. These results may be used to explain the 2011 earthquake, past tsunamigenic events along the Japan Trench, and possibly other great subduction earthquakes world-wide.

Planned drilling includes a variety of investigations targeting the fault zone and associated structures. Geologic studies will focus on structure and physical properties, especially frictional characteristics for components of the input pelagic sediments, such as the abundant smectite. Hydrological and chemical effects in and around the fault zone are largely unknown, but likely contribute to earthquake processes. We plan analyses of interstitial water to evaluate the role of fluids during faulting, along with investigations of the local permeability structure. The evolving stress state following the earthquake will be studied with borehole breakouts and temperature/pressure monitoring in a borehole observatory. JTRACK has the unique opportunity to study fault healing after a large earthquake.

In addition to investigations of the 2011 earthquake, we plan paleoseismic studies of past earthquakes. Using shallow cores from this region, we have identified sediment remobilizations associated with three historical earthquakes over the last 1200 years. We plan further development of techniques and more data collection to identify sediment proxies for past earthquakes. These studies may enable reconstruction of earthquake histories over tens to hundreds of thousands of years. This may be the only method for obtaining sufficient data to statistically evaluate (varying) recurrence intervals of great earthquakes.

The strategy for this proposal consists of two 3-hole transects across the Japan Trench in the region of the shallow plate boundary fault that ruptured in 2011. One transect for an area of large slip (~50 m) and the other for small (~5-10 m) slip. Each transect has an inner trench slope site mainly targeting the plate boundary fault zone, an input site seaward of the trench, and a paleoseismology site to obtain long sediment records of past events.

The borehole sites have largely independent science objects and there are few logistical constraints on the order or timing of drilling. This may be advantageous for scheduling since operations can be done during several expeditions of short duration.

## Scientific Objectives

1. Define spatially-varying physical and chemical properties and conditions of the sediments and fluids of the near-trench megathrust that contribute to huge fault displacements and very large tsunamis.

We will investigate the detailed geologic structures and rock properties of the fault zone, especially frictional and strength characteristics. Permeability and chemical studies will be used to infer the local hydrological structure and its effect on the earthquake rupture. Combining these observations and using comparisons of similar measurements for areas of high and low slip during the 2011 earthquake, we will try to infer key factors that control the amount of displacement during large earthquakes.

In addition, time dependent observations will be carried out to study fault healing after a large earthquake. How do the local hydrological and stress conditions change during the few years following the large fault displacement during the earthquake ?

2. Develop and begin implementation of new methods to determine recurrence of great tsunamigenic earthquakes in the sediment record.

There is a high potential for using turbidites and other sedimentary features to reconstruct a long history of tsunamigenic earthquakes. We plan development of analysis techniques along with detailed sediment core sampling. Long records that include many earthquake occurrences are needed to establish the recurrence pattern of events similar to the 2011 Tohoku-oki earthquake.

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

## Proposed Sites

| Site Name | Position<br>(Lat, Lon) | Water<br>Depth<br>(m) | Penetration (m) |     |       | Brief Site-specific Objectives  |
|-----------|------------------------|-----------------------|-----------------|-----|-------|---|
|           |                        |                       | Sed             | Bsm | Total |   |
| JTCT-02A  | 37.9267, 144.0688      | 6945                  | 450             | 0   | 450   | Obtain sample and logging data of a reference section on the incoming plate seaward of the large slip area of the 2011 Tohoku earthquake as a baseline for comparison with sediments in the prism, plate-boundary décollement and underthrust section. Investigate the role of fluids in the reference input section with geochemical and physical property data from continuous cores. Measure the stress state in the incoming sediment section from borehole and sediment property measurements. |
| JTNT-02A  | 38.5272, 144.1992      | 7115                  | 520             | 0   | 520   | Obtain sample and logging data of a reference section on the incoming plate seaward of the small slip area of the 2011 Tohoku earthquake as a baseline for comparison with sediments in the prism, plate-boundary décollement and underthrust section.  |

|          |                   |      |     |   |     |  |
|----------|-------------------|------|-----|---|-----|--|
| -        | -                 | -    | -   | - | -   | Investigate the role of fluids in the reference input section with geochemical and physical property data from continuous cores. Measure the stress state in the incoming sediment section from borehole and sediment property measurements.   |
| JTNT-03A | 38.5760, 144.1227 | 7550 | 180 | 0 | 180 | D/V Chikyu HPSC coring, as proposed in proposal 866Pre (Japan Trench Paleoseismology) to recover a continuous upper Pleistocene-to-Holocene stratigraphic successions comprising sedimentary extreme event deposits, which will be analyzed for proxy-evidence of large earthquakes. To be established history of extreme events will contribute to investigate long-term recurrence pattern of great earthquakes at Japan Trench subduction zone.   |
| JTCT-03A | 38.0225, 144.0368 | 7180 | 130 | 0 | 130 | D/V Chikyu HPSC coring, as proposed in proposal 866Pre (Japan Trench Paleoseismology) to recover a continuous upper Pleistocene-to-Holocene stratigraphic successions comprising sedimentary extreme event deposits, which will be analyzed for proxy-evidence of large earthquakes. To be established history of extreme events will contribute to investigate long-term recurrence pattern of great earthquakes at Japan Trench subduction zone.   |
| JTCT-01A | 37.9389, 143.9135 | 6930 | 950 | 0 | 950 | Continuously core the frontal prism, fault zone and subducted plate to oceanic basement in large slip area of the 2011 Tohoku earthquake to obtain representative fault and surrounding rock samples and logging data for structural analyses and laboratory experiments. Install a long-term fault zone observatory to monitor pore pressure and temperature near the previous JFAST temporary temperature observatory. Investigate the role of fluids in slip with geochemical and physical property data from continuous cores. Measure the prism stress state from borehole and sediment property measurements and long-term observatory monitoring. |
| JTNT-01A | 38.5520, 144.0355 | 7400 | 980 | 0 | 980 | Continuously core the frontal prism, fault zone and subducted plate to oceanic basement in the small slip area of the 2011 Tohoku earthquake to obtain representative fault and surrounding rock samples and logging data for structural analyses and laboratory experiments. Investigate the role of fluids in slip with geochemical and physical property data from continuous cores. Measure the prism stress state from borehole and sediment property measurements.   |