# IODP Proposal Cover Sheet

1010 - APL

JTRACK Deep-Time Paleoseismology

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| Title | TRACKing past earthquakes in the sediment record in a Japan Trench basin: Applying submarine paleoseismology in the Deep-time trench-fill sediments (JTRACK Deep-Time Paleoseismology) |
| Proponents | Ken Ikehara, Michael Strasser, Yasuyuki Nakamura, Toshiya Kanamatsu, Troy Rasbury, Takuya Itaki, Yoshitaka Nagahashi, Joel Johnson, Jyh-Jaan Huang, Rui Bao, Takashi Ishizawa, Jasper Moernaut |
| Keywords | Paleoseismology, Earthquake, Sedimentology, Interstitial-water geochemistry |
| Area | Japan Trench |

## Proponent Information


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## Abstract


Short historical and even shorter instrumental records limit our perspective of earthquake maximum magnitude and recurrence, and thus are insufficient for fully characterize Earth's complex and multiscale seismic behavior and its consequences. To fill the gap in long-term paleoseismic records of giant (Mw9-class) subduction zone earthquakes such as the Tohoku-oki earthquake in 2011, IODP Expedition 386 successfully collected 29 Giant Piston Cores (GPCs) at 15 sites, recovering up to 37.82-meter-long, continuous, upper Pleistocene to Holocene successions from 11 individual trench-fill basins. Preliminary results of Expedition 386 indicated that numerous event deposits of a few centimeters to a few meters in thickness are intercalated in the bioturbated clay and silty clay in the cores from the central to southern Japan Trench (JT). No obvious influence of sea-level fluctuation was recognized that would jeopardize the long-term paleoseismic record contained in the up to ~160-m-thick trench-fill sequence. Identical to the results from conventional coring, thick muddy event deposits are possible records of the past megathrust earthquakes along the JT.

In central JT basins, trench-fill sediment sequences are characterized by several slightly tilted prominent seismic reflections with high amplitudes in multi-channel seismic profiles. Tilts become larger with increasing subbottom depths, suggesting periodic tilting events, which were possibly generated by large coseismic slip propagation to trench events in the past. The initial GPC-to-seismic correlation suggests that the uppermost reflector is correlative with the base of a thick turbidite bed of the 869 Jogan earthquake, which was a major earthquake event before the 2011 earthquake. However, due to the short recovery of GPCs, it is impossible to date the older hypothesized slip-to-trench events.

This APL to the upcoming IODP Expedition 405 Japan Trench Tsunamigenesis proposes to drill a trench basin fill deposit in the central JT to recover the whole trench-fill sequence for dating and establishing event-stratigraphy for paleoseismologic interpretations. Based on the combination with stratigraphy and chronology of thick event deposits, interstitial-water geochemistry proxy-data for past fluid flow pulses in the cores and core-to-seismic correlation to paleo-slip-to-trench events, we would like to clarify how often the slip-to-trench events have occurred. The results of this proposed drilling will cover a time period that is several times longer than what can be obtained from GPC. D/V Chikyu is the only facility to recover ~160 m cores from the hadal JT. This will significantly advance our understanding of the recurrence pattern of giant earthquakes and earthquake-induced geohazards.

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## Scientific Objectives

There is high potential of using event-stratigraphy of trench-fill sedimentary successions in the Japan Trench to reconstruct a long history of giant megathrust earthquakes for evaluating earthquake recurrence patterns. Furthermore, dating key-reflectors in seismic profiles suggesting tsunamigenic slip-to-the-trench earthquakes and testing interstitial water geochemical proxies is expected to deliver better understanding how often and when megathrust ruptures have propagated into the shallowest part to reach the trench. To address these overarching goals, the primary scientific objectives of JTRACK-Deep-Time Paleoseismology are to:

O-1: Identify and explore the temporal distribution of event-deposits and tectonic-driven deformation and tilting events to investigate time-dependent up-dip rupture variability of the megathrust fault.
O-2: Develop a long-term earthquake record for tsunamigenic giant earthquakes.
O-3: Evaluate the influence of earthquake-induced fluid migration (discharge) in trench-fill sediments.

The cores from a proposed primary site will be used for multi-method applications to characterize and date event-deposits and transient geochemical profiles.

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

X-ray computed tomography (X-CT) imaging of whole-round cores before opening cores

Have you contacted the appropriate IODP Science Operator about this proposal to discuss drilling platform capabilities, the feasibility of your proposed drilling plan and strategies, and the required overall timetable for transiting, drilling, coring, logging, and other downhole measurements?

yes

# Science Communications Plain Language Summary

Using simple terms, describe in 500 words or less your proposed research and its broader impacts in a way that can be understood by a general audience.

The 2011-Mw9.0-Tohoku-oki earthquake and tsunami was a catastrophic geological event with major societal consequences. Unexpected shallow and large coseismic slip contributed to the large tsunami. Short historical and even shorter instrumental records limit our perspective of earthquake maximum magnitude and recurrence, and thus are insufficient for fully characterize Earth's complex and multiscale seismic behavior and its consequences. The geological record is a reliable tool for reconstructing the history of giant earthquakes with long recurrence intervals and to help reduce epistemic uncertainties in seismic-hazard assessment. Results of IODP Expedition 386 using ~40-m long piston cores suggested that megathrust earthquakes have been recorded as thick turbidites in the central Japan Trench. Therefore, the ultra deep-sea trench-fill sediments in the central Japan Trench are the best archive of past giant earthquakes to expand turbidite paleoseismology toward a much deeper time. Furthermore, the seismic profiles indicated that a deformed structure created during large coseismic slip was detected in the trench-fill sequence of central Japan Trench. Such deformation is likely another geological evidence of the extreme slip which propagated to the trench ("slip-to-the-trench") and is considered important for causing outstanding large tsunami. Establishing a chronology for such deformation horizons in seismic profiles may improve our understanding of the recurrence of tsunamigenic slip-to-the-trench vs deep megathrust rupture modes.
This APL proposes to drill a trench basin fill deposit in the central Japan Trench to recover the whole trench-fill sequence for dating and establishing event-stratigraphy for paleoseismologic interpretations. Based on the combination with stratigraphy and chronology of thick event deposits, interstitial-water geochemistry proxy-data for past fluid flow pulses in the cores and core-to-seismic correlation to paleo-slip-to-the-trench events, we would like to clarify how often the slip-to-the-trench events have occurred in the past and to understand the recurrence patterns of giant earthquakes and earthquake-induced geohazards in the central Japan Trench as an example of a major subducting plate margin on Earth.

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Proposed Sites (Total proposed sites: 1; pri: 1; alt: 0; N/S: 0)

| Site Name | Position (Lat, Lon) | Water Depth (m) | Penetration (m) | | | Brief Site-specific Objectives |
|---|---|---|---|---|---|---|
| | | | Sed | Bsm | Total | |
| JTC-01A (Primary) | 38.7500 144.1293 | 7630 | 160 | 0 | 160 | (i) Recover a continuous and whole trench-fill sequence for dating and establishing event-stratigraphy for paleoseismologic interpretations (O-1). (ii) conduct core-to-seismic correlation for dating paleo-slip-to-trench events and develop a long-term earthquake record for tsunamigenic giant earthquakes (O-2). (iii) analyze solid and interstitial water geochemistry for evaluating contribution of earthquake-induced sediment remobilization on elemental cycling and influence of earthquake-induced fluid migration in trench-fill sediments (O-3). |