KCC - J-DESC
Repository Core Re-Discovery Program (ReCoRD)
Proposal Form

Received date	Oct. 1, 2023
Proposal No.	No. 003
New / Revised	New

(Above For Official Use Only)

Basic Information

Title:	Understanding the Formation Process and Physical Property Distribution of the Upper Prism in the Japan Trench
Keywords: (5 or less)	Japan Trench, Upper prism, Physical properties, Formation process, Deformation history
Lead Proponent:	Nana Kamiya
Affiliation:	Kyoto University
Address:	C1-1-110 C-cluster, Kyoto Daigaku Katsura, Nishikyo-ku, Kyoto, 615-8540, Japan
Phone:	+81 75 383 3403
E-mail:	Kamiya.nana.4h@kyoto-u.ac.jp

Permission is granted to post the proposal contents on www.j-desc.org.
☒ Granted. ☐ Not Granted.

Scientific Objectives (250 words or less)

The Japan Trench is an erosional subduction zone, where the shallow part of the plate boundary fault was thought to have neither strain accumulation nor slip propagation due to the non-asperity nature of the shallow plate boundary. However, the 2011 off the Pacific coast of Tohoku earthquake demonstrated that the shallow part has the potential to generate a large slip during an earthquake.

IODP Exp. 343 (JFAST), which conducted drilling in the shallow part of the plate boundary at the Japan Trench, found that the plate boundary fault had been developed in low-friction pelagic claystone and that strain had been accumulated in the frontal prism of the hanging wall and stress was released during the earthquake. On the other hand, because of limited sample recovery from the upper prism during the JFAST, structural development processes and material characteristics of the upper prism have not been clarified.

The objectives of this project are (1) to elucidate the formation processes of the hanging wall where strain accumulates, and (2) to clarify the temporal and spatial physical and structural characteristics of the sediments in the hanging wall. These objectives will contribute to the understanding of the pre-, co-, and post-seismic processes of a mega-earthquake. To achieve this goal, we plan to construct a gamma-ray stratigraphy, measure the anisotropy of various physical properties, and perform microstructural analysis. The structural and physical characteristics obtained in this project are comparable with these not only from JFAST but also from JTRACK.

Proposed Target Cores

Leg/Exp.	Site-Hole	Cores
Leg 56	Site 434-Hole B	1-4, 7-11, 14-20, 24-28, 30, 32-37
Leg 57	Site 440-Hole B	1, 3-43, 45-71
Leg 56	Site 436	1-42
Leg 57	Site 439	14-15, 36, 38
Exp. 343	C0019	1-10, 12-16, 19-21 (Only observation and sampling)

Add lines as needed
[Note: Only cores in KCC are available.]

Proposed analysis prior to sampling

Analyses by X-ray CT and MSCL at the Kochi Core Center is required prior to the sampling. X-ray CT scans of the cores (AH) will be compared with core structure description and will be used to estimate continuous density distribution using CT values. MSCL (natural gamma ray, gamma ray density, elastic wave velocity, and resistivity) scans of the cores (AH) are important measurements for qualifying the fundamental physical properties of the samples, and also for obtaining more precise density estimation. Natural gamma rays, in particular, are essential for contrasting the litho-stratigraphy of the all drilling sites.

[Note: Please describe above any analysis needed prior to sampling. Standard set is X-ray CT, split core image (WH and/or AH), microscopic imaging of smear slide and/or thin section.]

Summary of previous studies of the target cores

DSDP Leg 56, Site 436, is located seaward of the trench and is an important input site for understanding the structure of the incoming oceanic crust; Site 436 reached approximately 0-400 m below the seafloor (mbsf) and drilled cores consist mainly of Holocene to Eocene mudstones and, at the deepest depth, Cretaceous chert was identified. Overall, the sediments consist of diatom-rich hemipelagic sediments with volcaniclastics (Langseth et al., 1980). Kameda et al. (2015) conducted mineral analyses of the core samples from Site 436 and found a smectite concentration of >60 wt% in the uppermost pelagic clay (360 - 366 mbsf), which is contrasted with the plate boundary fault zone at the JFAST site. Sawai et al. (2014) performed friction experiments using this clay layer and found that the clay layer has low-friction over a wide range of slip velocities. Thus, Site 436 has been used as an analog for upper prism tips and plate boundary faults.

DSDP Leg 56, Sites 434 and 439, and Leg 57, Site 440 are located landward of the trench and are important for understanding the deformation structure of the upper prism; Site 434 is the closest to the trench and penetrated the tip of frontal prism. The main lithological components are terrigenous silty clay, biogenic silica, and vitric ash, which are similar to the Neogene sediments in the surrounding sites. Significant hardening was observed at 100 mbsf, and slicken lines are visible on fracture fragments and fracture surfaces (Langseth et al., 1980). Site 440 corresponds to a slope section that is landward of the frontal prism. Samples from this site consist mainly of homogeneous semi-pelagic mudstones with similar mineral composition to the landward sites (e.g., Site 439). Several age discontinuities have been identified in the Miocene and Pliocene sediments, and angular conglomeration was observed at depths where the sediments hardened (von Huene et al., 1980). Site 439 is the most landward of the three sites, and its upper section consists mainly of clay minerals such as montmorillonite, illite, and chlorite, similar to Site 436 (Langseth et al., 1980).

In Legs 56 and 57 of the DSDP, no X-ray CT or natural gamma-ray data were collected, and the lithology of the sites were not compared with those of other drill sites, thus only a sketchy stratigraphic comparison based on age estimations is available. The microstructural analyses such as magnetic fabric and pore geometry have also not been investigated. By acquiring these data at both of the input and the upper prism sites, it will be possible to correlate the litho-stratigraphy and to discuss the history of structural development.

IODP Exp. 343 (JFAST), C0019 was drilled targeting at a depth of 820 mbsf, which is the equivalent depth of the plate boundary fault, in the east of the Oshika Peninsula, Miyagi Prefecture. This site is located at the frontal prism at the south of the drilling sites of DSDP Leg 56. The analyses of drilled cores, logging, and borehole observations revealed differences in deformation structures between the upper and lower part of the fault (Chester et al., 2013; Kirkpatrick et al., 2014), and the frictional property and permeability of the fault are highly specific due to clay minerals (Ujiie et al., 2013; Fulton et al., 2013). Furthermore, stress analysis showed that the accumulated stress was released during the earthquake, suggesting that strain was accumulated even at the frontal prism (Lin et al., 2013). Despite many discoveries as described above, because the drilling was conducted at the only one site, the diversity and universality of the constituent lithologies and physicochemical properties of the faults orthogonal and parallel to the trench remained unclear.

Proponent List

Name	Affiliation	Position	Country	Expertise
Nana Kamiya	Kyoto University	Assistant Professor	Japan	Physical property
Yohei Hamada	JAMSTEC	Researcher	Japan	Logging
Keisuke Nakamoto*	Hokkaido University	Ph.D. student	Japan	Sedimentology
Hanaya Okuda	JAMSTEC	Researcher	Japan	Rock mechanics

Yoshitaka Hashimoto	Kochi University	Professor	Japan	Structure Geology

[Note: For proponents who do not have J-DESC memberships, please put an asterisk (*) AFTER his/her name.]