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Natsushima "Cruise Report"

NT13-02

Tsunami Prediction system:

Research Cruise in Japan Trench: Piston Coring

(Off Tohoku)

Jan.21th, 2013-Feb.9th, 2013

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

NT13-02 cruise report Contents

1. Cruise Information

Cruise ID: NT13-02
Name of vessel: NATSUSHIMA
Title of the cruise: Tsunami Prediction system: Research Cruise in Japan Trench
Chief scientist [Affiliation]: Toshiya Kanamatsu [IFREE-JAMSTEC]
Lead proponent [Affiliation] : Toshiya Kanamatsu [IFREE-JAMSTEC]
Title of proposal: Tsunami Prediction system: Research Cruise in Japan Trench: Coring research cruise
Cruise period: 21th, Jan – 9th, Feb 2013
Ports of call: JAMSTEC, Yokosuka -JAMSTEC, Yokosuka
Research area: Off Tohoku
Research map: Figure 1

Overview of the Observation

Sampling and analyzing of event deposits formed by submarine landslides, displacement of faults, and strong motion during earthquakes, were planed to understand distribution of event deposit to know damaged zone, and recurrence of earthquake. Sampling sites for piston coring operations were planed with referring to bathymetric and subbottom image records previously acquired. Due to bad weather, only eight coring operations were made. We also conducted bathymetric survey within the research area as much as possible. We took 2 cores (PC01 & PC02) from the upper middle terrace of water depth ca. 2,300m at 39°N, and 4 cores (PC03 - PC06) from the forearc basin of water depth 1000-2000m at 38°N-39°N, 2 cores (PC07 & PC08) from the upper slope of 600m-800m water depth at 38°N. Major lithology of PC01-PC06 is diatomousous bioturbated silt including foraminifera test with frequent interbedding with tephra layers. The tephra layers might be correlated to previously reported tephra sampled in the area. The lithology of the other cores (PC7 and PC8) are characterized by sandy layer in the upper, and silty layer in the lower. Bathymetric surveys were conducted in three areas, which are shallower than 2000m water depth.

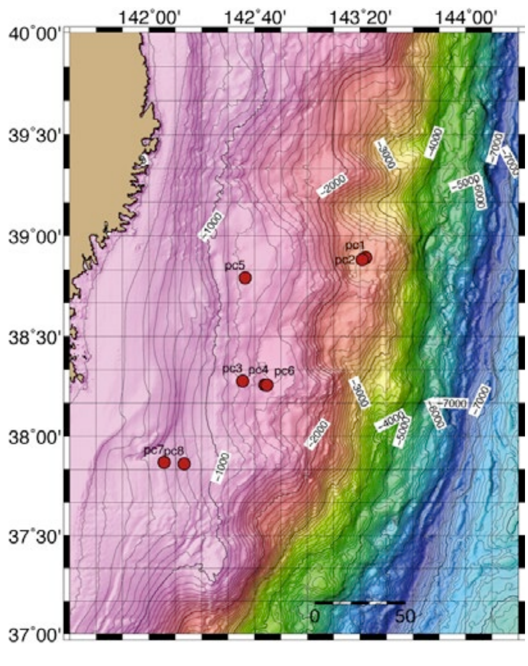

Figure 1: Sites for piston coring during NT13-02 cruise

2. Participant list

Scientific party

Toshiya Kanamatsu	JAMSTC
Cecilia McHugh	JAMSTEC/ Queens College, C.U.N.Y.
Ken Ikehara	AIST
Kazuko Usami	AIST
Kazuhiro Yoshida	Marine Works Japan Ltd
Hiroaki Hayashi	Marine Works Japan Ltd
Yasushi Hashimoto	Marine Works Japan Ltd
Yasumi Yamada	Marine Works Japan Ltd

R/V Natsushima Ship Crew

TAKAFUMI AOKI	Captain
AKIHISA TSUJI	Chief Officer
ISAO MAEDA	2nd Officer
HIROHARU OMAE	3rd Officer
HIROYUKI SHIBATA	Chief Engineer
KIMIO MATSUKAWA	1st Engineer
MORIHIKO MURAKAMI	2nd Engineer
KOICHI HASHIMOTO	3rd Engineer
NAOOMI UEMURA	Jr.3rd Engineer
HARUKI KAMADA	Jr.3rd Engineer
MASAMOTO TAKAHASHI	Chief Electronics Operator
HIROKI ISHIWATA	2nd Electronics Operator
TATSUHIRO TAKAKUWA	3rd Electronics Operator
YASUYOSHI KYUKI	Boat Swain
SHUJI TAKUNO	Able Seaman
YOSHITSUGU FUJII	Able Seaman
YUKITO ISHII	Able Seaman
TAKUMI YOSHIDA	Able Seaman
SHO SUZUKI	Sailor
TOMOAKI KUBOTA	Sailor
JUNJI MORI	No.1 Oiler
MORIYA ABE	Oiler
TATSUOMI CHINO	Oiler
MASAKI TANAKA	Oiler
RYO MATSUUCHI	Oiler
SUETO SASAKI	Chief Steward
KOJI KIRITA	Steward
HIROYUKI OHBA	Steward
AKIHIDE SAITO	Steward
KAWASE KATSUHIRO	Steward

3. Cruise Log

NT13-2 Cruise Log

Jan. 2013	
21	Left JAMSTEC, YOKOSUKA for research area.
22	Headed to Ishinomaki bay to stay there due to bad weather.
23	Visited PC01 site but coring was canceled due to bad weather. Implemented bathymetric survey.
24	Implemented bathymetric survey.
25	Stayed at Ishinomaki bay with waiting on weather.
26	Stayed at Ishinomaki bay with waiting on weather.
27	Stayed at Ishinomaki bay with waiting on weather. Moved to PC01 and PC02 sites in night.
28	Implemented PC01 & PC02 coring operations.
29	Implemented bathymetric survey.
30	Implemented bathymetric survey.
31	Implemented PC03 & PC04 coring operations and bathymetric survey in the night.
Feb. 2013	
1	Implemented PC05 coring operation.
2	Stayed at Ishinomaki bay with waiting on weather.
3	Stayed at Ishinomaki bay with waiting on weather.
4	Implemented PC06 operation in the morning. In the afternoon waiting on weather at Ishinomaki bay.
5	waited on weather at Ishinomaki bay
6	Implemented PC07 and PC08 operations in the morning. Bathymetric survey in the afternoon & night.
7	Terminated NT13-02 survey in the working area, headed for YOKOSUKA
8	Waited on weather form 7th evening to 8th noon in off Hitachi. Transited to YOKOSUKA,
9	Arrived in port of JAMSTEC

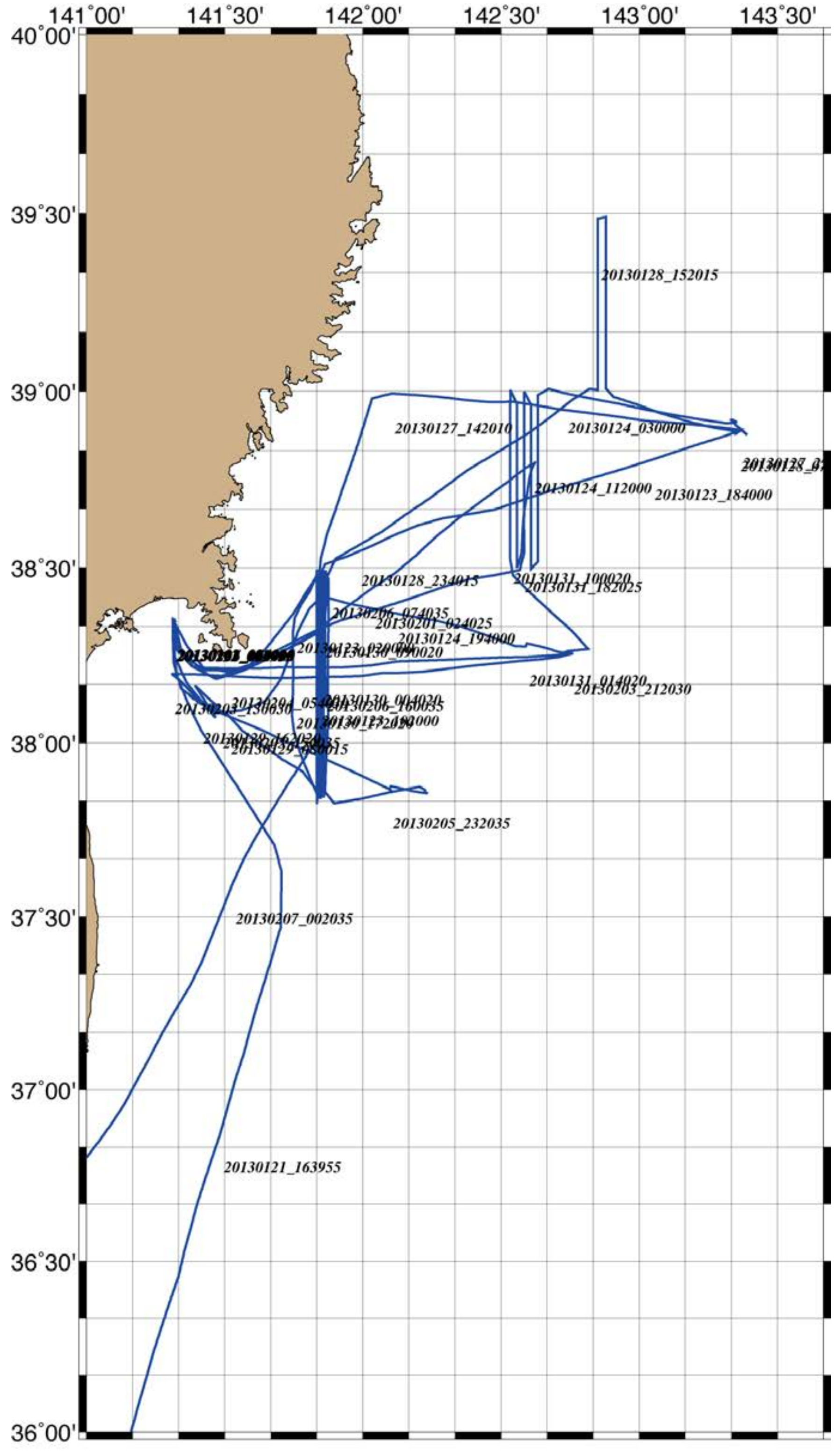

Figure 2. Ship track for NT13-02

4. Objective and summary of observation

A long term prediction for earthquake in a subduction zone should be based on its recurrence interval and past displacements of a megathrust. Unfortunately no such research has been conducted in the deep Japan Trench subduction zone before the 2011 Tohoku earthquake. The recurrence of earthquakes could be understood by evaluating timing of event deposits in the sequences. In this study, not only in the trench axis where the most prominent displacement occured, in the forearc basin and the landward slope areas. We first aim to document the evidence of the 2011 Tohoku-oki earthquake in the surface sediment, and then establish the earthquake recurrence in Tohoku-oki by identifying similar evidences in the past strata.

Sampling and analyzing of event deposits formed by submarine landslides, displacement of faults, and strong motion during earthquakes, were planed to understand distribution of event deposit to know damaged zone, and recurrence of earthquake. Sampling sites for piston coring operations were planed with referring to bathymetric and subbottom image records previously acquired. Due to bad weather, only eight coring operations were made. We also conducted bathymetric survey within the research area as much as possible. We took 2 cores (PC01 & PC02) from the upper middle terrace of water depth ca. 2,300m at 39°N, and 4 cores (PC03 - PC06) from the forearc basin of water depth 1000-2000m at 38°N-39°N, 2 cores (PC07 & PC08) from the upper slope of 600m-800m water depth at 38°N (Figure 2). Major lithology of PC01-PC06 is diatomousous bioturbated silt including foraminifera test with frequent interbedding with tephra layers. The tephra layers might be correlated to previously reported tephra sampled in the area. The lithology of the other cores (PC7 and PC8) are characterized by sandy layer in the upper, and silty layer in the lower. Bathymetric surveys were conducted in three areas, which are shallower than 2000m water depth.

5. Instruments and Operation of Piston corer (MWJ)

Piston corer system (PC)

Piston corer system consists of 0.48 ton weight, 4 m or 8m long stainless steel barrel with polycarbonate liner tube and a pilot core sampler (Fig.5.1). Two types of piston: stainless steel body and Brass body type were used. Both of pistons are composing of two O-rings (size: P63). The inside diameter (I.D.) of polycarbonate liner tube is 74 mm. The total weight of the system is approximately 0.7 ton. The pipe length was chose based on site survey data and "K-value". For a pilot core sampler, we used a "74 mm diameter long-type pilot corer".

The transponder (OKI ltd. SB-1018; max depth 6,200 m) was attached to the winch wire above 50 m from the PC to monitor the PC position.

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"K-value"

"K-value" is the hardness barometer of the sea floor sediment. K value = pure pull out load / (outer diameter of outer pipe * penetration length). Because of winding power of the winch, we were requested to choose pipe length with referring "K-value".

		4 m piston coring	6 m piston coring	8 m piston coring
K value:	0.34 or less	OK	OK	OK
	0.34 ~ 0.46	OK	OK	NG
	0.46 ~ 0.74	OK	NG	NG

Winch operation

When we started lowering PC, a speed of wire out was set to be 20 m/min, and then gradually increased to the maximum of 60 m/min. Lowering was stopped at a depth about 100 m above the seafloor. 3 minutes were spend to reduce some pendulum motion of the system. After stabilizing the corer motion, the wire was wound out again at a speed of 20 m/min. When the corers touched the bottom, the wire tension abruptly decreased by the loss of the corer weight. Immediately after confirmation that the corers hit the bottom, wire out was stopped and winding of the wire was started at a speed of 20m/min, until the tension gauge indicates that the corers were lifted off the bottom. After left the bottom, winch wire was wound in at the maximum speed.

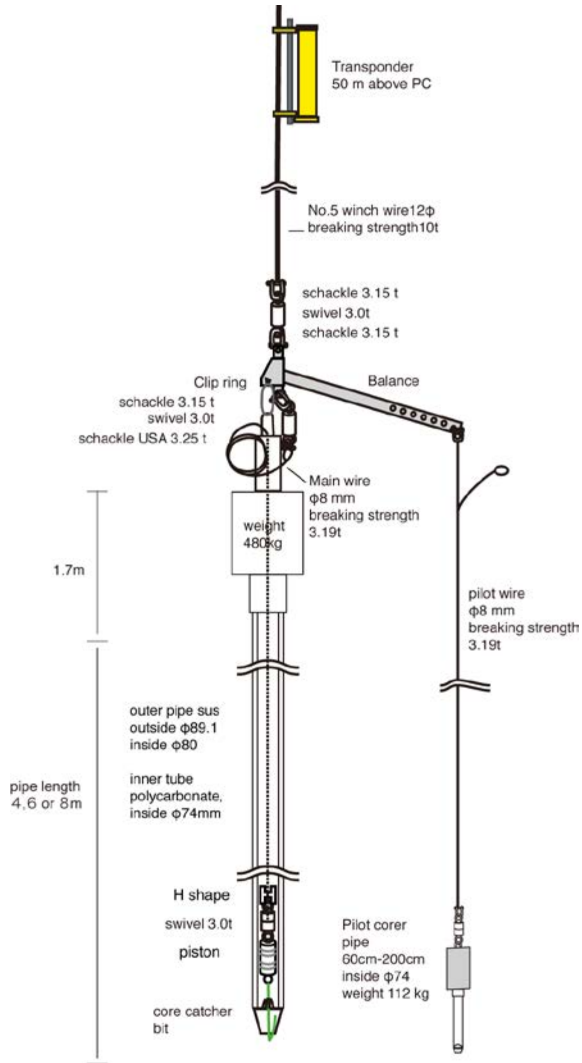

Figure 6.1 piston corer system

Core splitting

The sediment sections are longitudinally cut into working and archive halves by a splitting devise and a nylon line or a stainless wire.

6. Piston core preliminary Results

6-1 Site information for PC point

Because RV Natsushima is not equipped with sub bottom profiler, we referred the subbottom images, which are available, to design coring positions. All the SBP data were obtained after 2011 Tohoku earthquake by several cruises. Note most of bathymetry map were produced using grid data which was compiled from data obtained before the 2011 event.

PC1 and PC2

Sites PC1 and PC2 are located at the terrace of 2300 m water depth. SBL profile "YK_KR_2011SBP_38-50Line", which are in south of the sites, shows stratified reflectors and west of the terrace is deeper and thicker layers are recognized.

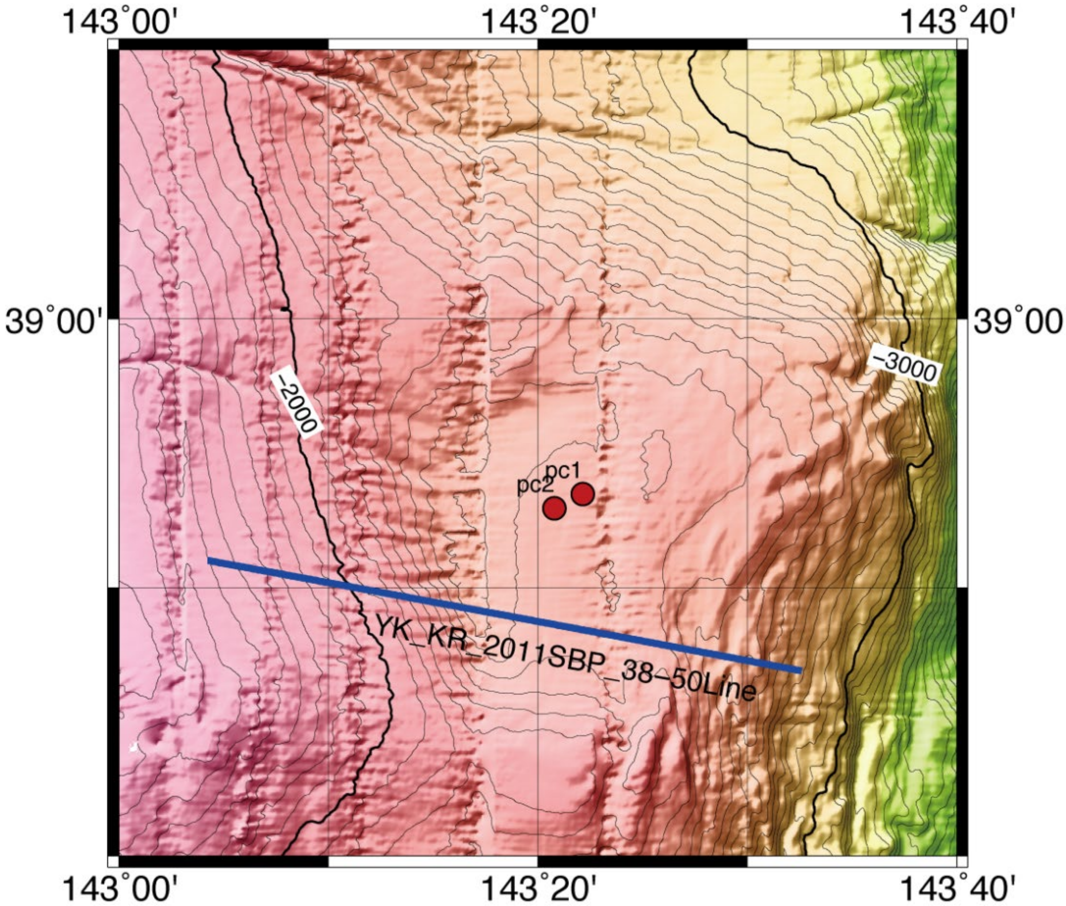

Figure 6.1. Location for PC01 and PC02

PC3, PC4, and PC6

PC3 and PC4, PC06 are on the line “YK_KR_2011SBP_38-20Line”. Between 1260m and 1600. Several km width steps are developed forming small basins. Reflectors in the basins suggest structures are active.

PC05

PC05 is located in the foot of the upper slope (200-1000m water depth). Well stratified reflectors are identified in the line “YK_KR_2011SBP_38-35Line”

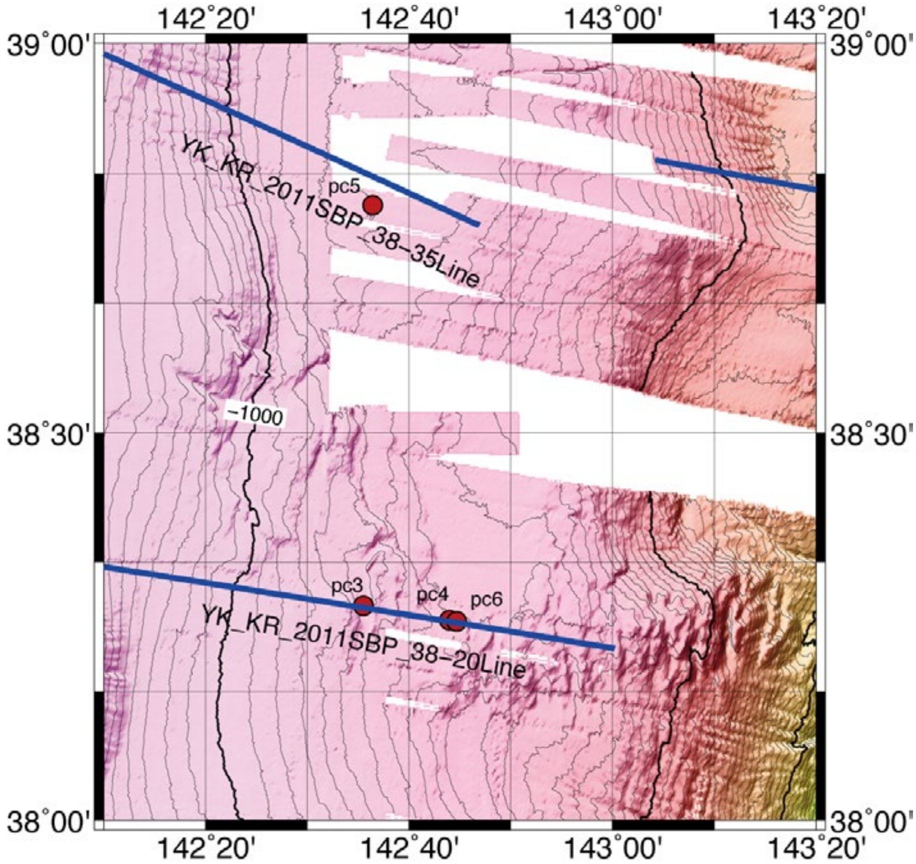

Figure 6.3. Location for PC03, PC04, PC05 and PC06

PC7 and PC8

PC7 and PC8 are located in the upper slope (200-1000m water depth). Reflectors in this slope can be continuously traced. Stratified reflectors are identified in the line "YK_KR_2011SBP_37-50Line"

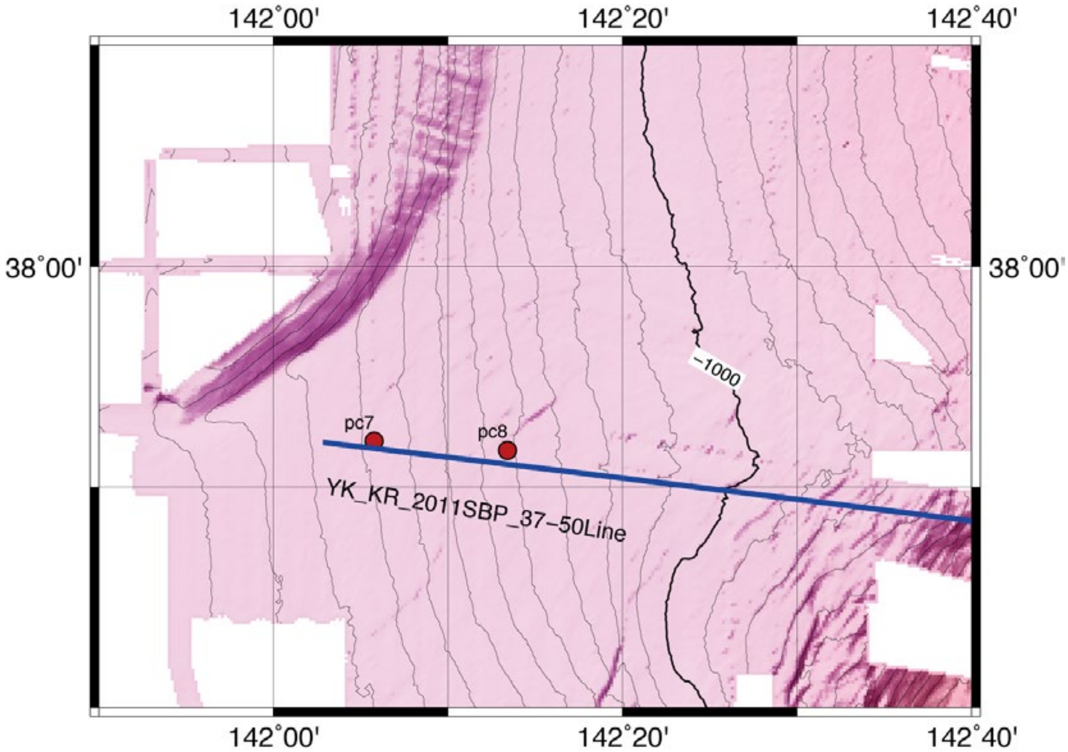

Figure 6.6. Location for PC07 and PC08

Figure 6.7 Subbotom profiler record of YK_KR_2011SBP_37-50Line

6-2. Summary of Piston coring Operation: Tables

Table 6.2.1: Coring Summary of NT13-02 cruise

Date (UTC) (yymmdd)	Core ID	Corer type*	Location	Lat. (TP**)	Lon. (TP**)	Lat. (Ship)	Lon. (Ship)	Depth (m)	Corebarrel length (m)	Tension max. (kN)	K value***	Core length (cm)
2013/1/28	PC01	Inner type PC	Off Sanriku (St.01)	38°53.3767'N	143°22.1545'E	38°53.4875'N	143°22.1434'E	2,373	4	24.6	0.15	265.5
	PL01	74 diam. corer							0.7			95.7
2013/1/28	PC02	Inner type PC	Off Sanriku (St.02)	38°52.8312'N	143°20.8083'E	38°52.9500'N	143°20.7839'E	2,373	8	30.0	0.17	676.3
	PL02	74 diam. corer							0.7			16.5
2013/1/31	PC03	Inner type PC	Off Sanriku (St.03)	38°16.6231'N	142°35.5148'E	38°16.6594'N	142°35.4489'E	1,303	4	20.2	0.22	219.0
	PL03	74 diam. corer							0.7			71.5
2013/1/31	PC04	Inner type PC	Off Sanriku (St.04)	38°15.4969'N	142°43.9970'E	38°15.5393'N	142°43.9581'E	1,408	8	25.6	0.24	349.0
	PL04	74 diam. corer							0.7			10.5
2013/1/31	PC05	Inner type PC	Off Sanriku (St.05)	38°47.5296'N	142°36.4523'E	38°47.4984'N	142°36.3587'E	1,266	4	19.7	0.18	193.0
	PL05	74 diam. corer							0.7			24.0
2013/2/3	PC06	Inner type PC	Off Sanriku (St.06)	38°15.4135'N	142°44.7054'E	38°15.4951'N	142°44.6743'E	1,394	4	23.5	0.25	302.0
	PL06	74 diam. corer							0.7			3.5
2013/2/5	PC07	Inner type PC	Off Sanriku (St.07)	37°52.0780'N	142°05.7689'E	37°52.0601'N	142°05.8142'E	626	4	16.7	0.26	133.5
	PL07	74 diam. corer							0.7			0.0
2013/2/6	PC08	Inner type PC	Off Sanriku (St.08)	37°51.6642'N	142°13.4024'E	37°51.6365'N	142°13.4450'E	806	4	17.8	0.49	90.7
	PL08	74 diam. corer							0.5			0.0

***K value is the strength barometer of the sea floor sediment; K value = pure pull out load / (outer diameter of outer pipe * penetration length). **Note: Because of possible no calibration of TP position for PC01 & PC02, don't use the TP positions but ship positions for PC01 and PC02.**

Table 6.2.2: NT13-02 Section Length

Core	Section No.	Section Length (cm)	Total Length (cm)
PC01	1	70.0	
	2	100.0	
	3	95.5	
			265.5
PL01	-	87.5	
	c.c.	8.2	
			95.7
PC02	1	78.0	
	2	100.0	
	3	99.5	
	4	100.2	
	5	100.6	
	6	100.0	
	7	98.0	
			676.3
PL02	-	16.5	
			16.5
PC03	1	106.0	
	2	98.0	
	c.c.	15.0	
			219.0
PL03	-	71.5	
			71.5

Core	Section No.	n Length (cm)	l Length (cm)
PC04	1	50.5	
	2	100.5	
	3	100.0	
	4	98.0	
			349.0
PL04	-	10.5	
			10.5
PC05	1	89.0	
	2	94.0	
	c.c.	10.0	
			193.0
PL05	-	24.0	
			24.0
PC06	1	104.0	
	2	100.0	
	3	98.0	
			302.0
PL06	-	3.5	
			3.5
PC07	1	37.0	
	2	96.5	
			133.5
PC08	1	90.7	
			90.7

6-3. Lithology of Piston cores

Ken Ikehara (Geological Survey of Japan, AIST)

Each section of working half of the obtained cores was visually described on the VCD sheet. Lithology of each core was summarized as below (Fig.6.3). The VCD sheets were attached as Appendix.

PC01 & PL01: Core site of cores PC01 and PL01 located on a mid slope terrace with its water depth around 2800 m. Cores PC01 (265.5 cm long) and PL01 (95.7 cm long) were mainly composed of bioturbated diatomaceous silt. Foraminiferal tests found throughout the cores, but more significantly at the mid-lower part of core PC01. Two tephra beds at 79-80.5 cm and 183.5-187.5 cm deep occurred in core PC01. A bioturbated tephra horizon at 45.5-48 cm deep found in core PL01. Sharp but inclined color and lithology boundary found at 59 cm deep in core PC01.
This core site locates near the coring site of KH LM-8. Yamane and Oba (1999) established the oxygen isotope stratigraphy of core LM-8, and Aoki and Arai (2000) reported the tephrostratigraphy of the core. According to these studies, fourteen tephra beds were recognized in the core. Some beds were correlated to wide-spread tephras such as Aso-4 from Aso Volcano of central Kyushu, Shikotsu daiichi (Spfa-1) from Shikotsu Volcano of Hokkaido, Towada-Ofudo (To-Of) from Towada Volcano of Tohoku, Aira-Tanzawa (AT) from Aira Caldera of southern Kyushu, Towada-Hachinohe (To-H) and Towada-Chuseri (To-Cu) tephra both from Towada Volcano in ascending order. Sub-bottom depth and the inferred eruption age of each tephra was summarized as follows; To-Cu (56-60 cm, 5.2-5.4 ka), To-H (150-180 cm, 14.9-15.3 ka), AT (~263 cm (dispersed), 25.4-26.0 ka), To-Of (291-300 cm, 29.0-29.6 ka), Spfa-1 (345-355 cm, 39.5-40.1) and Aso-4 (754-763 cm, 88 ka). Ikehara et al. (submitted) summarized the radiocarbon age of To-H in marine cores as 14.2 14C ky BP. On the basis of comparison of the sub-bottom depths of the tephra beds between cores PC01 & PL01 and LM-8, a tephra bed in core PL01 might be correlative to To-Cu.

PC02 & PL02: Cores PC02 and PL02 were collected from a site around 3 miles east and on the same mid-slope terrace of cores PC01 and PL01. Lithology of cores PC02 (676.3 cm long) and PL02 (16.5 cm long) was almost the same as that of cores PC01 and PL01. Bioturbated diatomaceous silt was a major lithology. A thick tephra beds (255-263.5 cm deep) and four tephra patches (234-236 cm, 312.8-313 cm, 412.2 cm and 526.8-528.8 cm deep) were observed. The tephra bed looks similar to that at 79-80.5 cm deep in core PC01, because the lower part of the beds composed of reddish fine-grained ash. Upper part of the beds, however, had slightly different feature (black pumiceous silt in core PC01, but white upward-fining ash in core PC02).

PC03 & PL03: Coring site of cores PC03 and PL03 was planed to locate in a small basin in the forearc upper slope. Cores PC03 (219 cm long) and PL03 (71.5 cm long) had similar lithology. That is, bioturbated diatomaceous silt with foraminiferal tests. Two fine-grained tephra patches were recognized in core PC03 (166-169 cm and 192.5-193 cm deep).

PC04 & PL04: Cores PC04 and PL04 were collected from another small basin near the coring site of cores PC03 and PL03 in the forearc area off southern Sanriku. Major lithology of cores PC04 (349 cm long) and PL04 (10.5 cm long) was diatomaceous silt. It was bioturbated and with foraminiferal tests. In core PC04, a thick tephra bed (205-211 cm deep) and 5 or 6 bioturbated tephra beds or patches (71.5-73.5 cm, 74-75 cm, 140.5-141.5 cm, 231-234 cm, 331-338 cm and 340 cm deep) were observed. Tiny shell fragments occurred at 159 cm deep. Isolated granules and pebbles found in mid-lower part of core PC04.

PC05 & PL05: Coring site of cores PC05 and PL05 were arranged at eastern end of a forearc basin floor off Kesen-numa. Cores PC05 (193 cm long) and PL05 (24 cm long) were composed of bioturbated diatomaceous silt. Five tephra beds (30-35.5 cm, 61.5-63 cm, 110.5-113.5 cm, 132-143 cm, and 191.5-193 cm deep), a pumiceous sand layer (19-20 cm) and a pumice concentrated part (80-83 cm) were found in core PC05. Another pumiceous tephra layer occurred at the core catcher of core PC05 (not described in the VCD sheet). Isolated lithic pebbles and pumice were recognized throughout core PC05.

PC06 & PL06: The cores were collected in the same basin of core PC04. Major lithology of core PC06 (302 cm long) and PL06 (3.5 cm long) was the same as that of core PC04 and PL04. A thick tephra bed at 250-263.8 cm deep looks similar to that at 205-211 cm deep in core PC04. Both beds had black coarse-grained pumice bed in the lower part and grayish fine-grained ash in the upper part, and fining-upward grading structure. A possible tephra patch horizon was recognized near the core bottom (297-298 cm deep). Two pumiceous sand layers with bioturbation at 108.5-110 cm and 220-221.5 cm deep were found.

PC07 & PL07: The coring site located on the upper slope off Sendai. Core PL07 was only a little amount of sandy silt in core catcher. Core PC07 was 133.5 cm long. The core composed of sandy sediment at the upper part of core PC07 (0-85 cm in sub-bottom depth), and silt at the lower part (below 85 cm deep). Lithological boundary was irregular and bioturbated. Lower silt had large burrows filled by the upper sandy sediments.

PC08 & PL08: The cores were also collected from the upper slope off Sendai, slightly larger water depth than location of cores PC07 and PL07. Core PL08 was a little amount of silty very fine sand in core catcher. Core PC08 (90.7 cm long) was divided into two lithological units. Upper unit (0-17.5 cm) composed of sand with low mud contents. Uppermost 14.5 cm was well-sorted and homogeneous very fine sand. But this part was highly disorganized during core preparation. Lower part of the upper unit (14.5-17.5 cm) contained small shell fragments and showed upward-fining grading structure from fine sand to very fine sand. Lower unit of the core (below 17.5 cm deep) was composed of silt and very fine sand. Both were bioturbated. A small silt-sized ash patch with lighter color than the surrounding silt found at 30-31.5 cm deep. Some pumice grains occurred in the lower unit, especially near the core bottom. Lithological boundary between the upper and lower units was sharp and erosional.

References

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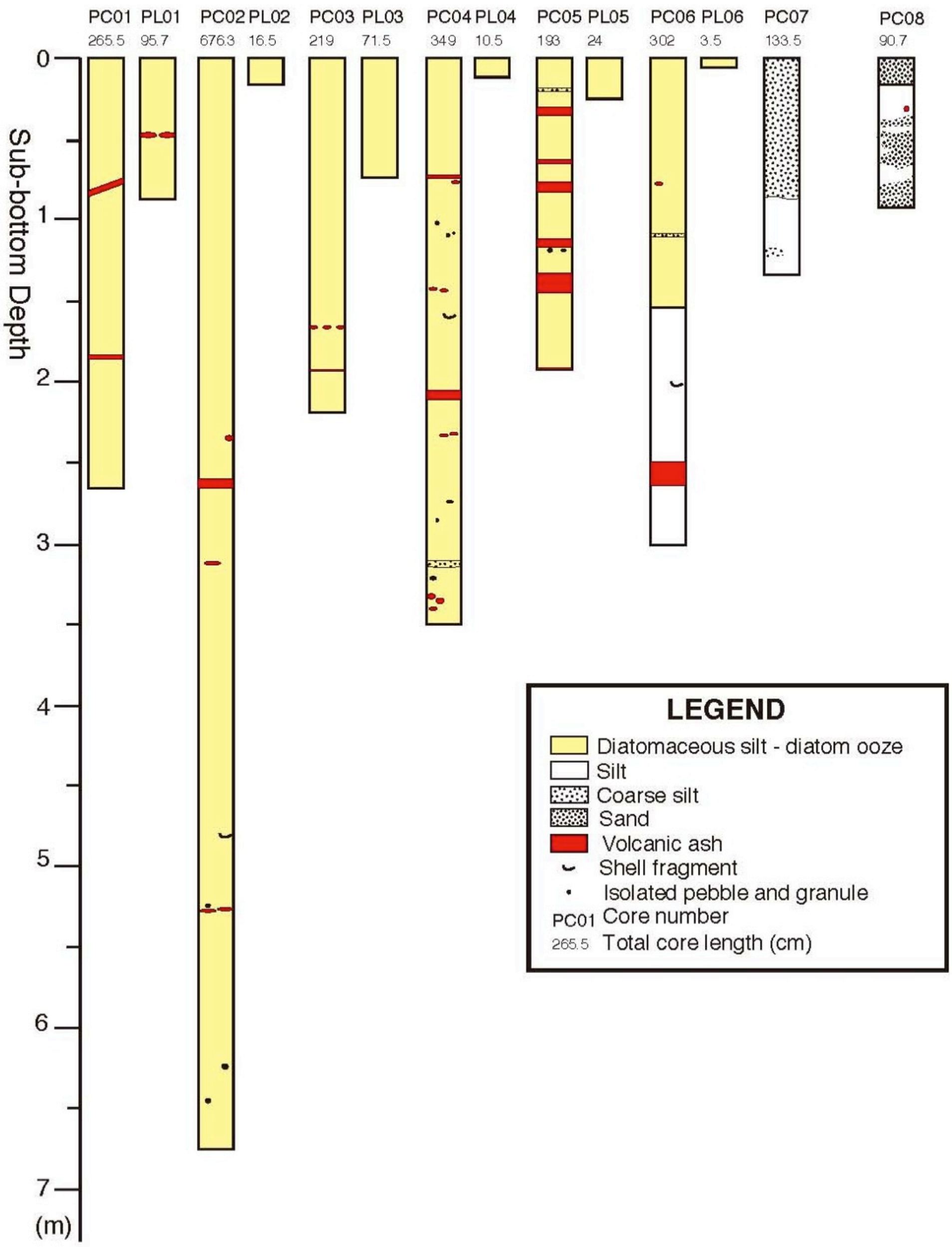

Figure 6.3 Lithologic summary for NT13-02 cores

6-4. Color spectroscopy

Cecilia McHugh

All the cores were measured for their reflectance spectra on fresh surfaces of the split core. The colorimetric information was recorded in the L*a*b* color space systems which expressed color as a function of lightness (L*) and color values a* and b* as mentioned on the Methods Section. The initial observations of the data plotted versus depth for each core show that small-scale variability at a centimeter scale dominates the signals. Longer-period trends are also revealed at the hundred of centimeter core length (e.g., PC-03). Post-cruise analyses will extract more detailed information about these measurements.

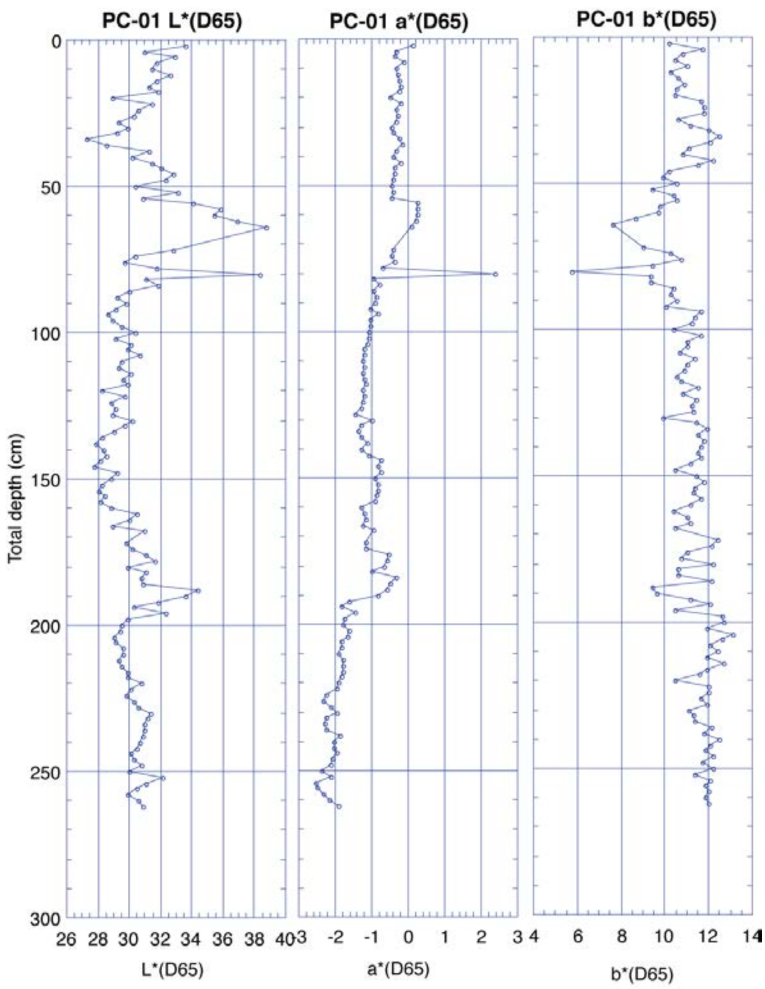

Figure 6.4.1 L*, a*, and b* values for PC01

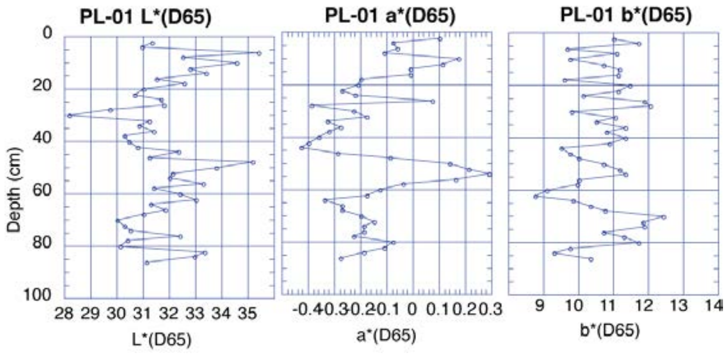

Figure 6.4.2 L*, a*, and b* values for PL01

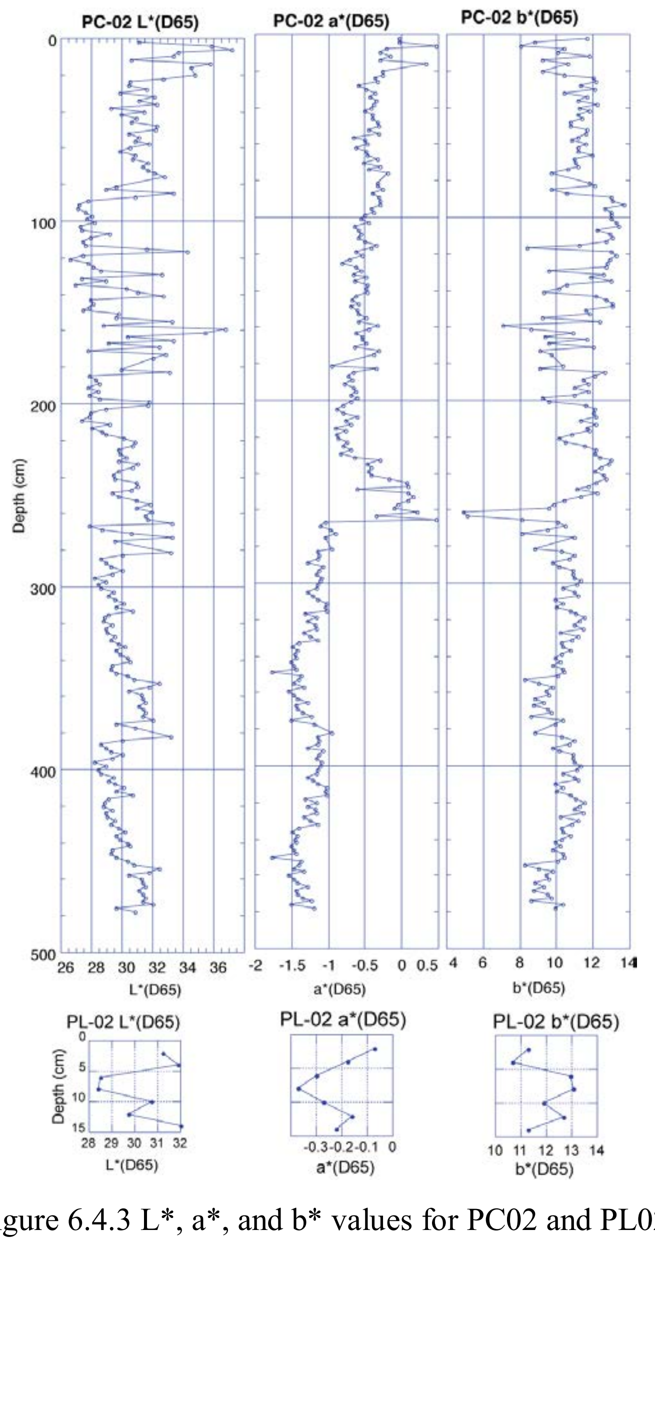

Figure 6.4.3 L*, a*, and b* values for PC02 and PL02

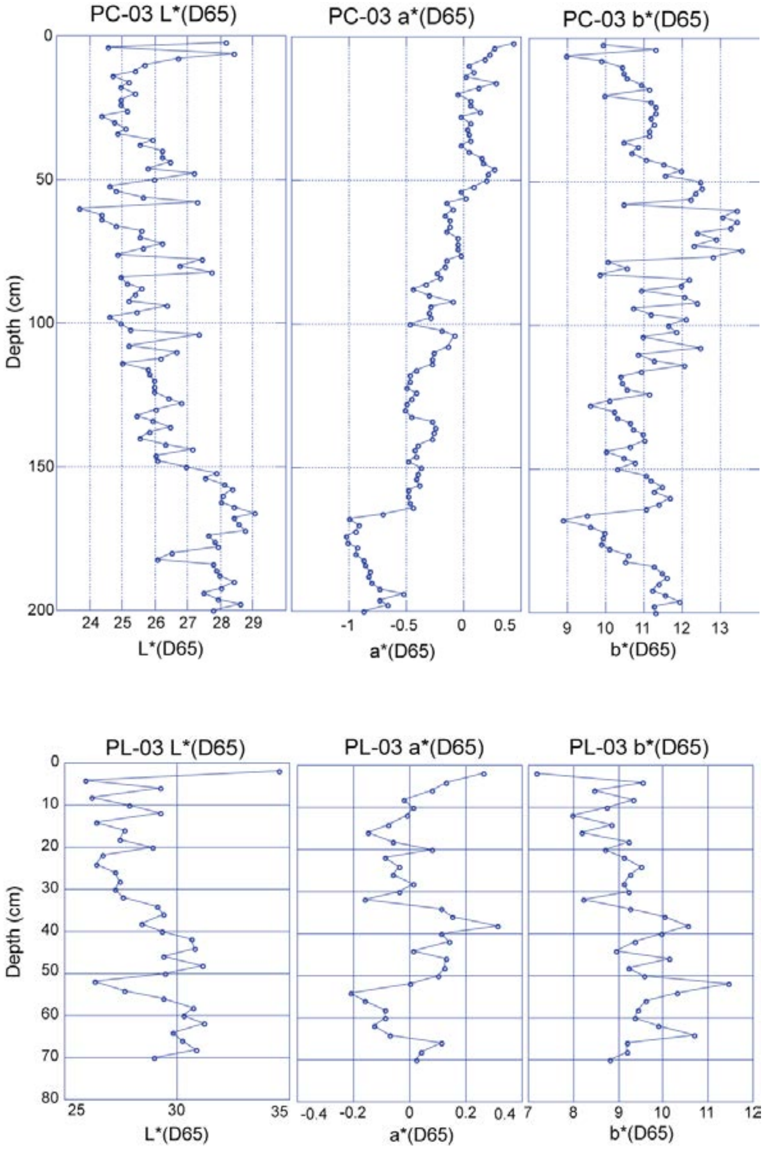

Figure 6.4.4 L*, a*, and b* values for PC03 and PL03

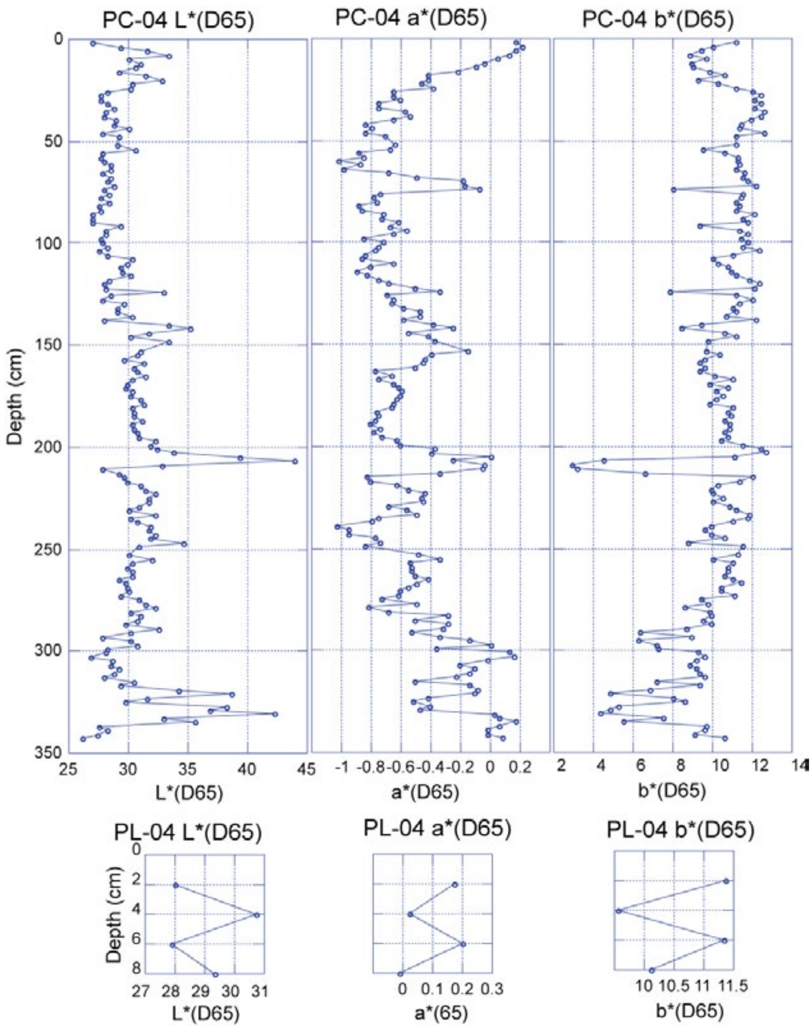

Figure 6.4.5 L*, a*, and b* values for PC04 and PL04

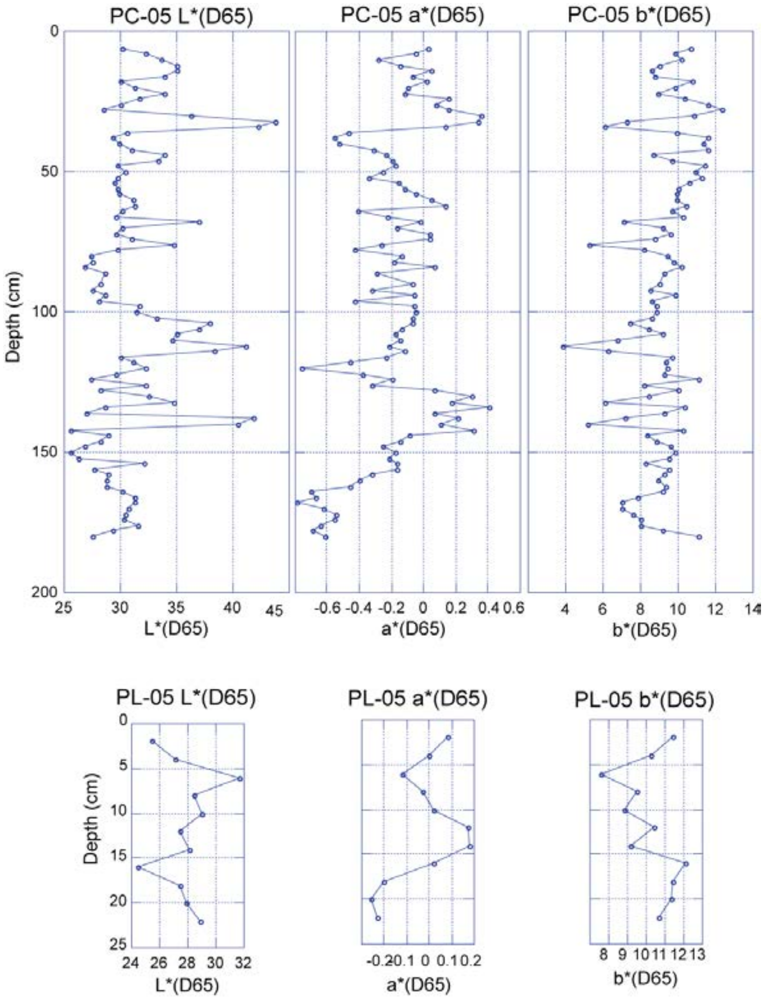

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Figure 6.4.6 L*, a*, and b* values for PC05 and PL05

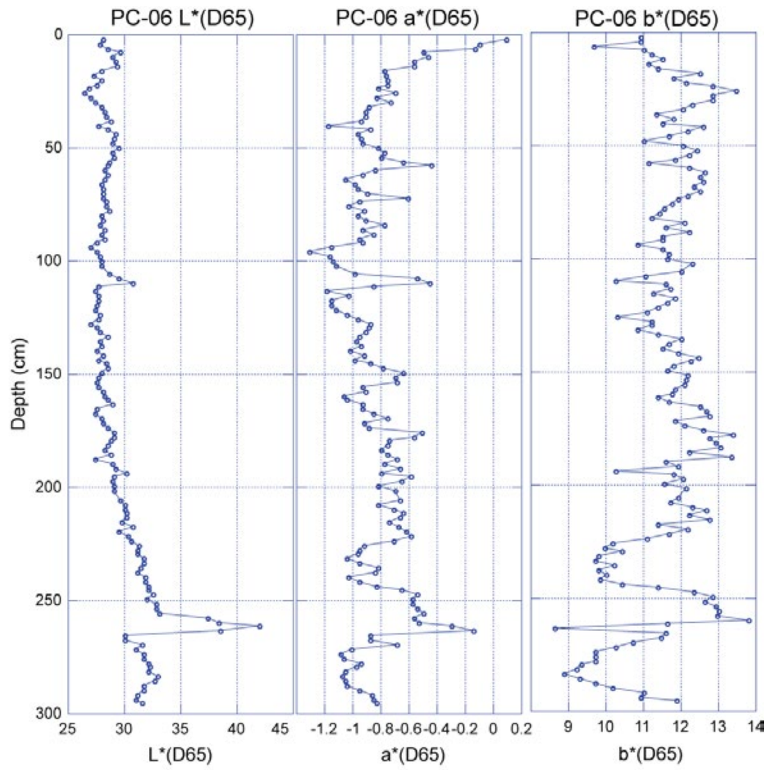


Figure 6.4.7 L*, a*, and b* values for PC06 and PL06

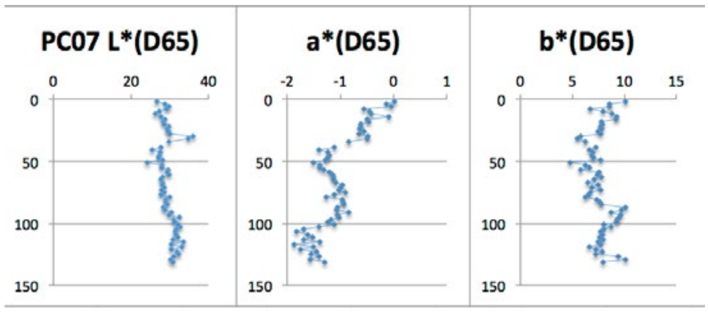


Figure 6.4.8 L*, a*, and b* values for PC07 and PL07

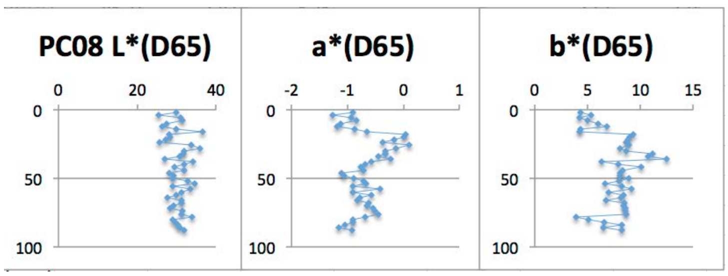
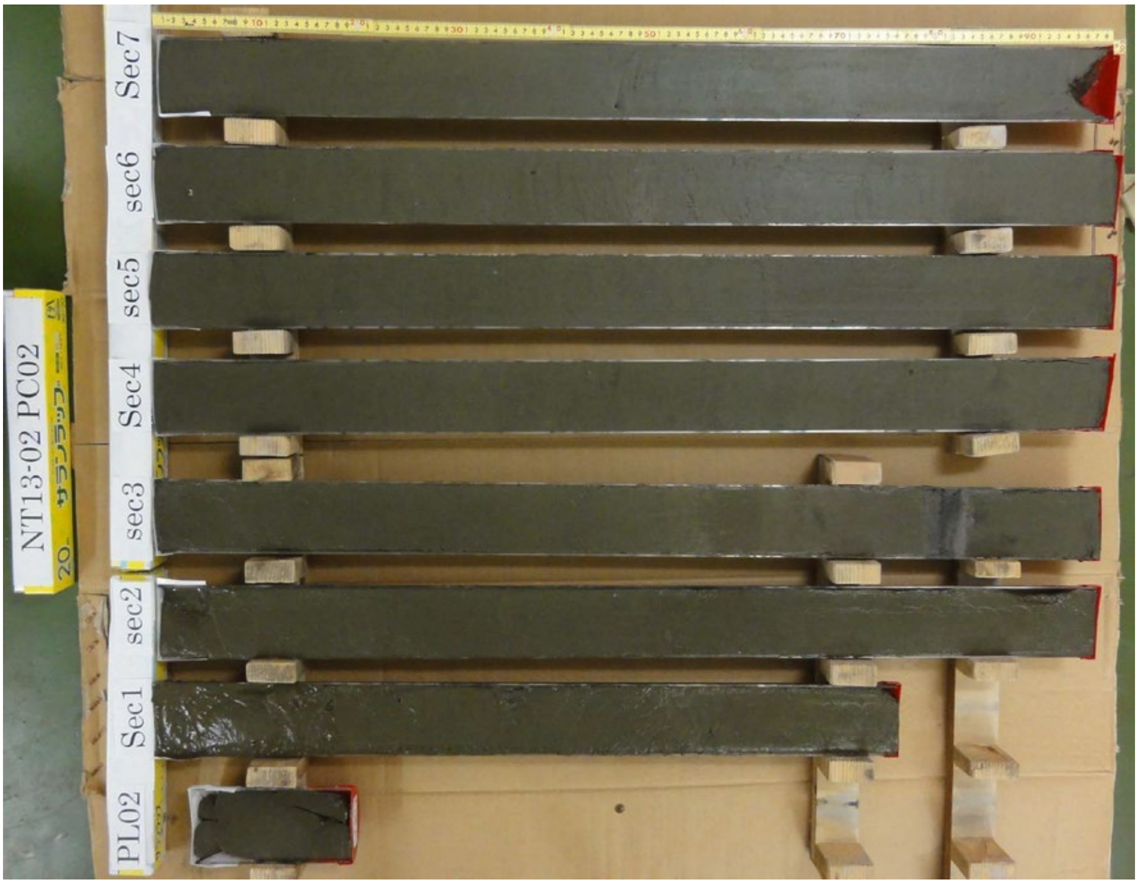


Figure 6.4.9 L*, a*, and b* values for PC08

6-5. Core Photo

NT13-02 PC-01

NT13-02 PC-02



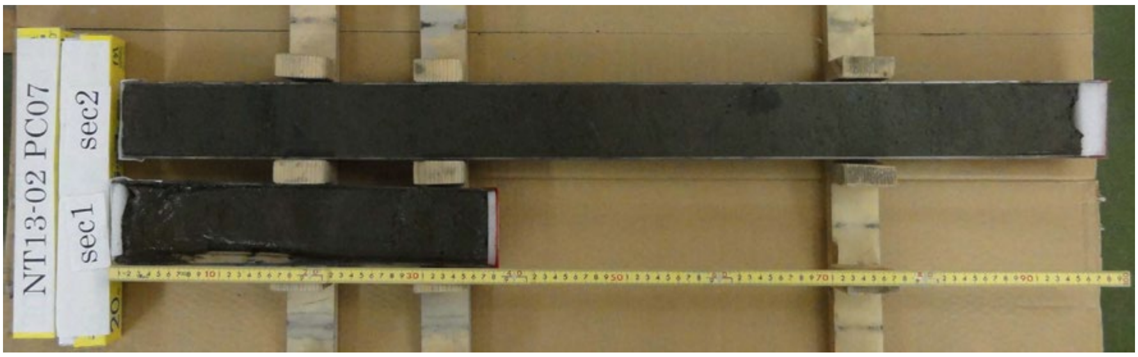
NT13-02 PC-03

NT13-02 PC-04

NT13-02 PC-05

NT13-02 PC-06

NT13-02 PC-07



NT13-02 PC-08

7. Multi-beam bathymetry

Bathymetric data were collected by a hull-mounted multi-narrow beam mapping system SEABAT 8160 aboard R/V Natsushima. The SEABAT system has hydrophone arrays that synthesize narrow, fan-shaped beams. The width of the sea floor mapping in a single swath is generally ca.0.7 times the local water depth, and the resolution of the depth measurement is generally within 0.25 % of the water depth. The SEABAT system can collect up to 126 soundings on each ping cycle over depths varying from 10 to 3,000 meters, providing swath width coverage up to 150°. The sound velocity profile of the local water column, which was used for calibration of depth, was estimated from a temperature profile based on in-situ XBT (Expendable Bathythermograph) measurements. Figure X shows the mapped areas by the SEABAT system during the cruise. Because of the system capability, which is restricted to shallow depth (ca. 2000m), and rough sea condition, the bathymetry survey was performed in three boxes.

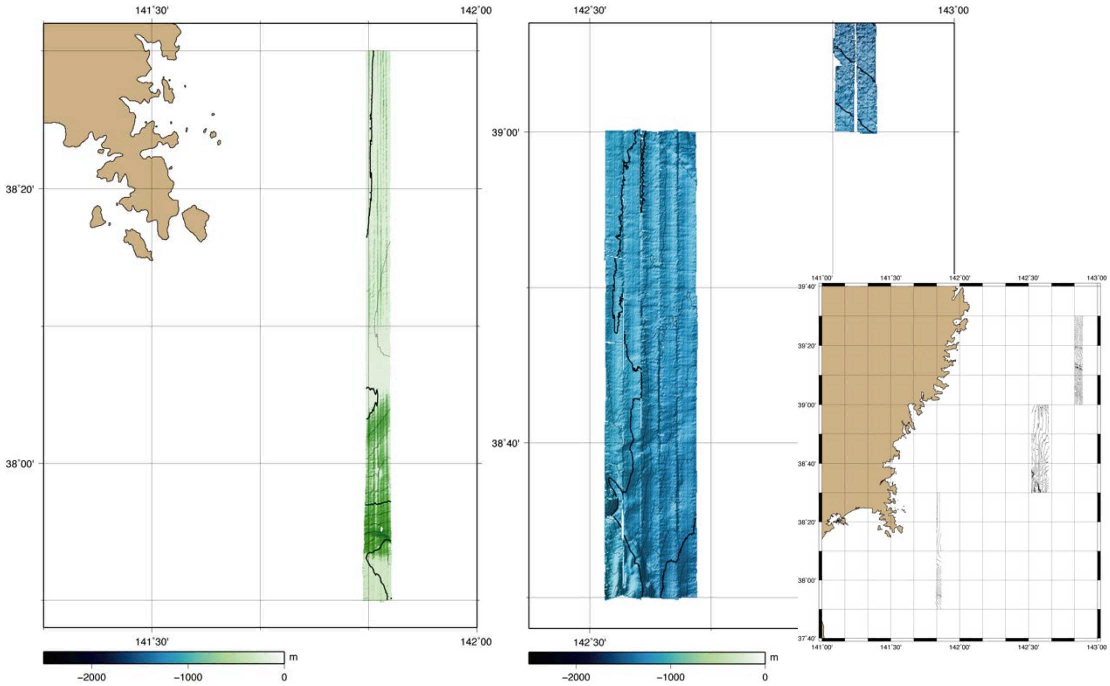


Figure 7 Legend map of topographic survey (right), and detail topography maps of surveyed areas (left and center).

8. Post cruise research

Ken Ikehara and Kazuko Usami (Geological Survey of Japan, AIST)

To confirm sediment lithology and structures, we will take x-ray radiographs using slab samples. Based on the radiographs, we will carry out 1) grain size analysis, 2) mineral composition analysis by smear slide observations and XRD, and 3) geochemical analysis (if necessary) (Ikehara and Usami).

To determine sediment ages, we will conduct the following analyses for the obtained samples. 1) Tephra analysis (major component of volcanic glass shards (and some selective heavy minerals if possible) and petrographic analyses such as heavy mineral composition and refractive index measurements for volcanic glass shards (and some selective heavy minerals if possible): Ikehara and Nagahashi (Fukushima Univ.)), 2) radiocarbon dating for planktonic (and benthic if possible) foraminiferal tests (Ikehara and Usami), 3) microfossil analyses for the selected cores (planktonic and benthic foraminifer, and radiolarian (if possible): Usami (and Itaki (GSJ, AIST)). Furthermore, results from 1) and 2) will be used for the evaluation of temporal change of marine reservoir effect in this region.

For the studies, we collected the 5 cm wide and 1 cm thick slab samples continuously, and the discrete samples (around 5 cc) every 20 cm intervals and additional samples at possible tephra horizons. Sample list is shown in Table.

Cecilia McHugh (Queens College, C.U.N.Y)

Introduction:

As part of the overall objectives of the scientific party of the *R/V Natsushima* 13-02 McHugh would like to contribute by conducting geochemical analyses of the core samples. The goal is to characterize the 11 March 2011 earthquake deposit and potentially older earthquake deposits to evaluate recurrence intervals. The area adjacent to the 11 March 2011 Tohoku-Oki earthquake has been surveyed in great detail over the past decade, with methods such as multibeam bathymetry, high-resolution subbottom profiles, mutlichannel seismic, and core sampling. This pre-earthquake dataset offers the first-ever opportunity to precisely quantify the morphological, sedimentological, and structural changes that may occur along a submerged plate boundary during a large earthquake. The *R/V Natsushima* 13-02 expedition provides a unique opportunity to study these changes. These studies that will be conducted in collaboration with the scientific party will contribute critical information about the stratigraphy, submarine paleoseismology, and in turn about the recent (Pleistocene-Holocene) seismotectonic growth of the Japan margin.

A fundamental problem of global scope that will be additionally investigated relates to seafloor ruptures and the preservation of the earthquake-triggered deposits in basins most proximal to the rupture. This link between tectonics, earthquakes, and sedimentation will be studied by applying a multi-proxy approach that consists in the identification of faults and their associated fault basins from the geophysical data (multibeam bathymetry and chirp subbottom profiling). The core site selection of the *R/V Natsushima* 13-02 was guided by structures and sea floor topography. The Cores PC-03, PC-04, PC-06 were recovered from basins associated to steep scarps that appear to be fault controlled. Cores PC-01 and PC-02 were recovered from a flat terrace but the subbottom profiles reveal dipping reflectors beneath the flat surface. Core PC-05 was recovered from a flat terrace downslope from a steep slope. Each setting has a distinct set of morphological and structural characteristics that core sampling strategy will help to understand. The cores will be studied by conducting closely spaced x-ray fluorescence wet chemistry elemental analyses. The small and larger scale variability in elemental concentrations will help in the identification of sedimentary deposits. Sediment transport deposits (debris flows, turbidites) will also be identified from their characteristics observed from the cores (e.g., sharp angular contacts, lithic clasts, beds, laminae). The elemental chemical composition of the cores can also be correlated to the colour spectrometry measurements taken during the *R/V Natsushima*. Both techniques can nicely enhance each other for the detection of small- and large-scale variability in the cores. Dr. Ken Ikehara and Dr. Kazuko Usami will develop a chronology from tephra layers, short-lived radioisotopes and radiocarbon. These ages will in the future provide a framework within which to interpret the data collected during the *R/V Natsushima* expedition.

Methods:

X-ray fluorescence analyses. The samples will be weighted wet, dried in an oven at low temperature and grounded. The dried and ground sediment samples will be analysed through wet acid digestion chemistry for major and trace elements using a XEPOS III X-ray fluorescence spectrometer (Spectro; Kleve, Germany). Quantification will be accomplished using the TurboQuant Powder software from the manufacturer. Sediment or soil standard reference materials (SRM 2702, 2704 and 2709) will be analysed regularly providing a continuous monitor of accuracy. For all elements reported there will be duplicate analyses of the sediment samples agreed to within five percent.

Long-term goals and future collaborations:

A long-term objective is that through the application of these submarine earthquake geology and paleoseismology techniques contributions to seismic hazards and models could be provided for the Japan margin. Through continued collaborations between Japan and USA these studies could be extended along the strike of the trench. This collaboration should lead to fruitful discussion and new insights into fundamental processes at convergent margins. It will also advance the methodology in the emerging field of submarine earthquake geology.

Toshiya Kanamatsu (JAMSTEC)

1. Magnetic fabric
   Anisotropy of magnetic susceptibility in order to detect depositional or deformed grain alignment, which may be evidences of events.
2. Paleomagnetic direction
   - Paleomagnetic direction will be used to reorient magnetic fabric, and other structures in cores.
   - Paleomegnetic secular variation signal will be extracted and tested its availability for age control.
3. Rock-magnetic property
   Various magnetic properties will be measured characterize event deposits.

9. Notice on Using

Notice on using: Insert the following notice to users regarding the data and samples obtained.