



NATSUSHIMA Cruise Report

NT13-20



Abashiri Submarine Canyon

Sep. 8, 2013 - Sep. 18, 2013

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Contents

1. Cruise Information	2
2. Researchers	3
3. Observation	4
3.1 Overview of the Observation	4
3.1.1 Background and Purpose	4
3.1.2 Research Items and Activities	4
3.2 Bathymetric and Seismic Surveys	5
3.3 Coring and Core Analysis	6
3.3.1 Station List of Coring	6
3.3.2 Core Lithology	6
3.3.3 Gas Analysis	14
3.3.4 Pore Water Analysis	16
3.3.5 Sediment Analysis	17
4. Notice on Using	18
5. Acknowledgements	18
6. Appendices	19
6.1. Cruise Log	19
6.2 R/V NATSUSHIMA Officers and Crew	21

1. Cruise Information

Cruise ID: NT13-20

Name of vessel: R/V NATSUSHIMA

Title of the cruise: Distribution and origin of gas hydrate off Abashiri, Okhotsk Sea

Title of proposal: Basic study on distribution and origin of seabed methane and gas hydrate on continental slope off Abashiri, Okhotsk Sea

Cruise period: September 8, 2013 – September 18, 2013

Ports of call: September 8, 2013 Dept. from Otaru

September 18, 2013 Arrive. at Sekinehama

Research area: Abashiri Submarine Canyon

Research map:

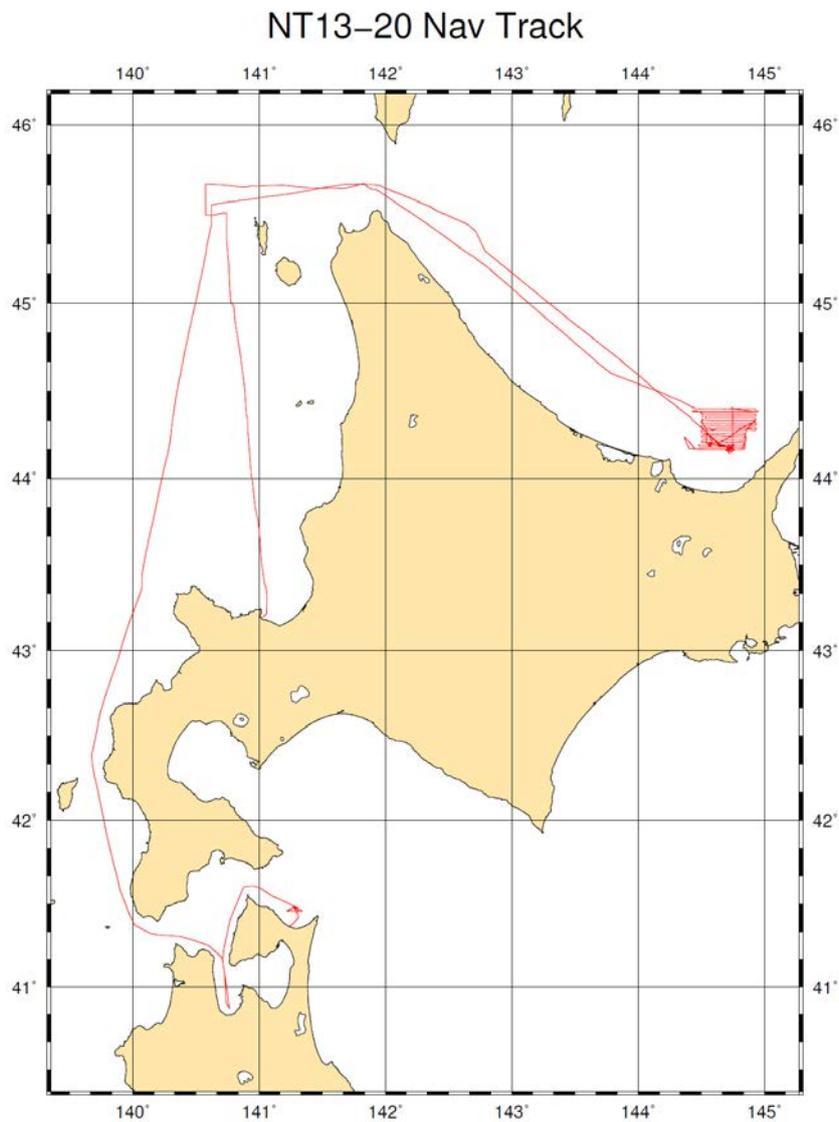


Fig. 1.1 Cruise track of NT13-20.

2. Researchers

Chief scientist:

Satoshi YAMASHITA Kitami Institute of Technology

Representative of the science party:

Nobuo TAKAHASHI Kitami Institute of Technology

Science party:

Hitoshi SHOJI Kitami Institute of Technology

Hirotsugu MINAMI Kitami Institute of Technology

Akihiro HACHIKUBO Kitami Institute of Technology

Hirotohi SAKAGAMI Kitami Institute of Technology

Shintaro YAMASAKI Kitami Institute of Technology

Satsuki KATAOKA Kobe University

Ryuji MIURA Kitami Institute of Technology

Tsuyoshi KOTAKE Kitami Institute of Technology

Keisuke KUBO Kitami Institute of Technology

Keisuke OGAWA Kitami Institute of Technology

Yota SASAKI Kitami Institute of Technology

Takuma HIRANO Kitami Institute of Technology

Syohei TOKIWA Kitami Institute of Technology

Marine Technician:

Satoshi OKADA Nippon Marine Enterprises, LTD.

Masayuki TOIZUMI Nippon Marine Enterprises, LTD.

Satomi MINAMIZAWA Nippon Marine Enterprises, LTD.

Kimiko SERIZAWA Nippon Marine Enterprises, LTD.

Yasushi HASHIMOTO Marine Works Japan, LTD.

Naotaka TOGASHI Marine Works Japan, LTD.

Kazuhiro YOSHIDA Marine Works Japan, LTD.

Mika YAMAGUCHI Marine Works Japan, LTD.

3. Observation

3.1 Overview of the Observation

3.1.1 Background and Purpose

When Japanese resource project of gas-hydrate launched in 1995, the seismic data of Kitami-Yamato Bank off Abashiri, Okhotsk Sea caught outstanding BSRs (Bottom Simulating Reflectors), which indicated the existence of gas-hydrate. Then, obvious BSRs and geologic structures indicating gas-hydrate also showed in the seismic data collected by GH01 cruise in 2001 for the same area conducted by Geological Survey of Japan, AIST. However, the sufficient survey has not been carried out after GH01 cruise, and the actual geologic condition and its gas-hydrate formative condition have not been clear. Our recent survey cruises conducted in 2012 found many gas-flares and retrieved crystals of gas-hydrate from a part of off Abashiri. These facts suggest that promising wide gas-hydrate formative area exists around this area.

Therefore, to clarify the distribution of gas-hydrate and its formative environment of seabed methane, and to evaluate the potential as resource of gas-hydrate, the geologic survey was conducted by this cruise covering a wide area of Abashiri Submarine Canyon. The conducted investigations are the seismic geologic survey, the bathymetry and the gas-flare observation by an echo sounder, and drill sampling of sea-bottom sediments.

3.1.2 Research Items and Activities

Seismic survey

To analyze geological structure and obtain the depth distribution of BSR, the Single Channel Seismic (SCS) survey along following lines were conducted:

line 1	44°10.000'N, 144°30.000'E	—	44°10.000'N, 144°50.000'E
line 2	44°11.647'N, 144°30.000'E	—	44°11.647'N, 144°50.000'E
line 3	44°23.000'N, 144°30.000'E	—	44°23.000'N, 144°56.000'E
line 4	44°23.000'N, 144°56.000'E	—	44°24.000'N, 144°45.000'E
line 5	44°24.000'N, 144°45.000'E	—	44°10.000'N, 144°45.000'E.

Bathymetry and gas-flare observation surveys

The bathymetry for the survey area conducted with the multi narrow beam system (SEBAT8600), and mapping and observations of gas-flares were conducted with the multi narrow beam system and the quantitative echo sounder (ER60). The following areas and points are surveyed:

- Abashiri Submarine Canyon (water depth; 500 - 1350 m)

44°10.0'N, 144°30.0'E—44°24.0'N, 144°30.0'E—44°24.0'N, 144°56.0'E—44°10.0'N, 144°56.0'E

- North east of Rebun Island

45°33.55'N, 140°34.57'E (water depth; 480 m)

45°27.04'N, 140°44.55'E (water depth; 600 m).

3.3 Coring and Core Analysis

3.3.1 Station List of Coring

Table 3.1 Coring Summary of NT13-20 cruise

Date (UTC) (yyymmdd)	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) ****
2013/9/10	PC01 PL01	Inner type PC Ashura corer	Off Abashiri	44°11.5759' N	144°38.1379' E	44°11.5762' N	144°38.0982' E	573	$\frac{4}{0.6}$	13.8	0.22	148.5 0.0 0.0 0.0
2013/9/11	PC02 PL02	Inner type PC Ashura corer	Off Abashiri	44°11.5829' N	144°38.0095' E	44°11.5849' N	144°37.9715' E	580	$\frac{4}{0.6}$	25.1	0.52	219.6 0.0 0.0 0.0
2013/9/11	PC03 PL03	Inner type PC Ashura corer	Off Abashiri	44°11.6504' N	144°37.8041' E	44°11.6383' N	144°37.7692' E	651	$\frac{4}{0.6}$	16.0	0.18	380.0 (include void) 27.2 30.1 27.5
2013/9/12	PC04 PL04	Inner type PC Ashura corer	Off Abashiri	44°11.6659' N	144°34.1727' E	44°11.6809' N	144°34.1392' E	678	$\frac{4}{0.6}$	14.2	0.12	235.5 27.0 27.0 26.1
2013/9/12	PC05 PL05	Inner type PC Ashura corer	Off Abashiri	44°11.9298' N	144°34.2196' E	44°11.9412' N	144°34.1821' E	704	$\frac{6}{0.6}$	16.3	0.12	463.8 29.8 27.9 29.6
2013/9/12	PC06 PL06	Inner type PC Ashura corer	Off Abashiri	44°10.0589' N	144°42.9396' E	44°10.0520' N	144°42.9096' E	770	$\frac{6}{0.6}$	15.9	0.10	500.0 (pipe length) 41.9 37.1 44.4
2013/9/13	PC07 PL07	Inner type PC Ashura corer	Off Abashiri	44°10.6210' N	144°43.1624' E	44°10.6188' N	144°43.1263' E	822	$\frac{6}{0.6}$	15.7	0.09	435.1 50.9 58.7 59.0
2013/9/13	GC08	Gravity corer (200kg)	Off Abashiri	44°10.0613' N	144°42.9429' E	44°10.0649' N	144°42.9112' E	769	3	9.5	0.07	136.2

*Weight of the PC is 480 kg.

**"TP" is position by the transponder.

***K value is the strength barometer of the sea floor sediment;

K value = pure pull out load / (outer diameter of outer pipe x penetration length).

****Core length is W-half measured after splitting.

3.3.2 Core Lithology

Sea bottom sediments and gas hydrates were sampled by piston corer and gravity corer. We sampled gas hydrate at three sites, and gas hydrate preserved with *in-situ* structure at PC02 site. All cores have sea fine sand, silt and clay, in addition, shells and carbonate gravel. These colors are dark green gray, black and white gray. Following pages are photos of all archive cores.



Photo 3.1 Core observation.

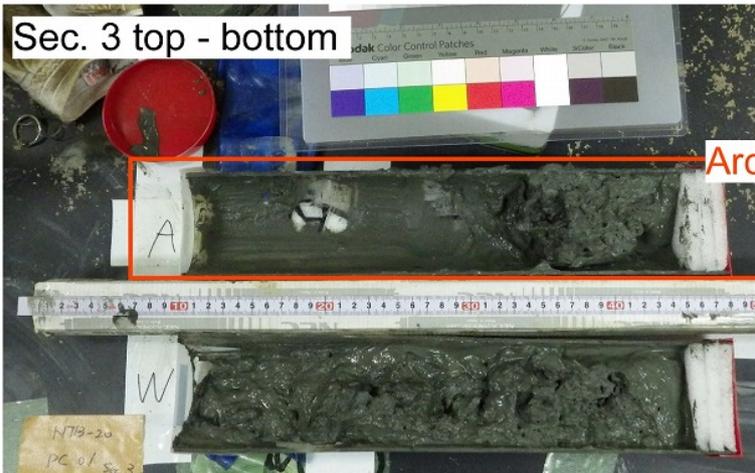
NT13-20 PC01 (Sec.2-4, total length 150 cm)

Sec.2 top - bottom



Archive core is not available

Sec. 3 top - bottom



Archive

Sec. 4 top - bottom



Archive core is not available

Photo 3.2 Core photo of NT13-20 PC01.

NT13-20 PC02 (Sec.1-4, total length 192 cm)

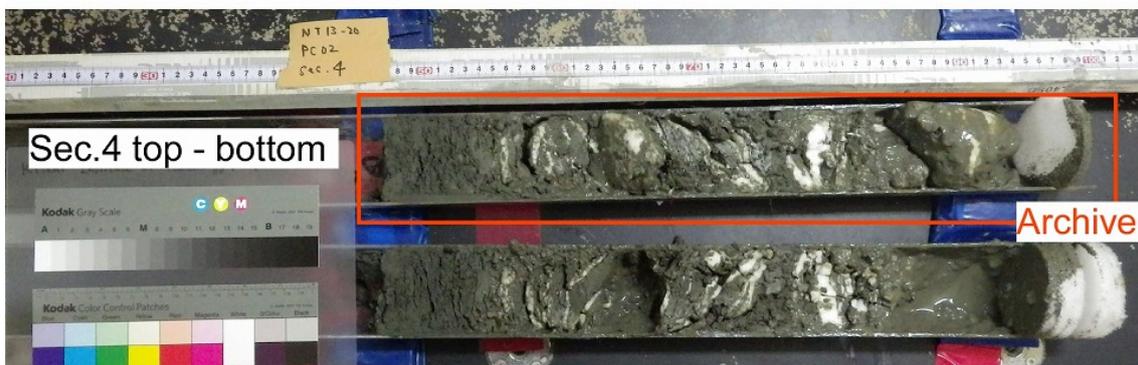
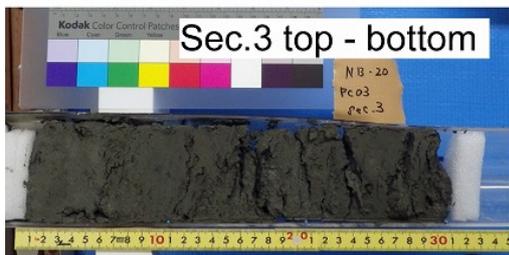
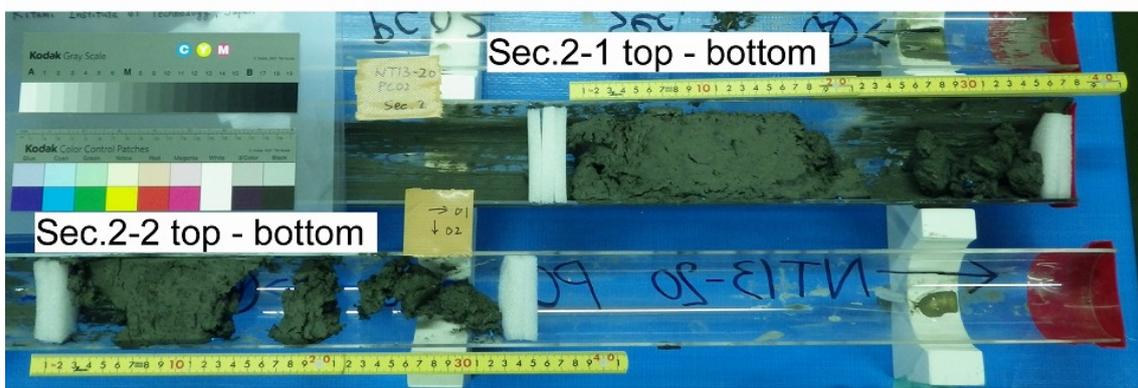
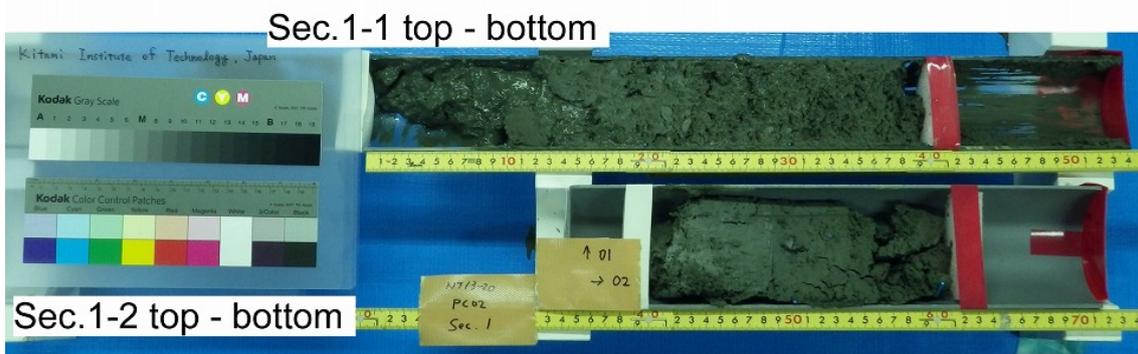


Photo 3.3 Core photo of NT13-20 PC02.

NT13-20 PC03 (Sec.1-4, total length 364 cm)

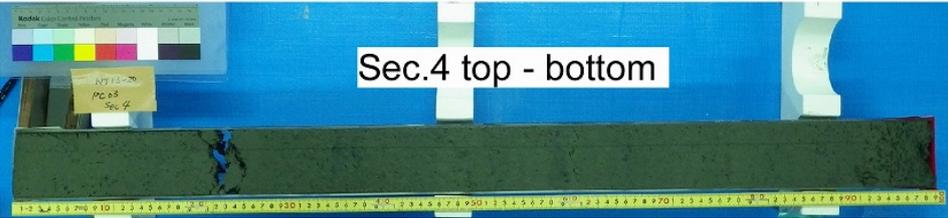
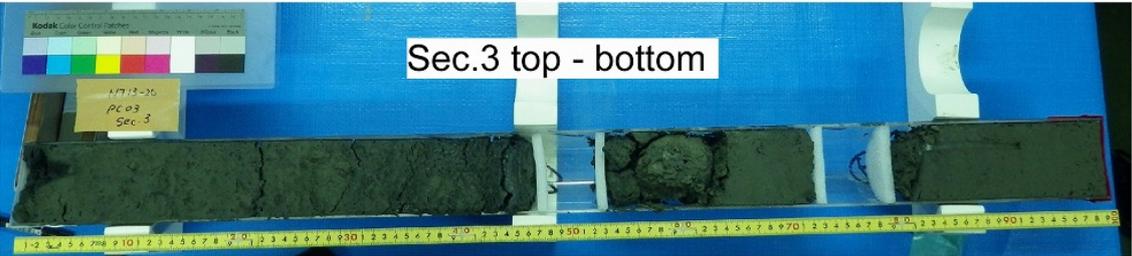


Photo 3.4 Core photo of NT13-20 PC03.

NT13-20 PC04 (Sec.2-4, total length 256 cm)

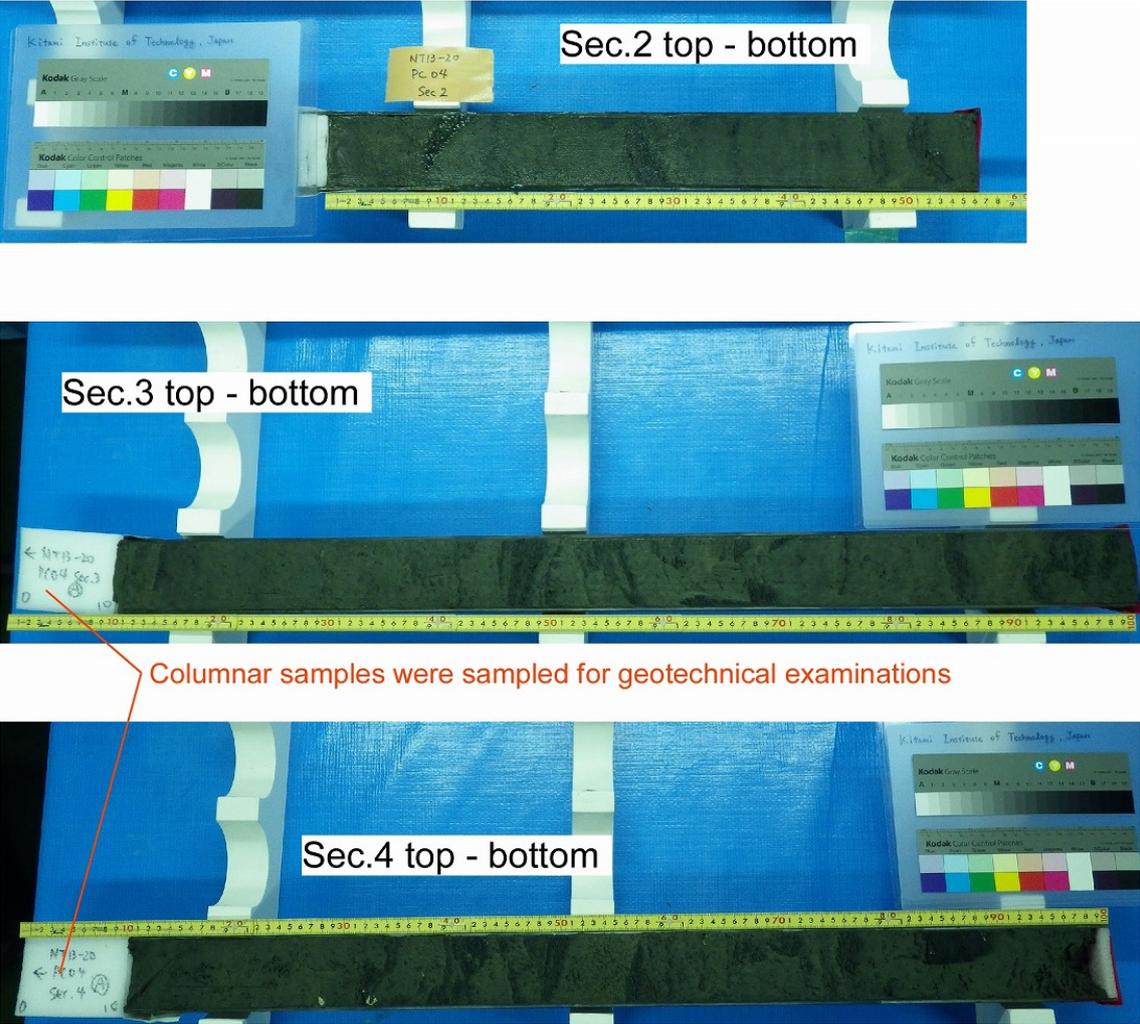
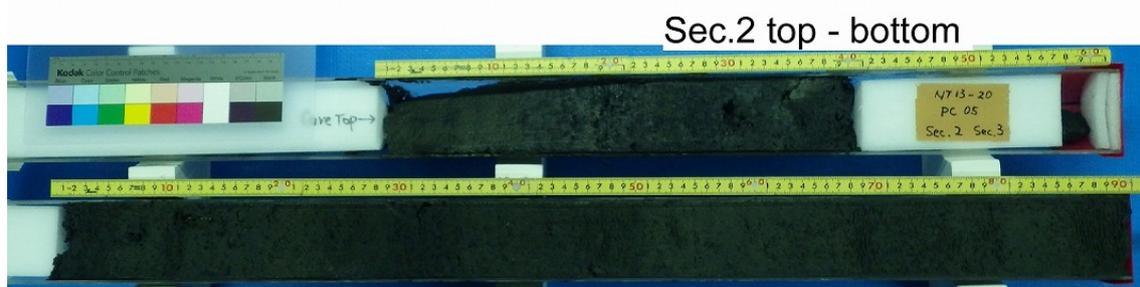


Photo 3.5 Core photo of NT13-20 PC04.

NT13-20 PC05 (Sec.2-6, total length 434 cm)



Sec.3 top - bottom



Sec.5 top - bottom

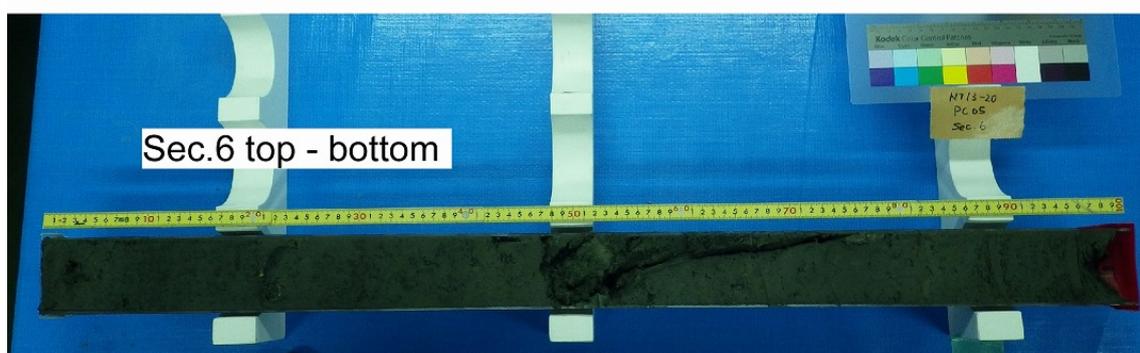
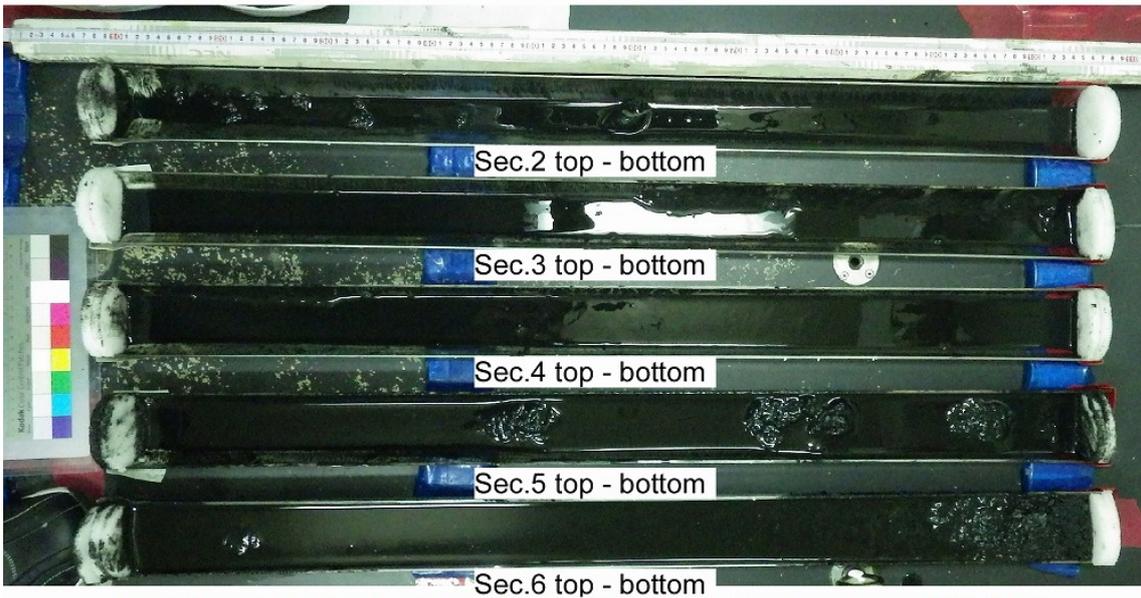


Photo 3.6 Core photo of NT13-20 PC05.

NT13-20 PC06 (Sec.2-6, total length 46 cm)



Archive core samples of Sec.2 to Sec. 6 are not available

PL06(Pilot core) (Hand1(total length, 41cm), Hand2(total length, 40cm)
Hand3(total length, 43cm) top - bottom

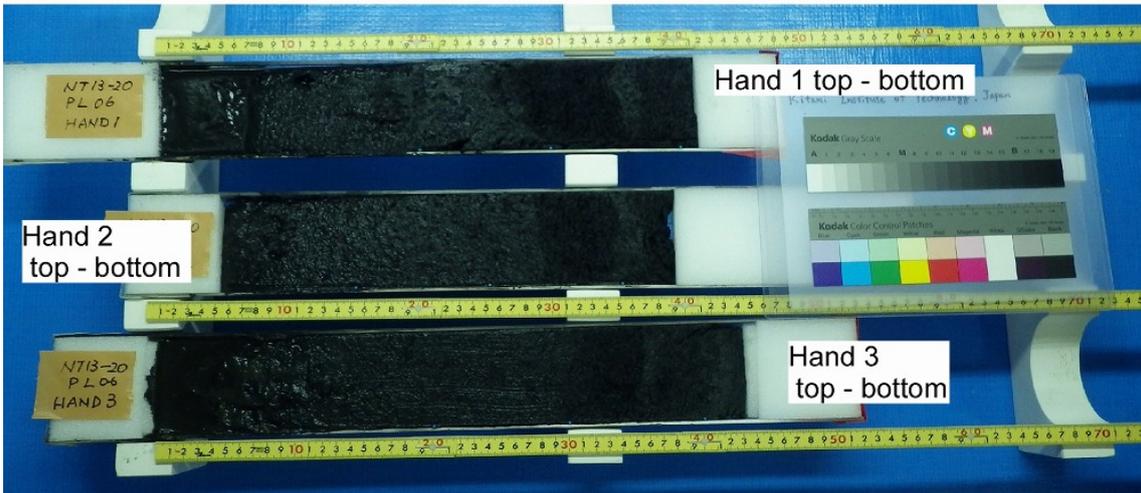


Photo 3.7 Core photo of NT13-20 PC06.

NT13-20 PC07 (Sec.2-6, total length 434 cm)

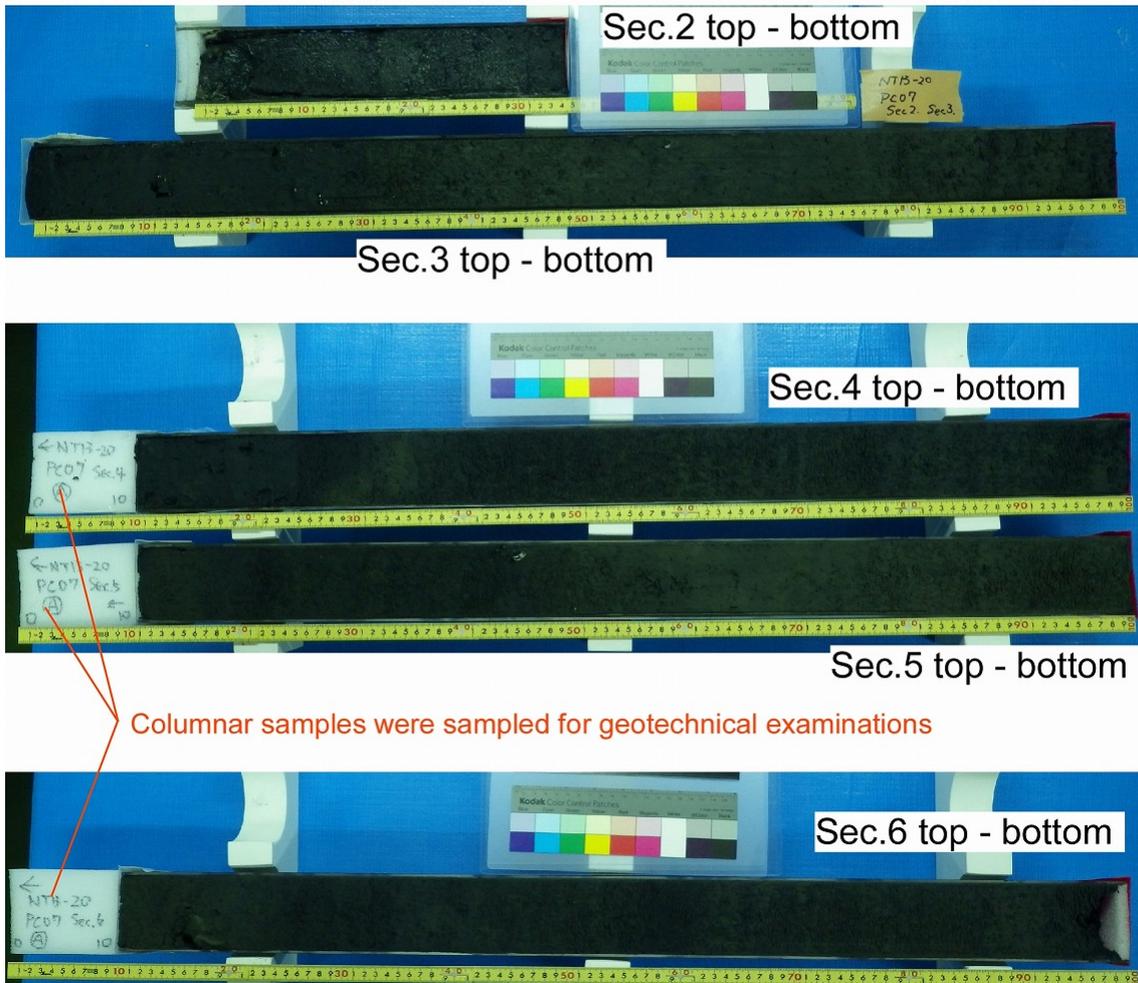


Photo 3.8 Core photo of NT13-20 PC07.

NT13-20 GCO08 (Sec.3-4, total length 130 cm)

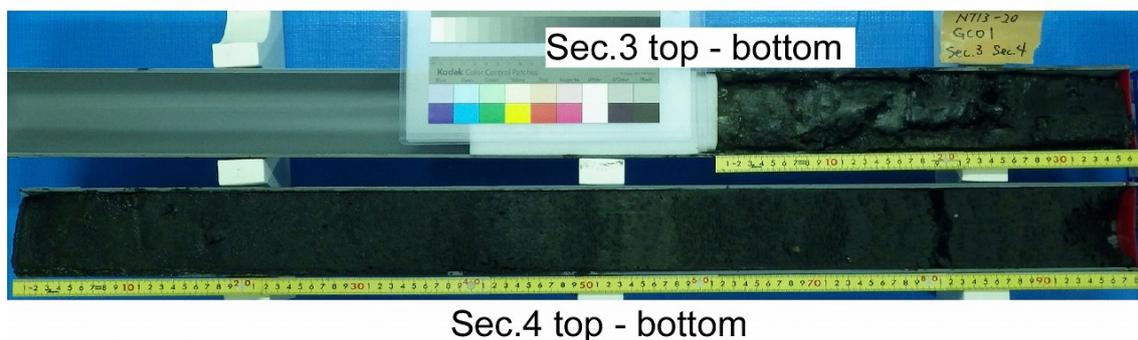


Photo 3.9 Core photo of NT13-20 GC08.

3.3.3 Gas Analysis

Sea-bottom sediments were sampled using a piston corer and a gravity corer during the cruise of RV Natsushima in September 2013 (NT13-20) at Okhotsk Sea off Abashiri. Sediment cores were retrieved from the Abashiri Submarine Canyon area. These locations and sample lists are summarized in Table 3.2. Gas hydrates were found in 3 cores during the cruise.

Following sampling for gas hydrate analyses were executed in the cruise: (1) sampling of hydrate-bound gas for molecular and isotopic measurements, (2) sampling of dissolved gas in pore water for molecular and isotopic measurements. Gas hydrate nodules were also stored into liquid nitrogen for further use. These sampling methods have been described by our previous report (Jin et al., 2012; Hachikubo et al., 2010; 2011).

Hydrate-bound gases were collected using a funnel and plastic bucket filled with water. Gas hydrate samples were dissociated in water and their gases were collected in 5-mL vials sealed with butyl septum stoppers. The dissolved gases in the pore water were extracted by a headspace gas method whereby 10-mL of sediment and a 9.7-mL saturated aqueous solution of NaCl were introduced into a 25-mL vial to create headspace. A 0.3-mL preservative (benzalkonium chloride (Waseda and Iwano, 2007), 50 wt% aqueous solution) was introduced into the 25-mL vial. The headspace was flushed by helium and the vials

were then thoroughly shaken and stored overturned. Gas hydrate crystals were stored in a dryshipper at the temperature of liquid nitrogen.

Gas composition of hydrocarbons (from C₁ to C₃), CO₂ and H₂S will be measured in KIT using a gas chromatograph (GC-2014, Shimadzu Corp.) equipped with thermal conductivity and flame ionization detectors coupled with a packed column (Sunpak-S, Shimadzu Corp.). The thermal conductivity detector (TCD) is to measure air components (N₂, O₂ and Ar: they are not separated), CO₂, H₂S and high concentration of C₁. The flame ionization detector (FID) is to measure minor (low concentration) hydrocarbons because of its high sensitivity for C₂₋₃. Carbon and hydrogen isotopes of hydrocarbons will be measured using a CF-IRMS (DELTA plus XP, Thermo Finnigan) employing a Carboxen-1006 PLOT capillary column (30 m length, 0.32 mm I.D., Supelco). To avoid air contamination in low concentration cases of C₁, a Carboxen-1010 PLOT capillary column (30 m length, 0.32 mm I.D., Supelco) will be also used. The lower limit of C₁ determination in the case of C₁ δ¹³C is 0.02% of the total headspace gas. A backflush system of GC coupled with CF-IRMS enables us to resolve low concentrations of C₂ and C₃ (less than 0.1%) from C₁ and measure their isotopic composition.

Table 3.2 Sampling date, core name, site, and sampling items.

Date	Core	Place	Dissolved gas in Hydrate gas	
			20 mL vial pore water	5 mL vial
2013/9/11	PC01	St1	6	
2013/9/11	PC02	St1	10	8
2013/9/11	PC03	St1	18	
2013/9/12	PC04	St2	13	
2013/9/12	PC05	St2	13	
2013/9/13	PC06	St3	1	5
2013/9/13	PL06	St3	6	
2013/9/13	PC07	St3	22	
2013/9/13	GC08	St3	7	

References

- Hachikubo, A., Krylov, A., Sakagami, H., Minami, H., Nunokawa, Y., Shoji, H., Matveeva, T., Jin, Y. K., and Obzhairov, A. (2010) Isotopic composition of gas hydrates in subsurface sediments from offshore Sakhalin Island, Sea of Okhotsk. *Geo-Mar. Lett.*, 30, 313–319, doi:10.1007/s00367-009-0178-y
- Hachikubo, A., Tatsumi, K., Sakagami, H., Minami, H., Yamashita, S., Takahashi, N., Shoji, H., Jin, Y. K., Vereshchagina, O., and Obzhairov, A. (2011) Molecular and isotopic compositions of

hydrate-bound hydrocarbons in subsurface sediments from offshore Sakhalin Island, Sea of Okhotsk. Proceedings of the 7th International Conference on Gas Hydrates (ICGH2011), 17-21 July, 2011, Edinburgh, UK

Jin, Y. K., Shoji, H., Obzhairov, A., and Baranov, B. (2012) Operation Report of Sakhalin Slope Gas Hydrate Project 2012, R/V Akademik M. A. Lavrentyev Cruise 59, Korea Polar Research Institute, 112 pages

Waseda, A., and Iwano, H. (2007) Reservoir evaluation using carbon isotope composition of gas (in Japanese with English abstract). J. Japanese Assoc. Petrol. Technol., 72(6), 585–59

3.3.4 Pore Water Analysis

The pore water sampling was conducted on board the R/V Natsushima using centrifuge method.

The pore water sampling procedure is as follows:

(i) Centrifuge

A 10 cm portion (10 cm depth interval) of the sediment core was taken into a plastic tube (volume: 50 mL) of a centrifuge machine and was kept in a refrigerator (usually less than one day) until centrifuge separation process was started. The sediment sample in the tube was then rotated at 3,500 r.p.m. for 20 minutes. When pore water was obtained from sediment interval containing gas hydrates, centrifuge condition at 3,500 r.p.m. for 20 minutes was used. The pore water was separated as supernatant in the centrifuge tube after rotation. The pore water sample was then taken into a polypropylene bottle (11 mL) passing through a 0.2 μm PTFE membrane filter and was kept under chilled temperature (in a refrigerator of the research vessel).

Water samples to be measured

The water samples obtained during in this cruise are 170 samples including (i) pore water samples, (ii) sea bottom water samples, and (iii) gas hydrate water samples. The sea bottom water samples were obtained by the pilot corer. The sea water from top of the gravity corer was also sampled. The gas hydrate water samples were obtained by the dissociation of gas hydrate samples. All water samples were filtrated by the 0.2 μm PTFE membrane filters and were kept under chilled temperature.

Chemical analyses of pore water

The pore water samples will be analyzed for sulfate ion, chloride ion, hydrogen carbonate ion, calcium, potassium, sodium and magnesium. The concentrations of anions will be determined by ion chromatography. The concentrations of sodium and magnesium will be determined by inductively coupled plasma optical emission spectrometry. The concentrations of potassium and calcium will be determined by flame atomic absorption spectrometry.

Stable isotope ratios of oxygen and hydrogen of the pore water samples will be analyzed by isotope ratio mass spectrometry. The results of the isotopic measurements of the water samples will be presented in per-mil delta notations ($\delta^{18}\text{O}$ and δD) relatively to Vienna Standard Mean Ocean Water (VSMOW)

and Standard Light Antarctic Precipitation (SLAP) issued from International Atomic Energy Agency (IAEA).

3.3.5 Sediment Analysis

To examine the soil properties of sea-bottom sediments and to evaluate the effect of the vaporization of dissolved gas in the pore water on the mechanical properties, two kinds of on-board tests were performed for the samples retrieved by a piston corer and a gravity corer.

On-board Tests

To measure the strength of sediments immediately after recovery, the following two kinds of tests were performed on-board.

a) Vane shear test

The test was conducted by using shear vanes of 10 mm in diameter, D , and 20 mm in height, H , attached to a compact torque driver. The vane shear test was conducted at 10 to 20 cm intervals on the longitudinally cut core surface (see photo 3.10). The maximum torque, M , is measured by rotating the torque driver while penetrating the vane in the core. The vane shear strength, τ_v , is calculated from the following equation.

$$\tau_v = \frac{M}{\pi\left(\frac{D^2H}{2} + \frac{D^3}{6}\right)}$$

b) Cone penetration test

The device used is a force gage type compact cone penetration meter (see photo 3.11). The diameter, length, and apex angle of the cone are 9mm, 18mm, and 30degrees. As for the vane shear test, the cone meter was applied to the longitudinally cut core surface at 10 to 20 cm intervals to measure the penetration load, p . The cone penetration resistance, q_c , is obtained using the following equation.

$$q_c = \frac{p}{A} \quad (A: \text{the sectional area of the cone})$$



Photo 3.10 Vane shear test



Photo 3.11 Cone Penetration test

Sub-sampling

For measurement of the various laboratory tests, the following two kinds of samples were taken.

- a) 10 to 20 cm interval sample (about 5ml, total 105samples) for measurement of the water content.
- b) 20 to 30 cm interval disturbed sample (total 82samples) and undisturbed sample (hole core, 10cm length, total 5 samples) for measurement of the grain size distribution, specific gravity, liquid and limits, box shear test, etc.

Table 3.3 shows the test and samples list for on-board and laboratory tests.

Table 3.3 On-board test and sample lists for soil analysis.

Core name	Water Depth (m)	Core length (cm)	On-board test		Sub-sampling		
			Vane shear	Cone penetration	water content	Lab. test	
						Zip.	Hole
NT13-20 PC01*	573	150			6	4	
NT13-20 PC02*	580	190	10	10	10	4	
NT13-20 PC03	651	364	18	18	18	19	
NT13-20 PC04	678	256	13	13	13	8	2
NT13-20 PC05	704	434	22	22	22	21	
NT13-20 PC06*	770	46			1	1	
NT13-20 PL06*	770	40,41,43			6	3	
NT13-20 PC07	822	434	22	22	22	15	3
NT13-20 GC08	769	133	5	5	7	7	
Total			90	90	105	82	5

* core contained gas hydrate

4. Notice on Using

This cruise report is a preliminary documentation as of the end of the cruise.

This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.

Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.

5. Acknowledgements

We are grateful to Captain T. Aoki, the officers and the crew of the R/V Natsushima for skillful operations of the ship and research equipment. We are also grateful to technical staffs from Nippon Marine Enterprises, Ltd. and Marine Works Japan, Ltd. for making this cruise a success. The research conducted on this cruise was partly supported by Kitami Institute of Technology and Ministry of Education, Culture, Sports, Science and Technology through Grant-in Aid for Scientific Research.

6. Appendices

6.1. Cruise Log

Date	Local Time	Note	Description	Position/Weather/Wind/ Sea condition
08-Sep-13		Sail out, arrive to methane plume survey area		09/08 12:00(UTC+9h)
	08:00	Boarded.		43-35.8N,141-01.1E
	09:20	Let go all shore line, left OTARU.	For Off Abashiri	Ishikari Wan
	10:15-10:40	Carried out onboard education & training for scientists.		Cloudy
	13:00-13:30	Practiced fire and water proof station drills.		NW-2 (Light breeze)
	14:30-15:00	Scientific meeting.		2 (Sea smooth)
	16:40-17:00	Komplia seremony for good cruise.		1 (Low swell)
	21:30	Arrived at methane plume survey area.		Visibly: 8'
	21:34	Released XBT.	45-20.5497N, 140-44.5683E	
	21:36	Com'ced MBES methane plume survey.		
09-Sep-13		Arrive at research area		09/09 12:00(UTC+9h)
	01:06	Finished MBES survey, then proceeded to research area.		44-59.2N,143-10.5E
	18:20	Arrived at research area, then com'ced to MBES mapping survey and released XBT.	44-23.9874N, 144-30.0655E	Off Eko
				Blue sky
				NW-3 (Gentle breeze)
				2 (Sea smooth)
				1 (Low swell)
				Visibly: 8'
10-Sep-13		SCS survey (Line1,Line3)		09/10 12:00(UTC+9h)
	04:15	Finished MBES mapping survey.		44-10.0N,144-44.7E
	08:09	Lounded GI gun.		Off Abashiri
	08:30	Lounded streamer cable.		Fine but cloudy
	09:43	Com'ced SCS survey on line 1.		NE-2 (Light breeze)
	12:51	Cleaed out line 1.		2 (Sea smooth)
	13:25	Com'ced SCS survey on line 3.		1 (Low swell)
	17:38	Cleaed out line 3 & finished SCS survey.		Visibly: 8'
	17:46	Recovered streamer cable.		
	17:58	Recovered GI gun.		
	18:14	Com'ced to MBES mapping survey.		
11-Sep-13		Carry out Piston corer sampling		09/11 12:00(UTC+9h)
	06:08	Finished MBES mapping survey.		44-11.6N,144-38.0E
	08:55	Piston corer (PC01) stuck in the sea bottom.	Depth= 574 m	Off Abashiri
	15:02	Piston corer (PC02) stuck in the sea bottom.	Depth= 579 m	Fine but cloudy
	15:10	Piston corer (PC03) stuck in the sea bottom.	Depth= 653 m	SE-2 (Light breeze)
	17:34	Com'ced to MBES mapping survey.		2 (Sea smooth)
				1 (Low swell)
				Visibly: 8'
12-Sep-13		Carry out Piston corer sampling & SCS survey (Line19, Line20, Line21)		09/12 12:00(UTC+9h)
	05:50	Finished MBES mapping survey.		44-11.9N, 144-34.2E
	09:38	Piston corer (PC04) stuck in the sea bottom.	Depth= 674 m	Off Abashiri
	13:09	Piston corer (PC05) stuck in the sea bottom.	Depth= 704 m	Cloudy
	14:50-15:10	Carried out MBES mapping survey.		East-2 (Light breeze)
	15:44	Lounded GI gun.		2 (Sea smooth)
	15:52	Lounded streamer cable.		1 (Low swell)
	16:24	Com'ced SCS survey on line 19.		Visibly: 7'
	20:43	Cleaed out line 19.		
	21:10	Com'ced SCS survey on line 20.		
	23:09	Cleaed out line 20.		
	23:30	Com'ced SCS survey on line 21.		
13-Sep-13		SCS survey (Line21) & Carry out Piston		09/13 12:00(UTC+9h)

		corer sampling	
	03:01	Cleaed out line 21.	44-10.6N, 144-43.2E
	06:33	Recovered streamer cable.	Off Abashiri
	06:45	Recovered GI gun.	Overcast
	08:45	Piston corer (PC06) stuck in the sea bottom.	Depth= 770 m NNE-1 (Light air)
	13:13	Piston corer (PC07) stuck in the sea bottom.	Depth= 820 m 1 (Sea Calm)
	15:42	Piston corer (PC08) stuck in the sea bottom.	Depth= 772 m 1 (Low swell short)
	16:30	Left research area for methane plume survey area.	Visibly: 7'
14-Sep-13		Carry out MBES methane plume survey	09/14 12:00(UTC+9h)
	12:20	Arrived at methane plume survey area.	45-33.6N, 140-42.0E
	12:24	Com'ced to MBES methane plume survey.	West of Rebunto
	12:27	Released XBT.	45-32.5476N, 140-37.3486E Fine but cloudy
	13:14	Finished MBES methane plume survey.	NE-3 (Gentle breeze)
	13:15	Left methane plume survey area for Aomori Wan.	4 (Sea moderate)
			3 (Moderate short)
			Visibly: 8'
15-Sep-13		Arrive at Aomori Wan & Anchoring	09/15 12:00(UTC+9h)
	09:00-09:40	Scientific seminar.	41-43.6N, 139-51.0E
	18:48	Arrived at Aomori Wan.	Off Okushirito
	18:50	Let go the anchor at Aomori Wan.	Rain
			SSW-4 (Moderate breeze)
			3 (Sea slight)
			2 (Low swell long)
			Visibly: 5'
16-Sep-13		Anchoring at Aomori Wan	09/16 12:00(UTC+9h)
			40-52.4N, 140-45.9E
			Aomori Wan
			Rain
			NNE-6 (Strong breeze)
			4 (Sea moderate)
			3 (Moderate short)
			Visibly: 1'
17-Sep-13		Anchoring at Aomori Wan & Proceeding to Sekinehama Ko	09/17 12:00(UTC+9h)
	08:00	Heaving anchor, then com'ced proceeding to Sekinehama.	41-34.0N, 140-51.0E
			Off Oomasaki
			Fine but cloudy
			SW-7 (Near gale)
			5 (Sea Rough)
			3 (Moderate short)
			Visibly: 8'
18-Sep-13		Arrive at Sekinehama Ko	09/18 12:00(UTC+9h)
	09:00	Arrived at Sekinehama Ko.	Sekinehama Ko
	12:00	Disembarked from NATSUSHIMA.	
		Concluded NT13-20 cruise.	

6.2 R/V NATSUSHIMA Officers and Crew

Captain	AOKI TAKAFUMI
Chief Officer	ADACHI TATSUO
2nd Officer	TAKAHASHI TOMOYUKI
3rd Officer	IJICHI KAKERU
Chief Engineer	SHIBATA HIROYUKI
1st Engineer	TADOOKA NAOHITO
2nd Engineer	IKUTA SHINITI
3rd Engineer	YOSHIMURA SHOGO
Chief Electronics Operator	SUDA FUKUO
2nd Electronics Operator	KATAGIRI MICHIVASU
3rd Electronics Operator	TAKAKUWA TATSUHIRO
3rd Electronics Operator	SHIROZUME TAKATOMO
Boat Swain	HOSOKAWA SEIJI
Able Seaman	FUJII YOSHITSUGU
Able Seaman	KONNO YASUO
Able Seaman	NAGAI HIROAKI
Sailor	KAWAMURA KOSEI
Sailor	NAKANISHI TORU
Sailor	KAWABE YASUNOBU
Sailor	KOJIMA SHINYA
No.1 Oiler	IKEDA TOSHIKAZU
Oiler	SATO KAZUO
Oiler	AIZAWA KOTA
Oiler	TANIGUCHI KEIYA
Oiler	SUMITOMO SHOTARO
Chief Steward	YOSHIKAWA TERUYUKI
Steward	KIRITA KOJI
Steward	OKADA YOSHIO
Steward	OHBA HIROYUKI
Steward	NAKANO MIZUKI