doi : 10.17596/0003194

1 Cruise Information

Cruise number:

KR09-10

Ship name:

R/V KAIREI

Title of the cruise:

2009 Deep Sea Research

Research cruise with KAIREI

Title of proposal:

S09-33

Geophysical and Geological site survey (mainly heat flow measurement and piston sampling) for the proposal of the Integrated Ocean Drilling Program (IODP): (IODP proposal # 707: Kanto Asperity project: Geological and Geophysical Characterization of the History and Present Behavior of the Earthquake Cycle)

Cruise period:

August 14, 2009 – August 18, 2009

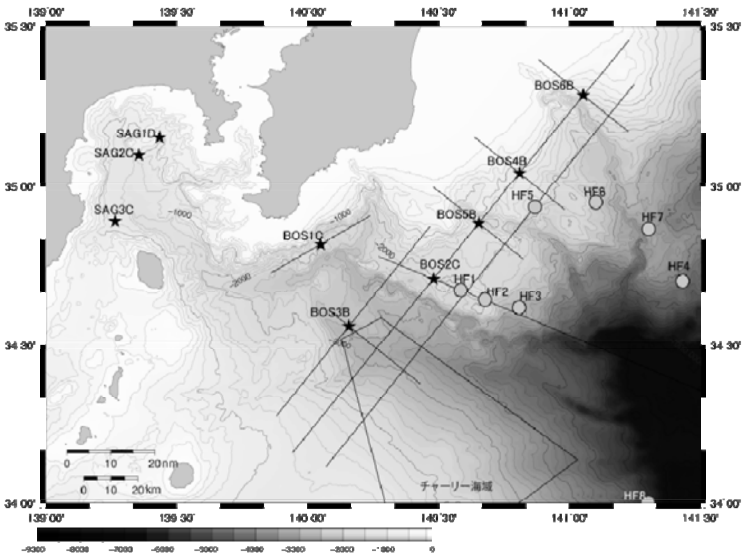
Port call:

2009	Aug. 14	Dept. from Yokosuka (JAMSTEC)
	Aug. 18	Arriv. at Yokosuka (JAMSTEC)

Research area:

Sagami Bay and off Boso peninsula

Research map:



2 KR09-10 Onboard Scientists

Kagoshima University	Reiji Kobayashi (Cruise Chair)
Earthquake Research Institute, Univ. of Tokyo	Makoto Yamano
Center for Environmental science in Saitama	Hideki Hamamoto
Fukada Geological Institute	Kiichiro Kawamura
Ocean Research Institute, Univ. of Tokyo	Humihiko Misawa

Marine Technician

Nippon Marine Enterprise (NME)	Satoshi Shimizu (Chief)
NME	Shusuke Machida
NME	Atsushi Isogai
NME	Satoshi Okada
Marine Works Japan (MWJ)	Yoshitaka Matsuura
MWJ	Hiroyuki Hayashi
MWJ	Naohito Mori

R/V KAIREI Crews

Captain	Satoshi Susami
Chief Officer	Yoshiyuki Nakamura
2nd Officer	Isao Maeda
Jr. 2nd Officer	Tatsuo Adachi
3rd Officer	Ryo Yamaguchi
Chief Engineer	Minoru Tsukada
1st Engineer	Koji Hunae
2nd Engineer	Kenzo Kato
3rd Engineer	Daisuke Matsushita
Chief Radio Operator	Hideyuki Akama
2nd Radio Operator	Yosuke Komaki
3rd Radio Operator	Michiyasu Katagiri
Boat Swain	Shoichi Abe
Able Seamen	Yoshiaki Kawamura
Able Seamen	Tsuyoshi Chimoto
Able Seamen	Masanori Ohata
Sailer	Shohei Ono
Sailer	Hideo Ito

Sailer	Hideaki Nakata
No.1 Oiler	Kozo Miura
Oiler	Yoshinori Kawai
Oiler	Masami Ueda
Oiler	Yuji Higashikawa
Oiler	Masayuki Hujiwara
Oiler	Humihiro Ueki
Chief Steward	Sueto Sasaki
Steward	Shigeto Ariyama
Steward	Hideo Hukumura
Steward	Takahiro Abe
Steward	Kana Yuasa

3 Observation

3.1 Introduction

The southern Kanto region (Tokyo Metropolitan Area) of southeastern Japan is an important and densely populated economic center, and has been subjected to repeated great (M~8.0) earthquakes (Figure 3.1-1). Slow slip events have also recurrently occurred east off Boso peninsula. The Kanto Asperity Project (KAP) proposal for the Integrated Ocean Drilling Program (IODP) addresses key questions regarding the geometry, physical properties, and geological record of the plate boundary along the Sagami trough, which are thought to control the occurrence of great earthquakes and slow slip events in subduction/collision zones. The KAP proposes a drilling and long-term monitoring program with the aim of determining the characteristics of the plate boundary in and around the source region (asperity) of great earthquakes and slow slip regions, based on geological, paleoseismological, seismological, and geodetic approaches.

Heat flow data are required to determine target depths where temperatures are not too high to drill and to install equipments. However, few heat flow data were acquired around the sites, in particular off Boso peninsula (Figure 3.1-2). The aim of this cruise is to investigate heat flow in this region. We also obtained piston core samples to know geological background and to know earthquake history by using event sediments caused by earthquakes.

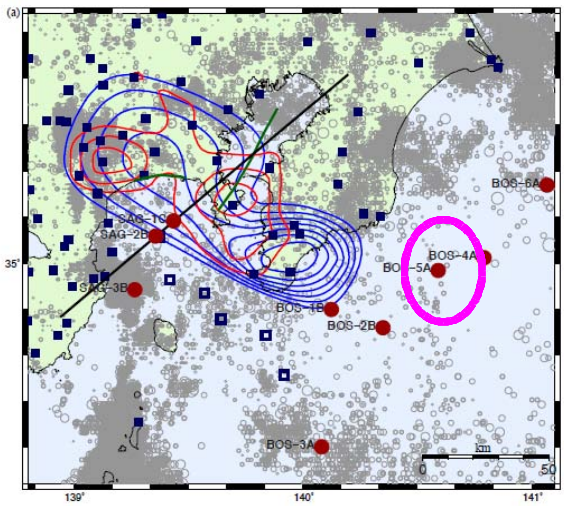


Figure 3.1-1. Slip distributions during the 1923 Kanto earthquake (red) and during the 1703 earthquake (blue). Purple ellipse denotes slow slip event region. Red circles show candidates of drilling sites for the KAP and blue squares are present seismic network. Gray circles show recent seismicity.

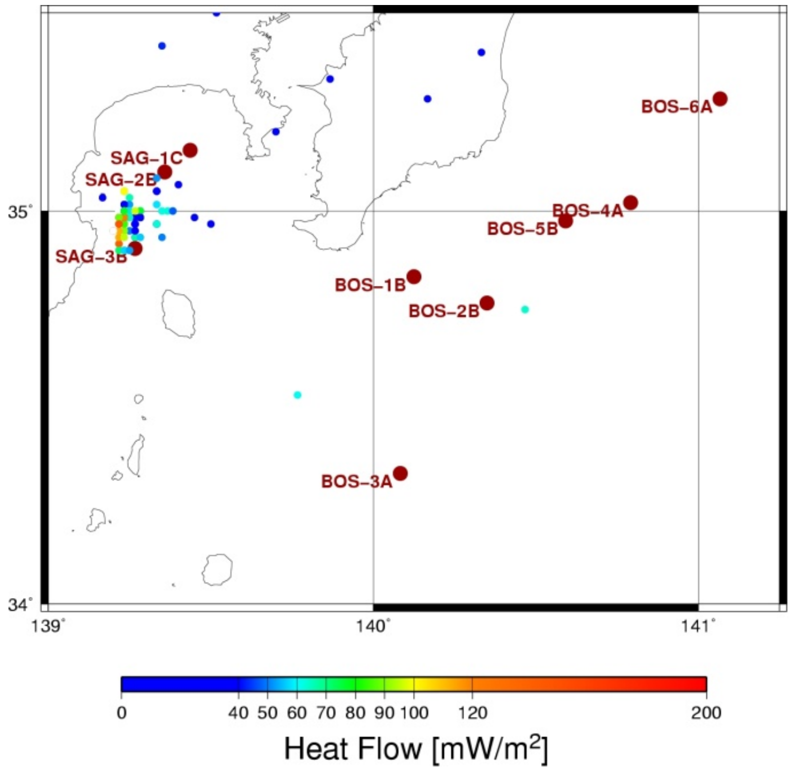


Figure 3.1-2. Heat flow data in Sagami bay and off Boso peninsula estimated by previous studies (small dots; compiled by Yamano, 2004). Red circles are candidates of drilling sites for the KAP.

3.2 Summary of the cruise

3.2.1 Research items

(1) Heat flow measurement

Heat flow measurement with an ordinary deep-sea heat flow probe and a piston corer with temperature sensors mounted on the core barrel.

(2) Long-term temperature monitoring on the seafloor

Long-term monitoring of the bottom water temperature using pop-up type instruments for determination of heat flow in areas with relatively shallow water depths.

(3) Piston core sampling with heat flow measurement (HFPC)

Sampling of surface sediments with a piston corer and heat flow measurement at the same site using temperature sensors mounted on the core barrel.

(4) Single-channel seismic reflection survey

Fine seismic structures in shallow layers around the drilling sites using single-channel seismic survey system.

3.2.2 Cruise schedule and operations

Date	Events, Operations
Aug. 14	Leave Yokosuka SAG-2: Heat flow measurements and deployment of pop-up water temperature monitoring system BOS-1 SCS survey (in the night)
Aug. 15	BOS-2: Piston core sampling with heat flow measurement and deployment of pop-up water temperature monitoring system HF-3: Heat flow measurements BOS-2 SCS survey (in the night)
Aug. 16	BOS-4: Deployment of pop-up water temperature monitoring system and piston core sampling with heat flow measurement HF-6: Heat flow measurements BOS-2 SCS survey (in the night)
Aug. 17	HF-4: Piston core sampling with heat flow measurement Boso Canyon: SeaBeam
Aug. 18	Arrive at Yokosuka

3.2.3 Ship track and observation points

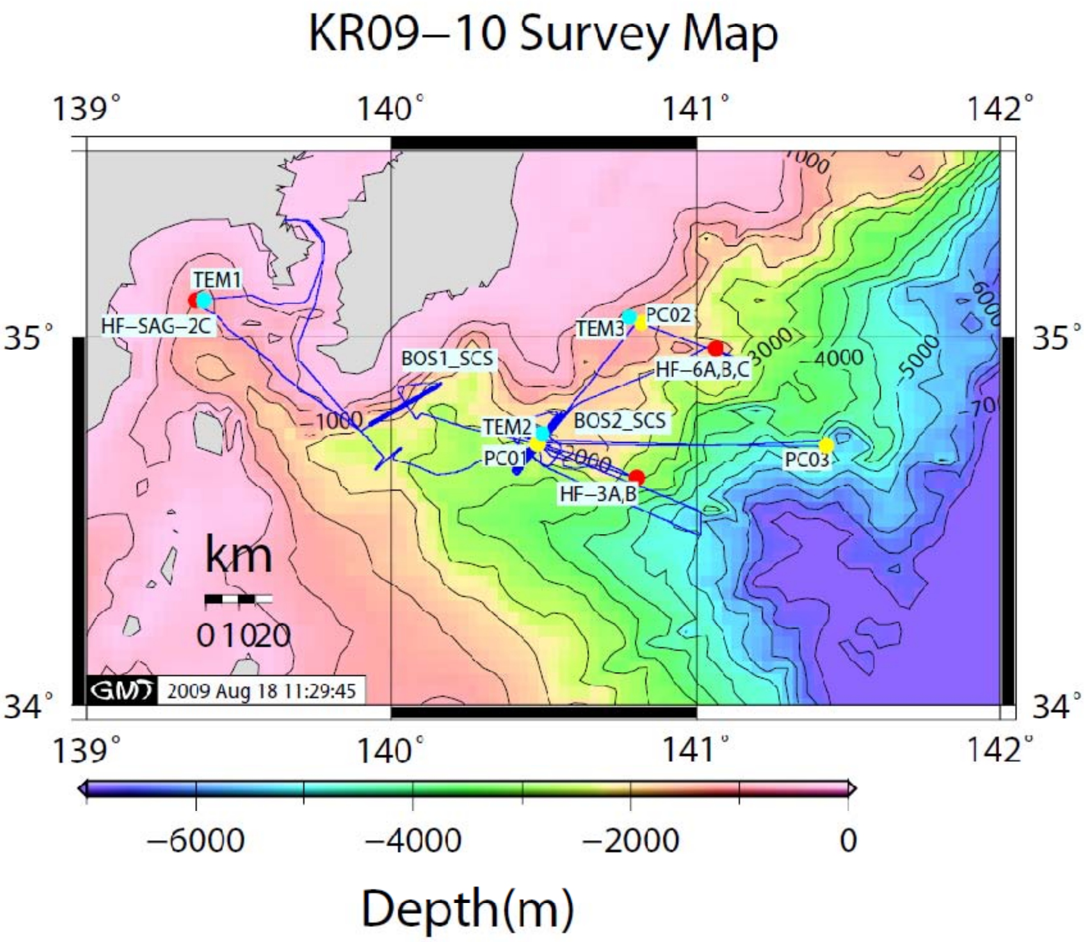


Figure 3.2-3. The ship track of this cruise (blue lines). Red, blue, and yellow circles denote sites of heat flow measurement, long-term temperature monitoring, and piston coring with heat flow measurement, respectively.

3.3 Research Objectives

3.3.1 Heat flow measurement

It is important to know the temperature distribution along the subducting plate interface for investigation of physical and chemical processes in the seismogenic zone of large thrust earthquakes, because these processes are strongly temperature dependent. The thermal structure of subduction zone can be estimated through numerical modeling, in which the convergence rate, subduction angle, and the thermal structure of the incoming oceanic plate at the trench are main parameters. Frictional heating along the plate interface and radiogenic heat generation in the landward plate also has significant influence on the temperature structure around the seismogenic zone (e.g., Wang et al., 1995). Some of these parameters cannot be well determined from observation and we need use heat flow distribution at the surface as constraint on the thermal models.

In the study area of this cruise, surface heat flow data are particularly essential, since there are some unknown factors in thermal models of this subduction zone due to uncertainty in the shape of the Philippine Sea slab and the subduction history. In addition, it is difficult to estimate the thermal structure of the subducting Philippine Sea plate. The thermal structure of the incoming oceanic plate is generally determined by its age (e.g., Sclater et al., 1980; Stein and Stein, 1992), but this relationship cannot be applied in the study area as it is the forearc of the Izu-Bonin arc that is subducting. We therefore need to obtain heat flow data both on the Philippine Sea plate before subduction and on the landward plate above the seismogenic zone for constructing reliable thermal structure models.

Heat flow data at the proposed IODP drill sites are also necessary for estimation of the temperature condition in drill holes. Comments on the previous drilling proposals by IODP panels, the Site Survey Panel (SSP) and the Science Steering Evaluation Panel (SSEP), strongly recommended that heat flow data in the vicinity of the proposed sites should be given. There are, however, few existing heat flow data in the study area (Fig. 3.1-2; Yamano, 2004)

On this cruise, we conducted heat flow measurements in the area landward of the trench (Sagami Trough). At three stations, located at the proposed drill sites, pop-up water temperature measurement systems were deployed for monitoring of the bottom water temperature. The water depths at these stations are relatively shallow, 1045 to 2010 m. Bottom water temperature variation is expected to be rather large in this depth range, which disturbs the temperature in sediment just below the seafloor. We will recover the temperature measurement systems about one year after deployment and measure the temperature profiles in sediment at that time. Analysis of the measured temperature profiles and the bottom water temperature records will allow us to determine heat flow at these stations (Hamamoto et al., 2006).

3.3.2 Piston coring

Aim of piston coring is to clarify deep-sea sedimentary process of this study area. The Sagami trough has been surveyed by the Japan-French KAIKO project in 1980's. In the project, seabeam box surveys, multichannel seismic surveys and two dive surveys using manned-submersible “Nautile” have done in the Sagami Bay and off Boso along the Sagami trough, but sediments were not collected. In this cruise, we want to know when, where and how sediments come from, and where it will go to?

This is a key to understanding paleoseismology in this study area. We have thought that some of sand layers record paleo-earthquake events as a seismogenic turbidite. When a large earthquake occurs beneath a sea bed, a slope and/or a cliff are collapsed due to earthquake shaking. Then, debris flow and/or turbidity currents would occur from the collapsed slope and/or cliff. In a downslope basin, the debris flow and/or turbidity current might be deposited to be a seismogenic turbidite. This is a theory of deposition of a seismogenic turbidite. Such theory was applied in the Nankai trough and Kuril trench, recurrence intervals of large eartheuakes were deciphered from seismogenic turbidites. However, we ought to understand a sedimentary system in an study area where we study the seismogenic turbidite. We need to know supply, transportation and deposition of seismogenic turbidites, so that we investigate deep-sea sedimentary process during this cruise.

3.3.3 Single channel seismic survey

The Single-Channel Seismic (SCS) survey system consists of a set of GI_GUN and streamer cables with hydrophone sensors towing behind the ship's stern (Fig. xxx). Active seismic sounding survey methods are including this SCS and Multi-Channel Seismic (MCS) survey systems both JAMSTEC research vessels can frequently operate crustal structural survey. At this time, we selected the former one to reveal shallower structure around BOS1 and BOS2, which are planned to drill sites. There are small number of crustal structure data obtained so far due to following several reasons: e.g. (1) main marine traffic route off Boso peninsula, (2) dense submarine cables concentrating into the bay of Tokyo, (3) fishery banks and regions where quite sensitive area of airgun shooting, and (4) the military training zone "Charley" which is access restricted, are all including operating area of KR0910. Before KR0910 cruise, JAMSTEC operating devision had some negotiation and contacted between fishery communities, cable companies, and related government agencies. Through there are so many limitations for marine operations, we should reveal crustal structure off Boso and Sagami in detail to understand characteristics of Kanto asperity. There are still lack of knowledge of plate/slab geometry underneath Kanto region. One of our goals are to drill several sites of Kanto asperities and to establish network observations around Kanto region for science of disaster prevention. This SCS operation is the first step of site survey for ocean drilling to Kanto asperity.

3.4 Instruments and Operation Methods

3.4.1 Deep-sea heat flow probe

Heat flow is obtained as the product of the geothermal gradient and the thermal conductivity. We measured the geothermal gradient by penetrating an ordinary deep-sea heat flow probe or a heat flow piston corer (HFPC, cf. 3.4.2).

[Specification of tools]

The deep-sea heat flow probe has a 4.5 m-long lance, along which seven compact temperature recorders (Miniaturized Temperature Data Logger, ANTARES Datensysteme GmbH) are mounted in an outrigger fashion (Fig. 3.4-1). ANTARES Miniaturized Temperature Data Logger (MTL) is a self-contained, autonomous instrument that measures temperature in its tip at a preset time interval (Fig. 3.4-2). Additional temperature sensors (six or eight) are also attached to the lance and connected to a data logger (Kaiyo Denshi Co., DHF-650) housed in the head of the probe. The data logger measures temperature of the additional sensors and two components of the instrument tilt every 30 sec and send the data to the surface with acoustic pulses so that we can monitor the status of the probe on the ship. The total weight of the probe is about 800 kg and the lance is strong enough to allow multi penetrations at each station.

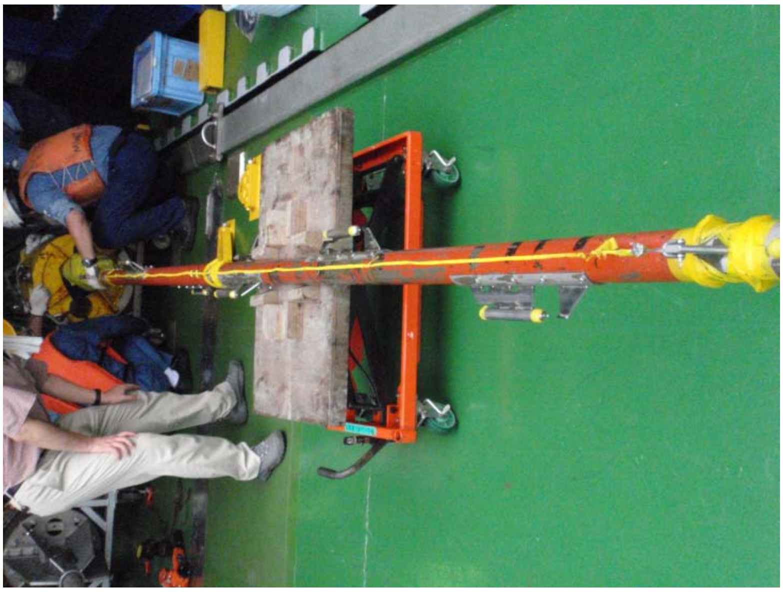


Figure 3.4-1. Deep-sea heat flow probe with MTLs and additional temperature sensors.

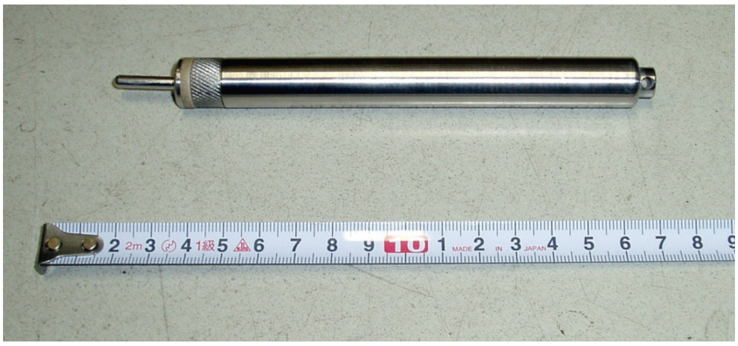


Figure 3.4-2. ANTARES Miniaturized Temperature Data Logger (MTL).

Specifications of the MTL and the data logger for the heat flow probe are summarized below:

Miniaturized Temperature Data Logger (ANTARES Datensysteme GmbH)

Pressure case: stainless steel

Case length: 160 mm

Diameter: 15 mm

Pressure rating: 6000 m water depth

Number of temperature channel: 1

Temperature resolution: 1.2 mK at 20°C, 0.75 mK at 1°C

Sample rate: variable from 1 sec to 255 min.

Heat Flow Data Logger DHF-650 (Kaiyo Denshi Co.)

Pressure case: titanium alloy

Case length: 725 mm

Maximum diameter: 145 mm

Pressure rating: 7000 m water depth

Number of temperature channels: 9

Temperature resolution: 1mK

Tilt: two-axis, 0 to ±45°

Data-cycle interval: 30 sec

Pinger frequency: 15.0 kHz (or 12.0 kHz)

[Operations]

A 15 m long nylon rope was put between the heat flow probe and the winch wire rope in order not to kink the wire rope during probe penetrations. An acoustic transponder was attached 55 m above the probe for precise determination of the position of the probe and the distance from the seafloor (Fig. 3.4-3).

Multi-penetration heat-flow measurement operations were conducted following the procedures described below.

1. Measure water temperature about 30 m above the sea floor for calibration of temperature sensors.
2. Lower the probe at a speed of about 1 m/sec until it penetrates into the sediment.
3. Measure temperatures in the sediment for about 15 min. Monitor the wire tension and pay out the wire when necessary to keep the probe stable.
4. Pull out the probe.
5. Repeat measurements.

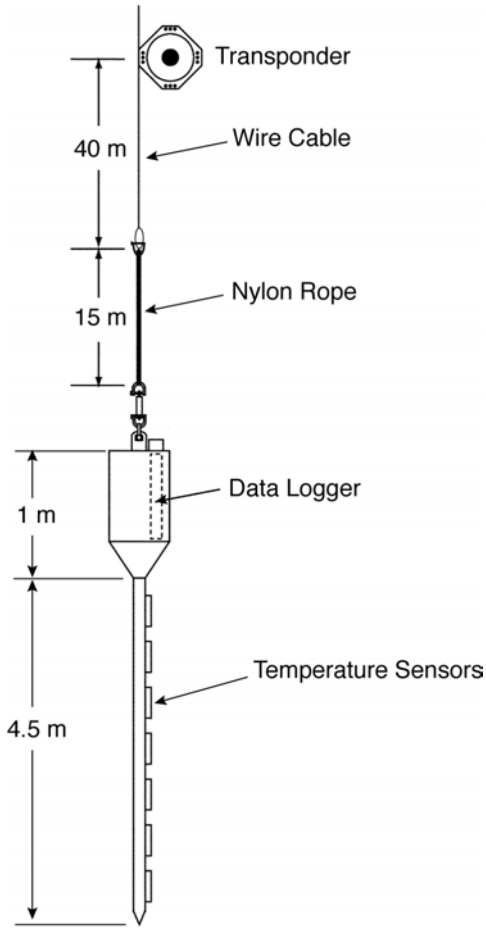


Figure 3.4-3. Configuration of the heat flow measurement system using a deep-sea probe.

3.4.2 Heat flow with piston coring system

[Specification of tools]

During this cruise, sediment core samples were taken with the heat flow piston coring system (HFPC) (Fig. 3.4-4). This coring system was used for combined operation of measuring heat flow and recovering sediments. The general outline of the system is shown in Fig.3.4-5.

A stainless steel barrel was attached to a piston core head of 800 kg weight. The core head has a space for mounting the heat flow data logger to record the temperatures of thermistor sensors mounted along the barrel. On this cruise, six ANTARES MTLs (cf. 3.4.1) were mounted helically on the outside of barrel, between the base of the weight stand and the core catcher bit. A transponder was also mounted on the winch wire to obtain the water depth and position of this equipment. The stainless steel barrel with this system is 4 m in length and liner is used for recovering sediments. The balance and pilot corer are the same as ones for ordinary piston core systems. 24mm nylon rope was placed between the balance and winch wire for additional wire out and/or increased tension after hitting sea bottom. Because the system must be kept in the sediment for 15 to 20 minutes to obtain stable temperature, additional wire out is necessary for avoiding pulling the barrel out of the sea floor by either heaving or drifting of the ship during the measurement.

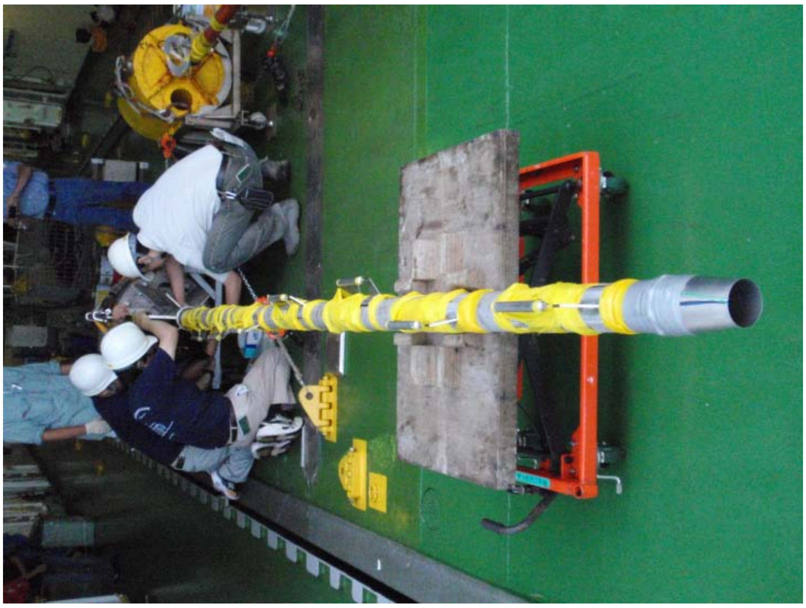


Figure.4-4. HFPC with compact temperature data loggers (MTLs).

[Operations]

Preparation for the piston coring

After barrels are attached to the head (weight stand), the main wire is connected, through the barrel, to the piston at the bottom of the barrel. The core catcher and bit are then attached.

The balance is connected to the end of the main wire. The entire assemblage is carried under the A flame using a cart and is lifted over the edge of the deck by the winch, A flame and capstan winches, the pilot core and it's wire are then connected to the balance. During the launch into the sea we have to add a large amount of water into the barrel from the top to prevent the piston moving due to water pressure from below. The system is then lowered through the water to the sea floor.

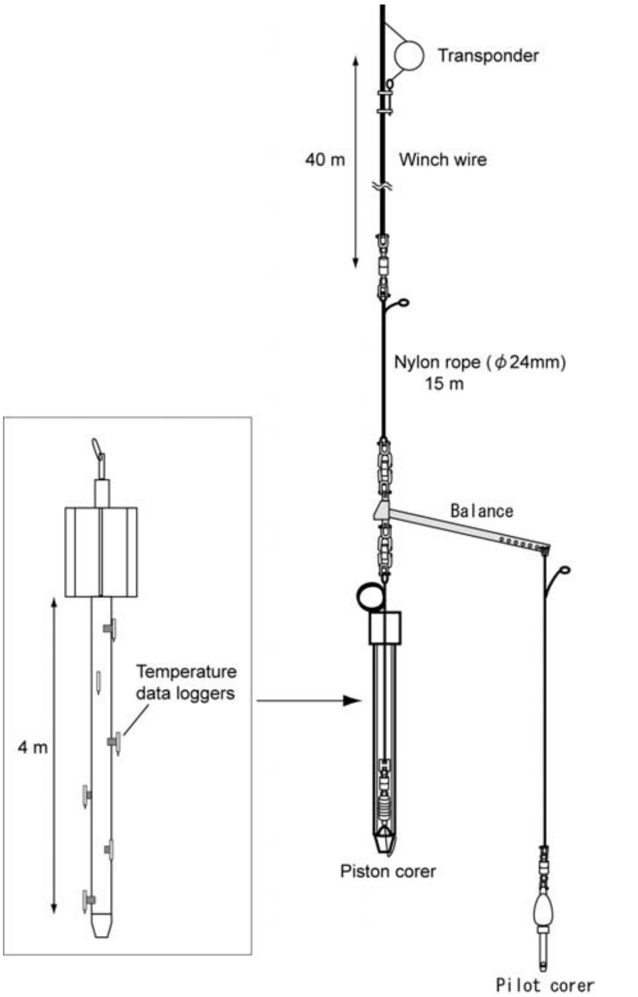


Figure 3.4-5. Configuration of the heat flow piston coring (HFPC) system.

<u>Hit the bottom and off the bottom</u>

The piston core system starts lowering at a winch speed of 20 m/min, which is gradually increasing to a maximum 60 m/min. The piston core is stopped at a depth about 60 m above the sea floor for 10 minutes to reduce any pendulum motion and to calibrate the temperature sensors on the outside of barrel.

After 10 minutes, the wire is lowered at a speed of about 20m/min., at the same time carefully watching the pen recorder of the strain gauge tension meter. When the piston core hit the bottom the tension will abruptly decrease by the amount of the piston core weight.

Therefore, it is easy to detect the bottom hit.

After the recognition of hit the bottom, add 5m to wire out, stopped and keep the position for 20 minutes. And then, rewinding of the wire is started at a dead slow speed (～20 m/min.), until the tension gauge indicate that the core has lifted off the bottom. The tension meter shows a small increase in tension when the core is being pulled out of the sea floor and then a steady value. After we can recognize absolutely that the piston core is above the sea floor, the winch to keep speed is increased to 60m/min., and then gradually to maximum speed.

3.4.3 Long-term temperature monitoring system

For heat flow measurement at stations with water depths less than about 2000 m, we deployed long-term temperature monitoring systems (cf. 3.3.1).

We have been using a pop-up water temperature measurement system (termed PWT below) in order to obtain long-term bottom water temperature records. PWT consists of an acoustic releaser, weights, floats (glass spheres), and a small water temperature recorder (NWT-DN, Nichiyu Giken Kogyo Co.) (Fig. 3.4-4). For deployment, the whole system is released at the sea surface and it sinks freely down to the sea floor. The system is recovered by activating the acoustic releaser with a command sent from a surface ship.

Specifications of the water temperature recorder (NWT-DN) are summarized below.

Pressure case	titanium alloy
Case length	212 mm
Diameter	41 mm
Pressure rating	6000 m water depth
Number of temperature channel	1
Temperature resolution	1 mK
Sample rate	variable from 2 sec to 1 day

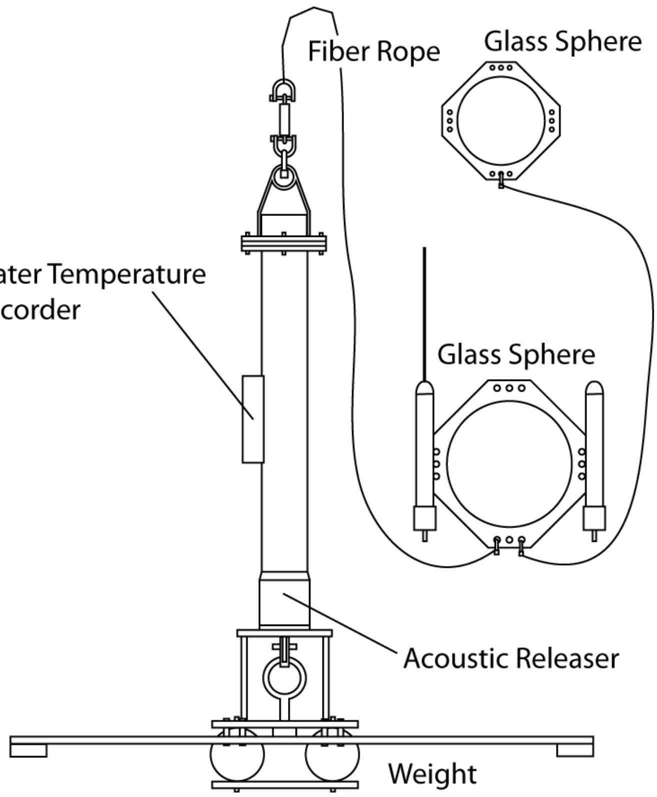


Figure 3.4-4. Schematic drawing of PWT.

3.4.4 Physical properties of core samples

[Thermal conductivity]

We need to know thermal conductivity of surface sediments in order to obtain heat flow values. Thermal conductivity of piston core samples was measured using two different types of line-source commercial devices. One is KD2 Pro (Decagon Devices) with a full-space type needle probe (von Herzen and Maxwell, 1959). The probe was inserted into whole-round core samples. The other is QTM-500 (Kyoto Electronics Manufacturing Co.) with a half-space type box probe (Sass et al., 1984). Measurements with this instrument were made on split core samples.

[Shear strength]

In order to understand shear strengths of core samples under the undrainage and unconsolidation (UU) conditions, we conducted vane shear test. The shear strength is measured using four-wing-bearing torque driver of 2 cm in height and 1 cm in width. The measurement has done as follows; 1) the whole wings of the torque driver were penetrated directly into the splitting surface of the working half after cube sampling, 2) the torque driver was rotated slowly, 3) record the torque force by 1 second interval. Each test was done for approximately 20 seconds. If the sediment samples were too hard to measure, the penetration depth of the wings was changed from 2 cm to 1 cm, and measured again for 20 seconds at new surface.

The shear strength is calculated by the shear friction working during rotation of the driver. According to the vane rotation length, it is calculated the one unit on the driver is 4.54 kPa as below calculation.

$$C = \frac{M_{t\,\max}}{\pi D^2 \left(\frac{H}{2} + \frac{D}{6} \right)}$$

where C is the shear strength (kg / cm^2), $M_{t\max}$ is the torque moment (kg cm), H is the wing height (cm), and D is the total wing width (cm).

3.4.5 Single channel seismic survey

We designed to deploy SCS system as parallel, subparallel or crisscross tied track lines as shown in Figures 3.4-1 and -2. Based on MCS sections obtained by IFREE cruises of KR0804 and KR0907, SCS system had been carried out to recover wave signals from much shallower reflectors, horizontal sediment layers and high quality signal/noise ratio with 300 m length streamer cable. The 65 m active section part with a single channel and 235 m lead-in cable operated and recorded seismic signals. The GI_Gun (350 cu in: Generator 245 cu in and Injector 105 cu in), which is a sound source by SSI Co.ltd., can generate high fidelity pulse (Table 3.4-1, Figure 3.4-3).

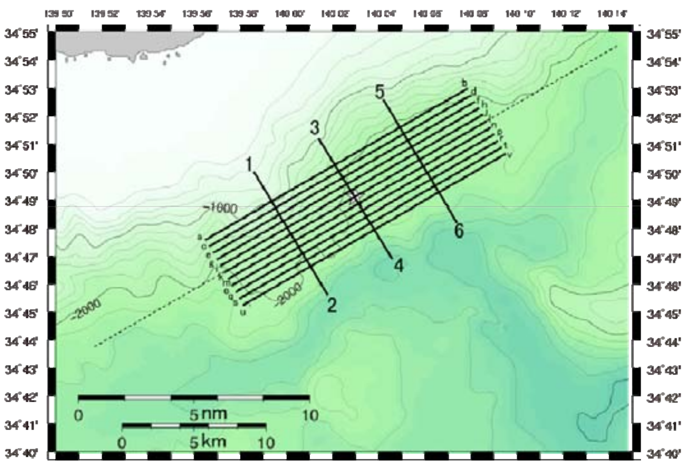


Figure 3.4-1: SCS track chart around BOS1 region.

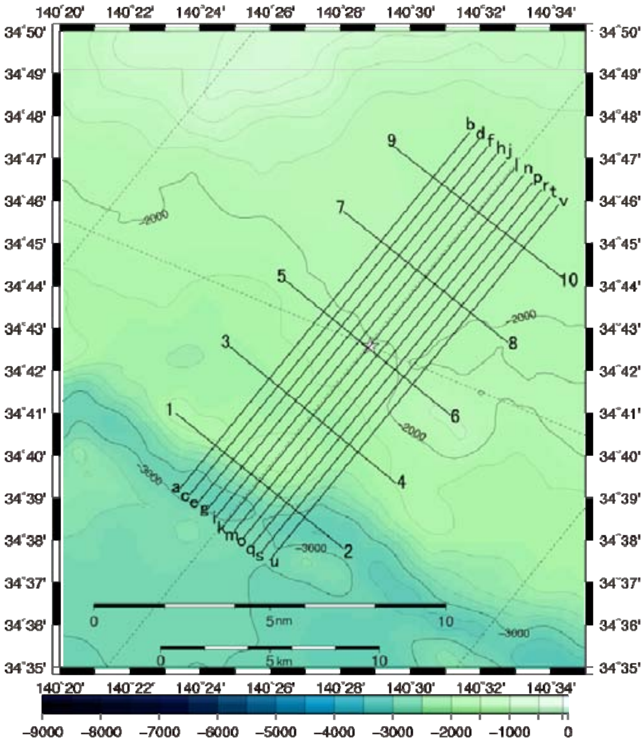


Figure 3.4-2: SCS track chart around BOS2 region.

Table 3.4-1 The single channel seismic survey equipment and specification.

Streamer

Manufacturer	S.I.G
Active section length	47m
Hydrophone Interval	1m
Type of Hydrophone	S.I.G.16
Hydrophone output	-90 dB,re 1V/μbar, ±1dB
Frequency	flat from 10Hz to 1000Hz
Depth sensor	Yes
Preamplifier	gain 39
Lead in cable	120m
Receiver depth	See General Information

Source

Manufacturer	Sercel
Type of airgun	GI-GUN
Volume	355cu.in. [250(G)+105(I)] or 210cu.in.

	[105(G)+105(I)]
	See General Information
Air pressure	13.5 Mpa
Source depth	See General Information
Depth sensor	No
Gun Controller	HOT SHOT

Air Compressor

Manufacturer	Leobersdorfer Maschinenfabrik AG Wien
Type of machine	LMF 24/150-E60(VC2214w15)
Air supply Capacity	$24m^3$/min.

Recording System

Manufacturer	GEOMETRICS
Type of system	Geode
Recording format	SEG-D Rev.1
Recording length	8,000 msec
Water Delay	0 sec
Sample rate	1.0 msec
High cut filter	None
Low cut filter	None
Recording media	HD

GPS System

Manufacturer	Fugro
Type of system	SkyFix XP(DGPS)
DGPS Reference Station	ALL

GPS System

Manufacturer	MARIMEX JAPAN
Type of system	NAVLOG

Shot Point Geometry

Time mode shooting	See General Information

Geodetic Parameter

Spheroid	WGS84
Semi-major Axis	6,378,137m
Inverse Flattening	298.26
Projection	U.T.M
	Zone54

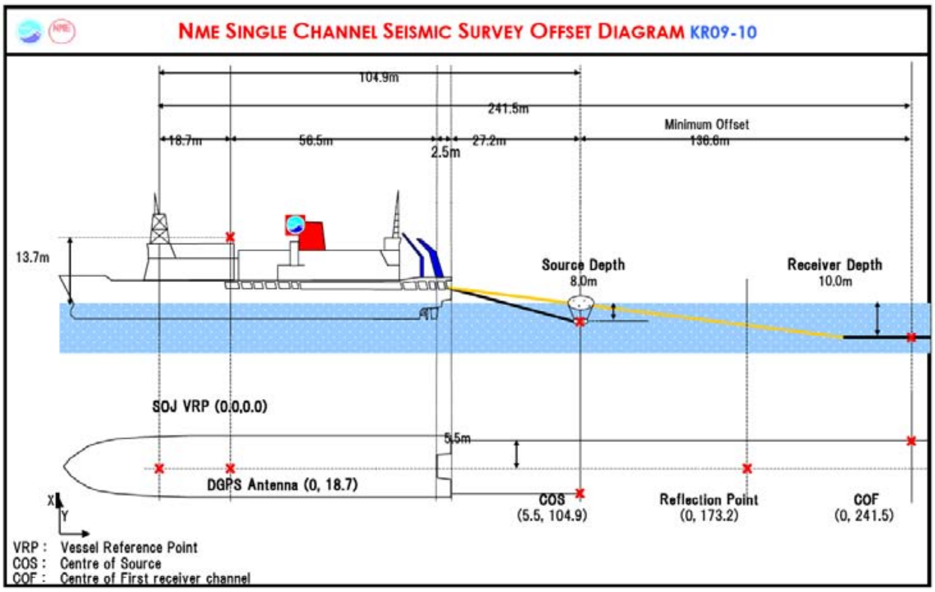


Figure 3.4-1: Schematic figure of SCS towing system

3.5 Preliminary results

3.5.1 Heat flow measurement

We carried out heat flow measurements at three sites with the deep-sea heat flow probe and at three sites with the HFPC (Table 3.5-1; Fig. 3.5-1). At HF-3 and HF-6, multiple penetrations were made for examining local variability of heat flow. The coordinates of the stations listed in Table 3.5-1 are the positions of the transponder attached just above the probe or HFPC determined with the SSBL system of the ship, while the water depth is the depth right below the ship and may be slightly different from the depth at the station. Deep penetration of the probe and the corer could not be attained at HF-SAG-2C and PC01(BOS-2C), probably due to some coarse sediments.

Sites HF-SAG-2C, PC01(BOS-2C), and PC02(BOS-4B) are located in the close vicinity of the proposed drill sites. Other sites are located on or close to lines along which multichannel seismic reflection survey was made or is planned. The water depths of the drill sites are shallower than about 2000 m and the measured temperature profiles are clearly disturbed by temporal variation of the bottom water temperature. They need to be analyzed with long-term records of bottom water temperature which will be obtained with PWTs. Temperature profiles at deeper sites may also have been affected by the bottom water temperature variation to some extent. We should examine the effect through repeated measurements at the same stations.

Table 3.5-1. Results of heat flow measurements

Date	Station	Latitude (N)	Longitude (E)	Depth (m)	N
Deep-sea heat flow probe					
Aug. 14	HF-SAG-2C	35°05.92'	139°21.47'	1050	4
Aug. 15	HF-3A	34°37.09'	140°48.37'	2905	6
	B	34°37.12'	140°48.36'	2905	3
Aug. 16	HF-6A	34°58.09'	141°03.98'	2380	7
	B	34°58.08'	141°03.97'	2390	7
	C	34°58.07'	141°03.99'	2385	7
HFPC					
Aug. 15	PC01(BOS-2C)	34°42.56'	140°28.79'	2055	4
Aug. 16	PC02(BOS-4B)	35°02.58'	140°48.55'	1185	7
Aug. 17	PC03(HF4)	34°42.21'	141°25.65'	4310	7

N: number of temperature sensors used to obtain temperature profile in sediment.

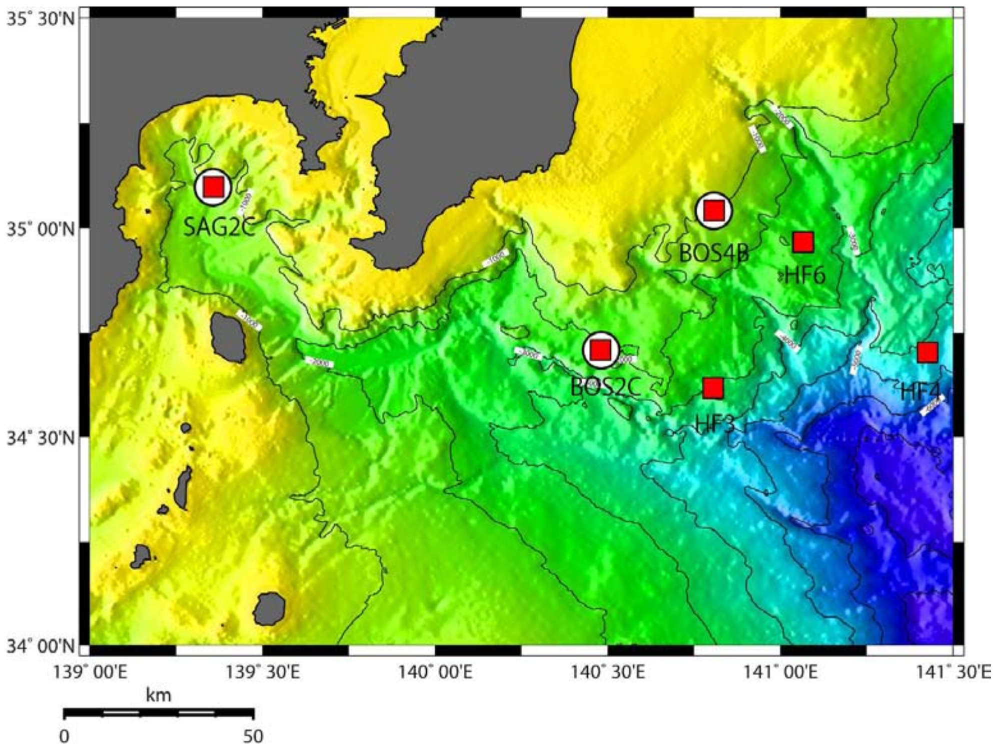


Figure 3.5-1. Locations of the stations (red squares: heat flow measurement, circles: PWT deployment).

We deployed pop-up water temperature measurement systems (PWTs; cf. 3.4.3) at three proposed drill sites, SAG-2C, BOS-2C, and BOS-4B (Table 3.5-2; Fig. 3.5-1). The coordinates of the stations listed in Table 3.5-2 are the positions of the ship at the times when the systems were released at the sea surface. The sampling interval of the water temperature recorders was set as 10 min. The PWTs will be recovered about one year after deployment.

Table 3.5-2. Deployment of PWTs

Station	Date of deployment	Coordinates	Water depth (m)
SAG-2C	Aug. 14, 2009	35°05.9’N, 139°21.5’E	1045
BOS-2C	Aug. 15, 2009	34°42.6’N, 140°28.9’E	2050
BOS-4B	Aug. 16, 2009	35°02.6’N, 140°48.5’E	1195

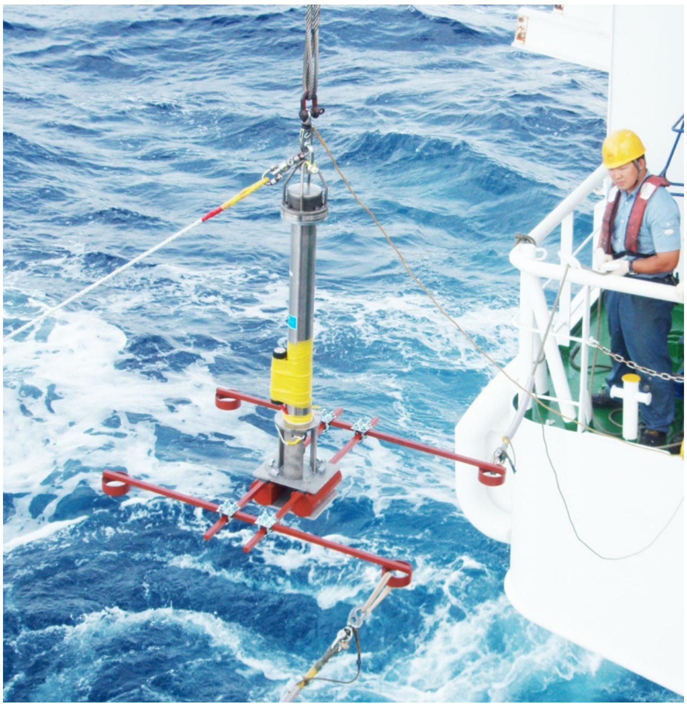


Figure 3.5-2. Deployment of a pop-up water temperature measurement system (PWT).

3.5.2 Piston core samples

HF-SAG-2C (see Fig. 3.5-3)

HF-SAG-2C was performed at a gentle slope of southern part of the Sagami Knoll (35°05.92'N, 139°21.45'E). The water depth was 1050 m. This site is correspondent with a proposed drill site (SAG-2C) in a drilling proposal, Kanto Asperity Project. In order to measure geothermal gradient and thermal conductivity, a heat flow pier was penetrated once into the gentle slope. Sediments were accreted on the pier. I observed the sediments using smear slide method following the ODP procedure.

The sediment is dominantly nanno sandy clay with diatoms, which is composed mainly of nanno fossils, quartz grains, diatoms and forams. In this site, PC02 was collected during Kaiyo cruise KY07-14. PC04 was composed of clayey sediments (probably calcareous) and four medium sand layers. Sedimentary sequence of the sediments on HF-SAG-2C should be originally same as that of PC04.

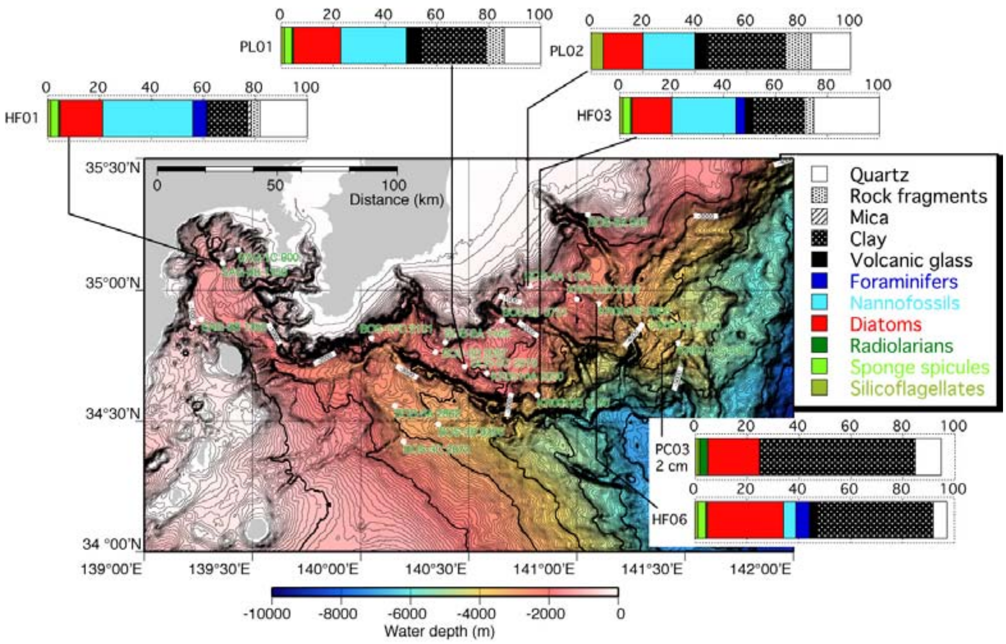


Fig. 3.5-3 Grain component of surface sediments.

PC01 (BOS-2C)

PC01 is located on a west foot of the Dai-san Chikura knoll in north of the Boso canyon (34°42.5593'N, 140°28.7864'E). The water depth was 2053 m. This site is correspondent with a proposed drill site (BOS-2C) in a drilling proposal, Kanto Asperity Project. To measure heat flow and to know sedimentary processes in this site, we have done the piston coring in there.

The Dai-san Chikura knoll is one of the knolls in the Chikura seamount chain, where is located along the Boso canyon. The knolls are thought to be formed by erosion as a monadnock. A small valley is seen in this coring site. This valley is derived probably from erosion of the knoll.

In pre-site survey using subbottom profiler system, we could not detect no layering structures in this coring site.

The sediment core of 121.2 cm long was recovered. The sediments of this core are composed dominantly of nanno sandy to silty clay with diatoms. This sediment is well bioturbated. There are several sandy horizons of about 10 cm thick or less. A volcanic ash layer of grayish olive to gray are seen at 74-82 cm bsf. This ash layer has upward fining structure from pumice to silt sized volcanic glass. This is purely composed of volcanic glass. It means that the volcanic ash layer was deposited as a fall deposit.

Vane shear strengths of these cores are ranging from about 5 to 15 kPa. This is probably resulting from variation of grain size of the sediments. In general, sandy sediments tend to be large strengths, and muddy sediments are being small strengths. In this sediment, the lithological unit of nanno sandy to silty clay with diatoms changes its lithofacies from sandy to silty sediments in place.

3.5.3 Single-channel seismic images

During night-time operation from Aug. 14th to Aug. 17th, we observed totally 200 km (110 miles) long and 12 SCS lines (8 lines for a 20 km (10 mile) long parallel line, four lines for 10 km (5.4 mile) length). Single-channel seismic reflection survey along four lines for BOS-1C and eight lines for BOS-2C were successfully completed during three nights. Sections shown in Figures 3.5-1 and -2 are obtained by SCS reflection survey during KR0910 cruise. Each profile consists of SEG-Y format file and treated as onboard processing procedure. These clearly show the details of shallow sediment layers. The images along dense lines enable us to infer the three-dimensional structures around the BOS-1C and BOS-2C. For the case of BOS-1C, in particular, the spatial variation is abrupt, and may be important to determine the drill site location and target depth.

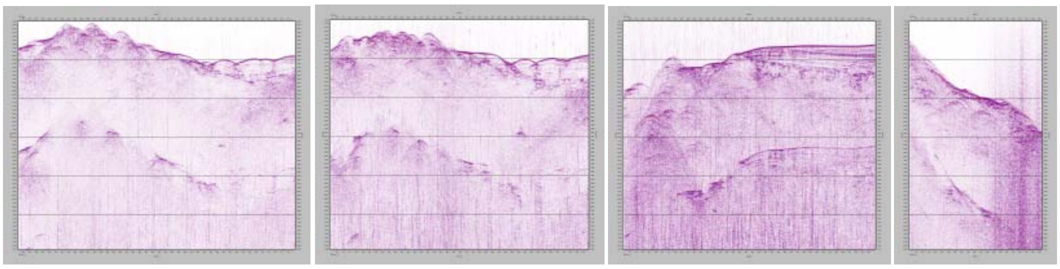
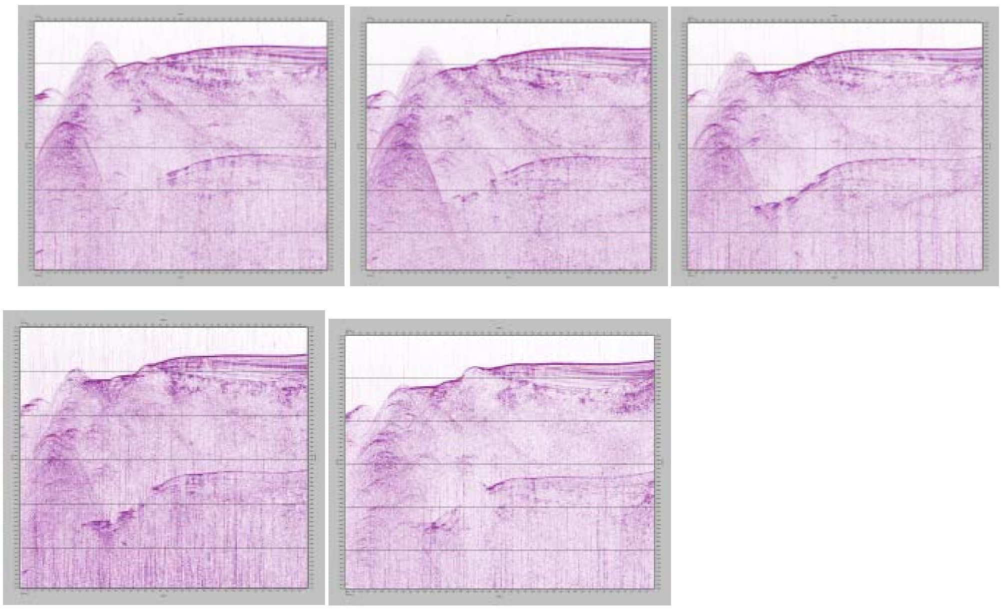


Figure 3.5.3-1 SCS onboard processing sections along lines i-j, k-l, m-n, and 3-4 around BOS-1C. Horizontal axis shows the shot point number and vertical line is two-way travel time (sec).



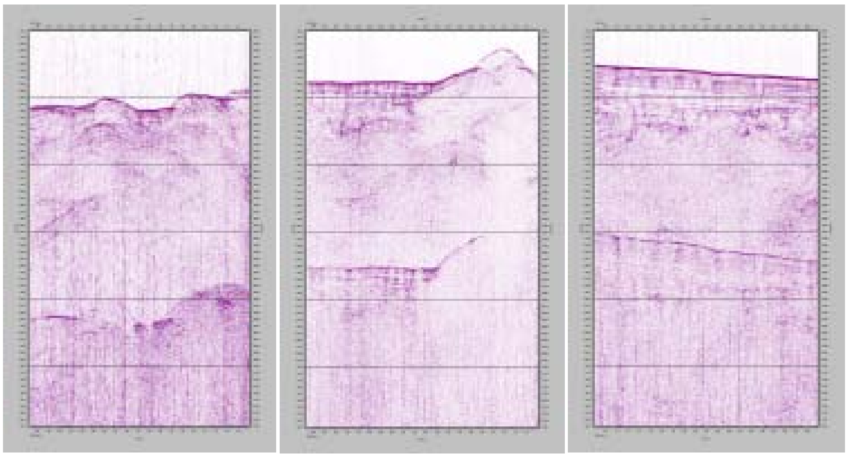


Figure 3.5.3-2 SCS onboard processing sections along lines g-h, i-j, k-l, m-n, o-p, 3-4, 5-6, and 7-8 around BOS-2C.

4. Notice on Using

This cruise report is a preliminary documentation as of the end of the cruise. It may not be corrected even if changes on content (i.e. taxonomic classifications) are found after publication. It may also be changed without notice. Data on the cruise report may be raw or not processed. Please ask the Chief Scientist for the latest information before using.

Users of data or results of this cruise are requested to submit their results to Data Integration and Analysis Group (DIAG), JAMSTEC.

5. Acknowledgments

We are grateful to Captain Susami, the officers, and the crew from NME and MWJ, for skillful operations of the ship and research equipment. The staff of the Operation Group, Research Vessel Operation Department, Marine Technology Center, especially T. Hirai, made excellent arrangements for the cruise.

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7. Appendix

7.1 Cruise log

Shipboard Log & Ship Track(KR0910 08/8/14 - 09/8/18)				Position/Weather/ Wind/Sea condition (Noon)
Date	Time	Description	Remark	
14,Aug, 09	9:00	embarked on KAIREI		8/14 12:00
	10:00	departed from YOKOSUKA(JAMSTEC)		35-05.8N, 139-34.3E
	10:45-11:00	onboard education & training	for scientists	Overcast
	11:00-11:20	onboard seminar	for safety KAIREI life	NNE-2(Light breeze)
	12:30	arrived at reserch area (SAG-2C)	35-05.9N , 139-21.4E	Sea smooth
	12:40	released XBT	35-05.9N , 139-21.4E	
	13:33-15:28	heat flow data sampling	SAG-2C	
	15:34-16:04	depoloyed water thermometer	35-05.9N , 139-21.5E	
	16:05	commenced shifting to BOS-1C		
	18:20	arrived at reserch area (BOS-1C)		
	18:27	released XBT	34-44.8N , 139-53.6E	
	18:43	launched GI gun		
	18:50-18:	paid out streamer cable		

	56			
	19:29	commenced SCS survey	BOS-1C site	
15,Aug, 09	6:13	finished SCS survey		8/15 12:00
	06:14-06:20	recovered streamer cable		34-42.6N, 140-28.9E
	6:25	recovered GI gun		Fine but cloudy
	09:20-11:20	heat flow sampling	BOS-2C	NNE-5(Fresh breeze)
	11:58	depoloyed water thermometer	34-42.5N , 140-28.8E	Sea moderate
	12:47-13:26	carried out SBP survey	HF-3	
	13:54-16:49	heat flow data sampling	34-37.1N , 140-48.4E	
	17:00	commenced shifting to BOS-2C		
	18:00	arrived at reserch area (BOS-2C)		
	18:06-18:17	launched GI gun		
	18:13-18:17	paid out streamer cable		
	18:37	commenced SCS survey	BOS-2C site	
16,Aug, 09	4:47	finished SCS survey		8/16 12:00
	05:53-05:58	recovered streamer cable		34-57.5N, 141-04.3E
	6:04	recovered GI gun		Fine but cloudy
	6:10	commenced shifting to BOS-4B		NNE-5(Fresh breeze)
	7:20	arrived at reserch area (BOS-4B)		Sea moderate

	7:55	depoloyed water thermometer	35-02.5N , 140-48.5E （BOS-4B）	
	08:26-10:22	carried out piston core sampling with HF	BOS-4B	
	10:51	commenced shifting to HF-6		
	12:40	arrived at reserch area (HF-6)		
	12:59-15:53	heat flow data sampling	34-58.1N , 141-03.9E(HF-6)	
	16:00	commenced shifting to BOS-2C		
	17:50	arrived at reserch area (BOS-2C)		
	18:01	launched GI gun		
	18:06-18:09	paid out streamer cable		
	18:36	commenced SCS survey	BOS-2C site	
17,Aug, 09	4:24	finished SCS survey		8/17 12:00
	05:51-05:56	recovered streamer cable		34-42.2N, 141-25.6E
	6:07	recovered GI gun		Fine but cloudy
	6:08	commenced shifting to HF4		NE-6(Strong breeze)
	9:15	arrived at reserch area (HF4)		Sea moderate
	10:14-14:47	carried out piston core sampling	34-42.2N , 141-25.6E(HF-4)	
	15:00	commenced shifting to BOS-2C		

	18:30	arrived at reserch area BOS-2C		
	19:13	commenced MBES survey	BOS-2C site	
	23:50	finished MBES survey		
	23:55	left research area for YOKOSUKA(JAMSTEC)		
18,Aug, 09	9:00	arrived at JAMSTEC		
	12:00	disembarked from KAIREI and concluded KR0910	KR0910 scientists	