doi : 10.17596/0003270

Nankai Trough
"*Yokosuka*" YK08-04
Cruise Report

April 4, 2008 – April 10, 2008

Photo by Aoki, M.

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Contents

1. Cruise Information

(1) Cruise Number / Ship Name: YK08-04/ “Yokosuka”

(2) Title of the Cruise: Seafloor-Borehole Integrated Hydrologic Observation
in the Nankai Seismogenic Zone

(3) Proposal Number/ Title of the Proposal: S08-37/ Seafloor-Borehole
Integrated Hydrologic Observation in the Nankai Seismogenic Zone

(4) Period of the cruise: April 4, 2008 to April 11, 2008

(5) Port Calls: Yokosuka to Ooarai

(6) Investigation Area: Nankai Trough off Kumano

(7) Dive Number/ Observer/ Dive Point/ Keywords
#1061/ Morita, S./ Oodai Ridge off Kumano/ strike-slip fault
#1061/ Miyazaki, J./Oomine Ridge off Kumano/ splay fault, cold seep
#1062/ Morita, S./No. 8 Kumano Knoll/ mud colcano, cold seep

(8) Ship Track Map/ Dive Track

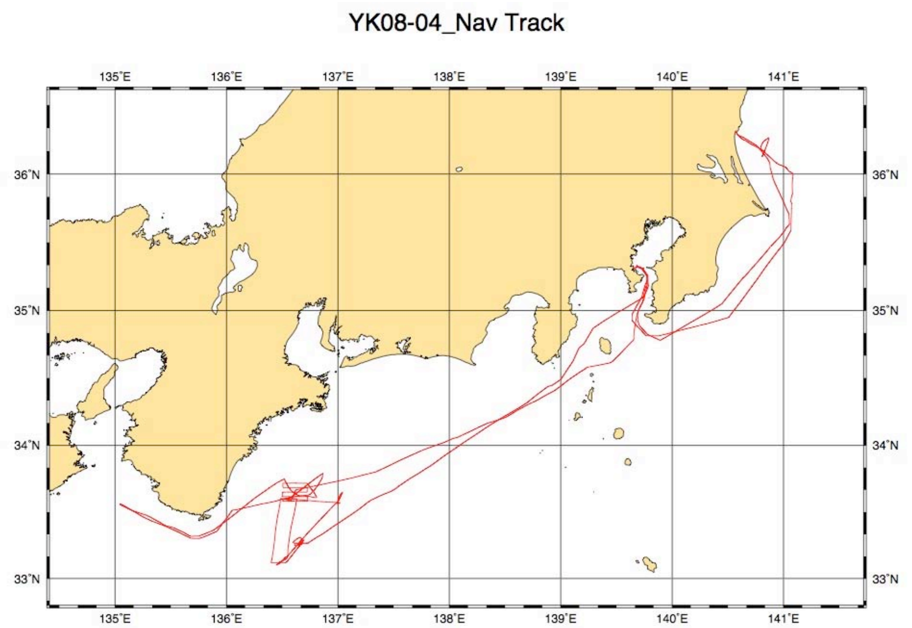

Fig. 1-1 Ship Track Map

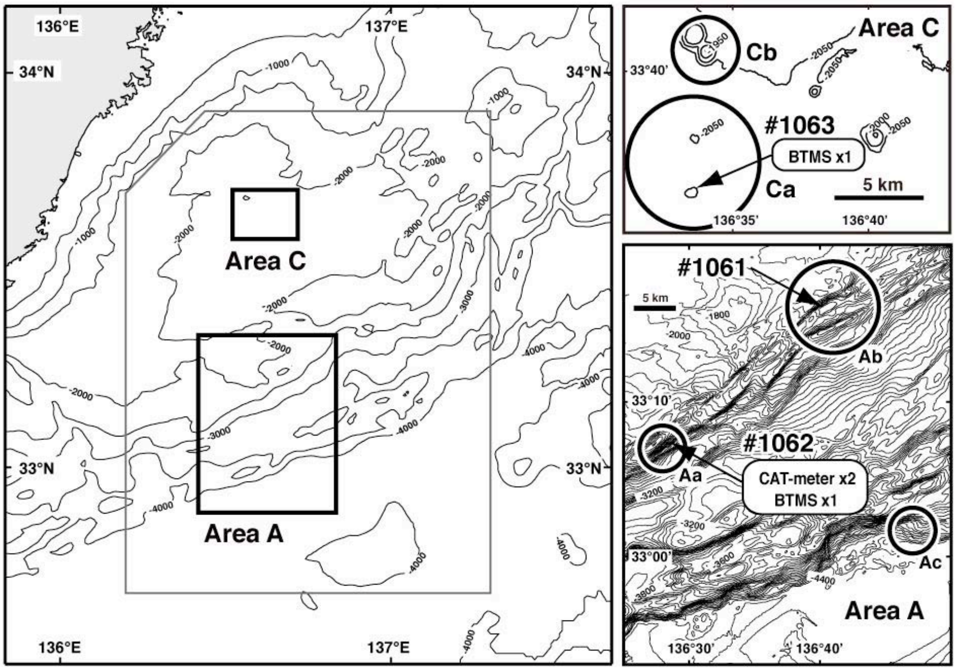

Fig. 1-2 Dive site of YK08-04

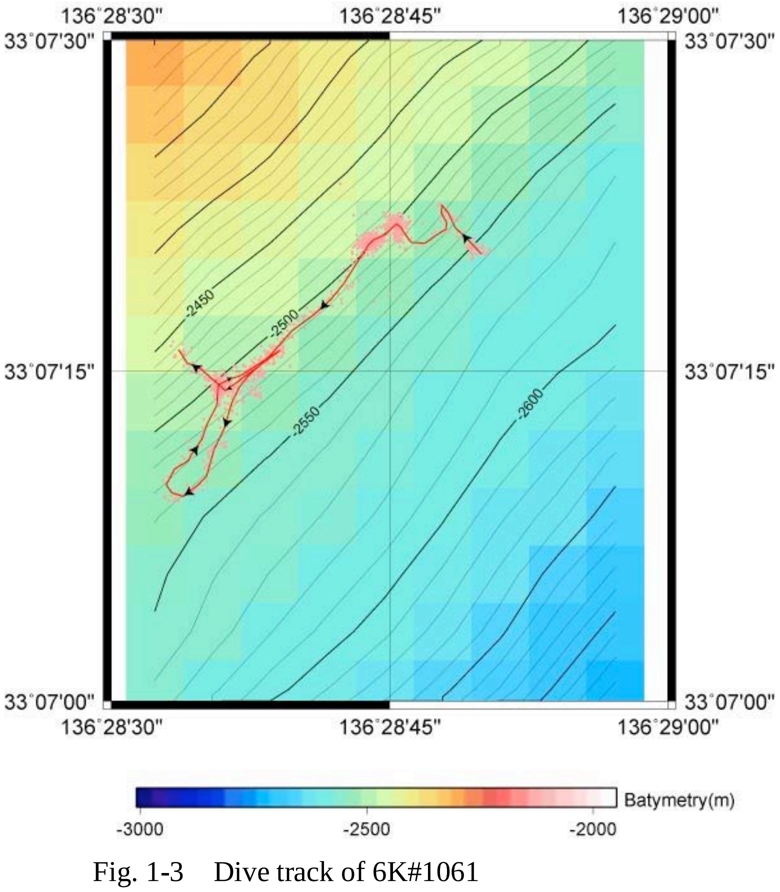

Fig. 1-3 Dive track of 6K#1061

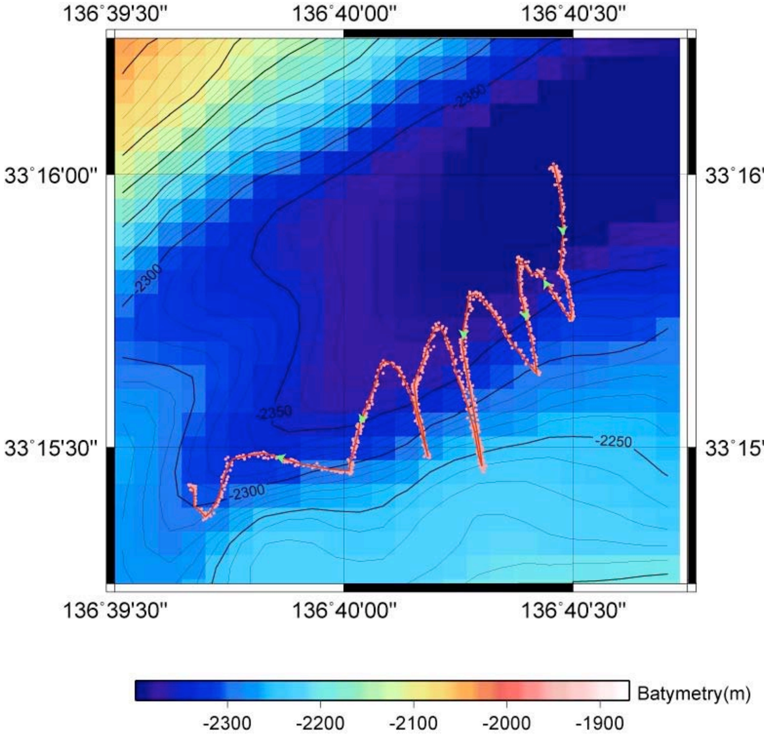

Fig. 1-4 Dive track of 6K#1062

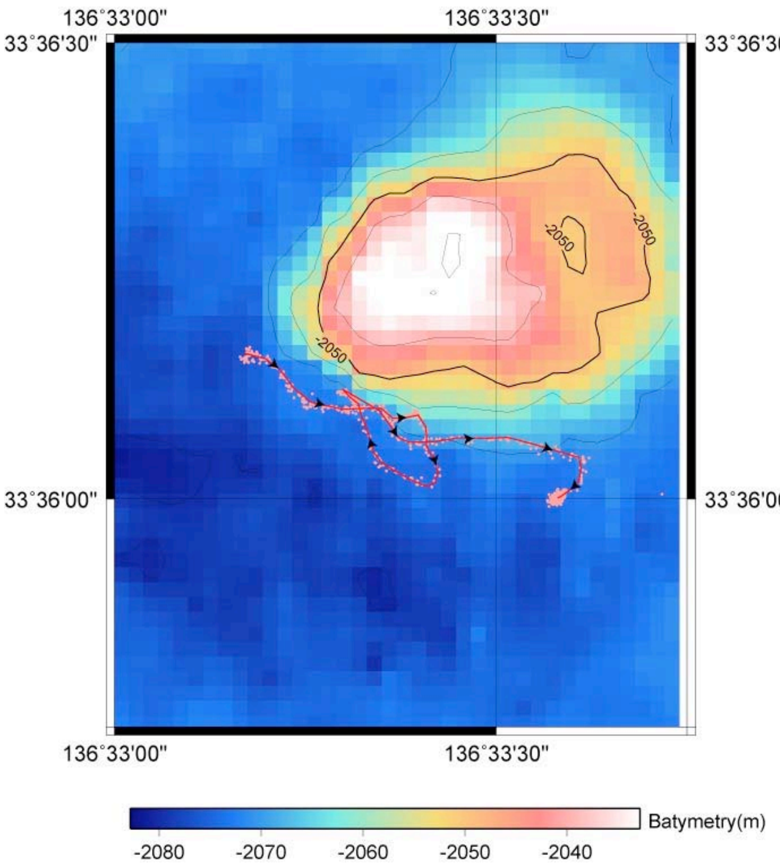

Fig. 1-5 Dive track of 6K#1063

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3. Introduction and Objectives

Fluids in subduction zones strongly control mechanical strength of rocks. Their distribution, migration and discharge processes are crucial to understand structural evolution such as plate boundary fault deformations. Variation of geochemical component and/or seep rate with time is one of indicators for stress condition within an accretionary prism. We deployed five seep meters and one long-term temperature meter at the base of the fault scarp and the mud volcano to monitor one year's variation of seep activity. YK07-09 was cancelled by a hatch trouble of Shinkai 6500 although the cruise planned for retrieval of these instruments and deployment of new ones. All instruments were successfully retrieved by NT07-E01 that scheduled for an emergency action. However, instrument deployment and exploration of new seep sites were postponed.

We planned this cruise for studies of unexplored faults and deployments of seep meters again. Primary objective of our study is to measure fluctuation of seep activity and to examine the cause of the fluctuation in terms of short-term environmental changes of formation such as seismic activities including VLF (Very Low Frequency) and tidal effect. Our study would contribute ongoing IODP NanTroSEIZE as a pilot observation of hydrogeology for future long-term borehole observatory.

Heat flow is also a good indicator for detecting seep activities. However, high fluctuation of bottom-water temperature makes difficult to estimate actual changes of flow rate. Therefore, monitoring of bottom-water temperature before heat-flow measurements is crucial to evaluate changes of geothermal gradients. We planned to deploy BTMS (Bottom-water Temperature Monitoring System) for future heat flow measurements near cold seep sites.

Microbiological studies in cold seep sites are also planned. The following is the summary of microbiological study objectives (see 7.5 for more information). Most of the methane seeping upward in the marine sedimentary column is intercepted biologically by the anaerobic oxidation of methane (AOM). There is now a consensus that AOM can be mediated by consortia of methane-oxidizing Archaea and sulfate-reducing bacteria, although microorganisms responsible for AOM have remained isolated and characterized. To better study microbial AOM, we have to be more effort to cultivate and obtain the microbes responsible for the AOM reaction in pure culture. After obtaining deep-sea sediments, we will culture these microbes using a special cultivation apparatus. To understand the nitrogen cycle in the anoxic methane-seep sediments, moreover, we try to cultivate with stable isotopes to investigate if ANME have ability to fix nitrogen gas.

Geochemistry of interstitial water and bottom-water is one of key parameters showing fluid sources and fluxes. Main objective of geochemical studies is to understand chemical conditions at the seep site of the mega-splay fault where the barite chimney was developed. We also planned collaboration study between geochemistry and microbiology using the same samples from sediment cores and in-situ pressure bottom-water samplers.

4. Background

Mega-earthquakes of magnitude eight-classes repeatedly occurred with 150-250 years' interval along the Nankai Trough. Our research group promotes the IODP drilling project named "NanTroSEIZE", which aims to understand the rupture process of the plate boundary fault and mega-splay fault in the Nankai Trough off Kumano. The stage 1 of the drilling project just started in September, 2007.

Our group has performed submersible dive surveys of the SHINKAI 6500 by the cruises YK01-04, YK02-02 and YK03-03 as site surveys in this area, where subbottom observations, surface sediment corings, rock samplings, long-term temperature monitoring, natural gamma ray analysis were carried out, and we have found that there were, for example, geochemical anomalies of cold seepage, very high thermal gradient effected by up-dip fluid migration and high radionuclide anomalies of uranium series along the mega-splay fault branching from the plate boundary fault.

The cruise YK06-03 deployed seep monitoring system for one year. We put four flow-meters named "CAT-meter" on the base of the fault scarp in the maga-splay fault off Kumano, and one CAT-meter and one ERI long-term temperature monitoring system at the bacterial mats in the No. 8 Kumano Knoll. All instruments were retrieved by the ROV "HyperDolphin" during NT07-E01.

The site Aa is located at the upper slope of the accretionary prism that is also the southern flank of the outer arc high. It corresponds to the zone where the splay fault reaches to the seafloor. In this zone, a number of bacterial mats have been observed by the submersible dives. The site Ca is a primitive mud volcano in the Kumano Trough, which is about 40 meter high and has some cold seep sites at the foot of the knoll.

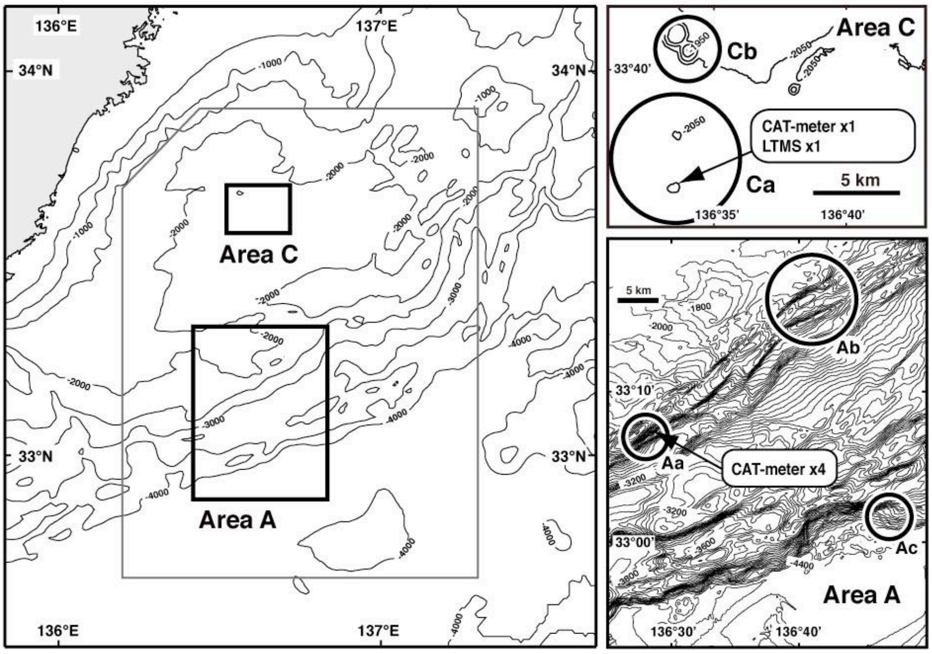


Fig. 4-1 Dive sites during YK06-03 and NT07-E01.

5. Operation and Instruments

5.1 CAT-meter

The Chemical and Aqueous Transport (CAT) meter (Fig. 5.1-1**)** is designed to quantify both inflow and outflow rates on the order of 0.01 cm/yr to 100 m/yr by Scripps Institution of Oceanography, University of California San Diego. At high outflow rates, a time series record of the outflow fluid chemistry may also be obtained. These instruments have been in use since 1998 and have been very successful in monitoring long term fluid flow in both seep and non-seep environments. The CAT meter uses the dilution of a chemical tracer to measure flow through the outlet tubing exiting the top of a collection chamber. The pump contains two osmotic membranes that separate the chambers containing pure water from the saline side that is held at saturation levels by an excess of NaCl. Due to the constant gradient, distilled water is drawn from the fresh water chamber through the osmotic membrane into the saline chamber at a rate that is constant for a given temperature. The saline output side of the pump system is rigged to inject the tracer while the distilled input sides of the two pumps are connected to separate sample coils into which they draw fluid from either side of the tracer injection point. Each sample coil is initially filled with deionized water. Having two sample coils allows both inflow and outflow to be measured. A unique pattern of chemical tracer distribution is recorded in the sample coils allowing a serial record of the flow rates to be determined. Upon recovery of the instruments the sample coils are subsampled at appropriate intervals and analyzed using a Perkin-Elmer Optima 3000XL ICP-OES. Both tracer concentration and major ion concentration (Na, Ca, Mg, S, K, Sr, B, Li) are determined simultaneously.

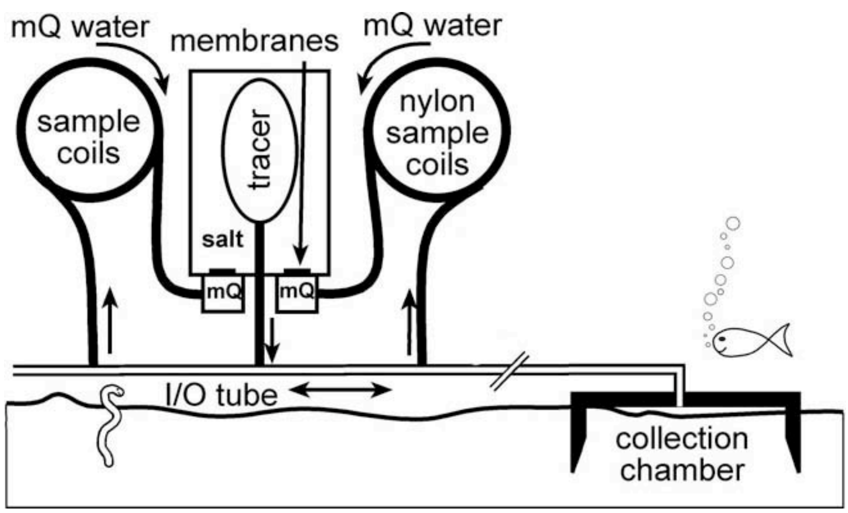


Fig. 5.1-1 Schematic diagram of CAT meter.

5.2 Gamma Ray Monitoring Sensor

Natural gamma -ray (NGR) activity in sediments arises from potassium, uranium and thorium contents, and has been used for lithological estimation by well logging. On this cruise, “Shinkai 6500” was equipped with gamm-ray spectrometer developed by IFREE. Sensor unit including 3 inch NaI (TI) detector was loaded at the base of the right side sample basket. Spectrum analyses of records provide us with total count of gamma ray, radionuclide contents of K, Th-series and U-series. Seafloor gamma-ray derived from radionuclide of sediments are measured during landing of the submersible although data are recorded during the dive.

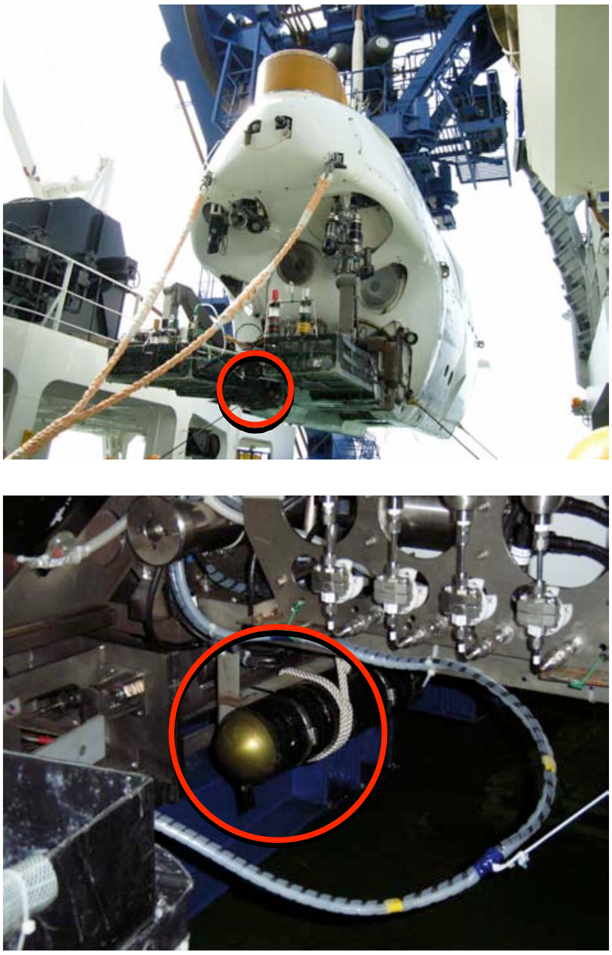


Figure 5.2-1 Gamma-ray spectrometer

5.3 Bottom-water temperature monitoring system

S. Goto and S. Morita (GSJ, AIST)

In heat flow measurement in shallow sea area, bottom-water temperature variation (BTV) with large amplitude prevents to measure accurate temperature gradient by penetrating geothermal probe. There are two methods to remove the effects of BTV from temperature gradient disturbed by BTV. One is that both bottom-water and associated sub-bottom temperature variations are monitored for a long-time. By removing the effects of BTV from the sub-bottom temperatures, non-disturbed temperatures is obtained. The other is that BTV is monitored for a long-time and then temperature gradient that is disturbed by BTV is measured. By removing the effects of BTV from the temperature gradient, non-disturbed temperature gradient is obtained.

Bottom-water temperature monitoring system (BTMS, Fig.5.3-1) is designed to monitor BTV for a long-time. This system is composed of a water-temperature recorder, a platform made of vinyl chloride, a buoy, and anchor weights. By measuring temperature gradient using geothermal probe such as SAHF (stand-alone heat flow meter) and removing the effects of BTV measured BTMS from the temperature gradient, we can obtain BTV-freed temperature gradient. During YK08-04 cruise, two bottom-water temperature monitoring systems (BTMS#1 and BTMS#2) were installed. Before recovery of the systems, heat flow measurements using SAHF will be performed. In the following, water-temperature recorders used are described.

Water-temperature meter (Nichiyu Giken Kogyo Co., Ltd.)

Model	NWT-DN
No.	79 (BTMS#1) and 166 (BTMS#2)
Material of pressure case	Alloy of titanium
Length	212 mm
Diameter	41 mm
Weight	7.0 kg in air (including platform and weight)
	4.5 kg in seawater (including platform and weight)
Number of thermistor	1
Accuracy	0.05 K
Sampling interval	20 min
Repeat of measurement	1
Measurement start	April 5, 2008 09:00:00

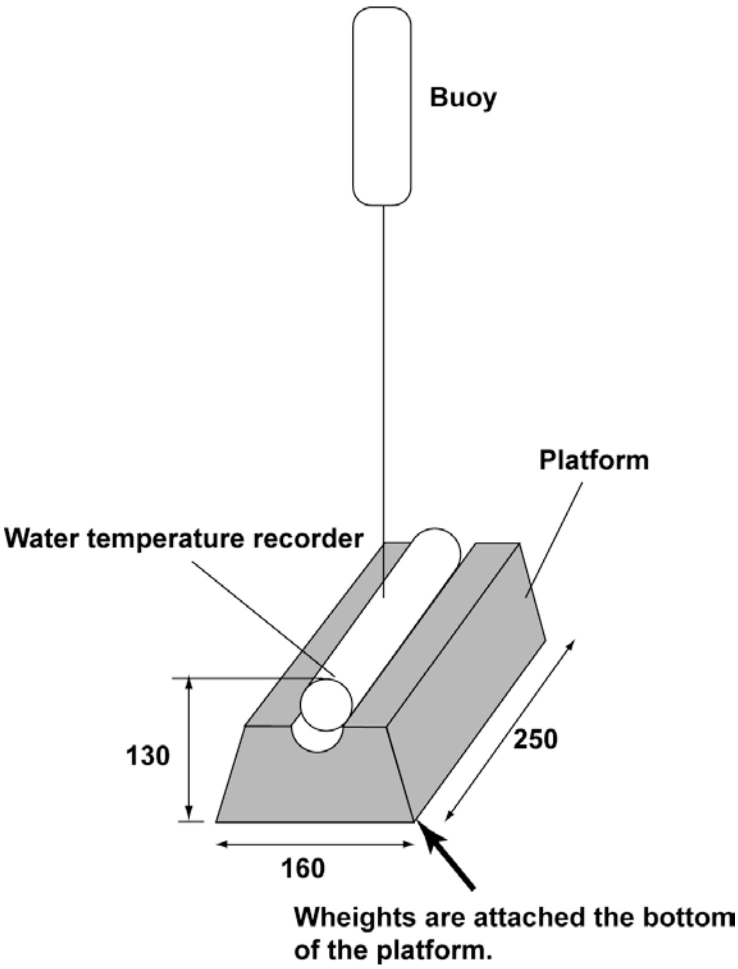


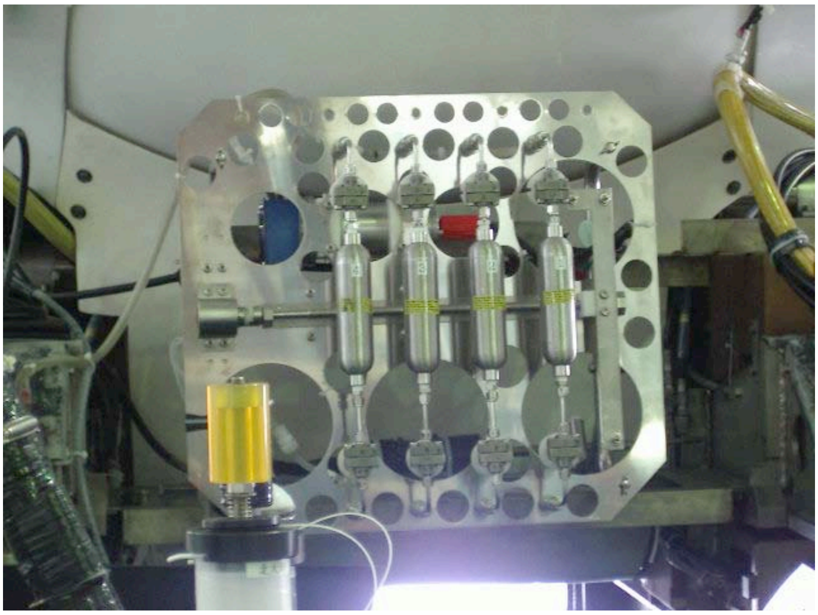
Fig. 5.3-1 Schematic illustration of Bottom-water temperature monitoring system

5.4 WHATS (Water and Hydrothermal *Atsuryoku* Tight Sampler)

A "WHATS" was designed to hold collected gas and gas-riched fluids tight during the ascent of the submersible. It consists of a pump, 4 stainless steel samplers, 8 revolving switch valves, and an inlet tube. By pumping out distilled water which had occupied a room of the sampler, the introducing sample waters sufficiently flows in a room. With rotation of the revolving switch valve, one sampler was closed and the next sampler becomes to be ready for sampling. The pump and the revolving switch valve can be controlled from a submersible cabin. For an inlet tube is set up as close to a vent as possible, the sampler is operated for collecting seeping fluid free from ambient seawater. At the same time of the sampling, fluid temperature is monitored using a thermometer attached to the top of the inlet tube. It takes about 7 minutes to fill up one sample room of 150 ml capacity. The following is description of this system in detail.

Description

Dimension of frame	600 mm × 660 mm
Weight	35.2 kg in air
	28.0 kg in seawater
Depth range	3000 m
Sample volume	150 ml × 4
Sampling rate	120 ml / min.
Battery	DC19-32 V / 1.0 A



WHATS attached to Shinkai 6500

5.5 MBARI-type core sampler

A “MBARI-short” is a tool to take surface sediment from the seafloor by using submersible *Shinkai 6500.* Especially, this tool is designed to collect interstitial water from the sampled sediment core in an on-board laboratory as quickly as possible without evaporation, degassing and contamination. The sampler has holes on the side of an acrylic inner tube in the interval of 5 cm and closed the holes before a dive. After recovery, we open the seal on the holes and put a 50ml syringe into the each hole for retrieval of interstitial water from sediment sample.

6. YK08-04 Cruise Log

2008/04/04

Weather: fine but cloudy/ Wind direction: NW/ Wind force: 2/
Wave: 1 m/ Swell: 1 m/ Visibility: 8 mile (12:00 JST)

10:00	Departure from JAMSTEC
11:00-11:30	Briefing about ship's life and safety
13:00-	Meeting about the cruise plan
19:00-20:00	Science meeting

2008/04/05

Weather: fine but cloudy/North/3/3/1/12 (12:00 JST)

05:01	XBT
05:56-06:30	MBES survey
10:00	Surface water sampling

6K#1061 dive (Observer: S. Morita, AIST)

11:15	Landing (2,380m)
16:01	Left bottom (2,305m)
19:00-20:00	Science meeting
19:09-19:52	MBES survey
21:48-22:31	MBES survey

2008/04/06

Weather: over cast/NE/4/3/1/8 (12:00 JST)

6K#1062 dive (Observer: J. Miyazaki, JAMSTEC)

11:16	Landing (2,568m)
15:49	Left bottom (2,503m)
19:00-20:00	Science meeting

2008/04/07 over cast/SE/6/5/4/10 (12:00 JST)

Dive canceled because of bad weather

09:11	XBT
09:44-	MBES mapping
19:00-20:00	Science meeting

2008/04/08 bc/NNW/7/6/4/10 (12:00 JST)

Dive canceled because of bad weather

19:00-20:00	Science meeting

2008/04/09 o/East/2/1/3/9 (12:00 JST)

6K#1063 dive (Observer: S. Morita, AIST)

11:01	Landing (2,059m)
14:13	Left bottom (2,056m)
13:00	Surface water sampling
16:30	Left the survey area
19:00-19:40	Science meeting

2008/04/10 (12:00 JST)

12:30	Scientist disembarkation at Yokosuka

Transit to the Ooarai Port

2008/04/11

09:00	Arrive at Off Ooarai port

2008/04/12

09:00	Arrive at Ooarai port, Scientists disembarkation

7.1 Dive Report of *Shinkai 6500* #1061

Morita, S. (AIST)

Date: April 5, 2008
Site Name: Oodai Ridge (Site C2)
Water Depth: 2220-2380 m
Landing: 33° 16.0151'N, 136° 40.4571'E, 11:15, 2380 m
Leaving: 33° 15.4287'N, 136° 39.6662'E, 16:06, 2305 m
Observer: Sumito Morita (Geological Survey of Japan, AIST)
Pilot: Yoshio Ohno, Co-Pilot: Hirofumi Ueki

Objectives:
"Oodai Ridge" is one of outer ridges formed by displacements of the mega-splay fault off Kumano. Deep-towed side-scan sonar "WADATSUMI" reveals NE-SW trending distinct lineament on the elongated basin north of the ridge. Westward continuity of this lineament cuts and displaces the Shionomisaki canyon. Right lateral displacement of the canyon axis suggests that this lineament correspond to the dextral strike slip fault. No seafloor observation by submersible dive around this lineament has been conducted. This dive tries to find outcrops of fault scarps and chemosynthetic biological community around this lineament.

Dive Summary:
Figure 7.1-1 shows the Shinkai vehicle's track of the Dive 1061 on bathymetric map of the north slope on Oodai Ridge. The vehicle basically went zigzag along the typical lineament on side-scan sonar image so as to find geological anomalies.

The vehicle landed at the center of north basin of the Oodai Ridge at the Point 2 at 11:15. Water depth was 2380 m. Water temperature was 1.7 degrees centigrade and the bottom current is very little. Visibility is 3 m. Sub-bottom material was hemi-pelagic mud, which forms slight waves in NE-SW direction.

At 11:16, the vehicle started moving toward the north slope of the Oodai Ridge in 180 degree direction, searching geological anomalies.

The slope gradually changed the grade to the steeper, and the vehicle at 11:34 reached very steep scarp where there are light gray mudstone outcrops. The scarp shows some scars of collapses. At some portions like such scars, fresh mudstone indicates gray.

At 11:42, the slope became gentle again. The sediments were hemi-pelagic mud.

At 11:48, the vehicle started zigzag navigation in the mean direction of 230 degree to search around the side-scan sonar lineament, and first switched the heading toward 320 degree and started going down the slope.

The slope changed to steep scarp again at 11:55. While going down the steep slope, it is almost impossible to observe seafloor condition. At 12:04, the vehicle reached back to the north basin. Sub-bottom material was still mud. Heading was changed to 180 degree.

At 12:11, the vehicle faced the scarp again, and at 12:22 reached gentle plain.

At 12:29, heading was changed to 320 degree to go down the slope. At 12:36, the vehicle reached and passed through the top of the steep scarp.

It was 12:43 when the vehicle reached down on the bottom in the north basin. Since there was nothing special observed, the vehicle changed its direction to 180 degree to go up the slope at 12:47.

On the way climbing up the slope, opened small clam shells were found on in the muddy seafloor at 13:16 at the Point 3. The shells were completely isolated and there is no associated object around.

At 13:21, one small shell was found on the seafloor, and at 13:26 also a small shell was found. These shells were also very isolated. Considering a possibility of clam colony upslope in this direction, the vehicle kept going up the slope farther until when it changed the heading to 350 degree at 13:29.

The vehicle went down the slope and reached on the north basin at 13:55. Heading was switched to 180 degree to go up the slope at 13:56.

The steep slope was passed through between 14:16 and 14:18. After reaching the gentle slope, small shell-like objects were observed on the gentle muddy slope for one piece at each time of 14:23, 14:24, 14:27 and 14:32. They are also isolated and far apart each other.

At 14:37, heading was changed to 350 degree. The search was kept going.

At 14:50, heading was changed to 190 degree. Still no geological anomaly was found.

At 15:02, the vehicle found manganese film-coated mud cobbles aligned in W-E direction at the foot of the slope.

Considering rest of the dive time, at 15:20 the vehicle shifted westward (280 degree) so as to cover the whole distance of the side-scan sonar lineament within the time limits.

At 15:35, heading was changed to 260 degree. At 15:41, heading was changed to 200 degree. At 15:52, heading was changed to 350 degree.

At 16:05, the time was over. The vehicle left the bottom at the Point 4. Water depth is 2305 m. As soon as leaving the bottom, 2 bottles of WHATs water sampler were operated just for examination.

Keywords:
Outer ridge, mega-splay fault, lineament

Instrumentation (Payload):

1. MBARI-type Core Sampler x5
2. Marker x3
3. Scoop x1
4. Sample Box x1
5. Gamma-ray sensor
6. WHATS
7. Seawater thermometer

Table 7.1-1 Location of events

Point	Time	X	Y	LAT	LON	Depth	Event
1	10:00:00	0.0	0.0	33° 16.0000' N	136° 40.5000' E		Landing Target
2	11:15:00	27.9	-66.6	33° 16.0151' N	136° 40.4571' E	2380	Landing Point
3	13:17:00	-849.2	-330.7	33° 15.5405' N	136° 40.2870' E	2256	Finding Shells
4	16:06:00	-1055.9	-1294.6	33° 15.4287' N	136° 39.6662' E	2305	Left Bottom

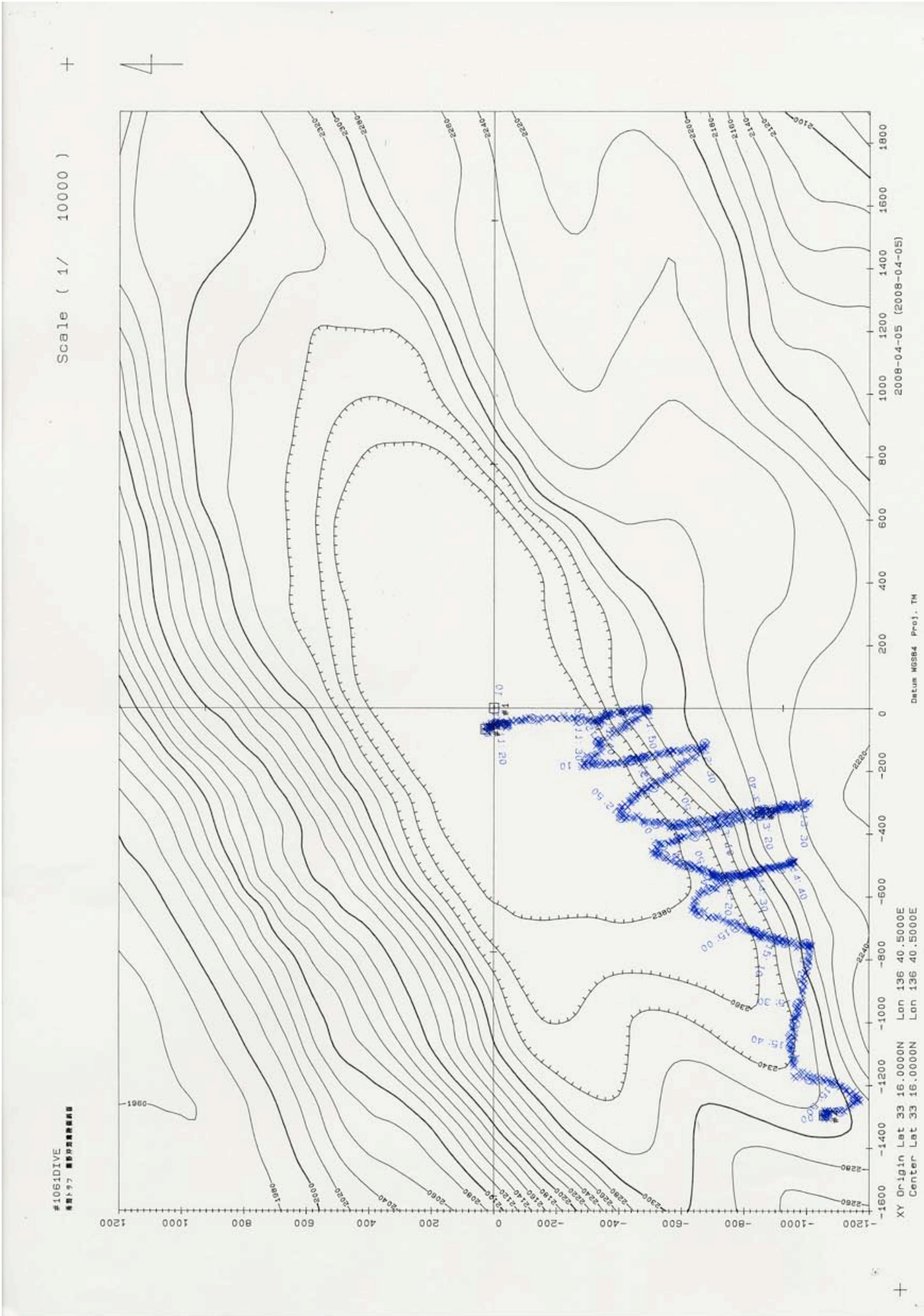


Fig. 7.1-1 The Shinkai vehicle's track.

Video digest:

11:12:24-11:12:47 2379m
The SHINKAI vehicle landed on the center of north basin of Oodai Ridge at the Stop 2. Subbottom material was hemi-pelagic mud.

11:16:17-11:16:35 2380m
Circumstance of the landing point.

11:19:59-11:20:17 2379m
The vehicle started moving toward the north slope of the Oodai Ridge. Subbottom material is still mud. Big red Jellyfish passed the camera view.

11:25:12-11:25:26 2378m
Mud on the seafloor shows slight waves in NE-SW direction.

11:32:58-11:33:15 2365m
Reaching foot of the north slope of the Oodai Ridge, some mud gravels appeared on the seafloor.

11:34:37-11:34:54 2353m
Cobble to pebble size of mud gravels rolling on the slope. The number of gravels gradually increased. Mud gravels are generally light gray.

11:35:32-11:35:53 2348m
Scar of the slope sediments collapse. Fresh scars show gray mud outcrops.

11:37:57-11:38:11 2337m
Flattened steep slope plain may indicate slip plain of itself.

11:38:21-11:38:50 2335m
Huge mudstone outcrop appeared on the scarp. The outcrop shows light gray mud strata and lots of gravels scattering in the slope.

11:39:08-11:39:26 2332m
Big scar of slope collapse. Fresh outcrop shows gray mud bed.

11:42:48-11:43:00 2311m
After passing through the scarp, the vehicle reached gentle slope where the seafloor is covered with mud.

11:47:51-11:48:07 2300m
Seafloor mud shows slight wavy forms indicating NE-SW elongation.

11:55:23-11:55:39 2308m
When going down, gentle slope suddenly changed to steep escarpment.

13:16:34-13:16:59 2258m
Open small clam shells were found on muddy slope at the Point 3.

13:25:23-13:25:38 2228m
One small shell found on the slope.

14:24:06-14:24:17 2300m
One small shell found on the slope.

1427:44:-14:27:54 2283m
Another small shell found on the muddy slope.

14:32:27-14:32:43 2261m
2 shells found on the slope.

14:35:00-14:35:06 2249m
Fish crossed the camera view.

14:35:54-14:36:06 2245m
Transparent pink sea cucumber.

14:49:43-14:50:06 2345m
Very many small white sea cucumbers floating in marine snow.

14:50:57-14:51:09 2360m
Big jellyfish or sea urchin (?) and a shrimp on the seafloor.
15:02:44-15:02:59 2335m
Manganese film-coated cobbles rolling on the foot of the north slope of the Oodai Ridge. They are aligned in W-E direction.

15:03:36-15:04:05 2330m
Gray scar outcrop on the steep escarpment. Small sea anemone and pink sea cucumber on the slope.

16:05:13-16:05:24 2305m
Water sampling tool of WHATs was got ready before leaving the bottom.

16:05:52-16:06:13 2305m
The vehicle left the bottom at the Point 4.

Photo 7.1-1 Hemi-pelagic mud on the landing point at the center of north basin of Oodai Ridge. 11:07am. (Point 2)

Photo 7.1-2 Wavy surface around the landing point. Waves trend NE-SE direction. 11:08am.

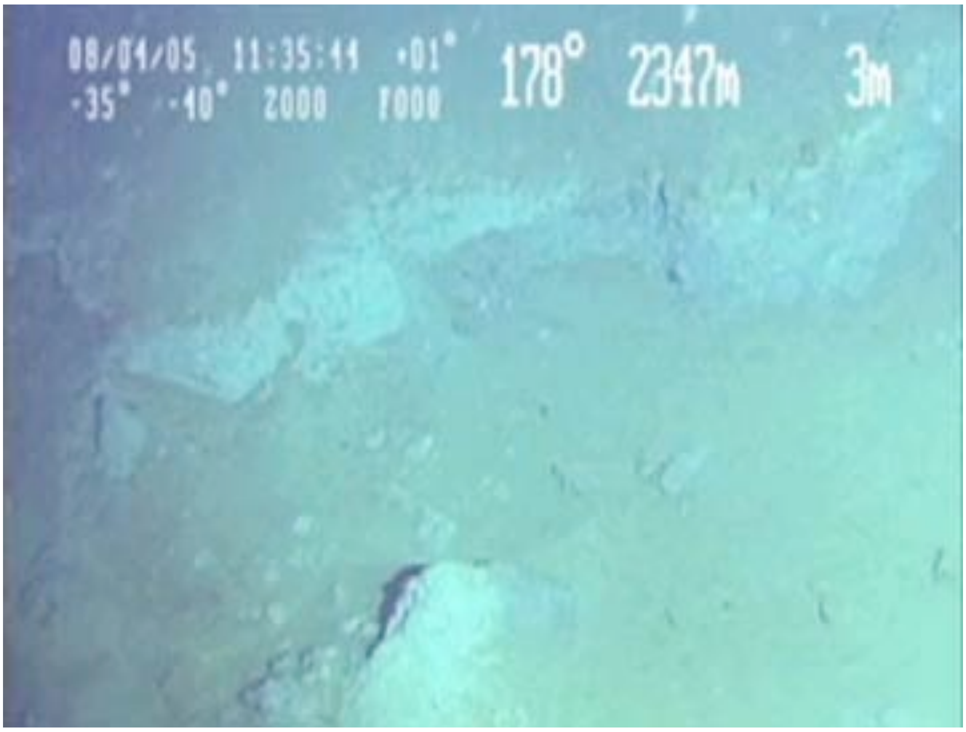


Photo 7.1-3 Scar of slope collapse and detached mud blocks. 11:35am. (from video camera 1)

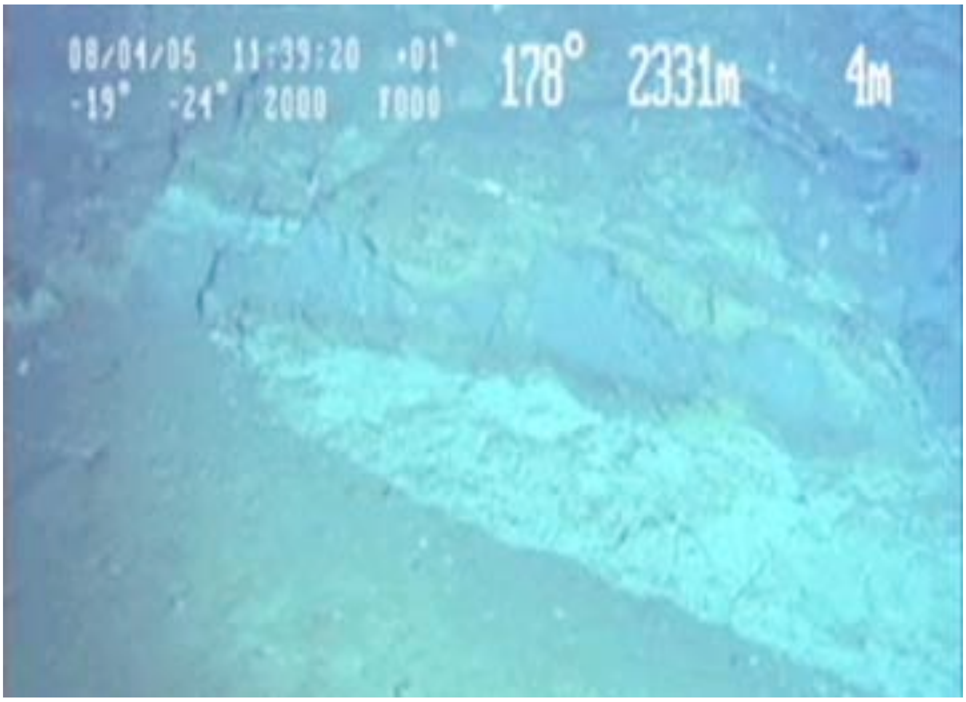


Photo 7.1-4 Revealed outcrop by collapse of escarpment. Fresh outcrop shows gray mud. 11:39am. (from video camera 1)

Photo 7.1-5　Light gray mudstone outcrop on the steep slope. 11:40am.

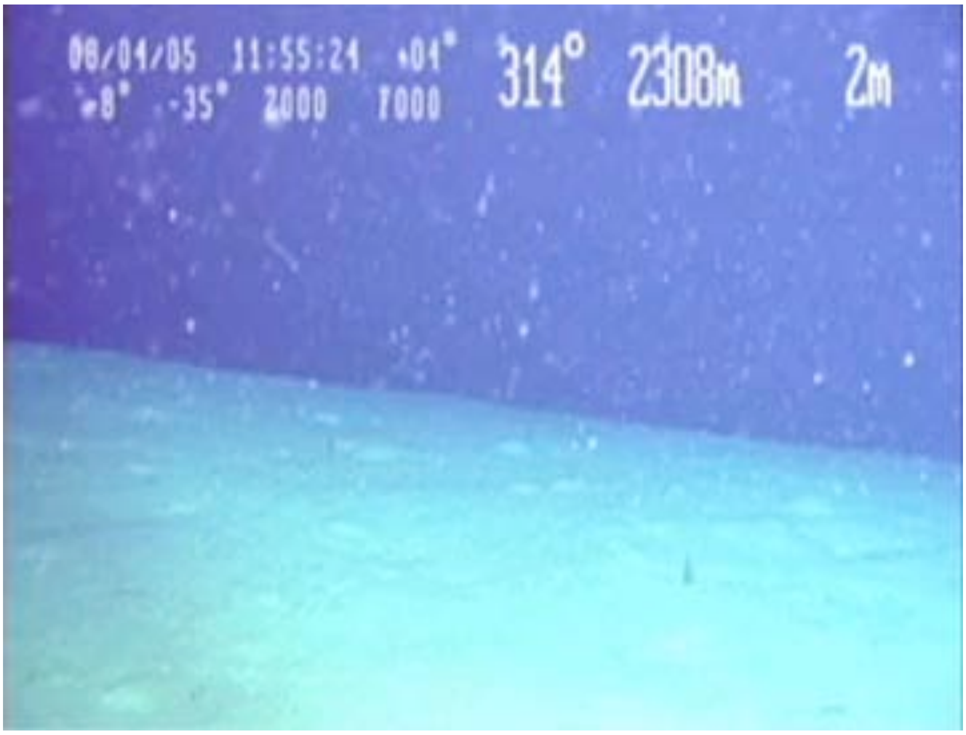


Photo 7.1-6　Downslope view from the top of the escarpment. The grade of the slope rapidly changes. 11:55am. (from video camera 1)

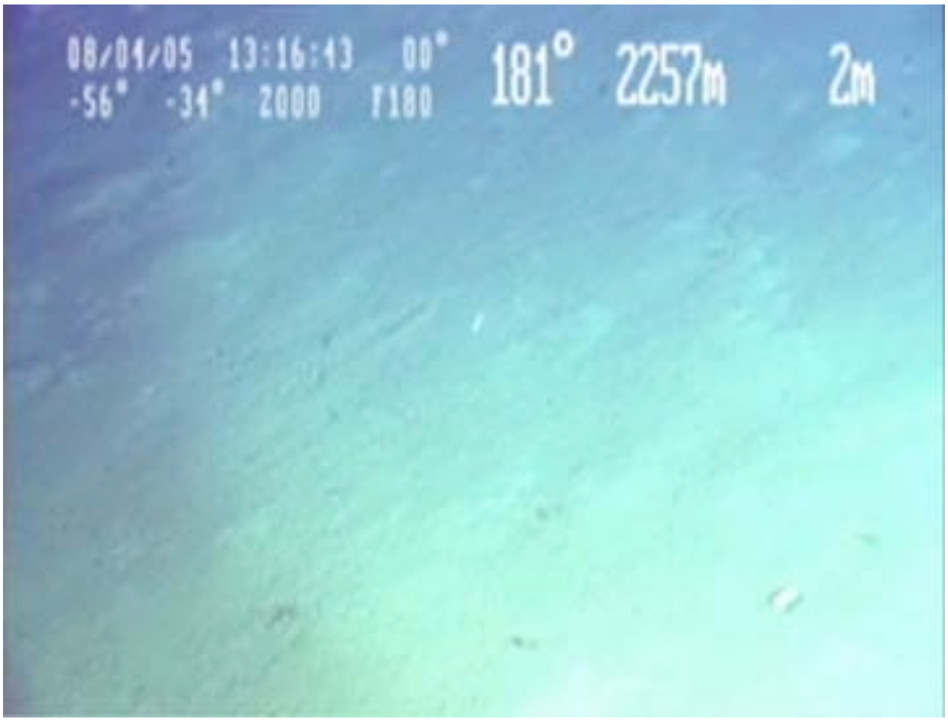


Photo 7.1-7 Open clam shells on the muddy slope (right bottom). There are no associates nearby. 1:16pm. (from video camera 1)

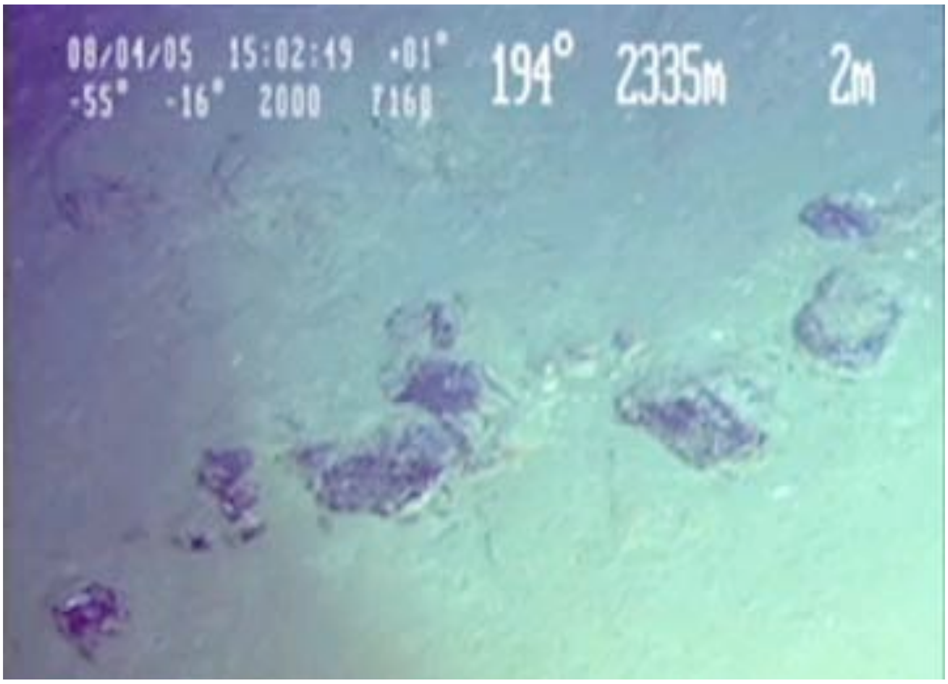


Photo 7.1-8 Mn-coated blocks were found at the foot of the north slope of Oodai Ridge. The rocks were aligned in W-E, according to the slope strike. 3:02pm. (from video camera 1)

Photo 7.1-9　Scar of collapse on the steep slope. 3:06pm.

Photo 7.1-10　Mudstone outcrop exposed by slope collapse. Difference in color indicates variation in freshness of mudstone outcrop. 3:12pm.

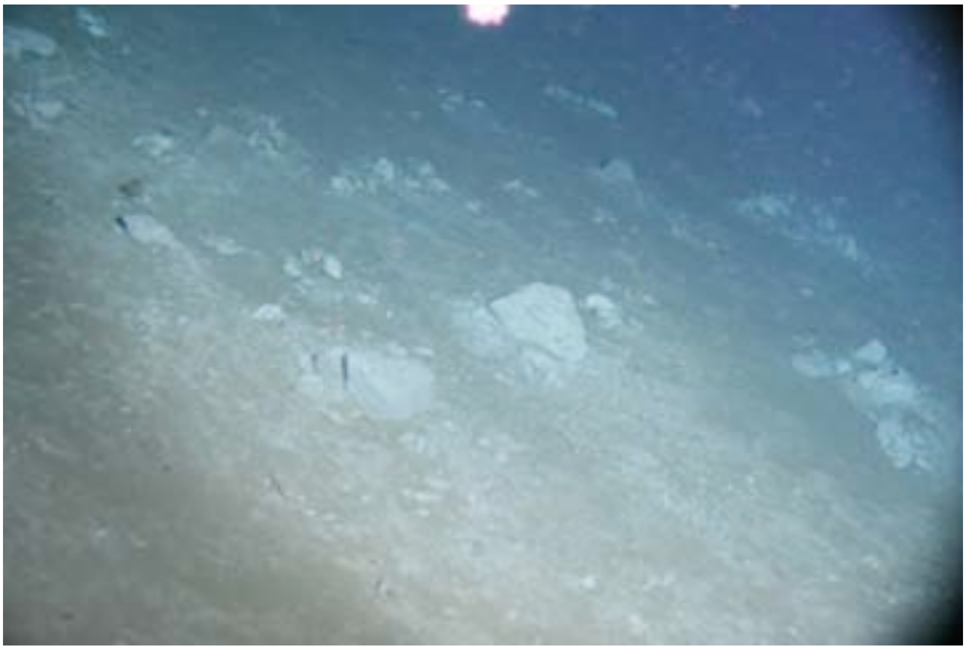


Photo 7.1-11　Rolling mudstone blocks derived by collapse on the steep slope. 3:34pm.

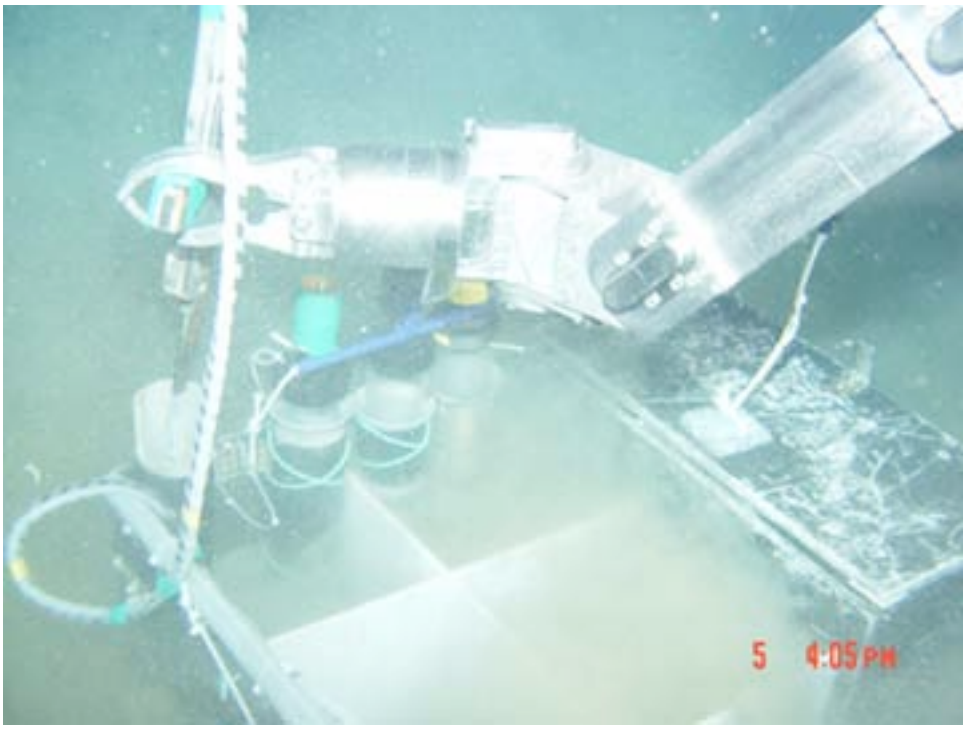


Photo 7.1-12　The vehicle left the bottom and prepared for WHATs water sampling test. 4:05pm.

7.2 Dive Report of *Shinkai 6500* #1062

Miyazaki, J. (SUGAR, JAMSTEC)

Date: April 6, 2008
Site Name: Oomine Ridge at Nankai trough
Water depth: 2530-2560 m
Landing: 33°7.3373'N, 136°28.8217'E, 11:16, 2558m
Leaving: 33°7.2456'N, 136°28.5846'E, 15:49, 2503m
Observer: Junichi Miyazaki (SUGAR, JAMSTEC)
Pilot: Keita Matsumoto
Co-Pilot: Tetsuya Komuku

Objectives:

"Oomine Ridge" is the surface expression formed by the mega-splay fault off Kumano. Our group has observed a large number of cold seep sites along the NE-SW trending small terrace at the middle slope of the fault scarp. Long-term measurements of formation temperature and geochemical analysis of pore fluids indicate active fluid expulsion including methane. We deployed long-term seep meters named "CAT-meter" for fifteen months and observed gradual decay of seep activity. The primary objective of this cruise is deployment of CAT-meters at an active seep site to obtain more information about variations of seep rate and tectonic activities such as VLF. Secondary objective is to take surface sediment samples for microbiological study and geochemical study. We also try to find barite chimney collected during YK06-03.

Dive Summary

The track of DSV *Shinkai* 6500 dive 1062 was demonstrated in the Fig. 1. This dive was carried out by a 2520 m counter line from northeast to southwest of "Oomine ridge". The purposes of this dive 1062 were deployment of CAT-meter and seawater temperature meter, and sampling of core sediments from anoxic methane-seep. These purposes were achieved in this dive 1062. However, the third purpose which was finding of barite chimneys could not accomplished. The events of this dive 1062 were described below.

The *Shinkai* vehicle was landed on the middle terrace of the fault scarp at 11:16. The landing site was covered with hemi-pelagic mud. Water depth was 2558 m. Water temperature was 1.7°C. The vehicle started to move toward north.

At 11:26, we found the small and white microbial mats (33°7.3517'N, 136°28.8157'E) on a comparably steep slope. Several tubeworms were also found. The surface of this area was covered with small stones. However, we did not land on here because these microbial were too small to deploy the CAT-meter.

At 11:35, we found the Marker 35. We moved in close to the marker 35 and reached at 11:40. At this site, white microbial mats were found and several tubeworms were also found on a gentle slope covered with small stones. These microbial mats were comparably larger than the microbial mats found at 11:26.

At 11:50, we landed near Marker 35 and tried to deploy the No. 5 CAT-meter. However, we found the right manipulator of the vehicle could not control. Therefore trying to CAT-meter was carried out using left manipulator. The No.5 CAT-meter was deployed at the largest mat in here (12:17). We leaved from here and went west to find Marker 34 and 58.

At 12:29, we reached at the site Marker 34 and 58. We observed the large microbial mats on a gentle slope. The surface of this area was covered with small stones. We tried to deploy the No.17 CAT-meter and seawater temperature meter. The No. 17 CAT-meter set up at largest and whitest microbial mat (12:55). The seawater temperature meter also deployed at 1.5 m apart from Marker 34 where microbial mats did not formed (13:00). We also sampled core sediments at this site. By MBARI core sampler (Green), we obtained 25 cm core sediments from the microbial mat. And also 10 m apart from the former core-sampled site, we obtained 25 cm-core sediments by MBARI (Black).
At 13:30, we left this site and went southwest along the counter line.

At 13:55, we found the Marker 37. At this site, several small microbial mat and tubeworms were observed on a gentle slope covered with small stones. And we also found a living calyptogena. We did not perform sampling because the microbial mats in this area were comparably small and the small stones were larger than those of sampling site described before so that it is difficult to obtain core sediment. We continued to go southwest along 2520 m counter line.

At 14:41, we found the Marker 61. Around the marker, the microbial mats were observed on steep slope. The surface of this area was covered with small stones. To look for the barite chimney, we moved east along the contour line.

At 15:05, we re-reached the Marker 37. In the track between Marker 61 and Marker 37, several tubeworm colonies were observed. However, there were no chimneys. Therefore, we returned to the Marker 61 and continued to look for chimneys.

At 15:15, we re-reached the site Marker 61, and we could not find the chimneys. Therefore, we gave up finding the barite chimneys. We tried to sample core sediments at this site. First, we tried to obtain sediment core samples from white microbial mat using MBARI (Yellow). We got the 20 cm core sediments and the color of core sediments was black (15:29). 2nd, we obtained the core sediments using MBARI (Red) from reference site 60 cm apart from the MBARI (yellow) coring site (15:35). 3rd, we retried to get the core sediments from white microbial mat because we wanted to obtain long size core sediments. However, we could only obtain 25 cm core sediments by 50 cm size MBARI (white)(15:42).

At 15:49, we left the seafloor and went back to the R/V *Yokosuka*. The gamma-ray sensor looked like good among this dive 1062.

Keywords

Active cold-seep, Bacterial mat, Methane

Instruments (Payload)

1. CAT-meter x 2 (No. 5 and 17)
2. Seawater temperature meter
3. Gamma-ray sensor
4. Marker x 3
5. MBARI push core sampler (50 cm x 2 (White and Red), 35 cm x 3 (Yellow, Green, Black)
6. Scoop
7. WHATS (Water and Hydrothermal-fluid Atsuryoku Tight Sampler)

Samples

In this dive 1062 of DSV Shinkai 6500, we could obtain 5 core sediments from Oomine ridge. We named these MBARI core sediments (green, black, yellow, red, white), C1, C2, C3, C4 and C5, respectively. The color of C1, C3 and C5 core sediments were black, suggesting anoxic methane oxidation coupling with sulfate-reduction occurred in these core sediments. While the color of C2 and C4 were blown at the surface region and gray at the 10 – 25 cm region. The smell of hydrogen sulfide was observed from C1, C3, and C5 core sediments, and 15-25 cm region of C4. And also these core samples contained many of small stones. These core sediments will be utilized for geochemical and microbiological research and the small stones in these sediments will be analyzed geologically.

And also we obtained the rock samples from this dive. These rock samples named R1 were in sample basket. We could not find where these rock samples were in basket. It was thought that these rock samples were in bascket when DSV Shinkai landed on the seafloor or contacted with slope. These samples will be analyzed geologically.

Table 7.2-1 **Location of events**

Point	Time	X	Y	LAT	LON	Depth	Event
1	10:00	1201.3	1011.0	33°7.2500'N	136°28.75'E		Landing Target
2	11:16	1362.7	1122.5	33°7.3373'N	136°28.8217'E	2558	Landing Point
3	11:26	1389.3	1113.2	33°7.3517'N	136°28.8157'E	2553	Finding microbial mat
4	12:17	1407.6	1020.3	33°7.3616'N	136°28.7560'E	2530	Deployment #5 CAT-meter
5	12:55	1382.6	986.3	33°7.3481'N	136°28.7341'E	2528	Deployment #17 CAT-meter
6	13:00	1382.6	986.3	33°7.3481'N	136°28.7341'E	2528	Deployment seawater temperature meter
7	13:16	1382.6	986.3	33°7.3481'N	136°28.7341'E	2528	Sampling MBARI (Green)
8	13:24	1382.6	995.6	33°7.3481'N	136°28.7301'E	2531	Sampling MBARI (Black)
9	14:41	1184.5	773	33°7.2409'N	136°28.5970'E	2529	Finding #61 Marker
10	15:15	1182.5	797.8	33°7.2398'N	136°28.6129'E	2532	Finding #61 Marker
11	15:29	1173.2	773.6	33°7.2348'N	136°28.5974'E	2530	Sampling MBARI (Yellow, Red, White)
12	15:49	1193.2	753.7	33°7.2456'N	136°28.5846'E	2503	Left Bottom

Table 7.2-2 **Sample list**

Event mark No.	Sample No.	Sampling date	Water depth (m)	Latitude	Longitude	X	Y	Photo	Sample type	etc.
5	C1	2007.4.6	2528	33°7.3481'N	136°28.7341'E	1382.6	986.3	○	Mud containing small stones	MBARI (Green)
5	C2	2007.4.6	2531	33°7.3481'N	136°28.7301'E	1382.6	995.6	○	Mud	MBARI (Black)
11	C3	2007.4.6	2530	33°7.2348'N	136°28.5974'E	1173.2	773.6	○	Mud containing small stones	MBARI (Yellow)
11	C4	2007.4.6	2530	33°7.2348'N	136°28.5974'E	1173.2	773.6	○	Mud	MBARI (Red)
11	C5	2007.4.6	2530	33°7.2348'N	136°28.5974'E	1173.2	773.6	○	Mud containing small stones	MBARI (White)
?	R1	2007.4.6	?	?	?	?	?	○	Small stones	

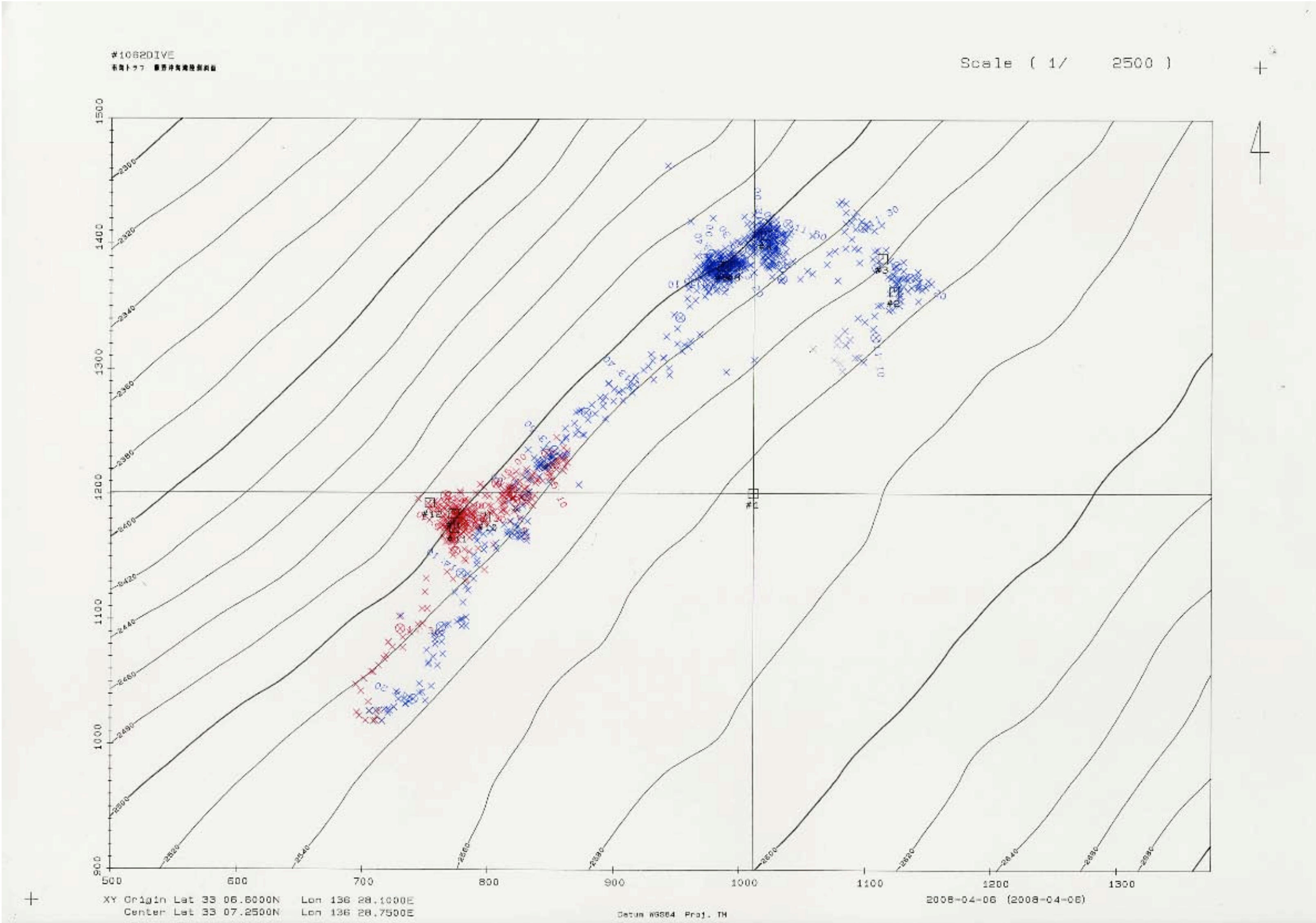


Fig. 7.2-1 The track of No. 1062 *Shinkai* 6500 dive

Video Digest

11:14-11:16
Landing the seafloor.

11:26
Finding microbial mat at

11:40-11:42
Overview around the No. 35 marker.

12:06-12:07
Deployment No. 5 CAT-meter at the site, the No. 35 marker.

12:29-12:33
Overview of No.58 and 34 markers.

12:43-12:45
Deployment No. 17 CAT-meter at the site, No.58 and 34 markers.

12:58-12:59
Deployment the seawater temperature meter and arrangement of No. 34 marker, No. 17 CAT-meter, and the seawater temperature meter.

13:14
Sampling MBARI (Green) core sediments at the site, No. 34 and 58 markers.

13:23
Sampling MBARI (Black) core sediments at the site, No. 34 and 58 markers.

15:22
Overview around No. 61 marker.

15:27-15:28
Sampling MBARI (Yellow) core sediments at the site, No. 61 marker.

15:34-15:35
Sampling MBARI (Red) core sediments at the site, No. 61 marker.

15:40
Sampling MBARI (White) core sediments at the site, No. 61 marker.

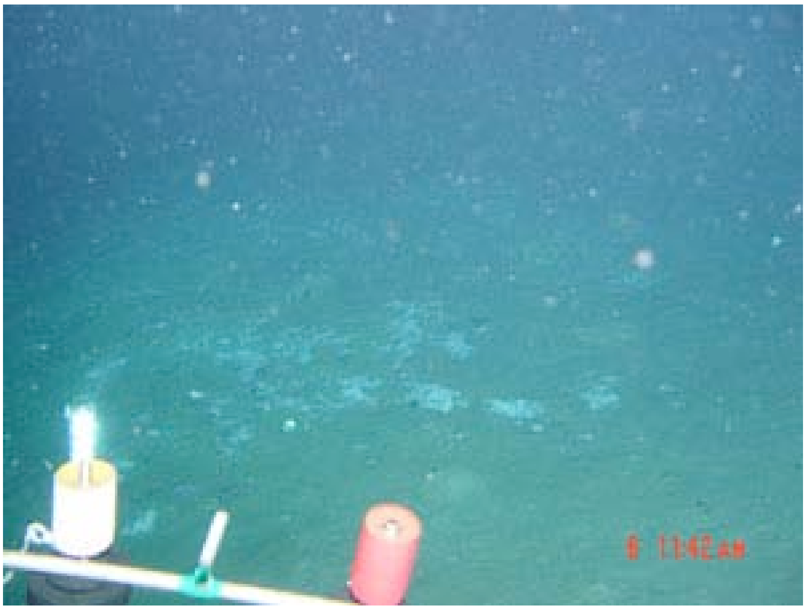


Fig. 7.2-1   Overview around the No. 35 marker.

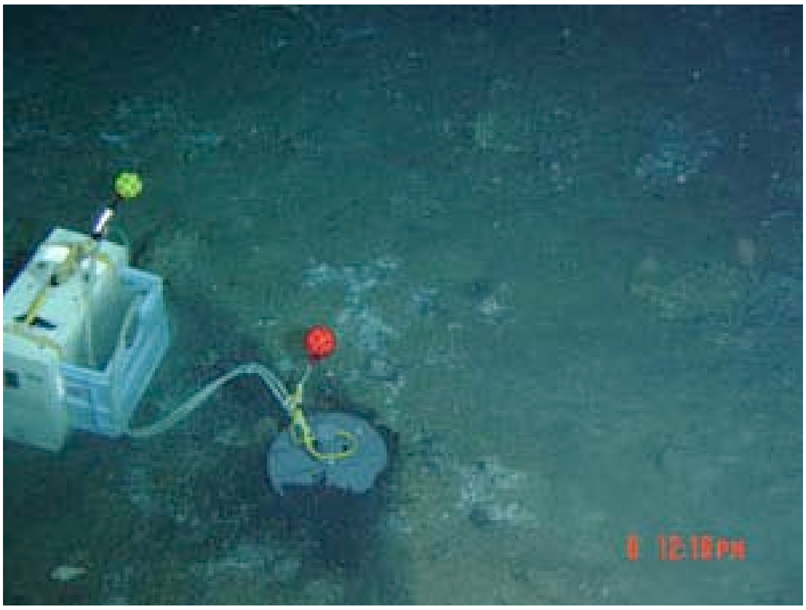


Fig. 7.2-2   Deployment of No. 5 CAT-meter

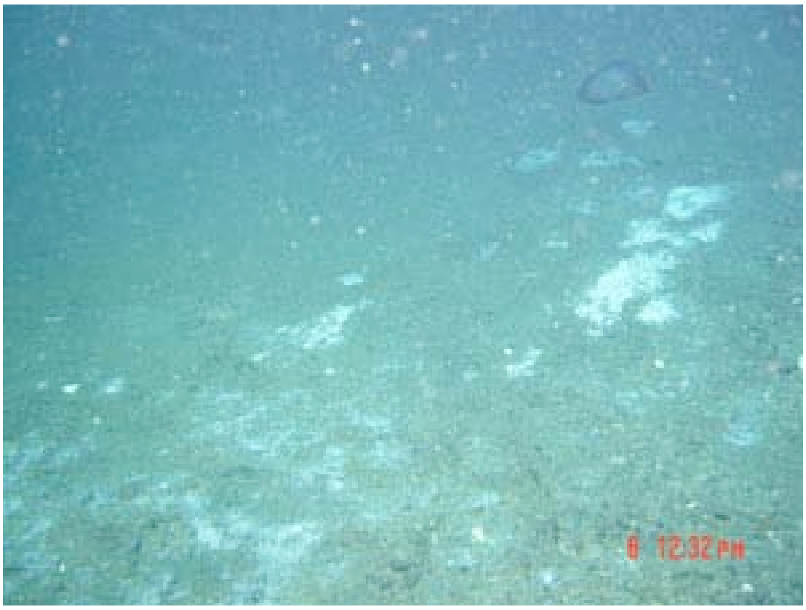


Fig. 7.2-3　Overview around Marker No. 34 and No. 58

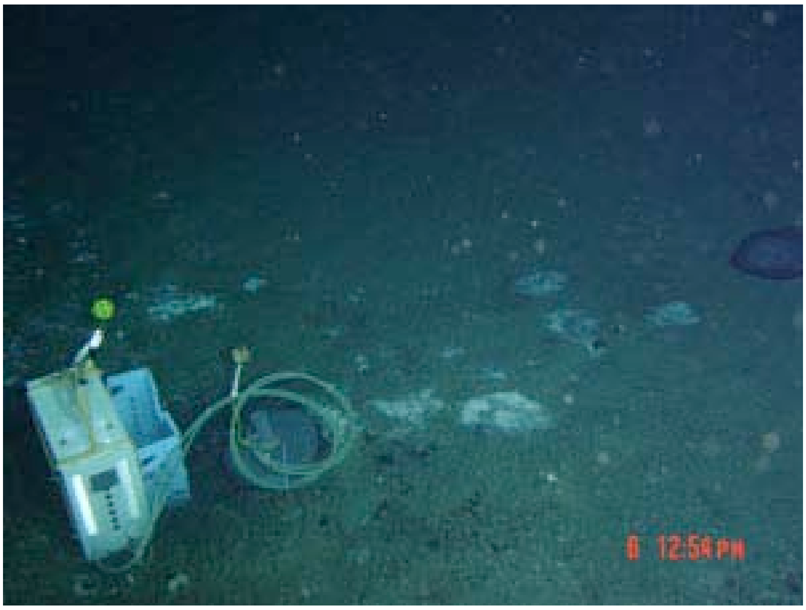


Fig. 7.2-4　Deployment No. 17 CAT-meter

Fig. 7.2-5 Deployment the seawater temperature meter

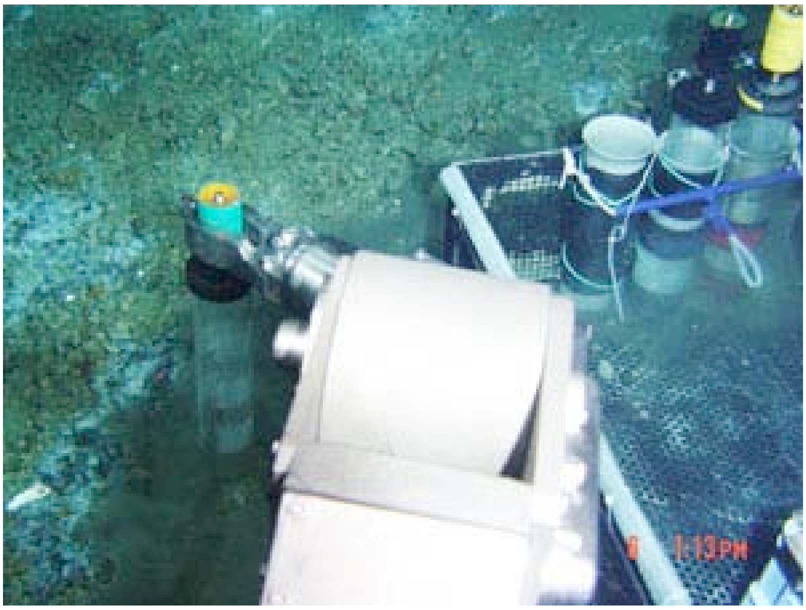


Fig. 7.2-6 Sampling core sediments by MBARI (Green)

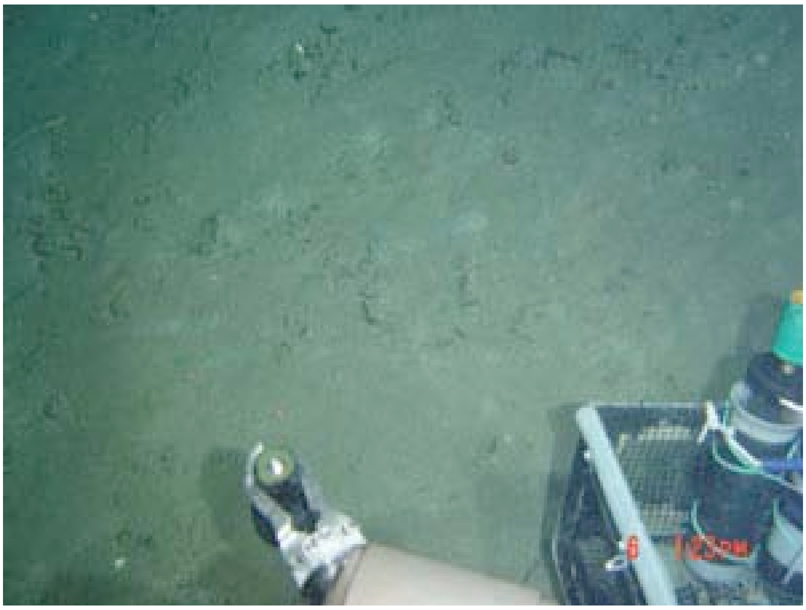


Fig. 7.2-7 Sampling core sediments by MBARI (Black)

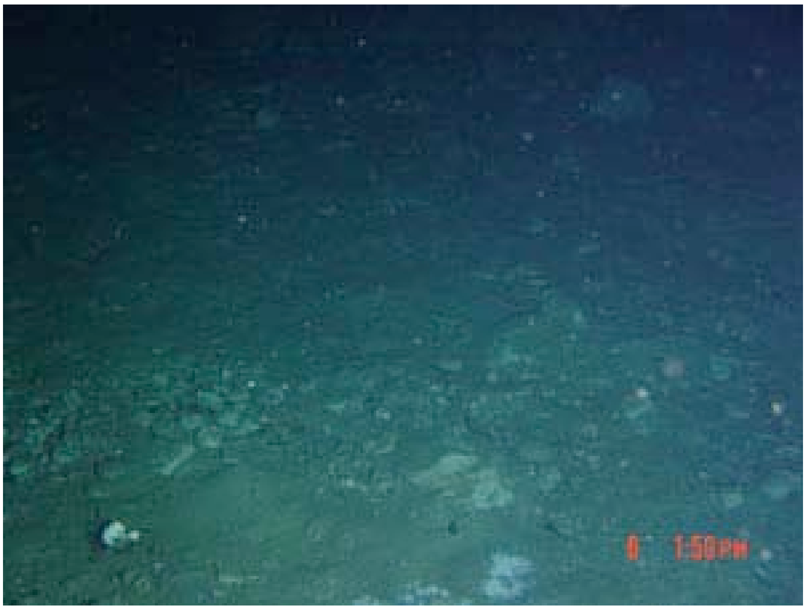


Fig. 7.2-8 Overview around Marker No. 37

Fig. 7.2-9   Tubeworms around the Marker No. 37

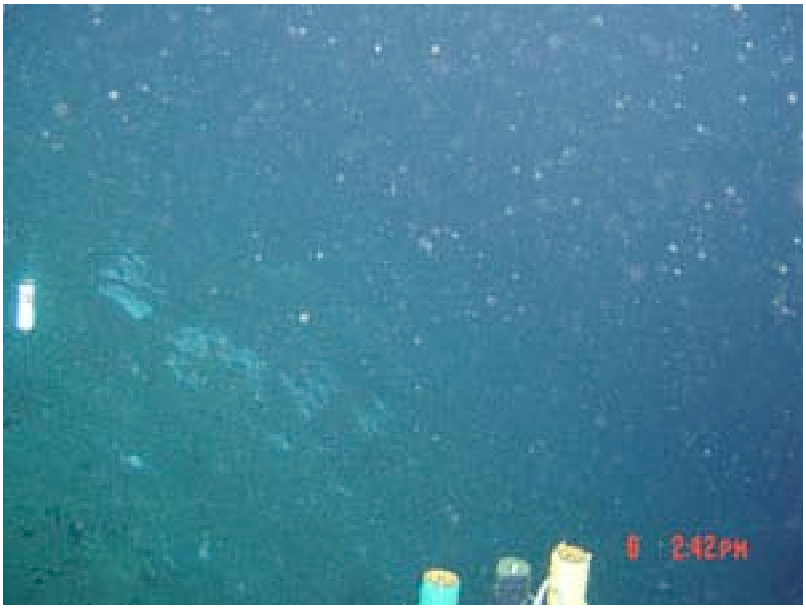


Fig. 7.2-10   Overview around Marker No. 61

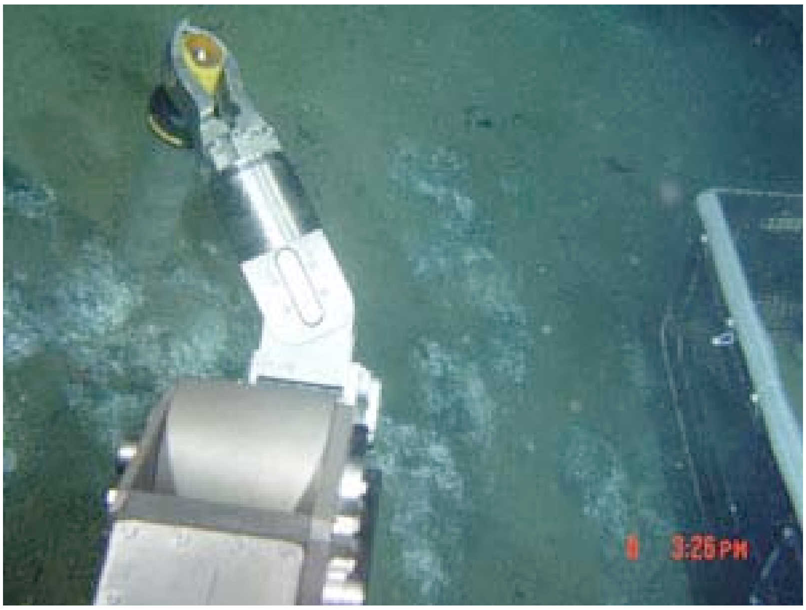


Fig. 7.2-11　Sampling core sediments by MBARI (Yellow)

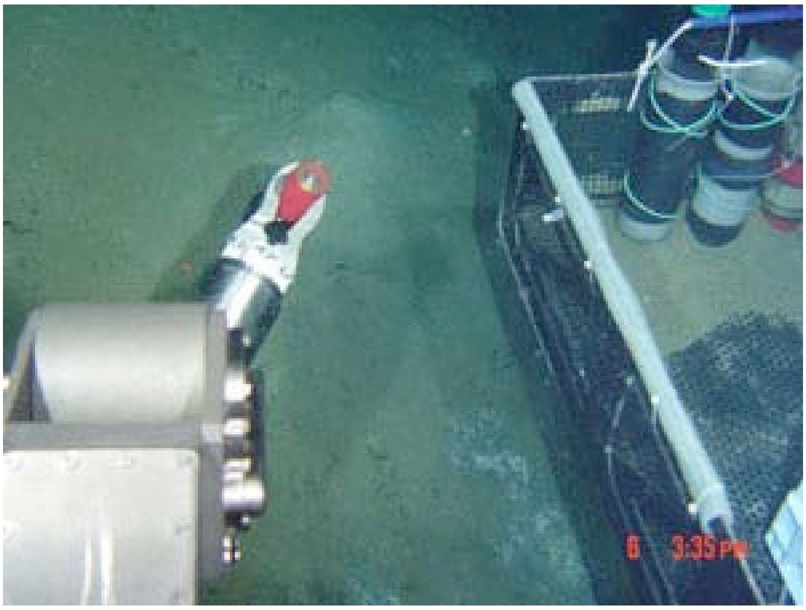


Fig. 7.2-12　Sampling core sediments by MBARI (Red)

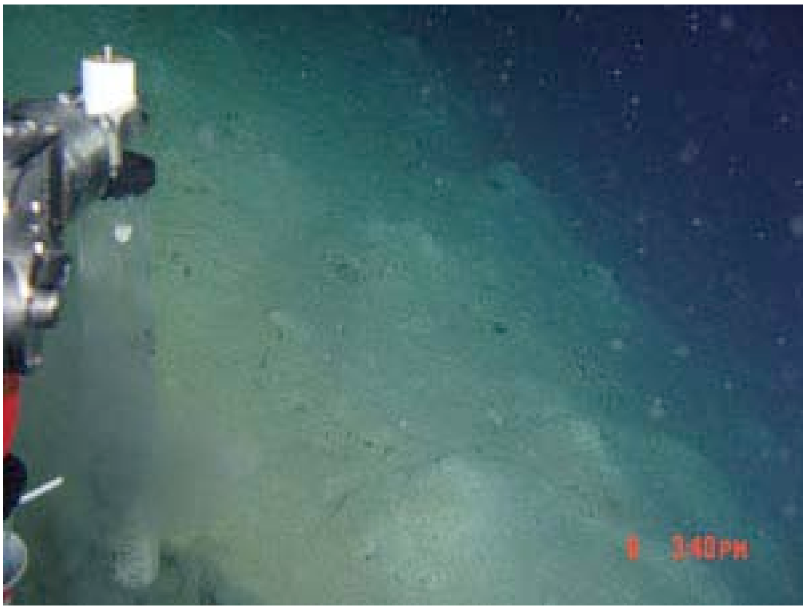


Fig. 7.2-13 Sampling core sediments by MBARI (White9)

Fig. 7.2-14 The core sample C1 (MBARI Green)

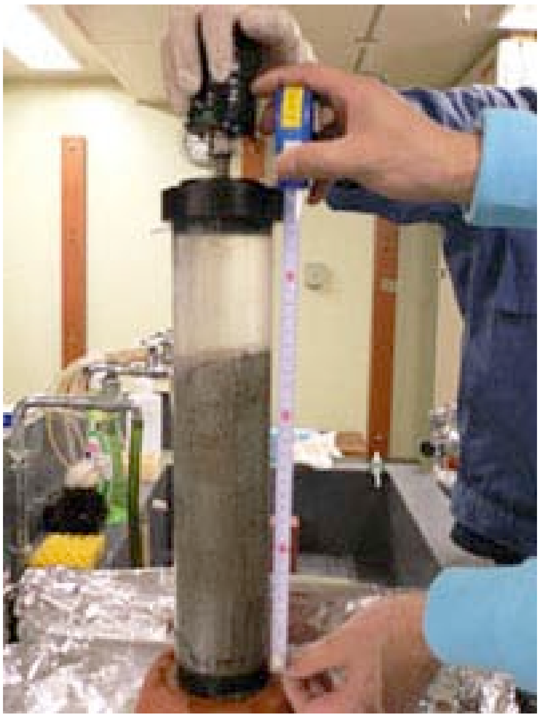


Fig. 7.2-15 The core sample C2 (MBARI Black)


Fig. 7.2-16 The core sample C3 (MBARI Yellow)


Fig. 7.2-17 The core sample C4 (MBARI White)

Fig. 7.2-18 The core sample C5 (MBARI Red)

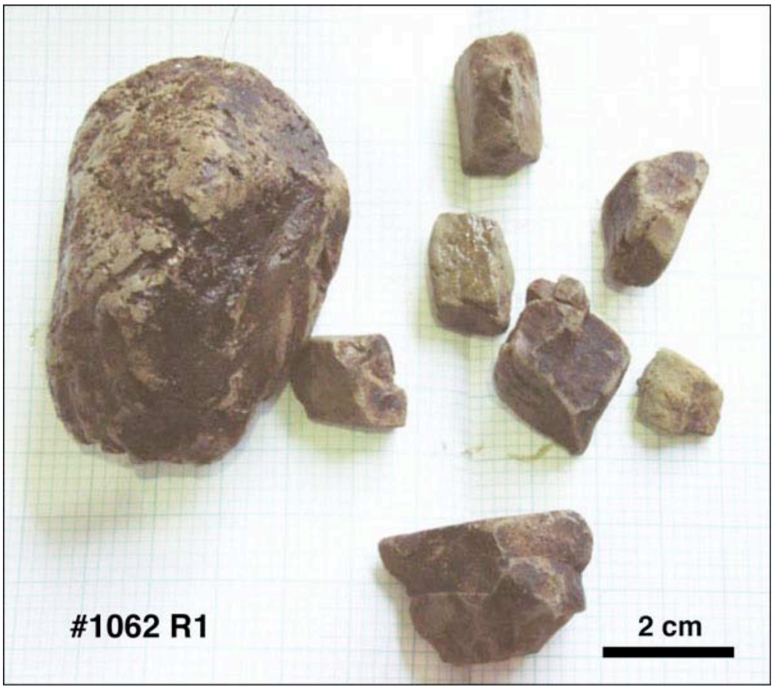


Fig. 7.2-19 The rock sample R1

7.3 Dive Report of Shinkai 6500 #1063

Sumito Morita

Dive Report of *Shinkai 6500* #1063

Date: April 9, 2008
Site Name: Dai-hachi Kumano Knoll (C3 site)
Water Depth: 2050-2060 m
Landing: 33° 36.1535'N, 136° 33.1720'E, 11:01, 2059 m
Leaving: 33° 35.9849'N, 136° 33.5884'E, 14:13, 2056 m
Observer: Sumito Morita (Geological Survey of Japan, AIST)
Pilot: Yoshitaka Sasaki, Co-Pilot: Yosuke Chida

Objectives:

Dai-hachi Kumano Knoll is a juvenile mud volcano which is about 40 meter in height and 0.8 kilometer in diameter. Previous SHINKAI and AUV dives revealed that the knoll has thick roof sediments which correspond to the surrounding trough sediments, and that very active bacterial mats (wide discolored zone) and Calyptogena colonies occur at some areas along the foot of the knoll. This SHINKAI dive aims to make sure how cold seep distribute and to take some sediment cores and very near surface water samples for geochemical and microbiological analyses. Seawater thermometer is adopted for long term monitoring of bottom water temperature.

Dive Summary:

Figure 7.3-1 shows the Shinkai vehicle's track of the Dive 1063 on bathymetric map of the Dai-hachi Kumano Knoll. The vehicle basically went along the southern foot of the knoll, where cold seeps are expected.

The vehicle landed at the southwestern foot of the knoll at the Point 2 at 11:01. Water depth was 2059 m. Water temperature was 1.9 degrees in centigrade and the bottom current was 10cm to 250 degree. Visibility is 6 m. Sub-bottom material was mud.

At 11:02, the vehicle started moving to the east to find the point of Marker #32 where a wide discolored area accompanying Calyptogena communities was found by the previously performed Dive 946.

On the way to the east, dead Calyptogena shells and isolated tubeworm were identified in places.

The vehicle once could not find the Marker #32, however, many dead Calyptogena shells were observed around the area of the marker at 11:33 (Points 3 and 4).

At 11:48, after passing over this area, a huge carbonate block on the mud was found at the Point 5. The block is about 2m wide and 2m high. It is unclear whether the block was formed at this location or was tumbled down from the flank of the mound.

At 12:22, after right turning round, the vehicle returned to former position and found the Marker #32 at last (Point 6).
Around the area of the Maker #32, there were lots of Calyptogena shells but they all look dead. The last time we visited this location on the Dive 946, there was wide discolored zone of bacterial mats on the mud where there are a number of short spaghetti-like worms within the discolored zone and are many living Calyptogena surrounding the zone. However, discolored zone could not be observed this time and Calyptogena seem to have died in the last two years. Trace of the discolored zone is rather rough than other smooth mud surface. Anemic carcasses of the spaghetti-like worms were remained within the south zone.

After leaving the area of the Marker #32, the vehicle started moving to the southeastern foot of the mound where there are some bright reflection spots on AUV Urashima's sidescan sonar image.
On the way to the east, there also some Calyptogena shells but most of them seem to be dead.

When hanging around the area of the bright reflection spots, the scraped marks by the vehicle's bottom was found to show black color of sulfate although discolored zone was not found. Some Calyptogena in this area seem to be alive. Spaghetti-like worms were also observed.

At 13:46, very near surface water sampling was done for two bottles of WHATs just on the black colored scraped mud. And normal bottom water was also taken for the other two bottles of WHATs. (Point 7)
At 13:51, MBARI push corings (yellow: C1) was done on spaghetti-like worms near the point of WHATs water sampling (Points 8). At 13:56, MBARI push corings (black: C2) was done on the normal mud sediments for reference (Points 9).
At 14:01, seawater thermometer and new marker #65 were set on the sea floor at the Point 10.
At 14:10, MBARI push coring (red: C3) was operated on another spaghetti-like worms point (Point 11).
Due to bad weather condition, the vehicle was made leave the bottom just after this coring at the Point 12 at 14:13.

Keywords:
Dai-hachi Kumano Knoll, mud volcano, cold seep, bacterial mat, Calyptogena colony, carbonate rock

Instrumentation (Payload):

1. MBARI-type Core Sampler x5
2. Marker x3
3. Scoop x1
4. Sample Box x1
5. Gamma-ray sensor
6. WHATS
7. Seawater thermometer

Table 7.3-1. Location of events

Point	Time	X	Y	LAT	LON	Depth	Event
1	10:00:00	−1665.0	−134.7	33° 36.0992' N	136° 33.3129' E		Landing Target
2	11:01:00	−1564.6	−352.6	33° 36.1535' N	136° 33.1720' E	2059	Landing Point
3	11:33:00	−1672.2	−145.6	33° 36.0953' N	136° 33.3059' E	2057	Finding shell
4	11:40:00	−1676.6	−67.7	33° 36.0929' N	136° 33.3562' E	2055	Finding Calyptogena
5	11:48:42	−1679.0	−10.0	33° 36.0916' N	136° 33.3935' E	2056	Finding big rock
6	12:22:00	−1651.7	−130.6	33° 36.1064' N	136° 33.3155' E	2058	Finding Marker#32
7	13:46:00	−1850.2	277.2	33° 36.9990' N	136° 33.5793' E	2056	WHATs sampling
8	13:51:00	−1850.2	277.1	33° 36.9990' N	136° 33.5792' E	2056	MBARI(yellow: C1) sampling
9	13:56:00	−1835.6	284.7	33° 36.0069' N	136° 33.5841' E	2056	MBARI(black: C2) sampling
10	14:01:00	−1835.6	284.7	33° 36.0069' N	136° 33.5841' E	2056	Deployment Thermometer
11	14:10:00	−1845.6	274.6	33° 36.0015' N	136° 33.5776' E	2056	MBARI(red: C3) sampling
12	14:13:00	−1876.3	291.3	33° 36.9849' N	136° 33.5884' E	2056	Left Bottom

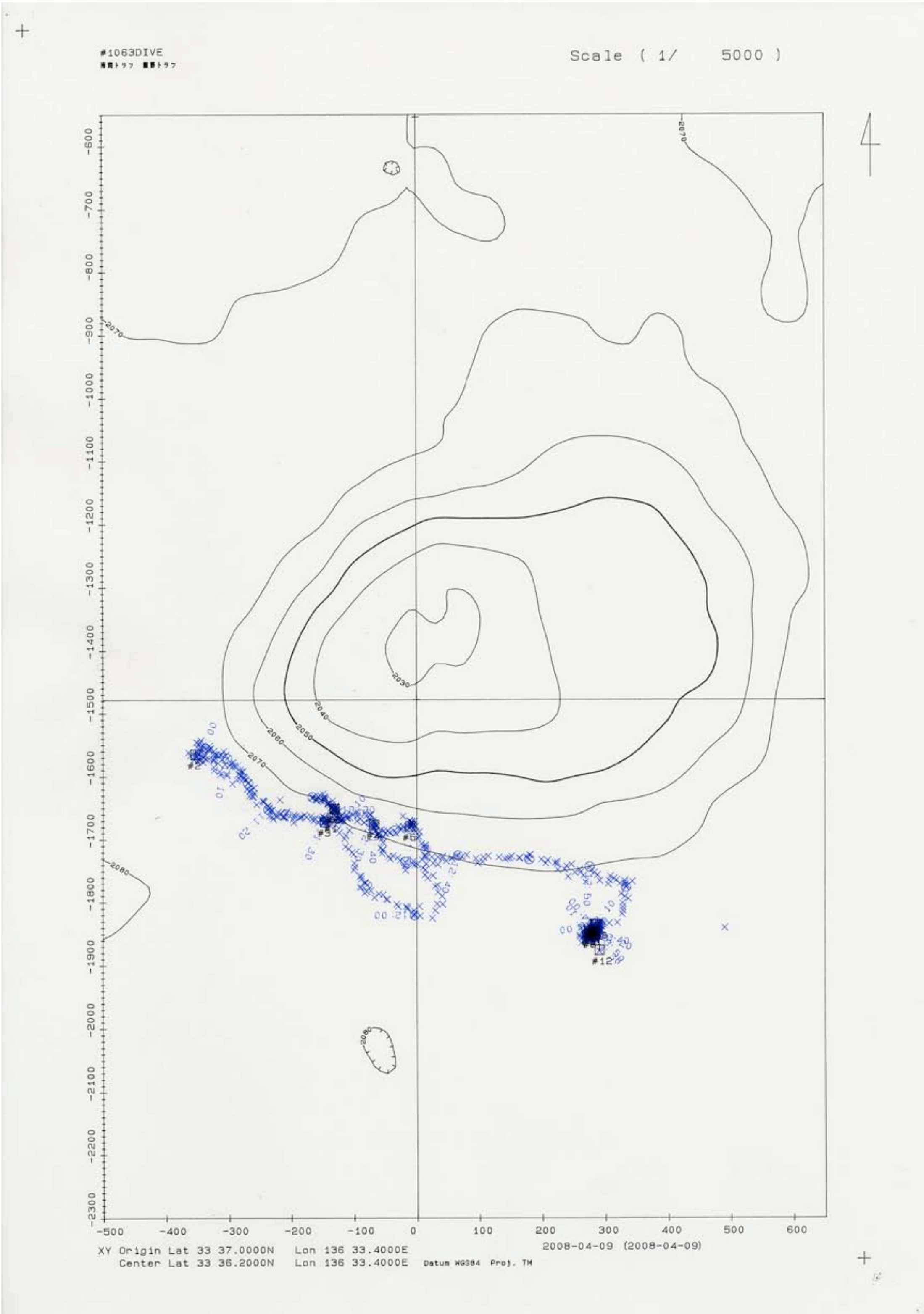


Figure 7.3-1: The Shinkai vehicle's track.

Video digest:

11:01:01-11:01:21 2059m
The Shinkai vehicle landed on the sea bottom at the southwestern foot of the Dai-hachi Kumano Knoll at the Point 2. Subbottom material was mud.

11:06:59-11:07:12 2059m
There are very few shells on the mud at the southwestern foot of the knoll. Isolated little tubeworms were also observed off and on.

11:14:24-11:14:40 2059m
Dead shells on the mud. Isolated little tubeworms were also observed.

11:22:51-11:23:00 2059m
Isolated little tubeworms were also observed alone.

11:30:59-11:31:19 2058m
11:32:54-11:33:09 2058m
Many Calyptogena shells were observed, but they are all dead at the Point 4. Surface mud is rather rough than the other normal smooth mud.

11:46:33-11:46:52 2053m
11:49:01-11:49:15 2052m
11:49:56-11:50:13 2052m
Huge carbonate block was found at the southern foot of the knoll at the Point 5.

12:17:57-12:18:14 2059m
The Marker #32 was found at the Point 6. The location is very calm rather than that at the previous dive (Dive 946) two years ago.

12:25:18-12:25:37 2057m
Just after leaving the Marker #32, it was found that the mud scraped by the vehicle showed sulfate black although the normal surface mud is not discolored and most of the Calyptogena here seem to be dead.

12:29:51 -12:30:45 2056m
There are lots of Calyptogena shells but discolored zone was not found. The Calyptogena were standing on the mud but most of them seem to be dead.

12:58:02-12:58:30 2056m

There are lots of Calyptogena standing on the mud but most of them seem to be dead. Little spaghetti-like warms were found to be spread on some points.

13:05:46-13:06:07 2056m
The mud scraped by the vehicle bottom indicated sulfate black although the surface mud showed oxidized brown.

13:19:12-13:19:21 2056m
Very near surface water on the scraped black mud was sampled by the WHATs water sampler.

13:31:55-13:32:03 2056m
During the water sampling, it was confirmed that the original water in the sampling bottles came out from the nozzle.

13:49:01-13:49:37 2056m
MBARI push coring (yellow: C1) was performed on the spaghetti-like worms at the Point 8.

13:55:21-13:55:42 2056m
MBARI push coring (black: C2) was performed on the normal mud for reference at the Point 9.

14:04:53-14:05:03 2056m
Seawater thermometer and marker #65 were set on the sea floor at the Point 10.

14:08:43-14:09:20 2056m
MBARI push coring (red: C3) was performed on spaghetti-like worms at the Point 11.

14:10:26-14:11:17 2056m
The vehicle left the bottom at the Point 12.

Dive photos:

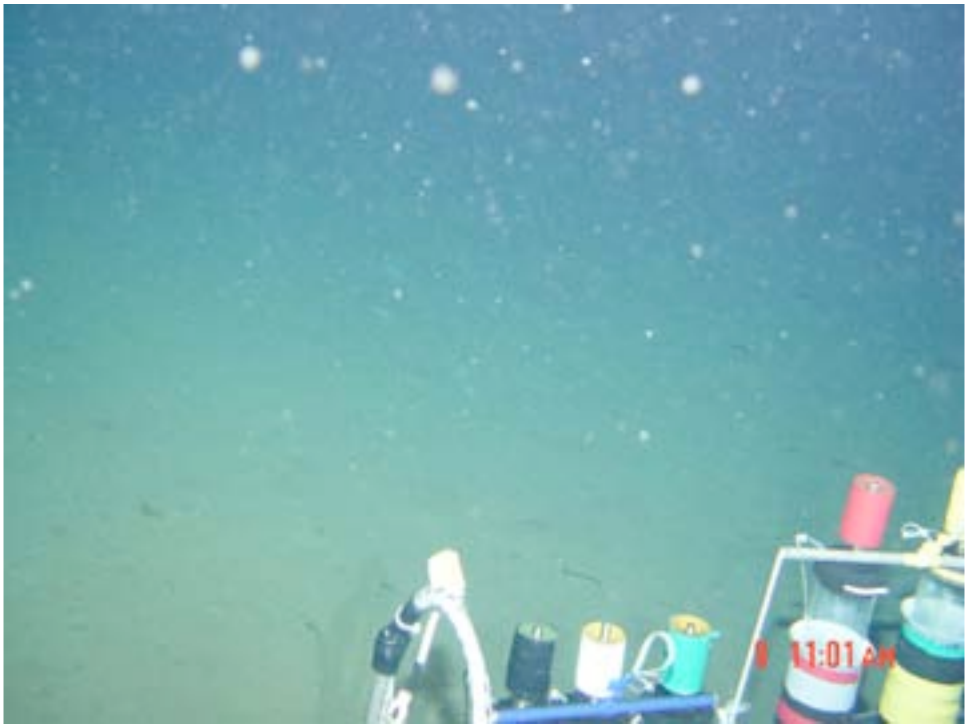


Figure 7.3-2: The landing point at the southwestern foot of the Dai-hachi Kumano Knoll is covered with hemi-pelagic mud. 11:01am. (Point 2)

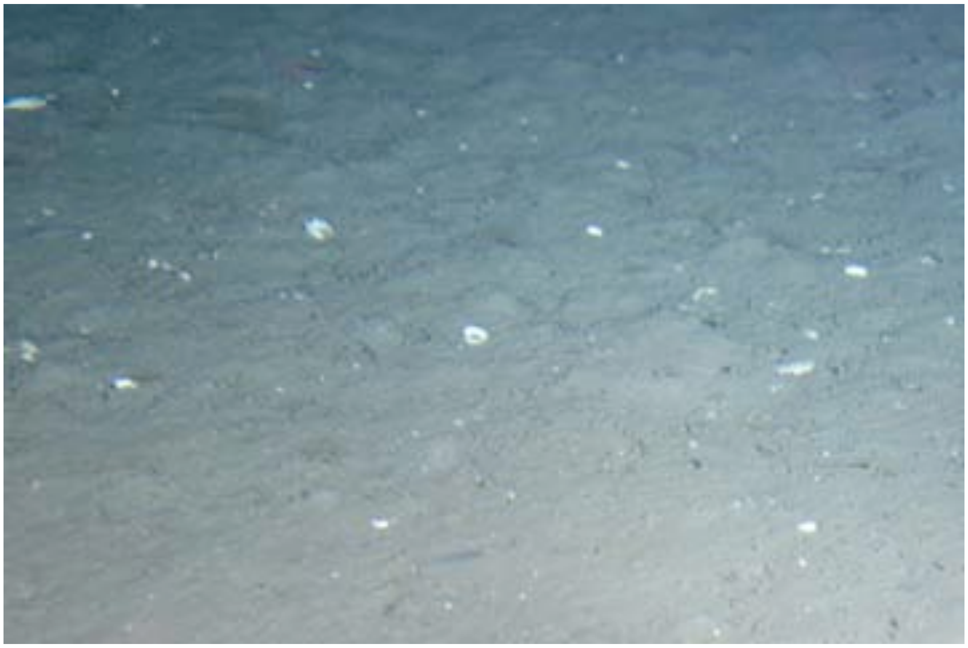


Figure 7.3-3: The surface mud which used to be discolored as bacterial mat before indicated normal brown color and rough surface. Calyptogena in this area were all dead. 11:32am. (Point 3)

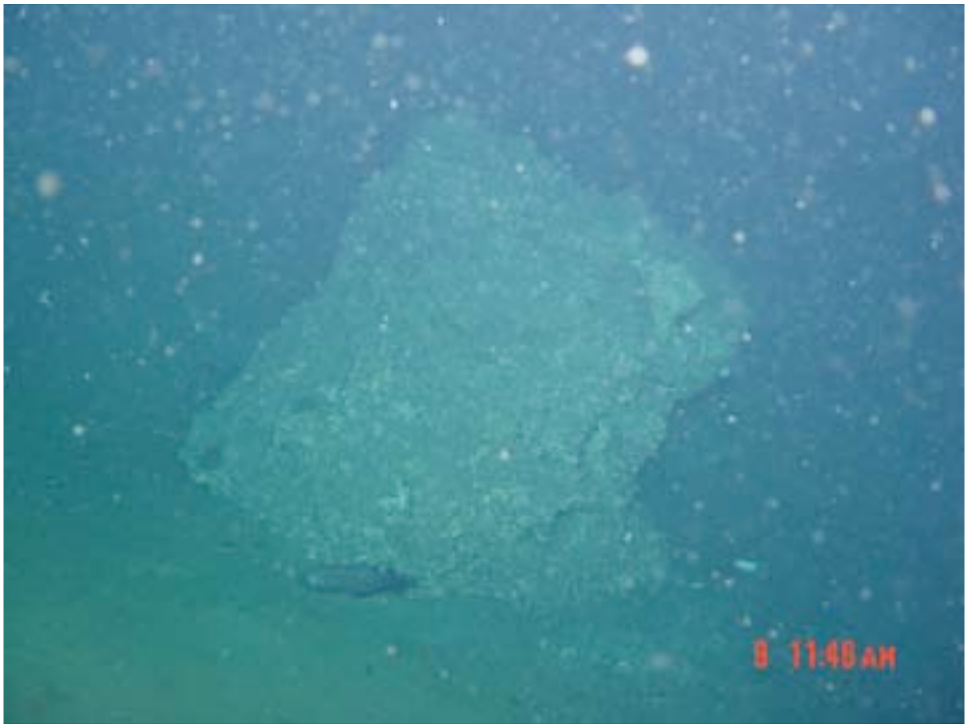


Figure 7.3-4: Huge carbonate block was found at the south foot of the knoll. 11:46am. (Point 5)

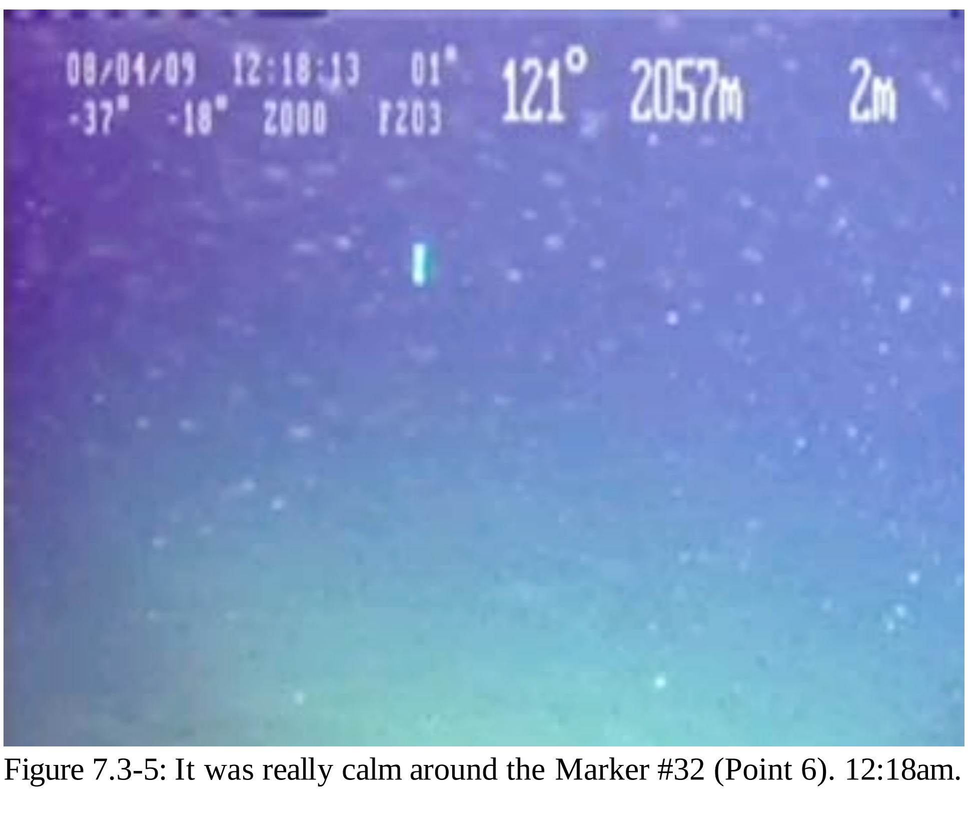


Figure 7.3-5: It was really calm around the Marker #32 (Point 6). 12:18am. (from video camera 1)

Figure 7.3-6: Calyptogena near Marker #32 were all dead. 12:23pm.

Figure 7.3-7: Living Calyptogena is very rare. 12:58pm. (from video camera 1)

Figure 7.3-8: Scraped mud indicated sulfate black although the normal surface showed brown mud. 1:09pm.

Figure 7.3-9: Very near surface water sampling by WHATs was performed just above the scraped black-colored mud in the blight spots area (Point 7). 1:19pm. (from video camera 1)

Figure 7.3-10: MBARI push coring (yellow: C1) was performed on the spaghetti-like worms in the blight spots area (Point 8). 1:49pm. (from video camera 1)

Figure 7.3-11: MBARI push coring (black: C2) was performed for reference outside the spaghetti-like worms in the blight spots area (Point 9). 1:55pm. (from video camera 1)

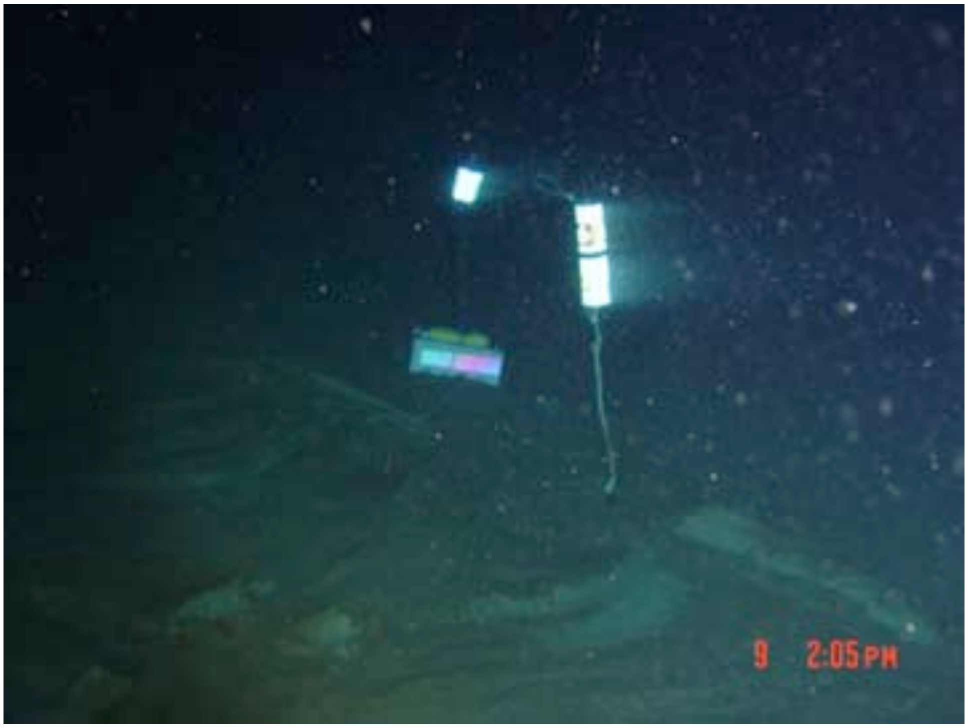


Figure 7.3-12: Seawater thermometer and Marker #65 were deployed after water and core samplings in the blight spots area. 2:05pm. (Point 10)

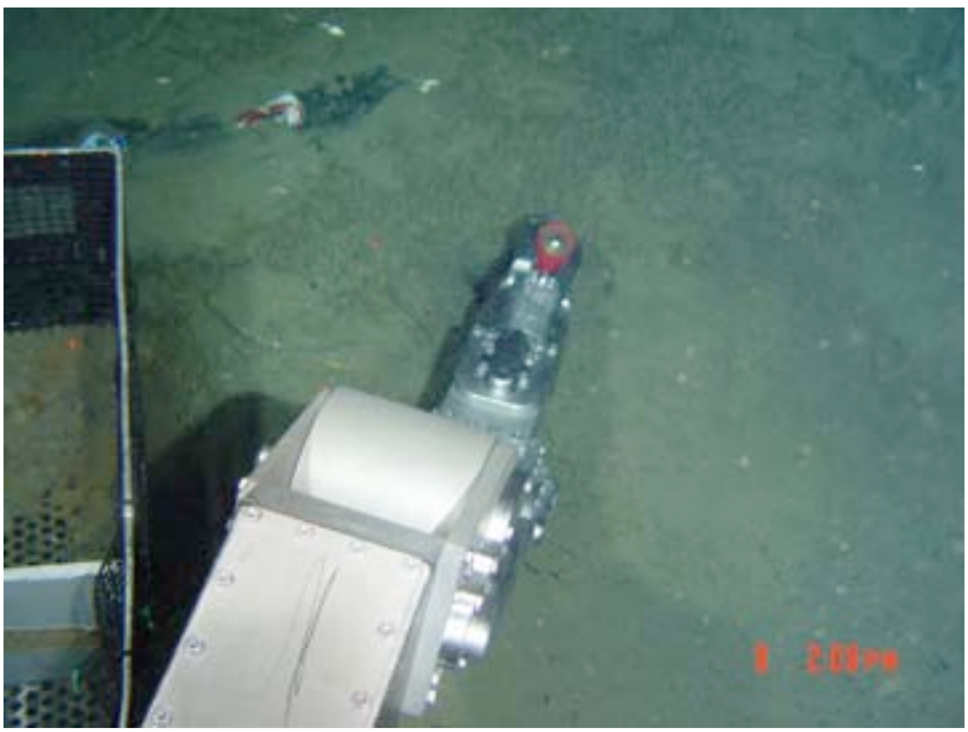


Figure 7.3-13: MBARI push coring (red: C3) was performed on the spaghetti-like worms in the blight spots area. 2:09pm. (Point 11)

Core photos:

Figure 7.3-14: MBARI push core (yellow: C1)

Figure 7.3-15: Little spaghetti-like worms at the top of the MBARI push core (yellow: C1).

Figure 7.3-16: MBARI push core (black: C2)

Figure 7.3-17: MBARI push core (red: C3)

7.4 Onboard Analysis of Geochemistry

- Formation mechanism of barite chimney at the Oomine Ridge -

Higa, R. and Toki, T. (University of the Ryukyus)

Barite chimney was found at the Oomine Ridge in YK03-06 cruise. Barite chimney has been reported at only six seepage areas in the world. In this study, we will determine the chemical characteristics of pore water from the Oomine Ridge, and illuminate the formation mechanism of barite chimney. In this cruise, we took sediment samples (Length: 30 to 60 cm) from some seepage areas on the seafloor off Kumano, including the Oomine Ridge, and retrieved the pore water from sub-samples of the sediment in the intervals of 5 cm. We analyzed on board the pore water for salinity and concentration of ammonium, nitrate, and sulfate ions (Table 7-1).

Table 1 Results of onboard analysis

Date	dive	observer	area	site	type	Sample	No.	Depth	Sal.	NH4	Br	squeeze	remark
								cmbsf	‰	mM	mM	method	
2008.04.06	1062	J. Miyazaki	Oomine ridge	Bacterial mat	MBARI-Short	C1	0	0					
					Green		1	5.5	34.0	204.9	0.6948	centrifuge	H2S smell
							2	10.5	33.0	284.3	0.7075	centrifuge	H2S smell
							3	15.5	32.0	298.4	0.7178	centrifuge	H2S smell
							4	20.5	31.0	301.9	0.7450	centrifuge	H2S smell
							5	25.5	31.5	299.4	0.7650	vice	H2S smell
				near C1,BM	MBARI-Short	C2	0	0	35.5	＜6	0.6752		
					Black		1	2.5	37.0	6.875	0.6552	vice	
							2	7.5	35.5	18.51	0.6533	vice	
							3	12.5	36.5	26.55	0.6549	vice	
							4	17.5	35.0	26.01	0.6700	vice	
							5	22.5	36.0	33.18	0.5843	vice	
				Bacterial mat	MBARI-Short	C3	0	0	36.0	15.14	0.6861	vice	
					Yellow		1	4	34.5	177.1	0.6786	vice	H2S smell
							2	9	34.0	154.5	0.6708	vice	H2S smell
							3	14					
							4	19	34.0	243.1	0.6740	vice	H2S smell
				near C3, BM	MBARI-Long	C4	0	0		＜6	0.6540		
					Red		1	2	35.0	7.580	0.6487	centrifuge	
							2	7	34.5	9.695	0.6417	centrifuge	
							3	12	34.5	21.45	0.6515	centrifuge	
							4	17	34.5	38.18	0.6549	centrifuge	H2S smell
							5	22	33.5	57.86	0.6630	centrifuge	H2S smell
				Bacterial mat	MBARI-Long	C5	0	0	35.0	＜6	0.6693		
				near C3, BM	White		1	4	34.0	104.7	0.6457	centrifuge	H2S smell
							2	9		124.9	0.6703	centrifuge	H2S smell
							3	14	32.5	182.5	0.6827	centrifuge	H2S smell
							4	19	34.0	139.2	0.6720	centrifuge	H2S smell
							5	24	34.0	137.5	0.6665	centrifuge	H2S smell
2008.04.09	1063	S. Morita	Dai-hachi	Black colored	MBARI-Long	C1	0	0		＜1	0.6922		
			Kumano Knoll	area	Yellow		1	0	34.0	14.91	0.6916	centrifuge	H2S smell
							2	5					
							3	10	34.5	37.85	0.7213	centrifuge	H2S smell
							4	15					
							5	20	34.0	81.68	0.7506	centrifuge	H2S smell
							6	25					
							7	30		90.24	0.7527	centrifuge	H2S smell
				near black	MBARI-short	C2	0	0	35.5	1.240	0.6827		
				colored area	black		1	3		1.889	0.6871	centrifuge	
							2	8					
							3	13		19.40	0.6739	centrifuge	
							4	18					
							5	23		33.29	0.6868	centrifuge	
				Black colored	MBARI-Long	C3	0	0	35.5	1.240	0.6859		
				area	Red		1	0					
							2	5					
							3	10					
							4	15		43.34	0.7270	centrifuge	H2S smell
							5	20					
							6	25	34	48.58	0.7407	centrifuge	H2S smell
							7	30					
							8	35	33.5	29.23	0.7589	centrifuge	H2S smell
					WHATs	W-3				＜1	0.6764		

Table 7.4-1 Results of onboard analysis of geochemistry

7.5 Objective and Shore-base Study of Microbiology

Objectives and shore-base study plans for microbiology are reported in this section because the most studies are conducted onshore.

Microbiology I by Imachi, H. and Yashiro, Y. (SUGAR, JAMSTEC)

Most of the methane seeping upward in the marine sedimentary column is intercepted biologically by the anaerobic oxidation of methane (AOM) and in thus prevented from reaching the atmosphere. There is now a consensus that AOM can be mediated by consortia of methane-oxidizing Archaea and sulfate-reducing bacteria, although microorganisms responsible for AOM have remained isolated and characterized. To better study microbial AOM, we have to be more effort to cultivate and obtain the microbes responsible for the AOM reaction in pure culture. After obtaining deep-sea sediments from the Nankai Trough area, we will culture these microbes using a special cultivation apparatus.

Microbiology II by Miyazaki, J. (SUGAR, JAMSTEC)

In anoxic methane-seep sediments, there are consortiums consisting of anaerobic methanotroph (ANME) and sulfate reducing *d-Proteobacteria*. It is thought that these consortiums gain energy by anoxic methane oxidation coupling with sulfate reduction and prevent methane from emitting into sea. However, these consortiums have never been cultivated therefore we don't know how these consortiums maintain their life activity. Especially, it is proposed that the ANME gain energy by reverse-methanogenesis. In this cruise, we focused nitrogen cycle in the anoxic methane-seep sediments. Nitrogen is very important source for life activity, especially nucleotide, protein and so on. Our previous studies suggest that one of the ANME can utilize nitrogen gas to obtain ammonia as nitrogen source. To understand the nitrogen cycle in the anoxic methane-seep sediments, we try to cultivate with stable isotopes to investigate if ANME have ability to fix nitrogen gas.

7.6 Preliminary Repot of Seabeam Survey

We conducted seabeam bathymetric survey at the central part of the Kumano Trough. There are some mud volcanoes in this area and some of them have low relief. Therefore, we tried to take high quality bathymetric data on calm sea condition for detecting fine textures of seafloor deformations. We successfully obtained swath bathymetric data (Fig. 7.6-1) and backscattering intensity (Fig. 7.6-2). They reveal a NE-SW trending lineament and a strong intensity patch northeast and southwest of No. 8 Kumano Knoll, respectively.

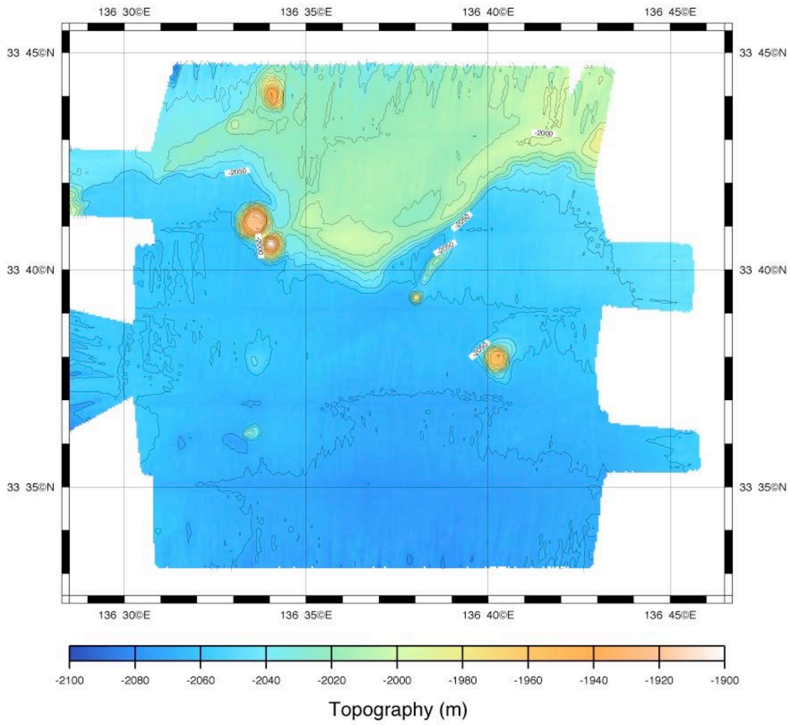


Fig. 7.6-1 Seabeam bathmetric map in the central Kumano Trough

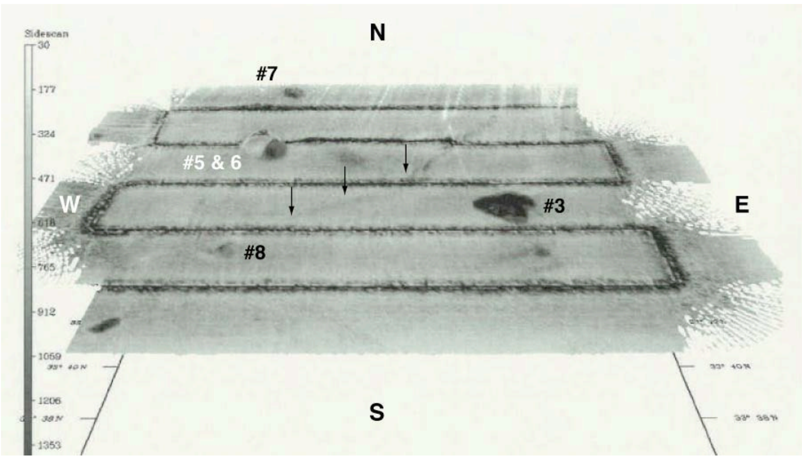


Fig. 7.6-2 Backscattering image of the Kumano Trough

8. Summary

We conducted three dives of “Shinkai 6500” in the Nankai Trough off Kumano. Dive studies at three isolated sites have individual objectives and achievements as follows.

Dive #1061: We conducted seafloor observation across the distinct lineament on the elongated basin north of the Oodai Ridge. It is inferred that this lineament corresponds to a strike slip fault identified by axis displacement of a deep-sea canyon axis. This dive confirmed continuity of cliffs with pervasive landslides suggesting active crustal movement along this lineament. No cold seep was observed during the dive survey.

Dive #1062: We deployed two CAT-meters (seep meter developed by Scripps Institute of Oceanography) at the bacterial mats in the small terrace of the middle slope of the fault scarp at the “Oomine Ridge”. This fault corresponds to one of branched faults of the mega-splay fault off Kumano. We are planning two year’s monitoring using CAT-meters at cold seep sites. For future heat flow measurements, we also deployed one BTMS (Bottom-Water Temperature Monitoring System) at the outside of bacterial mats. The primary objective of these monitoring is to obtain information about variations of seep rate and tectonic activities. Surface sediment samples for microbiological and geochemical studies were also successfully obtained. We could not find barite chimney discovered during YK06-03 although we carefully observed the seafloor around the previous yield location.

Dive #1063: The main objective of this dive was to collect sediment core samples from bacterial mats discovered during YK06-03 and to examine surface sediments microbiologically and geochemically. This seep site was characterized by wide discolored (gray) seafloor probably due to bacterial mats. However, we revealed that the activity of cold seepage at the same location completely terminated. We observed the outer edge of the No. 8 Kumano Knoll and found relatively active seep area. Surface sediment samples were taken for microbiological and geochemical analysis from this site. Deployment of BTMS was also conducted at the outside of the cold seep site for future heat flow calibration.

We successfully deployed long-term monitoring instruments according to the original plan, and took sediment samples for microbiological and geochemical studies although the discolored area at the No. 8 Kumano Knoll was disappeared. Two CAT-meters recording for two years will provide us with changes of cold seep activities. Two BTMS will record basic data of bottom water temperature for heat flow calibration.

Acknowledgements

The authors greatly appreciate the Operations Team of the "Shinkai 6500" and the officers and crews of the R/V "Yokosuka" for their assistances. The study area was located at the axis of strong Kuroshio Current and it was unstable weather season. Scrupulous judgments led our difficult mission to success. Thank are due to supporting stuffs of JAMSTEC headquarter for smooth cruise operations.