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Yokosuka Cruise Report

YK10-09

Off Kumano, Nankai Trough

Aug. 4 2010 – Aug. 11 2010

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

YK10-09 Cruise report contents

1. Objectives of YK10-09 cruise

The purpose of this cruise is to detect relationships between seep activities and fault displacement using long-term heat flow measurement and acoustic ranging system. The relatinoship is important to examine the stress change in an accretionary prism. Because fluid along a subduction zone affects on the strength of rocks, understandings of distribution, migration and drainage processes of fluid are significant to reconstruct evolutions of deformation and kinematics of an accretionary prism. Furthermore, the origin of the fluid will be also examined by chemical analyses of pore fluids from samples in seep-area.

At Nankai Trough, large earthquakes have been occurred repeatedly with 100-250 year interval. Nankai trough is the area where the most number of detailed researches have been conducted for geology, geophysics, geochemistory in the world revealing physical properties along subduction interface, relationship between subducting seamount and slip zone and so on. NanTroSEIZE was started from September 2007 as a bunch of expeditions in Integrated Ocean Drilling Program (IODP) to understand the seismogenic mechanism along subduction zones. Shinkai 6500 dives have been operated many times in this area for observations seafloor, core sampling, collection of rocks, long-term temperature and heat flow monitoring, natural gamma measurements and flow meter monitoring, providing many evidences that fluid seeps are related to deformation structures in accretionary prism such as faults, landslides, and mud volcanos.

2. List of participants

Scientific participants

Yoshitaka HASHIMOTO, Kochi University (Chief Scientist)

Motoyuki KIDO, Tohoku University (Vise Chief Scientist)

Tomohiro TOKI, Ryukyu University

Ayumu MIYAGAWA, Kyoto University

Shoko KOGA, Tohoku University

Go HONDA, Osaka University

Miki TAWADA, Ryukyu University

Chiyo KOMATSU, Kochi University

Misumi AOKI, Nippon Marine Enterprises, Ltd.

"Shinkai 6500" Operation Team

Toshiaki SAKURAI, Chief Submersible Staff

Kazuhiro CHIBA, Sub-Chief Submersible Staff

Tsuyoshi YOSHIUME, 1st Submersible Staff

Yoshinobu NANBU, 1st Submersible Staff

Masanobu YANAGITANI, 1st Submersible Staff

Hirofumi UEKI, 2ndSubmersible Staff

Akihisa ISHIKAWA, 2ndSubmersible Staff

Takuma ONISHI, 2nd Submersible Staff

Hitomi IKEDA, 3rd Submersible Staff

Yudai TAYAMA, 3rd Submersible Staff

Masaya KATAGIRI, 3rd Submersible Staff

Takashi ASAI, 3rd Submersible Staff

R/V YOKOSUKA Crew

Eiko UKEKURA, Captain

Takafumi AOKI, Chief Officer

Shintaro HASHIMOTO, 2nd Officer

Yumihiko KOBAYASHI, 3rd Officer

Toshihiro KIMURA , Chief Engineer

Kazunori NOGUCHI, 1st Engineer

Saburo SAKAEMURA , 2nd Engineer

Kenta IKECUGHI, 3rd Engineer

Hideyuki AKAMA, Chief Radio Operator

Hiroshi ISHIWATA, 2nd Radio Operator

Mai MINAMOTO, 3rd Radio Operator

Kazuo ABE, Boatswain

Hatsuo ODA, Able Seamen

Naoki IWASAKI, Able Seamen

Kuniharu KADOGUCHI, Able Seamen

Shun ABE, Sailer Able Seamen

Ryoma TAMURA, Able Seamen

Saikan HIRAI, Able Seamen

Kozo MIURA, No.1

Yuki NAKAHARA, Oiler

Daiki SATO, Oiler

Yukinori NAKAHARA, Oiler

Masami UEDA, Oiler

Takeshi MIYAUCHI, Chief Steward

Yoshinobu HASATANI, Steward

Hiroki FUKUDA, Steward

Kazuma SODA, Stweard

Shigeto ARIYAMA, Steward

3. YK10-09 Cruise Log

(4th Aug. 2010 - 11th Aug. 2010)

08/04 Noon weather: bc / wind direction: SSE / wind speed index: 3 / wave: 2 / swell: 2 / visibility: 7 mile

09:00 scientists on board

10:00 departure from JAMSTEC

10:45-11:15 briefing about onboard life and safety

11:15-11:45 meeting

19:00-20:35 meeting and seminar

08/05 bc/ SSE/ 4/ 4/ 3/ 8

05:22 XBT

05:54-06:48 MBES

10:02 vent open, start diving

6K#1210 (Observer : M. Kido), area Aa (Nankai Trough)

11:26 on bottom (depth 2,680m)

16:07 off bottom (depth 2,571m)

17:03 surface

19:00-20:30 meeting and seminar

19:53 start MBES survey in the area B

08/06 bc/ ENE/ 3/ 1/ 1/ 8

02:29 finish MBES survey

09:00 arrive at the Shingu port

13:00-15:00 looking around M/V YOKOSUKA

19:00-21:45 meeting and seminar

08/07 bc/ East/ 5/ 3/ 2/ 6

06:00 leave port

09:59 vent open, start diving

6K#1211 (Observer: M. Kido), are Aa (Nankai Trough)

11:11 on bottom (depth 2,589m)

16:04 off bottom (depth 2,530m)

17:00 surface

19:00-20:05 meeting and seminar

19:49-20:18 MBES survey in

08/08 c/ NE/ 2/ 3/ 4/ 7

09:58 vent open, start diving

6K#1212 (Observer: T. Toki), area C (Kumano Trough, mud volcano)

10:59 on bottom (depth 2,057m)

16:00 off bottom (depth 2,013m)

16:45 surface

19:30-20:30 meeting and seminar

08/09 bc/ South/ 3/ 3/ 3/ 8

08:54 vent open, start diving 6K#1213

(Observer: Y. Hashimoto), area B (Nankai Trough, Kashinozaki Knoll)

10:49 on bottom (depth 4,459m)

15:29 off bottom (depth 4,330m)

17:01 surface

19:30-20:30 meeting and seminar

08/10 r/ South/ 3/ 3/ 3/ 5

07:00 start GPS buoy towing

07:49 start data recording

14:00 finish data recording

18:00- meeting

08/11

07:00 arrive at JAMSTEC

weather:　bc=fine but cloudy, c=cloudy r=rain

wind speed index: 0 = 0 - 0.2 m/sec., 1 = 0.3 - 1.5m/sec., 2 = 1.6 - 3.3m/sec., 3 = 3.4 - 5.4m/sec.,4 = 5.5 - 7.9m/sec., 5 = 8.0 - 10.7m/sec., 6 = 10.8 - 13.8m/sec., 7 = 13.9 - 17.1m/sec., 8 = 17.2 - 20.7m/sec., 9 = 20.8 - 24.4m/sec., 10 = 24.5 - 28.4m/sec., 11 = 28.5 - 32.6m/sec., 12 = more than 32.7 m/sec.

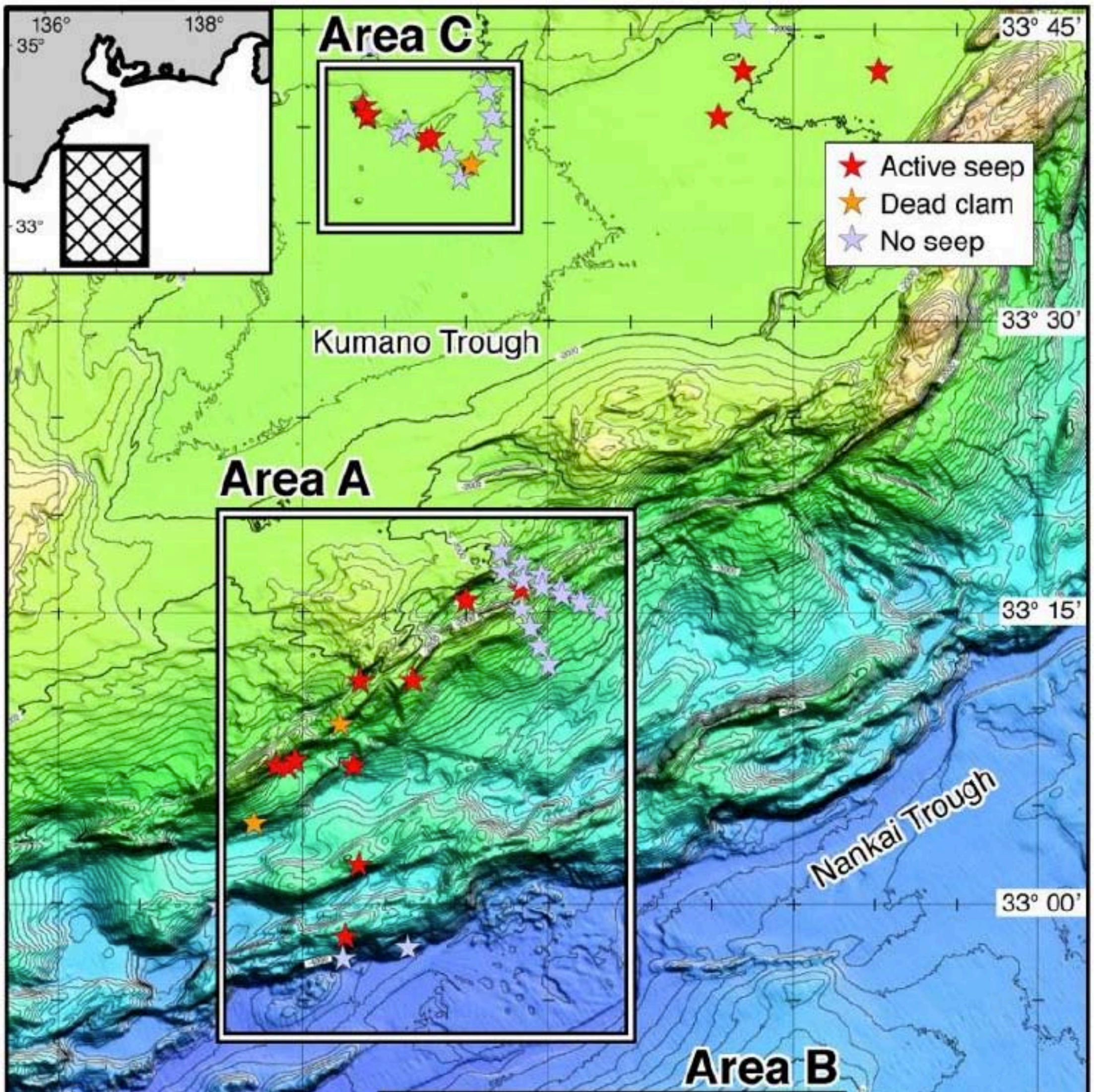
4. Survey and Dive log

4.1 Survey area

Survey area is off Kumano, Kii peninsula shown in Fig.1.

Three areas are focused in this cruise.

1. Area A: seaward slope off Kumano (water depth: 2,000- 3,000m)
2. Area B: Kashinozaki Knoll in Shikoku Basin (water depth: 4,000-4,400m)
3. Area C: Kumano trough (water depth: 2,000-2,050)



4.2 Dive log

4.2.1. Dive #1210 and #1211 Report: Omine Ridge (Area Aa)

Motoyuki Kido (Tohoku University)

Dive#1210

Date: August 5, 2010

Site: Oomine Ridge

Water Depth: 2520 m – 2680 m

Landing: 33°07.0216N, 136°28.9112E, 2680 m

Leaving: 33°07.2958N, 136°28.8700E, 2571 m

Observer: Motoyuki Kido (Tohoku University)

Pilot: Tsuyoshi Yoshiume, Co-Pilot: Yoshinobu Nanbu

Dive#1211

Date: August 7, 2010

Site: Oomine Ridge

Water Depth: 2400 m – 2620 m

Landing: 33°07.2750N, 136°28.9866E, 2589 m

Leaving: 33°07.2022N, 136°28.6164E, 2571 m

Observer: Motoyuki Kido (Tohoku University)

Pilot: Hirofumi Ueki, Co-Pilot: Takuma Onishi

1. Overview

In the original schedule, Dive #1210 and Dive #1211 were separately planned for geophysical and geochemical oriented operations, respectively. The main scheduled operations in Dive #1210 were: 1) re-installation of an acoustic ranging system at the hillside of Oomine ridge, which geodetically monitors fault activity, and 2) replacement of two pairs of long-term Stand Alone Heat Flow meters (SAHFs) with 3) MBARI coring at the same time, while in Dive #1211: sampling of

4) MBARI core, 5) push core and 6) rocks, along with 7) spot SAHF measurements along the hillside terrace of Oomine ridge, in where many evidences of cold seepage, such as existence of Calyptogena and bacterial mat, have been reported. All the operations aim to elucidate the processes in Nankai accretionary prism especially along splay fault. However, the two dives were conjugated to each other because the scheduled operations in Dive #1210 had not been completed in time. Therefore the report of these dives are merged in a single section.

All the operations during the two dives are given in Table 1 in time-series and summarized in Fig. 4.2.1.1 in geographic. In the following, we will report the dives in views in individual operations.

Table 1. Event List.

Dive#1210 2010/08/05

10:00 -184.8, 622.1,33-07.1000N,136-29.0000E,Landing Target

11:26 -329.7, 484.0,33-07.0216N,136-28.9112E,Landing D=2680m

14:44 221.6, 294.7,33-07.3199N,136-28.7895E,

Retrieved #7 SAHF,Set #3 SAHF,Sampling MBARI(yellow) D=2535m,

15:11 221.6, 274.0,33-07.3199N,136-28.7762E,

Retrieved #6 SAHF,Set #4 SAHF D=2531m

16:07 177.0, 419.9,33-07.2958N,136-28.8700E,Left Bottom D=2571m

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Dive#1211 2010/08/07

10:00 70.0,589.9, 33-07.2379N,136-28.9793E,Landing Target

11:11 130.3,601.2, 33-07.2705N,136-28.9866E,Landing D=2589m

11:55 375.7,531.6, 33-07.4033N,136-28.9418E,Find M1 D=2555m

13:23 370.0, 88.0, 33-07.4002N,136-28.6566E,Set M1 D=2395m

14:15 221.6,274.0, 33-07.3199N,136-28.7762E,

Find #4 SAHF #35 Marker,Sampling MBARI(red) D=2531m

14:25 205.5,263.9, 33-07.3112N,136-28.7697E, Sampling Push core(red) D=2532m

14:37 206.2,259.5, 33-07.3116N,136-28.7669E,Sampling Mud D=2529m

14:48 63.3, 132.2, 33-07.2343N,136-28.6850E,Find #37 Marker D=2530m

14:54　16.0,　54.7, 33-07.2087N,136-28.6352E,Find #61 Marker D=2530m

15:47 -75.9,-61.9,33-07.1589N,136-28.5602E,

Find #34 Mkr, Samp. MBARI(green),Rock, Measur SAHF D=2526m

16:04　 4.0,　25.5, 33-07.2022N,136-28.6164E,Left Bottom D=2530

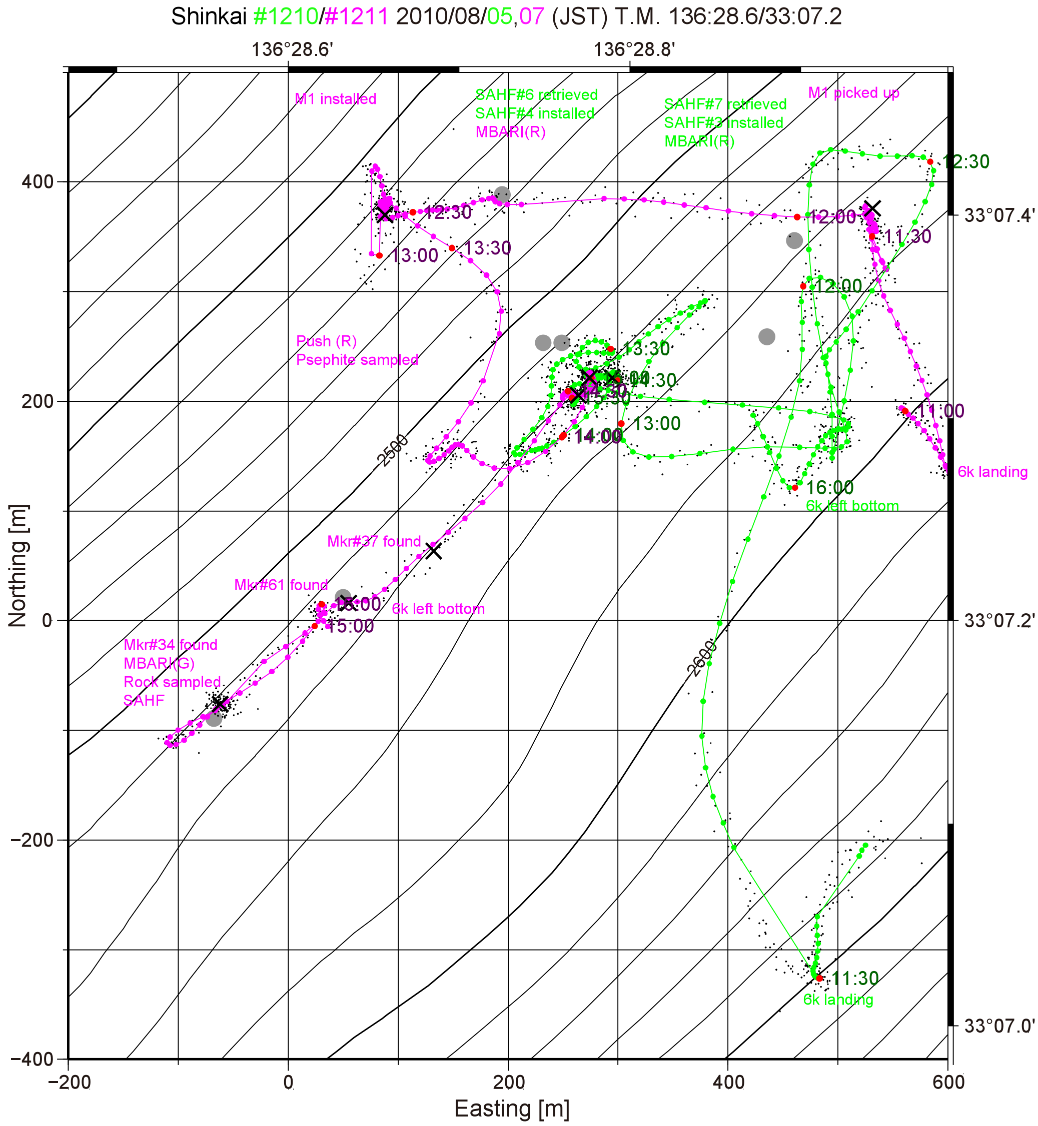

Figure 1. Dive track with events indicated.

2. Re-installation of an Acoustic Ranging System

The Acoustic Ranging System (ARS) consists of two or more seafloor instruments, which acoustically monitors the distance between each pair. In KH10-03 cruise, which is simultaneously conducted along with our YK10-09 cruise, totally three instruments were installed by wire-hanging operation along the relatively narrow hillside terrace of Oomine ridge. One of these instruments must be placed at the hillside of Oomine ridge in order to measure the distance across the surface trace of the splay fault. The pressure vessel of the instrument of the target (hereafter called M1) of Shinkai dive is made of titanium alloy to keep safety for the manned vehicle. The appearance of M1 is shown in Fig. 4.2.1.2, which is 2.5m in height and 40kg in weight in seawater.

In the Dive #1210, we tried to find M1 relying on acoustic sonar response equipped on Shinkai 6500. However, mainly due to uncertainty in the reported position of M1 installation determined using the SSBL system equipped on Hakuho-maru (nominal accuracy ~30m), we failed to catch sight of M1 after 2 hours of exploration. In advance of Dive #1211, updated M1 installation position determined by three point acoustic calibration (estimated accuracy ~10m) was reported. With this position information, we easily found M1 at the beginning of Dive #1211.

After picked-up M1 grabbing its top lope, we carried it to the hillside about 400m west of the picked-up position. The slope of the hillside is generally steep with giant outcrops. In addition, we cannot observe condition of seafloor from the vehicle because we must keep rather high altitude so as not to hit M1 below the vehicle to the seafloor. We released M1 with trial and error, and found that it sat on the edge of cliff with roughly 40 degree slope, which looked like quite unstable. Then we dig the cliff with manipulator just adjacent to M1 to make flat ground. Finally, we moved M1 on there. The cliff is made of unconsolidated rocks. The procedure for this operation seems to be a subject to improve.

3. Long-Term SAHF Replacement

In NT10-05 cruise (March, 2010), two long-term SAHF (SAHF#6 and SAHF#7) were installed along narrow terrace of Oomine ridge, where cold seepage are widely observed. The two SAHF were close to each other (~20m), but for comparison, SAHF#6 was installed just on a bacterial mat while SAHF#7 was on the normal sediment. In this cruise (YK10-09) the two SAHFs are scheduled to be replaced with new pair of SAHFs.

In Dive#1210, we visited SAHF#7 site first and found the SAHF#7 with Marker#1087-1 near by. We installed new long-term SAHF#3 close to SAHF#7 (~1m) after 5 min. temperature calibration being kept it horizontal (Fig. 4.2.1.3). Sediment of the seafloor was soft enough to penetrate completely to the end. Next, SAHF#7 were retrieved. No black fluid associated sulfide flown from the hole just after the retrieval.

The SAHF#6 site is quite close to the SAHF#7 site (~20m); we could observe SAHF#6 and Marker#35 just looking modest up-slope to the west. The SAHF#6 site is sporadically covered with bacterial mat. SAHF#6 was found just on one of spot-like mat. Distribution of the mat seems not to be changed, but brightness of the white looks weak in this time compared to that in NT10-09. However it perhaps due to variation in viewing condition between Hyper Dolphin and Shinkai 6500. No living Calyptogena nor Calyptogena colony were found; only isolated dead shells are observed. Most part of seafloor is coverd with mud sediment, but episodically with small psephite, which might comes from failure of outcrop in upper steep cliff. At this site, we first install long-term SAHF#4 near SAHF#6 (~1m) after calibration in the same procedure above (Fig. 4.2.1.4). Then SAHF#6 was retrieved. Clear black fluid flown from the hole after the retrieval.

After the replacement of the SAHFs at SAHF#6 site, we almost encountered a serious accident that the vehicle destroy the instrument. When the vehicle left the seafloor, the vehicle was flown over the instrument by strong bottom current. We had almost no visibility at that time and could not confirm the status of the instrument. However, in Dive#1211, we confirmed that newly installed SAHF#4 is alive and stood straight as if no crush with the vehicle.

4. Spot SAHF

In Dive#1211, a measurement of spot SAHF was carried out at Marker#34 along the narrow terrace, where bacterial mat and a single community of tube worm (consists of several individuals) are observed. The seafloor was partially covered with psephite rocks.

5. MBARI and Push coring

Like as comparison of the long-term SAHFs, two MBARI cores were sampled at SAHF#7 site with bacterial mat in Dive#1210 and SAHF#6 site without mat in Dive#1211. While the former could sampled the core deeply due to clay, the latter penetrate only 20cm deep due to psephite small rocks. We sample an additional MBARI core at Marker#34 (Fig. 4.2.1.5), in where bacterial mat and psephite covering are developed, which resulted in short penetration again. Description of the cores are shown in the later section.

6. Rock Sampling

Psephite rocks are often observed in bottom of the cliff along Oomine ridge, since cliff is so steep that it frequently fails. We sampled these psephite rocks near Marker# (Fig. 4.2.1.5), where bacterial mat is developed (Fig. 4.2.1.6) and a few tube worms are found (Fig. 4.2.1.6). We also sampled a rock at Marker#35. Description of these rocks are shown in the later section.

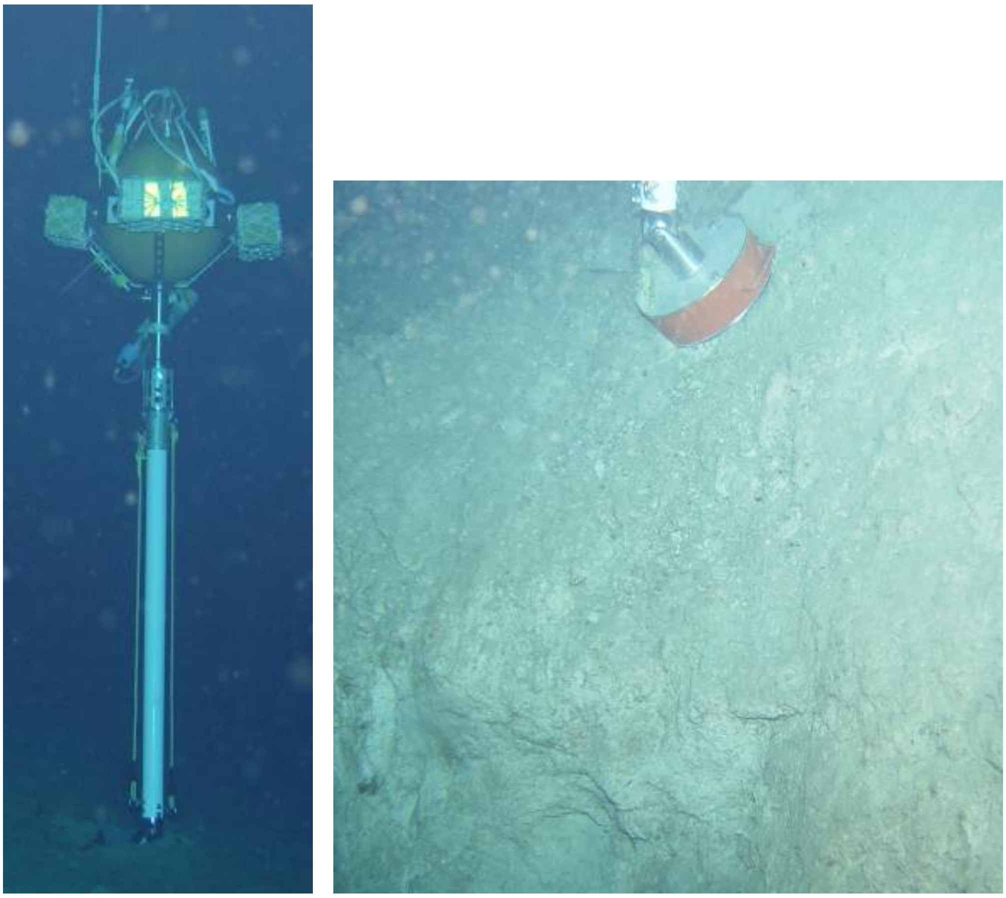

Figure 4.2.1.2. Acoustic Ranging System deployed on the narrow terrace by KH10-03 (left) and after temporal relocation on steep cliff by Dive#1211 (right). Finally the instrument installed at man-made flat place.

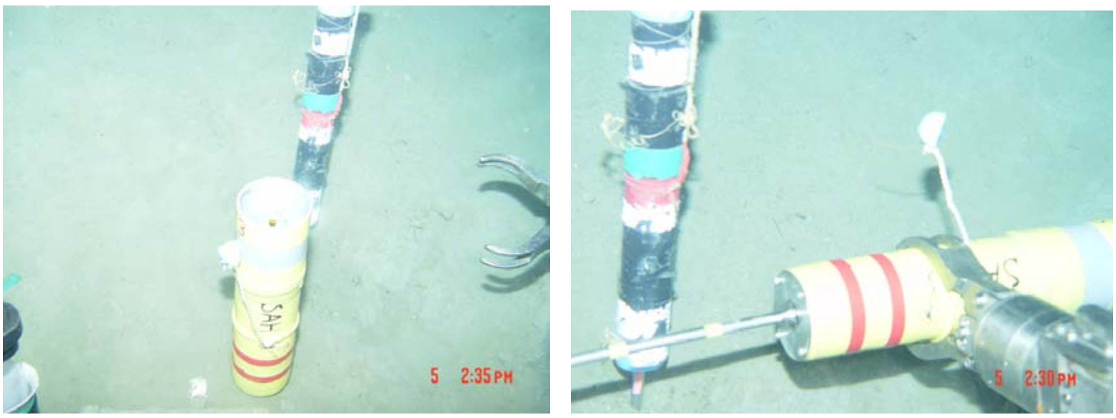

Figure 4.2.1.3. Replacement of SAHF#7 with SAHF#3 in Dive#1210.

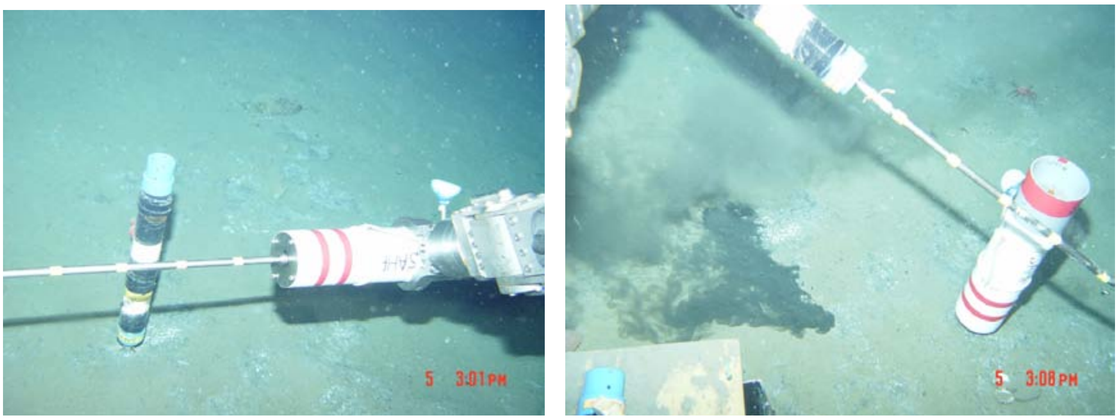

Figure 4.2.1.4. Replacement of SAHF#6 with SAHF#4 in Dive1210.

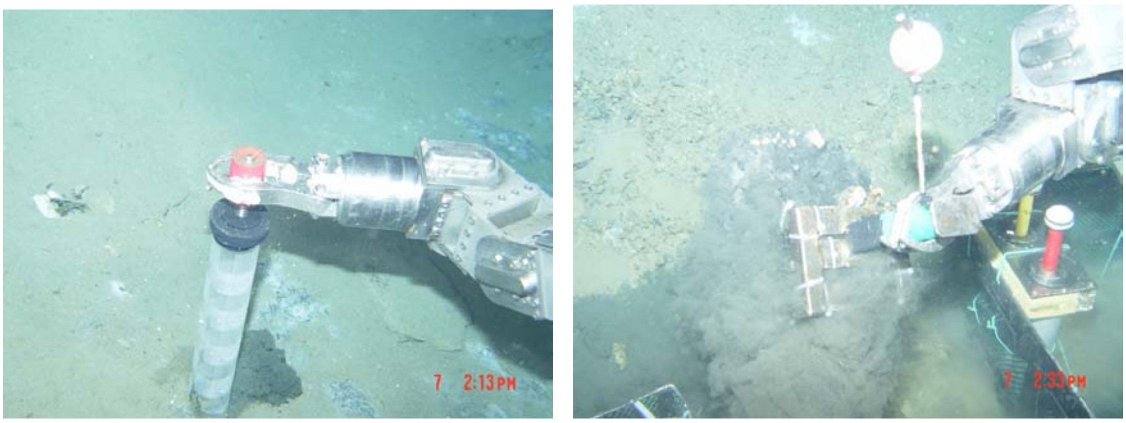

Figure 4.2.1.5. MBARI coring and psephite rocks sampling.

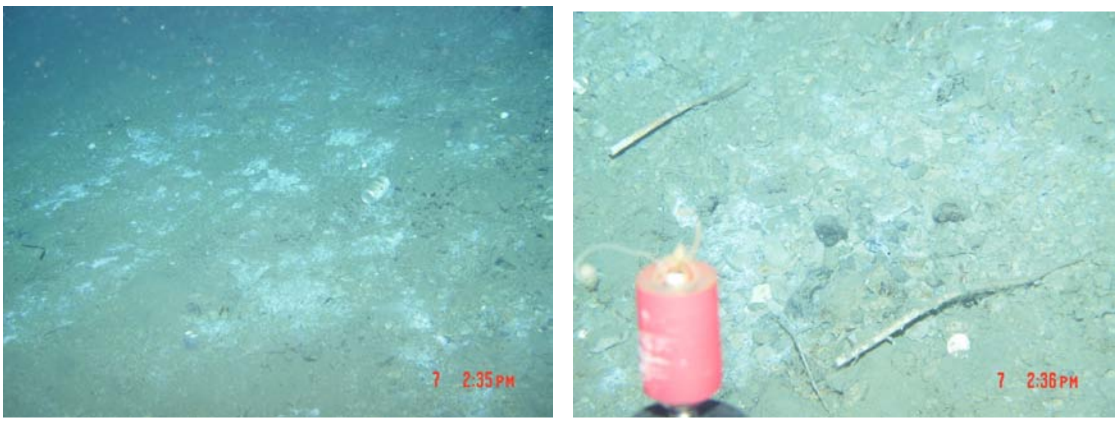

Figure 4.2.1.6. Bacterial mat and tube worm.

7. Description of MBARI and push cores

D#1210

C1 MBARI (yellow)

Figure 4.2.1.7: MBARI push core (yellow: D#1210 C1).

Total length of the sample D#1210 C1 is 50 cm. The sample composed of silty clay that is greenish grey (7-50 cm from the top) and sandy clay that is dark yellow (0-7cm from the top). Some piesies of sulfide are contained in the lower silty clay (45-46 cm from the top). Boundary between lower silty clay and upper sandy clay is infant.

D#1211

C1 MBARI red

D#1211 C1 sample of MBARI push core (red) is lost after landing, because the sample was so loose that we could not recover the sample.

C2 MBARI green

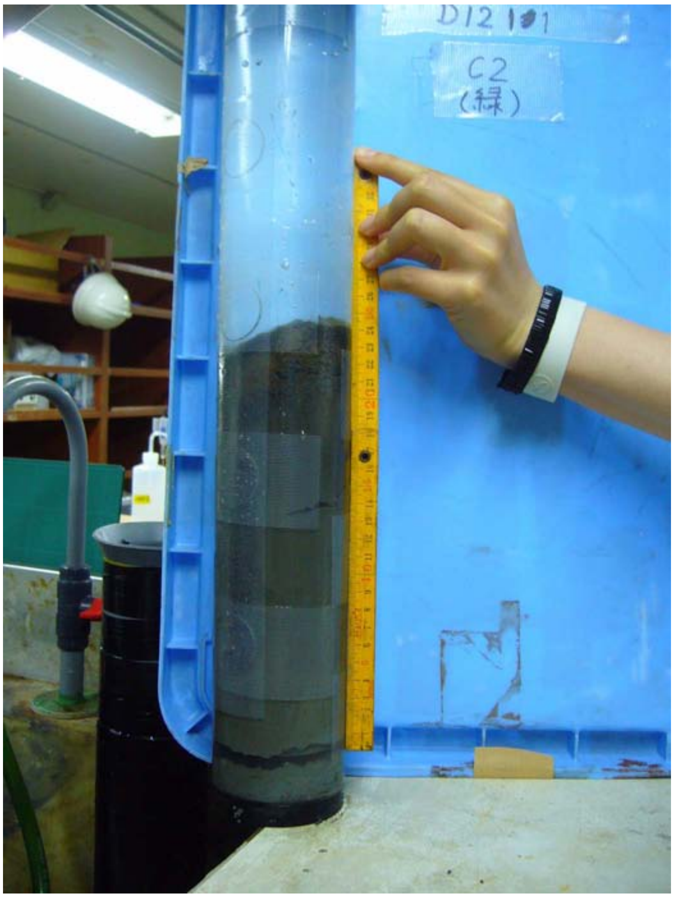

Figure 4.2.1.8: MBARI push core (green D#1211 C2).

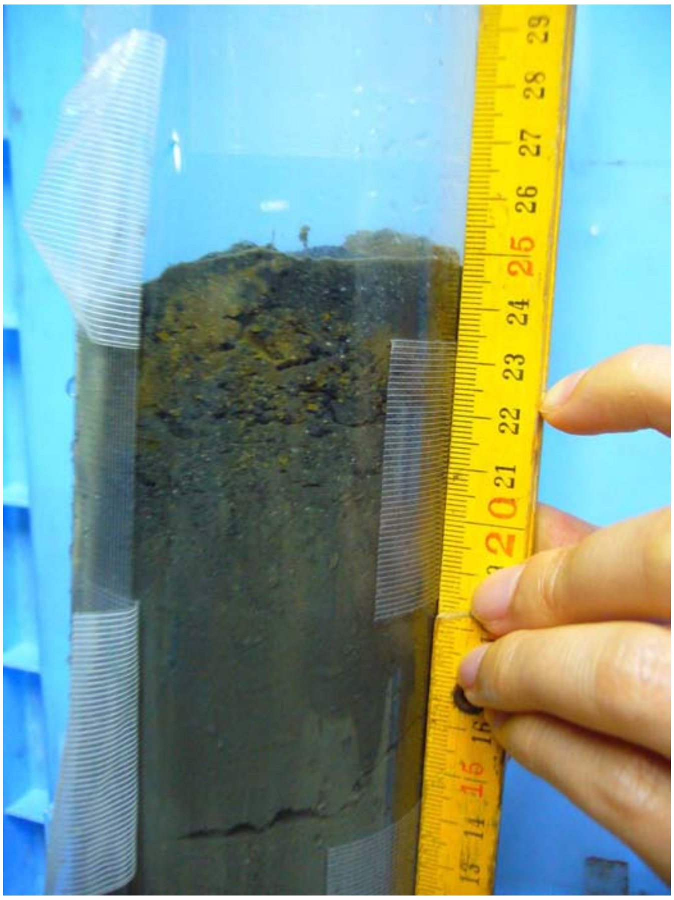

Figure 4.2.1.9: Close image of anti grading in upper sand of D#1211 C2.

Total length of the sample D#1211 C2 is 24 cm. The sample is composed of gray silt (6-24 cm from the top) and sand that is brown to dark grey (0-6 cm from the top). Anti grading is formed in the sand (2-6 cm from the top).

8. Description of rock samples

Psephite rocks are 1-2 cm in diameter with rounded shapes. Most of them are brownish gray silty clay. Some of that are coated by manganese. Another rock sample is brownish gray Sandstone (~20 cm in diameter) with semi-rounded shapes. Middle size grains can be seen by eyes. Almost half of that is sulfated as a black patch in the block (Fig. 4.2.1.10).

Figure 4.2.1.10 Sandstone blocks with blacky-coated sulfate.

4.2.2 Dive #1212 Report : Kumano Knoll No.8 (Area C)

Tomohiro Toki (University of the Ryukyus)

Date: August 8, 2010

Site: Kumano Knoll No.8

Water Depth: 2,020-2,060 m

Landing: 33°35.8718´N, 136°33.5259´E, 2,057 m

Leaving: 33°36.2595´N, 136°33.4476´E, 2,013 m

Observer: Tomohiro Toki (University of the Ryukyus)

Pilot: Masanobu Yanagitani, Co-Pilot: Kazuhiro Chiba

1. Objectives:

Kumano Knoll No.8 is one of the mud volcanoes in Kumano Basin that is about 40 m in height and 800 m in diameter. In previous dives, bacterial mats and *Calyptogena* colonies were observed at the western side of the foot area of the knoll along contours ranging from 2,050 to 2,070 m. Sub-bottom profiler and Side-Scan Sonar by AUV *Urashima* suggested that a mud dike occurs around the eastern foot of the knoll. The aim of this dive is to take the evidence of the mud dike and to collect sediment from the eastern foot area. Recovery of seawater thermometer already deployed at the northern foot of the knoll and measurements of heat flow by SAHF across the knoll on the eastern slope also are the aims of this dive.

2. Dive tracks

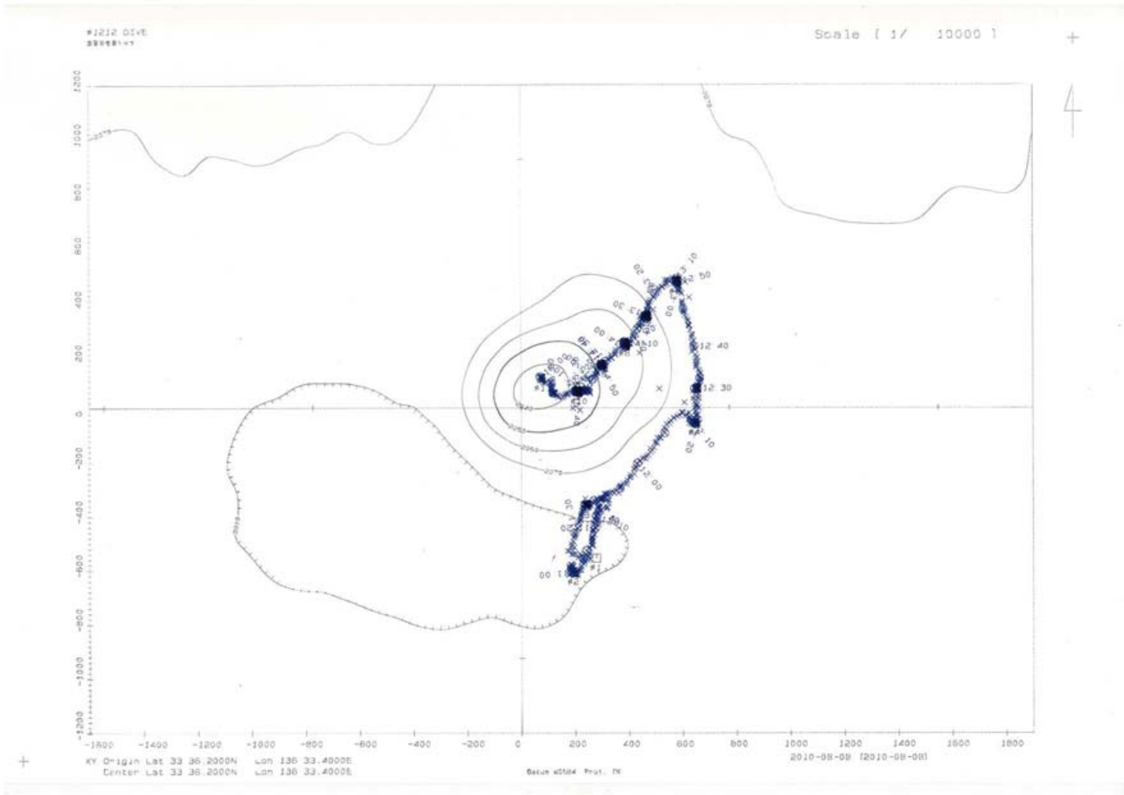

Figure 4.2.2.1: *Shinkai 6500* track

3. Dive Summary:

Figure 4.2.2.1 shows *Shinkai* track of Dive 1212 on bathymetric map of Kumano Knoll No.8.

At 10:59, *Shinkai* landed on mud and transported heading 20 degree to recover seawater thermometer. At the first time, we could not find the thermometer, and passed through the point that we expected where the thermometer was. We turned back toward south, and retried to find the thermometer heading 10 degree.

At 11:40, we found the thermometer, and recover it (Figure 4.2.2.2). And then, we began to move where the mud dike would intrude surface sediment. On the way, we observed some colonies of a few *Calyptogena* in the south side of the knoll, but we could not observe such colonies in its east side, in stead, we looked sea anemones on the seafloor of mud.

At 12:15, we arrived at the point that we expected where the mud dike was. Surface sediment was taken by MBARI-type push corer (red) (Figure 4.2.2.3). Sediment was composed of mud, but clastic ejecta could not be included in the sediment (Figure 4.2.2.16). After that, we transported to the other point that we expected where the mud dike was.

At 12:29, we reached the other point that we expected where the mud dike was, and looked around the area. But the area was mud plain, and sediment was taken by MBARI-type push corer (yellow) near a sea anemone (Figure 4.2.2.4). Sediment also was composed of mud, but clastic ejecta could not be included in the sediment (Figure 4.2.2.17). And then, we transported toward north to the planned point that SAHF1 would be carried out.

At 12:58, SAHF measurement started at SAHF1 after its calibration of 5 min (Figure 4.2.2.5). The seafloor around SAHF1 was mud plain. At 13:32, SAHF measurement started at SAHF2 after its calibration of 5 min (Figure 4.2.2.6). At 14:06, SAHF measurement started at SAHF3 (Figure 4.2.2.8) after its calibration of 5 min (Figure 4.2.2.7). After recovery of SAHF at SAHF3, we run to SAHF4. On the way, we come across bumpy geographical features, and at 14:38 SAHF measurement started at SAHF4 (Figure 4.2.2.11) after its calibration of 5 min (Figure 4.2.2.9). After SAHF4, we climbed up to a steep slope, and we reached a flat space corresponding to the top of the knoll. At 15:22, SAHF measurement started at SAHF5 (Figure 4.2.2.13) after its calibration of 5 min (Figure 4.2.2.12).

At 15:41, Surface sediment was taken by MBARI-type push corer (green) near SAHF5 (Figure 4.2.2.14), but sub-surface sediment below surface sediment was too hard to penetrate, and the core length was limited to 25 cm (Figure 4.2.2.19).

We completely accompanied the pre-programmed plan before the dive, and so observation of the seafloor was carried out around the top of the knoll. Finally, we left the seafloor at 16:00.

4. MBARI core samples

Total length of the sample D#1212 C1 is 40 cm (Figure 4.2.2.17). The sample is composed of silty clay which is greenish gray (12-40 cm from the top), vertical mixture of greenish gray silty clay and dark brown silty clay (10-12 cm from the top) and dark brown silty clay (0-2 cm from the top). OOZ was observed in the boundary zone between dark brown silty clay and mixture zone (2-3 cm from the top). Small patches of dark brown clay are in the boundary zone between dark brown silty clay and mixture zone (2-3 cm from the top) and greenish gray silty clay.

Total length of the sample D#1212 C2 is 42 cm (Figure 4.2.2.18). The sample is composed of greenish gray silty clay (6-42 cm from the top), mixture zone of greenish gray silty clay and dark brown silty clay (4-6 cm from the top) and dark brown clay (0-4 cm from the top). Small patches of dark brown clay which are about 1 cm wide are in the greenish gray silty clay (32 cm from the top).

Total length of the sample D#1212 C3 is 25 cm (Figure 4.2.2.19). The sample is composed of greenish gray silty clay (9-25 cm from the top), mixture zone of greenish gray silty clay and dark brown silty clay (4-9 cm from the top) and dark brown clay (0-4 cm from the top). Small patches of pyrite in the greenish gray silty clay (15 cm from the top).

Payload:

- MBARI-type push corer-long (x3)
- 6K type push corer (x3)
- SAHF (1)
- Sample box with lid (x3)
- Shovel
- Marker (2)

Table 1 Location of events

Point	Time	X	Y	LAT	LON	Depth	Event
1	10:00	-555	278	33-35.9000N	136-33.5800E		Landing Target
2	10:59	-607	195	33-35.8718N	136-33.5259E	2,057	Landing Point
3	11:41	-361	235	33-36.0049N	136-33.5521E	2,056	Find #65 Marker, Retrieve Thermometer
4	12:17	-53	645	33-36.1715N	136-33.8172E	2,055	Sampling MBARI(red)
5	12:30	72	654	33-36.2390N	136-33.8228E	2,055	Sampling MBARI(yellow)
6	13:13	469	577	33-36.4537N	136-33.7728E	2,055	Measur. SAHF1
7	13:49	341	466	33-36.3845N	136-33.7011E	2,052	Measur. SAHF2
8	14:23	237	388	33-36.3284N	136-33.6506E	2,034	Measur. SAHF3
9	14:54	161	300	33-36.2869N	136-33.5940E	2,036	Measur. SAHF4
10	15:43	60	207	33-36.2326N	136-33.5340E	2,021	Measur. SAHF5, Sampling MBARI(green)
11	16:00	110	74	33-36.2595N	136-33.4476E	2,013	Left Bottom

5. Dive photos:

Figure 4.2.2.2: Recovery of thermometer

Figure 4.2.2.3: Sampling sediment from the seafloor of east foot where we expected that the mud dike exposes up to surface sediment according to the AUV exploration.

Figure 4.2.2.4: Sampling sediment of the other point where we expected that the mud dike exposes up to surface sediment.

Figure 4.2.2.5: Measurement of heat flow by SAHF at point SAHF1

Figure 4.2.2.6: Measurement of heat flow by SAHF at point SAHF2

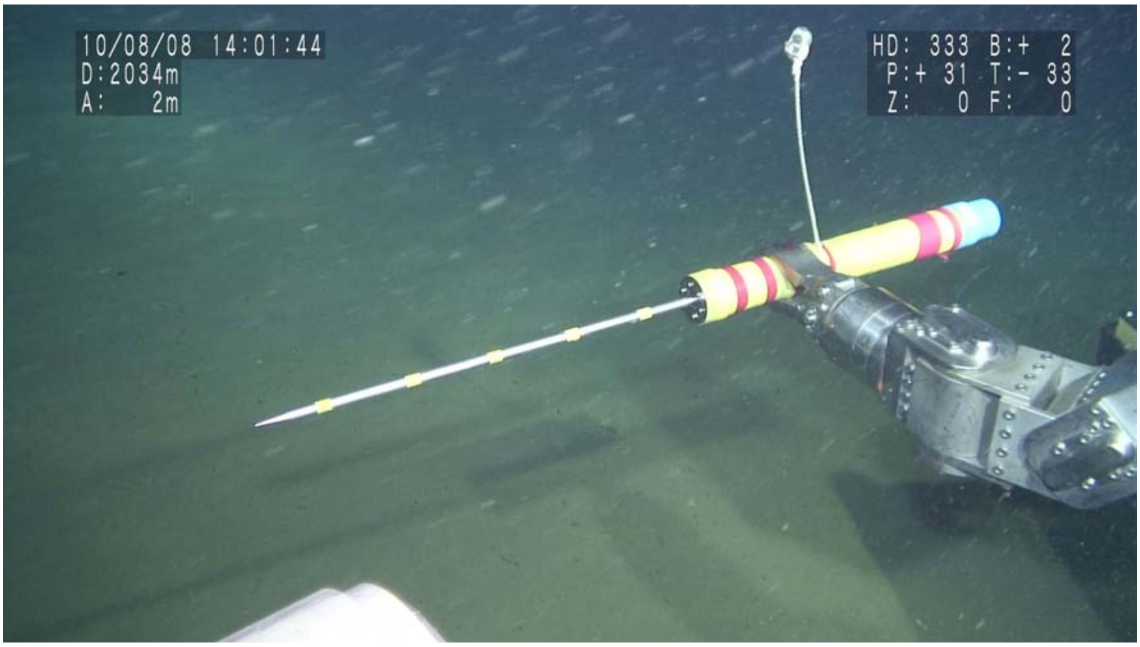

Figure 4.2.2.7: Calibration of SAHF prior to SAHF3 measurement.

Figure 4.2.2.8: Measurement of heat flow by SAHF at point SAHF3

Figure 4.2.2.9: Calibration of SAHF prior to SAHF4 measurement.

Figure 4.2.2.10: Deploying SAHF for SAHF4

Figure 4.2.2.11: Measurement of heat flow by SAHF at point SAHF4

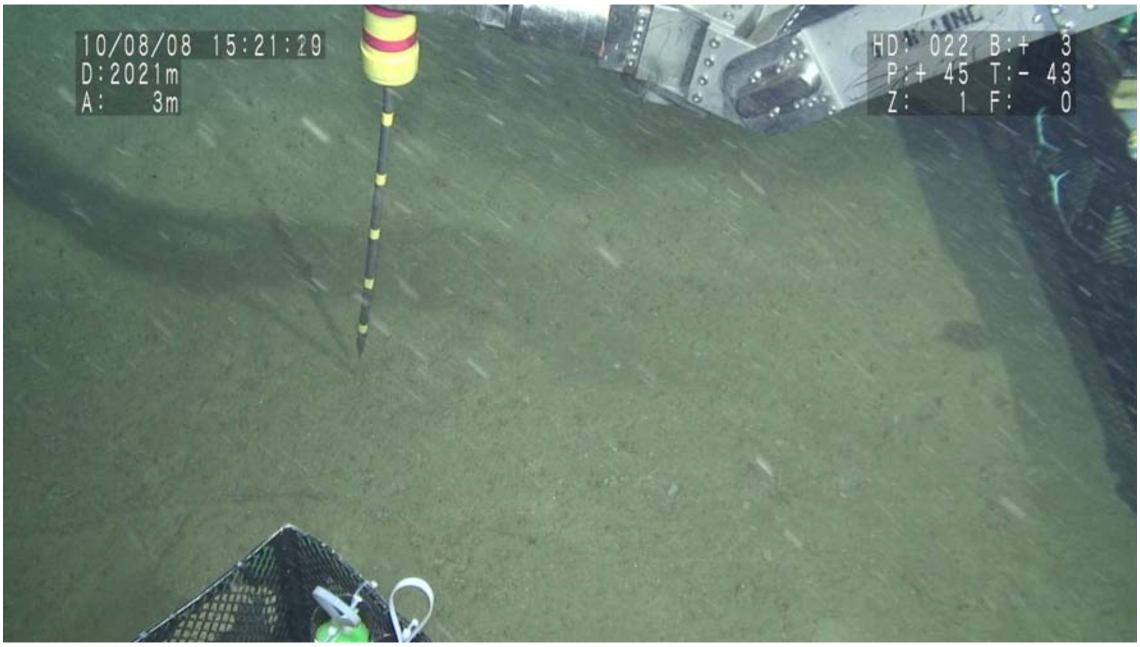

Figure 4.2.2.12: Deploying SAHF for SAHF5

Figure 4.2.2.13: Measurement of heat flow by SAHF at point SAHF5

Figure 4.2.2.14: Sampling sediment from the top of the Kumano Knoll No.8 close to SAHF5 after SAHF measurement.

Figure 4.2.2.15: Feature of the top of the knoll, where the bottom current was so strong up to ca. 20 cm/sec.

Figure 4.2.2.16: MBARI-type push corer (red: C1)

Figure 4.2.2.18: MBARI-type push corer (yellow: C2)

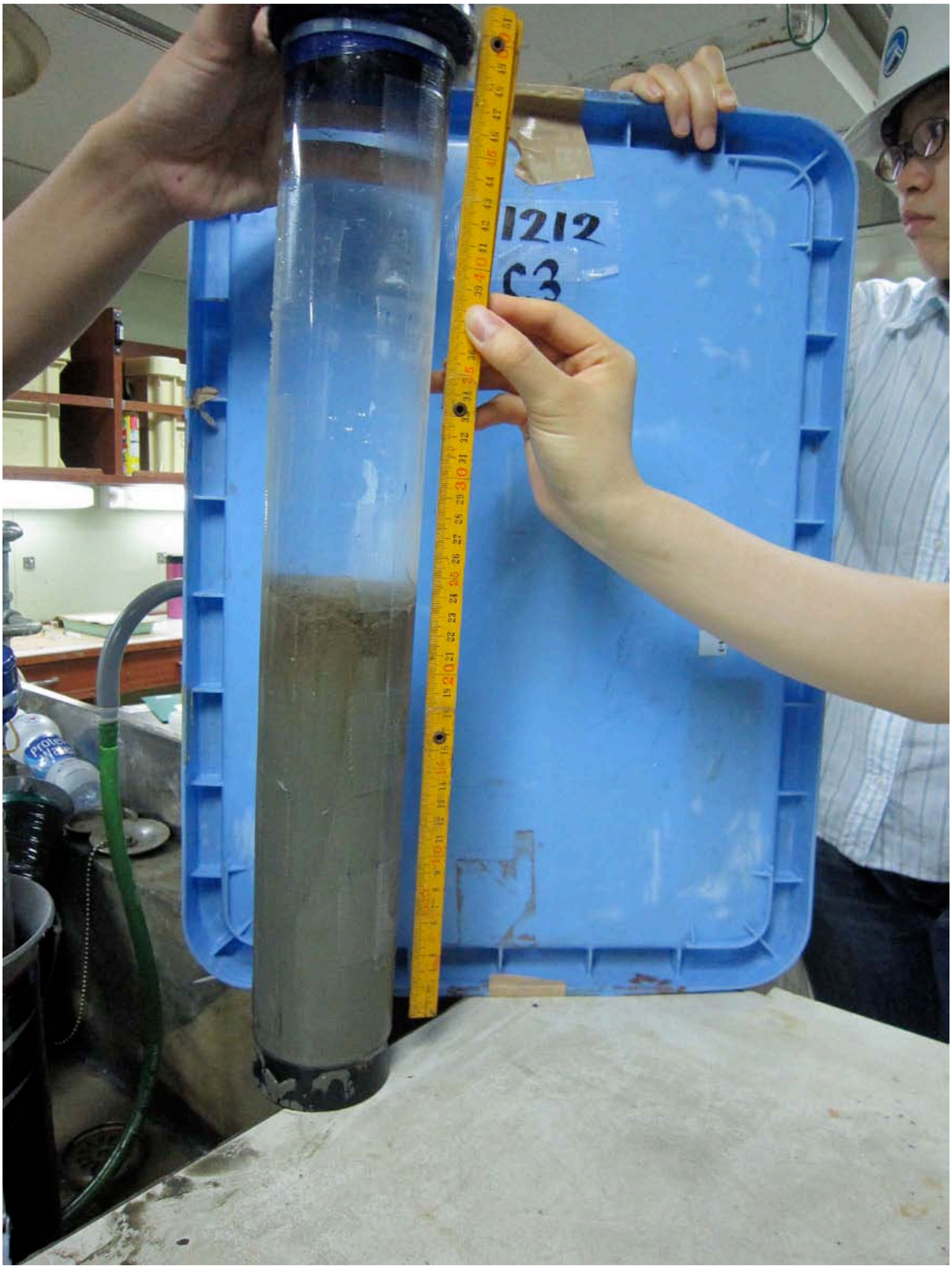

Figure 4.2.2.19: MBARI-type push corer (green: C3)

4.2.3 Dive #1213 Report: Kashinosaki knoll (Area B)

Yoshitaka Hashimoto (Kochi University)

Date: August 9, 2010

Site: Kashinosaki Knoll

Water Depth: 4459 m – 4330 m

Landing: 32°45.9283N, 136°36.9474E, 4459 m

Leaving: 32°45.8091N, 136°37.6541E, 4330 m

Observer: Yoshitaka Hashimoto (Kochi University)

Pilot: Tauyoshi Yoshiume, Co-Pilot: Akihisa Ishikawa

1. Objectives

The objects of this dive is to observe geology and find some evidences for cold seeps along an intraocanic fault in Kashinosaki knoll. A seismic profiles reveals that the fault trace can be found along the cliff of the Kashinosaki knoll. The fault is cutting basement basalts and Moho. This fault is expected to be the seismogenic fault of 2004 off Kii peninsula southeastern earthquake. The topographic features suggest that the thick sediments cover over the center to eastern sides of Kashinosaki Knoll. In the western side, however, the cover sediments can be thinner in the deepest seafloor where the fault is expected to be exposed.

2. Cruise Track

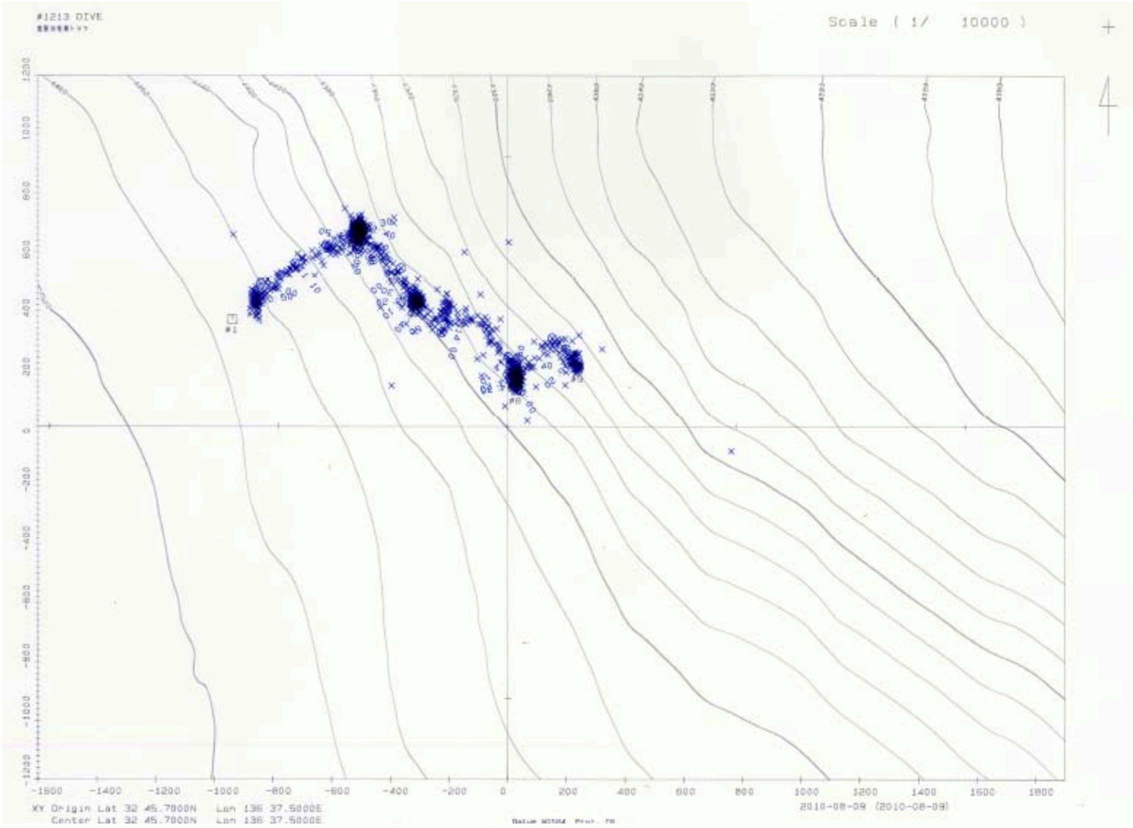

Table. 1 Event mark list

Day Time X Y Lon Lat

1, 2010/ 8/ 9 9: 0: 0, 369.6, -936.9, 32-45.9000N, 136-36.9000E,

Landing Target

2, 2010/ 8/ 9 10:49: 0, 421.9, -862.9, 32-45.9283N, 136-36.9474E,

Landing D=4459m

3, 2010/ 8/ 9 11:44: 0, 683.6, -503.3, 32-46.0699N, 136-37.1777E,

Sampling Rocks(2) D=4400m

4, 2010/ 8/ 9 12:21: 0, 662.3, -505.9, 32-46.0584N, 136-37.1760E,

Measurement SAHF, Sampling MBARI(green) D=4403m

5, 2010/ 8/ 9 12:34: 0, 664.4, -521.2, 32-46.0595N, 136-37.1662E,

Sampling MBARI(red) D=4406m

6, 2010/ 8/ 9 13:35: 0, 425.6, -306.6, 32-45.9303N, 136-37.3036E,

Measurement SAHF D=4398m

7, 2010/ 8/ 9 14:25: 0, 176.3,22.0, 32-45.7954N, 136-37.5141E, Sampling Rocks(2) D=4369m

8, 2010/ 8/ 9 14:57: 0, 128.2, 29.9, 32-45.7694N, 136-37.5192E, Measurement SAHF, Sampling MBARI(yellow) D=4374m

9, 2010/ 8/ 9 15:29: 0, 201.6, 240.6, 32-45.8091N, 136-37.6541E, Sampling Rock,Left Bottom D=4330m

3. Dive summary

Landing point was 600 m away from a fault cliff to the southwestward, 4459 m in depth (Event #2). The seafloor was covered by mud sediments. Rounded rocks (a few mm ~ a few cm in diameter) were found in places. The rocks were coated by manganese representing black colored surfaces (Figure 4.2.3.1).

Figure 4.2.3.1 Mud sediments with rounded rocks close to the landing point.

After moving to the northeastward, outcrops were observed at the depth of 4400m. The rock fragments at just the southern part of the outcrops was getting lager and its shape was more angular. Outcrops extended to NW-SE direction continuously (Figure 4.2.3.2). Bedding planes are almost perpendicular to the direction, indicating NE-SW strikes, almost parallel to the Nankai Trough (Figure 4.2.3.2). The bedding planes dips gently to the south or the north. Two rock samples were collected (Event #3). The rock samples have pretty low porosity, suggesting that the outcrops are the eroded surface related to fault activities.

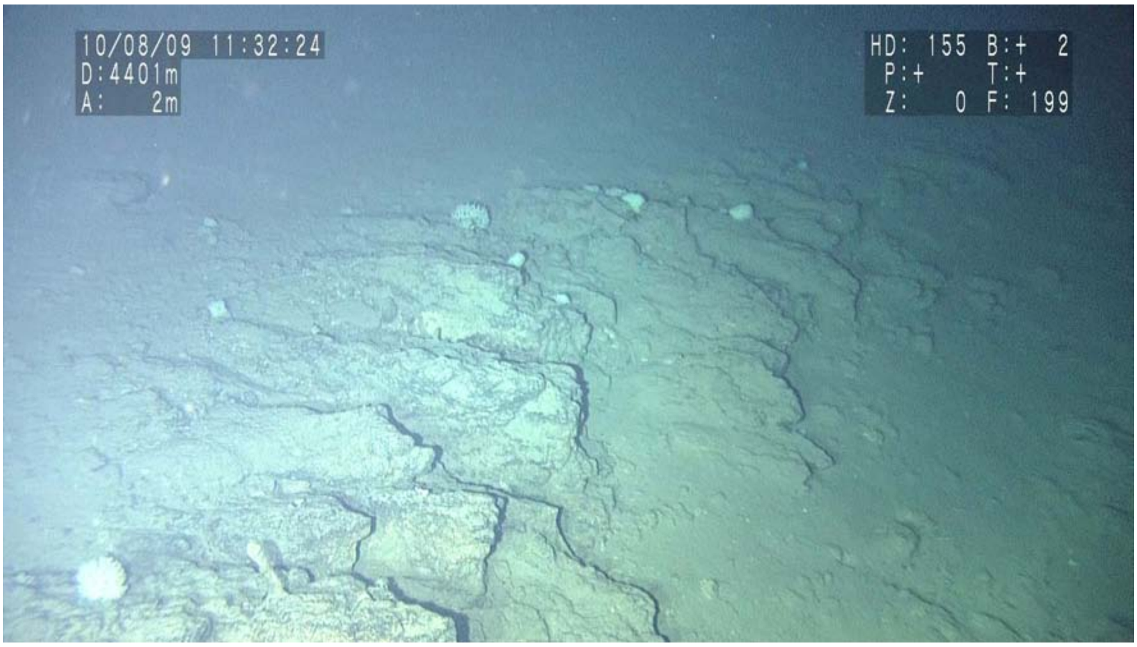

Figure 4.2.3.2 Outcrops extending NW-SE ward and bedding planes perpendicular to the directions.

The boundary between the northern outcrops and the southern mud sediments are relatively clear. Any evidence for cold seep was not identified around the boundary. SAHF measurements and MBARI core sampling (green) were conducted at this point (Event #4). The thickness of sediments was very thin (a few cm) in this point. It was pretty hard to put the SAHF into the seafloor. Just a few cm of siltstone was collected in the MBARI core.

Moving to a few m below the slope where sediments were expected to be thicker, MBARI core sampling (red) was conducted (Event #5).

Moving to the north to observe outcrops again. Then set directions to the southeastern-ward to trace the outcrops. Outcrops were observed intermittently. Mud sediments were covered between outcrops. Arrived at the 4398m depth, because any outcrop was identified for a while, the sediments might be at the below the cliffs. After landing, SAHF measurement was done (Event #6).

Moving to the north to find outcrops again, it was found at the 4380m depths. The outcrops were intermittently observed to the southeastern-ward as well. Huge outcrops were found at the 4380m depths. Small canyon like topography was observed, which is formed by normal faults at the surface of outcrops (Figure 4.2.3.3). A rock sample was taken (Event #7). Moved to mud sediments just below the outcrops, SAHF measurement and MBARI core sampling (yellow) were conducted (Event #8).

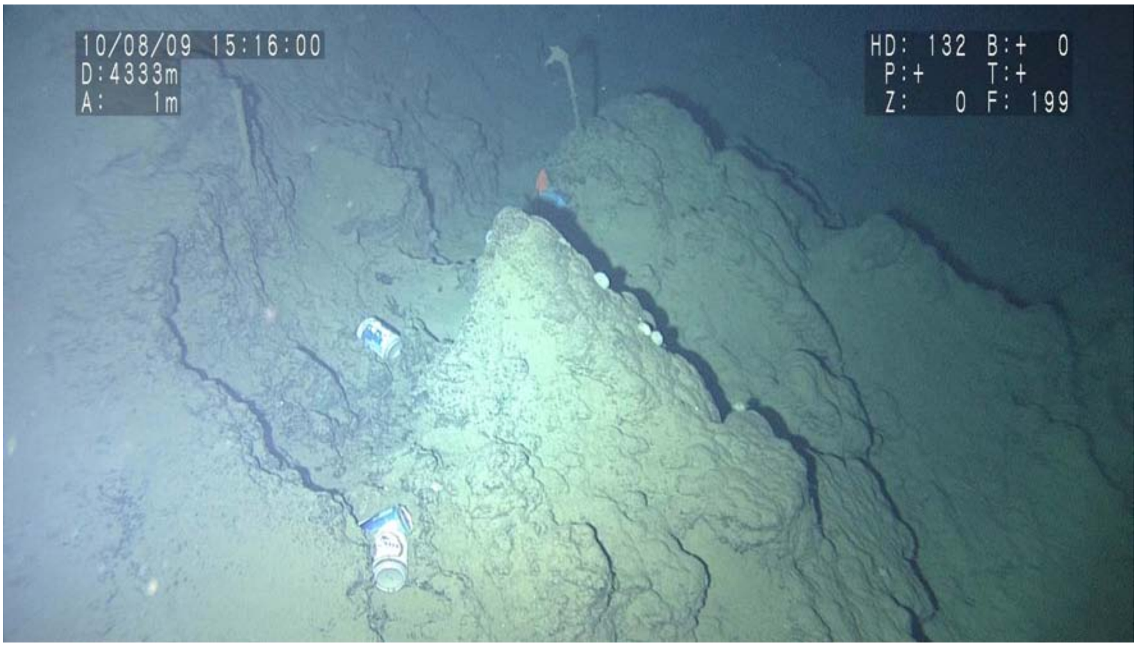

Figure 4.2.3.3 Canyon like topography formed by normal faults at the surface of outcrops.

Finally, moving to the northeastern-ward climbing the cliff, outcrops were observed continuously along the track, from 4370m to 4325 m depths. Mud sediments were observed shallower than the top of outcrops. The upper boundary between outcrops and mud sediments was also extending NW-SE directions. Therefore, outcrops were expected to distribute with some thickness along the bottom of the cliff (Figure 4.2.3.4). Further moving to the southwestern-ward, another huge outcrops were identified. Because the outcrops were coated by thick manganese, it was pretty hard to get. A rock sample was collected (Even #9). Leaving from the bottom.

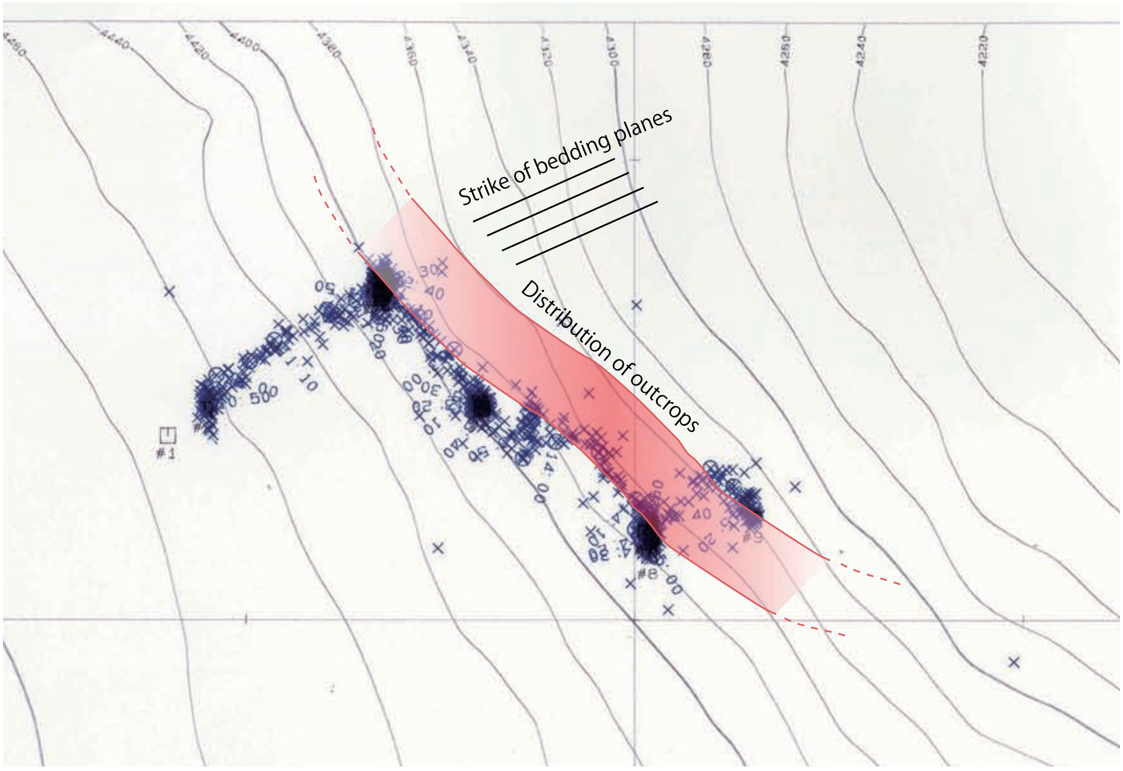

Figure 4.2.3.4 Distribution of outcrops and strikes of bedding planes

4. Rock Samples

Pale yellowish-gray siltstone composed of relatively abundant volcanoclastics with minor pelagic grains (Figure 4.2.3.5).

Figure 4.2.3.5 A collected rock samples

5. MBARI core samples

Three MBARI core samples were collected.

First core (Green) is composed of thin (~5 cm) mud sediments above and pretty hard siltstone bellow (Figure 4.2.3.6). Siltstone contains mainly clays, quarts and diatom. Rare volcanocalstics are also observed in the siltsone. There is no nannofossiles.

Figure 4.2.3.6 A photograph of MBARI core (Green)

Second (red) and third (yellow) cores are basically the same each other, comprising brownish gray silty clay above (up to 20 cm in thickness) and dark gray sility clay (Figure 7). There is hardness contrast between them clearly, harder one is the dark gray silty clay. Brownish gray silty clay is composed of caly mineals. quartz, sponge spicule and diatoms. Rare volcanocalstics are included. No nannofossils was identified. This composition is similar to that of siltstone described above. Dark gray silty clay contains abundant nannofossiles, clay minerals and quartz. Abundant nannofossiles is the characteristic for the dark gray silty clay.

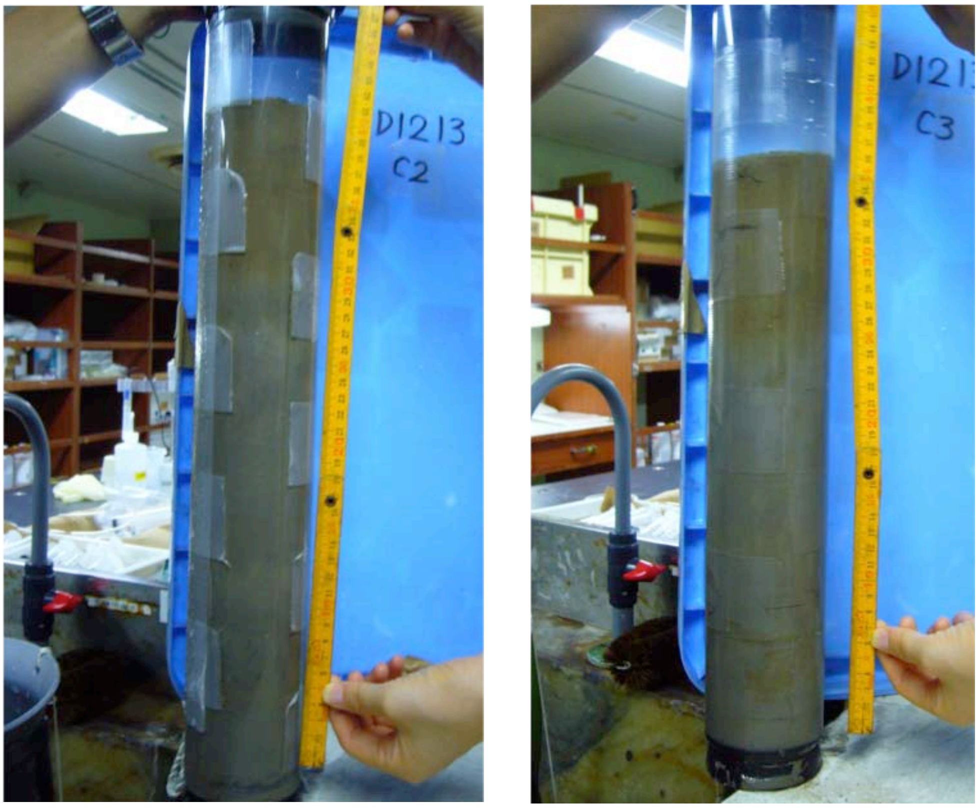

Figure 4.2.3.7 Photographs of MBARI cores (Red in left and yellow in right)

5. GPS/Acoustic measurement (Area C)

Motoyuki Kido (Tohoku University)

1. Introduction

GPS/Acoustic technique is almost only the way to measure precise position (1-5cm) of seafloor in long-baseline (10-1000km) relative to a land station. The technique is to acoustically measure the relative position of a seafloor instrument to sea-surface buoy whose exact position is monitored by kinematic GPS analysis. In this cruise we use small towing buoy with single GPS antenna with inertial gyro. The acoustic unit is equipped with bottom of the buoy, which communicate with seafloor transponders.

2. Survey site and time

Because the buoy operation is restricted in daytime in this cruise, we conducted GPS/Acoustic measurement on 2010/08/10, after all dives had carried out. The buoy was deployed at 07:30 at KM3 (33°34.95N, 136°42.29E) and stationary survey is continued to 11:30. Then we slowly moved to KM4 (33°34.92N, 136°41.06E) and finished the measurement at 14:00 (Fig. 5.1).

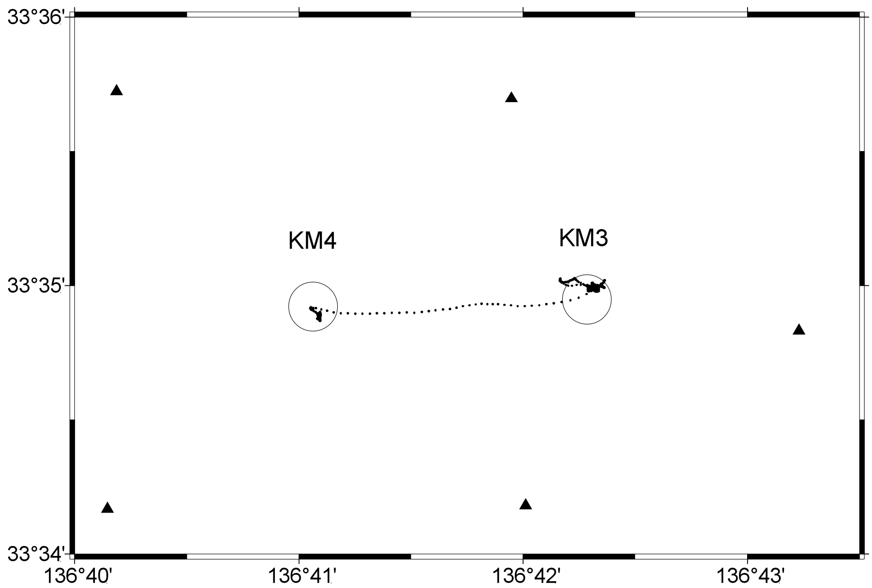

Figure 5.1. Ship track during the GPS/Acoustic measurement. Triangles are location of five seafloor transponders.

3. Operation

The buoy was deployed with A-frame (Fig. 5.2) and towed with combined strengthen cable (Fig. 5.3).

Figure 5.2. Overview of the deployment operation using A-frame.

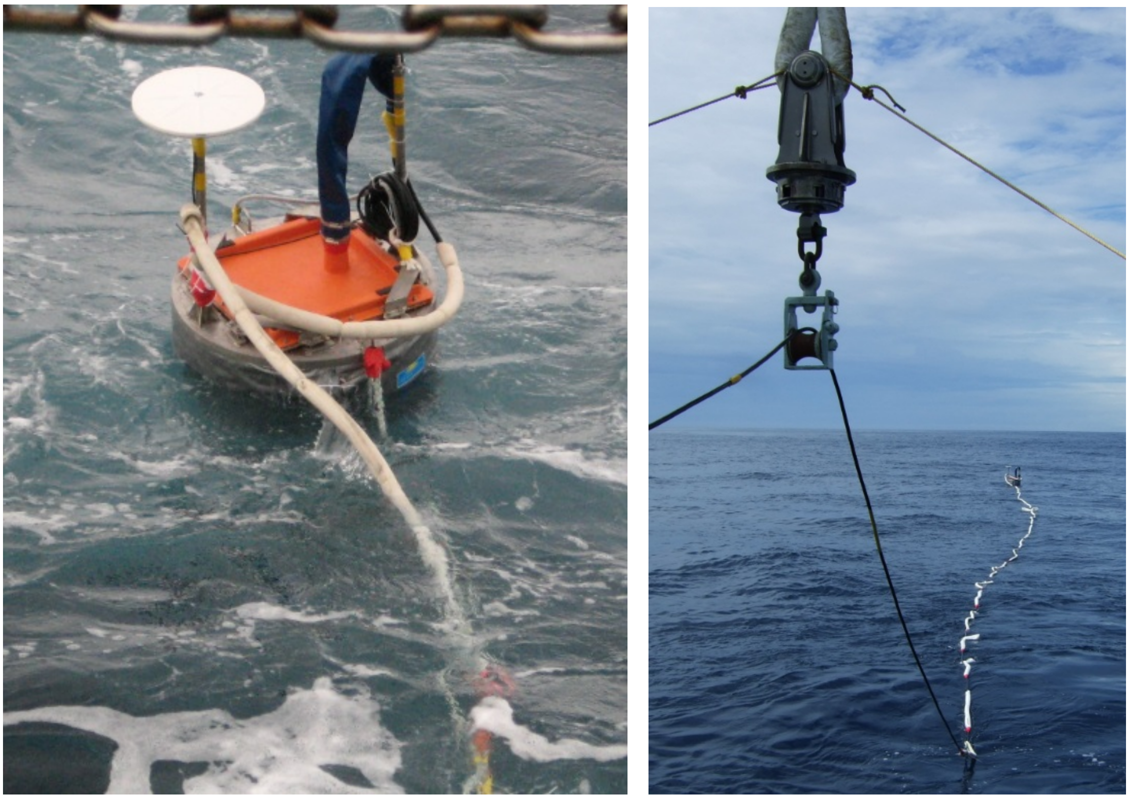

Figure 5.3. Closed view of the buoy at sea-surface (left) and towing cable (right).

6. Notice on using

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

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

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