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NATSUSHIMA Cruise Report

NT08-19

Sept. 3, 2008 – Sept. 12, 2008

Installation of short baseline seafloor strain-meters
and examination of their stability toward the long-term
real-time seafloor geodetic measurement
&
Accumulation of artificial toxic chemical compounds
in deep-sea animals at the cold seep area
of Nankai Trough, Japan

Kumano-nada and offshore Omae-zaki

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

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1. Cruise Information

Cruise number: NT08-19

Ship name: Natsushima

Title of the cruise: Research Dives using the Hyper Dolphin

Title of proposal:

S08-13: Installation of short baseline seafloor strain-meters and examination of their stability toward the long-term real-time seafloor geodetic measurement

S08-05: Accumulation of artificial toxic chemical compounds in deep-sea animals at the cold seep area of Nankai Trough, Japan

Cruise period: September 3, 2008 – September 12, 2008

Port call: Kochi – Owase

Research Area: Kumano-nada and offshore Omae-zaki

Research Map:

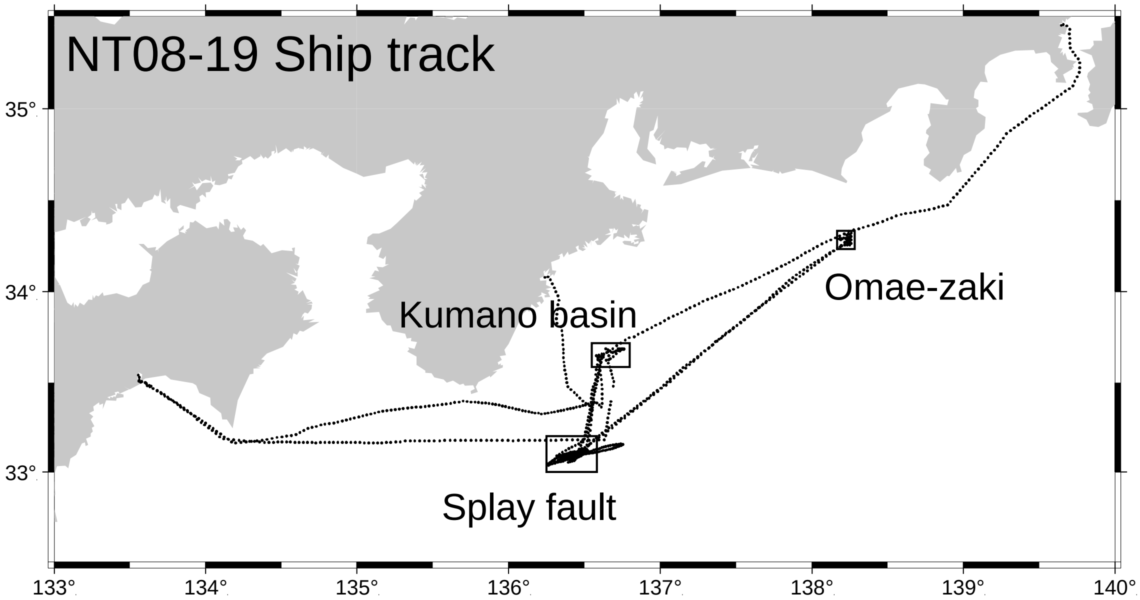


Fig. 1-1. Entire ship track during NT08-19 cruise.

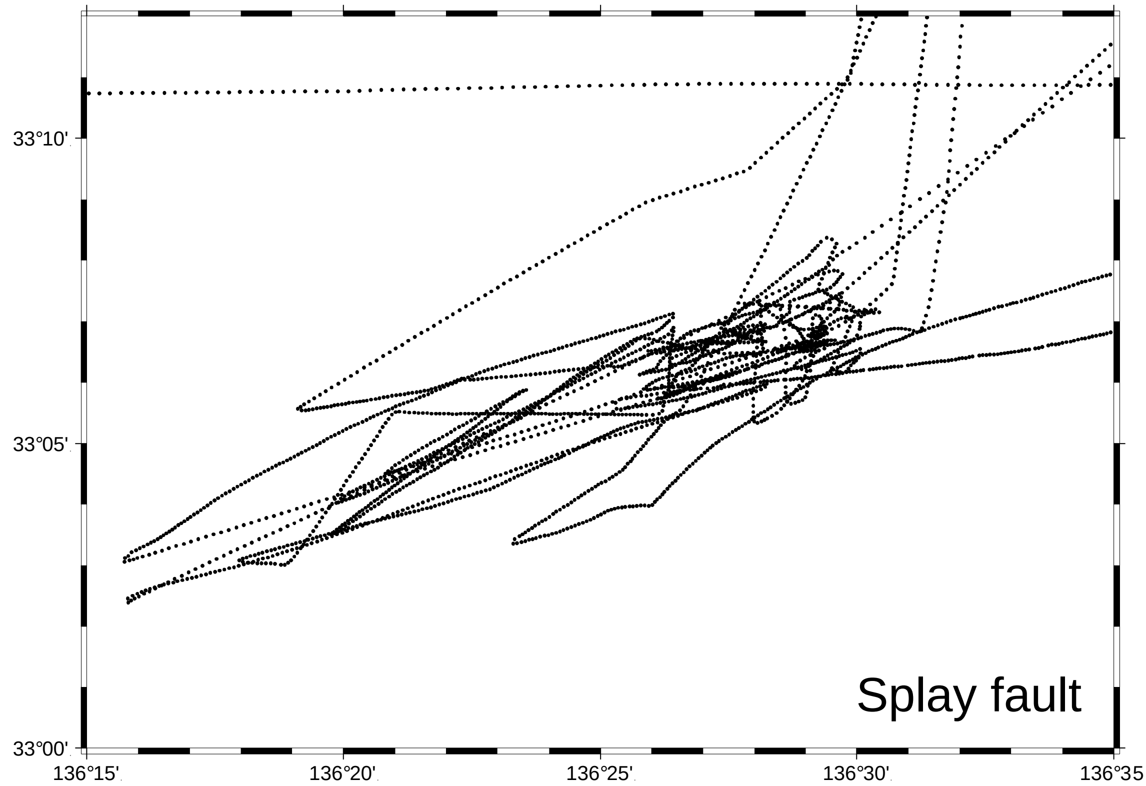
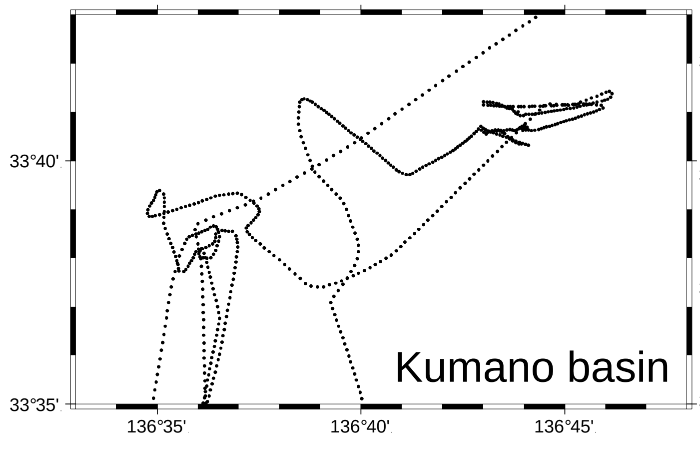


Fig. 1-2. Closed view around splay fault area.



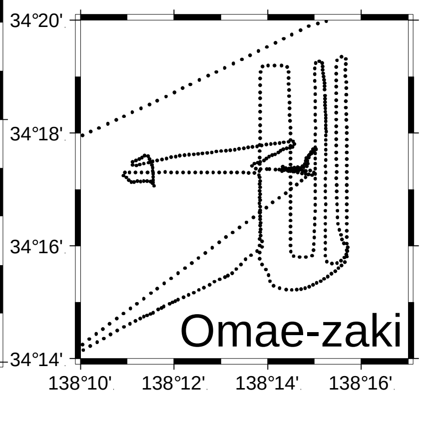


Fig. 1-3. Closed view around Kumano basin. **Fig. 1-4.** Closed view of Omae-zaki.

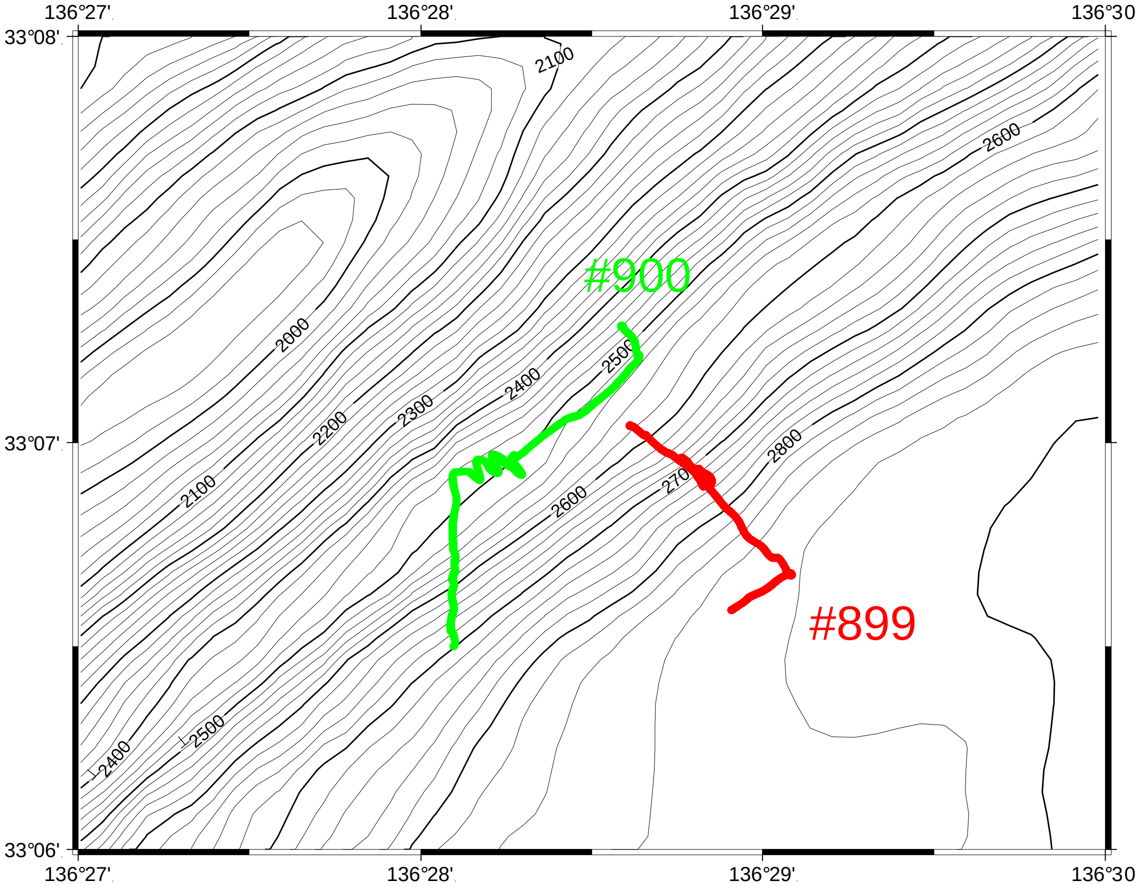


Fig. 1-5. Dive tracks in the splay fault area.

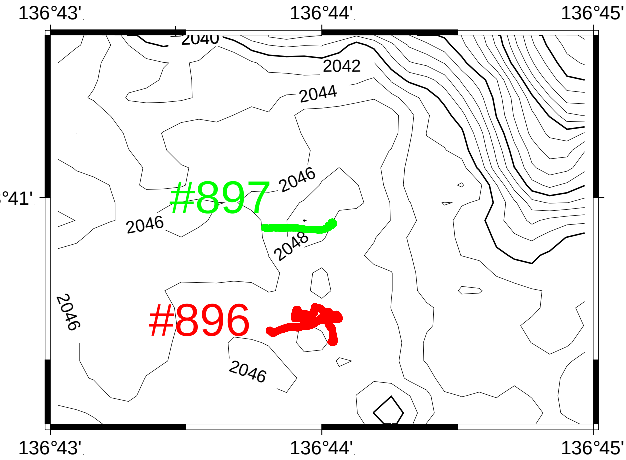


Fig. 1-6. Dive tracks in Kumano-nada.

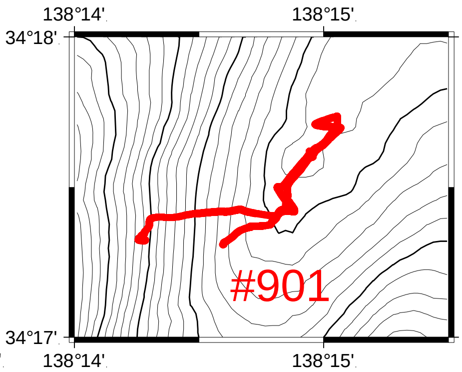


Fig. 1-7. Dive track in Omae-zaki

2. Researchers

Chief Scientist

Motoyuki Kido

Graduate School of Science, Tohoku University

Representative of Science Party

Motoyuki Kido (S08-13)

Graduate School of Science, Tohoku University

Nozomu Iwasaki (S08-05)

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Science Party (S08-13)

Yukihito Osada (on board)

Graduate School of Science, Tohoku University

Hiromi Fujimoto (system development)

Graduate School of Science, Tohoku University

Koji Matsumoto (planning installation site)

DONET, JAMSTEC

Ryota Hino (sound speed analysis)

Graduate School of Science, Tohoku University

Satoshi Miura (crustal deformation on land)

Graduate School of Science, Tohoku University

Yoshihiro Ito (slow earthquakes)

Graduate School of Science, Tohoku University

Syuichi Suzuki (slow earthquakes)

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Kouhei Ohnishi (on board)

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Kanazawa University

Bhuiyan F. Ahamed (microbial community analysis)

Graduate School of Agriculture, Kochi University

Issei Hyodo (on board)

Graduate School of Agriculture, Kochi University

Kodai Yamane (on board)

Ocean Research Institute, University Tokyo

3. Observation

3-1. Objective

This cruise consists of two scientific parties, geophysicists (S08-13) and biologists (S08-05), whose specialistic fields are much different to each other. What in common is *cold seepage*, where geophysical events such as fault activity are expected as well as unique bio-ecological system is developed due to cold seep upwelled along the fault within sediment. Among the deep-sea animals, clam colony is the most prominent indicator of active fault or cold seepage. The outer bound of Kumano-nada is known as one of the most dense distribution of calm colony, as well as in Omae-zaki.

The geophysical group plans to physically detect the fault displacement in terms of geodetic technique that measures temporal variation of distance across the fault using acoustic ranging. Quantitative measurements will give crucial information for the destructive large earthquakes, such as Nankai or To-Nankai, which are expected to occur in the future.

On the other hand, the biological group exploits animals and sediments to analyze toxic chemical compounds, especially organotin compounds. The purpose of the investigation is to clarify the present status of pollutions in the deep-sea bottoms and biological accumulation of deep-sea animals.

3-2. Seafloor Acoustic Ranging

3-2-1. Recovery of the seafloor acoustic ranging system

(Yukihito Osada and Motoyuki Kido)

Introduction

We have carried out the experiment to estimate the accuracy of the long period since August 2007. But it collected the data during four month because it had made a trouble. Therefore we can recovery only two slave PXPs. We try to recover 2 master PXPs (Precise acoustic transponder) using Hyper dolphin in this cruise.

Method

The short-range seafloor ranging system consists of precise acoustic transponders (PXP). The PXP consists of a monopod anchor, a pressure housing in the shape of a 17" diameter glass ball for batteries and electronics, and an acoustic transducer on the top (Figure 3-2-2-1, Figure3-2-2-2). Although such a design allows the PXP to sway slightly due to bottom currents, the internal tilt meter and compass can be used to correct these effects. Individual PXPs in pairs act as either a "master" or a "slave". The master can be recorded the received signals of up to four slaves. To initiate a range measurement, the master sends out a command signal. The PXPs use a relatively simple detection method, triggering on the leading edge of an incoming wave when the amplitude rises above a fixed threshold. When the slave detects the master's signal, it replies with an identical wave (after a precise 3 second delay). Finally, the master records the signal from the slave. This system automatically adjusts the receiver gain for the incoming signal and records the receiver gain.

Preliminary

We carried out 2 dives by the hyper dolphin in order to recover for 2 master seafloor acoustic ranging system on 6 September 2008.

The dive #897 started at the water-depth 2030 m, at the position 33°40.905N, 136°43.793S and ended at the position 33°40.922N, 136°44.041S. We aim to recover one PXP in this dive. We found the PXP and recovery the PXP with the condition, which was deployed on the sea-surface (Fig. 3-2-1-1).

The next dive #898 started at the water-depth 2030 m, at the position 33˚40.629N, 136˚43.808S and ended at the position 33˚40.554N, 136˚44.038S. We aim the same thing on dive #897. We can find only the frame because of releasing the glass sphere. Therefore we try to recover the frame on this dive (Fig. 3-2-1-1).

We collected 73,806 pressure data and about 37,000 ranging data in the recovered PXP. The difference from pressure and ranging data had made a trouble.

Table 3-2-1-1. Location of the seafloor acoustic ranging system.

Station	Latitude	Longitude	Height
M1	33˚40.922N	136˚44.041E	2043
M2	33˚40.554N	136˚44.038E	2043

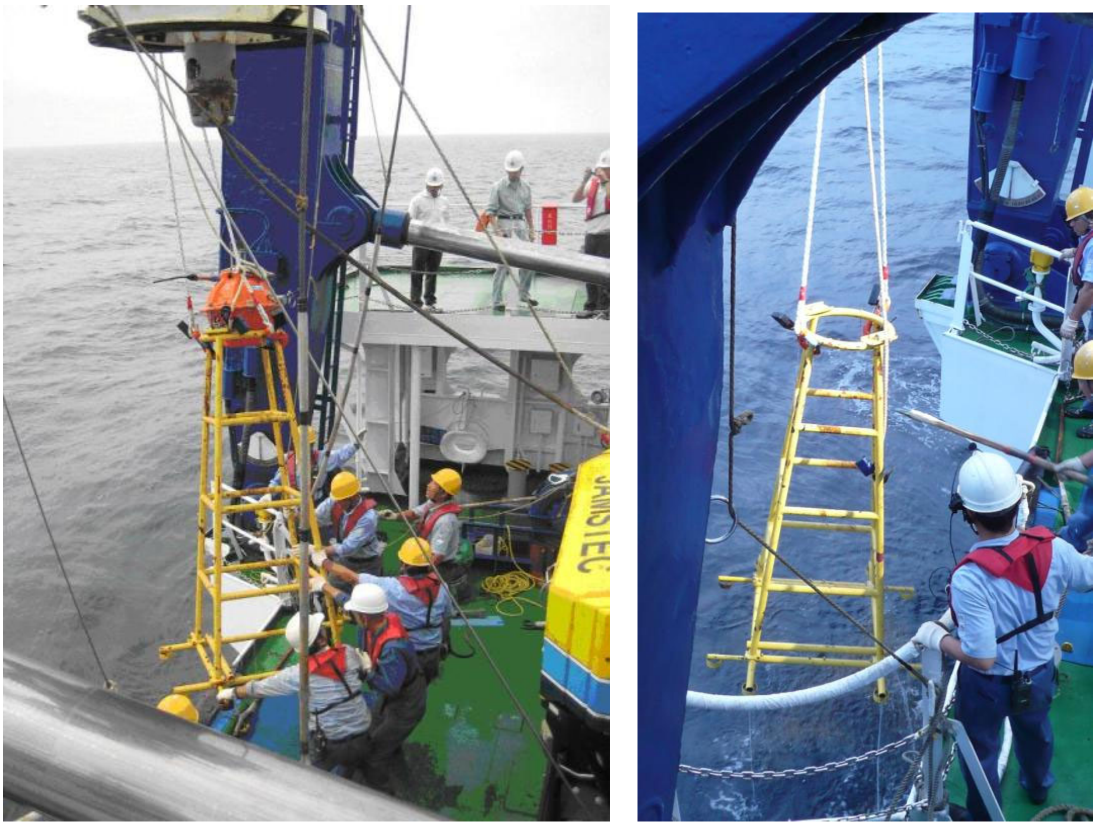


Fig. 3-2-1-1. A photograph of the recovered PXP and frame.

3-2-2. Installation of the seafloor acoustic ranging system

(Yukihito Osada and Motoyuki Kido)

Introduction

We start the seafloor acoustic ranging system to observe the seafloor crustal movement on Kumano nada area. We usually deploy the PXP from deck of vessel. But it is difficult to set up the point, which satisfies the requirement because of sea current and weather condition. Therefore we set up to use the Hyper dolphin.

Preliminary

We deploy three PXPs on September 6 (Figure 3-2-2-3). We observed from the deck of the vessel, while sunk with a speed of 60 ~ 70 m/min. Firstly, we calculated the location of AS1 using two way travel time to estimate the effect of sea current on the position. The difference from the deployed and calculated point, which was used two-way travel time, is 400 m. Considering the sea current, we deployed two PXPs. The location of AS1, AS2, and AM1' is calculated by two-way travel times, which were observed on the sea-surface around PXP (Figure 3-2-2-4).

We change the location of AM1' using the Hyper dolphin on the dive #899. The dive #899 started at the water-depth 2881 m, at the position 33°06.591 N, 136°28.907E and ended at the position 33°07.040 N, 136°28.621 E.

We try to check the two points in the dive #899; one point is the stability of deployment from deck of vessel, and using the hyper dolphin on a cliff. Another point is the installation of the PXP on a cliff across the spray faults. In case deployment from the deck of the vessel, the weight, which is equipped the PXP, was buried in 10cm on AM1' (Fig. 3-2-2-3). We pick up and move into AM1 across the spray faults. Firstly we deploy the PXP above 5 m with free fall. But we can't install a stable condition because of a hard clayey layer and slope of a cliff (Fig. 3-2-2-5). Therefore we prepare the seafloor for the installation of PXP with a rake (Fig. 3-2-2-6). In this result, we can install a stable condition.

After the dive #899, we check the acoustic wave of a seafloor acoustic ranging system on the sea-surface. We success to catch on the wave of a seafloor acoustic ranging system.

Table 3-2-2-1. Location of the seafloor acoustic ranging system.

Station	Latitude	Longitude	Height
AM1’	33°06.674N	136°29.091E	2898
AM1	33°06.910N	136°28.820E	2751
AS2	33°06.869N	136°29.280E	2906
AS1	33°06.416N	136°29.002E	2894

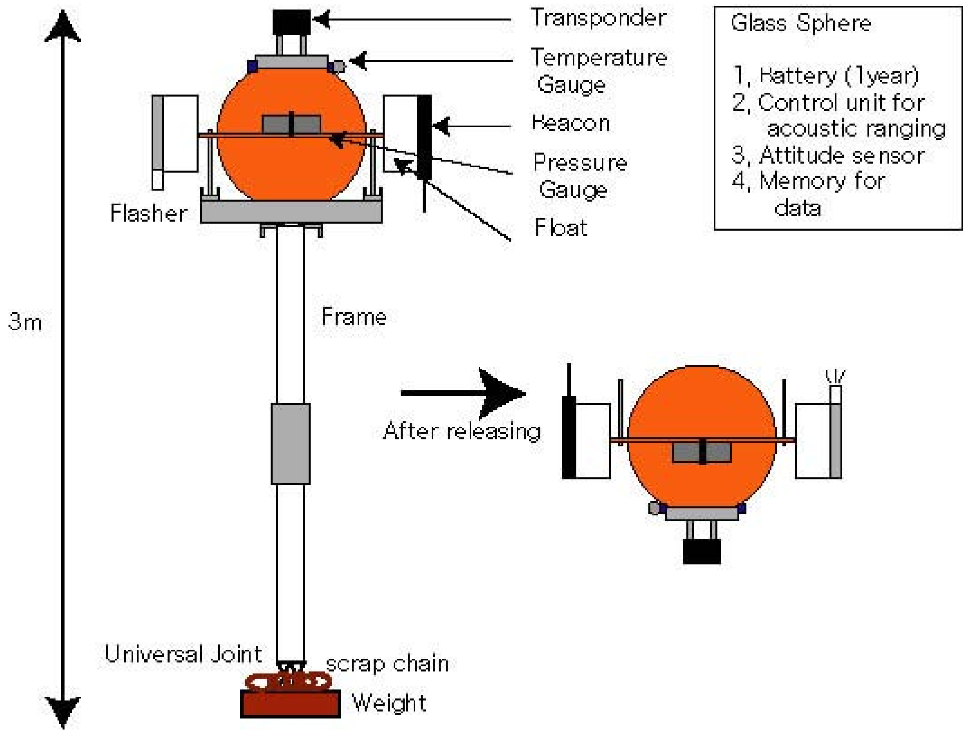


Figure 3-2-2-1. A scheme of the seafloor acoustic ranging system.

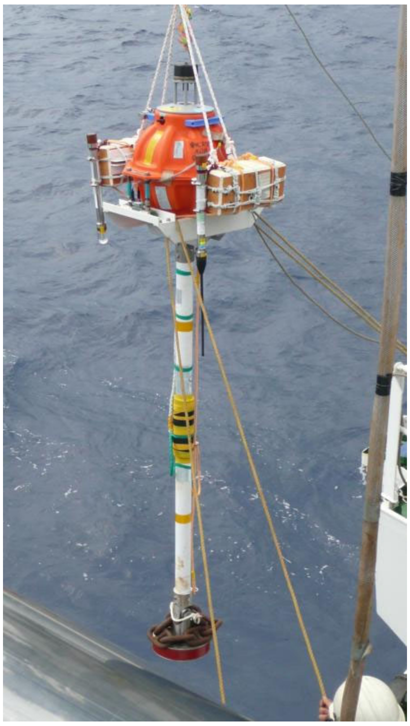


Fig. 3-2-2-2. A photograph of the PXP

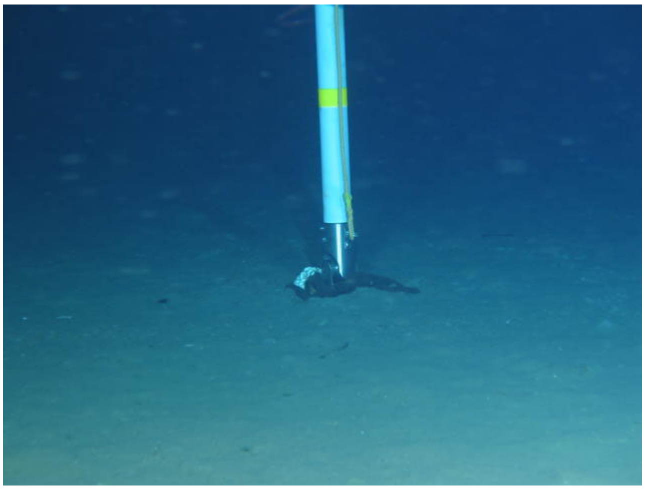


Fig. 3-2-2-3. A photograph of the PXP

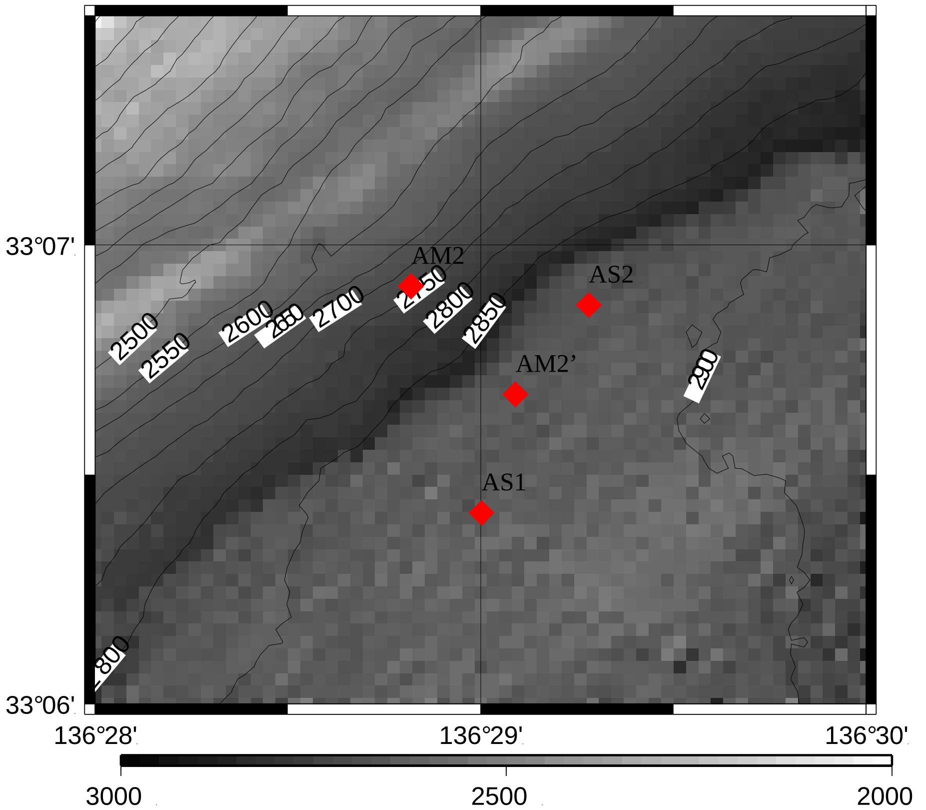


Fig. 3-2-2-4. Location of the PXP

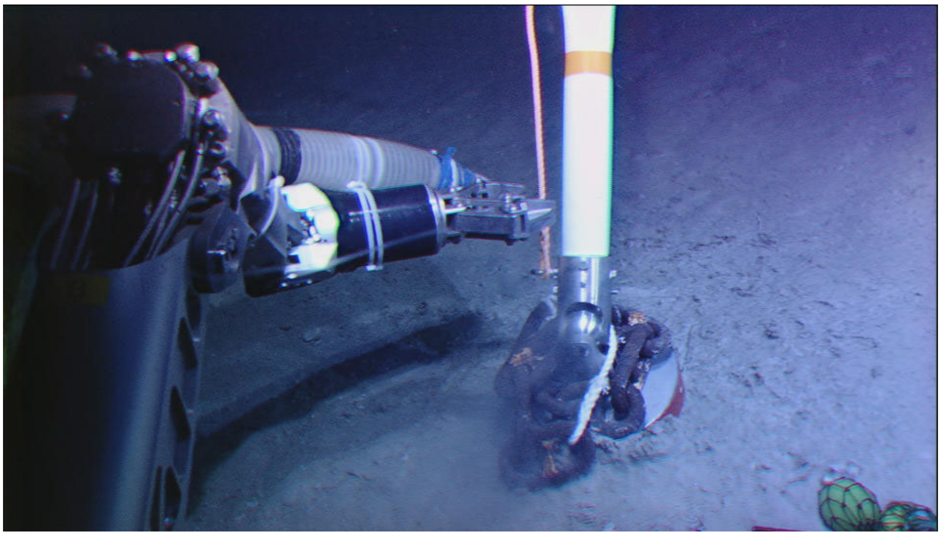


Fig. 3-2-2-5. A photograph of the PXP

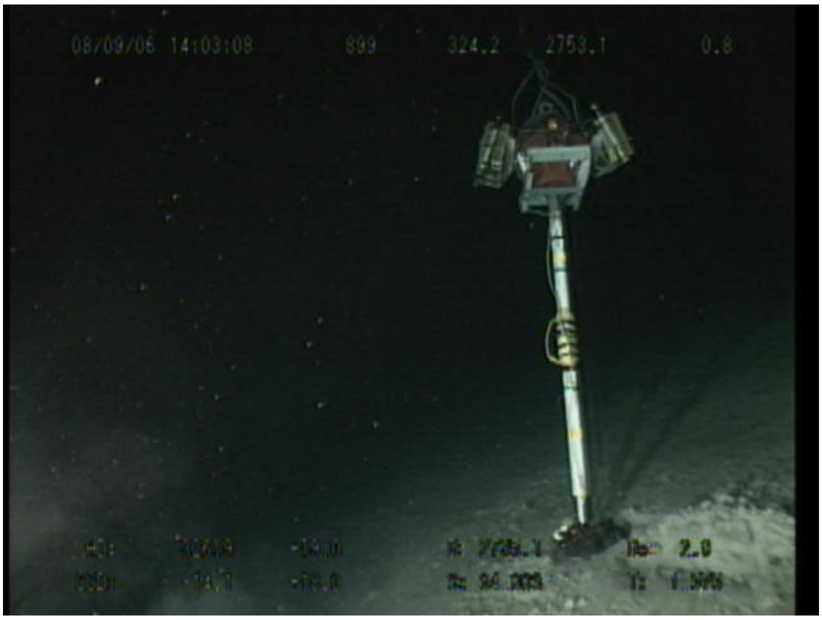


Fig. 3-2-2-6. A photograph of the PXP.

3-2-3. Retrieving the IES (Motoyuki Kido and Yukihito Osada)

An Inverted Echo Sounder (IES) is an instrument which measures round trip traveltime from the instrument itself on the seafloor to the sea surface at a given time interval. Although the range from the seafloor to sea surface is undulating due to ocean tide and current, it can be corrected with pressure data on seafloor measured by a pressure gauge equipped with the IES. After removal of the height variation to the sea surface, one can estimate mean sound speed in seawater as a time series. The IES has an on demand pop up system triggered by acoustic command from sea surface.

Fig. 3-2-3-1. Pre-deployed IESs with sinker.

Fig. 3-2-3-2. Recovering IES-7

In August 12, 2006, the Tohoku University seafloor geodesy group deployed a long-term IES, called IES-7 (Fig. 3-2-3-1), at the central Kumano-nada basin (N33°38.508' E136°36.005') to monitor sound speed variation for one year, which will give an insight on long-term continuous seafloor geodetic measurement using the DONET cable system. However we missed a chance to recover it in 2007. The battery to release the pup up system has only one year lifetime. Therefore we have planed to retrieve it using Hyper Dolphin if we have enough time in this cruise.

Fortunately it found that the IES-7 is still alive even 2 years have past since installation when we called it to calibrate its position from surface transducer on September 4, 2008. Then we retrieved it without a dive in September 5, 2008. Pup up command was sent at 17:20 (JST) then the IES was released from its sinker within 5 minutes and started bobbing up at a rate of 70 m/min. After recovering (Fig. 3-2-3-2), we confirmed that the batteries of the radio beacon and flasher were also alive.

3-3. Accumulation of artificial toxic chemical compounds in deep-sea bottoms

3-3-1. Analysis of artificial toxic chemical compounds

Objectives

Organotin (OT) compounds have been extensively used in boat paints since 1960, because of their excellent and long-lasting antifouling properties. During early to middle 1980, tributyltin (TBT) compounds caused malformation of oyster shell and led the decrease of fishery resource. Since then, TBT has been one of the contaminants of environmental concerns. Over the past few decades, a considerable number of studies have been conducted on the effect for aquatic organisms and concentration in aquatic environment of OTs. In spite of regulation concerning of TBT in various countries between the latter of 1980 and the early of 1990, TBT has been still detected in aquatic environment. Especially, coastal area was contaminated widely by OTs.

Recently, the contaminants by artificial chemical substances in deep-sea ecosystems are of very concern. Recent our study suggested the potential of contamination by OTs in deep-sea. To understand the present status of deep sea pollutions in OTs as well as other chemical pollutants such as organochlorine compounds and heavy metals, bottom sediment and deep-sea organisms were collected from deep-sea under 2000m and beyond in this cruise.

Samples

Samples were collected from Kumano-nada at the depth of about 2500m and Kanasu-no-se at the depth of about 300 m and 500m using the ROV Hyper Dolphin. Deep-sea animals such as crustaceans, gastropods and brittle stars were collected by a slurp gun. Sediments and bottom water were collected with MBARI corers and Niskin bottle samplers. Samples were stored in freezer at -80°C immediately. We will analyze organotin compounds by a gas chromatography equipped with a mass spectrometry.

3-3-2. Microorganisms in the deep-sea sediments

Objective

The deep-sea sediment is very low nutrient condition for the growth of microorganisms except for limited areas. Several bacteria are known to be able to utilize even man-made pollutants, which are normally toxic to living organisms. So if these pollutants are piled on the deep-sea, there might emerge some bacteria, which rely their grown on the pollutants. In this cruise, we would like to elucidate the relationship between the concentration of the pollutants and the existence of the pollutant-utilizing bacteria in the deep-sea sediment.

Samples

We collected core sediments with MBARI core sampler from several sampling points, Kumano-nada and offshore of Omae-zaki. The former point is deeper than the later. Core sediments were cut into smaller pieces, every 2cm in length. Several sediments were kept at -80˚C. Sediments were suspended in 100-ml autoclaved artificial sea water (ASW) and mixed well with mixer. After sediments were removed, microorganisms were filtrated on the 0.3-µm membrane filter. The membrane-trapped microorganisms were dispersed in ASW and collected by centrifugation. The cells were stored at -80 °C for the future procedure of metagenome DNA isolation. We will determine the bacterial communities in each sediments and find out the relationship with the concentrations of the pollutants.

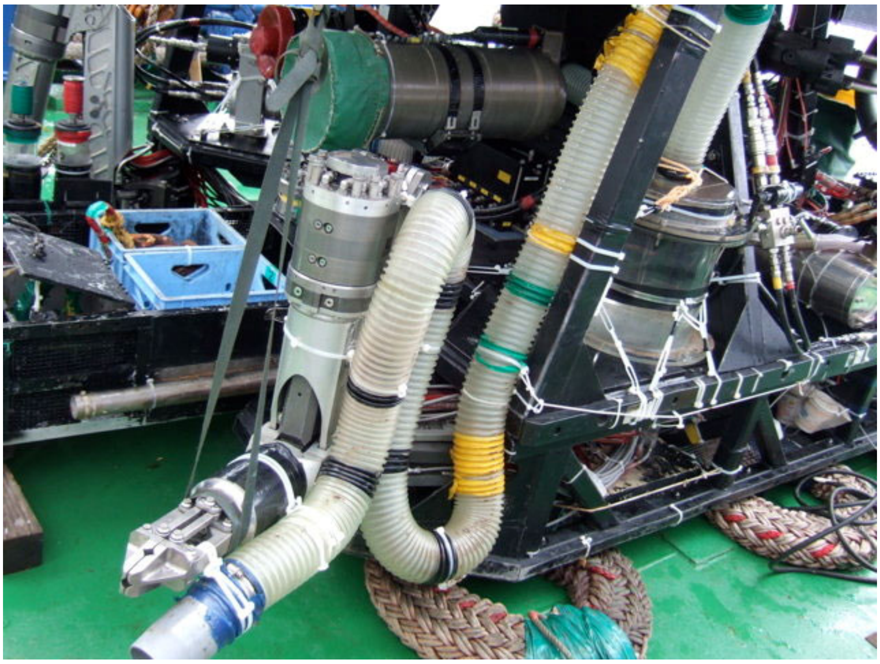


Fig. 3-3-1. Slurp gun.

Fig. 3-3-2. MBARI corers.

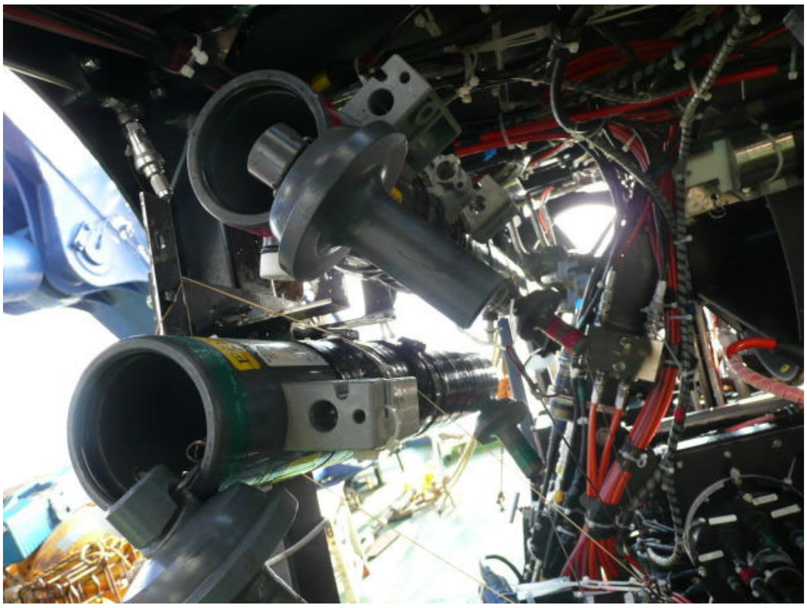


Fig. 3-3-3. Niskin bottle samplers.

3-4. List of Instruments

Seafloor Strainmeter (M1)	300x90x60cm 145 kg in air, 40 kg in water
Seafloor Strainmeter (S1, S2)	300x90x60cm 130 kg in air, 40 kg in water
Inverted Echo Sounder (IES-7)	
NISKIN water sampler	2.0 little
MBARI corer	
Slurp gun	
Scoop	
Plankton net	ϕ = 300cm, mesh size = 0.01mm

3-5. NT08-19 Cruise Log

2008/09/03

Weather: fine but cloudy/ Wind direction: NNW/ Wind force: 4/ Wave: 2 m/ Swell: 2 m/ Visibility: 7 nautical mile (12:00 JST)

09:00	Onboard the R/V NATSUSHIMA
10:00	Departure from Kochi-ko port
11:00-11:45	Briefing about ship's life and safety
13:00-13:30	Scientists and HPD team meeting
19:00-20:00	Scientists meeting

2008/09/04

Weather: rain/ Wind direction: NNE/ Wind force: 5/ Wave: 4 m/ Swell: 2 m/ Visibility: 5 nautical mile (12:00 JST)

06:00	XBT
08:08	Launching HPD (HPD#896 dive)
09:29	HPD landing (2,040m)
12:01	HPD leave the bottom (2,042m)
13:15	HPD come up to surface
14:58	Launching HPD (HPD#897 dive)
16:07	HPD landing (2,042m)
16:46	HPD leave the bottom (2,040m)
17:59	HPD come up to surface
19:15-20:50	Transponder (IES-7) calibration
21:00-21:45	Scientists meeting

2008/09/05

Weather: fine but cloudy/ Wind direction: South/ Wind force: 3/ Wave: 2 m/ Swell: 2 m/ Visibility: 7 nautical mile (12:00 JST)

06:00	XBT
07:16	Transponder (S1) deployed
07:55-08:46	Transponder (S1) calibration
09:26	Transponder (M3) deployed

09:57	Transponder (S2) deployed
10:48-11:45	Transponders (M3 and S2) calibration
12:44	Launching HPD (HPD#898)
14:20	HPD come up to surface
17:10-18:00	Transponder (IES-7) recover
19:00-19:30	Scientists meeting

2008/09/06

Weather: fine but cloudy/ Wind direction: SSE/ Wind force: 2/ Wave: 2 m/ Swell: 2 m/ Visibility: 7 nautical mile (12:00 JST)

08:10	Launching HPD (HPD#899)
10:23	HPD landing (2,881m)
15:10	HPD leave the bottom (2,588m)
16:32	HPD come up to surface
16:32-16:50	Surface plankton sampling
17:30-18:05	Listening transponder communication
20:30-21:00	Scientists meeting

2008/09/07

Weather: fine but cloudy/ Wind direction: West/ Wind force: 2/ Wave: 2 m/ Swell: 2 m/ Visibility: 7 nautical mile (12:00 JST)

09:44	Launching HPD (HPD#900)
11:30	HPD landing (2,719m)
16:23	HPD leave the bottom (2,464m)
17:42	HPD come up to surface
17:42-17:57	Surface plankton sampling
20:00-20:40	Scientists meeting

2008/09/08

Weather: fine but cloudy/ Wind direction: NE/ Wind force: 4/ Wave: 3 m/ Swell: 2 m/ Visibility: 7 nautical mile (12:00 JST)

11:30	Transit to Omae-zaki
20:00-20:30	Scientists meeting

20:50	Arrival at Omae-zaki
20:53	XBT
21:25-00:51	MBES survey

2008/09/09

Weather: fine but cloudy/ Wind direction: East/ Wind force: 5/ Wave: 4 m/ Swell: 2 m/ Visibility: 7 nautical mile (12:00 JST)

09:56	Launching HPD (HPD#901)
10:34	HPD landing (337m)
17:38	HPD leave the bottom (506m)
18:11	HPD come up to surface
18:07-18:16	Surface plankton sampling
18:21	Transit to Kumano-nada
21:00-21:30	Scientists meeting

2008/09/10

Weather: fine but cloudy/ Wind direction: ENE/ Wind force: 6/ Wave: 5 m/ Swell: 4 m/ Visibility: 7 nautical mile (12:00 JST)

08:55-10:22	Transponders (M3) calibration

2008/09/11

Weather: fine but cloudy/ Wind direction: ENE/ Wind force: 2/ Wave: 2 m/ Swell: 2 m/ Visibility: 7 nautical mile (12:00 JST)

07:00	Transit to Owase-ko port
13:40	Mooring in the Owase bay

2008/09/12

09:00	Arrival in Owase-ko port
10:00	Leave the R/V NATSUSHIMA

Wind force criteria

0: Calm, 1: Light air, 2: Light breeze, 3: Gentle breeze, 4: Moderate breeze, 5: Fresh breeze, 6: Strong breeze, 7: Near gale, 8: Gale, 9: Strong gale, 10: Storm, 11: Violent storm, 12: Hurricane

3-6. Dive Information

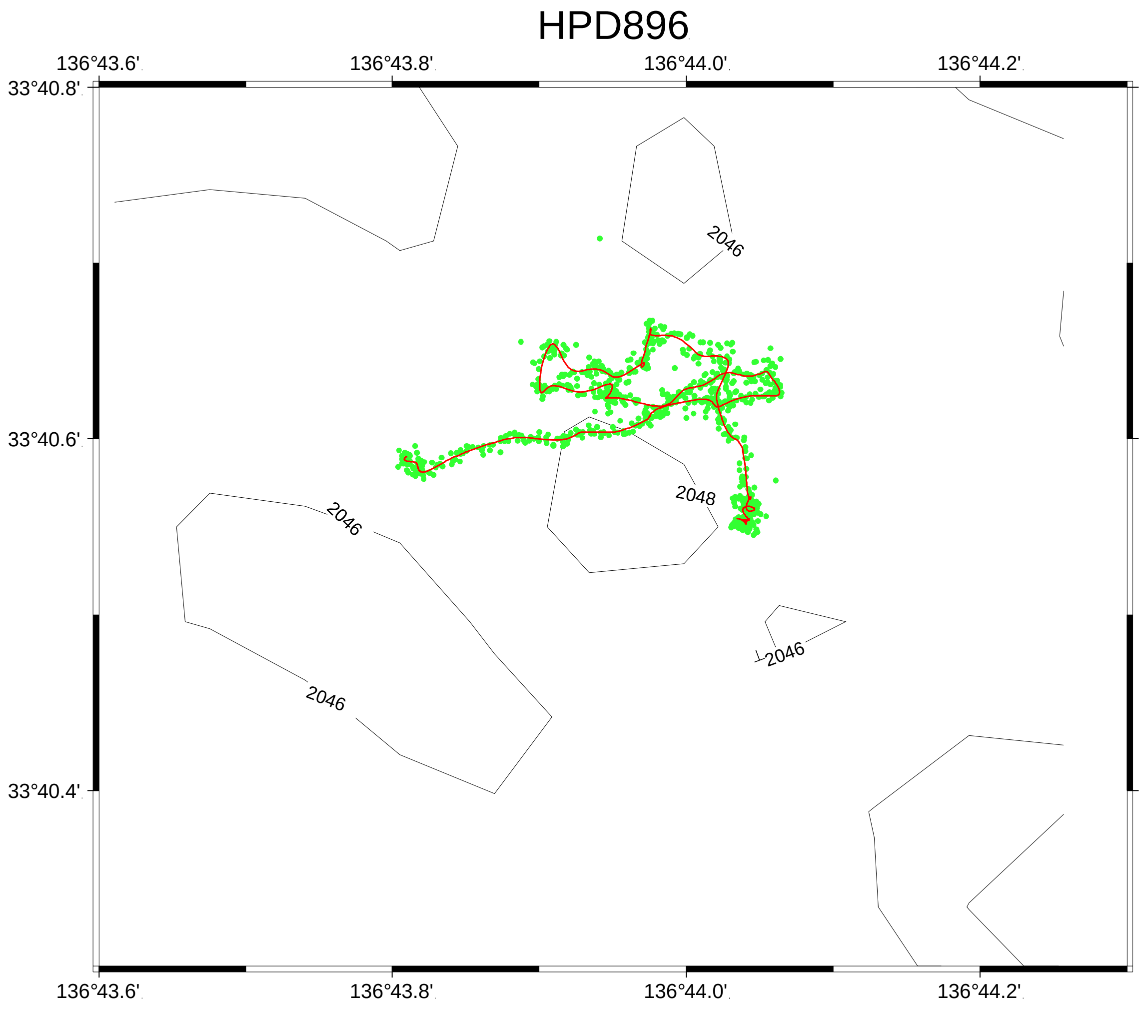
3-6-1. #896

September 4, 2008 08:21 – 12:58 (4:37h) Kumano-nada basin

Retrieving seafloor strainmeter, M2

Remarks:

12:01 33-40.554N 136-44.038E 2042m: Retrieved M2



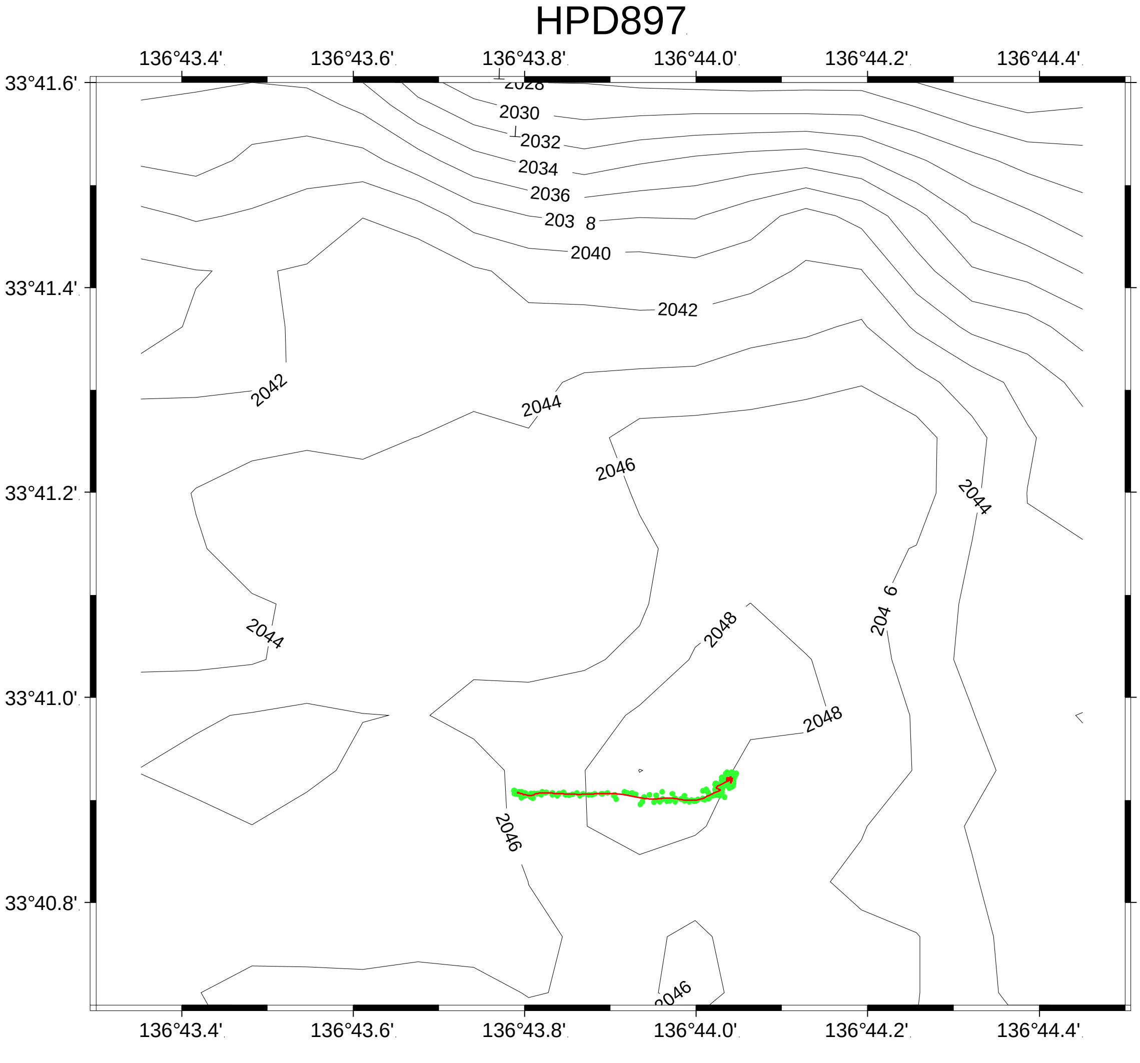
3-6-2. #897

September 4, 2008 14:58 – 17:45 (2:47h) Kumano-nada basin

Retrieving seafloor strainmeter, M1

Remarks:

16:45 33-40.922N 136-44.041E 2043m: Retrieved only M1's stand



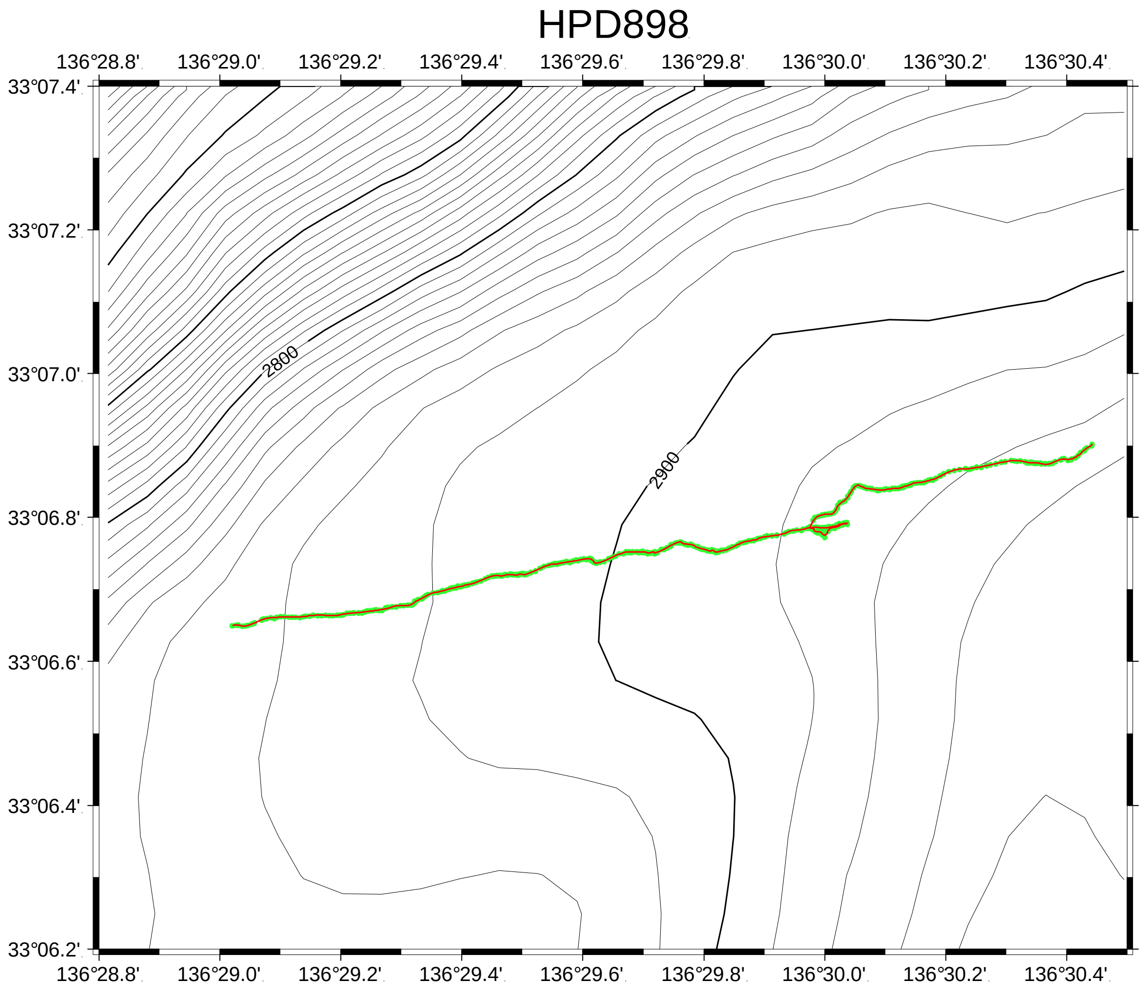
3-6-3. #898

September 5, 2008 12:58 – 14:06 (1:08h) Splay fault, Kumano-nada

Reinstallation of new M1 on the cliff

Remarks:

13:37 33-06.775N 136-29.914E 485m: Stopped diving due to strong current at the depth



3-6-4. #899

September 6, 2008 08:25 – 16:19 (7:54h) Splay fault, Kumano-nada

Reinstallation of M on the cliff and exploration of animals

Remarks:

12:44 33-06.910N 136-28.820E 2751m: Reinstalled M

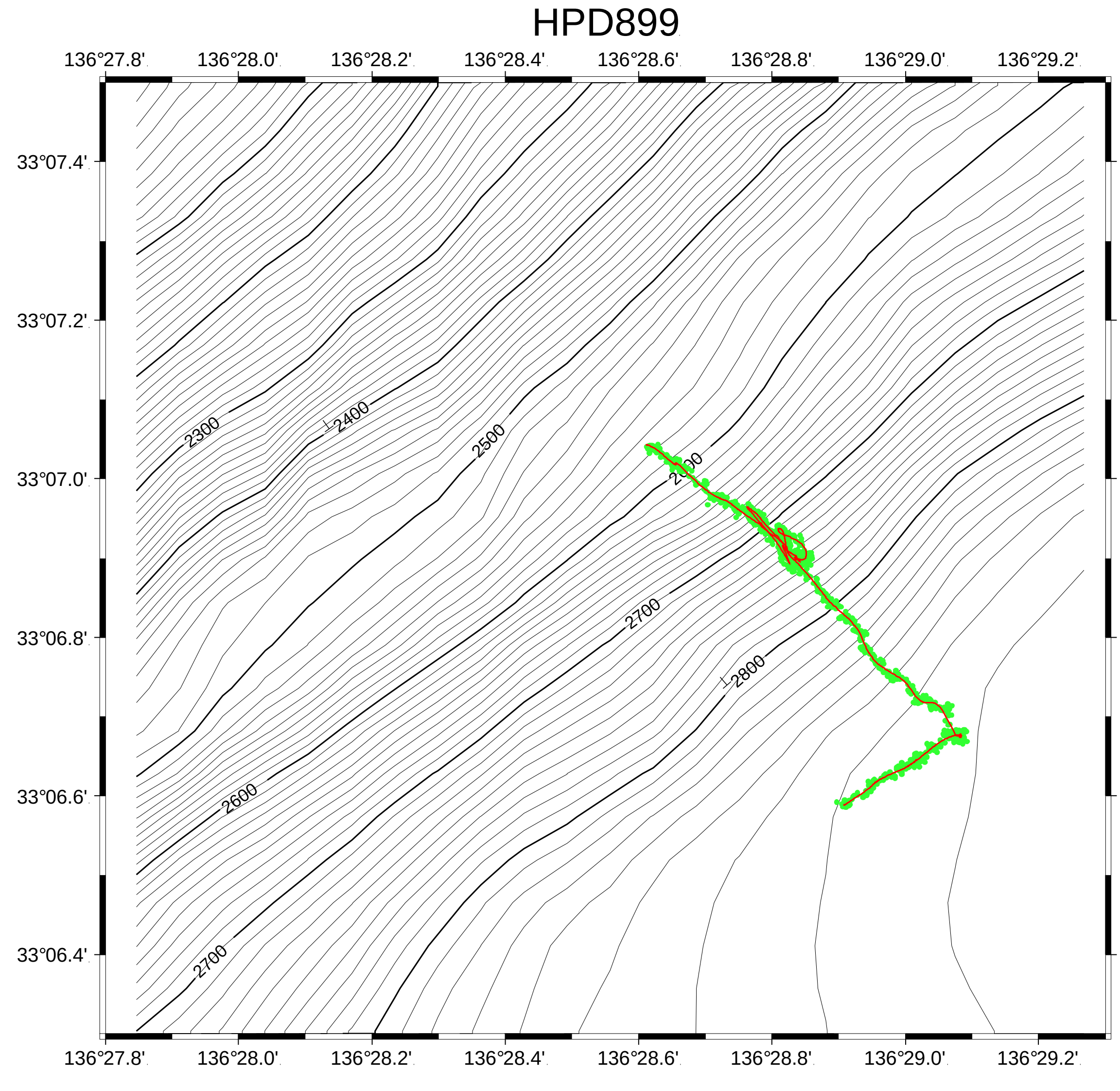
14:06 33-06.910N 136-28.820E 2753m: MBARI (blue)

14:06 33-06.910N 136-28.820E 2753m: NISKIN

14:58 33-07.020N 136-28.654E 2605m: MBARI (green)

15:01 33-07.020N 136-28.654E 2605m: MBARI (red)

15:10 33-07.020N 136-28.654E 2605m: NISKIN



3-6-5. #900

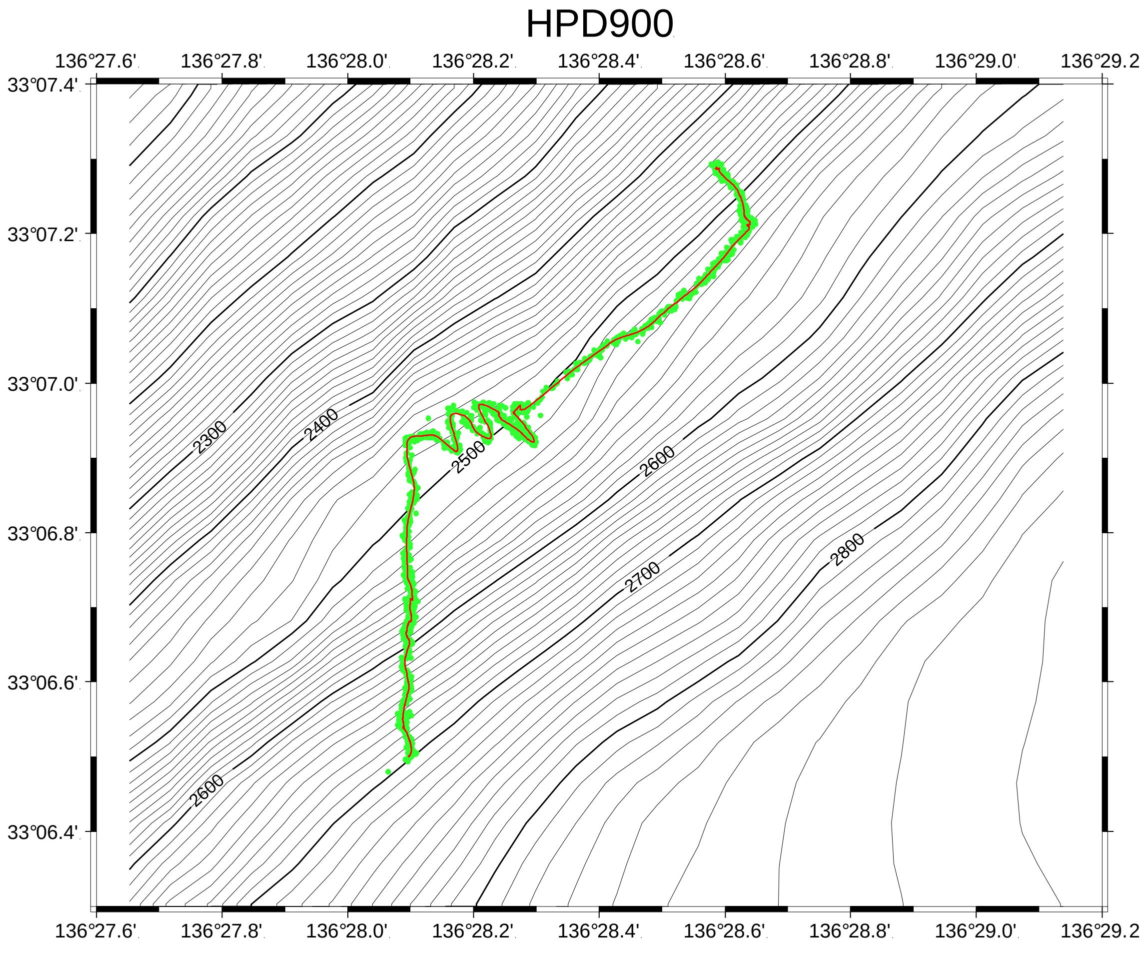
September 7, 2008 09:58 – 17:30 (7:32h) Splay fault, Kumano-nada

Exploration of animals

Remarks:

14:53 33-06.968N 136-28.275E 2514m: NISKIN (red)

14:53 33-06.968N 136-28.275E 2514m: MBARI (yellow)



3-6-6. #901

September 9, 2008 10:09 – 17:56 (7:47h) Kanesunose, offshore Omae-zaki

Exploration of animals

Remarks:

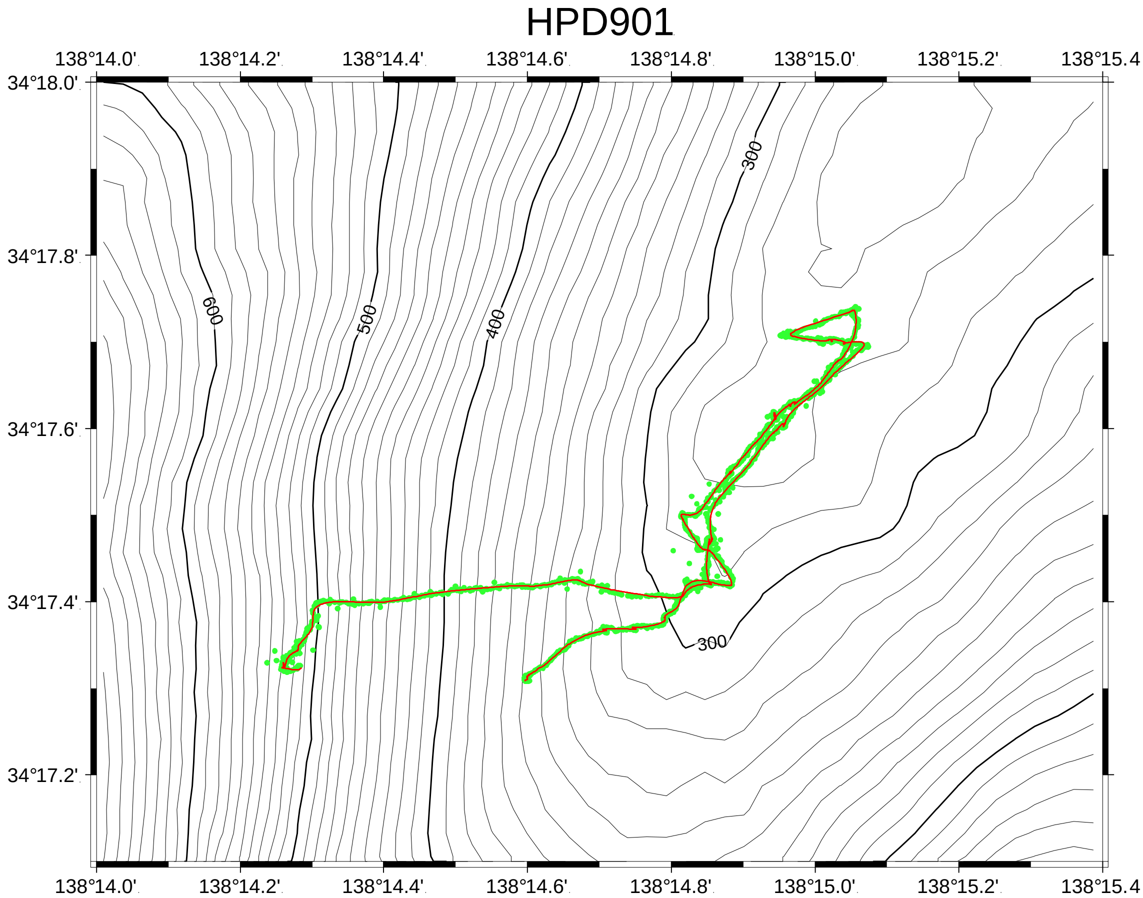
15:53 34-17.473N 138-14.854E 290m: MBARI (green)

16:22 34-17.417N 138-14.831E 297m: MBARI (red)

16:22 34-17.417N 138-14.831E 297m: NISKIN (red)

17:34 34-17.325N 138-14.259E 521m: MBARI (yellow)

17:38 34-17.323N 138-14.278E 506m: NISKIN (green)



3-7. Research Information

3-7-1. Sample point list (except for animals)

Instruments:

2008/09/04 12:01 33-40.554N 136-44.038E 2042m: Retrieved M2

2008/09/04 16:45 33-40.922N 136-44.041E 2043m: Retrieved only M1's stand

2008/09/06 12:44 33-06.910N 136-28.820E 2751m: Reinstalled M

Water:

2008/09/06 14:06 33-06.910N 136-28.820E 2753m: NISKIN

2008/09/06 15:10 33-07.020N 136-28.654E 2605m: NISKIN

2008/09/07 14:53 33-06.968N 136-28.275E 2514m: NISKIN (red)

2008/09/09 16:22 34-17.417N 138-14.831E 297m: NISKIN (red)

Core:

2008/09/06 14:06 33-06.910N 136-28.820E 2753m: MBARI (blue)

2008/09/06 14:58 33-07.020N 136-28.654E 2605m: MBARI (green)

2008/09/06 15:01 33-07.020N 136-28.654E 2605m: MBARI (red)

2008/09/07 14:53 33-06.968N 136-28.275E 2514m: MBARI (yellow)

2008/09/09 15:53 34-17.473N 138-14.854E 290m: MBARI (green)

2008/09/09 16:22 34-17.417N 138-14.831E 297m: MBARI (red)

2008/09/09 17:34 34-17.325N 138-14.259E 521m: MBARI (yellow)

2008/09/09 17:38 34-17.323N 138-14.278E 506m: NISKIN (green)

3-7-2. Calibrated instruments

2008/09/04 20:32 33-38.378N 136-36.026E 2030m: IES-7

2008/09/05 09:00 33-06.869N 136-29.280E 2906m: S2

2008/09/05 11:44 33-06.416N 136-29.002E 2894m: S1

2008/09/10 10:22 33-06.896N 136-28.806E 2750m: M