

Cruise Report

YK10-06

(R/V Yokosuka)

Site Surveys for drilling projects of IODP at the Kumano-nada and
the northern Izu-Bonin arc

June 13 – 20, 2010

Center for Deep Earth Exploration (CDEX)
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

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Preface

The YK10-06 cruise of the *R/V Yokosuka* was carried out as operational site surveys for hazard assessment of scientific drilling campaigns with the *D/V Chikyu* in the Integrated Ocean Drilling Program (IODP), consisting of two missions. The first mission was to set mooring systems for observing the Kuroshio Current near a NanTroSEIZE drilling site, C0002, at which an ultra-deep riser hole toward a seismogenic zone of the eastern Nankai Trough is planned. The second mission was a seafloor survey by using the *AUV Urashima* and the hull-mounted multi-beam bathymeter system (SeaBeam) of the mother vessel *Yokosuka* around Site IBM-4, a site of an IODP proposal in the northern Izu-Bonin arc, where ultra-deep riser drilling is proposed. In the first mission, two mooring systems were installed successfully to the planned sites. These mooring systems shall be retrieved about after four months. In the second mission, the bathymetry survey with the *Yokosuka's* SeaBeam system filled up some areas where previous surveys did not cover; however, high resolution bathymetry data could not be acquired due to a mechanical trouble occurred in the *AUV Urashima* besides data of sidescan imaging and sub bottom profiling. Another survey using the *AUV Urashima* needs to be scheduled again in future, because the high resolution seafloor data is critical for planning a riser hole drilling.

1. Participants aboard the *R/V Yokosuka* cruise YK10-06

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2. Objectives

The YK10-06 cruise by the *R/V Yokosuka* was planned as operational site surveys for hazard assessment of scientific drilling campaigns with the *D/V Chikyu* in the Integrated Ocean Drilling Program (IODP), consisting of following two missions:

- 1) To set mooring systems near a NanTroSEIZE drilling site, C0002, at which an ultra-deep riser hole toward a seismogenic zone of the eastern Nankai Trough is planned, for observing the Kuroshio Current. Site C0002 is situated on an area above which the main stream of the Kuroshio Current passes ordinary: this strong current, exceeding 5 knots sometimes, is expected to exert severe influences on the riser pipe of the *D/V Chikyu* while operations. In order to simulate behaviors of the riser pipe and mitigate operational risks under such strong current conditions, a riser analysis using actual data of current direction and speed with temporal variation of a reasonably long period is required. We, thus, install mooring systems equipped with acoustic Doppler current profilers to target sites for recording sea current profiles of direction and speed in vertical for an extended period of time. The mooring systems installed in this cruise shall be retrieved after four months.
- 2) To conduct seafloor surveys by using the *AUV Urashima* and the hull-mounted multi-beam system of the mother vessel *Yokosuka* around Site IBM-4 in the northern Izu-Bonin arc, where ultra-deep riser drilling toward an oceanic island arc middle crust is proposed in the IODP proposal #698. In planning a riser hole drilling, detailed information of the seafloor conditions at the site, including fine topography, seafloor deposits and subseafloor structure, is very important for assessing shallow geological hazards, designing the well head, securing escape/drift routes, etc. Therefore we perform surveys for acquiring ultra high resolution bathymetry, acoustic seafloor images and subseafloor shallow structures by using the *AUV Urashima*, in addition, local bathymetry by means of the hull-mounted multi-beam system of the *R/V Yokosuka*.

3. Survey Areas and Plans

3.1. Mooring System Installation in the Kumano-nada

The sites to which the mooring systems were installed are located near an IODP site, C0002, at the southern margin of the Kumano Basin, a forearc basin of the eastern Nankai Trough, about 70 km southeast of Shingu City, Wakayama Prefecture, Kii Peninsula (Fig. 1). Two sites, CM03 and CM04, were selected for mooring installation from an upstream area of Site C0002 along the Kuroshio Current ordinary pass. Site CM03 is located on the northern foot of a knoll, 12 km east from Site C0002, 1950 m in water depth. Site CM04, in contrast, is located near the top of the knoll, 8 km southeast, 1790 m in water depth. Each mooring systems is equipped with one Acoustic Doppler

Current Profiler (ADCP) at the top, four Doppler current meters (RCM 11), three conductivity-temperature-depth recorders (CTD) and two acoustic releasers (Fig. 2, Fig. 3).

The ADCP used for CM03 is a long-range type (long ranger ADCP: LR-ADCP). The mooring system at CM03 was planned as the primary set and designed so that the top buoy with the ADCP was situated at a depth of 600 mbsl for covering a whole depth of the Kuroshio Current including shallow layers as much as possible. On the other hand, the mooring system at CM04 was the secondary set, equipped with a broad band ADCP (BB-ADCP), laid out so that the top buoy came to a depth of 350 mbsl

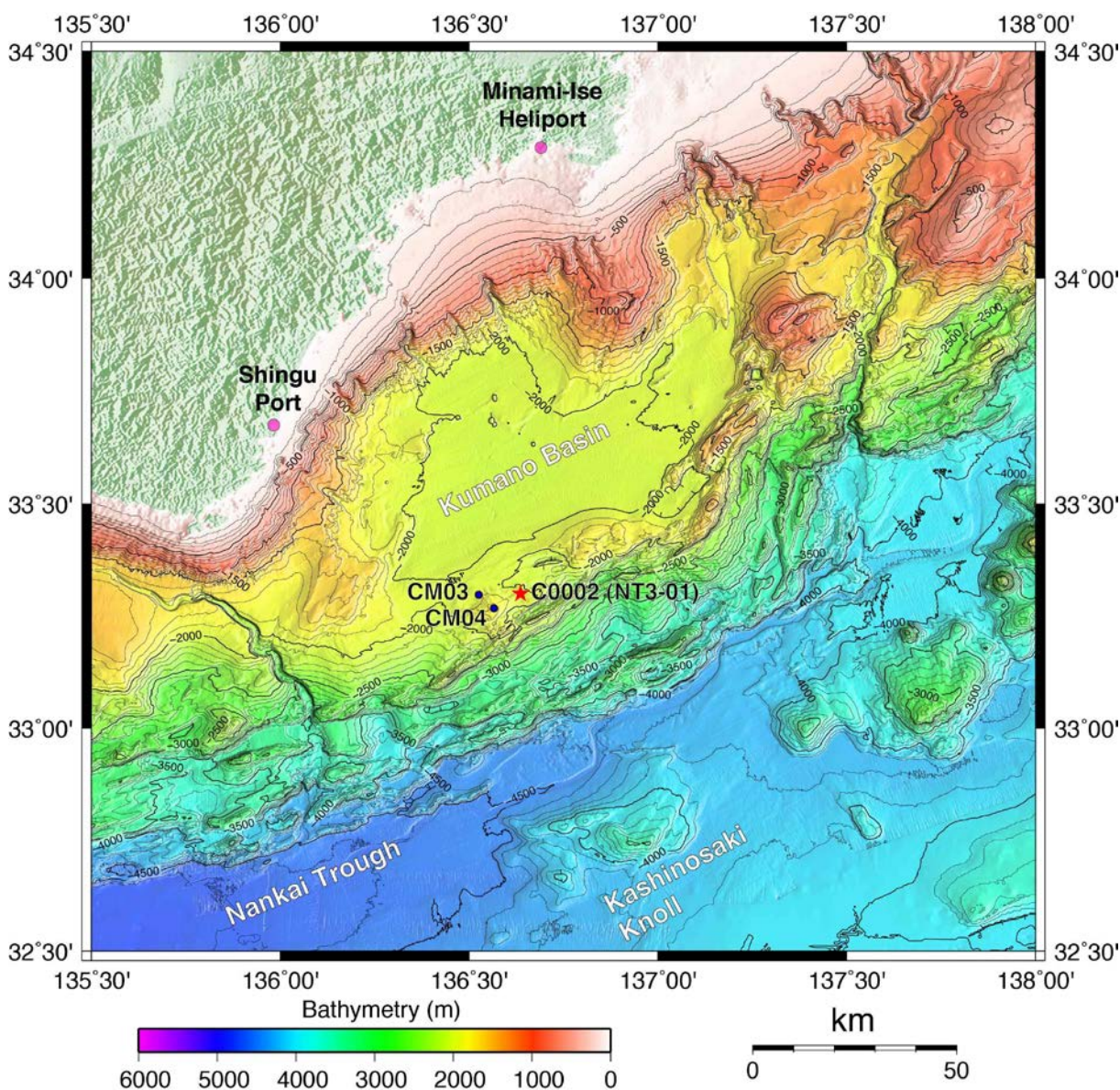
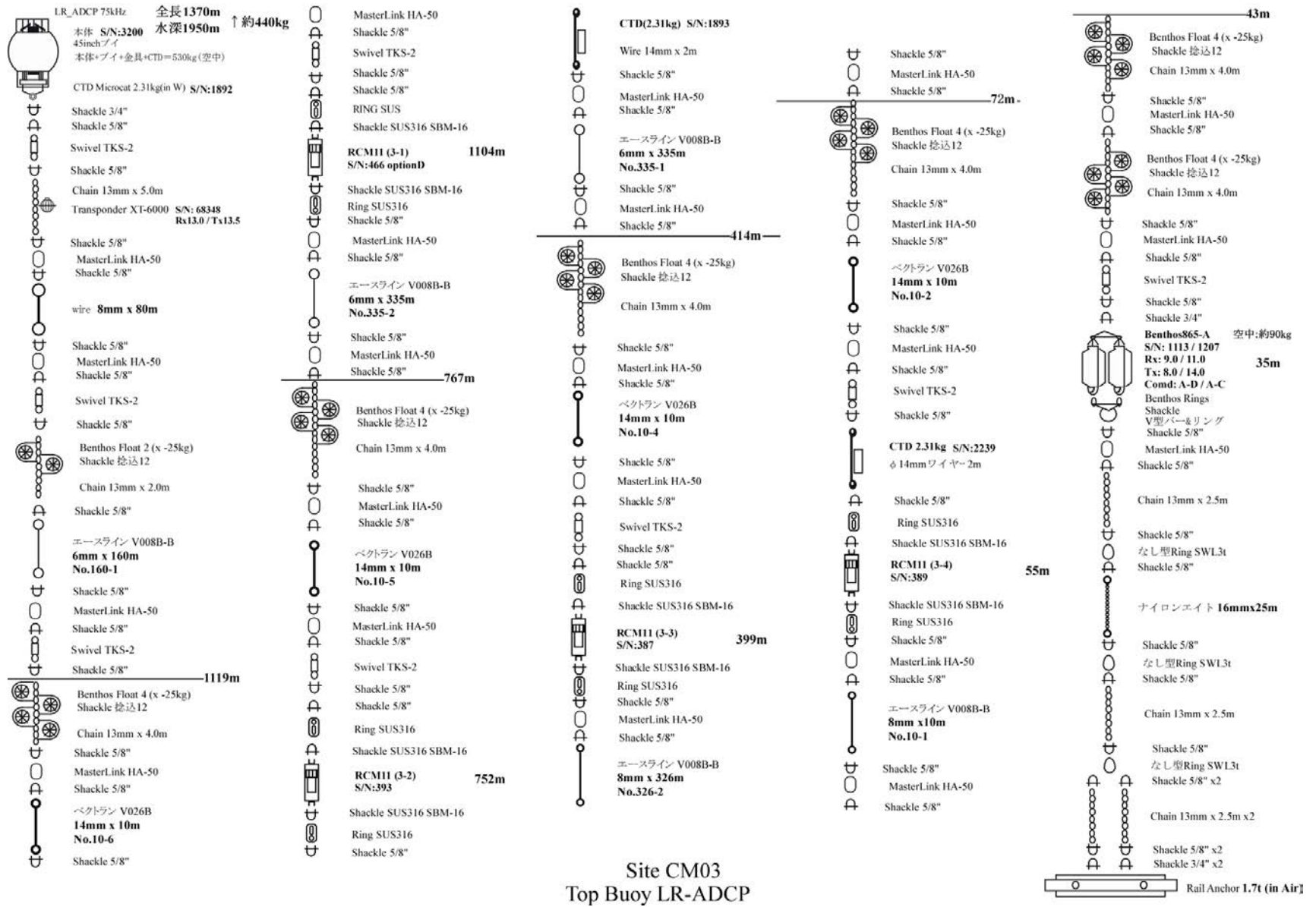


Fig. 1. A bathymetry map the eastern Nankai Trough with showing the installation points of the mooring systems and the location of Site C0002.

Fig. 2. A schematic diagram of the mooring system installed to the site CM03.



3.2. Seafloor Surveys in the northern Izu-Bonin arc

Site IBM-4 is a drill site proposed in the IODP proposal #698 located about 60 km east of Aogashima, northern Izu-Bonin arc (Fig. 4). Seafloor surveys with the *AUV Urashima* and the hull-mounted SeaBeam system of the *R/V Yokosuka* were carried out around Site IBM-4. Eight survey lines for the *AUV Urashima* survey were planned so that they were arranged around Site IBM-4 extending north and south at intervals of 15 m (Fig. 5). The *AUV Urashima* is equipped with three main survey systems: Multi Narrow Echo Sounder system (SeaBat7125), Side Scan Sonar system (2200-M) and Sub Bottom Profiler system (DT-106), acquiring data of ultra high resolution bathymetry, sea surface acoustic images and subseafloor shallow structures. Specifications of each survey instrument are as follows:

1) Multi Narrow Echo Sounder system (SeaBat7125)

Manufacturer:	Reson Inc.
Frequency:	400 kHz
Number of Beams:	256
Beam Width:	1.0°x 0.54°(along-track x across-track)
Swath Angle:	128°
Depth Resolution:	6mm
Horizontal Resolution:	1.75 x 0.94m (along-track x across-track, @Altitude 100m)

2) Side Scan Sonar system (2200-M)

Manufacturer:	EdgeTech
Frequency:	120 kHz (full spectrum chirp)
Beam Width:	0.9°x 0.9°(along-track x across-track)
Swath Width:	25~300m
Altitude:	~120m
Vertical Resolution:	6.25cm
Horizontal Resolution:	1.57 x 3.54m (along-track x across-track, @Altitude 100m)

3) Sub Bottom Profiler system (DT106)

Manufacturer:	EdgeTech
Frequency:	1 ~ 6 kHz (chirp)
Beam Angle:	28°~ 36°
Vertical Resolution:	15 ~ 25cm

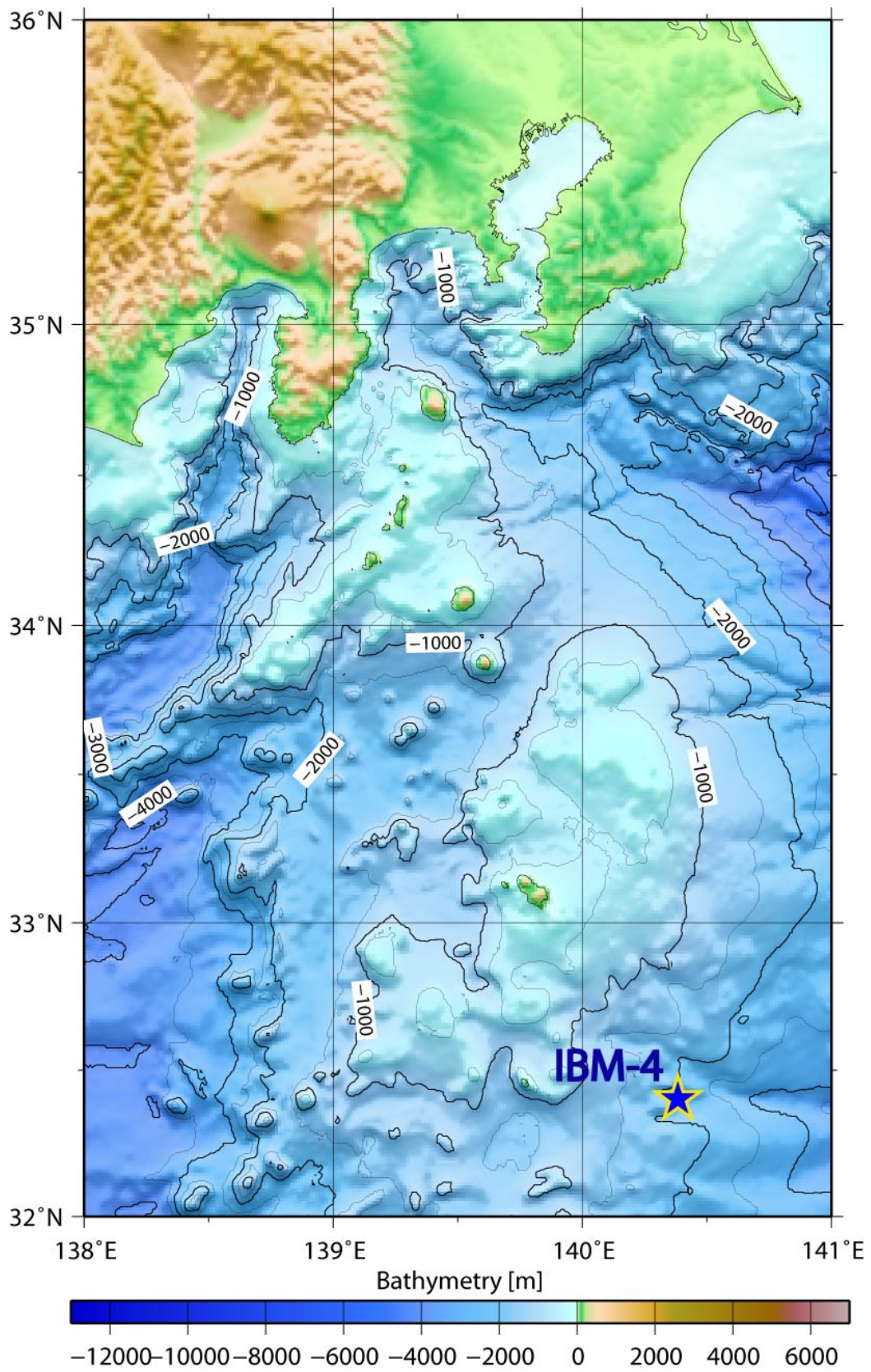


Fig. 4. A bathymetry map the northern Izu-Bonin arc with showing the location of the site IBM-4.

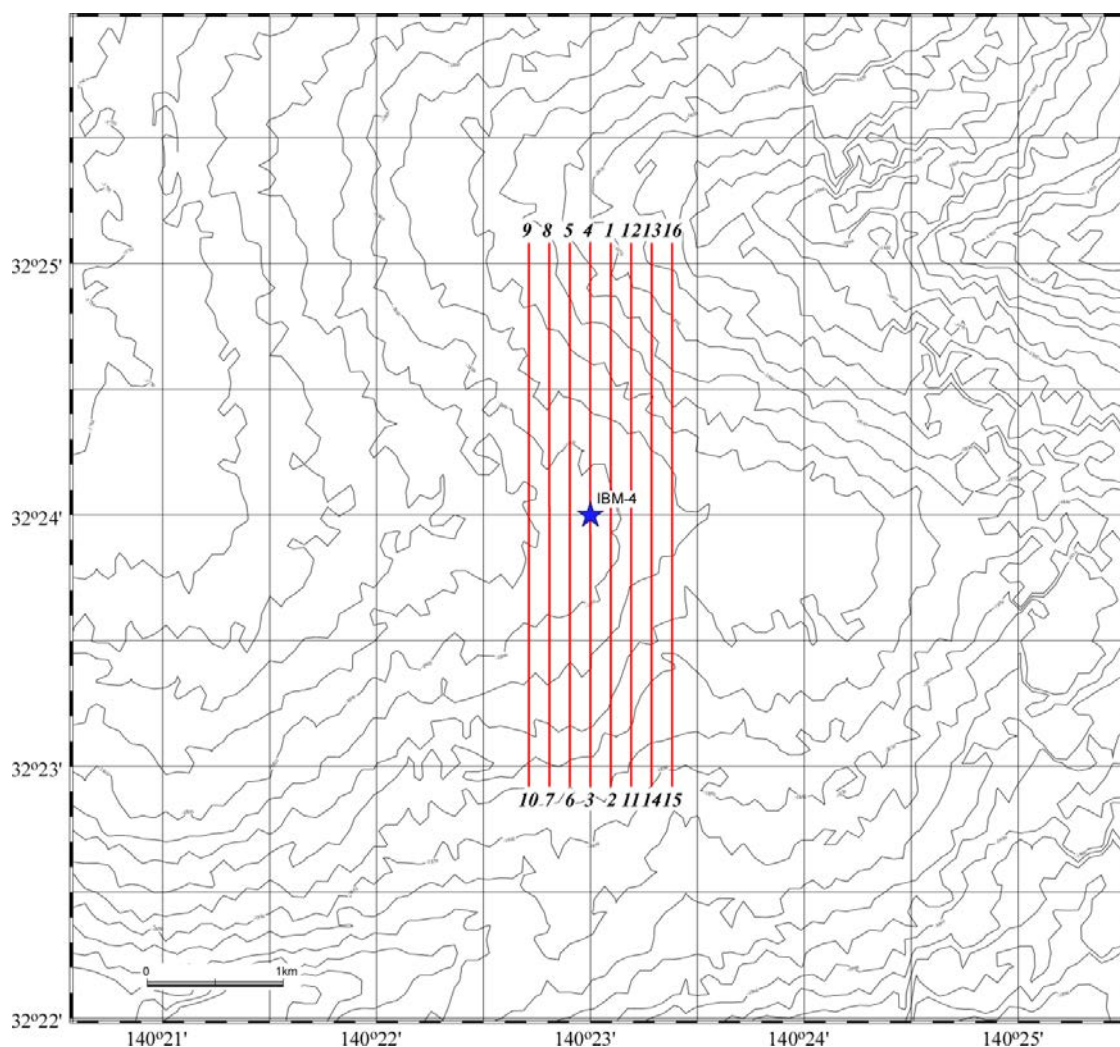


Fig. 5. A high resolution bathymetry map around the site IBM-4, northern Izu-Bonin arc, with showing the planned survey lines of the seafloor survey using the *AUV Urashima*.

4. Activity Log of Cruise and Ship Track

The *R/V Yokosuka* departed the quay of JAMSTEC, Yokosuka HQ at 14:00 on 13th June and got into wait on weather (WOW) in the Suruga Bay. She left for the Mikawa Bay at 04:00 on 14th, arrived at 09:35 and then got into WOW again. She left for Owase at 17:25, arrived at 22:00 and then got into WOW again. She left for the Kumano-nada at 01:00 on 15th, engaged in the mooring retrieval operations from 06:00, left for Hachijo-jima at 12:45 and then got into WOW off Hachijo-jima. She left for the IBM-4 area at 23:30 on 16th and arrived at 04:00. After being engaged in the surveys by the *AUV Urashima* and the hull-mounted SeaBeam system, she left for Yokosuka at 13:00 on 19th and then came alongside the quay of JAMSTEC, Yokosuka HQ, at 09:00 on 20th June. A brief log of the cruise and the ship track are shown in Table 1 and Fig. 6.

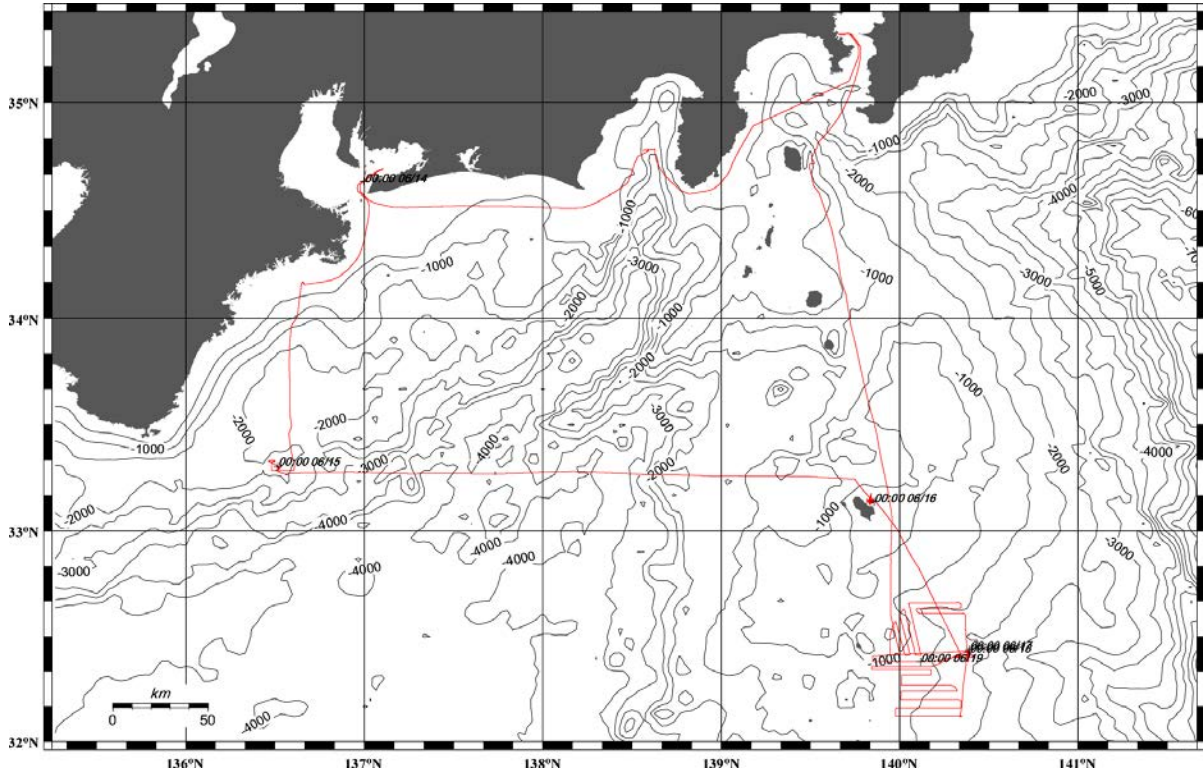


Fig. 6. A map showing the cruise track of YK10-06.

Table 1. Cruise log

Date	Remarks
June 13	Departure from Yokosuka, Transit to Suruga Bay for WOW
14	Transit to Mikawa Bay for WOW, Move to Kumano-nada
15	Arrive at Kumano-nada, XBT measurement, SeaBeam survey, Mooring installation (CM03 & CM04)
16	Transit to Off Hachijo-jima for WOW
17	Move to survey area (IBM-4), Topographic survey by <i>AUV Urashima</i> and SeaBeam survey during the night
18	<i>AUV Urashima</i> survey and SeaBeam survey
19	SeaBeam survey, Transit to Yokosuka
20	Arrive at Yokosuka

5. Preliminary Results

5.1. Installation of Mooring Systems

Installation of the mooring systems was carried out in the Kumano-nada area on 15 June after one-day WOW. Two sets of mooring systems were installed successfully to the planned sites, CM03 and CM04, of which expected water depths are 1947 m and 1784 m, respectively (Fig. 7). The

installation operations were conducted firstly at the site CM03 and then CM04. The geographic position of each mooring system installed was determined by triangulation using slant ranges from the transponder above the releaser on the mooring system, combined with the shipboard Differential Global Positioning System (DGPS) of WGS84. Due to the Kuroshio Current, the moorings at CM03 and CM04 were drifted about 240 m to the east and about 250 m to the northeast from the anchor release points, respectively. These mooring systems shall be retrieved after a four-month observation. The determined position and the parameter settings of each mooring system are shown in Table 2.

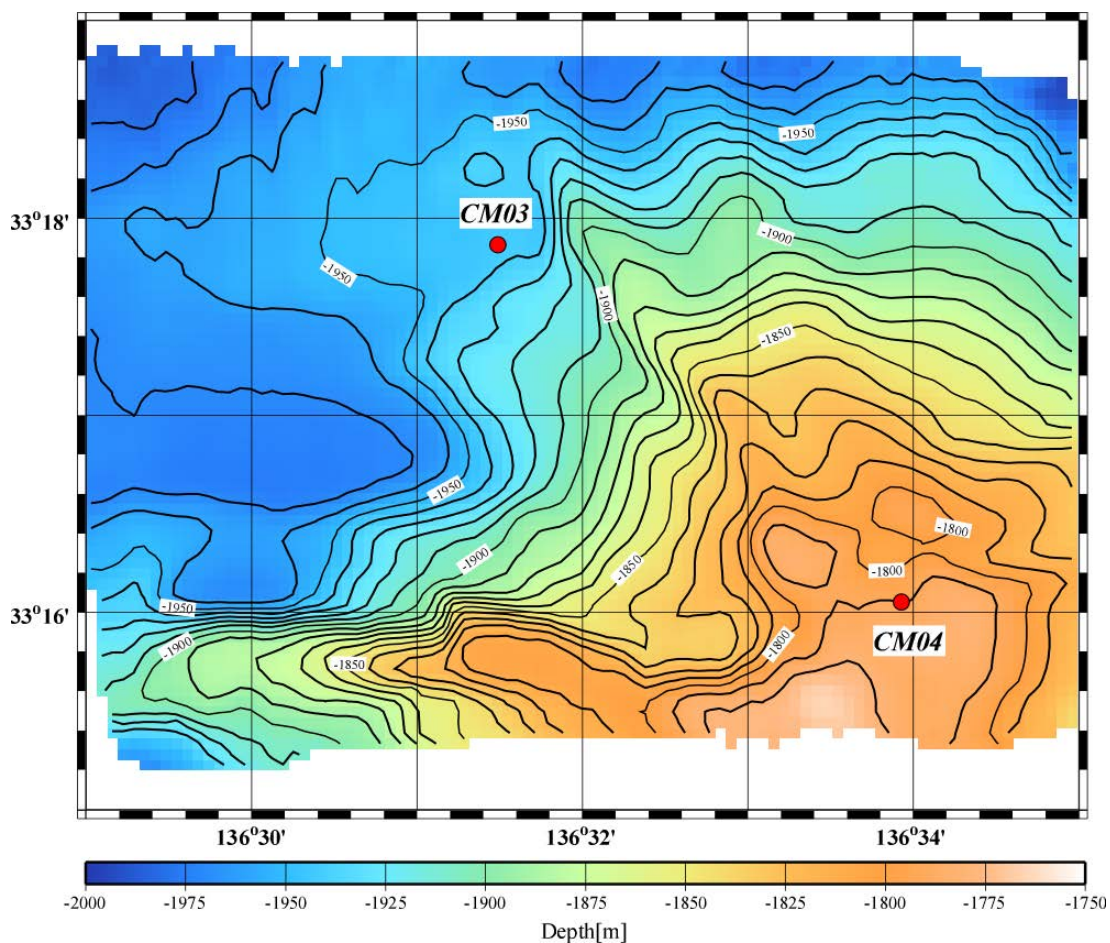


Fig. 7. A close-up bathymetry map around the mooring installation area with showing the positions installed.

Table 2. Determined geographic positions of the mooring systems installed and parameter settings of devices equipped.

Site	CM03	CM04
Position	33-17.8651'N 136-31.4914'E	33-16.0531'N 136-33.9294'E
Water Depth	1947m	1784m

ADCP	Serial Number	3200	1152
	Frequency	76.8kHz	153.6kHz
	Head Angle	20 degrees	30 degrees
	Head Arrangement	4 Beam Convex	4 Beam Convex
	pings per ensemble	10	13
	Bin size	32m	16m
	Number of Bins	19	20
	Blank after Transmit	7.04m	16m
	Time between pings	6 sec	2 sec
	Recording Interval	30 min	
	Transducer Depth (Plan)	577 bMSL	350 bMSL
	Depth of First Bin (Plan)	537 bMSL	316 bMSL
	Depth of Last Bin (Plan)	35 bMSL	46 bMSL
	Velocity standard deviation	1.28 cm/s	1.8 cm/s
	Total space needed	3.63 MB	4.26 MB
Energy required	1090 Wh	1040 Wh	

RCM	Recording Interval	30 min	
	Serial Number	466	467
	Sensor Depth (Plan)	843 bMSL	626 bMSL
	Option Sensor	Pressure, Tilt, Signal strength	Pressure, Tilt, Signal strength
	Serial Number	393	380
	Sensor Depth (Plan)	1195 bMSL	983 bMSL
	Option Sensor	Tilt, Signal strength	Tilt, Signal strength
	Serial Number	387	139
	Sensor Depth (Plan)	1548 bMSL	1357 bMSL
	Option Sensor	Tilt, Signal strength	
	Serial Number	389	394
	Sensor Depth (Plan)	1892 bMSL	1729 bMSL
Option Sensor	Tilt, Signal strength	Tilt, Signal strength	

CTD	Recording Interval	30 min	
	Serial Number	1892	2287
	Sensor Depth (Plan)	578 bMSL	350 bMSL
	Serial Number	1893	2288
	Sensor Depth (Plan)	1196 bMSL	984 bMSL
	Serial Number	2239	2289
Sensor Depth (Plan)	1891 bMSL	1728 bMSL	

Acoustic Releaser	Serial Number	1113	1207	1086	1120
	Receive Frequency	9.0	11.0	10.0	9.0
	Transmit Frequency	8.0	14.0	13.0	9.5
	Enable Code	A	A	B	A
	Release Code	D	C	E	F

5.2. AUV Urashima Survey

Seafloor survey by means of the *AUV Urashima* for acquiring data of high resolution topography, sidescan images and sub bottom profiles was carried out in an area of the northern Izu-Bonin arc from 17 to 18 June after the mooring system installation operations and another one-day WOW. On the first day the survey was suspended due to a mechanical trouble, which occurred to the back-forth thruster on the way to the seafloor during both the two dives (Dive #109 and #110) conducted on the day. Upon replacing the parts that are considered to be potentially the causes of the trouble, third dive (Dive #111) was conducted on the second day. The trouble of the day before did not appear; however, navigation mode of the vehicle was changed to a semi-manual one because the automatic navigation got to be inoperative not long after coming into the first survey line. Four and half lines were surveyed finally (Fig. 8). Sidescan and sub bottom seismic data could be extracted properly from the data loggers; however, no bathymetry data was unfortunately recorded because the data logger of the SeaBat system was turned off probably when the thruster was once stopped for setting the trim to horizontal. No bathymetry data precludes not only making a depth correction on the sub bottom profiles, but also doing shallow hazard assessment sufficiently. Therefore, another survey using the *AUV Urashima* needs to be scheduled again in future. The sidescan images obtained are shown in Fig. 9.

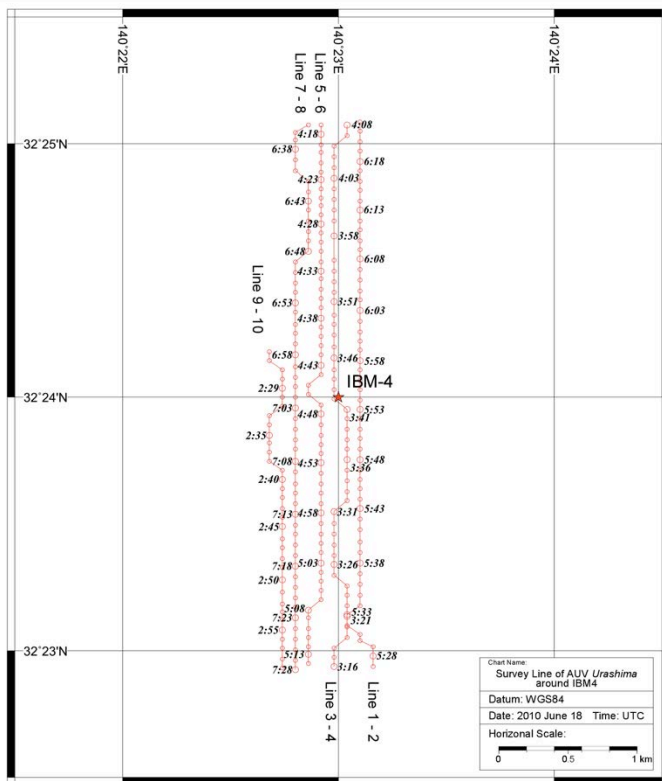


Fig. 8 The actual survey track of Dive #111 of *AUV Urashima* around the site IBM-4.

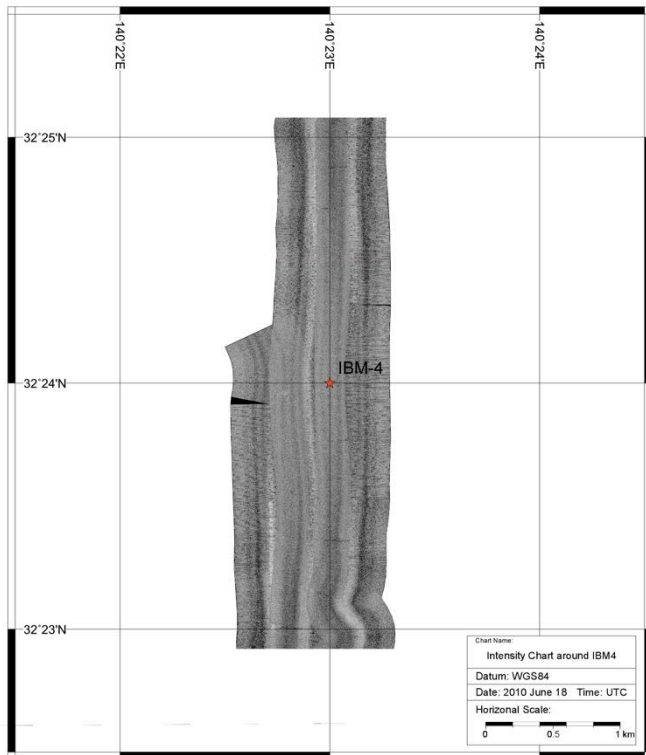


Fig. 9. Sidescan acoustic seafloor images around the site IBM-4 obtained by Dive #111.

5.3. Hull-mounted SeaBeam Bathymetry Survey

Local bathymetry survey with the hull-mounted multi-beam system, SeaBeam2112 (12kHz), was carried out in an area of the northern Izu-Bonin arc, in the nighttime on 17 and 18, and until 13 o'clock on 19 June, besides that of the steady observation of JAMSTEC outside the planned survey area. The western areas about 15 km away from the site IBM-4 were newly surveyed. A new bathymetry map created by the survey is shown in Fig. 10.

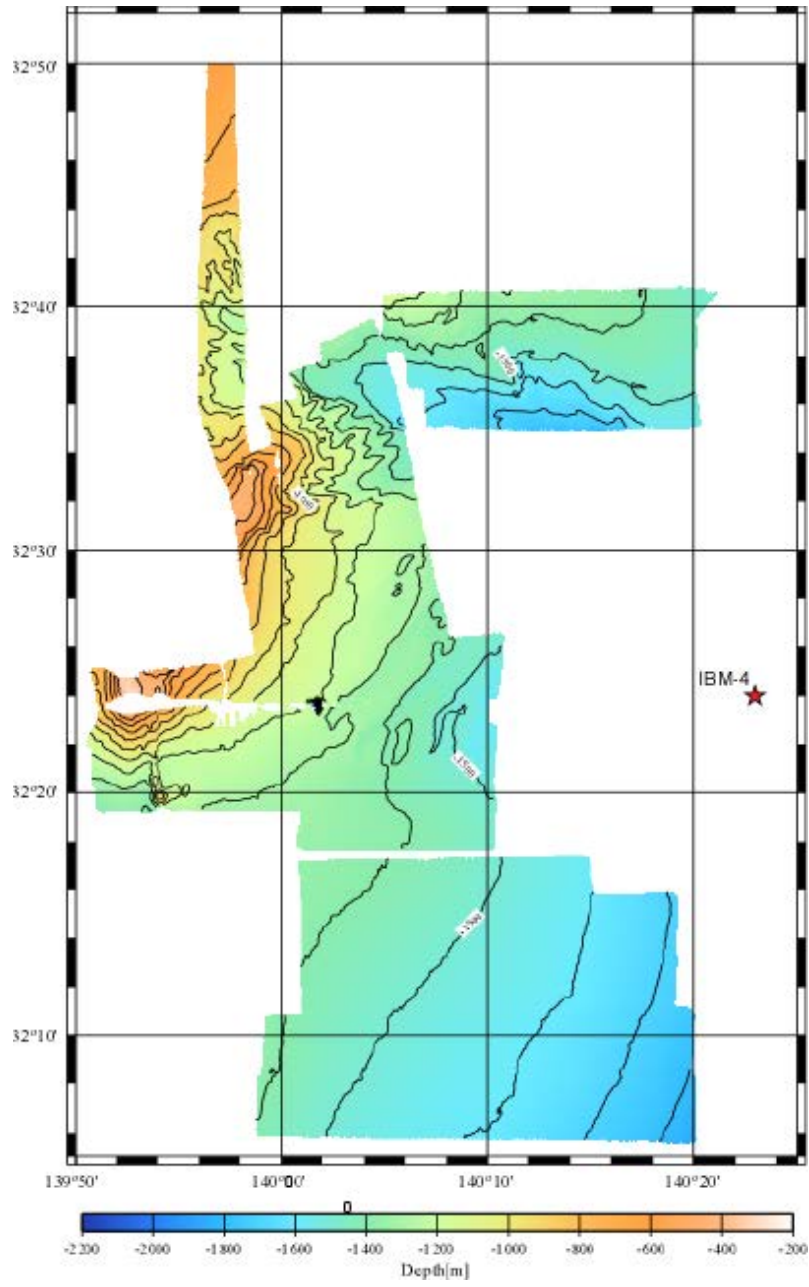


Fig. 10. A bathymetric map newly created during the YK10-06 cruise by using the hull-mounted SeaBeam system of the *R/V Yokosuka* near the site IBM-4.

6. Acknowledgement

We thank Captain EIKOU Ukekura, crew and technical staffs of our experiments conducted during the YK10-06 cruise, for their kind and thoughtful supports during the cruise.

References

IODP Proposal 698-Full3, Continental Crust Formation at Intra-Oceanic Arc: Ultra-Deep Drilling to the Middle Crust of the Izu-Bonin-Mariana Arc.

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