



R/V Kaimei “Cruise Report”
KM18-02C

Confirmation of the geophysical exploration using
multi-AUVs and an ASV

East Aogashim, Izu-Ogasawara
Sagami Bay

Feb.8,2018–Feb16,2018

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

Contents

1. Cruise Information
2. Research Proposal and Science Party
3. Research/Development Activities
 - 3.1 Instruments
 - 3.2 Operation reports
4. Cruise Log

This cruise report is a preliminary documentation as of the end of cruise.
This report is not necessarily corrected even if there is any inaccurate description (i.e. taxonomic classifications). This report is subject to be revised without notice. Some data on this report may be raw or unprocessed. If you are going to use or refer the data on this report, it is recommended to ask the Chief Scientist for latest status.

Users of information on this report are requested to submit Publication Report to JAMSTEC.

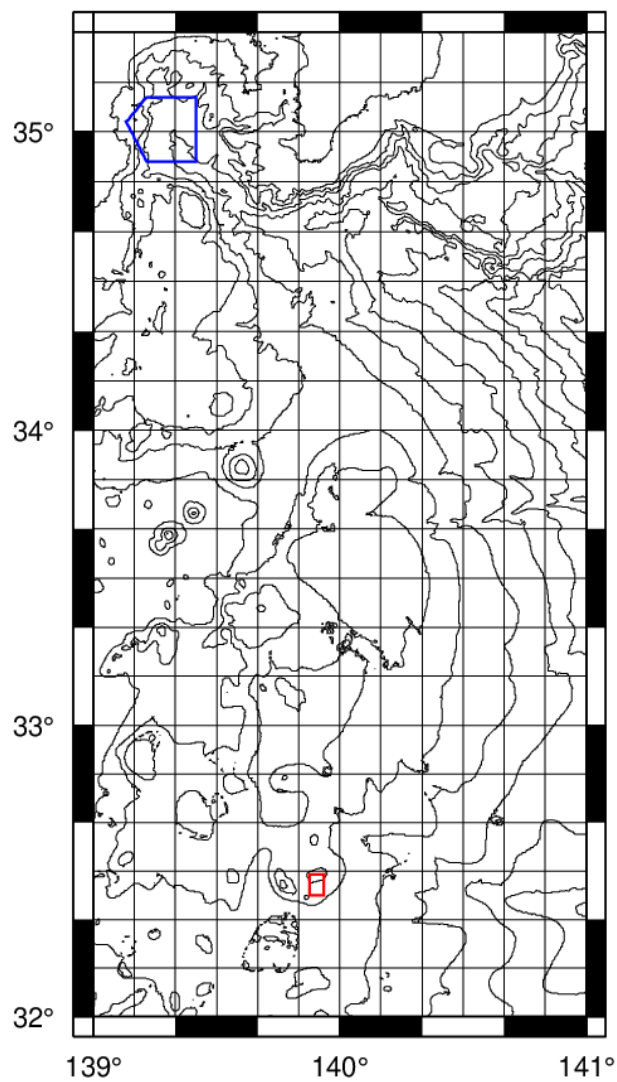
<http://www.godac.jamstec.go.jp/darwin/explain/1/e#report>
E-mail: submit-rv-cruise@jamstec.go.jp

Acknowledgements

We would like to thank Captain Mr. Yoshida and all ship crew of R/V KAIMEI for their safe cruise. We are grateful to AUV JINBEI and KM-ROV operation team and marine technicians of NME for their operation. We are pleased to MARITEC staff for their supports during our cruise. This study was supported by the Cross-ministerial Strategic Innovation Promotion Program “Next-generation technology for ocean resources exploration” launched by the Council for Science, Technology and Innovation (CSTI) and managed by the Japan Agency for Marine–Earth Science and Technology (JAMSTEC).

1. Cruise Information

- Cruise ID KM18-02C
- Name of vessel R/V KAIMEI
- Title of proposal Zipangu in the Ocean program
- Title of cruise Confirmation of the geophysical exploration using multi-AUVs and an ASV
- Chief Scientist Takafumi Kasaya [JAMSTEC]
- Cruise period Feb.8,2018–Feb16,2018
- Ports of call Yokosuka–Yokosuka
- Research area East Aogashima, Izu-Ogasawara and Sagami Bay
- Research map



2. Research Proposal and Science Party

- Title of proposal

Zipangu in the Ocean program

- Representative of Science Party [Affiliation]

Eiichi Kikawa [JAMSTEC]

- Science Party (List) [Affiliation, assignment etc.]

Scientists

Takafumi Kasaya (Chief Scientist)	JAMSTEC
Hisanori Iwamoto	JAMSTEC
Jyunji Kaneko	JAMSTEC
Ayu Takahashi	JAMSTEC
Hiroshi Matsumoto	JAMSTEC
Yutaka Ohta	JAMSTEC
Yoshinobu Nanbu	JAMSTEC
Hiroshi Ochi	JAMSTEC
Tatsuya Aso	JAMSTEC
Tsuyoshi Yoshiume	JAMSTEC
Tadahiro Hyakudome	JAMSTEC
Yoshiyuki Nakano	JAMSTEC
Tatsuya Fukuda	JAMSTEC
Yoshitaka Watanabe	JAMSTEC
Koji Meguro	JAMSTEC
Seiya Yoshida	Oki Seatec Co., Ltd.
Norihiko Katayama	National Institute of Information and Communications Technology.
Gouei Hashimoto	Space Engineering Development Co., Ltd.
Masahiko Sasano	National Maritime Research Institute
Takehiro Seta	National Maritime Research Institute
Akihiro Okamoto	National Maritime Research Institute
Shogo Inaba	National Maritime Research Institute
Suehiro Nitta	JAMSTEC
Hiroaki Hamada	Tokyo University for Marine Science and Technology

Marine Technician

Toshimasa Nasu	Nippon Marine Enterprises, LTD.
Yasushi Hashimoto	Nippon Marine Enterprises, LTD.

R/V KAIMEI Officers and Crew

Captain	Rikita Yoshida
Chief Officer	Naoto Kimura
1st Officer	Tatsuo Adachi
2nd Officer	Akira Suzuki
3rd Officer	Kazuma Yamamoto
Chief Engineer	Kazuhiko Kaneda
1st Engineer	Takahiro Mori
2nd Engineer	Akira Hanawa
3rd Engineer	Kota Fujii
Chief Electronic Operator	Hiroki Ishiwata
2nd Electronic Operator	Emi Sawayanagi
3rd Electronic Operator	Kazumi Ugajin
Boat Swain	Masanori Ohata
Able Seaman	Yuki Yoshino
Able Seaman	Naoki Iwasaki
Able Seaman	Takuya Miyashita
Sailor	Yuta Ohojiri
Sailor	Shinya Kojima
Sailor	Yudai Yoshimi
No.1 Oiler	Keita Funawatari
Oiler	Shinya Sugi
Oiler	Yuji Higashigawa
Oiler	Shota Shimohata
Chief Steward	Tatsunnari Onoue
Steward	Tsuyoshi Nagatomo
Steward	Yukihide Chikuba
Steward	Shinobu Ohyu

AUV-JINBEI Operation Team

Operation Manager	Fumitaka Saito
1st ROV Operator	Atsumori Miura
2nd ROV Operator	Tetsuya Ishitsuka

2nd ROV Operator	Yoshikazu Kuramoto
2nd ROV Operator	Mitsuru Torigoe
3rd ROV Operator	Shuya Sugiura

3. Research/Development Activities

3.1 Instruments

3.1.1 Ocean bottom electro-magnetometer (OBEM)

The OBEM system can measure time variations of three components of magnetic field, two components of horizontal electric field, the instrumental tilts, and temperature. It mainly consists of two titanium pressure housing, magnetometer, glass sphere floats and electrode arm unit with arm holding mechanism (Fig. 3.1.1, Fig. 3.1.2). A data logger and a lithium battery pack are installed in two titanium pressure housing. The sensor unit has a high-accuracy fluxgate magnetometer and thermometer. The electrodes are Ag-AgCl equilibrium type made by Clover Tech. For electric field, four voltage differences between the electrodes on the tip of the pipes and the ground electrode are measured. The electrodes were monitored their self-potentials in laboratory in advance of the seafloor observation and pairs that the coherence is high enough were selected, in order to reduce the noise due to the voltage drift of electrodes themselves. A transponder unit, radio beacon and a flashlight are also mounted on the OBEM. The acoustic system can communicate with the SSBL system and it is easy for us to detect its position in the sea or on the seafloor. There are a transponder unit mounted on the OBEM system. This transponder unit, of which the acoustic and the pressure case units are combined, has 2-year battery life.

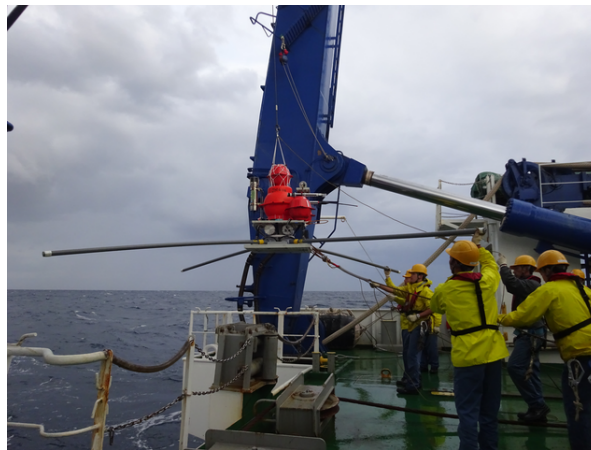


Fig. 3.1.1 OBEM system

Concepts of the type the OBEM system are miniaturization, a high sampling rate, easy assembly and recovery operations, and low costs of construction and operation. The arm holding mechanism, which electrode arm is folded when OBEM is in surfacing (Fig. 3.1.2), enable recovery operation even by the small ship that do not equip A frame ([Kasaya et al., 2006](#); [Kasaya and Goto, 2009](#)).

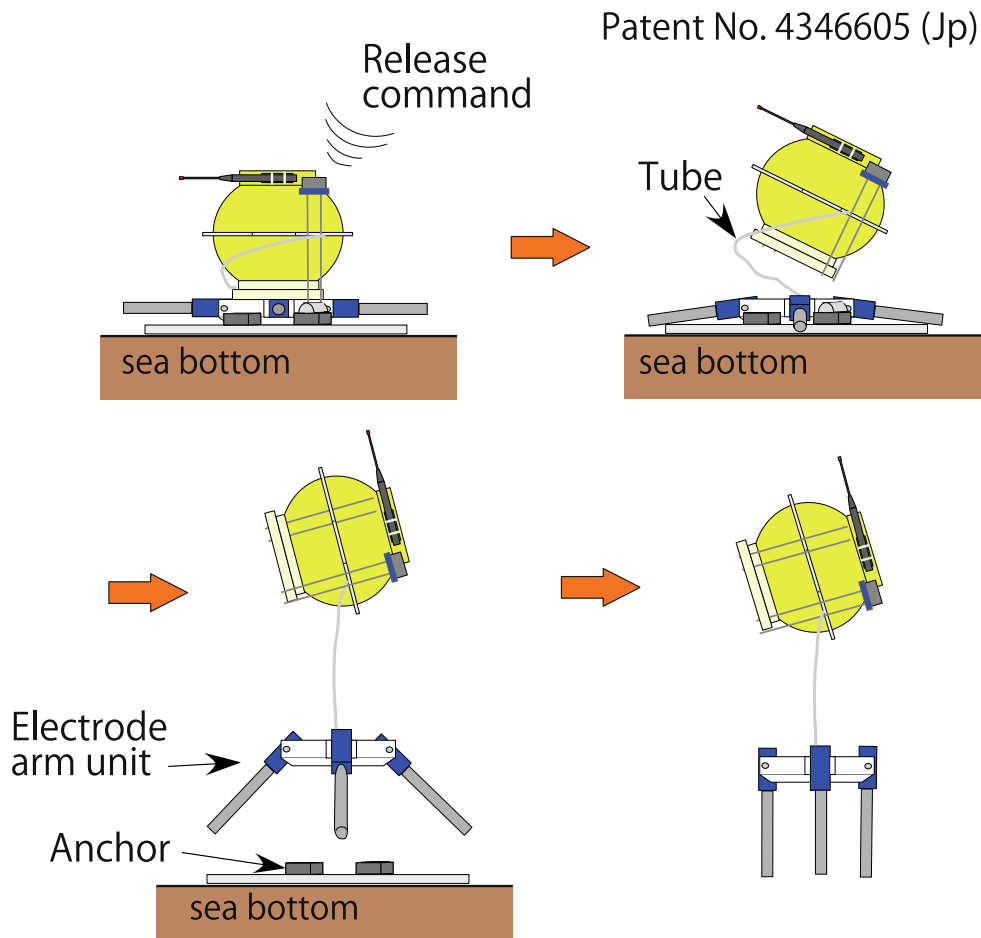


Fig. 3.1.2 Electrode arm-holding mechanism of type A OBEM

References

- Kasaya, T., T. Goto, and R. Takagi, Marine electromagnetic observation technique and its development –For crustal structure survey-, *BUTSURI-TANSA*, **59**, 585-594 (in Japanese with English abstract), 2006.
- Kasaya, T., and T. Goto, A small OBEM and OBE system with an arm folding mechanism, *Exploration Geophysics*, **40**, 41-48, 2009.

3.1.2 Electrometer

The electrometer system is originally designed for the controlled source survey with 1 kHz sampling rate (Table 3.1.1). All electric circuits and batteries are installed in a cylinder type aluminum or titanium pressure case. In this cruise, the electrometer optimized for AUV was install on the fore head of AUV (Fig. 3.1.3).

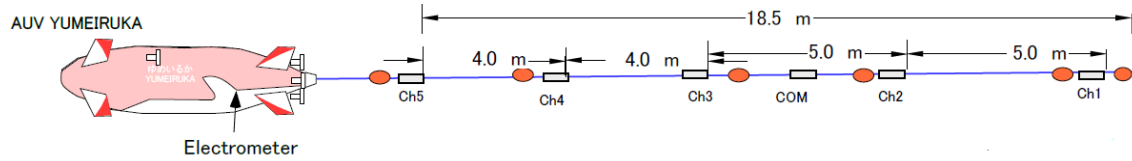


Fig. 3.1.3 Configuration of the electrode array on an AUV YUMEIRUKA.

Table3.1.1 Specification of an electrometer

Logger unit

Measurement channels: 5 CH

Measurement Voltage Range: ± 100 mV

A/D converter: 24 bit

Recording Media: SDHC

Sampling rate: 1 kHz

3.1.3 Transmitter system on AUV

On this cruise, we use new controlled-source system optimized for an AUV use which based on the deep-tow transmitter. This transmitter was loaded on the fore top of AUV JINBEI. Because of battery's capacity of AUV JINBEI, a battery for transmitter was also loaded (Fig. 3.1.4). A transmitter unit including the IGBT unit and all electrical circuits is installed in a cylinder type aluminum pressure case.

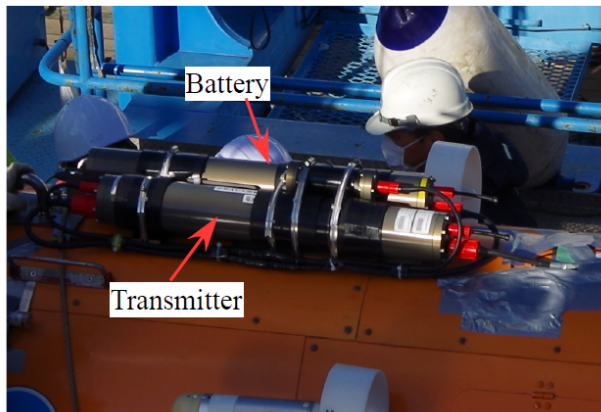


Fig.3.1.4 Photo of a controlled source survey system on the deep-tow system.

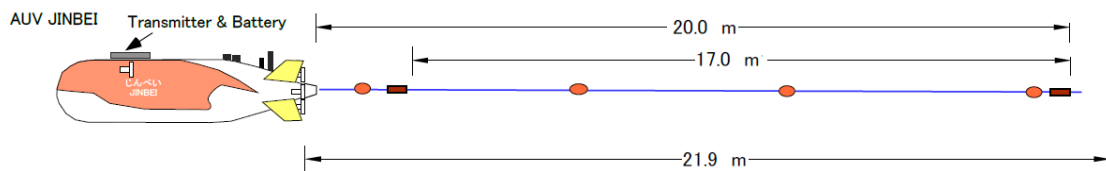


Fig. 3.1.5 Photo of a controlled source survey system on the deep-tow system.

Table3.1.2 Specification of a control source survey system

Max Output Current: 30 A

Circuit type: IGBT

Transmit channel: 1 ch

A/D converter: 24 bit

Recording Media: SDHC

Sampling rate: 500 Hz

3.1.4 Autonomous Surface Vehicle (ASV)

For the efficient observation of hydro-thermal deposit survey using multiple AUVs, JAMSTEC have developed and researched an autonomous Surface Vehicle (ASV). To monitor and control an AUV JINBEI, we used a demonstration ASV developed by JAMSTEC in this cruise. Because of the necessity to monitor and control AUVs with 2 knots, this vehicle can sail with a maximum speed of 5 knots taking the sea current into consideration. Typical operational cruising speed is about 3 knots. It is very important to communicate between a mother ship and an ASV. Therefore, two satellite communication systems, VHF communication system and wireless LAN are equipped on this ASV. DGPS, AIS and INU are also loaded for the nautical instruments. This ASV also can measure the position of an AUV using an acoustic navigation system.



Fig. 3.1.6 Photo of a demonstrational ASV.

Table 3.1.3 Specification of a ASV

The general specifications of a demonstration ASV

Length	4.45 m
Width	1.95 m
Height	1.81 m
Weight	2.0 t
Speed	typically 3 knots
Power source	Deisel engine
Actuator	Azimuth thruster
Communication equipment	Ka band satellite communication
	L band satellite communication
	VHF communication
	Wireless LAN

Nautical instrument	Acoustic communication
	DGPS
	AIS
	INU
	Acoustic positioning system

3.2 Operation reports

3.2.1 OBEM recovery operations

For characterization a back-arc basin development, we have obtained Magneto-telluric data using OBEMs. In this cruise, we carried out recovery operations of OBEMs which were deployed in YK17-24C cruise. (Fig. 3.2.1). The operations were quick and smooth. During the recovery operations, each position was determined by the SSBL system equipped on the R/V KAIMEI.

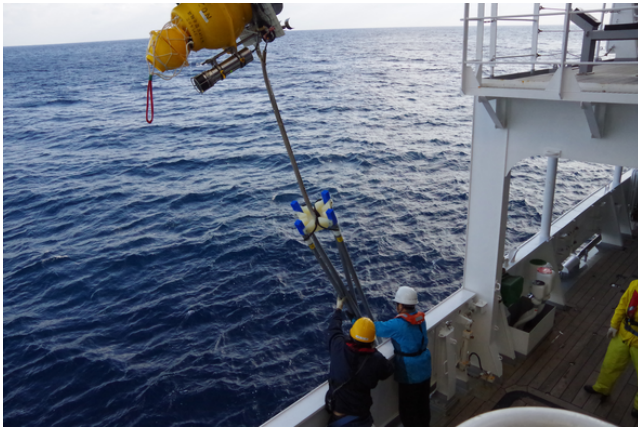


Figure 3.2.1 Photo of the OBEM recovery operation

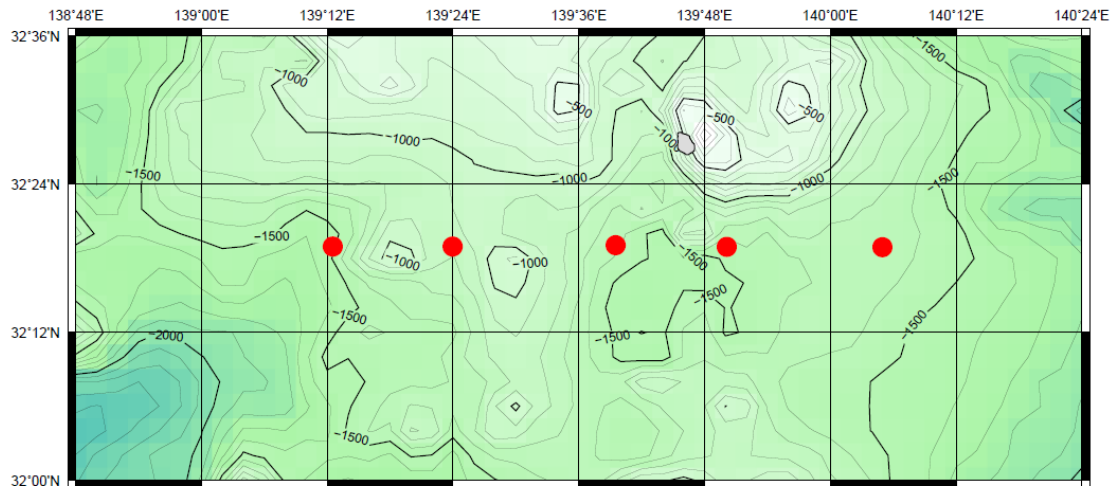


Figure 3.2.2 Positions of all deployed OBEMs.

Table 3.2.1 Information of OBEMs.

site ID	OBEM ID	Deployed time (JST)	Landed time (JST)	Landed Latitude	Landed Longitude	Depth
OBE M1	JM402	2017/12/14 16:42:01	2017/12/14 17:15:03	32_18.9742N	139_12.5234E	1707m
OBE M2	JM109	2017/12/10 18:51:47	2017/12/10 19:12:40	32-18.9797N	139-23.9546E	1065 m
OBE M3	JM406	2017/12/14 12:37:06	2017/12/14 14:09:24	32_19.0606N	139_39.5512E	1767m
OBE M4	JM404	2017/12/10 16:03:54	2017/12/10 16:34:48	32_18.9407N	139_50.1200E	1423 m
OBE M5	JM401	2017/12/10 6:35:33	2017/12/10 7:05:51	32_18.9237N	140_04.9704E	1376 m

3.2.2 AUV collaborate dives

Main topic of this cruise is the collaboration dive using AUVs and an ASV. We conducted three collaborate dives in two area. First dive were carried out in the east Aogashima area using an AUV JINBEI, an AUV YUMEIRUKA and an ASV for marine direct current resistivity (MDCR) data and self-potential (SP) survey data (Fig. 3.2.3). Because of the weather condition, we were able to dive on only one observation line. However, small SP anomaly related to the hydrothermal vent were able to be detected. After first dive we only carried out in the Sagami Bay because of rough weather condition. Second dive is the test dive using an AUV HOBARIN by National Maritime Research Institute (NMRI) which is the hovering type AUV (Fig. 3.2.4). We succeeded in collaborate dive using three AUVs and an ASV at once (Fig. 3.2.5). In this dive we were able to obtain MDCR and SP data.

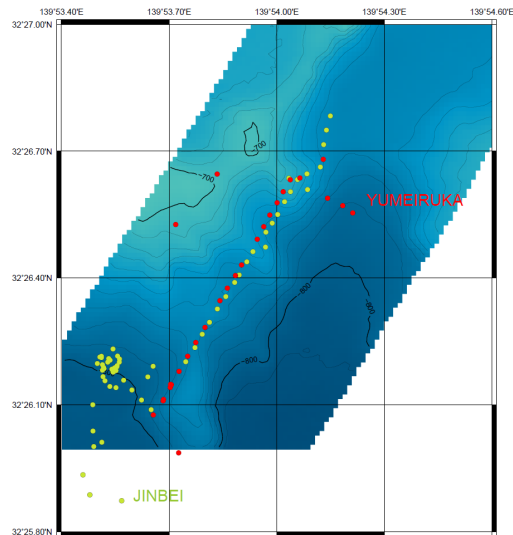


Fig. 3.2.3 Two AUVs and ASV collaboration dive areas at the Okinawa trough.

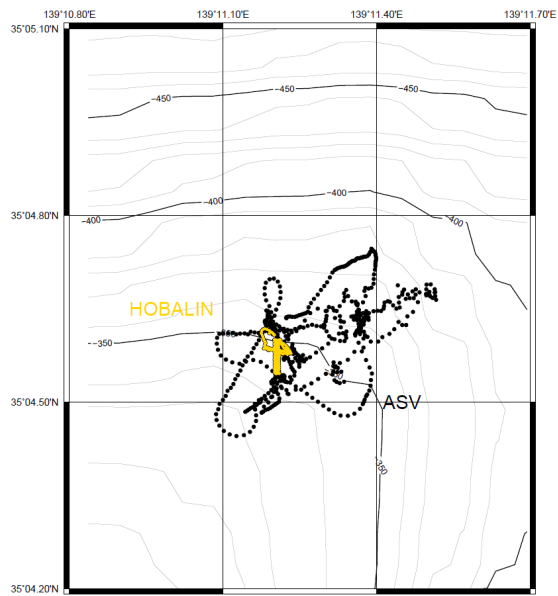


Fig. 3.2.4 Single AUV dive areas at the Okinawa trough.

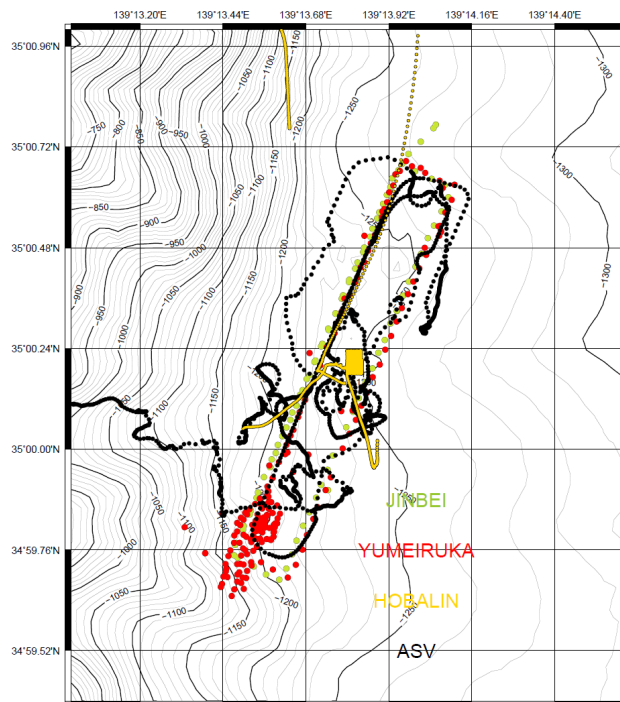


Fig. 3.2.5 ROV dive areas at the Okinawa trough.

4. Cruise Log

2018/2/8 OFF KENZAKI (35-11.4N,139-45.8E)

Weather: Fine but Cloudy / Wind direction: NE / Wind force: 3 / Wave scale: 2 /

Swell scale:2 / Visibility: 8 miles (12:00 JST)

08:00 Scientists onboard.

09:00 Let go all shore line, left YOKOSUKA, for Research area (IZU-OGASAWARA).

10:00-11:00 Carried out "ASV" trial.

13:00-14:00 Carried out education and training for scientists.

18:00-18:15 Scientists meeting

2018/2/9 OFF Southwest AOGASHIMA (32-18.6N,139-35.0E)

Weather: Fine but Cloudy / Wind direction: NE / Wind force: 3 / Wave scale: 2 /

Swell scale:2 / Visibility: 8 miles (12:00 JST)

01:00 Arrived at research area (IZU-OGASAWARA).

01:08 Released XBT at <32-30.4580N, 139-57.6219E>

01:34-02:08 Carried out MBES mapping survey.

04:20 Arrived at OBEM #5 (OBEM5) point.

06:45 Recovered OBEM #5.

06:50 Proceeded to OBEM #4 (OBEM4) point.

08:05 Arrived at OBEM #4 point.

09:15 Recovered OBEM #4.

09:20 Proceeded to OBEM #3 (OBEM3) point.

10:20 Arrived at OBEM #3 point.

11:28 Recovered OBEM #3.

11:35 Proceeded to OBEM #2 (OBEM2) point.

12:45 Arrived at OBEM #2 point.

13:39 Recovered OBEM #2.

13:45 Proceeded to OBEM #1 (OBEM1) point.

14:40 Arrived at OBEM #1 point.

15:47 Recovered OBEM #1.

18:00-18:30 Scientists meeting

17:09 Com'ced MBES mapping survey.

2018/2/10 OFF East AOGASHIMA (32-25.6N,139-53.5E)

Weather: Fine but Cloudy / Wind direction: SW / Wind force: 2 / Wave scale: 2 /

Swell scale:2 / Visibility: 8 miles (12:00 JST)

04:53 Finished MBES mapping survey. but soon changed dive point.

Due to strong current.

05:10 Proceeded to East AOGASHIMA.

07:00 Arrived at above dive point.

08:12 Launched "ASV". Com'ced above operation.

08:42 Hoisted up "YUMEIRUKA".

08:49 Launched "YUMEIRUKA".

10:03 Hoisted up "YUMEIRUKA", soon recovered "YUMEIRUKA".

12:12 Hoisted up "YUMEIRUKA".

12:16 Launched "YUMEIRUKA".

12:17 "YUMEIRUKA" dove and started her operation #35.

12:41 Hoisted up "JINBEI".

12:45 Launched "JINBEI".

12:48 "JINBEI" dove and started her operation #59.

13:59 "JINBEI" com'ced refloated.

14:13 "JINBEI" refloated.

14:45 Hoisted up "JINBEI".

14:53 Recovered "JINBEI" & finished above operation.

15:12 "YUMEIRUKA" com'ced refloated.

15:20 "YUMEIRUKA" refloated.

16:06 Hoisted up "YUMEIRUKA".

16:14 Recovered "YUMEIRUKA" & finished above operation.

16:53 Recovered "ASV".

17:30 Left research area, proceeded to SAGAMI-WAN.

18:00-18:15 Scientists meeting.

2018/2/11 SAGAMI-WAN (35-02.0N,139-08.2E)

Weather: Fine but Cloudy / Wind direction: W / Wind force: 5 / Wave scale: 2 /

Swell scale:2 / Visibility: 8 miles (12:00 JST)

04:00 Arrived at SAGAMI-WAN.

07:50 Shifted to OFF HATSU-SHIMA.

14:30 Shifted to OFF ITO-KO due to rough sea.

2018/2/12 OFF ITO-KO (34-59.8N,139-07.8E)

Weather: Fine but Cloudy / Wind direction: W / Wind force: 7 / Wave scale: 4 /

All day Waiting at OFF ITO-KO due to rough sea.

Swell scale:4 / Visibility: 8 miles (12:00 JST)

18:00-18:15 Scientists meeting.

Swell scale:2 / Visibility: 8 miles (12:00 JST)

12:03 "HOBALIN" com'ced refloated.

12:46	“HOBALIN” refloated.
12:54	Hoisted up “HOBALIN”.
12:56	Recovered “HOBALIN” & finished above operation.
12:56	“YUMEIRUKA” com’ced refloated.
13:13	“YUMEIRUKA” refloated.
13:38	Hoisted up “YUMEIRUKA”.
13:46	Recovered “YUMEIRUKA” & finished above operation.
14:17	Recovered “ASV”.
15:30	Left research area, proceeded to OFF YOKOSUKA.
18:00-18:15	Scientists meeting.
19:15	Arrived at OFF YOKOSUKA Section 4.
2018/2/15	OFF YOKOSUKA Sec.4 (35-19.8N,139-40.4E)
Weather: Fine but Cloudy / Wind direction: ENE / Wind force: 3 / Wave scale: 1 /	
Swell scale:1 / Visibility: 8 miles (12:00 JST)	
09:30	Let go starboard anchor in 29 m of water at OFF YOKOSUKA Sec.4.
2018/2/16	YOKOSUKA (JAMSTEC)
09:00	Arrived at YOKOSUKA(JAMSTEC), then completed voy. No.KM18-02C.

s

Wind Scale

0	Calm	0~0.2m/s
1	Light air	0.3~1.5m/s
2	Light breeze	1.6~3.3m/s
3	gentle breeze	3.4~5.4m/s
4	Moderate breeze	5.5~7.9m/s
5	Fresh breeze	8.0~10.7m/s
6	Strong breeze	10.8~13.8m/s

Wave scale

0	Calm (Glassy)	0.0m
1	Calm (Rippled)	0~1/10m
2	Smooth (Wavelet)	1/10~1/2m
3	Slight	1/2~1 1/4m
4	Moderate	1 1/4~2 1/2m

SWELL SCALE

0	No Swell	
1	Low Swell Short or Average	<2m
2	Low Swell Long	<2m
3	Moderate Short	2m~4m