

R/V Yokosuka “Cruise Report”

YK23-08C

In-situ monitoring and long-term explosion test of cement
mortar specimen at a deep sea condition and fundamental
strength evaluation of sub-seafloor

May 10th, 2023 –17th, 2023

Nankai Trough Northern Margin

Off Shimizu

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Contents

1. Participants aboard	- 1
2. Cruise Summary	
2-1. Cruise Information	- 3
2-2. Overview of the Observation	- 4
3. Cruise Log	- 5
4. Observation and Activity results	
4-1. MBES survey off Shimizu	- 9
4-2. Dive logs	- 10
5. Acknowledgements	-18
6. Notice on Using	-19
Appendix 1 (HOV Shinkai6500)	-20
Appendix 2 (S/V Yokosuka)	-23

1. Participants aboard

1-1. Research group

Position	Name	affiliation
Chief scientists	TAKAFUMI KASAYA	Japan Agency for Marine-Earth Science and Technology
Deputy scientists	SHUN NOMURA	Japan Agency for Marine-Earth Science and Technology
Scientists	TOSHIRO YAMANAKA	Tokyo University of Marine Science and Technology
Scientists	KEISUKE TAKAHASHI	Mitsubishi UBE cement corporation
Scientists	YUICHIRO KAWABATA	Port and Airport Research Institute
Scientists	HIROKO MAKITA	Tokyo University of Marine Science and Technology
Scientists	SHINPEI GOTO	Tokyo University of Marine Science and Technology
Scientists	MANA YASUI	Waseda University
Scientists	YUGO NOJIMA	Tokyo University of Marine Science and Technology
Scientists	AOI MITSUISHI	Tokyo University of Marine Science and Technology
Scientists	RIKUTO FUJIKATA	Tokyo University of Marine Science and Technology
Marine technician	HISANORI IWAMOTO	Nippon Marine Enterprises,LTD.

1-2. SHINKAI6500 Operation Team

Position	Name
Submersible Operation Manager	CHIBA KAZUHIRO
Deputy Submersible Operation Manager	MATSUMOTO KEITA
1st Submersible Staff	UEKI MITSUHIRO
1st Submersible Staff	KONDO TOMOE
1st Submersible Staff	ISHIKAWA AKIHISA
2nd Submersible Staff	UEKI HIROFUMI
2nd Submersible Staff	SUZUKI KEIGO
2nd Submersible Staff	SAIGO RYO
2nd Submersible Staff	ONISHI TAKUMA
2nd Submersible Staff	IJIMA SATSUKI
3rd Submersible Staff	ICHINOSE DAIKI
3rd Submersible Staff	SATO KAISEI

1-3. Captain and crew of the R/V Yokosuka

Position	Name
Captain	AOKI TAKAFUMI
Chief Officer	KATO HIROYUKI
2nd Officer	DEGUCHI TATSUMI
3rd Officer	MATSUDA RIKU
Jr.3rd Officer	SAKAMOTO RINDO
Jr.1st Engineer	IKUTA SHINICHI
1st Engineer	MORI TAKAHIRO
2nd Engineer	INOMOTO TAKAATSU
3rd Engineer	SHIMIZU KOKI
Jr.3rd Engineer	TERAKAWA AKINORI
Chief Electronic Op.	TAKAHASHI MASAMOTO
2nd Electronic Op.	ONIKUBO RYUJI
Boatswain	MURATA KAITO
Quarter Master	OGASAWARA KAZUMI
Quarter Master	CHIMOTO TSUYOSHI
Quarter Master	NAGAI HIROAKI
Quarter Master	NASU KENTA
Sailor	NAKANISHI RYO
Sailor	MATSUDA TAISEI
No.1 Oiler	MORI JUNJI
Oiler	SUZUKI RYOTA
Oiler	HIDAKA TORU
Assistant Oiler	FUJISHIMA TAMAKI
Assistant Oiler	WAKUGAWA YUTA
Chief Steward	HIRAYAMA KAZUHIRO
Steward	NAGATOMO TSUYOSHI
Steward	KASHIWAGI KOICHIRO
Steward	SHIRASAKI YUKI
Steward	TANAKA TSUGUMI
Captain	AOKI TAKAFUMI

2. Cruise Summary

2-1. Cruise Information

- Cruise ID: YK23-08C
- Name of vessel: S/V Yokosuka
- Chief Scientist: Takafumi Kasaya (JAMSTEC)
- Title of cruise proposal:

In-situ monitoring and long-term explosion test of cement mortar specimen at a deep sea condition and fundamental strength evaluation of sub-seafloor

- Cruise period: May 10th - 17th 2023
- Ports of departure /arrival: JAMSTEC-Yokosuka / JAMSTEC-Yokosuka
- Research area: Northern area of Nankai trough and Off Shimizu
- Research area and track map: Fig. 1

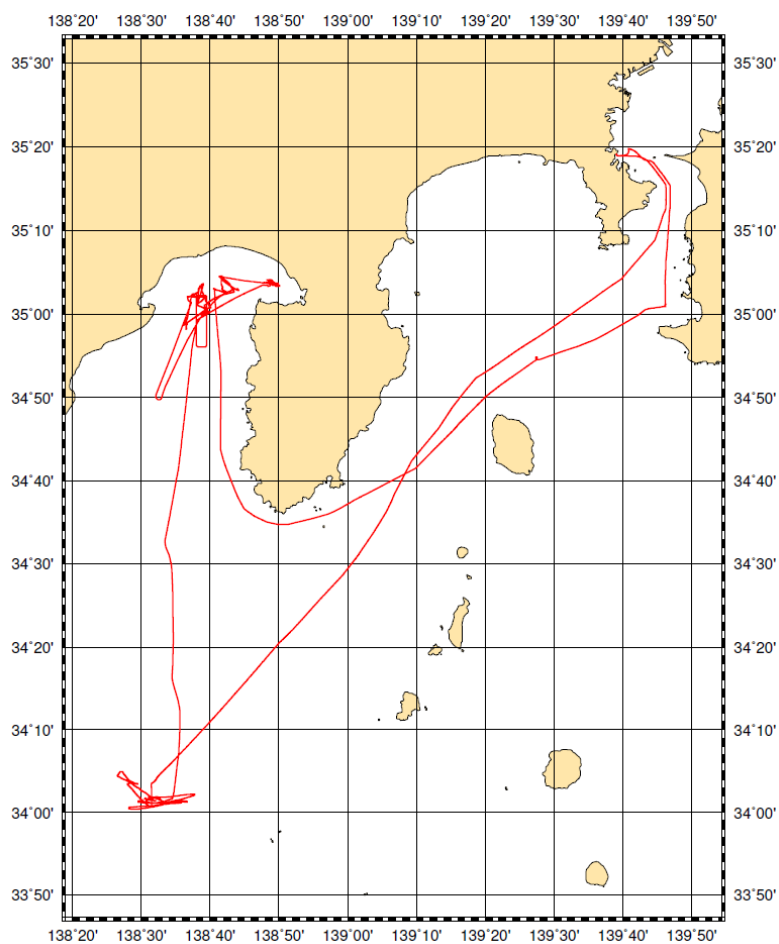


Fig. 1 Track map of YK23-08C Cruise.

2-2. Overview of the Observation

We have been conducting in-situ measurements and long-term exposure tests of concrete and mortar specimens in deep water at the depth of about 3500 m since 2018. In 2022, various small specimen sets were set up for new long-term exposure tests on some small platform at a depth of about 1000 m.

As new experiments of this cruise, we conducted CPT observations for seafloor foundation strength evaluation (Fig. 2) and in-situ loading tests of specimen. The in-situ loading tests were conducted at both area in all dives. At both sites, many long exposure specimens were recovered. CPT observations were carried out in the central canyon area of northern of Suruga Bay. We succeeded CPT data acquisition at five sites, which carried out going up and down operation of a CPT probe using electric actuator by visual observation from the Shinkai 6500.

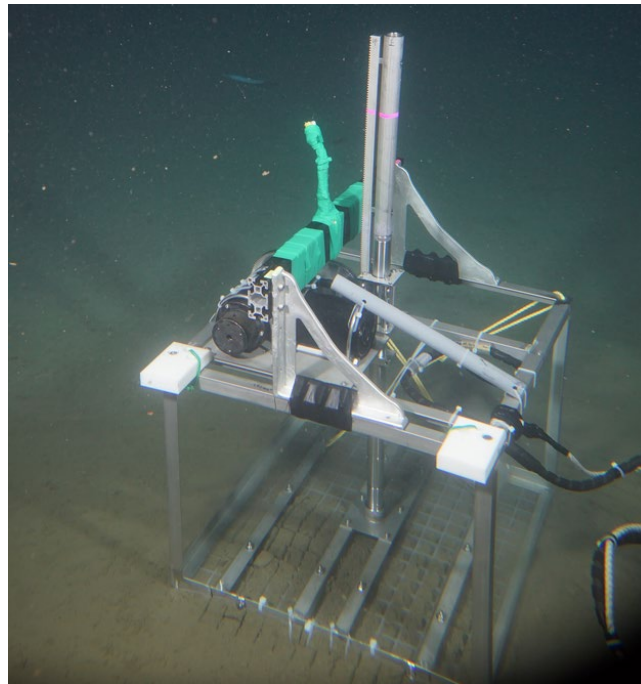


Fig. 2 Photo of small CPT tool operated from the Shinkai 6500.

3. Cruise Log

日付 Date	時間 Local Time	内容 Note	特記事項 Description	本船位置／気象／海象 Position/Weather/Wind/Sea condition
10- May -23	08:00	Scientists onboarded.		12:00 (UTC+9h)
	09:00	Let go all share line and left YOKOSUKA for research area.		34-55.5N,139-23.9E
	09:20 - 09:50	SHINKAI 6500 team and Scientists team meeting.		Off north of Izuoshima
	10:00 - 10:30	Practiced fite,water proof and life boat station drill.		Weather:bc
	10:50 - 11:20	SHINKAI 6500 briefing.		Wind:Nnorth-3
	13:00 - 13:20	Practiced fire,water proof and life boat station drill.		Wave scale:2
	16:15	Arrived at research area.		Swell scale:2
	16:27	Released XBT.		Visibly: 8'
	18:50 - 19:00	Scientists meeting.		
11- May -23	09:52	Hoisted up "SHINKAI6500".		12:00 (UTC+9h)
	09:59	Launched "SHINKAI6500".		34-01.6N,138-31.3E
	10:07	"SHINKAI6500" dove, and started her operation dive No.1684.		Northern end of Nankai trough
	11:45	"SHINKAI6500" landed the sea bottom.	D=3,516m	Weather:bc

	15:27	"SHINKAI6500" left the sea bottom.	D=3,452m	Wind:East-3
	16:47	Refloated "SHINKAI6500"		Wave scale:2
	17:14	Recovered "SHINKAI6500",and finished above operation.		Swell scale:2
	19:00 - 19:10	Scientists meeting.		Visibly: 8'
12-May-23	09:51	Hoisted up "SHINKAI6500".		12:00 (UTC+9h)
	09:58	Launched "SHINKAI6500".		34-01.5N,138-31.2E
	10:06	"SHINKAI6500" dove, and started her operation dive No.1685.		Northern end of Nankai trough
	11:47	"SHINKAI6500" landed the sea bottom.	D=3,517m	Weather:o
	15:20	"SHINKAI6500" left the sea bottom.	D=3,493m	Wind:NE-4
	16:39	Refloated "SHINKAI6500"		Wave scale:3
	17:09	Recovered "SHINKAI6500",and finished above operation.		Swell scale:2
	19:00 - 19:15	Scientists meeting.		Visibly: 8'
13-May-23	09:59	Hoisted up "SHINKAI6500".		12:00 (UTC+9h)
	10:05	Launched "SHINKAI6500".		34-58.9N,138-36.4E
	10:12	"SHINKAI6500" dove, and started her operation dive No.1686.		Off Shimizu
	10:52	"SHINKAI6500" landed the sea bottom.	D=978m	Weather:r

	16:04	"SHINKAI6500" left the sea bottom.	D=976m	Wind:North-2
	16:27	Refloated "SHINKAI6500"		Wave scale:2
	16:53	Recovered "SHINKAI6500",and finished above operation.		Swell scale:1
	19:00 - 19:10	Scientists meeting.		Visibly: 6'
14-May-23		6K maintenance day.		12:00 (UTC+9h)
				35-03.1N,138-41.8E
				Off Shimizu
				Weather:r
				Wind:East-1
				Wave scale:1
				Swell scale:1
				Visibly: 7'
15-May-23	09:47	Hoisted up "SHINKAI6500".		12:00 (UTC+9h)
	09:54	Launched "SHINKAI6500".		35-00.0N,138-38.8E
	10:01	"SHINKAI6500" dove, and started her operation dive No.1687.		Off Shimizu
	10:51	"SHINKAI6500" landed the sea bottom.	D=1,400m	Weather:r
	16:26	"SHINKAI6500" left the sea bottom.	D=1,334m	Wind:NNE-4
	16:56	Refloated "SHINKAI6500"		Wave scale:3
	17:23	Recovered "SHINKAI6500",and finished above operation.		Swell scale:2

	19:10 - 19:30	Scientists meeting.		Visibly: 8'
16- May -23		Transit to JAMSTEC.		12:00 (UTC+9h)
				35°01.0N, 139°46.1E
				Tateyama-wan bay
				Weather:bc
				Wind:West-3
				Wave scale:2
				Swell scale:1
				Visibly: 8'
17- May -23	09:45	Arrived at JAMSTEC Yokosuka. Finished YK23-08C cruise.		

4. Observation and Activity results

4-1. MBES survey

For collecting the detailed geographical character at the dive area for #1687 dive site off Shimizu, we obtained the bathymetric data and sub-bottom data using shipboard equipment (see Appendix). Figure 3 show the preliminary bathymetry map, respectively. In this cruise, these data were collected with about 8 knots ship speed.

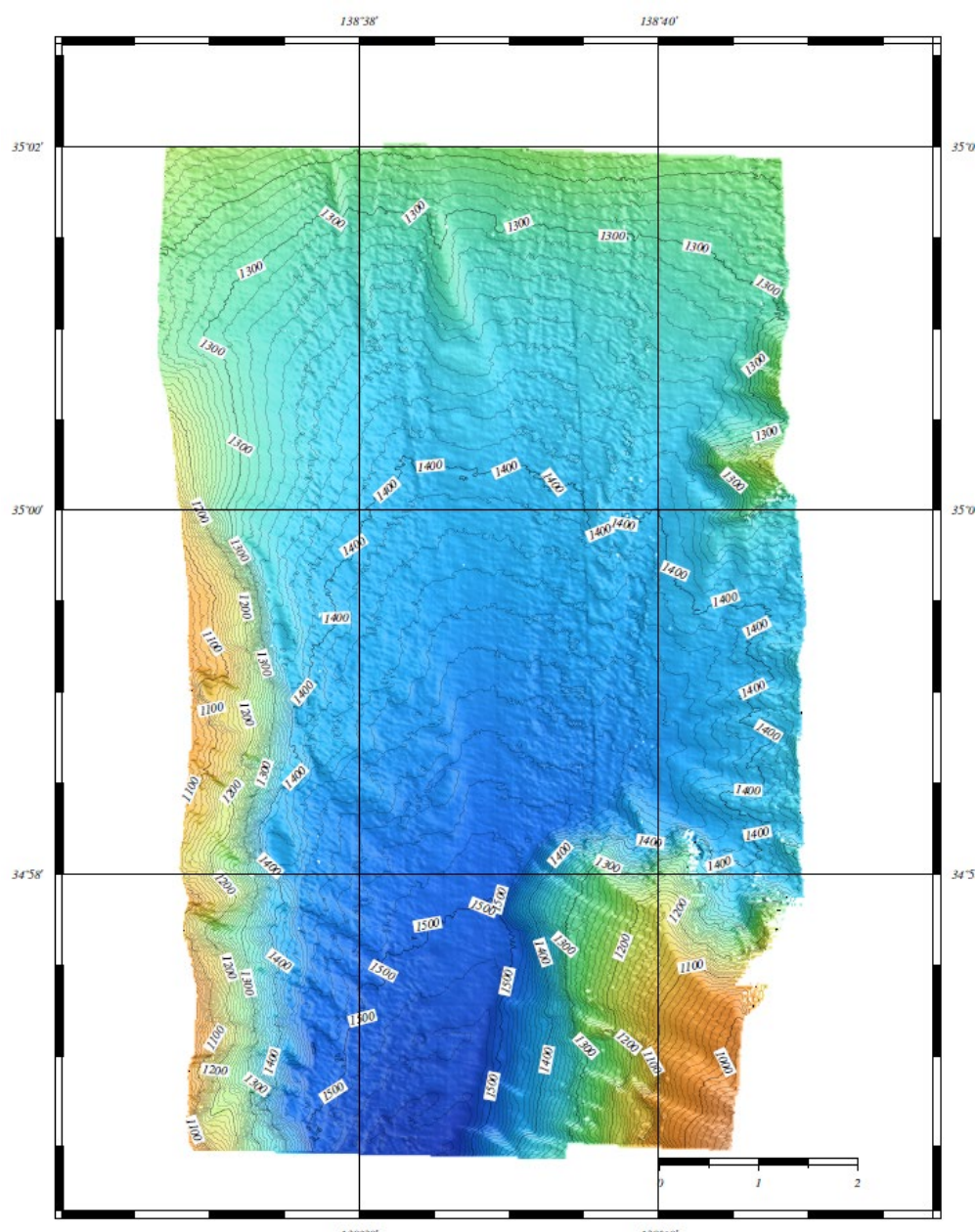


Fig. 3 Preliminary result of MBES survey.

4-2. Dive logs

- Dive 1684

Dive No.: # 1684

Date: 13/5/2023

Dive area: Nankai Trough North Edge (34°1.8'N, 138°31.6'E, 3516 m in depth)

Time of arriving the bottom: 11:45 (JST)

Time of leaving the bottom: 15:27 (JST)

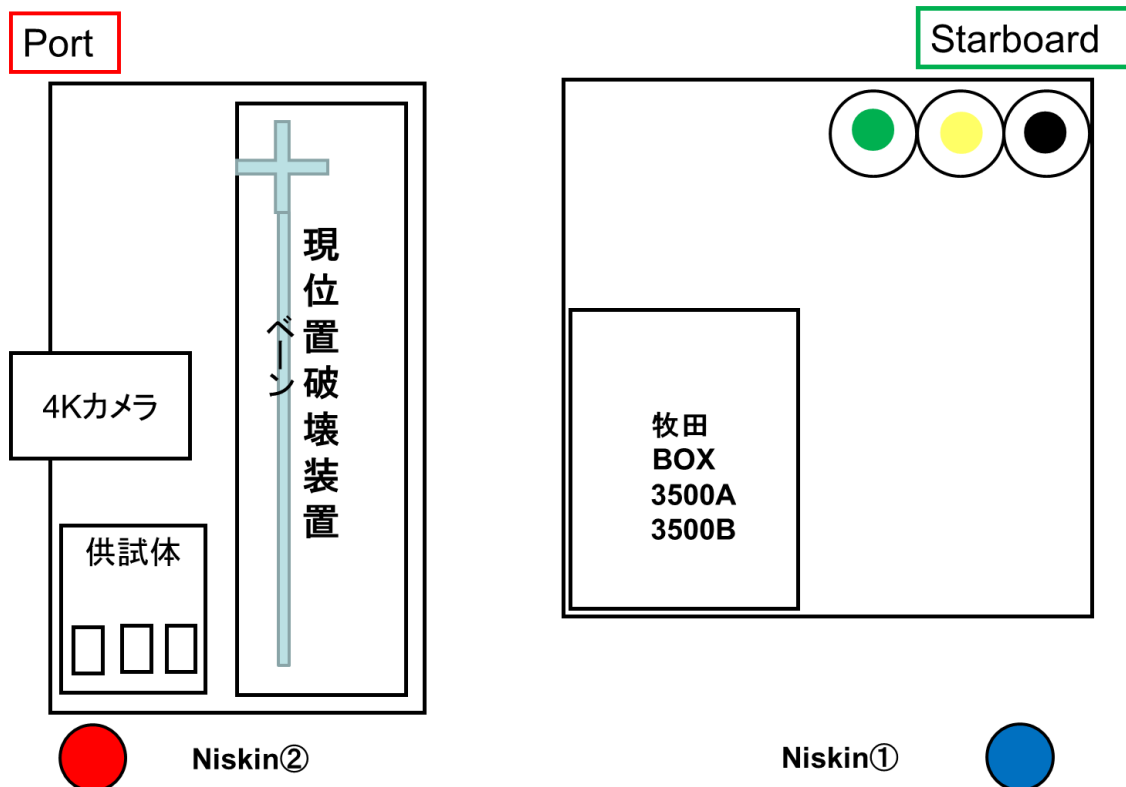
Observer: Keisuke Takahashi

Pilot: Onishi, Kondo

Purpose of dive:

1. Observation for the structure of surface sediment using a sub-bottom profiler
2. Retrieval of concrete specimens
3. In-situ loading test of a mortar block with rebar
4. Field trial of vane shear test
5. Sampling of bottom seawater and sediment cores

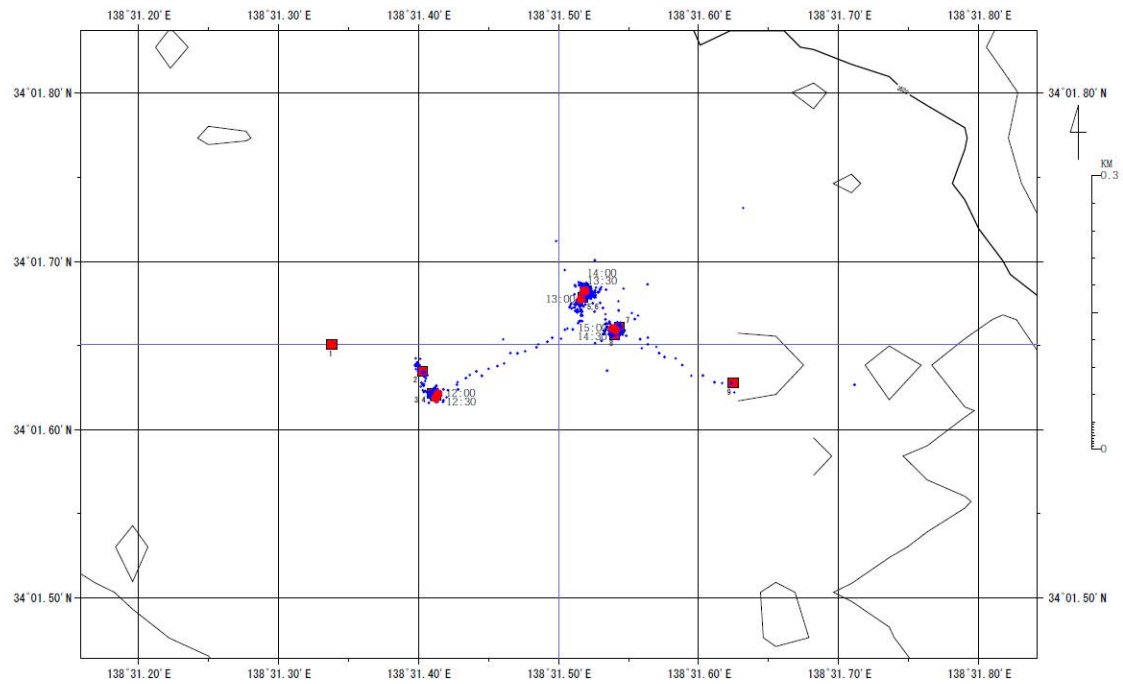
Payload:



Dive summary:

Before just landing on seafloor bottom seawater was sampled using Niskin bottles at 20 m height from seafloor. Observation with a sub-bottom profiler was started. After landing the seafloor at a depth of 3516m, in-situ loading test of a mortar block with rebar was conducted at the point #1. Then we moved to the point #2, retrieved concrete specimens and conducted coring of the sediment

Track and points of operation:



● Dive 1685

Dive No.: # 1685

Date: 12/5/2023

Dive area: Nankai Trough North Edge (34°1.8'N, 138°31.6'E, 3516 m in depth)

Time of arriving the bottom: 11:47 (JST)

Time of leaving the bottom: 15:20 (JST)

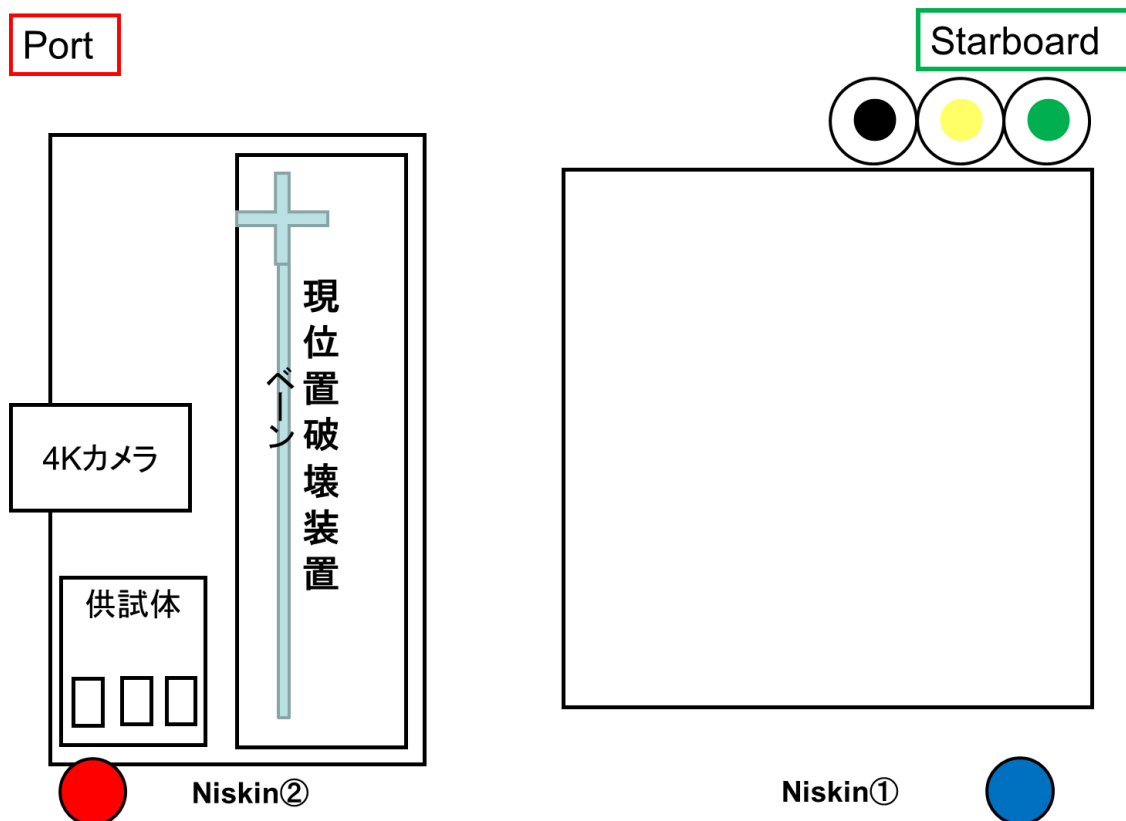
Observer: Yuichiro Kawabata

Pilot: Saigo, Iijima

Purpose of dive:

1. Observation for the structure of surface sediment using a sub-bottom profiler
2. Retrieval of concrete specimens
3. In-situ loading test of a mortar block with rebar
4. Field trial of vane shear test
5. Sampling of bottom seawater and sediment cores

Payload:



Dive summary:

Track and points of operation:



● Dive 1686

Dive No.: # 1686

Date: 13/5/2023

Dive area: Suruga Bay (34°58.9816'N, 138°36.5222'E, 1000 m in depth)

Time of arriving the bottom: 10:52 (JST)

Time of leaving the bottom: 16:04 (JST)

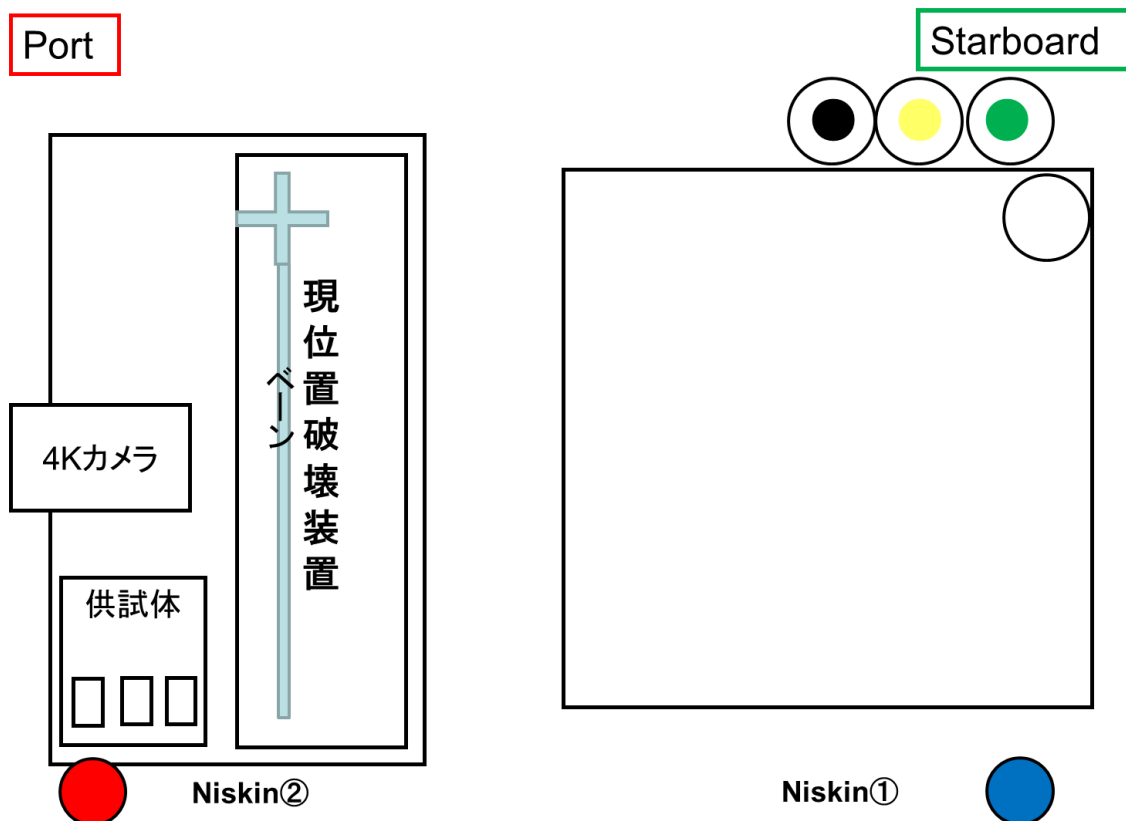
Observer: Shinpei Goto

Pilot: Matsumoto, Ishikawa

Purpose of dive:

1. Sampled seawater using Niskin bottles at 20 m height from seafloor.
2. Observation for the structure of surface sediment using a sub-bottom profiler.
3. Retrieval of platforms and SAHF.
4. In-situ loading test of a mortar block with rebar
5. Field trial of vane shear test
6. Sampling of bottom seawater and sediment cores

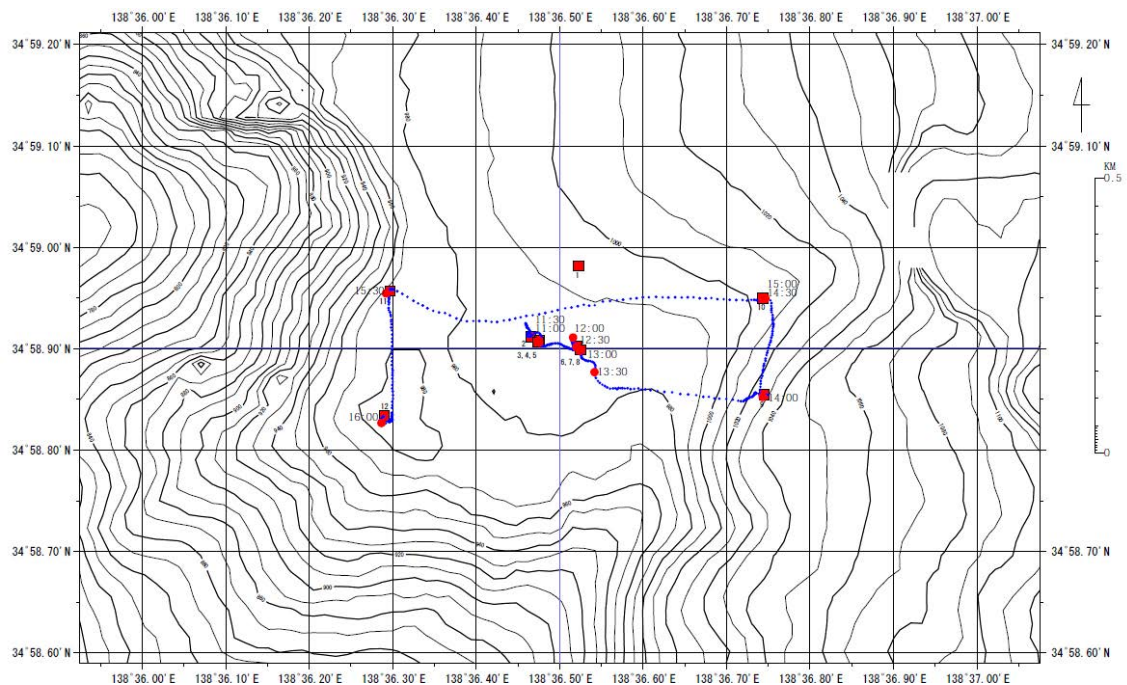
Payload:



Dive summary:

Before just landing on seafloor bottom seawater was sampled using Niskin bottles at 20 m height from seafloor. Observation with a sub-bottom profiler was started. After landing the seafloor at a depth of 978 m, sampling of sediment cores and in-situ loading test of a mortar block with rebar were conducted at the point #2. After that, we searched the vicinity of Point #2 to retrieve the sample that was installed last year. Then we moved to the point (-100, 400) and vane shear tests was done. After that, we proceeded to final point (-100, -300) via point (100, 400) and point (100, -300) while conducting vane shear tests and SBP. Finally, seawater was sampled using Niskin bottles at 20 m height from seafloor before leaving the bottom.

Track and points of operation:



● Dive 1687

Dive No.: # 1687

Date: 15/5/2023

Dive area: Suruga Bay (35°00.0005'N, 138°39.0005'E, 1402 m in depth)

Time of arriving the bottom 10:51 (JST)

Time of leaving the bottom 16:26 (JST)

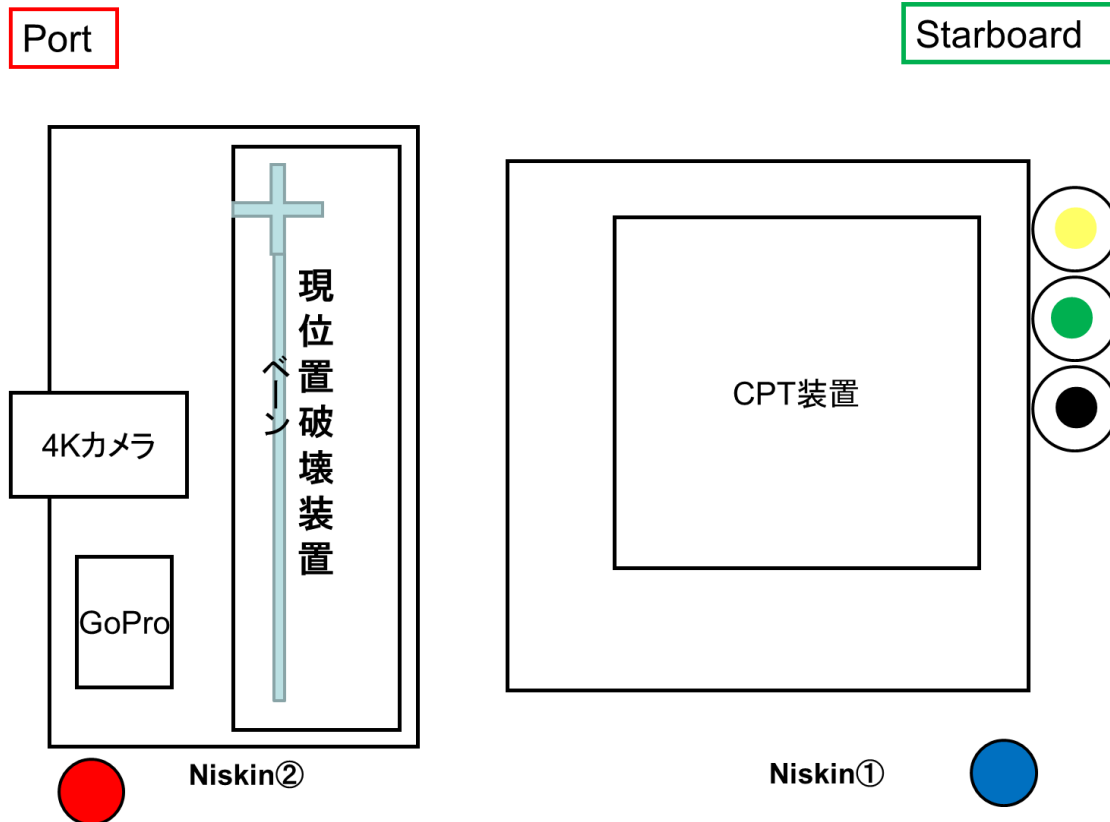
Observer: Takafumi Kasaya

Pilot: Suzuki, Kondo

Purpose of dive:

1. CPT tool
2. In-situ loading test of a mortar block with rebar
3. Sampler of bottom seawater and sediment cores
4. Vane shear test tool

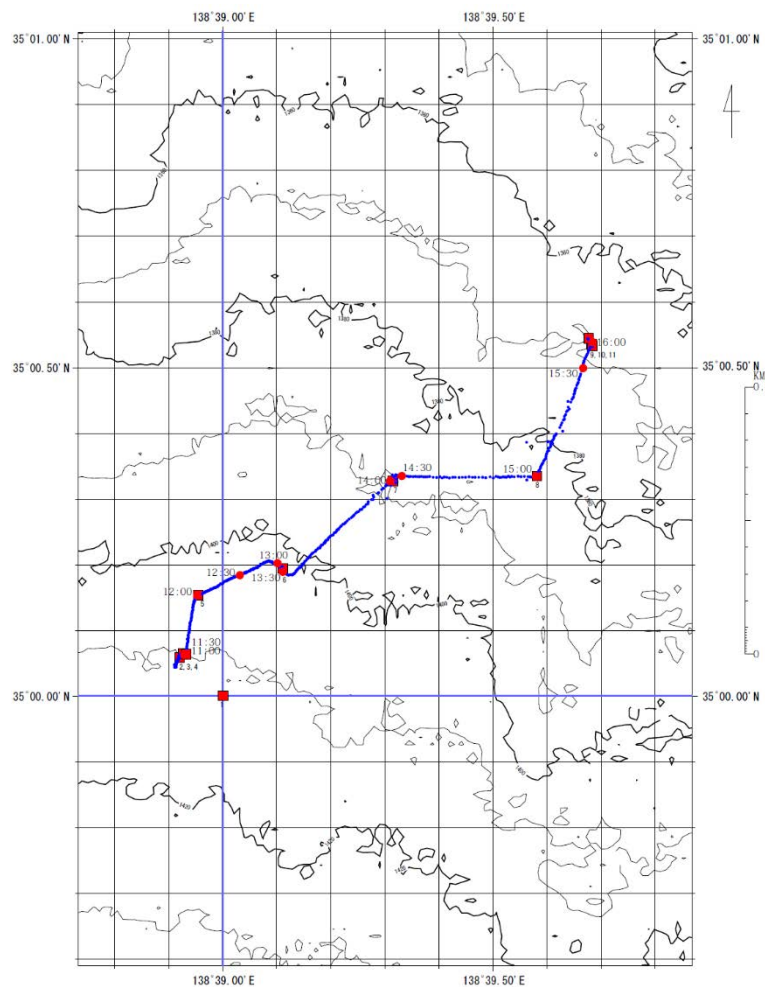
Payload:



Dive summary:

Before just landing on seafloor bottom seawater was sampled using Niskin bottles at 24 m height from seafloor. Data acquisition of a sub-bottom profiler was started. After landing the seafloor at a depth of 1402 m, sampling of sediment cores and test operation of CPT tool, and we collected first CPT data at the same point. The going up and down operation of a CPT probe were carried out with visual observation from the Shinkai 6500. After that, we started to move to north-east direction with visual observation of seafloor and took CPT data at five sites and core sampling at three sites when bottom sediment feature changed. Moreover, a in-situ loading test also was carried out at the middle of this dive. Before leaving the sea bottom, sea water sampling and vane shear test were carried out.

Track and points of operation:



5. Acknowledgements

I am deeply thanking for the captain and all ship crews of S/V Yokosuka. We are grateful to the SHINKAI 6500 operation team and marine technicians of NME for their operation. We are pleased to MarE3 staff for their special supports.

6. Notice on Using

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

Appendix 1

SHINKAI 6500

SHINKAI 6500 is Human Operated Vehicle (HOV). The HOV navigation consists of two sub-system, SSBL(Super Short Base Line) and LBL(Long Base Line).

INS and DVL data logged in slc format include status of HOV, there are acoustic sonar equipments, temperature gauge and CTD sensor.

The general specifications of SHINKAI 6500

Length	9.7 m
Width	2.7 m
Height	4.1 m
Weight	27 t
Maximum operation depth	6,500 m
Speed(Cruising)	– 2.7kt
Speed(Seafloor Observation)	– 1.0knot
Positioning	SSBL/LBL

Forward Looking sonar

Frequency	105~120kHz
Detection range	6,20,60,200,600,1000m
Angle of traverse	360°

CTD/DO

The general specifications of SeaBird Electronics SBE19/SBE43

Measurement range	-5 to + 35 °C
	0 to 70 mS/cs
	0 to 15,000 psia
Initial accuracy	0.01 °C
	0.01 mS/cm
	0.015% full scale
	0.01 ml/l

INS (Inertial Navigation System)

Measurement range	$\pm 180^\circ (\Phi)$ 、 $\pm 90^\circ (\theta)$
Initial accuracy	$0.1^\circ \times 1/\cos(\text{Lat})$

Current Direction / Speed Meter

Measurement range (Speed)	0 – 6 kt
(Direction)	0 – 360 °
Initial accuracy (Speed)	2cm/sec (0-40 cm/sec)、5% FS(40-300 cm/sec)
(Direction)	5° (22.5-300m/sec)

Depth meter

Type	Crystal oscillator
Measurement range	0 – 133.8MPa
Initial accuracy	0.01 FS

Altimeter

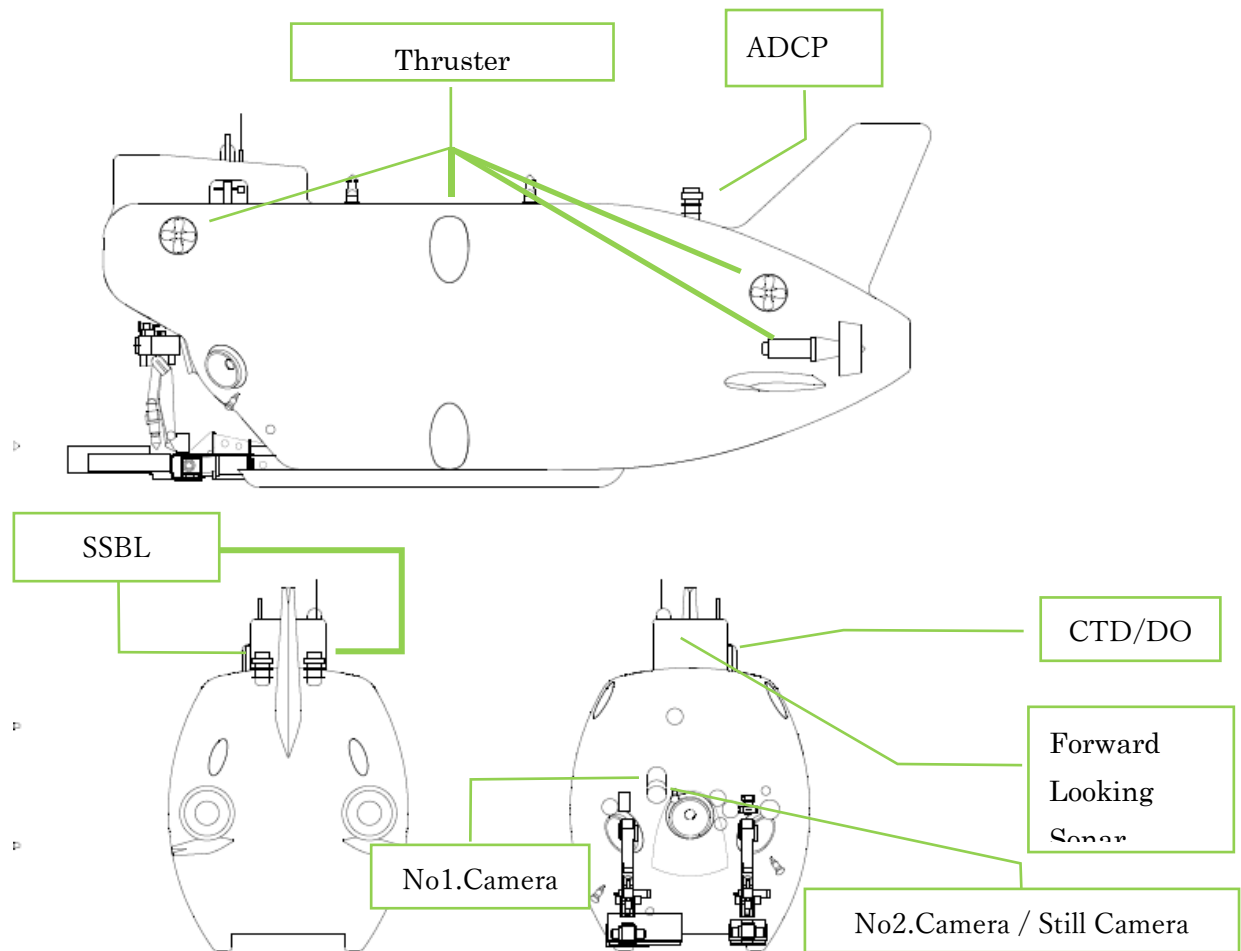
Frequency	14.829 kHz
Measurement range	2 – 1000m

ADCP

Frequency	300 kHz
Measurement range	– 128m

Temperature gauge

Measurement range	0 – 400 °C
Initial accuracy	0.15 °C (0 – 100°C)
	0.03 °C (100 – 400°C)



Appendix 2

Research Vessel YOKOSUKA

R/V YOKOSUKA was originally designed to serve as the mother vessel for SHINKAI 6500. Since the construction of an autonomous underwater vehicle (AUV), URASHIMA, YOKOSUKA has been shared by SHINKAI and URASHIMA. It has silent engine, an advanced acoustic navigation system and an underwater telephone for its state of the art operations. There are 5 laboratories on Yokosuka, No.1-No.4 laboratories and No.1 Study room. No.1 Lab. has dry space. The permanent installations are PC and a printer. No.2 Lab. has semi-dry and wet space. There are two freezers (-40 & -80 deg.C), an incubator, a Milli-Q, and a fumigation chamber at dry one, and wet one. No.3 Lab. has dry space with storage. No.4 Lab. has semi-dry and wet space. There are a rock saw and a Milli-Q. No.1 Study room has dry space, there are a gravity meter, a data acquisition system of gravity meter, a three-axis fluxgate magnet-meter and also a proton magnet-meter, a work station for data processing, and a A0 size plotter.

The general specifications of R/V YOKOSUKA

Length overall	105.2 m
Beam overall	16.0 m
Depth	7.3 m
Draft	4.5 m
Gross tonnage	4,439 tons
Service speed	16knot
Main propulsion system Diesel engines	2,206kW x 2
Main propulsion method	Controllable pitch propeller x 2

Complement

Crew	28 persons
Submersible operation staff	8 persons
Researchers	15 persons
Total 51 persons	

R/V YOKOSUKA MBES / SBP / magnetometers / gravity meter

YOKOSUKA is equipped with various kinds of underway geophysical equipment, a multi narrow beam echo sounder (EM122, Kongsberg Maritime, Inc.), a gravity meter (Type S-63, LaCoste & Romberg Gravity Meters Inc.), a ship borne three-axis magnet-meter (Type SFG-1212, Tierra Technica Inc.), and a proton magnet meter (Type STC 10, Kawasaki Geological Engineering Co., Ltd.). The specifications of these instruments are listed below.

The specifications of Multi-Beam Echo Sounder (EM122, Kongsberg Maritime, Inc.)

Measurement depth (m)	20 ~ 11,000
Measurement frequency (kHz)	12
Measurement method	cross fan beam style
Beam numbers	288
Mesurement point	432
Pulse lengths	2/5/15msec CW(∼2000m) 100msec FM(2000m∼)
Beam width (deg.)	2
Beam interval (deg.)	2
Swath width (deg.)	150 (Max)
Sampling rate (msec.)	0.33
Roll (deg.)	± 15
Pitch (deg.)	± 10
Yaw (deg.)	± 10

The specifications of Sub-Bottom Profiler (3300-HM, EdgeTec Inc.)

Transducers	4 × 4 plane array
Center frequency (kHz)	2 ~ 16
Type of pulse	FM
Band width (kHz)	2 ~ 16
Length of pulse (ms)	5 ~ 100
Resolution	8cm, for 2 ~ 12 kHz
Penetration (m)	6 for sand 80 for soft clay
Width of beam (using 4 × 4 array)	33° for 3.5 kHz 24° for 4.5 kHz 20° for 6 kHz

The specifications of Gravity meter

Measurement range (m Gal)	12,000
Drift	3mGal per month or less
<u>Stabilized platform</u>	
Platform pitch(deg.)	± 22
Platform roll(deg.)	± 25
Platform period(min.)	4 to 4.5
Beam interval(deg.)	1
<u>Control system</u>	
Recording rate(Hz)	1
Serial out put	RS-232
<u>System performance</u>	
Resolution (mGal)	0.01
Static repeatability (mGal)	0.05
50,000m Gal horizontal acceleration (mGal)	0.25
100,000m Gal horizontal acceleration (mGal)	0.50
100,000m Gal vertical acceleration (mGal)	0.25
Dimension (cm)	$71 \times 56 \times 84$
Weight (kg)	Meter:86, UPS:30

The specifications of three-axis magnet meter

System	ring core fluxgate
Number of component directly	3 axes
Cable length (m)	50
Sensor dimension (mm)	$\phi 280 \times 130H$
Measurement range (nT)	$\pm 100,000$
Resolution (nT)	1

The specifications of Proton magnet meter

Measurement range (nT)	$3 \sim 7 \times 10^{**4}$
Resolution (nT)	0.01
Sampling rate	10sec, 20sec, 1min, manual, external
Time of applying field(sec.)	3 to 10
Sensor dimension (mm)	$\phi 200 \times 1050$
Weight (kg)	28.6(in the air), 6.2(in the sea)