



R/V KIREI Cruise Report

KR21-15C

Evaluation test
for measuring the amount of methane bubbles
generated under the seafloor
using an underwater laser scanner

Sep. 5, 2021 - Sep. 17, 2021

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

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1. Cruise Information

- Cruise ID: KR21-15C
- Name of vessel: R/V KAREI
- Title of the cruise:
Evaluation test for measuring the amount of methane bubbles generated under the seafloor using an underwater laser scanner.
- Cruise period: Sep. 5, 2021 - Sep. 17, 2021
- Ports of departure / call / arrival: KEIHIN port, Tokyo sect. ODAIBA No.3 - Yokosuka (JAMSTEC)
- Research area: Umitaka Kaikyaku, Jyoetsu off.
- Research Map

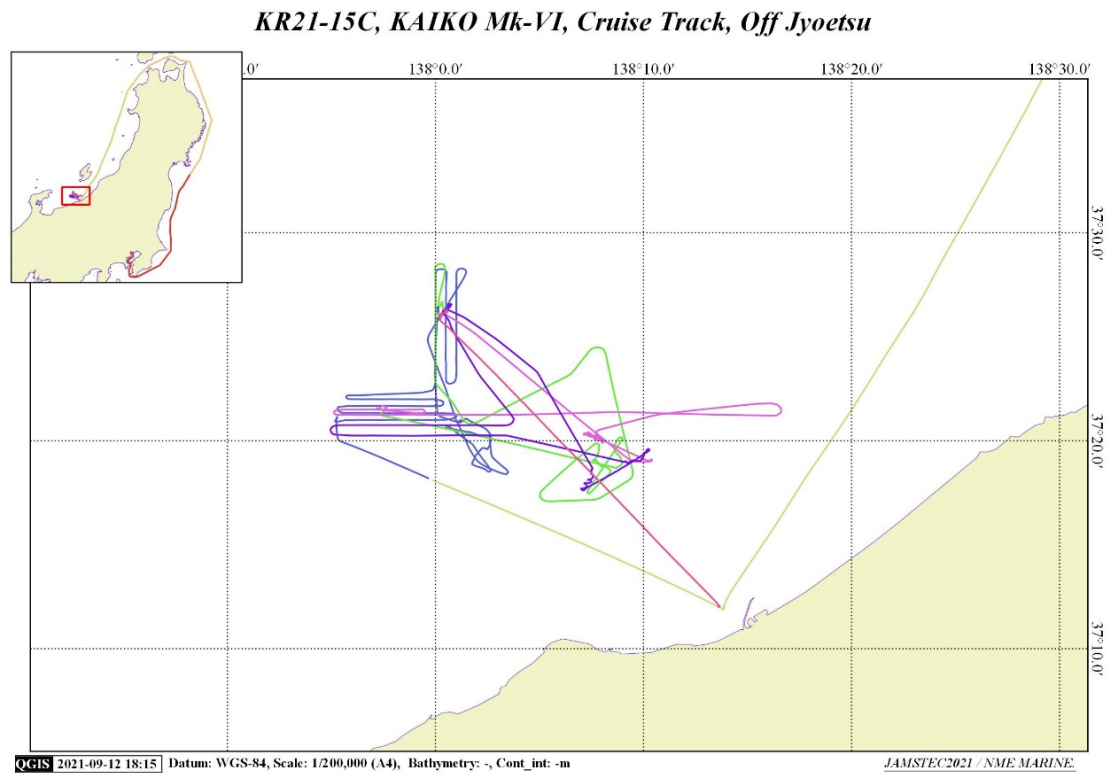


Fig.1 Cruise track of KR21-15C

2. Researchers

- Chief Scientist [Affiliation]: Kenji NAGAHASHI [JAMSTEC]
- Representative of the Science Party [Affiliation]: Shojiro ISHIBASHI [JAMSTEC]
- Onboard scientist [Affiliation]
 - Kenji NAGAHASHI [JAMSTEC]
 - Kiyofumi SUZUKI [AIST]
 - Satoru TAKAHASHI [AIST]
 - Naoki SAITO [AIST]
 - Hiroki KISE [AIST]
 - Shinsuke Aoki [AIST]
 - Masahiro SUZUMURA [AIST]
 - Haruka NAKANO [AIST]
 - Takashi SAITOH [MELOS]
 - Daisuke TETSUDA [MELOS]
 - Masaaki KAI [SAS]
 - Dai SASAKAWA [MELCO]
 - Morifumi TAKAESU [NME]

3. Results of Observations.

● Overview

This issue is a project entrusted by the National Institute of Advanced Industrial Science and Technology (hereinafter referred to as AIST) from the Ministry of Economy, Trade and Industry. It will be carried out as a commissioned research in "Research and development of methane hydrate)". AIST is working on "Survey of surface methane hydrate environment" in the Sea of Japan" in accordance with the policy of the Ocean Basic Plan. Therefore, we propose a survey of "methane seepage" that apply laser ranging technology (visualization technology) in the sea, and aim to understand detailed and precise "methane seepage" by using the technology and methods.

This voyage (evaluation test) is for a "methane seep" survey technology / method that applies laser ranging technology when carrying out the contract research "Measurement / evaluation of the amount of methane bubbles generated under the seafloor". The purpose is to estimate the physical quantity when methane is bubbled and spouted from below the seafloor, and the practicality of the algorithm constructed in the previous year will be evaluated in the actual sea area to which ROV"KAIKO" is applied. At the same time, we will acquire data that will contribute to the implementation study of the bubble search algorithm in the methane hydrate region.

In this voyage, we conducted a biological distribution survey by seafloor photography at ROV"KAIKO". We also collected sponges and etc, which observed around the methane

seep area. Several sensors such as a pH-CO₂ hybrid sensor, a dissolved methane sensor (LMS), a suspension particle size sensor (LISST), a turbidity meter, and a DO meter were mounted on the stake to measure the environment in the methane spring area.

- An underwater laser scanner (JAMSTEC carry-on item)



Fig.2 An underwater laser scanner.

Table 1 Specifications of An underwater laser scanner.

Size[L×B×H] (mm)	200 x 200 x 535
Mass in air(kg)	21
Max. operation depth (m)	1800
Max. Range (m)	50m (< NTU0.3)
Resolution	< 1cm
Laser wavelength	532nm green laser
Angle of view	H: 120 deg P: 30deg

- pH-CO2 Hybrid sensor (AIST carry-on item)

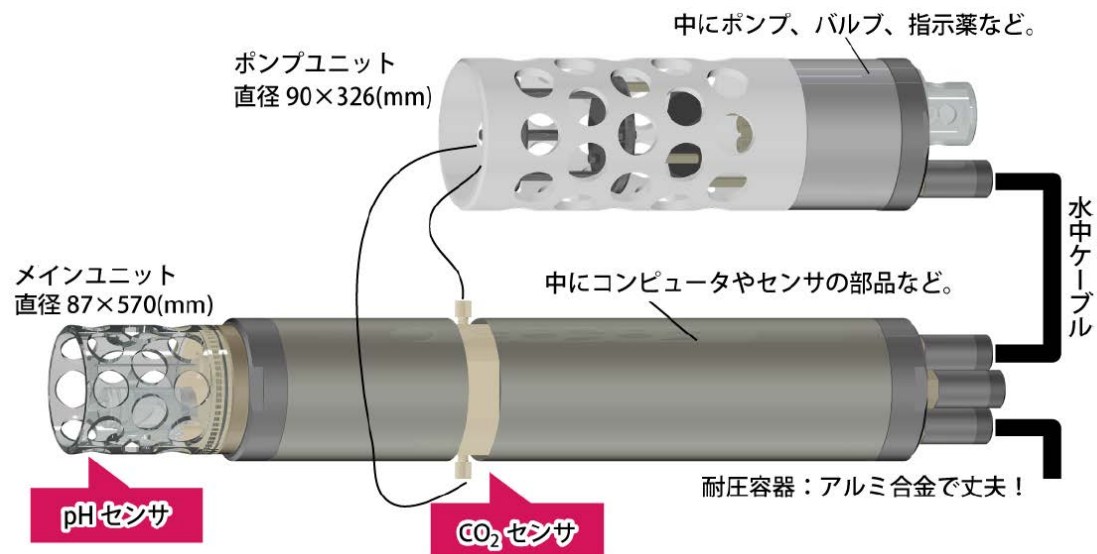


Fig.3 pH-CO2 Hybrid sensor (AIST carry-on item)

ITEM	SPECIFICATIONS
Size	Φ84×570mm
Weight (air)	4kg
Weight(water)	1.2kg
Accuracy	3μatm 0.01pH
Resolution	1μatm 0.001pH
Response Spd.	< 3min (CO2) < 20sec (pH)
Pressure Resi.	3,000m

Table 2 Specifications of pH-CO2 Hybrid sensor

- Laser Methane Sensor(LMS) (AIST carry-on items)



Fig.4 LMS

Table 3 Specifications of LMS

ITEM	SPECIFICATIONS
Size	Φ190×694 mm
Weight (air)	14kg
Weight(water)	8kg
Water Displacement	5.9L
Range	2-10000 ppmv
Reaction times	5 sec
Running Temp.	-3 ~ +20℃
Resource	Titanium alloy
Power	External supply
Pressure Resi.	4,000m

- Underwater particle measure sensor (LISST) (AIST carry-on items)

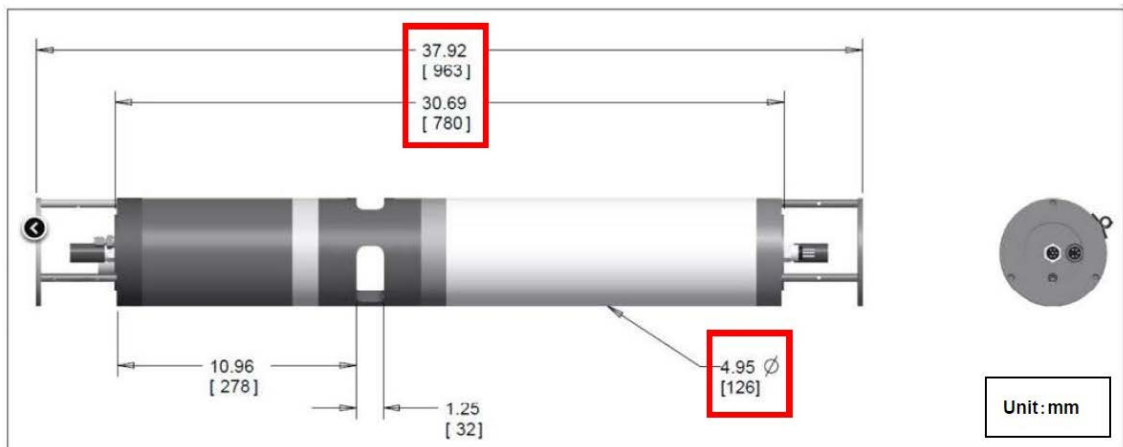


Table 4 Specifications of LISST

SPECIFICATIONS (subject to change without notice)						
Parameters Measured			Technology			
• Particle size in 32 size ranges • Depth @ 0.8 m (80 cm) resolution • Optical transmission • Volume concentration • Volume scattering function (VSF) • Temperature @ 0.01 °C resolution			• Small-angle forward laser light scattering • 670 nm laser diode • 32-ring custom photodiode ring detector • 50 mm optical path • 10 mm optical path with optional 80 % path reduction module.			
Measurement Ranges			Mechanical and Electrical			
• Particle size from 1.25 µm to 250 µm OR 2.5 µm to 500 µm • Depth from 0 m to 3,000 m • Optical transmission from 0.3 to 0.985 (30 % to 98.5 %) • Concentration from 1 mg-L⁻¹ to 800 mg-L⁻¹. NOTE: Strongly grain-size dependent; see table • Temperature from -5 °C to 45 °C			• Dimensions [Ø × L]: 12.57 cm × 80.3 cm (4.95" × 31.5") • <u>Weight [air / water]: 17 kg / 8 kg (38 lbs / 18 lbs)</u> • <u>Depth rating: 3,000 m</u> • External power input: 9 VDC nominal, 6 VDC to 24VDC • Power drain [measuring / quiescent]: 145 mA / 8 mA • Sampling rate: Up to 1 Hz • Memory: 1 GB (~12,500,000 size distributions)			
Material	Concentration [mg/l] 98% optical transmission	Concentration [mg/l] 30% optical transmission	D10 [µm]	D50 [µm]	D90 [µm]	SMD* [µm]
ISO Fine (ISO 12103-1,A2)	1	70	1.5	7	41	3
ISO Coarse (ISO 12103-1,A4)	5	150	4	38	99	10
20-30 µm glass beads	8	445	19	24	34	24
75-125 µm sieved sand	13	810	85	122	175	112

- DO sensor (AIST carry-on items)



Fig.6 DO sensor

Table 5 Specifications of DO sensor

ITEM	SPECIFICATIONS
Size	60×60×250mm
Weight (air)	0.9kg
Weight(water)	0.6kg
Range	Oxygen saturation 0-200%
Accuracy	2%
Resolution	Oxygen saturation 0.001-0.004%
Running Temp.	確認中
Pressure Resi.	7,000m

- Turbidity meter (AIST carry-on items)



Fig.7 Turbidity meter

Table 6 Specifications of Turbidity meter

ITEM	SPECIFICATIONS
Size	Φ54×290.5mm
Weight (air)	1.2kg
Weight(water)	0.8kg
Range	0-1,000FTU
Accuracy	±0.03FTU or ±2%
Resolution	0.03FTU
Pressure Resi.	6,000m

- Activities

Table 3 shows the activities of the cruise.

Table 7 Schedule of KR21-15C cruise

2021/09/04 Sat.	Noon Position: 35-37.1N, 139-47.0E (KEIHIN port,Tokyo sect. ODAIBA No.3)
19:00	Onboard "KAIREI" at ODAIBA
2021/09/05 Sun.	Noon Position: 35-18.6N, 139-43.5E (URAGA route)
08:30	Carried out education & training for scientists
10:00	Let go all shore lines & left ODAIBA for research area
11:00	Research meeting
13:15	Meeting for ROV dive operation and payload setup schedule
17:30	Research meeting
2021/09/06 Mon.	Noon Position: 38-37.0N, 141-56.1E (off MINAMI-SANRIKU)
	Transited to research area
17:40	Research meeting
2021/09/07 Tue.	Noon Position: 40-30.1N, 139-39.6E (off NISHI-TSUGARU)
	Transited to research area
14:20	Meeting for ROV route planning
17:40	Research meeting
2021/09/08 Wed.	Noon Position: 37-21.6N, 138-00.0E (off JYOETSU)
07:00	Arrived at off NAOETSU
07:55	Onboard "KAIREI" at off NAOETSU port
08:00	Commenced proceeding to research area
08:50	Carried out education & training for scientists
09:30	Arrived at research area
09:32	Released XBT at 37-20.8216N, 137-55.2329E
10:07	Commenced MBES mapping survey
16:12	Finished MBES mapping survey
17:40	Research meeting
2021/09/09 Thu.	
08:36	Hoisted up "KAIKO Mk-IV"
08:41	Launched and commenced KK871 dive operation

09:52	Landed on the sea floor (D=901m)
14:03	Left the sea bottom (D=894m)
14:59	Hoisted up
15:09	Recovered "KAIKO Mk-IV"
16:14-16:57	Commenced MBES mapping survey
17:40	Research meeting
2021/09/10 Fri.	
08:28	Hoisted up "KAIKO Mk-IV"
08:33	Launched and commenced KK872 dive operation
09:23	Landed on the sea floor (D=558m)
14:21	Left the sea bottom (D=550m)
15:01	Hoisted up
15:12	Recovered "KAIKO Mk-IV"
16:11-17:33	Commenced MBES mapping survey
17:50	Research meeting
2021/09/11 Sat.	
08:28	Hoisted up "KAIKO Mk-IV"
08:33	Launched and commenced KK873 dive operation
09:38	Landed on the sea floor (D=893m)
14:00	Left the sea bottom (D=888m)
14:53	Hoisted up
15:05	Recovered "KAIKO Mk-IV"
16:13-18:01	Commenced MBES mapping survey
17:40	Research meeting
2021/09/12 Sun.	
08:25	Hoisted up "KAIKO Mk-IV"
08:30	Launched and commenced KK874 dive operation
09:34	Landed on the sea floor (D=892m)
13:05	Left the sea bottom (D=892m)
14:00	Hoisted up
14:14	Recovered "KAIKO Mk-IV"
15:00	Commenced proceeding to off NAOETSU port
16:15	Let go anchor, arrived at off NAOETSU port

18:15	Research meeting
2021/09/13 Mon.	
08:00	A parts of Scientists disembarked
09:00	A parts of Scientists disembarked
09:10	Heaving anchor, left off NAOETSU port
2021/09/14 Tue.	Transited to YOKOSUKA JAMSTEC Port
2021/09/15 Wed.	Transited to YOKOSUKA JAMSTEC Port
2021/09/16 Thu.	
09:00	Arrival at YOKOSUKA JAMSTEC Port

- Results

The observation results of KR21-15C are shown below.

Since this voyage is a commissioned voyage of AIST, the sensors brought in by AIST will not be announced.

The announcement will be limited to the seafloor mapping measurement by MBES and the methane discharge measurement result by Laser scanner.

We were able to capture the methane eruption with a laser scanner. Details will be analyzed in the future.

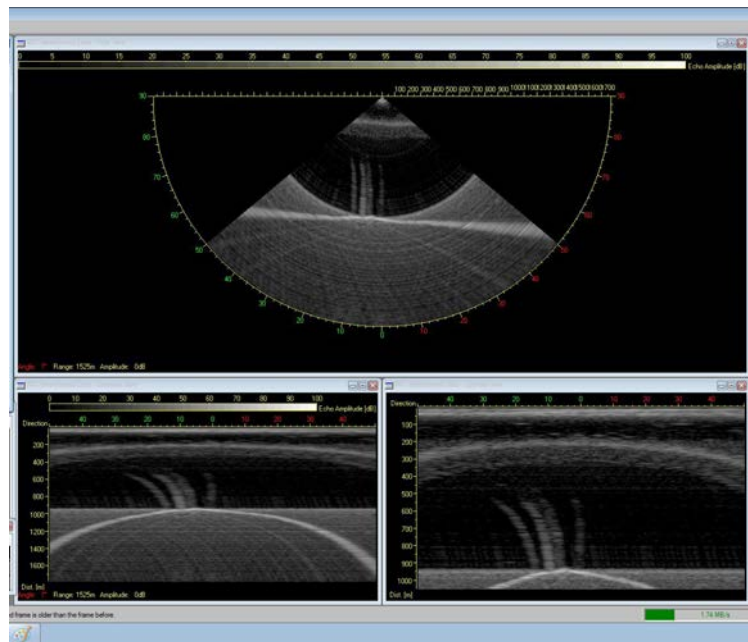


Fig.8 MBES data at UMITAKA KAIKYAKU

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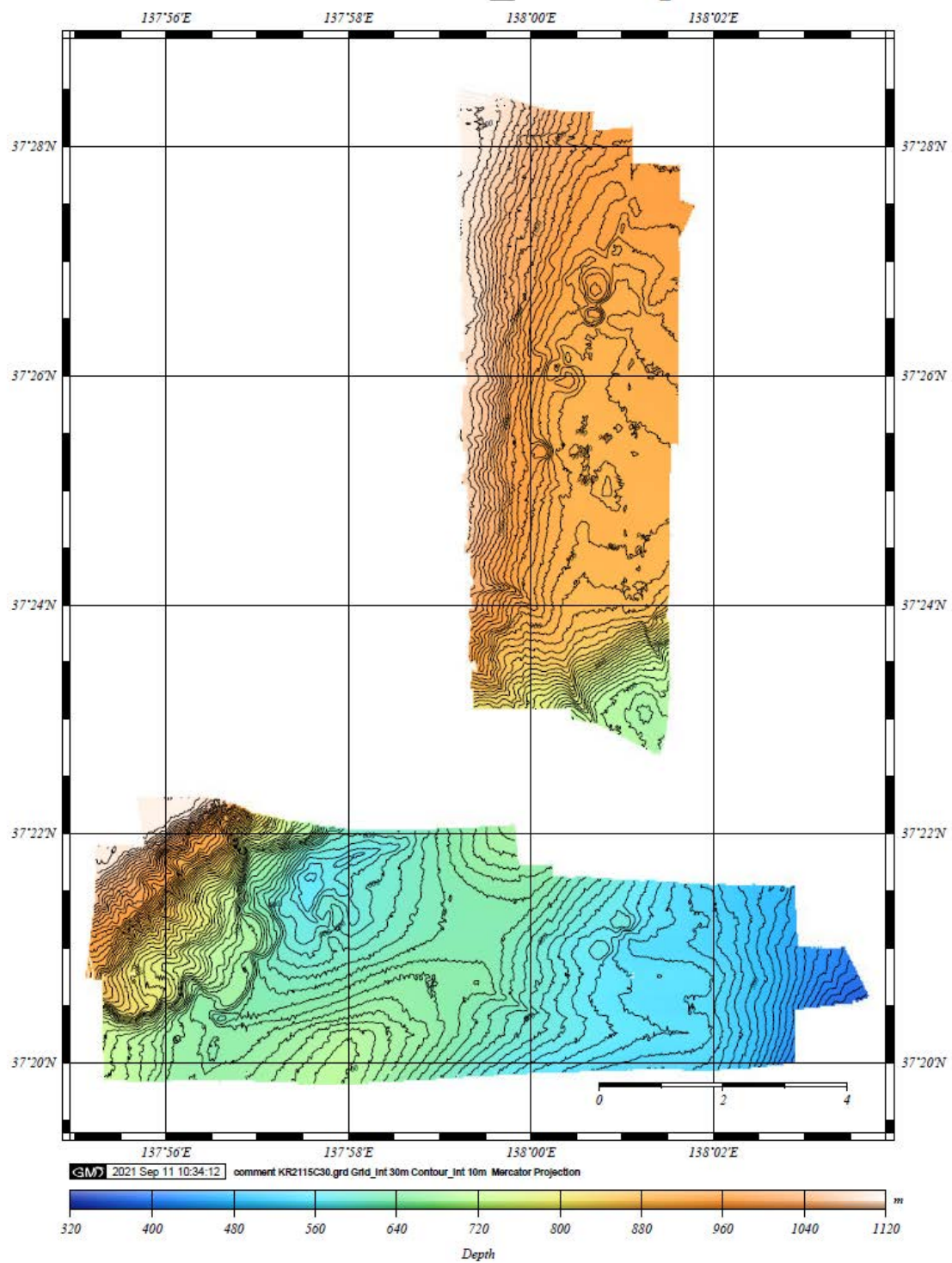


Fig.9 MBES data at UMITAKA KAIKYAKU

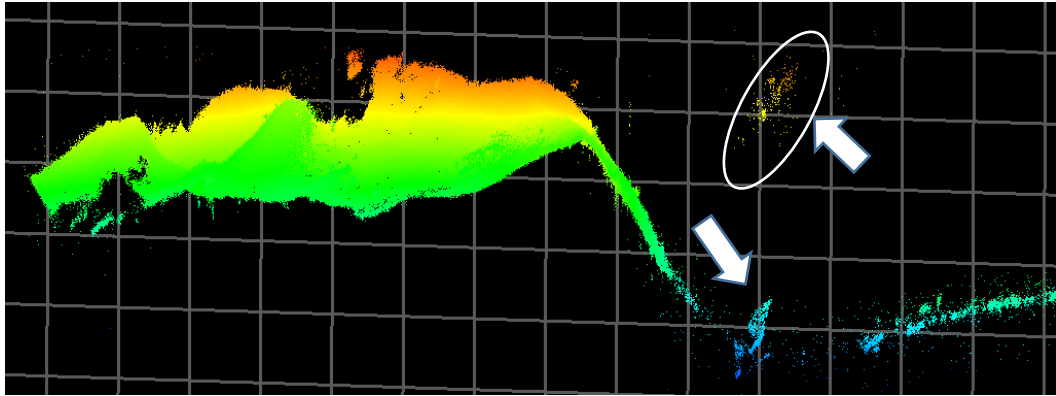


Fig.10 3D Image of Lassr scanner

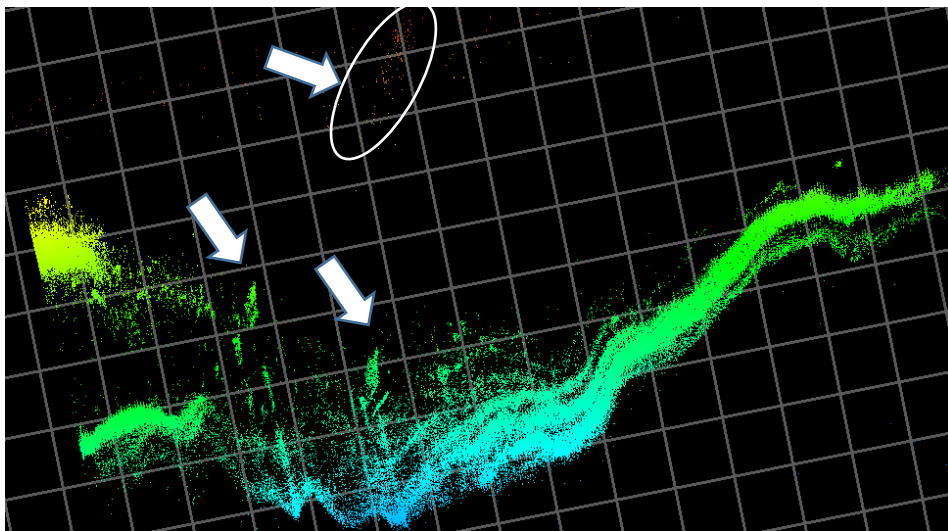


Fig.11 3D Image of Lassr scanner

4. 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

Acknowledgement

We would like to thank the captain Takafumi AOKI and his crew of the R/V KAIREI, and Seiji SHIGETAKE and the ROV “KAIKO Mk-IV” technical support team (Nippon Marine Enterprises, Ltd.) for safe operation and great support during the cruise.

5. Appendix

Research Vessel KAIREI

R/V “KAIREI” is the exclusive mother ship for the 7,000m class remotely operated vehicle “KAIKO7000II” which entered service in 2006. In addition, R/V "KAIREI" is equipped with geophysical instruments such as a 444 channel seismic profiler. The major instruments installed in KAIREI are a multi-narrow beam bathymetric mapping system (Sea Beam3012), and integrated sub-bottom profiler, gravity meter, proton magnetometer and three components magnetometer, and various kinds of sampling devices such as piston corer and dredge. There are several onboard laboratories for data recording, and data and sample analysis. These are the Research Room, Mission control & Computer Room, Wet laboratory (chemistry and biology), Dry laboratory (Geophysics), Gravimeter room, KAIKO Operation's Center, Rocks and sediment laboratory, Library, Video Room and Personal computer Room. The ship also has an aft wheel house which overlooks the entire aft operations deck for the operation of the ship, winches, A-frame and cranes during station work such as dredge hauls, piston coring and sampling, launch and recovery operations.

The general specifications of R/V KAIREI

Length overall	106.0 m
Beam overall	16.0 m
Depth	7.3 m
Draft	4.5 m
Gross tonnage	4,517 tons
Service speed	16.7 knot
Main propulsion system Diesel engines	2,206kW x 2
Main propulsion method	Controllable pitch propeller x 2

R/V KAIREI MBES / magnetometers / gravity meter

KAIREI is equipped with various kinds of underway geophysical equipment, a multi narrow beam echo sounder (Type SeaBeam 3012, L-3 ELAC Nautik GmbH.), a sub bottom profiler (Type BATHY-20101, SyQwest, Inc.), a gravity meter (Type KSS31, BODENSEEWERK PERKIN-ELMER), a portable gravity meter (Type CG-3M, SCINTREX Inc.), a shipboard three components magnetometer (Type SFG-1214, Tierra

Technica Inc.), and a proton magnet meter (Type PM-217, Kawasaki Geological Engineering Co., Ltd.). The specifications of these instruments are listed below.

The specifications of SeaBeam 3012

Technical Data

Operating frequency	12 kHz
min. depth	50m below transducers
max. depth	11,000 m (full ocean depth)
number of Beams	301 equi-distance
Accuracy	< 1 % of water Depth (Average Across Swath)
Side scan	12-Bit Resolution to maximum 2000 pixels
Average Footprint Resolution	2° x 1.6°
Max. Vessel Speed	6 knots (100 % Coverage @ 140° swath) 12 knots (100 % Coverage @ 120° swath)
Workstations	Computer with Windows 7 operating system
measurement method	Swept beam technique
Environmental limits for compensation	
Roll	±10°
Pitch	±7°
Yaw	±5°

The specifications of BATHY-2010

Depth Ranges	10, 20, 40, 80, 150, 300, 500, 750, 1000, 2000, 5000, 12000 Meters
Strata Resolution	Up to 6 cm with 200 Meter of bottom penetration bottom type dependant
Depth Resolution	0.1 Meters
Depth Accuracy	±0.3% to 6000 m
Frequency Output	3.5 KHz