doi : 10.17596/0003435

R/V Kaimei "Cruise Report"

KM23-02

Jan 25th, 2023 – Feb 6th, 2023

Higashi-Aogashima Knoll Caldera in the Izu-Ogasawara area

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

Contents

1. Participants aboard

1-1. Research group

Chief Scientist / Representative of Science Party:

KASAYA Takafumi	Japan Agency for Marine-Earth Science and Technology: JAMSTEC

Onboard Researchers:

KANEKO Junji	JAMSTEC
ISHIZU Keiichi	University of Hyogo
NAKANO Yoshiyuki	JAMSTEC
OKADA Kazuma	University of Hyogo
KITAYA Ryoichi	University of Hyogo
ODA Ayako	University of Hyogo

Technical supporting stuffs:

IWAMOTO Hisanori	NME
KAWAMURA Yosuke	NME
SUGIMOTO Yohei	NME
OKADA Fumine	NME

1-2. AUV and ROV Operation Team

AUV Operation Manager	SITO FUMITAKA
1st AUV Operator	UEKI MITSUHIRO
2nd AUV Operator	KURAMOTO YOSHIKAZU
3rd AUV Operator	MATSUZAKA MOTOHIRO
3rd AUV Operator	ICHINOSE DAIKI
ROV Operation Manager	ISHITSUKA TETSUYA
2nd ROV Operator	KUMAGAI SHINNOSUKE
2nd ROV Operator	GOTO TAKUMA
3rd ROV Operator	KOGUMA ATSUSHI
3rd ROV Operator	TAKEDA KAI

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

Captain	KIMURA NAOTO
Chief Officer	YAMAGUCHI RYO
2nd Officer	OKADA MASAKI
Jr.2nd Officer	IIDA YASUTO
3rd Officer	INOUE MIYU
Jr.3rd Officer	TSURUMAKI AOI
Chief Engineer	KANEDA KAZUHIKO
1st Engineer	SHIRAKATA KENICHI
Jr.1st Engineer	NOGUCHI KAZUNORI
2nd Engineer	INOMOTO TAKAATSU
3rd Engineer	IKEZAKI KOHSHUN
Chief Electronic Operator	NASU TOKINORI
2nd Electronic Operator	MATSUI RYOSUKE
3rd Electronic Operator	OI KEISUKE
Boat Swain	KUWAHARA YOSUKE
Able Seaman	NAKAE KENJI
Able Seaman	SHIMPO SATOSHI
Able Seaman	HIRAI SAIKAN
Able Seaman	UENO SHINYA
Able Seaman	OHJIRI YUTA
Sailor	SEGUCHI KEITO
No.1 Oiler	HIGASHIGAWA YUJI
Oiler	SATO RYO
Oiler	HIDAKA TORU
Assistant Oiler	MARUYAMA KYOTARO
Assistant Oiler	MIZUNO RIKU
Chief Steward	CHIKUBA YUKIHIDE
Steward	KUNITA MASANAO
Steward	NOJIRI TAKEHIRO
Steward	WAKIZAKA HODAKA

2. Cruise Summary

2-1. Cruise Information

- Cruise ID: KM23-02
- Name of vessel: R/V Kaimei
- Chief Scientist: Takafumi Kasaya (JAMSTEC)
- Title of cruise proposal:

  Preliminary geophysical survey at the Higashi-Aogashima Knoll Caldera hydrothermal field for the future BMS drilling cruise
- Cruise period: Jan 25th –Feb 6th 2023
- Ports of departure /arrival: JAMSTEC-Yokosuka / JAMSTEC-Yokosuka
- Research area: Higashi-Aogashima Knoll Caldera in the Izu-Ogasawara area
- Research area and track map: Fig. 1

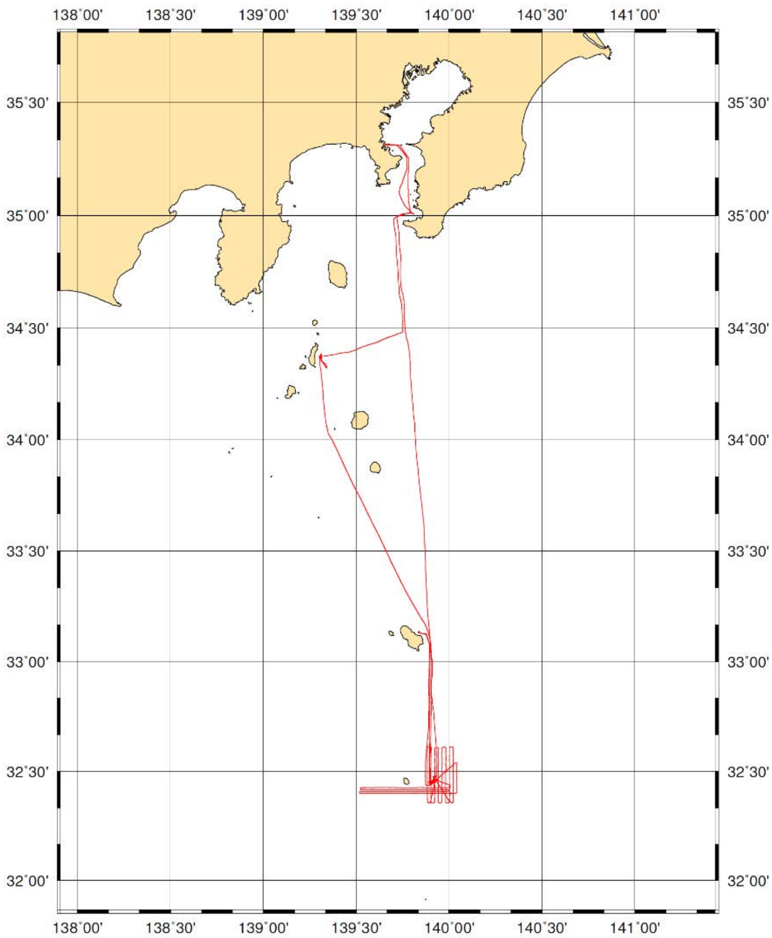


Fig. 1 Track map of KM23-02 Cruise.

2-2. Overview of the Observation

Higashi-Aogashima Knoll Caldera Hydrothermal field has been paid attention to as research target of hydrothermal deposit because of the high gold concentration detected from the mound samples at the Central Cone site of this caldera (Iizasa et al., 2019). Electrical properties of sub-seafloor structure are very important to consider to the growth process and volume potential of metal resources. For detecting the shallow resistivity structure and vertical electric field anomaly, we have developed a marine DC resistivity system with a vertical electrode array (Kasaya et al., 2021; 2022). It is easy to operate in the hydrothermal activity area with rough topography. Moreover, self-potential survey is also an effective tool for detecting the existence of the buried hydrothermal deposit (Kawada and Kasaya, 2017; 2018).

We improved the system increasing the potential electrode number before the cruise. In this cruise, we conducted three ROV dives for DC resistivity survey and self-potential survey. A vertical electrode array and sub towed body is lowered from the KM-ROV. This towed body equips a HD camera, underwater light, altimeter, and CTD sensor. Therefore, we can observe the real-time seafloor image with resistivity and self-potential data. Figure 2 is a captured image of small dead chimney in the East site. Moreover, we carried out the self-potential survey at a AUV dive. Voltmeter was mounted on the top of AUV JINBEI, and an electrode array with six electrodes was towed from the tail of AUV (Kawada and Kasaya, 2018). Moreover, we attached the pH-CO_2 Hybrid sensor on both vehicles to aim at obtaining pH and pCO2 data near the sea floor

Fig. 2 Captured photo by the HD camera mounted on the sub towed body of DC resistivity system in the East sites of Higashi-Aogashima Knoll Caldera Hydrothermal field

References

Iizasa, K., Asada, A., Mizuno, K., Katase, F., Lee, S., Kojima, M. and Ogawa, N. (2019) Native gold and gold-rich sulfide deposits in a submarine basaltic caldera, Higashi-Aogashima hydrothermal field, Izu-Ogasawara frontal arc, Japan. *Mineralium Deposita*, **54**, 117–132.

Kawada, Y., and Kasaya, T. (2017): Marine self-potential survey for exploring seafloor hydrothermal ore deposits. Sci. Rep., 7, 13552.

Kawada, Y., and Kasaya, T. (2018): Self-potential mapping using an autonomous underwater vehicle for the Sunrise deposit, Izu-Ogasawara arc, southern Japan. *Earth, Planets and Space,* **70,** 142.

Kasaya, T., Iwamoto, H., Kawada, Y. (2021): Characteristics of vertical electric field deduced by newly developed DC resistivity system with vertical electrode array around hydrothermal deposit area, *BUTSURI-TANSA*, **74**, 57-64.

Kasaya, T., Iwamoto, H., Kawada, Y. (2022): Resistivity structure deduced from the developed marine vertical DC resistivity survey system around a hydrothermal deposit area, *BUTSURI-TANSA*, **75**, sp42-49.

3. Cruise Log

日付 **Date**	時間 **Local Time**	内容 **Note**	本船位置／気象／海象 **Noon Position Weather/Wind/Sea Condition**
25-Jan-23	8:00	Scientists party onboard R/V KAIMEI	JAMSTEC
	10:00-10:30	Onboard lecture for evacuation and onboard life	35-19.8N,139-41.0E
	18:00-18:30	Researcher's meeting	Weather: bc
			Wind direction/force: NW/4
			Wave scale: 1
			Swell scale: 0
			Visibility(miles): 8
26-Jan-23	13:30	Engine room tour for researcher	JAMSTEC
			35-19.8N,139-41.0E
			Weather: bc
			Wind direction/force: West/3
			Wave scale: 1
			Swell scale: 0
			Visibility(miles): 8
27-Jan-23	17:30-17:40	Researcher's meeting	JAMSTEC
			35-19.8N,139-41.0E
			Weather: o
			Wind direction/force: East/2
			Wave scale: 1
			Swell scale: 0

			Visibility(miles): 8
28-Jan-23	9:00	Let go all shore line & left YOKOSUKA J.P.P.1	Tokyo Bay
	10:00	Practiced life boat station drill at YOKOSUKA sec.4	35-08.3N,139-44.6E
	13:00	Arrived at off the coast of TATEYAMA Bay & stanby for rough sea	Weather: bc
	19:00	Left TATEYAMA Bay & proceeded to research area	Wind direction/force: North/4
	22:20	Changed the destination to off the coast of NIIJIMA due to rough sea	Wave scale: 2
			Swell scale: 1
			Visibility(miles): 8
29-Jan-23	5:00	Arrived at off the coast of NIIJIMA & stanby for rough sea	Off the east coast of NIIJIMA
			34-22.2N,139-18.8E
			Weather: bc
			Wind direction/force: West/6
			Wave scale: 4
			Swell scale: 2
			Visibility(miles): 8
30-Jan-23	14:00-14:50	Presentation of thesis by students	Off the east coast of NIIJIMA
			34-22.2N,139-18.8E
			Weather: bc
			Wind direction/force: West/6
			Wave scale: 4
			Swell scale: 2
			Visibility(miles): 8

31-Jan-23	6:00	Left the coast of NIIJIMA & proceeded to research area	Off the NE coast of HACHIJYOJIMA
	16:15	Arrived at research area(AOGASHIMA)	33-17.9N,139-46.7E
	16:16	Let go XBT	Weather: o
	18:00	Com'ced MBES ploom survey	Wind direction/force: NW/6
			Wave scale: 4
			Swell scale: 3
			Visibility(miles): 7
1-Feb-23	4:30	Finished MBES ploom survey	East AOGASHIMA knoll caldera
	7:06	Hoisted up "KM-ROV"	32-28.4N,139-55.5E
	7:11	Lounched "KM-ROV",then it dove & com'ced her operation #203	Weather: bc
	7:33	"KM-ROV"breakaway	Wind direction/force: W/5
	7:39	"KM-ROV"landed on the sea bottom	Wave scale: 4
	11:29	"KM-ROV"left the sea bottom	Swell scale: 2
	11:36	"KM-ROV"combined	Visibility(miles): 8
	11:52	Hoisted up "KM-ROV"	
	11:59	Recovered "KM-ROV"& finished the operation	
2-Feb-23	23:40	Com'ced MBES ploom survey	Off the NE coast of HACHIJYOJIMA
			33-07.8N,139-50.1E
			Weather: o
			Wind direction/force: NW/6
			Wave scale: 4
			Swell scale: 4
			Visibility(miles): 8

3-Feb-23	5:30	Finished MBES ploom survey	East AOGASHIMA knoll caldera
	8:11	Hoisted up "JINBEI"	32-26.9N,139-54.6E
	8:15	Lounched "JINBEI"	Weather: bc
	8:17	"JINBEI"dove & started her operation #79	Wind direction/force: W/1
	15:01	Start surfacing "JINBEI"	Wave scale: 2
	15:09	Surfaced "JINBEI"	Swell scale: 2
	15:28	Hoisted up above"JINBEI"	Visibility(miles): 8
	15:34	Recovered "JINBEI"& finished above operation	
	16:08	Towed cesium magnetometer	
4-Feb-23	7:06	Recovered cecium magnetmeter	East AOGASHIMA knoll caldera
	8:34	Hoisted up "KM-ROV"	32-28.1N,139-55.2E
	8:40	Lounched "KM-ROV",then it dove & com'ced her operation #203	Weather: c
	9:17	"KM-ROV"breakaway	Wind direction/force: W/6
	9:22	"KM-ROV"landed on the sea bottom	Wave scale: 4
	16:14	"KM-ROV"left the sea bottom	Swell scale: 2
	16:22	"KM-ROV"combined	Visibility(miles): 8
	16:41	Hoisted up "KM-ROV"	
	16:48	Recovered "KM-ROV"& finished the operation	
	17:14	Towed cesium magnetometer	
5-Feb-23	6:04	Recovered cecium magnetmeter	East AOGASHIMA knoll caldera
	7:08	Hoisted up "KM-ROV"	32-26.2N,139-53.8E
	7:12	Lounched "KM-ROV",then it dove & com'ced her operation #203	Weather: bc
	7:48	"KM-ROV"breakaway	Wind direction/force:

			NW/4
	7:53	"KM-ROV"landed on the sea bottom	Wave scale: 4
	12:42	"KM-ROV"left the sea bottom	Swell scale: 2
	12:51	"KM-ROV"combined	Visibility(miles): 8
	13:12	Hoisted up "KM-ROV"	
	13:20	Recovered "KM-ROV"& finished the operation	
6-Feb-23	10:05	Arrived at YOKOSUKA, then completed voyage KM23-02	

4. Observation and Activity results

4-1. Shipboard survey

During the KM23-02 cruise, gravity survey and magnetic survey were conducted aboard the R/V Kaimei in research area, and cesium magnet survey was conducted two nights around Higashi-Aogashima knoll caldera (a red line in Fig. 3). For detecting anomalous water column points related to the hydrothermal activity, Multi-narrow beam echo sounder recorded water column reflectivity data in Higashi-Aogashima knoll caldera. The water column observation point is shown in Fig. 3. The specifications of these instruments used in this cruise are followed as appendix part of this report.

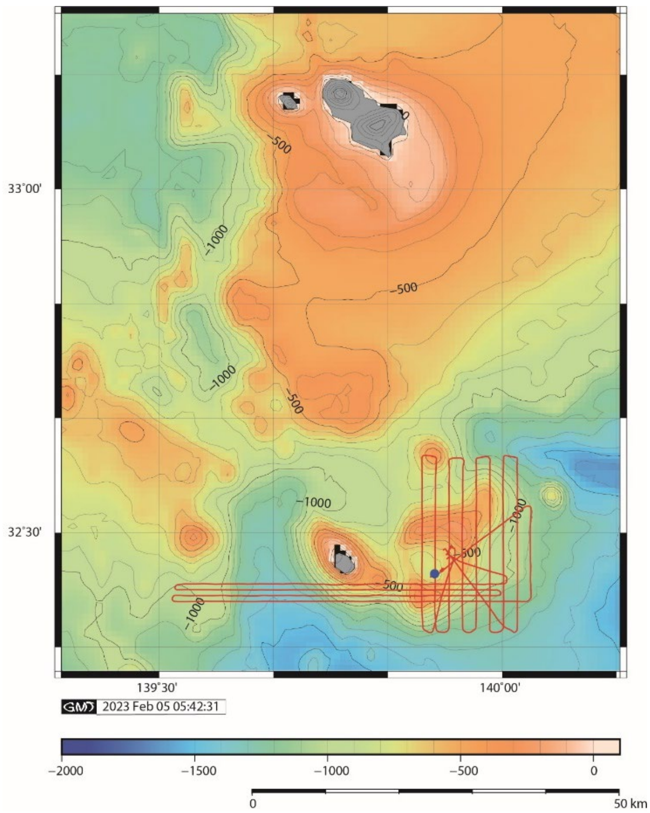


Fig. 3 Ship track of cesium magnet meter survey and water column reflectivity observation. Red line indicates Cesium Magnet Meter track, Blue point indicate Water column observation area.

4-2. Instruments for AUV and ROV dives

4-2-1. Marine DC resistivity system with vertical electrode array

The specific feature of this Marine DC resistivity system is that vertical electrode array is lowered from a ROV or a Towed body for observation (Kasaya et al., 2021; 2022). The sub towed body which is equipped with an HD camera, underwater light, altimeter, and CTD sensor is loaded at the bottom of the vertical electrode array. Therefore, the seafloor images can be also obtained (Fig. 2). In this cruise, an electrode array length is 22 m with 16 potential electrodes. The sub towed body and electrode array of the DC resistivity system was loaded on the payload space of the front of the ROV (Fig. 4).

Fig. 4 Photo of the front side of ROV with the sub towed body and electrode array cable.

After the ROV landed on the seafloor and the sub towed body is set on the seafloor using manipulators, the electrode array cable is unloaded while mobbing backward gradually. When all array cable was unloaded completely, the ROV ascent until the altitude of the sub towed body is about 5 m, and started to move along the survey line.

4-2-2. CO_2-pH hybrid sensor

The measurement principle for the CO_2 sensor is based on spectrophotometry. The pCO_2 is calculated from the optical absorbance of the pH indicator solution equilibrated with CO_2 in seawater through a gas permeable membrane. On the other hand, we adopt potentiometric analysis using original glass and reference electrodes as a pH sensor because of the most commonly used technique for sea water pH measurements and high-speed response (within 20 seconds). From simultaneously measured data of in situ pCO_2 and pH, we can also calculate dissolved inorganic carbon (DIC) and total alkalinity (TA) as other carbonate species in the ocean. The resolutions of HCS are 1 μatm for pCO_2 and 0.001 pH. In the laboratory experiment, the HCS obtained precisions within 3 μatm and within 0.01 pH, respectively. As one example, concentrations of CO_2 (pCO_2) and sea water pH distribution in KM-ROV dive #204 is shown in Fig. 5.

Related references

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) (2007) Guide to best practices for ocean

CO_2 measurements. PICES Special Publication 3, 191 pp.
Nakano, Y., H. Kimoto, S. Watanabe, K. Harada and Y. W. Watanabe (2006): Simultaneous Vertical Measurements of In situ pH and CO2 in the Sea Using Spectrophotometric Profilers. J. Oceanogra., 62, 71-81.
Yao, W. and R. H. Byrne (2001): Spectrophotometric determination of freshwater pH using bromocresol purple and phenol red, Environ. Sci. Technol., 35, 1197-1201.

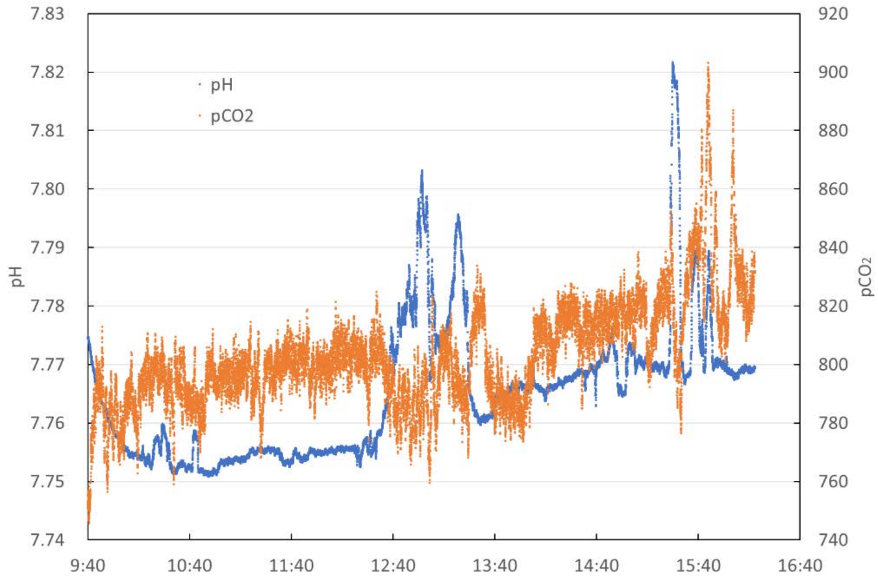


Fig. 5 Distributions of pCO_2 and sea water pH in KM-ROV dive #204 at Higashi-Aogashima Knoll Caldera.

4-3 AUV and ROV Dive logs

Through all dives, we obtained the electrical properties related with the sub-surface structure, and pH and CO_2 of the sea water using various sensing instruments (see previous section in this reports) loaded as payload on each vehicle. Our Marine DC resistivity system with vertical electrode array is especially powerful tool for the hydrothermal deposit survey.

- KM-ROV dive #203

Date: Feb 1st 2023

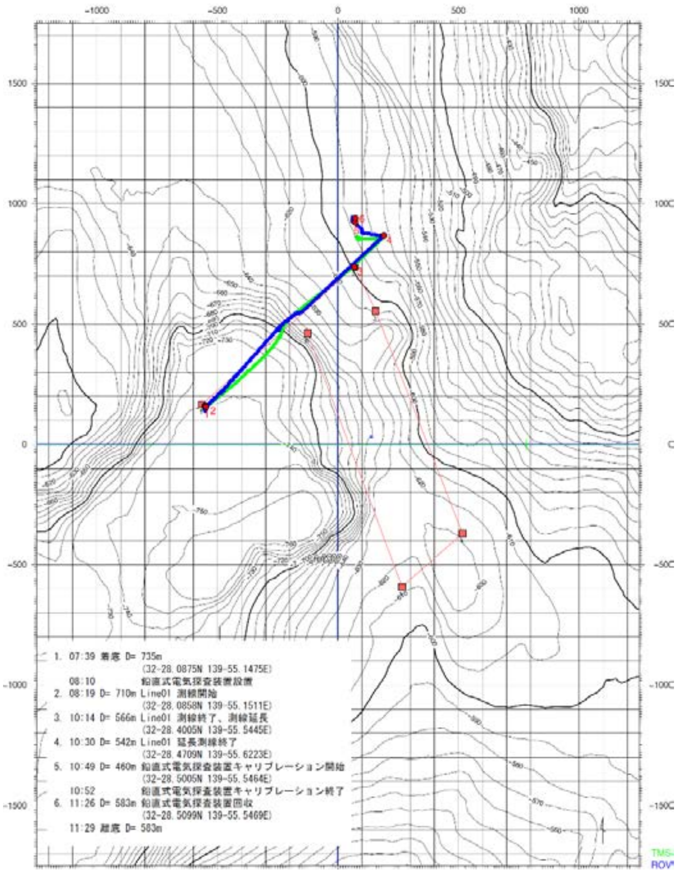
Dive purpose:

- ✓ Resistivity survey
- ✓ Self-potential survey
- ✓ CO_2 and pH data acquisition

Payloads:

- ✓ Marine DC resistivity system with vertical electrode array
- ✓ CO_2-pH hybrid sensor

ROV (blue) and TMS (green) track of this operation:



- AUV JINBEI dive #79

Date: Feb 3th 2023

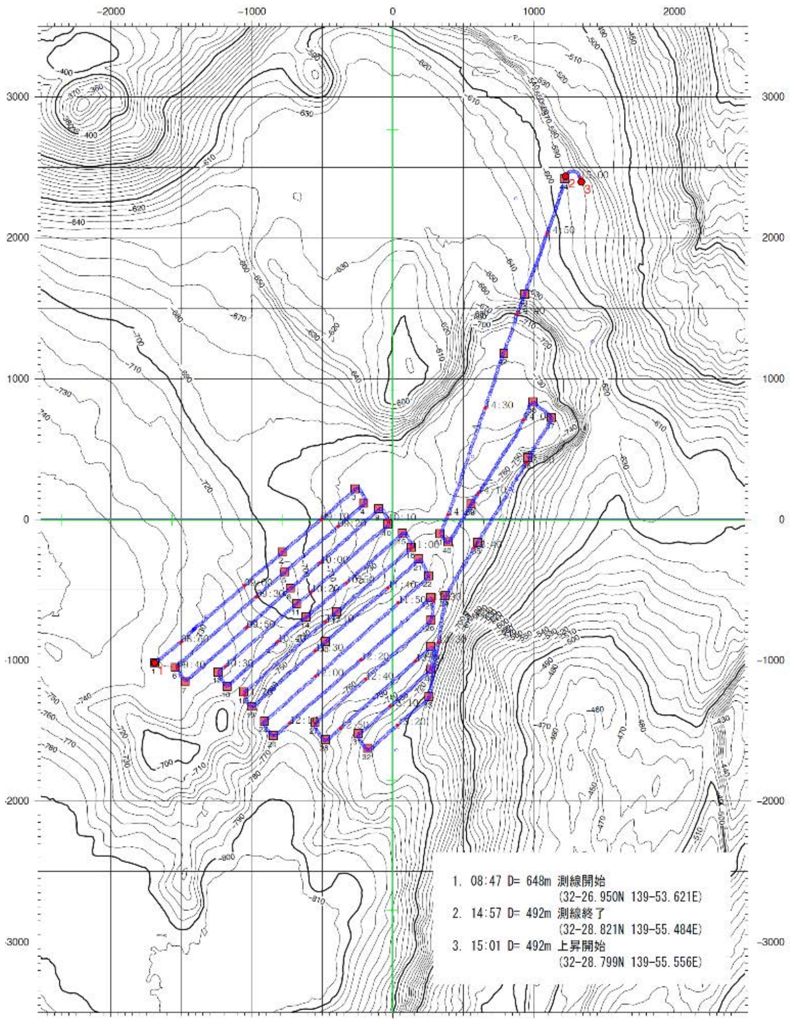
Dive purpose:

- ✓ Detailed bathymetric data acquisition
- ✓ Self-potential survey
- ✓ CO_2 and pH data acquisition

Payloads:

- ✓ Voltage meter with potential electrode array
- ✓ CO_2-pH hybrid sensor

AUV track of this operation:



- KM-ROV dive #204

Date: Feb 4th 2023

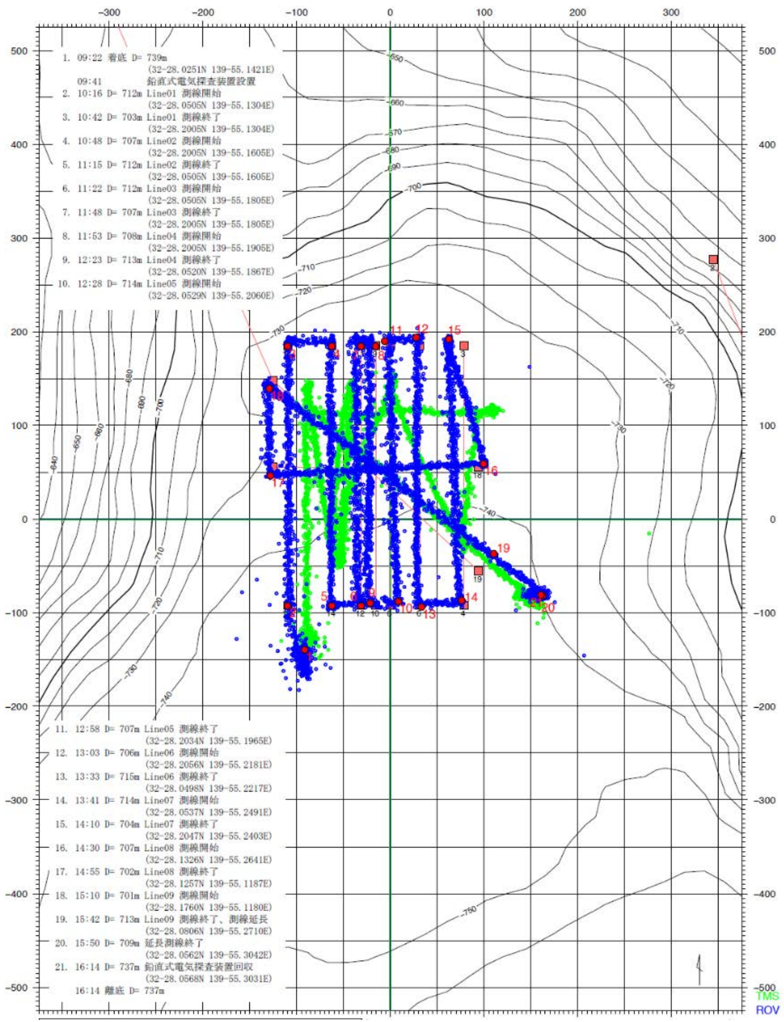
Dive purpose:

- ✓ Resistivity survey
- ✓ Self-potential survey
- ✓ CO_2 and pH data acquisition

Payloads:

- ✓ Marine DC resistivity system with vertical electrode array
- ✓ CO_2-pH hybrid sensor

ROV (blue) and TMS (green) track of this operation:



- KM-ROV dive #205

Date: Feb 5th 2023

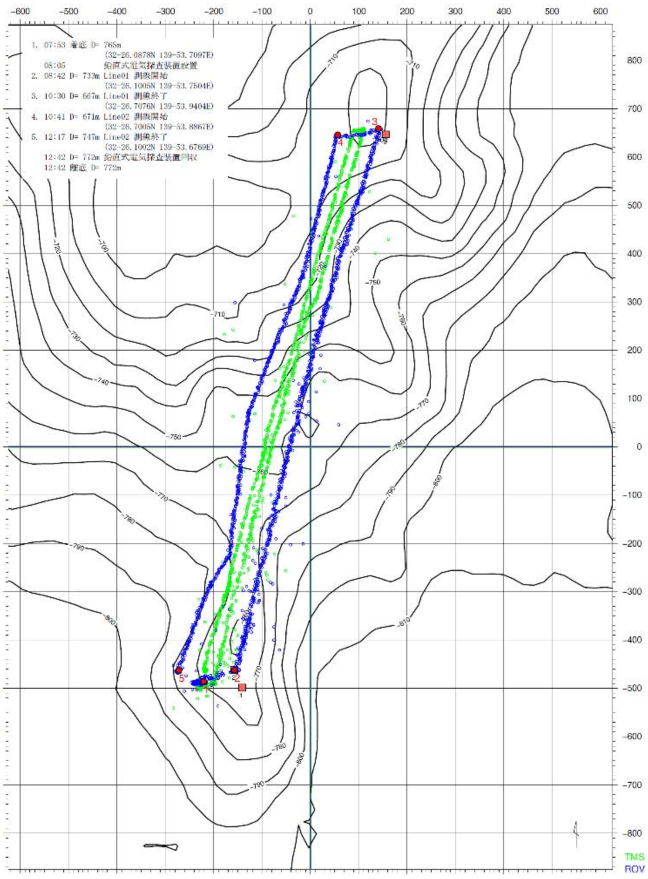
Dive purpose:

- ✓ Resistivity survey
- ✓ Self-potential survey
- ✓ CO_2 and pH data acquisition

Payloads:

- ✓ Marine DC resistivity system with vertical electrode array
- ✓ CO_2-pH hybrid sensor

ROV (blue) and TMS (green) track of this operation:



5. Acknowledgements

I am deeply thanking for the captain and all ship crews of R/V Kaimei. We are grateful to the AUV JINBEI and KM-ROV operation teams 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

The specification of a ship borne gravity meter (MGS 6, Micro-g Lacoste Co., Ltd.) , a ship borne 3 axis magnet meter (Type SFG-2015, Tierra Technica Inc.), cesium magnet meter (G882 Geometrics Co., Ltd.) and Multi-narrow beam echo sounder (EM712, Kongsberg Maritime, Inc.) are listed below.

<u>The specifications of Gravity meter</u>

Measurement range (m Gal)	±500,000
Drift	3mGal per month or less
<u>Stabilized platform</u>	
Platform pitch (deg.)	±25
Platform roll (deg.)	±35
<u>Control system</u>	
Recording rate (Hz)	1
Serial out put	RS-232
<u>System performance</u>	
Resolution (mGal)	0.0001
Static repeatability (mGal)	0.02
Dimension (cm)	61.4×55.5×72.0
Weight (kg)	101

<u>The specifications of Three Axis Magnet Meter</u>

System	ring core fluxgate
Number of component directly	3 axes
Cable length (m)	50
Measurement range (nT)	±100,000
Resolution (nT)	0.01

<u>The specifications of Cesium Magnet Meter</u>

Measurement range (nT)	20,000 ~ 100,000
Resolution (nT)	0.01
Sampling rate (Hz)	1
Weight (kg)	18(in the air), 13(in the sea)

<u>The specifications of EM722</u>

Measurement depth (m)	3 ~ 3,200
Measurement frequency (kHz)	40～100
Measurement method	cross fan beam style
Pulse lengths (msec)	0.2～2.0 CW
	～120 FM
Beam width (deg.)	0.5
Beam interval (deg.)	0.5
Swath width (deg.)	140 (Max)
Roll (deg.)	±15
Pitch (deg.)	±10
Yaw (deg.)	±10