

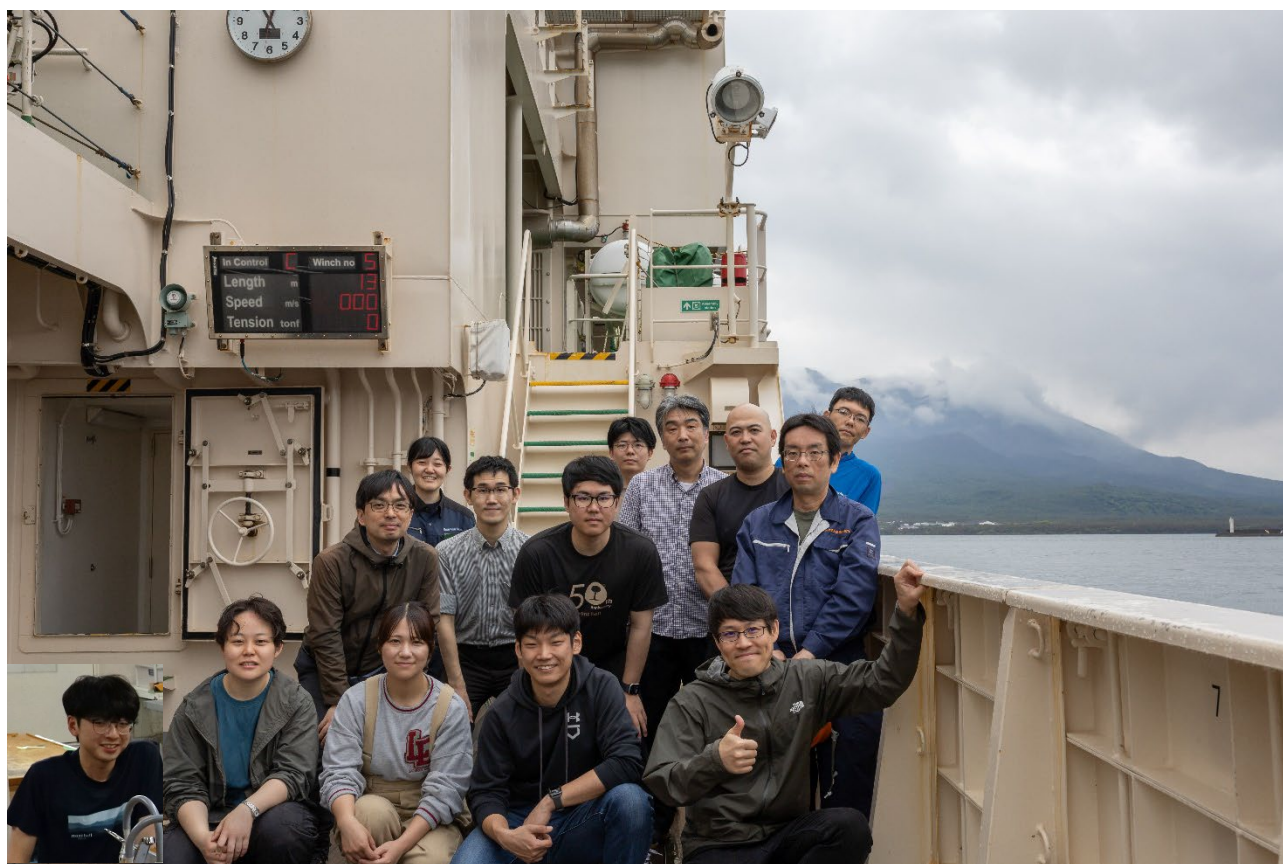
KS-25-2 R/V Shinsei-maru

Cruise Report

Seismic turbidite studies to reveal the northern Ryukyu

Trench and Kikai Island uplift events

琉球海溝北部および喜界島隆起イベントの成因解明に
向けた地震性タービダイト研究



April 13, 2025 (Kagoshima) – April 20, 2025 (Kagoshima)

Acknowledgements

We are grateful to Captain T. Aoki and the crew of R/V Shinsei-maru for their professional work to make the cruise successful. We also thank the staff of the Center for Cruise Coordination at the Atmosphere and Ocean Research Institute (AORI), the University of Tokyo and members of Institute for Marine-Earth Exploration and Engineering (MarE3), Japan Agency for Marine-Earth Science and Technology (JAMSTEC).

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1. Cruise Summary

1.1. Cruise Information

Cruise ID: KS-25-2

Ship: R/V Shinsei-maru

Period: 13 April 2025 (Kagoshima) – 20 April 2025 (Kagoshima)

Area: Off Amami

Theme: Seismic turbidite studies to reveal the northern Ryukyu Trench and Kikai Island uplift events

Chief scientist: NAKANISHI Ryo (AIST)

1.2. Background and Objectives

The Ryukyu Trench is a subduction zone where M7-8 earthquakes have occurred and caused great damage. Kikai Island has been a site of terrace formation for a short period of time (four times in the past 6,000 years), and its relationship to seismic activity has been discussed for many years. In order to elucidate the prehistoric seismic history in island regions such as the Nansei Islands, it is necessary to examine the “turbidite”, which is a geological record derived from earthquakes, from marine cores. The purpose of this study is to understand the formation mechanism of turbidites by seismic motion in order to understand the paleoearthquakes that occurred around Amami Oshima Island.

1.3. Summary of Operations

KS-25-2 cruise started from Kagoshima on 13 April 2025. Multibeam bathymetry data were collected throughout the entire schedule and the sub-bottom profiles (SBPs) were done along the selected lines. The sea condition was good during the SBP and coring works, and we conducted 4 piston coring, 7 multiple coring and compact CTD measuring. The cruise ended successfully at Kagoshima on 20 April 2025. The daily schedules of these operations are summarized in Table 1.1. Sampling sites were planned in the forearc slope basin off Amami Island. Figures 1.1 and 1.2 show all track lines and stations. The location of each station is listed in Table 1.2.

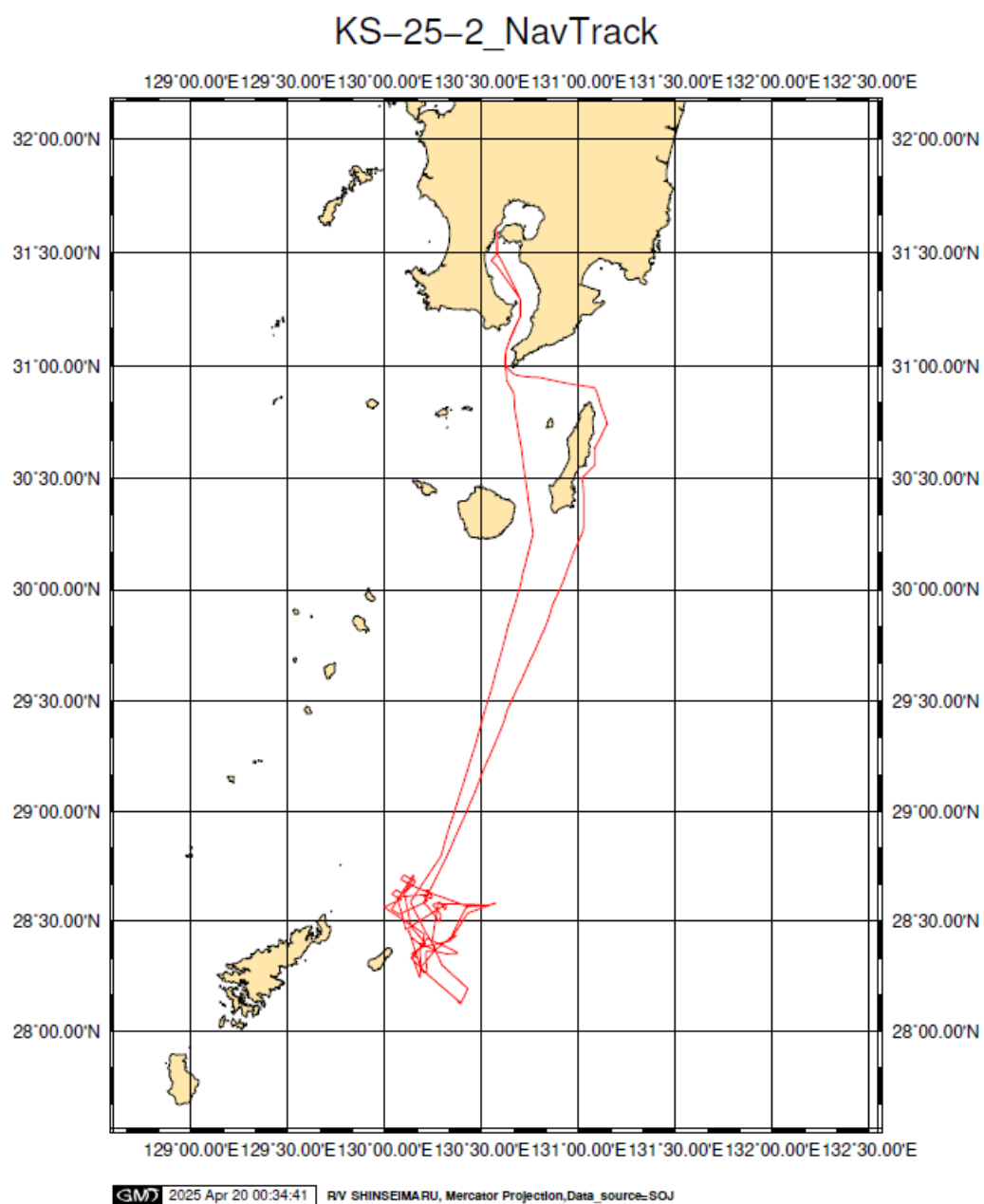


Fig. 1.1 Summary of the cruise track.

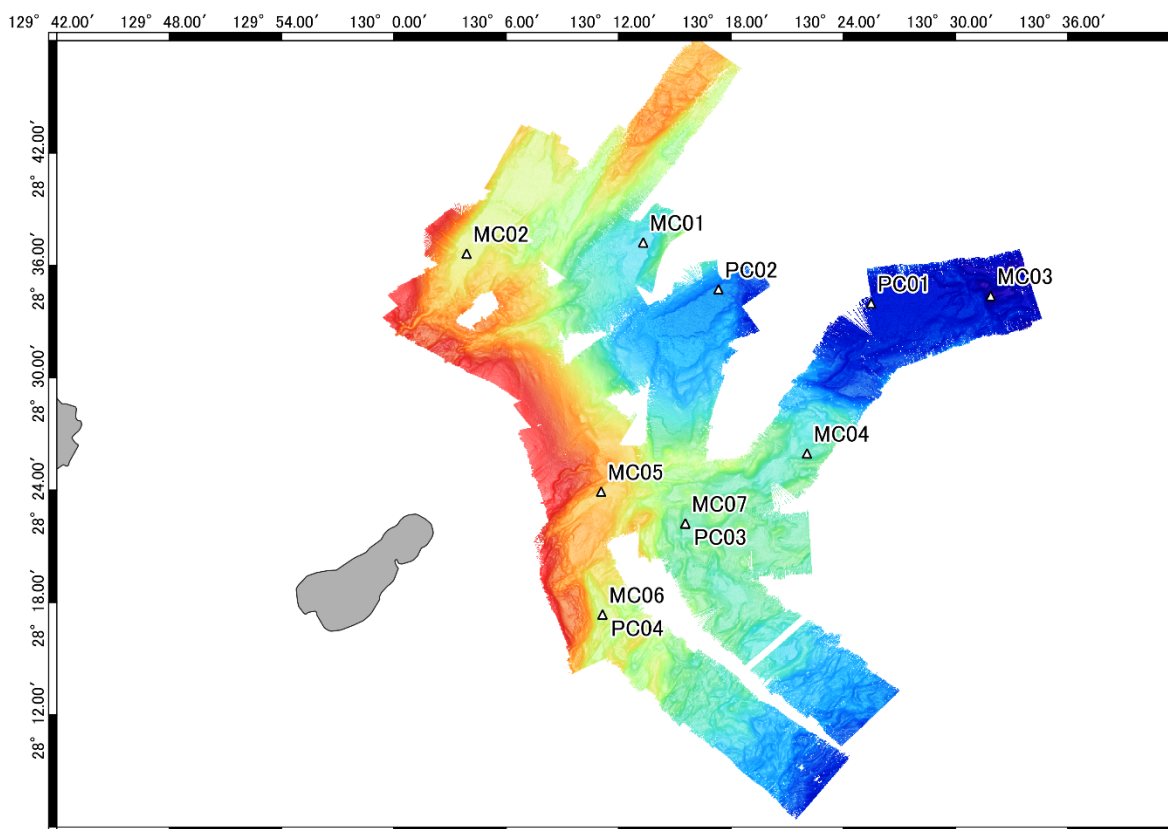


Fig. 1.2 Survey lines and coring sites.

Table 1.1 Work Schedule of KS-25-2. Date/time is JST (+9)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
13-Apr																								
14-Apr																								
15-Apr																								
16-Apr														MC01		MC02								
17-Apr										PC01	MC03	PC02	MC04											
18-Apr										MC05		PC03		MC06										
19-Apr										PC04	MC07													
20-Apr																								
		Transit			Coring				Acoustic survey															

Table 1.2. Station List

Site	Day and time of touch bottom (UTC)		Latitude			Longitude			Core number	Water Depth (m)	Movie	CTD
	Day	Time	deg	min	N/S	deg	min	E/W				
KE-7	Apr. 16, 2025	5:02:05	28	37.2219	N	130	13.3204	E	MC01	1891	✓	✓
KE-13	Apr. 16, 2025	7:47:40	28	36.6255	N	130	3.8887	E	MC02	1266	✓	
KE-1	Apr. 17, 2025	0:39:46	28	33.9721	N	130	25.496	E	PC01	2637		
KE-15	Apr. 17, 2025	3:25:32	28	34.3674	N	130	31.8822	E	MC03	2753	✓	
KE-3	Apr. 17, 2025	7:03:01	28	34.7191	N	130	17.3412	E	PC02	2261		
KE-9	Apr. 17, 2025	1:10:47	28	25.9537	N	130	22.0686	E	MC04	1727	✓	✓
KE-4	Apr. 18, 2025	3:35:47	28	22.2216	N	130	15.5734	E	PC03	1642		
KE-8	Apr. 18, 2025	5:25:59	28	23.9107	N	130	11.0738	E	MC05	1105	✓	
KE-5	Apr. 18, 2025	7:10:06	28	17.3438	N	130	11.1468	E	MC06	1366	✓	
KE-5	Apr. 19, 2025	23:35:53	28	17.3533	N	130	11.1465	E	PC04	1367		
KE-4	Apr. 19, 2025	1:44:45	28	22.2105	N	130	15.5645	E	MC07	1645	✓	✓

1.4. Contact information

- All data: NAKANISHI Ryo (AIST)

KS-24-4 Onboard Scientist Team

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Zih-Lin Hong 台湾大学海洋研究所 Zih-Lin Hong, Taiwan Univ.

On-shore participants

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Assignment

1. Coring

Kiichiro Kawamura, Goichiro Uramoto, Kazuki Kikuchi, Katsura Kameo, Makoto Takeuchi, Hisashi Ikeda, Chika Onai, Koshiro Kaneko, Ayako Nagasawa, Seiya Fujishima

2. Hydroacoustics

Takumi Nagato, Seiya Fujishima, Zih-Lin Hong

3. Compact CTD

Makoto Takeuchi, Ayako Nagasawa

2. Hydroacoustics

Author: Ryo Nakanishi

The MBES, PDR, and SBP observations were conducted in 8not cruises over basins with mud sampling points. MBES was used for bottom topographic surveys and reflection intensity data, while PDR and SBP were used for shallow sedimentary structures below the seafloor.

2.1. Multibeam Echo Sounder (MBES)

2.1.1. Properties & Acquisition

- Model: SeaBeam 3020 (ELAC SONAR)
- Swath: Auto
- Operation frequency: 20 kHz
- Sounding pattern: Equi-Angle
- Sound velocity profiles were determined by a CTD measurement (KE-7, KE-9 sites: Fig. 2.1).
- Lateral resolution of processed data: 50 m

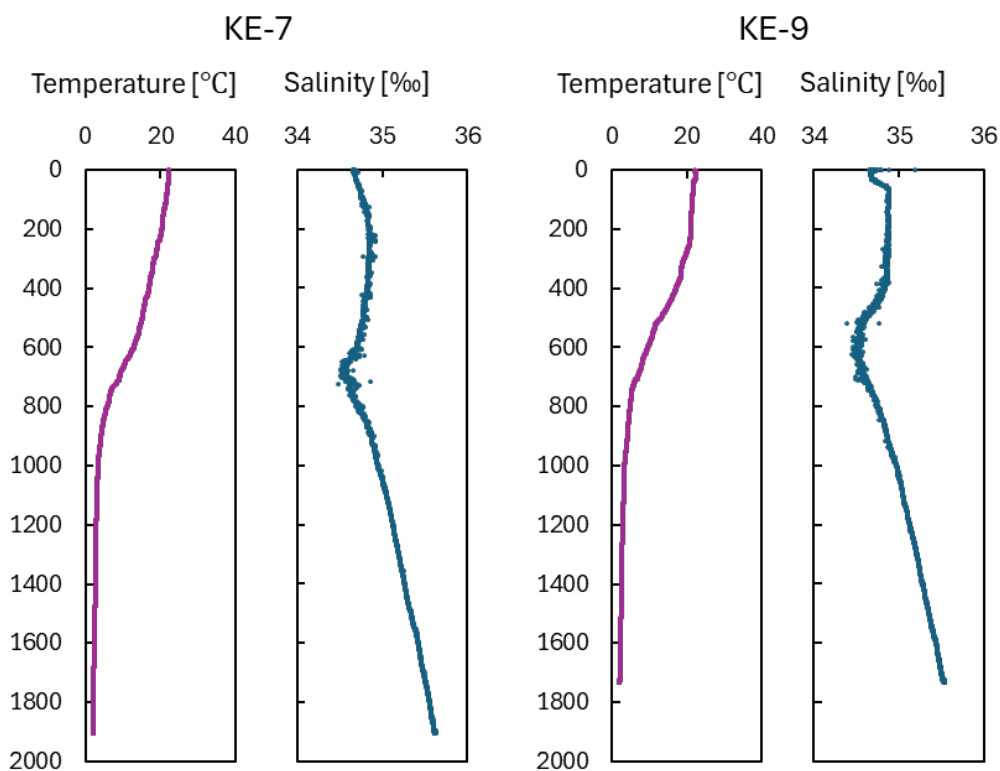


Fig. 2.1 Compact CTD data.

2.1.2. Acquired Data

The MBES survey lines were set up to capture changes in reflection intensity from the slope area to the basins, and to capture topographic changes in areas where earthquakes have occurred frequently over the past year. The pinging and recording of MBES were continuously done within the survey areas and transits from/to Kagoshima port. The data quality was good. Editing and cleaning the raw MBES data were done using the CARIS HIPS and SIPS software available onboard R/V Shinsei-Marui. We also exported the acoustic backscatter data to characterise seafloor conditions. Figures 1.2 shows bathymetry maps in the Amami study areas.

2.2. Sub-bottom profiler (SBP)

2.2.1. Properties & Acquisition

- Frequency: A hull-mounted TOPAS PS 18 uses a primary frequency of 15–21 kHz, and a secondary frequency of 0.5–6.0 kHz. The secondary low frequency is used for subseafloor imaging.
- Transmit: single pulse.
- Ship speed: ~8 knot.
- Ping interval: 4000 ms.
- Pulse: A linearly coded chirp pulse wavelet (LFM), where the frequency changes linearly with time, of frequencies of 2.0–6.0 kHz with a chirp length of 20 ms was used.
- Primary & secondary beam widths: ~4.5 deg & ~5.5 deg.
- Beam offset pitch: 0.0 deg.
- Beam offset roll: 0.0 deg.
- HRP Stabilization (for heave-roll-pitch compensation): YES.
- Delay time: mostly within 1000–3000 ms depending on water depth.
- Sampling rate: 50.0 kHz.
- Trace length: 500 ms.
- Receiver gain: 18.0 dB.
- Auto gain control: OFF.
- Data format: TOPAS.raw format files (TOPAS SW software version 1.9.2) were combined and converted into *.sgy files. Shot point (SP) number, X- and

Y-coordinates, and delay recording time are stored respectively in byte 17–20, 73–76, 77–80, and 109–110 of the SEG-Y header.

- Processing gain: 0 dB.

2.2.2. Acquired Data

We acquired SBP data in the Amami study areas. Most of the SBP lines were selected for the purpose of better characterizing of the basins in the Amami area. After converting RAW format files into SEG-Y files, the data quality check was checked during the cruise using CWP/SU. The survey lines were set up to make several cross cuts over three basins and to pass through unexplored mud sampling points.

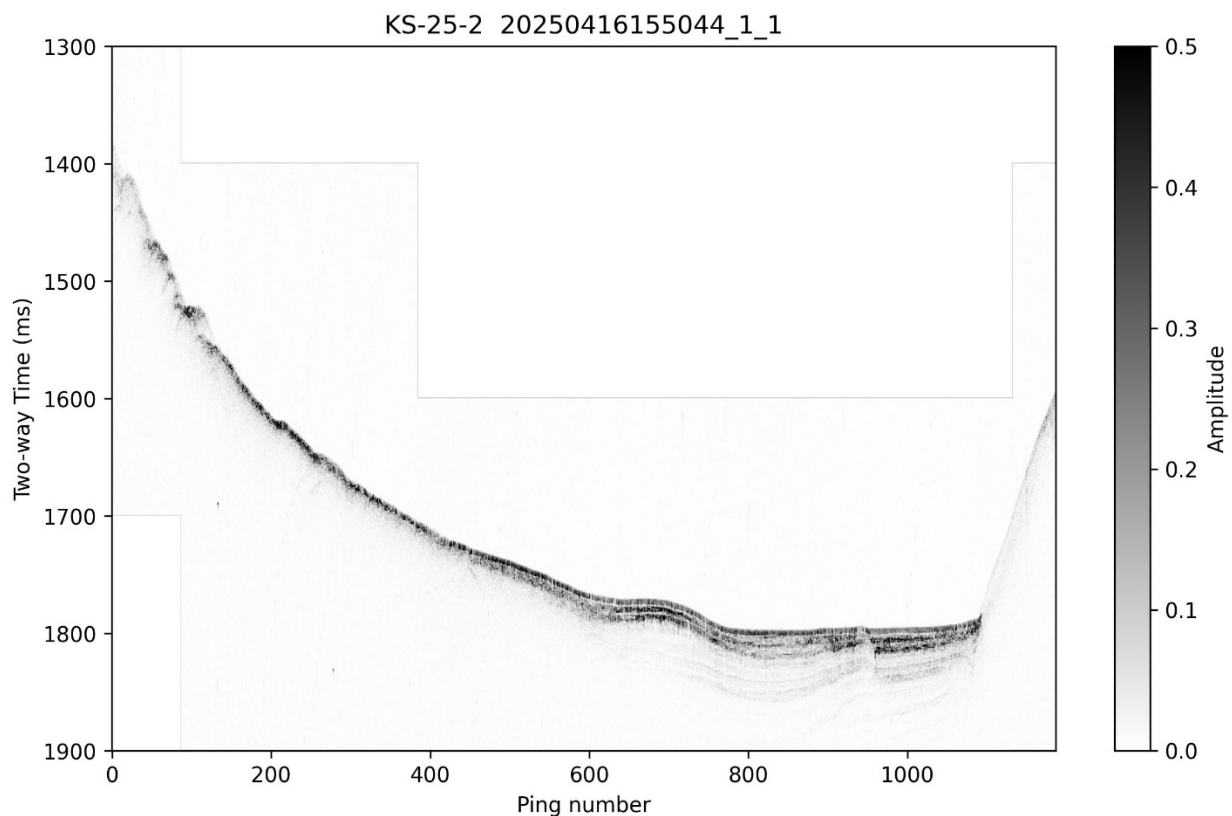


Fig. 2.2 Example of a SBP profile.

2.3. Precision depth recorder (PDR)

2.3.1. Properties & Acquisition

- Frequency: Kongsberg EA600 uses a primary frequency of 12 kHz.
- Transmit level: 2000W.
- Ship speed: ~8 knot.
- Ping interval: 10000 ms.
- Pulse length: 16 ms.
- Beam widths: 16/60 degrees.
- Receiver gain: -60.0 dB.
- TVG: 20 log TVG.
- Data format: **.raw .out .idx** format files

2.3.2. Acquired Data

PDR data were obtained for all survey lines. The frequencies between SBP and MBES have been successfully used for imaging at depths of several tens of meters below the seafloor. It is expected to be used for estimation of bottom sediments from the reflection waveform and intensity near the very surface.

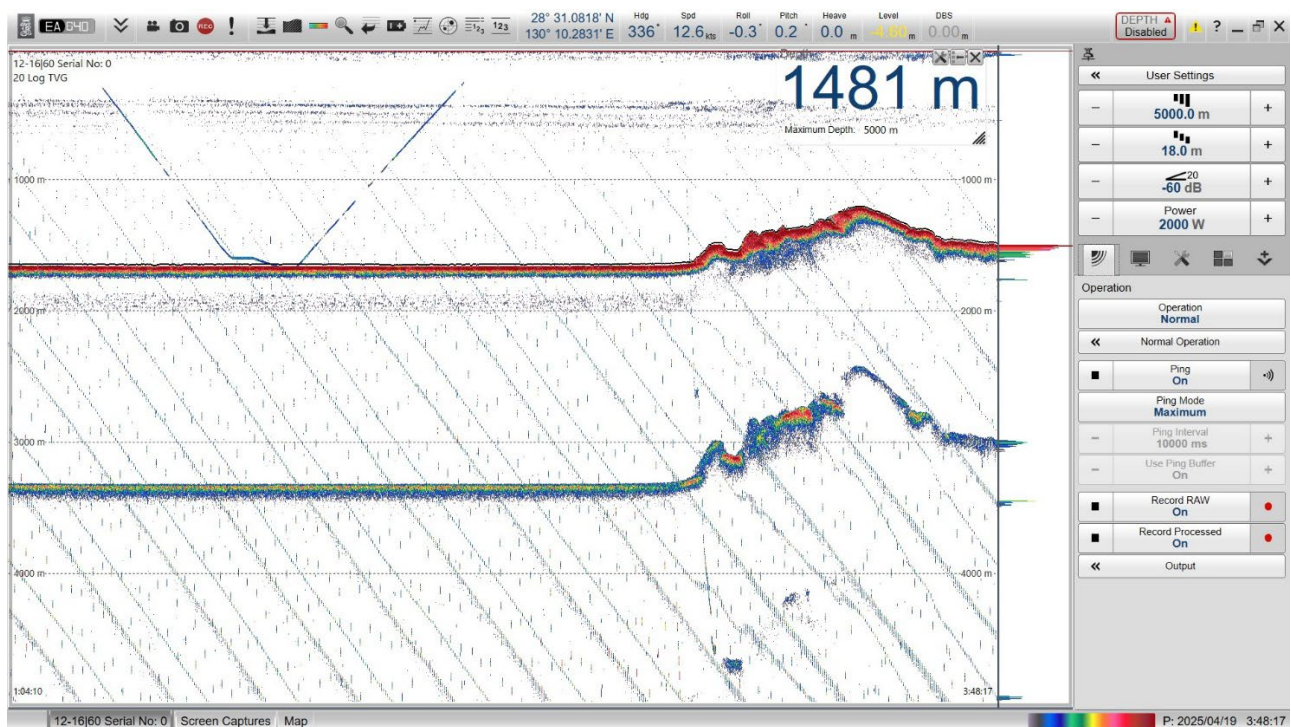


Fig. 2.3 Chapter image of a PDR profile.

3. Sediment core sampling

Author: Seiya Fujishima, Ryo Nakanishi

3.1 Piston Coring

3.1.1 Method

On this cruise, sediment sampling was conducted using a 6 m piston corer.

The piston corer consisted of a 500 kg weight, a stainless steel outer pipe, a polyvinyl chloride inner pipe, and a piston with 10 m of main wire attached to it. A 10 m pilot wire and an “Ashura” corer with three 1 m pipes with a bit without trigger arms (~120 kg).

The winch wire was continuously veered out at 1 m/s, and the wire stopped at 100 m above the seafloor for 3 minutes and then the wire veered out at 0.3 m/s. After landing on the seafloor, the wire was immediately unloaded at 0.3 m/s. When the length of the wire became shorter than the water depth, the wire was rolled up at 1.0 m/s.

3.2 Multiple coring

The multiple corer was equipped with a 600 kg weight, four 0.6 m pipes, and four 1 m pipes. After the multiple corer was deployed, the winch wire was started at 1.0 m/s. At 50 m above the seafloor, the wire was stopped for 3 minute. After that, the wire was unreeled at 0.3 m/s. After reaching the sea floor, winch wire was further unreeled 6 m. After that, ~30 s of unreeling was stopped, and the wire was started to wind up at 0.3 m/s. When the wire length became shorter than the water depth, the winding speed was switched to 1.0 m/s.

3.3 Coring sites and Description

We collected sediment sample using piston corer at KE-1, KE-3, KE-4 and KE-5 and using multiple corer at KE-4, KE-5, KE-7, KE-13 and KE-15 (Table 1.2, Figure 3.1). KE-8 was a hard substrate covered with sandy sediments, so no sediments were obtained. The piston core was not split in half during the research cruise. At site KE-4, the Ashlar pilot core corer was lifted with the

top lid not closed, so no sediment was obtained. After lifting, a lifting test was conducted and the trap was confirmed to be operational.

Observation point KE-7

Multiple corer sampling was conducted in a relatively shallow water basin located in the northeastern part of Kikai Island. Memory-type CT and TD devices were installed to compensate for the sound velocity of the acoustic survey. The core sample (MC01) was less than 30 cm in length and consisted of sandy sediment. Ripples indicating multiple flow directions were observed by the deep-sea camera.

Observation point KE-13

Multiple corer sampling was conducted in a submarine basin connected to a submarine channel located in the northern part of Kikai Island. The core sample (MC02) was about 30 cm in length and was basically silty sediment. No significant sand layers were observed.

Observation point KE-1

Piston corer (6 m) mud sampling was conducted in a basin located in the northeastern part of Kikai Island, using an ashlar corer as a pilot. PC01 was 4.76 cm long and was transported to the Kochi Core Center as a hole. The pilot core yielded about 30 cm of surface sediment as AS01, which was basically muddy sediment.

Observation point KE-15

Located in the eastern part of Kikai Island, multiple corer sampling was conducted in the deepest basin in this survey. The core sample (MC03) was about 70 cm in length and was basically muddy sediment. No significant sand layers were observed.

Observation point KE-3

Piston corer (6 m) mud sampling was conducted in a basin located in the eastern part of Kikai Island, using an ashlar corer as a pilot. 3.29 cm of PC02

was collected and transported to the Kochi Core Center as a hole. The pilot core yielded about 45 cm of surface sediment as AS02, which was essentially muddy sediment. One sand layer was identified at the bottom level.

Observation point KE-9

Multiple corer sampling was conducted in a fore-arc slope concave terrain located in the eastern part of Kikai Island. Memory-type CT and TD devices were installed to compensate for the sound velocity of the acoustic survey. The core sample (MC04) measured approximately 70 cm and was essentially muddy sediment. No significant sand layers were observed.

Observation point KE-4

Piston corer (6 m) mud sampling using an ashlar corer as a pilot corer was conducted on a fore-arc slope concave topography located in the eastern part of Kikai Island. PC03 was 4.25 cm in length and was transported to Kochi Core Center as a hole. The pilot core ashlar corer was lifted with the top lid not closed, so no sediment was obtained. After lifting, a lifting test was conducted, and the trap was confirmed to work.

The next day, multiple corer sampling was conducted at the same location. Memory-type CT and TD devices were installed to compensate for the sound velocity of the acoustic survey. The core sample (MC07) was approximately 65 cm in length and was basically silty sediment, but one distinct sand layer was identified.

Observation point KE-8

Multiple corer sampling was conducted in an elongated basin located in the eastern part of Kikai Island. This site is located downstream of the sand surface collapse topography and is the shallowest water depth in this study. No sediment was recovered in all cores. Sandy sediments were observed by the deep-sea camera.

Observation point KE-5

Multiple corer sampling was conducted in a fore-arc slope concave topography located in the eastern part of Kikai Island. The core sample (MC06) was less than 70 cm in length and basically consisted of muddy sediment, but a sand layer was observed at the lowest level.

The next day, a piston corer (6 m) using an ashlar corer as a pilot corer was collected at the same location. 3.45 cm of PC04 was collected and transported as a hole to the Kochi Core Center. The pilot core yielded about 60 cm of surface sediment as AS04, which was essentially sandy silt sediment.

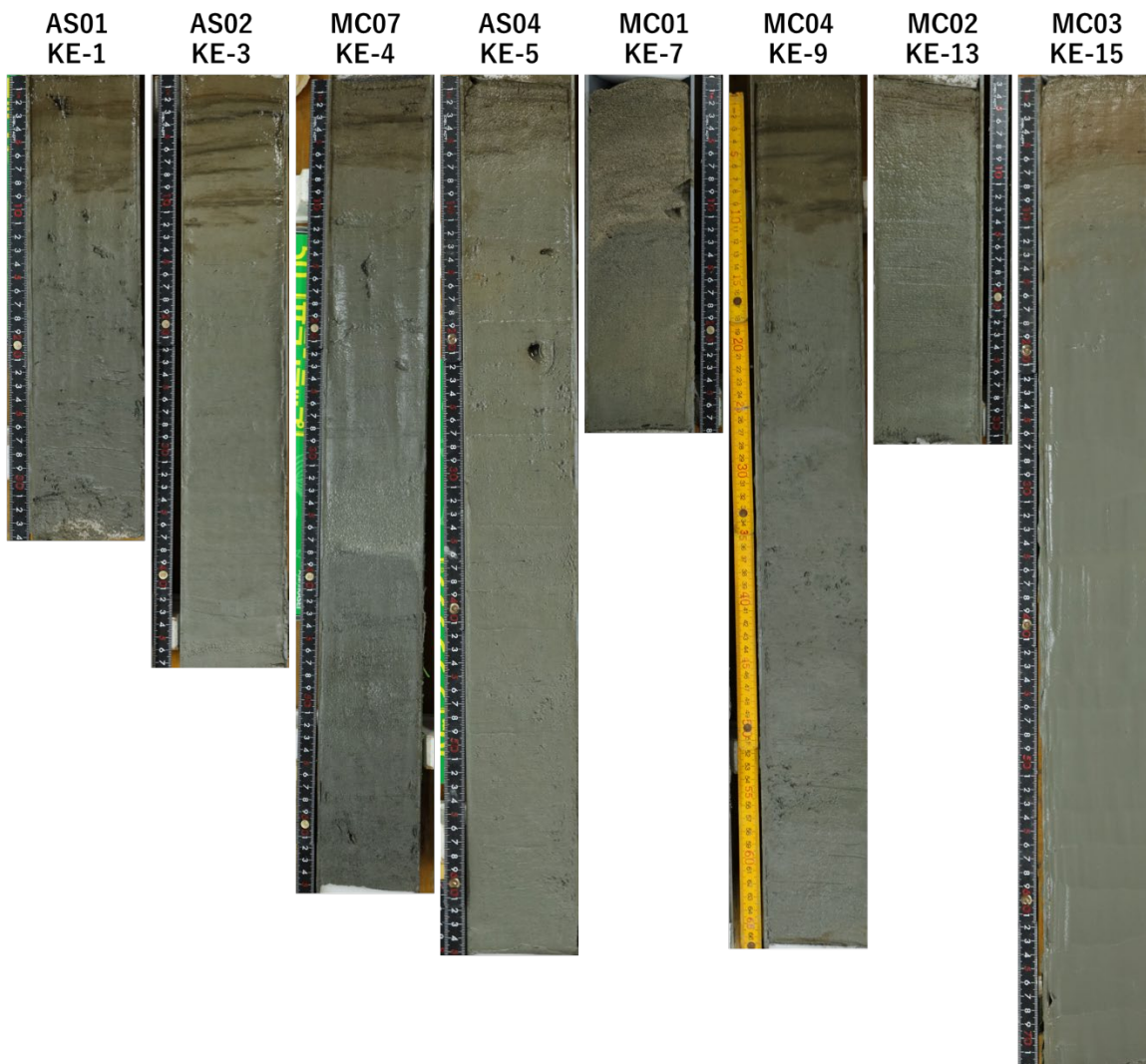


Fig. 3.1 Multiple and pilot core sample photos on board.

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 Cooperative Research Cruise office.

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新青丸共同利用研究航海報告書

- * 航海番号 KS-25-2 次研究航海
- * 航海名称 琉球海溝北部および喜界島隆起イベントの成因解明に向けた地震性タービダイト研究
Seismic turbidite studies to reveal the northern Ryukyu Trench and Kikai Island uplift events
- * 観測海域 奄美大島周辺海域
Off Amami Island
- * 航海期間 令和7年4月13日(日)～令和7年4月20日(日)
- * 出港日時・場所 4月13日 14時 鹿児島港
- * 入港日時・場所 4月20日 10時 鹿児島港
- * 寄港期間・場所 なし
- * 研究課題 琉球海溝北部および喜界島隆起イベントの成因解明に向けた地震性タービダイト研究
- * 主席研究員(氏名・所属・職名)
中西諒・産業技術総合研究所・研究員
- * 研究内容, 主調査者, 観測項目
 1. 採泥による堆積物観察・サンプリング, 中西諒, ピストンコア・マルチプルコア
 2. 物理探査, 中西諒, マルチビーム音響測深機・サブボトムプロファイラによる海底探査
- * 乗船研究者氏名・所属・職名
 - 中西 諒・産業技術総合研究所・研究員
 - 川村 喜一郎・山口大学・研究教授
 - 浦本 豪一郎・高知大学・講師
 - 菊地 一輝・中央大学・助教
 - 亀尾 桂・東京大学大気海洋研究所・技術専門職員
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 - 池田 尚史・山口大学・大学院生
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 - 金子 幸司朗・高知大学・大学院生
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 - 長門 巧・京都大学・大学院生
 - 藤島 誠也・京都大学・大学院生
 - Zih-Lin Hong・台湾大学・大学院生

* 航跡・測点図

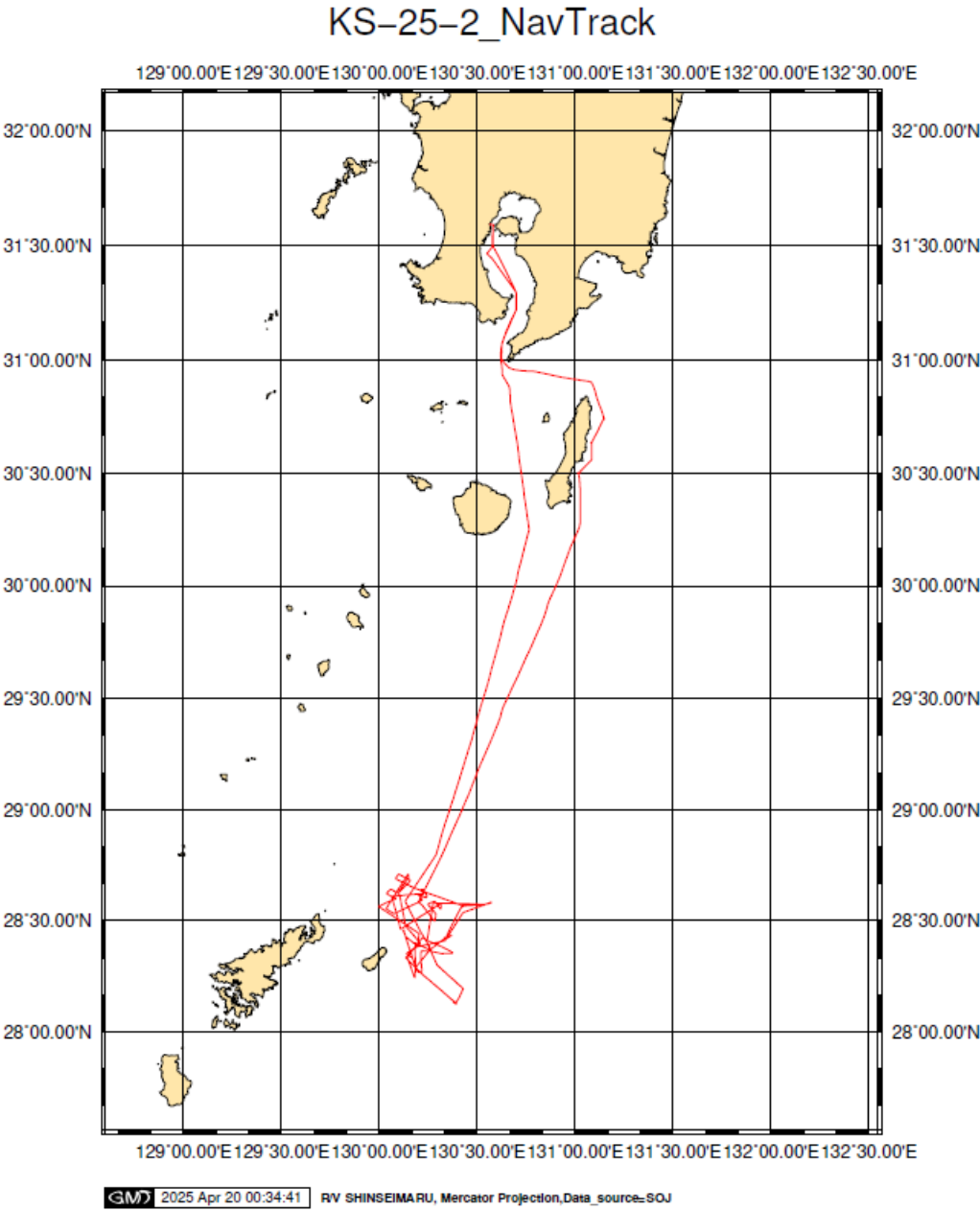


図 1 航跡図

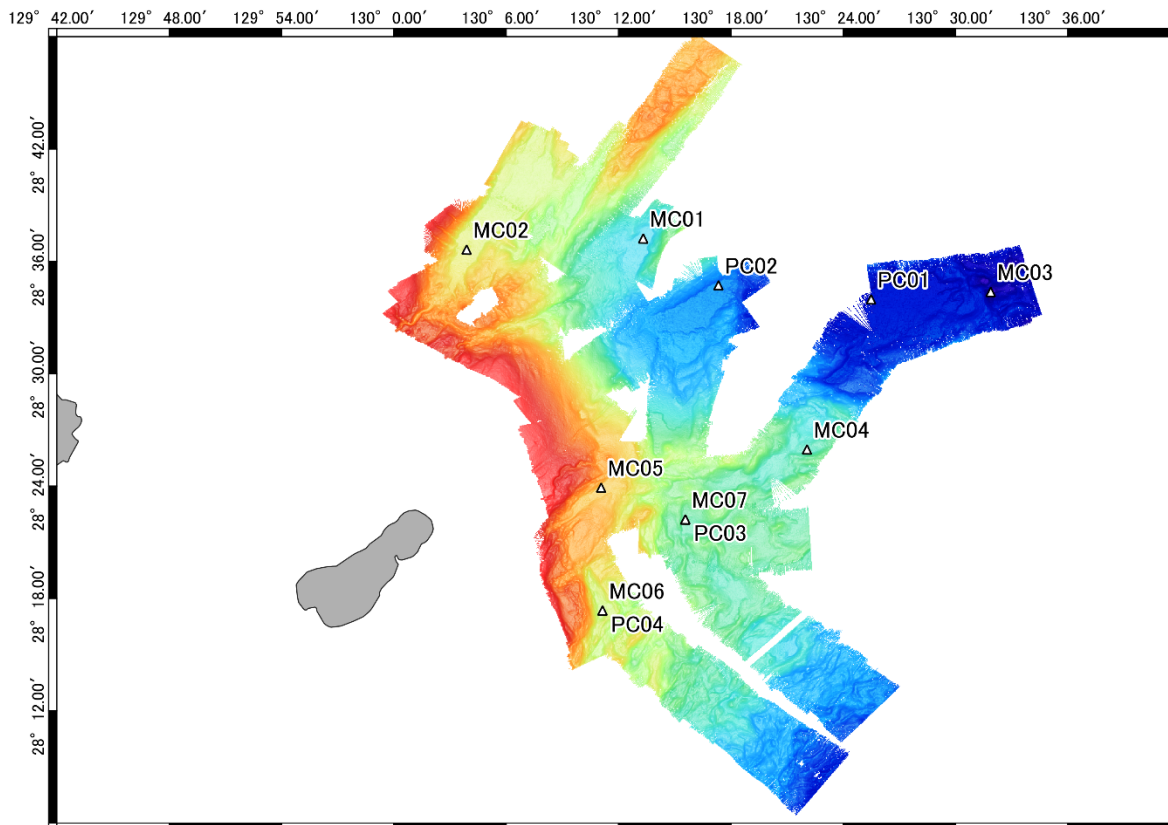


図2 採泥点

●調査研究の概要

本調査は奄美大島周辺で発生した古地震を理解するために、地震動によるタービダイトの形成メカニズムの理解を進めること目的としている。本航海では、観測地震によるタービダイト形成過程を基に、喜界島段丘形成期間におけるタービダイト層から地震履歴を解明するため、採泥及び音響探査を行った。古地震によるタービダイトの分布を明らかにするため、4サイトでピストンコア試料を取得した。また、マルチプルコアラーやアシュラコアラーを用いて11サイトで表層堆積物を採取し、観測地震によるとタービダイト分布の調査を行った。斜面崩壊を起こす震度閾値や斜面堆積物の海底条件を明らかにするため、表層堆積物試料や音響探査から砂層の分布・物性情報を取得した。

●実施内容

- (1) マルチビーム音響測深機による海底地形調査
- (2) ピストンコアラーによる堆積物採取
- (3) マルチプルコアラー（カメラ付き）による表層堆積物採取、メモリ式 CTD 観測
- (4) サブボトムプロファイラーおよび精密音響測深機による海底表層構造調査

●観測内容

観測については以下の表の通り実施された。主に喜界島から北東に位置する7つの海盆を観測対象とした。西から東にかけて水深が大きくなる。ピストンコアラーは6m長で、パイロットコアラーとして100cm採泥管を装着したアシュラコアラーを用いた。マルチプルコアラーはアーム付き60cm採泥管が4本、フラップ付き100cm採泥管が4本仕掛けた。マルチプルコアラーには深海カメラ×1および水深2000m以深では小型CT・Dセンサー各1機を取り付けた。

マルチビーム音響測深機（MBES）、精密音響測深機（PDR）、サブボトムプロファイラー（SBP）の観測は、泥のサンプリングポイントがある海盆や供給源となる斜面域で実施した。MBESの調査ラインは、斜面域から盆地にかけての反射強度の変化や、過去1年間に地震が頻発した地域の地形変化を捉えるために設定された。SBPおよびPDRの測線は、盆地の浅部堆積断面を取得する目的で選択された。特に3つの海盆では数本の縦・横断し、堆積物の面的な広がり把握を行った。

表 1 採泥位置情報および観測項目

Site	Day and time of touch bottom (UTC)		Latitude			Longitude			Core number	Water Depth (m)	Movie	CTD
	Day	Time	deg	min	N/S	deg	min	E/W				
KE-7	Apr. 16, 2025	5:02:05	28	37.2219	N	130	13.3204	E	MC01	1891	✓	✓
KE-13	Apr. 16, 2025	7:47:40	28	36.6255	N	130	3.8887	E	MC02	1266	✓	
KE-1	Apr. 17, 2025	0:39:46	28	33.9721	N	130	25.496	E	PC01	2637		
KE-15	Apr. 17, 2025	3:25:32	28	34.3674	N	130	31.8822	E	MC03	2753	✓	
KE-3	Apr. 17, 2025	7:03:01	28	34.7191	N	130	17.3412	E	PC02	2261		
KE-9	Apr. 17, 2025	1:10:47	28	25.9537	N	130	22.0686	E	MC04	1727	✓	✓
KE-4	Apr. 18, 2025	3:35:47	28	22.2216	N	130	15.5734	E	PC03	1642		
KE-8	Apr. 18, 2025	5:25:59	28	23.9107	N	130	11.0738	E	MC05	1105	✓	
KE-5	Apr. 18, 2025	7:10:06	28	17.3438	N	130	11.1468	E	MC06	1366	✓	
KE-5	Apr. 19, 2025	23:35:53	28	17.3533	N	130	11.1465	E	PC04	1367		
KE-4	Apr. 19, 2025	1:44:45	28	22.2105	N	130	15.5645	E	MC07	1645	✓	✓

●観測結果

①採泥結果

観測点 KE-7

喜界島北東部に位置する比較的水深の浅い海盆においてマルチプルコアラ採泥を行った。音響探査の音速補正を目的としたメモリ式 CT, TD 装置を取り付けた。コア試料 (MC01) は 30cm 弱で、砂質堆積物であった。深海カメラでは複数の流向を示すリップルが観察された。

観測点 KE-13

喜界島北部に位置する海底チャネルとつながる海盆においてマルチプルコアラ採泥を行った。コア試料 (MC02) は 30cm 程度で、基本的にシルト質の堆積物であった。目立った砂層は見られなかった。

観測点 KE-1

喜界島北東部に位置する海盆においてアシュラコアラをパイロットとしたピストンコアラ (6m) 採泥を行った。PC01 の採取長は 4.76cm でホールのまま高知コアセンターに輸送された。パイロットコアは AS01 として 30cm 程度の表層堆積物が得られ、基本的に泥質の堆積物であった。

観測点 KE-15

喜界島東部に位置し、本調査において最も深い水深の海盆にてマルチプルコアラ採泥を行った。コア試料 (MC03) は約 70cm で、基本的に泥質の堆積物であった。目立った砂層は見られなかった。

観測点 KE-3

喜界島東部に位置する海盆においてアシュラコアラをパイロットとしたピストンコアラ (6m) 採泥を行った。PC02 の採取長は 3.29cm でホールのまま高知コアセンターに輸送された。パイロットコアは AS02 として 45cm 程度の表層堆積物が得られ、基本的に泥質の堆積物であった。最下位に 1 枚の砂層が確認された。

観測点 KE-9

喜界島東部に位置する前弧斜面凹地形にてマルチプルコアラ採泥を行った。音響探査の音速補正を目的としたメモリ式 CT, TD 装置を取り付けた。コア試料 (MC04) は約 70cm で、基本的に泥質の堆積物であった。目立った砂層は見られなかった。

観測点 KE-4

喜界島東部に位置する前弧斜面凹地形においてアシュラコアラをパイロットとしたピストンコアラ (6m) 採泥採泥を行った。PC03 の採取長は 4.25cm でホールのまま高知コアセンターに輸送された。パイロ

ットコアのアシラコアラは上蓋が閉まっていない状態で揚収されたため、堆積物は得られなかった。揚収後つり上げ試験をしたところ、仕掛けの作動が確認された。
翌日、同地点においてマルチプルコアラ採泥を行った。音響探査の音速補正を目的としたメモリ式 CT, TD 装置を取り付けた。コア試料 (MC07) は約 65cm で、基本的にシルト質堆積物であったが、明瞭な砂層が 1 層確認された。

観測点 KE-8

喜界島東部に位置する細長い海盆にてマルチプルコアラ採泥を行った。このサイトは砂面崩壊地形の下流に位置しており、本調査において最も浅い水深である。すべてのコアで堆積物が回収されなかった。深海カメラでは砂質堆積物が確認され、着底時の様子では硬質な底質であったとみられる。

観測点 KE-5

喜界島東部に位置する前弧斜面凹地形にてマルチプルコアラ採泥を行った。コア試料 (MC06) は約 70cm 弱で、基本的に泥質堆積物であったが最下位に砂層が見られた。

翌日、同地点においてアシラコアラをパイロットとしたピストンコアラ (6m) 採泥を行った。PC04 の採取長は 3.45cm でホールのまま高知コアセンターに輸送された。パイロットコアは AS04 として 60cm 程度の表層堆積物が得られ、基本的に砂質シルト堆積物であった。

コア試料は船内では冷蔵保存され、常温トラック輸送で高知コアセンターに運ばれた。ピストンコアおよび半裁されたマルチプルコアは高知大学学術コアレポジトリとして高知大学に保管されている。

②音響探査結果

採泥地点を設定した海盆を 8not で航走し、MBES、PDR および SBP 観測を行った。MBES では海底地形探査および反射強度データを取得した。PDR や SBP では海底下の浅部堆積構造を取得した。測線は 3 つの海盆を対象に何度か十字に切るように設定したものと、未探査の採泥点を通るように設定された。MBES では斜面域から海盆にかけて反射強度の変化を捉えるための測線および、過去 1 年間で地震が多発した領域において、地形変化を捉えるための測線を設けた。航走観測は 18 時から翌 6 時に行われ、計 3 日間の観測を行った。