doi : 10.17596/0002931

YOKOSUKA Cruise Report
YK14-09

Geophysical Survey at Nosappu Fracture Zone

Northwest Pacific Ocean

May 28 - June 6, 2014

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

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1. Cruise Information

1-1. Basic Information

- Cruise ID: YK14-09
- Name of vessel: YOKOSUKA
- Title of the cruise: Geophysical Survey at Nosappu Fracture Zone
- Title of proposal: Water circulation in the solid Earth: Role of Fracture Zone
- Cruise period: May 28 - June 6, 2014
- Ports of call: Yokosuka - Hakodate

1-2. Research area

Our research target is the Nosappu Fracture Zone, Northwest Pacific Ocean (Figure 1-2-1). The ship tracks of the cruise are shown in Figure 1-2-2.

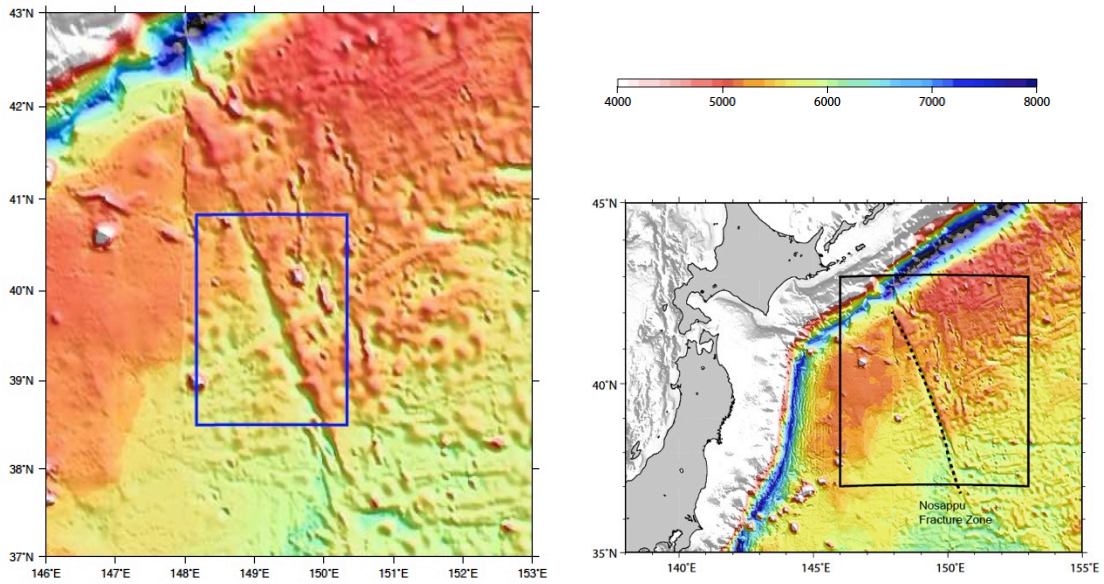


Figure 1-2-1. Bathymetry map of our research area (left) and its location shown by square in the right figure. AUV Urashima dive area is shown by blue square.

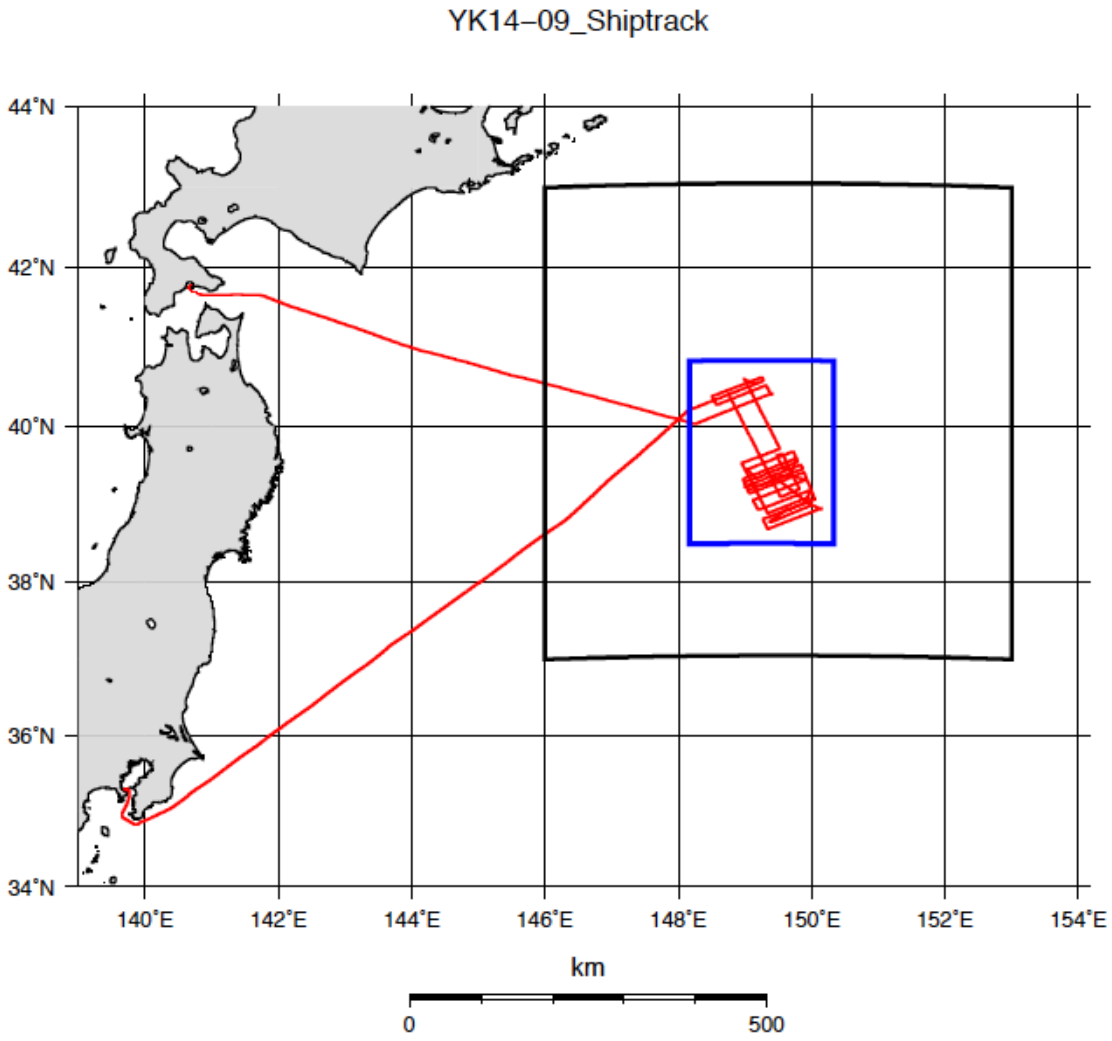


Figure 1-2-2. Ship tracks of the cruise. Our research area and AUV Urashima dive area are shown by black and blue squares, respectively.

1-3. Ship Log

YK14-09 Shipboard Log **Research Area:**
(28. May 2014 - 6. June, 2014) **North-West Pacific Ocean**

Date	Local Time	Description	Note	Position/Weather/Wind/ Sea condition
28-May-14		**Let go all shore lines & left YOKOSUKA for Research area.**		5/28 12:00 (UTC+9h)
	09:00	Let go all shore lines & left YOKOSUKA for Research area.		OFF SOUTH SUZAKI
	10:00-10:30	Carried out shipboard education & training for scientists.		34-52.0N,139-45.9E
	10:30-11:00	Scientists meeting.		Cloudy
	13:00-13:30	Carried out URASHIMA team & Scientists meeting.		SSE-2 (Light breeze)
	16:40-17:00	Carried out KONPIRA pray.		2 (Sea smooth)
	19:00-19:47	Carried out figure eight running.		2 (Low swell long) Visibly: 6'
29-May-14		**Proceeded research area.**		5/29 12:00 (UTC+9h)
	10:00-11:00	Scientists meeting.		North-West Pacific Ocean
	11:00-11:13	Carried out figure eight running.		38-06.5N,145-11.7E
	13:00-15:20	Scientists meeting.		Cloudy
	15:30	Arrived at research area.		South-3 (Gentle breeze)
	15:35	Carried out towing proton magnetometer.		3 (Sea slight)
				2 (Low swell long)
				Visibly: 8'
30-May-14		**"AUV URASHIMA" operation #165**		5/30 12:00 (UTC+9h)
	01:59	Com'ced MBES site survey.		OFF Nosappu
	05:57	Finished MBES site survey.		40-29.4N,148-59.8E
	06:09	Recovered proton magnetometer.		Cloudy
	06:19	Released XBT(Data=BT-006020140530.XBT).	40-33.4075N,149-12.6276E	SSE-2 (Light breeze)
	"	Proceeded to "AUV URASHIMA" dive point.	BOX B	2 (Sea smooth)
	06:24	Arrived at dive point.		2 (Low swell long)
	06:30-07:10	"AUV URASHIMA" payload set up.		Visibly: 6'
	7:24	"AUV URASHIMA" removed to deck.		
	07:33	Hoisted "AUV URASHIMA".		
	07:42	Lounched above "AUV URASHIMA".		
	"	"AUV URASHIMA" dove & started her operation.		
	08:00-08:06	Carried out "AUV URASHIMA"s figure eight running.		
	9:48	Started "AUV URASHIMA" track line.	Depth=3,313m	
	15:34	Finished "AUV URASHIMA" track line.	Depth=3,309m	
	15:34-15:48	Carried out "AUV URASHIMA"s figure eight running.		
	17:06	Refloated "AUV URASHIMA".		
	17:22	Hoisted "AUV URASHIMA".		
	17:28	Recovered "AUV URASHIMA" & finished her operation.		
	18:01	Com'ced towing proton magnetometer.		
	18:26	Com'ced MBES mapping survey.	Used Data=BT-005920140529.XBT	
	19:30-21:00	Scientists meeting.		
31-May-14		**"AUV URASHIMA" operation #166**		5/31 12:00 (UTC+9h)
	05:38	Finished MBES mapping survey.		OFF Nosappu
	06:10	Recovered proton magnetometer.		39-26.2N,149-25.6E
	06:17	Released XBT(Data=BT-006020140530.XBT).	39-30.4295N,149-37.8108E	Overcast
	"	Proceeded to research area.	BOX D	SW-4 (Moderate breeze)

YK14-09 Shipboard Log **Research Area:**
(28. May 2014 - 6. June, 2014) **North-West Pacific Ocean**

Date	Local Time	Description	Note	Position/Weather/Wind/ Sea condition
	06:24	Arrived at dive point.		3 (Sea slight)
	07:05	"AUV URASHIMA" removed to deck.		2 (Low swell long)
	07:15	Hoisted "AUV URASHIMA".		Visibly: 5'
	07:45	Lounched above "AUV URASHIMA".		
	"	"AUV URASHIMA" dove & started her operation.		
	08:00-08:14	Carried out "AUV URASHIMA"s figure eight running .		
	9:43	Started "AUV URASHIMA" track line.	Depth=3,300m	
	15:34	Finished "AUV URASHIMA" track line.	Depth=3,437m	
	15:34-15:48	Carried out "AUV URASHIMA"s figure eight running for .		
	16:51	Refloated "AUV URASHIMA".		
	17:17	Hoisted "AUV URASHIMA".		
	17:28	Recovered "AUV URASHIMA" & finished her operation.		
	17:55	Com'ced towing proton magnetometer.		
	18:27	Com'ced MBES mapping survey.	Used Data=BT-006020140530.XBT	
	19:30-20:50	Scientists meeting.		
01-Jun-14		**Suspended "AUV URASHIMA"**		6/1 12:00 (UTC+9h)
	05:41	Finished MBES site survey.		OFF Nosappu
	06:11	Recovered proton magnetometer.		38-57.0N,150-07.5E
	07:18	Com'ced towing proton magnetometer.		Fog
	07:30	Suspended "AUV URASHIMA" dive operation,		SW-4 (Moderate breeze)
		due to poor visibly.		3 (Sea slight)
	07:47	Com'ced MBES mapping survey.	Used Data=BT-006020140530.XBT	2 (Low swell long)
	12:03-12:23	Carried out figure eight running.		Visibly: 0.1'
	15:30-17:00	Scientists meeting.		
02-Jun-14		**"AUV URASHIMA" operation #167**		6/2 12:00 (UTC+9h)
	05:54	Finished MBES mapping survey.		OFF Nosappu
	06:09	Recovered proton magnetometer.		39-20.1N,149-29.2E
	"	Proceeded to research area.	BOX D	Blue sky
	06:39	Arrived at dive point.		North-4 (Moderate breeze)
	06:40-07:10	"AUV URASHIMA" payload set up.		3 (Sea slight)
	07:15	"AUV URASHIMA" removed to deck.		2 (Low swell long)
	07:20	Hoisted "AUV URASHIMA".		Visibly: 8'
	07:27	Lounched above "AUV URASHIMA".		
	07:28	"AUV URASHIMA" dove & started her operation.		
	07:45-08:03	Carried out "AUV URASHIMA"s figure eight running .		
	09:39	Started "AUV URASHIMA" track line.	Depth=3,284m	
	15:29	Finished "AUV URASHIMA" track line.	Depth=3,296m	
	15:29-15:43	Carried out "AUV URASHIMA"s figure eight running.		
	16:54	Refloated "AUV URASHIMA".		
	17:12	Hoisted "AUV URASHIMA".		
	17:19	Recovered "AUV URASHIMA" & finished her operation.		
	17:51	Com'ced towing proton magnetometer.		
	18:11	Com'ced MBES mapping survey.	Used Data=BT-006020140530.XBT	
	19:30-21:00	Scientists meeting.		

YK14-09 Shipboard Log
(28. May 2014 - 6. June, 2014)

Research Area:
North-West Pacific Ocean

Date	Local Time	Description	Note	Position/Weather/Wind/ Sea condition
03-Jun-14		**"AUV URASHIMA" operation #168**		6/3 12:00 (UTC+9h)
	06:11	Recovered proton magnetometer.		OFF Nosappu
	06:14	Finished MBES mapping survey.		38-57.0N, 149-40.8E
	"	Proceeded to research area.		Fine but cloudy
	06:45	Arrived at dive point.		ESE-3 (Gentle breeze)
	06:45-07:09	"AUV URASHIMA" payload set up.		2 (Sea smooth)
	07:20	"AUV URASHIMA" removed to deck.		2 (Low swell long)
	07:24	Hoisted "AUV URASHIMA".		Visibly: 8'
	07:34	Lounched above "AUV URASHIMA".		
	"	"AUV URASHIMA" dove & started her operation.		
	07:53-08:05	Carried out "AUV URASHIMA"s figure eight running.		
	09:32	Started "AUV URASHIMA" track line.	Depth=3,298m	
	12:11	Finished "AUV URASHIMA" track line.	Depth=3,296m	
	13:49	Refloated "AUV URASHIMA".		
	14:22	Hoisted "AUV URASHIMA".		
	14:30	Recovered "AUV URASHIMA" & finished her operation.		
	15:09	Com'ced towing proton magnetometer.		
	16:19	Com'ced MBES mapping survey.	Used Data=BT-006020140530.XBT	
	18:00-18:30	Scientists meeting.		
04-Jun-14		**Carried out MBES mapping survey & SBP survey**		6/4 12:00 (UTC+9h)
	03:04	Change XBT data for MBES.	Used Data=BT-005920140529.XBT	OFF Nosappu
	08:01	Com'ced SBP survey.		40-24.2N, 149-33.8E
	13:00-13:30	Scientists meeting.		Fine but cloudy
	16:44	Recovered proton magnetometer.		WSW-3 (Gentle breeze)
	16:14-16:30	Carried out figure eight running.	40-25.3259N,149-24.2954E	2 (Sea smooth)
	16:12	Finished SBP survey.		1 (Calm)
	16:50	Released XBT(Data=BT-006120140604.XBT).		Visibly: 8'
	17:13	Change XBT data for MBES.	Used Data=BT-006120140604.XBT	
	17:00	Proceeded to HAKODATE.		
	17:20	Com'ced MBES mapping survey.		
05-Jun-14		**Proceeded to HAKODATE**		6/4 12:00 (UTC+9h)
	05:10	Carried out figure eight running.		OFF S-E ERIMO-MISAKI
	13:00-13:30	Recovered proton magnetometer.		40-58.5N, 144-05.2E
				Cloudy
				SSE 4 (Moderate breeze)
				2 (Sea smooth) 1 (Calm) Visibly: 7'
06-Jun-14		**Arrived at HAKODATE**		
	09:00	Sent out 1st shore line, arrived at HAKODATE,conpleted YK14-09.		

2. Participants

2-1. Science party

Nobukazu Seama (Professor, Chief scientist and Representative of the science party)
Department of Earth and Planetary Sciences, Kobe University
1-1Rokkodai, Nada, Kobe 657-8501, Japan
Email: seama@kobe-u.ac.jp

Kazuo Nakahigashi (Research Associate)
Department of Earth and Planetary Sciences, Kobe University
1-1Rokkodai, Nada, Kobe 657-8501, Japan

Masakazu Fujii (Graduate Student)
Department of Earth Planetary Science, Atmosphere and Ocean Research Institute
University of Tokyo
5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8564, Japan

Eri Iizuka (Graduate Student)
Faculty of Science
Kobe University
1-1, Rokko-dai, Nada-ku, Kobe 657-8501, Japan

Takayuki Kitagawa (Graduate Student)
Graduate School of Science
Kobe University
1-1, Rokko-dai, Nada-ku, Kobe 657-8501, Japan

Toshimasa Nasu (Marine Technician)
Marine Science Department, Nippon Marine Enterprises
14-1, Ogawa-cho, Yokosuka 238-0004, Japan

2-2. Scientists on land

Kyoko Okino	Atmosphere and Ocean Research Institute, University of Tokyo
Yoshifumi Nogi	National Institute of Polar Research

2-3 AUV Urashima Operation team

Kazuhiro Chiba	Operation Manager
Yoshitaka Sasaki	1st Submersible Staff
Akihisa Ishikawa	1st Submersible Staff
Yuta Sakakibara	2nd Submersible Staff
Takuma Onishi	2nd Submersible Staff
Ryo Saigo	2nd Submersible Staff
Yudai Tayama	2nd Submersible Staff

2-4. R/V Yokosuka Officers and Crews

Yoshiyuki Nakamura	Captain
Naoto Kimura	Chief Officer
Takeshi Egashira	2nd Officer
Tomohiro Yuasa	3rd Officer
Tadashi Abe	Chief Engineer
Wataru Kurose	1st Engineer
Kenichi Shirakata	2nd Engineer
Koichi Hashimoto	3rd Engineer
Kazuki Ono	Jr.3rd Engineer
Hiroyasu Saitake	Chief Radio Officer
Misato Hata	2nd Electronic Officer
Yoshikazu Saitake	2nd Electronic Operator
Kozo Yatogo	Boat Swain
Tsuyoshi Chimoto	Quarter Master
Hatsuo Oda	Quarter Master
Hiroaki Nagai	Quarter Master
Kazuho Ikeda	Sailor
Sho Suzuki	Sailor
Yoshihiro Ogawa	Sailor
Kento Kanda	Sailor
Ikeda Toshikazu	No.1 Oiler
Shinya Sugi	Oiler
Keita Funawatari	Oiler

Toshinari Matsui	Oiler
Ryo Matsuuchi	Assistant Oiler
Seiya Watanabe	Assistant Oiler
Yukio Tachiki	Chief Steward
Toru Murakami	Steward
Kazuma Sonoda	Steward
Yoshie Hidaka	Steward
Yohei Ebiko	Steward

Photo 2-1. Group photo during the cruise.

3. Purpose

Water exists in the solid earth and affects solid earth dynamics through its circulation. Our approach is the first attempt to understand the role for the fracture zone in the lithosphere, as a carrier of water into the deep mantle. Our target is the Nosappu Fracture Zone in the old Pacific lithosphere just before subducting into the deep mantle at the Kuril trench. We conduct AUV Urashima geomagnetic surveys and surface geophysical surveys across the Nosappu Fracture Zone to derive areas of serpentinited peridotite in the mantle beneath the Nosappu Fracture Zone. The areas of serpentinited peridotite allow us to estimate water contents in the lithosphere; the water has been transported through the fracture zone from the ocean to the lithosphere, and mantle peridotite becomes serpentinited peridotite by absorbing the water. Our estimate of the water contents beneath the Nosappu Fracture Zone will provide important constraint on the contribution of the fracture zone to carry water into the deep mantle by the lithosphere, and on the role for fracture zone in the water circulation through the solid earth.

4. Observation

4-1. Surface Geophysical Survey

We conducted a surface geophysical survey to collect multi-narrow beam bathymetry, geomagnetic field, and gravity field data. The ship tracks in the AUV Urashima dive area are shown in Figure 4-1-1, and we could cover total 1,200 miles in the area. The surface geophysical surveys contain 17 survey lines across the Nosappu Fracture Zone with their length of 40 miles for most. Survey lines along the fracture zone cover 110 miles at each side of the fracture zone.

Multi-narrow beam bathymetric data were obtained using a KONGSBERG EM122 (Swath width 100°; 288 beams with its width of 2°), which also provides a backscatter image that will be processed after the cruise. The bathymetric data is shown in Figure 4-1-2. Three XBTs were done in the research area (Table 4-1-1). We also conducted sub-Bottom profiler survey on 4 June (Figure 4-1-3). The GPS (Global Positioning System) was used to derive the ship location.

Geomagnetic field data were collected with three instruments; two shipboard three component magnetometer (STCM: Isezaki, 1986) that can measure the vector geomagnetic field using deck-mounted fluxgate magnetometers and gyros, and a ship-towed proton precession magnetometer that can measure the intensity of the geomagnetic field. One is Kobe STCM system brought from Kobe University, which consists of five parts; magnetometer sensors, ring laser gyrocompass (provided by Tohoku University), GPS, magnetometer control unit, and data logger (Photo 4-1-1). The magnetometer sensors are three flux gate magnetometers orthogonally aligned to each other, and their dynamic range is ±100,000 nT with resolution of 1 nT. The magnetometer sensors were installed on the top deck. The gyrocompass comprises three ring laser gyros and three single axis accelerometers, giving resolution of 0.025 degree and heading accuracy of < 0.1 degree. The location and time data are supplied by GPS. The magnetometer control unit (TIERRA TECNICA Ltd., Japan) digitizes values from the magnetometer sensors and compiles geomagnetic field, ship's attitude, location, and time data with their sampling rate of 8Hz. A laptop computer records these data via a RS-232C serial port. We obtained the continuous geomagnetic field data after 07:31:04 on 29 May, but we could not obtain the data from 28 May to 29 May due to the recording system trouble. The fragmented geomagnetic field data during recording system trouble were listed in Table 4-1-2. The other STCM is the system, which has been already installed on board the R/V Yokosuka. The STCM data contain the effects of the ship's magnetic field that must be corrected in order to derive the real geomagnetic field. Twelve constants related to the ship's permanent and induced magnetic field will be estimated using data from "Figure 8 turns". "Figure 8 turns" is made by steering the ship in a tight circle, both clockwise and counter clockwise. During the cruise, four "Figure 8 turns" were conducted as listed in Table 4-1-3. Ship-towed proton precession magnetometer was towed 380 m behind the GPS position.

Gravity field data were obtained from a shipboard gravimeter (Model S-63, Lacoste & Romberg). The instrument drift will be corrected using gravity field data measured by a portable gravimeter at two ports (Yokosuka Shin-Kou and Yokosuka).

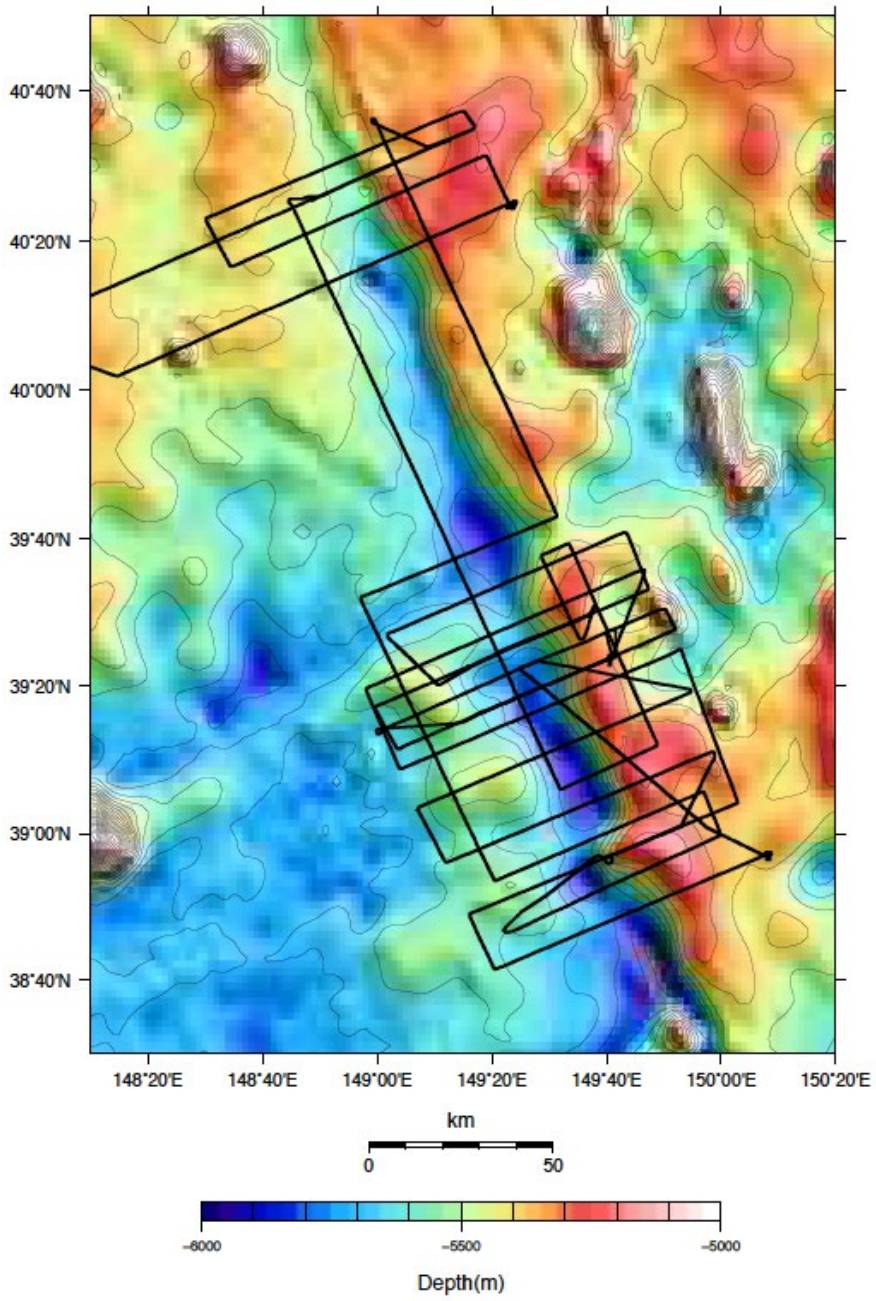


Figure 4-1-1. Ship tracks in the AUV Urashima dive area.

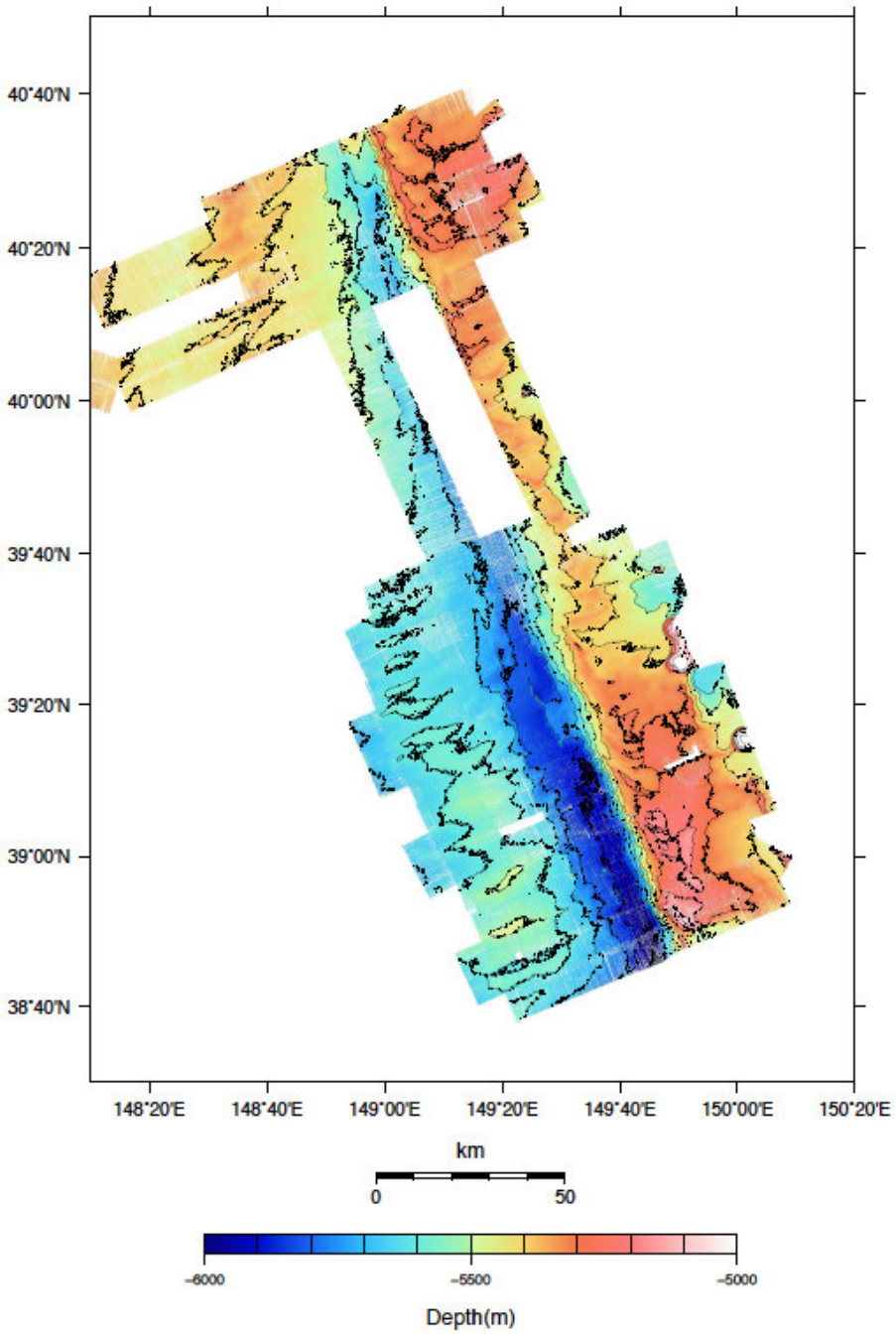


Figure 4-1-2. Bathymetric data obtained during the cruise in the AUV Urashima dive area.

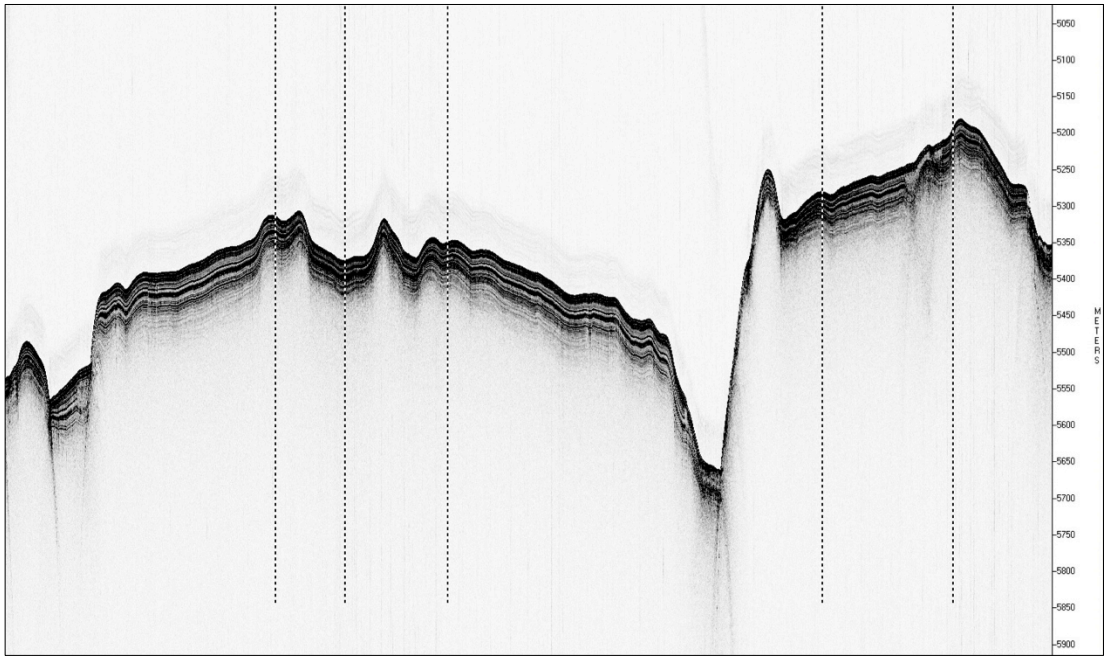


Figure 4-1-3. Image obtained from the sub-bottom profiler survey.

No.	Date	Time(UT)	Latitude	Longitude
1	29/May	21:10	40°33.41'N	149°12.63'E
2	30/Mar.	21:10	39°30.43'N	149°37.81'E
3	4/June	07:50	40°25.32'N	149°24.29'E

Table 4-1-1. List of "XBT deploy position"

No.	Start Time(UT)	End Time(UT)	Recording System
1	14/05/28-00:33:22	14/05/28-20:44:07	SFG1211
2	14/05/28-05:49:39	14/05/28-06:30:52	SFG1211
3	14/05/28-07:29:30	14/05/28-07:30:26	SFG1211
4	14/05/28-07:30:39	14/05/28-08:04:44	SFG1211
5	14/05/28-08:10:13	14/05/28-08:33:57	stcmrg1
6	14/05/28-11:16:43	14/05/28-11:43:11	SFG1211
7	14/05/28-15:05:56	14/05/28-15:47:24	SFG1211
8	14/05/28-15:10:31	14/05/28-17:54:58	stcmrg1
9	14/05/28-22:27:05	14/05/28-22:54:04	SFG1211
10	14/05/28-22:37:43	14/05/29-00:19:43	stcmrg1
11	14/05/29-02:27:34	14/05/29-04:13:37	SFG1211

12	14/05/29-02:28:14	14/05/29-03:23:27	stcmrg1
13	14/05/29-03:46:49	14/05/29-04:44:26	stcmrg1
14	14/05/29-06:40:28	14/05/29-07:05:42	SFG1211
15	14/05/29-06:50:13	14/05/29-10:28:19	stcmrg1
16	14/05/29-08:39:09	14/05/29-09:20:23	SFG1211
17	14/05/29-11:20:51	14/05/29-11:46:00	SFG1211
18	14/05/29-11:25:12	14/05/28-12:24:42	stcmrg1
19	14/05/29-13:19:33	14/05/29-14:35:17	stcmrg1
20	14/05/29-13:20:46	14/05/29-13:46:00	SFG1211
21	14/05/29-19:28:00	14/05/29-19:43:23	SFG1211
22	14/05/29-20:40:58	14/05/29-21:26:08	stcmrg1
23	14/05/29-23:09:04	14/05/30-01:34:04	SFG1211
24	14/05/29-23:39:23	14/05/30-03:29:28	stcmrg1
25	14/05/30-02:08:38	14/05/30-02:52:35	SFG1211
26	14/05/30-03:54:12	14/05/30-04:37:25	SFG1211
27	14/05/30-03:58:37	14/05/30-05:35:48	stcmrg1
28	14/05/30-04:52:09	14/05/30-05:56:56	SFG1211
29	14/05/30-05:44:33	14/05/30-07:28:10	stcmrg1

Table 4-1-2. List of "Fragmented geomagnetic field data"

No.	Date	Time(UT)	Latitude	Longitude
1	28/May	10:30-19:47	35°50.9'N	141°38.6'E
2	29/May	02:00-02:13	37°59.8'N	145°00.4'E
3	1/June	03:03-03:23	38°57.0'N	150°08.0'E
4	4/June	07:14-07:30	40°24.7'N	149°23.2'E

Table 4-1-3. List of "Figure 8 turns"

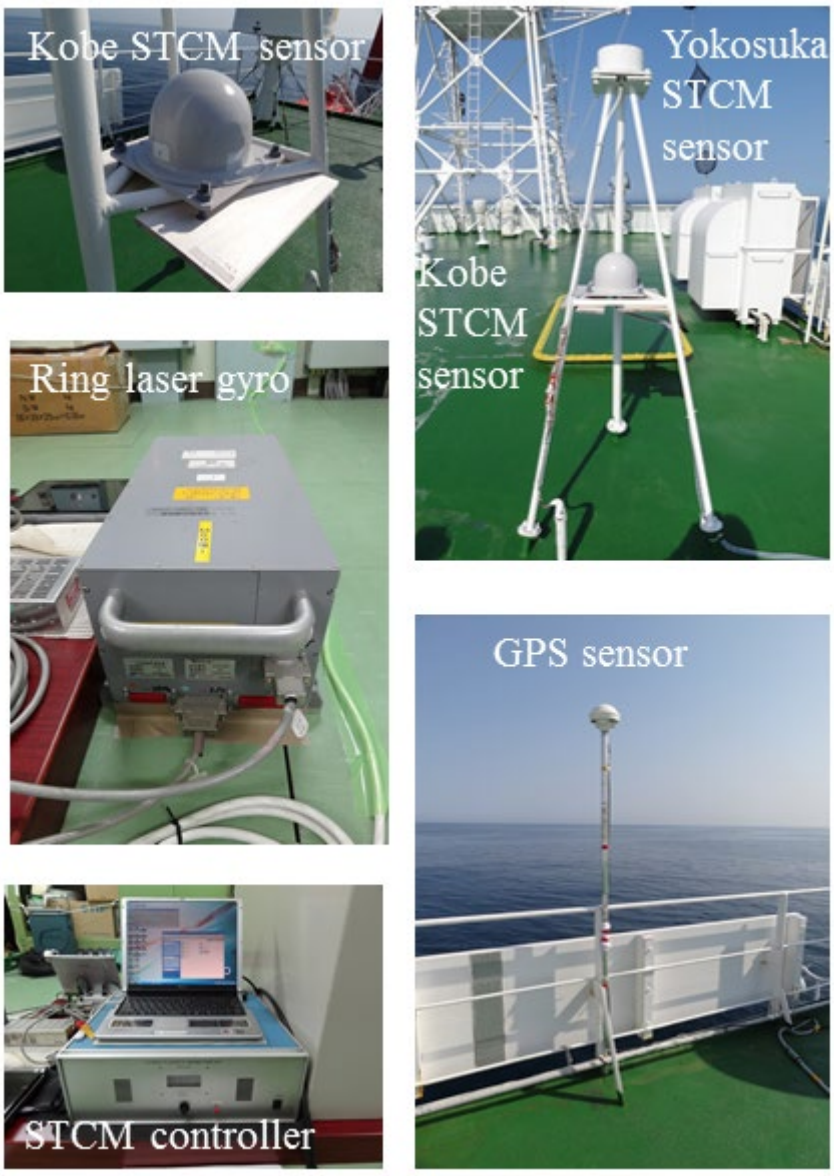


Photo 4-1-1. Kobe STCM system

4-2. Geomagnetic survey using AUV Urashima

We conducted deepsea geomagnetic field measurement using the AUV Urashima to reveal detailed geomagnetic anomaly signature from oceanic lithosphere beneath the Nosappu Fracture Zone, where magnetic property could be changed as a result of reaction with water. Our deepsea geomagnetic field measurement system and AUV Urashima dive summary are described as following.

4-2-1. Instrument and Measurements

A deepsea geomagnetic field measurement system (TIERRA TECNICA Ltd., Japan; National Institute of Polar Research) has been developed for the AUV Urashima, and we used a part of the system to obtain vector geomagnetic field data during this cruise. This system consists of three-axis fluxgate-type sensors (Bartington MAG-03H), an A/D conversion unit (3ch-32bit-A/D), an overhauser magnetometer (OH Marin Magnetics Explorer), and a data controller/logger (Linux OS). We used three three-axis fluxgate-type sensors, but did not use the overhauser magnetometer because the depth limitation of the pressure-resistant shell for this magnetometer is less than 2500 m. The pressure-resistant case of the data controller/logger with the A/D conversion unit, and the three magnetic sensors (FG1, FG2, FG4) were fixed inside of the AUV (Photo 4-2-1). Another magnetic sensor called FG3 was not installed in this cruise. The three-axis coordinates (X, Y, and Z axes) of the three magnetic sensors are the same; the +X axis orients ship's stem, + Y points starboard, and + Z downward.

The data controller/logger records geomagnetic field, attitude, and navigation data. The geomagnetic field is measured by each three-axis fluxgate-type sensor with A/D conversion unit (3ch-32bit-A/D), and their dynamic range, resolution, and accuracy are ±70000 nT, 0.01 nT, and 0.4 nT, respectively. The AUV Urashima provide the data controller/logger with attitude from gyro compass (heading, pitch, roll), GPS time, vehicle position from inertia navigation system (INS), and water depth from CTD sensor, and The data controller/logger records all these data together with the geomagnetic field data by the same files with their sampling interval of 10 Hz. The memory device of the data logger is a compact flash card with 2 GB containing capacity of 500 MB for the system and 1500 MB for measured data. The volume of the measured data files for an hour is approximately 10 MB in usual. A laptop computer is used to communicate with the data controller/logger through a cross-LAN cable between them before and after measurements, which allows us to set up the data controller/logger and to download the data from it. Note that positions of the AUV Urashima are independently measured by a super short base line (SSBL) positioning system installed in R/V Yokosuka.

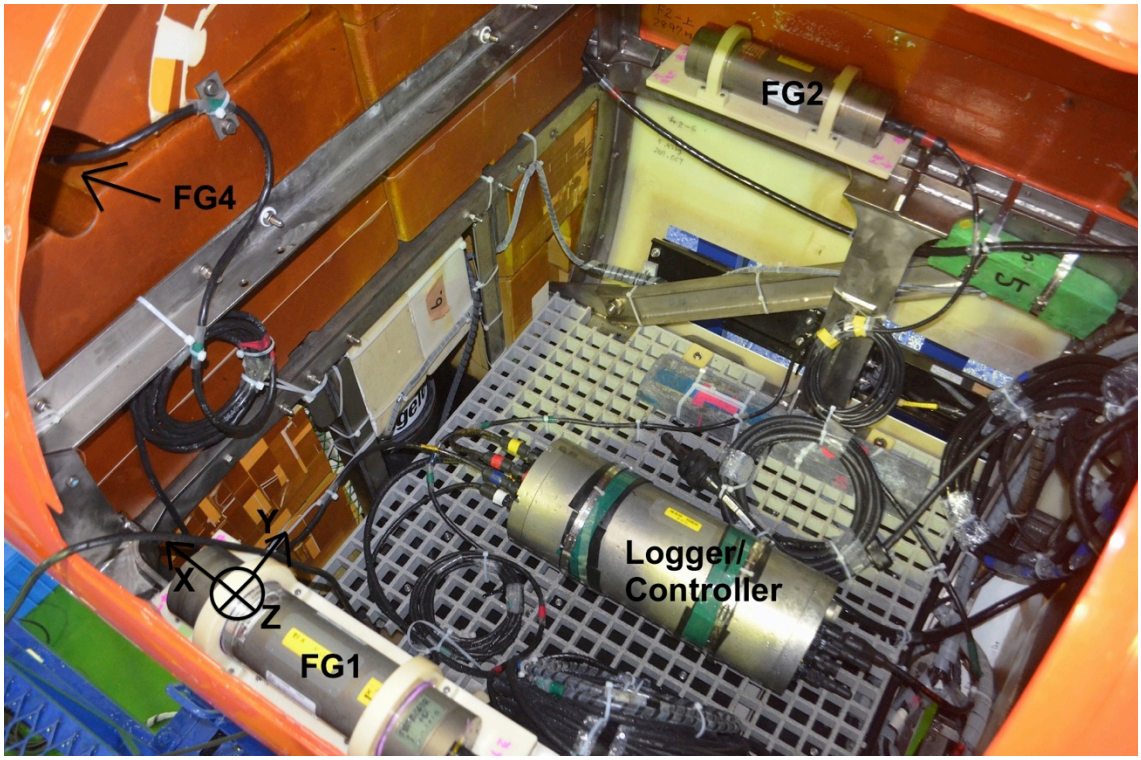


Photo 4-2-1. Deepsea geomagnetic field measurement system fixed inside of the AUV Urashima.

4-2-2. Dive Operation Note and Results

Total four AUV Urashima dives of Dives #165, #166, #167, and #168 (Figure 4-2-1) were conducted under similar operation (Table. 4-2-1). After the AUV launches into underwater, she started to keep on descending spontaneously. When she reaches 700 m deep, a 8-figure loop was conducted for calibration of geomagnetic data with 80 m diameter for 6-18 minutes. Vehicle pitch were aimed to have variation from -25° to 25°, but resulting in -25° to 10-15° in actual. After the 8-figure loop, the AUV ran in the direction of ~240° toward the next waypoint, which is 2 miles away on the line between the start point of the dive and the final waypoint. The vehicle speed, descending speed, and descending angle are 2.3−2.6 kt, ~30 m/min, and ~25°, respectively. After reaching 3300 m deep, the vehicle started to keep constant depth of 3300 m and headed for the final waypoint as fast as possible. In the end, the second 8-figure turrn was conducted in the same way as described above. Then, the AUV started to go up to the surface with its average rising speed of ~45 m/min.

Three components of the geomagnetic field are successfully obtained along the all dive tracks of the AUV Urashima (Figures 4-2-2 and 4-2-3). The data from three flux gate sensors are well correlated with each other. Heading, pitch, roll, and depth were also measured uneventfully except the Dive #168. The Dive #168 was stopped suddenly at 12:11 (JST) because of the machine trouble. Therefore, a second 8-figure loop could not be conducted in the Dive #168. While geomagnetic field data are successfully acquired until 13:43 at the depth of about 100 m, the recording of the AUV Urashima system data (attitude, GPS time, position, depth) was stopped at 12:11 in 3,300 m deep.

We need to carefully handle the files recorded during the Dive #167, because we made a mistake to set up date of the data controller/logger for the Dive #167. The real date was 2 June 2014, but 3 June 2014 was set. The date of the data controller/logger is only reflected to the recoding date. Since the measurement time of all sensors is based on GPS time, the mistake is not critical, but we need to handle the files carefully.

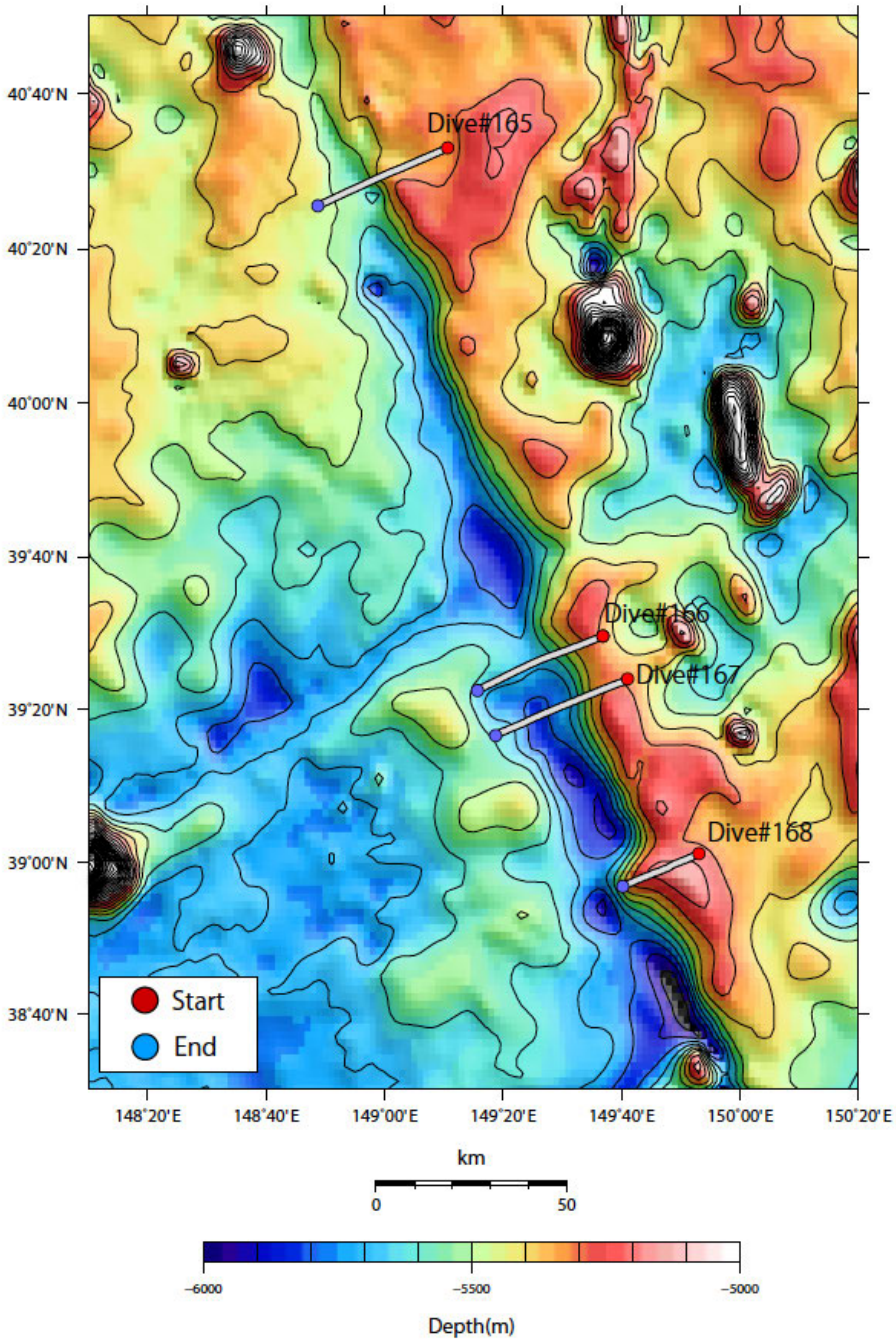
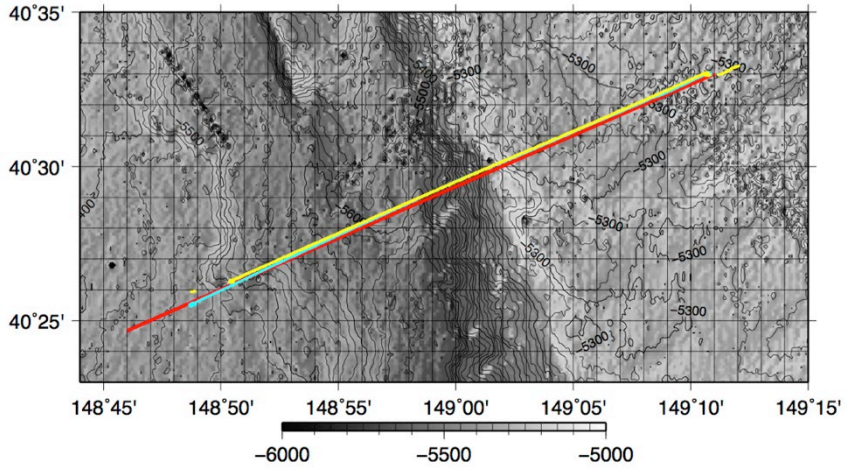


Figure 4-2-1. AUV Urashima dive tracks in the AUV Urashima dive area.

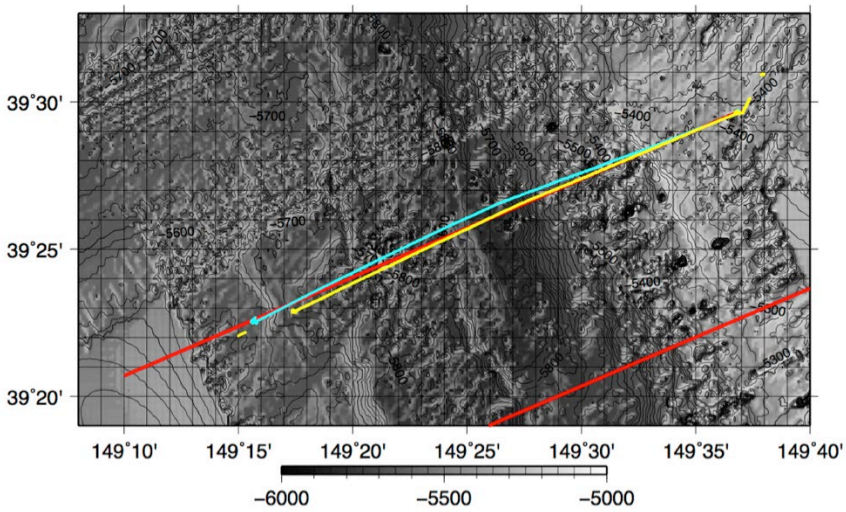
	Dive #165	Dive #166	Dive #167	Dive #168
Date	31 May 2014	31 May 2014	2 June 2014	3 June 2014
Covered horizontal mileage during descent into deep	3.76 mile (7.0 km)	3.56 mile (6.6 km)	3.41 mile (6.3 km)	3.60 mile (6.7 km)
Covered horizontal mileage on constant depth track	12.97 mile (24.0 km)	12.96 mile (24.0 km)	13.61 mile (25.2 km)	6.25 mile (11.6 km)
Start to descend	07:42 149.179°E 40.500°N	07:45 149.615°E 39.494°N	07:30 149.682°E 39.399°N	07:34 149.884°E 39.018°N
1st 8-figure loop start	08:00 D=694 m 149.177°E 40.550°N	08:00 D=550 m 149.613°E 39.495 °N	07:45 D=538 m 149.683°E 39.400°N	07:53 D=691 m 149.885°E 39.019°N
1st 8-figure loop end	08:06 D=928 m	08:14 D=1,005 m	08:03 D=855 m	08:05 D=953 m
Start of track line	09:48 D=3,310 m 149.103°E 40.526°N	09:43 D=3,320 m 149.544°E 39.471°N	09:39 D=3,290 m 149.615°E 39.376°N	09:32 D=3,320 m 149.814°E 38.993°N
End of track line	15:34 D=3,309 m 148.843°E 40.439°N	15:34 D=3,430 m 149.290°E 39.381°N	15:29 D=3,301 m 149.350°E 39.280°N	12:11 D=3,301 m 149.693°E 38.948°N
2nd 8-figure loop start	15:35	15:34	15:29	-
2nd 8-figure loop end	15:48 D=3,434 m	15:48 D=2,816 m	15:43 D=3,394 m	-
Surface	17:06	16:51	16:54	14:30
Note: Time is shown in Japanese Standard Time (JST). Vehicle position data is based on the inertia navigation system (INS).				

Table 4-2-1. AUV Urashima Dive information

(a) Urashima Dive #165



(b) Urashima Dive #166



(c) Urashima Dive #167

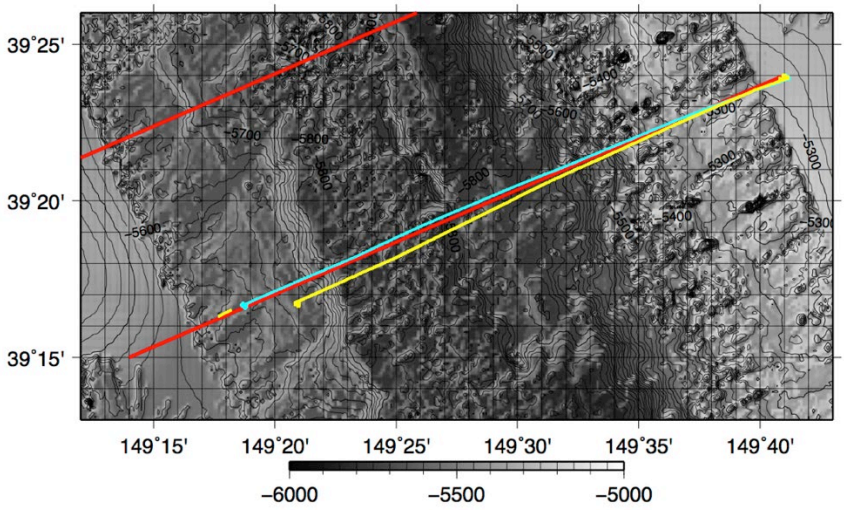


Figure 4-2-2. Track charts of Urashima Dives #165 (a), #166 (b), #167 (c), and #168 (d) on bathymetric map with position measured using the SSBL (sky blue) and the INS (yellow). Red line shows planned dive track. All dives were started from the west side.

(d) Urashima Dive #168

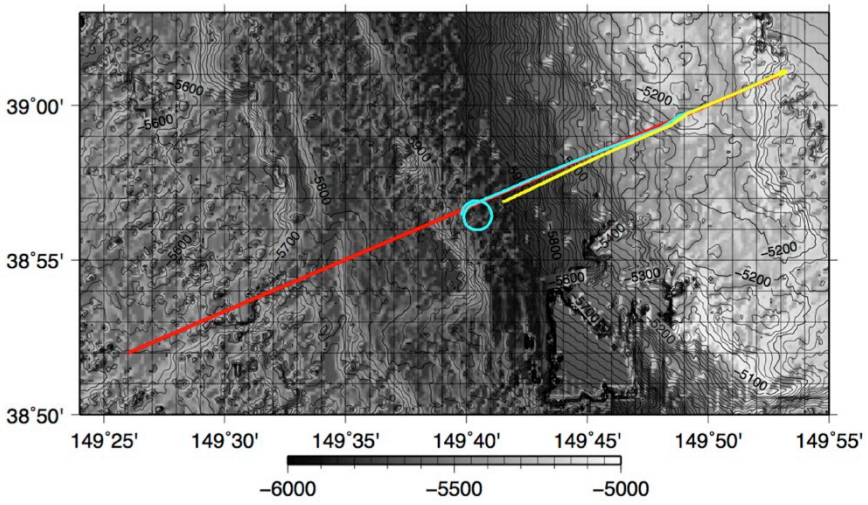


Figure 4-2-2. (continued)

Figure 4-2-3. Time series of measured three component of geomagnetic field, heading, pitch, roll, depth, and seafloor bathymetry obtained during Urashima Dives #165 (a), #166 (b), #167 (c), and #168 (d). Geomagnetic field data from sensor FG1, FG2 and FG4 are shown as red, green, and blue points respectively in X, Y, and Z components figures. In the depth figure, vehicle depth (thick lines) and seafloor bathymetry (thin lines) are shown and the maximum vehicle depth of each dive is ~3300 m.

(a) Urashima Dive #165

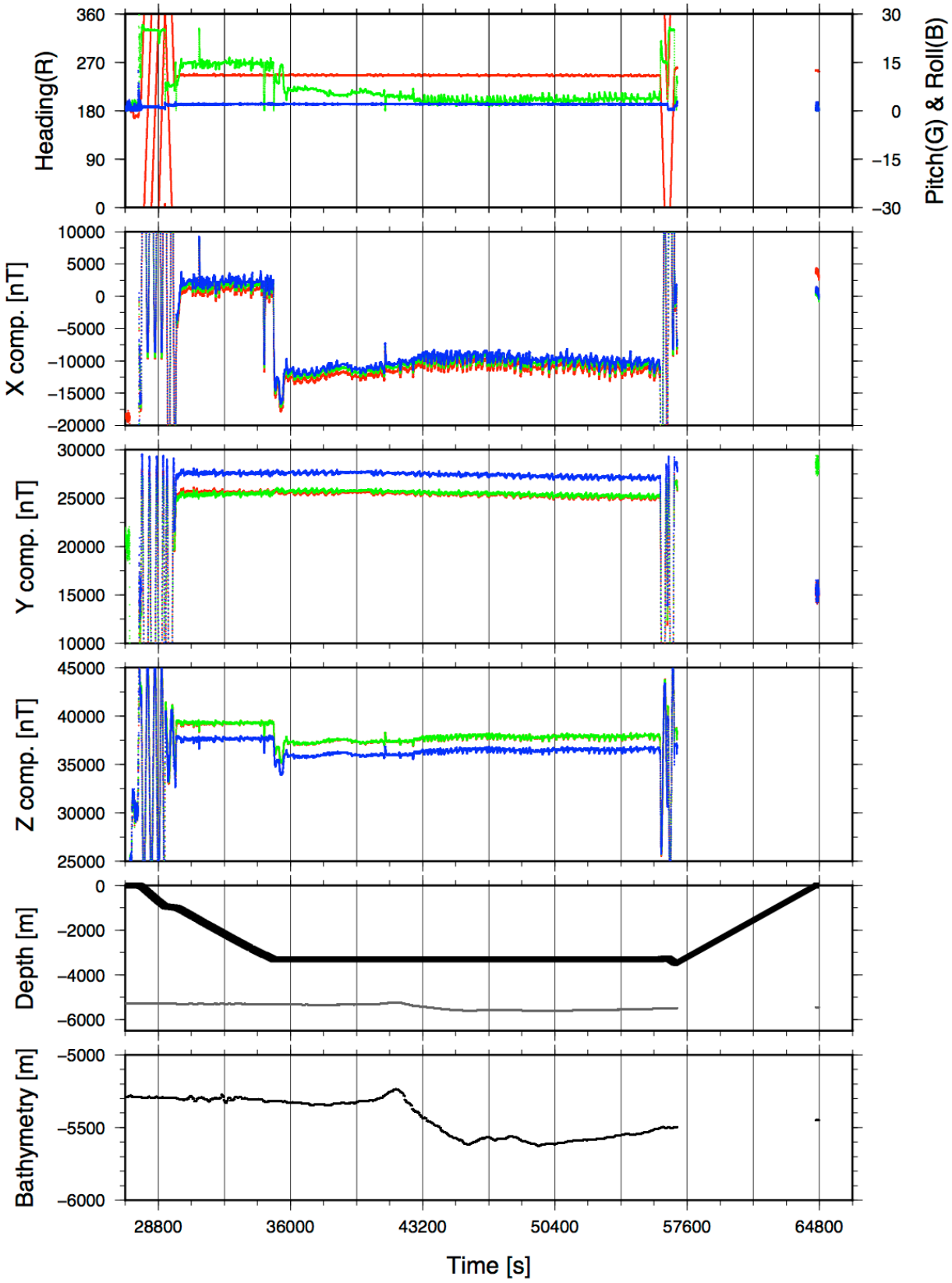


Figure 4-2-3a. (continued)

(b) Urashima Dive #166

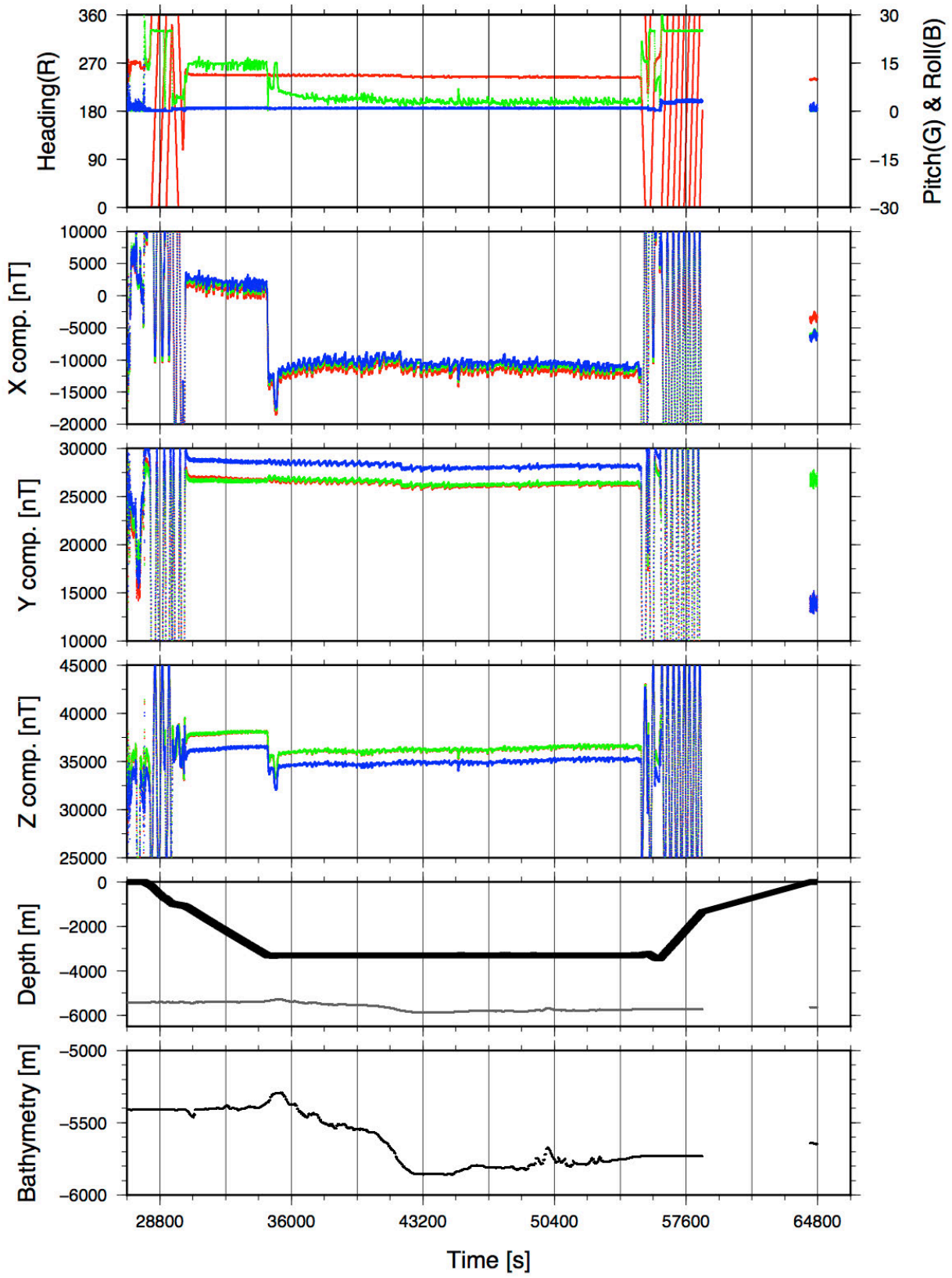


Figure 4-2-3b. (continued)

(c) Urashima Dive #167

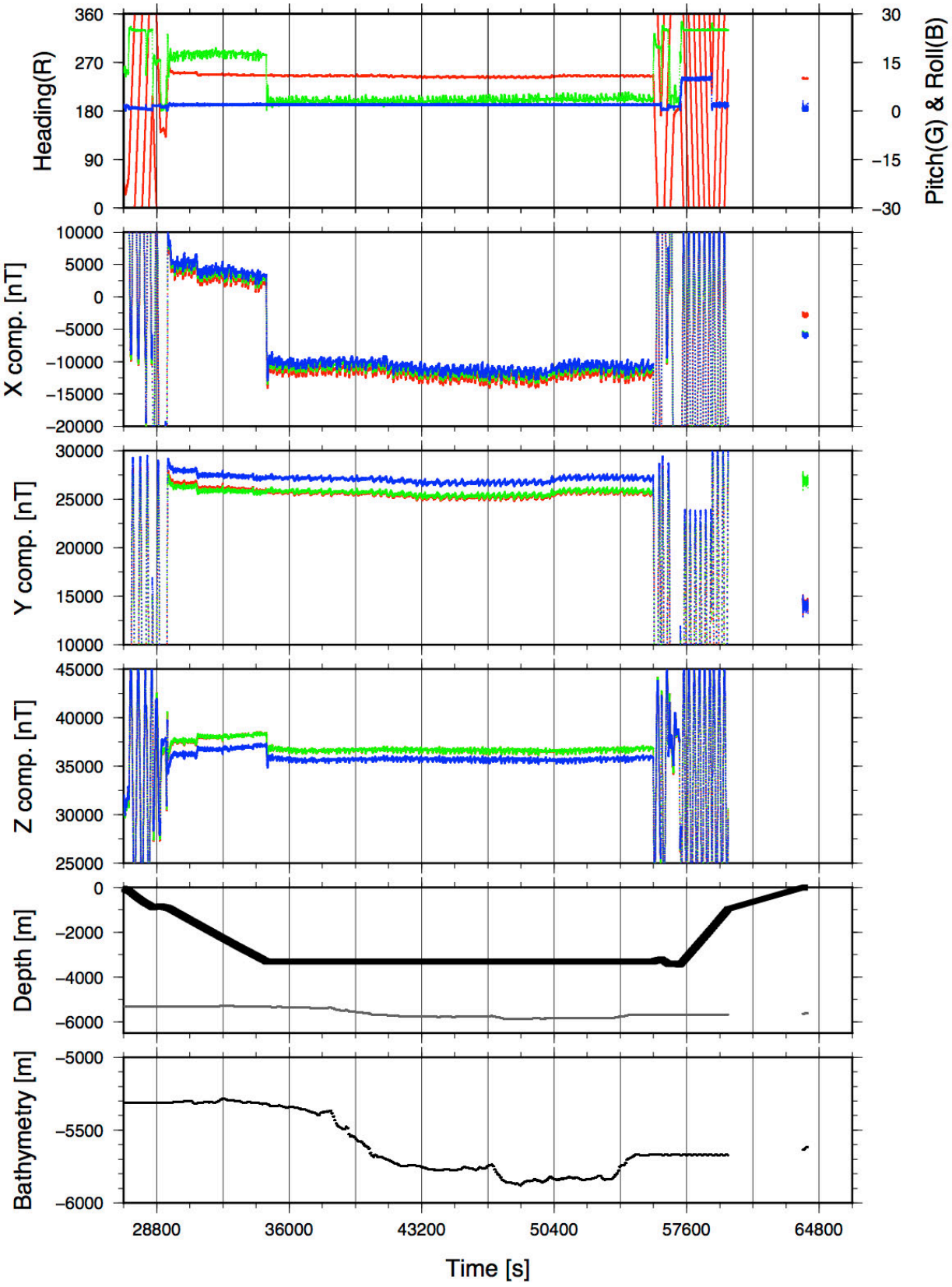


Figure 4-2-3c. (continued)

(d) Urashima Dive #168

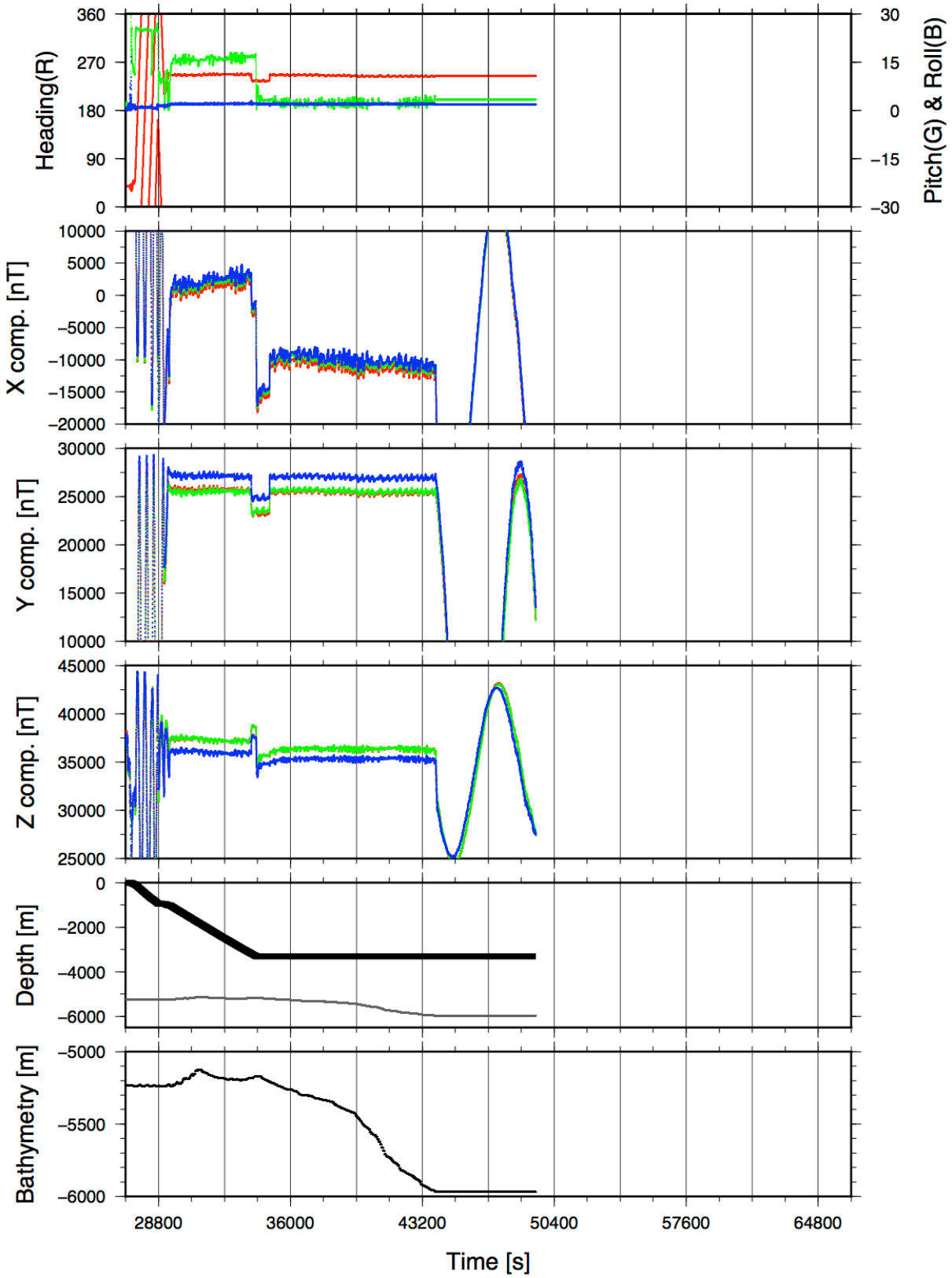


Figure 4-2-3d. (continued)

5. Summary

We successfully conducted AUV Urashima geomagnetic surveys and surface geophysical surveys at the Nosappu Fracture Zone between 38°40'N and 40°40'N. We had four AUV Urashima dives across the fracture zone to obtain geomagnetic data. The length of each survey line is about 17 miles, which contain about 13 miles at the AUV depth of 3,300m. The exception is one dive, which was forced to end at the middle of the survey line due to an emergency uplift of the AUV. The surface geophysical surveys allow us to collect multi-narrow beam bathymetry, geomagnetic field, and gravity field data, which cover total 1,200 miles in the AUV Urashima dive area. The surface geophysical surveys contain 17 survey lines across the fracture zone with their length of 40 miles for most. Survey lines along the fracture zone cover 110 miles at each side of the fracture zone. The observed data will be analyzed to derive areas of serpentinited peridotite and to estimate water contents in the mantle beneath the Nosappu Fracture Zone, which will provide important constraint on the role for fracture zone in the water circulation through the solid earth.

Acknowledgement

We gratefully recognize the efforts of the R/V Yokosuka Officers and Crews (Yoshiyuki Nakamura, captain) and the AUV Urashima Operation team (Kazuhiro Chiba, operation manager) during the cruise. Takafumi Kasaya helped to prepare the magnetometer for the AUV Urashima. We also thank all the support staffs in JAMSTEC.

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