

KAIREI Cruise Report

KR08-07

R/V KAIREI + ROV KAIKO7000II

*Crustal and magmatic evolution of an early stage
intra-oceanic arc
Izu-Bonin Arc (Ogasawara Ridge & Torishima Forearc)*



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June 23, 2008 – July 3, 2008

Chichijima – JAMSTEC

Institute for Frontier Research on Earth Evolution (IFREE)
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

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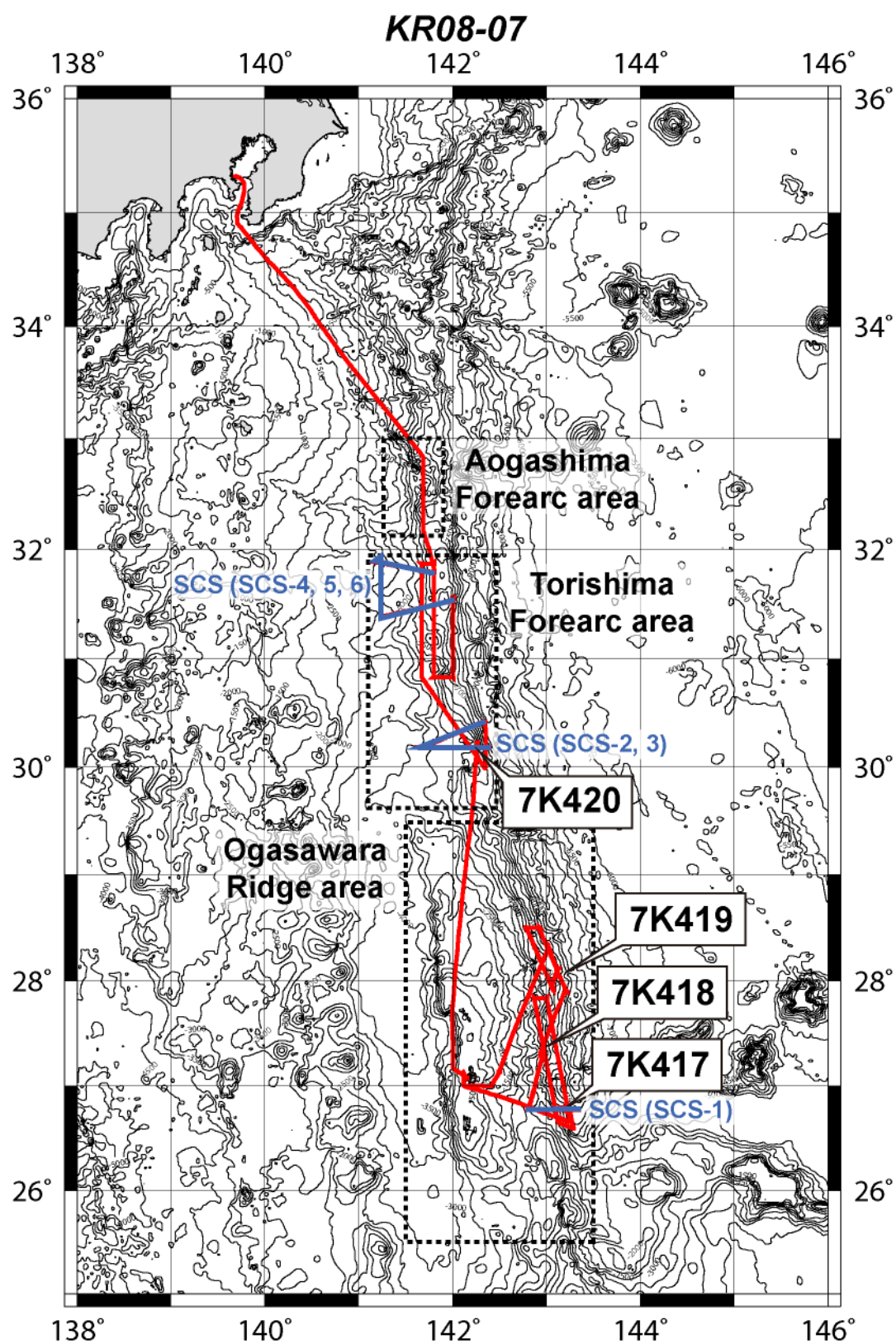
KR08-07 R/V KAIREI Crew

<i>Captain</i>	<i>E. Ukekura</i>
<i>Chief Officer</i>	<i>Y. Nakamura</i>
<i>2nd Officer</i>	<i>K. Oya</i>
<i>3rd Officer</i>	<i>T. Shirayama</i>
<i>Chief Engineer</i>	<i>E. Sakaguchi</i>
<i>1st Engineer</i>	<i>K. Kaneda</i>
<i>2nd Engineer</i>	<i>N. Takahara</i>
<i>3rd Engineer</i>	<i>S. Maruyama</i>
<i>Chief Radio Operator</i>	<i>H. Akama</i>
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<i>Oiler</i>	<i>S. Misago</i>
<i>Oiler</i>	<i>T. Iwao</i>
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<i>Steward</i>	<i>Y. Tachiki</i>
<i>Steward</i>	<i>K. Kosuji</i>
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<i>Trainee</i>	<i>T. Kimura</i>
<i>Trainee</i>	<i>M. Katsumata</i>

Acknowledgements

We are grateful to Captain E. Ukekura and the crew of the R/V KAIREI, the ROV KAICO7000II operation team manager K. Hirata and the ROV operators for their professional and outstanding efforts to make this scientific cruise successful. We also thank ship management divisions of JAMSTEC for their helpful support while organizing the cruise.

Figure 1. KR08-07 survey ship track



1. Cruise Summary

R/V KAIREI and ROV KAIKO7000II cruise (KR08-07) was held from June 23, 2008 to July 3, 2008. The cruise started from Chichijima, Bonin Islands and finished at JAMSTEC pier in Yokosuka. The chief target of the cruise was to discover outcrops of crust formed during the initiation of the Izu-Bonin arc. These are extremely important in attempting to understand the crustal evolution of the Izu-Bonin intra-oceanic arc and the magmatic processes operating as it became established. The most likely setting to find such rocks is the landward slope of the Izu-Bonin trench.

As a result, we selected 3 survey areas in the trench where the chances of finding exposures of initial crustal sections were highest; Ogasawara Ridge, Torishima Forearc, and Aogashima Forearc (Figure 1).

The cruise was originally planned to include 9 KAIKO7000II dives, but due to the repeated mechanical failures of the ROV system, only 4 dives (#417 – #420) were completed. Three dives (#417 – #419) took place in the Ogasawara Ridge area, and 1 dive (#420) in the Torishima Forearc area. In addition, SEABEAM bathymetry survey and single-channel seismic (SCS) survey were performed in between the KAIKO7000II dives.

Instead of returning to JAMSTEC pier as planned on July 5, owing to the mechanical failure of the KAIKO7000II, the cruise ended 2 days early on July 3.

The following summarizes our findings in each survey area;

Ogasawara Ridge:

Discovery of peridotite and gabbro exposures

Three KAIKO7000II dives were performed on the landward slope of the Izu-Bonin trench, where it forms the eastern slopes of the Ogasawara Ridge (Figure 2). In 2007, during KH07-02 Leg4 cruise, peridotite and gabbroic rocks were recovered in several dredges in this area. This was the first reported recovery of peridotite samples from the Izu-Bonin arc other than from a serpentine seamount. Peridotite and gabbroic rocks are considered to be the main component of the mantle and lower crust, respectively. Their discovery strongly indicates that a deep section of the arc crust is exposed on the landward trench slope in the dredged area.

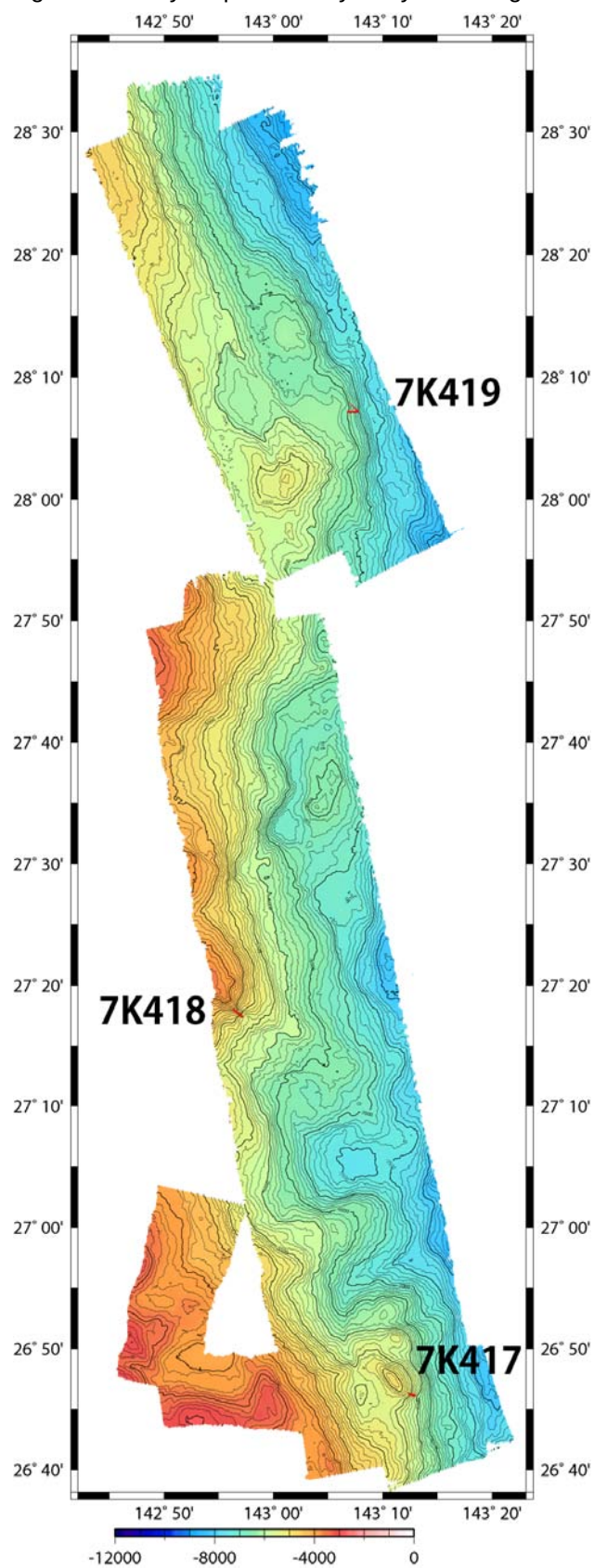
The main objective of the ROV surveys in this area was to discover exposures of the deep arc crust structure and to investigate the lithology of the crustal materials.

Dive #417 visited the southern part of the landward trench wall, and was successful in finding outcrops of peridotite and gabbroic rocks, 19 rock samples were recovered. The dive started from a depth of 5800 m and ended at 5300 m. Due to the thick sediment cover, detailed relationships between the outcrops of peridotite and gabbro could not be directly observed during the dive. However, the recovered samples indicate that the rock type changes from peridotite to gabbro upslope. This suggests that the lithological boundary between the peridotite and gabbroic rocks may have been crossed in this dive. The peridotite and gabbro samples were fresh to moderately altered with a thin Mn-coating.

Dive #418 visited a ridge-like structure on the landward slope approximately 70 km north of #417 site. The dive started at a depth of 5200 m and ended at 4300 m, encountering occasional outcrops of jointed intrusive and related talus deposits. The 23 rock samples collected during this dive were gabbro and conglomerate, the latter containing gabbroic clasts. Most of the samples were fresh with a thin Mn-coating.

Dive #419 visited the deeper part of the northern landward slope, from a depth of 7000 m to 6500 m. White streaked outcrops, probably consisting of strongly altered peridotite were occasionally observed. This dive recovered 15 rock samples of serpentinized peridotite, gabbro, and strongly altered volcanic breccias. Peridotite samples were collected only from the deeper part of the dive, whereas gabbro and volcanic breccia were collected throughout the dive, across all depths. As with #417, the inference from this is that the dive crossed the lithological boundary between the peridotite and gabbroic rocks.

Figure 2. Newly acquired bathymetry of the Ogasawara Ridge and KAIKO7000II dive sites.

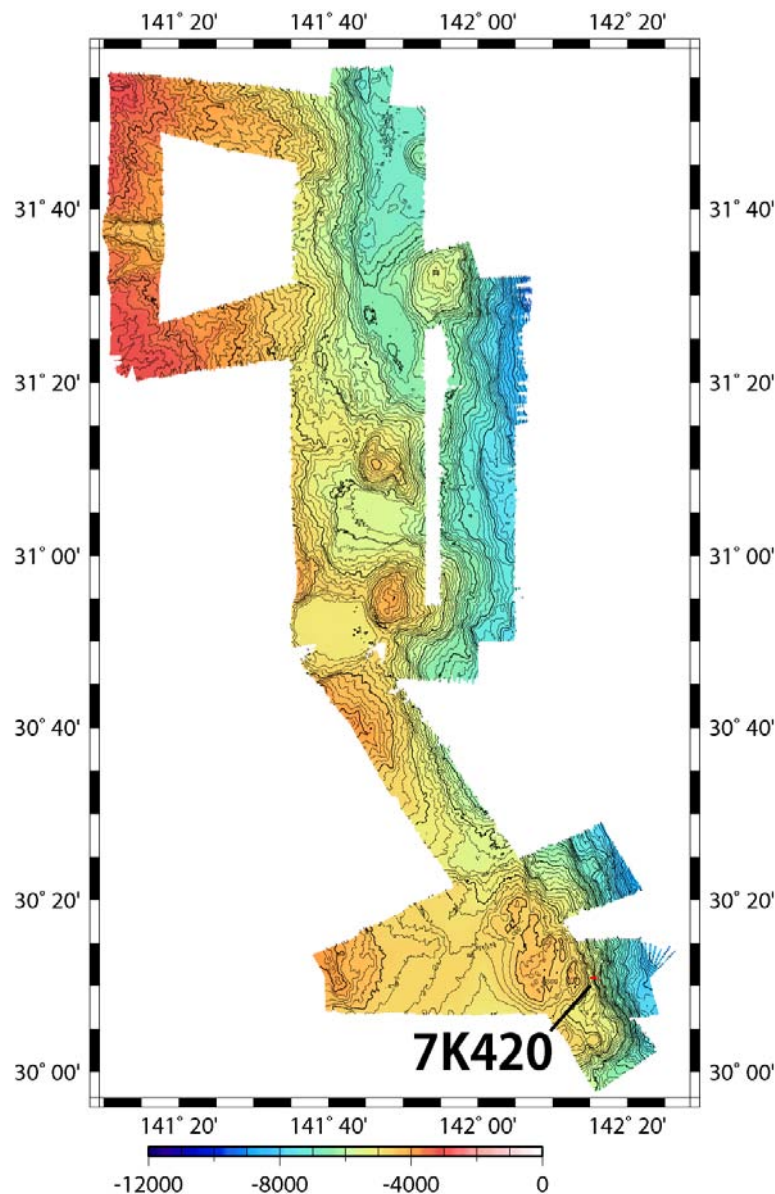


Torishima Forearc:

Discovery of tonalite exposures

Dive #420 visited an unnamed knoll on the landward slope of the Izu-Bonin trench, east of Torishima (Figure 3). Dredging of this knoll in the 1970s by a Russian research vessel recovered granitic rocks, although the sample details are uncertain. Dive #420 started from a depth of 5700 m, traversing the mid-slope of the knoll up to 5100 m, and successfully collected 20 rock samples. During the lower half of the traverse, outcrops of tonalitic intrusive were observed. The tonalites were capped by mudstones in the upper part of the traverse. This is the first discovery of a granitic exposure in the trench wall of an intra-oceanic arc anywhere on Earth. The mudstones do not show evidence of contact metamorphism, which indicates that their deposition post-dates the intrusion of the tonalites.

Figure 3. Newly acquired bathymetry of the Torishima forearc and KAIKO7000II dive site.

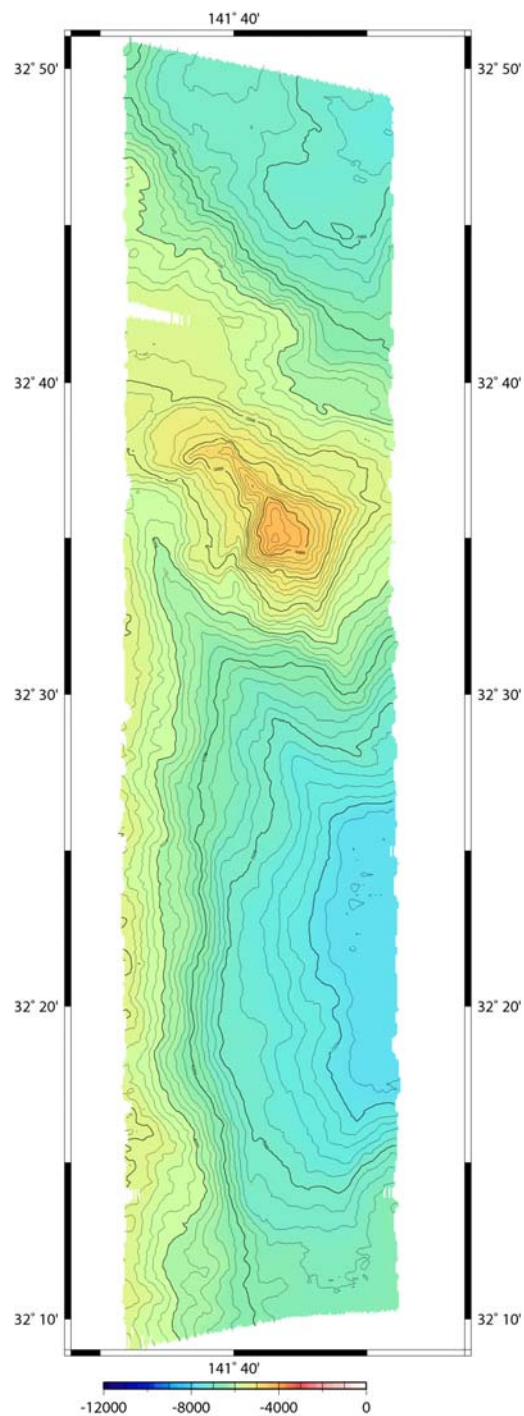


Aogashima Forearc:

Three dive surveys were originally planned on the landward slope of the Izu-Bonin trench, east of Aogashima. As with the surveys at the Ogasawara Ridge and the Torishima Forearc, the objective of these was to investigate the structure and lithology of the deep crustal section of the initial Izu-Bonin arc.

Due to the KAIKO7000II mechanical failure, the dive survey in this area was canceled. For future surveys, new detailed bathymetry was acquired (Figure 4).

Figure 4. Newly acquired bathymetry of the Aogashima forearc..



KR08-07 Shipboard Log:

Date	Time	Log
2008/06/23	10:00	Onboard
	11:00	Departure from Futami Chichijima Island
	13:00-	Briefing about ship's life and safety
	15:00	Arrive at survey area
	15:40	XBT
	16:19	Start MBES survey
	18:30-19:20	Meeting
	Weather: fine but cloudy/ Wind direction: SW/ Wind force: 4/ Wave: 3 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)	
2008/06/24	04:54	Finish MBES survey
	08:35	Launch KAIKO (7K#417 dive)
	10:58	KAIKO lands (5,792m)
	14:01	KAIKO leaves the bottom (5,336m)
	15:50	KAIKO surfaces
	17:08-17:31	Deploy air guns and streamer cable
	19:02	Start SCS survey
	Weather: cloudy/ Wind direction: SSW/ Wind force: 5/ Wave: 3 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)	
2008/06/25	01:51	Finish SCS survey
	05:57-06:19	Air guns and streamer cable come up to surface
	08:24	Launch KAIKO (7K#418dive)
	10:36	KAIKO lands (5,199m)
	14:22	KAIKO leaves the bottom (4,303m)
	15:57	KAIKO surfaces
	19:07	XBT
	19:30-19:35	Meeting
	19:35	Start MBES survey
	Weather: cloudy/ Wind direction: SSW/ Wind force: 4/ Wave: 3 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)	
2008/06/26	02:46	Finish MBES survey
	07:58	Launch KAIKO (7K#419dive)
	10:39	KAIKO lands (6,991m)
	13:46	KAIKO leaves the bottom (6,486m)

	15:49	KAIKO surfaces
	18:00-18:05	Meeting
	Weather: fine but cloudy/ Wind direction: SW / Wind force: 5/ Wave: 3 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)	
2008/06/27	06:00	Arrive at Futami, Chichijima Island and moor to the buoy
	Weather: cloudy/ Wind direction: SW / Wind force: 4/ Wave: 1 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)	
2008/06/28	16:00	Depart from Futami Chichijima Island
	Weather: fine but cloudy/ Wind direction: WNW / Wind force: 3/ Wave: 1 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)	
2008/06/29	05:00	Arrive at survey area
	05:14	XBT
	05:48	Start MBES survey
	06:08	Finish MBES survey
	08:26	Launch KAIKO (7K#420dive)
	10:37	KAIKO lands (5,704m)
	13:30	KAIKO leaves the bottom (5,137m)
	15:16	KAIKO surfaces
	16:21-16:41	Deploy air guns and streamer cable
	17:09	Start SCS survey
	Weather: fine but cloudy/ Wind direction: West / Wind force: 2/ Wave: 2 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)	
2008/06/30	12:38	Finish SCS survey
	12:38-13:08	Air guns and streamer cable reach surface
	14:57	Start MBES survey
	Weather: cloudy/ Wind direction: WSW / Wind force: 5/ Wave: 3 m/ Swell: 1 m/ Visibility: 7 nautical miles (12:00 JST)	
2008/07/01	12:06-12:26	Deploy air guns and streamer cable
	12:50	Start SCS survey
	13:00-14:00	Ship's facility tour
	18:00-18:05	Meeting
	Weather: fine but cloudy/ Wind direction: ENE / Wind force: 5/ Wave: 3 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)	

2008/07/02	08:45	Finish SCS survey
	10:25-17:00	SCS survey
	17:32-17:49	Air guns and streamer cable reach surface
	19:20	XBT
	19:43-23:01	MBES survey
	23:05	Transit to Yokosuka
	Weather: fine but cloudy/ Wind direction: ENE / Wind force: 4/ Wave: 3 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)	

2008/07/03	11:30	Disembark R/V KAIREI
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2. Operations and data processing information

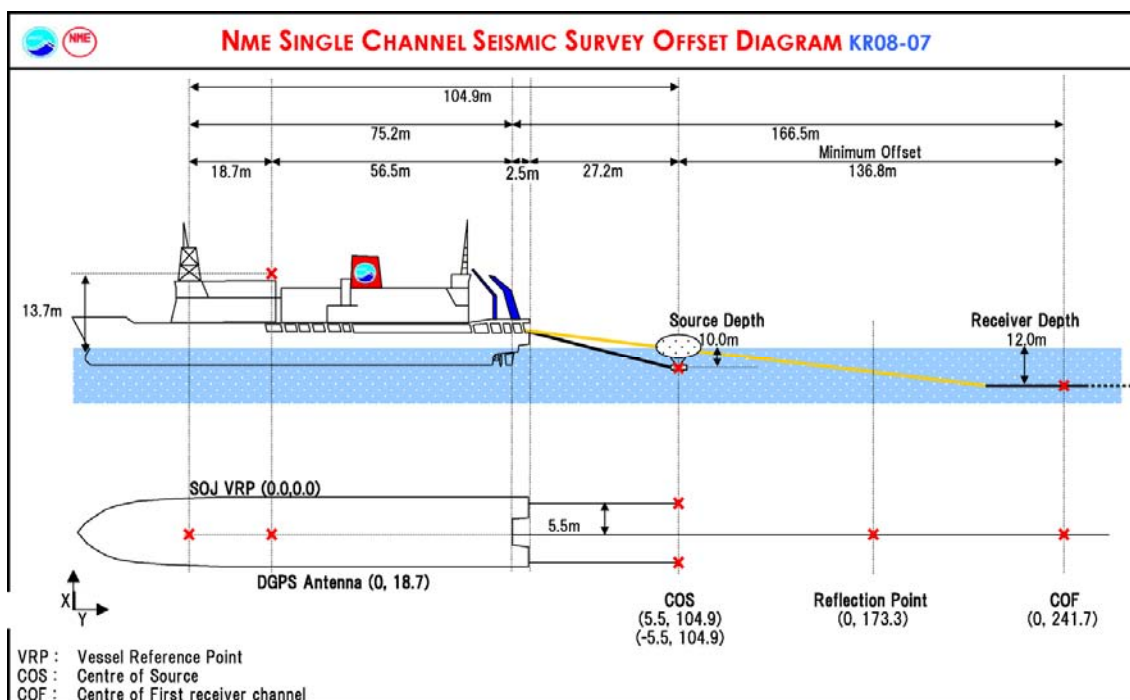
2.1 SEABEAM bathymetric survey

Bathymetric data were obtained using a hull-mounted multi-narrow beam mapping system SEABEAM 2112 aboard R/V KAIREI. The SEABEAM system has hydrophone arrays that synthesize narrow, fan-shaped beams. The system can collect multiple soundings on each ping cycle over a depth range of 100 to 11,000 meters, providing swath width coverage up to 120° ($< 4,000$ mbsl). The ship speed was kept below 12 knots (against water) during the SEABEAM survey. In bathymetric measurements, one of the important parameters is the sound velocity profile of the local water column. We calculated the sound velocity profile onboard, using a temperature profile based on in-situ XBT (Expendable Bathythermograph) measurements.

2.2 Single-Channel Seismic (SCS) survey

The single channel seismic (SCS) system is comprised of generator-injector (G.I.) air gun(s) as a seismic source, a streamer cable as a receiver, controllers for firing and data processors. Compressed air was supplied from air compressors aboard R/V KAIREI. During KR08-07 surveys, 2 GI guns were towed 27.2 m aft, at a depth of 10 m. The generator (G) and injector (I) were fired simultaneously to give a total gun volume of 710 cubic in. Seismic waves were received by an analog streamer filled with mineral oil. The streamer had an active section of 47 m, with 48 hydrophones, which was towed 135m aft, at a depth of 12 m (Figure 5). Received seismic data were monitored with an on-line processing system and recorded digitally in SEG-Y format. The system was operated at a ship speed of ~ 4 knots (against ground), with shot intervals of 10-14 seconds.

Figure 5. Offset diagram of the SCS survey



2.3 KAIKO7000II survey

Geological observations and rock / sediment sampling were conducted using the ROV KAIKO7000II (Figure 6). The KAIKO7000II is capable of operating to a maximum depth of 7000 m. The general payload of the KAIKO7000II surveys was a large sample basket subdivided into 4 smaller spaces, including a box covered by a lid. In some dives, the MBARI-type core was used to sample soft sediments.

Rock and sediment samples, video images (high definition & CCD cameras), and digital still-photographs (SEAMAX) from the dives are archived at JAMSTEC.

Figure 6. ROV KAIKO7000II system



3. Scientific results

3.1 SEABEAM bathymetric survey

New bathymetry data were obtained using SEABEAM 2112 in each survey area (Figure 2 – 4). These data were used to make a final decision regarding the KAIKO7000II dive sites, and will also be combined with preexisting multi-narrow beam data to produce final bathymetric maps.

3.2 SCS surveys

One SCS survey line was conducted in the Ogasawara Ridge area (Figure 1). Line SCS-1 crosses the landward trench slope in E-W direction, through the area covered by KAIKO7000II #417 dive (Figure 7).

Five SCS survey lines were conducted in the Torishima Forearc area (Figure 1). Lines SCS-2 and -3 transect the unnamed knoll on the landward trench slope, surveyed in KAIKO7000II #420 dive, in E-W and ENE – WSW directions, respectively (Figure 8 & 9). Lines SCS-4, -5, and -6 transect the northern trench slope in ENE-WSW, N-S, and WNW-ESE directions, respectively (Figure 10, 11, & 12). The intersection between Line-4 and -5 corresponds to the proposed IODP drilling site 696-Pre “IBM-2”.

Figure 7. Seismic profile of SCS-1

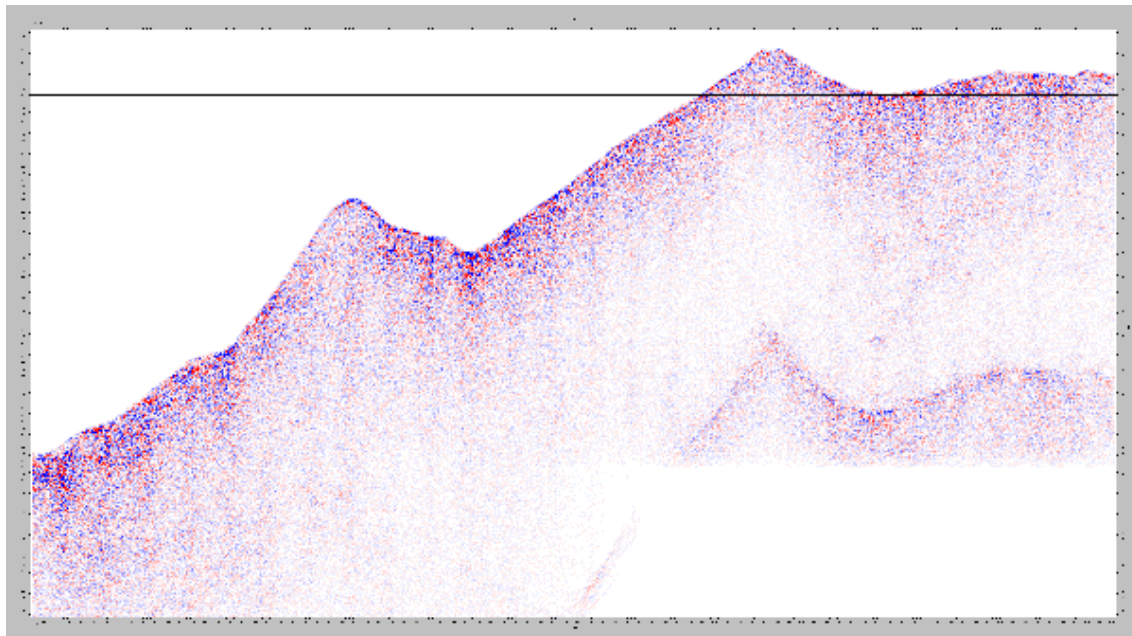


Figure 8. Seismic profile of SCS-2

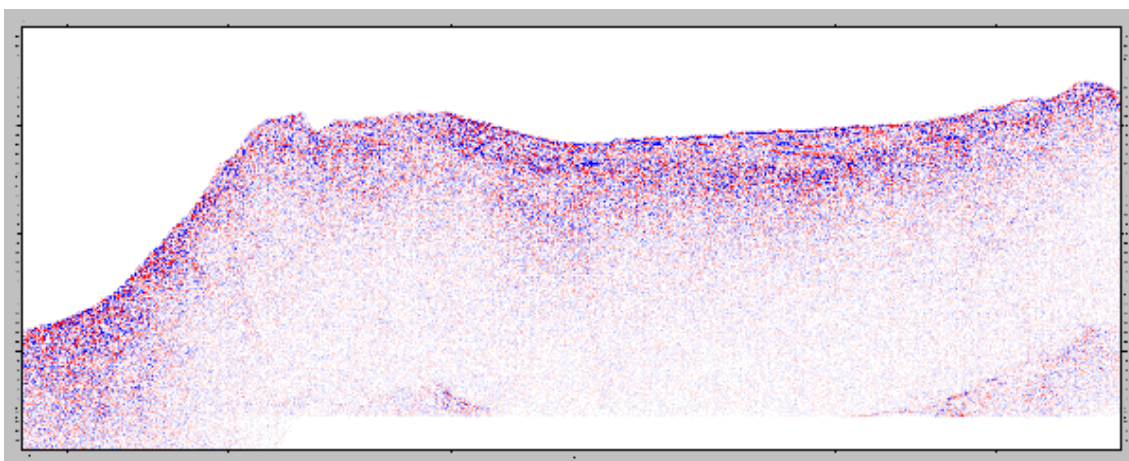


Figure 9. Seismic profile of SCS-3

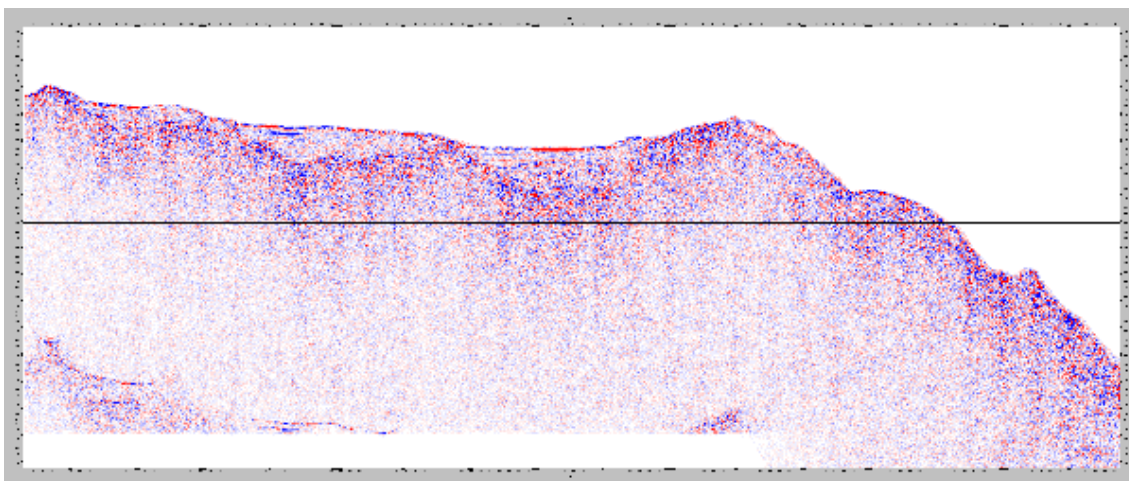


Figure 10. Seismic profile of SCS-4

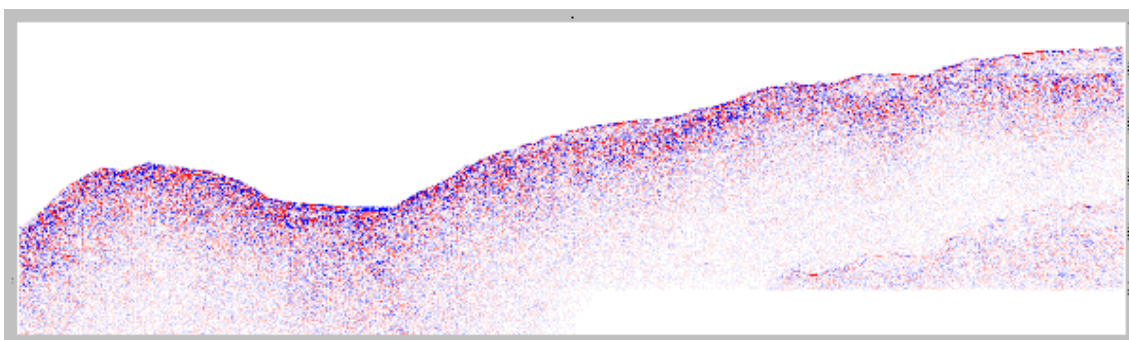


Figure 11. Seismic profile of SCS-5

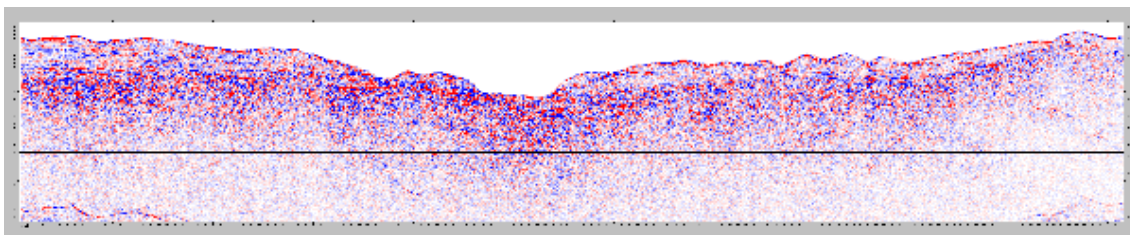
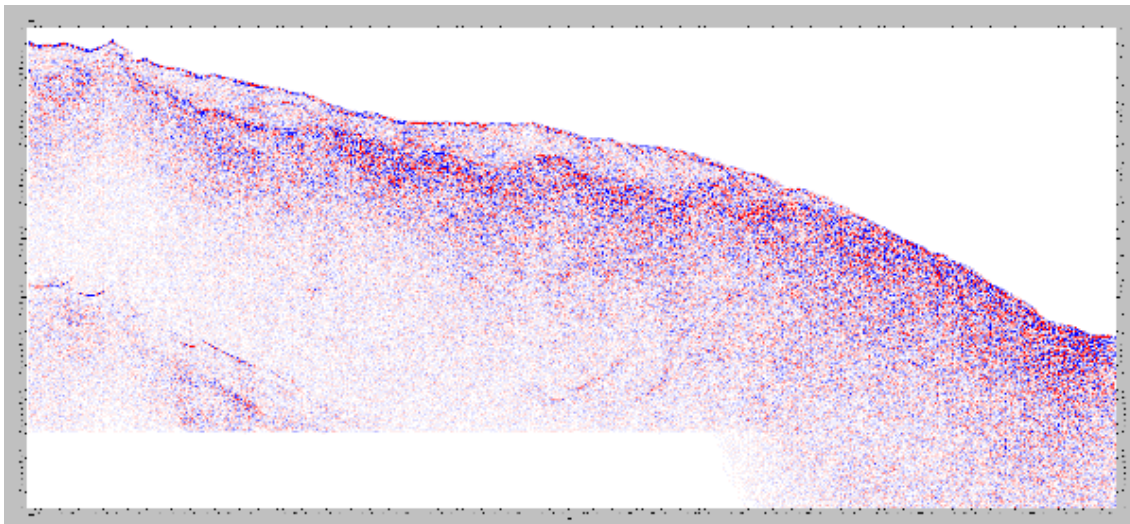
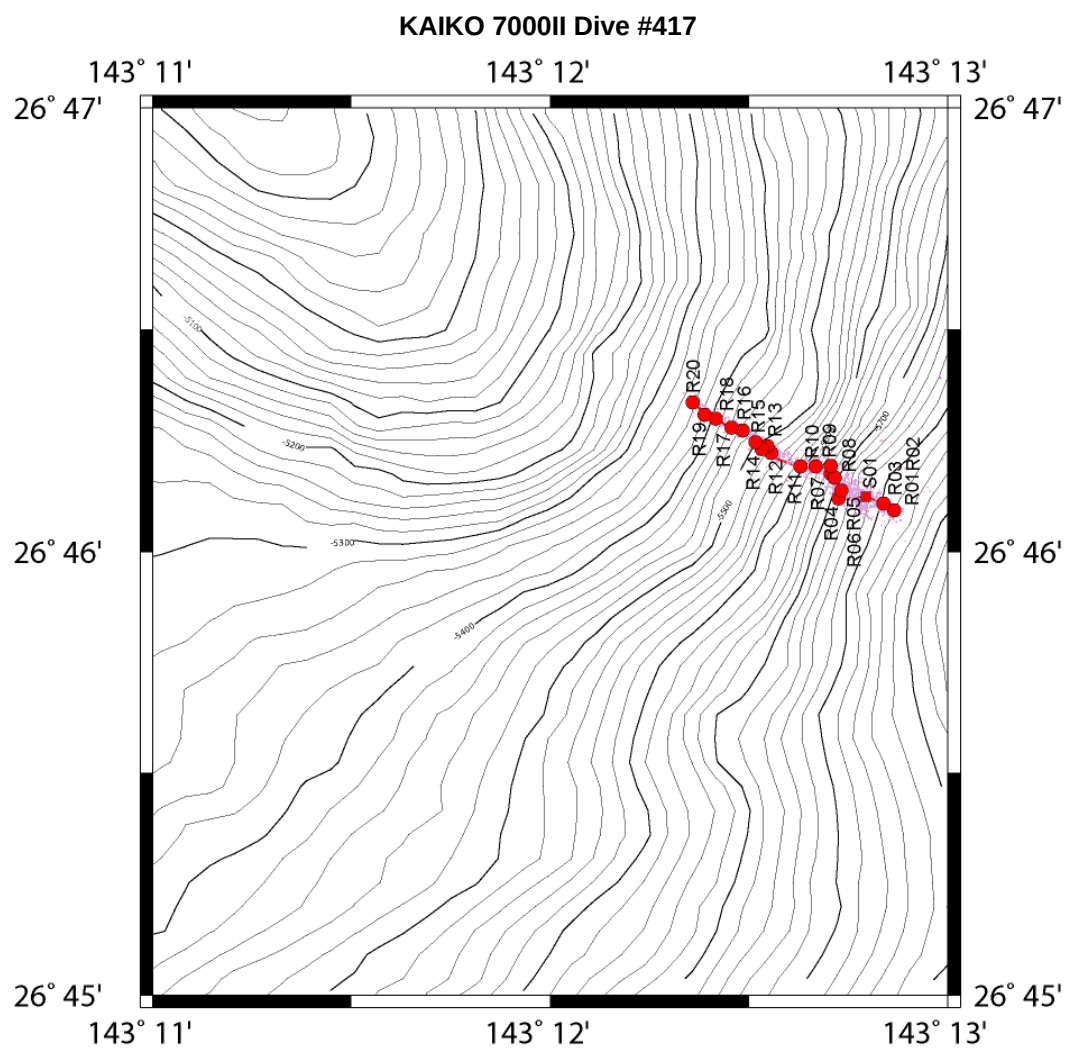


Figure 12. Seismic profile of SCS-6



3.3 KAIKO7000II dive surveys

3.3.1 #417 dive



Date: 2008/06/24

Objective

To survey the landward slope of Izu-Ogasawara trench east of Hahajima, close to D31 dredge site of R/V Hakuho-maru in 2007 (KH07-02 Leg. 4 cruise). The chief objective of the dive is to find exposures of the deep crustal section at the trench slope.

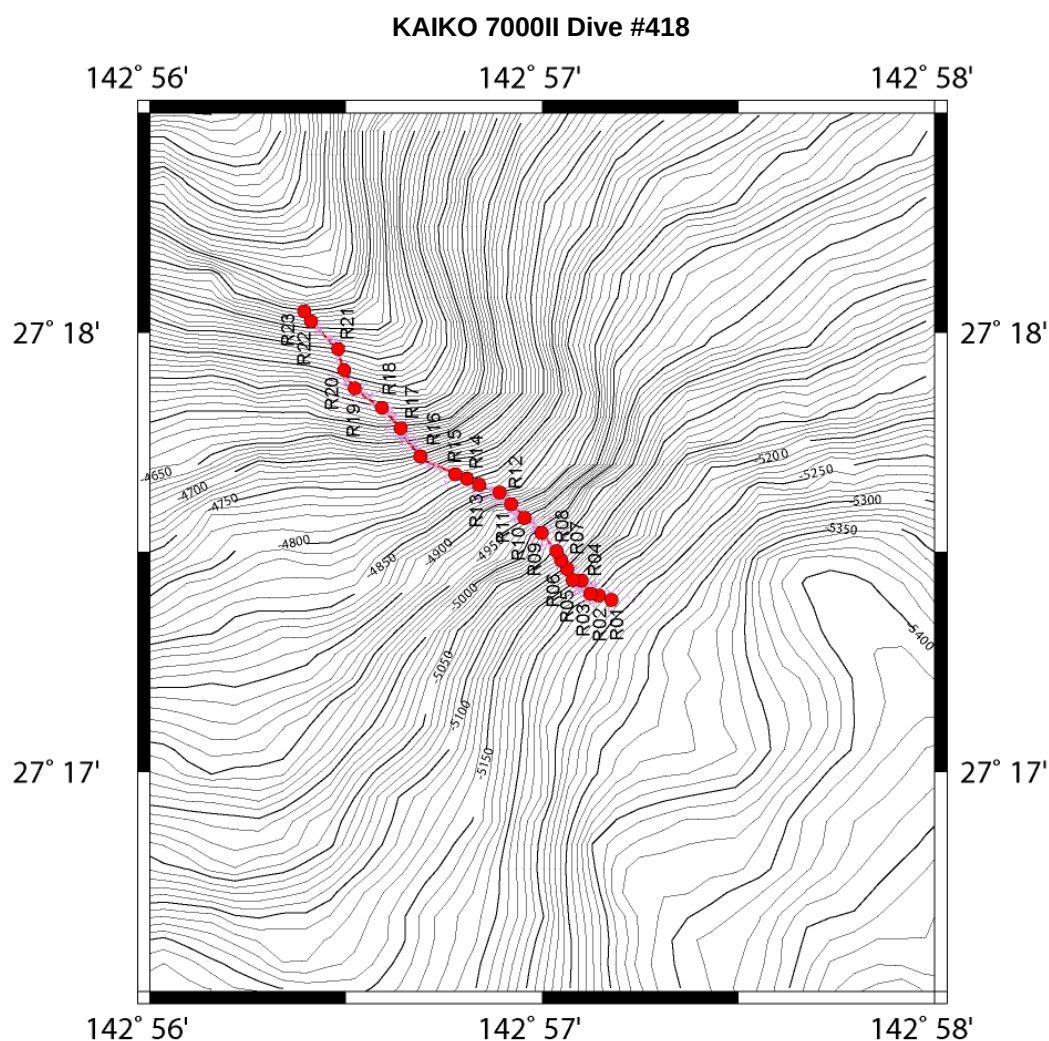
Dive Summary

Start: 26° 46.11' N, 143° 46.35' E (depth = 5792 m) 10:58

Finish: 26° 46.35' N, 143° 12.35' E (depth = 5336 m) 14:01

Recovered samples: 19 rock samples (peridotite, gabbro, and conglomerate) & 1 sediment core.

3.3.2 #418 dive



Date: 2008/06/25

Objective

The dive track has been designed to transect the ridge-like structure in the forearc region of the Izu-Bonin arc, with the aim of investigating the structure and lithology of the basal part of the arc crust. This site is located ~70 km north of #417 dive site, close to the dredge site of the R/V Hakuho-maru cruise in 2007 (KH07-02 Leg. 4 cruise, D37).

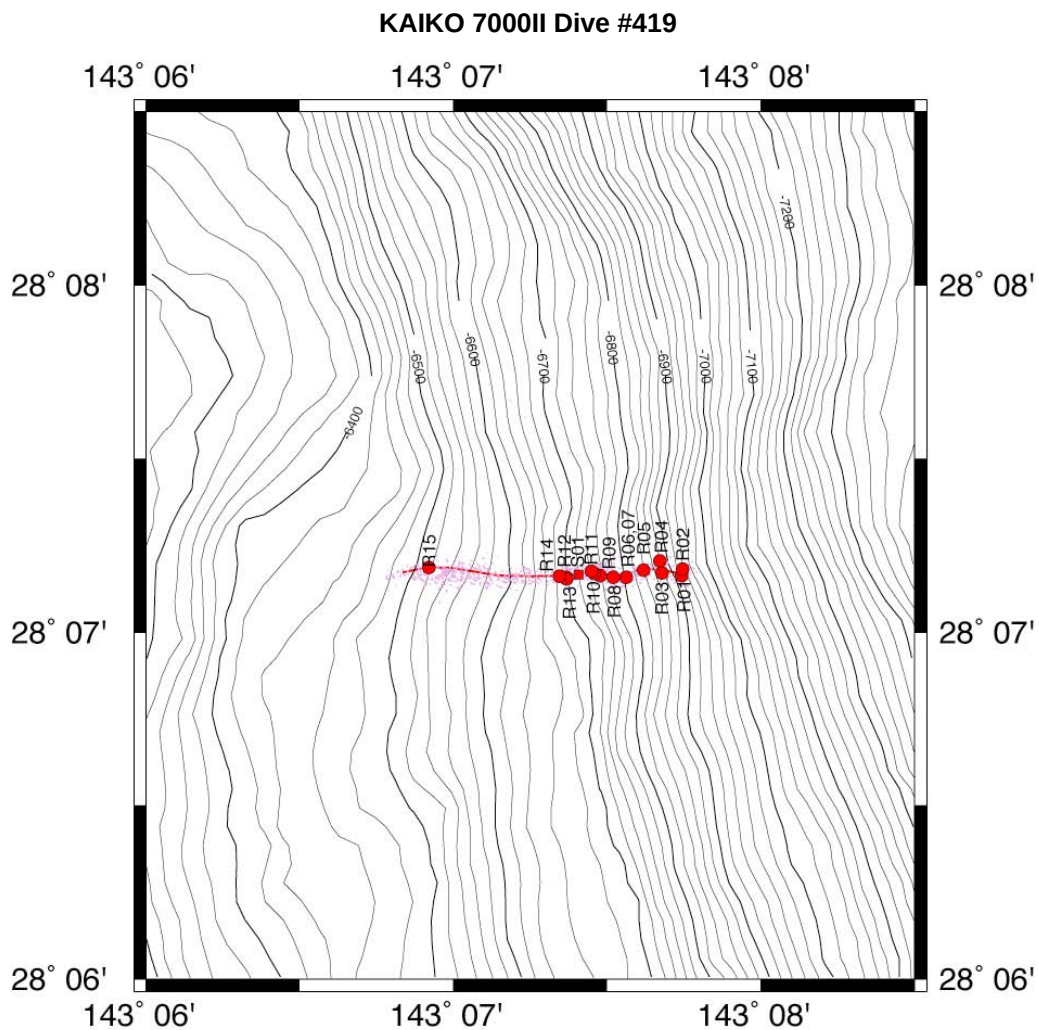
Dive Summary

Start: 27° 17.35' N, 142° 57.20' E (depth = 5199 m) 10:35

Finish: 27° 18.05' N, 142° 56.40' E (depth = 4303 m) 14:22

Recovered samples: 23 rock samples (gabbro and conglomerate).

3.3.3 #419 dive



Date: 2008/06/26

Objective

In this dive, ~100 km north of #418 dive site, the deeper part (7000 m) of the landward trench slope will be surveyed. This will allow us to investigate what is exposed on the lower portion of the forearc slope and determine whether the observations from the previous dives that peridotite tends to dominate the lower part of the trench slope hold.

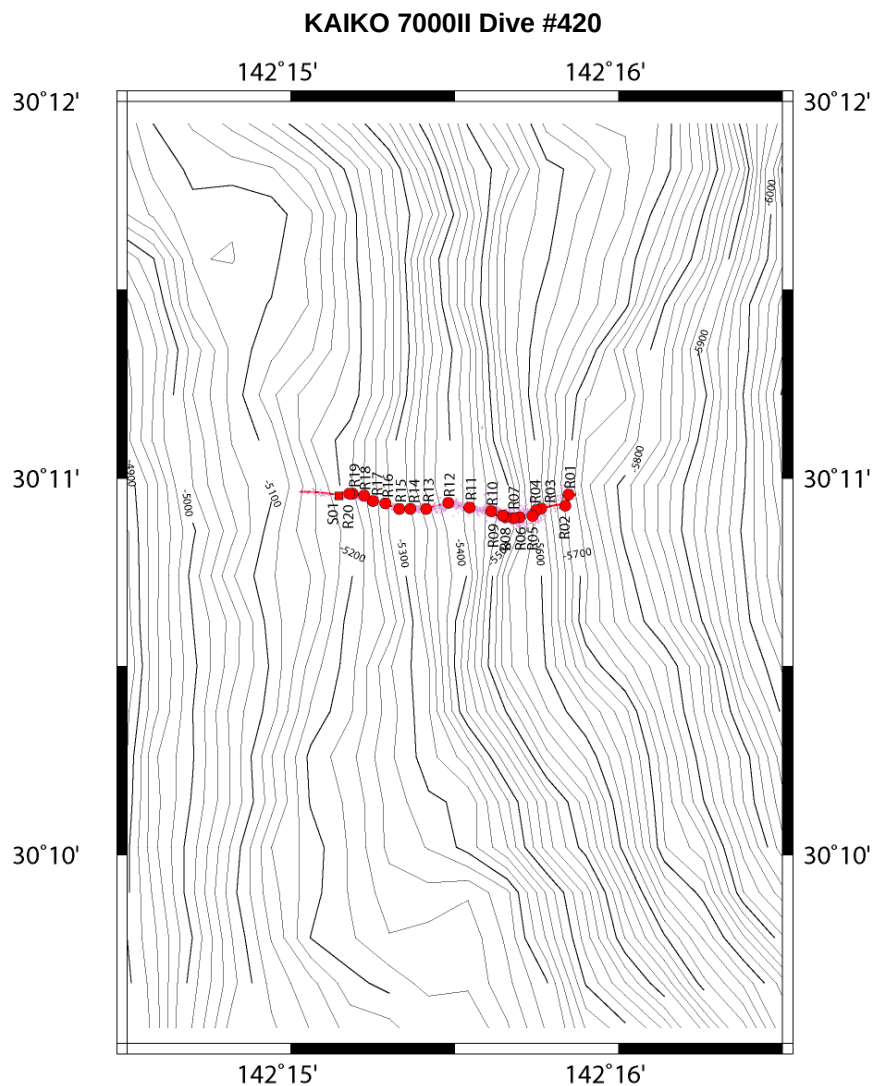
Dive Summary

Start: 28° 07.18' N, 143° 07.80' E (depth = 6994 m) 10:39

Finish: 28° 07.16' N, 143° 06.80' E (depth = 6486 m) 13:46

Recovered samples: 15 rock samples (peridotite, gabbro, volcanic breccia, and mudstone) & 1 sediment core.

3.3.4 #420 dive



Date: 2008/06/29

Objective

To dive on the landward slopes of an unnamed 300 m high knoll on the western slope of the Izu-Bonin trench, previously dredged by the Russian research vessel during the 1970s. The Russian dredge recovered granitic rocks. The chief objective of the dive is to find this granitic outcrop and investigate the geology and structure of a granite exposure.

Dive Summary

Start: 30° 11.30' N, 142° 15.90' E (depth = 5704 m) 10:37

Finish: 30° 10.60' N, 142° 14.80' E (depth = 5137 m) 13:30

Recovered samples: 20 rock samples (tonalite and mudstone) & 1 sediment core.

4. Notice on using this cruise report

This cruise report is a preliminary documentation as of the end of the cruise. It may not be corrected even if changes on content (i.e. taxonomic classifications) are found after publication. It may also be changed without notice. Data on the cruise report may be raw or not processed. Please ask the Chief Scientist for the latest information before using.