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KAIREI Cruise Report

KR09-04

R/V KAIREI + ROV KAIKO7000II

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

June 14, 2009 – June 24, 2009
KURIHAMA – JAMSTEC

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

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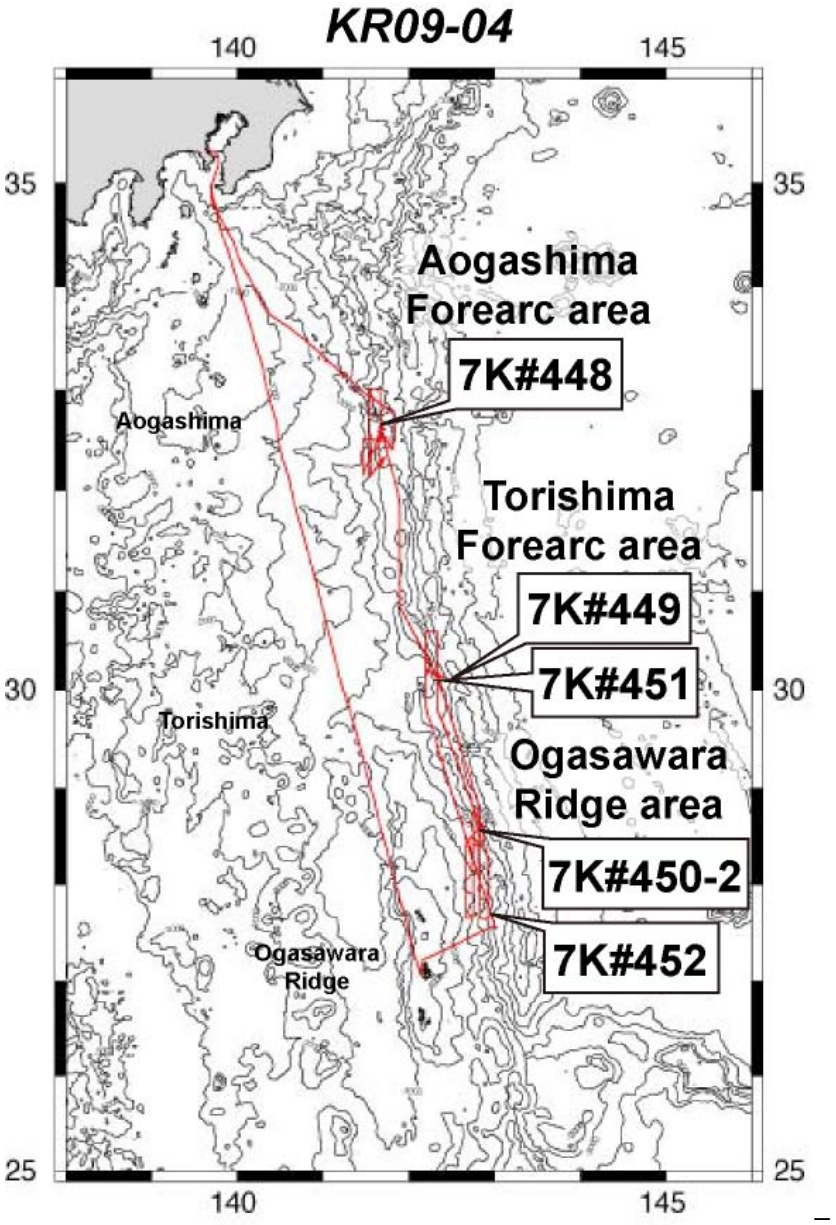
Acknowledgements

We are grateful to Captain S. Susami and the crew of the R/V KAIREI, the ROV KAIKO7000II 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. KR09-04 survey ship track



1. Cruise Summary

R/V KAIREI and ROV KAIKO7000II cruise (KR09-04) was held from June 14, 2009 to June 24, 2009. The cruise started at Kurihama port, Yokosuka and ended at JAMSTEC pier. The chief target of the cruise was to discover outcrops of deep crustal section formed at the earliest stage of Izu-Bonin arc magmatism. From the dredge surveys of recent cruises, the most likely setting to find such sequence is the landward slope of the northern Izu-Bonin trench.

As a result, we selected 3 survey areas in the trench where the chances of finding exposures of initial arc crustal sections were highest; Aogashima Forearc, Torishima Forearc, and Ogasawara Ridge (Figure 1). We have surveyed the same areas with this objective by KAIKO7000II in June-July, 2008 (KR08-07 cruise) which originally planned to have 9 dives. However, due to the mechanical failure of KAIKO system, only 4 dives (Dive#417 – 420) were completed during the 2008 cruise. This KR09-04 cruise was organized to accomplish the originally planned surveys.

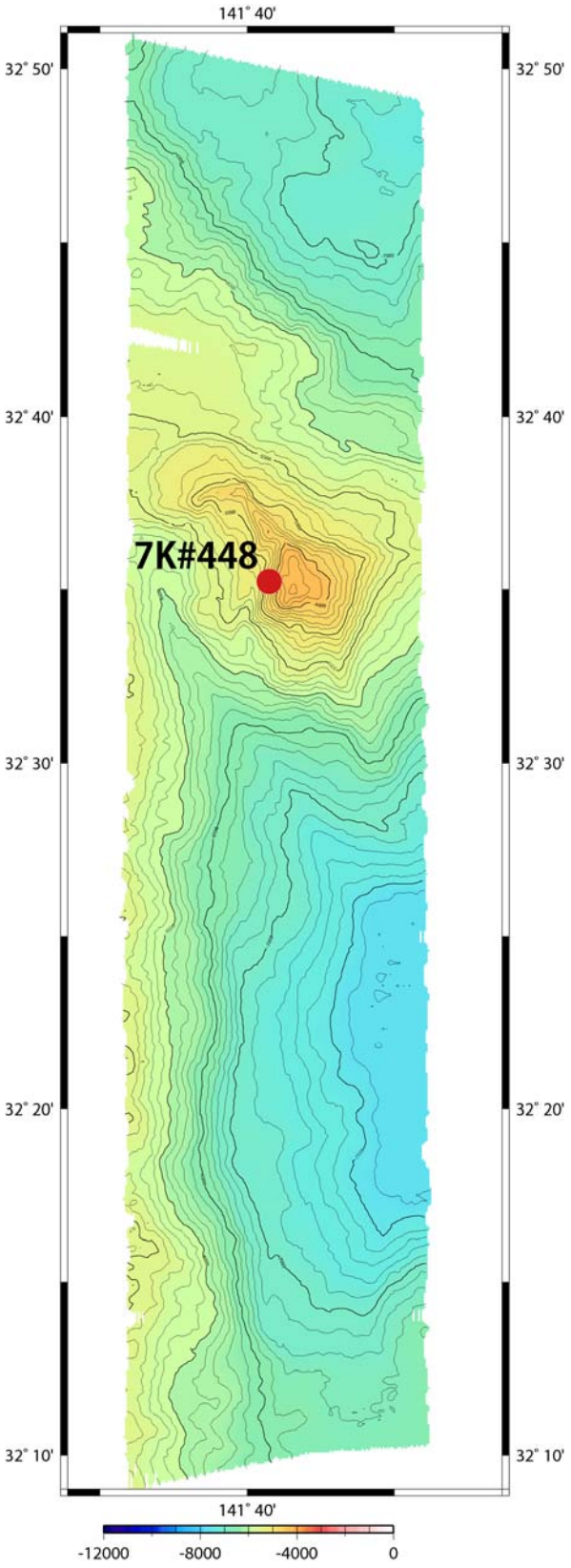
Luckily, we were successful in accomplishing planned 5 dives: 1 dive in Aogashima Forearc (Dive#448), 2 dives in Torishima Forearc (Dive#449 & 451), and 2 dives in Ogasawara Ridge (Dive#450-2 & 452), with detailed geological observations of the deep crustal sections and rock sampling. The recovered rocks from these deep crustal sections will provide us completely new information on the crustal formation during the initial stage of the arc magmatism. The following summarizes our findings in each survey area;

Aogashima Forearc:

One KAIKO7000II dive (Dive#448) was conducted at a knoll on the landward slope of the Izu-Bonin trench, east of Aogashima (Figure 1). Small fragments of tonalitic rock were previously dredged from this knoll by Tansei-Maru cruise (KT06-09). The dive survey to this knoll was planned to discover the outcrops of these rocks.

Dive#448 visited the western slope of the knoll from a depth of 5234 to 4536 mbsl (Figure 2). Outcrops of jointed intrusive rocks and associated talus deposits are frequently observed at the lower part of the slope, and then gradually covered with sediments at the upper part. A total of 28 rocks were successfully collected, which were mostly gabbroic and basaltic rocks with some diorite and serpentinite samples. The rocks show variable degree of alteration with a thin-Mn coating.

Figure 2. Bathymetric map of Aogasima forearc



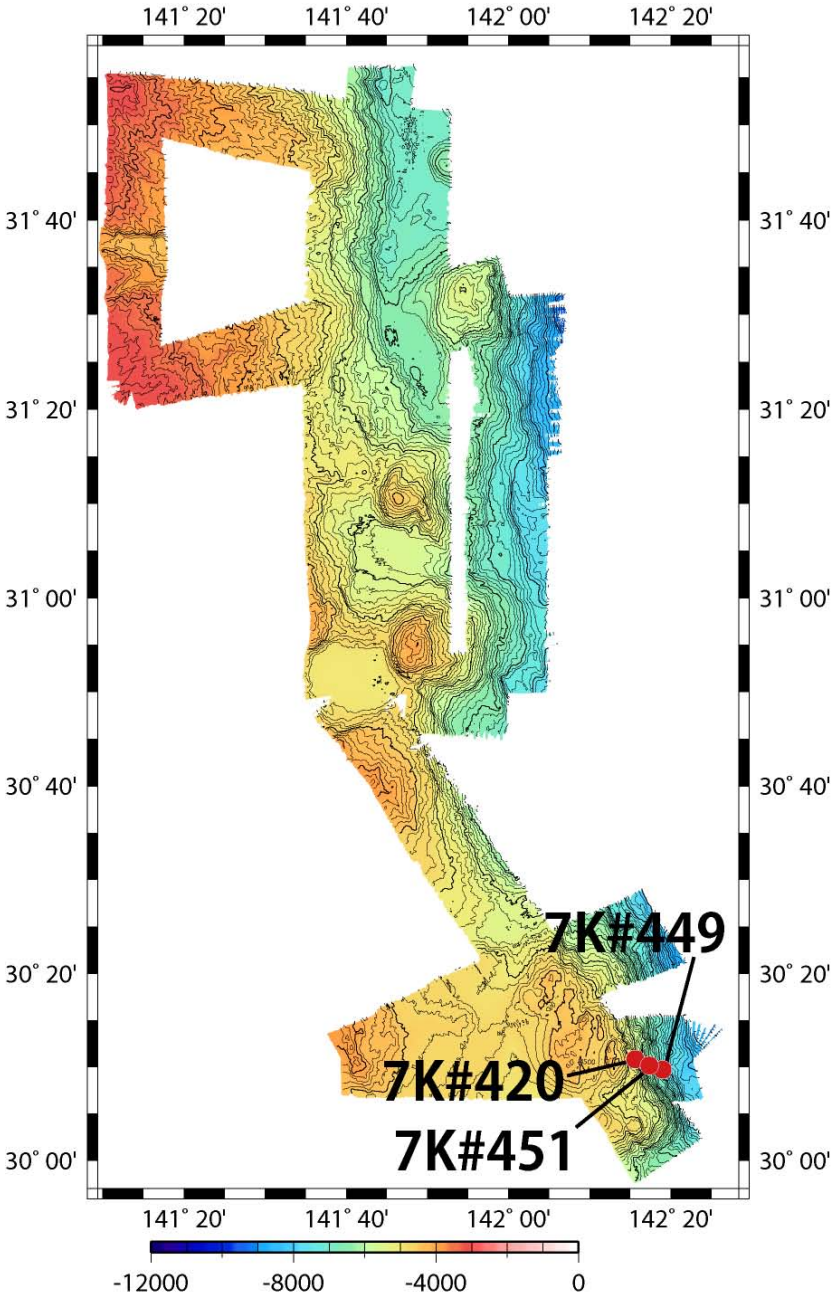
Torishima Forearc:

Two KAIKO7000II dives (Dive#449 and 451) were conducted at an unnamed seamount on the landward slope of the Izu-Bonin trench, east of Torishima (Figure 1). Dredging of this seamount in the 1970s by a Russian research vessel recovered granitic rocks, although the sample details are uncertain. KAIKO7000II survey during the KR08-07 cruise (Dive#420) conducted in this seamount was successful in discovering outcrops of tonalitic rocks from a depth of 5700 to 5300 mbsl.

Dive#449 visited the deeper part of the seamount from a depth of 6993 to 6717 mbsl, traversing ~0.6 km in a horizontal distance (Figure 3). A total of 18 samples were recovered. Most of the samples were basalt and dolerite/fine-grained gabbro with variable degrees of alteration with a thin Mn-coating. Several rocks are weakly to highly altered, and are brecciated with carbonate-veins/cementations.

Dive#451 visited the middle section of the seamount from a depth of 6250 to 5551 mbsl (Figure 3). Outcrops of white intrusive rock and associated talus deposits were frequently observed which was composed of dacitic porphylite with large quartz phenocrysts. A total of 30 samples were recovered, mainly porphylite with some gabbros, basalts, and tonalites. The rocks were mostly fresh to weakly altered with a thin Mn-coating.

Figure 3. Bathymetric map of Torishima forearc



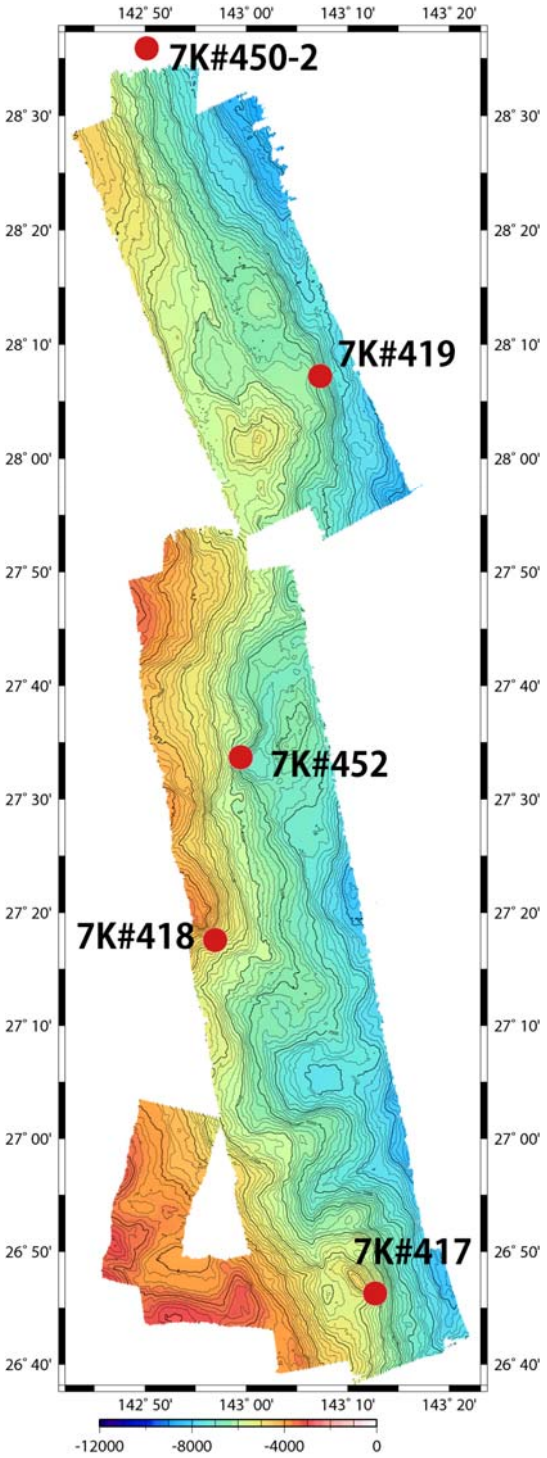
Ogasawara Ridge:

Two KAIKO7000II dives (Dive#450-2 and 452) were conducted on the landward slope of the Izu-Bonin trench, where it forms the eastern slopes of the Ogasawara Ridge (Figure 1).

Dive#450-2 visited the northen part of the Ogasawara Ridge forearc slope (Figure 4), and was successful in finding outcrops of gabbroic and basaltic intrusive and associated talus deposits. The dive covered a horizontal distance of ~2 km. A total of 26 rock samples were recovered. The dive started from a depth of 6941 m and ended at 6552 m. In general, lower part of the surveyed section is composed of mudstone and basalt, whereas samples collected from the upper part were gabbros. The collected gabbro and basalt samples were weakly to highly altered with a thin Mn-coating.

Dive#452 visited the southern part of the Ogasawara Ridge forearc slope (Figure 4). The dive started at a depth of 6958 m and ended at 6379 m, covering ~1.8 km in a horizontal distance. The dive encountered outcrops of mono-lithologic talus deposits with occasional outcrops of intrusive rocks. The 29 rock samples collected during this dive were mainly gabbroic and basaltic rocks. The samples showed variable degree of alteration from fresh to highly altered with a thin Mn-coating.

Figure 4. Bathymetric map of Ogasawara Ridge forearc



KR09-04 Shipboard Log:

2009/05/14

12:00 Onboard

13:00 Departure from Kurihama port

14:00-14:35 Briefing about ship's life and safety

14:40-15:00 Briefing about KAIKO

18:00-18:30 Science Meeting

Weather: fine but cloudy/ Wind direction: SSE/ Wind force: 5/ Wave: 1 m/ Swell: 0 m/ Visibility: 8 nautical miles (12:00 JST)

2009/05/15

00:45 XBT

01:50 Arrive at survey area “J”

01:52 Start MBES survey

03:42 End MBES survey

06:30 Departure from survey area “J”

07:30 Arrive at survey area “I”

09:15 Departure from survey area “I”

10:36 Start MBES survey

23:58 End MBES survey

Weather: fine but cloudy/ Wind direction: ENE/ Wind force: 6/ Wave: 4 m/ Swell: 3 m/ Visibility: 8 nautical miles (12:00 JST)

2009/05/16

06:00 Arrive at survey area “J”

08:27 Launch KAIKO (7K#448dive)

10:44 KAIKO lands (5,234m)

14:33 KAIKO leaves the bottom (4,536m)

16:18 KAIKO on deck

19:50-20:00 Science Meeting

20:12 Start MBES survey

Weather: cloudy/ Wind direction: East/ Wind force: 4/ Wave: 3 m/ Swell: 2 m/ Visibility: 8 nautical miles (12:00 JST)

2009/05/17

01:09 End MBES survey

06:00 Arrive at survey area “D”

06:01 XBT

08:30 Launch KAIKO (7K#449dive)
11:27 KAIKO lands (6,997m)
13:20 manipulator malfunctioned, left hand in use
14:33 KAIKO leaves the bottom (6,717m)
16:58 KAIKO on deck
18:45-18:53 Science Meeting
23:22 Start MBES survey
Weather: fine but cloudy / Wind direction: SSE/ Wind force: 5/ Wave: 3 m/ Swell: 2 m/ Visibility: 8 nautical miles (12:00 JST)

2009/05/18
03:13 End MBES survey
06:00 Arrive at survey area “C”
06:00 XBT
08:30 Launch KAIKO (7K#450-1dive) – 150m test not passed
09:21 KAIKO on deck
13:39 Start MBES survey
Weather: fine but cloudy / Wind direction: South/ Wind force: 4/ Wave: 3 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)

2009/05/19
04:08 End MBES survey
06:00 Arrive at survey area “C”
08:28 Launch KAIKO (7K#450-2dive)
10:52 KAIKO lands (6,941m)
14:38 KAIKO leaves the bottom (6,555m)
16:45 KAIKO on deck
20:00-20:10 Science Meeting
22:27 Start MBES survey
Weather: fine but cloudy / Wind direction: South / Wind force: 3/ Wave: 2 m/ Swell: 1 m/ Visibility: 7 nautical miles (12:00 JST)

2009/05/20
04:42 End MBES survey
06:00 Arrive at survey area “D”
08:36 Launch KAIKO (7K#451dive)
10:53 KAIKO lands (6,260m)
14:52 KAIKO leaves the bottom (5,662m)
16:51 KAIKO on deck

19:50-20:00 Science Meeting
17:58 Start MBES survey
19:40 End MBES survey
Weather: rain / Wind direction: SW/ Wind force: 5/ Wave: 3 m/ Swell: 1 m/ Visibility: 3 nautical miles (12:00 JST)

2009/05/21
06:00 Arrive at survey area “B”
06:00 XBT
08:36 Launch KAIKO (7K#452dive)
11:01 KAIKO lands (6,958m)
14:41 KAIKO leaves the bottom (6,380m)
16:48 KAIKO on deck
21:15 Arrive at Futami, Chichijima Island
Weather: Overcast / Wind direction: NE/ Wind force: 4/ Wave: 3 m/ Swell: 2 m/ Visibility: 7 nautical miles (12:00 JST)

2009/05/22
08:30 Tani & Miyajima get off R/V KAIREI
10:00 Transit to Yokosuka (JAMSTEC)
13:00 Emergency Drill
Weather: Overcast / Wind direction: South/ Wind force: 3/ Wave: 2 m/ Swell: 1 m/ Visibility: 7 nautical miles (12:00 JST)

2009/05/23
Transit to Yokosuka (JAMSTEC)
Weather: fine but cloudy / Wind direction: South/ Wind force: 4/ Wave: 3 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)

2009/05/24
09:00 Arrival at Yokosuka (JAMSTEC), KR09-04 finish and disembarkation

2. Operations and data processing information

2.1 KAIKO7000II survey

Geological observations and rock / sediment sampling were conducted using the ROV KAIKO7000II (Figure 5). 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 5. ROV KAIKO7000II system

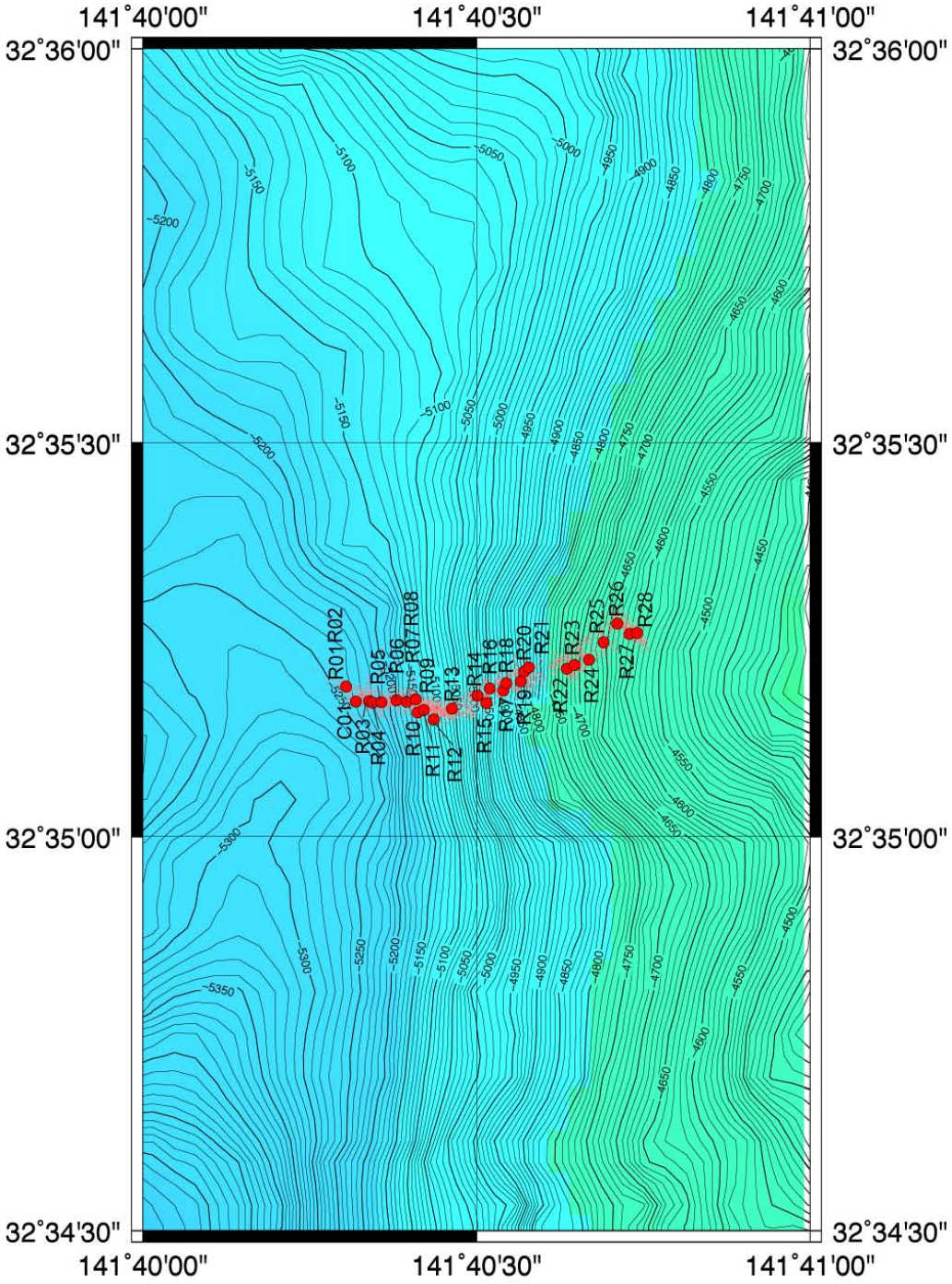
3. Scientific results

3.1 KAIKO7000II dive surveys

3.1.1 #448 dive

KAIKO 7000II Dive #448

7K448



Date: 2009/05/16

Objective

The dive was planned on a 1000 m-high knoll at the landward trench slope of Aogashima forearc. KAIKO Dive#420 (KR08-07) discovered exposures of granitic rock (tonalite) from a knoll in Torishima forearc, located to the south of this area. The observation of Dive#420 indicated that the crustal materials like granitic rock are exposed on the landward slope of the Izu-Bonin trench. At this planned area, similar fragments of granitic rocks were previously dredged by Tansei-Maru cruise (KT06-09). The dive was planned to confirm the dredge results.

Dive Summary

Start: 32° 35.20’ N, 141° 40.40’ E (depth = 5234 m)

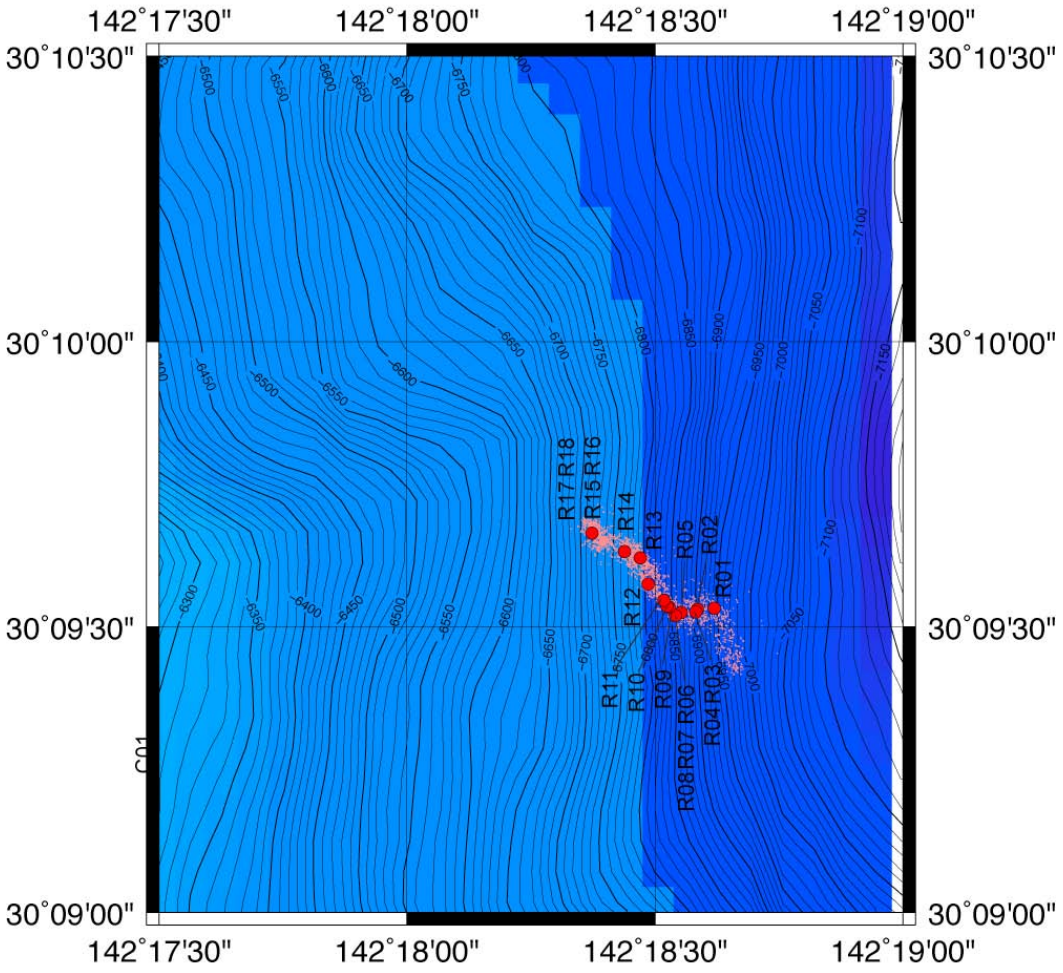
Finish: 32° 35.24’ N, 141°40. 75’ E (depth = 4536 m)

Recovered samples: 28 rock samples (gabbro, metabasalt, serpentine, diorite, and conglomerate) & 1 sediment core.

3.1.2 #449 dive

KAIKO 7000II Dive #449

7K449



Date: 2009/05/17

Objective

The dive was planned to survey the deeper part of an unnamed seamount at landward trench slope in Torishima forearc previously studied by KAIKO Dive#420. The Dive#420 succeeded to recover tonalitic samples from 5700 to 5400 mbsl. In order to explore the deeper section of the seamount, we planned this dive route starting from 7000 mbsl and end at 6000 mbsl.

Dive Summary

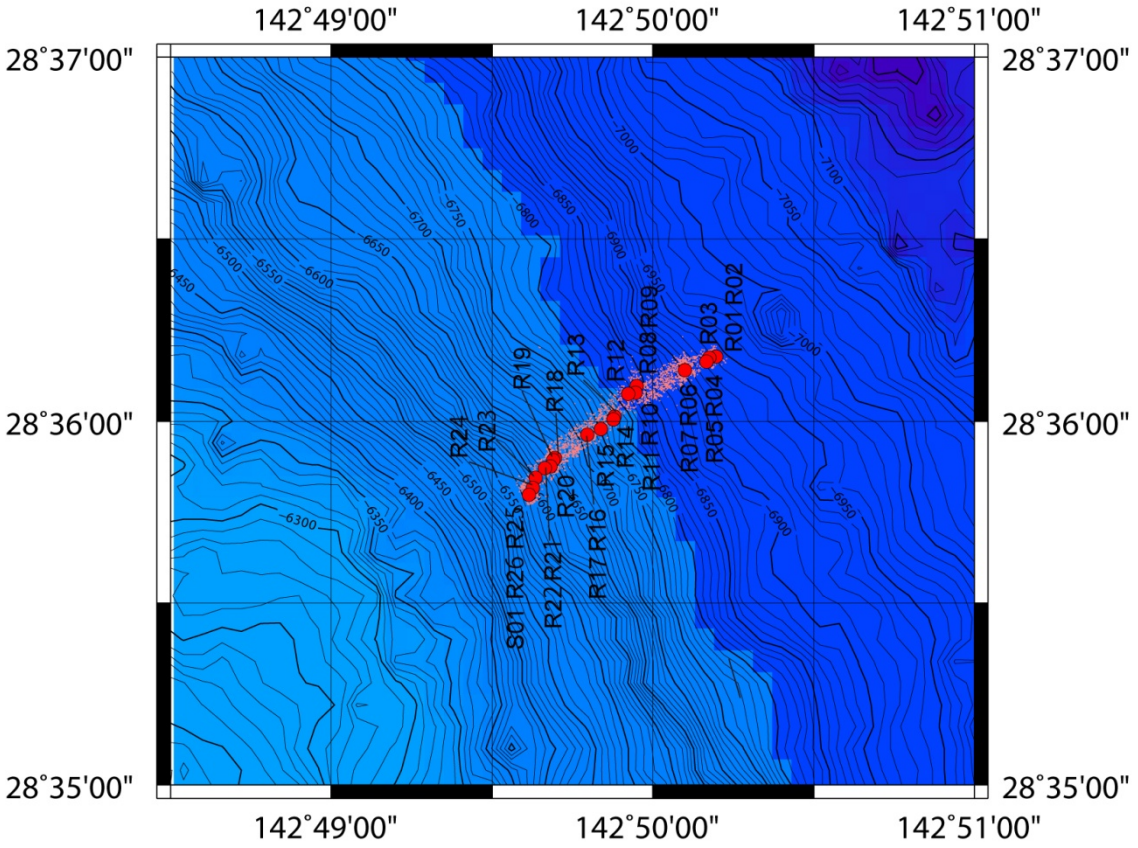
Start: 30° 09.450’ N, 142° 18.650’ E (depth = 6993 m)

Finish: 30° 09.675’ N, 142° 18.350’ E (depth = 6717 m)

Recovered samples: 18 rock samples (gabbro, basalt, porhylite, and sandstone).

3.1.3 #450-2 dive

KAIKO 7000II Dive #450-2



Date: 2009/05/19

Objective

KAIKO Dive#419 during the KR08-07 cruise successfully recovered serpentinized peridotite and gabbro from the base of Ogasawara Ridge forearc at a depth of ~7000 mbsl. This dive site is located ~50 km north of the Dive 7K419 site. It is expected that this dive will also recover deep crustal materials and increase our understanding of the basal part of the Izu-Bonin arc

Dive Summary

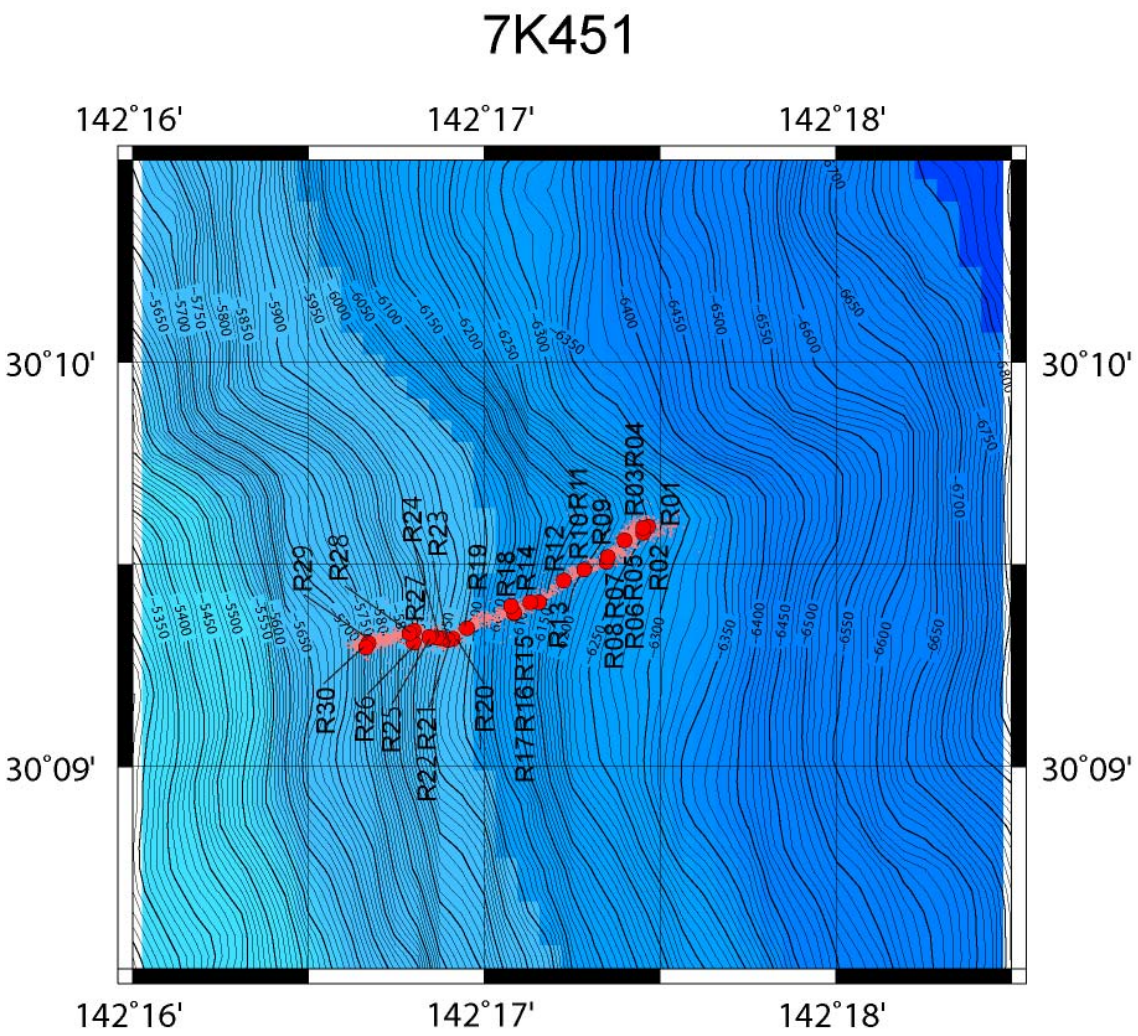
Start: 28° 36.20’ N, 142° 50.25’ E (depth = 6941 m)

Finish: 28° 35.75’ N, 142° 49.60’ E (depth = 6552 m)

Recovered samples: 26 rock samples (gabbro, basalt, and mudstone) &1 sediment core.

3.1.4 #451 dive

KAIKO 7000II Dive #451



Date: 2009/05/20

Objective

This dive was planned to survey the middle section of an unnamed seamount at the landward trench slope in Torishima forearc, where deeper section (7000 – 6500 mbsl) was surveyed in Dive#449, and shallower section (5700 – 5100 mbsl) was surveyed in Dive#420 in 2008. The deeper part was composed of gabbro and basalt, whereas shallower part was tonalite. This dive was planned to observe the transitional zone between the two lithofacies.

Dive Summary

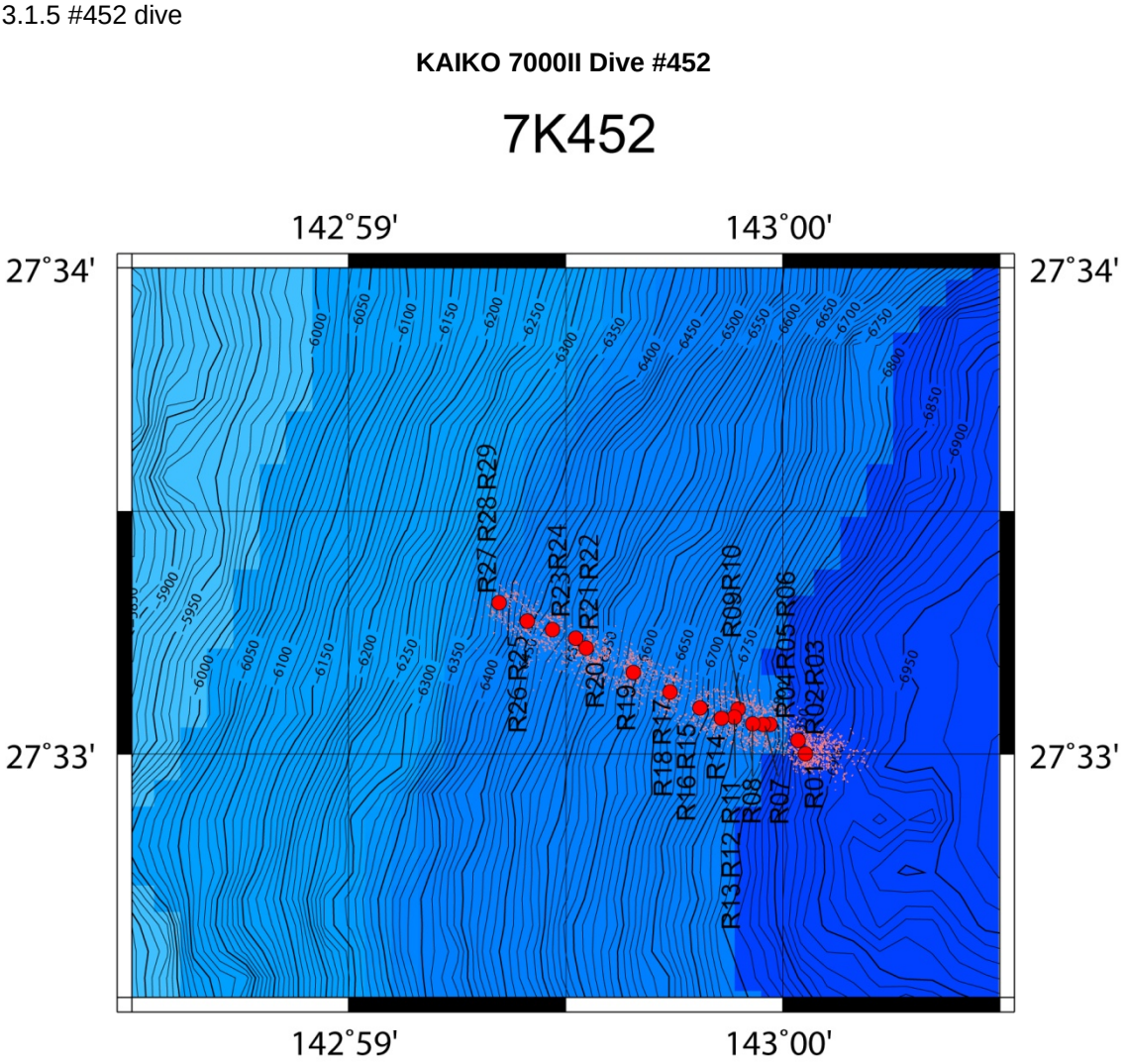
Start: 30° 09.60’ N, 142° 17.50’ E (depth = 6250 m)

Finish: 30° 09.20’ N, 142° 16.20’ E (depth = 5551 m)

Recovered samples: 30 rock samples (gabbro, basalt, porphylite, tonalite, and conglomerate).

3.1.5 #452 dive

KAIKO 7000II Dive #452



Date: 2009/05/21

Objective

The dive track was designed to transect steep slope of the Ogasawara Ridge forearc to investigate the structure and lithology of the basal part of the intra-oceanic arc. Dive 7K417 and 7K419 of KR08-07 cruise recovered peridotite in deeper part and gabbro in shallower part. So it is also expected to obtain such rocks in present dive and increase our understanding of the basal part of the Izu-Bonin arc.

Dive Summary

Start: 27° 33.00’ N, 143° 0.10’ E (depth = 6958 m)

Finish: 27° 33.30’ N, 142° 59.30’ E (depth = 6379 m)

Recovered samples: 29 rock samples (gabbro, basalt, andesite, sandstone, and conglomerate).

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.