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R/V *KAIREI* "Cruise Report"

KR16–04

Detection of Ontong Java Plateau Magmatism Lasting for ~100 Million Years

March 6, 2016 – March 20, 2016

Pohnpei (Federal States of Micronesia) – Brisbane (Australia)

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

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1. Cruise Information

Cruise ID: KR16-04

Name of vessel: KAIREI

Title of the cruise: Detection of Ontong Java Plateau Magmatism Lasting for ~100 Million Years

Cruise period: March 6, 2016 ~ March 20, 2016

Ports of call: Pohnpei (Federal States of Micronesia) ~ Brisbane (Australia)

Research area: North of Eastern Salient, Ontong Java Plateau

(an area at S2°00'~4°30', E164°00'~166°30')

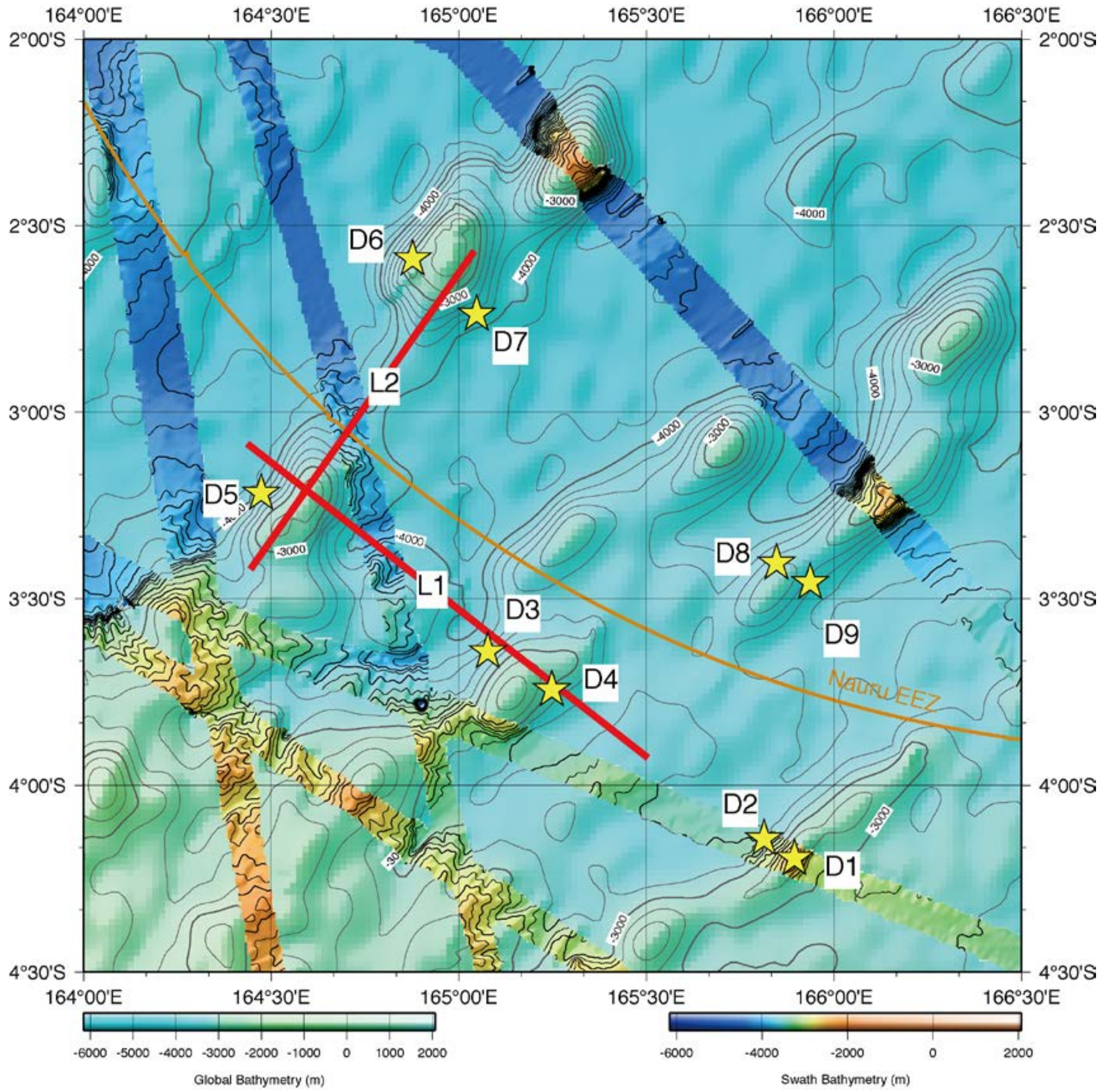

Figure 1. Bathymetry map of the survey area (Smith and Sandwell, 1997; MR14–06). Dredge sites (D1 to D9) are indicated by yellow stars and single channel seismic lines (L1 and L2) are shown by red lines.

2. List of Cruise Members

Shipboard Scientific Party

TAKASHI SANO (Chief Scientist & Representative of the Science Party)
National Museum of Nature and Science

TAKESHI HANYU (Sub-chief Scientist)
Japan Agency for Marine-Earth Science and Technology

MARIA LUISA TEJADA
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ANTHONY A. P. KOPPERS	Oregon State University
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SATSUKI IIJIMA	Nippon Marine Einterprises,Ink.

R/V KAIREI Officers and Crew

SHINYA RYONO	Captain
HIROYUKI KATO	Chief Officer
TOMOYUKI TAKAHASHI	2nd Officer
YOSHIHIRO OGAWA	3rd Officer
TADASHI ABE	Chief Engineer
SHINICHI IKUTA	1st Engineer
TAKAATSU INOMOTO	2nd Engineer
KATSUTO YAMAGUCHI	3rd Engineer
TAKEHITO HATTORI	Chief Electronics Operator

SHUNSUKE FUKAGAWA	2nd Electronics Operator
EMI SAWAYANAGI	3rd Electronics Operator
TADAHIKO TOGUCHI	Boat Swain
KAZUMI OGASAWARA	Able Seaman
YUKITO ISHII	Able Seaman
NAOKI IWASAKI	Able Seaman
YUTA MOTOOKA	Sailor
YUSAKU KANADA	Sailor
KOHEI SATO	Sailor
KOZO MIURA	No.1 Oiler
MASANORI UEDA	Oiler
KEIYA TANIGUCHI	Oiler
TOSHINORI MATSUI	Oiler
MOTOHIRO KAWANO	Assistant Oiler
TOYONORI SHIRAISHI	Chief Steward
TATSUNARI ONOUE	Steward
TORU MURAKAMI	Steward
YOSHIE HIDAKA	Steward
KOICHIRO KASHIWAGI	Steward

3. Observation

3–1. Background and Purpose

The Ontong Java Plateau (OJP) is the largest of the Earth's large igneous provinces (Figure 2). This plateau covers an area of ~1.9×10^6 km and has a total volume of 4.4–5.7×10^7 km (e.g., Coffin and Eldholm, 1994), with a maximum crustal thickness that exceeds 30 km (e.g., Miura et al., 2004). ^{40}Ar–^{39}Ar dating of OJP basalts indicates that most volcanic activities ended in relatively short periods (within a few million years) around 122 Ma, but post-emplacement volcanoes are evident on Solomon Islands that could have been formed by obduction of a part of the OJP in this subduction zone. Previous studies have reported that several post-emplacement volcanoes formed at ~90, 60, and 30 Ma on the OJP (e.g., Tejada et al., 2002). One idea to explain the post-emplacement volcanism is underplating of magma that resided for a very long time beneath the plateau (e.g., Ito and Clift, 1998), but geological information to support the idea is poor.

Geological information (eruption style, vent and lava flow distributions, etc.) of the post-emplacement volcanism may be similar to rejuvenated volcanism of hotspots. The rejuvenated volcanism is the final stage in volcanic evolution of a hotspot volcano and is characterized by a multi-stage, but infrequent, eruption sequence following an eruptive hiatus of variable duration (0.5–2

Myr) after the main shield construction stage. Many oceanic island groups show evidence for rejuvenated volcanism (e.g., Koppers et al., 2008; Garcia et al., 2010). The best-known Hawaiian rejuvenated volcanism is characterized by a number of monogenetic volcanoes that are arranged in NE–SW direction that intersects at a right angle to the direction of the Hawaiian chain. Similar to the Hawaiian rejuvenated volcanism, seamounts north of the Eastern Salient of the OJP are arranged in NE–SW directions that also are perpendicular to the plateau extension (Figures 1 and 2). We therefore proposed the working hypothesis that the seamounts on North of Eastern Salient represent rejuvenated volcanism on the OJP.

In order to research eruption style of the seamount, we planned to carry out topographical and geological survey as well as rock sample collection by dredge. We also planned to conduct the single-channel seismic survey to reveal the structure of the upper oceanic crust and seamounts.

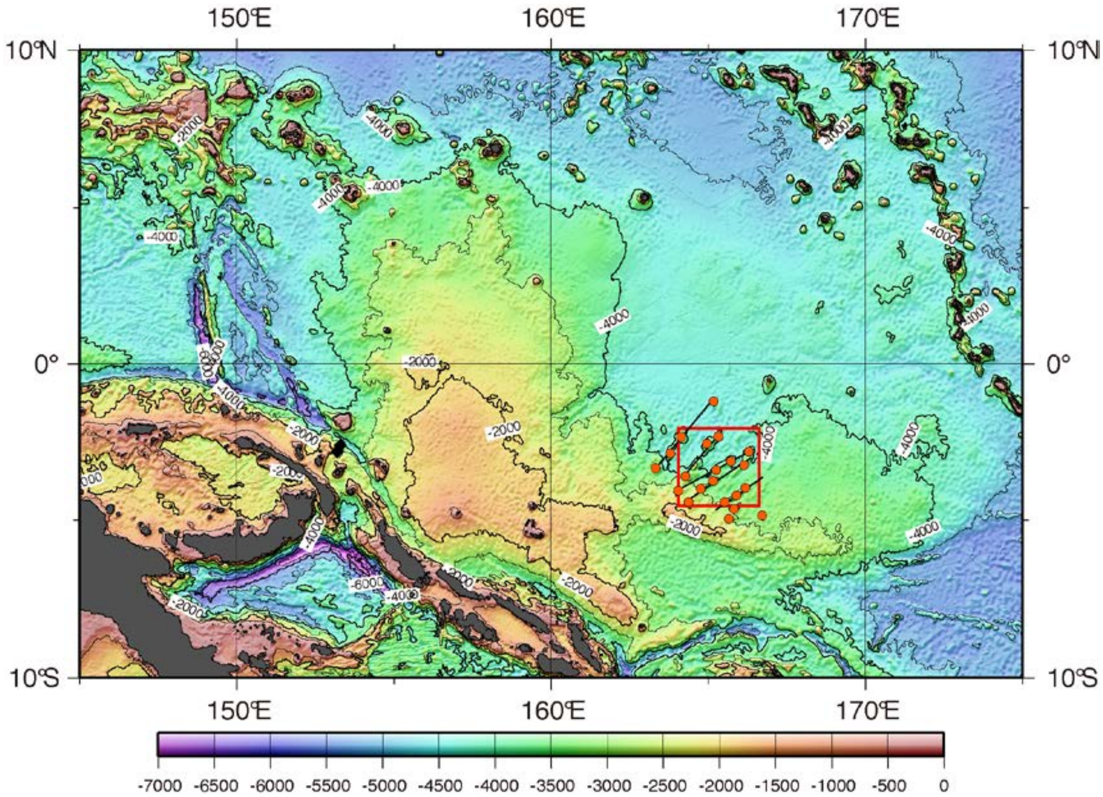

Figure 2. Map of Ontong Java Plateau showing research area (red box) and seamounts (orange circles). The seamounts are arranged in NE–SW directions. The edge of plateau is defined by the –4000 m depth contour, except in the SE part where part of the OJP has been uplifted through collision in the subduction zone at the Solomon Arc.

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3–2. Observations and Activities

To achieve the scientific objectives, we have conducted the following activities within the research area in Figure 1.

(1) Surface geophysical measurement (gravity and geomagnetics) and multibeam mapping to reveal the tectonic structure and the morphology of the seamounts north of the Eastern Salient of the Ontong Java Plateau.

(2) Basement rock sampling by dredging to determine the source and type of volcanism that formed the seamounts.

(3) Single-channel seismic (SCS) survey to elucidate the structures of the volcanic layers of the seamounts and in the adjacent basins.

3–3. Instrument and Methods

(1) Surface geophysical measurement

Bathymetry, geomagnetic and gravity data were recorded during the cruise. We used a Proton magnetometer, a three components magnetometer for geomagnetic measurement, multi-narrow beam echo sounder with a sub-bottom profiler equipped with Bathy–2010P and SeaBeam 3012 system for the bathymetric measurement, and a shipboard gravimeter for the gravity measurement. The degree of survey area was about 120° (auto system) and the ship speed was 8 knot at the dredge sites and 12 knot in other areas and during transit.

(2) Dredge

Two different dredge systems were deployed during KR16–04 as illustrated in Figures 3 and 4. Chief components of the system are a transponder, a lead wire, a chain, weights, a pipe dredge, fuse wires, life wires, and a chain-bag dredge (cylinder-shape or the new Satsuki-type box-shape dredge with a mounted camera system). The dredge assemblages were connected with a ship-board winch wire.

1. The transponder is used to estimate the position and depth of the dredge system. It is attached on the winch wire approximately 50 m above its end.

2. The lead wire is 200 m long and 12 mm in diameter. The breaking force is 7.27 ton. It is connected with the winch wire by shackles (3.15 ton) and a swivel (5 ton).

3. The chain is used to stabilize the dredge on the sea floor during operation. It is 5 m long and 19 mm in diameter. It is connected with the lead wire by shackles (3.25 ton) and a swivel (5 ton).

4. The weights keep the dredge on the sea floor during operation. A single weight is 50 kg. Six weights are assembled and are connected with the chain by a fuse wire (0.25 m long and 8 mm in diameter; 3.22 ton for breaking force), a life wire covered with a hose (2.3 m long and 10 mm in diameter; 5.03 ton for breaking force), shackles (1.2 ton), and a swivel (1 ton).

5. The pipe dredge is connected with the chain by a fuse wire (0.25 m long and 8 mm in diameter; 3.22 ton for breaking force), a life wire covered with a hose (0.9 m long and 10 mm in diameter; 5.03 ton for breaking force), shackles (0.6 ton; 1.2 ton), and a swivel (1.1 ton).

6. The dredge is connected with the chain by a fuse wire (0.25 m long and 8 mm in diameter; 3.22 ton for breaking force), a life wire covered with a hose (7.0 m long and 10 mm in diameter; 5.03 ton for breaking force), shackles (2 ton; 3.25 ton), a swivel (3 ton), and a master ring (3.2 ton; only for cylinder-shape dredge). Either cylinder-shape or box-shape dredges were used at each dredge site. The box-shape dredge, developed by Dr. Izumi Sakamoto of Tokai University, uses the technique of a mousetrap system and has camera on top (Satsuki-type, Figure 4). The cylinder-shape dredge has a round jaw (65 cm in diameter) with a chain bag behind it.

7. The ship position was kept still above the starting point of the dredge during the lowering of the dredge assembly. The assembly was lowered at a full speed of 60 m/min until the dredge was approximately 30 m above the seafloor, halted for 3 minutes to stabilize the system, and then lowered to the floor at a rate of 20 m/min. As soon as the dredge touched the seafloor, which was detected by a decrease in wire tension, 30 m of additional wire was let out to keep the dredge on the slope. Then the dredge was pulled by the ship towards the end point at 0.5 knt (SOG). Position of the dredge and its movement was monitored by the transponder signal. If the ship reached to the end point, or the distance between the ship and the transponder exceeded ~800 m, the wire was wound up at a rate of 10 m/min until the dredge leaves the bottom.

(3) SCS survey

The SCS survey system is comprised of generator-injector (G.I.) air guns 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 KR16-04 surveys, 2 GI guns were towed 20.1 m aft, at a depth of 2 m. The generator (G) and injector (I) were fired simultaneously to give a total gun volume of 710 cubic inch for the SCS survey. Seismic waves were received by an analog streamer filled with mineral oil. The streamer had an active section of 65 m, which was towed 135 m aft, at a depth of ~4 m (Figure 5). Received seismic data were monitored with an on-line processing system and recorded digitally in SEG-D 8058 Rev. 1 format. The system was operated at a ship speed of 4~7 knots (against ground), with shot intervals of 9 seconds for L1 line survey and 8 seconds for L2 line survey. Details of the SCS equipment and specification are listed in Table 1.

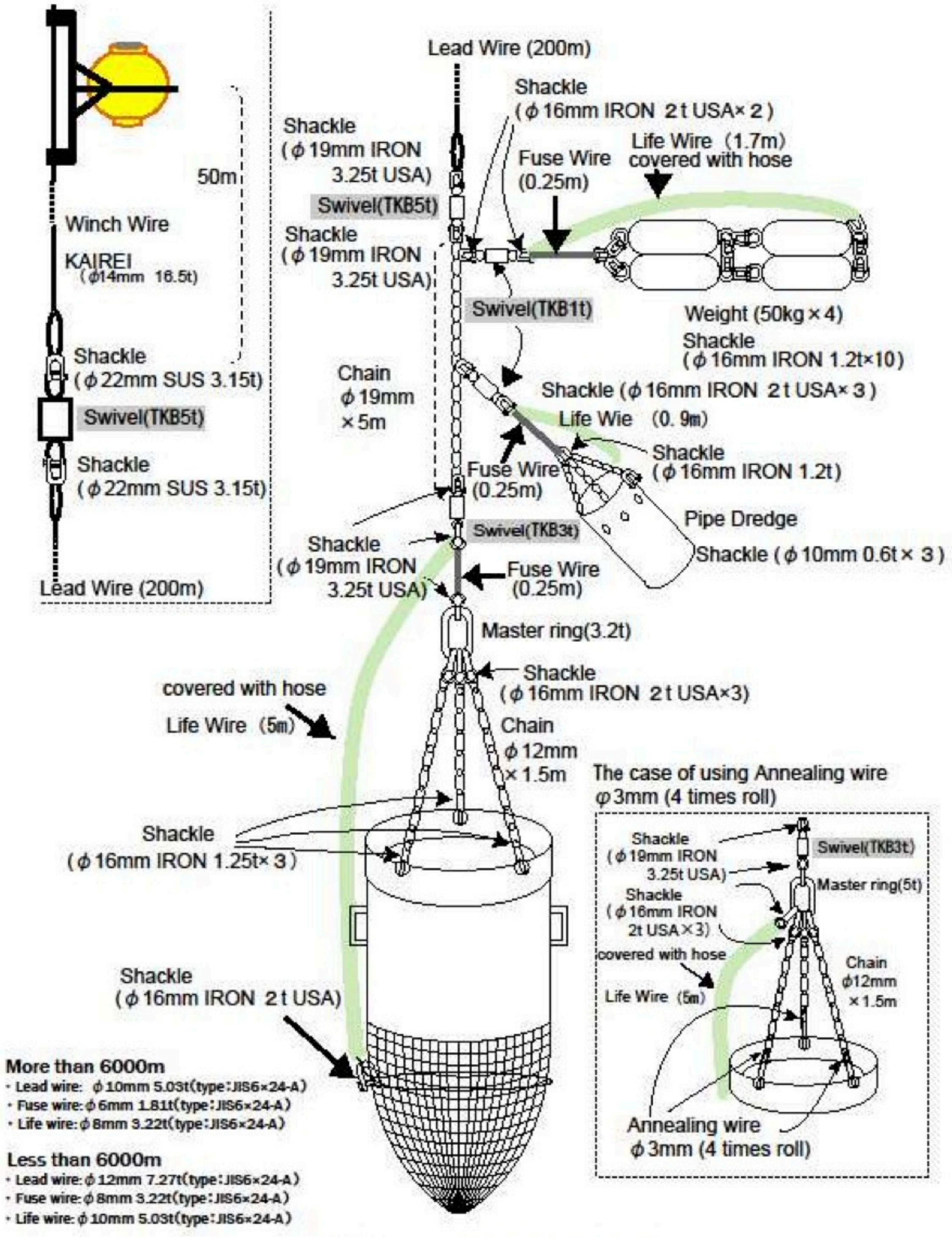

Figure 3. Dredge system with a cylinder-shaped dredge. In case of the box-shape dredge operation, an assembly beneath the master ring (3.2 t) was swapped to those of the box-shape dredge (Figure 4).

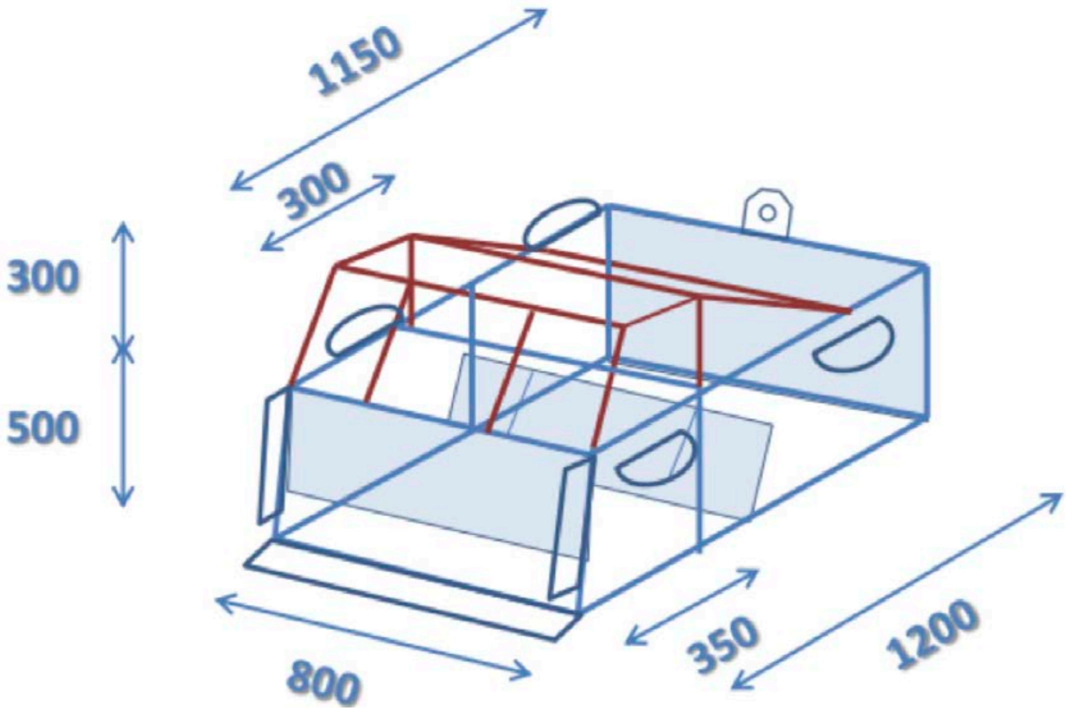

Figure 4. Satsuki-type box-shape dredge with camera and LED-light system.

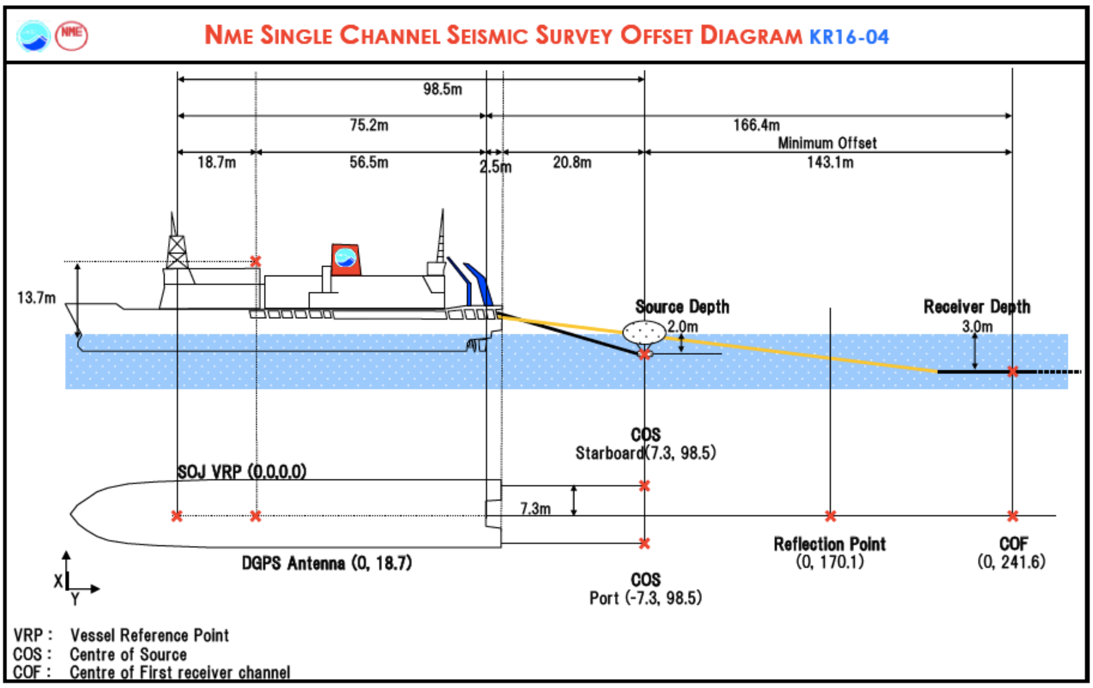

Figure 5. Offset diagram of the SCS survey.

Table 1. Single Channel Seismic Equipment and Survey Specification for KR16–04.

Streamer	
Manufacturer	S.I.G
Active section length	65 m
Hydrophone Interval	1 m
Type of Hydrophone	S.I.G.16
Hydrophone output	-90 dB,re 1V/μbar, ±1dB
Frequency	flat from 10Hz to 1000Hz
Depth sensor	Yes
Preamplifier	gain 39
Lead in cable length	135m
Receiver depth	3.9 m (L1_0)、3.7 m (L2_0)

Source	
Manufacturer	Sercel
Type of airgun	GI Gun
Volume	L1_0 : 355cu.in×2 (G:250cu.in, I:105cu.in)
	L2_0 : 355cu.in×2 (G:250cu.in, I:105cu.in)
Air pressure	137.7kgf/cm^2
Source depth	2 m
Depth sensor	No
Gun Controller	Hotshot ver. 3.3000

Air Compressor	
Manufacturer	Leobersdorfer Maschinenfabrik Ag Wien
Type of machine	LMF 24/150-E60
Air supply Capacity	24 m^3/min.

Recording System	
Manufacturer	GEOMETRICS
Type of system	Geode ver. 11.1.69.0
Recording format	SEG-D 8058 Rev.1
Recording length	8,000 msec(L1_0) or 7,000 msec(L2_0)
Water Delay	0 msec
Sample rate	1 msec
High cut filter	None
Low cut filter	None
Recording media	Hard Disk

GPS System	
Type of system	Star Pack

Navigation System	
Manufacturer	MARIMEX JAPAN
Type of system	Nav log ver. 2.2.3

Shot Point Geometry	
Time mode shooting	HARMONIC mode (9sec[L1_0] or 8sec[L2_0] interval)

Geodetic Parameter	
Spheroid	WGS84
Semi-major Axis	6,378,137m
Inverse Flattening	298.26
Projection	U.T.M
	Zone58

3-4. Research results

(1) Surface geophysical measurement

The survey lines for the surface geophysical mapping were designed mainly to see the detailed topography of each seamount and to identify both the direction and morphological arrangement of the seamounts. The result shows that all seamounts are elongated linear features having ridge-like shape on tops (up to 50 km in length and 20 km in width, and typically ~2000 m high) and, therefore, we call them ridge-type seamounts. The elongated directions of all seamounts studied are NE–SW and several small mounds (~2 km in diameter and ~300 m high) are present along the ridge-like tops. In addition, an obvious NE–SW arrangement of the studied seamounts is apparent.

The gravity measurements are useful for examining the deeper structure of each seamount and the geomagnetic measurements would be utilized to identify magnetic anomaly lineations in the adjacent basins next to the seamounts and to expose the tectonic fabrics in the survey area. The acquired data were good and will contribute to the understanding of the origin of the seamounts.

The sub-bottom profilers were deployed within the areas of the two dredge sites (D8 and D9) right before the dredging, and the data were used to determine the dredge points.

(2) Dredge

Nine dredge hauls were conducted on the flanks of five seamounts during the 6-day survey period from March 10 to 15, 2016. Each seamount has an elongated shape trending NE-SW, referred to as a ridge-like seamount. The seamounts generally have steep slopes at the edges and gentle slopes in the center. There also exist small mounds, likely late stage volcanic cones, on the seamounts. The dredge targets were typically placed on the steeper side slopes and the small mounds on top of the seamounts. The dredge points are shown in Figure 1. The position and depth of the dredge sites are summarized in Table 2. Total weight of the recovered rocks was 521 kg.

D1 (2016/3/11)

The dredge was conducted on a mound that exists on the southwestern slope of the ridge-like seamount. The dredge track was designed to collect rocks from the bottom to the top of the mound. The dredge started at 2486 (m beneath sea surface) mbsl and ended at 2105 mbsl, and the track length estimated by the movement of the transponder was approximately 0.2 mile. We had one weak bite during the dredge.

Recovered sample was a single piece of Fe-Mn crust with the thickness of approximately 30 mm.

D2 (2016/3/11)

The dredge was conducted on the western side of seamount. The dredger climbed up the steep slope from 3406 mbsl, that is nearly equivalent to the depth of the surrounding seafloor, to 3082 mbsl, and the track length estimated by the movement of the transponder was approximately 0.3 mile. We repeated landing and leaving the bottom twice. We had no bites in the first session, and one moderately strong bite, and three small bites in the second session.

Recovered samples were angular lava blocks, breccia, Fe-Mn crust, and carbonate. Two pieces of lava blocks were a moderately vesiculated olivine-phyric basalt and a weakly vesiculated plagioclase-phyric basalt. They were moderately altered. The Fe-Mn encoatings on the lava blocks were up to 18 mm in thickness.

D3 (2016/3/12)

The dredge was conducted on the northwestern side of seamount. The dredge D3 was originally planned to traverse all along the steep slope, but it finished nearly half way. The depths of the starting and ending points were 3668 mbsl and 3568 mbsl, respectively. The track length estimated by the movement of the transponder was approximately 0.4 mile. We repeated landing and leaving the bottom three times. We had no bites in the first session, one strong bite, four small bites, and two stacks in the second session, and one moderately strong bite and one stack in the third session.

Recovered samples were mostly volcanic breccias with a few pieces of Fe-Mn crusts. Volcanic breccias contain various size (up to 10 cm) of basaltic clasts. The clasts are non- or weakly-vesiculated and altered. Fe-Mn coatings are mostly less than 5 mm except for one sample that has a 7-10 mm thick Fe-Mn crust.

D4 (2016/3/12)

The dredge was conducted on the steep slope on the eastern side of seamount. The track of the dredge D4 was shortened from the original plan because of the limited time allowed for the dredge. The dredge haul started from the middle part of the slope at 2974 mbsl and ended at 2820 mbsl. The track length estimated by the movement of the transponder was approximately 0.2 mile. We had two moderately strong bites and one weak bite during the dredge.

Recovered samples were one volcanic breccia and four lava blocks. The lava blocks in the volcanic breccia are weakly vesiculated olivine-phyric basalts. They are strongly altered. Fe-Mn coating is relatively thin (up to 2 mm) for all the samples.

D5 (2016/3/13)

The dredge was conducted on the western side of seamount D3. The dredge track was designed to traverse the lower steep slope of the ridge-like seamount from 3963 mbsl to 3337 mbsl. The track length estimated by the movement of the transponder was approximately 0.8 mile. We repeated landing and leaving the bottom twice. Although we did not have any clear sign of bites during the dredge, we sampled a large amount of rocks (197 kg).

Recovered samples were mostly lava blocks and subordinate volcanic breccias. Lava blocks included a variety of rock types with olivine-phyric basalts being most abundant but some samples were recovered that are plagioclase-phyric, pyroxene-phyric and aphyric. They are weakly to strongly vesiculated. Vesicles are occasionally filled with secondary minerals. Olivines are up to 7mm in size, but they are altered to iddingsite. Some samples have chilled margins, although they are altered to paragonite. Most of the lava blocks were covered by thin Fe-Mn coatings and crusts (varying from a thin film to 12 mm thickness), but some volcanic breccias are associated with thick Fe-Mn crusts (~40 mm).

D6 (2016/3/14)

The dredge was conducted on the western side of seamount. The dredge track was designed to start from the middle part of the lower slope and end on the volcanic mound that exists near the slope. The depths of the starting and ending point were 2988 mbsl and 2460 mbsl, respectively. The track length estimated by the movement of the transponder was approximately 0.7 mile. We did not have any clear sign of bites during the dredge.

Recovered samples were a few pieces of pumice with a thin film of Fe-Mn coating. However, these rocks are likely not formed at the seamount, but rather floating in from regional arc volcanic eruptions.

D7 (2016/3/14)

The dredge was conducted on the lower slope on the southeastern side of seamount D4. The dredger climbed up the ridge that extends perpendicular to the SW-NE trending main axis of the seamount. The dredge started at 4013 mbsl and ended at 3482 mbsl with the estimated track length of 0.5 mile. We repeated landing and leaving the bottom twice. We had no bites in the first session, and four moderately strong bites and four weak bites in the second session.

Recovered samples were mostly lava blocks and subordinate volcanic breccias. Lava blocks are fragments of pillow basalts. Some of them are associated with altered chilled margin on one side. They are mostly olivine-phyric basalts, but some are plagioclase-phyric and aphyric. Most of the basalts are altered and weakly vesiculated. Olivines are up to 3 mm in size, and they are altered to iddingsite. The thickness of Fe-Mn encoating and crusts vary from thin films up to 25 mm thick crusts.

D8 (2016/3/15)

The dredge was conducted on the lower slope on the western side of seamount. The dredge climbed up the steep slope from 3799 mbsl to 3244 mbsl. The track length estimated by the movement of the transponder was approximately 0.5 mile. We had four moderately strong bites and 8 weak bites during the dredge.

Recovered samples were mostly lava blocks and subordinate volcanic breccias. Lava blocks are mostly aphyric basalts and a few olivine-phyric and pyroxene-phyric basalts. Most basalts are altered, but a small number of weakly altered basalts are present. The basalts are non- to strongly-vesiculated, and vesicles are occasionally filled with secondary minerals. Fe-Mn crusts are relatively thin up to 10 mm only.

D9 (2016/3/15)

The target of the last dredge was a mound on top of seamount. The dredge started from the bottom (2585 mbsl) to the top (2400 mbsl) of the mound. The track length estimated by the movement of the transponder was approximately 0.4 mile. We had one strong bite, five moderately strong bites, and 20 weak bites during the dredge.

Recovered samples were volcaniclastics and Fe-Mn crust. Volcaniclastics are grain-supported and consist of highly vesiculated clasts including some glassy (but totally altered) ones. Fe-Mn crusts are up to 10 mm in thickness.

(3) SCS survey

The SCS reflection data were acquired along two lines (L1 and L2) with a total length of approximately 259 km (Figure 1). In both tracks, reflection from the seafloor was clearly recorded. Igneous basement structures were confirmed except beneath steep slope of the ridge-like seamounts. In some places beneath the seamounts, upper volcanic breccia layer and lower lava flow layer are likely identified. In the basin area with near flat topography, some clear reflections were recognized within both sediments and basements. Although the SCS reflection data along the seamounts and basins are complex, possible slump structures and normal faulting are omnipresent. Along the L1 line in particular, several offsets, including possible normal faults in a parallel SW-NE configuration of likely several horsts and grabens, are confirmed in sediment (and basement) layers. On the other hand, obvious offset and other structure cannot be seen in L2 line, which was oriented parallel to the extensional features observed in the L1 line. Further descriptions and investigations will be reported later.

Table 2. The position and depth of the dredge sites.

Dredge number	On the bottom			
	Lat. (SOQ*)	Lon. (SOQ*)	Lat. (SOJ)	Lon. (SOJ)
D1	4-10.7972 S	165-53.5504 E	4-10.8471 S	165-53.5822 E
D2	4-07.8923 S	165-48.0639 E	4-07.9104 S	165-48.1160 E
D3	3-38.1010 S	165-05.5014 E	3-38.1342 S	165-05.5374 E
D4	3-45.1831 S	165-15.5560 E	3-45.1085 S	165-15.5831 E
D5	3-12.0089 S	164-28.9069 E	3-12.0075 S	164-28.9527 E
D6	2-35.4980 S	164-52.7103 E	2-35.4889 S	164-52.7775 E
D7	2-44.5884 S	165-02.3450 E	2-44.5727 S	165-02.3282 E
D8	3-21.3013 S	165-50.3908 E	3-21.2584 S	165-50.3971 E
D9	3-26.1704 S	165-53.9174 E	3-26.0911 S	165-53.9591 E

Dredge number	Off the bottom			
	Lat. (SOQ*)	Lon. (SOQ*)	Lat. (SOJ)	Lon. (SOJ)
D1	4-10.9608 S	165-53.6890 E	4-11.1945 S	165-53.8619 E
D2	4-07.9017 S	165-48.3807 E	4-07.9103 S	165-48.6036 E
D3	3-38.4370 S	165-05.7342 E	3-38.3086 S	165-05.5999 E
D4	3-45.0170 S	165-15.6841 E	3-44.9493 S	165-15.7906 E
D5	3-12.4976 S	164-29.5356 E	3-12.6425 S	164-29.6634 E
D6	2-35.5409 S	164-53.3711 E	2-35.5085 S	164-53.5242 E
D7	2-44.2890 S	165-01.9769 E	2-44.0759 S	165-01.8288 E
D8	3-21.6533 S	165-50.7067 E	3-21.7682 S	165-50.9459 E
D9	3-25.8723 S	165-54.1160 E	3-25.7756 S	165-54.1718 E

Dredge number	Date (UTC)	Depth (m)		Tension max. (kN)	Survey time
		On the bottom	Off the Bottom		
D1	2016/3/10~11	2,486	2,105	26	52min.
D2	2016/3/11	3,406	3,082	39	1h14min.
D3	2016/3/11~12	3,668	3,568	60	4h00min.
D4	2016/3/12	2,974	2,820	39	43min.
D5	2016/3/12~13	3,963	3,337	43	2h56min
D6	2016/3/13~14	2,988	2,460	27	1h53min.
D7	2016/3/14	4,013	3,482	45	1h53min.
D8	2016/3/14～15	3,799	3,244	42	1h35min
D9	2016/3/15	2,585	2,400	45	1h4min

*SOQ = Transponder's position, SOJ = Ship's position

4. Acknowledgements

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5. Notice on Using

Notice on using: Insert the following notice to users regarding the data and samples obtained.

This cruise report is a preliminary documentation as of the end of the cruise.
This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.
Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.

Appendix

Research Vessel KAIREI

R/V “KAIREI” is the exclusive mother ship for the 7,000m class remotely operated vehicle “KAIKO Mk-IV" which entered service in 2015. In addition, R/V "KAIREI" is equipped with geophysical instruments such as a 444 channel seismic profiler. The major instruments installed in KAIREI are a multi-narrow beam batymetric mapping system (Sea Beam3012), and integrated sub-bottom profiler, gravity meter, proton magnetometer and three components magnetometer, and various kinds of sampling devices such as piston corer and dredge. There are several onboard laboratories for data recording, and data and sample analysis. These are the Research Room, Mission control & Computer Room, Wet laboratory (chemistry and biology), Dry laboratory (Geophysics), Gravimeter room, KAIKO Operation’s Center, Rocks and sediment laboratory, Library, Video Room and Personal computer Room. The ship also has an aft wheel house which overlooks the entire aft operations deck for the operation of the ship, winches, A-frame and cranes during station work such as dredge hauls, piston coring and sampling, launch and recovery operations.

The general specifications of R/V KAIREI

Length overall	106.0 m
Beam overall	16.0 m
Depth	7.3 m
Draft	4.5 m
Gross tonnage	4,517 tons
Service speed	16.7 knot
Main propulsion system Diesel engines	2,206kW x 2
Main propulsion method	Controllable pitch propeller x 2

Complement

Crew	29 persons
Submersible operation staff	9 persons
Researchers	22 persons
Total	60 persons

R/V KAIREI MBES / magnetometers / gravity meter

KAIREI is equipped with various kinds of underway geophysical equipment, a multi narrow beam echo sounder (Type SeaBeam 3012, L-3 ELAC Nautik GmbH.), a sub bottom profiler (Type BATHY-20101, SyQwest, Inc.), a gravity meter (Type KSS31, BODENSEEWERK PERKIN-ELMER), a portable gravity meter (Type CG-3M, SCINTREX Inc.), a shipboard three components magnetometer (Type SFG-1214, Tierra Technica Inc.), and a proton magnet meter (Type PM-217, Kawasaki Geological Engineering Co., Ltd.). The specifications of these instruments are listed below.

The specifications of SeaBeam 3012

Technical Data	
Operating frequency	12 kHz
min. depth	50m below transducers
max. depth	11,000 m (full ocean depth)
number of Beams	301 equi-distance
Accuracy	< 1 % of water Depth (Average Across Swath)
Side scan	12-Bit Resolution to maximum 2000 pixels
Average Footprint Resolution	2° x 1.6°
Max. Vessel Speed	6 knots (100 % Coverage @ 140° swath)
	12 knots (100 % Coverage @ 120° swath)
Workstations	Computer with Windows 7 operating system
measurement method	Swept beam technique

Environmental limits for compensation

Roll	±10°
Pitch	±7°
Yaw	±5°

The specifications of BATHY-2010

Depth Ranges	10, 20, 40, 80, 150, 300, 500, 750, 1000, 2000, 5000, 12000 Meters
Strata Resolution	Up to 6 cm with 200 Meter of bottom penetration bottom type dependant
Depth Resolution	0.1 Meters
Depth Accuracy	±0.3% to 6000 m
Frequency Output	3.5 KHz

The specifications of Gravity meter

Accuracy on Profile	**DYNAMIC* (mgal RMS)**	**EFFECTIVE** (mgal RMS)**
Vertical Acceleration (mgal RMS)		
< 15,000	0.5	0.2
15,000 - 80,000	1	0.4
80,000 - 200,000	2	0.8
Accuracy during Turn	**DYNAMIC*** (mgal RMS)**	**EFFECTIVE*** (mgal RMS)**
Vertical Acceleration (mgal RMS)		
15,000 - 80,000	2.5	1
Drift Rate (mgal/month)		
< 3		
Measuring Range(mgal)		
10,000		
Scale Factor Calibration(standard)		
< 0.5%		
Platform Freedom		
Roll	±40°	
Pitch	±40°	
Environmental Conditions		
Temperature	+10℃ up to +35℃ (temperature gradient for the platform including gravity sensor < 2℃/hour)	
Response Time		
Definiition of :	$\tau = \frac{1}{2\pi fc}$ fc = corner frequency	
Gravity sensor (low pass filter 1st order)	τ = 36 sec.	
Selectable filter (Bessel filter 4th order)	τ = 5.2 to 75 sec.	

*   Accuracy without applying data reduction

** Accuracy applying data reduction procedures

*** Depending on accuracy of navigation data

The specifications of portable Gravity meter

Reading Resolution	0.001 mgal
Minimum Operating Range	7000 mgal,without resetting
Residual Long-term Drift	Less than 0.02 mgal /day
Typical Repeatability in field use	Less than 0.05 mgal standard deviation
Range of Automatic Tilt correction	±200 arc sec.

The specifications of 3 axis magnet meter

System	ring core fluxgate
Number of component directly	3 axes
Cable length (m)	50
Sensor dimension (mm)	φ280×130H
Measurement range (nT)	±100,000
Resolution (nT)	1

The specifications of Proton magnet meter

Measurement range (nT)	3 ~ 7 x 10**4
Resolution (nT)	0.01
Sampling rate	10sec, 20sec, 1min, manual, external
Time of applying field(sec.)	3 to 10
Sensor dimension (mm)	φ200×1050
Weight (kg)	28.6(in the air), 6.2(in the sea)