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R/V *KAIREI* "Cruise Report"

KR14-07

Magma genesis of Ojin Rise seamounts east of Shatsky Rise

Credit: Tomoko Ojima

Jun 28, 2014 - July 14, 2014

Tokyo Harumi - Hakodate

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

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1. Cruise Information

Cruise ID: KR14-07

Name of vessel: KAIREI

Title of the cruise and proposal: Magma genesis of Ojin Rise seamounts east of Shatsky Rise

Chief scientist: Takashi Sano [Department of Geology and Paleontology, National Museum of Nature and Science]

Representative of the Science Party: Takashi Sano [Department of Geology and Paleontology, National Museum of Nature and Science]

Cruise period: June 28, 2014~July 14, 2014

Ports of call: Tokyo Harumi~Hakodate

Research area: Ojin Rise seamounts, east of Shatsky Rise

(an area at N36°30'~37°50', E164°00'~167°00')

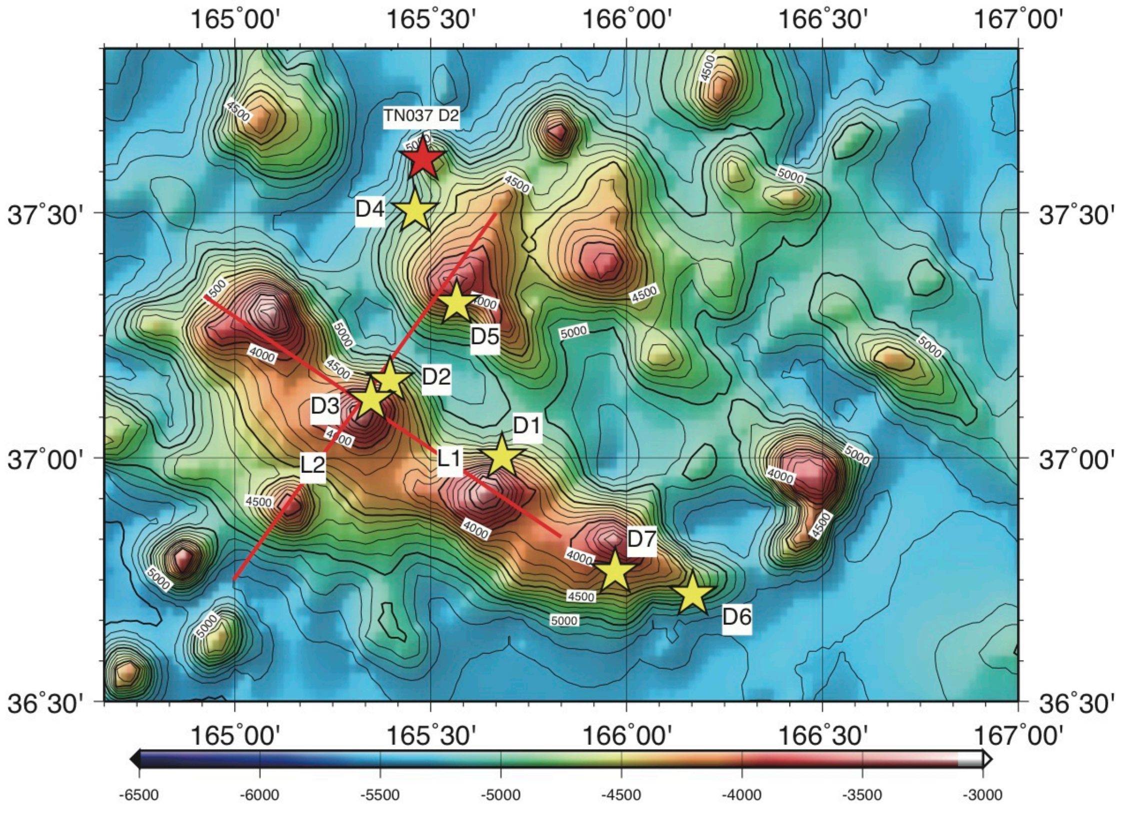

Figure 1. Bathymetry map of the survey area (Smith and Sandwell, 1997). Dredge sites (D1 to D7) are indicated by yellow stars and single-channel seismic survey lines (L1 and L2) are shown by red lines. A previous dredge site (red star) is also shown (TN037 D2: Sager et al., 1999).

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)	JAMSTEC
Maria Luisa Tejada	JAMSTEC
Tomoko Ojima	Tokyo Metropolitan University
Yuki Tsuchiya	The University of Tokyo
Saori Umeda	The University of Tokyo
Syoka Shimizu	Chiba University
Atsushi Nomura	National Museum of Nature and Science
Mitsuteru Kuno	Nippon Marine Enterprises, LTD
Toshimasa Nasu	Nippon Marine Enterprises, LTD
Kimiko Serizawa	Nippon Marine Enterprises, LTD
Yuki Miyajima	Marine Works Japan
Keiko Fujino	Marine Works Japan
Kazuhiro Yoshida	Marine Works Japan
Mika Yamaguchi	Marine Works Japan

KR14-07 R/V *KAIREI* Crew:

SHINYA RYONO	Captain
HIROYUKI KATO	Chief Officer
TETSUO SHIRAYAMA	2nd Officer
AKIRA SUZUKI	3rd Officer
KOJI FUNAE	Chief Engineer
KENZO KATO	1st Engineer
RYUZO MIKAMI	2nd Engineer
HIROKI TANAKA	3rd Engineer
MASAMOTO TAKAHASHI	Chief Electronics Operator
HIROKI ISHIWATA	2nd Electronics Operator
TOSHIHIKO YUASA	3rd Electronics Operator
KAZUO ABE	Boat Swain
SHUICHI YAMAMOTO	Able Seaman
YUKI YOSHINO	Able Seaman
TAKUMI YOSHIDA	Able Seaman
TOMOAKI KUBOTA	Sailor
JUN SHINODA	Sailor
FUMIAKI OMACHI	Sailor
KOZO MIURA	No.1 Oiler
SOTA MISAGO	Oiler
MAKOTO KOZAKI	Oiler
TAKUYA WATANABE	Assistant Oiler
ATSUMU HARA	Assistant Oiler
SUETO SASAKI	Chief Steward
YOSHIO OKADA	Steward

MASANAO KUNITA	Steward
SHINOBU OHYU	Steward
KANA YUASA	Steward

3. Observation

3-1. Background and Purpose

Enormous volcanism forming oceanic plateaus are thought to occur within relatively short periods (e.g., within a few hundred million years according to plume head model), but post-emplacement volcanoes are evident on some oceanic plateaus such as Ontong Java Plateau, Manihiki Plateau, and so on (e.g., Tejada *et al*., 1996). A possible explanation for the post-emplacement volcanism is underplating of magma for an extended period of time beneath the plateaus (e.g., Ito and Clift, 1998), but supporting geological information is poor. This is due to the difficulty of taking such geological information because the original setting of the plateau, relative to the post-emplacement volcanoes, is poorly known for most of them. Most of the plateaus were formed during the mid-Cretaceous when no magnetic reversals formed ridge-parallel anomalies to record the original spreading ridge locations.

Shatsky Rise, located ~1500 km east of Japan, is unique in being the only large oceanic plateau formed during a time of magnetic reversals, permitting its tectonic setting to be resolved (Figure 2). Magnetic lineations show that the plateau formed during the late Jurassic and Early Cretaceous along the trace of a triple junction (Nakanishi *et al*., 1999). The plateau extends laterally from SW toward NE direction and mainly consists of three massifs known, respectively, as Tamu, Ori, and Shirshov massifs (Figure 2).

In Fall 2009, the three massifs were cored by Integrated Ocean Driling Program Expedition 324 (Sager et al., 2010), and several new facts have been reported. One of the most important findings is that the southernmost and the oldest Tamu Massif is the largest single shield volcano in the solar system (Sager *et al*., 2013). This feature of Shatsky Rise is consistent with the plume head model (e.g, Campbell, 2005); wherein the oldest Tamu Massif is the largest and has homogeneous compositions, and the younger and smaller Ori and Shirshov massifs have heterogeneous ones (Sano *et al*., 2012).

The progressive decrease in magmatic activity forming the successively smaller massifs of the plateau toward the NE (i.e., Papanin Ridge in Figure 2) is also consistent with predictions of the plume head model. However, other post-emplacement volcanism on Shatsky Rise is likely present because several seamounts can be identified on the plateau and its margins. Among the seamounts on and near Shatsky Rise, most are concentrated in Ojin Rise. The number of the Ojin Rise seamounts is more than 60 and many seamounts are aligned in a NW-SE direction that intersects at right angle to the direction of the plateau extension. We will investigate the possibility of post- emplacement volcanism on Shatsky Rise to explain the origin of Ojin Rise seamounts, although previous work did not discuss relationships between Ojin Rise seamounts and Shatsky Rise.

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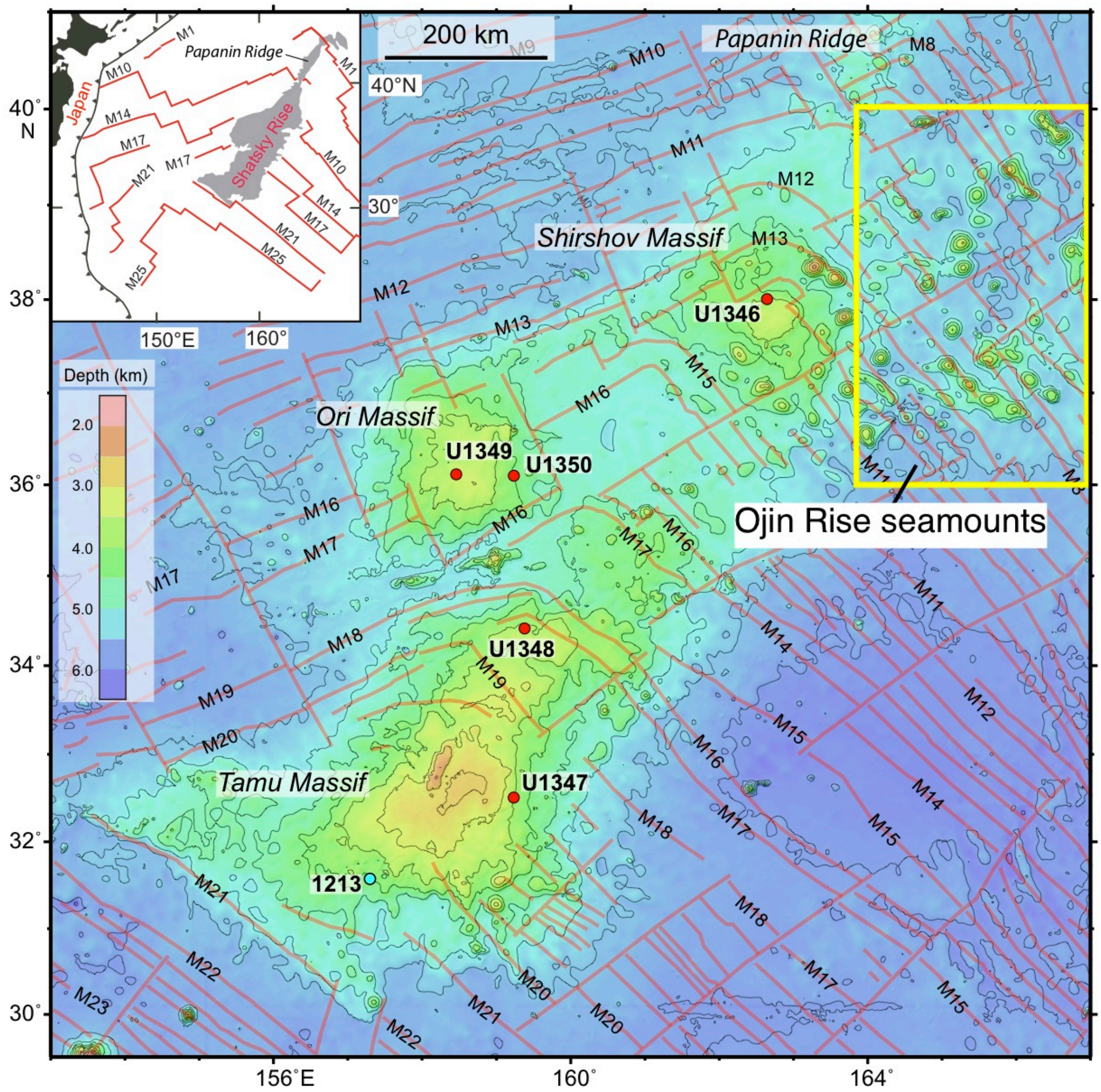


Figure 2. Map of Shatsky Rise, Ojin Rise seamounts (within yellow box), surrounding magnetic lineations (red lines), IODP Expedition 324 drill sites (red dots) and ODP Site 1213 (blue dot) after Sager *et al*. (2010) and Sano *et al*. (2012). Inset shows the location of Shatsky Rise relative to Japan. Note that research area (Figure 1) is a part of the area of Ojin Rise seamounts.

3-2. Observation and Activities

To achieve the purpose, we have conducted the following observation.

(1) Surface geophysical measurement to reveal the tectonic structure of the Ojin Rise seamounts.

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

(3) Single-channel seismic (SCS) survey to elucidate the structures of the volcanic layers of the Ojin Rise seamounts.

3-3. Instruments and Methods

(1) Surface geophysical measurement

Bathymetry, geomagnetic and gravity data were recorded during the cruise. We used a proton magnetometer, a shipboard three components magnetometer for the 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.

(2) Dredge

The dredge system during KR14-07 is 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 (box-shape or cylinder-shape). 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 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 box-shape or cylinder-shape dredges were used at each dredge site. The box-shape dredge has a square jaw (60 × 45 cm) with a chain-bag and a box-shape bucket. The cylinder-shape dredge has a round jaw (65 cm in diameter) with tied chains behind it.

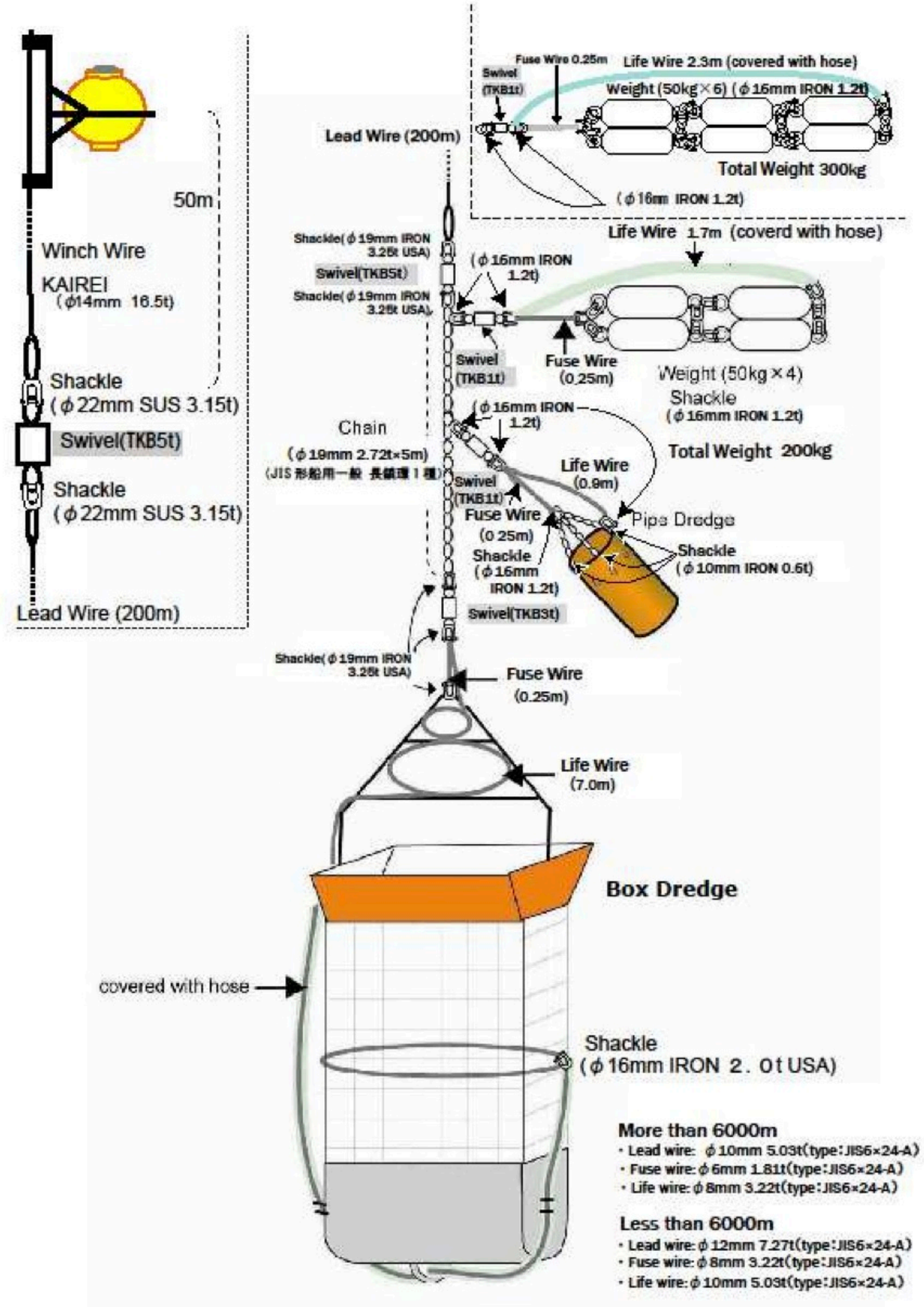


Figure 3. Dredge system with a box-shape dredge.

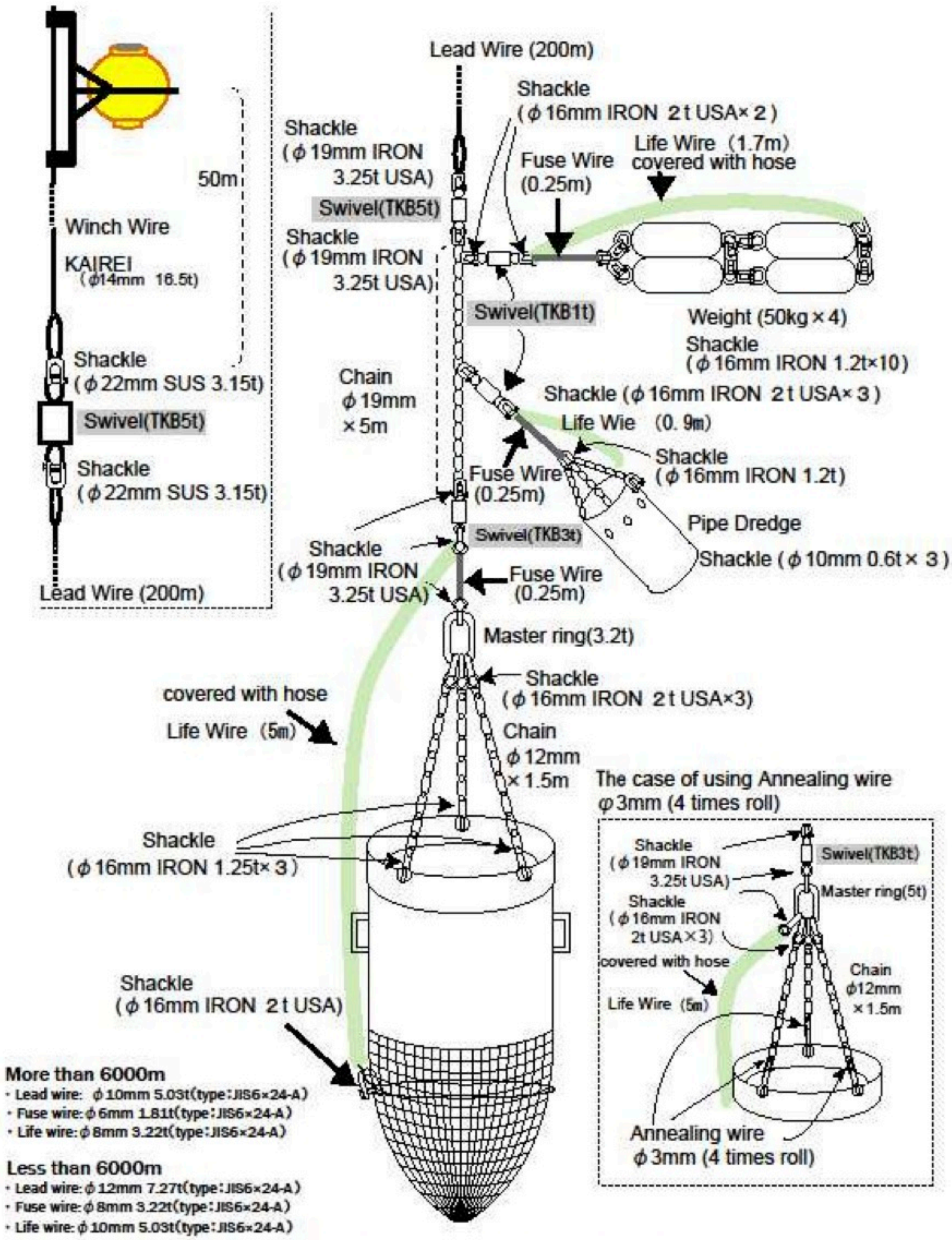


Figure 4. Dredge system with a cylinder-shape dredge.

(3) SCS survey

The SCS survey 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 KR14-07 surveys, 2 GI guns were towed 20.1 m aft, at a depth of 6 m. The generator (G) and injector (I) were fired simultaneously to give a total gun volume of 710 cubic in for L2 line 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 134 m aft, at a depth of 8 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 4~5 knots (against ground), with shot intervals of 12 seconds for L2 line survey and 15 seconds for L1 line survey. Details of the SCS equipment and specification are listed in Table 1.

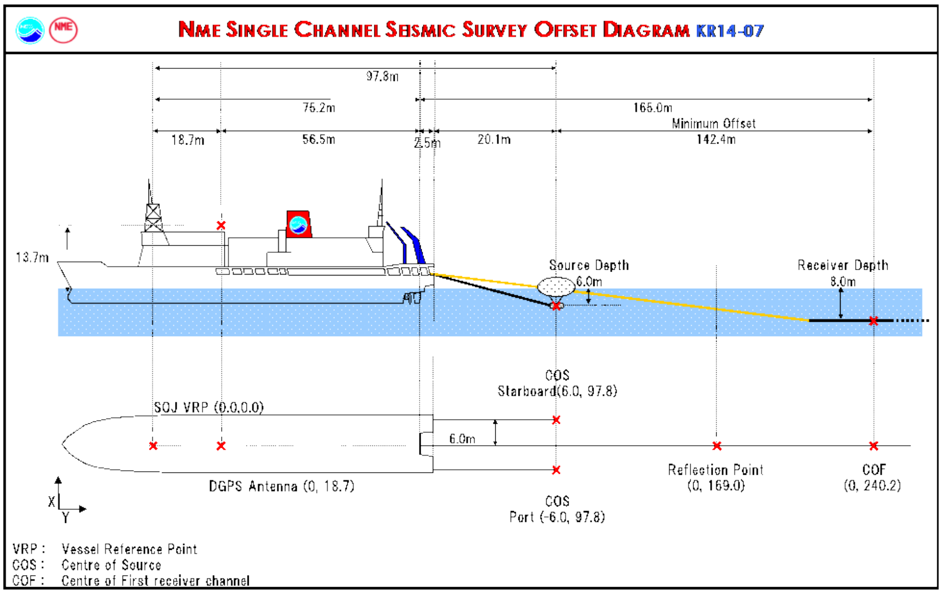


Figure 5. Offset diagram of the SCS survey.

Table 1. Single Channel Seismic Equipment and Survey Specification for KR14-07.

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	134m
Receiver depth	8m

Source

Manufacturer	Sercel
Type of airgun	GI Gun
Volume	L1_1 and L1_2 : 355cu.in×2(G:250cu.in, I:105cu.in):
	L2_1 : 355cu.in×2(G and I shot all together)
Air pressure	137.7 kgf/cm^2
Source depth	6 m
Depth sensor	No
Gun Controller	Hotshot ver. 3.005

Air Compressor

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

Recording System

Manufacturer	GEOMETRICS
Type of system	Geode ver. 9.28.0.0
Recording format	SEG-D 8058 Rev.1
Recording length	15,000msec(L1_1 and L1_2) or 12,000msec(L2_1)
Water Delay	0 msec
Sample rate	1msec
High cut filter	None
Low cut filter	None
Recording media	Hard Disk

GPS System

Manufacturer	Fugro
Type of system	SkyFix XP MultiFix6
DGPS Reference Station	Multi Reference Station (ALL)

GPS System

Manufacturer	MARIMEX JAPAN
Type of system	Nav log ver. 1.0.64

Shot Point Geometry

Time mode shooting	Simultaneous (16sec[L1_ 1 and L1_ 2] or 13sec[L2_ 1] interval)
Geodetic Parameter	
Spheroid	WGS84
Semi-major Axis	6,378,137 m
Inverse Flattening	298.26
Projection	U.T.M; Zone58

3-4. Research results

(1) Suface geophysical measurement

The survey line for the surface geophysical mapping was designed mainly to see the detailed topography of each seamount and to identify the alignment direction of the seamounts. The result shows that many of the seamounts are flat-topped guyots, with summit depths of about 3000 m. Many guyots are likely capped by shallow-water carbonate platform sediments overlying volcanic substrate, but this possibility would be examined further by post-cruise studies. Also, obvious NW-SE arrangement of four seamounts has been confirmed. The gravity measurements are useful for examining the underground structure of each seamount (e.g., area of volcanic vent), and the geomagnetic measurements would be utilized to identify magnetic anomaly lineations 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 Ojin Rise seamounts.

The sub-bottom profilers were deployed within the areas of the five dredge sites (D1, D2, D3, D6 and D7) right before the dredging, and the data were used to determine the dredge points.

(2) Dredge

Seven dredge hauls were conducted on the flanks of the four seamounts during the 6-day dredging operation from July 3rd to 8th, 2014. Each seamount consists of a lower platform and an upper flat-topped cone, the structure of which may reflect the complex volcanic history. The dredge tracks were designed to haul the dredge on steep slopes of the lower platform (D1, D2, D4, and D6) and the upper cone (D3, D5, and D7). The box-shape dredge was used during D1-D6 and the cylinder-shape dredge was used during D7. 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 328.5 kg.

D1 (2014/7/3-4)

The dredge was conducted on the northern slope of one of seamounts. The objective of the first dredge was to collect rocks from the whole section of this seamount, including the lower platform and the upper flat-topped cone. The originally planned dive track was a long one, starting from the surrounding ocean bottom (-4803 m) to the top, in order to collect rocks from both the lower platform and the upper cone. However, the dredge ended halfway up the track (-4000 m), and accordingly, the dredged rocks could be derived solely from the lower platform. The track length estimated by the movement of the transponder was approximately 0.6 mile. The first landing point was probably a muddy seafloor, and we repeated leaving and landing at the bottom three times to traverse the steep slope. We had some weak and strong bites during the dredge.

Recovered samples were pieces of Fe–Mn oxides (crust and nodule), pumice, volcanic rock fragments, and breccia with some sediments. These rocks were associated with deep-sea ooze which may have been sampled from the surrounding ocean floor at the first landing point. The volcanic rock fragments are typically aphyric and less vesiculated (~1 %). They are moderately to heavily altered. The maximum thickness of Fe–Mn cover is 27 mm. The pumices were moderately to highly altered, weakly vesiculated (~5 %), and with relatively thin Fe–Mn coating (<1 mm).

D2 (2014/7/4-5)

The dredge was conducted on the northern slope of one of seamounts. The dredge started at -4221 m, traversed nearly the whole slope of the lower platform, and ended at -4224 m with a track length of approximately 0.4 mile. We had some weak and strong bites with stacks in some cases during the operation.

Recovered samples were pieces of Fe–Mn oxides (crust and nodule), pumice, volcanic rock fragments, and sediments. These rocks were associated with deep-sea ooze, like the D1 dredge. The rock fragments are typically highly phenocryst-rich with large plagioclase crystals (up to ~10 mm). Minor olivine and pyroxene also appear in some samples. These rocks are weakly to heavily altered. The maximum thickness of Fe–Mn cover is 30 mm. The pumice samples were highly vesiculated (10 %) and without Fe–Mn coating.

D3 (2014/7/5)

The dredge was conducted on the northwestern side of the upper cone of the same seamount of D2 dredge. The objective of this dredge was to compare the rocks from the upper cone with those from the lower platform sampled by the D2 dredge. The dredge track was short (approximately 0.1 mile), starting at -3397 m and ending at -3298 m. We had some small bites without any strong bites or stacks during this short dredge.

Recovered samples were pieces of Fe–Mn nodule with cores consisting mostly of volcanic rock fragments inside. The rock fragments are mostly aphyric basalts. Note that the aphyric basalts collected during the D3 dredge contrast with the highly porphyritic basalts collected from the lower platform during the D2 dredge. These rocks are altered. The maximum thickness of Fe–Mn cover is 20 mm. No pumice was collected.

D4 (2014/7/5-6)

The dredge was conducted on the western slope of the lower platform of one of seamounts. Note that this seamount is located away from the aligned seamounts surveyed by the dredges D1, D2, D3, D6, and D7. The objective of the dredge was to compare the rocks from this isolated seamount with those from the aligned seamounts. The dredge started at -4438 m and ended at -4232 m with a track length of approximately 0.2 mile. We had some weak and strong bites during the dredge.

Recovered samples were pieces of Fe–Mn oxide (crust and nodule), sediments, pumice, a cobble-sized volcanic rock fragment, and a breccia. These rocks were associated with deep-sea ooze. The rock fragment is altered aphyric basalt without vesicles. The thickness of Fe–Mn cover is 14 mm. The pumice was associated with altered margin.

D5 (2014/7/6)

The dredge was conducted on the southern slope of the upper cone of the same seamount of D4 dredge. The objective of this dredge was to compare the rocks from the upper cone with those from the lower platform sampled by the D4 dredge. The dredge track was short (approximately 0.14 mile), starting at -3719 m and ending at -3489 m. We had some small bites and moderately strong bites during this short dredge.

Recovered samples were pieces of volcanic rock fragments, sediments, and breccia. Sample-01, -02, -03 are boulder-sized Fe-Mn crust breccia containing several volcanic rock fragments, Fe-Mn nodules, and sediments. The rock fragments were altered aphyric basalt and were less vesiculated. Note that the rock fragments recovered from the upper cone of the D3 dredge seamount were also aphyric. The maximum thickness of Fe–Mn cover is 15 mm. The breccia consists of small pieces of altered volcanic rock fragments.

D6 (2014/7/8)

The dredge was conducted on the eastern slope of the lower platform of a seamount located at the southeastern end of the aligned seamounts. The objective of the dredge was to investigate the compositional variation along the lower platform by comparing the rocks from this seamount with those dredged previously (D1 and D2). The dredge started at -4766 m and ended at -4375 m with a track length of approximately 0.2 mile. We had some weak bites during the dredge.

Recovered samples were pieces of Fe–Mn oxide (crust and nodule), sediments, pumice, a lava fragment, and a breccia. These rocks were associated with deep-sea ooze, like the previous dredges (D2 and D4). Fe–Mn nodules occasionally include volcanic rock fragments inside. The rock fragments are moderately to heavily altered and are aphyric with slight vesicularity. The maximum thickness of Fe–Mn cover is 25 mm. The pumice samples were highly vesiculated, highly to moderately altered, and covered by thin (<1 mm) Fe–Mn coating.

D7 (2014/7/8)

The dredge was conducted on the southern slope of the upper cone of the same seamount of the D6 dredge. The objective of this dredge was to compare the rocks from the upper cone with those from the lower platform sampled by the D6 dredge. The cylinder-shaped dredge was used this time. The dredge started at -3740 m and ended at -3511 m with a track length of approximately 0.15 mile. We had some weak bites during the dredge.

Recovered samples were three boulder-sized Fe-Mn crust breccias and several pieces of cobble-sized rock fragments, Fe–Mn nodules, sediments, and breccia. Fe–Mn nodules include cores of volcanic rocks, sediments, and volcaniclastic breccia inside. Sample-01, -02, -03 are large Fe-Mn breccias with several angular to subrounded rock fragments and sediments. The rock fragments are weakly to moderately altered. They are aphyric or plagioclase-phyric. They are moderately vesiculated (up to 30 %), which contrasts with the lavas sampled by the previous dredges. The maximum thickness of Fe–Mn cover is 35 mm.

<u>Remarks</u>

Recovered samples show a wide variety of rock types, including basaltic rock fragments, pumice, breccia, sediments, and Fe–Mn oxides (nodules and crusts). Pumices are believed to be exotic as these rocks have a high tendency to float, and have none or only thin film of Fe-Mn-coating. Fe–Mn nodules have cores of volcanic rock pieces and sediments (a few millimeter to a few centimeter) in their center. The rock pieces inside the Fe–Mn nodules could be fragments of previously emplaced lavas forming the seamounts, and the samples can be used for petrological studies even if fragments with clear indication of pillow lava structures were not sampled during dredging. Very thick Fe–Mn oxides coating suggests that the seamounts are old.

Pillow lavas have not been sampled during the dredge. Moreover, the volcanic rock fragments are weakly or not vesiculated. A plausible explanation for these observations is that the collected samples were subaerially erupted ones that had been degassed or were erupted in very deep water (>1000 m depth). However, there is also a possibility that pillow lavas or vesiculated lavas exist, but were not collected by the dredge. Some volcanic rock fragments are highly phenocryst-bearing. The phenocrysts are dominated by plagioclase with or without olivine and clinopyroxene, suggesting that these lavas are differentiated. It is not always clear from the on-board inspection of the rocks whether the lower platform and the upper flat-topped cone consist of different types of rocks. For example, the rock fragments collected from the lower platform and upper cones consist of both highly phenocryst-bearing and aphyric types, respectively. The difference in bulk rock and mineral compositions can be further studied after the cruise.

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

Dredge number	On the bottom			
	Lat.(SOQ*)	Lon.(SOQ*)	Lat.(SOJ)	Lon.(SOJ)
D1	37-00.3748 N	165-40.9865 E	37-00.2316 N	164-41.0024 E
D2	37-09.1800 N	165-23.3868 E	37-08.9917 N	165-23.3090 E
D3	37-07.5363 N	165-19.7883 E	37-07.2473 N	165-20.0127 E
D4	37-25.5145 N	165-30.0081 E	37-25.4138 N	165-30.1206 E
D5	37-19.5168 N	165-34.0903 E	37-19.6681 N	165-34.0802 E
D6	36-44.4860 N	166-09.9204 E	36-44.6897 N	166-09.7797 E
D7	36-46.7687 N	165-58.7799 E	36-46.8874 N	165-58.7713 E

Dredge number	Off the bottom			
	Lat.(SOQ*)	Lon.(SOQ*)	Lat.(SOJ)	Lon.(SOJ)
D1	36-59.5341 N	165-41.0107 E	36-59.0307 N	164-40.9915 E
D2	37-08.8053 N	165-23.2787 E	37-08.9368 N	165-23.3657 E
D3	37-07.4705 N	165-19.8543 E	37-07.0869 N	165-20.1584 E
D4	37-25.5026 N	165-30.2481 E	37-25.3460 N	165-30.7121 E
D5	37-19.6461 N	165-34.1308 E	37-20.0580 N	165-34.1921 E
D6	36-44.6172 N	166-09.7466 E	36-45.0919 N	166-09.3496 E
D7	36-47.9128 N	165-58.7600 E	36-47.3856 N	165-58.9912 E

Dredge number	Date (UTC)	Depth (m)		Tension max. (kN)	Survey time
		On the bottom	Off the bottom		
D1	2014/7/3-4	4,803	4,000	56	2h48min
D2	2014/7/4-5	4,221	4,224	60	3h16min
D3	2014.7.5	3,397	3,298	33	17min
D4	2014/7/5-6	4,438	4,232	55	1h1min
D5	2014.7.6	3,719	3,489	36	40min.
D6	2014/7/7-8	4,766	4,375	36	58min.
D7	2014.7.8	3,740	3,511	37	51min

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

(3) SCS survey

The SCS reflection data were acquired along two lines (L1 and L2) with a total length of approximately 200 km (Figure 1). In both tracks, well recognized reflection from the seafloor was clearly recorded. Igneous basement structures were confirmed except beneath the summits of the guyots, covering large amplitude reflection signals at the surface. In the basin area with near flat topography, some clear reflections were also recognized within both sediments and basements associated with normal-fault-like sharp displacements. Further descriptions and investigations will be reported later.

4. Acknowledgements

We thank Captain Ryono and the crew of R/V *KAIREI*, and the scientific support staff of NME and MWJ. Funding for this work was provided by a Grant-in Aid from the Ministry of Education, Culture, Sports, Science and Technology of Japan to TS, TH, and MLT(26302010).

5. Notice on Using

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

Appendix

R/V KAIREI

The deep sea research vessel "KAIREI" is designed to survey deep sea floor and sub-seafloor structures of arc-trench-backarc systems, ridge systems and basic oceanic crustal structure. R/V KAIREI is the exclusive mother vessel for “KAIKO 7000 II”.

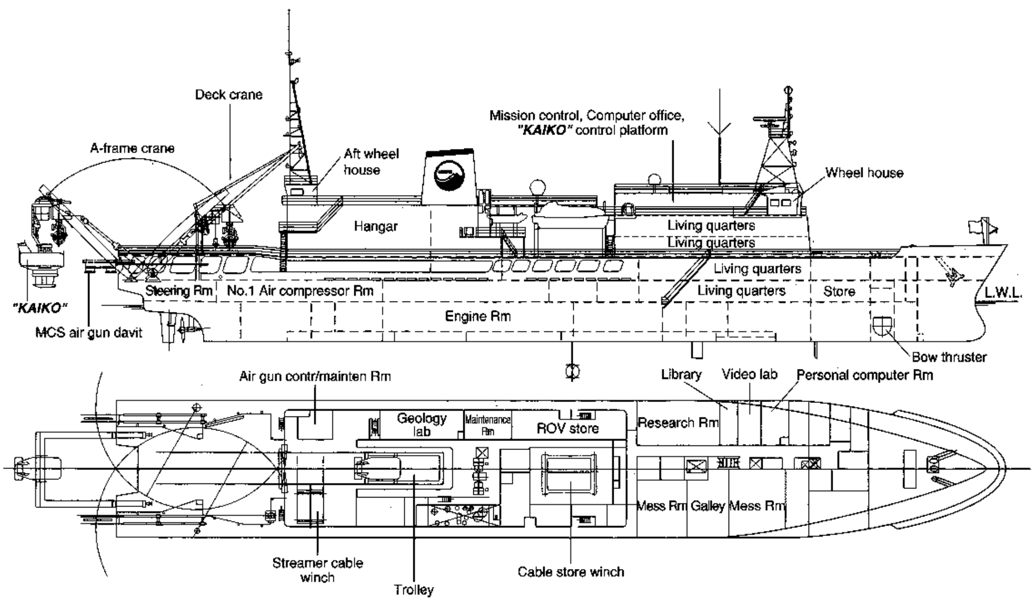
In addition, R/V KAIREI is equipped with various kinds of geophysical equipment; a multi narrow beam echo sounder and a sub bottom profiler (Sea Beam 3012, Sea Beam Instruments, Inc.), a gravity meter (Marine Gravity meter System type KSS 31, BODENSEEWERK PERKIN-ELMER), a three axis magnetometer (Type SFG-1214, Tera Technica Inc.), and a proton magnetometer (Type PM-217, Kawasaki Geological Engineering Co., Ltd.). The specifications of R/V KAIREI are listed below.

The general specifications of R/V KAIREI

Nationality	JAPAN
Owner	JAMSTEC
Operator	Nippon Marine Enterprises, Ltd
Length overall	106.0 m
Beam overall	16.0 m
Draft	4.5 m
Gross tonnage	4,517 tons
Maximum speed	16.7 knot
Main propulsion system Diesel engines	2,206kW x 2
Main propulsion method	Controllable pitch propeller x 2

Complement

Crew / Submersible operation staff	38 persons
Researchers	22 persons
	Total 60 persons



■**SEA BEAM 3012 (Sea Beam Instruments, Inc.)**

“KAIREI” ’s multi narrow beam survey system.

Survey depth	100～11,000m
Swath width	90°(11,000m)～150°
Maximum number of beams	151
Beam width	2°～1.6°
Accuracy	＜1% of water depth(average across swath)
Frequency	Multi Narrow Beam：12kHz Sub Bottom Profiler：4kHz
Sound velocity range	1,400 ~ 1,600 msec
Roll	±10°
Pitch	±7°
Yaw	±5°
Maximum vessel speed	6knot(100%Coverage at 140° width) 12knot(100%Coverage at 120° width)
Sidescan	12-Bit resolution to maximum 2,000 pixels
Sub Bottom Profiler’s Geological exploration ability	40~30 m(Under the sea bottom)
Output interfaces	**Offline:** CARIS HIP/SIPS EIVA MB Systems **Online:** EIVA NaviPac Hypack
Operation PC	Windows system

■Marine Gravity meter System type KSS 31(BODENSEEWERK PERKIN-ELMER)

"KAIREI" 's gravitymeter system.

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 on Profile	DYNAMIC(mgal RMS)	EFFECTIVE(mgal RMS)
Vertical acceleration(mgal RMS)		
15,000 - 80,000	2.5	1

Drift rate(mgal/mouth)	＜ 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	
Definition	$\tau = 1 / (2\pi \cdot fc)$ …….fc = corner frequency
Gravity sensor (low pass filter 1st order)	τ = 36 sec
Selectable filter (vessel filter 4th order)	τ = 5.2 to 75 sec

■Three axis magnetometer Type SFG-1214(Tera Technica Inc.)

"KAIREI" 's Three axis magnetometer system.

Sensor	
Sensor system	Ring core fluxgate
Number of axis	Three axis
Orthogonality	Within a ±2minits

Measuring instrument	
Measuring range	±100,000nT
Resolution	1nT
Noise	0.5nT
Stability of temperature	0.5T / ℃
Accuracy	Within a 100T

■Proton magnetometer Type PM-217(Kawasaki Geological Engineering Co., Ltd.)

"KAIREI" 's Proton magnetometer system.

Measuring instrument	
Measuring range	3～7 × 10^4 nT
Minimum measuring resolution	0.01nT
Excitation time interval	3～10 sec (1sec step)
Measuring interval	10sec or 20sec or 1minits

Sensor coil	
Format	Troidal
Inductance	About 22mH

■XCTD/XBT DIGITAL CONVERTER & MK-130 SYSTEM(Tsurumi Seiki Co.,LTD)

"KAIREI" 's XCTD & XBT system.

Digital converter	
Sampling interval	50msec(XBT)
	40msec(XCTD)
XBT probe	
Water temperature range	-2.2 ~ 35.5 ℃
Accuracy	±0.2℃
Measuring range	180m(T-5) Maximum 6knot
	460m(T-6) Maximum 15knot
	760m(T-7) Maximum 15knot
	About 300m(T-10) Maximum 10knot
Measuring time	291sec(T-5)
	70sec(T-6)
	118sec(T-7)
	About48sec(T-10)
XCTD probe	
Measuring range	Water temperature = -2 ~ 35℃
	Electric conductivity = 10～60mS/cm
	Depth: XCTD = 0 ~ 1000m XCTD II = 0 ~ 1850m
Accuracy	Water temperature = ±0.02℃
	Electric conductivity = ±0.03mS/cm
	Depth = 5m or <±2%
Measuring system	Water temperature = thermistor
	Electric conductivity = Electric induction cell
	Depth = Fall time from landing time
Maximum speed	XCTD = 12 knot XCTD II = 3.5 knot
Fall speed	3.4m/sec
Measuring time required	XCTD = 300sec / 1,000m XCTD II = 560sec / 1,850m
Battery volume	20 minuets