Cruise Summary

1. Cruise Information

(1) Cruise ID

KR17-15C

(2) Name of Vessel

R/V Kairei

(3) Title of Cruise

Lord Howe Rise Site Survey 2017 for proposed IODP Drilling

(4) Subtitle of Cruise

Acquisition of high-resolution seismic data, shallow sub-surface profiles, seafloor bathymetry, seabed samples and imagery data

(5) Cruise Periods and Port Calls

Departure:	29 October 2017 (Yokosuka)
Outward Transit:	29 October 2017 ~ 11 November 2017 (Yokosuka – Brisbane)
Port Call 1:	11 November ~ 14 November 2017 (Brisbane)
Leg 1:	14 November ~ 21 November 2017
Port Call 2:	21 November ~ 22 November 2017 (Brisbane)
Leg 2-1:	22 November ~ 27 November 2017
Port Call 3:	27 November ~ 29 November 2017 (Brisbane)
Leg 2-2:	29 November ~ 5 December 2017
Port Call 4:	5 December ~ 7 December 2017 (Brisbane)
Leg 3	7 December ~ 27 December 2017
Port Call 5:	27 December ~ 30 December 2017 (Brisbane)
Return Transit:	30 December 2017 ~ 11 January 2018 (Brisbane – Yokosuka)
Arrival:	11 January 2018 (Yokosuka)

(6) Research area

Lord Howe Rise, off the east coast of Australia

(7) Research maps

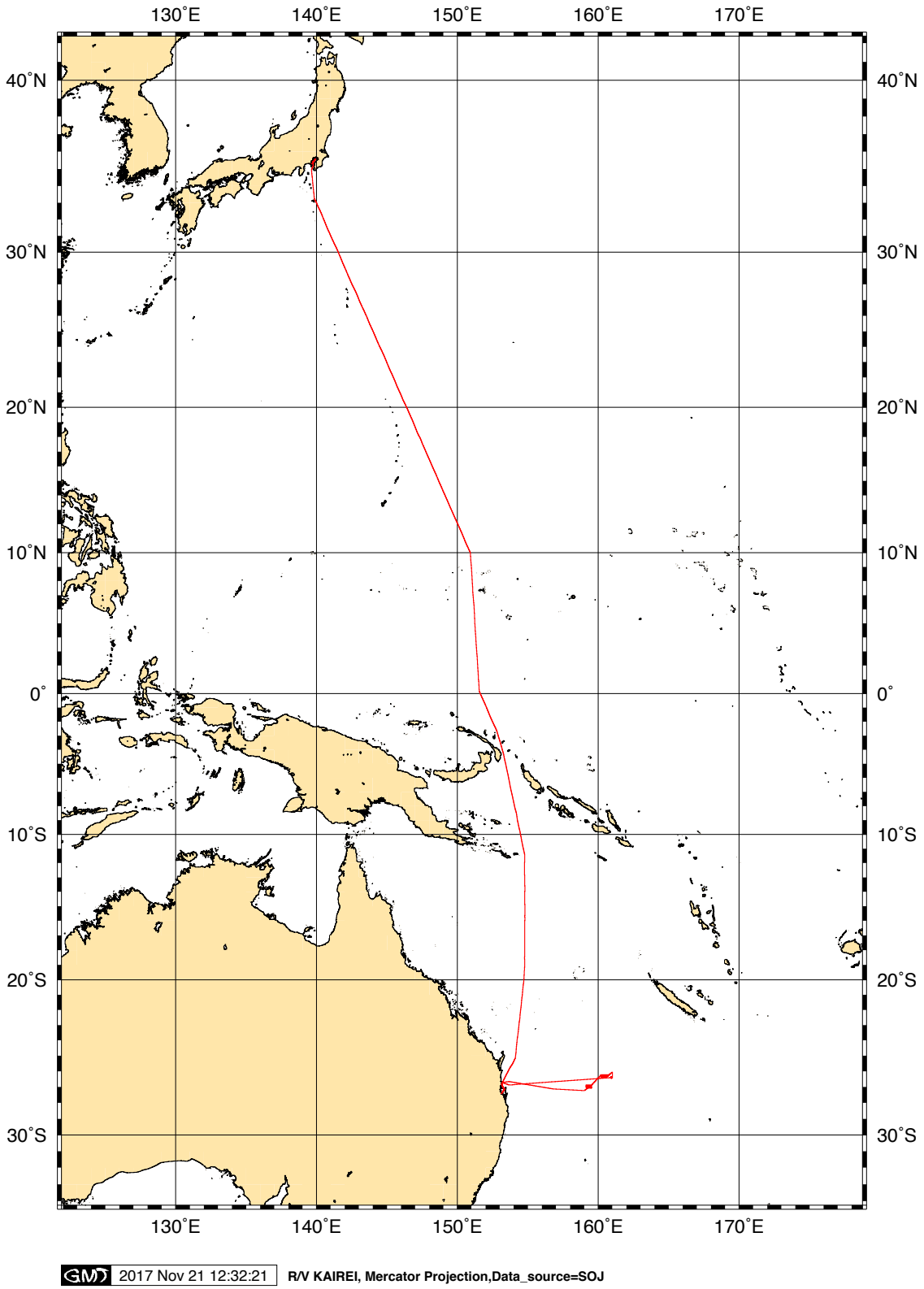

Figure 1. Cruise track of KR17-15C Leg 1 including the outward transit from Japan to Australia.

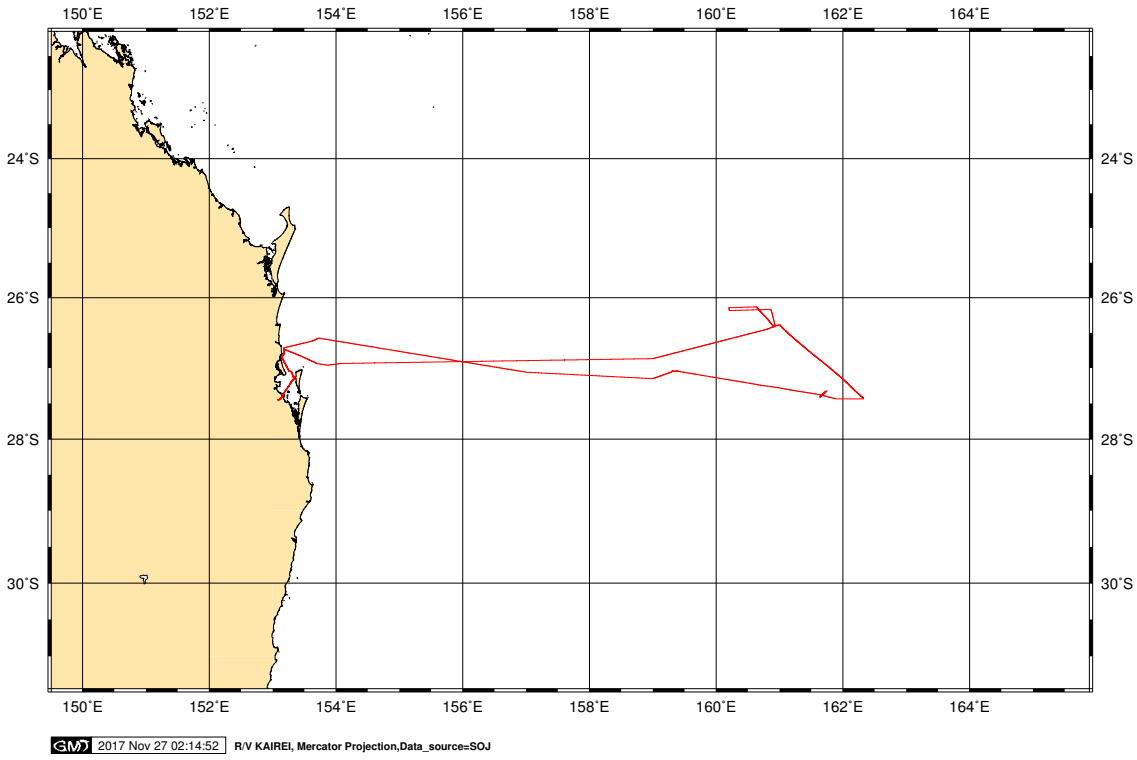

Figure 2. Cruise track of KR17-15C Leg 2-1.

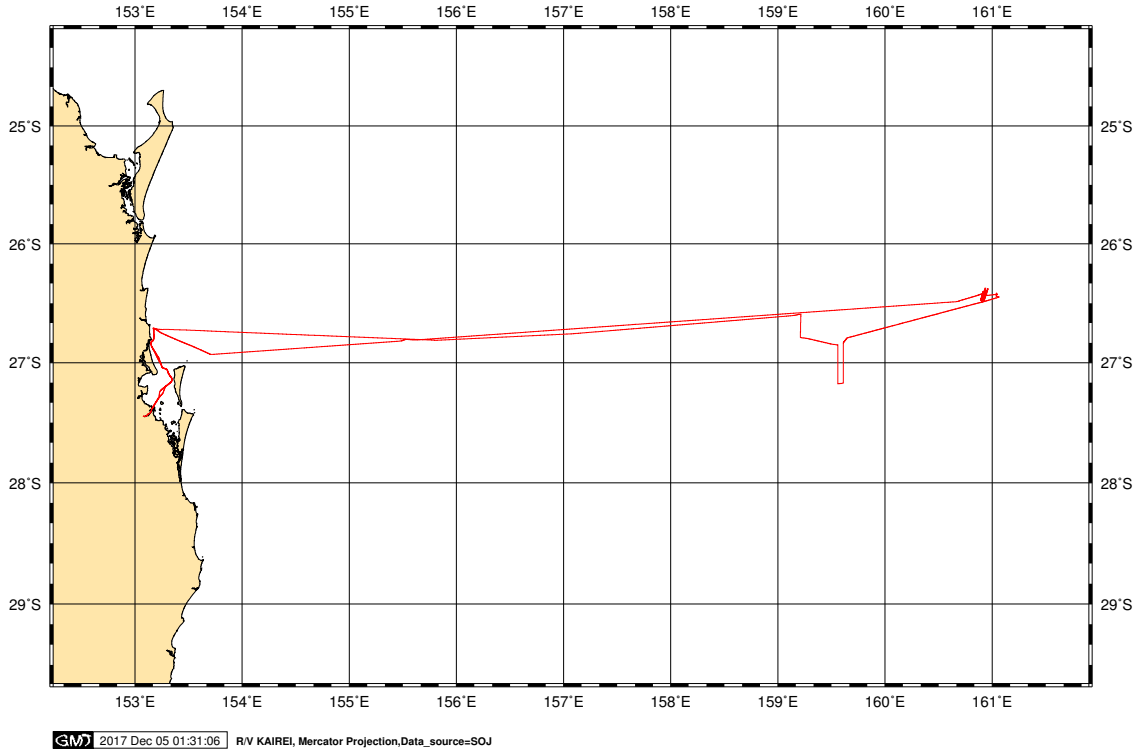

Figure 3. Cruise track of KR17-15C Leg 2-2.

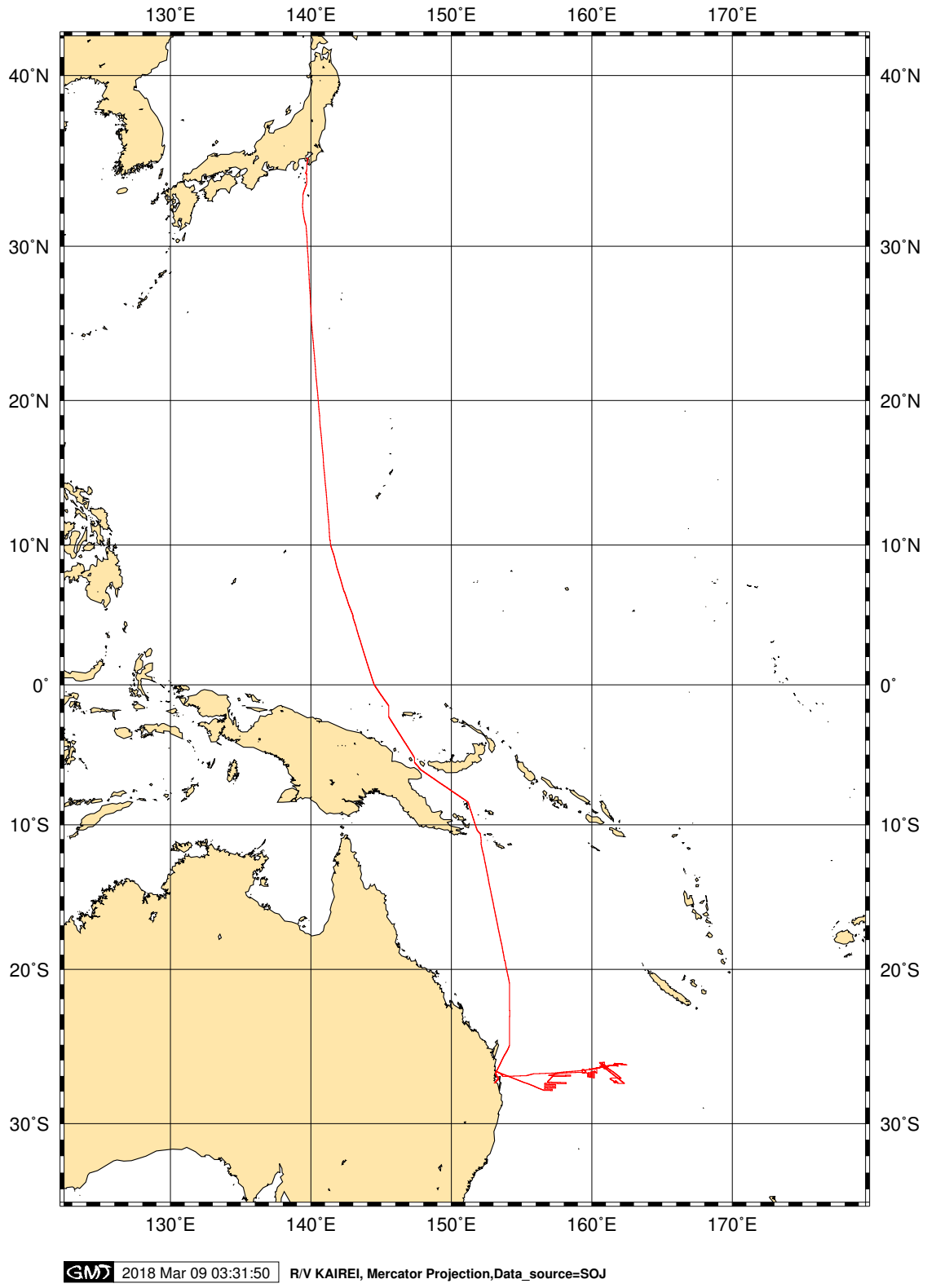

Figure 4. Cruise track of KR17-15C Leg 3 including the return transit from Australia to Japan.

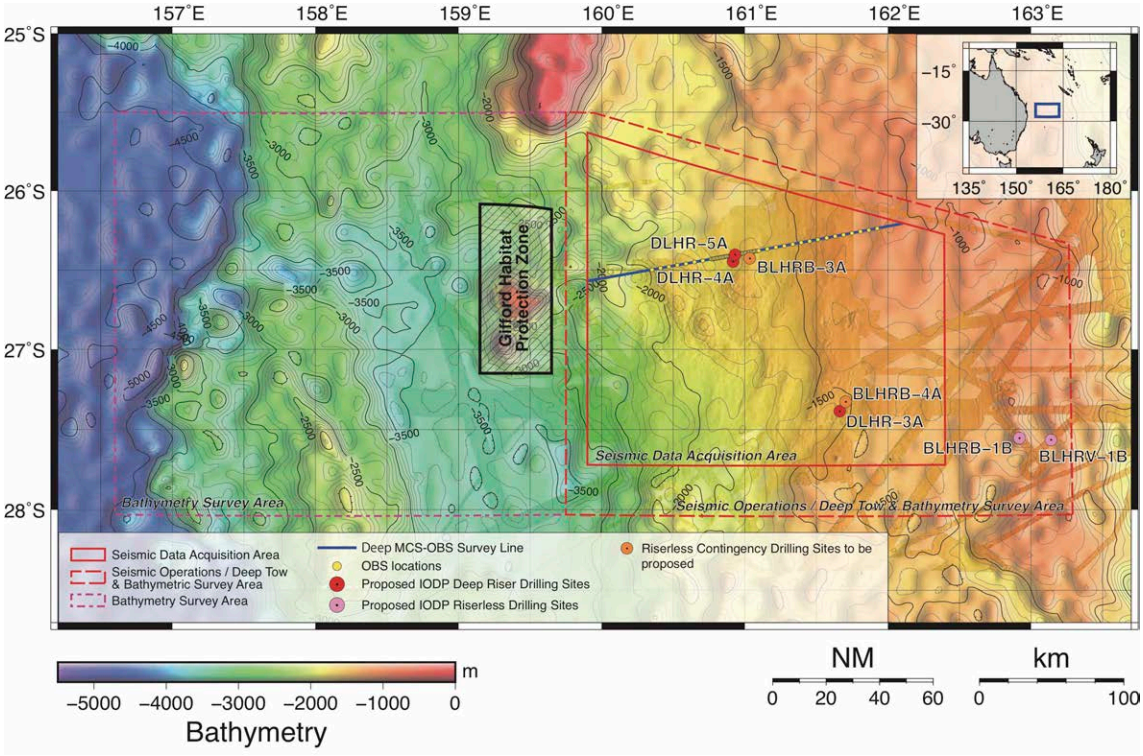

Figure 5. Overall map of the KR17-15C cruise survey areas.

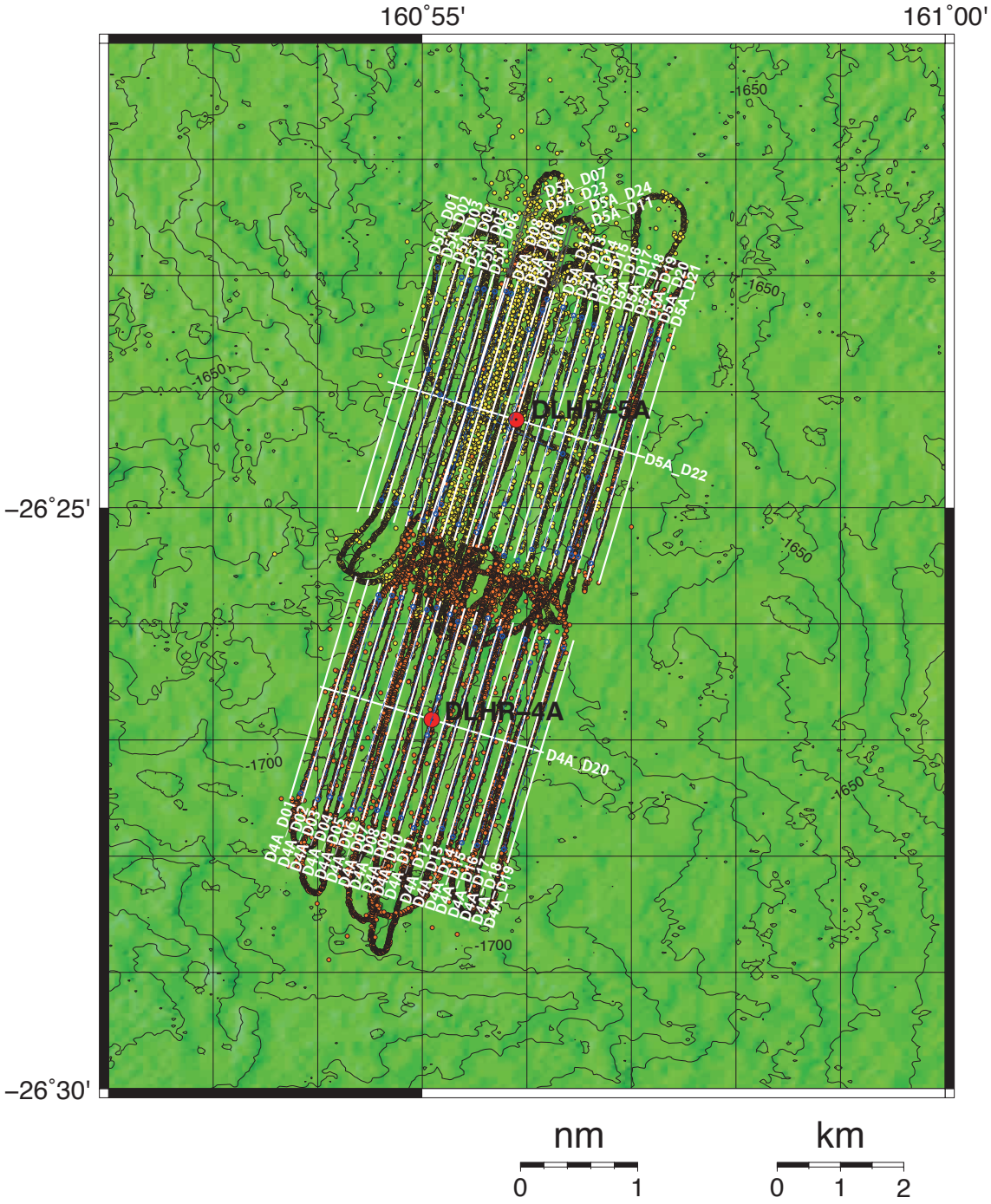

Figure 6. 6KSDT sonar survey planned lines and way points. White thick lines are planned survey lines. Yellow and orange dots are way points of the towfish during Leg 1 and Leg 2-2, respectively, as positioned by the shipboard Acoustic Navigation System (ANS). Blue dots are end points of surveyed lines positioned by ANS.

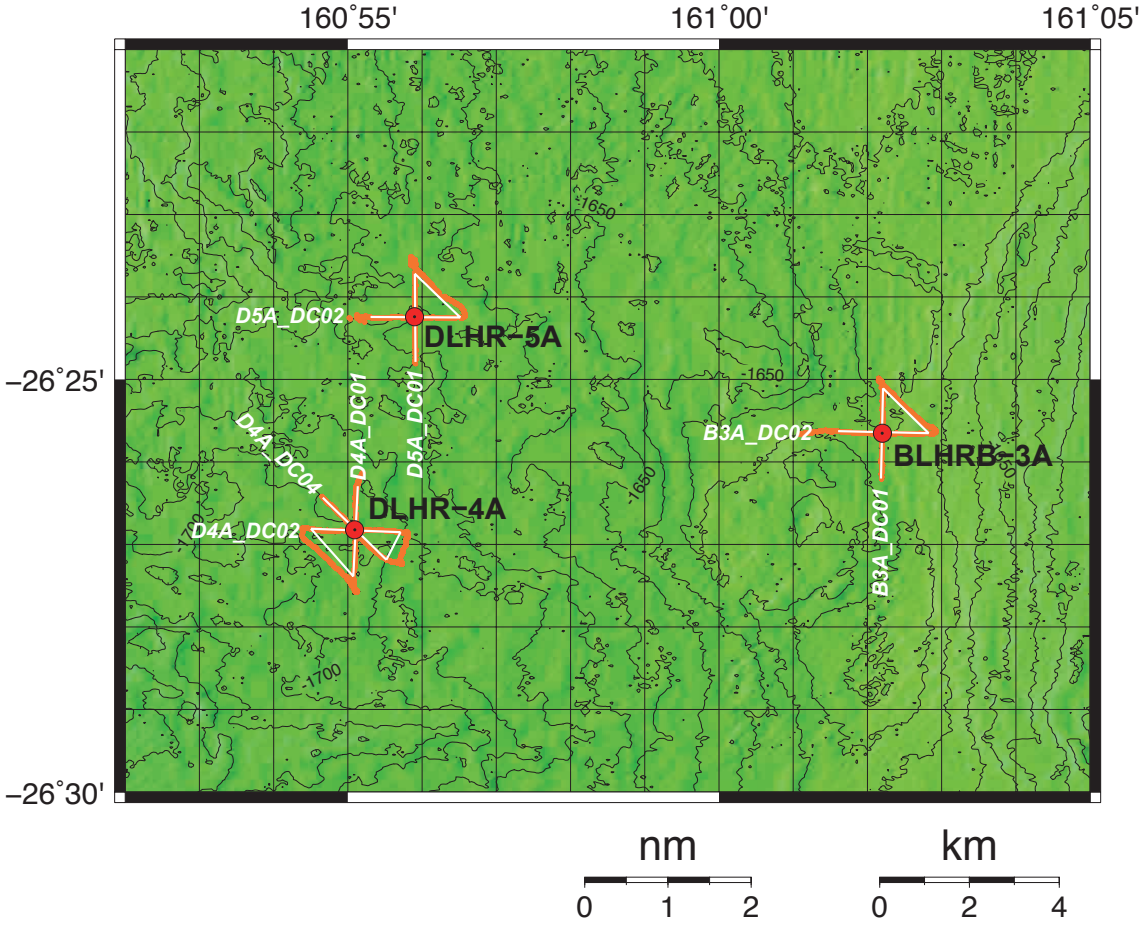

Figure 7. 6KSDT camera survey way points. White thick lines are planned survey lines. Orange dots are way points of the towfish positioned by phins DVL.

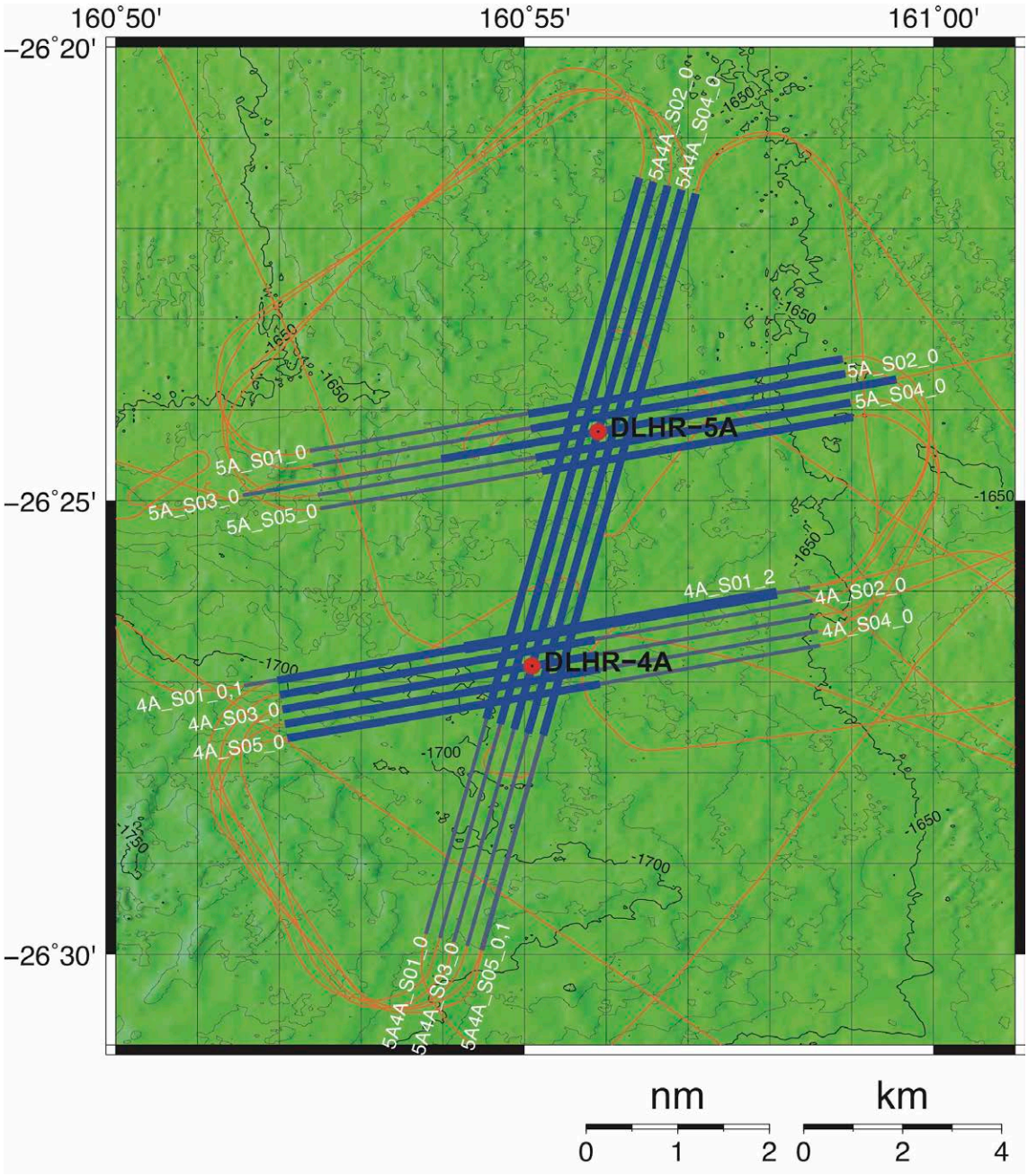

Figure 10. HR-MCS survey lines in the DLHR-5A/4A area. Blue thin and thick lines indicate regions of air gun shooting with partial volume and full volume, respectively. R/V Kairei's track during the OBS-MCS survey is shown by the orange line.

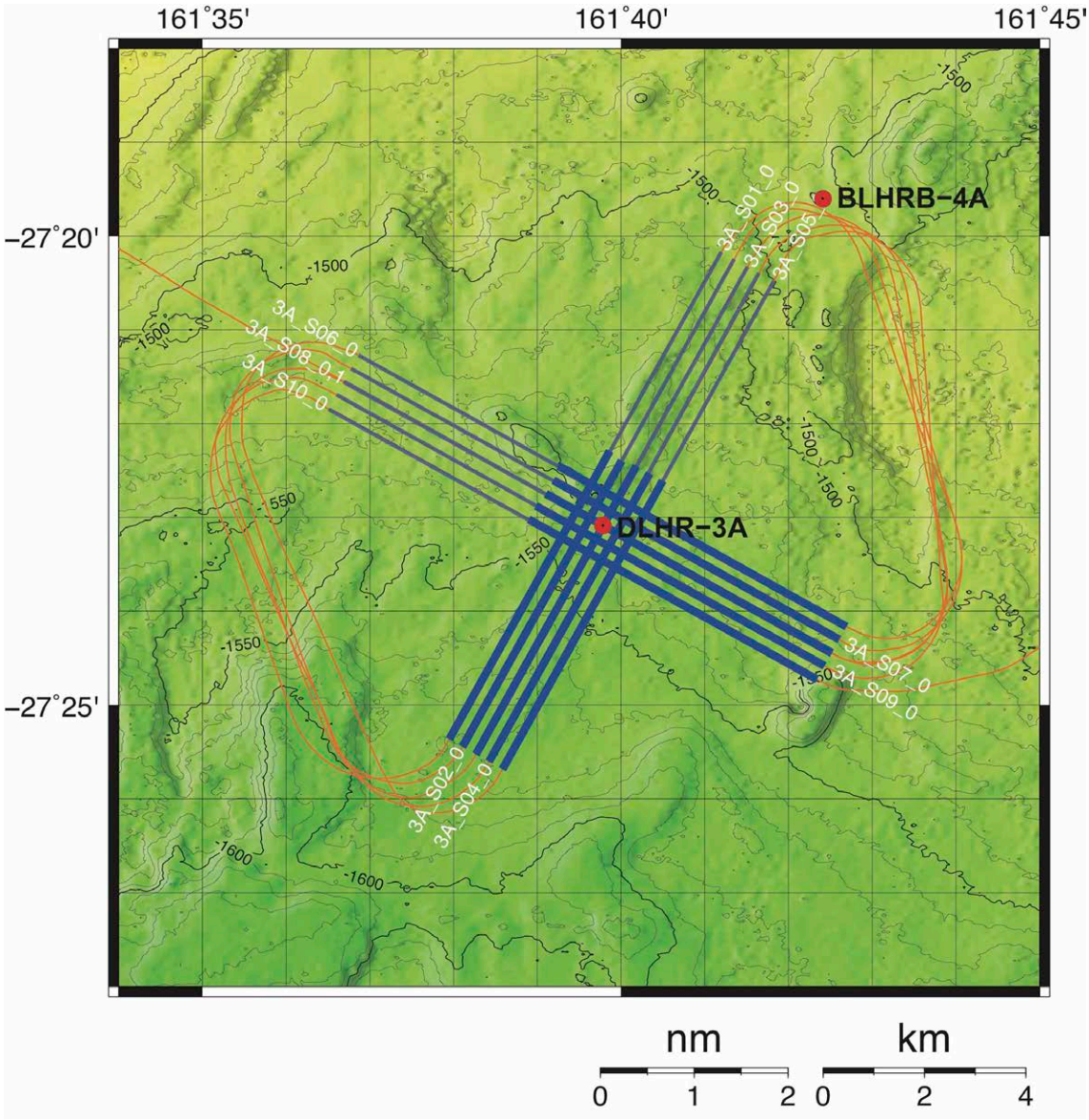

Figure 11. HR-MCS survey lines in the DLHR-3A area. Blue thin and thick lines indicate regions of air gun shooting with partial volume and full volume, respectively. R/V Kairei's track during the OBS-MCS survey is shown by orange line.

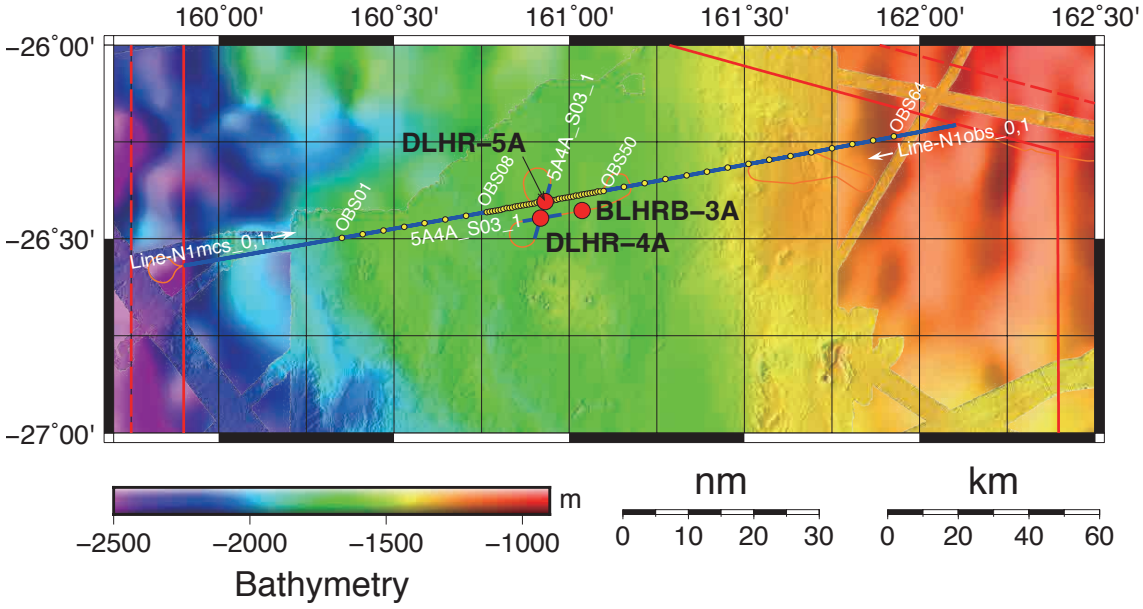

Figure 12. OBS-MCS survey lines (blue lines) and deployed OBS positions (yellow dots). R/V Kairei's track during the OBS-MCS survey is shown by orange line.

2. Researchers

(1) Chief Scientist

Kan Aoike (CDEX/JAMSTEC)	[Legs 1, 2-1, 2-2 and 3]

(2) Onboard Science Party Members

Yukari Kido (CDEX/JAMSTEC)	[Leg 1]
Yosaku Maeda (MARITEC/JAMSTEC)	[Legs 1 and 2-2]
Scott Nichol (GA)	[Legs 1, 2-1 and 2-2]
Maggie Tran (GA)	[Legs 1 and 2-1]
Takamitsu Sugihara (CDEX/JAMSTEC)	[Legs 2-1 and 2-2]
Brian Boston (CEAT/JAMSTEC)	[Legs 2-1, 2-2 and 3]
Rachel Przeslawski (GA)	[Leg 2-2]
Yoshinori Sanada (CDEX/JAMSTEC)	[Leg 3]
Kazuya Shiraishi (ODS/JAMSTEC)	[Leg 3]
Ron Hackney (GA)	[Leg 3]
George Bernardel (GA)	[Leg 3]

CDEX: Center for Deep Earth Exploration

MARITEC: Marine Technology and Engineering Center

ODS: R&D Center for Ocean Drilling Science

CEAT: R&D Center for Earthquake and Tsunami

GA: Geoscience Australia

3. Overview of Research Activities

(1) Objectives

The KR17-15C cruise was planned and executed under a Collaborative Project Agreement between Geoscience Australia (GA) and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) as the second phase site survey for a scientific drilling project in the Lord Howe Rise (LHR). The LHR, located off the east coast of the Australian continent, constitutes part of Zealandia which has recently attracted scientific attention as the suggested seventh largest but most submerged continent on Earth (Campbell and Mortimer, 2014) and is a continental ribbon created by breakup of eastern Gondwana during the Late Cretaceous. The sedimentary basins formed on the LHR are expected to preserve excellent records of tectonic processes involved in the formation of the LHR continental ribbon, paleoclimate change with ocean biogeochemical cycles in the southern hemisphere, and evolution of subseafloor microbial life from the Cretaceous onwards. To solve scientific questions relevant to these themes, a drilling project for the International Ocean Discovery Program (IODP) (IODP Proposal 871-CPP) titled "First deep stratigraphic record for the eastern Gondwana margin: Tectonics, paleoclimate and deep life on the Lord Howe Rise high-latitude continental ribbon" has been proposed. This proposal was developed at the initiative of GA and JAMSTEC and plans to use *D/V Chikyu* for deep riser drilling. The proposal was accepted by the IODP in January 2017 and was then officially designated as a Chikyu project by the Chikyu IODP Board.

The first phase site survey for this drilling project, cruise KR16-05, was conducted in 2016, with seismic data acquisition targeting regional and local crustal structures of the LHR across the proposed drill sites. The second phase site survey, cruise KR17-15C, focused on obtaining data to assess geotechnical, safety and environmental issues around the proposed drill sites. Based on the results of the first site survey, the primary drill site was revised from DLHR-3A to DLHR-5A. Due to this change, seismic transects to image the regional crustal structures through the revised primary drill site, DLHR-5A, were also scheduled. Following surveys were included in this cruise: high-resolution acoustic and visual seafloor mapping with a deep tow system; piston coring; seafloor sediment sampling; high-resolution shallow 2D multi-channel seismic (HR-MCS) reflection grid survey; deep MCS reflection survey and seismic refraction survey using ocean bottom seismometers (OBS). In addition, data acquisition of bathymetry, sub-bottom profiles, gravity and geomagnetics using shipboard observation systems along with the main surveys were planned.

(2) Observations

1） Deep Tow sonar survey

Deep Tow sonar seafloor mapping survey was carried out during Legs 1 and 2-2. Areas around two riser drill sites, 2 nm x 2 nm for Site DLHR-5A and 1.8 nm x 1.8 nm for Site DLHR-4A, were mapped. The 6000-m Super Deep Tow system, 6KSDT, equipped with three types of seafloor survey sonars, a multibeam echo sounder, two sets of side scan sonars and a sub-bottom profiler, was deployed for high-resolution acoustic seabed mapping. Navigation data of the towfish were acquired both by an inertial navigation system with Doppler velocity logger (phins DVL) and by the shipboard Acoustic Navigation System (ANS). When tracing survey lines, the towfish was towed to maintain an altitude of 100 m ± 10 m above the seabed and a ground speed of about 2 kt. The survey lines were aligned with a spacing of 200 m and in a NNE-SSW direction (parallel to a MCS survey line from the KR16-05 cruise). For data correction during post-cruise processing, a line perpendicular to the other lines was also traced. Due to serious damage to the towing winch (No.15 winch) and an additional port call for its repair, Leg 1 was shortened and the sonar survey was separated into Legs 1 and 2-2.

2) Deep Tow camera survey

The Deep Tow camera survey was carried out during Leg 2-2. The camera-mode 6KSDT was used for visual seafloor mapping around the riser and riserless drill sites, DLHR-5A, DLHR-4A and BLHRB-3A, to collect data for environmental assessment. In camera-mode, one HDTV camera with three LED lights facing 45° downward and two still cameras on both sides with two LED lights facing straight down were turned on. For this deployment, the skid on which MBES and SBP are mounted was removed from the towfish. The still camera system took seabed photo images every 6 seconds in automatic mode. Navigation data of the towfish were acquired both by the phins DVL on the towfish and the shipboard ANS. Visual seafloor mapping was performed along two 2-km survey lines normal to each other passing through each site and one 1.4-km connecting line with the two lines. For DLHR-4A, one additional oblique line was surveyed. When tracing the survey lines, the towfish was towed to maintain an altitude of 3-5 m above the seabed with a ground speed of 0.7-0.8 kt.

3) Piston Coring

Piston coring operations were conducted at two riser drill sites, DLHR-5A and DLHR-3A, during Leg 2-1. Two sediment cores at each site, in total four cores, were taken by using a 20-m piston corer. Although 15~20-m core barrels were deployed, recovered core lengths were 6~7 m and the core barrels were bent slightly. The recovered cores, composed of calcareous ooze, were cut into 1-m sections and stored without splitting. Undrained shear

strength measurement was performed on each bottom side section end by using a handheld penetrometer. Six whole-round core (WRC) samples of 30 cm length from the lower two sections of each core, in total 24 WRC samples, were taken after the sectioning. Those samples will be used for post-cruise soil tests including triaxial compression tests to assess the shallow formation strength at the riser drill sites. In addition to the main cores, short cores were taken by a 50-cm pilot corer: three of four pilot cores were recovered. The pilot cores were consumed for biological elutriation on board. The main cores, except for the WRC samples, were offloaded at Brisbane and sent to GA's core repository.

4) Box Coring

Box coring operations were attempted at two riser sites during Leg 2-1, but due to sea conditions and time limitations, were conducted only at DLHR-3A. The box corer was provided by GA, equipped with a box measuring 50 cm (L) x 50 cm (W) x 60 cm (D). Box coring was executed twice. The first attempt was successful with recovery of well-preserved seafloor sediment. The second attempt resulted in no recovery. The recovered sediment was used up for biological elutriation on board.

5) OBS deployment and retrieval

OBS deployment and retrieval was carried out during Leg 3. We successfully deployed 64 OBSs along an ENE-WSW regional survey line, Line-N1, passing through DLHR-5A. All OBSs were retrieved. The OBSs were deployed over 160 km of the 223-km-long Line-N1. OBS01 to OBS08 and OBS50 to OBS64 were deployed at 6-km intervals, while OBS08 to OBS50 around DLHR-5A were deployed at 800-m intervals. Five OBSs (OBS01, 08, 51, 57 and 64) were equipped with a hydrophone with reduced sensitivity to record sound in the water column: the data acquired will be used to test the sound modeling previously undertaken when determining the mitigations required to minimize the environmental impact of the seismic source.

6) HR-MCS survey

The HR-MCS survey was carried out around three riser drill sites, DLHR-5A, DLHR-4A and DLHR-3A, during Leg 3. Grid survey lines comprising five parallel survey lines with 300-m spacing and another five parallel crossing survey lines with the same spacing, in total 25 survey lines, were arranged around each drill site. With the aim to obtain high-resolution seismic reflection images of shallow formations down to at least 1000 m below seafloor, we modified the configuration of the Kairei's Annular Port Gun (APG) array system. In the modified configuration, two gun arrays were deployed at a towing

depth of 1.5 m and only four 100 cu.in. air guns, (400 cu.in. total), were activated. Air gun shooting was performed at intervals of 25 m, towing at the target log speed of 4.5 kt and not more than 5.0 kt. The record length was 6 seconds. The streamer cable was about 3 km long with 216 hydrophones channels aligned at 12.5 m. The target depth of the streamer cable was initially 3 m, but it was set deeper to 5 m, 6 m or 8 m due to difficulty in maintaining the 3 m target depth and a frequently unacceptable level of bubble noise when sea condition were worse than very calm. A passive acoustic monitoring (PAM) cable was towed along with the streamer and acoustic and visual marine mammal observations were performed by the service company (Blue Planet Marine: BPM) during air gun shooting. No whale instigated shutdown of the air guns was necessary during the survey.

7） OBS-MCS survey

The OBS-MCS survey was carried out along Line-N1, with a length of 223 km, during Leg 3. The full set of the APG gun arrays, consisting of four arrays each of 1950 cu.in. (total 7800 cu.in.), were deployed for this survey. The same streamer cable, about 3 km long with 216 hydrophone channels aligned at 12.5 m, was deployed at a depth of 12 m. Two series of air gun shooting were performed at intervals of 200 m westward from the east end (OBS acquisition) and 50 m eastward from the west end of Line-N1 (MCS acquisition), with a towing depth of 10 m, and log speeds of around 4.5 kt, not exceeding 5.0 kt. During the 50-m interval shooting, two short survey lines, centered on the HR-MCS survey grids for Sites DLHR-5A and DLHR-4A, were added because the survey proceeded ahead of schedule. The PAM cable was also towed along with the streamer and acoustic and visual marine mammal observations were performed by BPM during all air gun shooting. No whale instigated shutdown of air guns occurred during the survey. Because there were no whale instigated shutdowns, no wait-on-weather, very limited mechanical downtime and smooth operations, the planned seismic acquisition was completed without using any of the planned contingency days.

8） PAM standalone survey

A PAM standalone survey was carried out around the Gifford Seamount to monitor the activity of marine mammals around this important habitat.. The PAM cable was towed at 6 kt along a circuitous survey line of about 54 nm in length.

9） Bathymetry survey with shipboard MBES

Bathymetry and backscatter data acquisition with shipboard MBES was carried out along 6KSDT, HR-MCS and OBS-MCS survey lines, while in transit in the area east of around

153°45'E and in other specific areas of interest. The areas northwest of Sites DLHR-5A and 4A, east of Site DLHR-3A and the over the unnamed seamount in the Gifford Marine Park were mapped at 8 kt. Part of the Dampier Ridge, which bounds the eastern margin of the Tasman Sea, and transit lines were mapped at around 12~15 kt.

10) Sub-bottom profiling survey with Shipboard SBP

Shipboard SBP data was acquired along with the HR-MCS survey. Data acquisition started in the middle of the HR-MCS survey in the DLHR-5A/4A area, but the SPB was turned off during nighttime in that area. Therefore, additional SBP acquisition was carried out in the DLHR-5A/4A area after the HR-MCS survey along five remaining lines within the 3.6 km interval centered at DLHR-5A and DLHR-4A. Data were not acquired along the three center line of the grids, because data were previously acquired during the KR16-05 cruise.

11) Gravity survey with shipboard gravimeter

Gravity data acquisition with the shipboard gravity meter was carried out during the entire cruise. Gravity data calibration was performed using a portable gravity meter at the quay and the gravity reference station of the JAMTEC Headquarters at the beginning and end of the cruise. Calibration measurements were also undertaken during port calls in Brisbane (except between Legs 1 and 2-1) at quay sides and the gravity reference station at Northshore Riverside Park in Brisbane (station 2016909147 of the Australian Fundamental Gravity Network).

12) Geomagnetics survey with shipboard magnetometer

Geomagnetic data acquisition with the shipboard magnetometer was carried out during the entire cruise. During Legs 1 and 2-1, figure eight calibration maneuvers of the vessel were performed at three locations, 16 nm northwest of DLHR-5A, DLHR-5A and DLHR-3A, to acquire data for correcting the vessel's magnetic signature. The vessel traced a figure eight at 8~9 kt for about 20 minutes.

13) XBT and XCTD surveys

XBT and XCTD measurement surveys were carried out to correct for acoustic velocities of water in MBES, SBP and MCS data. XBT measurements were performed four times prior to: commencement of the 6KSDT survey at DLHR-5A, the first OBS deployment, the HR-MCS surveys in the DLHR-5A/4A area and the HR-MCS survey in the DLHR-3A

area. XCTD measurements were conducted just after completion of OBS deployment and recovery near the both ends of OBS deployment region.

(2) Cruise Logs

Table 1. Daily Activities of Leg 1

Date (LT)		Activities
Oct. 29	Sun	Departure from JAMSTEC Headquarters, Yokosuka, then evacuation in Tokyo Bay
Oct. 30	Mon	Departure from Tokyo Bay
Nov. 1	Tue	Transit
Nov. 10	Fri	
Nov. 11	Sat	Arrival at General Purpose Wharf, Fisherman Island, Port of Brisbane
Nov. 12	Sun	Rig-up
Nov. 13	Mon	Rig-up
Nov. 14	Tue	Departure from General Purpose Wharf, Fisherman Island, Port of Brisbane
Nov. 15	Wed	Transit, then 6KSDT sonar survey in DLHR-5A area
Nov. 16	Thu	6KSDT sonar survey in DLHR-5A area
Nov. 17	Fri	6KSDT sonar survey in DLHR-5A area
Nov. 18	Sat	MBES mapping and figure-8 maneuver
Nov. 19	Sun	MBES mapping
Nov. 20	Mon	Transit
Nov. 21	Tue	Arrival at QUBE bulk berth in Hamilton, Port of Brisbane

Table 2. Daily Activities of Leg 2-1

Date (LT)		Activities
Nov. 22	Wed	Departure from QUBE bulk berth in Hamilton, Port of Brisbane
Nov. 23	Thu	Transit
Nov. 24	Fri	Piston coring at DLHR-5A
Nov. 25	Sat	Piston coring and box coring at DLHR-3A
Nov. 26	Sun	Transit
Nov. 27	Mon	Arrival at QUBE bulk berth in Hamilton, Port of Brisbane
Nov. 28	Tue	Rig-up

Table 3. Daily Activities of Leg 2-2

Date (LT)		Activities
Nov. 29	Wed	Departure from QUBE bulk berth in Hamilton, Port of Brisbane
Nov. 30	Thu	Transit
Dec. 1	Fri	6KSDT sonar survey in DLHR-5A and DLHR-4A areas
Dec. 2	Sat	6KSDT sonar and camera surveys in DLHR-5A and DLHR-4A areas
Dec. 3	Sun	6KSDT camera survey in DLHR-4A and BLHRB-3A
Dec. 4	Mon	Transit
Dec. 5	Tue	Arrival at AAT wharf, Fisherman Island, Port of Brisbane
Dec. 6	Wed	Rig-up

Table 4. Daily Activities of Leg 3

Date		Activities
Dec. 7	Thu	Departure from AAT wharf, Fisherman Island, Port of Brisbane
Dec. 8	Fri	Transit and OBS deployment
Dec. 9	Sat	HR-MCS survey in DLHR-5A/4A area
Dec. 10	Sun	HR-MCS survey in DLHR-5A/4A area
Dec. 11	Mon	HR-MCS survey in DLHR-5A/4A area
Dec. 12	Tue	HR-MCS survey in DLHR-5A/4A area
Dec. 13	Wed	HR-MCS survey in DLHR-3A area
Dec. 14	Thu	HR-MCS survey in DLHR-3A area
Dec. 15	Fri	OBS deployment
Dec. 16	Sat	OBS deployment and OBS-MCS (200-m interval shooting)
Dec. 17	Sun	OBS-MCS survey (200-m interval shooting)
Dec. 18	Mon	OBS-MCS survey (200-m interval shooting)
Dec. 19	Tue	OBS-MCS survey (50-m interval shooting)
Dec. 20	Wed	OBS-MCS survey (50-m interval shooting) and OBS retrieval
Dec. 21	Thu	OBS retrieval
Dec. 22	Fri	OBS retrieval
Dec. 23	Sat	OBS retrieval and MBES survey
Dec. 24	Sun	MBES survey and PAM standalone survey
Dec. 25	Mon	MBES survey
Dec. 26	Tue	MBES survey
Dec. 27	Wed	Arrival at AAT wharf, Fisherman Island, Port of Brisbane
Dec. 28	Thu	Shifting to QUBE bulk berth in Hamilton and loading

Dec. 29	Fri	Loading
Dec. 30	Sat	Departure from QUBE bulk berth in Hamilton, Port of Brisbane
Jan. 1	Sun	Transit
Jan. 10	Wed	
Jan. 11	Thu	Arrival at JAMSTEC Headquarters, Yokosuka

4. Notice on using:

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.