doi : 10.17596/0002715

RV Kaimei “Cruise Report”
KM17-E01

Were intraplate volcanoes around Minami-Torishima derived from mantle plume or plate tectonics?

The seas surrounding Minami-Torishima Island

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

Introduction and scientific objectives

Japanese main islands are located at the convergent plate boundaries, where one plate is subducted beneath another (Figure 1). This subduction triggers huge earthquakes and explosive volcanic eruptions, and any part of Japanese main islands couldn't be stable in the range of one to hundred thousand years of period. On the other hand, Minami-Torishima Island is situated on the Pacific Plate, which is more than 1000 km away from the Izu-Ogasawara trench (Figure 2). Thus, theoretically, this island is one of the stablest island in Japan, which is free from earthquakes and volcanic eruptions caused by subduction of the plate. Figure 3 shows the distribution of ages of oceanic crust from Seton et al. (2012). The Minami-Torishima Island is located on the oldest part of the Pacific plate, which has been produced at the Jurassic midocean ridge between the Pacific and Izanagi plates.

"The Pacific triangle is an area of the western Pacific where three Mesozoic magnetic lineation sets (Japanese, Hawaiian and Phoenix lineations) intersect (Figure 4), recording the birth of the Pacific plate from three "parents": the Farallon, Izanagi and Phoenix plates. The evolution of the three parent plates has influenced the development of subsequent seafloor spreading systems in the Pacific. The northwestern (Japanese) lineations represent spreading between the Pacific and Izanagi plates and young towards the west–northwest, the easternmost (Hawaiian) lineations represent spreading between the Pacific and Farallon plates and young towards the east and the southernmost (Phoenix) lineations represent spreading between the Pacific and Phoenix plates and young towards the south (Atwater, 1990; Nakanishi et al., 1992) (Figure 4). These three plates radiated out from the emerging Pacific plate during the Mesozoic and existed prior to the establishment of the Pacific plate in a simple ridge– ridge–ridge configuration" (Seton et al., 2012, p. 225).

Seton et al. (2012) estimated maximum onset time of spreading between Pacific and Izanagi plates to be 190 Ma at the Farallon–Izanagi–Phoenix triple junction (Figure 5).

Why the Pacific plate suddenly appeared at the Farallon-Izanagi-Phoenix triple junction?

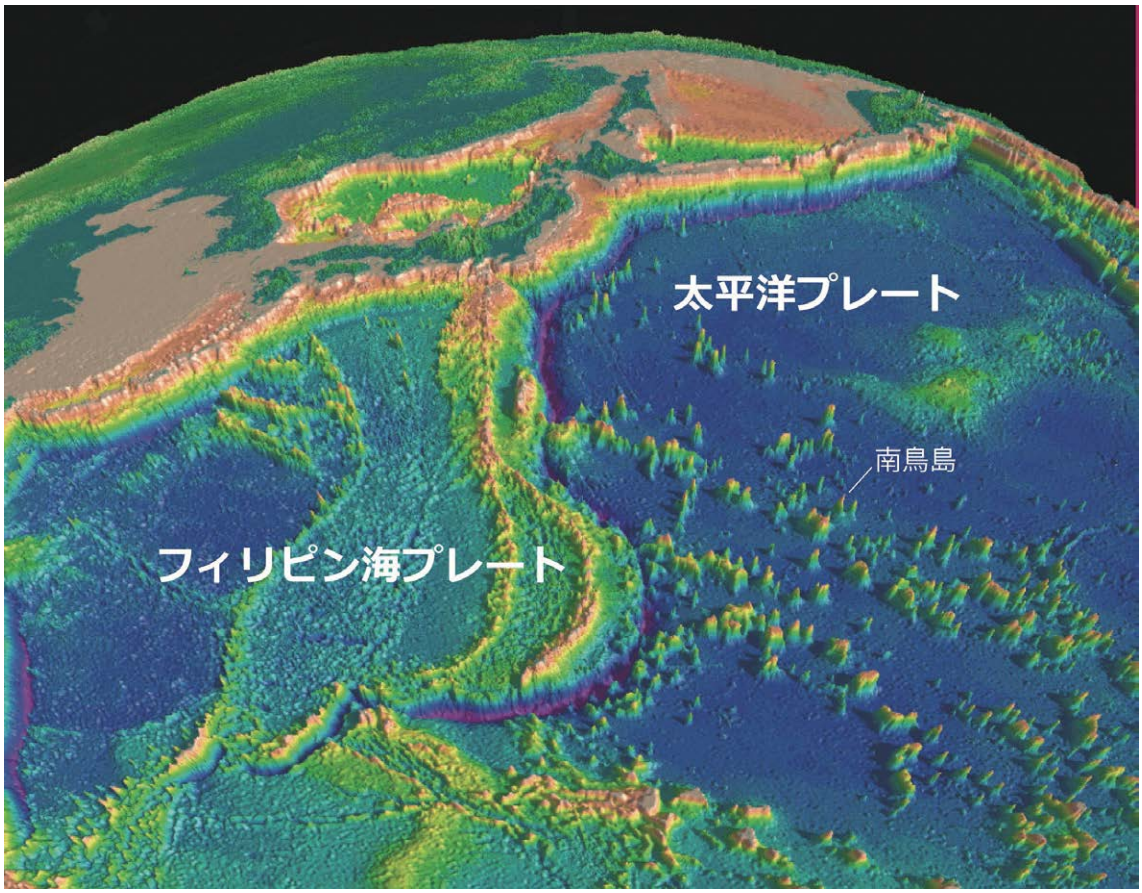


Figure 1. Geographic features of Japanese islands and the surrounding seafloor.

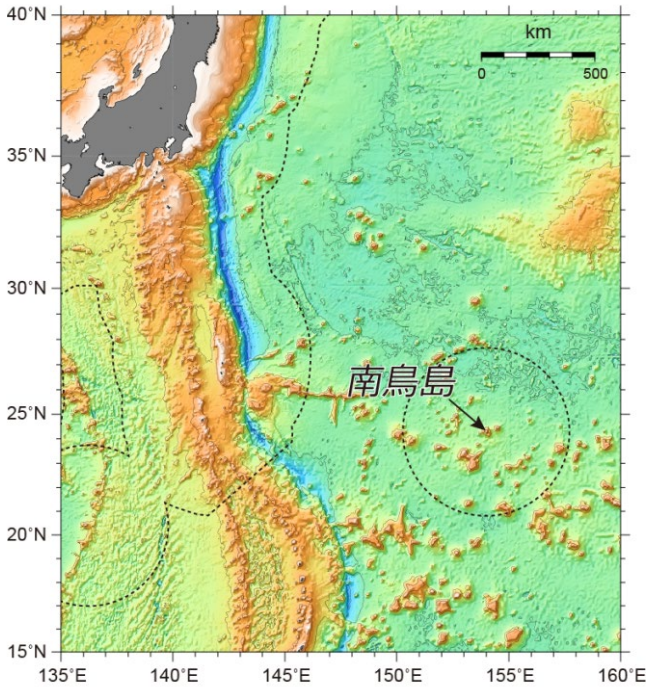


Figure 2. Minami-Torishima Island, which is situated at 24°17'12" N and 153°58'50" E and 1800 km away from the main island Honshu, is the southeastern

end of Japan's territories. Dotted lines show the boundaries of Japanese exclusive economic zone (EEZ).

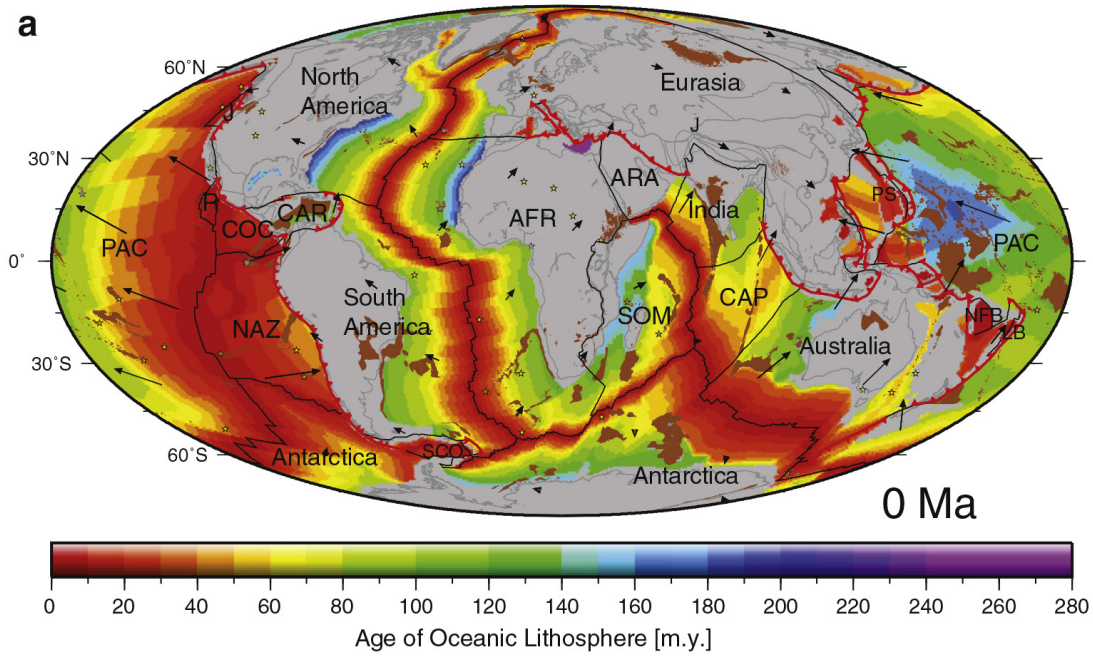


Figure 3. From Seton et al. (2012). The Minami-Torishima Island is located on the oldest part of the Pacific plate, which has been produced at the Jurassic midocean ridge between Pacific and Izanagi plates.

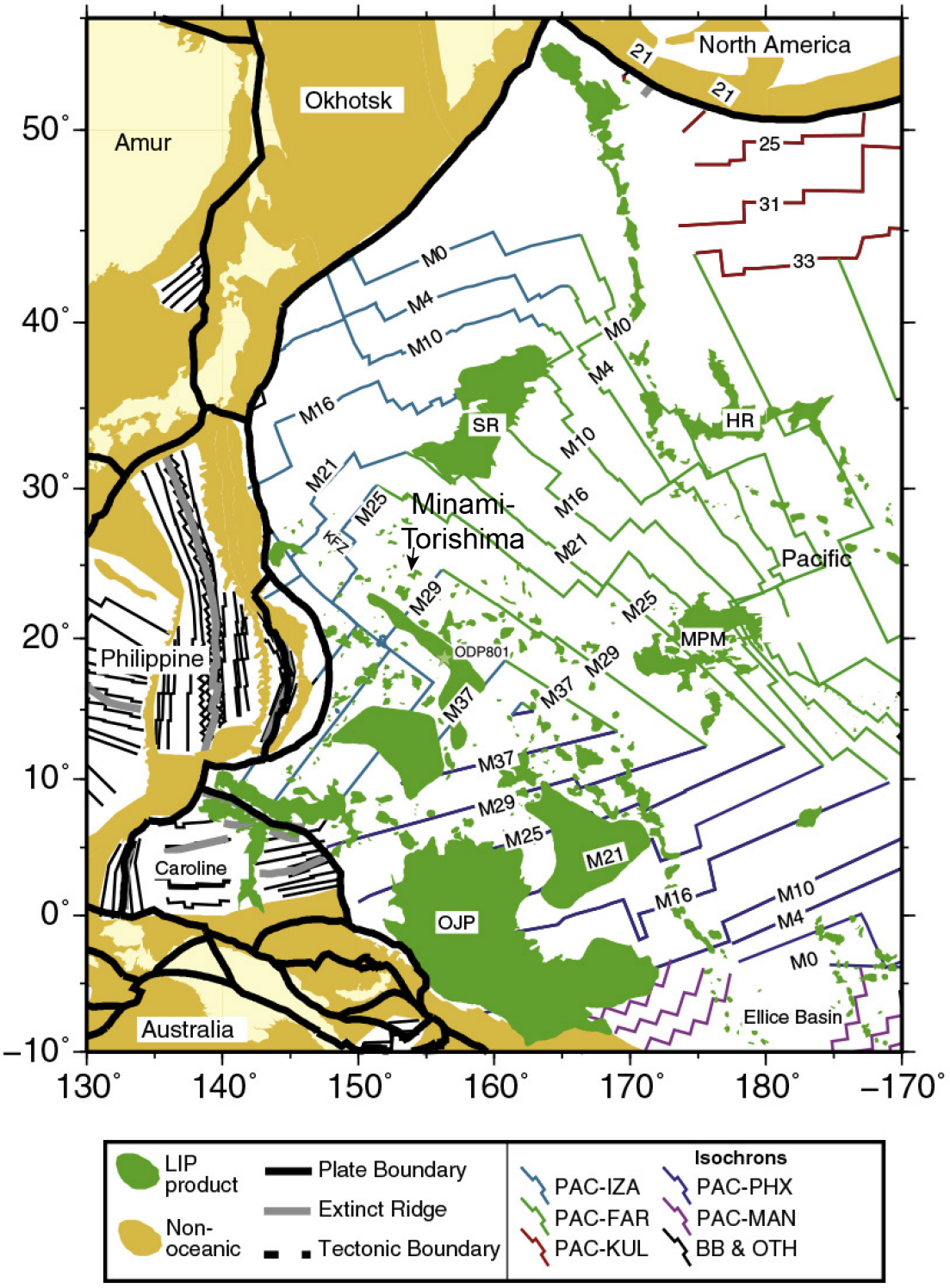


Figure 4. Seafloor spreading isochron map colored by spreading system or plate pair (Seton et al., 2012). The Minami-Torishima Island is located between M25 and M29 (~156-154 Ma) (Nakanishi et al., 1992) which has been produced at the Jurassic midocean ridge between Pacific and Izanagi plates.

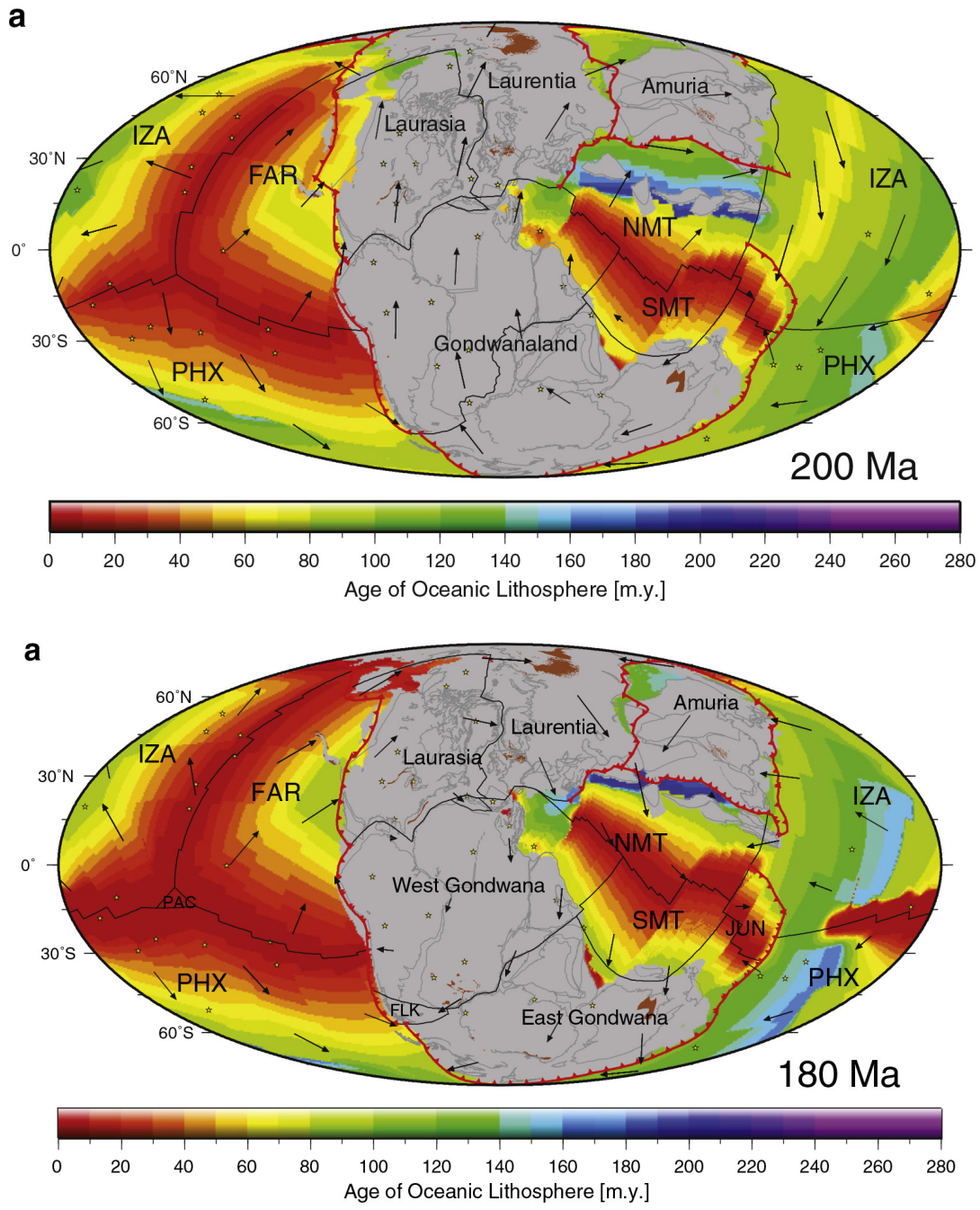


Figure 5. Global plate reconstructions of 200 Ma and 180 Ma. Red lines denote subduction zones, black lines denote mid-ocean ridges and transform faults. Absolute plate velocity vectors are denoted as black arrows. Abbreviations for the plates are: FAR = Farallon plate, IZA = Izanagi plate, NMT = North Meso-Tethys, PAC = Pacific plate, PHX = Phoenix plate, SMT = South Meso-Tethys.

The seas surrounding Minami-Torishima Island, however, have geographic features made of numerous intraplate volcanoes, which is called the Marcus-Wake Seamount

Chain and have been active since the Early Cretaceous (Figure 7). Koppers et al. (2003) reviewed the ages and isotopic ratios from the West Pacific Seamount Province (WPSP) that stretches all the way from the Mid-Pacific Mountains to the Mariana trench in the Western Pacific basin (Figure 8).

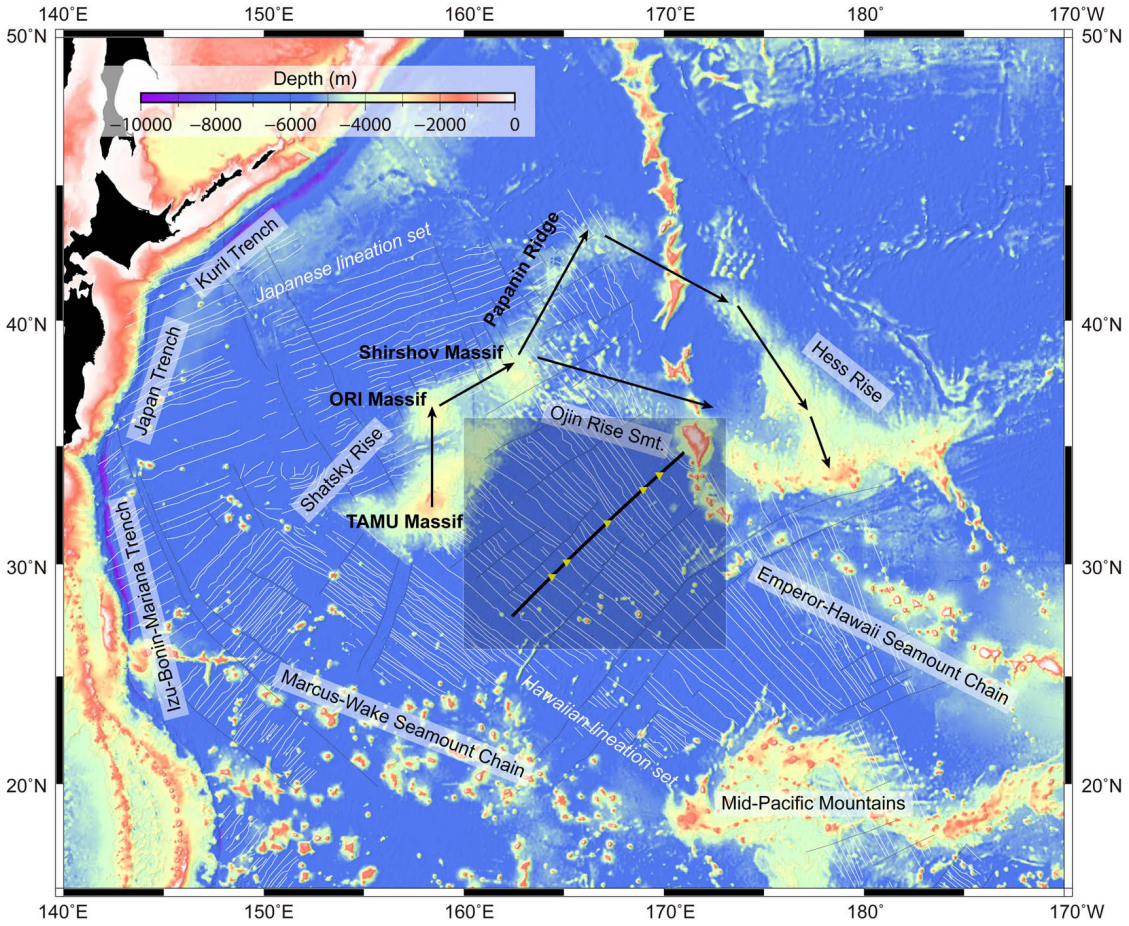


Figure 6. Seafloor map of the northwestern Pacific from Ohira et al. (2017). Marcus-Wake Seamount Chain is located on the oldest part of the Pacific plate.

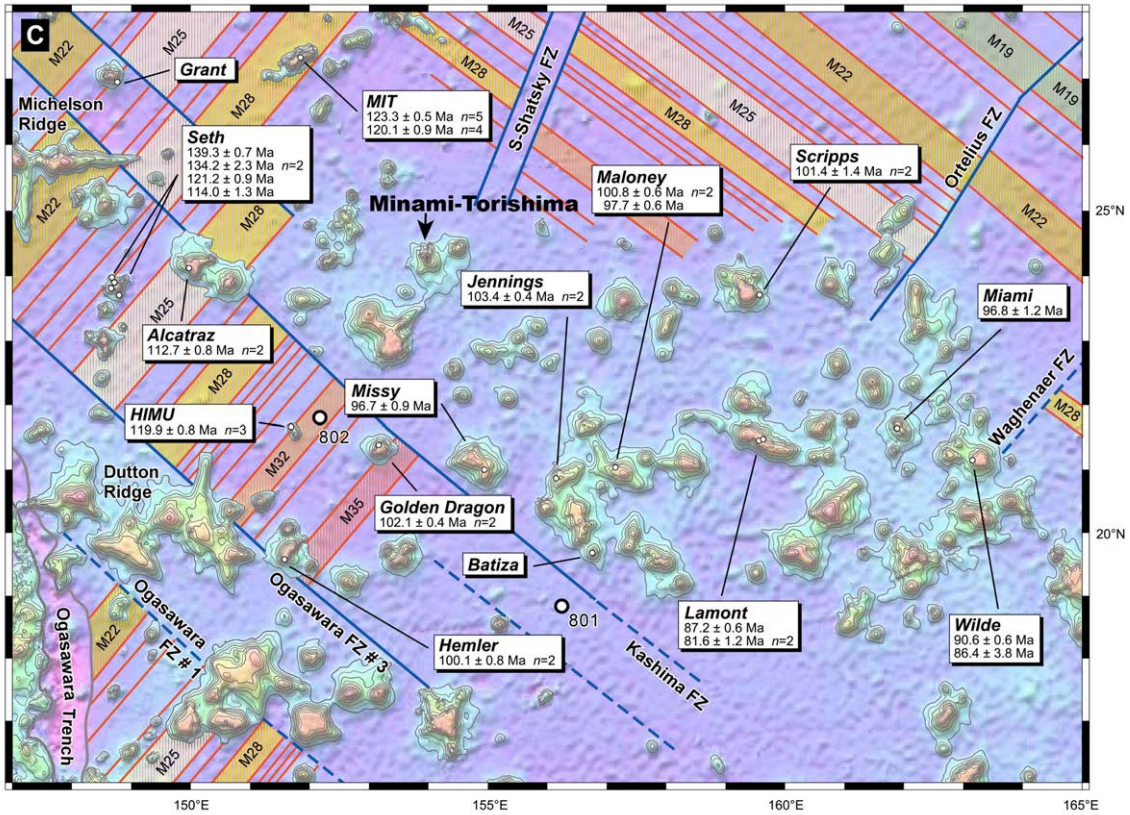


Figure 7. Map showing distribution of ages of oceanic crust (Seton et al., 2012). The oldest oceanic crust is of Jurassic age and is located in the NW Pacific (ca. 185 Ma).

1. Cruise Information

● Cruise ID: KM17-E01
● Name of vessel: RV Kaimei
○ Title of project: Minato Project
● Title of cruise: Were intraplate volcanoes around Minami-Torishima derived from mantle plume or plate tectonics?
● Chief Scientist: Yoshihiko Tamura [JAMSTEC]
● Cruise period: from December 30, 2017 to January 3, 2018
● Ports of departure / arrival: JAMSTEC Yokosuka/JAMSTEC Yokosuka
● Research area: the seas surrounding Minami-Torishima
● Research map

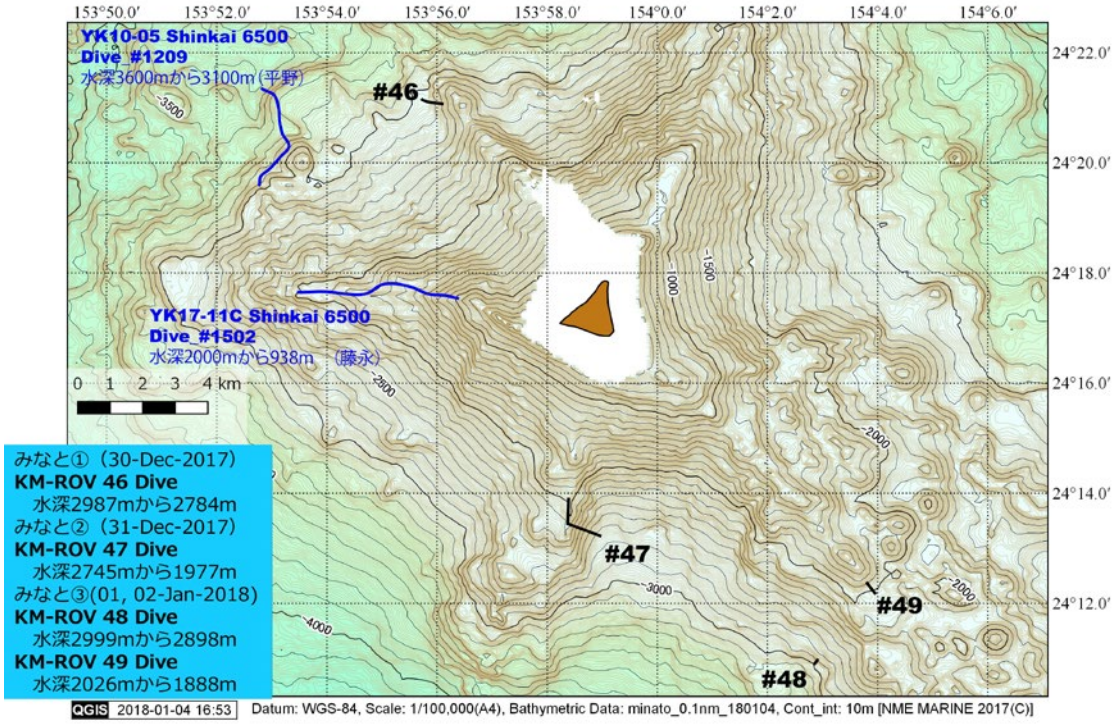


Figure 9. Map with KM-ROV dive tracks.

2. Research Proposal and Science Party

● Title of proposal: Were intraplate volcanoes around Minami-Torishima derived from mantle plume or plate tectonics?
● Representative of Science Party [Affiliation]
Yoshihiko Tamura [ODS, JAMSTEC]
● Science Party (List) [Affiliation, assignment etc.]

Yoshihiko Tamura	ODS	GL	研究統括・記載岩石学、鉱物化学分析	乗船
Osamu Ishizuka	ODS	招聘主任研究員	ドレッジ統括 Ar-Ar 年代測定	乗船
Tomoki Sato	ODS	技術スタッフ	XRF 分析 主要元素・微量元素測定	乗船
Tsuyoshi Hanyu	D-SEG	主任研究員	微量元素・同位体比測定	乗船
Yasuhiro Hirai	金沢大学	大学院	分析補助・記載岩石学	乗船

	(JAMSTEC)	生 (研究生)		
Takashi Miyazaki	D-SEG	主任技術研究員	微量元素・同位体比測定	乗船
Shigeaki Ono	ODS	主任研究員	高圧実験によるマグマ生成深度の推定	乗船
新研究員	ODS	研究員	鉱物分析によるマグマの揮発性物質の測定	乗船

(各研究課題の参加者を全て記載。List all Science Party members for individual proposal(s).)

Scientific Personnel on board RV Kaimei

Yoshihiko Tamura (ODS, JAMSTEC)
Tomoki Sato (ODS, JAMSTEC)
Takashi Miyazaki (ODS, JAMSTEC)
Yasuhiro Hirai (ODS, JAMSTEC)
Morifumi Takaesu (NME)

RV Kaimei Crew and KM-ROV Operation Team

職　名	氏　名	Position	NAME
船　長	吉田　力太	Captain	YOSHIDA RIKITA
一航士	足立　龍生	Chief Officer	ADACHI TATSUO
二航士	三宅　一輝	2nd Officer	MIYAKE KAZUKI
三航士	山本　一真	3rd Officer	YAMAMOTO KAZUMA
機関長	金田　和彦	Chief Engineer	KANEDA KAZUHIKO
一機士	加藤　兼三	1st Engineer	KATO KENZO
二機士	塙　明	2nd Engineer	HANAWA AKIRA
三機士	了舟　隼人	3rd Engineer	RYOSYU HAYATO
電子長	石渡　広樹	Chief Electronic Operator	ISHIWATA HIROKI
二電士	城詰　崇朋	2nd Electronic Operator	SHIROZUME TAKATOMO
三電士	宇賀神一三	3rd Electronic Operator	UGAJIN KAZUMI
甲板長	大端　正則	Boat Swain	OHATA MASANORI
甲板手	村田　海人	Able Seaman	MURATA KAITO
甲板手	岩嵜　生典	Able Seaman	IWASAKI NAOKI
甲板手	宮下　拓也	Able Seaman	MIYASHITA TAKUYA
甲板員	大尻　雄太	Sailor	OHJIRI YUTA
甲板員	小島　真也	Sailor	KOJIMA SHINYA
甲板員	吉見　雄大	Sailor	YOSHIMI YUDAI
操機長	大石　洋之	No.1 Oiler	OISHI HIROYUKI
操機手	上田　政実	Oiler	UEDA MASANORI

操機手	相澤　孝太	Oiler	AIZAWA KOTA
操機手	下畑　翔太	Oiler	SHIMOHATA SHOTA
司厨長	竹馬　幸秀	Chief Steward	CHIKUBA YUKIHIDE
司厨手	長友　剛士	Steward	NAGATOMO TSUYOSHI
司厨手	其田　和真	Steward	SONODA KAZUMA
司厨手	大湯　　忍	Steward	OHYU SHINOBU
運航長	三浦　豊司	Operation Manager	MIURA ATSUMORI
一潜士	木戸　哲平	1st ROV Operator	KIDO TEPPEI
二潜士	千葉　勝志	2nd ROV Operator	CHIBA KATSUSHI
二潜士	石塚　哲也	2nd ROV Operator	ISHITSUKA TETSUYA
二潜士	菊谷　　茂	2nd ROV Operator	KIKUYA SHIGERU
二潜士	榊原　佑太	2nd ROV Operator	SAKAKIBARA YUDAI
二潜士	竹ノ内　純	2nd ROV Operator	TAKENOUCHI ATSUSHI
三潜士	熊谷　新之祐	3rd ROV Operator	KUMAGAI SHINOSUKE

3. Research/Development Activities

● Bathymetric surveys around Minami Torishima Island

RV Kaimei conducted multi-beam echo-sounder surveys in areas around Minami Torishima. The data will be merged with existing multibeam data to produce final maps of this area.

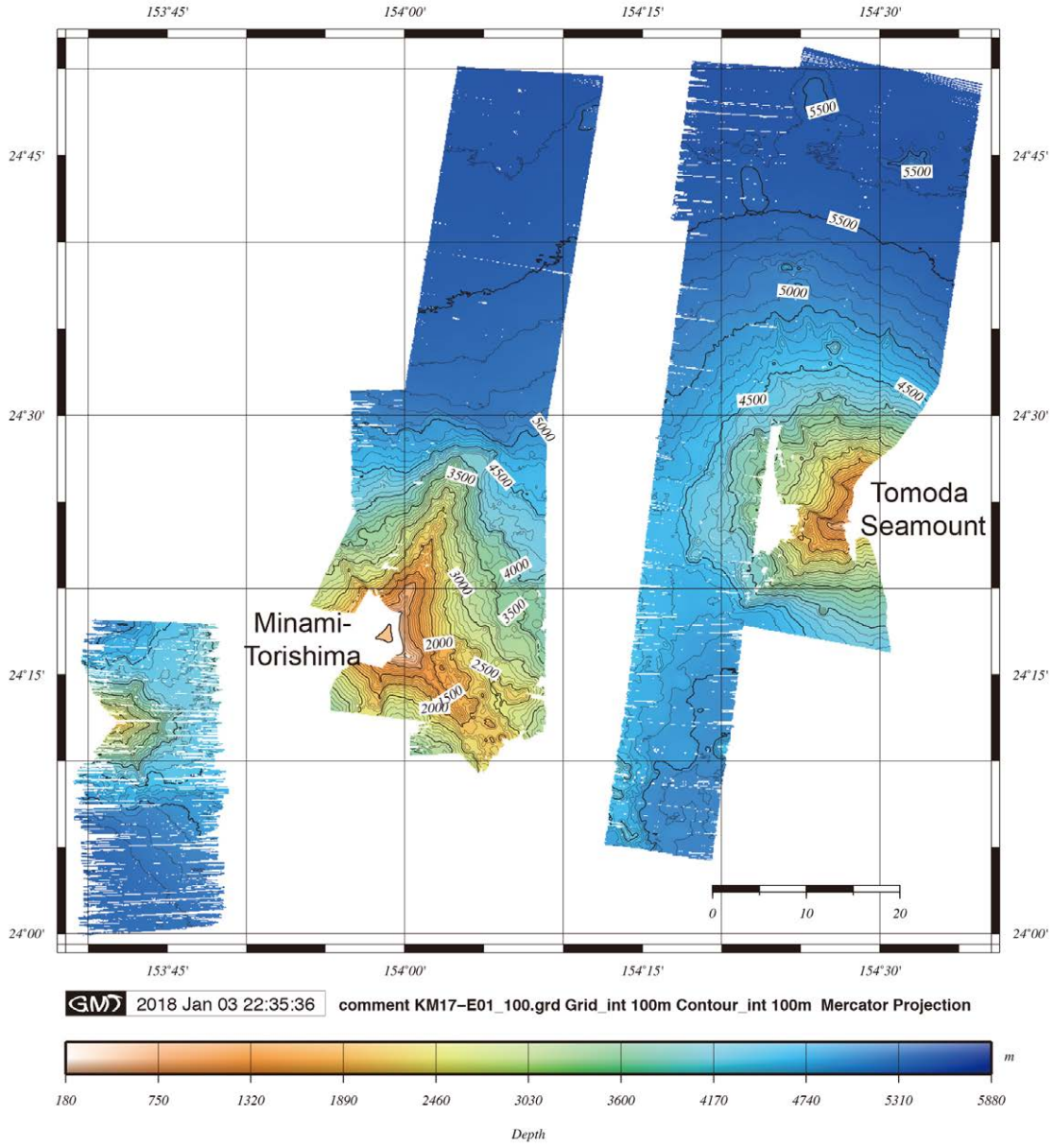


Figure 10. Bathymetric survey by RV Kaimei during km17-E01.

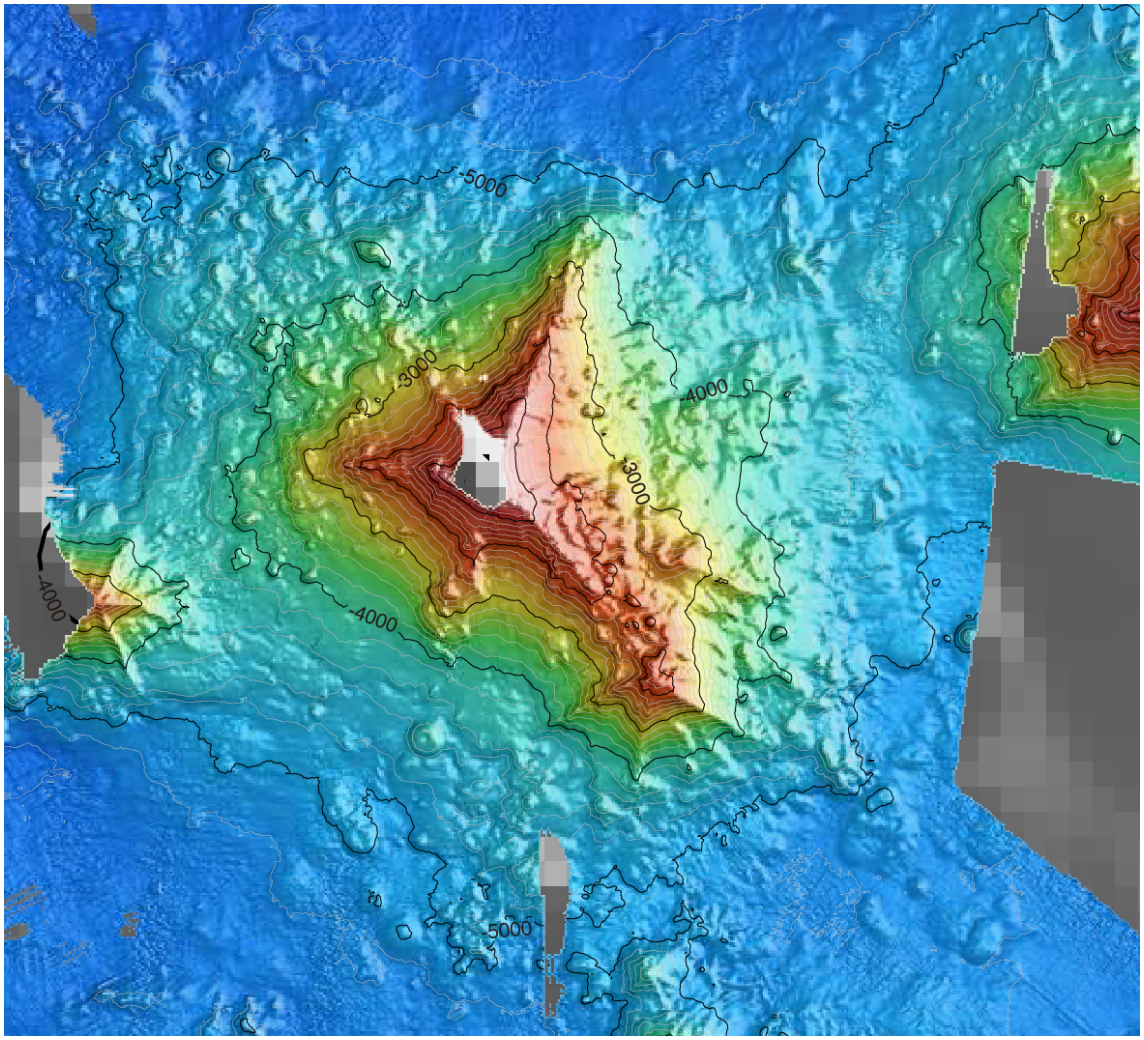


Figure 11. Bathymetric map of Minami-Torishima area merged with existing multibeam data.

● Heat Flow measurements by Stand-Alone Heat Flowmeter (SAHF)

Heat flows at submarine flanks of Minami-Torishima volcano has been measured by using Stand-Alone Heat Flowmeter (SAHF).

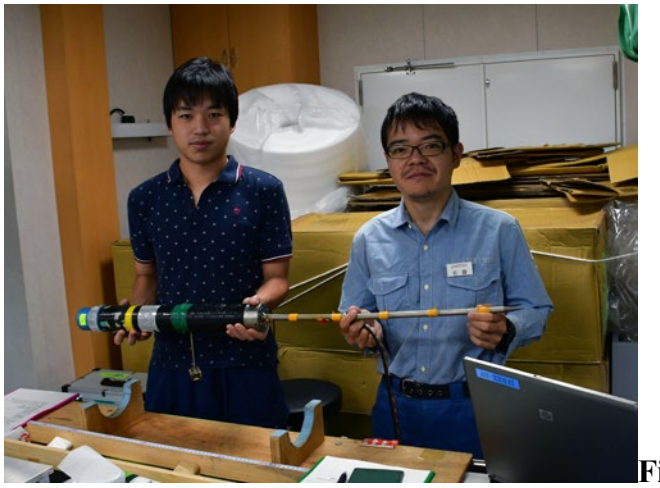


Figure 12. Sato-san and Hirai-san with SAHF.

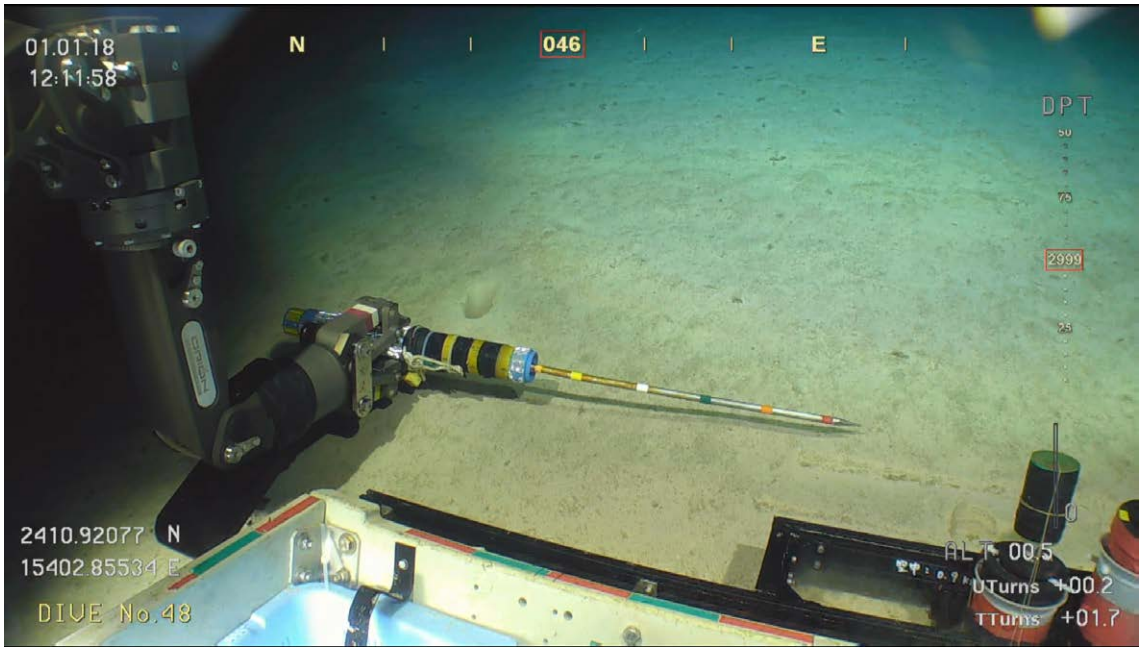


Figure 13. Stand-Alone Heat Flowmeter (SAHF) handled by KM-ROV manipulator.

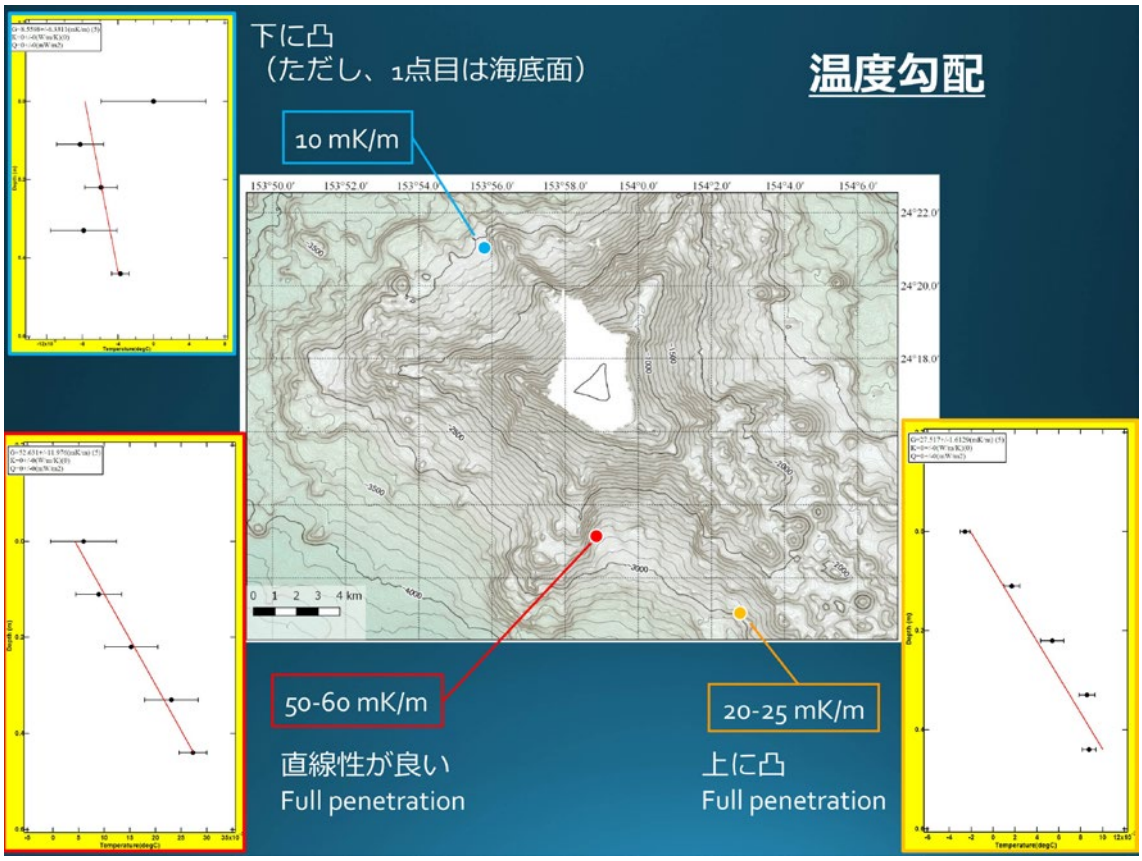


Figure 14. Temperature gradient measured by Stand-Alone Heat Flowmeter (SAHF).

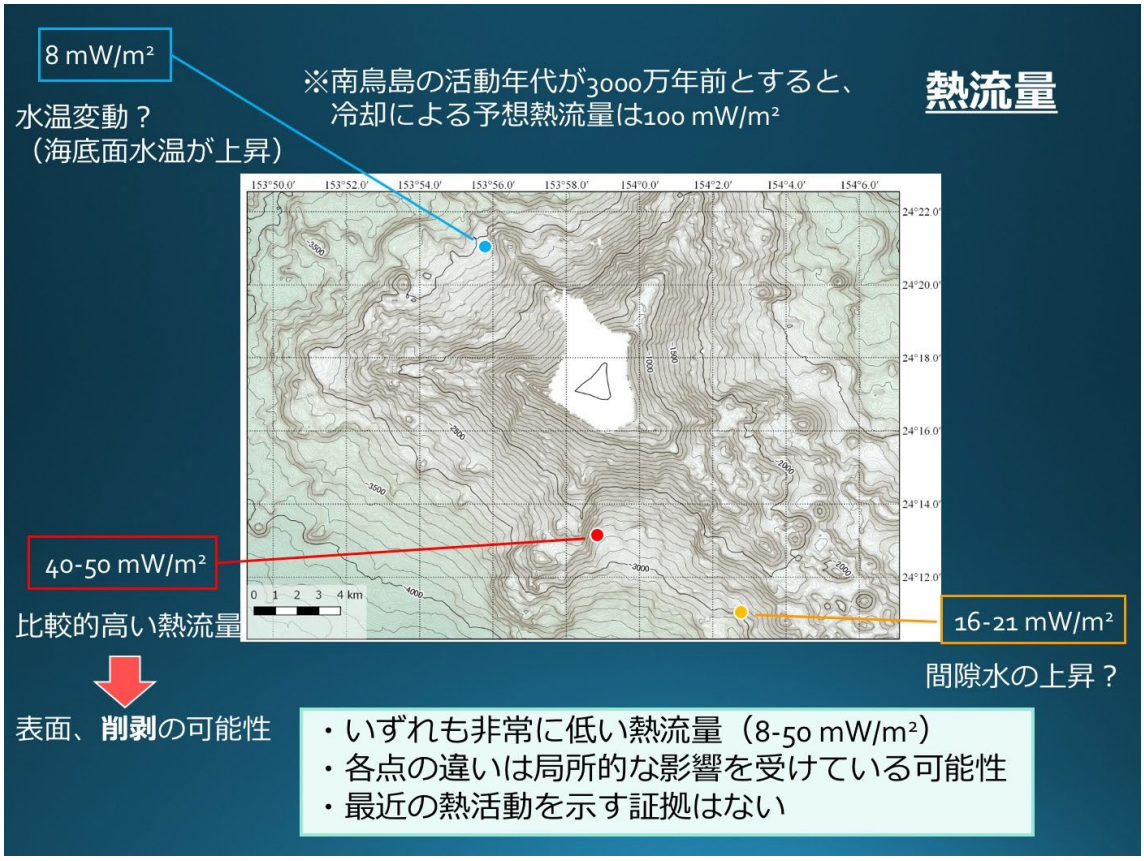


Figure 15. Heat flow around Minami-Torishima estimated by temperature gradient measured by Stand-Alone Heat Flowmeter (SAHF).

Figure 16. Sediment cores of the length of ~30 cm were collected from the same area where SAHF measurements had been carryed out.

● KM-ROV dives

Four dives were carried out at the flanks of Minami-Torishima volcano at depths ranging from 2,000 m to 3,000 m.

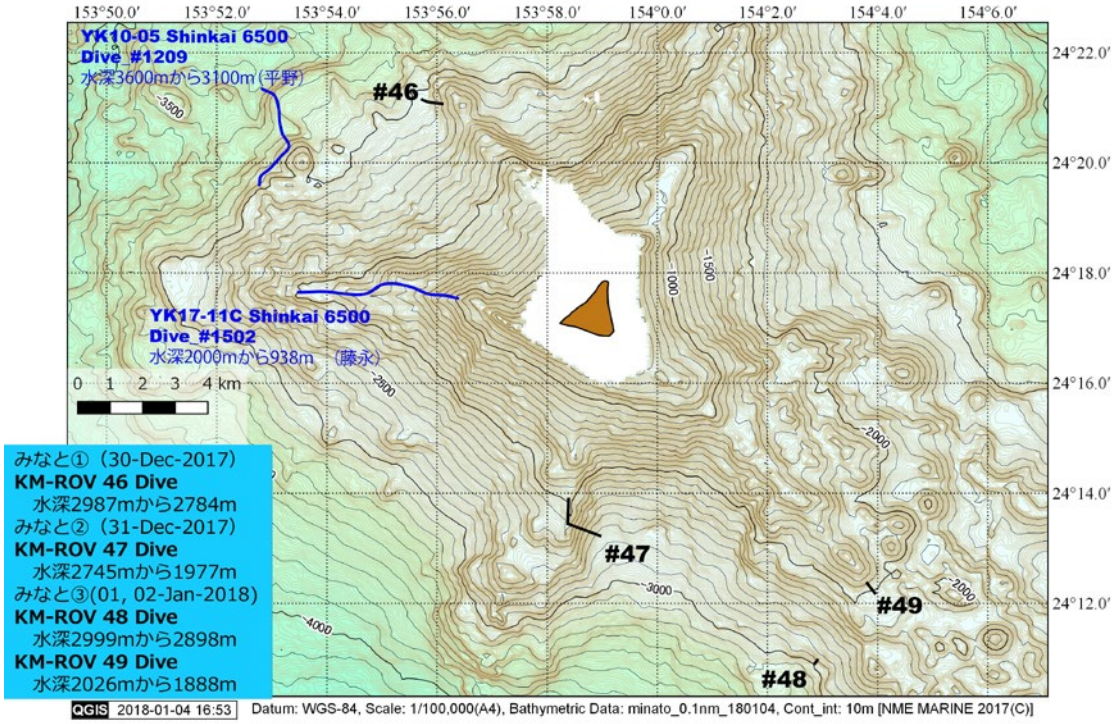


Figure 17. Dive tracks of KM-ROV for #46, #47, #48, and #49.

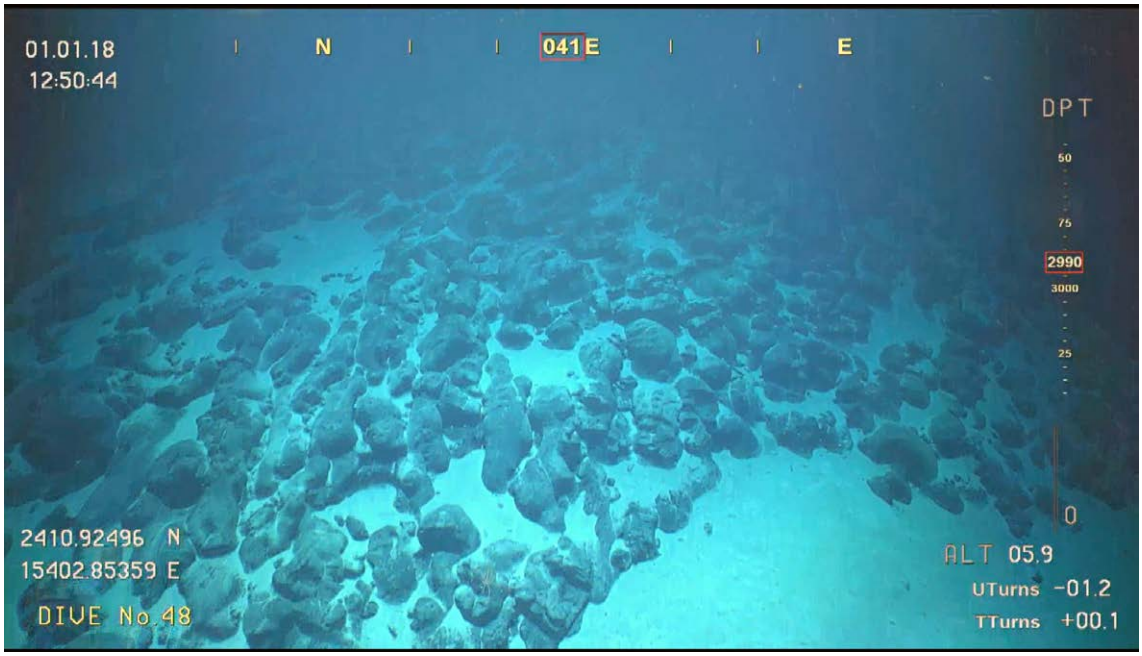


Figure 18. Pillow lavas observed v at the depth of 2,990 m during KM-ROV dive 48.

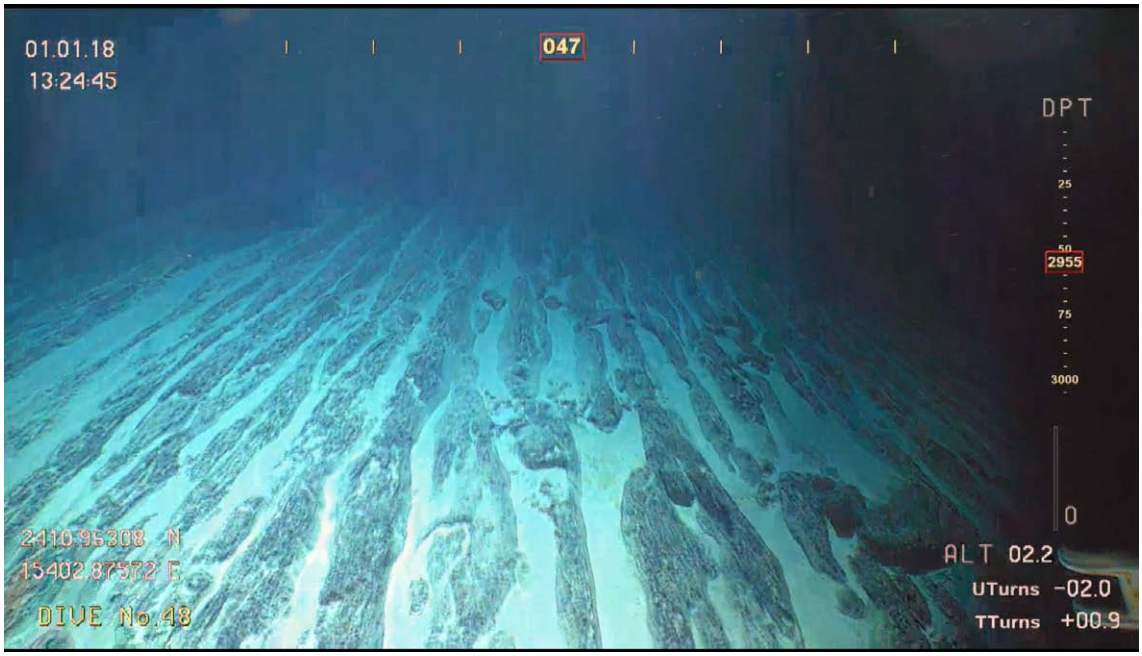


Figure 19. Rope-shaped lavas observed at the depth of 2,955 m during KM-ROV dive 48.

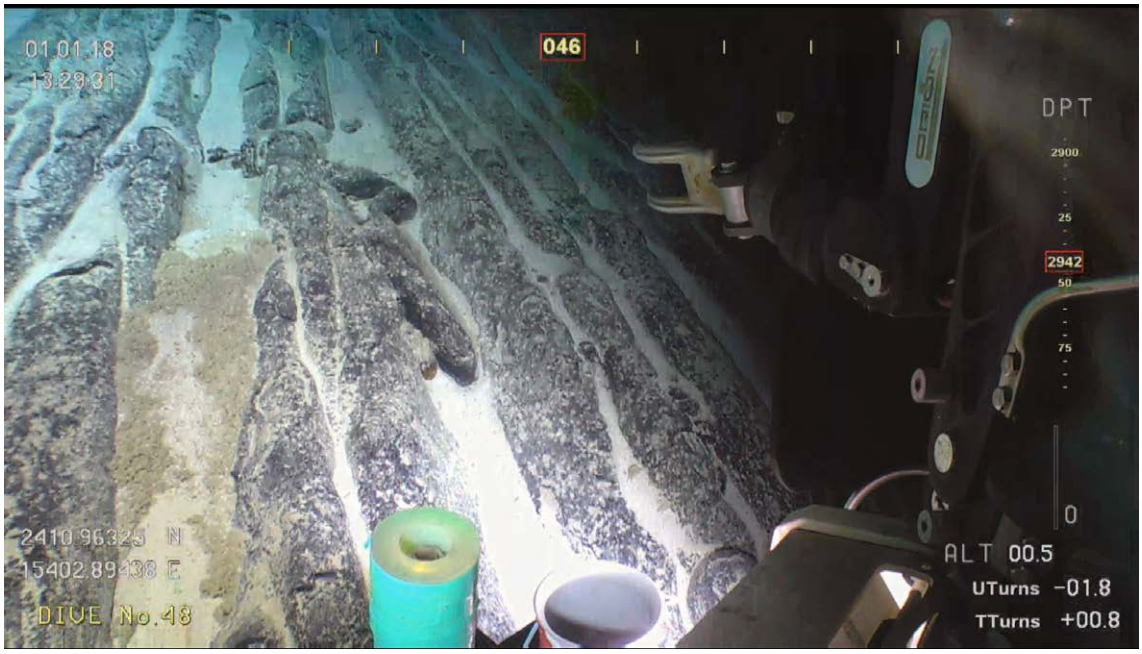
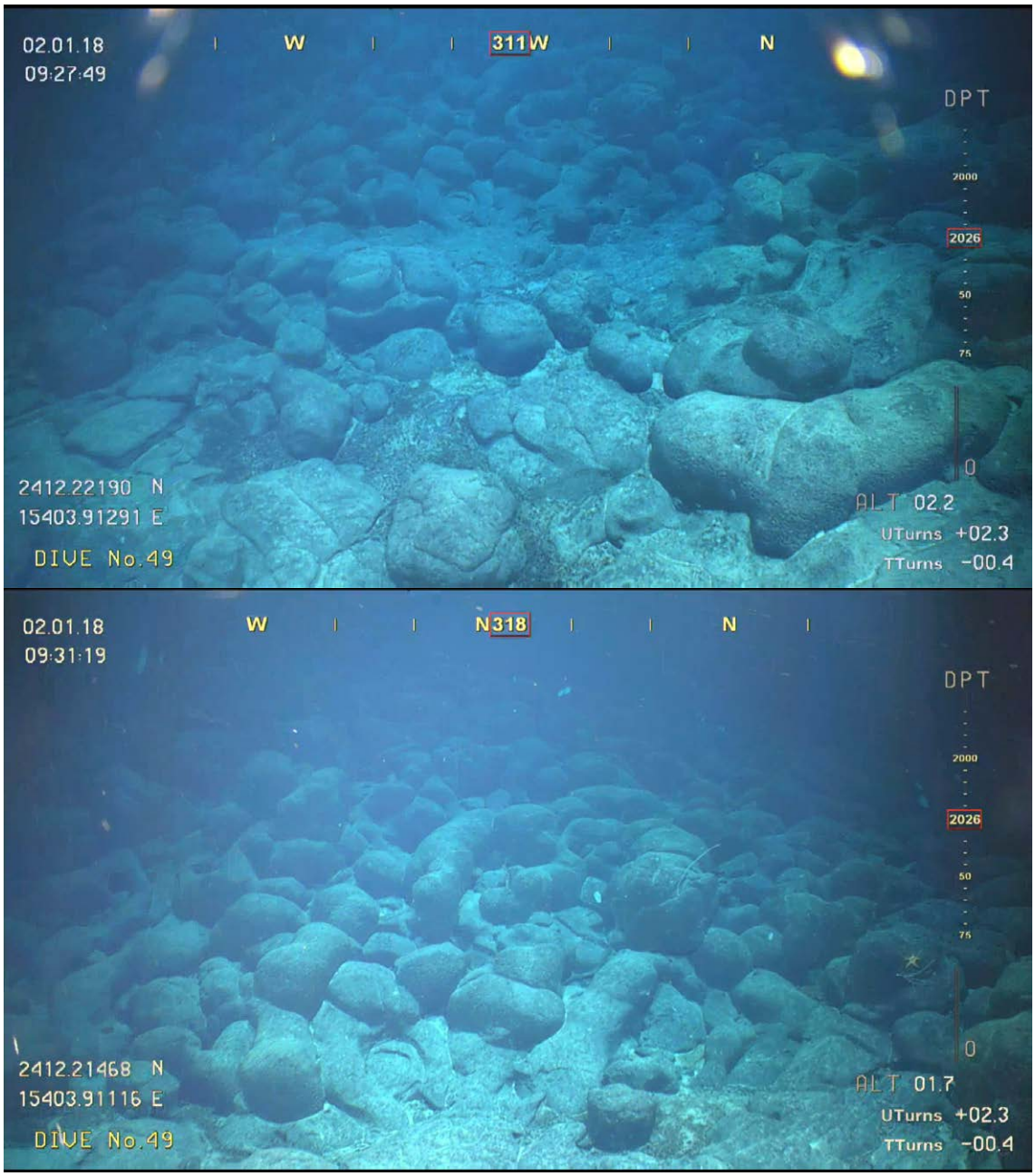


Figure 20. Rope-shaped lavas observed at the depth of 2,942 m during KM-ROV dive 48. These lavas change into pillow lavas after flowing down the cliff.



Figures 21 and 22. Beautiful pillow lavas at the depth of 2,026 m observed during KM-ROV dive 49.

● Rock samples collected during KM-ROV dives

Rolling stones of olivine basalts, aphyric basalts and limestones were collected by KM-ROV. However, outcrops of Minami-Torishima volcanoes, such as lava flows shown in Figs 17~20 had never been sampled by ROV manipulators because they were covered and consolidated by thick manganese oxides.

Figure 23. Rolling stones of olivine basalts collected during KM-ROV dives.

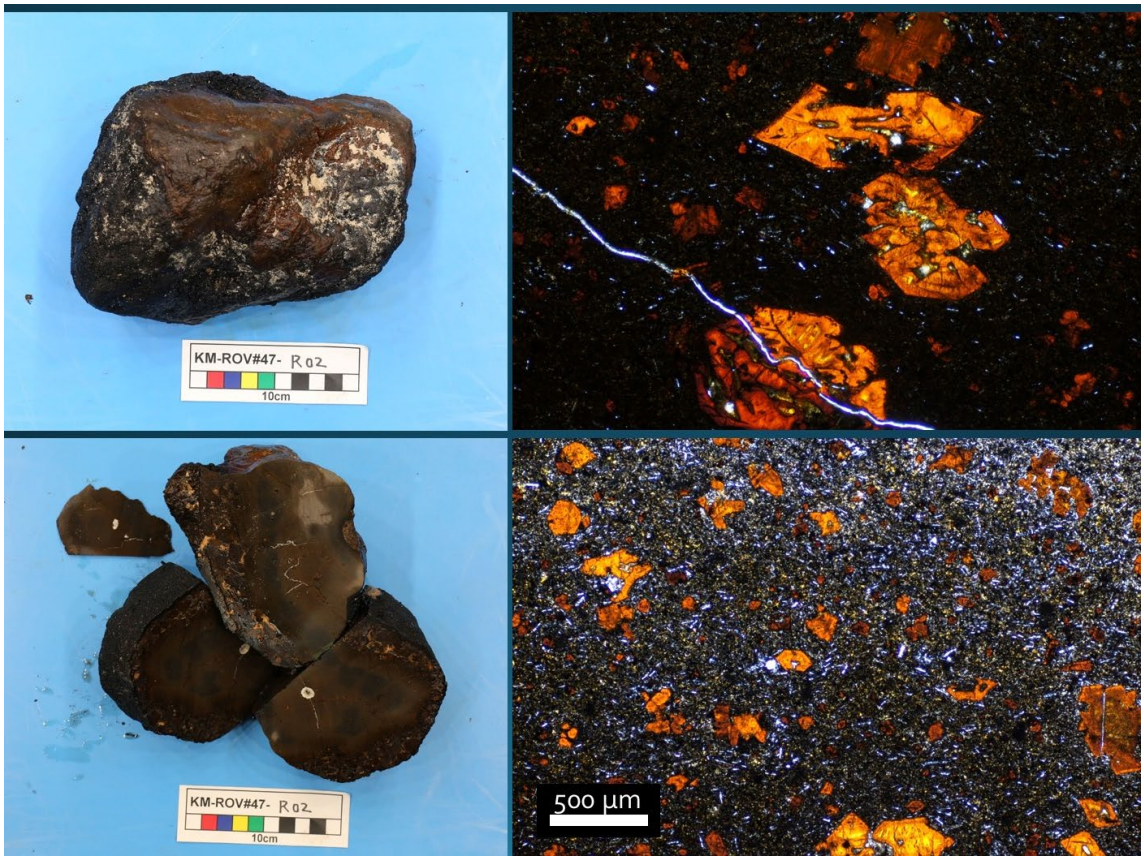


Figure 24. Rolling stone of primitive olivine basalts (KM-ROV #47 R02) collected during KM-ROV dive 47 at the depth of 2,700 m. Olivines had been altered into iddingsites.

Figure 25. Rolling stone of clinopyroxene basalt (KM-ROV #47 R05) collected during KM-ROV dive 47. Clinopyroxene is fresh but olivines in groundmass had been altered.

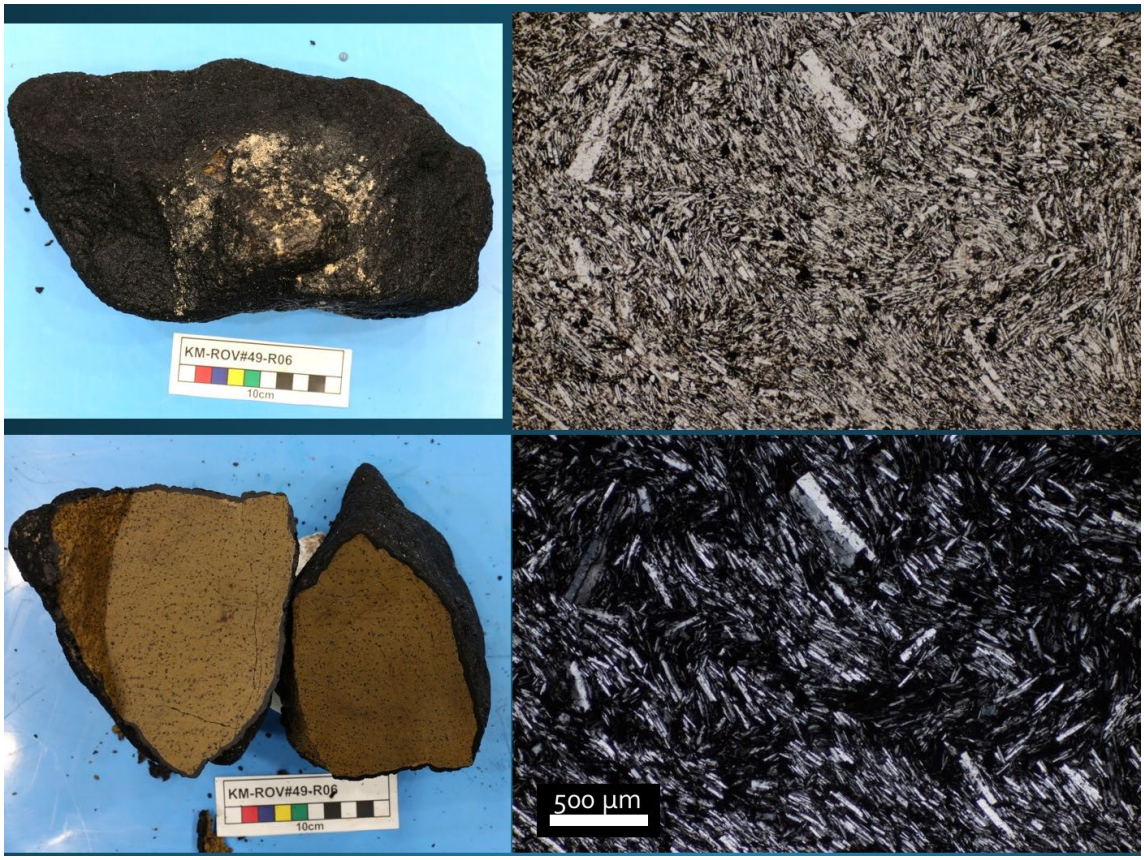


Figure 26. Rocks (KM-ROV #49 R06) collected during KM-ROV dive 49 at the depth of 1950 m. Micro-phenocrysts of plagioclases have flow structures.

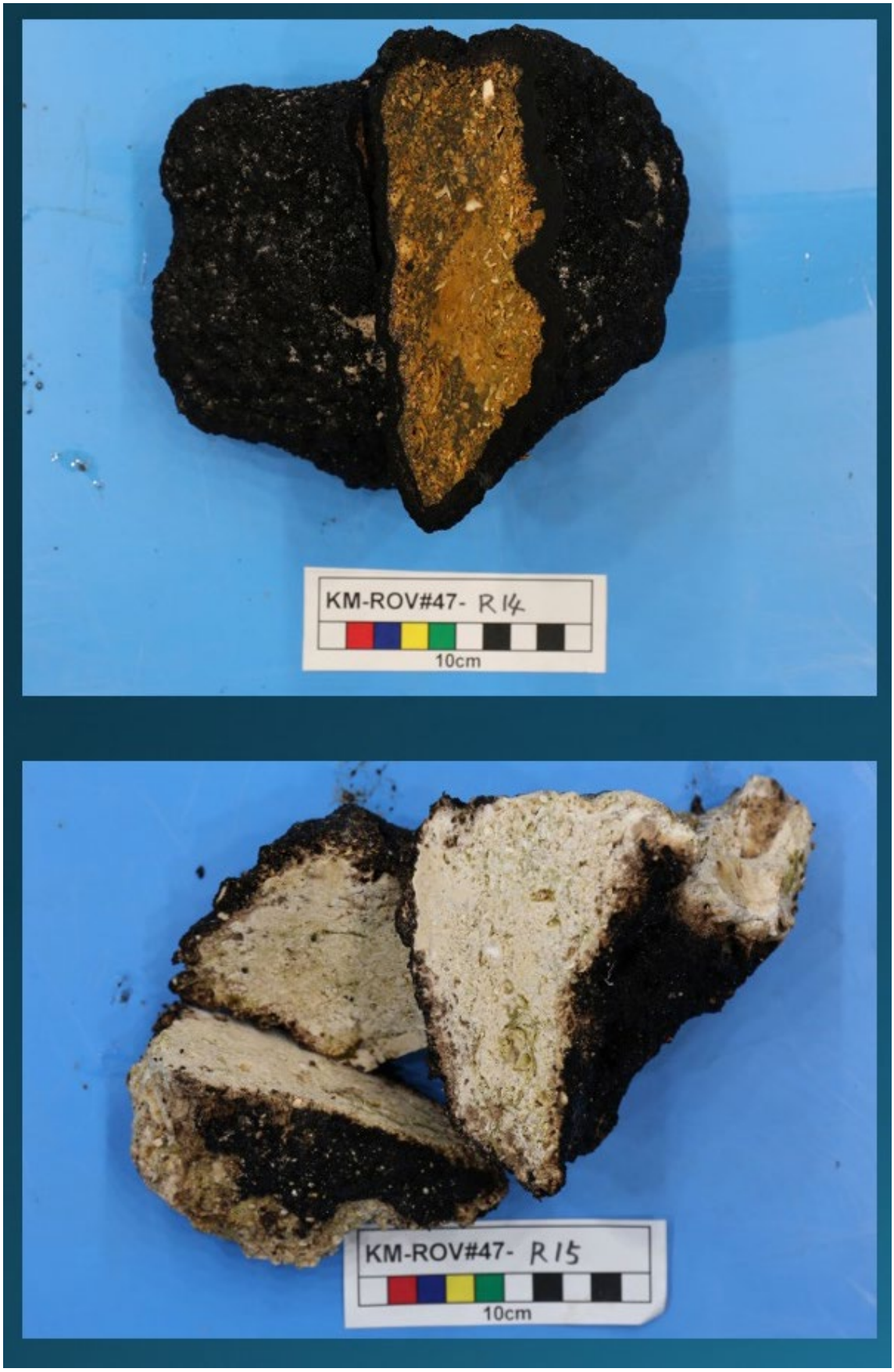

KM-ROV#47- R14
10cm
KM-ROV#47- R15
10cm

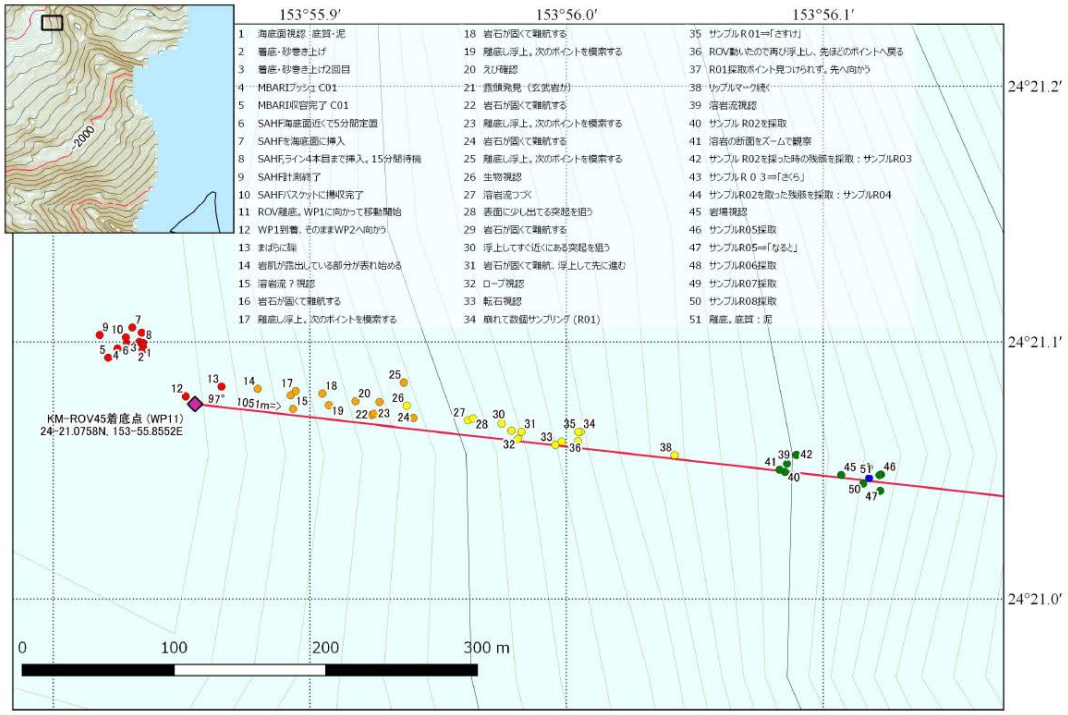
Figure 27. Limestone boulders collected from KM-ROV dive 47 at the depth of 2,000 m.

R/V "KAIMEI" KM17-E01 Cruise Log

Date & Time (JST: UTC +9h)	Description	Weather / Wind / Sea Condition
2017/12/16 Sat.	Noon Position: 34-31.2N, 139-43.5E (SE off OSHIMA)	bc / WSW-8 / 5
07:00	Onboard "KAIMEI" at JAMSTEC	
08:00	"KAIMEI" departured from JAMSTEC, Commenced KM17-14C	
09:00-09:40	Boat Drill at Compass deck, Onboard safety guidance at Research room	
13:00-13:30	Research Meeting at Research room	
16:40-17:00	KOMPIRASAN	
	KM17-14C during 2017/12/26 ~ 2017/12/29	
2017/12/30 Sat.	Noon Position: 24-21.1N, 153-55.8E (North of MINAMITORI-SHIMA)	bc / SW-4 / 3
00:00	Arrived at research area, MINAMITORI-SHIMA	
00:05	Release XBT at 23-57.2703N, 153-43.4526E	
02:42	Finished MBES mapping survey	
03:40	Release XBT at 24-21.2254N, 153-52.9035E	
04:01~04:21	Carried out MBES mapping survey (pre-dive survey)	
07:00	Hoisted up KM-ROV	
07:07	Lounched and Started KM-ROV45 operation	
07:54	Hoisted up KM-ROV	
08:02	Recovered KM-ROV due to TMS trouble	
11:04	Hoisted up KM-ROV	
11:12	Launched, and Started KM-ROV46 operation	
12:36	Landed on the sea floor (D=2,985m)	
14:48	Left the sea bottom (D=2,784m)	
16:10	Hoisted up KM-ROV	
16:16	Recovered KM-ROV, finished operation	
18:52	Commenced MBES mapping survey	
2017/12/31 Sun.	Noon Position: 24-13.5N, 153-58.7E (South of MINAMITORISHIMA)	bc / North-5 / 3
03:30	finished MBES mapping survey	
07:01	Hoisted up KM-ROV	
07:06	Launched	
07:06	Started KM-ROV47 operation	
08:25	Landed on the sea floor (D=2,745m)	
14:45	Left the sea bottom (D=1,977m)	
15:49	Recovered KM-ROV	
17:38	Commenced proceeding to MBES point	
18:20	Commenced MBES mapping survey	

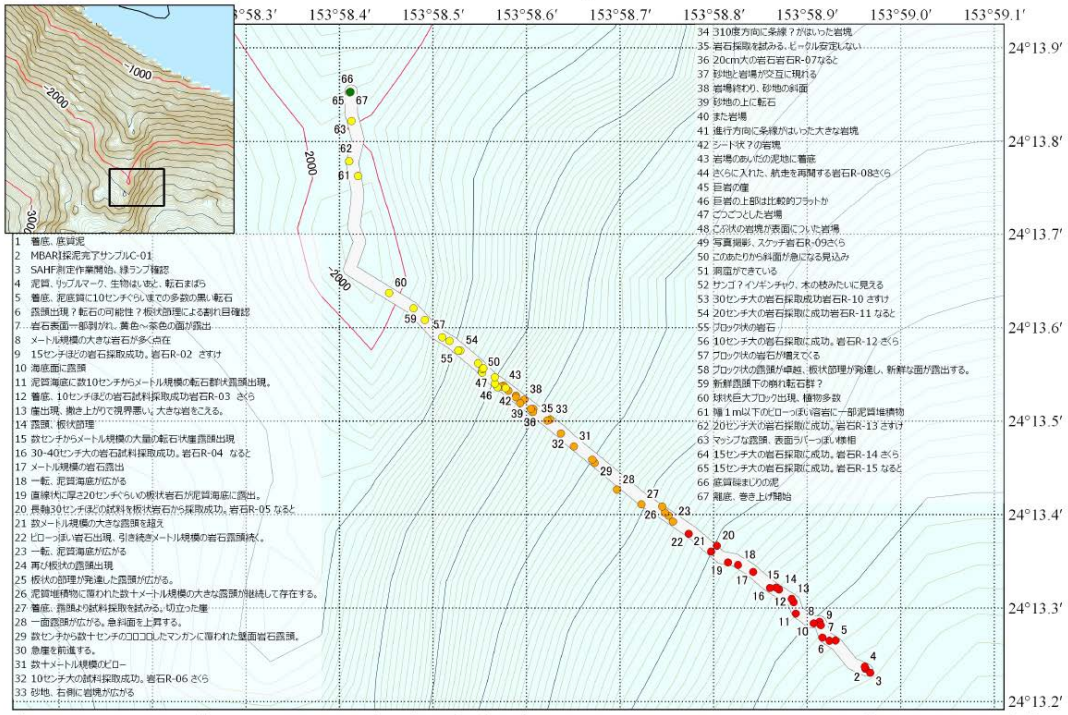
2018/01/01 Mon.	Noon Position: 24-10.9N, 154-02.8E (SE of MINAMITORISHIMA)	bc / NE-4 / 3
03:00	Finished MBES mapping survey	
05:27	HATSUHINODE, pray for new year sun rise	
05:40	HATSUMOUDE	
10:17	Hoisted up KM-ROV	
10:25	Launched	
10:25	Started KM-ROV48 operation	
11:59	Landed on the sea floor (D=2,999m)	
14:32	Left the sea bottom (D=2,899m)	
16:05	Recovered KM-ROV	
17:48	Commenced proceeding to MBES start point	
19:33	Commenced MBES mapping survey	
2018/01/02 Tue.	Noon Position: 24-12.4N, 154-03.8E (SE of MINAMITORISHIMA)	r / NNW-7 / 4
03:00	Finished MBES mapping survey	
08:22	Hoisted up KM-ROV	
08:29	Launched	
08:29	Started KM-ROV49 operation	
09:25	Landed on the sea floor (D=2,026m)	
11:08	Left the sea bottom (D=1,889m)	
12:02	KM-ROV floated	
12:09	Recovered KM-ROV	
13:40	Take memorial photo at South off MINAMITORISHIMA	
14:00	Commenced proceeding to West ward due to avoiding rough sea	
2018/01/03 Wed.	Noon Position: 23-01.3N, 148-28.9E (West ward Research Area)	bc / NNW-4 / 3
00:00	Proceeded to West ward due to avoiding rough sea	
24:00	Finished KM17-E01	

KM-ROV Dive46 Track, North of MINAMITORISHIMA



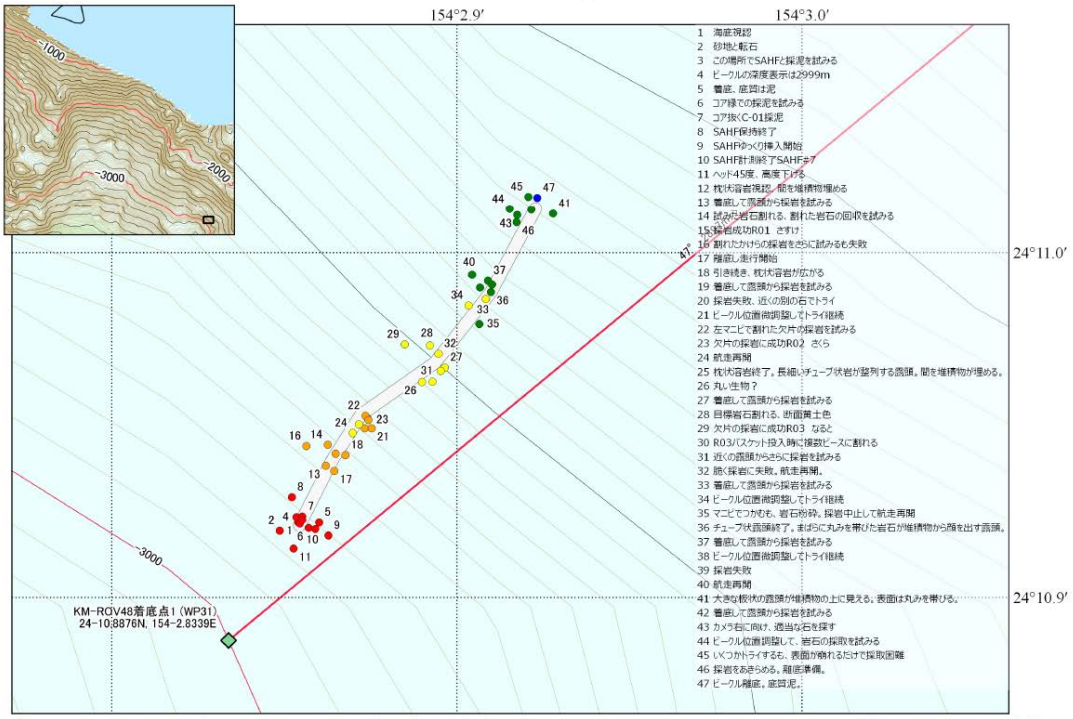
【QGIS 2017-12-30 17:53】Datum: WGS-84, Scale: 1/2,000(A4), Bathymetric Data: minato_0.1nm, Cont_int: 10m [NME MARINE 2017(C)]

KM-ROV Dive47 Track, South of MINAMITORISHIMA



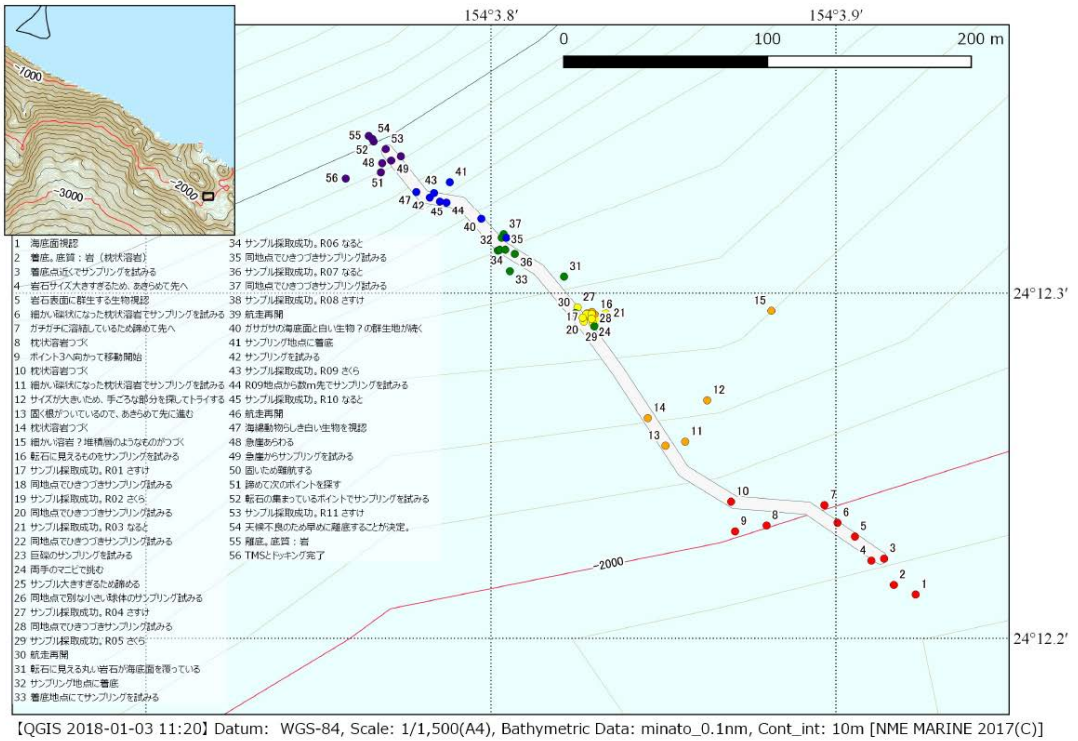
【QGIS 2018-01-01 06:34】Datum: WGS-84, Scale: 1/5,500(A4), Bathymetric Data: minato_0.1nm, Cont_int: 10m [NME MARINE 2017(C)]

KM-ROV Dive48 Track, South of MINAMITORISHIMA



【QGIS 2018-01-01 17:59】Datum: WGS-84, Scale: 1/1,500(A4), Bathymetric Data: minato_0.1nm, Cont_int: 10m [NME MARINE 2017(C)]

KM-ROV Dive49 Track, South of MINAMITORISHIMA



【QGIS 2018-01-03 11:20】Datum: WGS-84, Scale: 1/1,500(A4), Bathymetric Data: minato_0.1nm, Cont_int: 10m [NME MARINE 2017(C)]

● 4. Notice on Using

This cruise report is a preliminary documentation as of the end of cruise.
This report is not necessarily corrected even if there is any inaccurate description (i.e. taxonomic classifications). This report is subject to be revised without notice. Some data on this report may be raw or unprocessed. If you are going to use or refer the data on this report, it is recommended to ask the Chief Scientist for latest status.
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http://www.godac.jamstec.go.jp/darwin/explain/1/e#report