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R/V Yokosuka “Cruise Report”

YK17-11C

Cross-ministerial Strategic Innovation Promotion Program (SIP), Next-generation Technology for Ocean Resources Exploration (ZIPANG in ocean), “Extensive investigation of ferromanganese nodules around Minamitorishima”

Around Minamitorishima Island

May 29, 2017-Jun. 14, 2017

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Contents

1. Cruise Information

Cruise ID: YK17-11C

Name of vessel: R/V Yokosuka

Title of the cruise: Cross-ministerial Strategic Innovation Promotion Program (SIP), Next-generation Technology for Ocean Resources Exploration (ZIPANG in ocean), “Extensive investigation of ferromanganese nodules around Minamitorishima”

Title of proposal: Cross-ministerial Strategic Innovation Promotion Program (SIP), Next-generation Technology for Ocean Resources Exploration (ZIPANG in ocean), “Extensive investigation of ferromanganese nodules around Minamitorishima”

Cruise period: May 29 to June 14, 2017

Ports of departure: Charlie Dock Pier, Saipan

Ports of arrival: Yokosuka Pier, JAMSTEC

Research area: Southeastern region of the Japanese Exclusive Economic Zone around Minamitorishima Island, Northwestern Pacific.

Research maps

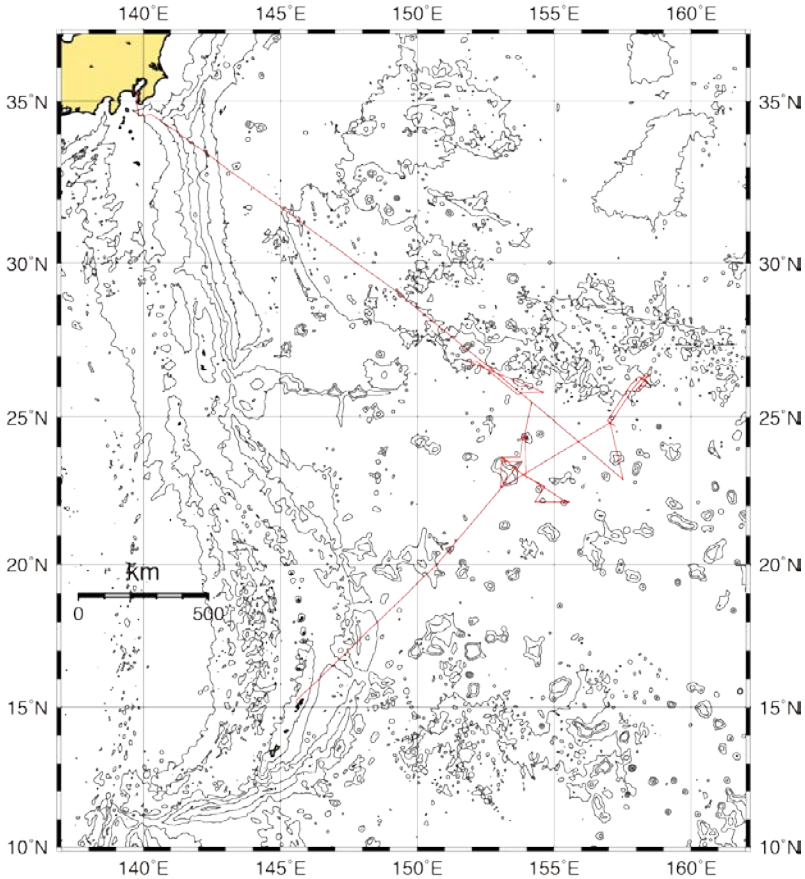

Figure 1-1. Ship track during the cruise YK17-11.

2. Researchers

Chief Scientist Shiki Machida Research Scientist, JAMSTEC

Chief scientist of the project on

"Extensive investigation of ferromanganese nodules around Minamitorishima"

Onboard Researchers

Vice-chief Scientist	Kazutaka Yasukawa	Researcher, The University of Tokyo
Scientist	Koichi Iijima	Researcher, JAMSTEC
Scientist	Junji Kaneko	Researcher, JAMSTEC
Scientist	Junichiro Ohta	Researcher, JAMSTEC
Scientist	Teruaki Ishii	Researcher, Shizuoka University
Scientist	Koichiro Fujinaga	Researcher, The University of Tokyo
Scientist	Erika Tanaka	Master Student, The University of Tokyo
Scientist	Chiaki Kawarabata	Master Student, The University of Tokyo
Scientist	Kazuhide Mimura	Master Student, The University of Tokyo
Scientist	Koichi Horinouchi	Master Student, The University of Tokyo
Scientist	Keishiro Azami	Research Student, JAMSTEC
Marine Technician	Yasushi Hashimoto	Nippon Marine Enterprises, Ltd.

Shore-based Researchers

Representative of the Science Party: Eiichi Kikawa (JAMSTEC)

Scientist	Taichi Sato	Researcher, AIST
Scientist	Kentaro Nakamura	Associate Professor, the Univ. Tokyo
Scientist	Yasuhiro Kato	Professor, the Univ. Tokyo

3. Observation

by Shiki Machida

3.1. Background

Ferromanganese (Fe-Mn) nodules and crusts, and REY-rich mud (deep-sea sediment containing high concentrations of rare-earth elements and yttrium (REY)) have been considered a potential resource for metals, such as Ni, Cu, Co, Li, and REY that are important in contemporary technology (e.g., Hein *et al.*, 2013; Kato *et al.*, 2011; Hein *et al.*, 2010). Recently, it is further considered that these three types of "oxide deposits" are also key to understanding of palaeoenvironmental change (e.g., Machida *et al.*, 2016; Hyeong *et al.*, 2013; Han *et al.*, 2003; Jeong *et al.*, 2000).

Machida *et al.* (2016) reported results of geological survey and geochemical analyses of Fe-Mn nodules densely distributing on a seamount approximately 300 km east of Minamitorishima Island, in the Japanese Exclusive Economic Zone (Figs. 3-1 and 3-2). They revealed two major important findings as follows. (1) Seafloor with extremely strong acoustic reflectivity is densely covered with the Fe-Mn nodules, a feature that should be noted in future exploration. (2) Textural and compositional changes over the growth history of the nodules are quite similar to those of the Fe-Mn crust on large seamounts in the western Pacific. Therefore, the Fe-Mn nodules formed solely by hydrogenetic Fe-Mn-(oxyhydr)oxide precipitation having a high potential as a future metal resource.

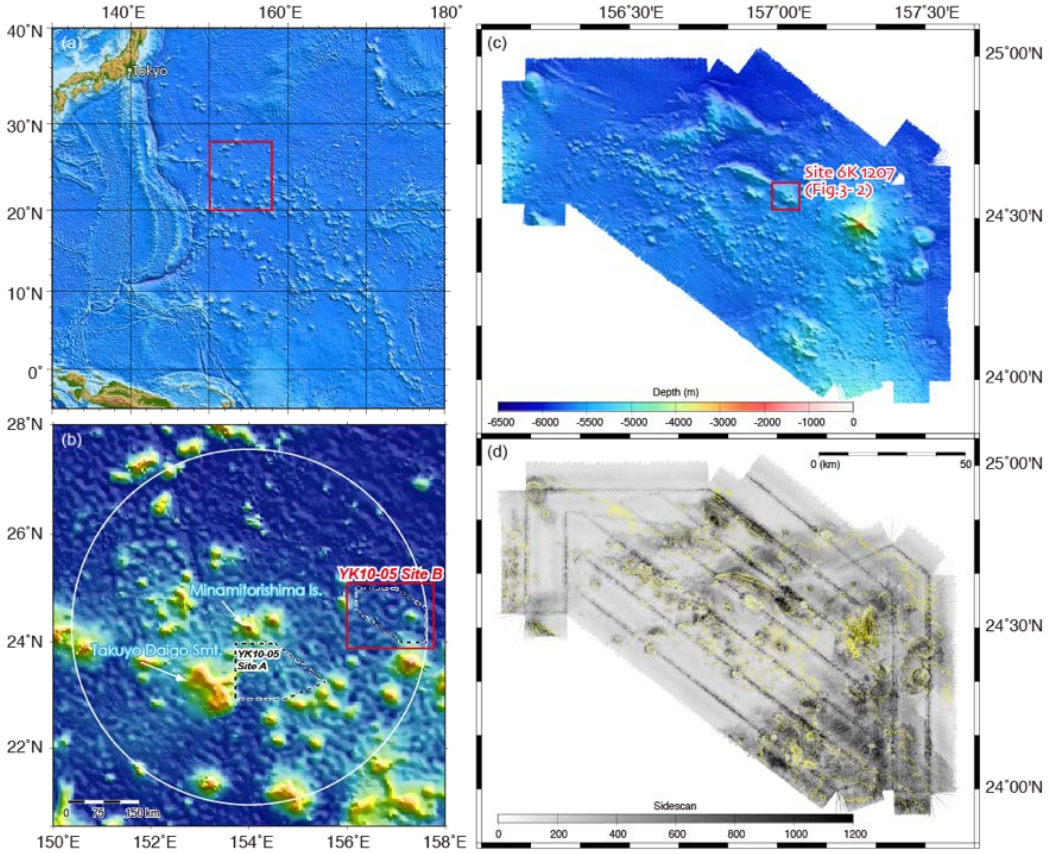

Figure 3-1. Maps of the Fe-Mn nodule field modified after Machida *et al.* (2016).

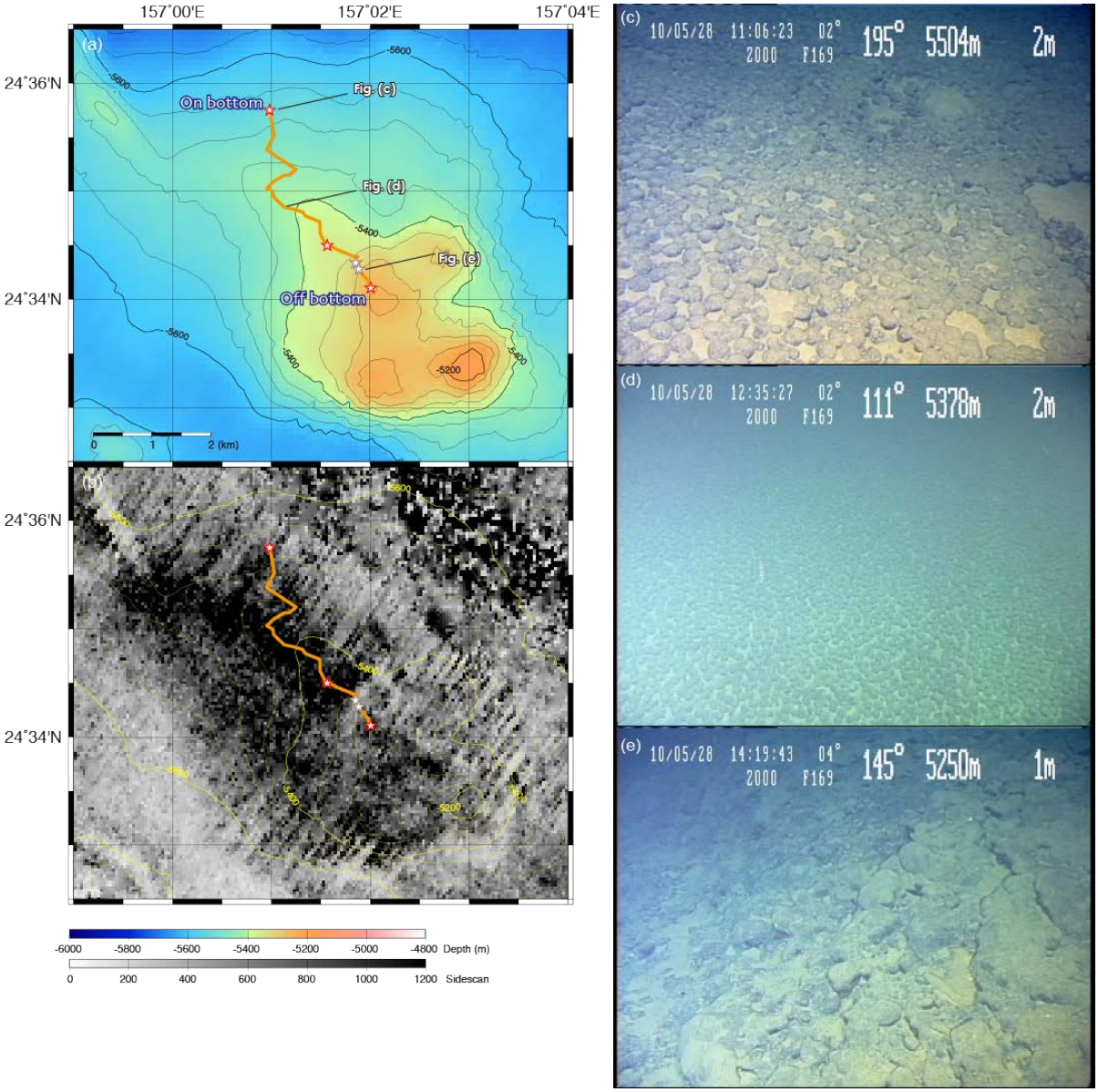

Figure 3-2. Maps and photographs of Site 6K 1207 modified after Machida *et al.* (2016). Orange line illustrates the survey track of *Shinkai 6500* dive No. 6K 1207. Red and gray stars respectively indicate sampling site for nodule and crust samples.

In precise data of bathymetry and acoustic reflectivity, using Multi narrow Beam Echo Sounder (MBES), acquired by the Japan Coast Guard around Minamitorishima Island (Oikawa and Morishita, 2009). These data indicate that regions showing high acoustic reflectivity are widespread especially in southeastern quarter of EEZ around Minamitorishima Island, not only Site 6K 1207 (Okino, personal communication). Such feature was also identified by our recent investigations using MBES, especially in from the eastern to southern region of the Minamitorishima EEZ (Figs. 3-3 and 3-4), during seven cruises YK10-05 of *R/V Yokosuka*, KR13-02 and KR14-02 of *R/V Kairei*, and MR13-E02, MR14-E02, MR15-E01, and MR15-02 of *R/V Mirai*. In this region, detailed observation using the *Shinkai 6500*

submersible had been conducted during cruise YK16-01 of *R/V Yokosuka* in the last year. As a result of the eight dives of the *Shinkai 6500* submersible, we confirmed that seafloor showing high acoustic reflectivity basically correspond to densely distribution of Fe-Mn nodules (Fig. 3-5; JAMSTEC Press Release, 26th august, 2016).

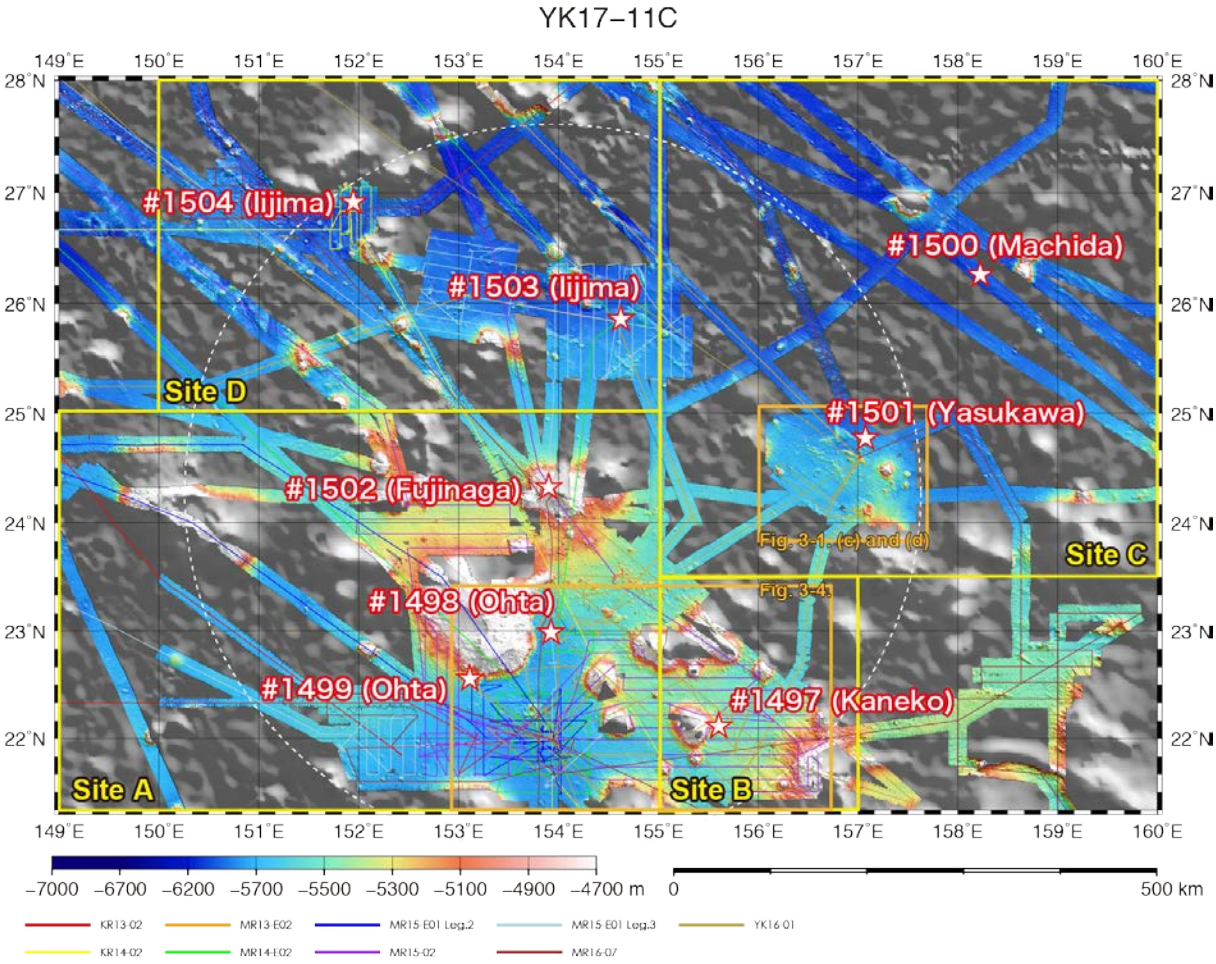

Figure 3-3. Map showing location of survey area during cruise YK17-11C. Topographic data by MBES with ship track lines were collected during previous cruises YK10-05, KR13-02, MR13-E02, KR14-02, MR14-E02, MR15-E01 Legs. 2 and 3, MR15-02, MR16-07, and YK16-01. Topographic data by MBES without ship track lines are from JAMSTEC database. Red stars with annotation indicate the site of 6K dive during cruise YK17-11C. Background topographic data are from ETOPO 1.

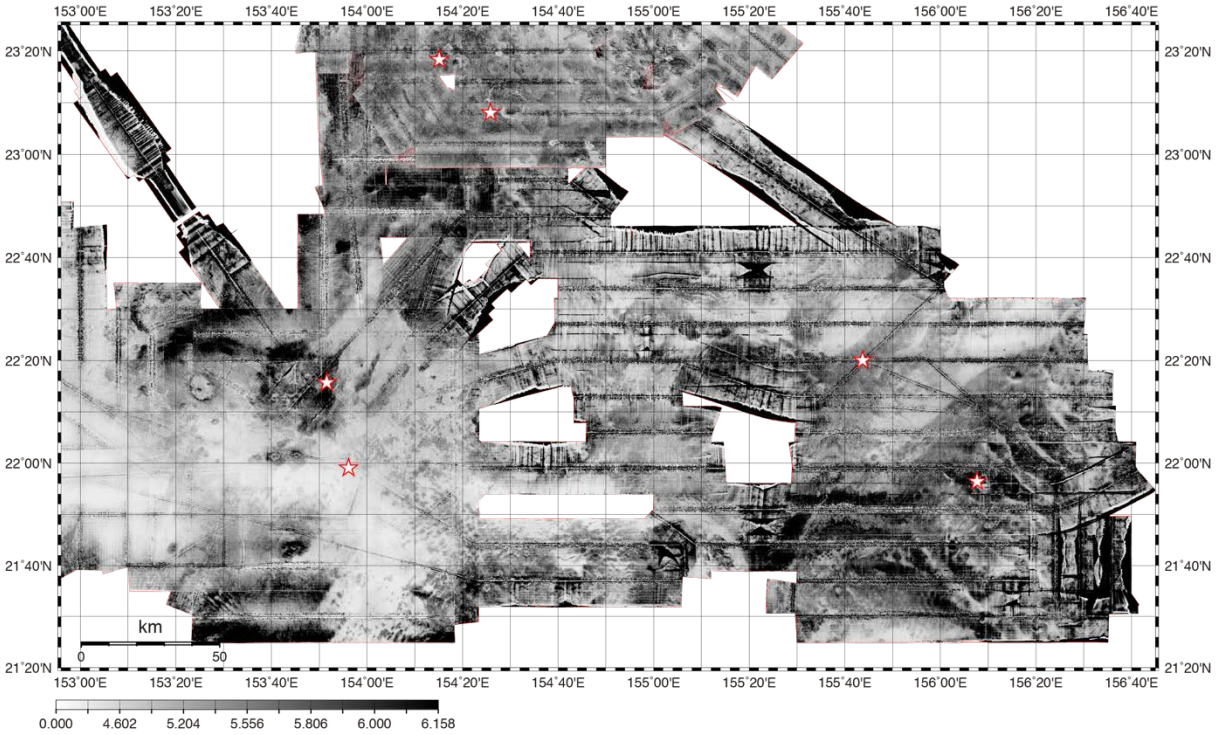

Figure 3-4. Map of acoustic reflectivity of the seafloor in the easterm (a) and southeastern (b) region of the Minamitorishima EEZ. Data were collected sing MBES during previous cruises YK10-05, MR14-E02, MR15-E01 Legs. 2 and 3, and MR15-02. Red stars indicate the site of 6K dive during cruise YK16-01 (YK16-01 Cruise Report, 2016).

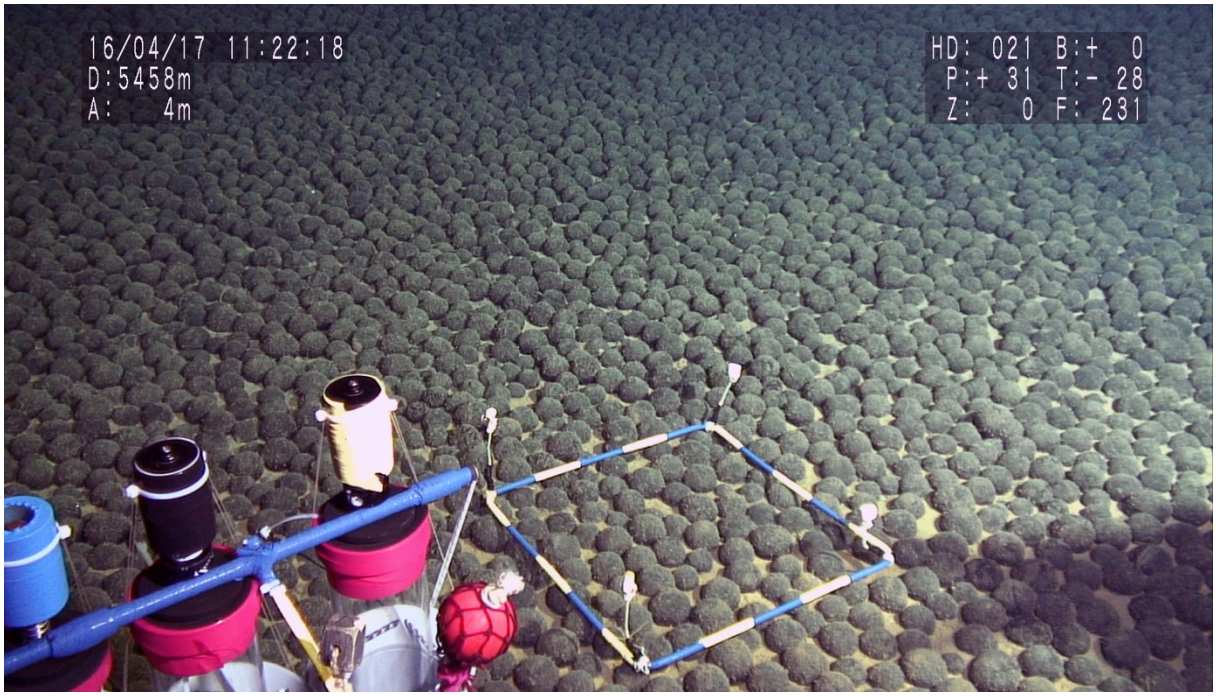

Figure 3-5. Densely distribution of Fe-Mn nodules on the seafloor in the southeastern region of the Minamitorishima EEZ.

Recent geological investigations using Shinkai 6500 further reveals that high acoustic intensity correspond to an area of T_I echo type determined by a sub-bottom profiler (Nakamura et al., 2016), which is region where REY-rich mud is exist in shallow depth below seafloor (Iijima *et al.*, 2016). Therefore, distribution of Fe-Mn nodules overlap that of REY-rich mud. Furthermore, Yasukawa *et al.* (2015) showed that Fe-Mn-(oxyhydr)oxides contribute to form REY-rich mud as a critical component of REY-enrichment in sediment cores drilled from the Indian Ocean. Accumulation of micro-ferromanganese nodules was also observed in the REY-rich mud cored from the Minamitorishima EEZ (Iijima *et al.*, 2016). These geological and mineralogical observations suggest that a geologic and genetic relationship between the Fe-Mn nodules and REY-rich mud in the Minamitorishima EEZ.

Previous studies for deep-sea mineral resources individually focused on the origin of each resource. However, our recent observations on (1) petrological similarity between Fe-Mn nodules and crusts, and (2) coexistence of Fe-Mn nodules and REY-rich mud, especially within southeastern quarter of EEZ around Minamitorishima Island, suggest a genetic relationship among these three types of oxide deposits. We thus need comprehensive geological and geochemical studies to understand genesis of “the Oxide Deposit Trinity” (nodules, crusts, and REY-rich mud) on the basis of a new unified framework.

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3.2. Cruise Objectives

The objective of this cruise is to elucidate the features on distribution of Fe-Mn nodules especially on the seafloor showing lower acoustic reflectivity than that of regions investigated during cruise YK16-01. Correlations between type sedimentation sequences and distribution density of nodules is also investigated. The following items will be done around Minamitorishima, especially in the Japanese EEZ (Fig. 3-3).

1. Observation of nodule fields: Detailed megascopic observation and recording of high-resolution visual image will be done to quantitatively define morphological features and density of distributions of nodules on the basis of dive using *Shinkai 6500*, especially in the region showing lower acoustic reflectivity.

2. Nodule and sediment sampling: Sampling of surface nodules and pelagic sediment below nodules will be done for comprehensive geochemical and geochronological analysis.

3. Geology of nodule fields: To identify geological features of nodule field and determine the extremely-REY-rich mud (which is potentially distributed below nodule field), acoustic stratigraphy will be observed in detail using SBP and MBES equipped on *Shinkai 6500*. Shipboard MBES and SBP data also contribute to interpretation on geology of studied area.

4. Magnetics and Gravity: Surface tow and shipboard magnetic survey will be done to estimate age of the seafloor in the survey area on the basis of magnetic lineation. Shipboard gravity survey using shipboard gravitymeter will be carried out to define structure of basement of the survey area. MBES data also will be used during magnetic and gravity analyses. XBT and CTD data also will be used to recalculate seafloor depth.

3.3. Activities

3.3.1. Cruise Log

2017/05/28 Scientists onboard

2017/05/29 North of SAIPAN (15-31.6N, 145-53.0E)

Weather: Fine but cloudy / Wind direction: ENE/ Wind force: 3 / Wave scale: 2 /Swell scale: 1 / Visibility: 8 miles (12:00 JST+1h)

9:00	Let go all shore lines & left SAIPAN for research area
10:00-10:35	Carried out education & training for scientists
10:40-11:00	Scientists meeting
13:00	SHINKAI 6500 team meeting
15:00	Ship data meeting
16:40	Konpira ceremony
18:40-19:00	Scientists meeting

2017/05/30 East of Mariana Islands (19-57.4N, 150-40.2E)

Weather: Fine but cloudy / Wind direction: ESE/ Wind force: 3 / Wave scale: 2 / Swell scale: 1 / Visibility: 8 miles (12:00 JST+1h)

8:30-9:00	Emergency station drill
9:30-11:30	Briefing of SHINKAI 6500 for scientists
12:15	Arrived at research area
12:20	Released XBT at 20-00.0172N, 150-43.0156E
12:21	Launched proton magnetometer
12:33	Com'ced Towing to proton magnetometer
12:49-13:10	Carried out 8 figure running
13:00	SHINKAI6500 tour for scientsts(sutudents)
13:16	Com'ced MBES mapping survey
18:00-19:00	Scientists meeting

2017/05/31 South of Minamitorishima (23-41.5N, 153.45.9E)

Weather: Fine but cloudy / Wind direction: WSW/ Wind force: 4 / Wave scale: 3 / Swell scale: 1 / Visibility: 8 miles (12:00 JST+1h)

1:32	Released XBT at 22-29.3840N, 152-57.7375E
2:02	Finished MBES mapping & SBP survey
2:02-2:52	Carried out MBES mapping & SBP survey (A-2)
2:52	Com'ced MBES mapping & SBP survey

14:00-15:00 Scientific seminar
14:23 Released XBT at 22-29.3840N, 152-57.7375E
14:54 Finished MBES mapping & SBP survey
14:54-16:23 Carried out MBES mapping & SBP survey (A-3)
16:23 Com'ced MBES mapping & SBP survey
18:00-19:00 Scientists meeting.
20:24 Released XBT at 23-04.3171N, 153-57.9302E
21:06 Finished MBES mapping & SBP survey
21:06-21:50 Carried out MBES mapping & SBP survey (A-1)
21:50 Com'ced MBES mapping & SBP survey

2017/06/01 Southeast of Minamitorishima (22-07.9N, 155-32.5E)
Weather: Overcast / Wind direction: WNW/ Wind force: 4 / Wave scale: 3 /
Swell scale: 2 / Visibility: 8 miles (12:00 JST+1h)
5:09 Released XBT at 22-09.7496N, 155-24.2971E
5:34 Finished MBES mapping & SBP survey
5:34-6:12 Carried out MBES mapping & SBP survey (B-1)
6:28 Finished towing to proton magnetometor
6:37 Recoverd proton magnetometor
8:52 Hoisted up SHINKAI 6500
8:59 Lunched SHINKAI 6500
9:06 SHINKAI 6500 dove & started her operation #1,497(19)
11:31 SHINKAI 6500 landed on sea bottom (Depth=5,158 m)
15:11 SHINKAI 6500 left the sea bottom (Depth=4,843 m)
16:54 Refloated SHINKAI 6500
17:16 Hoisted up SHINKAI 6500
17:36 Recovered SHINKAI 6500 & finished above operation
18:18 Launched proton magnetometer
18:25 Com'ced MBES mapping & SBP survey. Com'ced Towing to proton magnetometer
19:40-20:40 Scientists meeting

2017/06/02 Southeast of Minamitorishima (22-59.0N, 154-01.0E)
Weather: Fine but cloudy / Wind direction: South/ Wind force: 2 / Wave scale: 2 /
Swell scale: 2 / Visibility: 8 miles (12:00 JST+1h)
6:25 Finised MBES mapping, SBP survey & towing proton magnetometor
6:34 Recovered proton magnetometor
8:49 Hoisted up SHINKAI 6500

8:56 Launched SHINKAI 6500
9:05 SHINKAI 6500 dove & started her operation #1,498(20)
11:31 SHINKAI 6500 landed on sea bottom (Depth=5,634 m)
14:57 SHINKAI 6500 left the sea bottom (Depth=5,681 m)
17:06 Refloated SHINKAI 6500
17:26 Hoisted up SHINKAI 6500
17:52 Recovered SHINKAI 6500 & finished above operation
18:24 Launched proton magnetometer
18:29 Com'ced Towing to proton magnetometer
18:30 Com'ced MBES mapping & SBP survey
19:40-20:10 Scientists meeting

2017/06/03 Southwest of Minamitorishima (22-36.3N, 153-02.0E)
Weather: Fine but cloudy / Wind direction: South/ Wind force: 3 / Wave scale: 2 /
Swell scale: 1 / Visibility: 8 miles (12:00 JST+1h)
6:27 Finised MBES mapping ,SBP survey & towing proton magnetometor
6:35 Recovered proton magnetometor
8:42 Hoisted up SHINKAI 6500
8:50 Launched SHINKAI 6500
8:59 SHINKAI 6500 dove & started her operation #1,499(21)
11:29 SHINKAI 6500 landed on sea bottom (Depth=5,258 m)
15:11 SHINKAI 6500 left the sea bottom (Depth=4,946 m)
17:01 Refloated SHINKAI 6500
17:19 Hoisted up SHINKAI 6500
17:28 Recovered SHINKAI 6500 & finished above operation
18:03 Launched proton magnetometer
18:10 Com'ced MBES mapping & SBP survey
18:11 Com'ced Towing to proton magnetometer
18:50-20:00 Scientists meeting

2017/06/04 East of Minamitorishima (25-12.0N, 157.20.9E)
Weather: Fine but cloudy / Wind direction: South/ Wind force: 4 / Wave scale: 3 /
Swell scale: 1 / Visibility: 8 miles (12:00 JST+1h)
9:18 Released XBT at 24-45.8291N, 156-57.8561E
9:37 Finished MBES mapping & SBP survey
9:37-10:23 Carried out MBES mapping & SBP survey (C-1)
10:23 Com'ced MBES mapping & SBP survey
13:00-15:00 Scientific seminar & meeting

15:07 Released XBT at 25-55.1291N, 157-51.9398E
17:40 Finished MBES mapping & SBP survey
17:40-18:40 Carried out MBES mapping & SBP survey (C-2)
18:40 Com'ced MBES mapping & SBP survey

2017/06/05 Northeast of Minamitorishima (26-15.0N, 158-11.1E)
Weather: Fine but cloudy / Wind direction: South/ Wind force: 3 / Wave scale: 2 /
Swell scale: 1 / Visibility: 8 miles (12:00 JST+1h)
2:55-3:18 Carried out 8 figure running
5:42 Finised MBES mapping, SBP survey
6:25 Finished towing proton magnetometor.
6:33 Recoverd proton magnetometor.
8:45 Hoisted up SHINKAI 6500
8:51 Launched SHINKAI 6500
8:59 SHINKAI 6500 dove & started her operation #1,500(22)
11:36 SHINKAI 6500 landed on sea bottom (Depth=6,058 m)
14:52 SHINKAI 6500 left the sea bottom (Depth=6,009 m)
17:03 Refloated SHINKAI 6500
17:19 Hoisted up SHINKAI 6500
17:30 Recovered SHINKAI 6500 & finished above operation
18:08 Launched proton magnetometer
18:13 Com'ced MBES mapping & SBP survey
18:16 Com'ced Towing to proton magnetometer
19:45-20:40 Scientists meeting

2017/06/06 Northeast of Minamitorishima (24-48.7N, 157-02.8E)
Weather: Cloudy / Wind direction: South/ Wind force: 5 / Wave scale: 3 /
Swell scale: 3 / Visibility: 8 miles (12:00 JST+1h)
6:25 Finised MBES mapping, SBP survey & towing proton magnetometor
6:31 Recoverd proton magnetometor
8:42 Hoisted up SHINKAI 6500
8:50 Launched SHINKAI 6500
8:58 SHINKAI 6500 dove & started her operation #1,501(23)
11:41 SHINKAI 6500 landed on sea bottom (Depth=5,860 m)
14:51 SHINKAI 6500 left the sea bottom (Depth=5,819 m)
17:06 Refloated SHINKAI 6500
17:22 Hoisted up SHINKAI 6500
17:32 Recovered SHINKAI 6500 & finished above operation

18:09 Launched proton magnetometer
18:16 Com'ced MBES mapping, SBP survey & Towing to proton magnetometer
19:45-20:40 Scientists meeting.

2017/06/07 East of Minamitorishima (24-00.8N,156-05.9E)
Weather: Rain / Wind direction: SW/ Wind force: 4 / Wave scale: 3 /
Swell scale: 3 / Visibility: 6 miles (12:00 JST+1h)
all day MBES mapping ,SBP survey & towing proton magnetometor
13:00-15:00 Scientists meeting

2017/06/08 West of Minamitorishima (24-17.7N, 153-53.5E)
Weather: Overcast / Wind direction: South/ Wind force: 6 / Wave scale: 4 /
Swell scale: 3 / Visibility: 6 miles (12:00 JST+1h)
7:27 Finised MBES mapping ,SBP survey & towing proton magnetometor
7:35 Recoverd proton magnetometor
9:48 Hoisted up SHINKAI 6500
9:55 Launched SHINKAI 6500
10:06 SHINKAI 6500 dove & started her operation #1,502(24)
11:09 SHINKAI 6500 landed on sea bottom (Depth=2,000 m)
16:06 SHINKAI 6500 left the sea bottom (Depth=939 m)
16:30 Refloated SHINKAI 6500
16:47 Hoisted up SHINKAI 6500
16:57 Recovered SHINKAI 6500 & finished above operation
17:33 Launched proton magnetometer
17:39 Com'ced MBES mapping, SBP survey & Towing to proton magnetometer
19:45-20:30 Scientists meeting

2017/06/09 North of Minamitorishima (25-49.9N, 154-34.9E)
Weather: Cloudy / Wind direction: East/ Wind force: 4 / Wave scale: 3 /
Swell scale: 2 / Visibility: 8 miles (12:00 JST+1h)
4:54 Released XBT at 25-48.9609N, 154-27.7466E
5:20 Finished MBES mapping & SBP survey
5:20-6:00 Carried out MBES mapping & SBP survey (D-1)
6:24 Finished towing to proton magnetometor
6:31 Recoverd proton magnetometor
8:53 Hoisted up SHINKAI 6500
9:00 Launched SHINKAI 6500

9:09 SHINKAI 6500 dove & started her operation #1,503(25)
11:32 SHINKAI 6500 landed on sea bottom (Depth=5,851 m)
14:51 SHINKAI 6500 left the sea bottom (Depth=5,729 m)
17:03 Refloated SHINKAI 6500
17:20 Hoisted up SHINKAI 6500
17:28 Recovered SHINKAI 6500 & finished above operation
18:10 Launched proton magnetometer
18:15 Com'ced MBES mapping & SBP survey
18:18 Com'ced Towing to proton magnetometer
19:45-20:30 Scientists meeting

2017/06/10 Northwest of Minamitorishima (26-50.1N, 151-51.6E)
Weather: Fine but cloudy / Wind direction: SSW/ Wind force: 3 / Wave scale: 2 / Swell scale: 1 / Visibility: 8 miles (12:00 JST+1h)
4:56 Released XBT at 26-47.8415N, 151-56.2363E
5:20 Finished MBES mapping & SBP survey
5:20-6:00 Carried out MBES mapping & SBP survey (D-2)
6:24 Finished towing to proton magnetometor
6:31 Recoverd proton magnetometor
8:42 Hoisted up SHINKAI 6500
8:50 Launched SHINKAI 6500
8:58 SHINKAI 6500 dove & started her operation #1,504(26)
11:33 SHINKAI 6500 landed on sea bottom (Depth=6,012 m)
14:45 SHINKAI 6500 left the sea bottom (Depth=6,035 m)
17:01 Refloated SHINKAI 6500
17:20 Hoisted up SHINKAI 6500
17:29 Recovered SHINKAI 6500 & finished above operation
18:09 Launched proton magnetometer
18:15 Com'ced MBES mapping & SBP survey
18:18 Com'ced Towing to proton magnetometer
19:45-20:30 Scientists meeting

2017/06/11 West of Minamitorishima (26-47.9N, 152-24.3E)
Weather: Fine but cloudy / Wind direction: NW/ Wind force: 3 / Wave scale: 2 / Swell scale: 1 / Visibility: 8 miles (12:00 JST+1h)
all day MBES mapping, SBP survey & towing proton magnetometor
18:15-18:45 Scientists meeting

2017/06/12 Northeast of Chichijima (30-10.2N, 147-31.8E)

Weather: Drizzling rain / Wind direction: SW/ Wind force: 7 / Wave scale: 4 /
Swell scale: 3 / Visibility: 6 miles (12:00 JST+1h)

5:05	Finished MBES mapping, SBP survey & proton magnetometor
7:07	Recovered Proton magnetometor
7:10	Left research area & Com'ced proceeding to YOKOSUKA
13:00-14:00	Shipboard Science seminer
18:15-18:45	Scientists meeting
0:00	Put ship's time back 1h for JST

2017/06/13 North of Hachijojima (33-39.4N, 141-53.5E)

Weather: Overcast / Wind direction: ESE/ Wind force: 4 / Wave scale: 3 /
Swell scale: 1 / Visibility: 8 miles (12:00 JST)

all day	Proceeding to YOKOSUKA
8:00-10:30	Science seminer
13:00-14:00	Scientists meeting

2017/06/14

9:00	Arrived at YOKOSUKA, then completed voy. YK17-11C cruise

3.3.2. 6K Dive

YK17-11 cruise operated the eight dives 6K#1497 to 6K#1504 in Sites A, B, C, and D (Fig. 3-3, and section 3.3.1). The dive logs, related information and corrected samples, are confidential matters.

3.3.3. Multibeam Survey

Multi-narrow beam echo sounder (EM122, Kongsberg Maritime, Inc.) surveyed bathymetry and acoustic reflectivity of western Pacific, was powerful tool to search the ferromanganese nodules during cruise YK17-11C. The track lines are shown in Fig. 1-1. The data are confidencial matters.

The specifications of EM122

Measurement depth (m)	20 ~ 11,000
Measurement frequency (kHz)	12
Measurement method	cross fan beam style
Beam numbers	288

Mesurement point	432
Pulse lengths	2/5/15msec CW(～2000m)
	100msec FM(2000m～)
Beam width (deg.)	2
Beam interval (deg.)	2
Swath width (deg.)	150 (Max)
Sampling rate (msec.)	0.33
Roll (deg.)	±15
Pitch (deg.)	±10
Yaw (deg.)	±10

3.3.4 Sub-bottom profiler survey

Sub-Bottom Plofiler (SBP; 3300-HM, EdgeTech inc) was used to investigate stratigraphic feature of sedimentary layers beneath the ferromanganese nodules during cruise YK17-11C. The track lines are shown in Fig. 1-1. The data are confidencial matters.

The specifications of 3300-HM

Model	4×4
Frequency Range (kHz)	2-16
Pulse type	FM Chirp
Band width (kHz)	2-16
Pulse length (msec)	5-100
Resolution (cm)	8, (2-12khz)
Penetration (m)	80 (Max)
Beam width (deg.)	33 (3.5kHz) , 24 (4.5khz) , 20 (6kHz)

3.3.5. Geophysical survey

During the YK17-11C cruise, geophysical surveys, whose items included were gravity and geomagnetics, were conducted aboard the R/V Yokosuka around Sites A, B, C, and D (Fig. 3-3). The aim of geophysical surveys was to provide a detailed geophysical characterization of the lithosphere in the western Pacific, which will be used to unravel tectonic evolution and crustal structure. Shipboad gravity anomaly will be used for analysis the crustal structure combined with bathymetry data. The specification of a gravity meter (Type S-63, LaCoste & Romberg Gravity Meters Inc.), a ship borne 3 axis magnet meter (Type SFG-1212, Tierra Technica Inc.), and a proton magnet meter (Type STC 10, Kawasaki Geological Engineering Co., Ltd.) are listed below. The data are confidencial matters.

The specifications of Gravity Meter

Measurement range (m Gal)	12,000
Drift	3mGal per month or less
Stabilized platform	
Platform pitch(deg.)	±22
Platform roll(deg.)	±25
Platform period(min.)	4 to 4.5
Beam interval(deg.)	1
Control system	
Recording rate(Hz)	1
Serial out put	RS-232
System performance	
Resolution (mGal)	0.01
Static repeatability (mGal)	0.05
50,000m Gal horizontal acceleration (mGal)	0.25
100,000m Gal horizontal acceleration (mGal	0.50
100,000m Gal vertical acceleration (mGal)	0.25
Dimension (cm)	71x56x84
Weight (kg)	Meter:86, UPS:30

The specifications of Three Axis Magnet Meter

System	ring core fluxgate
Number of component directly	3 axes
Cable length (m)	50
Sensor dimension (mm)	φ280Å~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)	φ200x1050
Weight (kg)	28.6(in the air), 6.2(in the sea)

4. 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.