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Natsushima Cruise Report

NT11-10 (Leg2)

Growth Process and Environment of Ferromanganese Crusts a Case Study at the Ogasawara Plateau, Northwestern Pacific

July 3-7, 2011

Japan Agency for Marine-Earth Scienceand Technology

(JAMSTEC)

1 . Cruise Information

The research vessel NATSUSHIMA left the Futami Port, Chichijima Islands on June 3, 2011 for a joint exploration of ferromanganese crusts in the Minami Seamount, Ogasawara Plateau area, located about 100 nautical miles away from the ChichijimaIslands.The title of the Cruise NT11-10 (Leg 2) is "Growth Process and Environment for Deposition of Ferromanganese Crusts at the Ogasawara Plateau, Northwestern Pacific." Shipboard scientificparty consists of two scientists and two supporting staffs of NME on board and other 8scientists in collaboration of shore-based analyses with the party.

June 3NATSUSHIMA left Futami at 9 am
June 3-4 Topography survey over the dive line in plan
Feb. 4 ROV dive HPD#1296 at the Minami Seamount, Ogasawara Plateau
Feb. 7NATSUSHIMA arrived at JAMSTEC, Yokosuka at 10 am and scientists left the ship

2. Participants List

The cruiseNATSUSHIMA Leg2was successfully conducted by the science party,crew members, and ROV staffwith a dive of the ROV Hyper Dolphin 3K at the seamount in the scheduled period.

2.1 Scientist Party

Akira Usui ,Kochi University, geologist, Chief Scientist
AyakaTokumaru, graduate student, University of Tokyo
Satomi Minamizawa, technical engineer, Nippon Marine Enterprises Co., Ltd.
Masashi Ito, technical engineer, Nippon Marine Enterprises Co., Ltd.

2.2 Crew Member

Captain	YOSHIYUKI NAKAMURA
Chief Officer	HIROYUKI KATO
2nd Officer	ISAO MAEDA
3rd Officer	KAZUKI MIYAKE
ChiefEngineer	EIJI SAKAGUCHI
1stEngineer	KIMIO MATSUKAWA
2ndEngineer	MORIHIKO MURAKAMI
3RDEngineer	SHOTA NAGANO
Chief Radio Officer	MASAMOTO TAKAHASHI
2nd Radio Officer	HIROKI ISHIWATA
3rd Radio Officer	MICHIYASU KATAGIRI
Jr 3rd Radio Officer	SHINTA TAKAKUWA
Boat Swain	KOZO YATOGO
Able Seaman	HATSUO ODA
Able Seaman	HIDEO ISOBE
Able Seaman	NAOKI IWASAKI
Able Seaman	TAKUYA MIYASHITA
Sailor	TORU NAKANISHI
Sailor	RYOMA TAMURA
No1.Oiler	MASARU KITANO
Oiler	KAZUO ABE
Oiler	YUJI HIGASHIGAWA
Oiler	TOSHINORI MATSUI
Oiler	SHOTA SHIMOHATA
Chief Steward	ISAO MATSUMOTO
Steward	YOSHINOBU HASATANI
Steward	KIYOTAKA KOSUJI
Steward	TATSUYA YAMAMOTO
Steward	HIROKI FUKUDA

2.3 HyperDolphin Operation Team

Chief ROV Operator	KAZUYA MITSUFUJI
ROV Operator	KAZUKI IIJIMA
ROV Operator	KATSUSHI CHIBA
ROV Operator	HOMARE WAKAMATSU
ROV Operator	TEPPEI KIDO
ROV Operator	YUDAI SAKAKIBARA

<NME Marine Technician>

Chief Marine Technician	SATOMI MINAMIZAWA
Marine Technician	MASASHI ITO

3. On-site observation and sampling

We dove with ROV *HyperDolphin 3000*along a total approximately 1.5-km lines at water depths between 1800 and 1350 m on an eastern slope of the Minami Seamount, the Ogasawara Plateau as part of "Exploration of ferromanganese crusts in the NW Pacific Ocean."Two sub-programs are shown as below.

3.1 Growth processes and metal concentration into hydrogenetic ferromanganese crusts: A case study at the Ogasawara Plateau area.

Akira Usui(Kochi University) and KY11-02 Leg 2 Scientific Party

Objective: Ocean hydrogenetic ferromanganese crusts are potential archives ofpaleoceanographic and geological environments and events as well aspotential future mineral resources. However, the oceanographic or geological parameters controlling their elemental diversity have not been well determined with combined geochemical, mineralogical, physical and microbiological characterization on areal small-scale or microscopicscale, together with on-site geological and oceanographic observations. We attempt to figure out the parameters related to the variations of chemical and physical characteristic of ferromanganese crusts in space and time. For this purpose, the key technique is a delicate sampling method that should provide us with undisturbed ferromanganese crust samples and on-site measurement of chemical and physical parameters. This cruise is a part of our program to characterize the geological occurrences of ferromanganese crusts from two typical areas (MinamiTorishima Island area and OkinoTorishima Island area) over the northwestern Pacific Ocean. We plan to describe on microscopical scale geochemical, mineralogical, and structural properties with reliable time scales, as we did at the Takuyo-Daigo seamount during the earlier cruises NT09-02 and KY11-02.

Method and samples: We collected the crust samples without damage or break using the skilful and robust ROV, after continuous measurement of C-T-D-pH-DO throughout lowering and uplifting of the vehicle as well as on the track on the bottom. In-situ samples were taken for geochemisty, mineralogy and physical engineering studies on the crusts. At each station, with approximately 500m water-depth intervals, approximately 1-70 kg samples were taken, and then sliced and carefully kept wet cool in a refrigerator after packing in air-tight plastic bags. To avoid chemical damage, the air-tight, wet and cool conditions are requisites for analysis samples.

Results: We have successfully mapped the occurrence of the ferromanganese deposits during the dive along a total 1.5-km track within water depths between 1800 to 1350 meters on the eastern slope of the seamount. Total 14 ferromanganese samples (254 kg in wet total) were taken at 13 stops. The thickness of ferromanganese crusts ranges from less than 1 mm to 105 mm in maximum, whereas 11 samples were apparent crusts with over 5cm thick cover of ferromanganese oxide. Most of them show separated nature form the original substrate rocks but transported from shallower sea floors. The apparent rock outcrops that occur more than 90% on the entire track were fully coverage with ferromanganese crusts.

The overall coverage of sea bottom with the ferromanganese oxide depositswere much more than we expected. The samples were variable in thickness and in water depth. The DO varies from 1.8(1800m) to 0.9mL/L(1100m) . The apparent sediment cover is generally very thin mostly less than 10 cm, but very rarely greater than 30 cm. As a result, the areal distribution and thickness range of ferromanganese crusts in the upper slope of the seamount were much wider and ubiquitous than we expected.

Future plan: The slice samples (2 cm thickness each) are in plan to be analyzed for the items below in collaboration within the shipboard scientists for the first priority, and secondly with shore-based collaborators. The samples and topics of analysis will be shared and informed to each other among the party to avoid overlapping and secure priority of all members.

We will first select specific key samples from several sites on the track, and following analysis will be made mostly on the same slice or columns after discussion and negotiation.

-Bulk chemical analysis using ICP/AES and ICP/MS for about 2-3 meter intervals.
-Powder X-ray diffraction analysis for the above aliquots
-Microscopic observation on polished and thin sections for the same columns
-SEM&EDS
-EPMA/WDS
-XANES, EXAFS
-Spring-8 for trace metals
-Isotopes
-PGE
-Dating (radiochemical, paleomagnetic, paleontological)

In order to extend the range of depth environments, we should collect more samples in the adjacent areas out of the depth range, for examples, shallower than 1000m or deeper than 3000 m. On the other hand, micro-analysis including LA/ICP-MS, SIMS, TEM observation and analysis will be considered to specify chemical and mineralogical form of useful elements and fractionation..

3.2 Chemical speciation in ferromanganese crusts for paleoceanic reconstruction

AyaSakaguchi and T. Sugiyama (Hiroshima Univ.)

Objectives: Discussion on the paleoceanic environment was made from concentrations of elements without considering the incorporation mechanism of elements into the crusts. Recently, these ferromanganese crusts can be sampled without any disturbing of small scale sampling area by using the ROV Hyper-Dolphin system. We plan to get information on speciation and enrichment mechanism of elements to serve as an aid to reconstruct the paleoceanic environment using the samples obtained at the slope of the Minami Seamount, Ogasawara Plateau.

3.3 **Geochemical and mineralogical characterization**

AyakaTokumaru (Dept. Earth & Planetary Sciences, Univ. Tokyo)

Objective: The Minami Seamount, Ogasawara Plateauis expected to be, at least partly, covered with ferromanganese crusts by the past dredge survey. For further research, the samples should be collected by care not to hurt its surface. Its depth data and seafloor inspection are important to know its occurrence.In this cruise, we use ROV Hyper Dolphin to take clear and oblique images of the seafloor and to get samples from known depths. We plan to analyze chemical composition of the ferromanganese crusts and get the variations of each element, to know the relationships of major and trace elements in the ferromanganese crusts.

3.4 **Acoustic characterization offerromanganese crusts**

Blair Thornton(Institute of Industrial Science, The University of Tokyo)

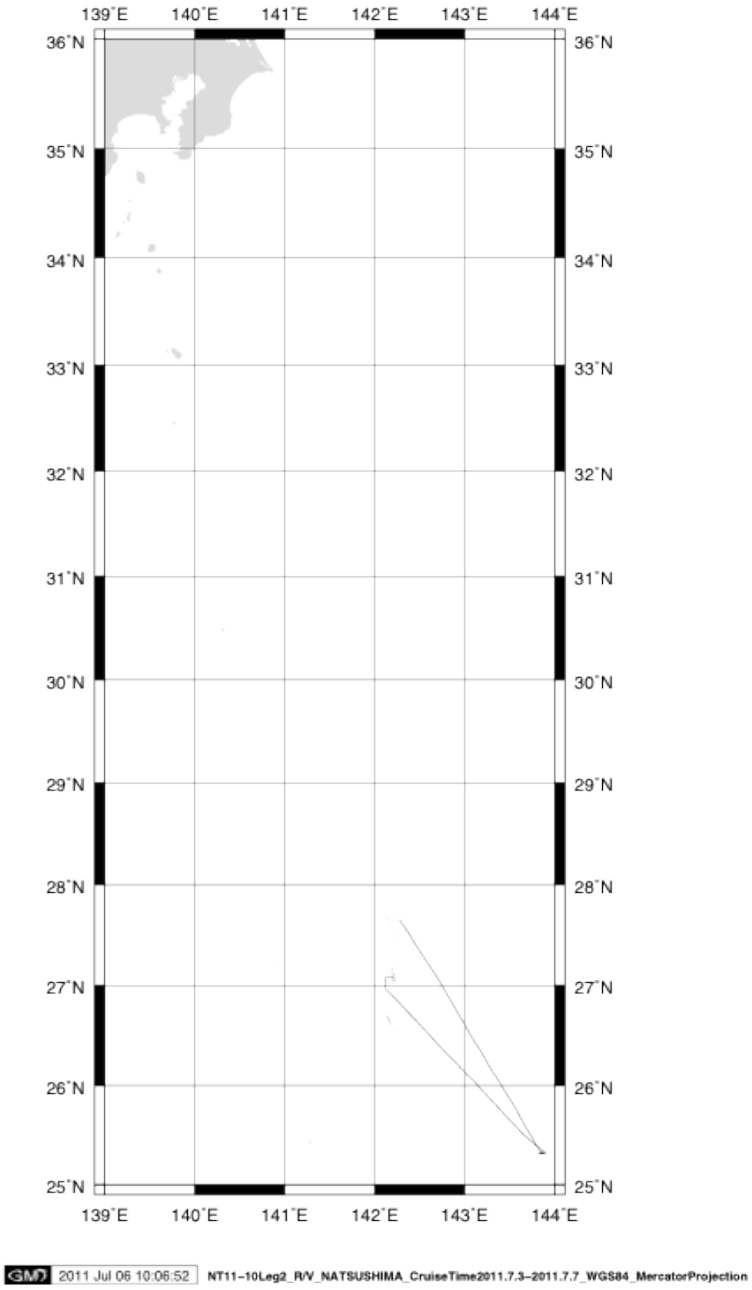
Objective: The engineering group is working towards the development of a remote manganese crust survey system that consists of an acoustic probe designed to measure the thickness of manganese crusts, and a mapping device that can generate 3-dimensional colour reconstructions of the seafloor. It is proposed that these systems can be mounted on a mobile underwater platform, such as an autonomous underwater vehicle (AUV) or remotely operated vehicle (ROV), to continuously map crust thickness from low altitudes at depths of up to 3000m. The proposed system will be deployed on the ROV HyperDolphin, and acoustic measurements of manganese crust thickness may be performed in theOgasawara Plateau. The main factors that influence the application of this approach to survey, are thought to be the microtopography of the seafloor and physical properties of substrate rocks. As a first step towards generalization, we designed a on-site rotary rock blade to split out the crusts together with substantial substrate rock of the real outcrops.

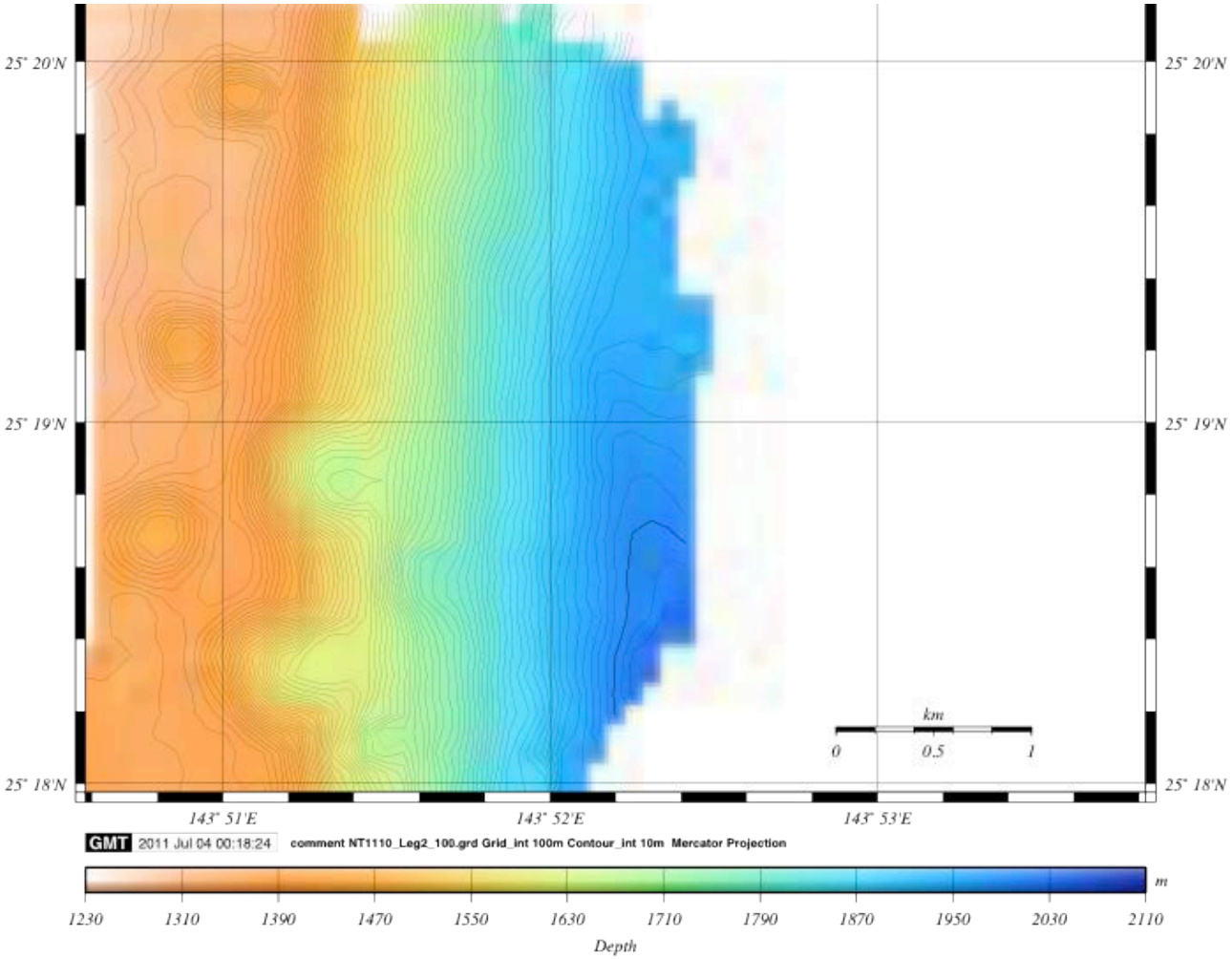
Results: The rotary rock blade worked when cutting the upper few-centimeter surface of hard outcrops, but often disturbed when attempting further thick crusts or substrate. It finally often stops probably because of unstable delicate hovering when floating. More improvement is necessary in future.

4. Other Research Information

See the track map of the ship “NATSUSHIMA”, topographic map of the study area, and the track map of “HyperDolphin for the dive.”

Other details will be open in symposiums and papers.

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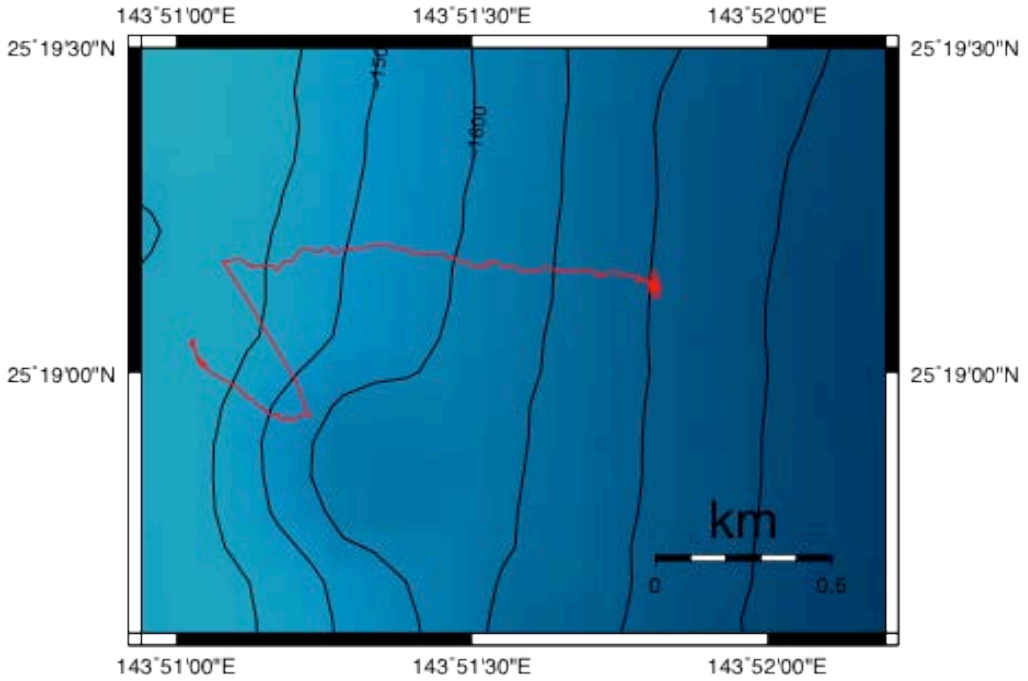
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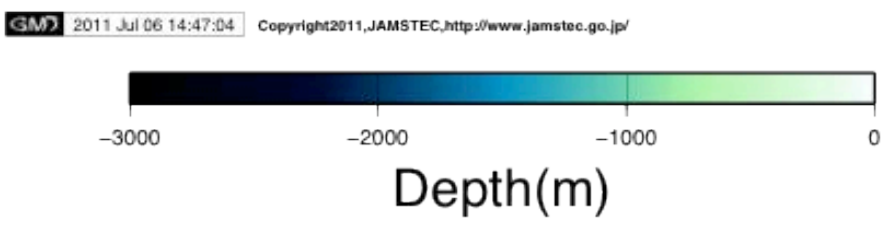
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Copyright2011,JAMSTEC,http://www.jamstec.go.jp/
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Depth(m)

5. Notice on Using

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

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