Kaiyo Cruise Report
KY12-16

Growth Process and Environment of Ferromanganese Crusts in the Hanzawa Seamount, Ogasawara Plateau

December 15-December 28, 2012

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

The research vessel Kaiyo left the Yokohama Shinko Port, at 9 am of December 15, 2012 for survey of ferromanganese crust deposits in the Takuyo Daigo seamount, a flat-top seamount in the NW Pacific Basin. The cruise was set for a collaboration science program “Geoscience of Co-rich Ferromanganese crusts based on a model seamount the Takuyo Daigo led by Dr. A. Usui at Kochi University. The four hi-tech ROV Hyper-Dolphin 4.5K (JAMSTEC) dives were approved to us and have been the only golden chance to obtain the intact, undisturbed ferromanganese crusts located below 3km water depth. This research cruise is a part of multi-institutional and multi-disciplinary program of the KAKEN project project. Unfortunately, hard gale winds hit us and pushed Kaiyo away from the planned sea area (Takuyo Daigo) and she harbored near an island chain for several days. Then much more unfortunately again we selected the second alternative area Ogasawara Plateau not the first priority target area. Actually only one incompletedive was performed during the 14-day cruise operation time schedule. Finally our trial of the second dive was ended by a serious winch trouble after only 45 minute survey.

December 15: KAIYO left Yokohama at 9 am
December 16-18: We harbored near islands due to rough sea state
December 19: We dove HPD#1459 at the Hanzawa Seamant, Ogasawara Plateau instead of the target area Takuyo Daigo smt., where rough sea state was expected.
December 20-21: We harbored near the Bonin islands due to rough sea state
December 22: We dove HPD#1460 at the Hanzawa seamount, but suspended by a serious a winch trouble after only 45 minute survey on the bottom.
December 23: We gave up further dive operations and left the study area.
December 24 Kaiyo harboured in the Futami Bay, Chichijima Is.
December 25 She left Chichijima for Yokosuka.
December 28: We arrived at JAMSTEC pier, at 9 am.

2. Participants List

The shipboard scientific party consists of 5 scientists, a supporting technical staff of NME, and 4 graduate/undergraduate students on board, and other scientists in collaboration of shore-based analyses with the party. ThecruiseKaiyoKY12-16 was incompletely ended, but supported by the science party, crew members, and ROV staff with a dive of the ROV Hyper Dolphin 4.5K at the seamount during the scheduled period.

2.1 Scientist Party

Akira Usui
Koichi Iijima
Tatsuo Nozaki
Teruhiko Kashiwabara
Kosuke Goto
Shota Nitahara
Hisaaki Sato
Keisuke Nishi
Ayaka Hatsuzawa
Kochi University, and Invited Researcher of Japan Agency for Marine-Earth Science and Technology
Japan Agency for Marine-Earth Science and Technology
Japan Agency for Marine-Earth Science and Technology
Japan Agency for Marine-Earth Science and Technology
National Institute of Advanced Industrial Science and Technology
Tokyo University of Pharmacy and Life Science
Kochi University
Kochi University
Ibaraki University

Marine Technician
Masashi Ito
Nippon Marine Enterprises, LTD.

2.2 Crew Member

Captain
Chief Officer
2nd Officer
3rd Officer
Chief Engineer
1st Engineer
2nd Engineer
3rd Engineer
Chief Electronic Operator
2nd Electronic Operator
3rd Electronic Operator
Eiko Ukekura
Naoto Kimura
Kazuki Miyake
Kakeru Ijichi
Kazuhiko Kaneda
Kenzo Kato
Takaatsu Inomoto
Arisa Ebisuno
Hiroyasu Saitake
Misato Hata
Ryousuke Komatsu

2.3 Hyper Dolphin Operation Team
3. Initial report on site

3.1 Seafloor observation and sampling

We dove with ROV *HyperDolphin* 4.5K two times (#1459 and #1460) at the Hanzawa seamount of the Ogasawara Plateau area, though the latter dive #1460 was incomplete due to a serious mechanical trouble just after 1 hour operation on the bottom.

During the two dives on the survey track between approximately 4450 to 3850m water depths, we tried to take intact, undisturbed, and in-situ samples of ferromanganese crusts, but due to troubles of CCD-camera, manipulator, it was not fully satisfactory. The dive area, the Hanzawa seamount of the Ogasawara Plateau area, was the alternative second choice, but not the original target.

During dives #1459, on the southern slope of the Hanzawa seamount, between water depths 4473m and 4363m. The average gradient is about 22 degree or less, and whole of the survey line was almost covered with thin brownish grey sediments. We found maximum 5-cm thick ferromanganese crust covering mostly highly-altered basalt and conglomerate, probably originally breccia, lava, and limestone. Semi-consolidated mudstones partly consist of substrates. The surface morphology of the slopes is generally bumpy or angular where the crusts grow over the outcrops. The knobby surface structure is again characteristic for the crusts in the area, often very thinly covered with sands and clayey sediments, which may be slump deposits from the shallower slope or tops.

During the dive #1460 at the waterdepth of 4030m to 3036m slope of the Hanzawa Seamount, with a 20 degree gradient or less. The slope was mostly covered with a brownish sediments and slump deposits, but most of bumpy outcrops and angular/platy rock fragment are thinly covered with ferromanganese crusts. Only one sample was sampled but suddenly suspended by a serious winch trouble after sea floor observation for 45 minutes.
<table>
<thead>
<tr>
<th>Date</th>
<th>Local Time</th>
<th>Note</th>
<th>Position/Weather/Wind/Sea condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>H24. 12. 16</td>
<td>9:00</td>
<td>Sail out &amp; started KY12-16 Let go all shore lines, left YOKOHAMA. Then com’ced proceeding to research area (Takuyo No5 seamount).</td>
<td>12/15 12:00 (UTC+9h) 12/16 12:00 (UTC+9h)</td>
</tr>
<tr>
<td></td>
<td>10:00</td>
<td>Carried out shipboard education for scientists.</td>
<td>35-00. 5N 139-50.0E Rainy</td>
</tr>
<tr>
<td></td>
<td>12:00</td>
<td>Arrived at off TATEYAMA, due to rough sea.</td>
<td>SSW-7 (Near gale) 4 (Sea moderate) 2 (Low swell long) Visibly: 4'</td>
</tr>
<tr>
<td>H24. 12. 17</td>
<td>6:30</td>
<td>Proceeding to research area</td>
<td>12/16 12:00 (UTC+9h) 34-01. 4N 139-47.0E Fine but coludy NNE-4 (Moderate breeze) 3 (Sea slight) 4 (Moderate average) Visibly: 7'</td>
</tr>
<tr>
<td></td>
<td>10:00</td>
<td>Carried out shipboard education for scientists.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17:30</td>
<td>Arrived at research area (Ogasawara plateau).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17:34</td>
<td>Released XBT at 25-56. 6959N 146-40. 4184E.</td>
<td></td>
</tr>
<tr>
<td>H24. 12. 18</td>
<td>09:00-09:30</td>
<td>Carried out master station &amp; fire station drill. Com’ed proceeding to Ogasawara plateau due to rough sea.</td>
<td>12/17 12:00 (UTC+9h) 30-08. 5N 142-00. 5E Rainy SE-4 (Moderate breeze) 3 (Sea slight) 3 (Moderate short) Visibly: 2'</td>
</tr>
<tr>
<td></td>
<td>Noon</td>
<td>Com’ed proceeding to Ogasawara plateau due to rough sea.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17:30</td>
<td>Released XBT at 25-56. 6959N 146-40. 4184E.</td>
<td></td>
</tr>
<tr>
<td>H24. 12. 20</td>
<td>3:27</td>
<td>Finished MBES mapping survey.</td>
<td>12/19 12:00 (UTC+9h) 26-38. 4N 146-44. 9E Fine but coludy WSW-5 (Fresh breeze) 3 (Sea slight) 2 (Low swell long) Visibly: 7'</td>
</tr>
<tr>
<td></td>
<td>7:29</td>
<td>Hoisted up HPD.</td>
<td></td>
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<tr>
<td></td>
<td>7:33</td>
<td>Launched HPD.</td>
<td></td>
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<tr>
<td></td>
<td>7:45</td>
<td>HPD dove &amp; started her operation#1458.</td>
<td></td>
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<tr>
<td></td>
<td>8:43</td>
<td>HPD floated due to mechanical trouble.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8:58</td>
<td>Recovered HPD &amp; finished above operation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9:51</td>
<td>Hoisted up HPD.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9:55</td>
<td>Launched HPD.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10:07</td>
<td>HPD dove &amp; started her operation#1459.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12:28</td>
<td>HPD landed on the sea bottom (4471m).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16:55</td>
<td>HPD left the sea bottom (4465m).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18:30</td>
<td>HPD floated.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18:44</td>
<td>Recovered HPD &amp; finished above operation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19:35-21:38</td>
<td>Carried out MBES mapping survey.</td>
<td></td>
</tr>
<tr>
<td>H24. 12. 21</td>
<td>9:00</td>
<td>Suspended HPD operation due to rough sea</td>
<td>12/20 12:00 (UTC+9h) 26-38. 4N 146-44. 9E Fine but coludy WSW-5 (Fresh breeze) 3 (Sea slight) 4 (Moderate average) Visibly: 7'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suspended HPD operation due to rough sea</td>
<td></td>
</tr>
</tbody>
</table>
H24.12.22  Suspended HPD operation due to rough sea
9:00  Suspended HPD operation due to rough sea.

12/21 12:00(UTC+9h) 26°31.0N 144°48.0E
Fine but cloudy
NNE-5(Fresh breeze)
4(Sea moderate)
Visibly:7'

Fine but cloudy
NNE-5(Fresh breeze)
4(Sea moderate)
Visibly:7'

26-31.0N 144-48.0E

H24.12.23  HPD#1460_Ogasawara plateau
00:20-05:52  Carried out MBES mapping survey.
10:10  Hoisted up HPD.
10:15  Launched HPD.
10:28  HPD dove & started her operation#1460.
12:27  HPD landed on the sea bottom(4030m).
13:16  HPD left the sea bottom(3911m).
22:47  HPD floated.

12/22 12:00(UTC+9h) 25°43.0N 146°45.3E
Fine but cloudy
ESE-6(Strong breeze)
4(Sea moderate)
Visibly:7'

10:10  Hoisted up HPD.

10:15  Launched HPD.
10:28  HPD dove & started her operation#1460.
12:27  HPD landed on the sea bottom(4030m).
13:16  HPD left the sea bottom(3911m).
22:47  HPD floated.

12/22 12:00(UTC+9h) 25°43.0N 146°45.3E
Fine but cloudy
ESE-6(Strong breeze)
4(Sea moderate)
Visibly:7'

H24.12.24  Proceeding to Off Chichijima
0:43  Recovered HPD & finished above operation.
1:00  Proceeding to Off Chichijima due to rough sea.

12/23 12:00(UTC+9h) 26°21.0N 144°34.0E
Fine but cloudy
WNW-4(Moderate breeze)
3(Sea slight)
2(Low swell long)
Visibly:7'

0:43  Recovered HPD & finished above operation.
1:00  Proceeding to Off Chichijima due to rough sea.

12/23 12:00(UTC+9h) 26°21.0N 144°34.0E
Fine but cloudy
WNW-4(Moderate breeze)
3(Sea slight)
2(Low swell long)
Visibly:7'

H24.12.25  Arrived at off Chichijima
7:30  Arrived at off Chichijima, then com'ced drifting.

12/24 12:00(UTC+9h) 27°05.0N 142°12.0E
Cloudy
NW-5(Fresh breeze)
3(Sea slight)
2(Low swell long)
Visibly:7'

7:30  Arrived at off Chichijima, then com'ced drifting.

12/24 12:00(UTC+9h) 27°05.0N 142°12.0E
Cloudy
NW-5(Fresh breeze)
3(Sea slight)
2(Low swell long)
Visibly:7'

H24.12.26  Proceeding to Yokosuka
12:00  Finished drifting, then com'ced proceeding to Yokosuka.

12/25 12:00(UTC+9h) 27°00.0N 139°10.5E
Fine but cloudy
NW-3(Gentle breeze)
2(Sea smooth)
2(Low swell long)
Visibly:7'

12:00  Finished drifting, then com'ced proceeding to Yokosuka.

12/25 12:00(UTC+9h) 27°00.0N 139°10.5E
Fine but cloudy
NW-3(Gentle breeze)
2(Sea smooth)
2(Low swell long)
Visibly:7'

H24.12.27  Proceeding to Yokosuka

12/26 12:00(UTC+9h) 30°00.0N 139°10.5E
Fine but cloudy
NW-6(Strong breeze)
4(Sea moderate)
3(Moderate short)
Visibly:7'

12/26 12:00(UTC+9h) 30°00.0N 139°10.5E
Fine but cloudy
NW-6(Strong breeze)
4(Sea moderate)
3(Moderate short)
Visibly:7'

H24.12.28  Proceeding to Yokosuka

12/27 12:00(UTC+9h)

12/27 12:00(UTC+9h)

H24.12.29  Arrived at Yokosuka

12/28 09:00(UTC+9h)

12/28 09:00(UTC+9h)
Figure 1 Ship Track
3.2 Mechanism of metal accumulation and process of growth of hydrogenetic ferromanganese crusts: A case study at the Hanzawasmt., Ogasawara Plateau

A. Usui, H. Sato, K. Nishi (Kochi Univ.), K. Iijima, T. Nozaki, T. Kashiwabara (JAMSTEC), K. Goto (Geological Survey of Japan), and A. Hatsuzawa (Ibaraki University)

Objective: Ocean hydrogenetic ferromanganese crusts are potential archives of paleoceanographic and geological environments as well as potential future mineral resources. However, the oceanographic or geological parameters controlling their elemental and mineralogical diversity have not been well determined with combined geochemical, mineralogical, physical and microbiological characterization on areal small-scale or microscopic scale. The ROV exploration and geological mapping proved the most elegant, accurate, and effective method for on-site geological study and geochemical analysis. We attempt to figure out the parameters related to the variations of chemical and physical characteristics 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 (Minami Torishima Island area, the Pacific and Okino Torishima Island area, the Philippine sea) over the northwestern Pacific Ocean. We plan to describe on microscopic scale geochemical, mineralogical, and structural properties with reliable time scales, as we did at the Takuyo Daigo seamount during the earlier cruises NT09-02, KY11-02, and NT 12-05.

Method and samples: We collect the crust samples without damage or break using the skilful and robust ROV, after continuous measurement of C-T-D-DO throughout lowering and uplifting of the vehicle as well as on the track on the bottom. In-situ samples were taken for geochemistry, dating, and mineralogy of the crusts. At each station, with approximately 500 m water-depth intervals, some kg samples at each site. The samples were 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 further chemical and mineralogical analyses.

Results: We observed the occurrence of the ferromanganese deposits and substrate and delicate sampling of ferromanganese crusts during only onedive between water depths 4450m and 3950m. Total 10 ferromanganese samples (25 kg in wet total) were taken at 6 stops. The thickness of ferromanganese crusts ranges from less than 1 mm to 50 mm in maximum. Only the steeper slumped slope is partly covered with crusts, but other less steep slopes are sediment-covered. Most of them show separated nature from the original substrate rocks but transported from shallower sea floors. The apparent rock boulders are calcareous conglomerate and basaltic rocks. Complicated internal structure of substrates suggests frequent landslide and reworking of slump deposits, composed of basaltic lava, limestone, manganese nodules and crusts.

The overall coverage of sea bottom with the ferromanganese oxide deposits were much more than we expected in the Daito ridge, but less in the Amami plateau. The samples were variable in thickness and in water depth. The DO varies from 4.0 (500m) to 0.9mL/L(1000m).

Future plan: The slice samples (2 cm thickness each) are in plan to be analysed 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 to secure their priority of all members.

We will first select specific key samples from the sites on the track line, 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 mm intervals.
- Powder X-ray diffraction analysis for the above aliquots
- Microscopic observation on polished and thin sections for the same columns
- Petrography and dating of substrates
- SEM/EDS for crusts
- EPMA/WDS
- XANES, EXAFS
- Isotopes (Be, Os)
- PGE and REE abundances
- more dating (above isotopic, 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.

3.3 Microbial concentration of ferromanganese minerals

Nitahara Shota and Kato Shingo (Tokyo University of Pharmacy and Life Science and RIKEN)

**Objective:** Ferromanganese crust is iron and manganese oxide deposite that is widely distributed in the world. The process of concentration of ferromanganese crust is controversial (ex. accumulation of metals into Fe or Mn colloid). We think that process of concentration of ferromanganese crusts involves activity or presence of microbes. However, microbe on ferromanganese crust is still unclear, especially there is no study using molecular biology techniques.

Thus, our purpose is to clarify microbial community on ferromanganese crust, and to discuss the involvement of microbes in concentration of ferromanganese crust.

**Method and samples:** We collected ferromanganese crust samples without damage using manipulator, sediment with M-typesampler and ambient seawater with NISKIN bottle. Ferromanganese crust was divided into some particles and stored – 80 °C (molecular biology) and 4 °C (microscopy and cultivation). Sediment sample was stored – 80 °C (molecular biology) and 4 °C (microscopy and cultivation). For microscopic observation, the samples were fixed with filter-sterilized seawater containing formalin (final 3–5 % v/v). Ambient seawater was filtered with 0.2 µm filter and stored – 80 °C (molecular biology). For microscopic observation, seawater sample was fixed by adding formaldehyde (final 3–5 % v/v). For cultivation, seawater was stored in sterilized bottle at 4 °C.

For cultivation on board, ferromanganese crust and sediment were suspended with 0.2 µm filtered seawater and inoculate into media for ammonia oxidizers and incubate 4 °C. About 1 ml of seawater was inoculated into media for ammonia oxidizers.

**Results:** We have successfully collected ferromanganese crusts, sediment and ambient seawater from Hanzawa seamount in Ogasawara plateau. Ferromanganese crusts were divided into several pieces (surface and center). A part of samples was suspended with filtered seawater and inoculated into media for ammonia oxidizer.

**Future plan:** On shore study, we plan to perform following analysis using molecular biology techniques to clarify microbial community on the surface of ferromanganese crust.

i. Construct clone library of 16S rRNA gene, ammonia monoxygenase subunit A (amoA gene) and other functional genes based on DNA and RNA.

ii. Quantitative PCR for 16S rRNA and amoA gene for quantify abundance microbes and ammonia oxidizers.

iii. Cultivation ammonia oxidizing bacteria and archaea, Fe (or Mn) oxidizing bacteria and other anaerobes.

iv. Microscopic observation of ferromanganese crusts with SYBR Green I and CARD-FISH.

4. Other Research Information

See the track map of the ship Kaiyo, and the track map of HyperDolphin for the dives are shown as follows. Other details will be open to public in coning symposiums and printed papers.
Figure 2 Track of ROV Dives

Dive HPD1459

Dive HPD1460
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 to submit their results to the Data Management Group of JAMSTEC. |