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# R/V Kaimei "Cruise Report"
# KM19-07

## Full-depth observation toward sustainable ocean use

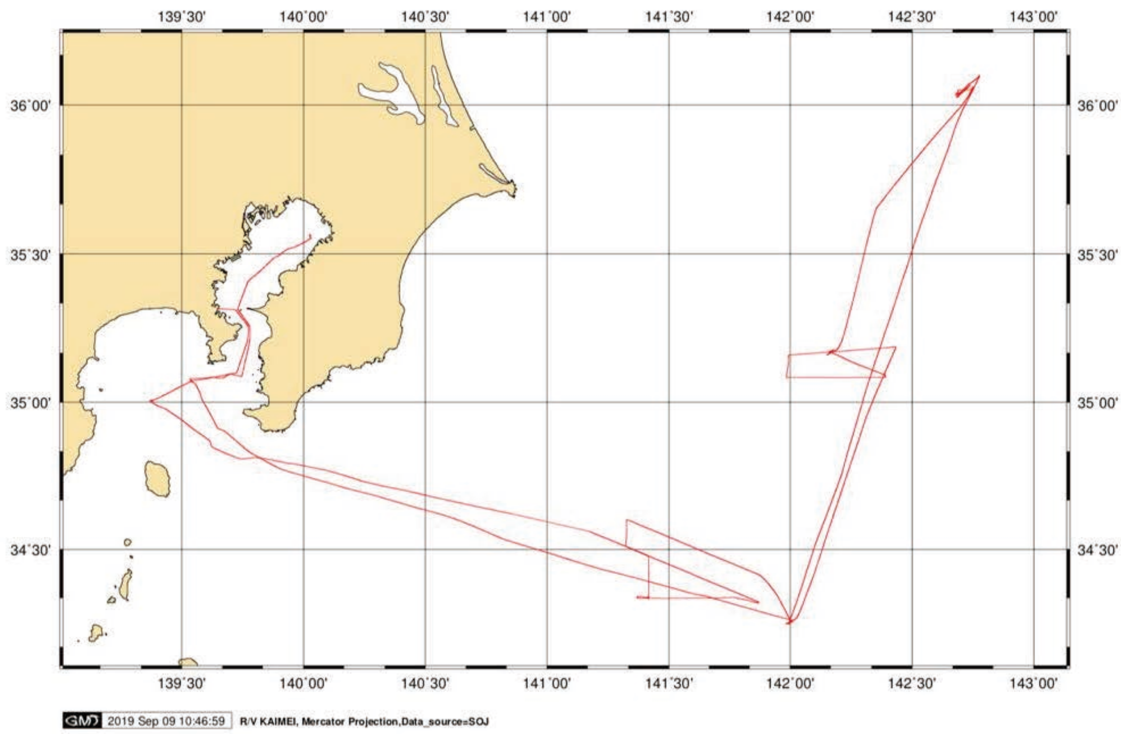
Izu-Ogasawara Trench and Sagami Bay

1st - 10th, Sep., 2019

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

## 1. Cruise Information

- Cruise ID KM19-07
- Name of vessel R/V Kaimei
- Title of cruise Full-depth observation toward sustainable ocean use
- Chief Scientist [Affiliation] KAWAGUCCI Shinsuke [JAMSTEC X-star]
- Cruise period 1-10, Sep., 2019
- Ports of departure / arrival JAMSTEC-JAMSTEC
- Research area Izu-Ogasawara Trench and Sagami Bay



## 2. Research Proposal and Science Party

● Title of proposal

To develop how we achieve sustainable use of ocean resource and environment by Kaimei's capability

● Representative of Science Party

| | |
|---|---|
| KAWAGUCCI Shinsuke | JAMSTEC X-star |

● Science Party

| | |
|---|---|
| KAWAGUCCI Shinsuke | JAMSTEC [chief scientist] |
| YOKOKAWA Taichi | JAMSTEC [CTD principal] |
| NOMAKI Hidetaka | JAMSTEC [MC principal] |
| HIRAI Miho | JAMSTEC |
| TASUMI Eiji | JAMSTEC |
| MAKABE Akiko | JAMSTEC |
| TSUKATANI Yusuke | JAMSTEC |
| TANAKA Keiko | JAMSTEC |
| HIRAOKA Satoshi | JAMSTEC |
| SUMIDA Tomomi | JAMSTEC |
| UCHIDA Hiroshi | JAMSTEC |
| SHIGEMITSU Masahito | JAMSTEC |
| HAMANA Minoru | JAMSTEC |
| TADA Yuya | NIMD |
| TAKEUCHI Akinori | NIES |
| OTA Shuhei | NIES |
| MATSUMOTO Misato | Saga University |
| JIMI Naoto | NIPR |
| FUJIMOTO Shinta | Tohoku University |
| MAKHALANYANE Thulani | University of Pretoria, South Africa |
| GOKUL Jarishma | University of Pretoria, South Africa |
| MABASO Mancha | University of Pretoria, South Africa |
| SATO Yusuke | MWJ |
| KITADA Mikio | MWJ |
| MATSUMOTO Keisuke | MWJ |
| KOBAYASHI Rio | MWJ |
| TUN Htet Aung | MWJ |
| IRIE Eri | MWJ |
| IWAMOTO Hisanori | NME |

○ Crew

| | |
|---|---|
| YOSHIDA Rikita | Captain |
| FUJII Shozo | Chief Officer |
| ITO Yuki | 2nd Officer |
| SHIRAISHI Eri | 3rd Officer |
| KANEDA Kazuhiko | Chief Engineer |
| IKUTA Shinichi | 1st Engineer |
| TANAKA Hiroki | 2nd Engineer |
| RYOSHU Hayato | 3rd Engineer |
| KAINO Yuna | Jr.3rd Engineer |
| ISHIWATA Hiroki | Chief Electronic Operator |
| ONIKUBO Ryuji | 2nd Electronic Operator |
| TAKI Misato | 3rd Electronic Operator |
| OHATA Masanori | Boat Swain |
| OKADA Masashige | Able Seaman |
| ISHIZUKA Nao | Able Seaman |
| KAWAMURA Kosei | Able Seaman |
| HONJO Hotaka | Sailor |

| | |
|---|---|
| SAGA Toshiya | Sailor |
| SAITO Akira | Sailor |
| UEDA Masanori | No.1 Oiler |
| SUZUKI Ryota | Oiler |
| TANIGUCHI Keiya | Oiler |
| TOMIYAMA Yusuke | Assistant Oiler |
| SONODA Kazuma | Chief Steward |
| OKADA Yoshio | Steward |
| YAMAMOTO Yoshitaka | Steward |
| KASHIWAGI Koichiro | Steward |

## 3. Research/Development Activities

● Introduction: Hadal water science

Sustainability of ocean is faced with serious problem due to increasing demand of ocean/ seafloor resources for growing world population and economy. To understand how ocean responses against natural and artificial impacts and to conduct environmental impact assessment (EIA) for ocean use are thus urgent issues.

The CTD-CMS (Conductivity Temperature Depth profiler with Carousel Multiple Sampling) system has been the most essential and fruitful device in the history of oceanography. Seawater sensing by the CTD draws a continuous profile of the general hydrographic property, while seawater sampling at multiple selected depths by the CMS allows a variety of subsequent analyses for chemical and biological properties. Cross-ocean observations with the CTD-CMS, in some case led by international programs such as WOCE (Siedler et al., 2001) and GEOTRACES (Cutter, 2013), have yielded datasets of comparable qualities and sufficient horizontal resolution that serve as a basis for us to paint the overall picture of the Earth's ocean. However, one blank gap remains in that picture – the hadal waters (deeper than 7,000 m), due to the extreme pressure there and a lack of full-depth CTD-CMS systems.

The lack of full-depth CTD-CMS systems greatly limited seawater sampling-based analyses and therefore the analysis and understanding of hadal water column in a way comparable to the CTD-CMS data available for all other parts of the ocean. Nevertheless, a small number of hadal sampling efforts, not using the CTD-CMS, have been carried out over the years. For example, a pioneering work (Mantyla and Reid, 1978) collected a total of four hadal seawater samples from two stations in the southern Mariana Trench (MT) with a specially-designed acoustic release device. Hydrographical properties (salinity, oxygen, and nutrients) of the samples obtained demonstrated that hadal and abyssal waters exhibit identical characteristics.

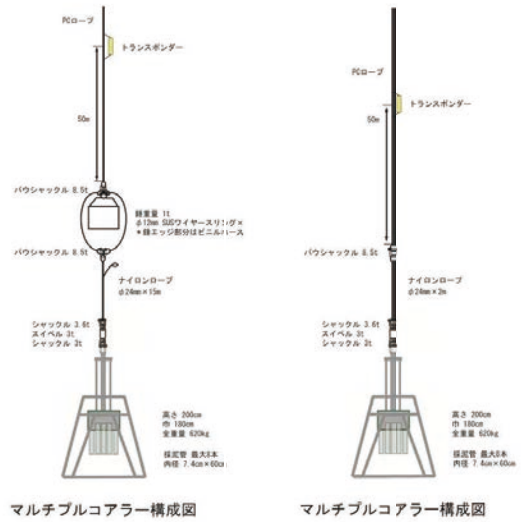
At a trench axis station AN1 (29°05N - 142°51E, 9,750 m) located in the mid Izu-Ogasawara Trench (IOT), vertical seawater samples were collected during two cruises of R/V Hakuho-maru in 1984 and 1994 (Nozaki et al., 1998; Gamo and Shitashima, 2018), by directly attaching standard Niskin bottles to a wire line. The samples were used to determine hydrographic properties and for 222Rn analyses, while three specially-designed samplers were also used for metals and other radionuclides analyses. The hadal water at AN1 exhibited vertically constant profiles in salinity, dissolved oxygen, nitrate, and phosphate, confirming the characteristics previously observed in the southern MT (Mantyla and Reid, 1978). The renewal time of the trench-filling hadal water was evaluated to be ~5 years from the distribution of radionuclides (Nozaki et al., 1998). Manganese and iron were slightly enriched in the hadal water only and was background level in the overlying abyssal water while significant 222Rn excess was detected in waters up to ~2,700 m above the trench axis seafloor, suggesting lateral 222Rn supply from the surrounding trench slope (Gamo and Shitashima, 2018). These hadal water-specific characteristics were consistent with a scenario where the transport of sedimentary component from the trench slope to hadal depths being frequent, which has indeed been commonly shown by sediment observations at trench axes of Izu-Ogasawara, Mariana, Japan, and Tonga trenches (Nozaki and Ohta, 1993; Glud et al., 2013; Oguri et al., 2013; Wenzhofer et al., 2016) and supported by numerical modeling (Ichino et al., 2015).

In addition to the geochemical studies outlined above, ~30 vertical seawater samples, including 7 hadal samples, were collected mainly for biological analyses by the remotely operated vehicle ABISMO at the Challenger Deep in the southern MT. Phylogenetic analyses from these samples revealed a hadal water-specific microbial community, named the hadal biosphere, which has been shown to be distinct from the abyssal one (Nunoura et al., 2015). Mechanisms developing the hadal biosphere are considered to be likely associated with the lateral supply of sedimentary organic matter from the trench slope as well as the hadal geochemical anomalies.

Despite these efforts, the spatial coverage within and among trenches, as well as the comprehensiveness of the (bio)geochemical and microbial dataset, is still greatly limited compared to other parts of the ocean. To resolve these problems and to obtain data from hadal depths in a directly comparable quality to the global CTD-CMS observations, the development of a full-depth CTD-CMS system is needed and indeed has long been awaited. At last, a full-depth-rated CTD-CMS system was equipped in 2015 on the research vessel R/V Kaimei launched that year. The R/V Kaimei CTD-CMS system has been deployed at the IOT and the MT including 5 full-depth vertical sequences at trench axes between 2016-2017 [Kawagucci et al. 2018].

● Sampling

KM19-07 cruise investigated anc 4 on-axis full-depth vertical sequences at northern IOT (CM1 or 34N11), northern IOT (CM5 or 35N11), eastern-end of Sa Trough (Ct9 or 34N12), and southern-en Japan Trench (CM3 or 36N11). Multiple sampling has also been conducted at the IOT JT stations as well as two reference statio Sagami Bay to understand endmer composition of the influx from seafloor/s sediment to seawater column. Geophy observation was conducted for site survey.




A 12,000m-long synthetic- coaxial cable of R/V Kaimei was used fo operation of full-depth CTD-CMS system v a 7,500m-capable steel cable was used onl Sagami Trough station. The full-depth C CMS consists of a CTD sensor (SBE911 11,000 m capable), a Carousel water san (SBE32, 11,000 m capable) for 36 Nisk bottles, and a dissolved oxygen sensor (RINKO, 7,000 m guaranteed but 10,000 m capable). The CTD thermometer (SBE3plus) was calibrated in situ with a deep ocean standard thermometer (SBE35, 7,000 m capable) to correct a pressure dependency of the CTD thermometer (Uchida et al., 2015).

A 12,000m-long synthetic-fiber rope of R/V Kaimei was used for the operation of ~600 kg full-depth multiple corer. Since the rope has positive buoyancy in seawater, ~1,000 kg weight was connected between the rope and corer to get sufficient negative buoyancy and rope tension safely going down to the hadal seafloor (see Figure). In the case of Sagami bay (700-1400 m depth), no additional weight was needed. All the sediment samples were 20-40 cm in length.

● Analyses

Hydrographic parameters (Sal/DO/Nuts/Dens) as well as short life-time gases ($H_2$, CO) and FDOM were analyzed onboard. Standard methods for WOCE expeditions were applied for the hydrographic parameters. Molecular hydrogen and carbon monoxide were analyzed with a head-space GC-TRD method reported previously [Kawagucci et al. 2014]. Phytoplankton composition and their response against metal/nutrient inputs, expected at the time of seafloor resource recovery, were examined by the onboard NIES-FCM method. Each of onboard members of KM19-07 will conduct further chemical and biological analyses with samples processed onboard. Details about the samples are described in JAMSTEC metadata sheets while the future study plans of onboard members can be seen by contacting the chief scientist. Any collaboration with non-onboard members is highly welcome once proposal of research plan is accepted by the chief scientist.

KM19-07

| 採水順番 | 写真 | 採水項目 | 容器形状 | チューブ | 共洗い | オーバーフロー | サンプル量 | 保存 | バケツ採水 | その他 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 |  | 溶存酸素(DO) | 100ml 定容ガラスビン | ○ | なし | 2倍量 | 満水 | 常温 | 有 | ビン番号と海水温記録、気泡NG→取り直すこともある。 |
| 2 |  | 水素濃度(H2 conc) | 100ml バイアルビン | ○ | 1 | 2倍量 | 満水 |  | 有 | ブチル栓を逆さにして置く.ブチル栓の穴にも水を満たす |
| 3 |  | メタン濃度(CH4 conc) | 100ml バイアルビン | ○ | 1 | 2倍量 | 満水 | 冷蔵 | 有 | ブチル栓を逆さにして置く.ブチル栓の穴にも水を満たす |
| 4 |  | Hg all | 1L テフロンボトル | なし | 2 | なし | 満水 | 冷蔵 | 有 | 手袋着用。ユニパックから出し、2回共洗い後、採水。ユニパックに入れて保管。 |
| 5 |  | HG_NIES | 500mL PFAボトル(中栓付き) | なし | 3 | なし | 満水 | 冷蔵 | — | 手袋着用。共洗いをして捨てる海水は、中栓にかけるように捨てる。常にユニパックに入れて保管 |
| 6 |  | 塩分(Sal) | 250ml 褐色角ビン | なし | 3 | なし | 白線目安 | 常温 | 有 | サンプル量少なければとり直し。共洗いのとき採水器のコックも洗浄する。フタ内側のパッキンを確認する。 |
| 7 |  | 海水密度(Dens) | 100ml アルミボトル | なし | 3 | なし | ビン首まで | 常温 | 有 |  |
| 8 |  | アルカリ度(TA) | 100ml DURANビン(赤タグ) | ○ | なし | 2倍量 | 満水 | 冷蔵 | 有 |  |
| 9 |  | 栄養塩(Nuts) | 10ml スピッツ管 x 2本 | なし | 3 | なし | 満水 | 冷蔵 | 有 | 共洗い時に海水をしっかりきること。 |
| 10 |  | 硝酸窒素同位体(DIN, 15NO3) | 50ml or 100ml プラスチックシリンジ | なし | 2 | なし | 満水 | 冷蔵 | 有 | プランジャーをキチンとはめる |
| 11 |  | Urea | 25ml 遠心管 | なし | 2 | なし | 満水 | 冷蔵 | 有 |  |
| 12 |  | 硝化活性測定 | 100ml 褐色バイアルビン(ゴムキャップ) | ○ | 2 | 2倍量 | 満水 | 冷蔵 | 有 | 5円玉の穴より大きい気泡NG→取り直し(フタを回しながら挿入するとよい)。 |
| 13 |  | 全有機炭素(TOC) | 60ml LDPE | なし | 3 | なし | 2/3程度 | 冷凍 | — |  |
| 14 |  | FDOM | 40mL バイアル瓶 | なし | 3 | なし | 2/3程度 | 冷蔵 | 有 |  |
| 15 |  | 植物プランクトン フローサイト用 | 500 mL広口アイボーイ | なし | 1 | なし | 500 mL目盛まで | 常温 | 有 |  |
| 16 |  | Abundance | 25ml 遠心管 | なし | なし | なし | 満水 | 冷蔵 | 有 |  |
| 17 |  | Acrtivity | 50ml 遠心管 | なし | なし | なし | 満水 | 冷蔵 | 有 |  |
| 18 |  | DIC取り込み速度 | 250mL アイボーイ | なし | なし | なし | 満水 | 冷蔵 | 無 |  |
| 19 |  | DNA | ステリテナー | ○ | なし | なし | 有るだけ | 冷蔵 | 有 |  |

## ● 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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