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Kaimei KM21-E02 cruise report

In situ biodegradibility tests on newly developed biodegradable materials and investigations on their controlling factors

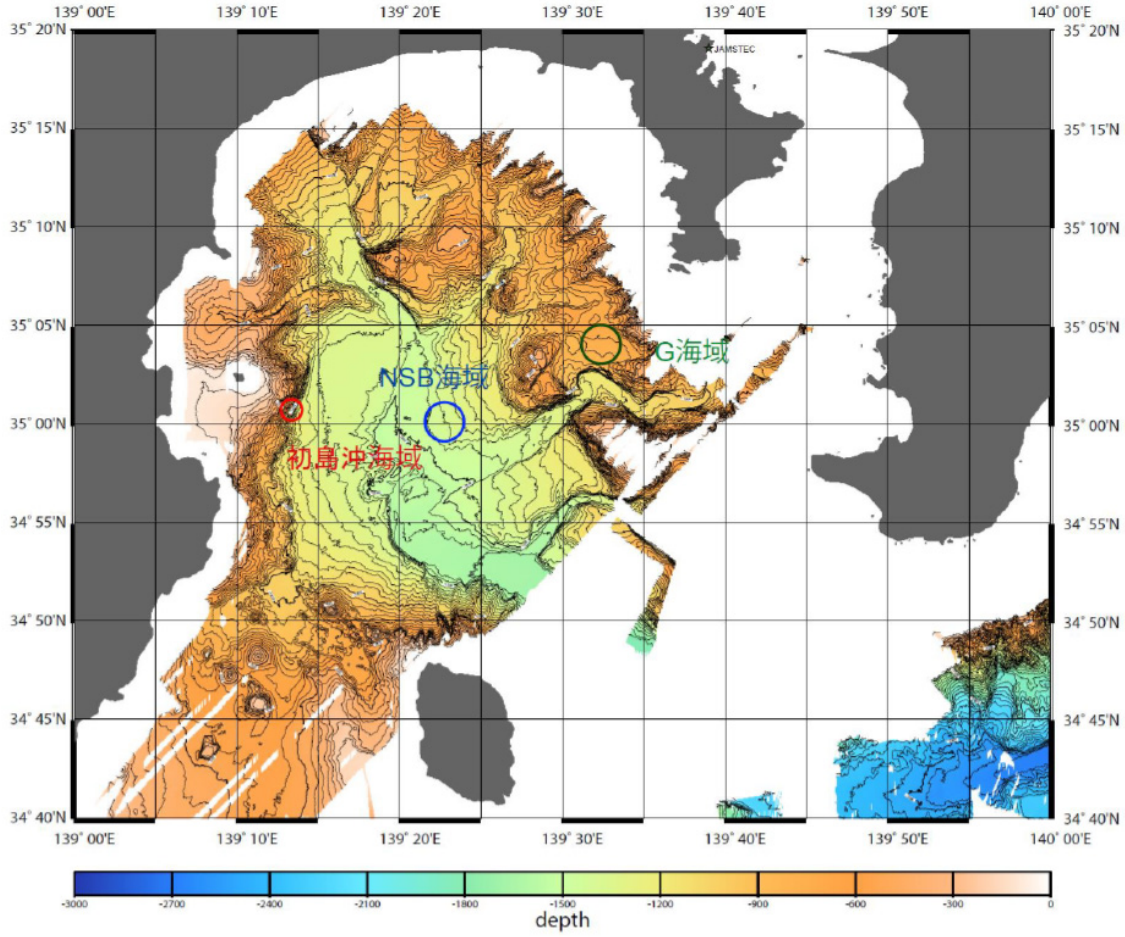
Survey Area: Sagami Bay

February 2nd to 6th, 2021

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

1. Cruise Information

● Cruise ID: KM21-E02
● Name of vessel: Kaimei
● Title of cruise: In situ biodegradibility tests on newly developed biodegradable materials and investigations on their controlling factors
● Chief Scientist [Affiliation]: Hidetaka Nomaki [JAMSTEC]
● Cruise period: February 2nd to 6th, 2021
● Ports of departure / call / arrival: Yokosuka-Yokosuka
● Research area: Sagami Bay
● Research map



2. Research Proposal and Science Party

● Title of proposal
In situ biodegradibility tests on newly developed biodegradable materials and investigations on their controlling factors

● Representative of Science Party [Affiliation]
Hidetaka Nomaki [JAMSTEC]

● Science Party (List) [Affiliation, assignment etc.]
1. Participants aboard

1-1. Research group

Chief Scientist	NOMAKI Hidetaka Japan Agency for Marine-Earth Science and Technology
Scientist	KAWAGUCCI Shinsuke Japan Agency for Marine-Earth Science and Technology
Scientist	ISOBE Noriyuki Japan Agency for Marine-Earth Science and Technology
Scientist	CHEN Chong Japan Agency for Marine-Earth Science and Technology
Scientist	SALONEN Iines Japan Agency for Marine-Earth Science and Technology
Scientist	METHOU Pierre Japan Agency for Marine-Earth Science and Technology
Scientist	TASUMI Eiji Japan Agency for Marine-Earth Science and Technology
Scientist	OGAWARA Miyuki Japan Agency for Marine-Earth Science and Technology
Scientist	KIMURA Satoshi The University of Tokyo
Student	MATSUMOTO YUSUKE The University of Tokyo
Student	HUANG QiuYuan The University of Tokyo
Marine Tec.	MORIOKA Miki Nippon Marine Enterprises, Ltd.
Marine Tec.	SERIZAWA Kimiko Nippon Marine Enterprises, Ltd.

1-2. Operation team of the KM-ROV

Operation Manager	ISHIZUKA TETSUYA
1st ROV Operator	KONDOU TOMOE
2nd ROV Operator	CHIDA YOSUKE
2nd ROV Operator	GOTO TAKUMA
3rd ROV Operator	KOGUMA ATSUSHI
3rd ROV Operator	OKUHIRA YUTO

1-3. Captain and crew of the R/V KAIMEI

Captain	KIMURA NAOTO
Chief Officer	MURAMATSU TAKESHI
2nd Officer	OKADA MASAKI
3rd Officer	KIKUCHI ASAMI
Jr.3rd Officer	OJIMA TAKUMI
Chief Engineer	TSUKADA MINORU
1st Engineer	GIBU DAISUKE
2nd Engineer	MIKAMI RYUZO
3rd Engineer	HAMAKAWA NAOYUKI
Chief Electronic Operator	KOMAKI YOSUKE
2nd Electronic Operator	MATSUI RYOSUKE
3rd Electronic Operator	ISHIWATA MINAMI
Boat Swain	OHATA MASANORI
Able Seaman	TAMOTSU HIDEAKI
Able Seaman	OHJIRI YUTA
Able Seaman	IWASAKI NAOKI
Able Seaman	KOJIMA SHINYA
Sailor	YOSHIMI YUDAI
Sailor	NAKANISHI RYO
No.1 Oiler	OISHI HIROYUKI

Oiler	FURUYAMA YUJI
Oiler	SUZUKI RYOTA
Assistant Oiler	ISHIDA MASAKAZU
Chief Steward	ONOUE TATSUNARI
Steward	HIDAKA YOSHIE
Steward	KUBOTA RYU
Steward	YAMAMOTO KOKI

3. Research/Development Activities

3.1. In situ biodegradability tests of bio-degradable plastics on the deep-sea floor

3.1.1. Objectives

The recently-uncovered marine plastic pollution has been attracting the social attention, thereby requesting the less-plastic society. For this objective, there are 2 options: 1) 100% recycling of conventional plastics or 2) development of marine-degradable plastics. Although the option 1 would be the ideal social system, there remain several high technical hurdles. Therefore, the option 2, the development of marine-degradable plastic, is the imminent task. However, the degradation of conventional biodegradable plastics such as polylactic acid (PLA) requires the "compostable" condition: the temperature must be higher than 40°C. This requirement does not match the marine environment, especially the deep-sea floor, where the temperature is only 1~4°C. And most importantly, all the biodegradable plastics are heavier than water, and thus accumulate on deep-sea floor. Hence, the development of materials that degrade under such deep-sea condition is in urgent need.

In this context, we launched a collaborative Moonshot project with Gunma University, University of Tokyo, Tokyo Institute of Technology, and RIKEN financially supported by NEDO. Herein, more than 100 types of novel bio-degradable materials developed by JAMSTEC, Gunma University, University of Tokyo, Tokyo Institute of Technology, and RIKEN will be subjected to the on-site degrading test on the deep-sea floor. In addition, to understand chemical environment of the degradation site, the chemical profiling analyzes such as dissolved oxygen, redox potential, and pH along the depth in the push core sample will be performed.

3.1.2. Methods

More than 100 types of novel bio-degradable materials (KM21-E02#149W2 and W3) were stored in the sample chamber (**Fig**). The chambers were deposited on the deep-sea floor off Hatsushima, Sagami-bay by Kaimei ROV (dive number: #149).

3.1.3. Results & findings in this cruise

The samples were deposited successfully, and the chemical profiling analyzes such as dissolved oxygen, redox potential, and pH along the depth in the push core sample was successfully performed.

3.1.4. Future plan

The sample specimen will be recovered 4 months and 10 months later. The recovered samples will be scrutinized to find out a clue for the deep-sea degradable materials. In addition, the microorganisms attaching on the plastics surface will be analyzed.

3.2. Geochemical measurements and biological analyses

3.2.1. Objectives

Geochemical conditions of the bottom water and in the sediments significantly effect on degradability of biodegradable plastics. Furthermore, compositions of both prokaryotes, eukaryotic microbes, and metazoans and their metabolic pathways/activities control the biodegradability at the deep-sea floor. We thus measured the geochemical conditions of the overlying water and surface sediments using a microelectrodes. We also collected sediments, water, debris, and megabenthos to investigate biological parameters.

3.2.2. Materials and Methods

We collected surface sediment cores (15 to 25 cm in length) using a push corer having an inner diameter of 8.2 cm. After recovery onboard, the microelectrode (oxygen, pH, and redox electrodes with reference electrodes) were inserted into overlying water and in the sediment down to approximately 2 cm. The surface sediments were further sampled for prokaryotic and eukaryotic microbes analyses.
Visible megabenthos were collected using a scoop or a suction sampler and were fixed with either EtOH, formaldehyde, or deep-frozen. Deep-sea debris were also collected with the KM-ROV to examine the microbiome of the debris surface. They were subsampled onboard and fixed with formaldehyde, deep-frozen, and some were also preserved in a refrigerator for the isolation of biodegrading microbes in the laboratory on land. For the better preservation of the deep-sea organisms, we tested a newly developed device which can freeze the samples on the bottom.

3.2.3. Onboard results and future research

The oxygen profiles showed an intense consumption of dissolve oxygen at the surface several mm in the sediments. Redox potential also changed drastically below the oxygen penetration depths. The microbial and metazoans analyses will be performed on land.

○ 4. Cruise Log

Descriptions	Weather, Wind and Sea condition
Noon Position : 35-19.2N,139-39.0E (YOKOSUKA Port, JAMSTEC)	-
Onboarded	
Scientists Meeting	
Let go all shore lines and left YOKOSUKA port for research area (SAGAMI-Bay)	
Carried out education and training for scientists	
Arrived at research area (Off-Hatsushima)	
Released XBT (35-02.7' N, 139-21.8' E)	
Noon Position : 35-00.9N,139-13.4E (SAGAMI-Bay)	**bc/WSW-5/4**
Hoisted up "KM-ROV"	
Launched "KM-ROV", then it dove and commenced her operation #Dive No.149 (Off-Hatsushima)	
"KM-ROV" landed on the sea bottom (D: 998m)	
"KM-ROV" left the sea bottom (D: 904m)	
Hoisted up "KM-ROV"	
Recovered "KM-ROV" and finished her operation	
Scientists Meeting	
Noon Position : 35-01.5N,139-07.2E (SAGAMI-Bay)	**bc/WSW-8/4**
Canceled "KM-ROV" dive due to rough sea	
Scientists Meeting	
Noon Position : 35-04.2N,139-32.6E (SAGAMI-Bay)	**bc/ESE-2/2**
Arrived at research area (Site G)	
Hoisted up "KM-ROV"	
Launched "KM-ROV", then it dove and commenced her operation #Dive No.150 (Site G)	
"KM-ROV" landed on the sea bottom (D: 758m)	
"KM-ROV" left the sea bottom (D: 742m)	
Hoisted up "KM-ROV"	
Recovered "KM-ROV" and finished her operation	
Scientists Meeting	
Sent out 1st shore line, arrived at JAMSTEC, then completed voy. No.KM21-E02	

● 5. 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.
Users of information on this report are requested to submit Publication Report to JAMSTEC.

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