



Yokosuka Cruise Report YK25-04C

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

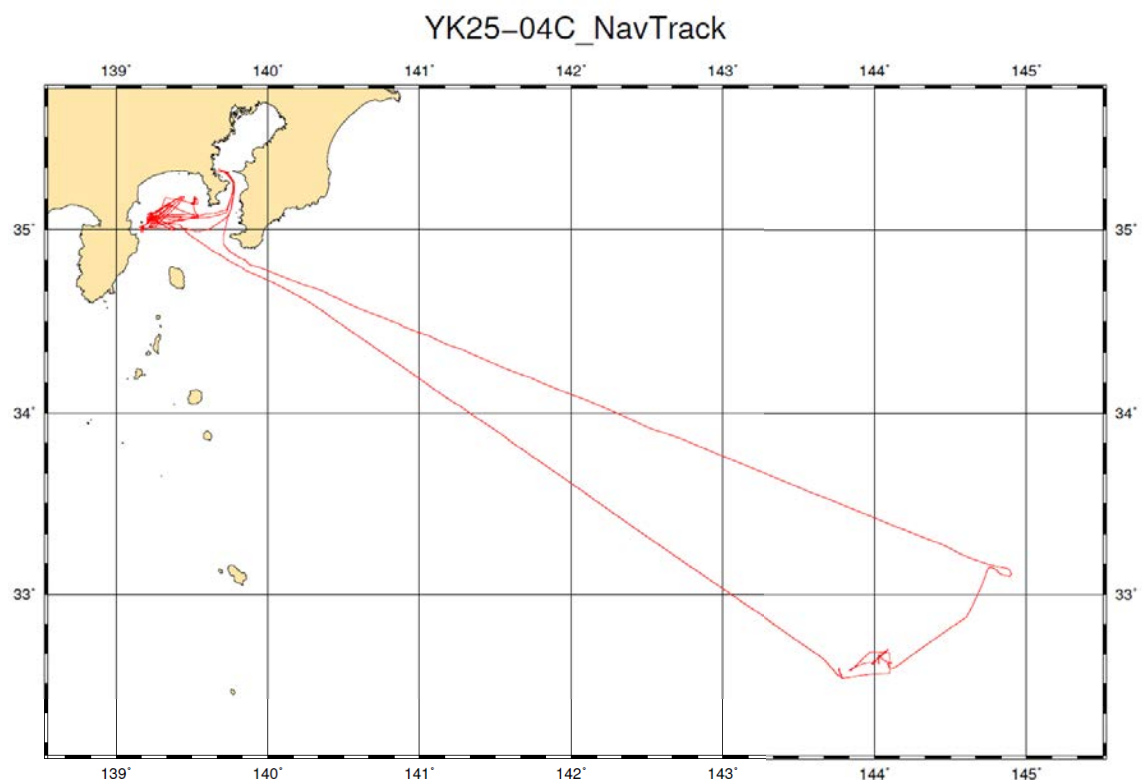
Sagami Bay, western North Pacific abyssal plain

4th April -18th April, 2025

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

1. Cruise Information

- Cruise ID
YK25-04C
- Name of vessel
RV Yokosuka
- Title of cruise:
In situ biodegradability tests on newly developed biodegradable materials and investigations on their controlling factors
- Chief Scientist [Affiliation]
Hidetaka Nomaki (JAMSTEC)
- Cruise period
4th to 18th April
- Ports of departure / call / arrival
Nissan-pier/JAMSTEC Yokosuka HQ
- Research area
Sagami Bay, western North Pacific abyssal plain
- Research map



2. Research Proposal and Science Party

- Title of proposal
In situ biodegradability 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.]
Noriyuki Isobe [JAMSTEC]
Yoshiyuki ISHITANI [JAMSTEC]
Chong CHEN [JAMSTEC]
Satoshi Okada [JAMSTEC]
Maki KAYAMORI [JAMSTEC/The University of Tokyo]
Soulethone PHOUVILAY [Gunma Univ.]
Tomoya SUZUKI [Gunma Univ.]
Qiu-Yuan HUANG [The University of Tokyo]
Zhengyu SU [The University of Tokyo]
Kotaro SHIRAI [The University of Tokyo]
Hisanori IWAMOTO [NME]
Sota SHIMURA [NME]

- Crew members
Captain NAKAMURA Yoshiyuki
Chief Officer CHIBA Masato
2nd Officer NOZAWA Tatsuya
3rd Officer MATSUDA Riku
Jr.3rd Officer OKAMOTO Hiroki
Chief Engineer GIBU Daisuke
1st Engineer SHIRAKATA Kenichi
2nd Engineer SHIMIZU Koki
3rd Engineer FURUYAMA Yuji
Jr.3rd Engineer OCHIAI Takamasa
Chief Electronic Op. KOMAKI Yosuke
2nd Electronic Op. MABARA Takayuki
BoatSwain IWASAKI Naoki
Quarter Master ISHIZUKA Nao
Quarter Master UENO Shinya
Quarter Master NAKANISHI Ryo
Quarter Master TANAKA Taisei
Sailor MATSUDA Taisei
Sailor INOUE Shinnosuke
No.1 Oiler UEDA Masanori
Oiler SATO Daiki
Assistant Oiler DANTSUKA Aoi
Assistant Oiler MATSUMURA Kota
Assistant Oiler OCHIAI Kenzo
Chief Steward ABE Takahiro
Steward SHIRAISHI Tatsuya
Steward SATO Jun
Steward TANAKA Tsugumi
Steward SATO Keito

- Shinkai 6500 operating team
Submersible Operation Manager CHIBA Kazuhiro
Deputy Submersible Operation Manager KONDO Tomoe
1st Submersible Staff UEKI Mitsuhiro
1st Submersible Staff ISHIKAWA Akihisa
1st Submersible Staff SAITO Fumitaka
1st Submersible Staff ONISHI Takuma
2nd Submersible Staff UEKI Hirofumi

2nd Submersible Staff	SUZUKI Keigo
2nd Submersible Staff	SAIGO Ryo
2nd Submersible Staff	IJIMA Satsuki
2nd Submersible Staff	SATO Kaisei
3rd Submersible Staff	EDA Tomoka

3. Research/Development Activities

3.1. *In situ* biodegradability tests of different types of novel plastics on the deep-sea floor

3.1.1. Objectives

Mismanagement of plastic wastes provoke leakage into the ocean and subsequent serious damages on marine ecosystems. Moreover, extreme weather events such as heavy rainfall and stormy wind remarkably intensifies the chances and amounts of plastic leakage into the ocean. Therefore, even under the proper management of plastic wastes, accidental releases by natural disasters such as extreme weather events and tsunamis are unavoidable. Once released into the ocean, plastic debris is assumed to remain in the marine environment for more than several hundred years. Part of them starts to sink because of their high specific weights in the seawater or increasing negative buoyancy due to biofouling or attachments of sediment particles. Eventually, the deep-sea floor that covers over 60% of the Earth's surface is a potential sink for plastic debris and our earlier observations confirmed the accumulation of single-use plastics even deeper than 5,000 m of water depth. To circumvent undesired accumulations of single-use plastics on the deep-sea floor, the conventional single-use plastics need to be replaced with the materials that can degrade on the deep-sea floor, such as biodegradable plastic. 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, i.e. low temperature, high water pressure, no sunlight penetration, and low biological activity, is still unclear. Hence, the development of materials that degrade under such deep-sea condition is in urgent need.

In this context, we are conducting a collaborative Moonshot project with Gunma University, University of Tokyo, Institute of Science Tokyo, and RIKEN financially supported by New Energy and Industrial Technology Development Organization (NEDO). Herein, more than 100 types of novel bio-degradable materials developed by above mentioned research institutes and universities as well as collaborating private companies are subjected to the *in situ* degradation tests on the deep-sea floor.

3.1.2. Methods

Sample chamber that contains more than 100 types of novel bio-degradable materials have been deployed on the deep-sea floor off Hatsushima, off Misaki of Sagami Bay, and west of KEO. The biodegradable plastic chambers deployed at Myojin-Knoll had already been recovered. We recovered some materials that have been deployed during the previous cruises and examine the degradation state of them. We also collected "natural" plastic debris, sediment, seawater, and organisms.

3.1.3. Results & findings in this cruise

The samples were deployed/recovered successfully, and the physicochemical measurements were performed using seawater and sediment samples. Plastic debris, sunken plants, and organism samples were collected and processed for subsequent analyses.

3.1.4. Future plan

The deployed samples will be recovered a year later or longer, partly depending on the

cruise schedule in the future. 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 deep-sea water and in the sediments significantly effect on degradability of biodegradable plastics. Furthermore, compositions of prokaryotes, eukaryotic microbes, and metazoans and their metabolic pathways/activities control the biodegradability on the deep-sea floor. We thus measured the geochemical conditions of the seawater and porewater in sediments using several different analytical methods. We also collected sediments, water, debris, and megabenthos to investigate biological parameters.

3.2.2. Materials and Methods

We collected seawater and sediment cores using a water sampler and push corer. After recovery onboard, seawater samples were further sub-sampled for different geochemical analyses. The surface sediments were further sampled for prokaryotic and eukaryotic microbial 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 *Shinkai6500* to examine the microbiome and their novel enzyme 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.

3.2.3. Onboard results and future research

Onboard preliminary analyses of chemical parameters of water showed unique characteristics depending on geological and oceanographic settings. The microbial and metazoans analyses will be performed on land.

3.3. Recovery of KEO buoy deployed by NOAA

3.3.1. Objectives

While many plastic debris sunk down to the water column and/or to the deep-sea floor, they are floating on the oceanic surface for certain period, particularly for low density plastics such as PE. Furthermore, some specific plastics are known to float for years. It is therefore important to test the biodegradability of novel materials at the oceanic surface, which have contrasting environmental conditions to that of deep-sea; sunlight radiation vs no sunlight penetration, warm temperature vs low temperature, atmospheric pressure to high pressure, and high organism biomass vs low biomass, at oceanic surface and at deep-sea, respectively.

We have deployed our biodegradable plastic samples onto the surface mooring buoy owned by NOAA in November 2024, together with NOAA collaborators.

3.3.2. Materials and Methods

The buoy was found at 21:00JST on 11th April based on the position information provided by NOAA colleagues. The recovery mission started in the morning of 12th and succeeded to recover the buoy at 10:40 (33d06.72N, 144d54.07E), using a motor boat and A-frame crane of the *RV Yokosuka*.

3.3.3. Onboard results and future research

The recovered biodegradable plastic sample chamber was covered by barnacles. Those organisms were removed manually and the biodegradable plastic samples were removed from the chamber. The samples were processed as same way as deep-sea test samples onboard and

will be served for further analyses including metaomics.

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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