



Yokosuka Cruise Report YK23-18C

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

Sagami Bay, Izu-Ogasawara arc, western North Pacific
abyssal plain

19th Oct - 5th Nov, 2023

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

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1. Cruise Information

- Cruise ID

YK23-18C

- Name of vessel

Yokosuka

- Title of project

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

- Title of cruise

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

- Chief Scientist [Affiliation]

Hidetaka Nomaki [JAMSTEC]/Yuriko Nagano [JAMSTEC]

- Cruise period

19th Oct to 5th Nov, 2023

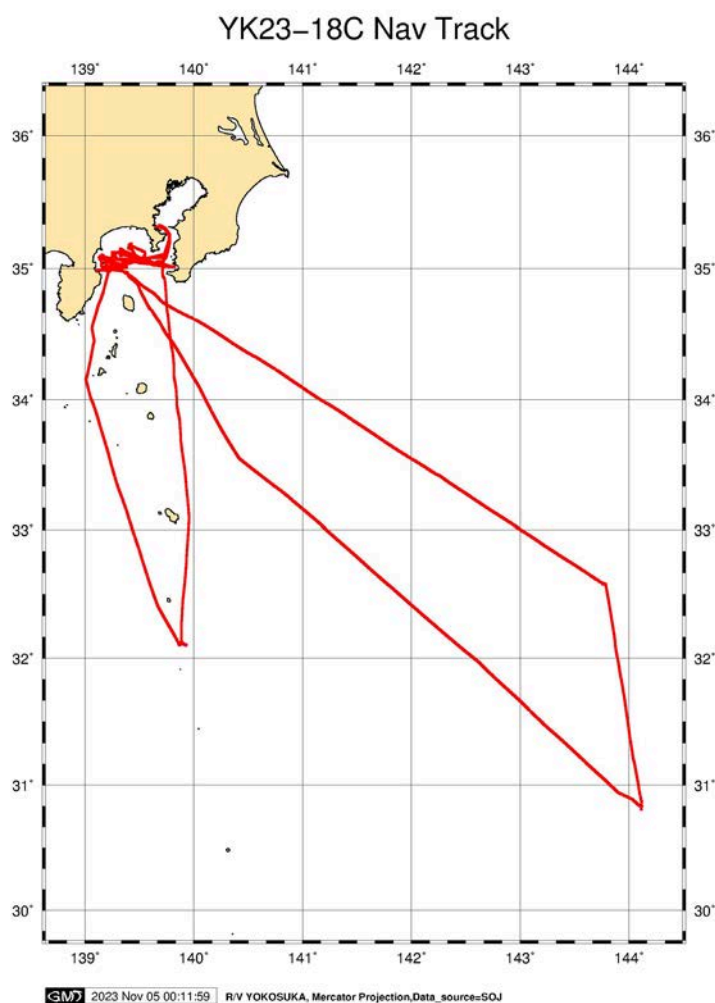
- Ports of departure / call / arrival

Yokosuka/Yokosuka No.4 Area/Yokosuka

- Research area

Sagami Bay, Izu-Ogasawara arc, 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 NOMAKI¹ [Japan Agency for Marine-Earth Science and Technology]

- Science Party (List) [Affiliation, assignment etc.]

Yuriko NAGANO ²	[JAMSTEC]
Yoshiyuki ISHITANI ¹	[JAMSTEC]
Satoshi OKADA ¹	[JAMSTEC]
Yuto FUKUYAMA ¹	[JAMSTEC]
Tetsuro IKUTA ¹	[JAMSTEC]
Yuuka INAGAKI ¹	[JAMSTEC]
Ayuu YUASA ¹	[JAMSTEC]
Noriyuki ISOBE ²	[JAMSTEC]
Ryota NAKAJIMA ²	[JAMSTEC]
Keiko TANAKA ²	[JAMSTEC]
Sachiko KAWADA ²	[JAMSTEC]
Miwa SUZUKI ¹	[Gunma Univ.]
Tomoya SUZUKI ¹	[Gunma Univ.]
Tadahisa IWATA ²	[The University of Tokyo]
Jobu TATEIWA ²	[The University of Tokyo]
Manikandan Ilangoan ²	[The University of Tokyo]
Yuya FUKATA ²	[The University of Tokyo]
Toshiaki Fukui ²	[TITEC]
Satomi OGAWA	[NME]
Wataru TOKUNAGA	[NME]

1: 10/19-11/1

2: 11/1-11/5

YOKOSUKA Crew List

Captain	Takafumi AOKI
Chief Officer	Hiroyuki KATO
2nd Officer	Tatsumi DEGUCHI
3rd Officer	Riku MATSUDA
Jr.3rd Officer	Shun ITO
Chief Engineer	Takashi OTA
1st Engineer	Shinichi IKUTA
2nd Engineer	Kota FUJII
3rd Engineer	Yusuke TOMIYAMA
Jr.3rd Engineer	Akinori TERAOKA
Chief Electronic Op.	Masamoto TAKAHASHI
2nd Electronic Op.	Ryosuke MATSUI
Boatswain	Hideo ISOBE
Quarter Master	Hiroaki NAGAI
Quarter Master	Kenji NAKAE
Quarter Master	Shinya KOJIMA
Sailor	Ryo NAKANISHI
Sailor	Taisei MATSUDA
Sailor	Shinnosuke INOUE

No.1 Oiler	Junji MORI
Oiler	Ryota SUZUKI
Oiler	Toru HIDAKA
Assistant Oiler	Haruki MATSUMOTO
Assistant Oiler	Kota MATSUMURA
Chief Steward	Kiyotaka KOSUJI
Steward	Tsuyoshi NAGATOMO
Steward	Seiji HONDA
Steward	Kina ABE
Steward	Tsugumi TANAKA

“SHINKAI 6500” Operation Team

Submersible Operation Manager	Keita MATSUMOTO
Deputy Submersible Operation Manager	Tomoe KONDO
1st Submersible Staff	Mitsuhiro UEKI
1st Submersible Staff	Akihisa ISHIKAWA
1st Submersible Staff	Fumitaka SAITO
2nd Submersible Staff	Keigo SUZUKI
2nd Submersible Staff	Takuma ONISHI
2nd Submersible Staff	Yoshikazu KURAMOTO
2nd Submersible Staff	Satsuki IIJIMA
3rd Submersible Staff	Motohiro MATSUSAKA
3rd Submersible Staff	Kaisei SATO
3rd Submersible Staff	Daiki ICHINOSE

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 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 above mentioned research institutes and universities as well as collaborating private companies are subjected to the *in situ* degrading test on the deep-sea floor.

3.1.2. Methods

More than 100 types of novel bio-degradable materials were stored in the sample chamber. The chambers have been deployed on the deep-sea floor off Hatsushima and off Misaki of Sagami Bay, and west of KEO. We recovered some materials that have been deployed in the previous cruises and examine the degradation state of them. We recovered ¹³C-labeled biodegradable materials which had been deployed on the seafloor in two different ways to monitor mineralization of the material. 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 6 months or 1 to 3 years 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 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 overlying water and surface sediments using several different sensors. We also collected sediments, water, debris, and megabenthos to investigate biological parameters.

3.2.2. Materials and Methods

We collected surface sediment cores using a push corer. After recovery onboard, microelectrodes or/and or pH and redox sensors were inserted into overlying water and into the sediment. The surface sediments were further sampled for prokaryotic and eukaryotic microbial analyses. In some oligotrophic area, we also used an optode oxygen sensor to measure oxygen concentration of the deeper sediment layers. 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

The oxygen profiles at abyssal sites showed slower consumption of dissolve oxygen at the surface in comparison to upper bathyal sediments. The microbial and metazoans analyses will be performed on land.

○ 4. Cruise Log

日付 Date	時間 Local Time	内容 Note	特記事項 Description	本船位置／気象／海象 Position/Weather/Wind/Sea condition
19-Oct-23	09:00	Scientists onboarded.		12:00 (UTC+9h)
	10:00	Let go all share line and left YOKOSUKA for research area.		Off South of Johgashima
	10:30-11:10	Carried out education and training for scientists.		35-04.3N, 139-32.4E
	11:10-11:30	Scientists meeting.		Fine but Cloudy
	12:15	Arrived at research area.		SSW-5 (Fresh breeze)
	12:30-13:00	Scientists meeting.		3 (Sea Slight)
	13:15-13:45	Practiced fite,water proof and life boat station drill.		2 (Low Swell Slong)
	13:45-15:00	SHINKAI 6500 team and Scientists team meeting and 6K briefing.		Visibly: 8'
	14:10	Released XBT.		
	18:50-19:00	Scientists meeting.		
20-Oct-23	08:47	Hoisted up "SHINKAI6500".		12:00 (UTC+9h)
	08:55	Launched "SHINKAI6500".		Off Misaki
	09:02	"SHINKAI6500" dove, and started her operation dive No.1734.		35-04.4N, 139-32.7E
	09:39	"SHINKAI6500" landed the sea bottom.	D=762m	Fine but Cloudy
	11:40	"SHINKAI6500" left the sea bottom.	D=749m	SW-7 (Near gale)
	11:59	Refloated "SHINKAI6500".		4 (Sea Moderate)
	12:45	Recovered "SHINKAI6500",and finished above operation.		2 (Low Swell Slong)
	15:10	Let go anchor off Ito-ko port.		Visibly: 8'
	18:50-19:15	Scientists meeting.		
21-Oct-23	07:50	Heave anchor, proceeded to research area.		12:00 (UTC+9h)
	09:51	Hoisted up "SHINKAI6500".		Off Hatsushima
	09:58	Launched "SHINKAI6500".		35-00.0N, 139-13.4E
	10:06	"SHINKAI6500" dove, and started her operation dive No.1735.		Fine but Cloudy
	10:46	"SHINKAI6500" landed the sea bottom.	D=1,192m	NE-3 (Gentle breeze)
	15:05	"SHINKAI6500" left the sea bottom.	D=1,049m	2 (Sea Smooth)
	15:28	Refloated "SHINKAI6500"		2 (Low Swell Slong)
	15:57	Recovered "SHINKAI6500",and finished above operation.		Visibly: 8'
	18:50-19:15	Scientists meeting.		
22-Oct-23	05:30	Proceeded to next research area.		12:00 (UTC+9h)
	08:30-09:30	Carried out 6K briefing.		Off Southeast of Boso
	18:00-18:15	Scientists meeting.		34-13.9N, 140-44.7E
				Fine but Cloudy

				NE-4 (Moderate breeze)
				3 (Sea Slight)
				3 (Moderate Short)
				Visibly: 8'
23-Oct-23	05:50	Arrived at research area.		12:00 (UTC+9h)
	05:57	Released XBT.		West of KEO
	08:45	Hoisted up "SHINKAI6500".		32-34.9N, 143-46.0E
	08:51	Launched "SHINKAI6500".		Fine but Cloudy
	08:58	"SHINKAI6500" dove, and started her operation dive No.1736.		East-4 (Moderate breeze)
	11:26	"SHINKAI6500" landed the sea bottom.	D=5,504m	3 (Sea Slight)
	13:50	"SHINKAI6500" left the sea bottom.	D=5,502m	3 (Moderate Short)
	15:51	Refloated "SHINKAI6500"		Visibly: 8'
	16:17	Recovered "SHINKAI6500",and finished above operation.		
	17:00	Proceeded to next research area.		
	19:00-19:15	Scientists meeting.		
24-Oct-23	05:40	Arrived at research area.		12:00 (UTC+9h)
	05:44	Released XBT.		30N around (31N site)
	06:07-06:29	Carried out MBES site survey		30-50.0N, 144-06.8E
	08:45	Hoisted up "SHINKAI6500".		Fine but Cloudy
	08:52	Launched "SHINKAI6500".		NW-1 (Light air)
	08:59	"SHINKAI6500" dove, and started her operation dive No.1737.		2 (Sea Smooth)
	11:39	"SHINKAI6500" landed the sea bottom.	D=5,897m	2 (Low Swell Slong)
	13:45	"SHINKAI6500" left the sea bottom.	D=5,898m	Visibly: 8'
	15:53	Refloated "SHINKAI6500"		
	16:18	Recovered "SHINKAI6500",and finished above operation.		
	17:00	Proceeded to next research area.		
	19:00-19:15	Scientists meeting.		
25-Oct-23	10:00	Tour of the "SHINKAI6500"		12:00 (UTC+9h)
	18:00-18:15	Scientists meeting.		Off Northeast of Hachijojima
	19:45	Arrived at research area.		33-27.6N, 140-33.4E
				Fine but Cloudy
				West-2 (Light breeze)
				2 (Sea Smooth)
				1 (Low Swell Short)
				Visibly: 8'
26-Oct-23	07:00	Arrived at dive point.		12:00 (UTC+9h)
	09:46	Hoisted up "SHINKAI6500".		Off Hatsushima
	09:53	Launched "SHINKAI6500".		35-00.8N, 139-13.4E
	10:00	"SHINKAI6500" dove, and started		Fine but Cloudy

		her operation dive No.1738.		
	10:37	"SHINKAI6500" landed the sea bottom.	D=1,104m	ENE-3 (Gentle breeze)
	15:45	"SHINKAI6500" left the sea bottom.	D=742m	2 (Sea Smooth)
	16:02	Refloated "SHINKAI6500"		1 (Low Swell Short)
	16:31	Recovered "SHINKAI6500",and finished above operation.		Visibly: 8'
	19:00-19:15	Scientists meeting.		
27-Oct-23	06:30	Arrived at dive point.		12:00 (UTC+9h)
	09:48	Hoisted up "SHINKAI6500".		Off Misaki
	09:55	Launched "SHINKAI6500".		35-04.1N, 139-32.6E
	10:02	"SHINKAI6500" dove, and started her operation dive No.1739.		Fine but Cloudy
	10:40	"SHINKAI6500" landed the sea bottom.	D=760m	Calm
	14:27	"SHINKAI6500" left the sea bottom.	D=765m	1 (Sea Calm Rippled)
	14:45	Refloated "SHINKAI6500"		1 (Low Swell Short)
	15:10	Recovered "SHINKAI6500",and finished above operation.		Visibly: 8'
	17:20	Let go anchor off Ito-ko port.		
	19:00-19:15	Scientists meeting.		
28-Oct-23	07:00	Heave anchor, proceeded to research area.		12:00 (UTC+9h)
	09:46	Hoisted up "SHINKAI6500".		Central Sagami-wan bay
	09:53	Launched "SHINKAI6500".		35-00.7N, 139-22.6E
	10:01	"SHINKAI6500" dove, and started her operation dive No.1740.		Fine but Cloudy
	10:50	"SHINKAI6500" landed the sea bottom.	D=1,396m	NE-2 (Light breeze)
	15:30	"SHINKAI6500" left the sea bottom.	D=1,390m	2 (Sea Smooth)
	16:03	Refloated "SHINKAI6500"		1 (Low Swell Short)
	16:29	Recovered "SHINKAI6500",and finished above operation.		Visibly: 8'
	19:00-19:20	Scientists meeting.		
29-Oct-23	11:00	Proceeded to off Tateyama		12:00 (UTC+9h)
	13:45	Let go anchor off Tateyama.		Off Southwest of Johgashima
	18:00-18:10	Scientists meeting.		35-03.2N, 139-26.4E
				Fine but Cloudy
				NNE-5 (Fresh breeze)
				3 (Sea Slight)
				1 (Low Swell Short)
				Visibly: 8'
30-Oct-23	06:55	Heave anchor, proceeded to research area.		12:00 (UTC+9h)
	08:15	Arrived at research area.		Off Misaki

	09:58	"SHINKAI 6500" dove & started her operation No.1741.		35-04.0N, 139-31.7E
	10:33	"SHINKAI6500" landed the sea bottom.	D=799m	Blue sky
	15:15	"SHINKAI6500" left the sea bottom.	D=711m	NE-3 (Gentle breeze)
	15:31	Refloated "SHINKAI 6500".		2 (Sea Smooth)
	15:59	Recovered "SHINKAI 6500" & Finished above operation.		1 (Low Swell Short)
	19:00-19:20	Scientists meeting.		Visibly: 8'
31-Oct-23	07:00	Proceeded to Yokosuka No.4.		12:00 (UTC+9h)
	10:10	Let go anchor Yokosuka No.4.		Yokosuka No.4
	18:00-18:10	Scientists meeting.		35-19.6N, 139-41.0E
				Overcast
				NNE-2 (Light breeze)
				1 (Sea Calm Rippled)
				1 (Low Swell Short)
				Visibly: 8'
01-Nov-23	09:50	Nine scientists disembarked by boat.		12:00 (UTC+9h)
	10:25	Ten scientists embarked by boat.		Off Northwest of Susaki
	10:35	Heave anchor, proceeded to research area.		35-04.8N, 139-43.6E
	11:00-11:30	Carried out education and training for scientists.		Fine but Cloudy
	13:10-14:00	SHINKAI 6500 team and Scientists team meeting and 6K briefing.		North-3 (Gentle breeze)
	17:30-17:45	Scientists meeting.		2 (Sea Smooth)
				1 (Low Swell Short)
				Visibly: 7'
02-Nov-23	00:30	Arrived at reserch area.		12:00 (UTC+9h)
	06:50	Released XBT.		Myojin knoll
	09:49	Hoisted up "SHINKAI 6500".		32-06.3N, 139-52.2E
	09:56	Launched "SHINKAI 6500".		Fine but Cloudy
	10:04	"SHINKAI 6500" dove & started her operation No.1742.		West-3 (Gentle breeze)
	10:53	"SHINKAI6500" landed the sea bottom.	D=1,365m	2 (Sea Smooth)
	14:58	"SHINKAI6500" left the sea bottom.	D=1,210m	2 (Low Swell Slong)
	15:27	Refloated "SHINKAI 6500".		Visibly: 8'
	15:53	Recovered "SHINKAI 6500" & Finished above operation.		
	17:00	Proceeded to next research area.		
	18:00-18:15	Scientists meeting.		
03-Nov-23	04:15	Arrived at research area.		12:00 (UTC+9h)

	09:44	Hoisted up "SHINKAI 6500".		Off Hatsushima
	09:50	Launched "SHINKAI 6500".		35-01.0N, 139-13.3E
	09:57	"SHINKAI 6500" dove & started her operation No.1743.		Blue sky
	10:35	"SHINKAI6500" landed the sea bottom.	D=1,111m	SE-2 (Light breeze)
	15:11	"SHINKAI6500" left the sea bottom.	D=747m	2 (Sea Smooth)
	15:28	Refloated "SHINKAI 6500".		1 (Low Swell Short)
	15:54	Recovered "SHINKAI 6500" & Finished above operation.		Visibly: 8'
	18:00-18:15	Scientists meeting.		
04-Nov-23	06:30	Arrived at dive point.		12:00 (UTC+9h)
	09:43	Hoisted up "SHINKAI 6500".		Off Misaki
	09:50	Launched "SHINKAI 6500".		35-04.3N, 139-32.6E
	09:57	"SHINKAI 6500" dove & started her operation No.1744.		Blue sky
	10:29	"SHINKAI6500" landed the sea bottom.	D=755m	SW-5 (Fresh breeze)
	15:15	"SHINKAI6500" left the sea bottom.	D=734m	3 (Sea Slight)
	15:32	Refloated "SHINKAI 6500".		1 (Low Swell Short)
	15:56	Recovered "SHINKAI 6500" & Finished above operation.		Visibly: 8'
	18:00-18:15	Scientists meeting.		
05-Nov-23	07:00	Proceeded to Yokosuka No.4.		
	10:00	Let go anchor Yokosuka No.4.		
	14:00	All scientists disembarked by boat. Finished YK23-18C cruise.		

● 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.
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