

Shinsei-maru Cruise Report
KS-24-15

Understanding the status of marine plastic pollution in the
Sea of Japan

Yamato Basin, Sea of Japan

August 4th-17th, 2024

Joint Usage/Research Center for Atmosphere
and Ocean Science (JURCAOS)

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

Acknowledgements

We thank Captain T. Aoki, the crew of the R/V *Shinseimaru*, ROV *Hyper Dolphin* Operator Manager T. Kido, and the *Hyper Dolphin* team for organizing the cruise and sampling. We also thank marine technicians from Nippon Marine Enterprises (NME) for research support and ground staff from Japan Agency for Marine-Earth Science and Technology (JAMSTEC) for all the procedures to make this cruise possible.



A group photo of the on-board members KS-24-15

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1. Cruise Information

Cruise ID: KS-24-15

Name of vessel: R/V Shinseimaru

Title of project/cruise: Understanding the status of marine plastic pollution in the Sea of Japan

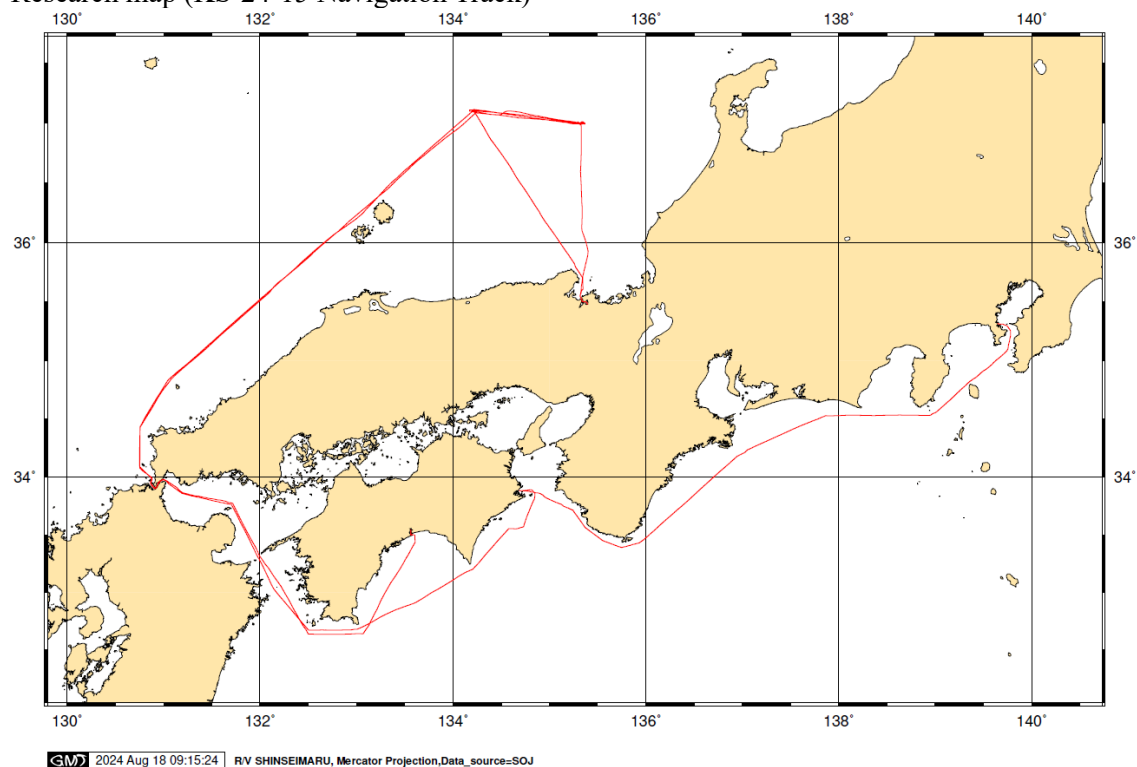
Chief Scientist: Tomoko Takahashi [JAMSTEC]

Cruise period: 4th August to 17th August, 2024

Ports of departure/port of call/arrival: Kouchi No. 1/Maizuru Meshima No.1/JAMSTEC

Research area: Yamato Basin, Sea of Japan

Research map (KS-24-15 Navigation Track)



2. Science Party

Title of proposal

Understanding the status of marine plastic pollution in the Sea of Japan

Representative of Science Party [Affiliation]

Tomoko Takahashi [Japan Agency for Marine-Earth Science and Technology]

Science Party and affiliation

Chief Scientists	TAKAHASHI TOMOKO Japan Agency for Marine-Earth Science and Technology
Scientist	NAKAJIMA RYOTA Japan Agency for Marine-Earth Science and Technology
Scientist	NISHIO TAKAKI Japan Agency for Marine-Earth Science and Technology
Scientist	YANAGIHARA AYARI Kumamoto University
Scientist	TAKEMOTO KENTO The University of Tokyo
TV crew	IKEDA SYUHEI NHK
TV crew	OGURA TAKAYUKI NHK
Marine Technician	OGAWA SATOMI Nippon Marine Enterprise Ltd.

Crew

Captain	AOKI TAKAFUMI
Chief Officer	EGASHIRA TAKESHI
2nd Officer	NOZAWA TATSUYA
3rd Officer	MATSUDA RIKU
Jr.3rd Officer	OKAMOTO HIROKI
Chief Engineer	ABE TADASHI
1st Engineer	YASUE YOICHI
2nd Engineer	HIRATSUKA YOSHINOBU
3rd Engineer	TERAKAWA AKINORI
Chief Electronics Op.	TAKAHASHI MASAMOTO
2nd Electronics Op.	TAKI MISATO
Boat Swain	YOSHINO YUKI
Able Seaman	FUJII TATSUO
Able Seaman	KAWAMURA KOSEI
Able Seaman	KURIHARA AKIRA
Able Seaman	OHJIRI YUTA
Sailor	NAKANO MIZUKI
No.1 Oiler	MORI JUNJI
Oiler	SATO RYO
Assistant Oiler	ISHIDA MASAKAZU
Assistant Oiler	ONO YUTARO
Assistant Oiler	AKIYOSHI YUTA
Chief Steward	HIRAYAMA KAZUHIRO
Steward	SATO JUN
Steward	SHINOHARA KOKI

Hyper-Dolphin operating team

ROV Operation Manager	KIDO TEPPEI
2 nd ROV Operator	IHARA SHOTA
2 nd ROV Operator	SAKAKIBARA YUDAI
2 nd ROV Operator	YAMAGUCHI TAIKEN
2 nd ROV Operator	ASANO WATARU
3 rd ROV Operator	NAKANISHI YOTARO

3. Research Activities

3.1. Overall objectives and sampling sites

3.1.1. Objectives

The contamination of marine ecosystems by marine debris, including microplastics, raises concerns globally, prompting nations to assess pollution levels and implement preventive measures. In particular, the deep-sea floor is considered as the final sink for marine debris, making the understanding of its distribution there significantly importance. This research aims to elucidate the distribution and ecological impacts of debris accumulated on the deep-sea floor in the Sea of Japan, an area near Japan expected to have high concentrations of debris.

Debris from major emission areas, including China, as well as debris transported by the Kuroshio Current from the southern regions of Japan, enters the Sea of Japan via the Tsushima Warm Current. According to our model estimates, most of the floating debris entering the Sea of Japan remains for about six months in the southern area of the Sea of Japan, Yamato Basin, thereafter flowing into the Pacific Ocean mainly through the Tsugaru Strait. The Yamato Basin, likely to contain depressions, retains sunken debris, potentially creating localized accumulations.

The aim of this study was to investigate the deep-sea floor of the Yamato Basin in the Sea of Japan, where significant debris accumulation is expected, in order to (1) clarify the distribution of marine debris, including microplastics, and (2) understand the impacts on the ecosystem through the study of chemical pollution derived from plastics.

3.1.2. Sampling sites

The observation of benthic plastic debris on the deep seafloor was conducted at two sites in the Yamato Basin (Sts. 5 and 7) (Table 3.1.).

Table 3.1. Survey sites in the cruise YS-24-15.

Site	Site name	Depth (m)	Latitude	Longitude
St. 7 (Dive #2246)	Yamato Basin	2205	37°06.300'N	134° 12.500'E
St. 5 (Dive#2247)	Yamato Basin	1738	37°00.000'N	135° 20.000'E
St. 7 (Dive#2248)	Yamato Basin	2200	37°05.760'N	134° 12.500'E
St. 5 (Dive#2249)	Yamato Basin	1738	36°59.600'N	135° 20.000'E
St. 7 (Dive#2250)	Yamato Basin	2215	37°06.800'N	134° 12.500'E

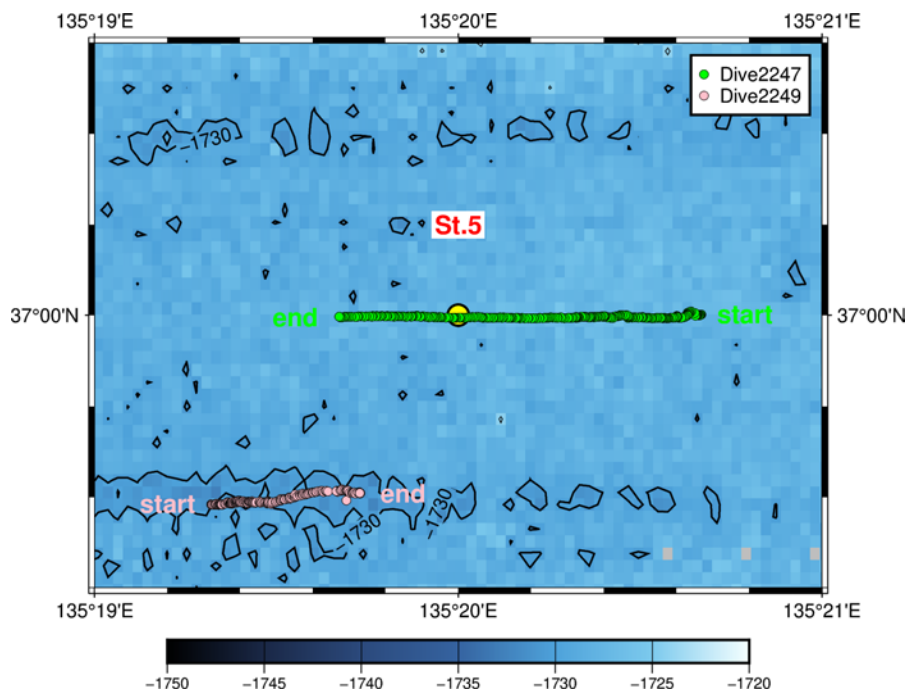
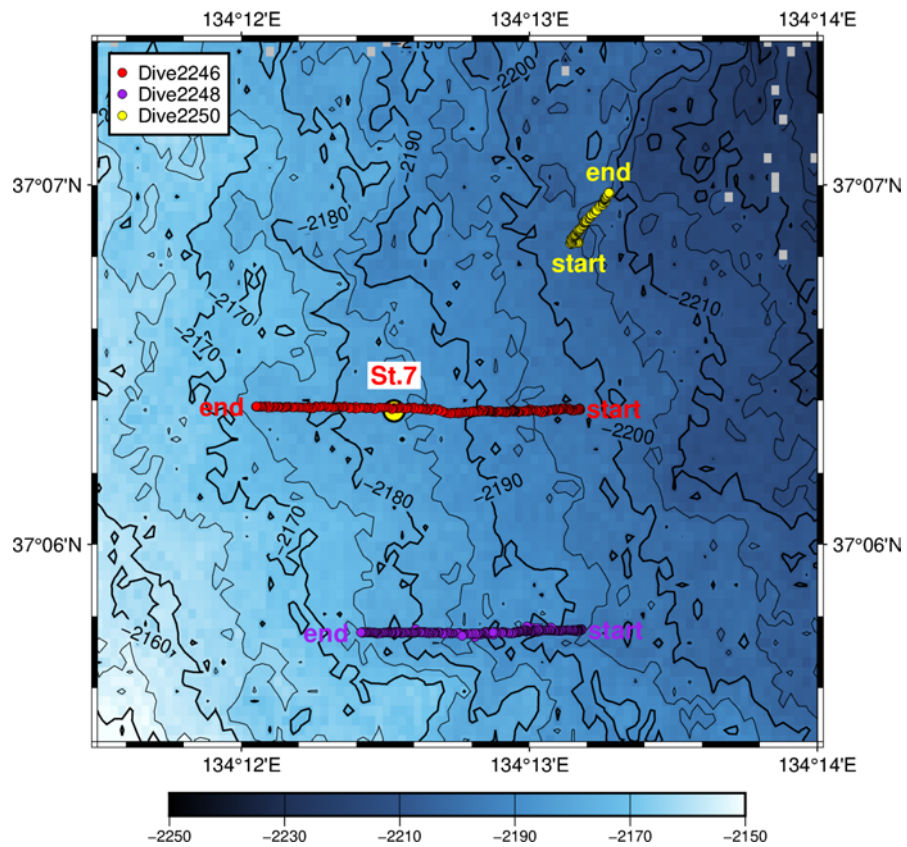


Fig. 3.1-2 Dive trajectory of ROV *Hyper Dolphin*.

3.2. Distribution of benthic macrodebris, microplastics and associated pollutants

3.2.1. Objectives

We examined the observation and collection of macrodebris and microplastics on the seafloor in the Yamato Basin to understand the distribution, numerical density, and volume of the plastic debris both macro- and microplastics. We also aimed to quantify the chemical additives associated with benthic debris.

3.2.2. Methods

Seafloor observations were carried out using JAMSTEC's remotely-operated vehicle (ROV) *Hyper Dolphin*. During ROV operations, video data were recorded with a forward-facing HD fixed video camera. The 3D mapping video camera was also deployed as shown in Fig. 3.2-1. The 3D camera has synchronized two cameras and can reconstruct 3D images through post-processing. During the observations, debris of both natural and man-made origin were collected whenever possible using either manipulators or a suction sampler. Retrieved plastic debris were photographed on board. A portion of the debris was sub-sampled for further analysis of polymer type and associated chemicals. In addition, sediment samples were collected for microplastic and associated chemicals by the H-type push corers (covering 52.8 cm² seafloor surface area) at Sts. 5 and 7 during the dive #2246 and #2247. We used aluminum-made tubes to prevent plastic contamination.

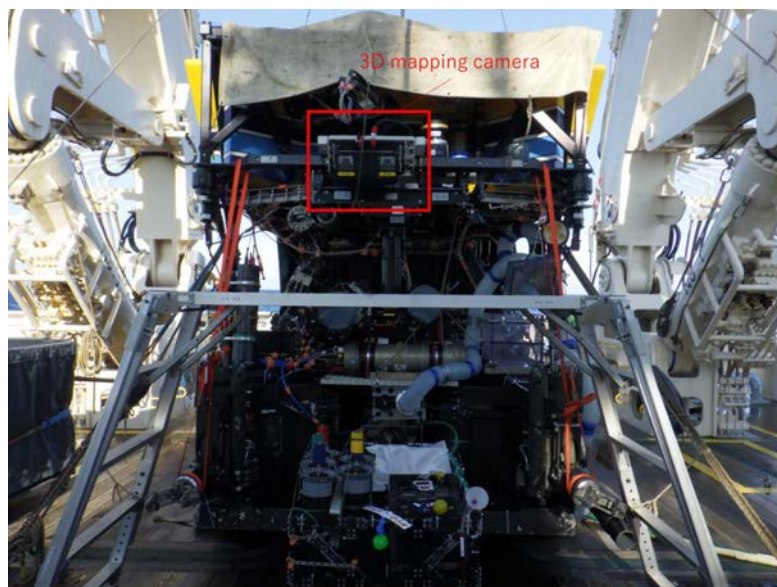


Fig. 3.2-1 3D mapping camera

3.2.3. Onboard results

Film-like fragments were common plastic debris observed during the dives. The production time could be estimated for some of the collected plastic debris, and it varied from recent to over 50 years old. The seafloor video images were taken during all dives using the 3D mapping camera. During the dive #2246 and 2247, three sediment cores were collected for microplastics analysis and one core for chemical analysis. The top 1 cm of the cores for microplastic analysis were collected and stored frozen until analysis. The sediment core sample for the chimerical analysis was sliced every 1 cm down to 15 cm of the core on board and stored frozen until analysis.

3.2.4. Future plan

The videos from the HD camera will be played onshore and all items of debris, both natural and man-made objects, will be identified through video analysis for the entirety of each dive. The obtained data will be submitted to JAMSTEC's Data Management Group (DMG). The 3D mapping camera images will be used for the number density ($\#/m^2$) and volume analysis of the debris. Sediment samples for microplastic analysis will be analyzed under a μ FTIR.

3.3. RamaCam

3.3.1. Objectives

Suspended bio-organic particles in the ocean are important for understanding ocean nutrient cycles, while microplastics, which are also floating in the ocean with a similar size to bio-organic particles, cause serious pollution on a global scale. However, very little is known about suspended and sinking particles particularly in the deep ocean due to their extremely low abundance, and currently with most knowledge based on pointwise measurements from sediment traps with accumulated information over long time periods.

During the cruise, a novel device for identification of suspended particles, "RamaCam", as shown in Fig. 3.3-1, was deployed in the deep ocean and in situ particle measurements were performed.

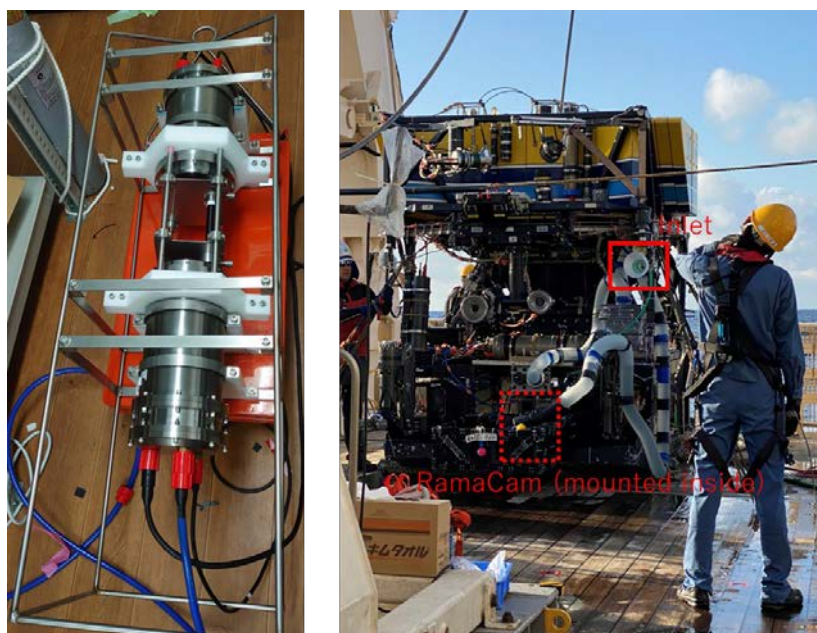


Fig. 3.3-1 (Left) RamaCam and (Right) RamaCam mounted on the ROV *Hyper Dolphin*

3.3.2. Methods

The RamaCam can analyse a particle trapped in a 20 cm water channel by holography and Raman spectroscopy simultaneously/successively. By complementary combining morphological information from holography and chemical composition from Raman spectroscopy, accurate particle identification and classification is possible. During this cruise, the RamaCam was mounted on the ROV *Hyper Dolphin* and semi-automatic continuous measurements of floating particles were performed.

3.3.3. Onboard results

Particles were successfully detected by real-time holographic image capturing. As not many

particles were trapped in the chamber due to too fast flow speed and unstable detection algorithm during our previous test during KM24-03, the system was improved and the number of trapped particles significantly increased during the cruise. In addition, the quality of holographic images was improved by redesigning the optical setup. For some particles, Raman peaks were detected.

3.3.4. Future plan

The detected Raman peaks will be identified using the standard samples/references. Holographic images and Raman spectrum taken for collected samples will be used for supervised machine learning algorithms for classification and identification of particle types. Based on the data of particle types and density collected during this cruise, parameters for the RamaCam, such as flow rate, shutter speed of the holographic camera, integration time of Raman measurements, will be improved. In our future works, the RamaCam will be improved for the full-autonomous system which enables standalone operations.

3.4. Real-time detection of macro plastic debris using AI

3.4.1. Objectives

Macro-sized benthic debris can be observed using the ROV's camera, but since the observation is done manually, it is needed to be automated detection for wide-area survey.

During the cruise, an AI that automatically detects benthic debris from images captured by the ROV's camera is tested in real time.

3.4.2. Materials and Methods

Training dataset was created from videos of plastic bags and other debris obtained during JAMSTEC's past deep-sea surveys, and an AI model (Convolutional Neural Network) was trained using the dataset. Images from Hyper Dolphin were transferred to an onboard PC, and the accuracy of the trained AI model in detecting benthic debris was verified.

3.4.3. Onboard results

The system of real-time detection was successfully worked. However, in the first deep-sea survey, there were many cases where jellyfish carcasses and parts of the ROV were mistakenly detected as artificial debris. To solve this problem, false positive images were collected and the AI was re-trained. After the re-training, the AI became possible to correctly distinguish debris and others. In addition, by adding various image data such as debris buried on the seafloor, debris noised by marine snow, and sea anemones attached debris, the accuracy of debris detection was improved. Examples of the detection result are shown in Figure 3.5-1.

Furthermore, images were collected by changing the shooting angle of ROV's camera and the brightness of the ROV's spotlight, to consider the shooting conditions suitable for benthic debris detection using AI.



Fig. 3.4-1. Examples of the detection result.

3.4.4. Future plan

To further improve the detection accuracy of the AI, the images obtained in this survey will be analyzed in detail, training data will be created. In addition, based on the results of this verification, shooting conditions suitable for automatic detection by the AI will be determined.

○ 4. Cruise Log

Date	Local Time	Note	Description	Position/Weather/Wind/Sea condition
04-Aug-24	12:30	Scientists onboarded.		Kochi Port
	13:30	Let go all share line and left KOCHI for research area.		33°32.5N, 133°33.6E
	14:30-15:10	Carried out education and training for scientists.		Fine but Cloudy
	18:00	Scientists meeting.		South-3 (Gentle breeze) 1 (Sea Calm Rippled) 0 (No Swell) Visibly: 8'
05-Aug-24		Leave for research area.		Off Mojisaki
				33°57.9N, 130°57.9E
				Fine but Cloudy
				SE-2 (Light breeze) 2 (Sea Smooth) 1 (Low Swell Short) Visibly: 7'
06-Aug-24	10:30	Arrived at research area.		Northeast off Okinoshima
	10:40	Released XBT.		37°06.7N, 134°14.0E
	11:09-11:58	Carried out MBES site survey (St.7).		Fine but Cloudy
	16:26-17:12	Carried out MBES site survey (St.5).		NE-3 (Gentle breeze)
	17:16-17:36	Carried out figure eight turn measurement.		2 (Sea Smooth)
	18:00	Scientists meeting.		2 (Low Swell Slong) Visibly: 8'
07-Aug-24	22:30	Arrived at dive point (St.7).		
	08:11	Hoisted up "HPD".		Northeast off Okinoshima
	08:15	Launched "HPD".		37°06.4N, 134°13.0E
	08:25	"HPD" dove & started her operation HPD#2246.		Fine but Cloudy
	09:41	Landed on the sea bottom (D=2,205m).		ENE-2 (Light breeze)
	15:06	Landed on the sea bottom (D=2,205m).		2 (Sea Smooth)
	16:14	Refloated "HPD".		2 (Low Swell Slong)
	16:24	Recovered "HPD".		Visibly: 8'
08-Aug-24	22:30	Arrived at dive point (St.5).		
	08:09	Hoisted up "HPD".		West off Noto Peninsula
	08:13	Launched "HPD".		37°00.0N, 135°20.5E
	08:23	"HPD" dove & started her operation HPD#2247.		Fine but Cloudy
	09:24	Landed on the sea bottom (D=1,738m).		ESE-2 (Light breeze)
	15:22	Landed on the sea bottom (D=1,738m).		2 (Sea Smooth)
	16:18	Refloated "HPD".		1 (Low Swell Short)
	16:28	Recovered "HPD".		Visibly: 8'
	16:40	Left research area for MAIZURU.		
09-Aug-24	18:00	Scientists meeting.		
	10:00	Arrived at MAIZURU.		Maizuru Port
				35°28.8N, 135°23.6E
				Cloudy
				North-4 (Moderate breeze) 1 (Sea Calm Rippled) 0 (No Swell) Visibly: 8'
10-Aug-24	09:00	Let go all share line and left MAIZURU for research area.		Northeast of Kyougamisaki
	18:00	Scientists meeting.		35°52.1N, 135°13.2E
	21:15	Arrived at research area (St.7).		Fine but Cloudy NNE-4 (Moderate breeze) 3 (Sea Slight) 2 (Low Swell Slong) Visibly: 8'

Date	Local Time	Note	Description	Position/Weather/Wind/Sea condition
10-Aug-24	09:00	Let go all share line and left MAIZURU for research area.		Northeast of Kyougamisaki
	18:00	Scientists meeting.		35-52.1N, 135-13.2E
	21:15	Arrived at research area (St.7).		Fine but Cloudy
				NNE-4 (Moderate breeze)
				3 (Sea Slight)
				2 (Low Swell Slong)
				Visibly: 8'
11-Aug-24	06:38	Hoisted up "HPD".		Northeast off Okinoshima
	06:43	Launched "HPD".		37-05.8N, 134-12.5E
	06:54	"HPD" dove & started her operation HPD#2248.		Fine but Cloudy
	08:15	Landed on the sea bottom (D=2,199m).		NE-5 (Fresh breeze)
	13:09	Landed on the sea bottom (D=2,184m).		3 (Sea Slight)
	14:23	Refloated "HPD".		2 (Low Swell Slong)
	14:35	Recovered "HPD".		Visibly: 8'
	18:00	Scientists meeting.		
	22:30	Arrived at dive point (St.5).		
12-Aug-24	08:11	Hoisted up "HPD".		West off Noto Peninsula
	08:16	Launched "HPD".		36-59.6N, 135-19.5E
	08:25	"HPD" dove & started her operation HPD#2249.		Cloudy
	09:53	Landed on the sea bottom (D=1,738m).		North-5 (Fresh breeze)
	15:21	Landed on the sea bottom (D=1,737m).		3 (Sea Slight)
	16:17	Refloated "HPD".		3 (Moderate Short)
	16:29	Recovered "HPD".		Visibly: 8'
	18:00	Scientists meeting.		
	23:30	Arrived at dive point (St.7).		
13-Aug-24	06:39	Hoisted up "HPD".		Northeast off Okinoshima
	06:43	Launched "HPD".		37-05.9N, 134-12.0E
	06:53	"HPD" dove & started her operation HPD#2250.		Fine but Cloudy
	08:06	Landed on the sea bottom (D=2,214m).		NE-3 (Gentle breeze)
	10:07	Landed on the sea bottom (D=2,213m).		2 (Sea Smooth)
	11:16	Refloated "HPD".		2 (Low Swell Slong)
	11:28	Recovered "HPD".		Visibly: 8'
	11:40	Left research area for YOKOSUKA.		
	18:00	Scientists meeting.		
14-Aug-24		Proceeding to YOKOSUKA.		West off Futaojima
				34-07.1N, 130-45.3E
				Fine but Cloudy
				North-4 (Moderate breeze)
				2 (Sea Smooth)
				1 (Low Swell Short)
				Visibly: 8'
15-Aug-24	14:10	Let go anchor, arrived at Tachibana Port.		South of Ishima
				33-46.2N, 134-49.2E
				Fine but Cloudy
				North-5 (Fresh breeze)
				3 (Sea Slight)
				3 (Moderate Short)
				Visibly: 8'
16-Aug-24	14:15	Heaving anchor, left Tachibana.		Off Tachibana Port
				33-53.0N, 134-41.4E
				Fine but Cloudy
				North-5 (Fresh breeze)
				3 (Sea Slight)
				1 (Low Swell Short)
				Visibly: 8'
17-Aug-24		Proceeding to YOKOSUKA.		Southwest off Daiousaki
	18:00	Scientists meeting.		34-01.2N, 136-43.8E
				Fine but Cloudy
				SSW-3 (Gentle breeze)
				2 (Sea Smooth)
				1 (Low Swell Short)
				Visibly: 8'
18-Aug-24	09:30	Arrived at YOKOSUKA. Finished KS-24-15 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.

Users of information on this report are requested to submit Publication Report to Cooperative Research Cruise office.

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新青丸共同利用研究航海報告書

- * 航海番号 KS-24-15 次研究航海
- * 航海名称 2024 年度共同利用 日本海における深海ごみの実態把握
Understanding the status of marine plastic pollution
in the Sea of Japan
- * 観測海域 日本海・大和海盆
Yamato Basin, Sea of Japan
- * 航海期間 令和6年8月4日（日）～令和6年8月18日（日）
- * 出港日時・場所 8月4日13時半 高知港
- * 入港日時・場所 8月18日9時半 横須賀港 JAMSTEC 岸壁
- * 寄港期間・場所 8月9日～8月10日 舞鶴港
- * 主席研究員（氏名・所属・職名）
高橋 朋子・海洋研究開発機構・研究員
- * 研究内容、主調査者、観測項目
 1. プラスチックごみ採取，中嶋亮太，海底のマクロプラスチックごみ種類・起源
 2. 採泥，中嶋亮太，堆積物中マイクロプラスチック
 3. 3次元マッピングカメラによる海底撮影，高橋朋子，海底のマクロプラスチックごみ
 4. RamaCamによる粒子計測，高橋朋子，海中粒子
 5. AIによる海底ごみ認識，西尾貴樹，リアルタイムでの海底ごみ自動検出
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小倉 孝之・NHK・カメラマン
小川 智美・日本海洋事業・観測技術員

* 航跡・測点図

