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R/V KAIYO Cruise Report

KY13-13

KY13-E05

Ocean testing for developing of the utilization deployment promotion program
"Free-fall type deep sea investigation shuttle device Edokko -1"
End of south at Japan Trench

KY13-13: Sep.22 2013 -Sep.23 2013
KY13-E05: Nov.21 2013-Nov.24 2013

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

1. KY13-13

1.1 Cruise Information

(1) Cruise ID : KY13-13

(2) Name of vessel : Kaiyo

(3) Title of the cruise : Ocean testing for developing of the utilization deployment promotion program "Free-fall type deep sea shuttle device Edokko 1"

(4) Chief scientist : Toshio Tsuchiya [MARITEC, JAMSTEC]

(5) Representative of the Science Party: Masami Matsuura [MARITEC, JAMSTEC]

(6) Title of proposal : The utilization deployment promotion program "Free-fall type deep sea investigation shuttle vehicle Edokko 1"

(7) Cruise period : Sep 22 –Sep23 2013

(8) Ports of call : Pier of Sumitomo heavy industry –Port of Yokosuka-Shinko

(9) Research area : South end of the Japan Trench

(10) Research map　2.2 (10)

1.2 Overview of the Observation and Results of Sea Trial

The purpose of the "Edokko -1" project is to develop the probe (shuttle vehicle) which photos the 8000m deep ocean floor. As for development, the small corporation in Tokyo or Chiba and JAMSTEC were performed by the utilization promotion program. This trial voyage is performed for an examination in the deep sea of the developed probe. As for the used probe, the domestic product is almost used including the glass spheres.

Several hours after leaving port, it was predicted that a billow becomes high wave height (2.5 m or more) under influence at the typhoon No. 20. Then, the captain consulted with the top researcher, and in order to ensure safety, the stop of this experiment was determined.

1.3 Outline of a time schedule

Date	Area	The contents of work
Nov.21（Sun）	Port of Yokosuka	09:00　Departure from　Pear of　the SHI 16:00 The stop of the experiment was determined by the influence of the typhoon No. 20. The captain started sailing towards Yokosuka.
Nov.22（Mon）	Port ort of Yokosuka	10:30　Arrives at the port of Yokosuka

2. KY13-E05

2.1 Cruise Information

(1) Cruise ID : KY13-E05

(2) Name of vessel : Kaiyo

(3) Title of the cruise : Ocean testing for developing of the utilization deployment promotion program "Free-fall type deep sea shuttle device Edokko -1"

(4) Chief scientist : Toshio Tsuchiya [MARITEC, JAMSTEC]

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(7) Cruise period : Nov.21-Nov.24 2013

(8) Ports of call : Pier of Sumitomo heavy industry –Port of Yokosuka-Shinko

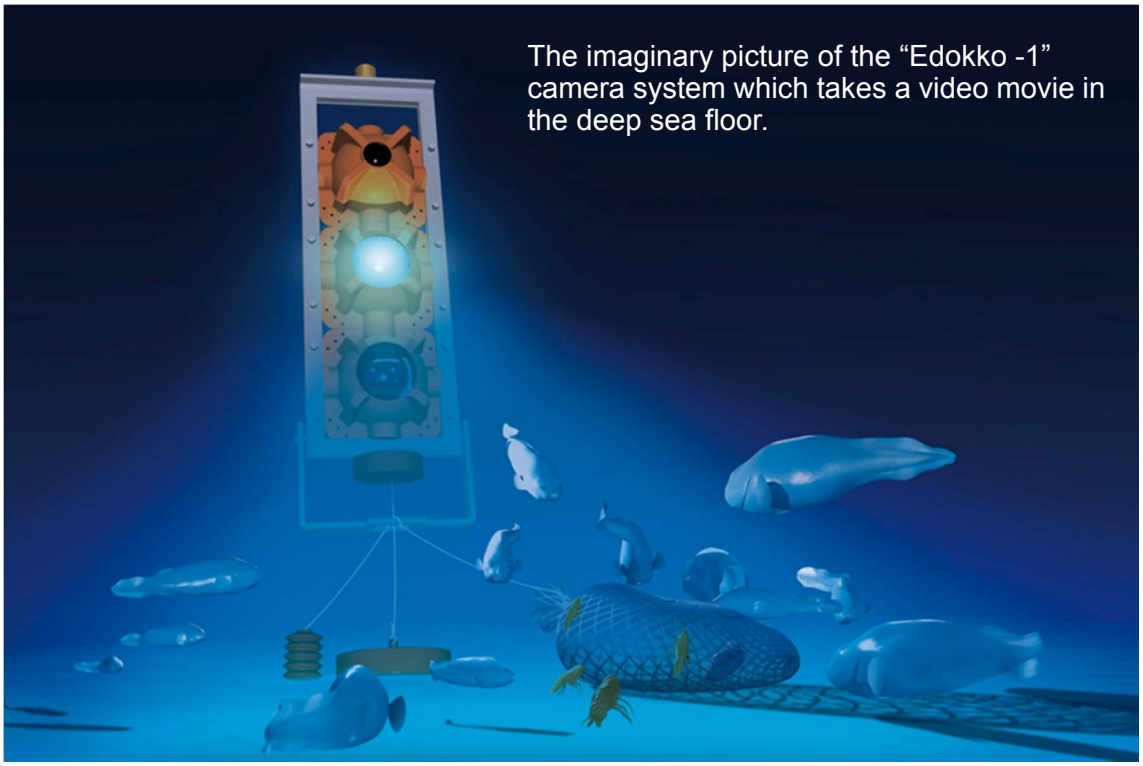
(9) Research area : South end of the Japan Trench

2.2. Outline of a time schedule

Date	Area	The contents of work
Nov.21 (Sun)	Port of Yokosuka 4,000m depth Area	09:00 Departure from Pear of the SHI 18:00 Arrival at the 4,000m area The depth confirmed by the Sea Beam 19:00 Unit No.2 Drop at 35°04′N,141°28′E (Depth 4,090m) Confirmation of depth by Sea Beam 21:00 started cruising to 8,00m area
Nov.22 (Mon)	8,000m depth Area	02:00 arrived at 8,000m depth 05:00 Confirmation of depth by Sea Beam Preparation work to drop into the sea 07:00 Unit No.3 drop 35°02′N,142° 07′E (depth 7,860m)

		08:30 N1drop　35°05′N142° 07′E (depth 8,060m) 09:30 Unit No.E drop.　35°07′N142° 13′E (depth7,822m) After confirming the arrival on the ocean floor, and started cruising to Unit No.3 13:00　Send a release command to Unit No.3 15:30　Recovery of Unit No.3
	8,000m depth Area	16:00　Send a release command to Natsushima No.1(N1) confirmed the release signal. 20:00 N1 went out to surface , but can not be found in the night.
Nov.23 (Tue)	4,000m depth Area	04:00　Send a release command to Unit No.4 07:00　The recovery of E4,started cruising to N1 08:00　N1 is found 08:30　The recovery of N1 and started cruising to E2 11:30　Send a release command to Unit No.2
Nov.24 (Wed)		12:45　Recovery of Unit No2, started cruising to Yokosuka
	Port of Yokosuka	09:00　Arrives in the port of Yokosuka

2.3 Overview of JAMSTEC efforts by "practical deployment Promotion Program" “Edokko -1 project”



17:00 November 22, 2013, 20 people have gathered in front of large monitor of the laboratory in oceanographic research vessel called “Kaiyo”, which is on about 200 km off the coast of the Boso Peninsula, Japan. Any people are owner of small factories, employers, bank clerks, engineers, and university students who are indifferent of the marine research.

On the large screen, the video which is from the memory that has been removed free fall type deep-water exploration camera called “Edokko -1” just pulled up from the bottom of the Japan Trench of about 7,800 m water depth to 30 minutes before has been playing. After the darkness for a while, the moment the screen becomes bright suddenly, a baited stand came down with fine mud soars of seabed. "I did, it's seabed. It is filmed video properly". Groans of relief went up from the people around us. I could see those two moving animals, mud is gone by fast flow. "Oh, it's amphipods". It was the same as the picture of deep-sea organisms that came out in the lecture that

Many fish have been recorded in the video of Edokko -1.

Experiment participants who were clapping joy success.

was received before the voyage begins. After 30 minutes, I saw a lot of amphipods that flock to the saury and mackerel bait to retract or jump out from the screen all the time in the 3D glasses over. "Fish are swimming," someone shouted. White fish that swim to sew the amphipods at the right of the screen was filmed clearly. At that moment, cheers are given from the people who were there. They are hugging each other, and some people are in tears. Edokko -1 development project that has been continued for four years is successful at this time.

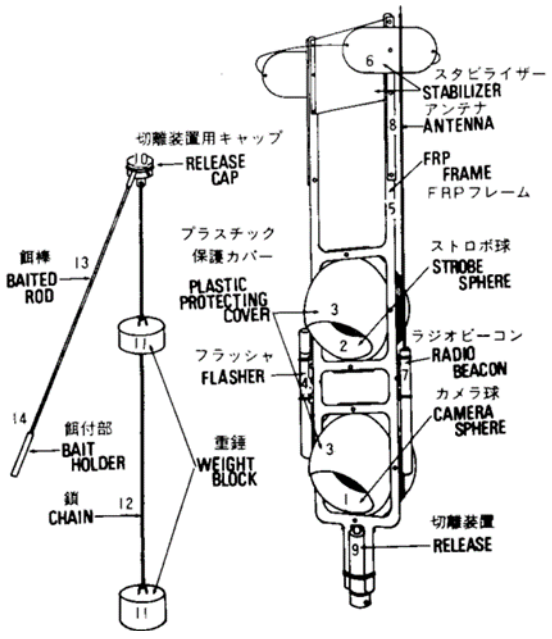
2.4. The sequence of the ”Edokko -1” project

The Edokko -1 project, Yukio Sugino who is the president of small company “Sugino rubber chemical industry plants Ltd." is inspired by satellite project of the small and medium-sized enterprises in Osaka “Maido Ichi Go” plan in 2009, was started as a purpose that the company of downtown Tokyo wants to be activated.

The president Sugino want to develop the unmanned exploration vessel that can be investigated deep sea. First of all, he brings this story to Tokyo Higashi Shinyo-kinko Bank then JAMSTEC was requested this project from this bank. However, technical experts of JAMSTEC explain that the development of the

unmanned exploration vessel for deep sea will be very expensive, and they described the current situation that a lot of foreign-made equipment have been sold already, so he cannot start developing immediately. He proceeds to study sessions of basic knowledge of deep-sea exploration with the coordinator and university researchers by researchers of JAMSTEC. In this session, a plan of remote controlled vessel (ROV) was conceived; however, the ROV plan was also assumed to discontinue by problem of technical and financial.

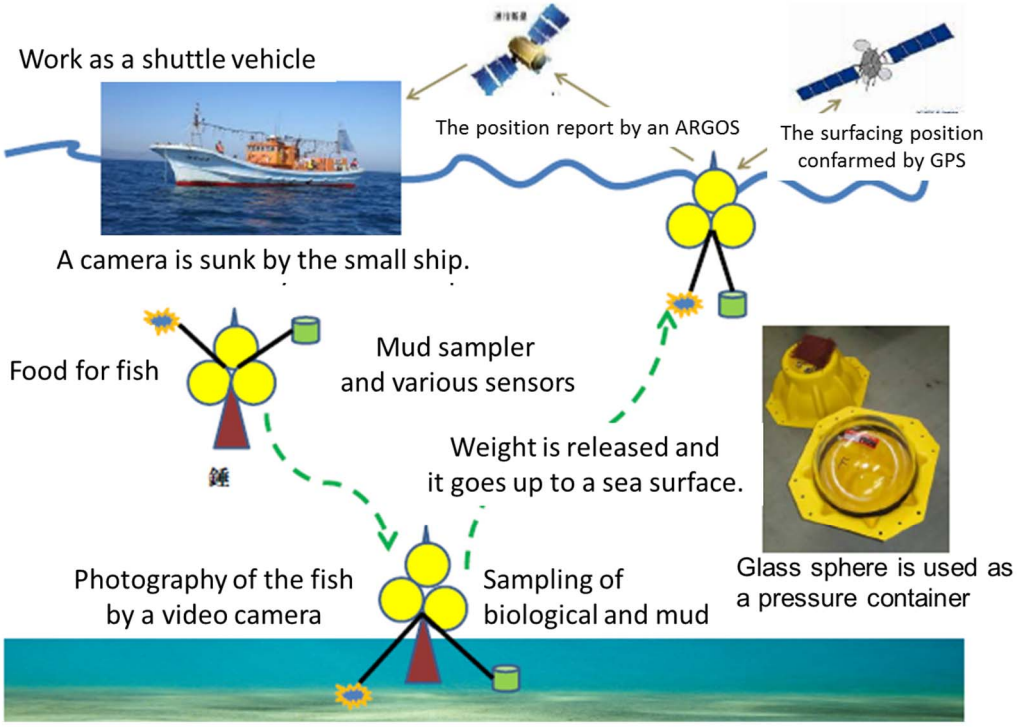
In order to overcome this state, Masami Matsuura director of JAMSTEC Marine Technology Development Department requested consideration to Toshio Tsuchiya who is technology officer of the same depertment. Officer Tsuchiya was remembered the Free fall type glass spheres underwater camera that was handmade when development funds also poor without a ship JAMSTEC since its inception. He was considered to be applied to latest electronic technology with Free fall type glass spheres underwater camera, it might be able at low cost system easy and guaranteed. This system is a "reciprocating type underwater camera system"which is free fall under its own weight to the seabed from the sea surface, lured the organism with a such as food, and come back to sea level again after taking a photo of organism and the seabed. To avoid problems of pressure vessel is the largest technical challenge by using a commercially available glass ball (made in Germany or America) for in a pressure vessel. In the other, officer Tsuchiya thought to be able to bring together the superior technology that small businesses have.



The free-fall camera system which JAMSTEC developed in 1973

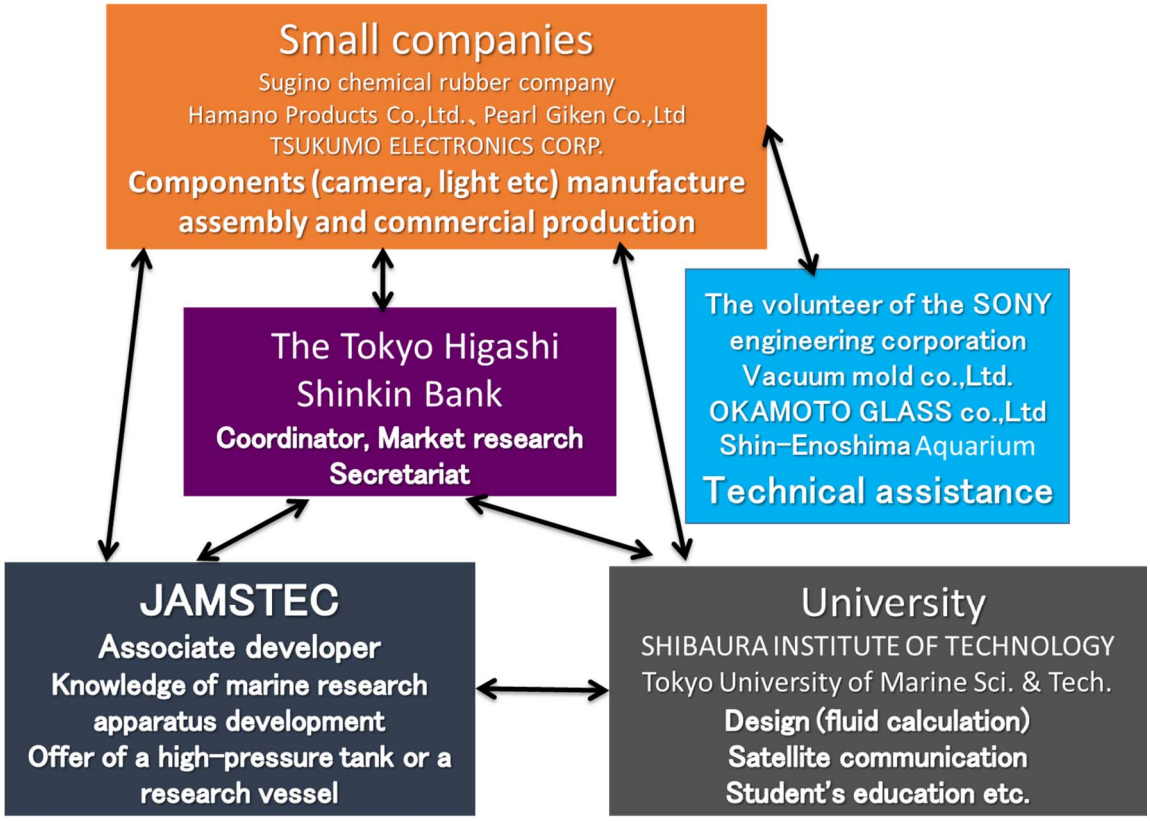
February 2010, project of "free fall type glass sphere underwater camera" was proposed and started. At this time, 4 small and medium-sized companies (Sugino rubber chemical industry plants, Hamano Works, Pearl Engineering, Tsukumo electronics industry) from among the collaborators of Shibaura Institute of Technology and customers of the Tokyo Higashi Shinkin Bank have announced its participation. In addition, Mr. Katsuragawa was appointed as the coordinator of the project in Tokyo Higashi Shinkin Bank that serves as the secretariat of this project. ” Edokko -1 Development Project Committee” was established by Shibaura Institute of Technology, Tokyo University of Marine Science and Technology, JAMSTEC, and in the other a total eight cooperate.

In September 2011, it was adopted in the model of strategic cooperation of JAMSTEC of "practical deployment Promotion Program". This program is a internal competitive funding programs aimed at commercialization and commercialization joint development by a combination of facilities, equipment and know-how of JAMSTEC on the basis of the proposal of business challenges. The Commission of this project, Shibaura Institute of Technology , Tokyo University of Marine Science and Technology, Tokyo Higashi Shinkin Bank, and JAMSTEC has



Operation concept of “Edokko No. 1” system

entered into a contract because it was adopted in the program. For this conclusion, it is possible to support the development of "Eddoko No. 1" in earnest as J



Implementation structure of the project

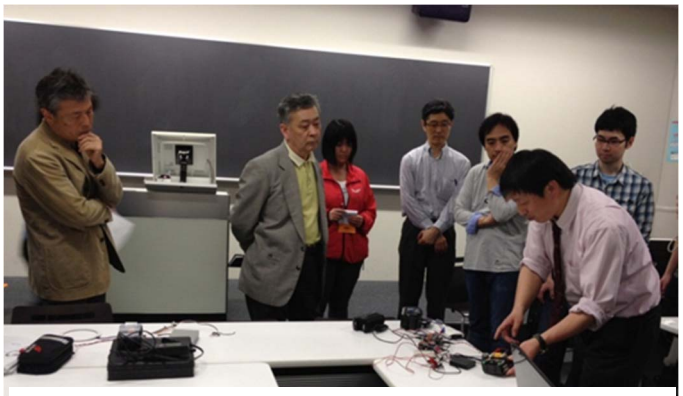
AMSTEC. In addition, high-pressure experimental aquarium, diving training pool, research vessels also available. As for the domestic production of glass spheres was the largest pending legislation of this project; we have succeeded in making the better glass sphere than foreign-made by Okamoto glass company that announced its participation later. The cover glass spheres associated therewith is not an import, we have succeeded to made domestically matched cover by Vacuum Mold Industry. By producing the cover in the country, the flexibility in designing the body greatly improved. As a result, we were able to start development of the research probe at

Glass spheres (Manufactured by Okamoto glass company)

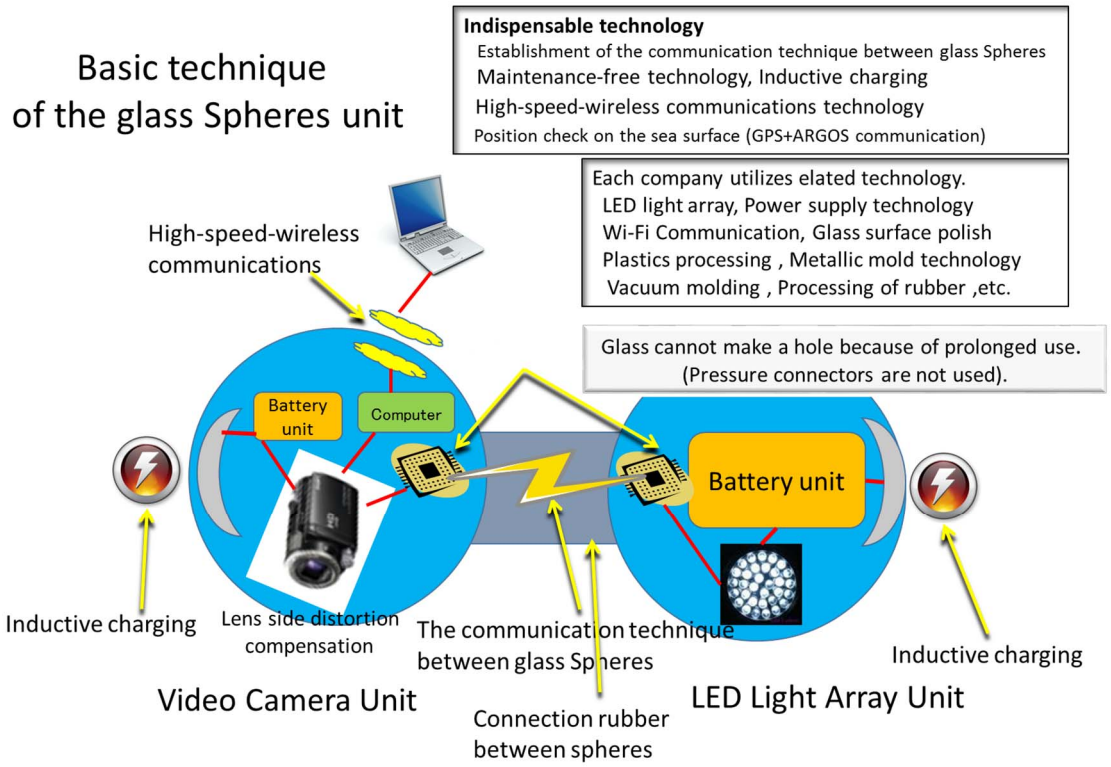
all domestic parts as the first goal.

As soon as the project began, Tetsuya Miwa group leader and Kazumasa Oguri vice research principal of JAMSTEC has proposed and evaluated from various point of view. The comission was held at least once a month, and set up the goal of Edokko -1 project is the development of a device that shoots a long time 3D images of the seabed at 8,000 m water depth, collect of mud, and come back to sea surface on their own. In this case, the

Japanese-made glass sphere was manufactured by the Okamoto glass co., Ltd.



The development examination committee was held periodically.



reason for setting a maximum 8,000 m water depth is

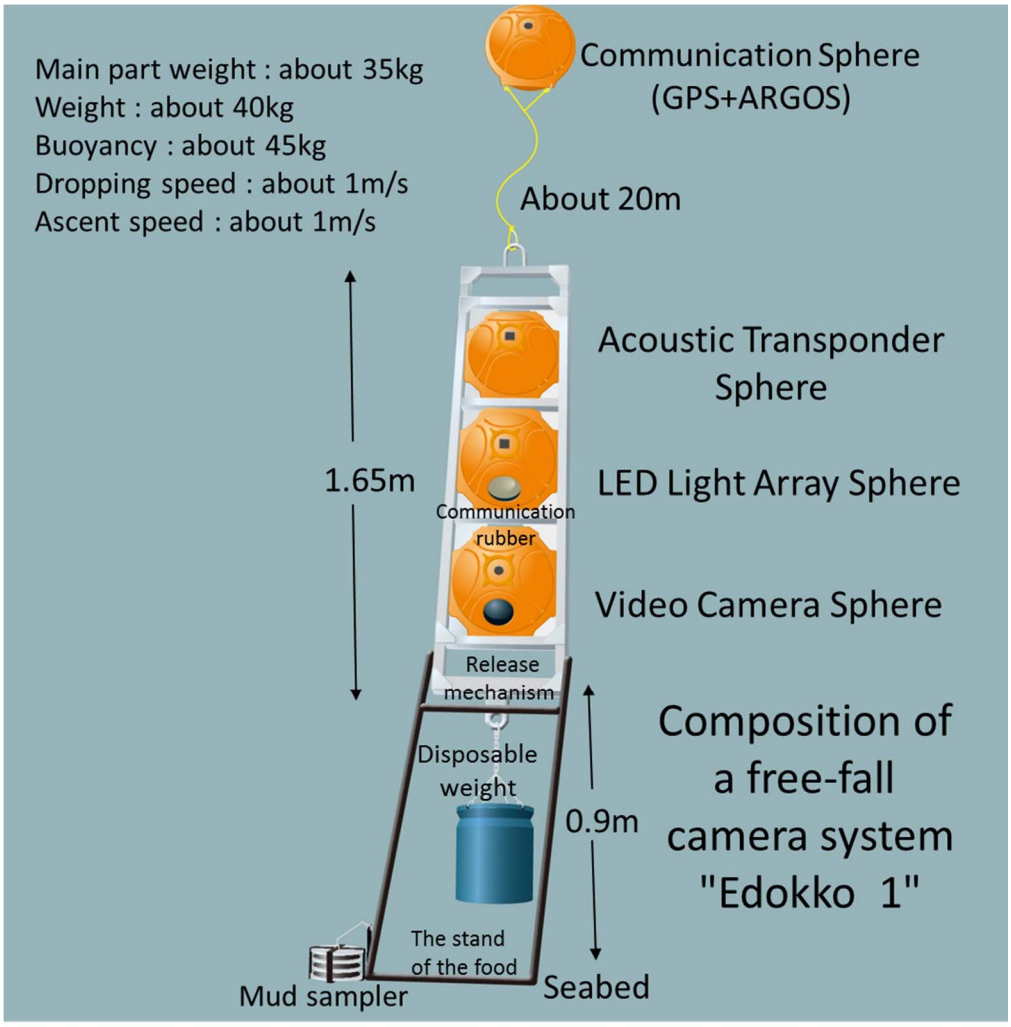
1) It is a water depth of glass spheres commercially available can be handled safely.
2) Maximum depth of water that have been identified in vertebrate is 7700m, so we want to exceed it.
3) There is a place where the source region of the East Japan Earthquake is greater than the dive depth of manned submersible "Shinkai 6500". In addition, detailed investigation has been required at more deeper, the deepest area is 8000m.

Schematic diagram below is showed the operation of the system. This is basically the same as the glass spheres camera 35 years ago as a basic operation. It was decided to incorporate as much as possible the latest technology currently available.

2.5 The summary of Edokko -1 project

Every component of Edokko -1 is sealed in 13 inch (33cm) glass sphere made by Okamoto Glass Company, and it enables maintenance free system which doesn't require disclosure on board. Please refer to Blue Earth No.120 (p26-27) about the development of these devices. Each project member has checked its progress by e-mail, held regular project meeting with JAMSTEC participation at least once a month, and promoted its development. In spring 2012. In spring 2012, we decided the outline of the equipment, verified its movement in a water tank at JAMSTEC and Enoshima Aquarium, and conducted experiments of video filming to advance the development. From October 2012, we have done 8 times of experiment by a fishing boat in Sagami Bay, and finally, practical testing machine has completed in August 2013.

This figure is of testing machine for sea traial (field experiments in ocean). Each unit of glass sphere is sealed I a 13 inch diameter glass sphere made by Okamoto Glass Company. A special rubber (patent pending) is placed between the glass spheres to control lighting bulb by Wi-Fi From this camera sphere control unit. This communication technology is also a product of this project. An acoustic transponder unit is sealed in a transponder sphere. This

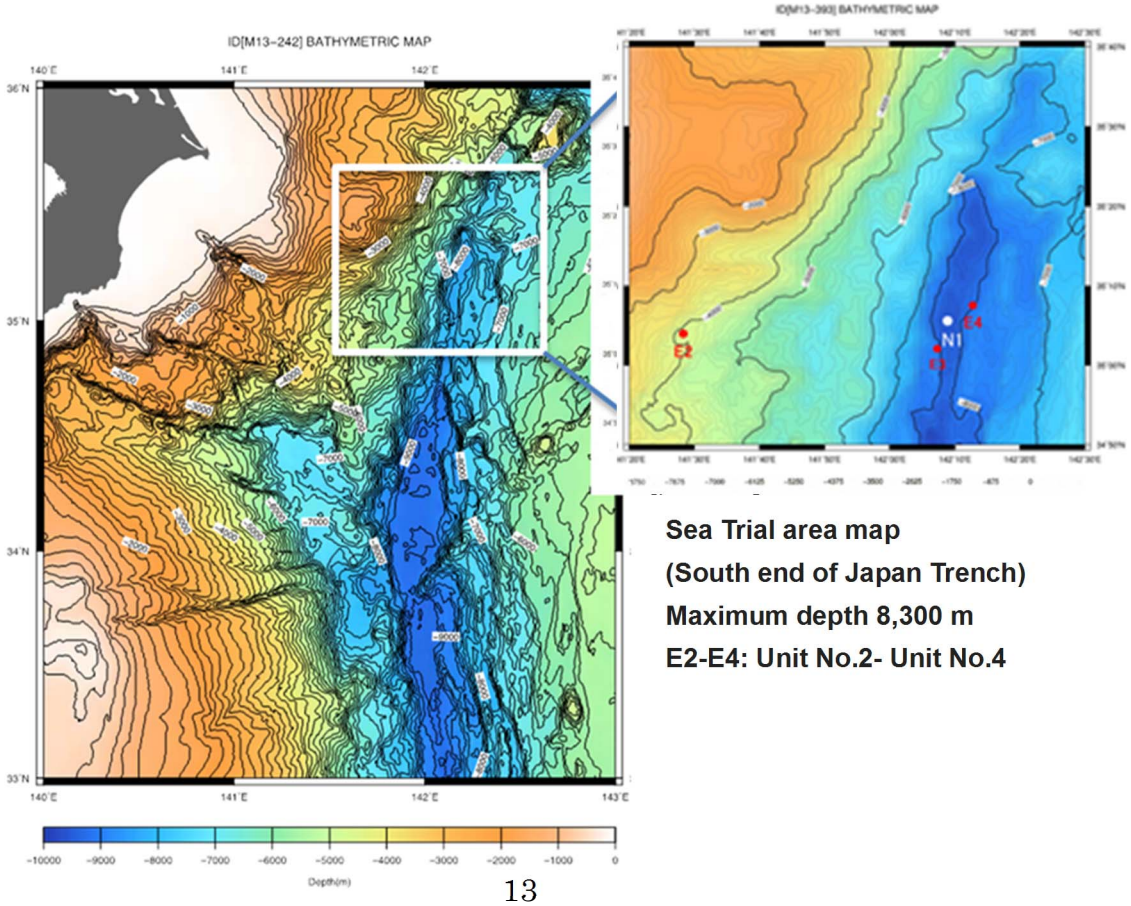


is used in the sea where we cannot use radio wave to measuring distance, and also receives command signal to release the spindle of the device. This release mechanism create electric corrosion forcibly by applying an electrical current and detach the metal plate with a weight. I t takes 10-20 minutes though the movement is stable. In a communication sphere, GPS for positioning, iridium communication system or ARGOS satellite communications equipment, are sealed. When this surfaces, it sends e-mail telling its own position via satellite to the ship. This time we prepared direction finder to receive the beacon signal of ARGOS to take all possible measures to ensure collection. In this cruise, JAMSTEC was preparing a direction finder of ARGOS radio confirmation. As a result, the direction of the sea surface of Edokko -1 was visible from the ship quickly. A communication sphere and the body were tied with 20m ropes, which will be used for collection on surfacing by hanging the smull . Bottom

sampler was as simple as it cuts apart bellows by Release metal wire; however, this time it didn't work well. fall rise velocities of Edokko -1 were estimated to be 1m/sec from the preliminary experimental results at a depth of 750m using fishing boat, so it is expected to take 2 hours to reach the 8000m bottom of the ocean.

2.6. Results of Sea trial

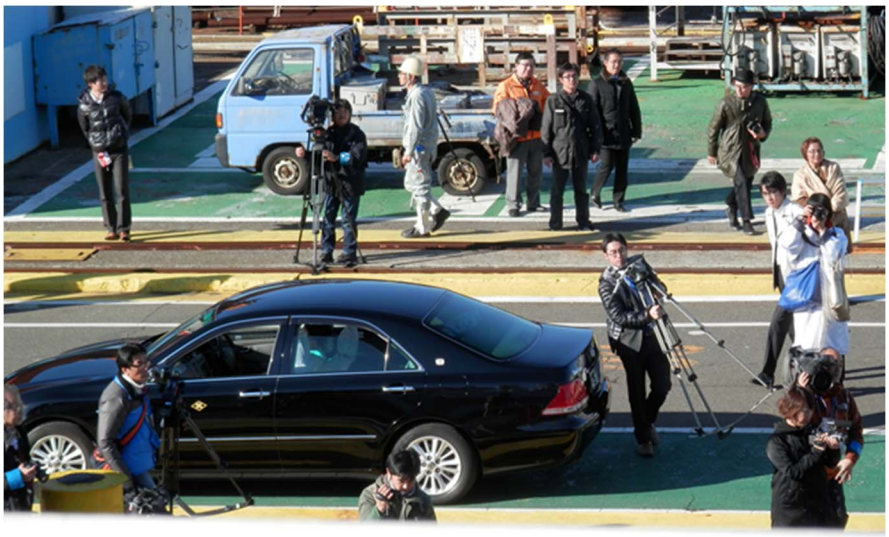
Official name of this cruise is “Reciprocating type deep sea probe " Eddoko No. 1 " sea trial (KY13-E05 cruise)" Originally, a cruise "Kaiyo" and KY13-13 was scheduled for 25 days 22 - September 9, 2013. However, because of the stormy weather due to the influence of the typhoon No. 20, the voyage was cancelled, and turned back to way to experimental area. As a re-challenge this time, the cruise was conducted between 21st and 24th November. The test sea area is a 7,700m to 8,00m of water depth in the southern tip of Japan Trench (north end of Izu-Ogasawara Trench). There is three ‘ Edokko -1’ units such as unit No.2(red), unit No.3(green), and unit No.4 (blue). Unit No.2 was dropped to about 4,000m depth of water, unit 3



Sea Trial area map
(South end of Japan Trench)
Maximum depth 8,300 m
E2-E4: Unit No.2- Unit No.4

Eddoko - 1 Free-fall camera system such as unit No.2 (red), unit No.3 (green), and unit No.4 (blue) on the deck of R/V Kaiyo.

and 4 were dropped to about 8,000m of depth of water. Normally, the probe that does not have depth gauge as Edokko -1, whether it has-grounding to the depth actually makes use of ship positioning system. Normally, the probe that does not have depth gauge like Edokko -1, whether it has grounding to that depth actually makes use of ship positioning system. However, positioning device that was used in this study could not able to be determined the exact position on the seafloor because of this device is simple

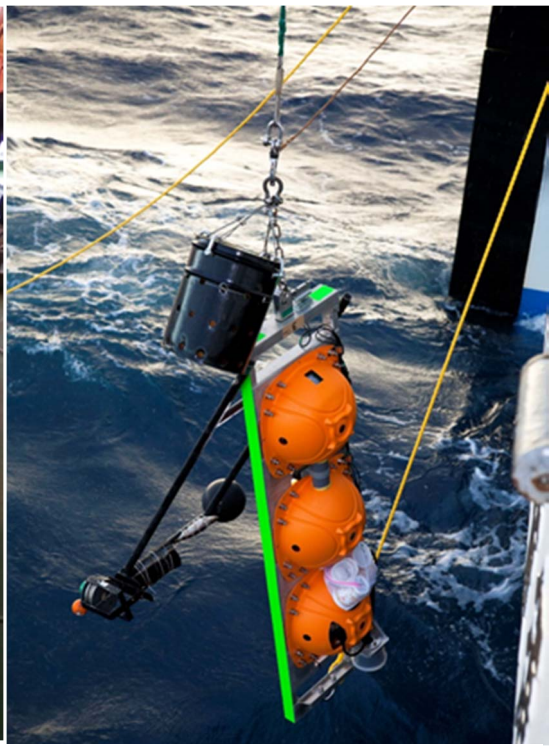


Research vessel 'Kaiyo' departs from the Yokosuka harbor to 09:00 on November 21. Many TV crews and newspaper reporters were coming for coverage.

portable, but we estimate that Unit 3 and 4 reached the bottom of seafloor, for sea level near the ocean current near sea level of 8,000 m sea area is approximately 0.3 knots (about 15cm / s) or less, and it is the same position when the Units rised to sea surface.

09:00 November 21, R/V Kaiyo left port of Yokosuka. In this time, overheating of the media report was amazing. Main newspaper and TV station kept collecting news materials until leaving a port, so everyone was surprised that this experiment has attracted a great deal of public attention. In this voyage, two media teams, NHK and Tokyo MX were on board for a reporting. After getting out of Tokyo bay, R/V Kaiyo was cruising with about 12 knots of up to 200km to field experimental of ocean. R/V Kaiyo arrived in experimental field of 4,000 m depth area 18:30, 21st. Before 2 hours of leaching experimental field, the staff was setting experiment of Edokko -1. In this experiment, many students play an important part of the experiment not only staff from small and medium-sized enterprises. Edokko -1 was able to drop in to the ocean without opening the glass sphere for setting up because the staff could set programs to the sealed control system by external PC using

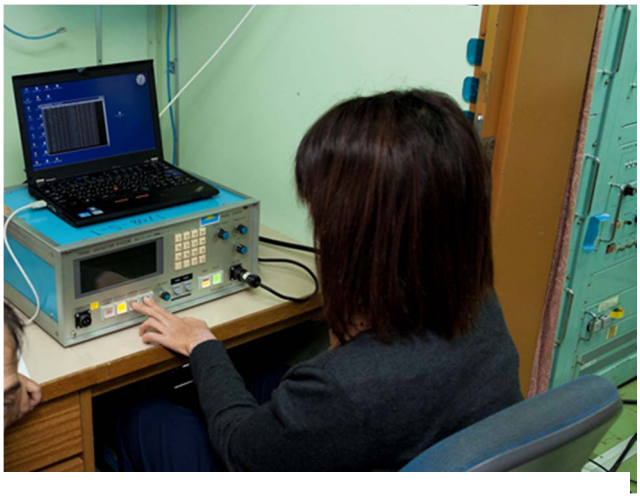
Unit No. 3 which preparation completed



Unit No. 3 is supplied to the sea from a stern.

Under maintenance of the Unit No. 2. A lighting sphere (center) and a camera sphere (right)

wireless LAN. Then the timer that is based on latest grounding time of the shooting schedule was set. A simple undersea organisms trap with feed of saury and mackerels was mounted to Edokko -1. 19:10, a Unit No.2 was dropped into the sea quickly by staff of R/V Kaiyo. It was about ten minuets time required. As a result of the Sea Beam sounding, its depth of the water is 4,090m. A unit No.2 was confirmed to achieve grounding by the Sea Beam. After confirming, R/V Kaiyo started to cruse to 8,00m of experimental field area. R/V Kaiyo arrived in depth 8,000 m area on the midnight of November 22. R/V Kaiyo was moved to the field experimental

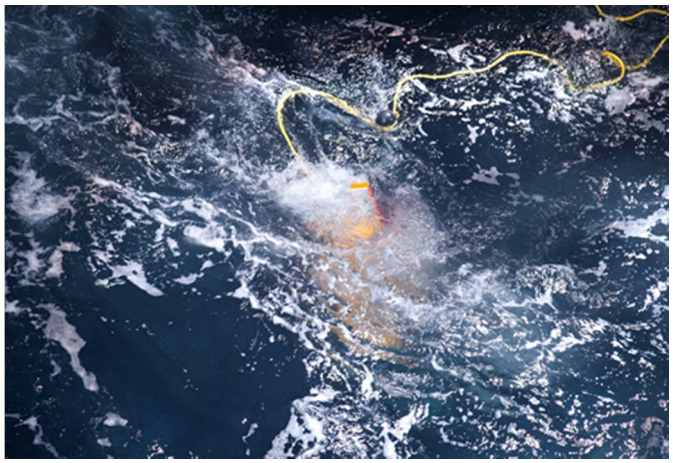


Acoustic positioning commander shipboard equipment of simplified

of the sea at the crack of dawn, and the unit 3 was dropped into the sea at 7:00. The depth of the drop point was measured was 7,860 m by the Sea Beam system. After dropping into the water, measurement of position started, measuring the slant range by the acoustic transponder in every minute, we calculated the rate of fall. As a result, the predicted is 1.1m / s slightly earlier than expected (1m / s) speed, and takes two hours to reaching of the bottom.

Without waiting for reaching of the unit3, R/V Kaiyo was headed up to predetermined area of the unit4, we corrected the position of the camera because the glass sphere that seals 3D video camera position is slightly off during servicing. In the end, the camera of Unit 4 was able to capture the feeding table in the center of the monitor. It was delayed to dropping in to the water for 30 minutes 09 hours 30 minutes behind schedule, but the depth of the waters, was 7,822 m. Thereafter, the ship back to the experimental point of the Unit 3 in order to recover the Unit 3. At 13:00 the Unit 3 was transmitted command for separating. At around 15:00, the Unit No.3 ARGOS satellite transmitter in the activated by

Unit No. 3 which floated at sea surface. The rope of the buoy was entangled.

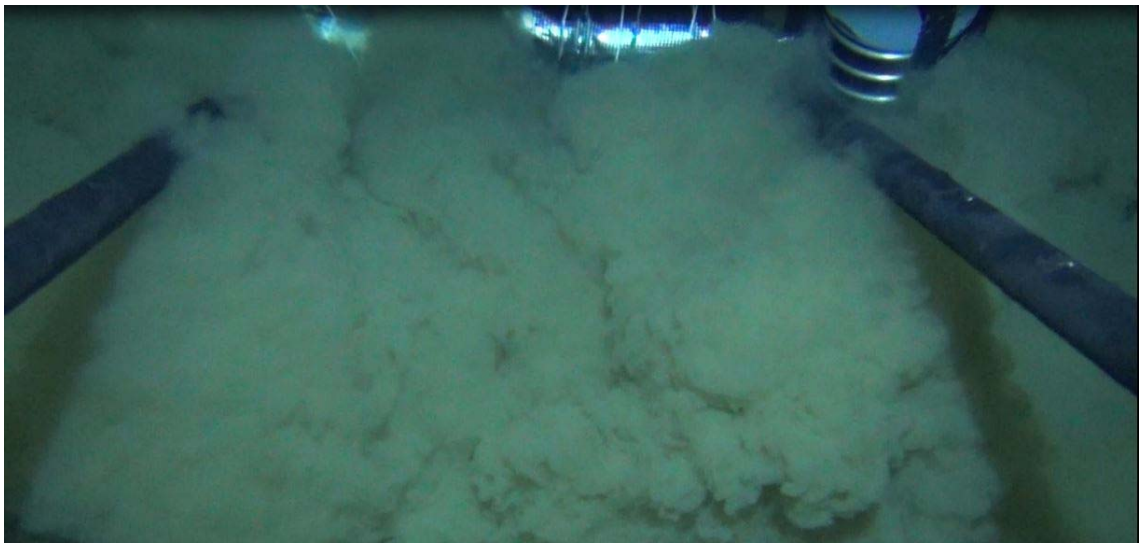


Unit No. 2 which floated at sea. The rope of the buoy was developed normally.

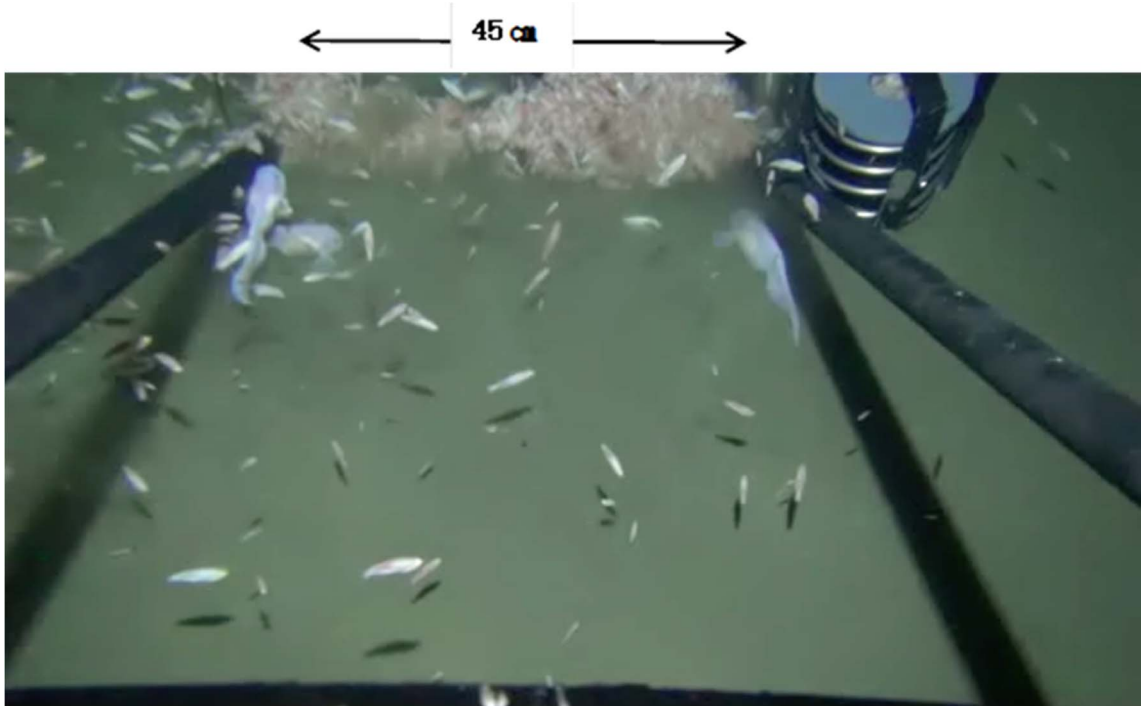
Unit No.3 was recovered on board

LED light is lit for Unit No.3 was operating continuously.

levitation, and the unit No.3 which was drifting about the place of one mile was communication sphere in was discovered by the crew. When the Unit No.3 had returned to the sea surface, staff felt greatly relieved for the first time. The camera sphere of Unit 3 was returned to the deck and was opened immediately. Video data is downloaded from the recording memory. Total time of 3D video data (MTS files for 3D video) recorded was 4 hours 41 minutes. Operation program had been exeuted



Unit No.3 video of the moment arrived at the water depth 7,860m. A large amount of mud soared, but it became clear quickly by fast flow. Saury of food can be seen on the upper side of the screen. This image is converted to 2D from 3D.



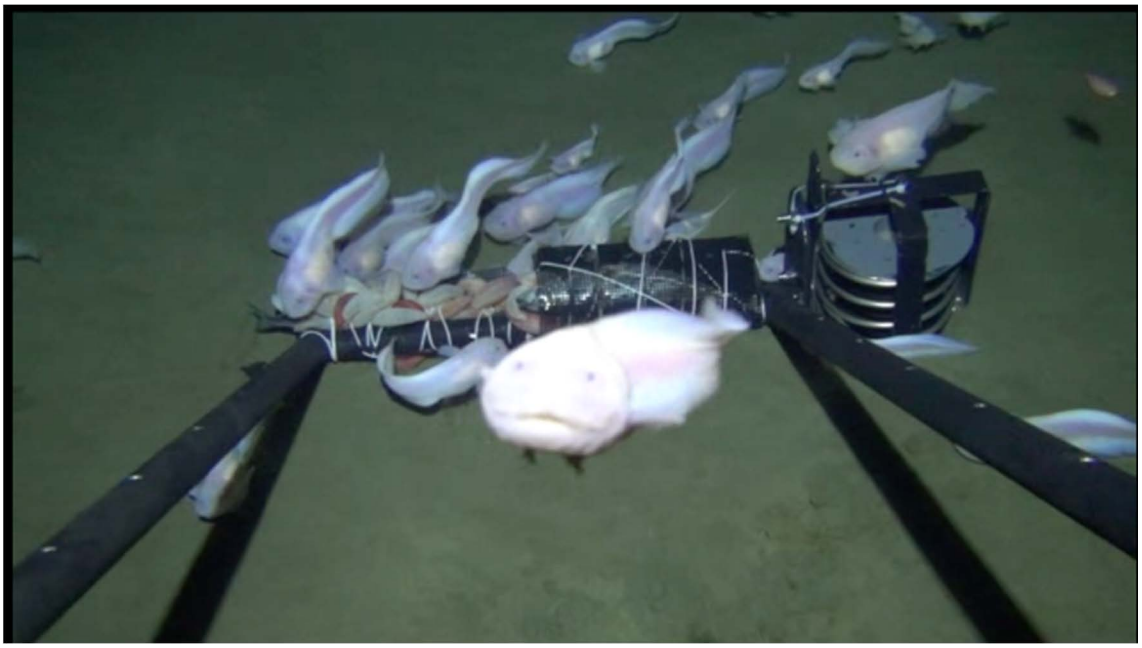
The screen from the video of Unit No. 3 3 hours after arriving at the seafloor. In a screen, a lot of *Hirondellea gigas* and *hadal snailfish* gathering in food were seen.

without problems from analysis of the log on the computer. In this video, process of all the way to the bottom to emerged was clearly recorded as a 3D full high-definition image, focusing of the camera was also well focused near the center of the screen and almost no non-uniformity of the lighting. In the video, the moment Unit No.3 arrived at the bottom of the sea, the field of vision became bad by the blown up mud, but Visibility became clear in a few tens of seconds for fast flow. An organism that seems to amphipods in about 20 minutes after landing, and number of amphipods were not visible saury and mackerel bait in about 30 minutes had been gathered. About 30

Collected Hirondellea gigas of the maximum length (5.5 cm)

The saury of food was eaten and became only a bone

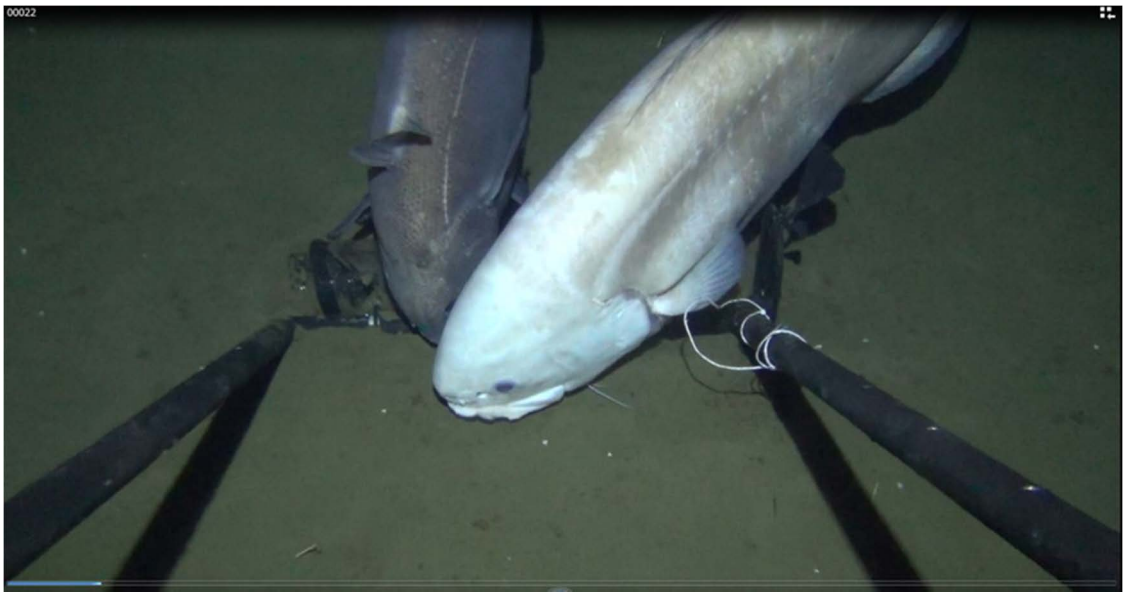
amphipods was captured in the collection trap attached to the feeding station, the maximum individual length was 5.3 cm. In addition, fish were the bait, had become like a fish bone specimen. We were confirmed the state that the fish swam from the right of the screen and ate amphipods in 35 minutes after landing the bottom. It was considered to be a kind of "pseudoliparis amblystomopsis" from the shape of this fish, but the details are being analyzed. We are able to learn in more detail than the swimming and the structure of the body of the pseudoliparis amblystomopsis by the 3D image. These fish were observed until rising to the surface; moreover, more than twenty fishes swam with the tide and these fish that were eating the food was clearly filmed by 3D camera. Finally, the fish (vertebrates) was taken by the 3D image in the deep sea of 7,800 m, it is to be the world's first probably. Early morning November 23, we started the recovery operations of unit No.4. After sending disconnect command to the unit No.4, we collected the unit No.4 on board around 7:00. After that, R/V Kaiyo was starting immediately towards the 4000m waters. As programed, video downloaded from the unit No.4 was recorded 17 hours intermittently. The time-grounding from the video data, it was a 11:29, amphipods began to gather after 10 minutes-



Unit No. 4 video after about 2 hour passes after arriving at the seafloor. Many *nadal snailfish* and *Hirondelleagigas* which eat food were seen. (Depth 7,822 m).

grounding as well as the unit No.3. However, in this case, the amphipods did not gather much like the unit No.3. Fish seems to be a kind of Pseudoliparis amblystomopsis at 12 o'clock began to gather. We were able to count 25 fish just before the recovery at 19:00.

At 11:30, Kaiyo arrived in 4,00m water. After sending disconnect command to the unit No.2, it was corroborated to surface about 300m to the rear of the ship at 12:45. After collection on the board, and servicing the unit2, working was finished at 14:00. After this, Kaiyo started to go back to the port of Yokosuka. As programed, video from the unit 2 was recorded 40 hours intermittently. After 10 minutes-grounding, some of the kind of grenadiers gathered and they ate all bites during 30 minutes. Over the 1.5m of Spectrunculus grandis and Coryphaenoides yaquinae were filmed by 3D camera. This camera records clear detail of this fish such as size of body, patterns of scratch, and scales, and we were able to learn about a lot of information about this fish from 3D images. R/V Kaiyo arrived at port of Yokosuka at 9:00 November 24. Reporters of media companies rushed a quay. We were busy to take the interview during 2 hours. This time, media was very concerned with social and economic success of the town factory by



The picture of No. 4 which passed after arriving at the seafloor for 1 hour. Big *Coryphaenoides yaquinae* (left) and *Spectrunculus grandis* (right) were seen. The length was presumed to be 1 m or more. (Depth of 4,090 m)

After all the opportunity recoveries of all Edokko -1 all units, a success was celebrated and commemoration photography was carried out by all experiment participants.

academia- industry cooperation.

After returning to port of Yokosuka, coverage of many TV crews or a newspaper reporter was received..

2.7. Future plan

In the future, prototype of Edokko -1 is planning to be improved for commercialization and all possible efforts will be made for cost reduction. When it is commercialized, our ultimate goal will be accomplished. It is also notable that this project made students and researchers of Shibaura Institute of Technology interested even though they had never participated in the field of marine engineering. Lastly, we would like to express our deep gratitude to the captain and crews of ocean investigation R/V Kaiyo for their support. Without their prominent technical help, we could not have completed such many missions in 4-day short cruise.

2.8. Cruise KY13-E05 participants

JAMSTEC：Toshio Tsuchiya, Masami Matsuura, Kei Shibata

Hamano Products Co., Ltd：Keiichi Hamano, Kayo Yamamoto

Pearl Giken Co., Ltd：Daisuke Kojima, Hironobu Kinuma

Okamoto Glass co., Ltd：Hiroshi Takahashi, Yuho Ueno

Tokyo Higashi Shinkin Bank：Masami Katsuragawa, Masakatsu Nakagawa

Shibaura Institute of Technology：Kinichi Iwata,Takuya Hizawa, Keita satou、Satoshi Okamoto, Souichi Isono

Tokyo University of Marine Science.& Technology：Azumi Takahashi, Akihiro Hayami

The volunteer of the SONY engineering corporation: Itaru Kawakami

Shin-Enoshima Aquarium：Makoto Sugimura

I2I Tech Inc.：Naruo Itoi

Nippon Marine Enter Prises Ltd.：Takuya Maekawa