



KAIYO Cruise Report

KY15-16Leg2

Construction of DONET2 system

Off Kii Channel

Kumano-nada

Nov. 10, 2015 – Dec.3, 2015

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

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1. Cruise Information

- Cruise ID KY15-16Leg2
- Name of vessel R/V KAIYO
- Title of the cruise Construction of DONET2 system
- Title of proposal
 - Theme 1: Construction of DONET2 system
 - Theme 2: Re-installation of DONET1 observatories
 - Theme 3: Development of long-term borehole observation technology using Nankai borehole monitoring systems
- Cruise period Nov.10, 2015 – Dec.3, 2015
- Ports of call JAMSTEC Yokosuka – Wakayama shimotsu – JAMSTEC Yokosuka
- Research area Off Kii-Channel, Kumano Nada
- Research Map

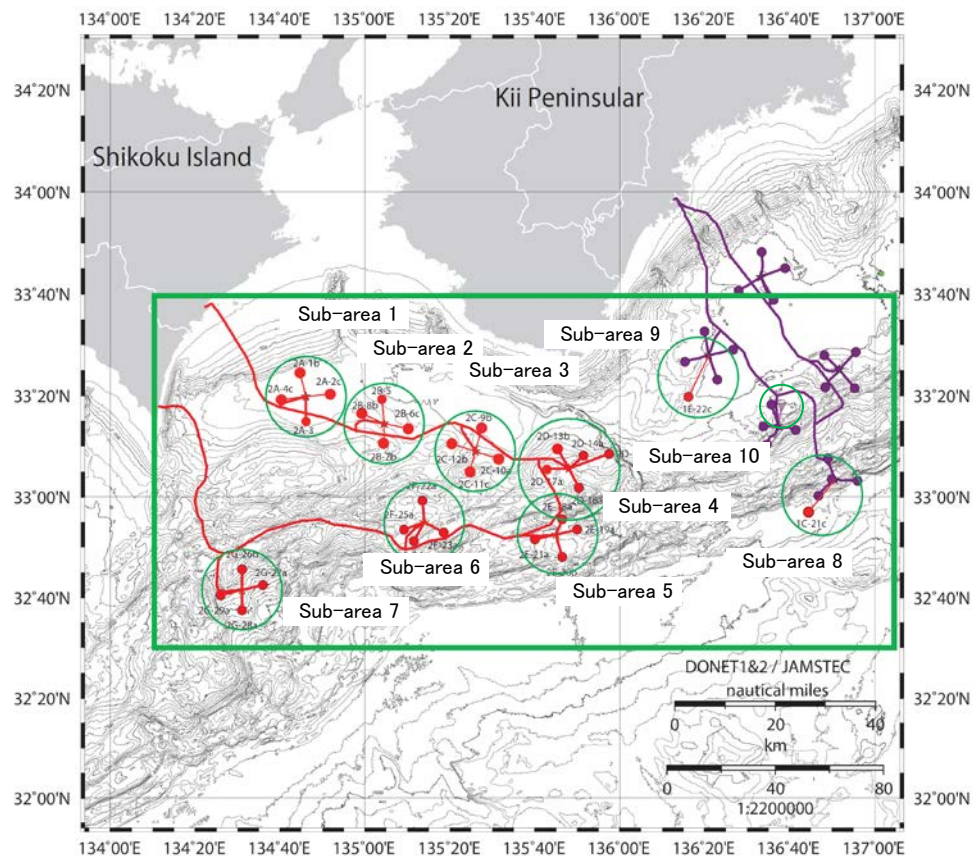


Figure 1.1 Research area and sub-area

2. Science Party

- Chief scientist: Takashi Yokobiki [JAMSTEC]
- Representative of the science party: Shuichi Kodaira (Theme 1, Theme 2) [JAMSTEC]
Eiichiro Araki (Theme 3) [JAMSTEC]
- Science party: Shuhei Nishida [JAMSTEC]
Yuuya Machida [JAMSTEC]
- Marine Technician: Masayuki Toizumi [NME]
Yuji Takaesu [NME]
Toshimasa Nasu [NME]

3. Background

3.1 Construction of DONET2 system

DONET (Dense Oceanfloor Network System for Earthquakes and Tsunamis) is a submarine cabled observatory network and has been developing for the purpose of monitoring the seismogenic zone around the Nankai Trough. The development of DONET has been carried out since 2006, and the system consists of three major components; the backbone cable system, the science node, and the measurement instrument. The electric power and the communication channels are provided to the underwater equipment through the high reliability backbone cable system that is developed based on submarine telecommunication cable systems. The science node is the device with the role of hub and electric power distributor. The measurement instruments are composed of precision seismometer and pressure gauge to observe small or large earthquakes, slow-slip events on the plate boundary, and tsunamis. The measurement instruments are connected to the science node with the extension cables that is laid on the sea bed using ROV. These components brings to DONET system three key features; Redundancy, Extendable, and Replaceable of the measurement instruments. The first DONET system named DONET1 has been operating with the 250km backbone cable, 5 science nodes and 20 observatories since August 2011. The second DONET project named DONET2 is composed of 320km backbone cable, 7 science nodes, 29 observatories and 2 additional observatories of DONET1. The first laying operation of the DONET2 backbone cable system was carried out from January to February in 2014. In the laying operation, three terminal units in the northern section were installed. The remaining section was installed in 2014 and two landing stations were connected through the backbone cable system. The purpose of this expedition is to connect the measurement instruments to the backbone cable system.

3.2 Theme 2: Re-installation of DONET1 observatories

The seismometers currently used with Dense Oceanfloor Network system for Earthquakes and Tsunamis (DONET), is buried under the seabed to suppress the background noise. To make the hole for the purpose of burying the seismometer, the caisson is set under the seabed using a piston corer. Then, ROV dives to the position in order to confirm the conditions of the caisson, and the sediment in the caisson is removed using the suction pump equipped in a ROV if requirements of the caisson installation are met. Due to solid sediment, sometimes the caisson cannot penetrate completely with the caisson installation technique of the piston corer. In this case, installation of other caisson is indispensable. But this two operations; the caisson installation and ROV operation need cruise period respectively because of on-board equipment. Since the second caisson installation is carried out after the ROV operation, it becomes a cause of delay of the construction schedule. In addition, because of low accuracy of piston corer's position, the install operation cannot be carried out at the place in which observational equipment is already installed. The new caisson installation technique using hydraulic vibration hammer is developed, as backup of the piston corer technique. The purpose of this expedition is to install new caissons using hydraulic vibration

hammer and re-install sensors at 1C-10 and 1C-11 of DONET1

3.3 Long-term bore hole

In the Nankai Trough region, several large interplate earthquakes with magnitudes of 8 have occurred repeatedly due to a subduction of the Philippine Sea Plate beneath the Eurasian Plate at a rate of 4-6 cm/year. In this area, we deployed a long-term borehole monitoring system (LTBMS) with pressure gauges (Paro-scientific Inc. 8b7000-2 and 8b7000-1) into the Hole C0002G during the IODP expedition 332 in 2010 to understand a seismogenic process of large interplate earthquakes. The precise pressure measurement such as the detection of long-term crustal deformation is important in order to obtain geophysical knowledge associated with the occurrence of large earthquakes. However, pressure measurements contain instrumental drifts in the sensors in addition to the pressure changes associated with a crustal deformations. We developed a mobile pressure gauge equipped with pressure holding system due to heating of the pipe to calibrate a pressure sensors which are already deployed in the seafloor, and experimental studies in a laboratory were repeatedly carried out. In the KY15-16 cruise, we calibrate the pressure gauge installed in the Hole C0002G using the gauge.

4. Operation list

Table 1 List of KY15-16 Leg2 operation

Date	Area	Dive No.	Operation
10. Nov, 2015	Shinguu		Departure
11	Off Kii Channel	Dive#1909	The sediment removal in the caisson; 2D-16
12			Harborage
13			Harborage
14			Harborage
15		Dive#1910	Laying operation of the extension cable; 2G-28
16		Dive#1911	Laying operation of the extension cable; 2E-20
17		Dive#1912	Laying operation of the extension cable; 2D-15(1)
18			Harborage
19			Harborage
20			Harborage
21		Dive#1913	Laying operation of the extension cable; 2D-15(2)
22			Harborage
23			Harborage
24		Dive#1914	Installation of the measurement instruments; 2D-13
25			Harborage
26			Harborage
27			Harborage
28		Dive#1915	Laying operation of the extension cable; 2F-24
29		Dive#1916	Laying operation of the extension cable; 1E-22(1)
30		Dive#1917	Laying operation of the extension cable; 1E-22(2)
1.Dec, 2015		Dive#1918	A measurement of a precise water pressure using a mobile pressure gauge on the C0002 platform
2			Umbilical cable maintenance
3	Wakayama port		Arrival; End of KY15-16Leg2

5. Dive Summary

5.1. DIVE #1909 on Nov. 11, 2015: Sediment removal at 2D-16

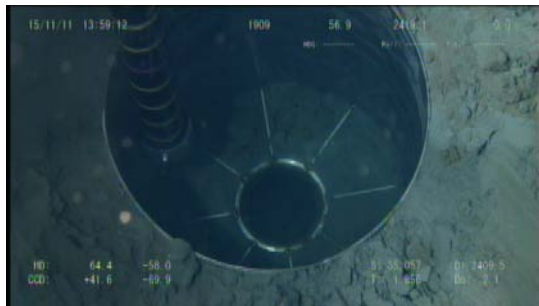
In this dive, the preparations which install measurement instrument in a caisson were carried out. The tilting angle of the caisson was measured to make sure whether it is suitable for installation of the seismometer package. It was confirmed that the tilting angle is less than 10 degrees and this indicates that the caisson can be used for housing the seismometer package. After measuring the tilting angle, the sediments in the caisson were removed using the vacuum system mounted on the ROV Hyper Dolphin and then a cover plate was placed on the caisson. The position of the caisson is 33-01.808N 135-50.430E, Depth: 2,419 m.



(a) Before operation



(b) Measuring the tilting angle



(c) After sediment removal

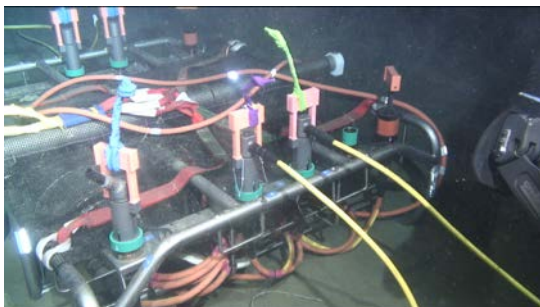


(d) Placing a cover plate on the caisson

Fig. 5.1. Measuring the tilting angle and sediment removal at 2D-16.

5.2. DIVE #1910 on Nov. 15, 2015: Laying operation of the extension cable at 2G-28

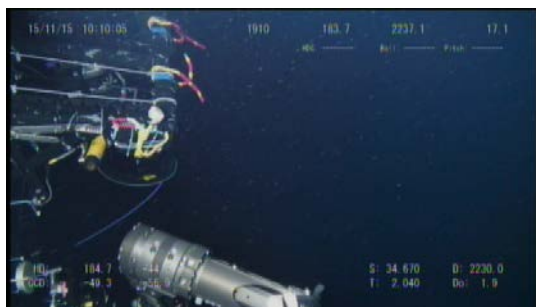
The cable-laying operation from the Node2G to the observatory 2G-28 was carried out using the automated cable-laying system. After landing on near the node, the ROV first put the underwater mateable connector linking to the upper end of the cable on the cable bobbin into the port 4 of the Node2G. After that, the junction box was put on the seafloor. Then, the cable laying operation was started. The ROV laid down the cable from the Node2G to the observatory 2G-28, and then the cable bobbin was put on the seafloor near the observatory 2G-26. At last, the ROV connected the cable from Node 2G to the observatory 2G-26. The length of the laid cable was 8,247 [m], the traveled distance was 7,526 [m].



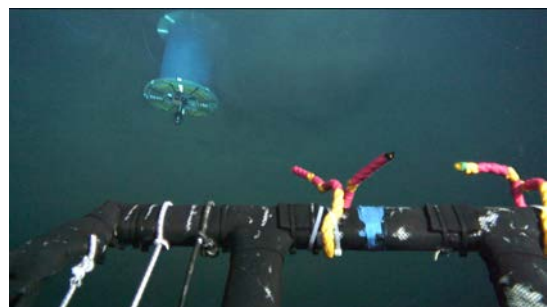
(a) Connection with the node (Port No.4)



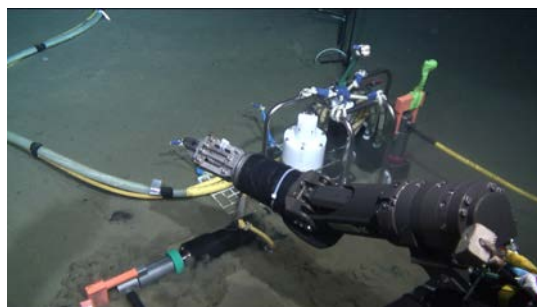
(b) The junction box



(c) Cable laying Operation



(d) Cable bobbin

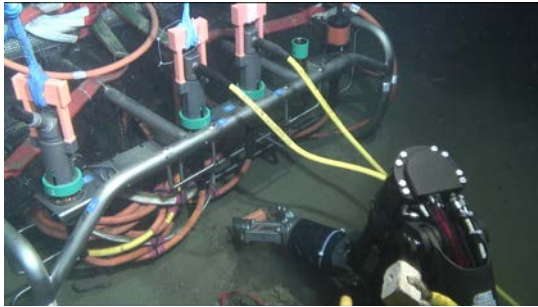


(e) The cable from "Node 2G" was connected to observatory 2G-28

Fig.5.2. Cable Laying operation of the extension cable at 2G-28

5.3. DIVE #1911 on Nov. 16, 2015: Laying operation of the extension cable at 2E-20

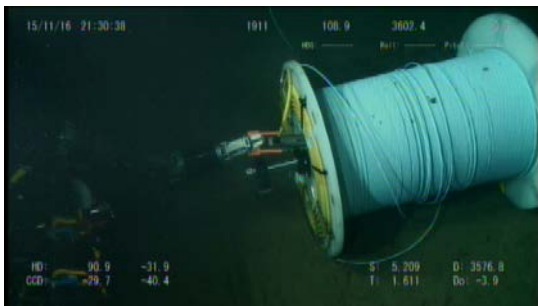
The cable-laying operation from Node 2E to the observatory 2E-20 was carried out using the automated cable-laying system developed. After landing near Node 2E, the ROV first put the underwater mateable connector linking to the forefront of the cable on the cable bobbin into the port 4 of the node. After that, the junction box was placed on the seafloor and the cable-laying operation was started. After arriving at near the observatory 2E-20, the ROV placed the cable bobbin on the seafloor and connected the cable from Node 2E with the observatory 2E-20 using the underwater mateable connector. It was confirmed that there is no problem in communication between the observatory 2E-20 and the landing station. The length of the laid cable was 9,389 [m], the traveled distance was 8,548 [m].



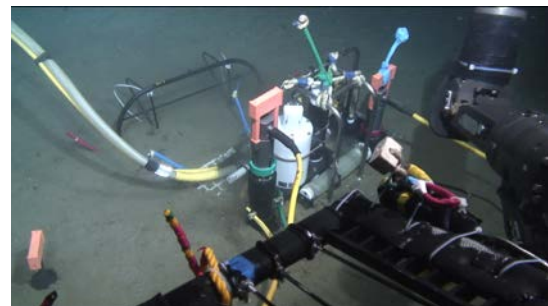
(a) Connection with Node 2E



(b) Placing the junction box on the seafloor



(c) Placing the cable bobbin on the seafloor

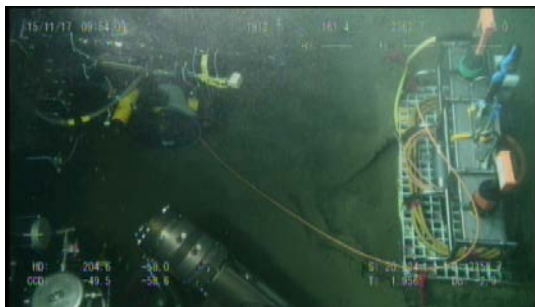


(d) Connection with the observatory

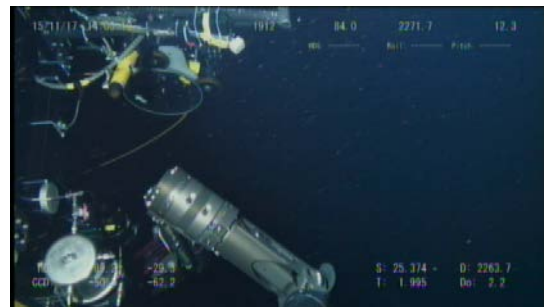
Fig.5.3. Cable Laying operation of the extension cable at 2E-20

5.4. DIVE #1912 on Nov. 17, 2015: Laying operation of the extension cable at 2D-15(1)

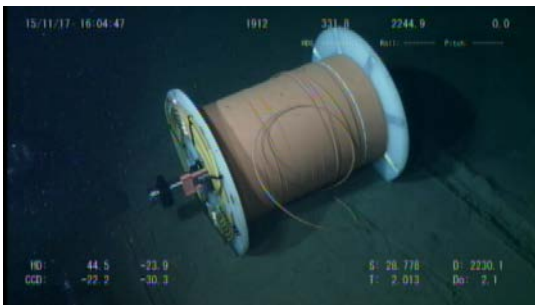
The cable-laying operation from the Connection Box 2D to the observatory 2D-15 was carried out using the automated cable-laying system. After landing on the halfway point between Node 2D and site 2D-15, the ROV put the Connection Box 2D that was connected to the upper end of the cable on the cable bobbin. After that, the junction box was put on the seafloor. Then, the cable laying operation was started. The ROV laid the cable from the Connection Box 2D to the observatory 2D-15, and then the cable bobbin was put on the seafloor near the observatory 2D-15. At last, the ROV connected the extension cable to the observatory 2D-15. The length of the laid cable was 7,926 [m], the traveled distance was 7,413 [m].



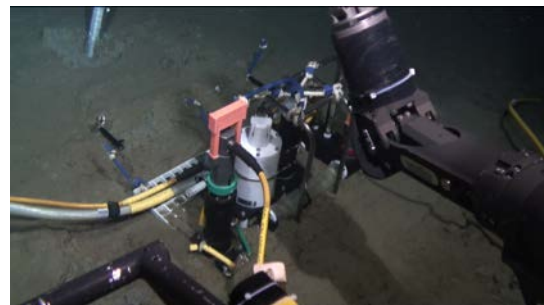
(a) The Connection Box 2D



(b) Cable laying operation



(c) Cable bobbin with cable on the seafloor

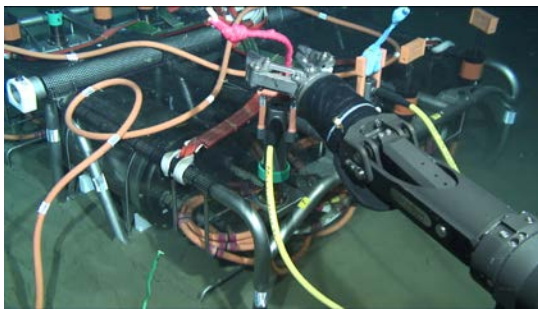


(d) The cable was connected to observatory 2D-15

Fig.5.4. Cable Laying operation at 2D-15

5.5. DIVE #1913 on Nov. 21, 2015: Laying operation of the extension cable at 2D-15(2)

The cable-laying operation from Node 2D to the Connection Box 2D was carried out using the automated cable-laying system. After landing near Node 2D, the ROV first put the underwater mateable connector linking to the upper end of the cable on the cable bobbin into the port 7 of the node. After that, the junction box was placed on the seafloor and the cable-laying operation was started. After arriving at near the Connection Box 2D, the ROV placed the cable bobbin on the seafloor and connected the cable with the Connection Box 2D using the underwater mateable connector. It was confirmed that there is no problem in communication between the observatory 2D-15 and the landing station. The length of the dispensed cable was approximately 9,169m and the traveled distance was approximately 8,571m.



(a) Connection with the node (Port No.7)



(b) Installation of the junction box



(c) Cable laying Operation



(d) Cable bobbin

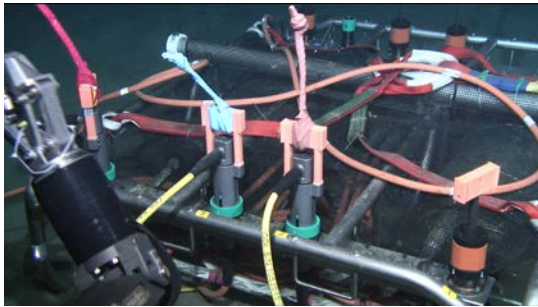


(e) The Connection Box 2D

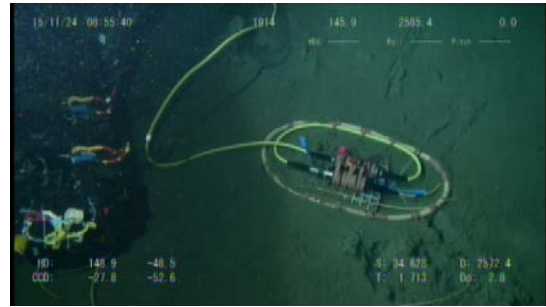
Fig 5.5. Cable-laying operation from Node 2D to the Connection Box 2D

5.6. DIVE #1914 on Nov.24, 2015: Cable-laying operation at 2D-13

The cable-laying operation from Node 2D to the observatory 2D-13 was carried out using the automated cable-laying system. After landing near Node 2D, the ROV first put the underwater mateable connector linking to the upper end of the cable into the port 3 of the node. After that, the junction box was placed on the seafloor and the cable-laying operation was started. After arriving at near the observatory 2D-13, the ROV placed the cable bobbin on the seafloor and connected the cable with the observatory 2D-13 using the underwater mateable connector. It was confirmed that there is no problem in communication between the observatory 2D-13 and the landing station. The length of the laid cable was approximately 8,954m and the traveled distance was approximately 8,063m.



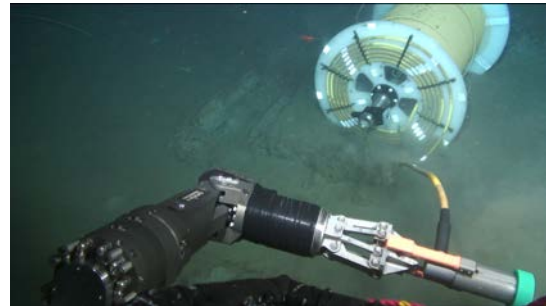
(a) Connection with the node 2D



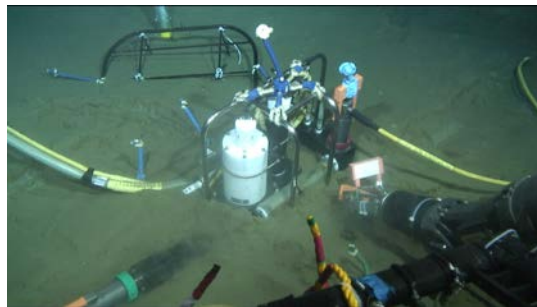
(b) Installation of the junction box



(c) Cable laying Operation



(d) Cable bobbin with cable on the seafloor

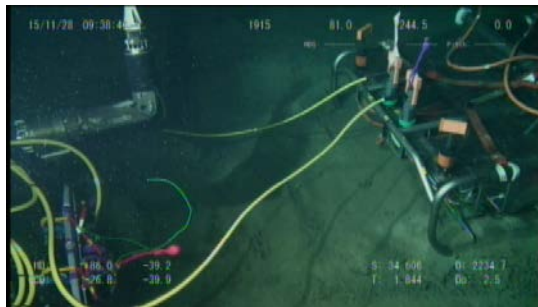


(e) The cable from Node 2D was connected to observatory 2D-13

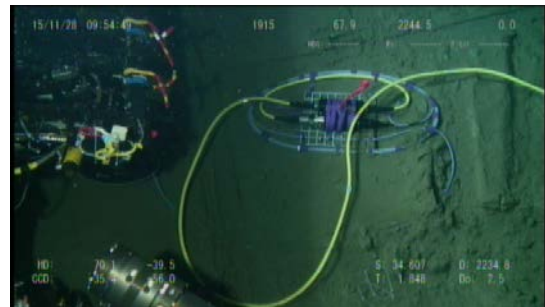
Fig 5.6. Cable-laying operation at site 2D-13

5.7. DIVE #1915 on Nov. 28, 2015: Cable-laying operation at 2F-24

The cable-laying operation from Node 2F to the observatory 2F-24 was carried out using the automated cable-laying system. After landing near Node 2F, the ROV first put the underwater mateable connector linking to the upper end of the cable into the port 3 of the node. After that, the junction box was placed on the seafloor and the cable-laying operation was started. After arriving at near the observatory 2F-24, the ROV placed the cable bobbin on the seafloor and connected the cable with the observatory 2F-24 using the underwater mateable connector. It was confirmed that there is no problem in communication between the observatory 2F-24 and the landing station. The length of the laid cable was approximately 8,484m and the traveled distance was approximately 7,960m.



(a) Connection with the node 2F



(b) Installation of the junction box



(c) Cable laying operation



(d) Cable bobbin

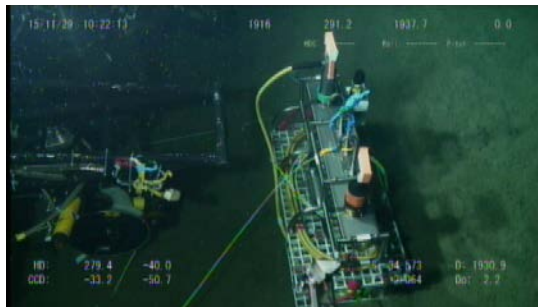


(e) The cable from Node 2F was connected to observatory 2F-24

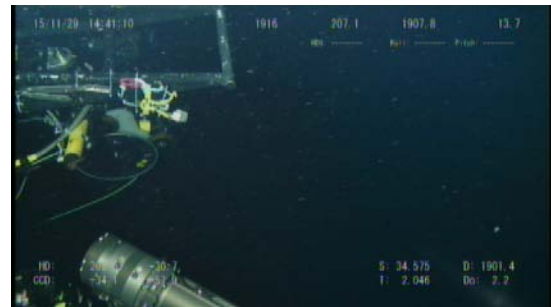
Fig. 5.7. Cable-laying operation at site 2F-24

5.8. DIVE #1916 on Nov. 29, 2015: Laying operation of the extension cable at 1E-22(1)

The cable-laying operation from the Connection Box 1E to the observatory 1E-22 was carried out using the automated cable-laying system. After landing on the halfway point between Node E and site 1E-22, the ROV put the Connection Box 1E that was connected to the upper end of the cable on the cable bobbin. After that, the junction box was put on the seafloor. Then, the cable laying operation was started. The ROV laid the cable from the Connection Box 1E to the observatory 1E-22, and then the cable bobbin was put on the seafloor near the observatory 1E-22. At last, the ROV connected the extension cable to the observatory 1E-22. The length of the laid cable was 8,982 [m], the traveled distance was 8,425[m].



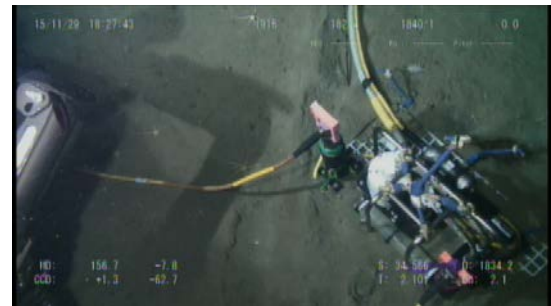
(a) The Connection Box 1E



(b) Cable laying operation



(c) Cable bobbin

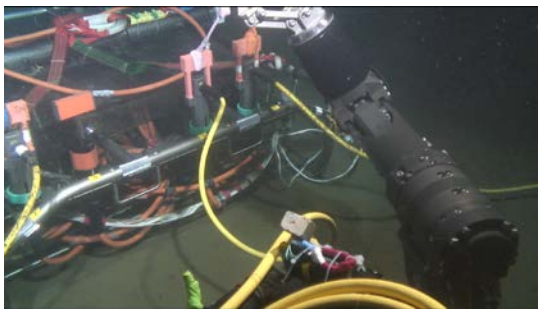


(d) The cable was connected to observatory

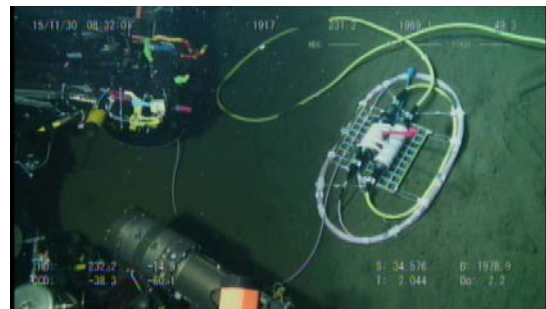
Fig. 5.8. Cable-laying operation at site 1E-22

5.9. DIVE #1917 on Nov.30, 2015: Cable-laying operation at 1E-22(2)

The cable-laying operation from Node E to the Connection Box 1E was carried out using the automated cable-laying system. After landing near Node E, the ROV first put the underwater mateable connector linking to the upper end of the cable on the cable bobbin into the port 3 of the node. After that, the junction box was placed on the seafloor and the cable-laying operation was started. After arriving at near the Connection Box 1E, the ROV placed the cable bobbin on the seafloor and connected the cable with the Connection Box 1E using the underwater mateable connector. It was confirmed that there is no problem in communication between the observatory 1E-22 and the landing station. The length of the laid cable was approximately 8,644m and the traveled distance was approximately 8,315m.



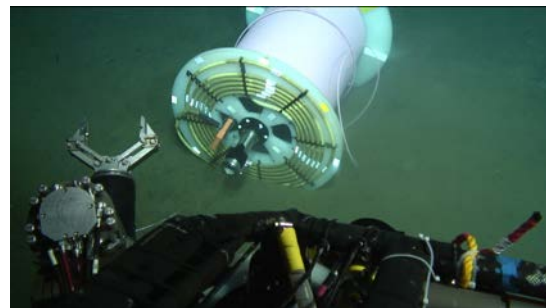
(a) Connection with the node E



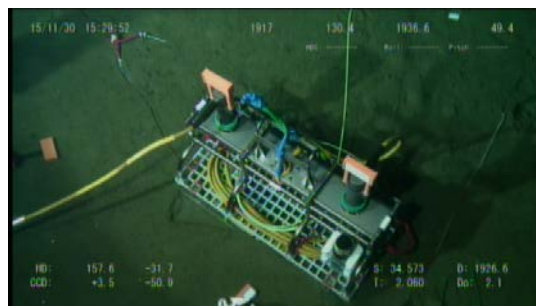
(b) Installation of the junction box



(c) Cable laying operation



(d) Cable bobbin



(e) The Connection Box 1E

Fig 5.9. Cable-laying operation from Node E to the Connection Box 1E

5.10. DIVE #1918 on Dec.1, 2015: A measurement of a precise water pressure using a mobile pressure gauge on the C0002 platform

In this dive, an ROV Hyper Dolphin (HPD) was operated for a measurement of a precise water pressure on the C0002 platform using a mobile pressure gauge and switching valve of the C0002 pressure sensor for the calibration. First, the HPD landed on the C0002 platform, and opened and closed a valve of the pressure gauge. After that we stayed about 3 hours near the platform for a thermally stable measurement of the mobile pressure gauge. Then we moved pressure gauge onto the C0002 platform, and placed the mobile pressure gauge. After an hour of the water pressure measurement, we recovered the pressure gauge. During the measurements, we opened and closed three valves of pressure sensors equipped in the C0002 borehole for the correction.

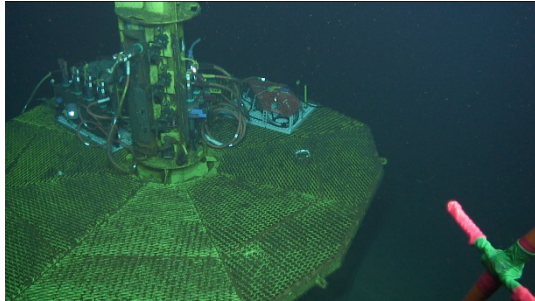


Fig.5.10.1 C0002 platform

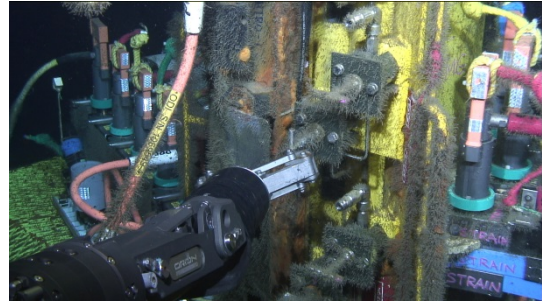


Fig. 5.10.2 Valve operations of the pressure sensors in the C0002 borehole

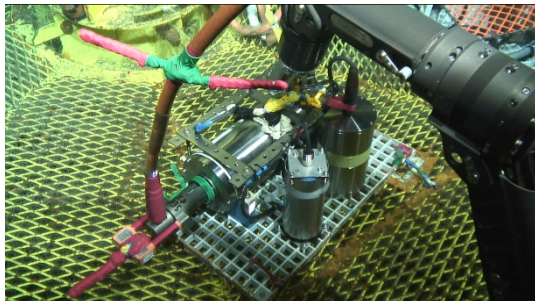


Fig. 5.10.3 Deployment of the mobile pressure gauge.

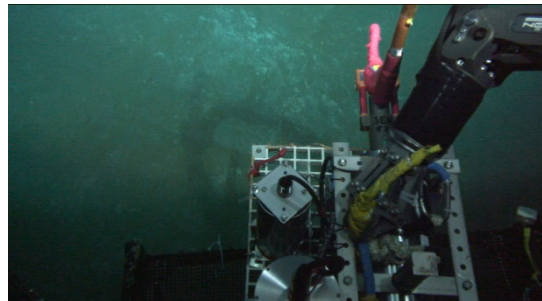


Fig. 5.10.4 The mobile pressure gauge on the C0002 platform.

6. Notice on Using

This cruise report is a preliminary documentation as of the end of the cruise.

This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.

Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.