



KAIYO Cruise Report

KY15-05Leg2

Construction of DONET2 system

Off Kii Channel

Kumano-nada

March.12 – March.29, 2015

Japan Agency for Marine-Earth Science and Technology

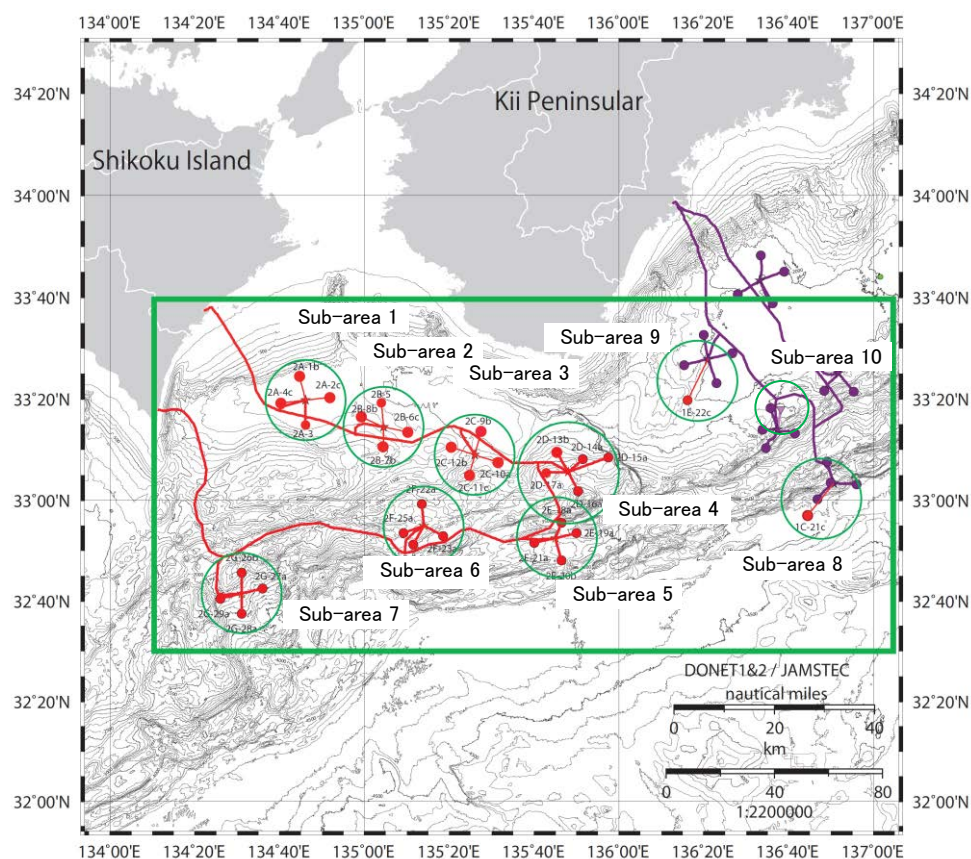
(JAMSTEC)

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1. Cruise Information

- Cruise ID KY15-05Leg2
- Name of vessel R/V KAIYO
- Title of cruise
 - Theme 1: Construction of DONET2 system
 - Theme 2: Re-installation of the Node E
 - Theme 3: Development of long-term borehole observation technology using Nankai borehole monitoring systems
- Title of proposal
 - Theme 1: Construction of DONET2 system
 - Theme 2: Re-installation of the Node E
 - Theme 3: Development of long-term borehole observation technology using Nankai borehole monitoring systems
- Cruise period March.12 – March.29, 2015
- Ports of call Wakayama shimotsu – Wakayama shimotsu
- Research area Off Kii-Channel, Kumano Nada
- Research Map



2. Science Party

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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 Re-installation of the Node E

DONET1 has been operating with 5 science nodes and 20 observatories in Kumano-nada since 2011. In May 30 2014, the data acquisition in Area E was interrupted by insulation fault between the Branching Unit E and the Node E. In order to find out the fault point, the investigation dive was carried out in expedition NT14-10, and it became clear that the fault was occurred in the Node E. The Node E was recovered in expedition KY14-13 and repaired by a manufacturer. In order to restore the failure which occurred in the system under operation, the node E was re-installed in this expedition.

3.3 Development of long-term borehole observation technology using Nankai borehole monitoring systems

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 (Paroscientific Inc. 8b7000-2 and 8b7000-1) into the C0002 boreholes 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 for the correction. The mobile pressure gauge has a crystal water pressure meter (Paroscientific Inc. 410K) as a pressure sensor and is equipped with a pressure holding function due to a temperature control using a heater. Also, an electric valve control was adopted. These systems decrease a pressure variation throughout an observation. In this dive, we calibrate the pressure gauge installed in the C0002 boreholes due to instrumental drifts using the mobile pressure gauge.

4. Operation list

Table 1 List of operation

Date	Area	Dive No.	Operation
12. Mar, 2015	Wakayama port		Departure
13.Mar, 2015	Off Kii Channel	Dive#1786	The sediment removal in the caisson; 2G-29
14.Mar, 2015		Dive#1787	The sediment removal in the caisson; 2E-18
15.Mar, 2015		Dive#1788	Installation of the measurement instruments; 2E-18
16.Mar, 2015			Harborage
17.Mar, 2015		Dive#1789	Laying operation of the extension cable; 2F-15
18.Mar, 2015		Dive#1790	Recovery of the measurement instruments; 2B-5
19.Mar, 2015			Harborage
20.Mar, 2015		Dive#1791	The sediment removal in the caisson; 2E-19
21.Mar, 2015		Dive#1792	Laying operation of the extension cable; 2E-18 (aborted)
22.Mar, 2015		Dive#1793 Dive#1794	Cleaning inside the caisson; 2B-5 Installation of the measurement instruments; 2B-5
23.Mar, 2015	Wakayama port		
24.Mar, 2015	Kumano nada	Dive#1795	Re-installation of the Node E
25.Mar, 2015	Off Kii Channel		Harborage
26.Mar, 2015		Dive#1796	Calibration of the pressure gage in the C0002 borehole and setting/recovery of the mobile pressure gauge.
27.Mar, 2015		Dive#1797	Laying operation of the extension cable; 2E-18
28.Mar, 2015		Dive#1798	Setting/recovery of the mobile pressure gauge.
29.Mar, 2015	Wakayama port		Arrival; End of KY15-05Leg2

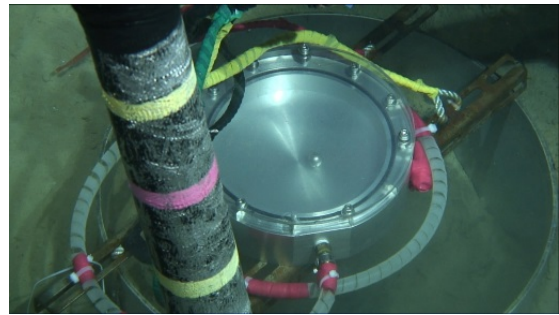
5. Dive Summary

5.1. DIVE #1786 on Mar. 13, 2015: Sediment removal at 2G-29

In this dive, the preparations which install measurement instrument in a caisson were carried out. The tilting angle of the caisson at 2G-29 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 HPD and then a cover plate was placed on the caisson. The position of the caisson is (32-40.502N, 134-25.995E, Depth: 2142m).



(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 2G-29.

5.2. DIVE #1787 on Mar. 14, 2015: Sediment removal at 2E-18

In this dive, the preparations which install measurement instrument in a caisson were carried out. The tilting angle of the caisson at 2E-18 was measured to make sure whether it is suitable for installation of the seismometer package. After landing, the ROV moved toward the caisson at 2E-18b (32-55.619N, 135-46.471E, 3,525m). 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 and then a cover plate was placed on the caisson. The position of the caisson is (2E-18c: 32-55.632N, 135-46.484E, 3550m).



(a) Before operation



(b) Measuring the tilting angle



(c) After sediment removal



(d) Placing a cover plate on the caisson

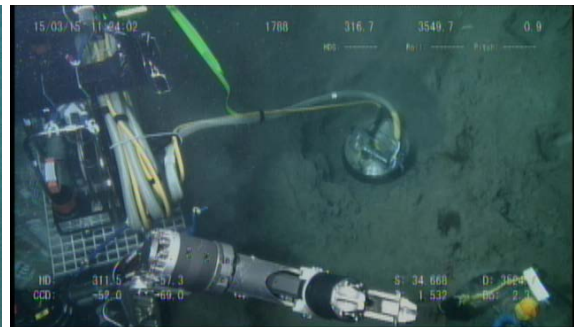
Fig. 5.2. Measuring the tilting angle and sediment removal at 2E-18

5.3. DIVE #1788 on Mar. 15, 2015: Installation of the measurement instrument at 2E-18

In this dive, we installed an observatory system at the caisson 2E-18. The observatory system consists of a seismometer, a pressure sensor package, and a battery package. First, the seismic sensor package was installed inside the caisson. Next, the pressure package was deployed next to the seismic package. These two sensors are initially connected. The battery package was then deployed next the pressure package and connected.



(a) Caisson and a cover plate before the installation



(b) Installtion of the seismometer



(c) The pressure sensor package and battery were connected.

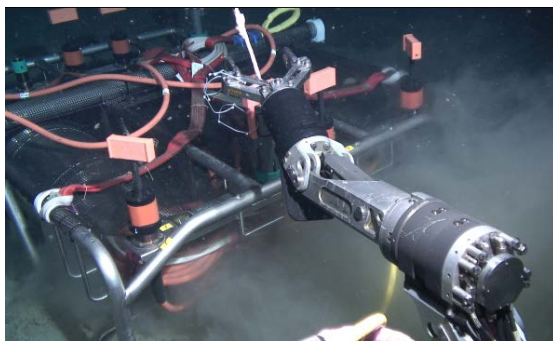


(d) The pressure sensor package and battery

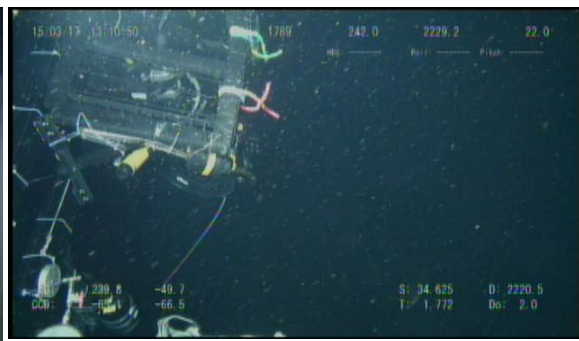
Fig 5.3. Installation of the measurement instruments at 2E-18

5.4. DIVE #1789 on Mar. 17, 2015: Laying operation of the extension cable at 2F-15

The cable laying operation from the Node 2F to the observatory 2F-15d 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 forefront of the extension cable into the port 5 of the Node 2F. After that, the junction box was put on the seafloor. Then, the cable laying operation was started. The ROV was lay down the cable from the Node 2F to the observatory 2F-15d, and then the cable bobbin was put on the seafloor near the observatory 2F-15d. At last, the ROV connected the extension cable from Node 2F to the observatory 2F-15d. The length of the laid cable was 10,136 [m], the traveled distance was 8,059 [m].



(a) Connection with the node (Port No.5)



(b) Cable laying Operation



(c) Cable bobbin with cable on the seafloor



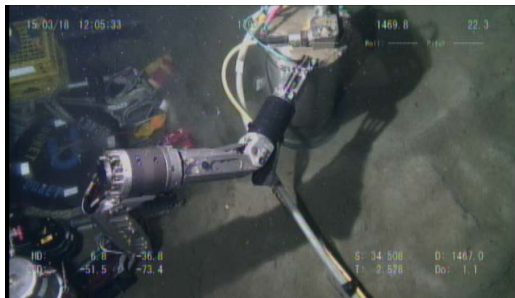
(d) Sensor package of 2F-15d

Fig.5.4. Cable Laying operation of the extension cable at 2F-15

5.5. DIVE #1790 on Mar. 18, 2015: Recovery of the measurement equipment at 2B-5

In this dive, the seismometer package and the pressure sensor package were recovered because there has been a trouble on the gimbal control of the seismometer package. The pressure sensor package is linking with the seismometer package by a cable and the extension cable from the science node and the battery equipment were connected with the pressure sensor package by using underwater mateable connectors.

After landing on the seafloor, the seismometer package was pulled out from the caisson and then the connectors for connecting the observation equipment with the science node and the battery equipment were pulled out. After that, the rope for recovery was hooked on the seismometer package and the pressure sensor package respectively. Lastly, the HPD ascended for recovery.



(a) Seismometer package



(b) Pressure sensor package



(c) Hooking the rope for recovery



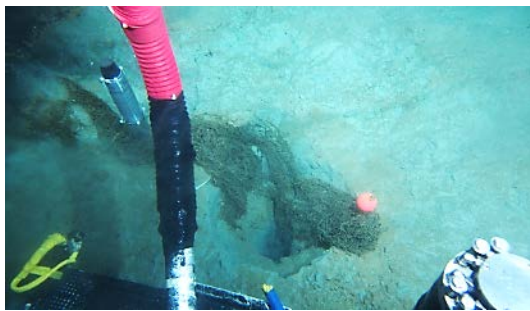
(d) Ascending for recovery

Fig. 5.5. Recovery operation of the measurement equipment at 2B-5.

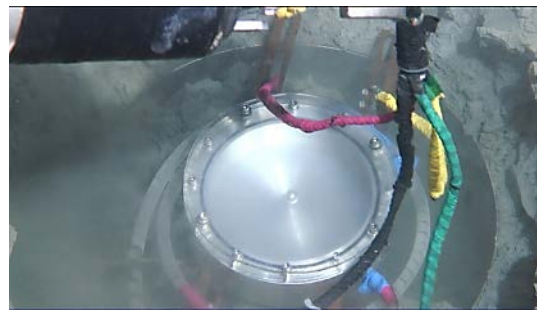
5.6. DIVE #1791 on Mar. 20, 2015: Sediment removal at 2E-19

In this dive, the preparations which install measurement instrument in a caisson were carried out. After landing, the ROV moved toward the caisson at 2E-19b (32-53.496N, 135-50.000E, 3,438m). The tilting angle of the caisson at 2E-19 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 and then a cover plate was placed on the caisson.

The position of the caisson is (2E-19c: 32-53.515N, 135-50.010E, 3,456m).



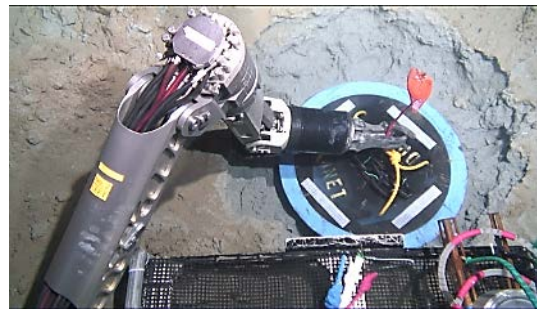
(a) Before sediment removal



(b) Measuring the tilting angle



(c) After sediment removal

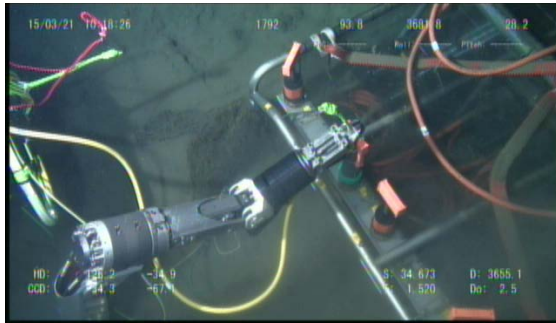


(d) Placing a cover plate on the caisson

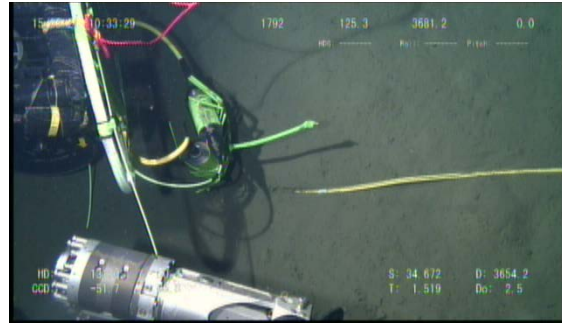
Fig. 5.6. Measuring the tilting angle and sediment removal at 2E-19

5.7. DIVE #1792 on Mar. 21, 2015: Cable laying operation at 2E-18 (aborted)

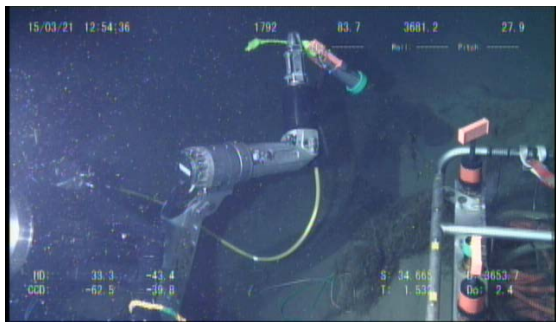
In this dive, The ROV Hyper Dolphin (HPD) was operated for cable-laying between node 2E and 2E-18 observatory. First, the HPD approached node 2E and then plugged the connector of the extension cable into node 2E port 5. Next, the HPD stepped away from node 2E. However, unexpected tension was applied on the junction box during the maneuver. Finally, the dive was aborted in order to confirm the validity of the cable. The HPD grasped the junction box and back to mother ship.



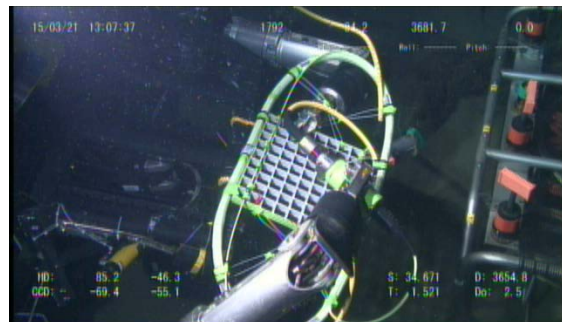
(a) The connector was plugged to Node 2E



(b) Tension was applied on junction box



(c) The connector was unplugging



(d) Recovering Junction box

Fig. 5.8. Cable laying operation to 2E-18 (aborted)

5.8. DIVE #1793 on Mar. 22, 2015: Cleaning inside the caisson at 2B-5

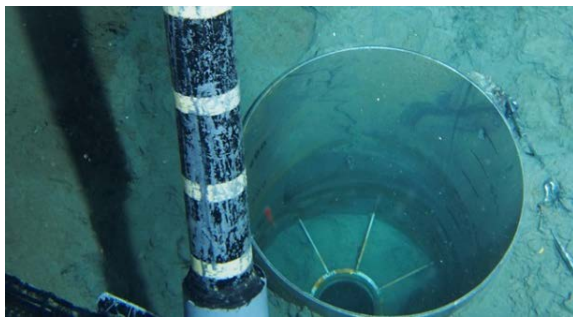
The measurement instrument of 2B-5 was recovered Dive#1790 in this expedition. The sediment or objects fell into the caisson during the measurement instrument was operating. Cleaning was carried out before re-install the measurement instrument. At first, the lid which was put on the caisson in Dive#1790 was removed, and the inside of the caisson was cleaned by the vacuum system. After checking the inside of the caisson, the lid was put on the caisson again.



(a) The lid was opened.



(b) Cleaning inside the caisson



(c) After cleaning

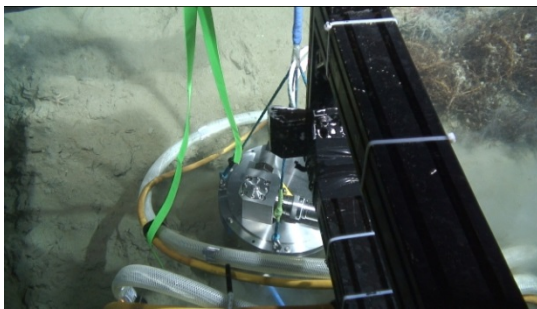


(d) The lid on the caisson

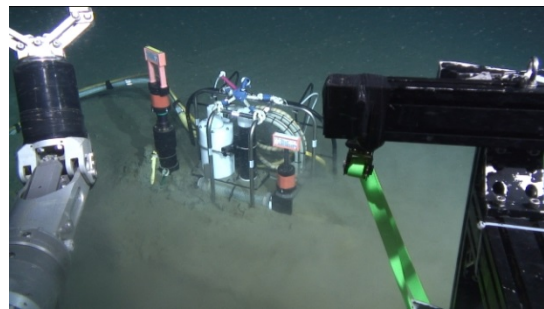
Fig. 5.8. Cleaning inside the caisson 2B-5.

5.9. DIVE #1794 on Mar. 22, 2015: Installation of the measurement instrument at 2B-5

In this dive, we installed an observatory system into the caisson at the point 2B-5 using an ROV Hyper Dolphin (HPD). The observatory system consists of the three parts; seismic sensor package, a pressure sensor package and a battery package. First the seismic sensor package was installed inside the caisson. The pressure sensor package was then deployed on the seafloor next to the seismic package. The battery package which was already put on the seabed was connected to the pressure sensor package. These three packages are connected by cables. An ROV Homer (ID: 49) was shifted to the pressure sensor package. Finally the cover plate was collected before leaving the point.



(a) Installing seismic sensor package



(b) Pressure sensor package

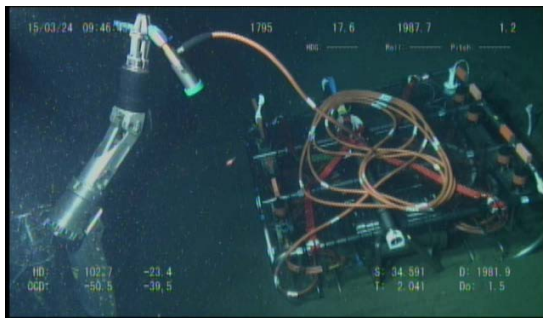


(c) Battery package was connected to the pressure sensor package.

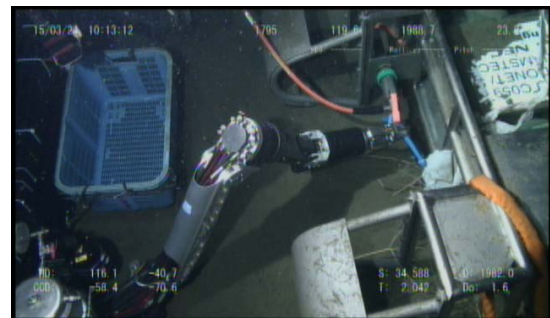
Fig. 5.9. Installation of the measurement instrument at 2B-5

5.10. DIVE #1795 on Mar. 24, 2015: Reinstallation of the node E

The node E had a trouble and was recovered for repair. In this dive, the repaired node was reinstalled. After landing on the seafloor, the HPD moved toward the terminal unit installed by a cable ship and placed the node on the seafloor near the terminal unit. Then, the HPD pulled the underwater mateable connector from the node and took it to the terminal unit for connection. After the connection, it was confirmed in the landing station that the node is operated correctly. After that, four underwater mateable connectors linking with four observatories at 1E-17, 1E-18, 1E-19 and 1E-20 were connected with the node. It was confirmed that the connections between the node and the observatories were achieved successfully.



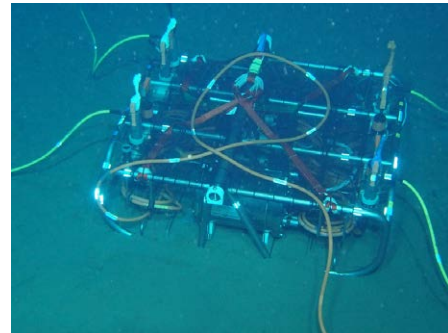
(a) Node E



(b) Connecting with the terminal unit



(c) Connecting with observatories

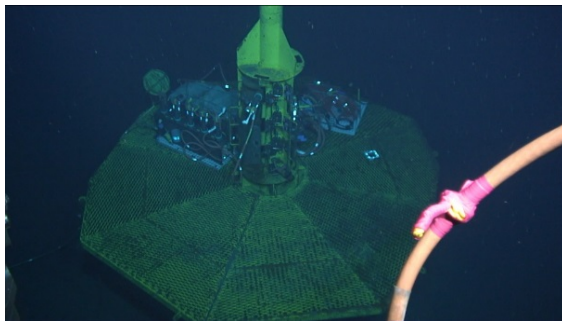


(d) re-installed Node E

Fig. 5.10. Reinstallation of the node E

5.11. DIVE #1796 on Mar.26, 2015: A measurement of a precise water pressure using a mobile pressure gauge on the C0002 platform

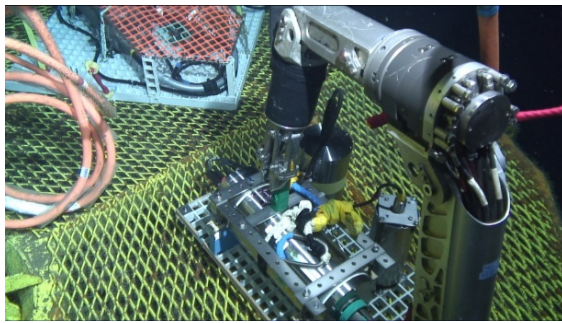
In this dive, an ROV Hyper Dolphin (HPD) was operated for a measurement of a precise water pressure on the C0002 platform using a mobile pressure gauge. First, the HPD landed near the C0002 platform. Then we opened a valve of the pressure gauge, and stayed about 3 hours for a thermally stable measurement. Then we moved the pressure gauge onto the C0002 platform, and placed the mobile pressure gauge. After an hours 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.



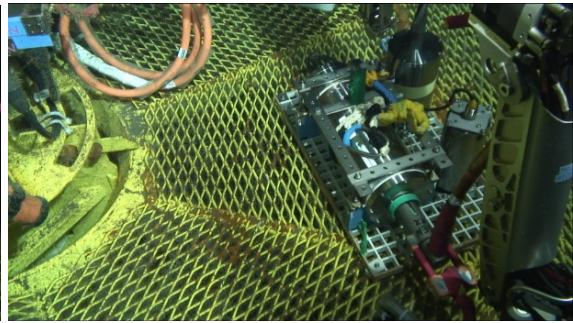
(a) C0002 platform



(b) Valve operations of the pressure sensors in the C0002 borehole



(c) Deployment of the mobile pressure gauge.

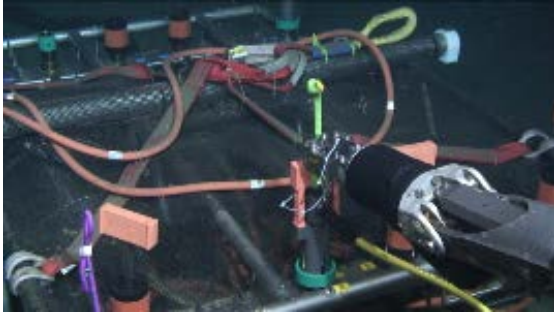


(d) The mobile pressure gauge on the C0002 platform.

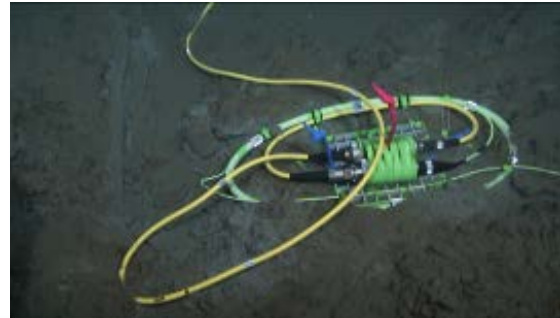
Fig. 5.11 . A measurement of a precise water pressure using a mobile pressure gauge

5.12. DIVE #1797 on Mar.27, 2015: Cable-laying operation at 2E-18

After landing near the Node 2E, the ROV put the underwater mateable connector linking to the forefront of the cable on the cable bobbin into the port 5 of the Node2E. After that, the junction box was put on the seafloor. Then, the cable laying operation was started. The ROV was lay down the cable from the Node2E to the observatory 2E-18d, and then the cable bobbin was put on the seafloor near the observatory 2E-18. At last, the ROV connected the cable from Node2E to the observatory 2E-18d.



(a) Connection with the Node 2E



(b) Installation of the junction box



(c) Cable laying operation

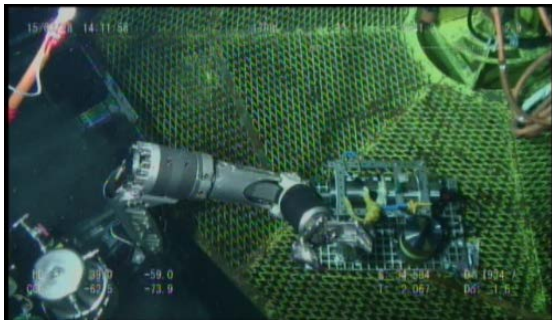


(d) Cable bobbin was putted on near the sensor

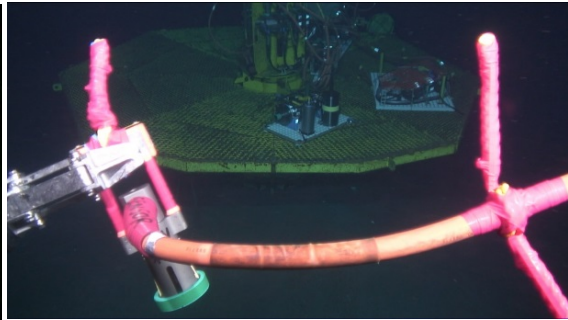
Fig 5.12. Cable-laying operation at 2E-18

5.13. DIVE #1798 on Mar.28, 2015: A measurement of a precise water pressure using a mobile pressure gauge on the C0002 platform

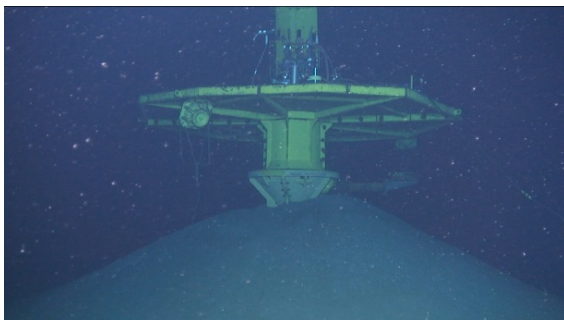
In this dive, an ROV Hyper Dolphin (HPD) was operated for a measurement of a precise water pressure on the C0002 platform using a mobile pressure gauge. First, the HPD landed near the C0002 platform. Then we opened a valve of the pressure gauge, and stayed about 3 hours for a thermally stable measurement. Then we moved the pressure gauge onto the C0002 platform, and placed the mobile pressure gauge. After an hours of the water pressure measurement, we recovered the pressure gauge.



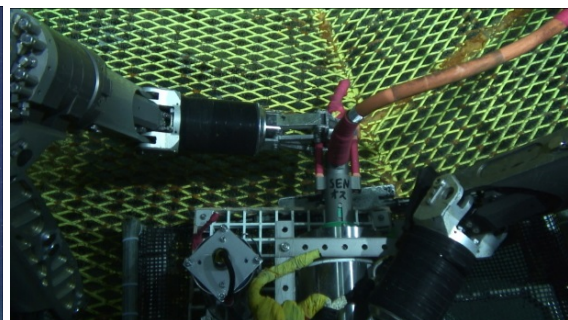
(a) A deployment of the mobile pressure gauge on the C0002 platform.



(b) The mobile pressure gauge on the C0002 platform.



(c) The mobile pressure gauge on the C0002 platform.



(d) A recovery of the mobile pressure gauge.

Fig. 5.13. A measurement of a precise water pressure using a mobile pressure gauge

6 . Notice on Using

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

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