

NT10-09 Cruise Report
KUMANO-NADA
DONET Node Installation & Observatory
Construction



June 2010

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1. Overview

DONET is a program to establish the technologies of large scale real-time seafloor research and surveillance infrastructure for earthquake, geodetic and tsunami observation and analysis. This program has been carried out since 2006 to settle on To-Nankai region in Nankai trough as the target of observation. From January to March 2010, the DONET backbone cable system was laid on the seafloor through the cable laying ship. First DONET science node and observatory was constructed on seafloor by using ROV “Hyper Dolphin” in DONET expedition NT10-04 on March 2010 (as Photo 1). The observatory in operation succeeded in demonstration of sophisticated measurement capability of earthquakes and tsunamis observation. The initial plan scheduled to construct twenty sets of observatories to cover the active seismogenic zone of To-Nankai earthquakes and secure the monitoring performance equal with the earthquakes observation network on land.

Expedition NT10-09 is scheduled to deploy another observatories and nodes on seafloor to round out the original observatory network topology.

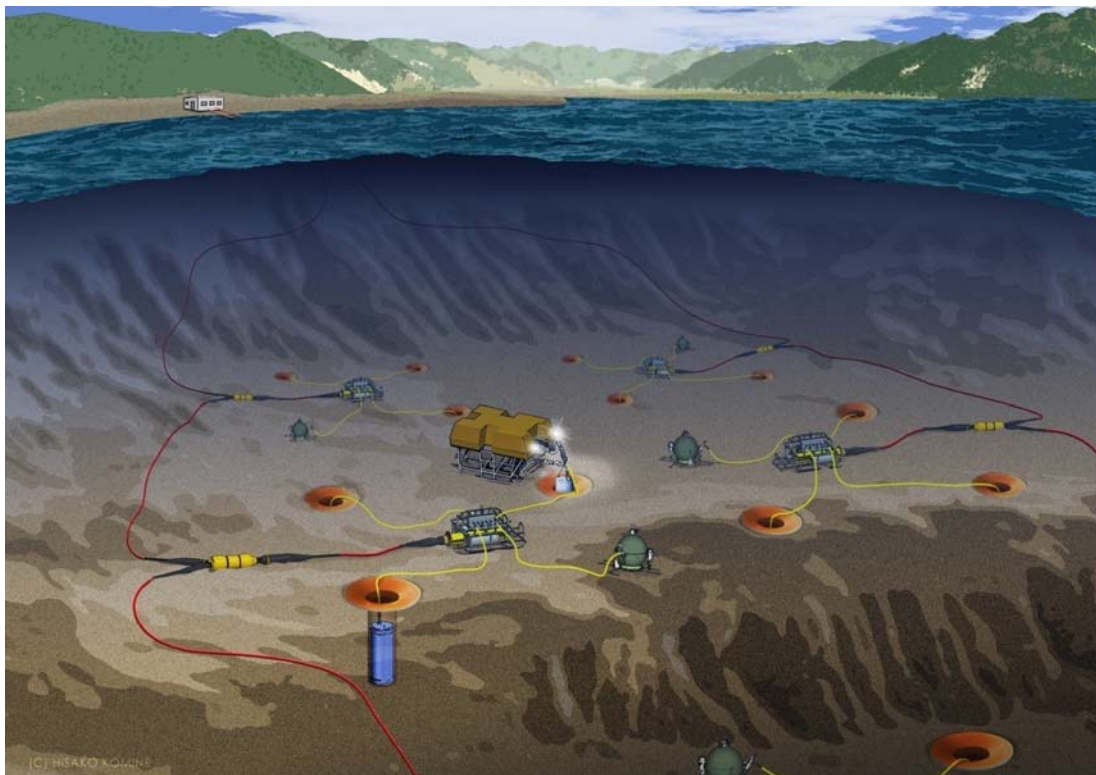


Figure 1 Image of DONET cable observatory

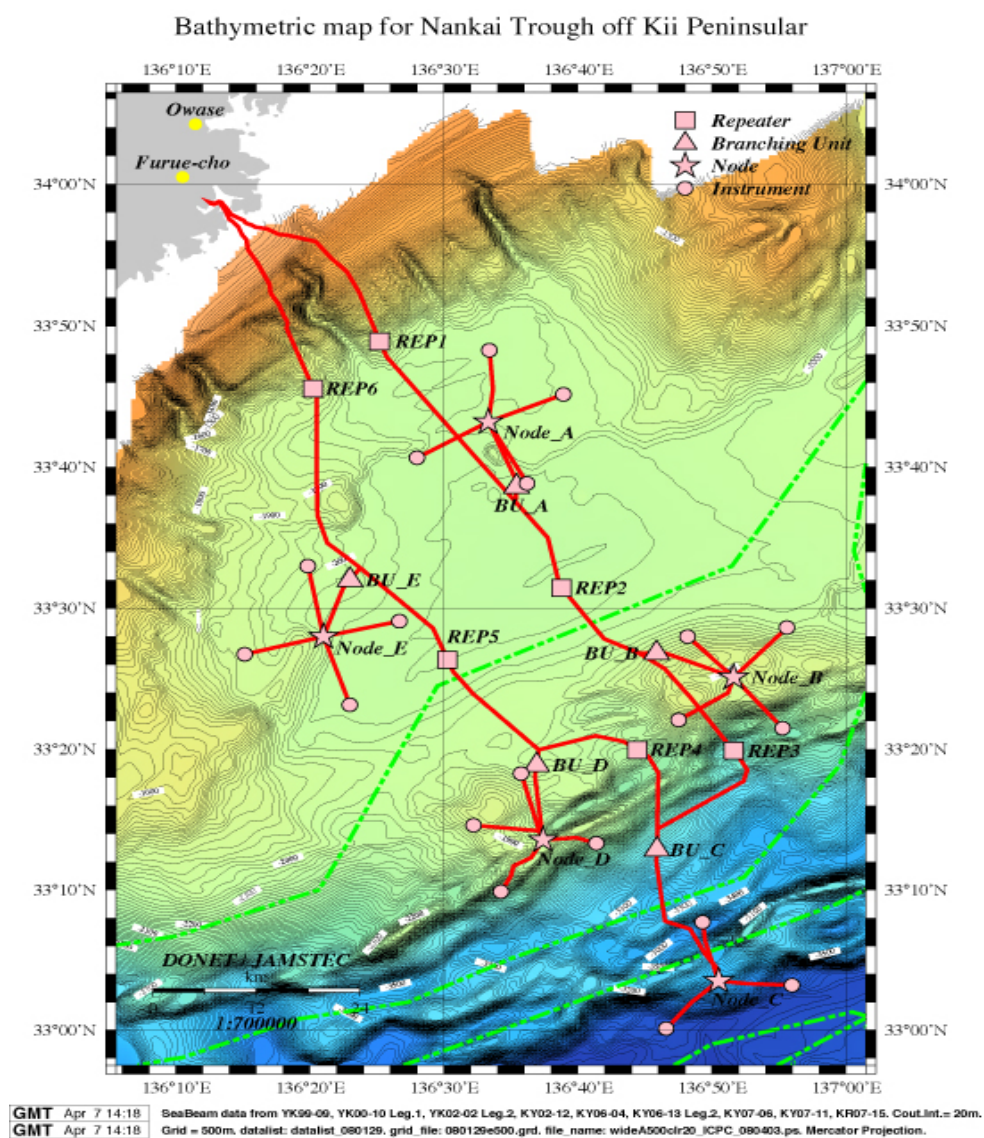


Figure 2 DONET backbone cable route and observatory & node position

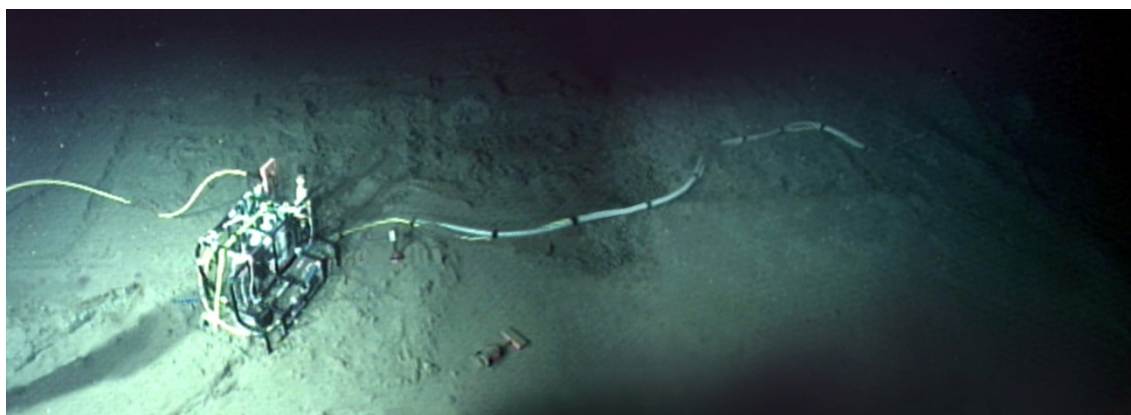


Photo 1 DONET observatory on seafloor

An observatory deployed on the seafloor is connected to one of the five hub systems (science node) in backbone submarine cable system as star formed topology. The extension cable system will be secured the point-to-point power distribution and communication channel between observatory and science node. The electrical and fiber optical hybrid underwater mate-able connectors fitted up the both cable end of extension cable system make possible the maintenance or replacement of observatories on the seafloor without difficulty. Approximately 10km length of extension cable is essential for each point-to-point connection to acquire proper observatory arrangement. In addition, it is necessary to connect the two accurate locations on deep seafloor with only several to a few tenth meters position error margin. Because of the conventional cable laying method by laying ship is not fit for this kind of operation requirement, a ROV (Remotely Operated Vehicle) based thin submarine cable laying method is contrived for seafloor observatory construction.

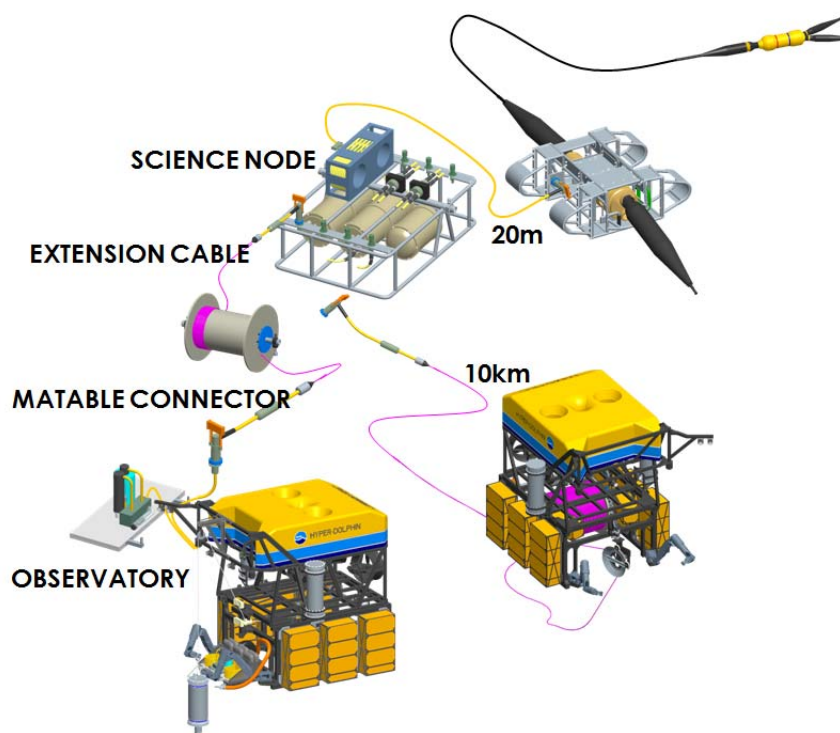


Figure 3 Scenario of DONET observatory construction

The cable laying ROV is remodeling of ROV Hyper Dolphin for loading 10km length of extension cable and make possible to laying a cable between any two points on seafloor. The cable laying system is composed of three main components these are cable bobbin elevator, tension controlled extension cable pay out system, and VBCS (variable buoyancy control system). The cable bobbin elevator make possible to equip and release the cable bobbin together with 10km length of extension cable in air and water. The elevator works by the supplied hydraulic power from ROV. It is generate one ton of pulling torque that is a sufficient power to lift the cable bobbin of 650kgf in air. The cable bobbin is fixed to the chase of cable laying system with the pair of stab rod when operating.

The cable payout system can control the cable payout speed voluntarily to manage the reasonable cable slack correspond to laying course or undulated seafloor terrain. The slip roller and bobbin break mechanically managed the cable payout tension 30kg constant. It is suits for the 100kg that is a designed value of extension cable breaking strength to prevent unexpected restrict of ROV on seafloor with extension cable.

The ROV hyper-dolphin has the 100kg of buoyancy compensate capability in water using vertical thrusters. However, this number is not sufficient for the cable laying operation which buoyancy variation during the cable pay out and wind up operation is 180kg. The VBCS is composed of a pair of 50L volume pressure resist water tank to compensate up to 100kg of buoyancy variation in water to maintain the mobility of ROV in operation.

In addition to these main components, cable laying ROV comes to be able to conduct cable recover operation by equipping it with a cable traverse actuator. Each component actuated by the hydraulic pressure distributed by the ROV hyper dolphin hydraulic interfaces for user payload.

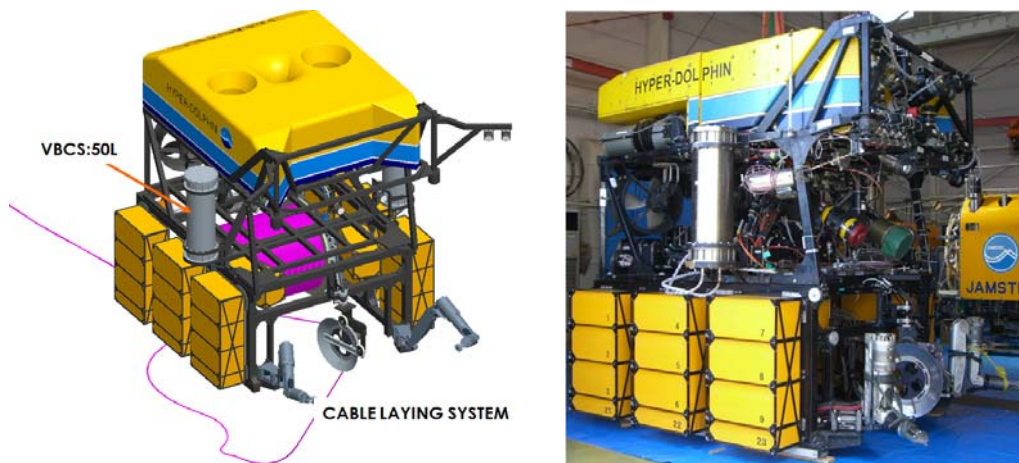


Figure 4 Cable laying ROV

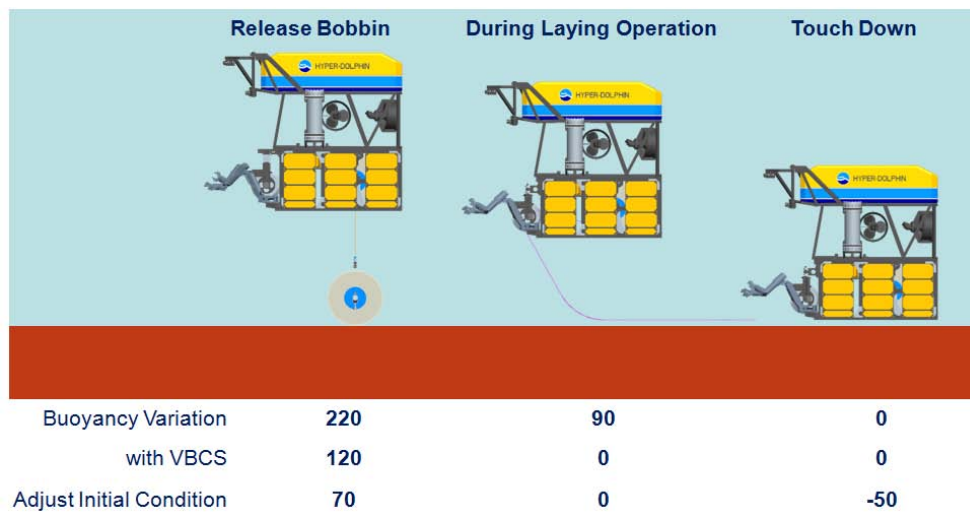


Figure 5 Estimation of buoyancy variation

2. Schedule

In NT10-09, nine ROV dives were originally scheduled for DONET node installation and observatory construction. The time window of this cruise was May 21th to June 3rd 2010. The summary of NT10-09 is listed in the table below.

Table 1 Summary of NT10-09 cruise

Date	Place	Action
21-May	Yokosuka	Embark at JAMSTEC Yokosuka HQ
22-May	Kumano-Nada	Dive #1130&1131: Science Node Installation
23-May	Mikawa-Bay	Evading Navigation
24-May	Mikawa-Bay	Evading Navigation
25-May	Mikawa-Bay	Evading Navigation
26-May	Kumano-Nada	Dive #1132: Observatory Construction
27-May	Kumano-Nada	Dive #1133: Observatory Construction
28-May	Kumano-Nada	ROV Maintenance
29-May	Kumano-Nada	Dive #1134: Observatory Construction
30-May	Kumano-Nada	Dive #1135: Observatory Construction
31-May	Kumano-Nada	Dive #1136: Observatory Construction
1-Jun	Kumano-Nada	Dive #1137: Science Node Installation
2-Jun	Kumano-Nada	Dive #1138: Science Node Installation
3-Jun	Yokosuka	Disembark at JAMSTEC Yokosuka HQ

3. Dive Summary

Dive 1130&1131

May 22th 2010. The first mission of expedition NT10-09 was science node installation to area “E”. A landing target is TU-E (Termination Unit E: 33-27.888N, 136-20.956E, ROV homer ID: 27). The dive 1130 started at 8:28 in the morning, however right after to descend a new main camera system had some telecommunication trouble and lost its image from operation monitor. The vehicle was recovered on deck, replace the main camera to conventional system, and resume the mission dive 1131 at 10:31. The vehicle touchdown to seafloor at 11:28, and easily found the target TU-E at 11:36 using an acoustic signal from ROV homer. The science node was placed 19m far from TU-E and set it up on the seafloor at 12:25.

The position of science node is

ID: Node-A020: 33-27.909N, 136-20.971E, 1984m

A interconnect cable between science node and TU which equipped science node, was laid to TU-E and connected to high voltage UMC (underwater mateable connector) interface by ROV manipulator (13:05). The science node was started up from landing station and confirmed basic functions at 13:44.



Photo 2 Approach to TU-E on seafloor

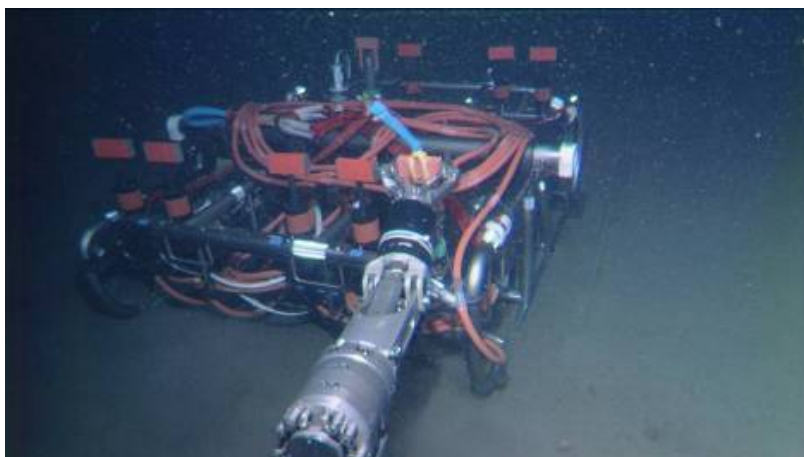


Photo 3 Setup science node on seafloor

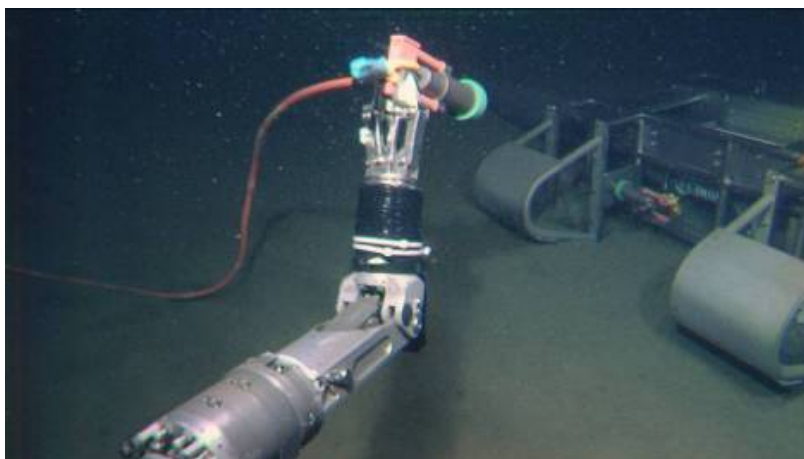


Photo 4 Interconnect cable mating operation

DIVE 1132

A DONET observatory construction was conducted in site A-2b (33-45.161N, 136-38.935E, ROV homer ID:92) at May 26th. A DOROTHY suction pump tool, an observatory (consist of a ground motion sensing system and a pressure sensing system), and 6 bags of burying material were loaded on the HPD and head for target site. HPD found the target burial casing at 09:37 and the exact location is 33-45.144N, 136-38.930E, 2011m. The vehicle started to make a burial hole at 10:05 and successfully complete the treatment at 13:35. After this treatment, a ground motion sensing system was installed in the hole and lay a pressure sensing system on the ground by 10m far from burial hole. This operation completed at 15:03 and 6 bags of materials placed beside the burial hole. The serial number of observatory of A-2 site is A040 and ROV homer ID is still 92.



Photo 5 Penetrated burial casing at observation site A-2



Photo 6 Burial hole conditioning by DOROTHY system

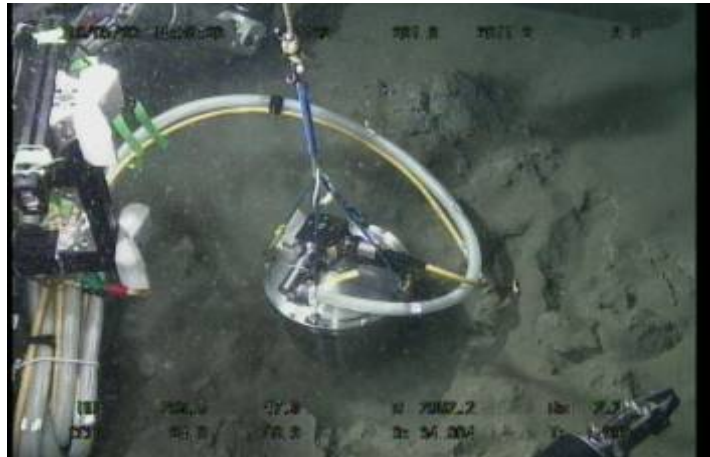


Photo 7 Ground motion sensing system installation

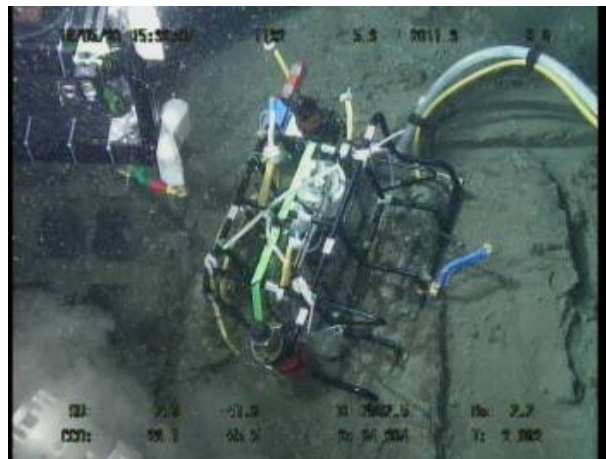


Photo 8 Pressure sensing system installation



Photo 9 Put burying materials on the seafloor

DIVE 1133

May 27th, HPD implemented a burial hole treatment at observation site E-17. HPD equipped only DOROTHY system in dive 1133 because the operation was begun in the afternoon and was not able to be expected enough working time for whole observatory construction. The vehicle arrived at the seafloor at 14:48 and took approximately 10 minute to looking for the burial casing in seafloor. 14:58, vehicle found the casing (33-29.101N, 136-26.699E, 2055m, ROV homer ID:98) and begun the treatment operation using DOROTHY. In this site, large amount of man-made garbage was dug up from the sediment and these obstacles made the operation difficultly. 18:07, the burial hole treatment was finally completed as a result of 3 hours ROV work as photo 12.



Photo 10 Penetrated burial casing at observation site E-17



Photo 11 Man-made garbage –Plastic bag-

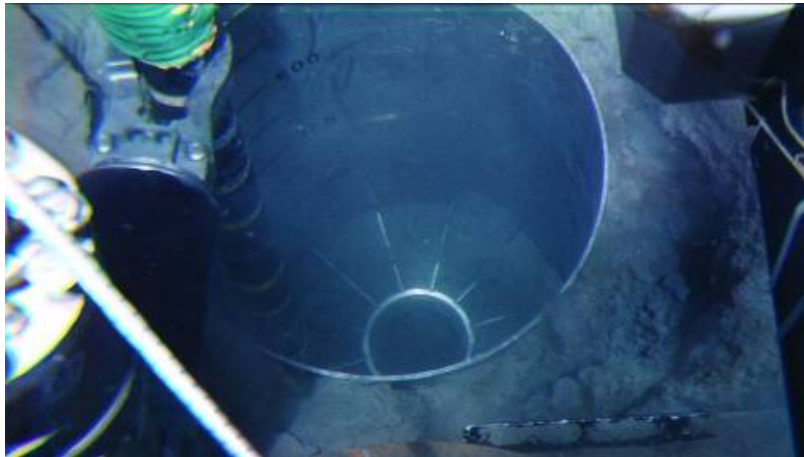


Photo 12 Burial casing –conditioned-

DIVE 1134

An observatory construction at E-17 was implemented May 29th in dive 1134. An observatory (consist of a ground motion sensing system and a pressure sensing system), and 6 bags of burying material (10L each) were loaded on the HPD and head for target site. HPD approached to the burial hole which inside was treated by DOROTHY system in dive 1133 and deployed the observatory (serial number: SPKG-A060) at 10:43. The final location of E-17 observatory is

Ground motion sensing system: 33-29.098N, 136-26.703E, 2054m

Pressure sensing system: 33-29.095N, 136-26.298E, 2054m, ROV Homer ID: 98

The gap between burial casing and ground motion sensing system was filled by the burying material (fine sand) to pack the sensing system into the seafloor. Reduction of environmental noise effect is expected from this treatment.

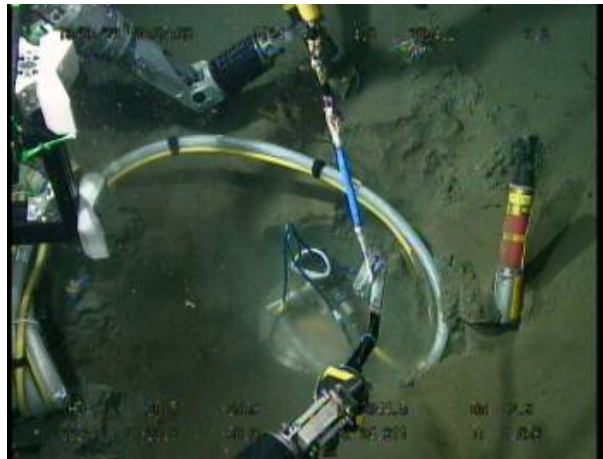


Photo 13 Ground motion sensing system installation at site E-17

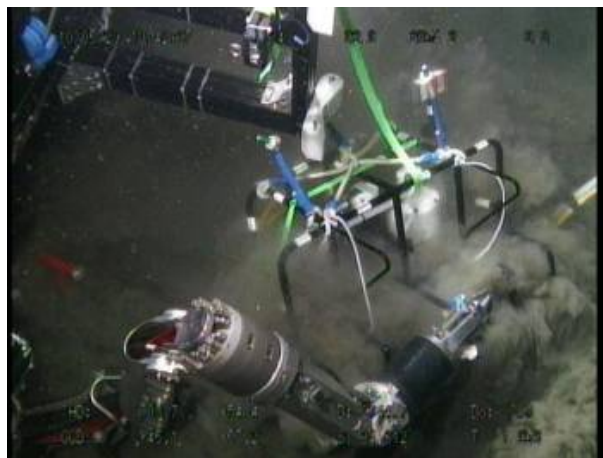


Photo 14 Pressure sensing system installation at site E-17



Photo 15 Post treatment of ground motion sensing system.

DIVE 1135

Because the weather had been expected to worsen the afternoon, DIVE 1135 was planned half day operation from morning. Site A-4 was selected for the observatory construction target. Only a burial hole treatment was scheduled in this dive. The HPD equipped DOROTHY system and six bags of burying material in payload. The pre-installed burial casing was found at 08:59 with a state of unexpected. Unfortunately, the casing started coming out of seafloor as figure 16. The HPD try to recover this accident and successfully re-insert the casing in sediment layer by a splendid manipulator operating. After the recovering operation, sediment leftover inside of burial casing was treated by using DOROTHY system. Six burying material bags were put aside of the casing and the vehicle close the mission at 10:53.

The location of A-4 site is..

33-40.680N, 136-28.035E, 2054m , ROV homer ID:24



Photo 16 Burial casing in unexpected condition



Photo 17 Burial casing recovery



Photo 18 Burial casing recovery -2



Photo 19 Burial casing conditioning



Photo 20 Put a cover on the top of Burial casing

DIVE 1136

Because the weather had recovered at next morning, a continuation of A-4 observatory construction was executed the afternoon May 31st. An observatory serial number SPKG-A080 was set up to the site A-4 in this dive. After observatory installation, on the half way of observatory burying operation, HPD had some hydraulic system trouble and break off the construction in this dive at 15:29. The observatory was not complete the construction in this expedition.



Photo 21 Ground motion sensing system installation at site A-4

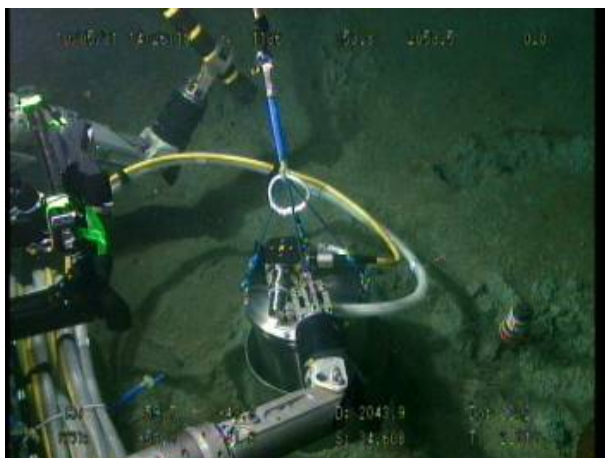


Photo 22 Ground motion sensing system installed to conditioned hole

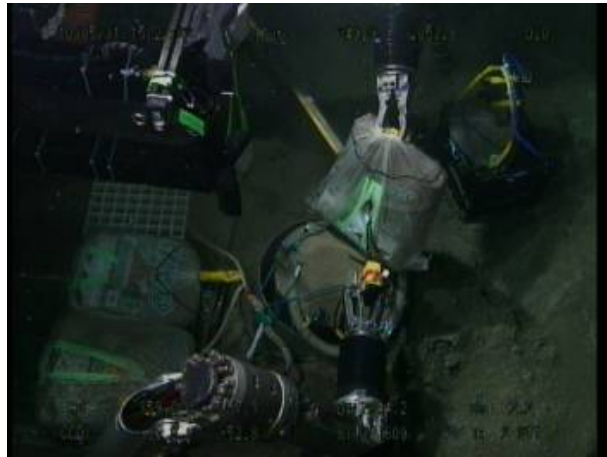


Photo 23 Post treatment of ground motion sensing system

DIVE 1137

June 1st. A science node was installed on seafloor in dive 1137. HPD placed science node ID: Node-A030 on aside of TU-B at 16:56. The information is..

TU-B: 33-25.161N, 136-51.666E, 1857m, ROV homer ID:24

Node-B: 33-25.150N, 136-51.683E, 1859m

18:24, Node –B was booted up and confirmed the basic functions from landing station.

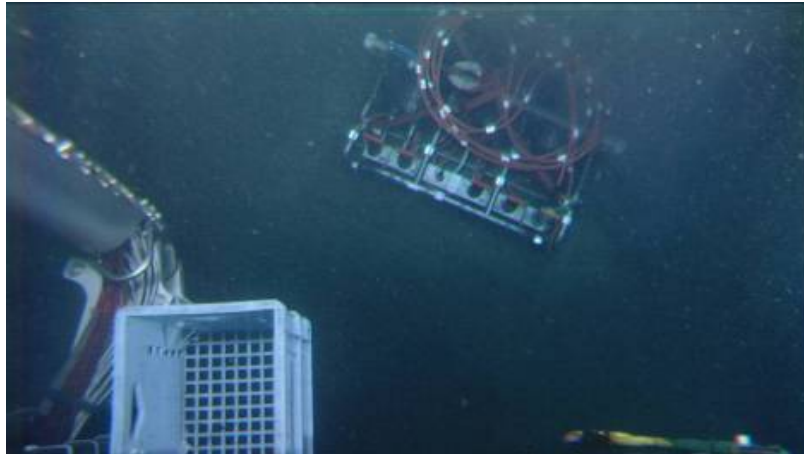


Photo 24 Science node installation at area-B

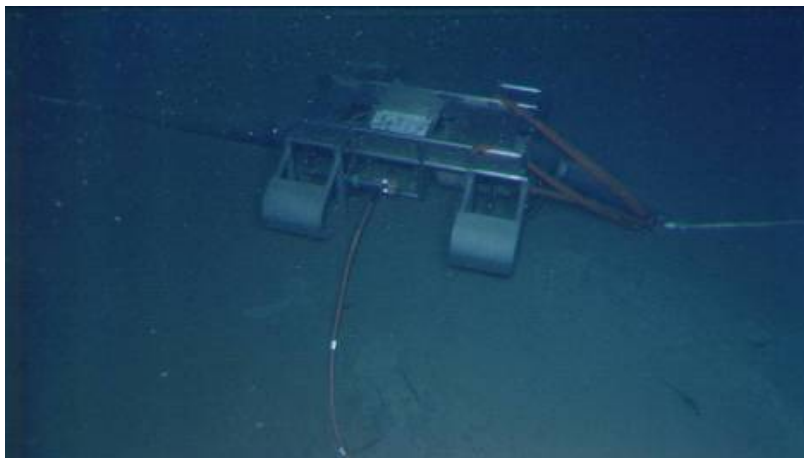


Photo 25 Termination unit at area-B (TU-B)



Photo 26 Sea-ground installation

DIVE 1138

This is a last dive of expedition NT10-09. Only 3 hours of seafloor operation time was secure the morning June 2nd. The HPD placed a science node (ID: Node-A040) on the observation area “D” (10:21), connected it to the TU-D (10:44) and confirmed the node functions from DONET landing station at Owase-city (11:17). The R/V Natsushima desert the area immediately after having completed confirming the node health check.

TU-D: 33-14.000N, 136-37.354E, 2070m, ROV homer ID:26

Node-D: 33-13.998N, 136-37.350E, 2080m



Photo 27 Interconnect cable mating operation to TU-D

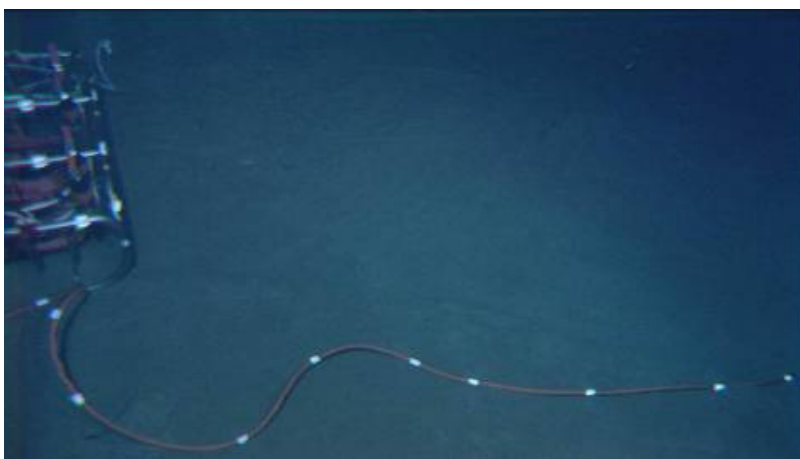


Photo 28 Interconnect cable on seafloor near science node



Photo 29 Interconnect cable on seafloor near TU (TU-D)

4. Concluding Remarks

Plenty of operation time on seafloor was not able to be secured in this cruise period because the stormy weather and condition of ROV umbilical cable. We could not find the chance to implement extension cable laying operation in this time (because this operation needs to have stable sea condition and more than 10 hours of operation time). However, on the other side 3 science nodes and 3 observatories were successfully constructed on the seafloor in this expedition. This preparation will be a great help to accelerate the construction of observatory near future (in the cruise on October).

End of report....