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Cruise report of R/V Kaiyo KY10-07 cruise.

"Installation of Earthquake and Tsunami monitoring system"

Kumano-nada, off Shiono-misaki, the Nankai Trough

Earthquake and Tsunami research project for Disaster Prevention, JAMSTEC

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1. Cruise summary information

Research Theme: Construction and improvement of Seafloor observation Network for Earthquakes and Tsunamis

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Research area: Kumano-nada

Cruise period: May 1/2010 (Yokosuka JAMSTEC) – Leg 1- May 9/2010 (Shingu) - Leg2 - May 18/2010 (Yokosuka JAMSTEC)

2. Background and Objectives

Research project of earthquake and tsunami, disaster prevention, JAMSTEC has been conducting development of monitoring system for earthquake and tsunamis since 2006 under a contracted research program from MEXT, "Development of monitoring system of earthquake and tsunami". The development consists from development of network system that can deploy seismometers and tsunami sensors densely in offshore Kii Peninsula (Figure 1), where large earthquake occurs in an interval of 100-150 years. We developed a network system consisting from a backbone cable, nodes, sensors, and extension cables. The backbone cable is a loop of approximately 250 km fiber optic cable both ends landed at land station in Furue-cho, Owase-city of Mie prefecture. The backbone cable has five termination units where we can connect a node that distributes power and data communication to sensors Searfloor sensors, 20 of which are distributed in and around the rupture zone of Tonankai Earthquake offshore Kii Peninsula, are connected to the backbone cable via a node, which distributes power and data to each seafloor sensors. The sensors, consists from a set of seismometers, pressure gauges, and a thermometer. Seismometers are buried in the seabed to improve its coupling to the ground motion and escape from influences caused by seafloor water motion.

The backbone cable was laid out by a commercial cable laying ship in January to March, 2010. Installation of nodes and sensors are conducted by JAMSTEC's R/V Natsushima with remotely operated vehicle (ROV) Hyper Dolphin. Seismic sensors are buried into the seabed. We need to have a shallow hole in the seafloor to bury the seismic sensor by ROV. Perforating seafloor shallow hole is planned by two steps, installing a caisson with a root using piston corer, and sweeping mud which is enclosed in the caisson using a hydraulic pump with ROV Hyper Dolphin. The purpose of this cruise is to conduct the former half operations to perforate seafloor hole; installation of caissons using piston corer.

Another objective of this cruise was to survey the seafloor by a camera to clear the route for cable extension. This was necessary to assure safe cable extension operation by ROV to connect seafloor sensors and the node. The survey was performed during the latter half of the cruise using JAMSTEC "Deep Tow" camera with a towing system to recover or cut obstacle such as a rope when encountered.

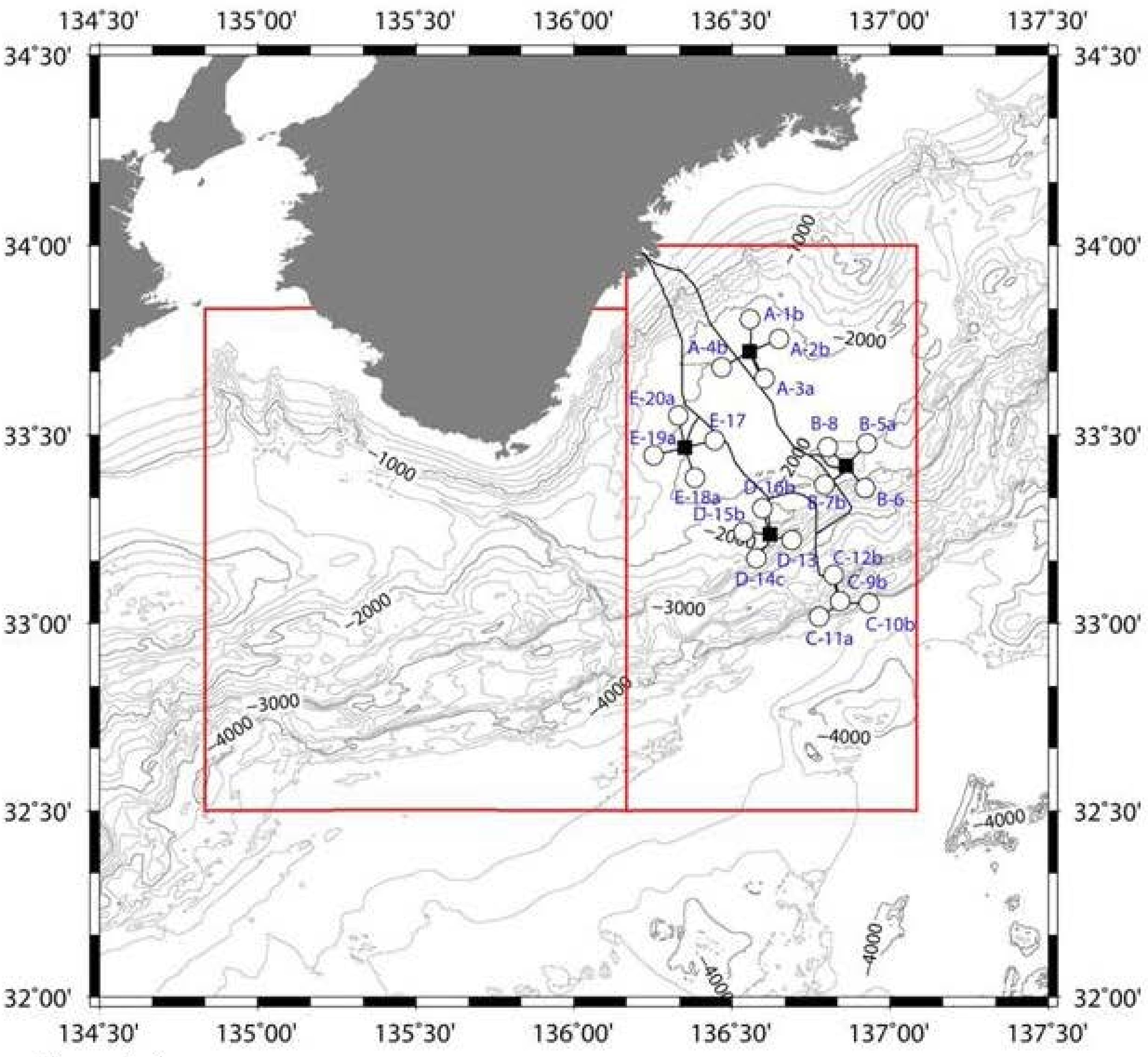
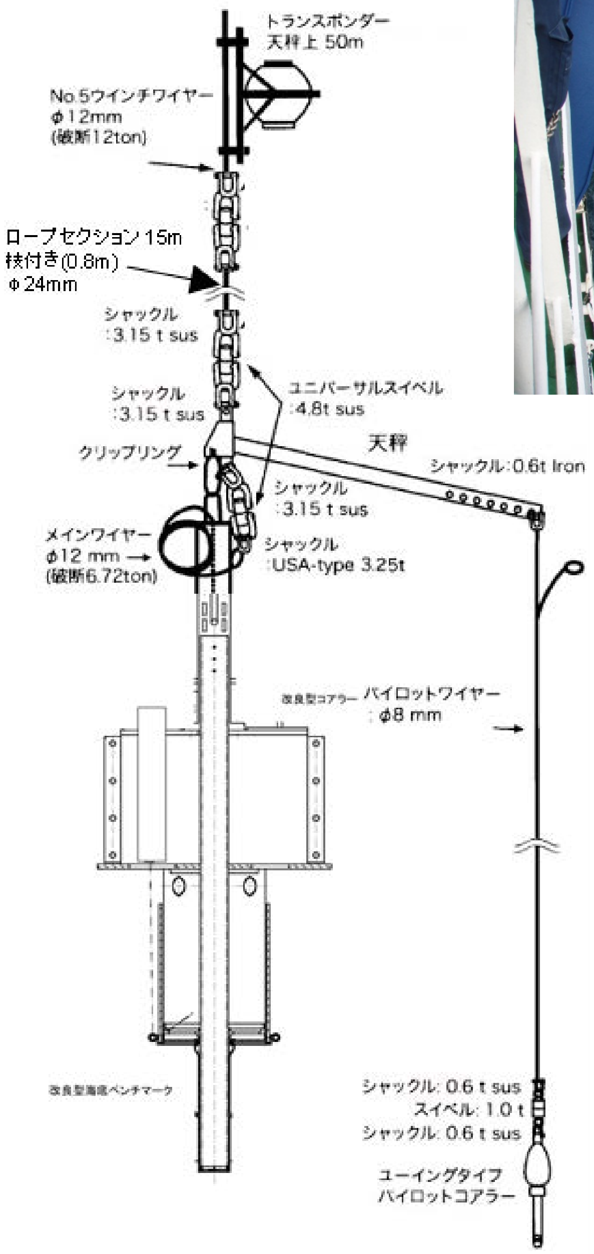


Figure 1. Survey area map.

3. Methods

3.1 Seafloor casing installation by gravity corer.

Perforation of seafloor and installation of seafloor casing for seismometer installation was performed by a gravity corer which can release a caisson attached to the end of corer. Figure 2 illustrates the gravity corer we used. The corer is lowered to the seafloor using #5 winch of R/V Kaiyo. When approached near the seafloor, after checking location using SSBL of the position of the corer from acoustic transponder located 50 m above the corer, the corer is further lowered to the seafloor until the pilot corer touch the seafloor and the corer weight and caisson free fall to penetrate seafloor. Penetration status of seafloor casing is confirmed by seafloor sensor and tiltmeter. Status of these sensors can be monitored by the response of the acoustic release transponder when called. Acoustic command to the acoustic release from R/V Kaiyo releases the casing while the inner pipe and core sample is recovered with the corer.



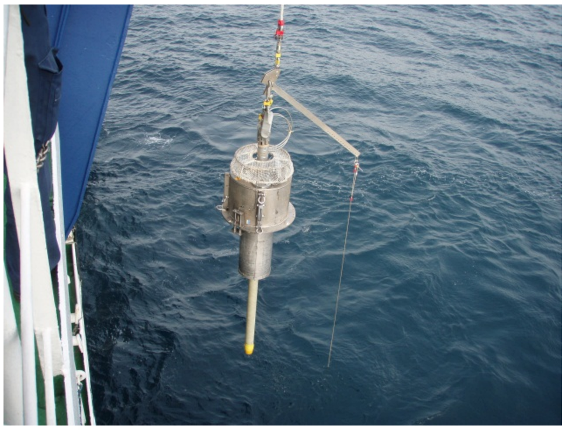


Figure 2. Casing installing piston corer.

3.2 Deep tow survey

Deep Tow survey used 6000m class Deep tow camera system to survey seafloor along the planned cable route between the science node of DONET and planned observatories. We prepared a towing system shown as Figure 3 to capture obstacle between the seafloor and the deep tow frame. The Deep tow camera system also equipped a ROV Homer acoustic transponder to measure distance to the ROV homer acoustic mini-transponder attached to the terminal unit of the DONET cable deployed by cable ship prior to the cruise.

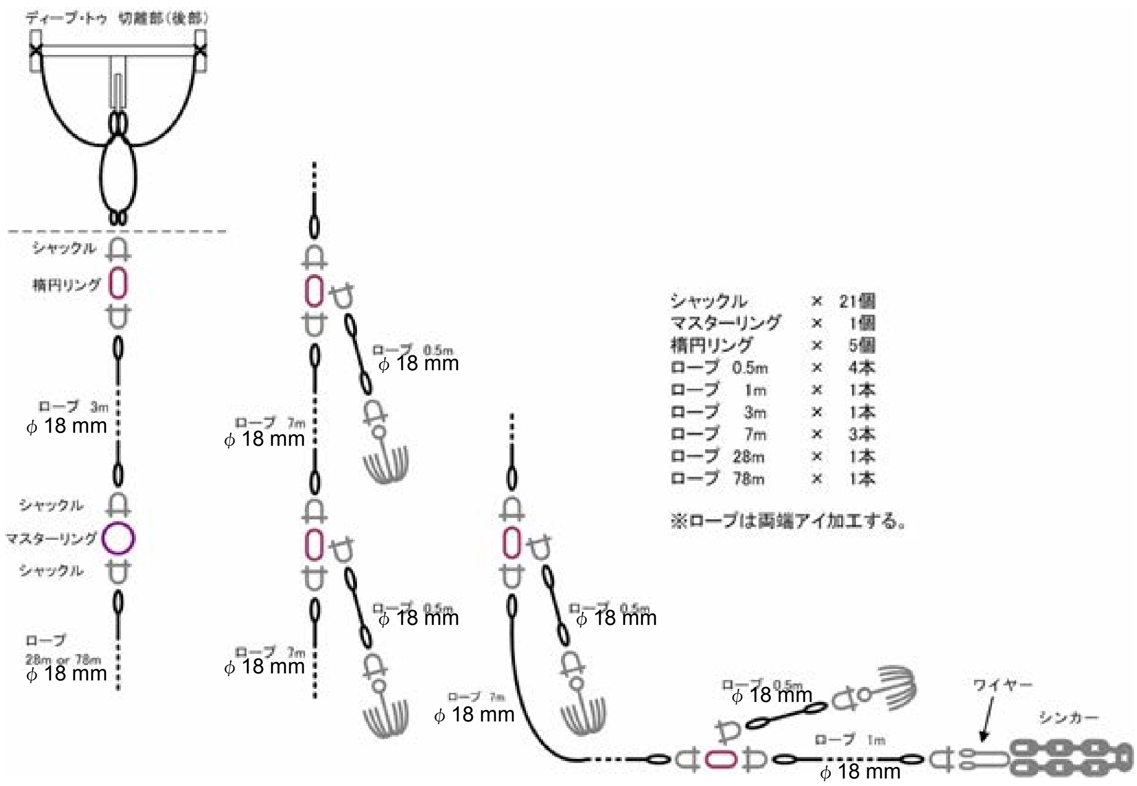


Figure 3. Towing system plan

4. Operation and results

4.1 Seafloor casing installation by gravity corer.

Seafloor casing installation using gravity corer in areas of Node A through E were attempted from May 2 to May 8. Two coring were attempted each day except for May 3rd. Operation of casing installation is summarized in Table 1, showing time of each attempt, location of the corer by transponder location from SSBL acoustic navigation, and tilt of installed casing, and the results of coring including if we released the casing.

Some of the attempts failed. There are various reasons of the failure, such because of unbalance of the corer system, insufficient penetration due to stiff seafloor. We analyzed the cause of the failure from response of acoustic transponder indicating tilt and penetration, tilt information given from tiltmeter and accelerometer attached to the corer, contents of cored sample. In the case that unbalance of the corer was found from the tiltmeter record, we tried to adjust the balance using counter weight and it was confirmed by the next coring attempt. At sites, D-15b, C-12b, E-20b, C-11a, and C10b, coring results were problematic with stiff seabed condition, and further coring operation was considered necessary in the following cruises. Overall, 9 useful casing installation was performed out of 15 coring trial and 11 releases.

	Point ID	ROV Homer ID	Shot time (JST)	Release	shot position from acoustic Latitude	Longitude	Depth
01	B-8	11	2010/05/02 09:26	Yes	33-27.9924' N	136-48.1742' E	1,714.1m
02	B-7b	16	2010/05/02 14:14	No	33-20.0892' N	136-47.5041' E	2,001.7m
03	B-7b	16	2010/05/03 07:35	Yes	33-20.0734' N	136-47.5088' E	2,013.7m
04	D-16b	13	2010/05/03 11:40	Yes	33-18.2528' N	136-35.7475' E	1,746.6m
05	D-15b	15	2010/05/03 15:07	No	33-14.5820' N	136-32.2234' E	1,637.9m
06	D-14c	14	2010/05/04 08:03	Yes	33-10.3585' N	136-34.6153' E	2,143.8m
07	D-13	17	2010/05/04 12:03	Yes	33-13.2863' N	136-41.4004' E	2,137.5m
08	B-5a	15	2010/05/05 08:18	Yes	33-28.6447' N	136-55.5920' E	1,781.9m
09	B-6	90	2010/05/05 11:47	Yes	33-21.4892' N	136-55.2914' E	2,237.8m
10	C-12b	12	2010/05/06 08:25	Yes	33-07.7025' N	136-49.3099' E	3,470.6m
11	C-9c	93	2010/05/06 13:14	Yes	33-03.5022' N	136-49.8918' E	3,246.5m
12	E-20b	30	2010/05/07 07:47	No	33-33.0084' N	136-19.8249' E	1,761.5m
13	A-1c	66	2010/05/07 14:10	Yes	33-48.2743' N	136-33.4647' E	1,828.8m
14	C-11a	19	2010/05/08 09:12	No	33-00.1393' N	136-46.6205' E	4,155.3m
15	C-10b	18	2010/05/08 14:22	Yes	33-03.2094' N	136-56.0334' E	4,061.0m
Piston corer setting: free fall 3.2m and extended main wire length 3.3m							
main wire length = 9.3m except for #8 and #13 = 10.3m							
pilot wire length = 7.6m except for #8 and #13 = 8.6m							

Table 1. Casing installation operation summary.

ID of the ROV homer attached in each casing, time and location of coring, as well as whether casing was released, are shown.

	Point ID	Corer tilt		coring result				Remarks
		X(°)	Y(°)	Sample ID	Penetratio	Piston	Pilot	
01	B-8	-	-	PC01	1.810m	1.850m	0.790m	
02	B-7b	-22.7	10.3	PC02	1.810m	1.400m	0.685m	broken casing when recovered
03	B-7b	-2.4	-0.6	PC03	0.600m	1.700m	0.975m	
04	D-16b	-	-	PC04	1.810m	1.000m	1.000m	
05	D-15b	-8.5	-11.0	PC05	0.570m	0.630m	0.740m	broken casing when recovered, tilt after landing.
06	D-14c	-1.8	-2.8	PC06	1.480m	1.480m	0.660m	
07	D-13	-7.1	-1.0	PC07	1.500m	1.700m	0.895m	
08	B-5a	-4.3	4.0	PC08	2.680m	2.740m	0.960m	casing length 2.5m
09	B-6	-1.8	-4.2	PC09	1.810m	1.520m	0.990m	
10	C-12b	-1.4	-5.6	PC10	0.580m	0.580m	0.580m	tilt after landing.
11	C-9c	-1.5	1.3	PC11	1.810m	1.390m	0.205m	
12	E-20b	-1.2	-11.6	PC12	0.540m	0.470m	0.365m	broken casing when recovered, ROV homer not recovered.
13	A-1c	-9.6	4.5	PC13	2.680m	2.690m	0.660m	casing length 2.5m
14	C-11a			PC14	1.700m	1.870m	0.110m	broken casing when recovered, ROV homer flooded, no tiltmeter attached
15	C-10b			PC15	-	0.240m	0.010m	no tiltmeter attached

Table 2. Casing installation operation summary (continued).

Corer tilt angle after penetration and coring penetration length are shown.

4.2. Deep-Tow Survey

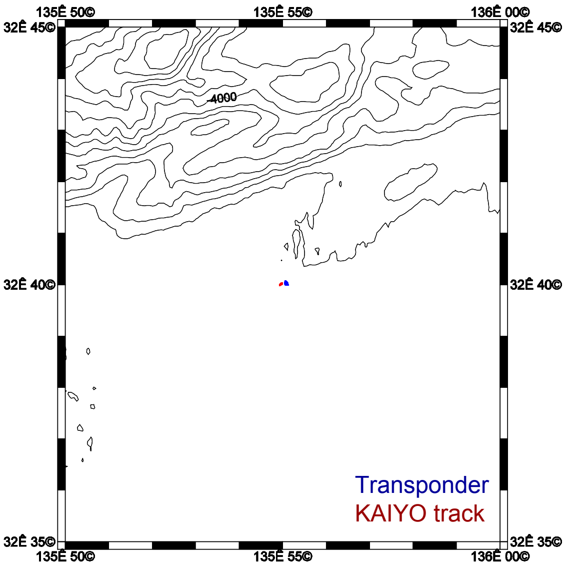
We carried out camera survey by using Deep Tow system during the KY10-07cruise as follows (summary in Table 3). Shaded route survey (DT-4C and DT-5C) indicate the route clearance to remove obstacle. Detailed survey results are given from the next page.

		Start		End	
FreeFall		32_40'0	135_55.0'		
DT-1C	Node_Aa -> A-2b	33_43.349	136_33.215	33_45.161	136_38.935
DT-2C	E-17 -> Node_E	33_29.079	136_26.698	33_28.000	136_21.000
DT-3C	A-4b -> Node_Aa	33_40.677	136_28.037	33_43.349	136_33.215
DT-4C	A-4b area	33_40.6171	136_27.8752		
DT-5C	A-4b area	33_40.68'	136_27.36'	33_40.88'	136_27.68
		33_40.80'	136_27.76'	33_40.60'	136_27.44
		33_40.52'	136_27.52'	33_40.72'	136_27.84'
		33_40.56'	136_28.00'	33_40.36'	136_27.68'
		33_40.28'	136_27.76'	33_40.48'	136_28.08
		33_40.40'	136_28.16	33_40.20'	136_27.84
DT-6C		33_40.677'	136_28.037'	33_43.349'	136_33.215'
DT-7C		33_13.920'	136_37.270'	33_14.238'	136_37.232'

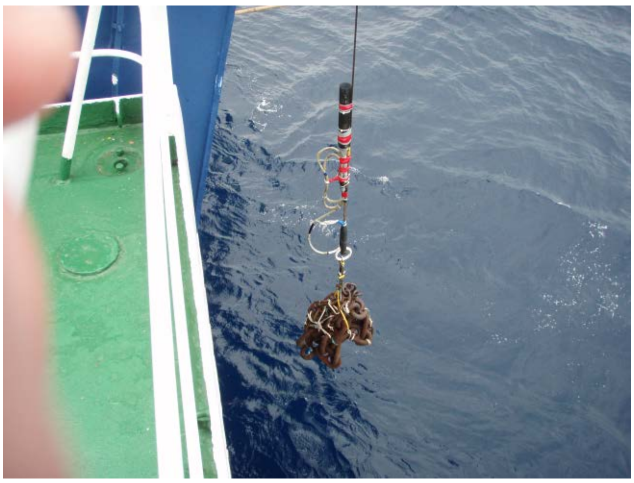
Table3 . Summary of the camera survey

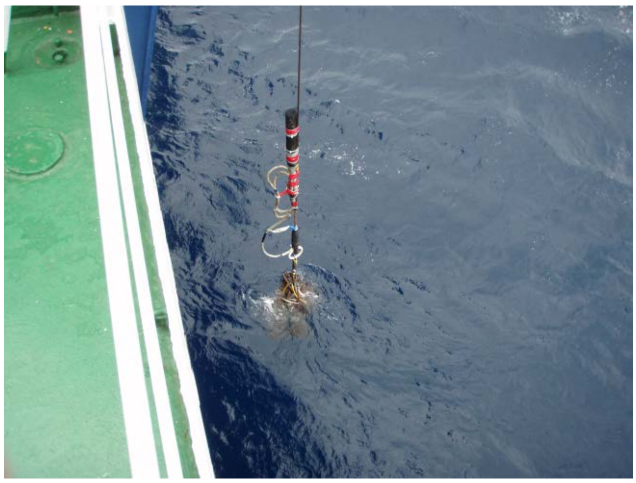
4.2.1 Free Fall(2010/05/10)

Point: 32_40.0'N, 135_55.0'E   D=4,620 m



Point



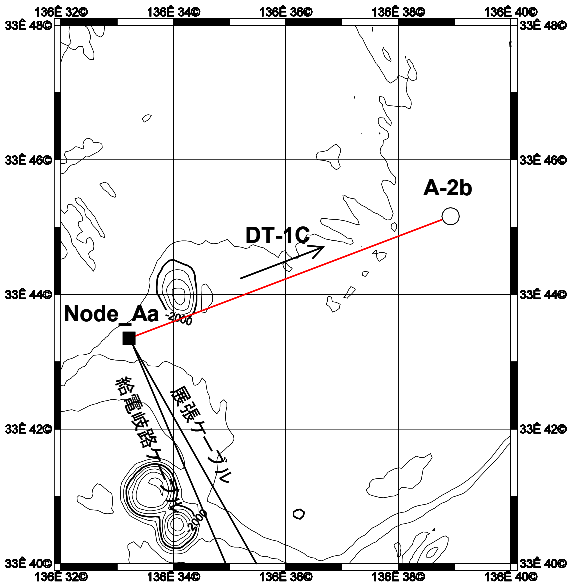


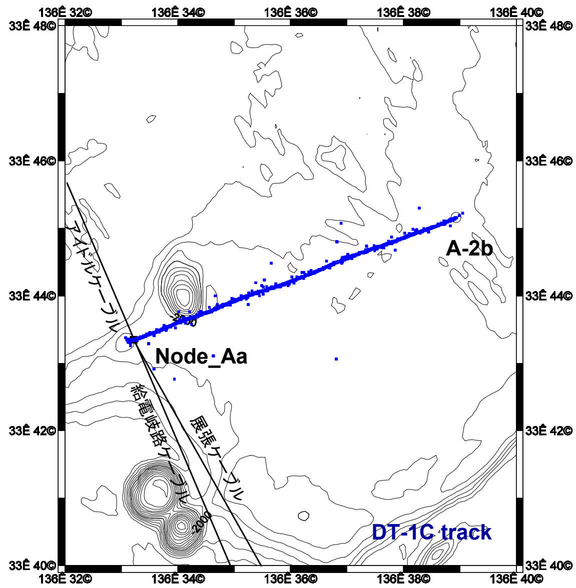
4.2.2 Route Survey

(1) DT-1C(2010/05/11) (Node_Aa -> A-2b)

Start: 33_43.349'N, 136_33.215'E D=2,009 m ROV-Homer ID: 23

End: 33_45.161'N, 136_38.935'E D=2,013 m ROV-Homer ID: 92



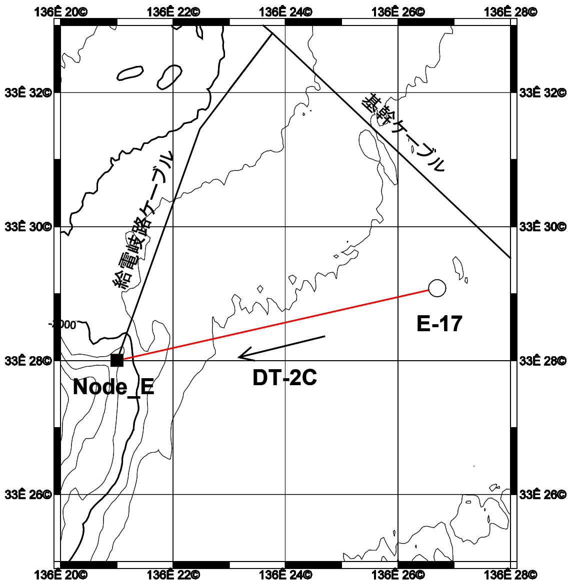


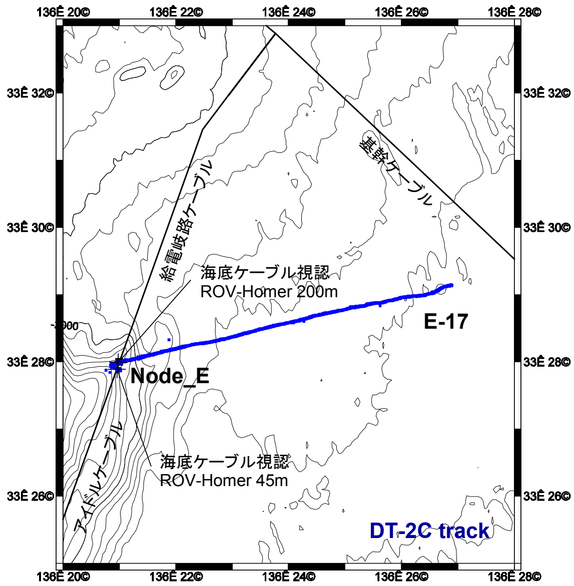
Plan DeepTow track

(2) DT-2C(2010/05/12) (E-17 -> Node_E)

Start: 33_29.079'N, 136_26.698'E D=2,056 m ROV-Homer ID: 98

End: 33_28.000'N, 136_21.000'E D=1,968 m ROV-Homer ID: 27



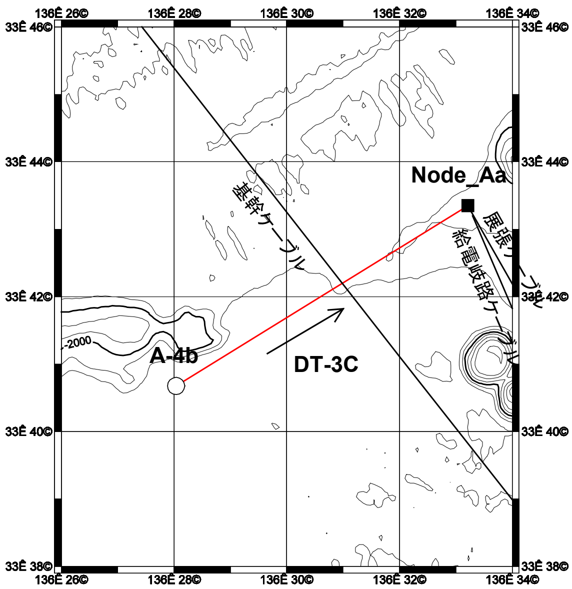


Plan DeepTow track

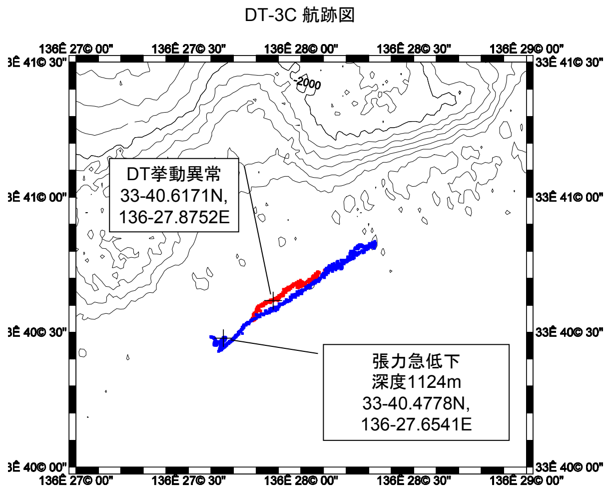
(3) DT-3C(2010/05/13) (A-4b -> Node_Aa)

Start: 33_40.677'N, 136_28.037'E D=2,056 m ROV-Homer ID: 24

End: 33_43.349'N, 136_33.215'E D=2,009 m ROV-Homer ID: 23



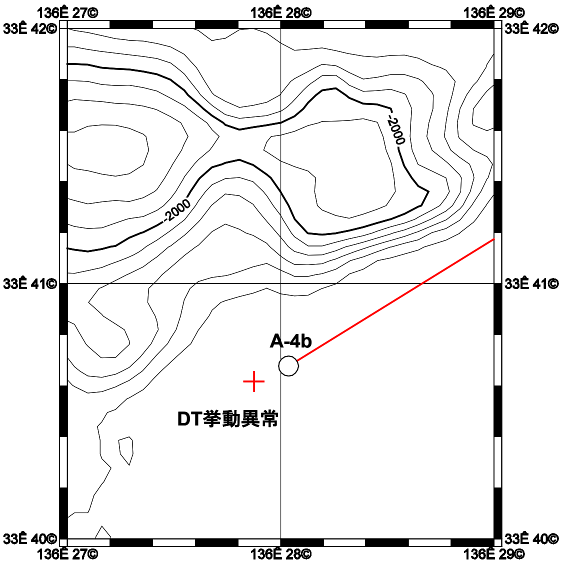
Plan DeepTow track

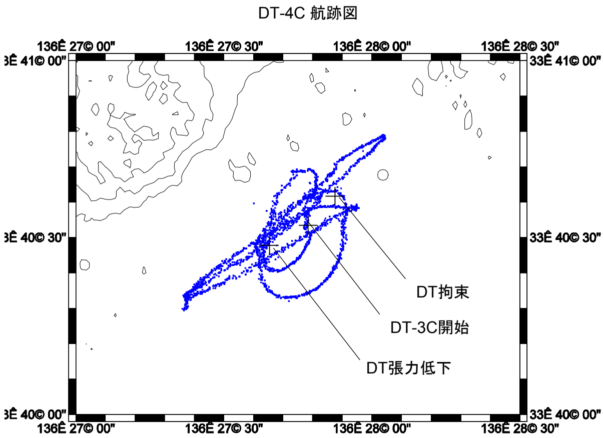


(4) DT-4C(2010/05/14) (A-4b area clearence)

Target: 33_40.6171'N, 136_27.8752'E D=2,054 m

A-4b: 33_40.677'N, 136_28.037'E D=2,056 m ROV-Homer ID: 23



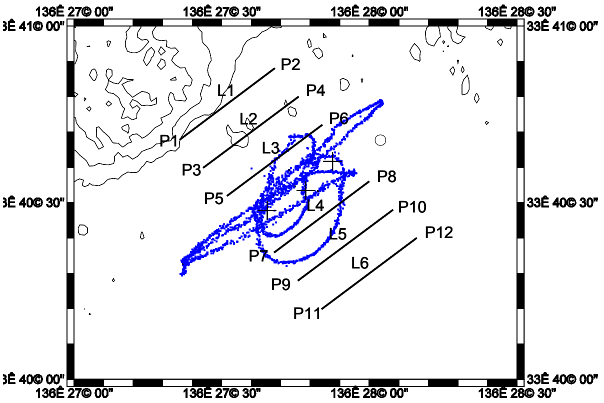


Plan DeepTow track

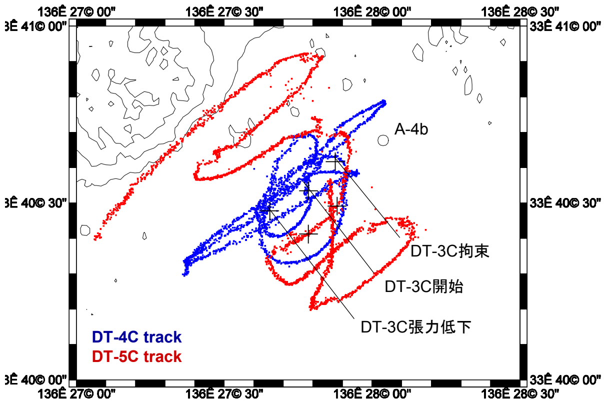
(5) DT-5C(2010/05/15) (A-4b area clearence)

Line		Lat.N	Lon.E		Lat.N	Lon.E
L1	P1	33° 40.68′	136° 27.36′	P2	33° 40.88′	136° 27.68′
L2	P3	33° 40.60′	136° 27.44′	P4	33° 40.80′	136° 27.76′
L3	P5	33° 40.52′	136° 27.52′	P6	33° 40.72′	136° 27.84′
L4	P7	33° 40.36′	136° 27.68′	P8	33° 40.56′	136° 28.00′
L5	P9	33° 40.28′	136° 27.76′	P10	33° 40.48′	136° 28.08′
L6	P11	33° 40.20′	136° 27.84′	P12	33° 40.40′	136° 28.16′

DT-5C測線(案)



DT-4C & DT-5C 航跡図

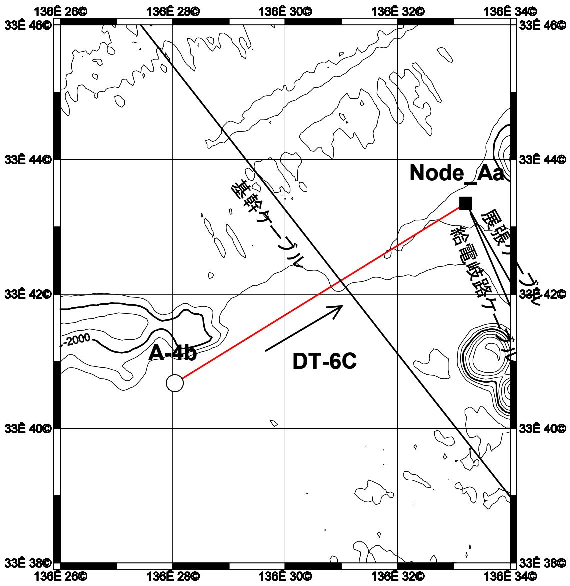


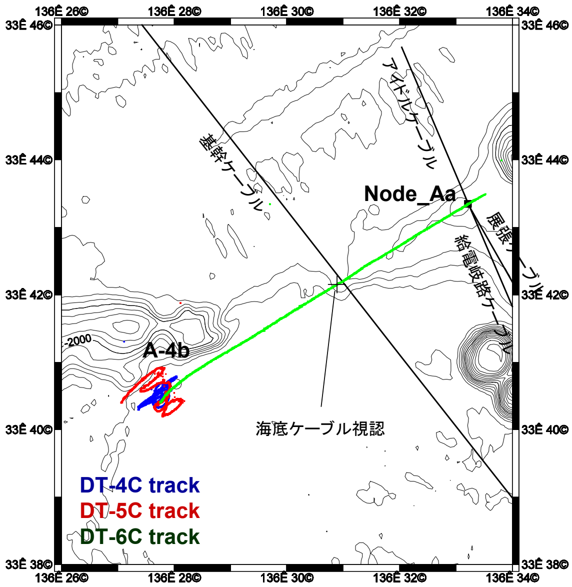
Plan DeepTow track

(6) DT-6C(2010/05/16) (A-4b -> Node_Aa)

Start: 33_40.677'N, 136_28.037'E D=2,056 m ROV-Homer ID: 24

End: 33_43.349'N, 136_33.215'E D=2,009 m ROV-Homer ID: 23



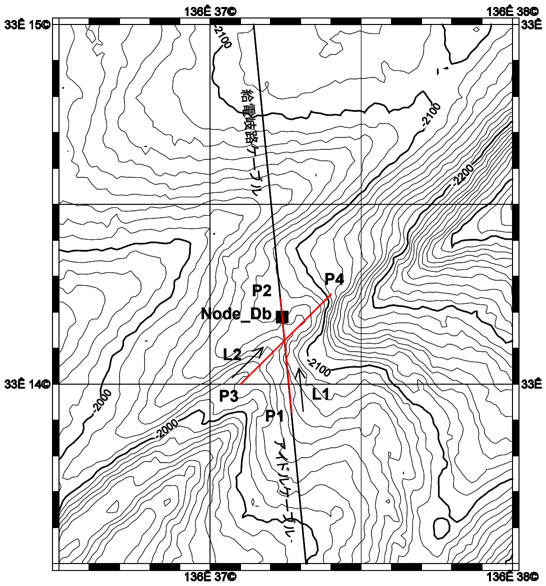


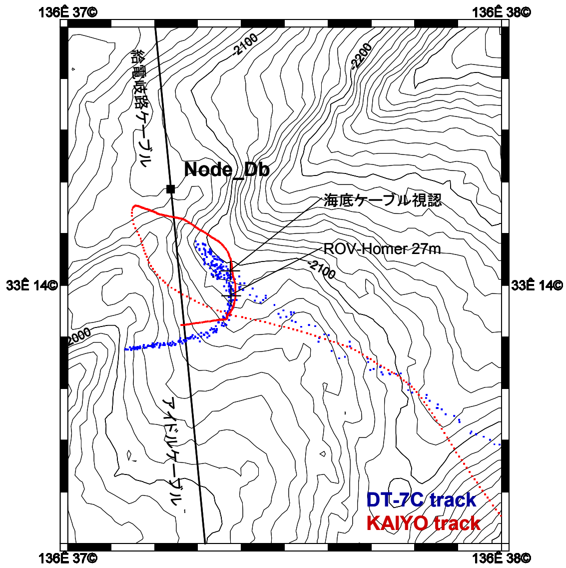
Plan DeepTow track

(7) DT-7C(2010/05/17) (Node_Db search)

Start: 33_13.920'N, 136_37.270'E D=2,057 m

End: 33_14.238'N, 136_37.232'E D=2,076 m





Plan   DeepTow track

5. Conclusions

During KY10-07 cruise, we conducted 15 piston coring operation to install seafloor casing for seismic sensor installation in the Kumano area of the Nankai Trough. Among 15 coring attempts, 12 shots released the casing in the seafloor and 9 of the released casing penetrated in the seabed enough for seismic sensor installation. These installed seafloor casings will be utilized to house buried ocean bottom seismic sensor for DONET.

Latter half leg of KY10-07 cruise conducted seafloor camera survey using "Deep-Tow" system of JAMSTEC. After free-fall cable maintenance, 7 survey was conducted to clear cable routes in Node-A and Node-E areas as well as to find the exact location of the backbone cable route after installation by cable ship. . Three route clearances, i.e., for A-2, A-4, and E-17 observatories have been completed during the present KY10-07 cruise. It should be noted that "Deep-Tow" seemed to be captured by something in the deep sea westward at A-4 observatory but out of science link cable route. We tried to remove the obstacle by two dives (DT-4C and DT-5C dives), but we could not finished yet. During the KY10-07 cruise, we also checked the location of two terminal units (TU_D and TU_E) by using acoustic instrument (ROV-Homer system). This is because all TUs of DONET have been deployed from the cable ship with no positioning system, we have to look for TUs at first in order for deployment of science node by ROV dive. We plan to establish 20 observatories in total by this fiscal year. We have checked no problems for ROV dive and its operation for A-2, A-4, and E-17 observatories at least after the present KY10-07 cruise.