

CRUISE REPORT

(KY08-03 R/V 'Kaiyo')



JAMSTEC

June 2008

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1. INTRODUCTION

Japan has started installing the offshore cabled observatories for disaster mitigation purposes since late 1970s. We have already developed seven cabled observatories around Japan, in particular along the Pacific rim, and brought us invaluable information. For example, the 2003 Tokachi-oki earthquake of M8.0, seafloor phenomena such as a generation process of tsunami, seafloor uplifts, etc., were observed (Mikada et al, 2006). At the 2004 off Kii peninsula earthquake of 7.4, the offshore observatory could detect tsunami 20 min before its arrival at the nearest coast (Matsumoto and Mikada, 2005).

Since 2006, Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has started to develop a new dense network system by using sub-marine cable off Kii-peninsula, where the last mega-thrust earthquake named Tonankai earthquake was took place in 1944. The Headquarters for Earthquake Research Promotion in the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has estimated that the probability of the next Tonankai earthquake is 60 to 70 % in the next 30 years, because the recurrent interval of the plate boundary earthquake is approximately 100 to 150 years there. Thus, the offshore seismic monitoring system for the forthcoming Tonankai earthquake is urgently needed to mitigate future disasters from the earthquake and resulting tsunami.

The system to be developed contains twenty seismometers, twenty tsunami meters, and other geophysical sensors covering the expected Tonankai earthquake source region in order to monitor both long-term seismic activities and mega-thrust earthquake and tsunami. Our goals are postulated to accomplish high precision earthquake prediction modeling, to detect precursory prior to the mega-thrust earthquake, and to contribute to mitigate disaster caused by the earthquake and the tsunami by providing the information, in addition to developing the network system itself.

Natural events such as slumps, slides and turbidity currents on steep, sediment covered slopes, and earthquake events are risks to the network system in the deep-sea area in its lifetime. In the shallow area, on the other hand, the potential risks to the network system are from human related activities, specifically from bottom contact fisheries and large ships' anchors. There is also a smaller danger that dumping or dredging operations could harm a submarine cable. For the first step in the network system development, an in-situ survey and a risk assessment is necessary in order to find better observatory's sites and safer submarine cable route.

In the R/V Kaiyo KY08-03 cruise, we carry out the visual survey of the cable route by using deep-sea survey system Deep-Tow and the installing the benchmark that is a platform of the observatory.

References

- Matsumoto, H. and Mikada, H. (2005), "Fault Geometry of the 2004 Off the Kii Peninsula Earthquake Inferred from Offshore Pressure Waveforms", *Earth Planets Space*, **57**, 161-166.
- Mikada, H., Mitsuzawa, K., Matsumoto, H., Watanabe, T., Morita, S., Otsuka, R., Sugioka, H., Baba, T., Araki, E., and Suyehiro, K. (2006), "New Discoveries in Dynamics of an M8 Earthquake -Phenomena and their Implications from the 2003 Tokachi-oki Earthquake Using a Long Term Monitoring Cabled Observatory-", *Tectonophysics*, **426**, 95-105.

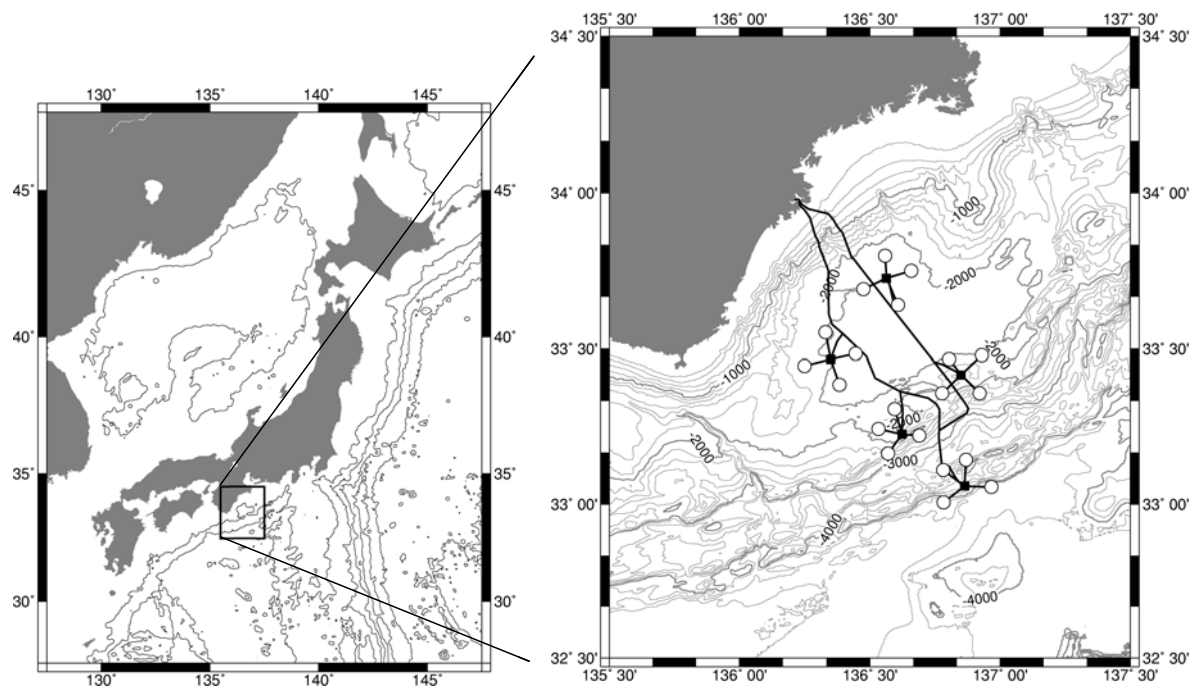


Figure 1 Map showing the deep-sea network observatory to be deployed off Kii-Peninsula. Circles and dots represent the observatories and the science nodes, respectively

2. Deep-Tow Survey

We carried out camera survey by using Deep Tow system during the KY08-03 cruise as follows. Shaded parts indicate the route clearance. Detailed survey results are given from the next page.

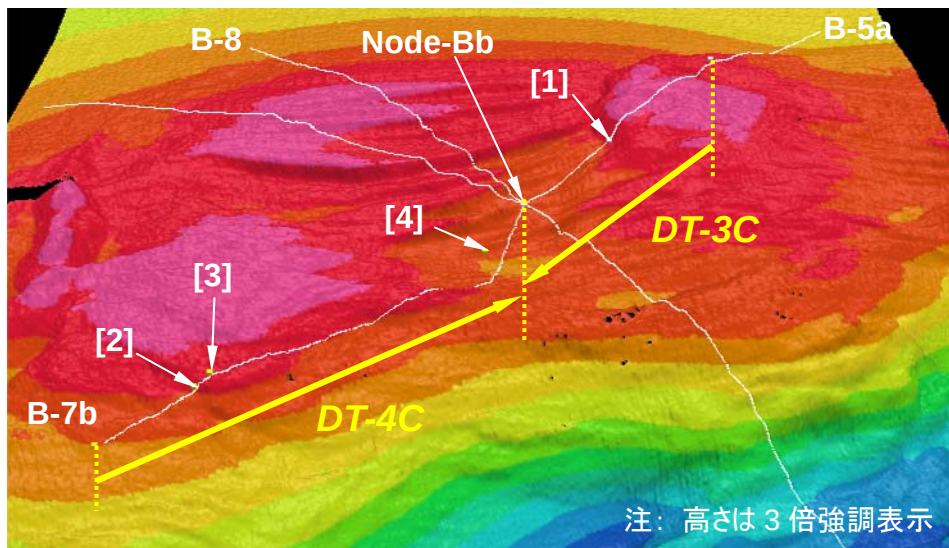
Table. Summary of the camera survey

Leg. No.	DT №	DATE	Priority No.	Survey Area
1	1C	2008/04/05	II -㉔	B5a - Node Bb
	2C			
	3C			
	4C	2008/04/06	I -㉑	B7b - Node Bb
	5C	2008/04/07	II -㉒	Owase Canyon West Route
	6C	2008/04/08		
	7C			
	8C	2008/04/09	III -㉓	Node E - E19a
	9C	2008/04/11	II -㉑	Owase Canyon East Route
	10C	2008/04/12		
	11C	2008/04/13	Route Clearance	A1b - Node Aa
	12C	2008/04/14		East of Owase Canyon East Route
	13C	2008/04/15		A1b - Node Aa
2	14C	2008/04/16	I -㉒	C10b - Node Cb
	15C	2008/04/17	II -㉒	Owase Canyon West Route
	16C	2008/04/18		
	17C			
	18C	2008/04/19	I -㉓	C11a
	19C	2008/04/20	II -㉗	Node Bb - BU B
	20C	2008/04/21	I -㉓	C11a - Node Cb
	21C	2008/04/22	I -㉓, ㉒	C11a - Node Cb - C10b
	22C		II -㉘	BU C - REP3
	23C	2008/04/23	II -㉔	D13 - Node Da
	24C	2008/04/25	Route Clearance	D13 - Node Da
	25C			
	26C	2008/04/26		
	27C	2008/04/27		
3	28C	2008/05/03	III -㉔	E20a - Node E
	29C		III -㉕	Node Aa - BU A
	30C	2008/05/04	II -㉔, ㉒, I -㉓	Node Da - BU D - D16b - Node Da
	31C	2008/05/05	II -㉗	Node Bb - BU B
	32C		II -㉘	REP3 - BU C
	33C			
	34C	2008/05/06	Route Clearance	Node Da - D13

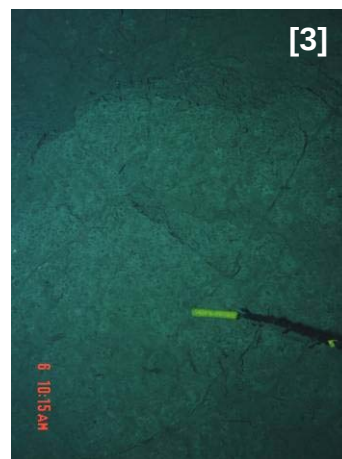
2.1. Route survey

2.1.1 Leg.1

(1) DT-3C (2008/04/05), DT-4C (2008/04/06)



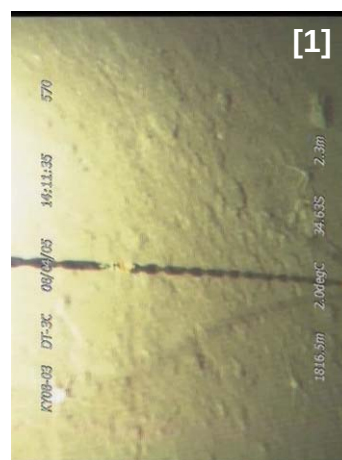
33_22.5462N / 136_48.3538E
[10:00] Digital Camera



33_22.6351N / 136_48.5086E
[10:15] Digital Camera



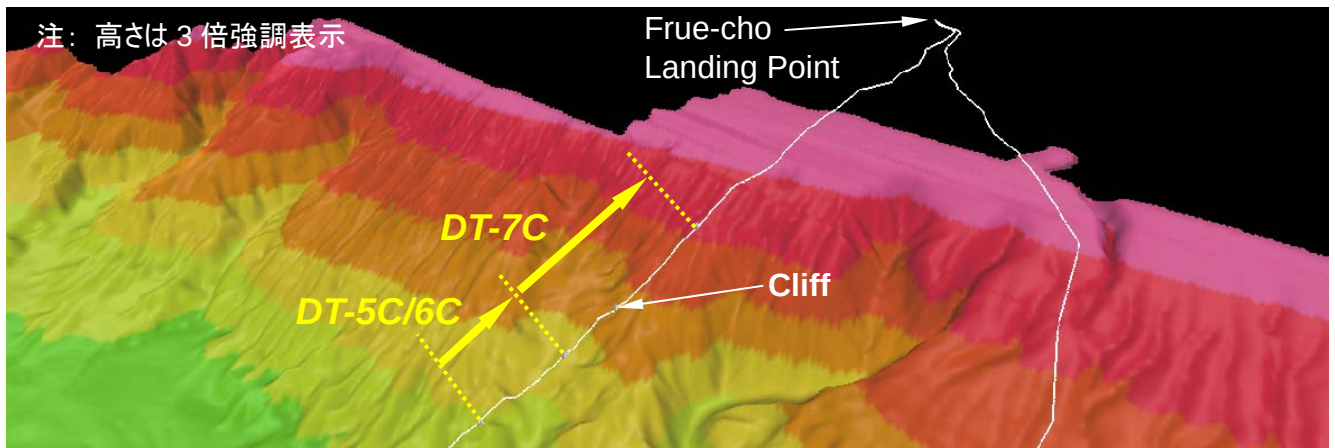
33_24.4481N / 136_51.1514E
[15:05] Digital Camera



33_25.9616N / 136_52.5765E
[14:11] SH Camera

(2) DT-5C (2008/04/07), DT-6C/7C (2008/04/08)

DT-7C で、基幹ケーブルルート上に崖の存在確認。



33_50.0551N / 136_18.2978E
[14:24] Color CCD



33_50.0551N / 136_18.2978E
[14:24] Color CCD



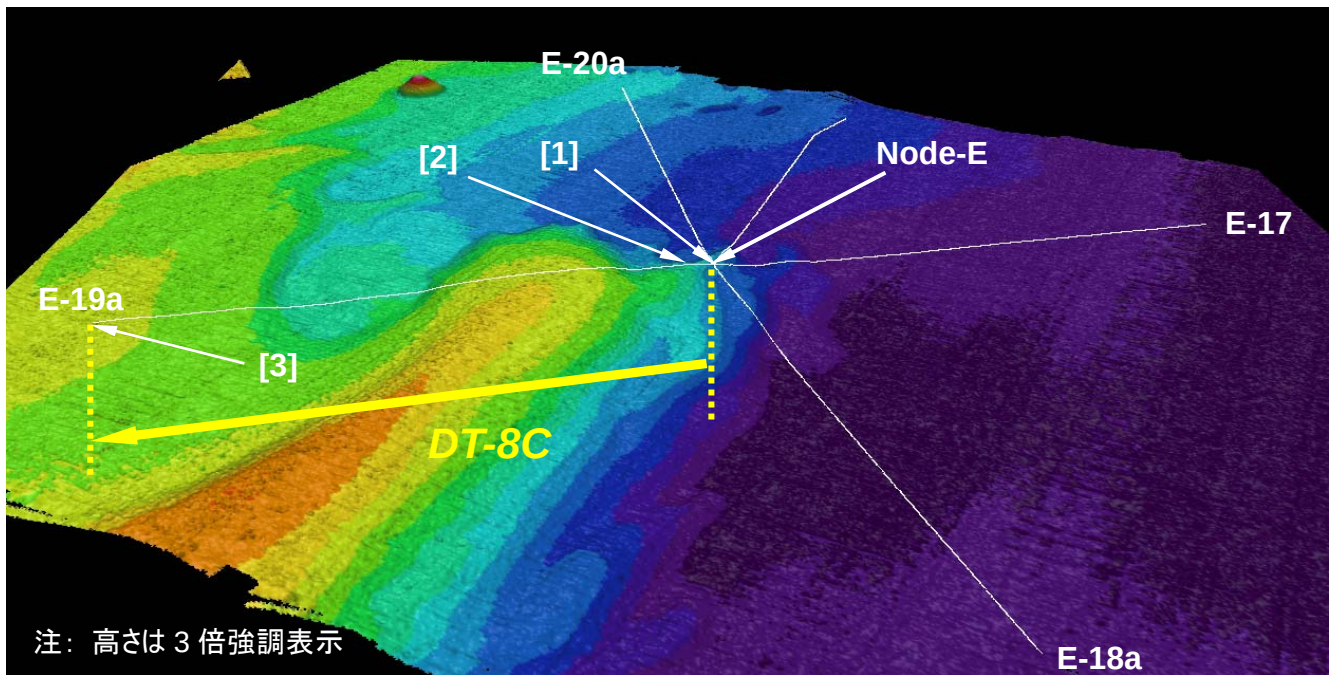
33_50.0551N / 136_18.2978E
[14:24] Black & White CCD



33_50.0551N / 136_18.2978E
[14:24] Color CCD

(3) DT-8C (2008/04/09)

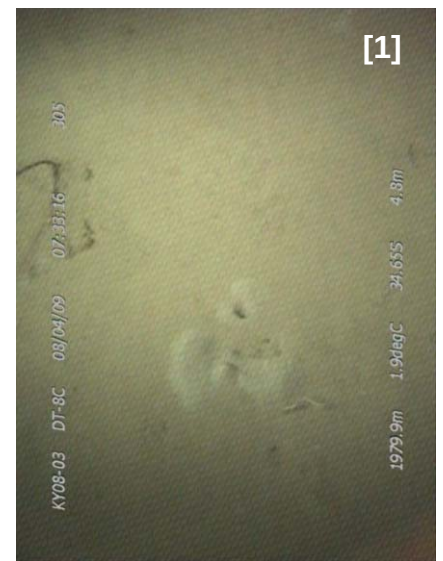
Node-E～E-19a 間は展張ケーブルルートとして適。



33_26.6826N / 136_14.9100E
[15:22] Color CCD



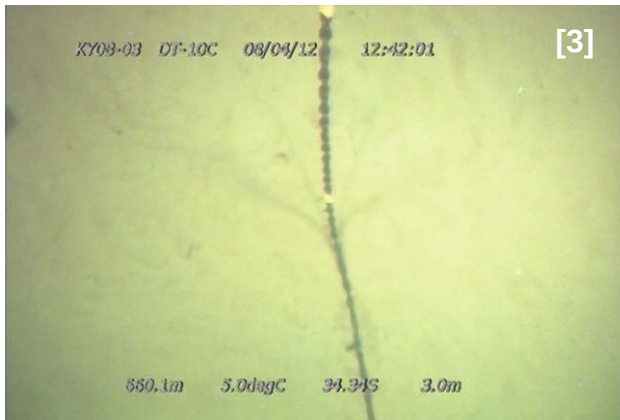
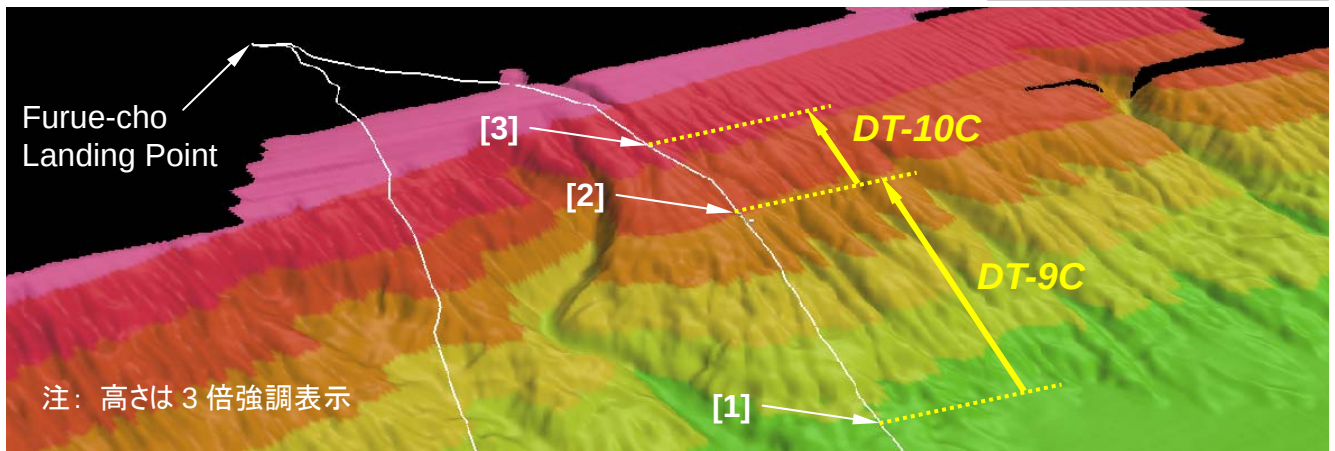
33_27.9422N / 136_20.8079E
[08:02] Color CCD



33_27.9314N / 136_21.0634E
[07:33] Color CCD

(4) DT-9C (2008/04/11), DT-10C (2008/04/12)

基幹ケーブルルートとして適。



33_54.7531N / 136_21.6296E
[4/12, 12:42] Super H



33_52.8958N / 136_23.4716E
[4/12, 07:35] Super H

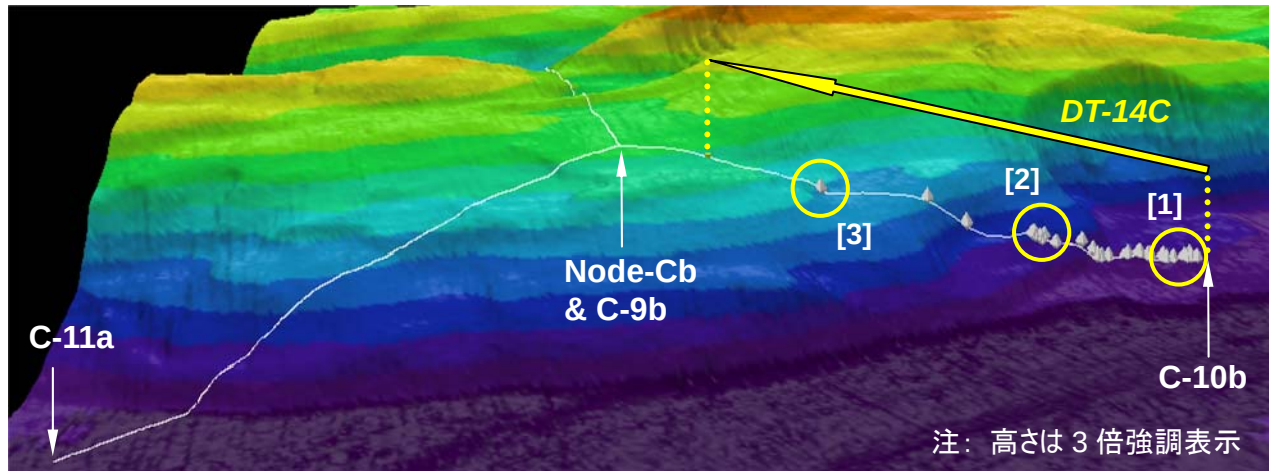


33_48.8448N / 136_25.2632E
[4/11, 08:36] Color CCD

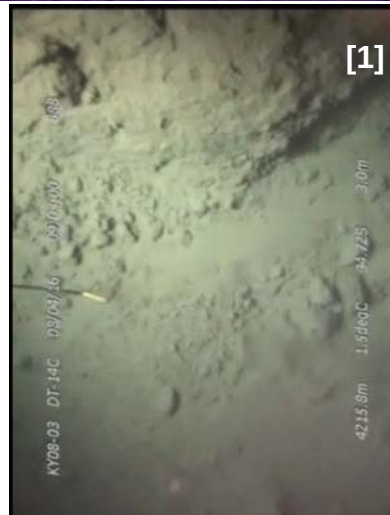
2.1.2 Leg.2

(1) DT-14C (2008/04/16)

C-10b から Node-Cb に向う展張ケーブルルートは継続して検討する必要あり。



33_03.2071N / 136_55.7961E
[09:31] Color CCD



33_03.1759N / 136_56.0259E
[09:03] Color CCD



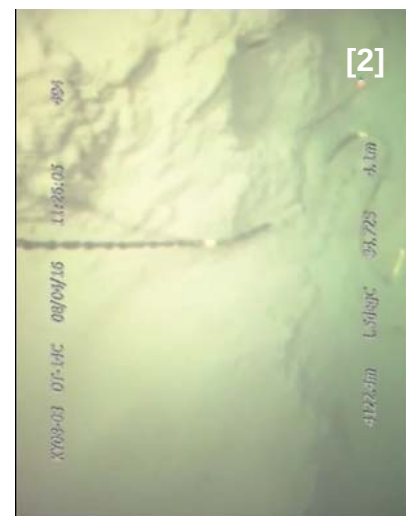
33_03.1611N / 136_56.0793E
[08:53] SH Camera



33_03.3316N / 136_52.4085E
[14:18] Color CCD



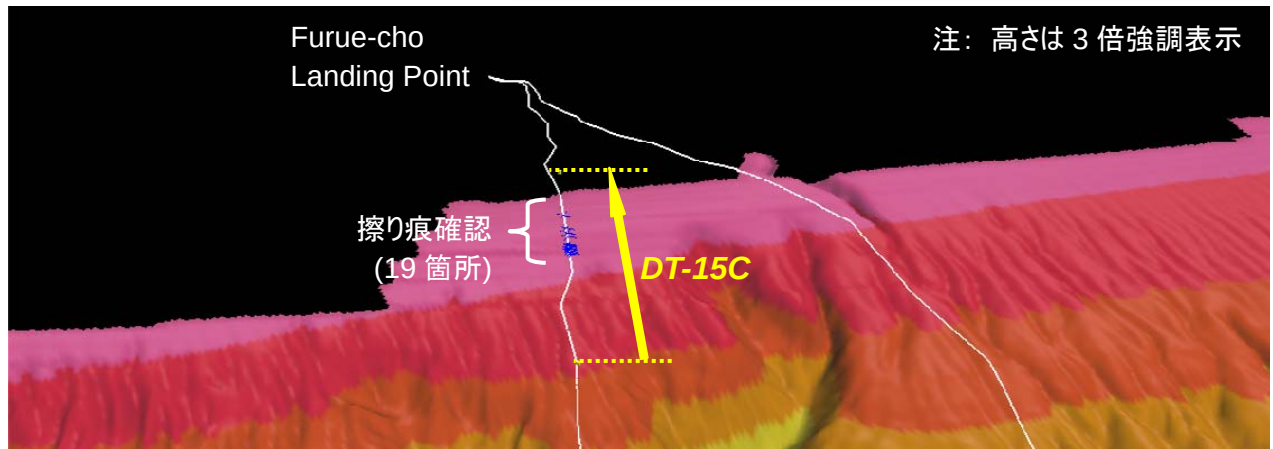
33_03.2813N / 136_54.5950E
[11:27] Color CCD



33_03.2498N / 136_54.5451E
[11:25] SH Camera

(2) DT-15C (2008/04/17)

水深 250m~390m 区間に人的活動の痕跡(19箇所)を確認。



Position: 33-53.2672 N, 136-16.8365 E
Deep-Tow Heading: 312.4
Water Depth: 387m



Position: 33-53.2854 N, 136-16.8097 E
Deep-Tow Heading: 300.6
Water Depth: 379m



Position: 33-53.2898 N, 136-16.8008 E
Deep-Tow Heading: 304.2
Water Depth: 378m



Position: 33-53.3066 N, 136-16.7692 E
Deep-Tow Heading: 305.7
Water Depth: 370m



Position: 33_53.335 N, 136_16.7516 E
 Deep-Tow Heading: 343.3
 Water Depth: 363m



Position: 33_53.3440 N, 136_16.7466 E
 Deep-Tow Heading: 345.5
 Water Depth: 361m



Position: 33_53.3478 N, 136_16.7438 E
 Deep-Tow Heading: 345.6
 Water Depth: 360m



Position: 33_53.3478 N, 136_16.7438 E
 Deep-Tow Heading: 347.5
 Water Depth: 360m



Position: 33_53.3773 N, 136_16.7311 E
 Deep-Tow Heading: 349.9
 Water Depth: 354m



Position: 33_53.3854 N, 136_16.7282 E
 Deep-Tow Heading: 344.3
 Water Depth: 351m



Position: 33_53.3943 N, 136_16.7206 E
 Deep-Tow Heading: 347.1
 Water Depth: 349m



Position: 33_53.4039 N, 136_16.7168 E
 Deep-Tow Heading: 342.8
 Water Depth: 347m



Position: 33_53.4106 N, 136_16.7133 E
 Deep-Tow Heading: 344.6
 Water Depth: 345m



Position: 33_53.5350 N, 136_16.6496 E
 Deep-Tow Heading: 349.5
 Water Depth: 316m



Position: 33_53.5954 N, 136_16.6114 E
 Deep-Tow Heading: 357.8
 Water Depth: 302m



Position: 33_53.5995 N, 136_16.6100 E
 Deep-Tow Heading: 358.9
 Water Depth: 302m



Position: 33_53. 6017 N, 136_16. 6088 E
 Deep-Tow Heading: 357.4
 Water Depth: 302m



Position: 33_53. 6893 N, 136_16. 5539 E
 Deep-Tow Heading: 1.5
 Water Depth: 286m

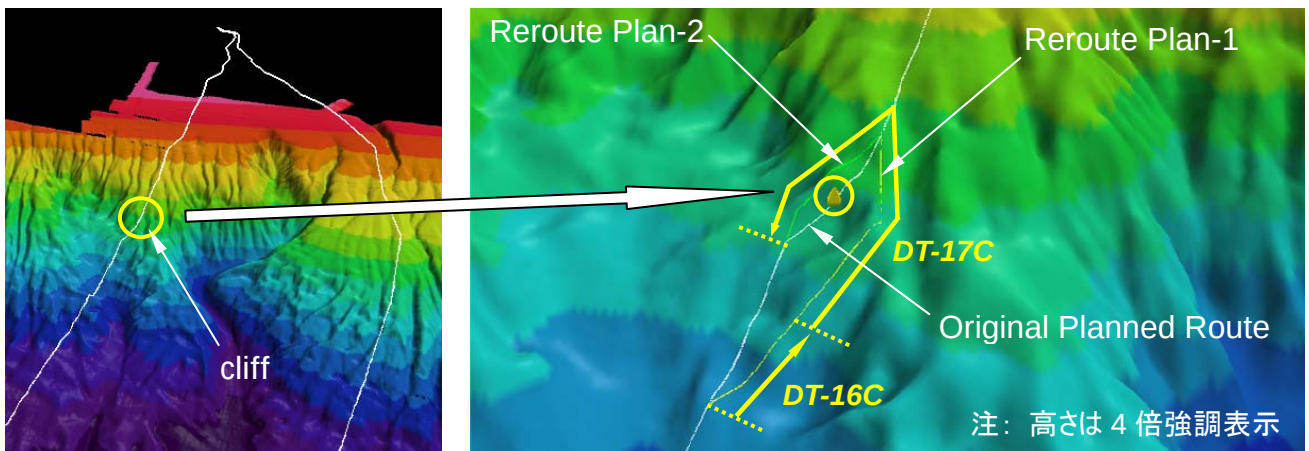


Position: 33_53. 9512 N, 136_16. 3782 E
 Deep-Tow Heading: 353.3
 Water Depth: 255m



(3) DT-16C/17C (2008/04/18)

DT-7C で確認された急峻の迂回ルートを確認。



DT-7C で観察された急峻



Super High Sensitivity HARP-tube Camera

Reroute Plan-1 での地形観察結果



Super High Sensitivity HARP-tube Camera



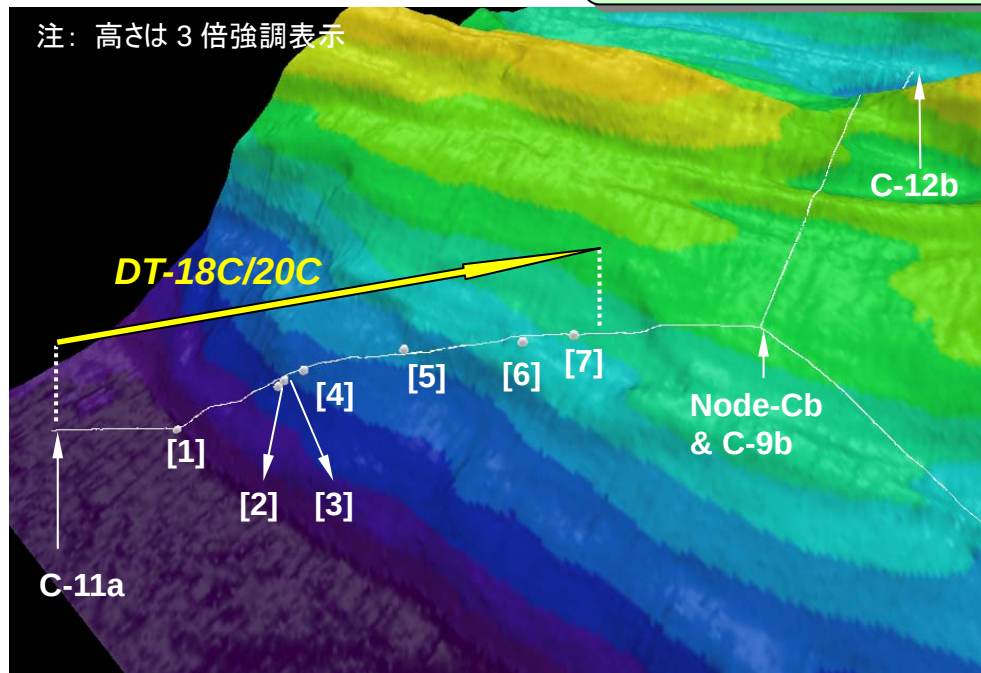
Color CCD Camera



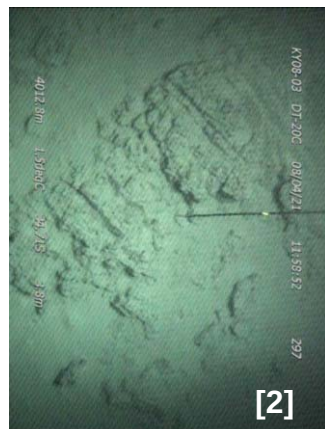
Color CCD Camera

(4) DT-18C (2008/04/19), DT-20C (2008/04/21)

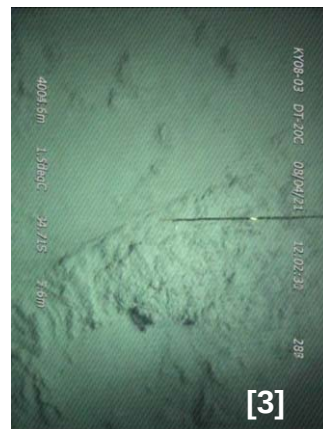
C-11a から Node-Cb に向うルートは、海底面が粗いものの展張ケーブルルートとして採用。



33_00.7685N / 136_47.2823E
[4/21, 10:35] Color CCD



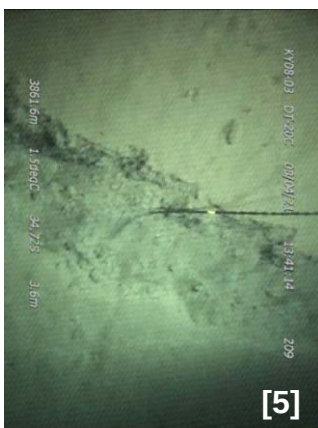
33_01.3578N / 136_47.9236E
[4/21, 11:58] Color CCD



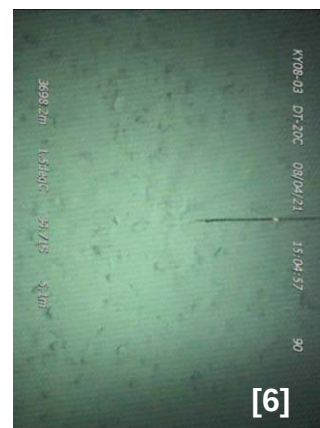
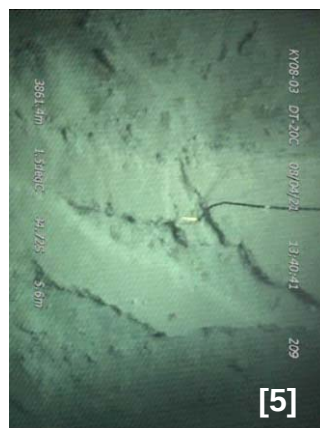
33_01.4048N / 136_47.9403E
[4/21, 12:02] Color CCD



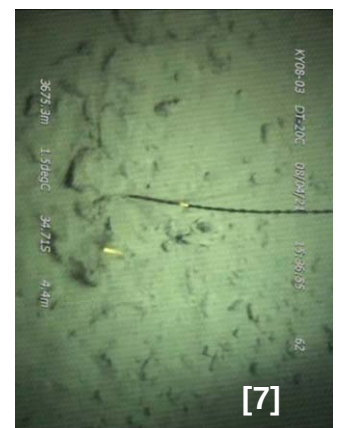
33_01.5228N / 136_48.0399E
[4/21, 12:18] Color CCD



33_02.0637N / 136_48.5305E
[4/21, 13:40] Color CCD



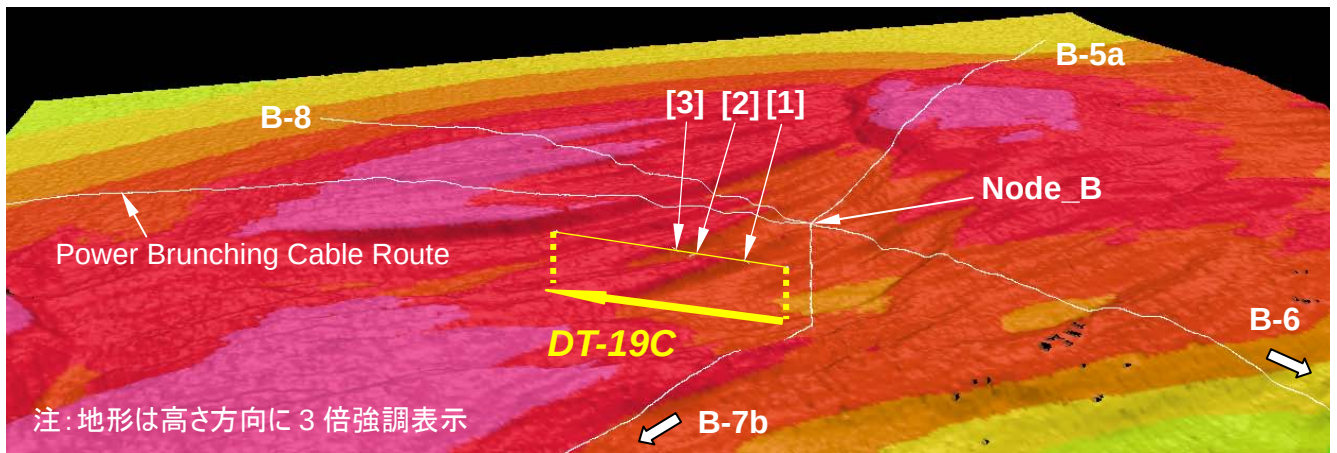
33_02.5200N / 136_49.2762E
[4/21, 15:05] Color CCD



33_02.7621N / 136_49.5253E
[4/21, 15:36] Color CCD

(5) DT-19C (2008/04/20)

B 海域の旧給電帰路ケーブルルート上に、急峻の存在を確認。



33_24.9177N / 136_50.5996E
[10:33] Color CCD



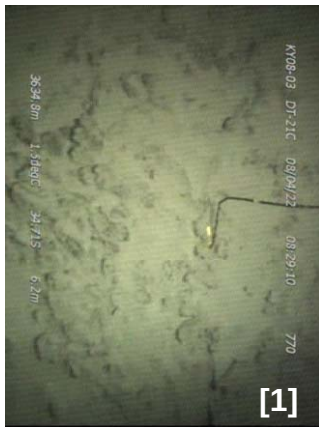
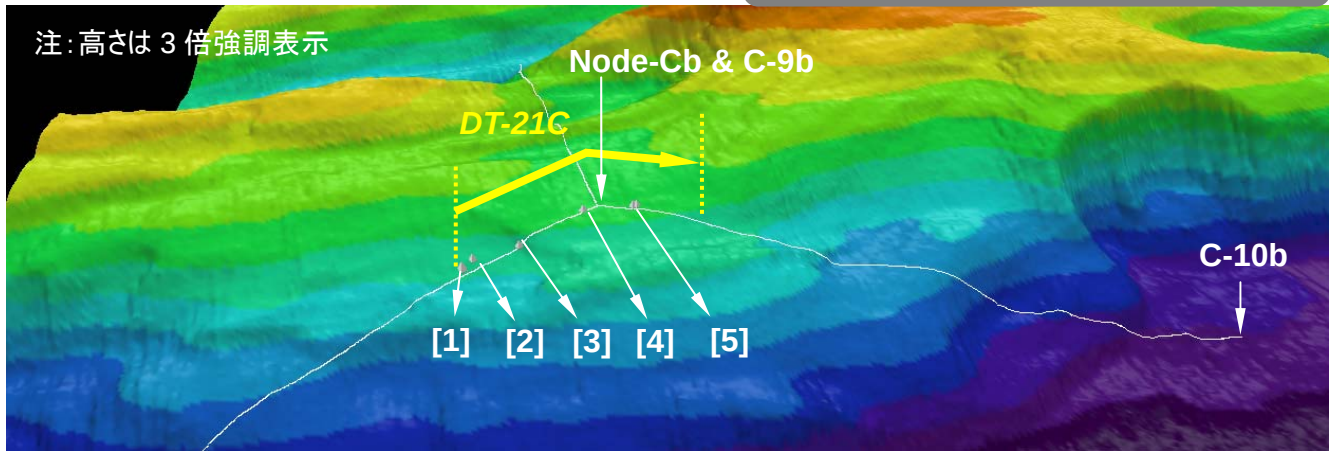
33_24.8670N / 136_50.6803E
[10:24] Color CCD



33_24.7263N / 136_50.9918E
[09:54] Color CCD

(6) DT-21C (2008/04/22)

Node-Cb/C-9b 付近は海底面が粗いため、観測装置設置場所の微修正を検討する必要があります。



33_02.7976N / 136_49.4898E
[08:28] Color CCD



33_02.8160N / 136_49.4853E
[08:35] Color CCD



33_02.8977N / 136_49.5565E
[08:54] Color CCD



33_03.0537N / 136_49.9026E
[09:32] Color CCD



33_03.4381N / 136_50.3841E
[10:31] Color CCD

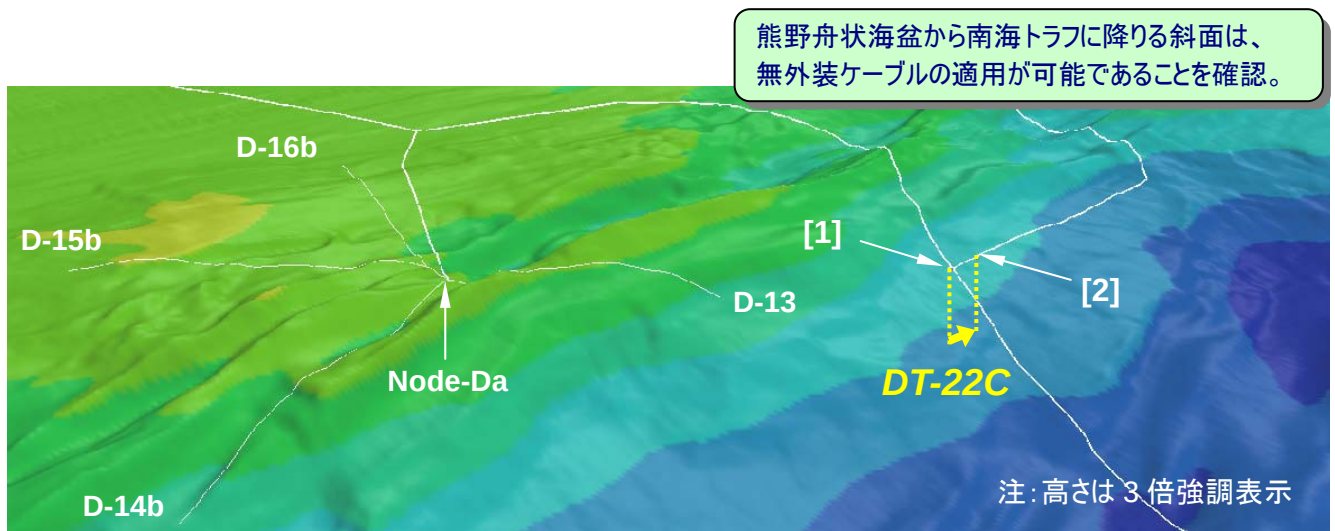


33_03.5049N / 136_50.7942E
[11:10] Color CCD



33_03.5116N / 136_50.8207E
[11:14] Color CCD

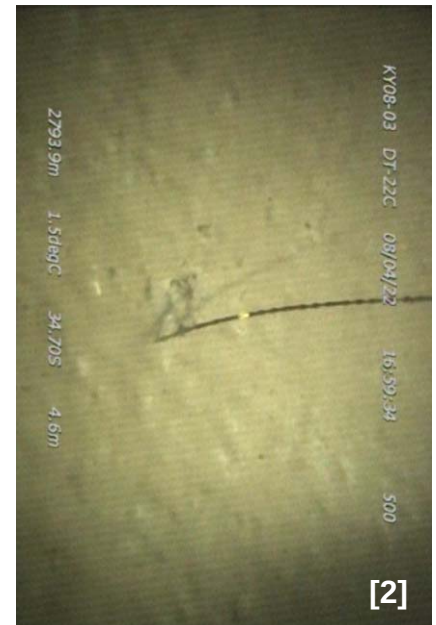
(7) DT-22C (2008/04/22)



33_14.3264N / 136_45.8691E
[15:48] Color CCD



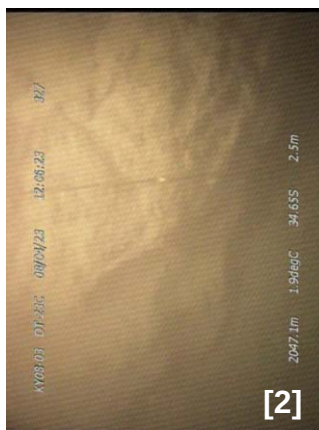
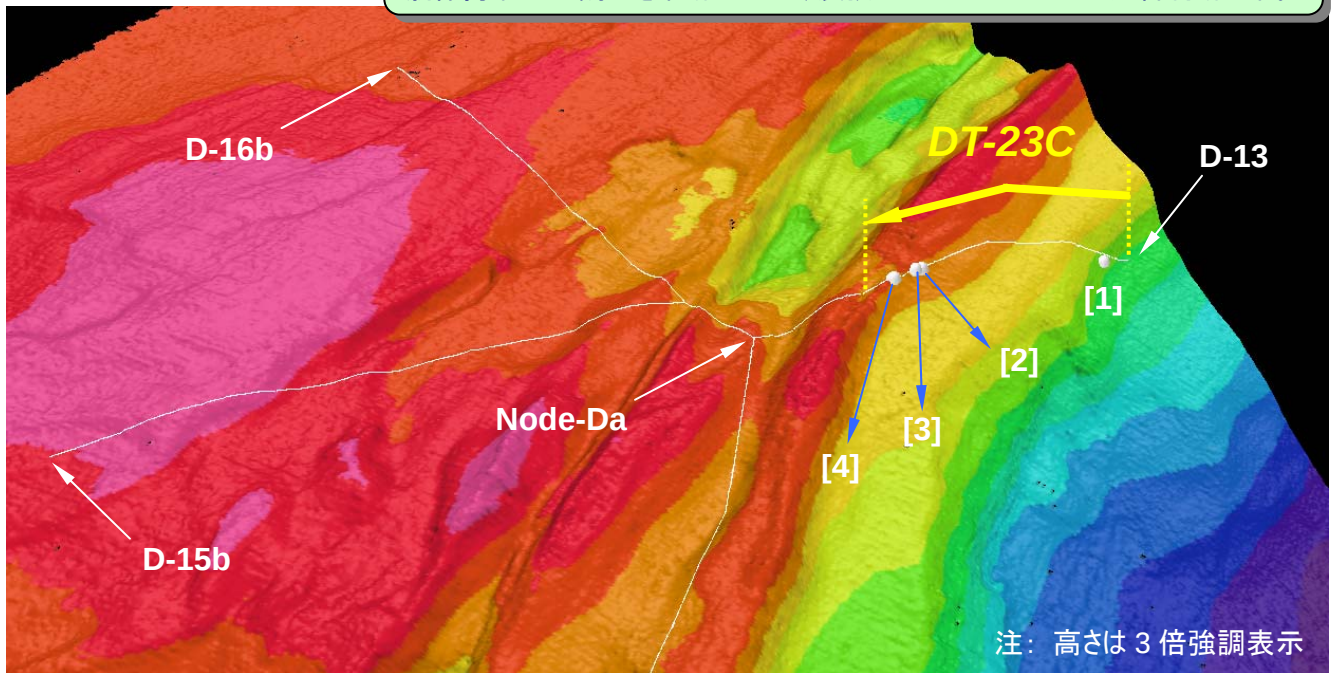
33_14.6113N / 136_46.5301E
[16:58] Super HP



33_14.6113N / 136_46.5301E
[16:59] Color CCD

(8) DT-23C (2008/04/23)

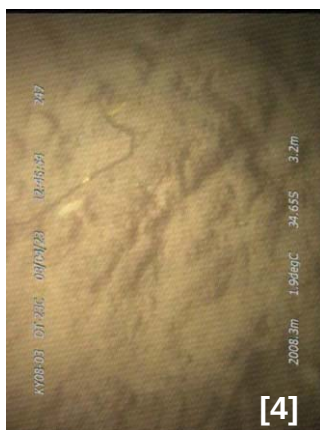
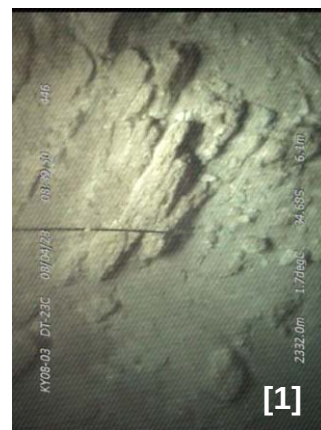
D-13～Node-Da 方面に向う展張ケーブルルートは、粗い海底面が続く。途中曳航体拘束により調査を中断したため、展張ケーブルルートとしての適否判断は未。



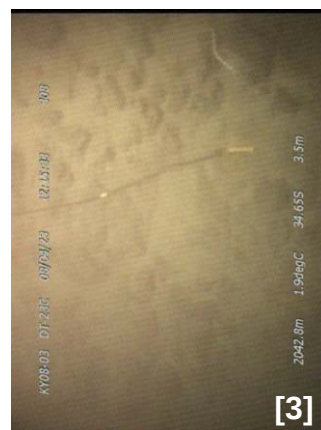
33_13.6577N / 136_39.1254E
[12:05] Color CCD



33_13.3291N / 136_41.0693E [08:39] Color CCD



33_13.6367N / 136_38.8186E [12:45] Color CCD



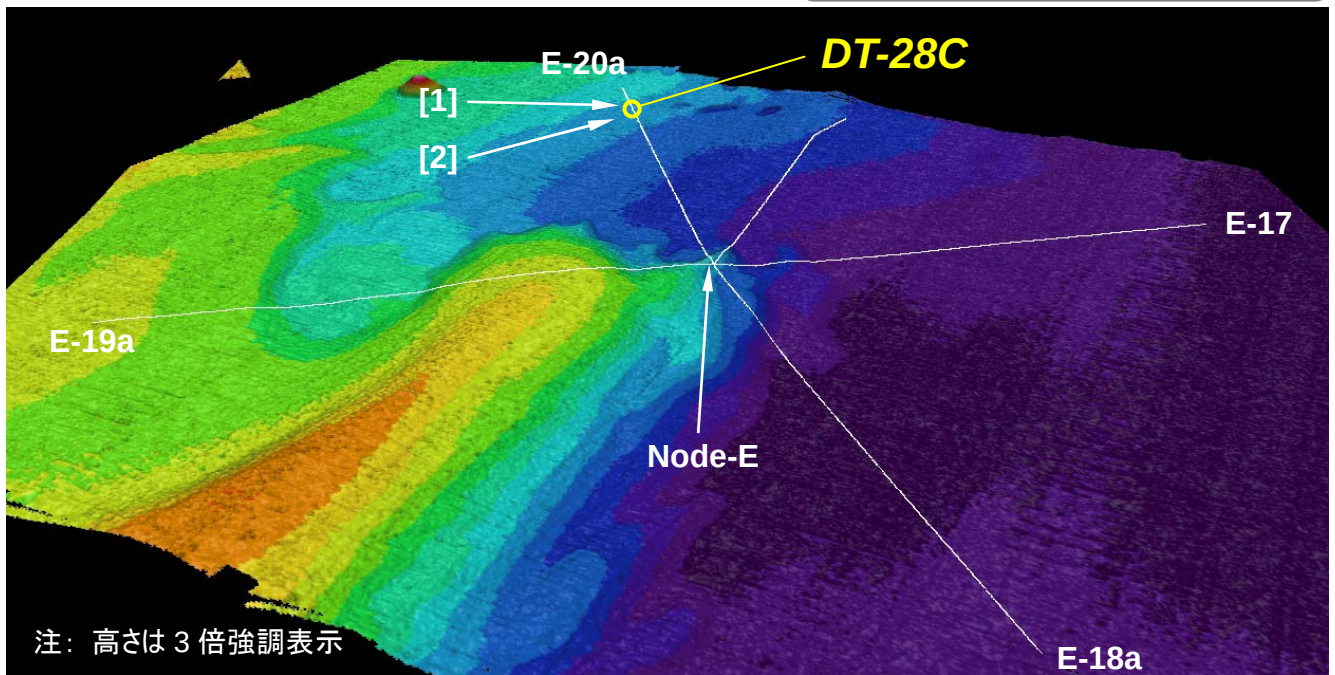
33_13.6607N / 136_39.0604E [12:15] Color CCD



2.1.3 Leg.3

(1) DT-28C (2008/05/03)

E-20a～Node-E の展張ケーブルルートの調査は、濁りが激しく視界不良のため中断。

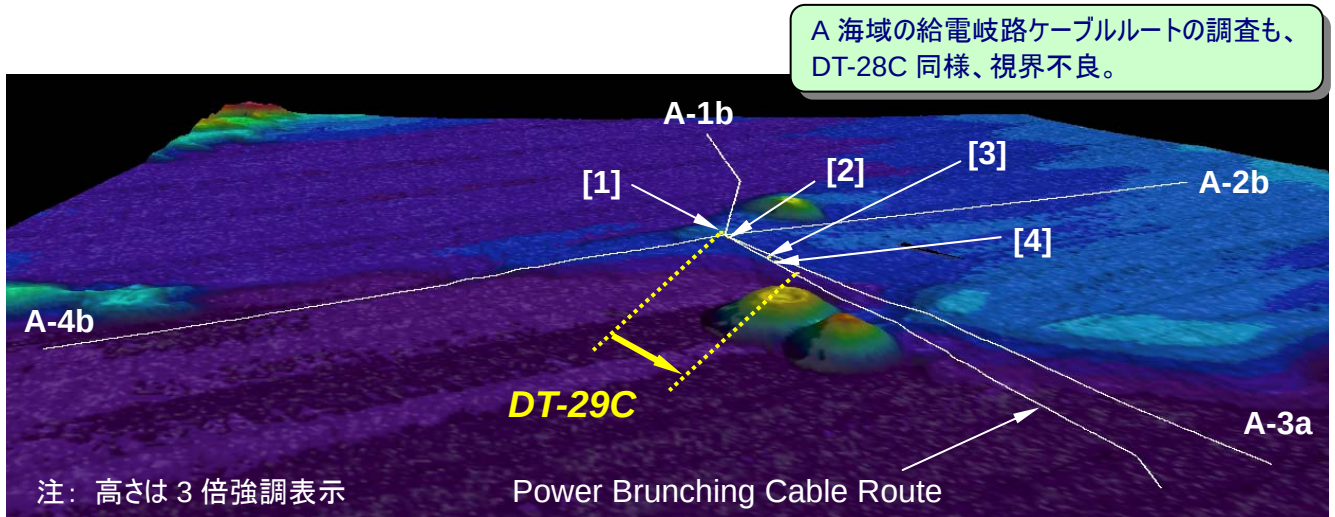


33_32.3032N / 136_19.9880E
[10:54] Color CCD



33_32.2801N / 136_19.9794E
[11:06] Color CCD

(2) DT-29C (2008/05/03)



33_43.2363N / 136_33.2686E
[14:28] Color CCD



33_43.1238N / 136_33.3319E
[14:45] Color CCD

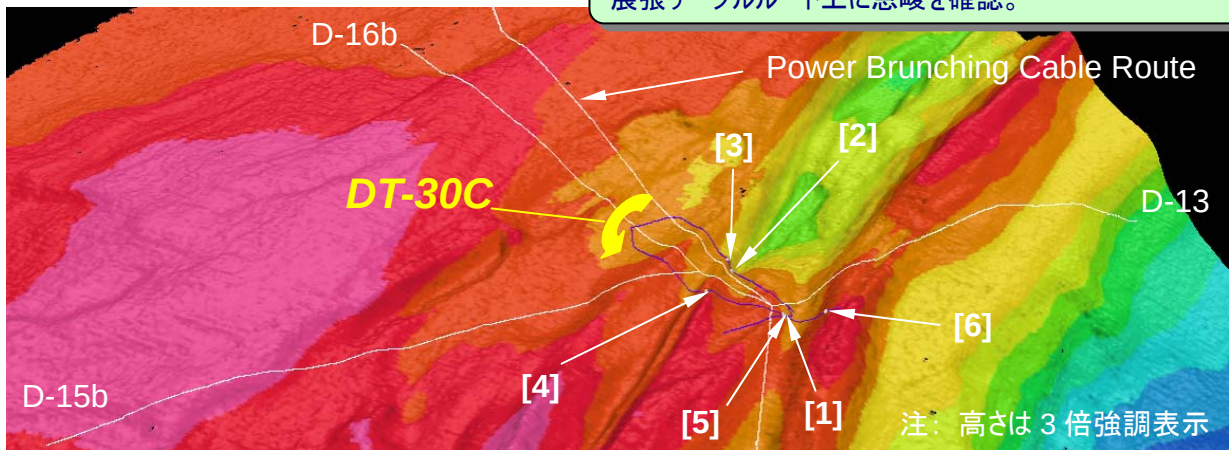


33_42.5373N / 136_33.6610E
[15:47] Color CCD



33_42.4238N / 136_33.7100E
[16:00] Color CCD

(3) DT-30C (2008/05/04)



33_13.4418N / 136_37.4518E
[08:39] Color CCD



33_14.1642N / 136_37.3907E
[10:41] Color CCD



33_14.2627N / 136_37.4041E
[10:53] Color CCD



33_13.8854N / 136_36.9890E
[14:34] Color CCD



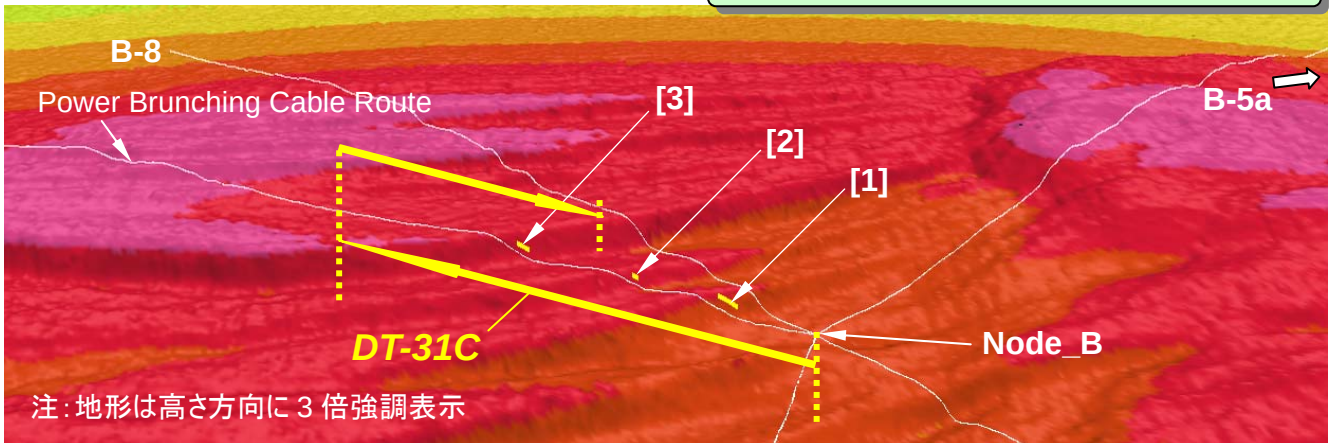
33_13.4556N / 136_37.4525E
[15:24] Color CCD



33_13.2599N / 136_37.7211E
[15:48] Color CCD

(4) DT-31C (2008/05/05)

B 海域の給電岐路ケーブルルート上に急峻を確認。



33_25.4530N / 136_50.6233E
[09:25] Color CCD



33_25.3178N / 136_51.0120E
[08:58] Color CCD

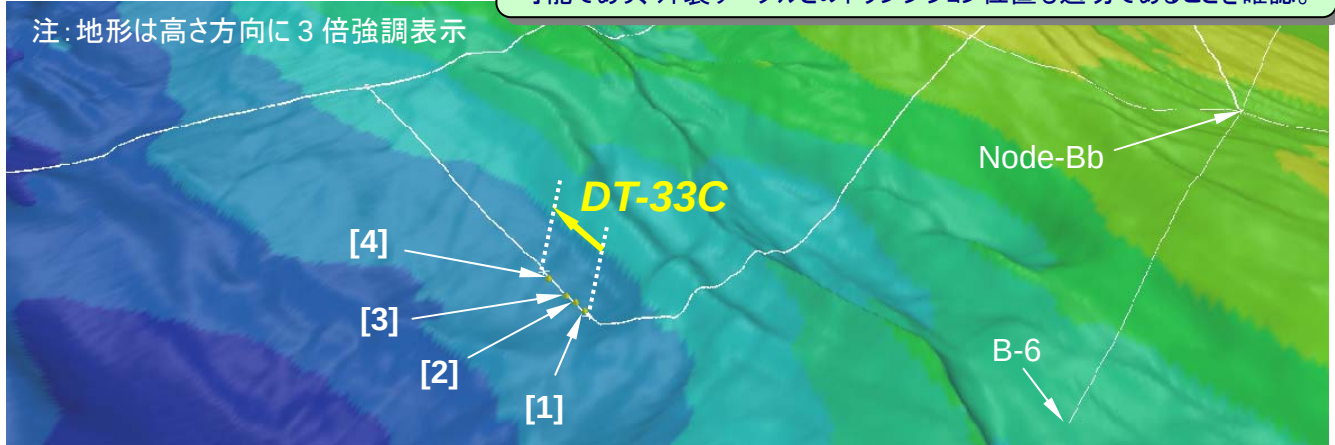


33_25.2155N / 136_51.3502E
[08:38] Color CCD

(5) DT-33C (2008/05/05)

熊野舟状海盆から南海トラフに降りる斜面は、無外装ケーブルの適用が可能であり、外装ケーブルとのトランジション位置も適切であることを確認。

注：地形は高さ方向に 3 倍強調表示



33_17.1739N / 136_51.3519E
[16:48] Color CCD



33_17.3725N / 136_51.7078E
[16:17] Color CCD

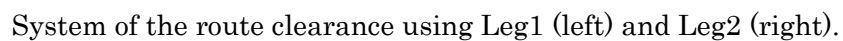


33_17.4733N / 136_51.8685E
[16:02] Color CCD

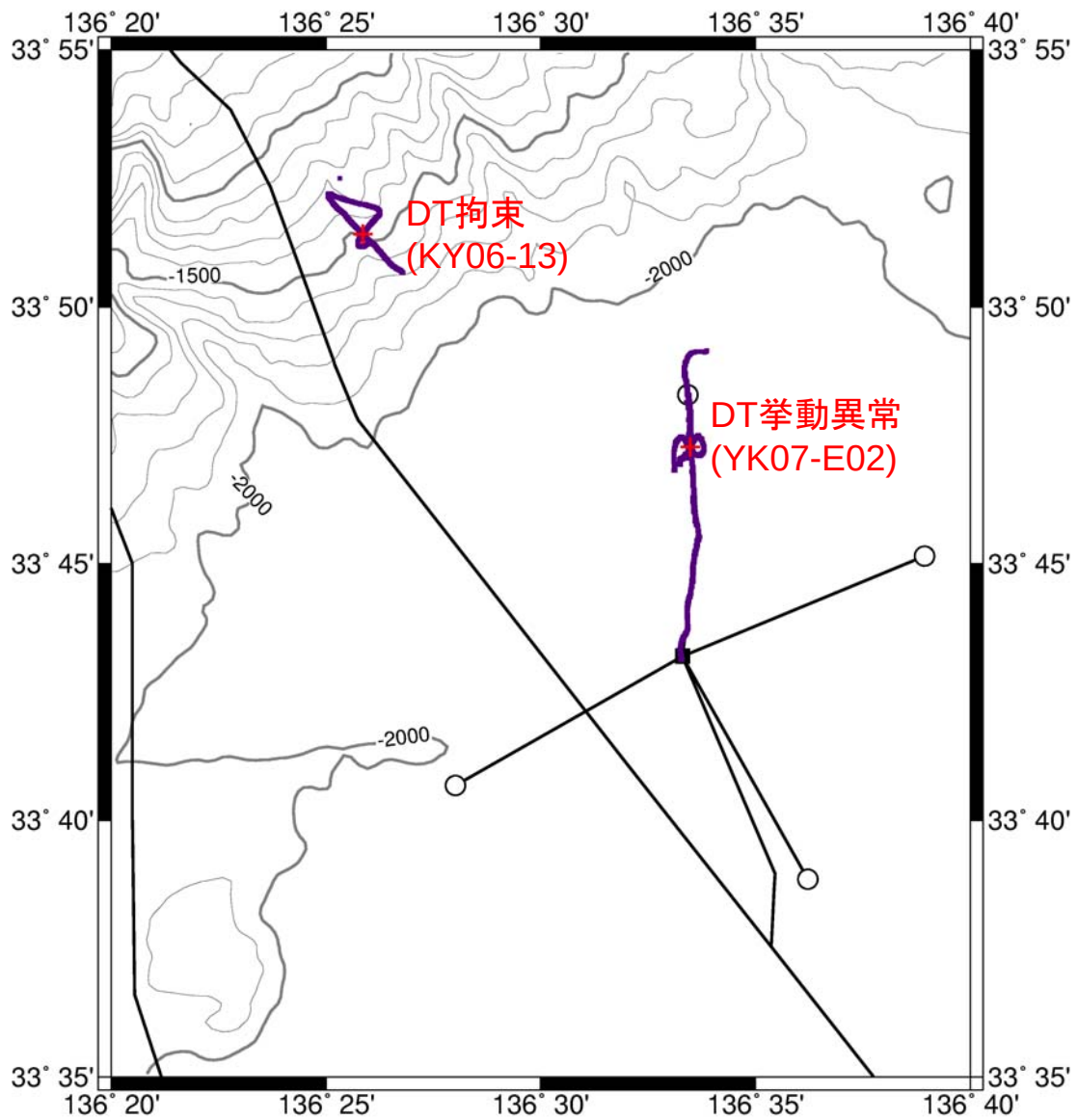


33_17.5708N / 136_52.0394E
[15:39] Color CCD

We tried to remove something capturing Deep Tow system in the past in terms of the small anchor system below. Nothing is recovered during this cruise. Moreover, Deep Tow was captured in the area D, and we have to spend a lot of time to try recovering new obstacle.

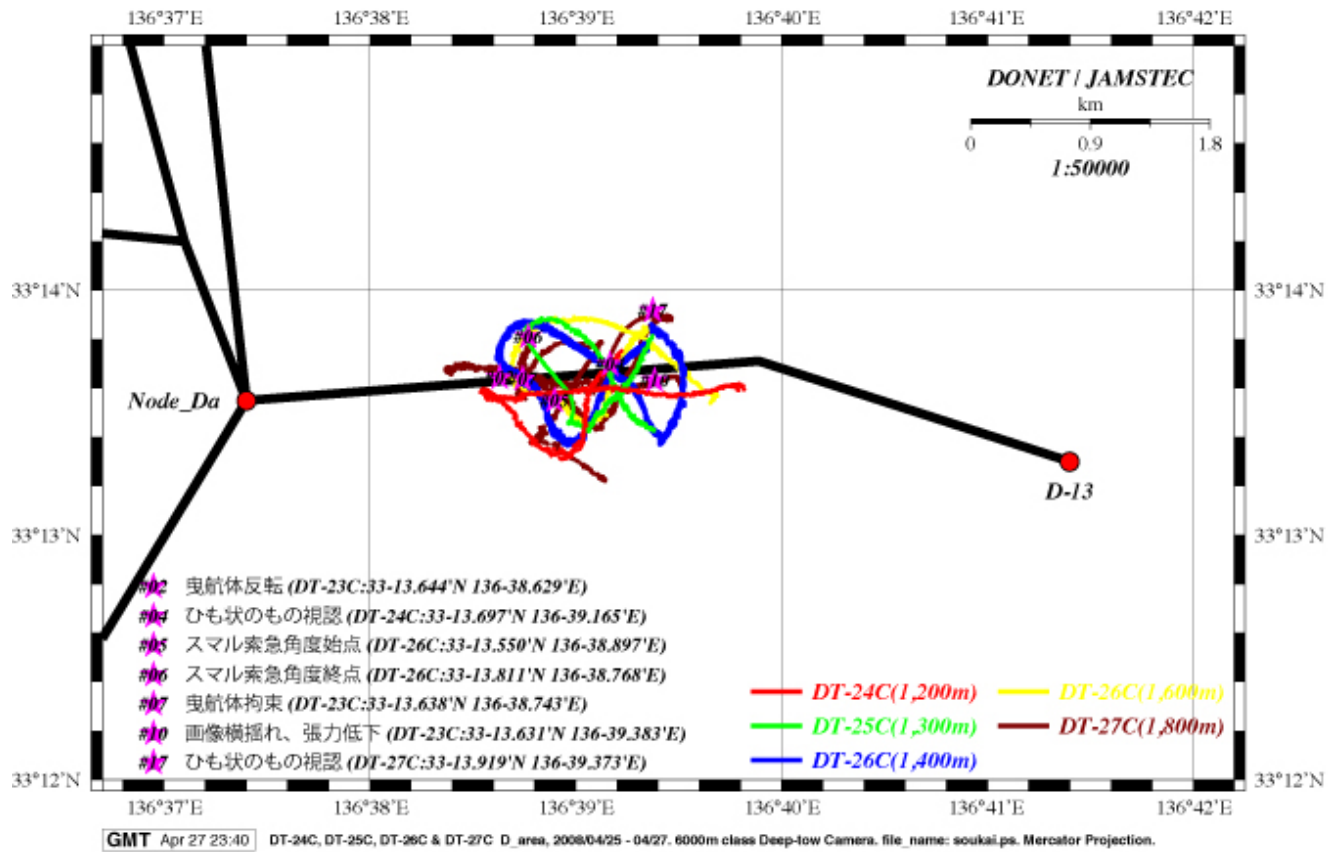


(1) Leg1



(2) Leg2

Deep-tow Camera Survey Line, SOUKAI line



3. Benchmark installation

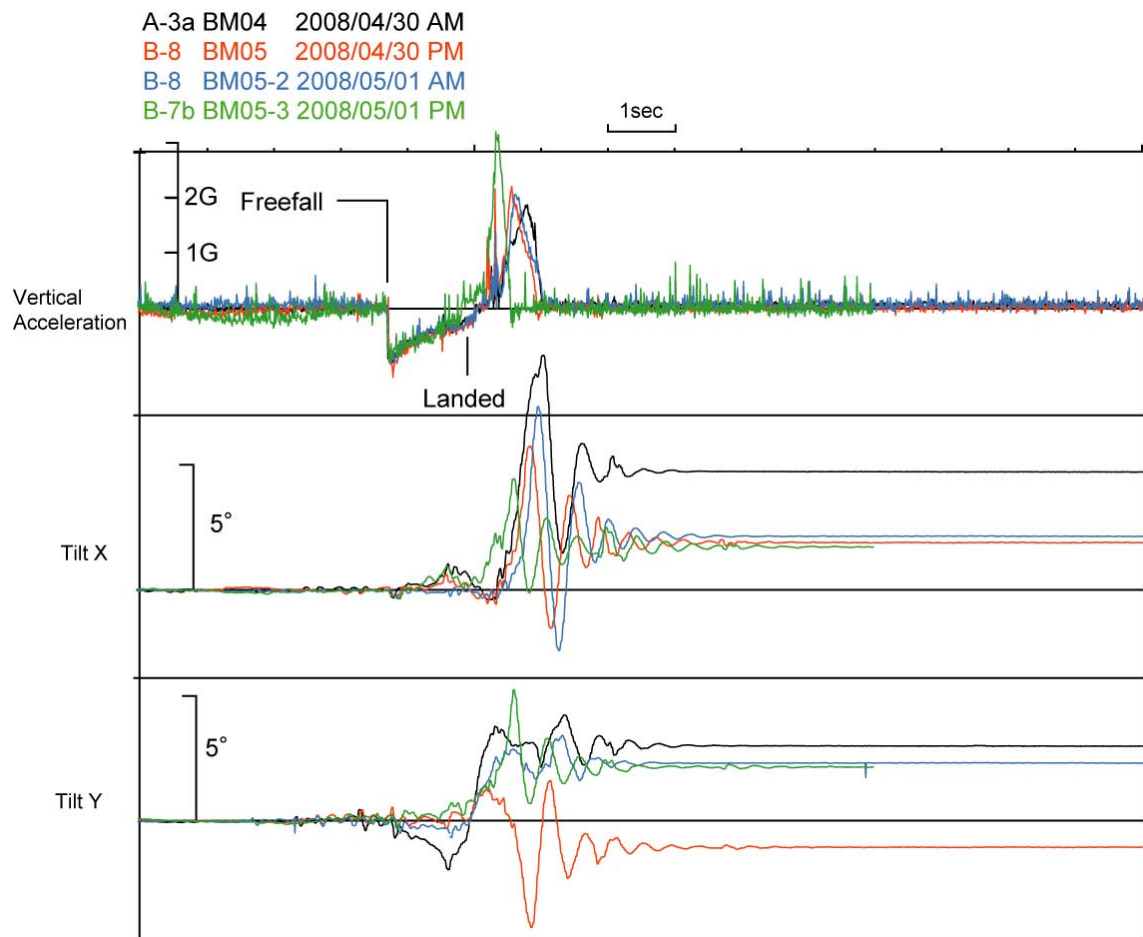
We have tried to install two benchmark platforms in the area of DONET, that will be used as the actual platform. As a result, we have succeeded to deploy one benchmark platform in A-3 area. Some improvements of the benchmarks are required to complete burials of the benchmark in the deep-sea area.



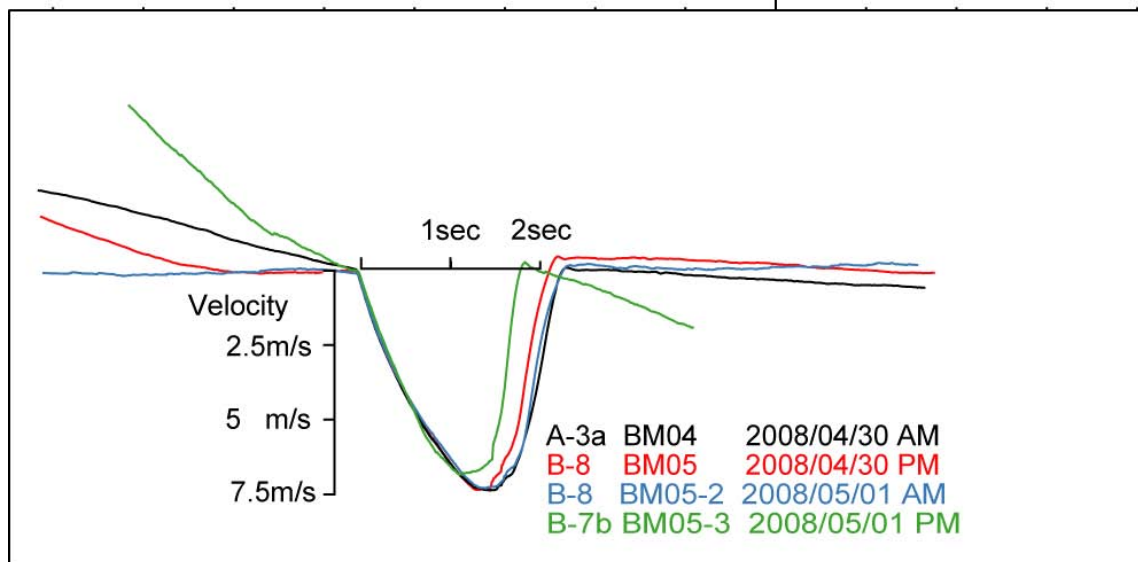
Benchmark installation from the vessel.



Tilt meter (left) and balance weight (right).



Tilt and acceleration changes during the benchmarks' installation.



Velocities during the installation.

ベンチマークピストンコアラー実施サマリー

ベンチマーク名	サイト名	実施日時間	ベンチマークタイプ (ケーソン部長さ/全長)	設置位置 (SSBLによる)	キャッチャータイプ	貫入長 (m)	ケーシング内部の泥の深さ(cm)	サンプル採取長(m)	設置中コアラー傾斜X	設置中コアラー傾斜Y	潮流、流された量	備考
BM04	A-3a	2008/4/30 9:02	80cm/240cm	33-38.8758N, 136-36.2057E, D=2.065m	改良後	2.21	約40	1.3	4.8	1.7	26°, 1.2kt 150m	着底スイッチ動作、設置した
BM05	B-8	2008/4/30 14:15	80cm/240cm	33-28.0061N, 136-48.1899E, D=1.921m	改良後	2.1	約20	0.95	1.9	-1.9	55° 0.6kt, 35m	着底スイッチ動作せず、設置せず
BM05-2	B-8	2008/5/1 8:17	80cm/240cm	33-28.0108N, 136-48.1914E, D=1.920m	改良前	2.11	約20	0.9	2.6	1.9	28° 0.8kt 80m	着底スイッチ動作せず、設置せず
BM05-3	B-7b	2008/5/1 12:21	80cm/240cm	33-22.0975N, 136-47.5509E, D=1.901m	改良後	1.66	0	1.45	1.7	1.4	85° 0.6kt	着底スイッチ動作せず、設置せず

*貫入長はアウターパイプに付着した堆積物より計測。

Summary of the benchmarks installation

海底ベンチマークコアラー傾斜サマリー

ベンチマーク名	サイト名	実施日時間	ベンチマークタイプ (ケーソン部長さ/全長)	設置前コアラー傾斜X deg	設置前コアラー傾斜Y deg	設置中コアラー傾斜X deg	設置中コアラー傾斜Y deg	巻き上げ後コアラー傾斜X deg	巻き上げ後コアラー傾斜Y deg	カウンターウェイト kg	メインワイアー長 m	パイロットワイアー長 m	フリーフォール m	備考
BM04	A-3a	2008/4/30 9:02	80cm/240cm	0	-1.4	4.8	1.7	0.2	-1.1	12	7.9	8.15	3.2	着底スイッチ動作、設置した
BM05	B-8	2008/4/30 14:15	80cm/240cm	-0.1	-0.8	1.9	-1.9	-0.1	-1.1	10	7.9	8.15	3.2	着底スイッチ動作せず、設置せず
BM05-2	B-8	2008/5/1 8:17	80cm/240cm	0	-1	2.6	1.9	0	-1.2	10	7.9	8.15	3.2	着底スイッチ動作せず、設置せず
BM05-3	B-7b	2008/5/1 12:21	80cm/240cm	0	-0.8	1.7	1.4	-0.1	-1.4	10	7.9	8.15	3.2	着底スイッチ動作せず、設置せず

Tilt change of the benchmarks' installation

4. CONCLUSIONS

We performed KY08-03 cruise by using R/V Kaiyo for approximately one month. Following the desktop study, we carried out route and site survey in the Kumano Trough, where the network system will be deployed next year. 34 line in total both along the backbone and the link cables are visually surveyed by Deep Tow camera system. Surveys along the link cable have been finished, except for seven survey lines. Among them left in the present survey, we consider that we don't need to do further survey in particular the Kumano Trough, because its topography is very flat and the bottom is covered by deep sediment. All of link cable route including detoured route we surveyed in the present survey are possible to deploy thin and long cable. As for the backbone cable, we focused on the cable route passing through the northern edge of the Kumano Trough and the transition of the cable type near the Nankai Trough. Although some steep cliffs have been found along the backbone cable route in the northern edge of the Kumano Trough, we could find new route detouring cliffs by the end of the survey. Visual surveys of power supply route in the areas B and D, however, still remains. During the camera survey in D area, Deep Tow system was captured by something in the deep sea. The cutter attached above Deep Tow vehicle was also broken. We tried to remove the obstacle in the deep sea by five dives as done in YK07-E02 cruise. We could remove nothing at all in the present cruise.

During the KY08-03 cruise, we carried out installation of the benchmark in addition to the route survey. We have improved sediment catcher system of the benchmark from the originals employed in KR07-15 cruise. We tried to deploy the benchmark in areas A and B. Because surface sediment in area B is harder than that in area A, the benchmark could not be deployed under the bottom in area B. In this cruise, we deployed one benchmark in area A, i.e., the central Kumano Trough. We realize that we need to improve benchmarks itself in the future. We will deploy the seismic sensor unit inside the benchmark deployed this by using ROV Hyper Dolphin survey in September.

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