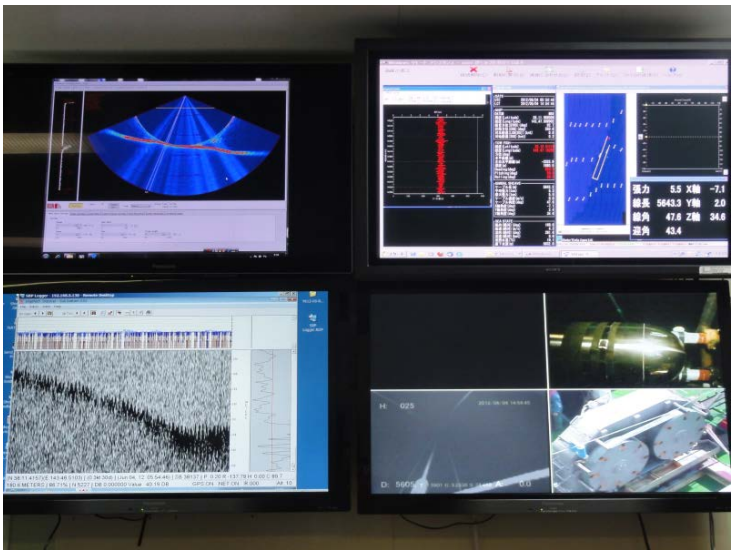
doi : 10.17596/0003056

R/V Yokosuka Cruise Report

YK12-08



Research program "The Survey and Observation for Earthquakes and Tsunamis off the Pacific Coast of Tohoku"

2 June 2012 (Yokosuka) – 12 June 2012 (Yokosuka)

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Acknowledgements

We would like to thank Captain Mr. Ukekura and all ship crew of R/V YOKOSUKA for their safe cruise. We are grateful to Commander Mr. Matsumoto and the operation team of a Yokosuka Deep-Tow (YKDT) for their operations in serious condition. We are pleased to Mr. Yamamoto and MARITEC staff for their supports during our cruise. We also thank Dr. Kodaira for their advices of cruise planning. This cruise is supported by a research program "The Survey and Observation for Earthquakes and Tsunamis off the Pacific Coast of Tohoku" by MEXT.

YK12-08 Cruise report contents

1. Objectives and Cruise summary of YK12-08 cruise

Cruise information

Cruise number	YK12-08
Name of the cruise	R/V YOKOSUKA
Title of the cruise	The Survey and Observation for Earthquakes and Tsunamis off the Pacific Coast of Tohoku (Bathymetric survey)
Chief scientist	Takafumi Kasaya (IFREE, JAMSTEC)
Representative of the Science Party	Takafumi Kasaya (IFREE, JAMSTEC)
Cruise period	2 July 2012 – 12 July 2012
Ports of call	Yokosuka – Yokosuka (JAMSTEC)
Research Area	Fig.1

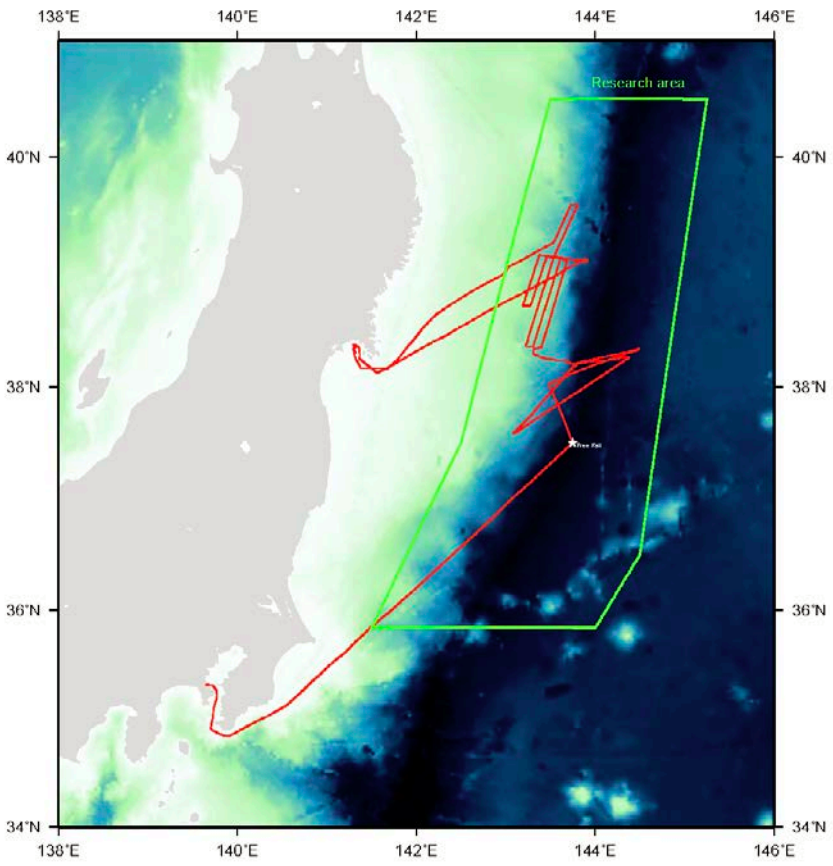


Fig.1 Research area map and ship track of this cruise.

Summary

On 11 March 2011, Tohoku, northeast Japan, experienced a great earthquake (Mw 9.0, Mt 9.1) called the 2011 off the Pacific coast of Tohoku earthquake. Seismic and tsunami inversion analyses have shown that tsunami waves with a maximum run-up height of 38 m were generated after the main shock by topographic changes on the seafloor in the toe region of the Japan Trench slope off Sendai. These inversion analyses (Maeda et al., 2011) and bathymetric surveys (Fujiwara et al., 2011) indicate that the toe region slipped about 50 m along the thrust.

To investigate many phenomena related with the earthquake, research program supported by MEXT has been started. Our main task of this cruise is to survey the bathymetric and geophysical data around off Tohoku area. Moreover, we used a high accuracy multi-beam echo sounder "Seabat 7125 system" and a sub bottom profiler (SBP) system on a Yokosuka deep-tow (YKDT) to obtain high resolution bathymetry and sub bottom structure. We could detect very clear sub-surface images with 50 ms penetration.

Moreover, this cruise is first use of new armored composite cable (umbilical cable) of optical fiber and electric wire for the No.3 winch system. Therefore, the free-fall is carried out for cancelling this twist at the begging of this cruise.

2. List of Participant(NME)

2-1.Research group

Takafumi Kasaya	Japan Agency for Marine-Earth Science and Technology
Toshiya Fujiwara	Japan Agency for Marine-Earth Science and Technology
Tuyoshi Yoshiume	Japan Agency for Marine-Earth Science and Technology
Junya Niikura	Japan Agency for Marine-Earth Science and Technology
Sayaka Nitta	Yamaguchi University
Masayuki Toizumi	Nippon Marine Enterprises, LTD.
Masashi Ito	Nippon Marine Enterprises, LTD.

2-2.Operation team of the YKDT

Operation Manager	Keita Matsumoto
1st Submersible staff	Masanobu Yanagitani
2nd Submersible staff	Keigo Suzuki
3rd Submersible staff	Hitomi Ikeda
3rd Submersible staff	Yudai Tayama
3rd Submersible staff	Ryu Asai

2-3.Captain and crew of the R/V YOKOSUKA

Captain	Eiko Ukekura
Chief Officer	Yasuhiko Sanmori
2nd Officer	Tomoyuki Takahashi
3rd Officer	Hiroharu Omae
Chief Engineer	Eiji Sakaguchi
1st Engineer	Takashi Ota
2nd Engineer	Kenta Ikeguchi
3rd Engineer	Katsuto Yamaguchi
Chief Radio officer	Fukuo Suda
2nd Electronic Operator	Hiroki Ishiwata
3rd Electronic Operator	Takatomo Shirozume
Boat Swain	Yoshiaki Kawamura
Able Seaman	Kazumi Ogasawara
Able Seaman	Masanori Ohata
Able Seaman	Yuki Yoshino
Able Seaman	Takuya Miyashita

Sailor	Shinya Ueno
Sailor	Yuta Motooka
No.1 Oiler	Kozo Miura
Oiler	Yoshinori Kawai
Oiler	Sota Misago
Assistant Oiler	Eiji Aratake
Assistant Oiler	Toru Hidaka
Chief Steward	Sueto Sasaki
Steward	Tatsunari Onoue
Steward	Toru Wada
Steward	Takahiro Abe
Steward	Masaru Takada

3. Ship Log

日付 Date	時間 Local Time	内容 Note	特記事項 Description	本船位置／気象／海象 Position/Weather/Wind/Sea condition
02-Jun-12		**Sail out, proceeding to research area**		06/02 12:00 (UTC+9h)
	09:00	Let go all shore lines,left YOKOSUKA.		34-52.8N 139-59.7E
	11:00-11:20	Carried out shipboard education & training for scientists.		Off Nojimazaki
				Overcast
				South-2(Light breeze)
				2(Sea smooth)
				1(Low swell sea)
				Visibly: 5'
03-Jun-12		**Free fall of cable**		06/03 12:00 (UTC+9h)
	02:00	Arrived at research area.		37-30.0N 143-45.0E
	04:20	Com'ced free fall of cable.		Off Sanriku
	11:55	Released XBT at 37-29.9838N,143-44.9610E.		Cloudy
	11:58	Finished free fall of cable.		SE-3(Gentle breeze)
	12:08	Com'ced free fall of cable.		2(Sea smooth)
	19:48	Finished free fall of cable.		1(Low swell sea)
	22:01	Released XBT at 37-56.0005N,143-31.7349E.		Visibly: 7'
	22:38	Com'ced MBES mapping survey.		
04-Jun-12		**YKDT#139**		06/04 12:00 (UTC+9h)
	02:55	Finished MBES mapping survey,then com'ced proceeding to survey area.		38-11.5N 143-46.4E

	05:30	Arrived at survey p't.		Off Sanriku
	09:33	Com'ced towing YKDT,then started her operation#139.		Fine but cloudy
	17:47	Recovered YKDT & finished above operation.		SSW-3(Gentle breeze)
	21:20	Com'ced MBES mapping survey.		2(Sea smooth)
				1(Low swell sea)
				Visibly:8'
05-Jun-12		**YKDT#140**		06/05 12:00 (UTC+9h)
	03:34	Finished MBES mapping survey,then com'ced proceeding to survey p't.		38-11.6N 143-47.4E
	06:00	Arrived at survey p't.		Off Sanriku
	09:35	Com'ced towing YKDT,then started her operation#140.		Fine but cloudy
	17:45	Recovered YKDT & finished above operation.		SSW-4(Moderate breeze)
	17:50	Com'ced proceeding to MBES mapping survey area.		3(Sea slight)
	19:48	Arrived at MBES mapping survey area,then com'ced MBES mapping survey.		1(Low swell sea)
				Visibly:8'
06-Jun-12		**MBES&SBP mapping survey**		06/06 12:00 (UTC+9h)
	07:34	Com'ced SBP survey.		39-03.0N 143-30.0E
	13:36	Finished SBP survey.		Off Sanriku
	17:45	Finished MBES mapping survey,then com'ced proceeding to ISHINOMAKI due to rough sea .		Overcast
				SE-4(Moderate breeze)
				3(Sea slight)
				3(Low swell long)
				Visibly:7'
07-Jun-12		**Drifting at ISHINOMAKI**		06/07 12:00 (UTC+9h)
	01:30	Arrived at ISHINOMAKI,then com'ced drifting.		38-21.0N

				141-19.6E
	18:00	Finished drifting,then com'ced proceeding to research area.		Ishinomaki bay
				Fine but cloudy
				SE-3(Gentle breeze)
				2(Sea smooth)
				1(Low swell sea)
				Visibly:8'
08-Jun-12		**YKDT#141**		06/08 12:00 (UTC+9h)
	04:45	Arrived at research area.		39-07.0N 143-55.0E
	05:28	Released XBT		Off Sanriku
	09:34	Com'ced towing YKDT,then started her operation#141.		Overcast
	18:44	Recovered YKDT & finished above operation.		SE-4(Moderate breeze)
	20:12	Com'ced MBES mapping survey.		3(Sea slight)
				3(Low swell long)
				Visibly:8'
09-Jun-12		**YKDT#142**		06/09 12:00 (UTC+9h)
	02:08	Finished MBES mapping survey.		39-06.0N 143-55.8E
	08:15	Com'ced towing YKDT,then started her operation#142.		Off Sanriku
	13:05	Recovered YKDT & finished above operation.		Rainy
	13:15	Com'ced proceeding to ISHINOMAKI due to rough sea.		SE-7(Near gale)
				5(Sea rough)
				3(Moderate short)
				Visibly:3'
10-Jun-12		**Anchorin at ISHINOMAKI**		06/10 12:00 (UTC+9h)
	01:00	Arrrived at ISHINOMAKI,then com'ced drifting.		38-21.6N

				141-21.2E
	07:00	Finished drifting,then let go anchor.		Ishinomaki bay
				Mist
				NE-3(Gentle breeze)
				2(Sea smooth)
				1(Low swell sea)
				Visibly:3'
11-Jun-12		**Proceeding to YOKOSUKA**		06/11 12:00 (UTC+9h)
	07:00	Heaving anchor,then com'ced proceeding to YOKOSUKA.		37-07.9N 141-20.5E
				Off Shioyazaki
				Fine but cloudy
				NNE-5(Fresh breeze)
				3(Sea slight)
				3(Moderate short)
				Visibly:8'
12-Jun-12	09:00	**Arrive at YOKOSUKA**		06/12 00:00 (UTC+9h)
				34-52.8N 139-59.7E

4. Deep-Tow dives

4.1 Seabat 7125 and SBP system

SeaBat7125 and SBP (Sub Bottom Profiler) are mounted on YKDT during YK12-08 cruise. SeaBat7125 is a 200 kHz high-resolution bathymetric system that collects high-resolution bathymetric data and backscattering intensity data simultaneously. 256 beams and equi-distant footprints provide us extremely high density and maximizing swath width. SBP's modulation is full spectrum chirp FM pulse with amplitude and phase weighting. SBP is a 1.5-4.5kHz. SBP's resolution is 15-25cm. All measurements are corrected for actual YKDT attitude by using PhinsDVL motion sensing unit. With No.3 fiber optic cable, SeaBat7125 and PhinsDVL mounted on YKDT can map water as deep as 6,000 meters. The specification of the system is shown in Table 4.2.1.

Table 4.2.1 Specification of SeaBat7125, SBP system and PhisDVL unit.

SeaBat7125

Frequency: 200kHz
Max Slant Range: 820m
Swath Coverage: 128°
Beam Width: 0.5×1° (Along-track ×Across-track)
Number of Beams: 256 Equi-angle or 256 Equi-distant
Depth Resolution: 6 mm
Operating Depth: 6000m

PhinsDVL

Heading Accuracy: 0.01°(working with GPS)
Roll / Pitch Accuracy: 0.01°rms
DVL Frequency: 600kHz
Operating Depth: 6000m

SBP: Sub Bottom Profiler

Frequency Band: 1-6kHz,
Pulse selection: 1.5-4.5kHz
Depth Resolution: 15cm – 25cm,
Beam Width: 28°- 36°,
Operating Depth: 6000m

SeaBat7125 system is composed of the receiver array, projector array, and SeaBat7125 Control PC (see, Fig.4.2.1) that can record by itself. SBP system is also composed of the receiver array, projector array, and SBP Control PC. SBP Control PC is ROV type, which cannot record by itself. So, SBP's Data logger is included in optical transmit device. PhinsDVL is a subsea inertial navigation system providing position, true heading (Fiber Optic Gyroscope), attitude, speed and heave. To increase position accuracy, Doppler Velocity Log (DVL) and depth sensor are connected to PhinsDVL.

Optical transmit device has three tasks. One is supplying electric power to Seabat7125, SBP and PhinsDVL. Another is transmitting PhinsDVL data to Seabat7125 control PC, SBP, and transmitting Seabat7125 and Phins DVL data to surface. All bathymetric data of SeaBat7125 including backscattering data and PhinsDVL data are stored on a hard disk drive in SeaBat7125 Control PC pressure case. The other is that SBP data is stored in SBP data logger in optical transmit device.

Block diagram of the system used during YK12-08 cruise SeaBat7125 and SBP system is shown in Fig.4.2.2. Through the No.3 winch cable, SeaBat7125, SBP and PhinsDVL can be controlled and monitored at ship's operation room. For optical communication being not available, real time monitoring of the SeaBat7125, SBP and PhinsDVL data is not available. However, SeaBat is stored in the Seabat7125 control PC of wet part, and SBP data is stored in the SBP logger of wet part.

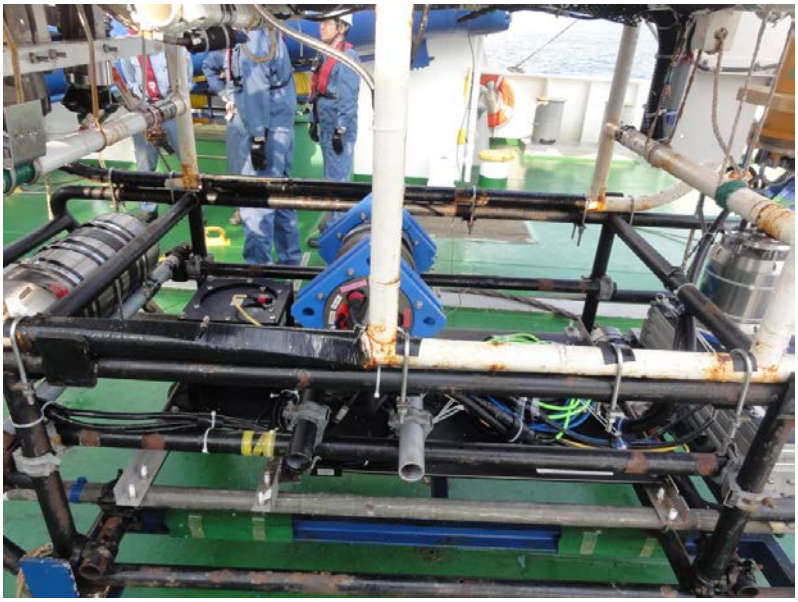


Fig. 4.2.1 Seabat 7125 and SBP system mounted on the YKDT.

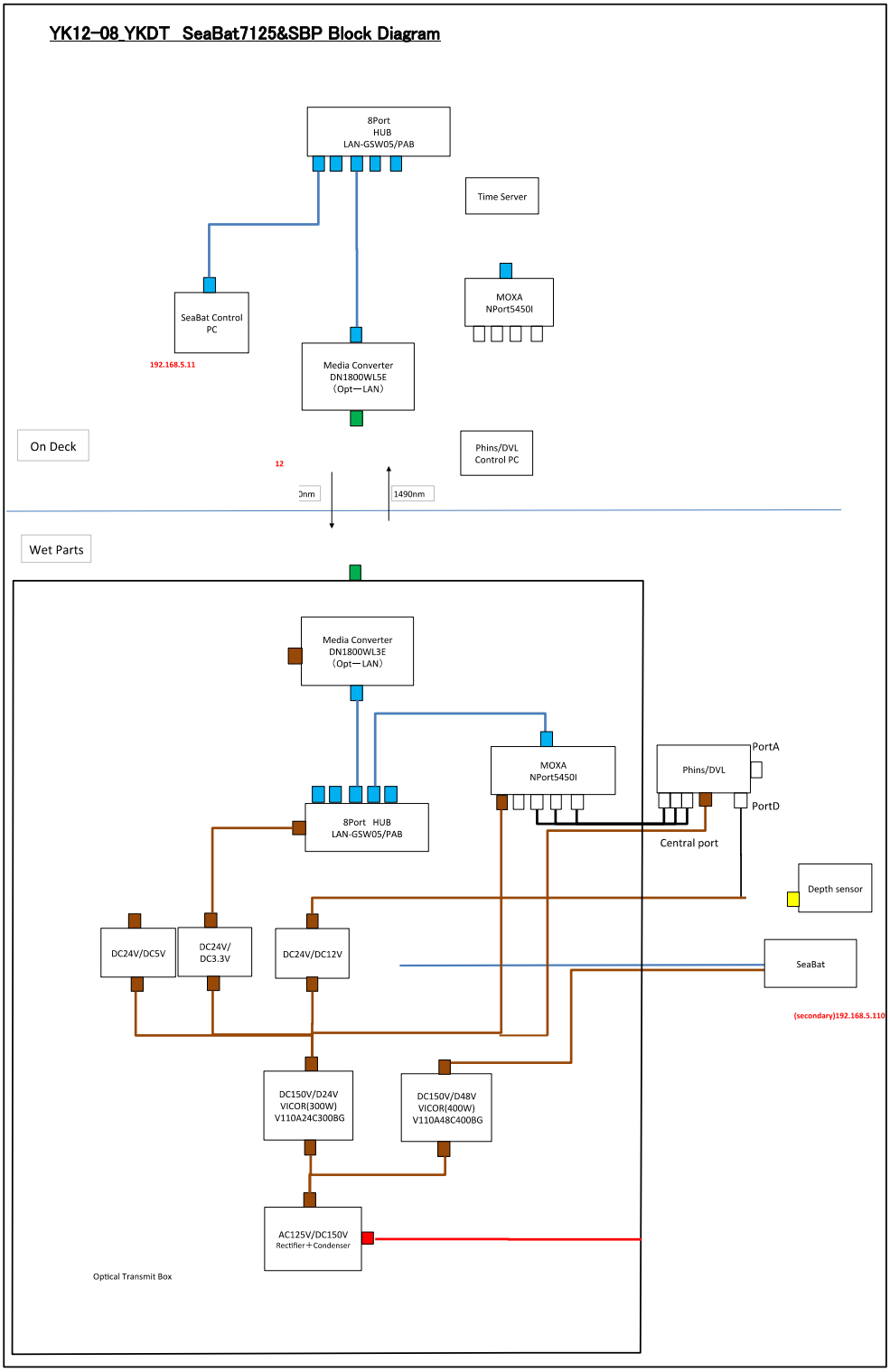


Fig. 4.1.2 Block diagram of YKDT and acoustic observation system.

4.2 Dive summary of YKDT dive

The purpose of YKDT dive #139 and #140 was to obtain the detailed bathymetry and sub-bottom structure around at 38º 10' N. This dive survey line of #139 was along with the slope, and it of #140 was across the slope. Towed speed of each dive was 0.5-0.7 knt in hight of 50 meters. The seabat 7125 system and sub-bottom profiler system worked well, and we could confirm the sonar data through the optical cable line.

YKDT dive #141 and #142 were carried out around 39º 06-07' N area, where we found many fissures and displacements by previous DT and Shinkai 6500 dives last year. We carried out on two survey lines across the slope at 39º 06' and 39º 07' degrees N. Towed speed was 0.5-0.7 knt. The towed height was about 50 and 100 meters each. Sub-bottom profiler data could detect sub-surface structures with 30-45 meters penetration.

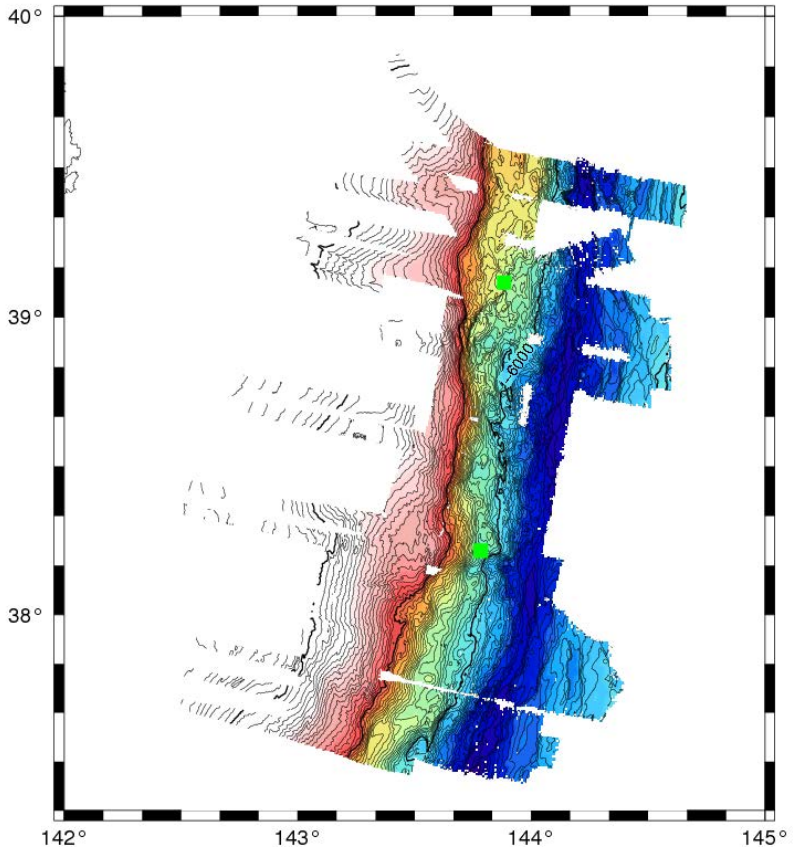


Fig. 4.2 Dive sites (green square) of this cruise.

Dive 139 Log Sheet

時間			方位	深度	高度	X	Y	観察記録
HH	MM	SS	(H)	(D)	(A)			
	32	40	177	5560	195.0	1200	500	調査開始。
	40	00	103	5558	195.0	1190	490	SBP 海底面、モニターにて確認。Seabat 海底面水平。
	50	00	200	5554	136.0	1200	480	
10	00	00	146	5549	200.0	1170	440	海底面右肩上がり
	10	00	150	5543	202.0	1090	390	海底面右肩上がり
	20	00	178	5553	205.0	1050	360	海底面右肩上がり
	30	00	291	5553	202.0	970	300	海底面平ら
	42	00	276	5558	200.0	930	300	
	50	00	274	5558	199.0	890	250	seabat 右舷側データばらつく
11	00	00	273	5554	200.0	830	250	海底面右肩上がり、傾斜やや急
	10	00	210	5567	200.4	670	190	
	16	00	271	5567				海底面右肩上がり（ほぼ平ら）
	19	22	286	5564				海底面平ら
	20	00	280	5561	199.0	570	140	海底面右肩上がり
	27	11	279	5564				海底面右肩上がり（ほぼ平ら）
	30	00	258	5566	193.0	430	80	海底面右肩上がり
	40	00	265	5556	201.3	300	20	
	51	00	271	5554	202.0	180	-50	海底面右肩上がり。SBP 海底面付近に２層の強い反射面[2m]。
12	00	00	271	5555	203.4	80	-100	海底面右肩上がり。SBP 海底面が浅くなる。
	10	20	218	5570	199.0	-40	-190	海底面右肩上がり。
	20	00	221	5575	197.0	-160	-230	海底面右肩上がり
	30	50	293	5575	200.0	-270	-280	海底面ほぼ水平。右端は、浅い。
	40	35	244	5581	197.7	-370	-350	海底面はほぼ水平。右端高まり。SBP 画面上５ｍ程の高低差?高度差?
	44	45	217	5579	202.0			SBP 画面上２ｍ程の地形変化あり（浅く）。
	50	40	226	5567	206	-550	-400	海底面右肩上がり、右端高まり。SBP 浅くなる傾向。
	52	19	218	5567	207			SBP 画面上１０ｍ程深くなった。
	57	0	248	5575	181.1			左回頭開始

13	1	0	222	559	203.2	−780	−490	海底面右肩上がり。
	7	8	245	5548				SBP 画面表示上深くなる。（ケーブル巻きだし中）
	10	30	265	5535	202.5	−910	−480	海底面やや右肩下がり。
	20	30	266	5530	196.6	−1050	−530	SBP 画面上浅くなる。
	30	40	194	5533	202.3	−1120	−530	
	40	40	166	5549	195.4	−1140	−400	
	50	50	117	5567	202	−1150	−350	
	53	00	137	5571	202	−1090	−370	#4 通過
14	00	00	117	5585	195	−1030	−280	海底面平ら
	07	00	30	5584	203			方位 030、反射面 2 枚?
	10	00	69	5587	203	−940	−220	海底面平ら
	20	00	46	5595	201	−790	−120	海底面右肩下がり、SBP の反射面の幅が広い（多重面のかんじ）。
	32	00	27	5600	199	−660	−60	海底面右肩下がり。
	40	00	29	5598	200	−560	0	海底面右肩下がり。
	50	00	27	5605	201	−450	70	海底面右肩下がり。のぼり段差（ケーブル操作？）があったのち単調下り斜面
	55	00	26	5605				SBP 下り斜面終了平坦に。
	57	18	28	5609	201			SBP 画面急な登り斜面
15	00	00	24	5609	202	−340	110	海底面右肩下がり、SBP 緩やかなのぼり傾斜
	02	54	23	5611				SBP 一時反射映像来ず。
	09	22	22	5602				SBP 画面上 8m 下がる、下がった後平坦
	10	00	24	5601	196	−190	160	海底面右肩下がり
	20	00	27	5599	196	−80	250	調査終了、巻き上げ開始

Dive 140 Log Sheet

時間			方位	深度	高度	X	Y	観察記録
HH	MM	SS						
	35	23	139	5544	50.0	590	-410	ウィンチ停止。調査開始。
	40	55	168	5542	50.0	570	-410	
	50	30	210	5535	58.6	580	-390	
	54	00	179	5534	60.0			ケーブル巻き出し
	55	20	175	5541	50.0			ケーブル巻き出し停止。線長５５７４.６m。
10	00	00	196	5538	48.7	570	-380	
	04	00						ケーブル巻き出し、5618m
	10	00	195	5555	54.5	640	-340	海底面左肩下がり
	20	00	129	5600	50.0	560	-210	陸向きに下がる反射面？
	35	00	126	5665	52.0	480	-40	
	40	00	130	5684	51.0	480	20	
	50	00	122	5714	52.5	320	160	海底面ほぼ平ら
11	00	00	144	5730	50.1	400	350	
	10	00	130	5751	53.1	290	460	海底面右肩下がり
	20	00	129	5765	54.0	230	600	海底面ほぼ平ら
	30	00	139	5792	50.4	150	680	海底面ほぼ平ら
	32	46						イベント 2 番まで 500m
	40	00	139	5801	53.6	30	820	
	43	40	137	5805	49.2			イベント 2 番まで 300m
	46	00						録画開始
	50	00	156	5807	54.0	-20	940	海底面右肩上がり
	58	20	178	5816	48.0			回頭終了
12	0	30	187	5819	48	-140	1060	
	8	17	208	5816	49			イベント２番を通過
	12	17	223	5818	51	-310	1040	
	20	12	314	5825	48.7	-390	890	SBP 海底面付近１３m 位反射面あり。地

								形は水平。
	26	22	325	5827	48.2			SBP 反射面は段々と薄くなり、海底面付近のみとなった。地形は左肩上がり。
	30	0	329	5826	47.4	-480	820	SBP 海底面 5m 程下がる。線長:5848.9m
	33	45	309	5815	50.9			SBP 海底面下がる。ケーブル巻き取り。５８４３．２m。
	37	20	331	5816	50			DT チェーン及び曳航ワイヤーが持ち上げられた様な動きがあった。SBP 乱れあり。
	40	12	340	5817	48.3	-560	670	SBP 海底面付近３m 強い反射、７m 別の反射面あり。地形は左肩上がり。
	41	30	352	5814				ケーブル巻取:５８３８m。
	50	05	356	5806	48.5	-580	560	SBP 海底面。地形なだらかに左肩上がり。
13	00	30	2	5797	50.4	-530	460	
	03	09	1	5799	49.4	-540	400	測線上に乗る
	10	31	7	5790	49.8	-520	340	
	20	30	7	5782	53.1	-480	260	海底面右肩下がり
	30	11	316	5757	51.6	-410	110	海底面ほぼ平ら
	40	35	313	5742	47.4	-340	-20	
	50	50	308	5713	45.9	-240	-110	海底面ほぼ平ら
14	00	00	314	5670	51.5	-190	-320	陸側に下る反射面？
	10	00	329	5640	45.2	-120	-450	
	20	00	320	5590	54.5	-60	-560	海底面反射が薄くなる
	30	00	325	5568	55.6	20	-720	
	40	00	323	5541	51.2	120	-780	
	47	00	331	5536	51.2	180	-950	＃４通過、海底下 10m 下は反射ある？
	50	00	321	5528	48.2	200	-980	
15	00	00	319	5508	48.3	260	-1100	海底面左舷側が下り
	10	00	321	5525	47.7	360	-1240	海底面ほぼ平ら
	20	00	321	5511	47.8	420	-1370	海底面右肩下がり、調査終了巻き上げ開始

Dive 141 Log Sheet

時間			方位	深度	高度	X	Y	観察記録
HH	MM	SS						
09	34	00	72	5048	51.0	710	-1870	調査開始。測線に沿って曳航開始。
	40	00	35	5052	51.3	720	-1870	SBP 反射面５０m 弱取得。Seabat 左肩上がり、ほぼ平。
	49	32	136	5055	53.7			SBP 出力を８８%とする。曳航体時折しゃくる。
	51	30	147	5054	50.5	730	-1850	SBP 反射面４０m 弱取得。Seabat 海底面水平。
10	00	00	67	5061	52.0	750	-1760	海底面平ら、曳航体ときどきしゃくり
	10	00	61	5075	51.6	760	-1630	海底面平ら、しゃくりのときは SBP に縦線が入る
	20	00	65	5086	50.2	750	-1470	反射断面の様相変わる、海底反射が弱くて下の面が強い
	30	00	69	5103	50.3	800	-1340	
	40	00	61	5128	50.5	770	-1120	海底面と下にあった反射面が merge したように見えた後、20m 下に下部反射面が見え出す。上部の浸食？
	50	00	61	5147	51.0	740	-960	下部反射面 10m 下
11	0	0	66	5173	52.8	750	-780	海底面右肩下がり
	10	0	77	5229	50.2	770	-580	海底面右肩下がり
	20	0	77	5311	44.5	770	-400	海底面ほぼ平ら
	30	0	77	5301	47	830	-260	海底面ほぼ平ら
	40	0	74	530	50	800	-40	海底面ほぼ平ら

				1	.3			
	50	0	87	5303	52.1	830	140	海底面ほぼ平ら。イベント 4 番まで 1500m
12	00	00	91	5306	50.1	820	340	SBP 海底面反射強く、下部反射面弱くボンヤリ。Seabat ほぼ水平。
	10	10	89	5305	50.4	770	550	SBP 海底下５０m 近くまで反射面あり。Seabat ほぼ水平。
	20	10	117	5301	53.8	850	770	SBP 下部反射面は海底下４０m 付近。Seabat ほぼ水平。SBP 海底下から１５m 程、２５m、４０m 付近にやや強い反射面あり。
	30	00	135	5297	52.5	790	860	SBP 海底下３０m に下部反射面。Seabat ほぼ水平。
	40	00	152	5291	50.8	690	1070	SBP 下部反射面３０m までの間にいくつか層を確認。Seabat ほぼ水平。
	50	00	158	5289	50	620	1190	SBP 海底下２０m、３０m、ほか５０m まで反射面を確認。Seabat はほぼ水平。時折、DT がしゃくられ SBP データに線が入る。
13	00	41	175	5288	53.1	450	1240	Seabat 海底面ほぼ平ら。
	10	20	181	5293	48.9	230	1350	Seabot 海底面ほぼ平ら。
	20	30	185	5289	50.5	30	1390	海底面平ら。
	30	41	188	5289	51.0	-100	1440	
	40	32	196	5287	50.7	-310	1450	海底面平ら。正面下方カメラの録画停止する（HDD 容量満タンのため）
	50	36	205	5289	52.7	-500	1420	海底面やや右肩下がり。
14	00	00	225	5293	51.7	-630	1460	
	10	00	240	5298	50.5	-810	1220	曳航体変針がすすむ
	20	00	258	5303	53.1	-910	1090	
	30	0	271	530	48	-97	103	

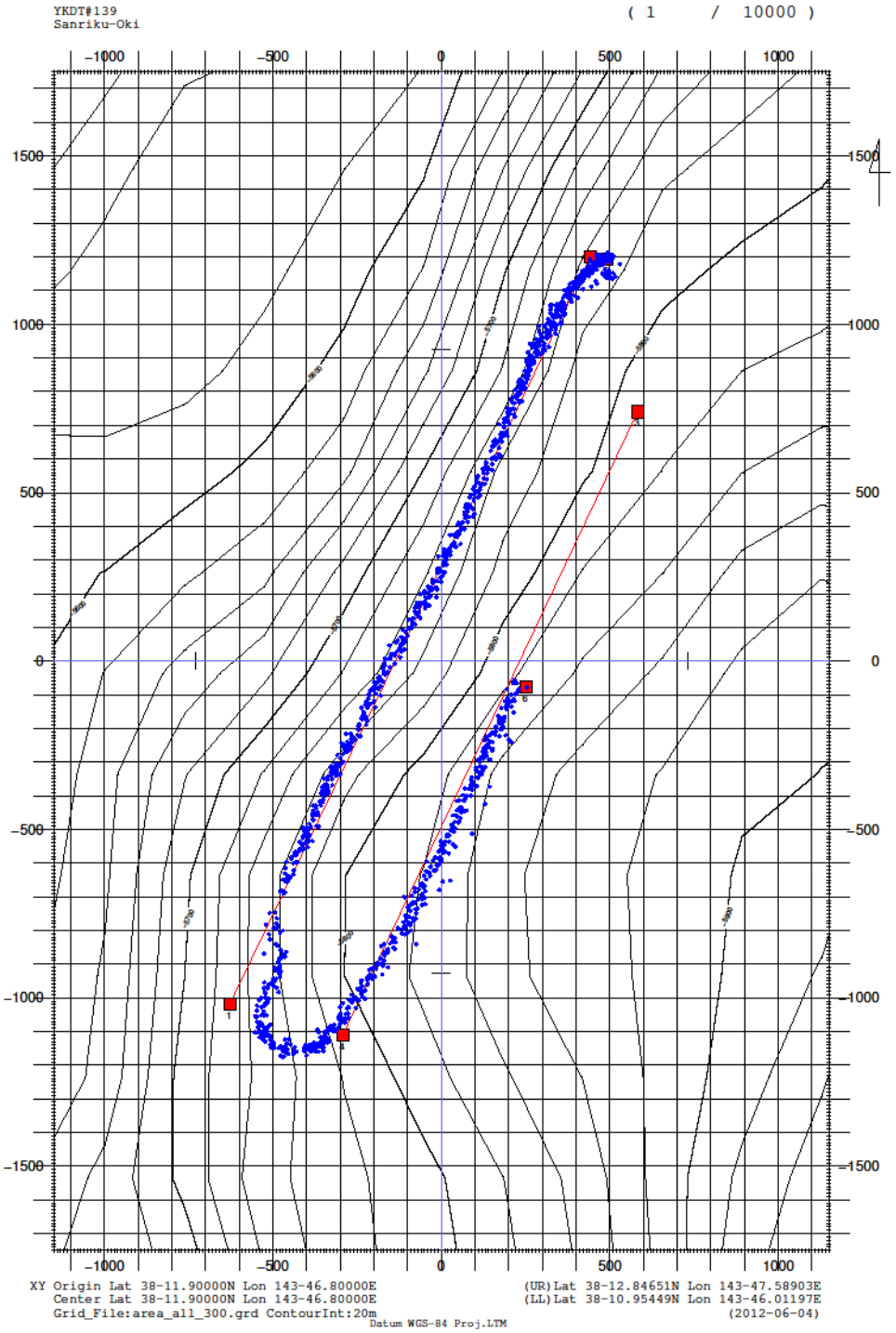
		0		8	.3	0	0	
	40	00	269	5305	50.3	-1050	840	海底面平ら、SBP 水平成層
	50	00	282	5300	53.2	-1020	610	海底面平ら、SBP 水平成層の構造つづく
15	00	00	289	5304	49.3	-1010	520	海底面平ら、SBP 水平成層
	10	00	291	5300	50.4	-1100	330	海底面平ら、SBP 水平成層
	20	00	297	5295	51.7	-1030	150	海底面平ら、SBP 水平成層
	30	00	304	5291	48.3	-1040	-40	海底面平ら
	31	00						テープ交換
	40	00	307	5291	50.9	-980	-220	海底面平ら
	43	12	308	5292	50.5			SBP 下部に反射面
	50	00	306	5291	57.1	-1030	-400	海底面平ら
16	00	00	305	5275	50.7	-910	-570	海底面右肩下がり。SBP 海底面より下の層がほとんど見られない。
	08	14	307	5190	54.2			SBP 海底面反射弱く、ぼやけている。（ケーブル操作の為？）
	10	00	306	5153	43.1	-890	-810	SBP 海底面反射弱いまま。海底面右肩下がり
	20	00	304	5051	49.9	-840	-950	海底面やや右肩下がり。SBP 海底？反射を捉える。
	30	00	303	5020	53.3	-820	-1160	海底面平ら。曳航調査終了、巻き上げ開始

Dive 142 Log Sheet

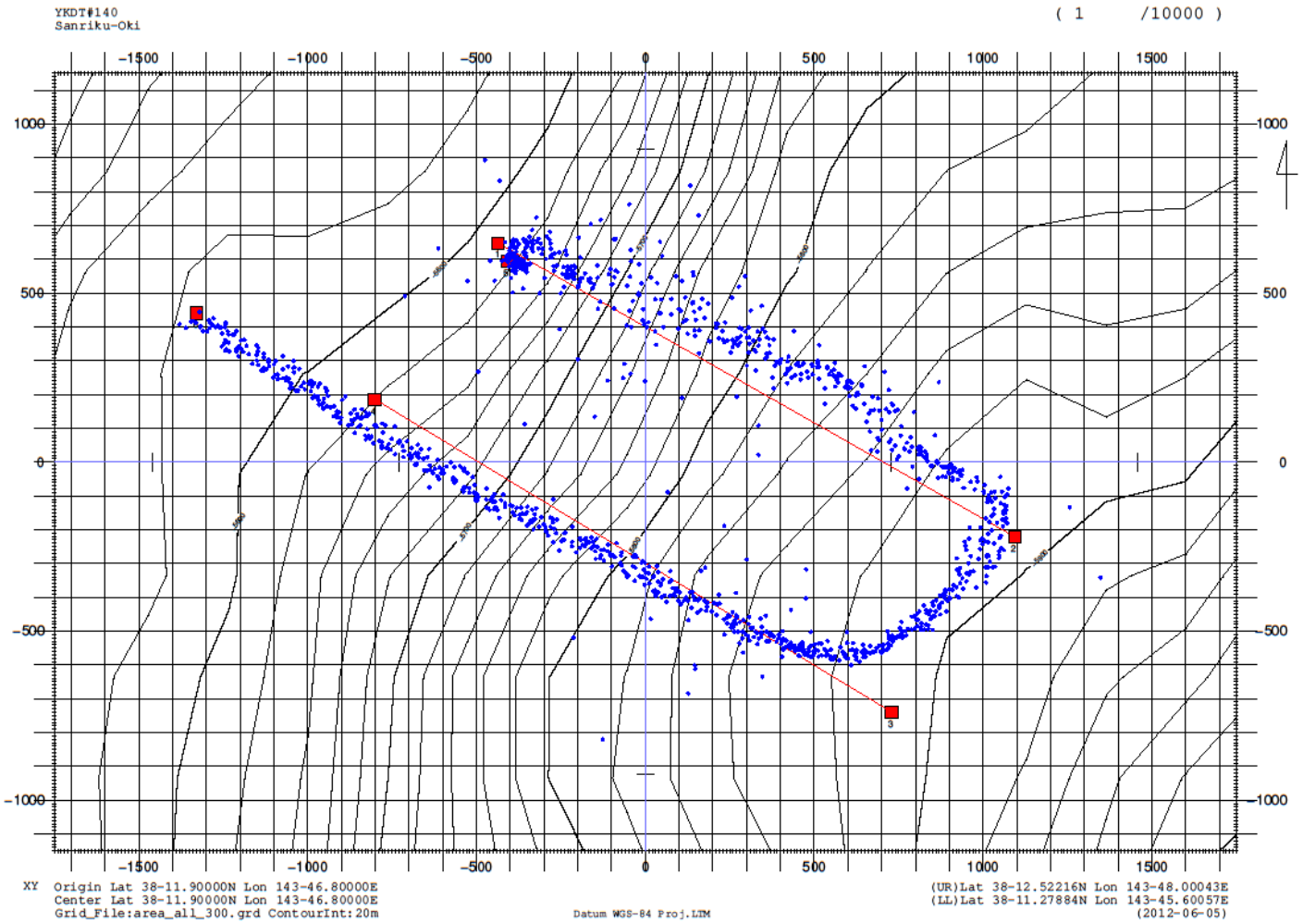
時　間			方位	深度	高度	X	Y	観察記録
HH	MM	SS						
08	16	00	142	4969				曳航調査開始
	17	52	129	4977	80.4			高度８０に変更
	20	00	147	4976	82.6	-480	-1320	海底面やや右肩上がり。
	30	00	145	4977	82.2	-480	-1240	
	40	00	156	4982	78.7	-410	-1150	SBP 海底面反射より約４０m 下に強い反斜面あり
	50	00	144	4981	80.4	-440	-1030	海底面平ら。
09	00	00	67	4982	82.6	-400	-930	海底面やや右肩上がり。SBP 海底下１５m 付近に強い反射面。
	09	10	62	4990	82.6			イベント２番まで残り１，０００m。
	10	00	70	4989	87.7	-460	-720	SBP 海底面１５m 強い反射。４０m 付近にも反射面あり、少しずつ浅く（薄く）なっている。Seabat 水平。
	20	00	72	5015	80.6	-400	-500	SBP 海底面より約５m、約２０m に強い反射面。見える反射面は、大分浅く（薄く）なってきた。Seabat は左肩上がり。
	27	27	70	5039	83.1			SBP 反射面が１０m までしか見えていなかったものが、２０m 程まで見えるようになる。
	30	00	75	5062	83.2	-360	-310	SBP 今まで見えていた反射面の下から別の反射面あり。Ｓｅａｂａｔは左肩上がりで、右舷側に２０m 程の落差あり。
	34	45	73	5107	83.6			イベント２番まで残り５００m。SBP 海底面かなり弱い反射。海底下約４０m 付近に反射面あり。Seabat 海底面、左肩上がり、凸凹。
	40	00	110	5188	87.3	-380	-130	SBP 強かった反射面が浅くなり、海底面となる。海底面下約４０～５０m 付近に弱いが反射面あり。Seabat は左肩上がりで、左端は急に立ち上

								がっている。
	46	50	73	5262	82.1			イベント２番まで３００m。SBP 堆積層はほとんど見られない。海底下約３０m 付近に強い反射面あり。
	51	00	80	5271	82.2	-390	-20	SBP 海底面は強い反射。約２０m 下に弱いがシャープな反射面あり。Seabat ほぼ水平。
	55	00						イベント２番まで２００m。海底下約１５m、約３０m に反射面あり。Seabat はほぼ水平。
	57	00	87	5263	80.0			イベント２番まで１００m。
10	01	00	77	5258	82.0	-410	260	イベント２番通過。
	10	00	81	5260	80.5	-360	420	海底面平ら、層構造は見えにくい不透明層。
	20	00	84	5262	81.2	-350	600	海底面平ら、層構造は見えるかも。水平層。
	30	00	84	5266	78.4	-340	850	
	35	00	83	5270	77.7	-320	1030	海底下 10m に褶曲（？）層。上に凸。
	42	00	86	5270	84.7			観測終了、巻取開始

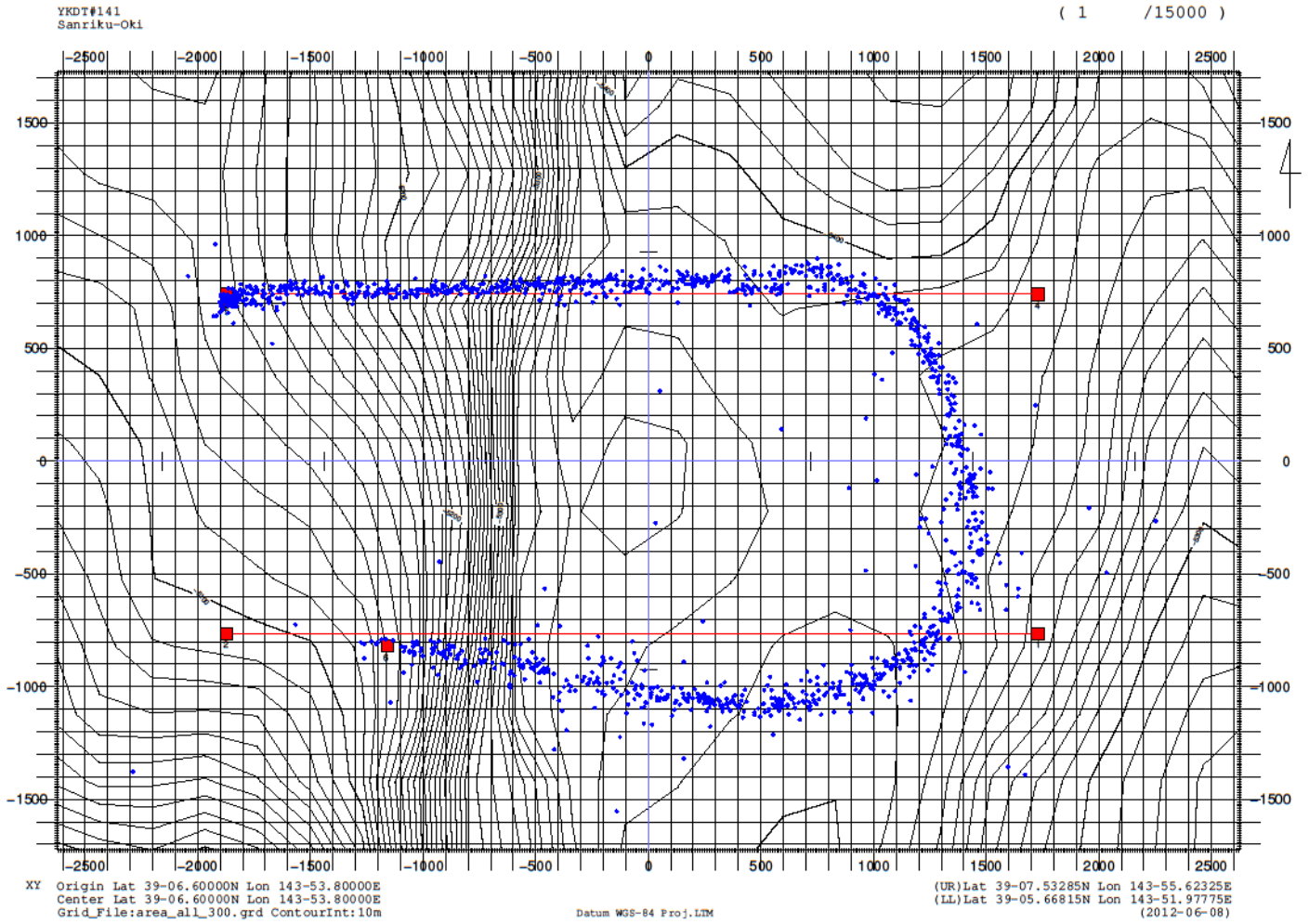
YKDT#139 Dive track



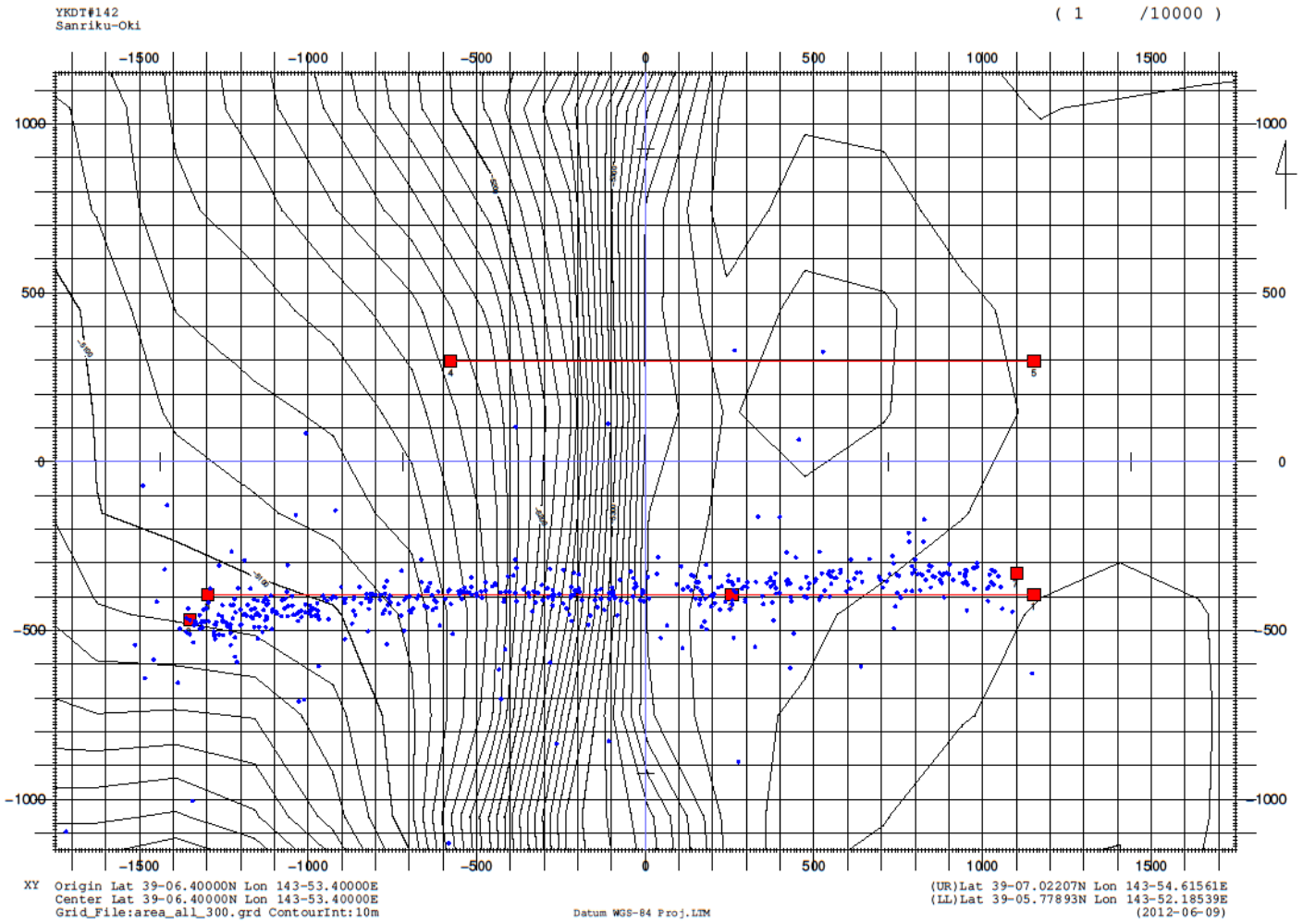
YKDT#140 Dive track



YKDT#141 Dive track



YKDT#142 Dive track



5. Shipboard data

Bathymetric data are obtained by SEABEAM2112 system with an array of transducers and hydrophones installed along and across keel of the R/V Yokosuka. The system transmits a 12 kHz sonar pulse at 2° x2° resolution for fore/aft direction, and records the travel time and amplitude of the returning echoes. The number of beams for this cruise is fixed in 121, thus there are overlap of beams in 1° . The swath range is changeable between 90 – 150° , and we fixed the range 120° during this cruise. Sound velocity profiles were obtained from ship-launched XBT measurements, and were updated into the SEABEAM system. Ship speed is 8 or 10 knots for all survey lines. We have two objectives of MBES survey in this cruise. One is to collect new bathymetric data around the Japan Trench after Tohoku earthquake. Other one is detection of the bathymetric change around the trench axis (Fujiwara et al., 2012). This MBES system has sub-bottom profiler with 4 kHz frequency. We only obtain the SBP data during day time survey at 6th June. Table 5.1 shows the survey line list of this cruise. Figure 5.1 shows the bathymetric map used by this data.

Specification of SEABEAM2112.004 on R/V Yokosuka

Depth range; 50-11000 m
Frequency; 12 kHz
Number of beams; 151 max
Beam resolution; 2° ×2°
Beam spacing; 1°
Maximum speed; 12 knot（8 knot fix during this cruise）
Accuracy of measurement; 0.5% of depth
Swath range; 90-150 (150° for ~300m, 140° for ~1500m, 120° for ~4500m, 100° for 8000m, and 90° for 11000m in depth. 120° fix in this cruise)

Specification of sub-bottom profiler system

Frequency; 4 kHz
Beam width; 45° ×5°
Profiling limit; 75mbsf
Number of pixels; 1000 pix. each for port and stbd

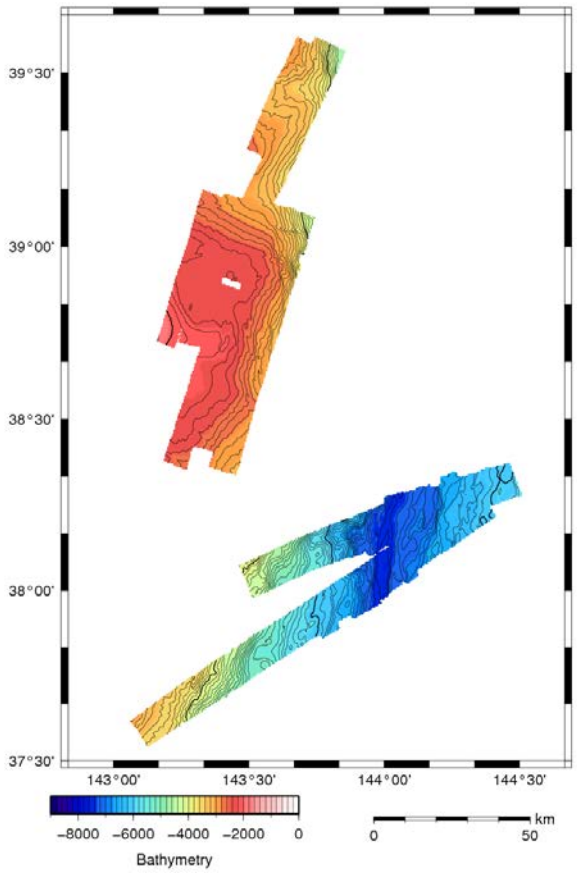


Figure 5.1 Bathymetric map of this cruise.

Table 5.1 List of MBES survey lines.

	Line name	Start				End				Comment
		Latitude		Longitude		Latitude		Longitude		
MBES	Line1	38-01.5742	N	143-29.4571	E	38-19.5928	N	144-29.1218	E	
	Line2	37-34.9673	N	143-05.5526	E	38-15.5257	N	144-22.7189	E	
	測線 1	38-20.9632	N	143-23.9878	E	39-06.0121	N	143-41.0144	E	
	測線 2	39-07.1303	N	143-36.4254	E	38-21.4876	N	143-18.4881	E	
	測線 3_0	38-21.9612	N	143-13.4745	E	38-24.7150	N	143-14.5790	E	SBP Stopped
	測線 3_1	38-23.1511	N	143-14.0311	E	38-53.0232	N	143-25.9519	E	SBP Stopped
	測線 3_2	38-54.1272	N	143-26.3970	E	39-35.0458	N	143048.0335	E	
	測線 4	39-35.0864	N	143-43.6031	E	39-15.9424	N	143-32.1830	E	
	測線 5	39-08.5501	N	143-27.5145	E	38-42.9767	N	143-16.7015	E	
	測線 6	38-42.9802	N	143-11.3715	E	39-09.0256	N	143-22.5007	E	

	Line name	Start				End				Comment
		Latitude		Longitude		Latitude		Longitude		
SBP	測線 3_0	38-23.4466	N	143-14.0640	E	38-42.8200	N	143-21.8400	E	SBP Stopped
	測線 3_1	38-54.7178	N	143-26.6357	E	39-19.3243	N	143-38.7050	E	SBP Stopped

6. Umbilical Cable free fall

6.1 Objective of cable free fall

The new armored composite cable (umbilical cable) of optical fiber and electric wire for No.3 winch system was twisted through the process of making cable. For cancelling this twist, the free-fall is done. The free-fall means that the weight is hanged from the cable end, and the cable is let go to deep-water. To do free-fall, the condition of cable gets higher. In YK12-08, this umbilical cable was used for YKDT

This umbilical cable is 17.2mm outside diameter, and 8000m total lengths. Figure 6.1 shows umbilical cable end structure. This umbilical cable 's specification is shown below,

- Optical fiber: SM mode, 4 cores
- Electric cable: 1.4 mm^2, 4 cores
- Weight; less than 1100kg/km (in the air), less than 860 kg / km （under water）
- Destruction Strength: Over 147kN
- Capacity of outer pressure: Over 78MPa

6.2 Free fall test results

We carried out the free fall test at the begging of this cruise. Figure 6.2 shows the free fall site. Total length of the umbilical cable which dive under water is 6500m. After letting out a cable until length of 6500 meters, we kept the same condition in an hour. During the test, we obtained the data of cable tention using rotation meter. The result is shown Fig. 6.4 and Fig. 6.5. According to results of Table 6.1, it is turned out that the twist of umbilical cable is cancelled.

Table 6.1 Results of rotation data of free-fall operation.

The number of free-fall times	Right rotation	Left rotation	Total rotation (Right - Left)
First time	364	25	339
Second time	33	31	2
Total (First + Second)	397	56	341

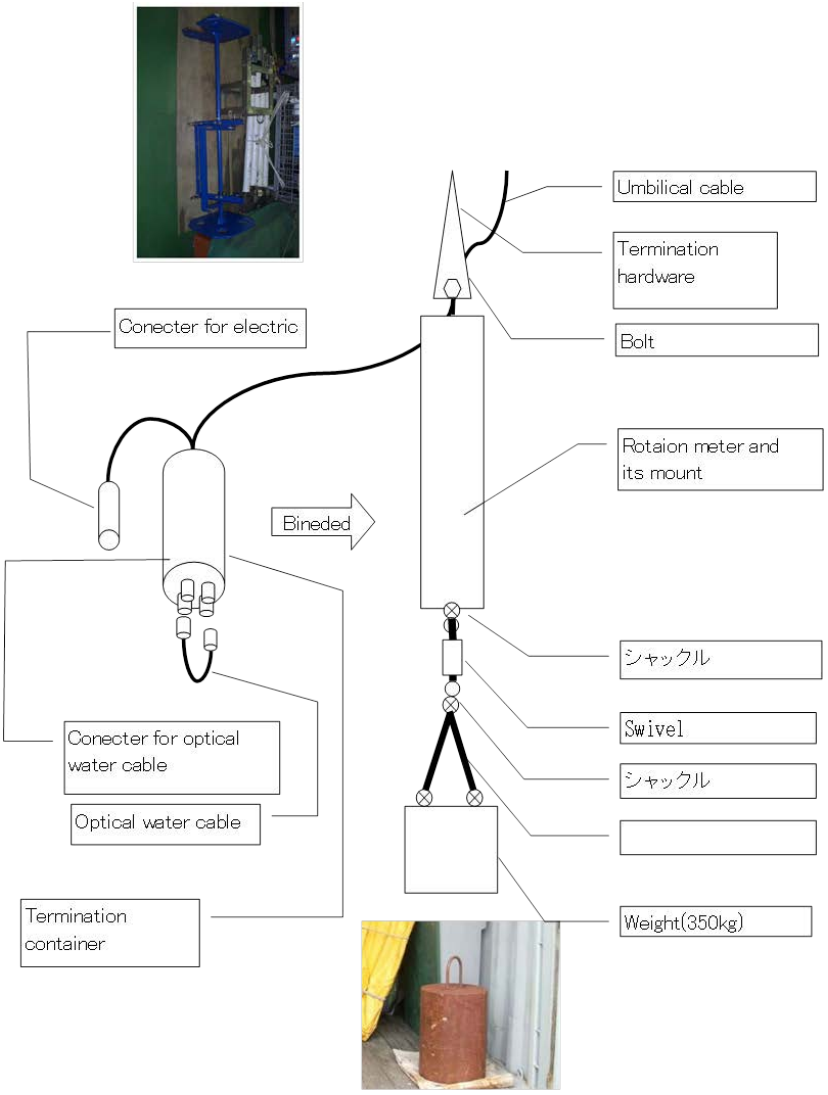


Fig.6.1 Umbilical cable end structure

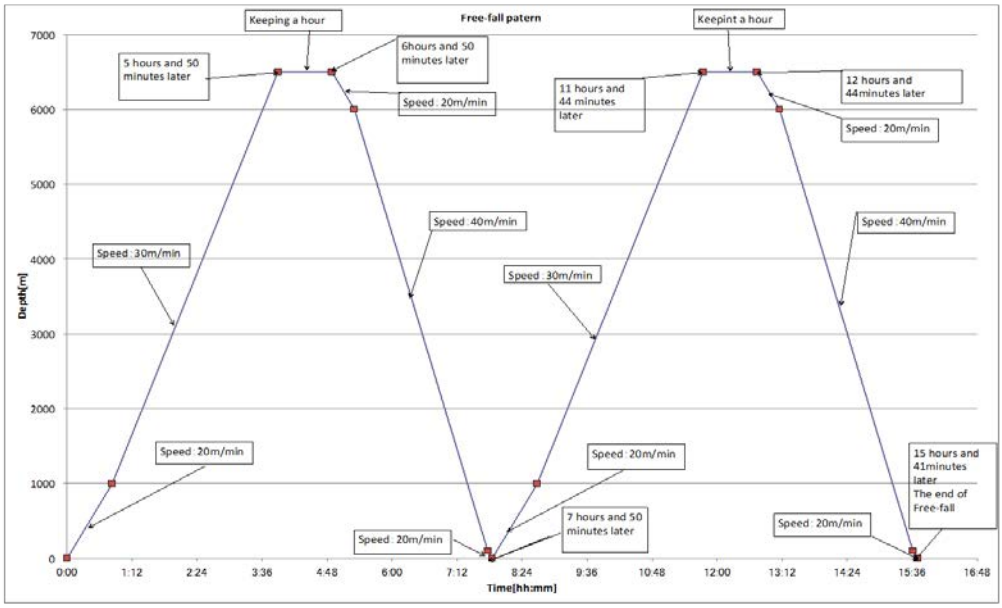


Fig. 6.2 Pattern of letting go umbilical cable

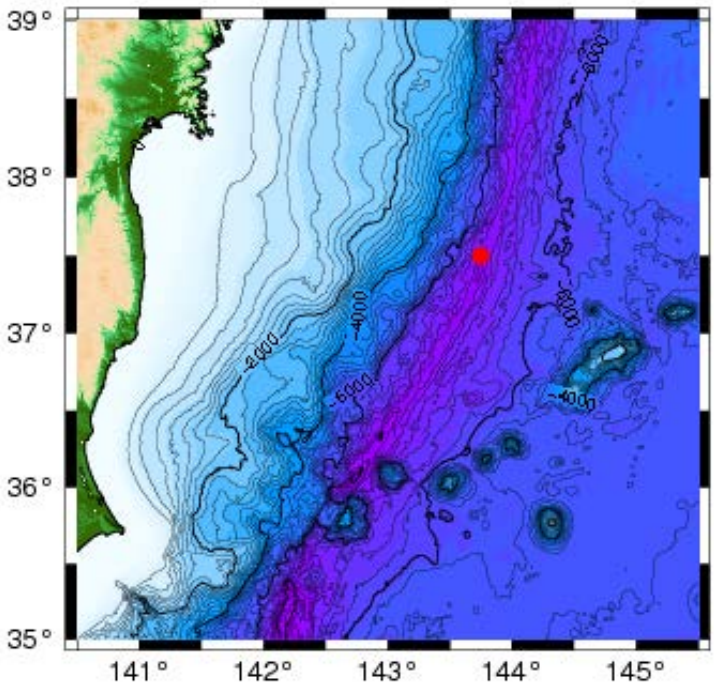


Fig. 6.3 The location of cable free-fall site (red circle).

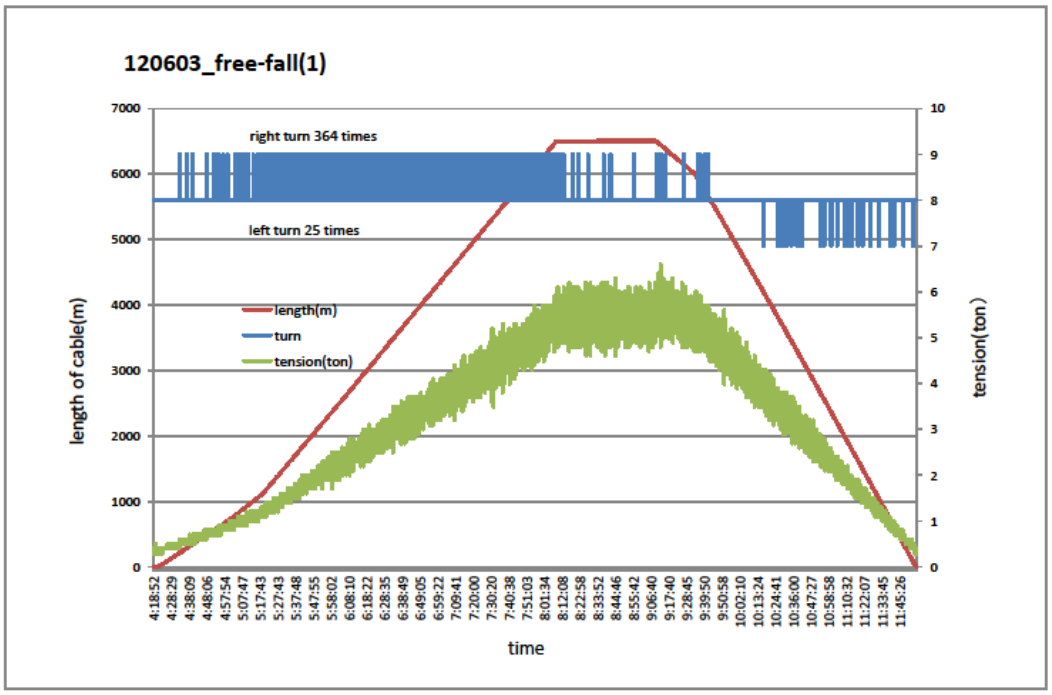


Fig. 6.4 Results of 1st free-fall operation.

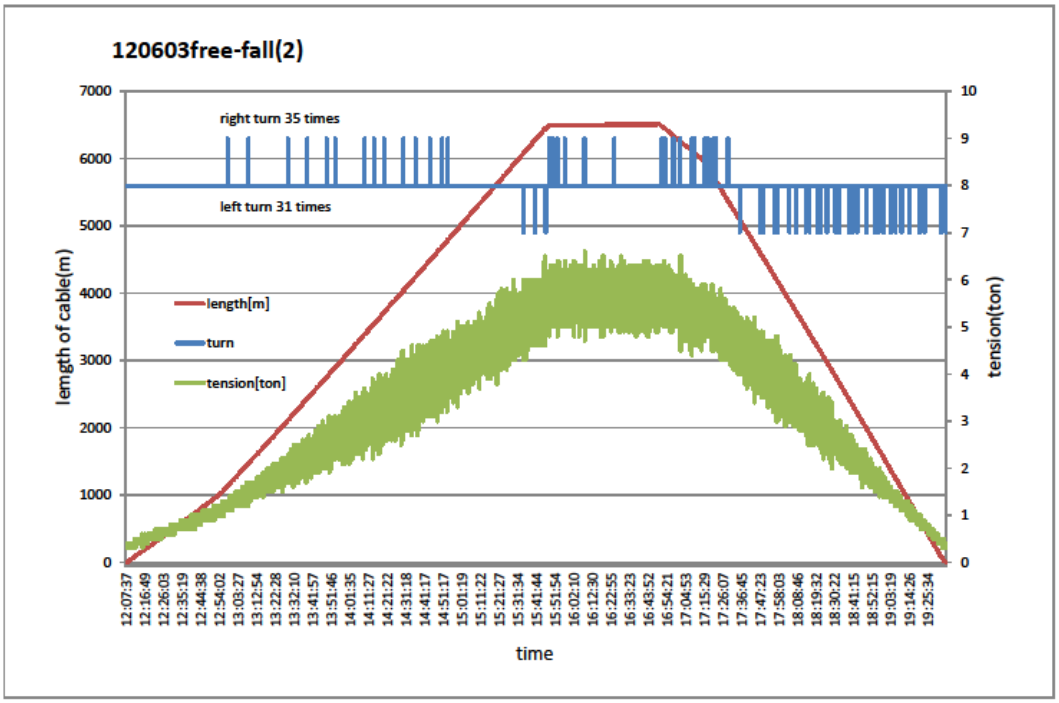


Fig. 6.5 Results of 2nd free-fall operation.

Appendix

A.1 R/V YOKOSUKA

R/V Yokosuka is designed serve as the mother vessel for Shinkai 6500 and Autonomous Underwater Vehicle Urashima. It has silent engine an advanced acoustic navigation systems and an underwater telephone for its state of the art operations.
There are 4 laboratories on Yokosuka, No.1～No.3 laboratories and No.1 Study room. No.1 Lab. has dry space. Permanent installations are video editing system, PC and printer. No.2 Lab. has semi - dry and wet space. There are two freezers (-40 & -80 deg.C), incubator, Milli-Q, fumigation chamber at dry one, and wet one has rock saw. No.3 Lab. has dry space with storage.No.1 Study room has dry space, there are gravity meter, data acquisition system of gravity meter, 3 axis fluxgate magnet meter and also proton magnet meter, work station for data processing, and A0 size plotter.

Length overall	105.2 m
Beam overall	16.0 m
Depth	7.3 m
Draft	4.5 m
Gross tonnage	4,439 tons
Service speed	16knot
Complement	
Crew	27 persons
Submersible operation staff	18 persons
Researchers	15 persons
Total	60persons
Main propulsion system	Diesel engines: 2,206kW x 2
Main propulsion method	Controllable pitch propeller x 2

Table A-1 Principal specifications of R/V Yokosuka

A.2 Yokosuka Deep-Tow (YKDT) system

Yokosuka Deep-tow is attached by armored cable between the mother vessel. There are color TV camera, black-white TV camera, digital still camera and CTD sensors.

color TV camera	SONY DXC-990, NTSC luminous intensity : 1 lux
black-white TV camera	SONY XC-ST50, NTSC luminous intensity : 0.3 lux
digital steel camera	AquaPix SeaSnap (3.34Mpixel)
flood lamp	500W×2 250W×2
CTD	Seabird SBE49
alt meter	MESOTECH 1007
trans ponder	Oki SB-1023 (7kHz)
releaser	Inter Ocean MR5000

Table A.2.1 The specifications of Yokosuka Deep-tow

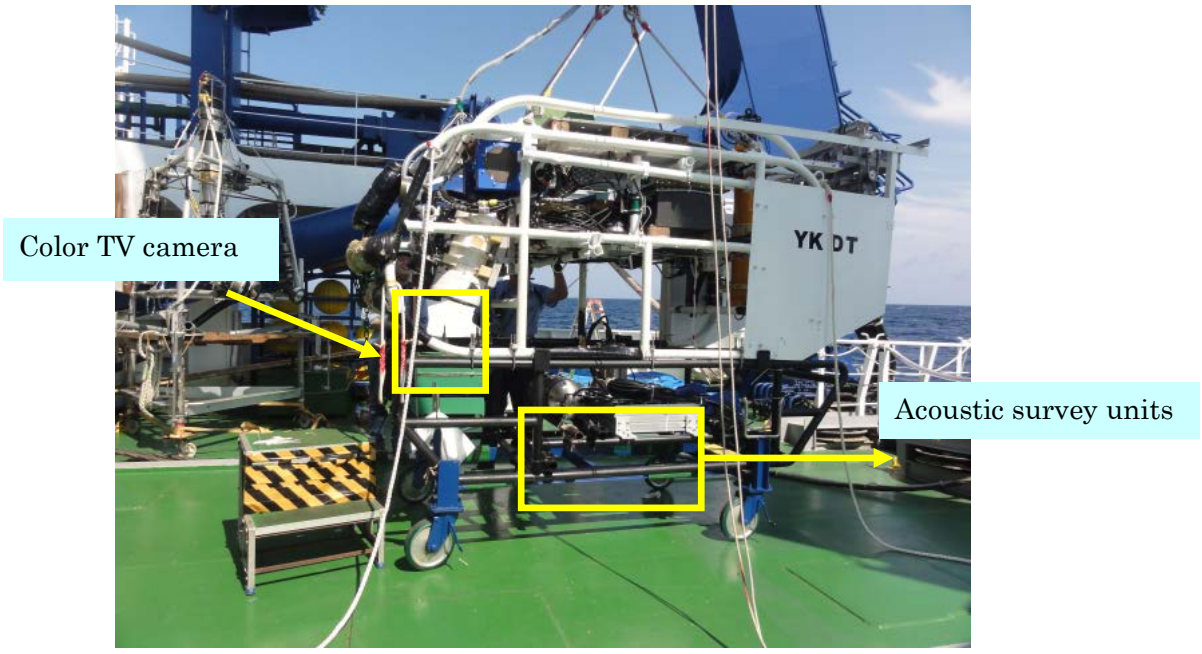


Fig.A.2.1 Yokosuka Deep-tow with a “SEABAT 7125” system.