Preliminary Report
of
The Hakuhō Maru Cruise KH-69-2

April 26 ~ June 19, 1969
Japan Trench and Sea of Japan

Ocean Research Institute
University of Tokyo
1971

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By

The Scientific Members of the Expedition

Edited by

Yoshibumi Tomoda and Noriyuki Nasu

Contents

1. List of scientists on board during the cruise KH-69-2

Chief scientist

Tracks A, B, F, G (April 26—May 20, June 5— June 19):

Yoshibumi TOMODA, Ocean Research Institute, Submarine Geophysics

Tracks C, D, E (May 21—June 4):

Noriyuki NASU, Ocean Research Institute, Submarine Sedimentation

Scientists from the Ocean Research Institute, University of Tokyo

Noriyuki NASU, Submarine Sedimentation
C, D, E

Yoshibumi TOMODA, Submarine Geophysics
A, B, C, D, E, F, G

Kazuo KOBAYASHI, Submarine Geophysics
A, B, C, D, E, F, G

Hideo KAGAMI, Submarine Sedimentation
A, B

Eiichi HONZA, Submarine Sedimentation
A

Masao INOUE, Submarine Sedimentation
B, C, D, E, F

Toshio KASUYA, Biology of Fisheries Resources
C, D, E, F

Kazuhiro KITAZAWA, Submarine Geophysics
A, B, C, D, E, F, G

Jiro SEGAWA, Submarine Geophysics
A, B, C, D, E, F, G

Yasuhiro SUGIMORI, Physical Oceanography
D, E, F

Koji HASUMOTO, Technical official
A

Chiaki IGARASHI, Technical official
A, B, C, D, E, F

Kinichiro KOIZUMI, Technical official
A, B, C, D, E, F, G

Kazuo KUREHA, Technical official
C, D, E, F

Toshisuke NAKAI, Technical official
A

Hirotaka OTOBE, Technical official
B, C, D, E, F, G

OTMARA Avello Suarez, Visiting Researcher from Institute of Oceanology, Cuba, Geology

A

Visiting scientists

From Earthquake Research Institute, University of Tokyo

Shozaburo NAGUMO, Seismology

A, B, C, D, E, F, G

Heihachiro KOBAYASHI, Technical official

A, B, C, D, E, F, G

Sadayuki KORESAWA, Technical official

A, B, C, D, E, F, G

From University Museum, University of Tokyo

Masuoki HORIKOSHI, Benthos research

A

From Geophysical Institute, Faculty of Science, University of Tokyo

Masaru KINOSHITA, Rock magnetism and dating

A

From Graduate School of Natural Sciences, University of Tokyo

Shuji HASEGAWA, Graduate student (Geophysics)

A, B, C, D, E, F, G

From Hokkaido University

Nozomu DEN, Department of Geophysics, Faculty of Science, Geophysics

C, D, E, F

Hiroshi HOTTA, Department of Geophysics, Faculty of Science, Geophysics

A, B

Naomi SAKAJIRI, Graduate student, Graduate School of Natural Sciences (Geophysics)

G

From Tohoku University

Kazuo TAGUCHI, Department of Petrology and Mineralogy, Faculty of Science, Geology

A

Masaharu WATANABE, Graduate student, Graduate School of Natural Sciences (Geology)

A, B, C, D, E, F, G

From Geographical Survey Institute

Haruo ISHII, Technical official, Gravity

A, B, C, D, E, F

From Geological Survey of Japan

Atsuyuki MIZUNO, Senior Researcher, Geology

C, D, E, F

Seizo NAKAO, Technical official, Geology

C, D, E, F

Tsunekazu MOCHIZUKI, Technical official, Geology

C, D, E, F

From National Science Museum

Minoru IMAJIMA, Technical official, Benthos research

A

Sadao KOSUGE, Technical official, Benthos research

A

From Yokohama National University

Shigeo GAMO, Faculty of Education, Benthos research

A

From Tokai University

Takeshi SATO, Faculty of Marine Sciences, Geology

A, B, C, D, E, F, G

Yasumasa KINOSHITA, Graduate student, Graduate School of Marine Sciences (Geology)

A, B

Yafue FUJIWARA, Graduate student, Graduate School of Marine Sciences (Geology)

C, D, E, F, G

From Shizuoka University

Ryuichi TSUCHI, Faculty of Natural Sciences, Geology

A

Naoshi KURODA, Faculty of Education, Geology

D, E, F

From Toyama University

Shoji FUJII, Faculty of Liberal Arts, Geology

C, D, E, F

From Kochi University

Hiromi MITSUSHIO, Faculty of Arts and Science, Geology

C, D, E, F

From Yomiuri Press Inc.

Hideo TAKEICHI, Journalist

A

From Academy of Sciences of USSR

Victor KANAEV, Institute of Oceanology, Geology

B, C, D, E, F, G

Valery ZDOROVENIN, Institute of Oceanology, Geophysics

B, C, D, E, F

Remark: Abbreviation of the ship's track

A: Tokyo to Kushiro (April 26—May 11)
B: Kushiro to Otaru (May 12—May 21)

C :	Otaru to Niigata	(May 22—May 27)
D :	Niigata to Nakhodka	(May 28—June 1)
E :	Nakhodka to Maizuru	(June 2—June 4)
F :	Maizuru to Toyama	(June 5—June 10)
G :	Toyama to Tokyo	(June 11—June 17)

2. General records of

Table 2-1.

KH-69-2 Abstract log From 26th

Date	Noon position		Under way		Propelling			Oceano- Var. propell-	
	Lat.	Long.	Hours	Miles	Hours	Miles	Average speed kt.	Hours	Miles
4. 27	36-05. 7 N	145-35. 6 E	22-55	276. 1	18-14	258. 8	14. 2	4-41	17. 3
28	36-15. 9	143-59. 9	24-00	106. 9	1-56	22. 8	12. 0	15-14	73. 7
29	36-43. 3	141-27. 1	24-00	149. 3	1-27	20. 5	14. 1	17-17	125. 2
30	37-12. 8	145-01. 7	24-00	199. 6				22-36	198. 3
5. 1	39-07. 7	144-17. 8	24-00	149. 4				17-57	146. 6
2	39-41. 4	142-21. 6	24-00	157. 5				18-37	149. 2
3	40-19. 7	142-29. 2	24-00	128. 8				19-08	125. 7
4	40-20. 0	143-00. 0	24-00	244. 8	5-58	83. 7	14. 0	15-24	159. 6
5	39-35. 5	142-59. 1	24-00	154. 1	1-00	13. 2	13. 2	16-08	137. 7
6	39-41. 7	143-37. 5	24-00	73. 3	0-29	6. 7	13. 4	15-31	61. 1
7	40-36. 9	145-18. 7	24-00	123. 4	11-49	76. 7	6. 5	5-50	34. 8
8	Kushiro		16-24 ⚓7-36	161. 8	10-14	121. 6	11. 9	4-13	38. 2
9	40-35. 5	145-20. 2	18-29 ⚓5-31	197. 5	0-21	1. 7	4. 9	18-08	195. 8
10	41-28. 0	145-32. 1	24-00	124. 7	4-19	52. 3	12. 2	12-20	67. 6
11	Kushiro		21-20 ⚓2-40	161. 7	7-05	64. 1	9. 0	8-45	93. 0
12	Kushiro		⚓24-00						
13	45-17. 0	150-20. 0	22-57 ⚓1-03	319. 9	22-57	319. 9	13. 9		
14	46-51. 0	148-34. 7	24-00	252. 3	3-30	49. 1	14. 0	20-30	203. 2
15	44-02. 0	144-21. 4	24-00	252. 6				24-00	252. 6
16	45-30. 3	144-24. 7	24-00	255. 7				24-00	255. 7
17	45-36. 1	142-09. 2	24-00	222. 2				24-00	222. 2
18	44-40. 4	140-29. 7	24-00	239. 1				24-00	239. 1
19	43-58. 1	138-07. 3	24-00	238. 1				24-00	238. 1
20	Otaru		22-30 ⚓1-30	146. 7	2-30	12. 3	4. 9	13-26	130. 9
21	Otaru		⚓24-00						
22	Otaru		⚓24-00						
23	Otaru		⚓24-00						
24	42-44. 2	136-14. 8	⚓0-55 23-05	241. 0	3-25	41. 4	12. 2	19-40	199. 6

the cruise NK-69-2

Summary log

Apr. 1969 To 19th June 1969

No. 1.

graphic log ing Drifting		Wind		Baro. in M.B.S.	Weather	Temperature		Remark
Hours	Miles	Direc.	Force			Air	Sea	
		ENE	5	14.2	c	15.0	17.5	26th 1305 left Tokyo
6-50	10.4	N	4	15.0	b	15.9	17.1	
5-16	3.6	SSW	5	17.6	pc	17.6	16.7	
1-24	1.3	S	2	05.6	r	15.2	15.7	
6-03	2.8	NNW	4	10.0	b	11.4	14.2	
5-23	8.3	S	5	20.5	pc	11.2	8.3	
4-52	3.1	S	4	22.4	b	10.9	7.0	
2-38	1.5	S	6	21.5	pc	12.2	8.2	
6-52	3.2	S	5	13.6	b	15.4	15.3	
8-00	5.5	WSW	5	02.5	pc	16.4	14.6	
6-21	11.9	S	6	14.6	b	10.0	8.4	
1-57	2.0	SSW	5	05.0	c	7.6	4.8	Entered into Kushiro to send captain to hospital
		WNW	5	14.2	pc	10.6	10.1	
7-21	4.8	WSW	3	14.7	pc	9.5	8.9	
5-30	4.6	N	2	02.4	d	6.4	4.1	0920 arrived at Kushiro
		NNW	4	01.0	pc	12.5	5.1	1303 left Kushiro
		W	5	14.6	pc	2.2	0.4	
		SSW	5	11.7	c	3.0	0.2	
		E	4	14.5	b	6.3	3.2	
		SE	4	05.8	b	5.3	2.6	
		NW	4	93.6	r	4.6	3.4	
		SSW	6	99.6	c	7.9	6.0	
		W	5	90.4	pc	7.3	6.0	
6-34	3.5	WSW	3	98.1	pc	10.1	8.1	1030 arrived at Otaru
								1255 left Otaru
		E	3	12.0	c	7.2	6.1	

Date	Noon position		Under way		Propelling			Oceano-	
								Var. propell-	
	Lat.	Long.	Hours	Miles	Hours	Miles	Average speed	Hours	Miles
5. 25	42-06. 1N	136-38. 2E	24-00	121. 0				15-05	112. 8
26	40-36. 3	139-07. 1	24-00	186. 1				24-00	186. 1
27	Niigata		⚓1-25 22-35	206. 7	21-25	5. 07	3. 5	21-10	201. 7
28	Niigata		⚓24-00	0					
29	38-33. 1	138-18. 4	⚓18-32 5-28	52. 6	0-58	6. 6	6. 8	4-30	46. 0
30	41-20. 8	134-25. 3	24-00	246. 3				23-20	245. 3
31	Nakhodka		⚓3-47 20-13	167. 9	8-13	70. 0	8. 5	9-40	95. 8
6. 1	Nakhodka		⚓23-12 0-48	3. 0	0-48	3. 0	3. 8		
2	Nakhdoka		⚓24-00	0					
3	39-43. 6	133-52. 5	24-00	221. 3	2-33	25. 7	10. 1	20-10	194. 6
4	35-43. 5	135-20. 8	24-00	253. 3				23-00	252. 1
5	Maizuru		⚓21-31 2-29	16. 9	1-59	11. 6	5. 8	0-30	5. 3
6	37-27. 4	131-44. 0	⚓4-02 19-58	230. 5	5-23	70. 6	13. 1	14-35	159. 9
7	40-52. 0	132-39. 3	24-00	223. 5				21-50	223. 5
8	39-44. 5	133-55. 5	24-00	132. 4	0-57	14. 5	15. 3	14-54	112. 4
9	38-53. 5	135-39. 2	24-00	128. 3				15-04	127. 0
10	Toyama		⚓0-44 23-16	196. 8	2-01	4. 8	2. 4	18-51	190. 7
11	Toyama		⚓24-00	0					
12	40-56. 7	139-55. 5	⚓4-00 20-00	272. 4	20-00	272. 4	13. 6		
13	40-20. 4	143-03. 7	24-00	202. 6	19-09	200. 6	10. 5		
14	40-14. 7	142-58. 5	24-00	159. 0				19-15	158. 1
15	37-33. 9	141-49. 8	24-00	198. 3	12-29	174. 5	14. 0	8-45	23. 8
16	34-59. 6	139-16. 0	24-00	307. 9	24-00	307. 9	12. 8		
17	Tokyo		⚓16-15 5-13	66. 2	5-13	66. 2	12. 7		
	Total		⚓280-43 963-40	3834. 0	200-22	1274. 8	6. 4	640-04	2488. 7

graphic log ing Drifting Hours	Miles	Wind Direc.	Force	Baro in M.B.S.	Weather	Temperature Air	Sea	Remark
8-55	8.2	E	8	97.3	r	7.4	5.7	
		N	3	97.0	c	10.3	11.1	
		N	3	08.8	c	11.2	13.3	1035 arrived at Niigata
		NW	3	04.2	o	13.2		
		ENE	3	15.1	pc	12.0	13.2	0632 left Niigata
0-40	1.0	E	5	09.5	c	7.2	6.3	
2-20	2.1	SSW	2	07.5	b	9.8	6.0	0813 arrived at Nakhodka
		S	1	10.7	c	18.2		
		E	4	12.1	r	7.1		1200 left Nakhodka
1-17	1.0	NW	4	00.5	o	9.0	7.3	
1-00	1.2	SSE	3	00.8	b	18.0	19.0	1619 arrived at Maizuru
		NNE	2	10.2	c	19.5	19.0	1602 left Maizuru
		NNE	6	04.6	o	14.0	15.9	
2-10	0	SW	5	07.2	pc	10.0	8.0	
8-09	5.5	W	5	09.9	b	14.0	13.3	
8-56	1.3	SSW	5	10.6	b	16.3	14.2	
2-24	1.3	N	1	12.2	b	23.0	18.7	1125 arrived at Toyama
		SW	2	06.2	b	24.8	19.1	1600 left Toyama
		CALM		06.0	d	17.0	14.7	
4-51	2.0	CALM		05.0	f	16.5	14.0	
4-45	0.9	N	4	05.2	f	12.9	9.5	
2-46	0	CALM		12.9	b	16.4	13.8	
		S	4	09.4	c	21.7	20.5	
		S	1	05.0	r	21.3		0928 arrived at Tokyo
123-14	24.5							

NOTE b: blue sky
pc: partly cloudy
c: cloudy
o: overcast
d: drizzling rain
f: fog
r: rain

Table 2-2. KH-69-2 Abstract log from 26th Apr. to 17th June 1969

Date	Abstract	Sampling field
4. 27	Dredging, Under Water Camera	North Pacific Ocean, Kashima II Seamount
28	Dredging, Under Water Camera	North Pacific Ocean
29	Benthos Sampling	〃 off Iso zaki
30	Piston Coring, Benthos Sampling, Under Water Camera	〃
5. 1	Dredging	〃
2	Benthos Sampling (3), Dredging, Under Water Camera	〃 off Todo-ga-saki
3	Setting of Ocean Bottom Seismo-Meter (2), Benthos Sampling	〃 off Kuro saki
4	Setting of Ocean Bottom Seismo-Meter, Benthos Sampling, Under Water Camera	〃
5	Dredging, Benthos Sampling (3), Under Water Camera	〃
6	Dredging, Benthos Sampling (2)	〃
7	Setting of Ocean Bottom Seismo-Meter	〃
9	Heaving up of Ocean Bottom Seismo-Meter, Dredging	〃 Erimo Seamount
10	Under Water Camera	〃
12 : 13	Air Gun & Proton	North Pacific Ocean
14 : 17	Air Gun & Proton	Okhotsk Sea
18 : 20	Air Gun & Proton	North Part of Japan Sea
19	Under Water Camera (2), Piston Coring	〃
24	Under Water Camera, Dredging	〃
25	Piston Coring	〃
30	Piston Coring	Japan Sea
6. 3	Setting of Current Meter, Serial Observation, Setting of Ocean Bottom Seismo-Meter	〃 Kita-Yamato Tai
7	Piston Coring (2)	〃 〃
8	Dredging (3), Recovery of Current Meter, Serial Observation, Recovery of Ocean Bottom Seismo-Meter, Under Water Camera	〃 〃
9	Gravity Coring, Serial Observation, Piston Coring	〃
13	Recovery of Ocean Bottom Seismo-Meter	North Pacific Ocean off Kuro saki
14	Recovery of Ocean Bottom Seismo-Meter	〃

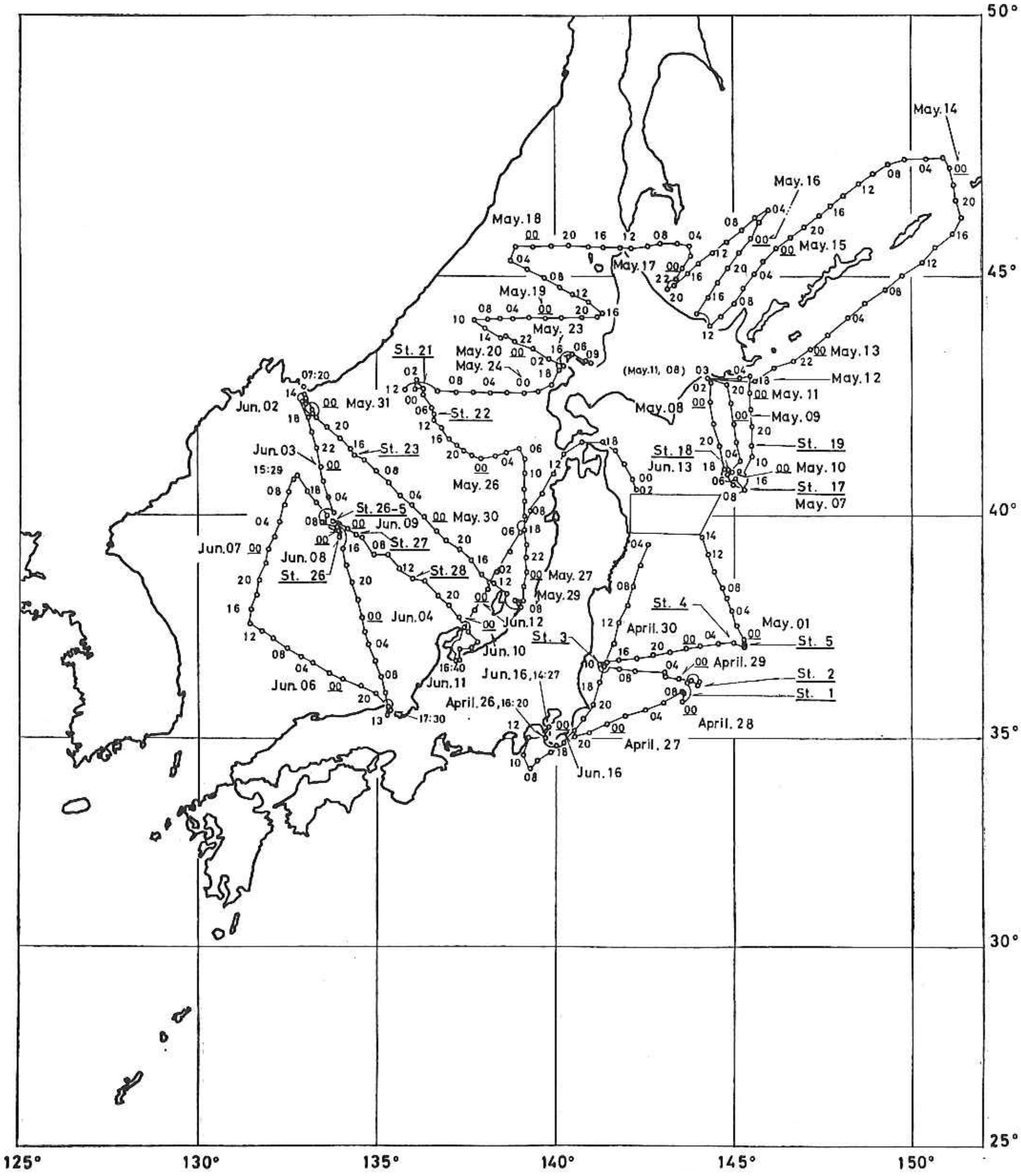


Fig. 2-1. Index map of the Cruise KH-69-2

Table 2-3.

List of Research Stations

I. (Tokyo-Kushiro)

St. No.	Observation	Position Lat. N Long. E	Date	Time	Uncorr. Water Depth (m)
1-1	Dredge haul	36°04. 2′ : 143°32. 2′	Apr. 27	09 : 00-14 : 30-17 : 45	3700
1-2	Deep-sea camera	36°02. 7′ : 143°32. 8′	Apr. 27	18 : 15-20 : 30-21 : 50	3150
2-1	Dredge haul	36°17. 3′ : 143°58. 7′	Apr. 28	07 : 53-11 : 00-15 : 51	2800
2-2	Deep-sea camera	36°17. 6′ : 144°00. 3′	Apr. 28	16 : 51-18 : 40-20 : 20	3350
3	Beam trawl	36°44. 5′ : 141°28. 6′ 36°45. 8′ : 141°30. 3′	Apr. 29	10 : 23-(12 : 54 / 13 : 30)-14 : 50	615-620
4	Piston corer	37°12. 3′ : 144°59. 2′	Apr. 30	07 : 52-10 : 15-11 : 40	5770
5-1	Dredge haul	37°07. 2′ : 145°18. 0′	Apr. 30	14 : 05-16 : 00-19 : 50	2630
5-2	Deep-sea camera	37°07. 8′ : 145°18. 8′	Apr. 30	20 : 10-21 : 50-23 : 10	2750
6	Dredge haul	39°33. 4′ : 144°06. 0′	May 1	14 : 30-16 : 23-19 : 45	5650
7	Skipped				
13-1	Beam trawl	39°39. 0′ : 142°20. 7′ 39°40. 0′ : 142°20. 4′	May 2	07 : 30-(09 : 14 / 09 : 52)-10 : 35	640-620
13-2	Smith-McIntyre sampler	39°41. 5′ : 142°21. 3′	May 2	11 : 33-12 : 25-13 : 03	642
12-1	S. M. sampler	39°37. 4′ : 142°31. 8′	May 2	14 : 24-15 : 33-16 : 10	840
12-2	Dredge haul	39°36. 8′ : 142°46. 3′	May 2	19 : 00-19 : 45-22 : 00	1210
12-3	Deep-sea camera	39°39. 4′ : 142°45. 0′	May 2	22 : 00-22 : 43-23 : 40	1100
15-1	Ocean Bottom Seismograph (B)	40°19. 3′ : 142°28. 7′	May 3	09 : 15-10 : 14-10 : 49	1000
15-2	S. M. sampler	40°19. 5′ : 142°29. 0′	May 3	11 : 18-12 : 15-13 : 05	1089
14	O.B.S. (C) setting	39°46. 9′ : 142°44. 7′	May 3	17 : 07-17 : 56-18 : 25	1050
16-1	O.B.S. (A) setting	40°21. 0′ : 143°00. 8′	May 4	13 : 20-14 : 20-14 : 50	1525
16-2	S. M. sampler	40°22. 0′ : 143°02. 8′	May 4	14 : 50-16 : 29-17 : 35	1550
16-3	Deep-sea camera	40°21. 7′ : 143°03. 9′	May 4	17 : 30-18 : 32-19 : 35	1570
11-1	Dredge haul	39°49. 2′ : 143°02. 7′	May 5	06 : 07-07 : 34-08 : 40	1450
11-1	S. M. sampler	39°35. 5′ : 142°59. 1′	May 5	11 : 04-12 : 06-13 : 14	1630
11-3	Beam trawl	39°36. 2′ : 142°59. 2′ 39°36. 0′ : 142°58. 4′	May 5	13 : 16-(14 : 50 / 15 : 28)-17 : 15	1655-1645
11-4	Deep-sea camera	39°40. 0′ : 142°59. 9′	May 5	17 : 15-18 : 10-18 : 54	1558
10	S. M. sampler	39°38. 2′ : 143°13. 1′	May 5	19 : 50-21 : 46-23 : 06	2100
8	Dredge haul	39°37. 8′ : 143°43. 4′	May 6	02 : 41-05 : 30-07 : 25	3050
9-1	S. M. sampler	39°40. 0′ : 143°36. 8′	May 6	09 : 00-10 : 29-11 : 50	2525
9-2	Beam trawl	39°43. 2′ : 143°38. 2′ 39°44. 8′ : 143°38. 0′	May 6	12 : 00-(14 : 20 / 15 : 03)-17 : 33	2530-2540
9-3	Deep-sea camera	39°42. 4′ : 143°47. 8′	May 6	17 : 33-failed-21 : 30	(3000-3245)
17	O.B.S. (ER) setting	40°37. 0′ : 145°18. 3′	May 7	10 : 08-12 : 50-13 : 50	5610
18-1	Dredge haul				
18-2	Deep-sea camera	40°57. 0′ : 144°55. 4′	May 10	03 : 35-05 : 14-06 : 58	3845
19	Deep-sea camera	41°29. 3′ : 145°33. 8′	May 10	11 : 48-14 : 30-17 : 28	7000

List of Research Stations

II. (the Sea of Japan)

St. No.	Observation	Position Lat. N Long. E	Date	Time	Uncorr. Water Depth (m)
20–1	Piston corer	43°46.9′ : 138°32.3′	May 19	14 : 24–15 : 23–16 : 45	3520
20–2	Deep-sea camera	43°46.8′ : 138°33.5′	May 19	17 : 15–19 : 00–20 : 40	3550
21–1	Dredge haul	42°43.6′ : 136°19.2′ 42°43.7′ : 136°19.9′	May 24	13 : 30–15 : 50–18 : 20 17 : 29	3100– 3150
21–2	Deep-sea camera	42°44.0′ : 136°18.8′	May 24	18 : 30–20 : 15–21 : 41	3140
22	Piston corer	42°12.9′ ‥ 136°36.5′	May 25	07 : 30–08 : 48–11 : 00	3650
23	Piston corer	41°21.0′ : 134°26.1′	May 30	11 : 34–12 : 55–14 : 05	3575
24–1	O.B.S. setting Current meter setting	39°42.5′ : 133°53.0′	June 3	12 : 10–12 : 49–13 : 12	755
24–2	Nansen cast	39°45.4′ : 133°51.8′	June 3		
25–1	Piston corer	40°52.0′ : 132°39.0′	June 7	10 : 07–11 : 30–12 : 00	3440
25–2	Piston corer	45°53.0′ : 132°40.2′	June 7	13 : 01–14 : 14–15 : 07	3390
26–1	Dredge haul	39°36.3′ : 133°57.3′	June 8	01 : 35–02 : 25–04 : 09 03 : 48	740
26–2	Dredge haul	39°51.0′ : 133°45.8′	June 8	05 : 37–06 : 45–08 : 48	440
24′	Current meter recovery				
26–3	Nansen cast	39°44.9′ : 133°53.7′	June 8		
24′	O.B.S. recovery	39°42.8′ : 133°53.3′	June 8	14 : 00–14 : 47–15 : 10	755
26–4	Deep-sea camera	39°50.6′ : 133°48.2′	June 8	16 : 17–17 : 00–17 : 41	485
26–5	Dredge haul	39°52.3′ : 133°49.3′	June 8	19 : 00–20 : 50–22 : 00 20 : 57	470
27–1	Gravity corer	39°35.9′ : 134°24.8′	June 9	01 : 13–02 : 12–	2100
27–2	Nansen cast	39°35.9′ : 134°24.8′	June 9		
28	Piston corer	38°39.0′ : 136°03.1′	June 9	14 : 35–15 : 41–16 : 24	2730
15–1′	O.B.S. (B) recovery	40°18.2′ : 142°30.0′	June 13	04 : 36–08 : 22–09 : 15	1010
14′	O.B.S. (C) recovery	39°47.3′ : 142°44.9′	June 14	05 : 05–08 : 28–09 : 17	1050
16–1′	O.B.S. (A)	failed			
16–1′	Dredge haul for search of O.B.S. (A)	around 16–1	June 14	13 : 25–14 : 08–18 : 23 17 : 10	1550
16–1′	Dredge haul for search of O.B.S. (A)	around 16–1	June 14	19 : 05–19 : 37–23 : 15 22 : 45	1550

3. Measurement of gravity, magnetic force and bottom topography in KH-69-2 cruise

by
Yoshibumi Tomoda, Jiro Segawa, Kazuhiro Kitazawa and Kinichiro Koizumi

1. Gravity data processing

Gravity data processing (1st step): Two sets of T.S.S.G. A and B were installed in the No. 9 laboratory of the ship. Simultaneous measurements were made by these gravity meters and improvement of reliability of the result was aimed at. In order to process the data from the two sets of gravity meters, soft ware for data processing, chiefly, high level processing program of "on line real time processing program" (Cruise Report of the Hakuho-maru KH-68-4) was altered. The interface devices of gravity meter and the Real Time Control (R.T.C.) were also temporarily altered a little.

When the two interruption signals from each gravity meter are fed to the interrupt terminal of the "same level" at almost the same time, it is expected that the computer processes the first one and the second interruption will be received by the central processor (C.P.U.) after the "interruption processing routine" for the first interruption is executed. The time required to execute "interruption processing routine" is estimated to about 20–30 μsec, that is, it requires about 20–30 μsec for the central processor control to know that the interruption is given. Therefore the information signal can be read into the computer if pulse width of the information signal and interruption signal is longer then 20–30 μsec. But in actual test it was found that pulse width longer than 30 msec was not sufficient to eliminate read-in error. That was because the time expended in the R.T.C. circuit was larger than 30 msec. That is, it takes more than 30 msec for the computer to know that the interrupt signal comes. When the C.P.U. fails in sensing the interrupt signal it does not read information signals. The pulse width of information signals is desirable to be as long as possible. For example, it is desirable that information signals hold until the next interruption signals. This condition could not be satisfied at first, because the old device, a counter 702S, was used with only slight inprovement; pulse width of the output of the counter 702S was changed from 30 msec to 40–50 msec.

The soft ware of the low level processing program was also exchanged from "averaged variance of the vertical acceleration method 'to' sampling interval interpolation method".

The real time processing of the two sets of gravity meter was successful as far as the data processing was concerned. But, the observation was often interrupted because the counter 702S was too much worn out to be used without error.

New interface device for real time processing of two gravity meters: At Toyama, June 11th, two sets of interchanging frequency counters were replaced by a new device designed for the purpose of the real time processing of the two sets of gravity meters. A block diagram of the device for 1 set of gravity meter is shown in Fig. 3-1.

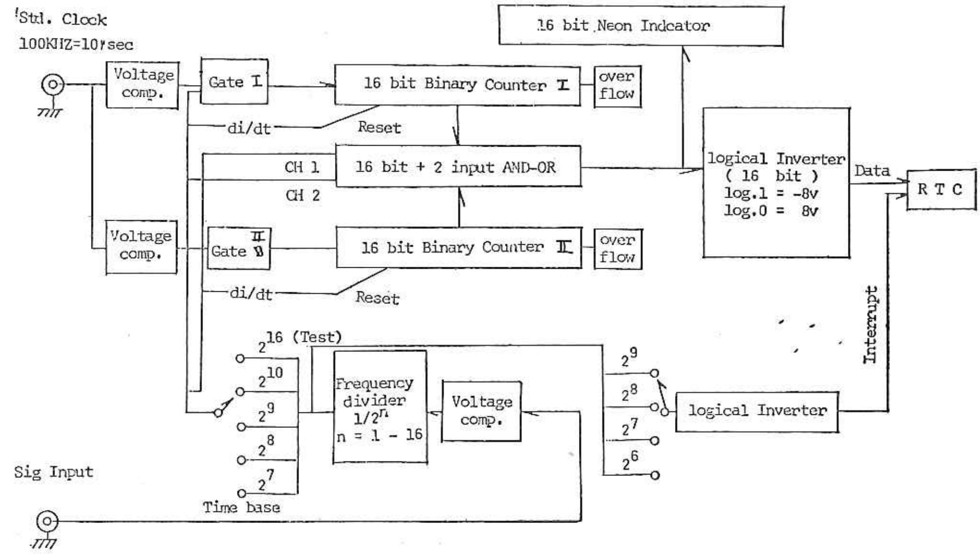


Fig. 3-1. Block Digram of the 16 bit Frequency Counter for Gravity

The same devices were used for each gravity meter. The device for one set of gravity meter is composed chiefly of 2 sets of 16 bits binary counters. 100 kc standard frequency signals are counted by the counter I or II according as the state of the gates are on or off. The state of the gate is controlled by the output of the frequency divider, to which signals from the string gravity meter are fed to control the gate interval. The output terminals the counter I or II are directly connected to the digital input terminals of the R.T.C. interchangingly as the gate I or II is off. The interruption signal is fed to the interruption terminal of the R.T.C. when the state of gate becomes from on to off.

2. Data processing of magnetic field, water depth and gravity (2nd step)

Earth's magnetic field was measured by the use of a proton magnetometer. Water depth was measured by the use of an echo sounder and it was manually read from the echo sounder chart at an interval of 10 min.

These data were manually punched on paper tapes together with the data of ship positions according to an appointed format. (Cruise Report of the Hakuho-maru KH-68-4). These tapes were processed by the use of a batch processing program ¥ SAMOA. Corrected water depth, Bouguer correction and Eötvös correction were calculated according to this program. In correcting the water depth, Mathew's table was used for the Pacific Ocean area and a table prepared for the C.S.K. by Hydrographic Office was used for the Japan Sea area and also for the Okhotsk Sea. These tables, which had been offered by Tokuhiro of the Hydrographic Office, are approximated by a polynomial for convenience of computer calculation.

Observed gravities (gravity results obtained by the 1st stage data processing) and Eötvös corrections (obtained by the program ¥ SAMOA) were manually punched on paper tapes and free air gravity anomalies are calculated according to the batch

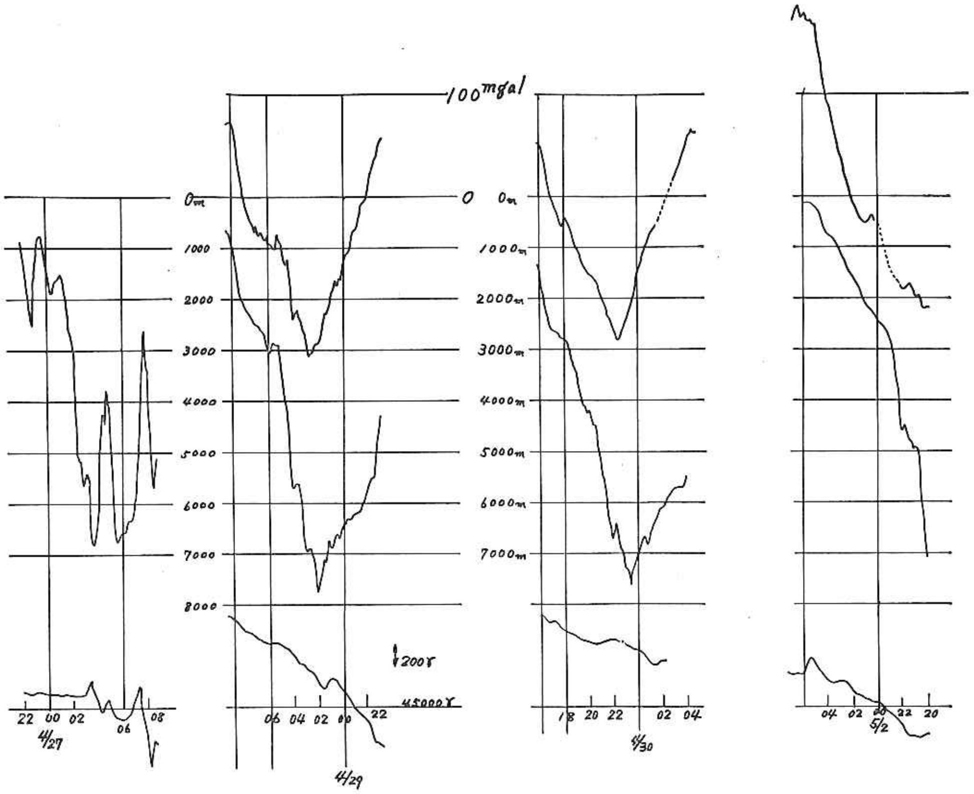

100 mgal
0
0m
1000
2000
3000
4000
5000
6000
7000
8000
0m
1000m
2000m
3000m
4000m
5000m
6000m
7000m
200γ
45000γ
22 00 02
06
08
4/27
06 04 02 00
22
4/29
18 20 22
02 04
4/30
04 02 00 22 20
5/2

Fig. 3-2

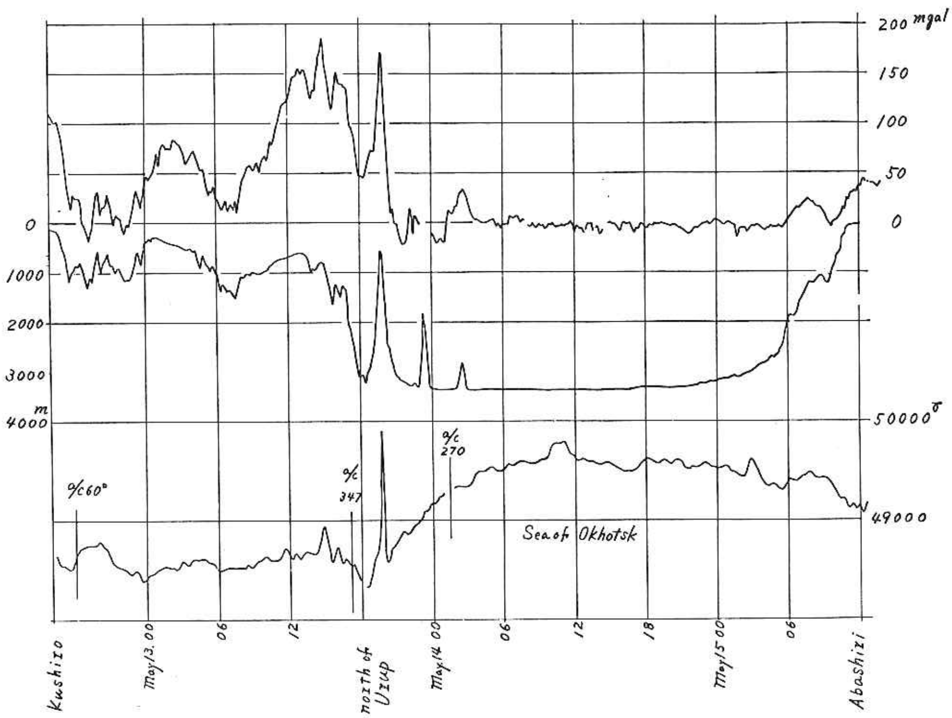
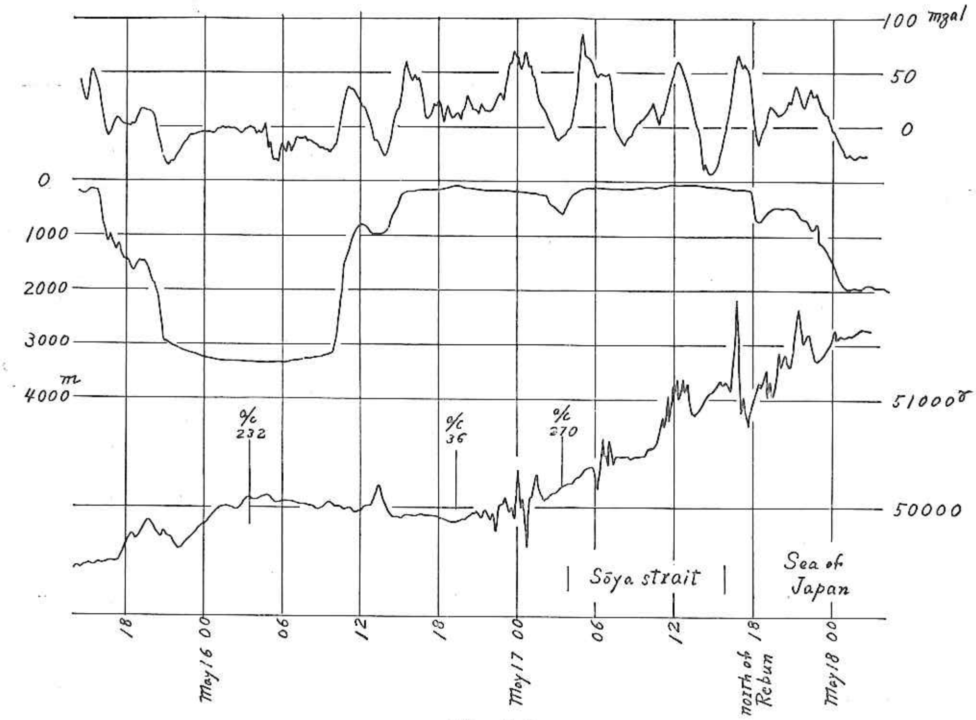
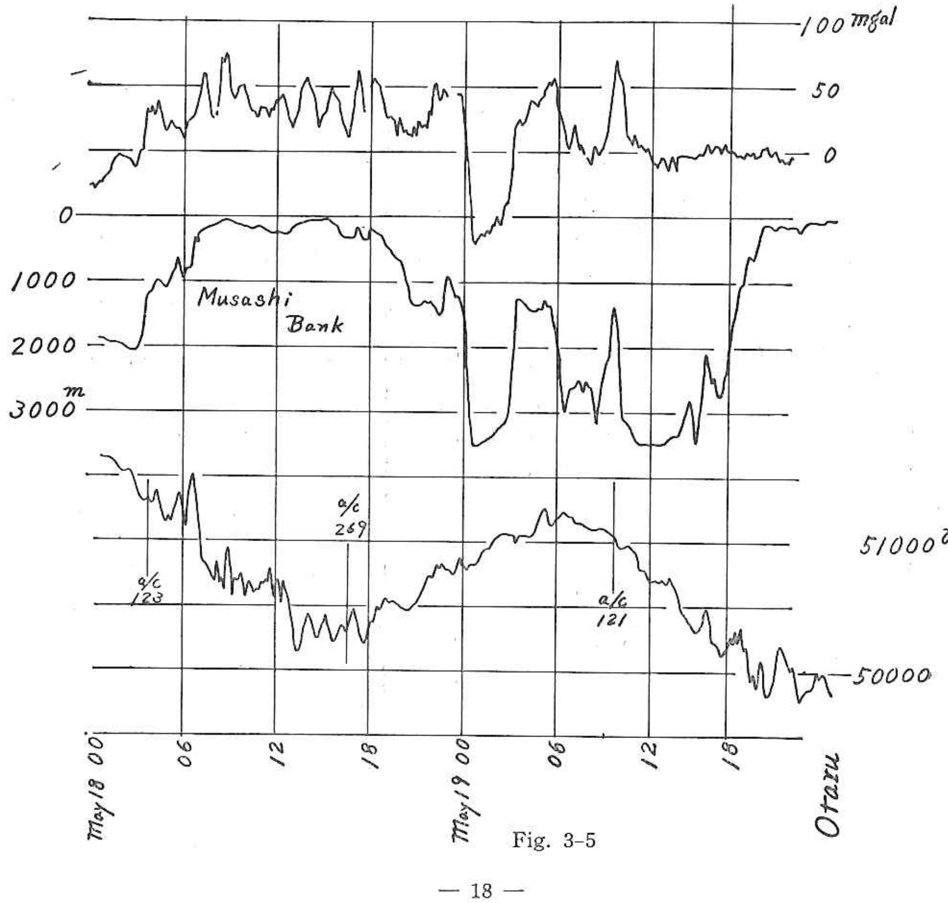

200 mgal
150
100
50
0
0
1000
2000
3000
m
4000
50000γ
49000
c/c 60°
c/c 347
c/c 270
Sea of Okhotsk
Kushiro
May 13.00
06
12
north of Urup
May 14 00
06
12
18
May 15 00
06
Abashiri

Fig. 3-3



100 mgal
50
0
0
1000
2000
3000
m
4000
51000γ
50000
a/c 232
a/c 36
a/c 270
Sōya strait
Sea of Japan
18
May 16 00
06
12
18
May 17 00
06
12
north of Rebun 18
May 18 00

Fig. 3-4



100 mgal
50
0
0
1000
2000
m
3000
Musashi Bank
51000γ
50000
a/c 123
a/c 269
a/c 121
May 18 00
06
12
18
May 19 00
06
12
18
Otaru

Fig. 3-5

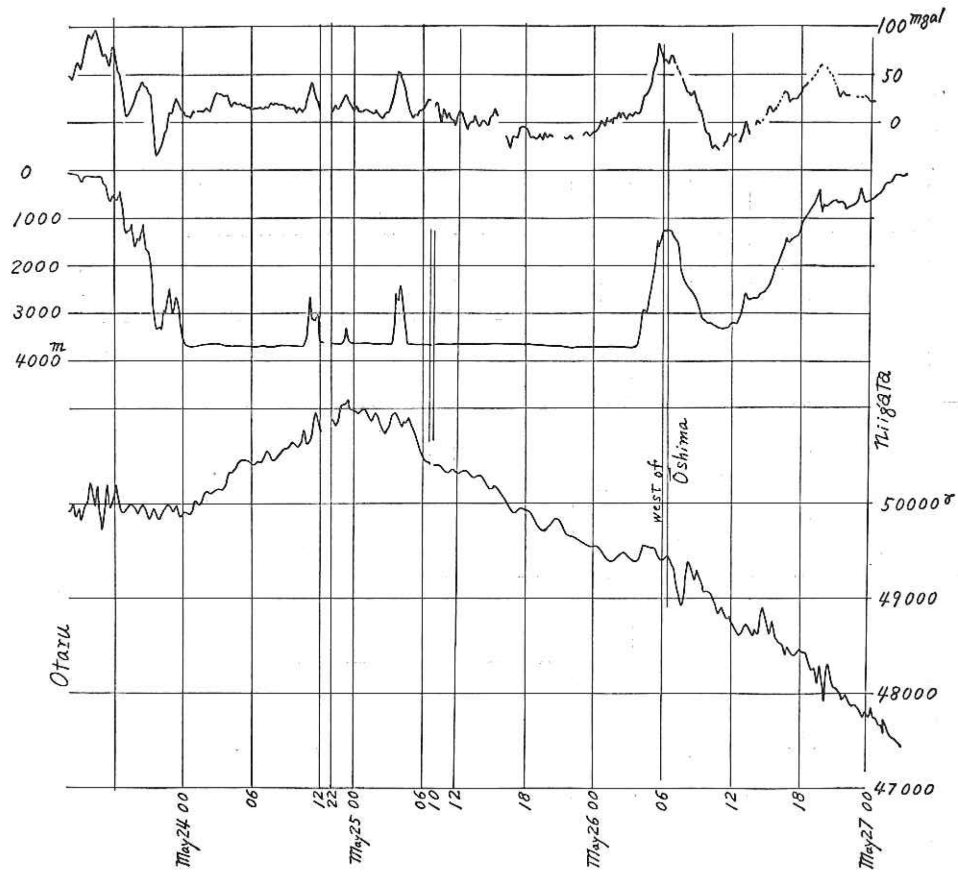


Fig. 3-6

processing program ¥ New Zealand. (Cruise Report of the Hakuho-maru KH-68-4).

3. Profiles of free air gravity anomaly, total magnetic force and bottom topography

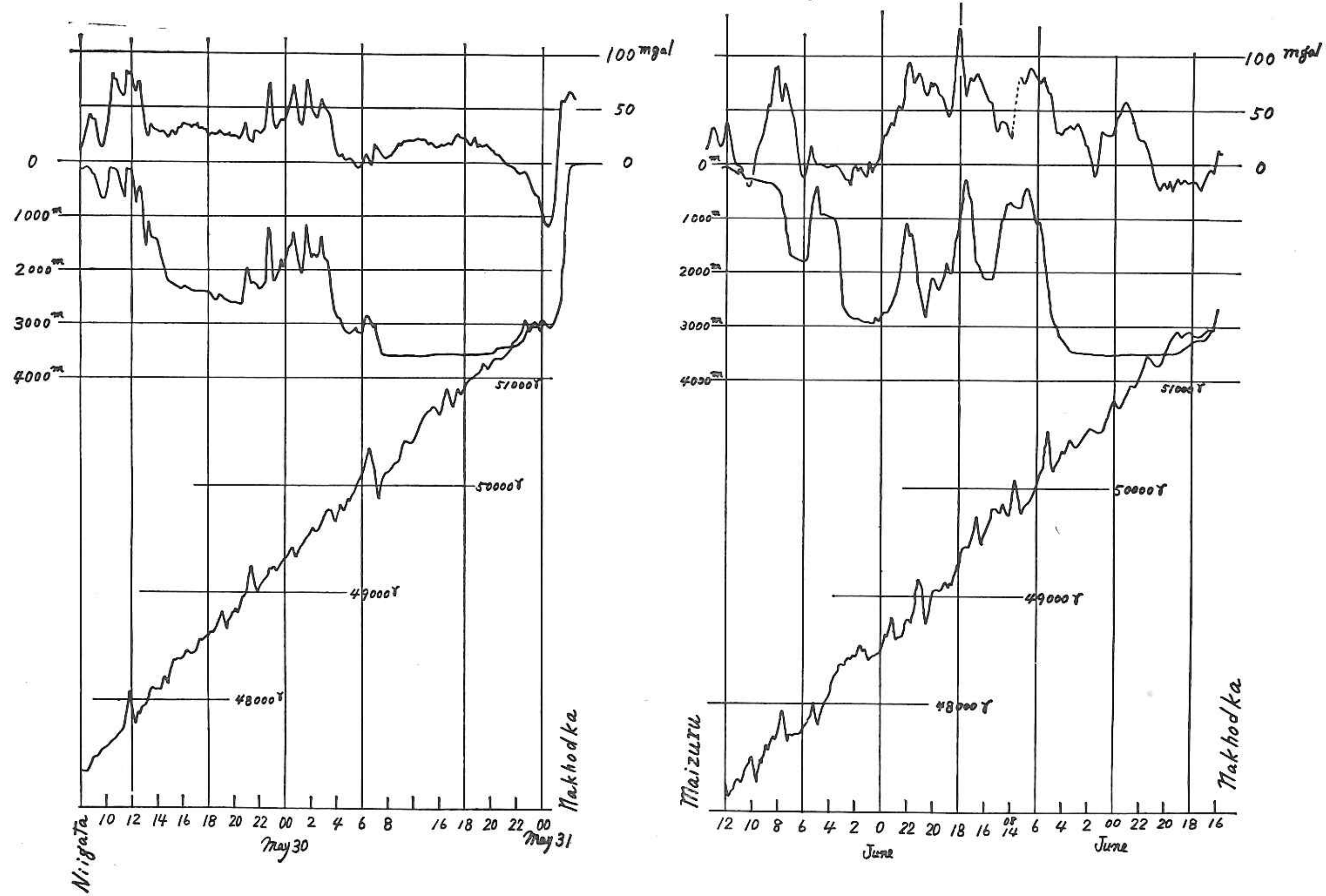
Profiles of free air gravity anomaly, total magnetic force and bottom topography are shown in Figs. 3-2 to 3-11. A position index map is shown in Fig. 2-1 to find out easily the position of the anomalies. In the case of the profile from Tokyo to Kushiro, only free air gravity anomaly and bottom topography are shown because the region has been well surveyed and because profiles are too short to see the characteristics of the magnetic anomalies as well as to improve the former knowledge.

Relation between magnetic and gravity anomaly

The free air gravity anomaly in the Soya Strait (Fig. 3-4) is one of the most typical example that the free air gravity anomaly of 30 to 50 mgals is found on the flat and shallow continental shelf where the gravity anomalies show one-to-one correlation to the magnetic anomalies.

General character of Kuril and Japan Basin

In the Kuril Basin, variation of the free air gravity anomaly is smaller than 5 mgals



100 mgal
50
0
0
1000m
2000m
3000m
4000m
51000γ
50000γ
49000γ
48000γ
Niigata
Nakhodka
10 12 14 16 18 20 22 00 2 4 6 8 16 18 20 22 00
May 30
May 31
100 mgal
50
0
0m
1000m
2000m
3000m
4000m
51000γ
50000γ
49000γ
48000γ
Maizuru
Nakhodka
12 10 8 6 4 2 0 22 20 18 16 08 14 6 4 2 00 22 20 18 16
June
June

Fig. 3-7 (a) (b)

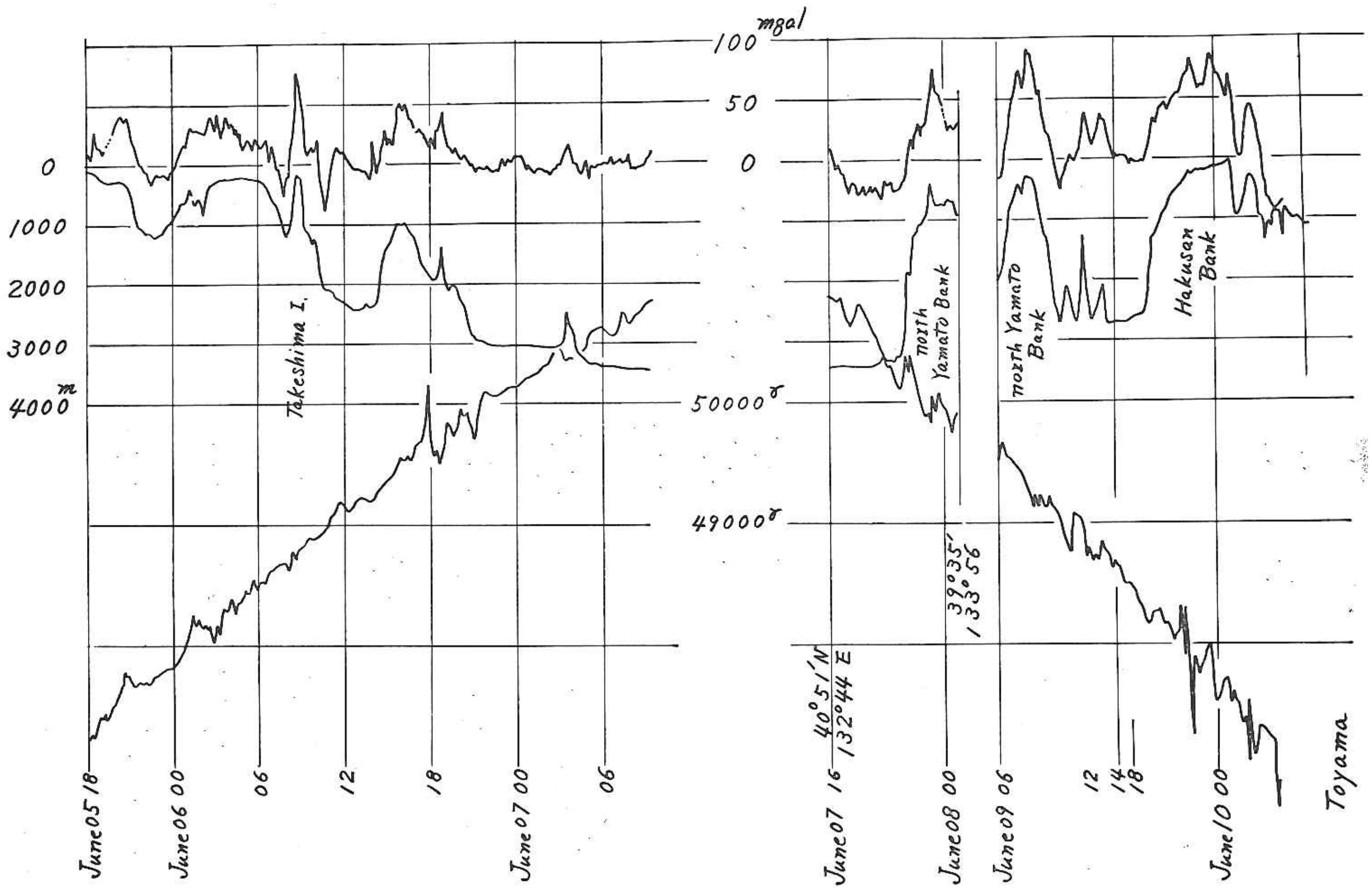

100 mgal
50
0
0
1000
2000
3000
4000 m
50000γ
49000γ
Takeshima I.
north Yamato Bank
north Yamato Bank
Hakusan Bank
40°51'N 132°44'E
39°35' 133°56'
June05 18
June06 00
06
12
18
June07 00
06
June07 16
June08 00
June09 06
12
14
18
June10 00
Toyama

Fig. 3-8 (a) (b)

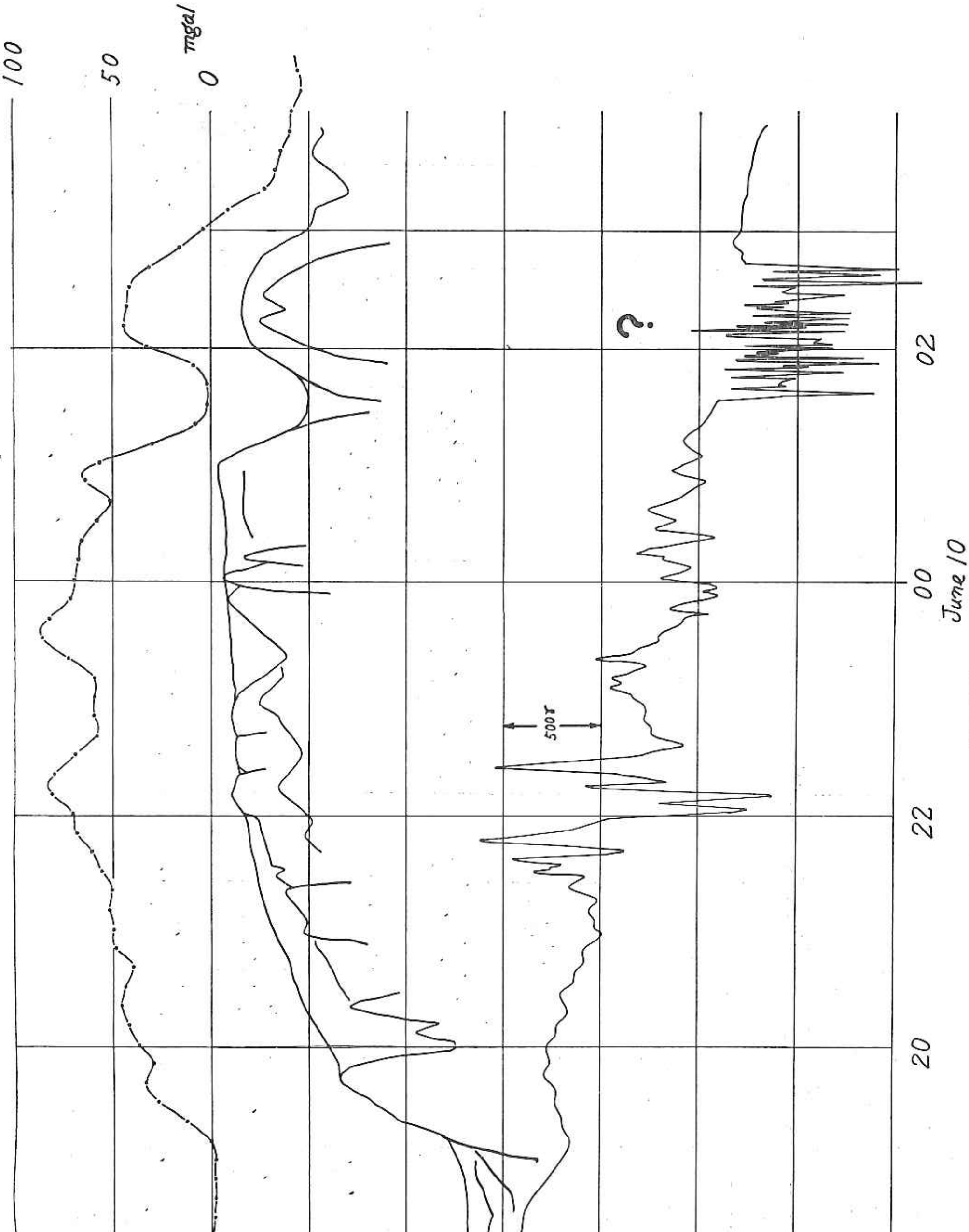

100
50
0
mgal
0 m
1000 m
2000 m
3000 m
48000γ
47000γ
500γ
?
18
June 9
20
22
00
June 10
02

Fig. 3-9

and bottom topography is flat (Fig. 3-3). Though the bottom topography is flat, variation in the free air gravity anomalies is large in the case of the Japan Sea compared with the case of the Kuril Basin. In the northern part of the Japan Basin the variation is about 20 mgals (Fig. 3-7a) and it seems that the variation in the free air gravity anomaly becomes large toward south west of the Japan Basin, for example, as in the profile from Nakhodka to Maizuru where variations as large as 50 mgals were observed (Fig. 3-7b). It is noticeable, too, that the positive gravity anomalies observed on land at Nemuro are extended over to the Urup channel.

The variation in the free air gravity anomaly on the flat bottom is interpreted to be caused by the undulation of the basement rock. From general characters of the change of variation of the free air gravity anomalies, it is suggested that the undulation of the basement rock gradually becomes large towards south east, or that the depth of basement rock in the Japan-Kuril region becomes deeper towards south west.

4. Table of ship position, echo sounder depth, corrected water depth and Bouguer correction

This table will be available when requested.

5. Grid survey

In the present cruise we could not have enough time to survey any seamount; only one or two profiles are added to the former survey.

Water Shear Seamount (Mizunagi Seamount)

The Mizunagi Seamount was found in the KH-67-2 Cruise of the Hakuho-maru. The name of " Mizunagi " was temporarily given, because we found many Water Shears (Mizunagidori) just above the top of the seamount during its grid survey.

Ship's tracks near the seamount in the KH-67-2 as well as in the present cruise are shown in Fig. 3-12. Total magnetic force, local free air gravity anomaly and the bottom topography near the seamount are shown in Figs. 3-14, 3-15, 3-13 respectively.

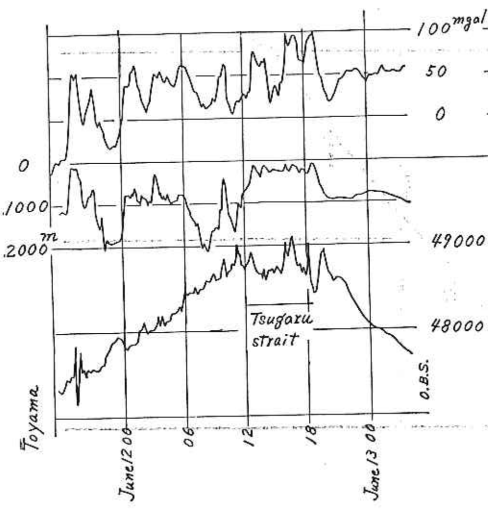


Fig. 3-10

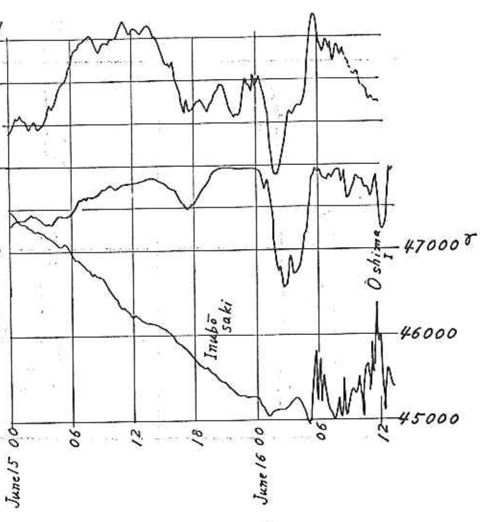


Fig. 3-11

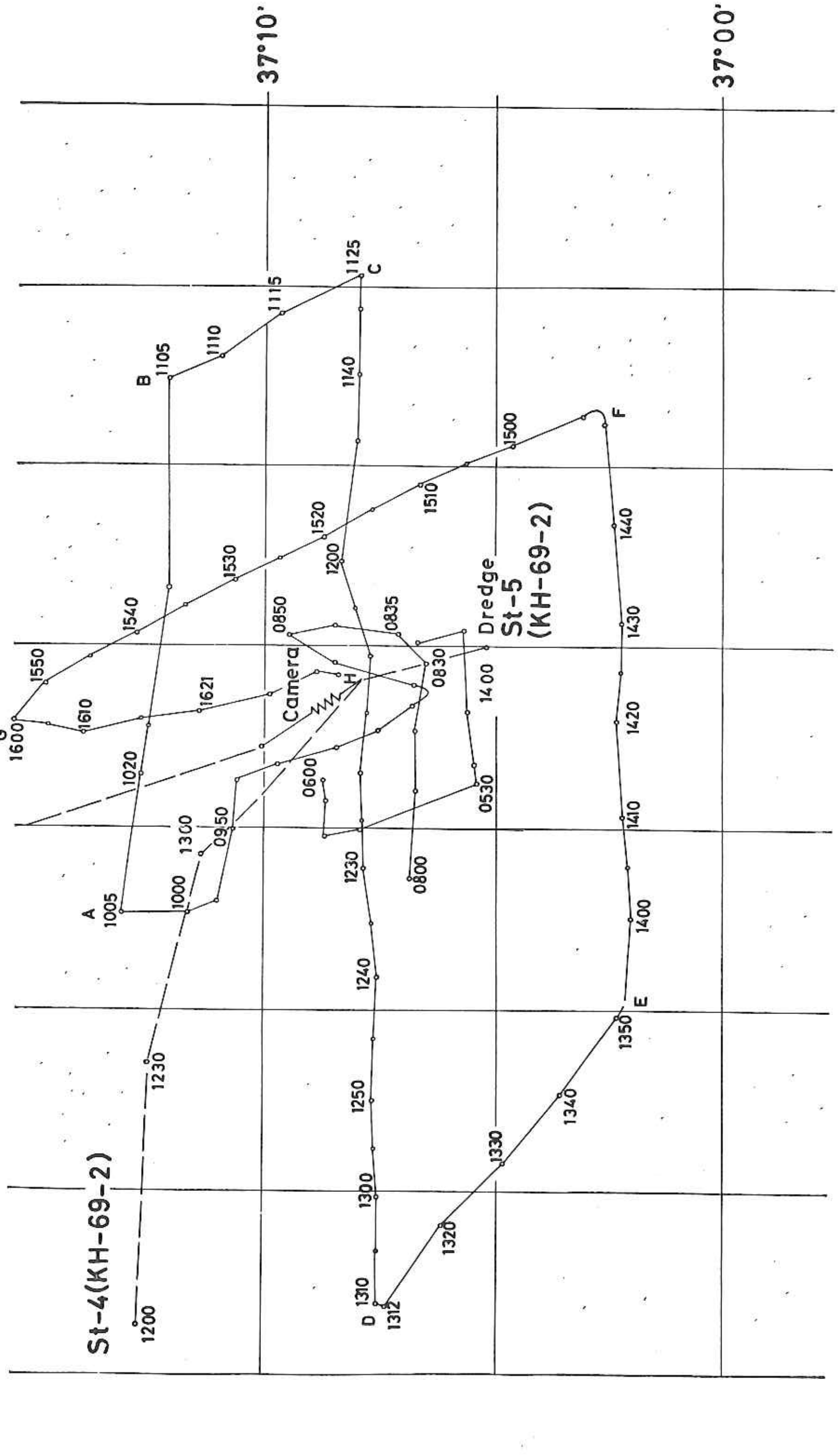

37°10'
37°00'
St-4(KH-69-2)
Dredge
St-5
(KH-69-2)
Camera
A
B
C
D
E
F
G
H
1005
1105
1110
1115
1125
1140
1200
1230
1240
1250
1300
1310
1312
1320
1330
1340
1350
1400
1410
1420
1430
1440
1500
1510
1520
1530
1540
1550
1555
1600
1610
1621
1000
1020
0950
1360
0850
0835
0830
0800
0600
0530

Fig. 3-12

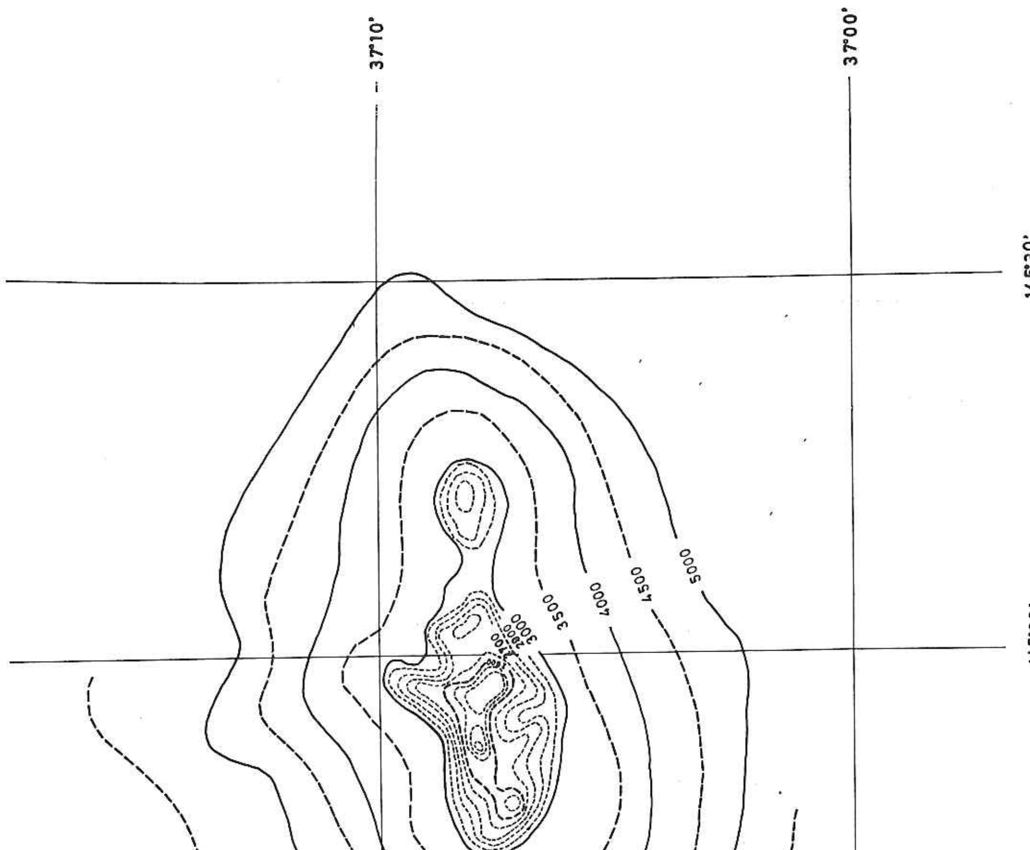


Fig. 3-13

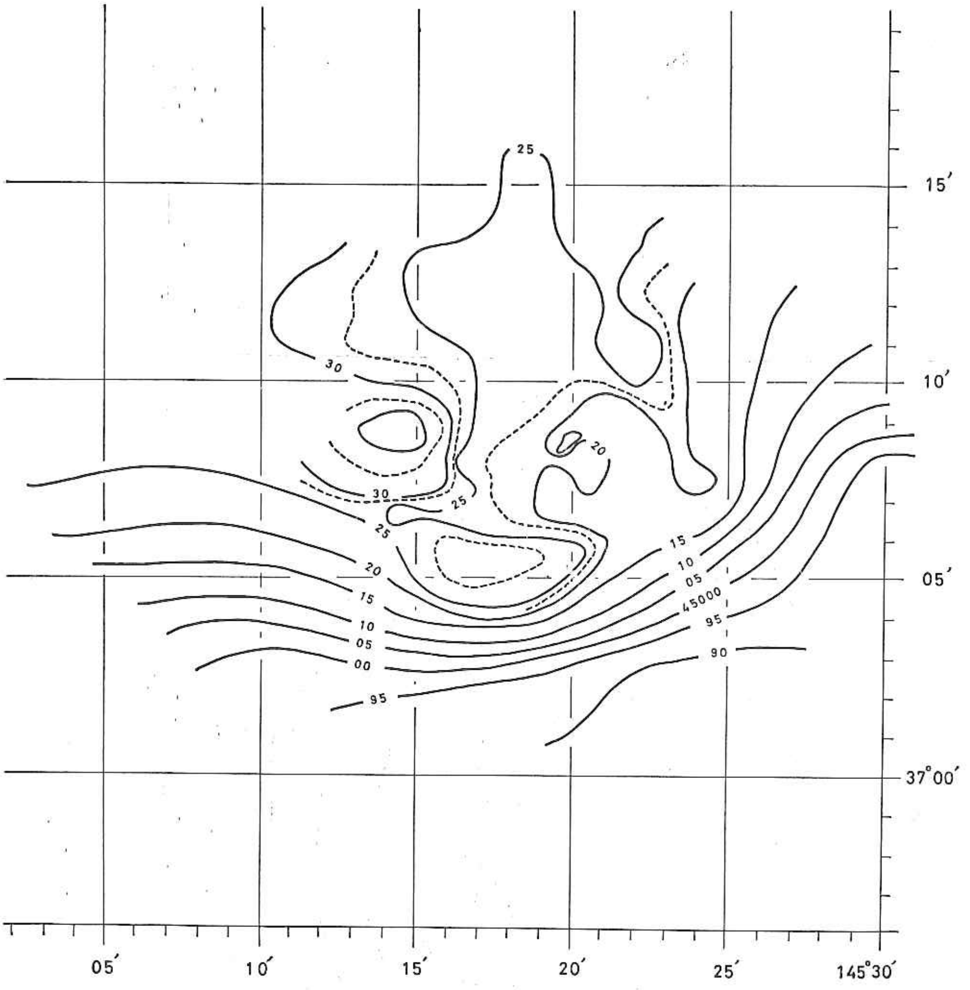


Fig. 3-14

The magnetic anomaly of the seamount is very small and the correlation to the topography is not clear. This is one of the remarkable characteristics of this seamount compared with the Kashima I or II seamount which lies about 50 miles south west of the present seamount. The magnetic anomalies of the Kashima seamount are interpreted to be caused by the magnetization in the present direction of the Earth's magnetic field. Samplings of rock by dredge haulings and deep-sea photography operations were carried out at the slope and top of the seamount as shown in Fig. 3-12.

6. Land gravity survey

Gravity measurement by the use of the La Coste Romberg land gravity meter G-124 was carried out at every port for the calibration to the T.S.S.G. In addition to the calibration measurements land gravity values in the Shakotan Peninsula were also measured to know details of the gravity distribution at the boundary between the land and the Japan Sea. The height of the station was estimated from the 1/50000 scale map of the Geographical Survey Institute. Results are tabulated in Table 3-1.

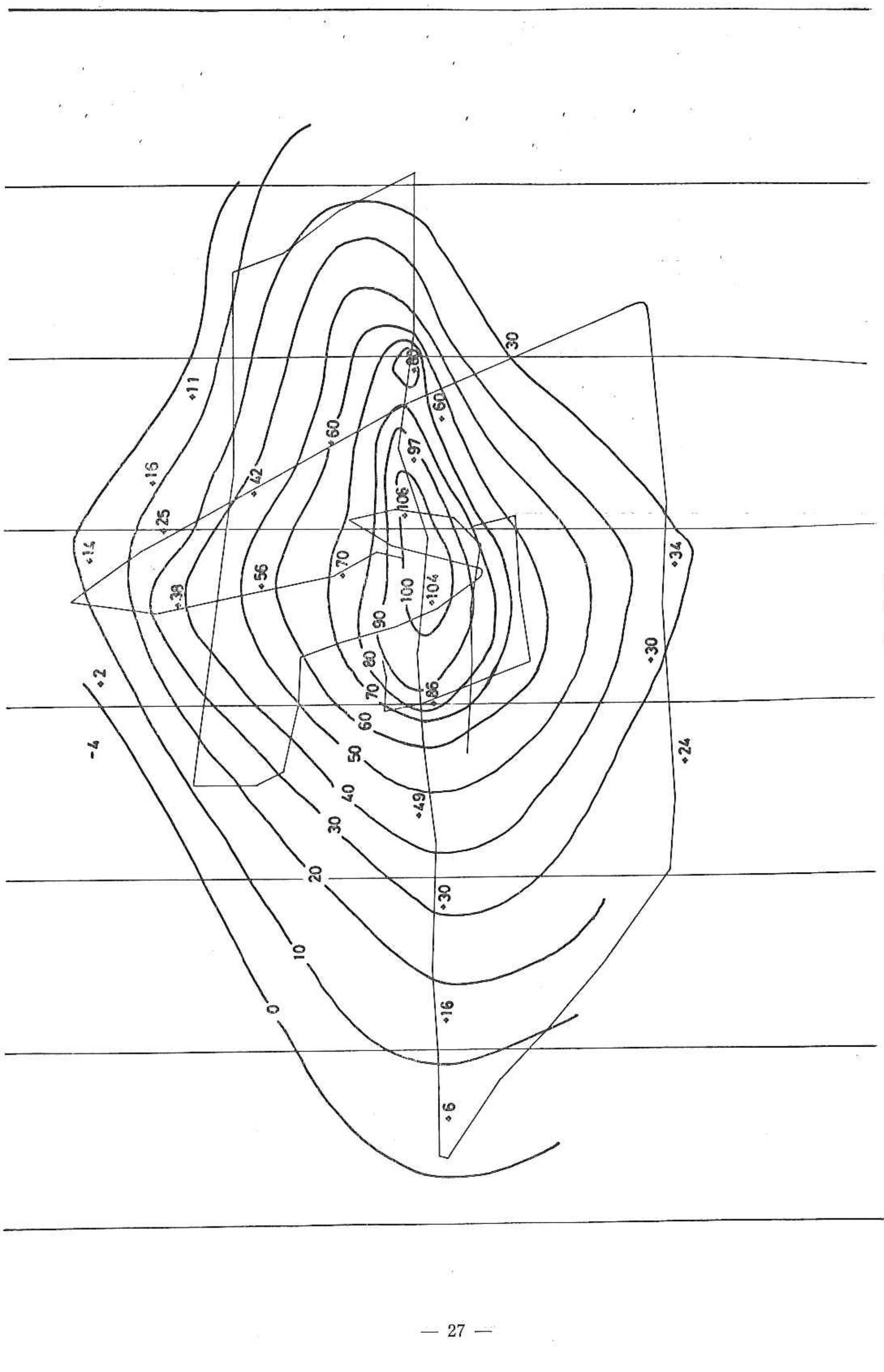


Fig. 3-15

Table 3-1

	Lat.	Long.	Height	g	g_0''
Otaru	45°11.5N	140°47.6E	2.5	980.516	+49
	45°12.3	140°46.7	0.5	980.519	+51
	43°12.8	140°46.7	0.5	980.523	+54
	43°14.0	140°44.2	1.5	980.532	+62
Toyohama	43°14.8	140°42.7	1.0	980.535	+63
Okimura	43°15.2	140°41.0	0.5	980.541	+69
Sawae	43°15.6	140°39.0	3.0	980.541	+68
Maruyama	43°16.9	140°38.9	3.0	980.544	+69
	43°17.8	140°36.3	2.0	980.549	+73
	43°18.6	140°32.9	—	980.530	+53
near Chinika cottage	43°21.0	140°31.2	—	980.528	+47
	43°21.7	140°28.5	2.0	980.569	+87
	43°19.8	140°27.0	0.5	980.543	+64
	43°19.5	140°23.5	1.0	980.549	+70
Ground of the Kamui primary school	43°19.7	140°21.5	15.0	980.552	+75
Pt. Kamui	43°19.9	140°21.5	2.5	980.550	+71

4. Local magnetic anomalies in the Okhotsk Sea and the Sea of Japan

Kin-ichiro Koizumi

Earth's total magnetic field was measured by the towing proton magnetometer at every 1 min with accuracy of $\pm 10\gamma$ throughout the cruise.

The proton magnetometer: Sensing coils in the towing fish was replaced by small one whose length, outer and inner diameter is respectively 67 mm, 61 mm, 34 mm (0.8ϕ Cu wire, 1300 turn). Volume of the water inside the coil is about 30 cc. Compared with former coils, present one is small in size and light in weight and expected to be storonger than old one, which was sometimes destroyed by shock when the fish is taken in the ship.

Magnitude of local magnetic anomalies: Profiles of total magnetic force were made, together with bottom topography and free air gravity anomaly. By the use of the profiles, local magnetic anomalies were studied and the Okhotsk and Japan Sea was classified according to the magnitude of local magnetic anomaly.

In Fig. 4-1, the area where local anomalies are larger than 300γ and the area where local anomalies are smaller than 100γ are shown by areas enclosed by solid lines and dotted area respectively.

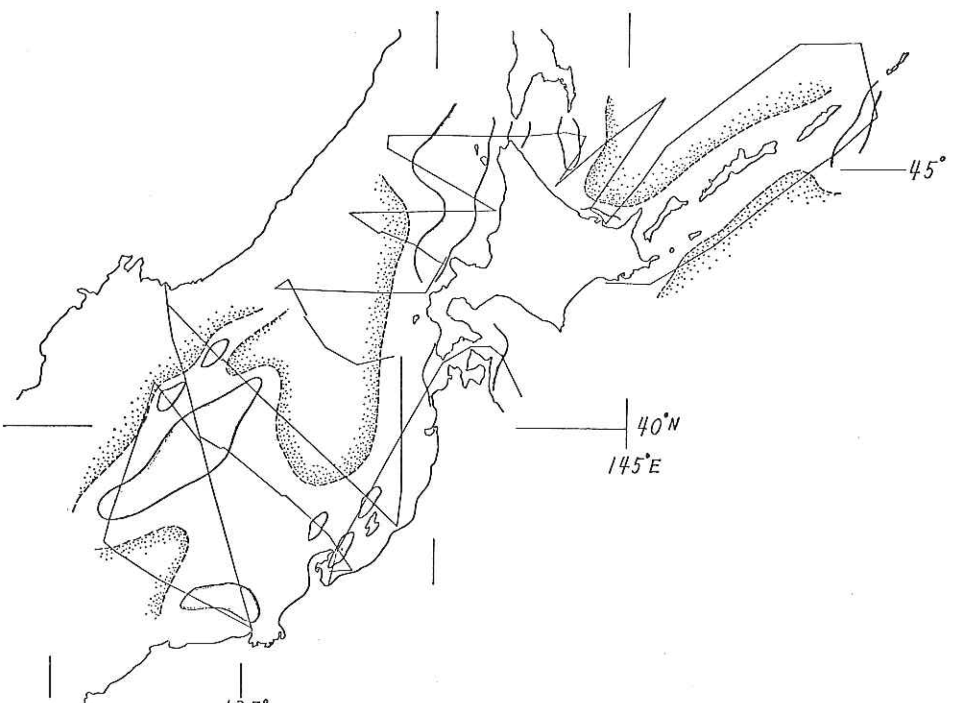


Fig. 4-1

Basin (Kuril Basin, Japan Basin): In Kuril or Japan Basin, local anomaly is generally smaller than 100 γ, water depth is about 3000 m and the bottom is flat.

This characteristics resemble south east part of the Philippine Basin and different from north Australia Basin.

Rise (Musashi Bank, Yamato Bank, Hakusan Bank): In the Musashi, Yamato or Hakusan Bank, the anomaly is larger than 300 γ, but not so large as in the active ridge or seamount. Bottom topography is irregular but the correspondence between the topography and anomalies is not clear, as is the general case of the rise or ridge. Large anomalies are found at the boundary between the rise and the adjacent basin. Especially, in the north east of Yamato Bank, isolated anomalies are found at both north and south boundary of the bank.

Seamount: At the seamount of 2500 m height in the north Urup strait (position index May 13, 20), anomaly is about 1300 γ and exactly corresponds to bottom topography. But in the case of seamount of 1000 m height (position index May 13, 23), no anomaly was observed.

Continental Shelf: Sharp and irregular local anomalies are sometimes found on the continental shelf or at margin of the continent. Anomalies off Abashiri, Nakashiretoko peninsula, Sado Island or Noto peninsula indicate the margin of Japan Islands.

The Soya Strait and Tsugaru Strait are also characterized by large local anomalies. Especially, in the case of Soya Strait correspondence between the free air gravity anomaly is very clear. This is one of the most typical example that the magnetic anomaly correspond to free air gravity anomaly and not to bottom topography.

5. Comparison measurement of gravity at sea by the use of two sets of the T.S.S.G.

Jiro Segawa

1. Characteristics of the gravity meters

Comparison measurement of gravity at sea was carried out by the use of two sets of the ship-borne gravity meter T.S.S.G. model 61 and model 67. The differences between the two sets lie in the method of mounting the string gravity meter on the gyroscope and in the design of the suspension case of the meter, but their essential structures are nearly the same. The signals from two meters were processed by the same method. In the present paper, the gravity meter used in model 61 and the results obtained by it will be denoted by A, and those concerned with model 67 will be denoted by B. The conditions of T.S.S.G.-A and-B in this cruise are tabulated in the following. Some of them in table were changed or improved later during the cruise.

T.S.S.G. 61 (A)

String gravity meter :	No. 68-7-14 (A)
Mean frequency of the string gravity meter :	1582. 6 Hz at 44°C
Temperature coefficient :	−49 mgals/°C
"Q" value :	20000
Elastic tension :	−98 gals
Exciting amplifier :	SHINDENSHI KOGYO K.K.
Temperature regulator :	SHINDENSHI KOGYO K.K. at temp. range 7 (44°C)
Counter :	Model 67 KOKUSAI DENSHI KOGYO K.K.
Gyro erection amp. :	Made at the Ocean Res. Inst. Low pass range 1 Pre-amp. Att. 0 Power amp. gain max.

T.S.S.G. 67 (B)

String gravity meter :	No. 67-11-9
Mean fraquency of the string gravity meter :	1476. 0 Hz at 38°C
Temperature coefficient :	−15~25 mgals/°C
"Q" value :	4500
Elastic tension :	−70. 6 gals

Exciting amp.	:	Made at the Ocean Res. Inst.
Temperature regulator	:	Model 67, KOKUSAI DENSHI KOGYO K.K. used at tem. range 36 (38°C)
Counter	:	Model 702 S (Pioneer) 63 A delay circuit was added in the read out pulse circuit. An on line interface circuit was installed. The counter was exchanged by a parallel counter since June 13.
Gyro erection amp.	:	Model 67, KOKUSAI DENSHI KOGYO K.K. Low pass range 1 Power amp. Att. 10 The circuit was greatly improved during the cruise.

The string gravity meter "A" has been continuously used since KH-68-3 cruise of the Hakuho-maru (July—Aug. 1968) and also used throughout KH-68-4 cruise (Nov. 1968—March 1969). During the cruise the drift rate of the gravity meter proved to be very small. On the other hand the characteristics of the string gravity meter "B" have not been tested in spite of the fact that it was made in 1967. The drift rate of the gravity meter "B" depends largely upon the amplitnue of oscillation of the string and therefore, the amplitude effect was measured and determined.

The temperature coefficient and the elastic tension of the gravity meter "A" were determined from the data of the former cruise, while those characteristics of the gravity meter "B" were determined during the present cruise. The drift rate of the gravity meter "B" was checked up before the cruise, and it showed at first a large positive drift (gravity value increase) even when it worked at the optimum amplitude, but it rapidly became so small with time as it was expected that the drift rate was $+1 \sim +3$ mgals/day during the present cruise.

Amplitude characteristics of the gravity meter "B"

The relation between the oscillation frequency of the string and the output voltage measured at the feed back terminal of the exciting amplifier is shown in Fig. 5-1, where the abscissa represents the p-p amplitude of the sinusoidal wave measured at the feed back terminal, and the ordinate represents the oscillation period of the string expressed by the number of 100 KHz clock pulses counted in the period exactly 2^{13} times as long as the oscillation period. According to this measurement the variation of the frequency of the string is 7.2 gals in terms of the gravity change, when the output voltage varies from 0 to 2.5 volts. For practical use it is desirable that frequency shift in terms of gravity is smaller than 10 mgals, when the amplitude of oscillation of the string varies more than 10%. In order to fulfill the requirement, the amplitude of the oscillation of the string must be smaller than 0.1 volts at the feed back terminals. The gravity meter was used in such conditions by adjusting the resistance in the A.G.C. circuit.

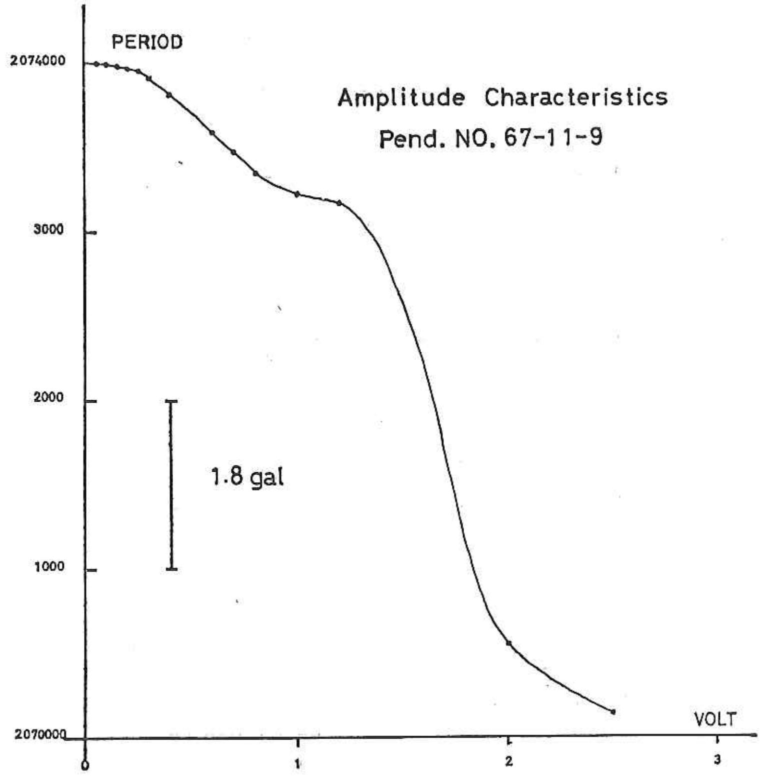


Fig. 5-1

The temperature characteristics of the gravity meter "B"

These characteriestics were measured just before the cruise. As shown in Fig. 5-2, the temperature coefficient of the gravity meter is −15 mgals/°C. However during this measurement the meter seems to have made a large amount of positive drift, and so the drift of the string canceled partially the temperature effect when it was measured from low to high temperatures. Considering these effects, a temperature coefficient of −25 mgals/°C seems more reliable for the gravity meter "B"

Determination of elastic tension of the gravity meter "B"

There occured many troubles in the T.S.S.G.-B in the present cruise and it was impossible to obtain a continuous measurement uniformly. The "elastic tension" had not been determined yet, so the data processing was carried out assuming that its effect was zero. The effect of the "elastic tension" can be determined by measuring the gravity value at least at 2 stations where their gravity values are known. This was carried out by the use of the results of the measurement from Toyama to Tokyo by comparing the results with that of T.S.S.G.-A the elastic tension of which had already been determined. The maximum gravity change from Toyama to Tokyo is about 700 mgals. The differences between "A" and "B" sampled at proper interval are plotted in relation to "A" in Fig. 5-3. There is a slight difference in the gradient

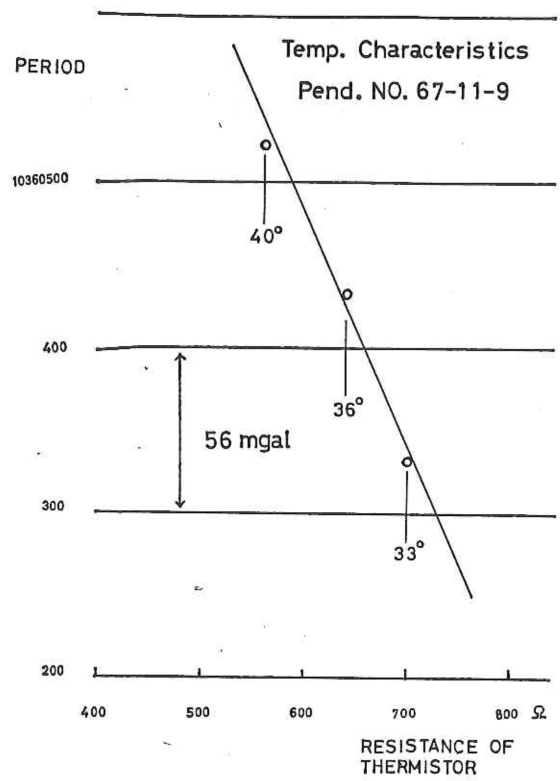


Fig. 5-2

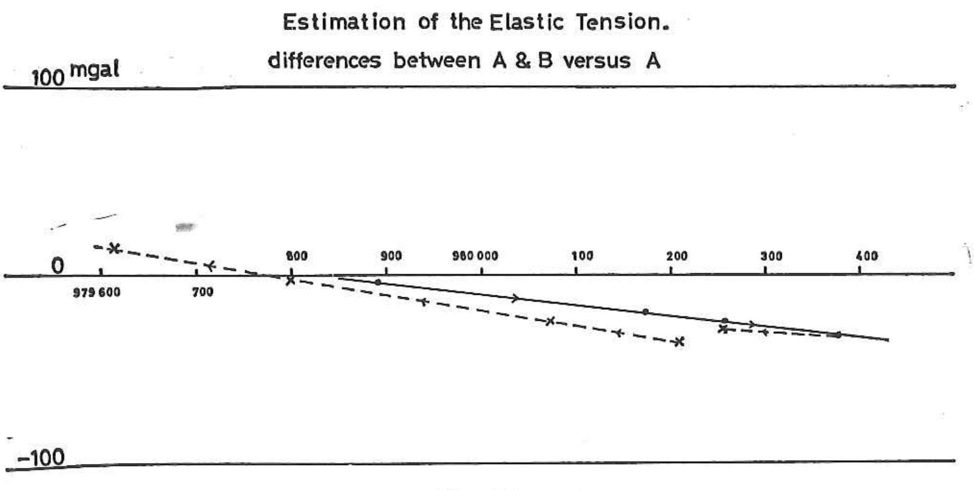


Fig. 5-3

of the most fitted line between that obtained from the first half data and that from the second half. It is because of a positive drift of frequency occured in the gravity meter "B". Assuming that the effect of the elastic tension is represented by the mean gradient, the elastic tension of the meter "B" is determined as −70.6 gals.

Characteristics of the drift rate of the gravity meter "A" and "B"

Fig. 5-4 shows the drift measurement of the gravity meter "B" before the cruise. The uppermost curve in the figure was obtained in the first test of the drift measurement made in the Institute and the rate was as large as +5.5 mgals/hour. In the test made on the next day the drift rate decreased to +1.6 mgals/hour as is shown in the middle curve. The lowest curve was obtained by the measurement made on the Hakuho-maru. The vertical of the gravity meter was kept by the use of a free gimbal, and the power supplied from a small motor generator driven by a 24 volts battery.

As is seen in the figure, the frequency of oscillation of the string gravity meter decreases in the period of 19^h00-22^h30 and 07^h30-14^h00. Its variation is equivalent to $-15\sim20$ mgals in terms of gravity variation. The period when the gravity value

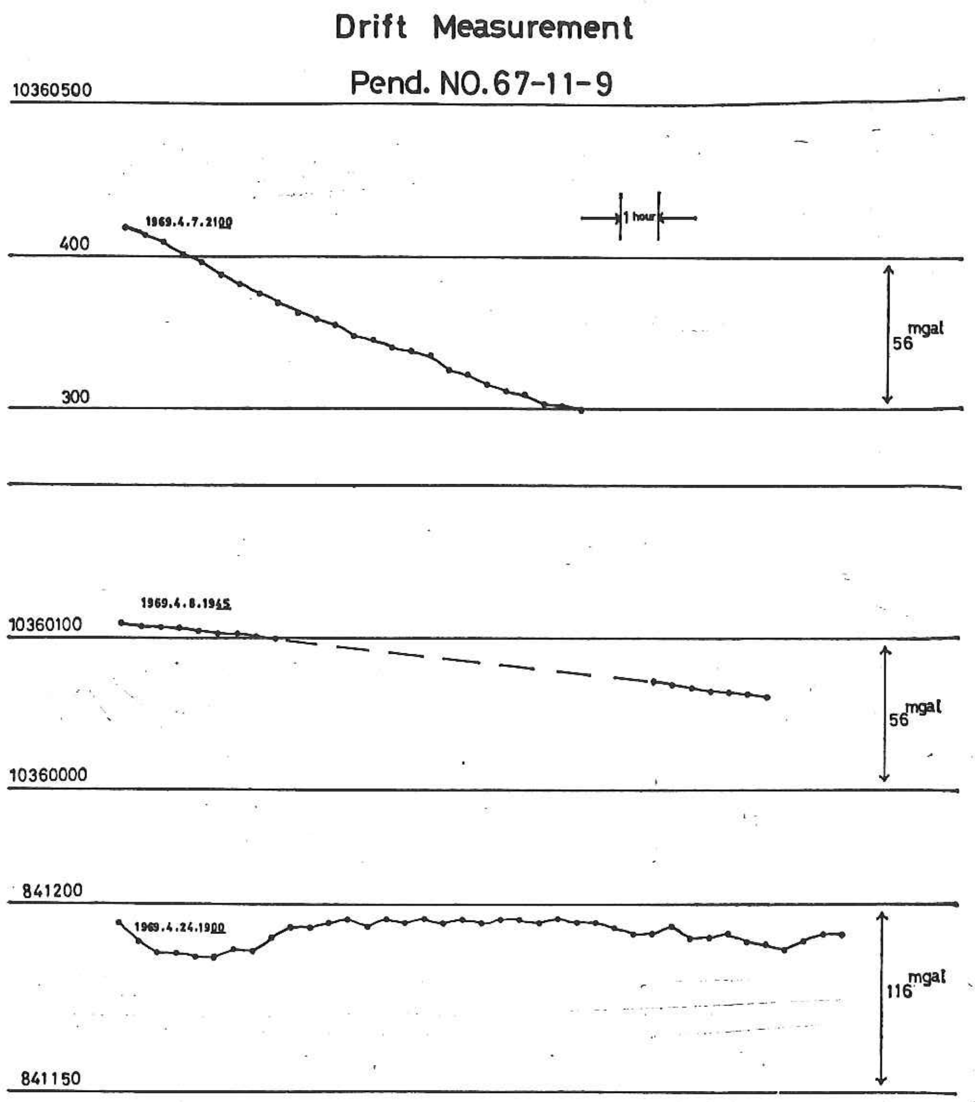


Fig. 5-4

apparently decreased corresponds to the period when the power of the ship was supplied to a battery charger. And so the abnormal decrease of the value is interpreted to be caused by an undesirable condition of the method of floating charge of the battery, resulting in the rise of the supplied voltage to the exciting amplifier beyond the capacity of the voltage regulator installed in the amplifier. On the other hand the drift rate is difficult to be recognized between 22^h30 and 07^h30 of the next day. From this, it is expected that the drift rate becomes as small as 1—3 mgals/day on the 25th of April while 5.5 mgals/hour rate was observed on the 7th of April.

Fig. 5-5-1 is the drift rate of the string gravity meter "A" set on the vertical

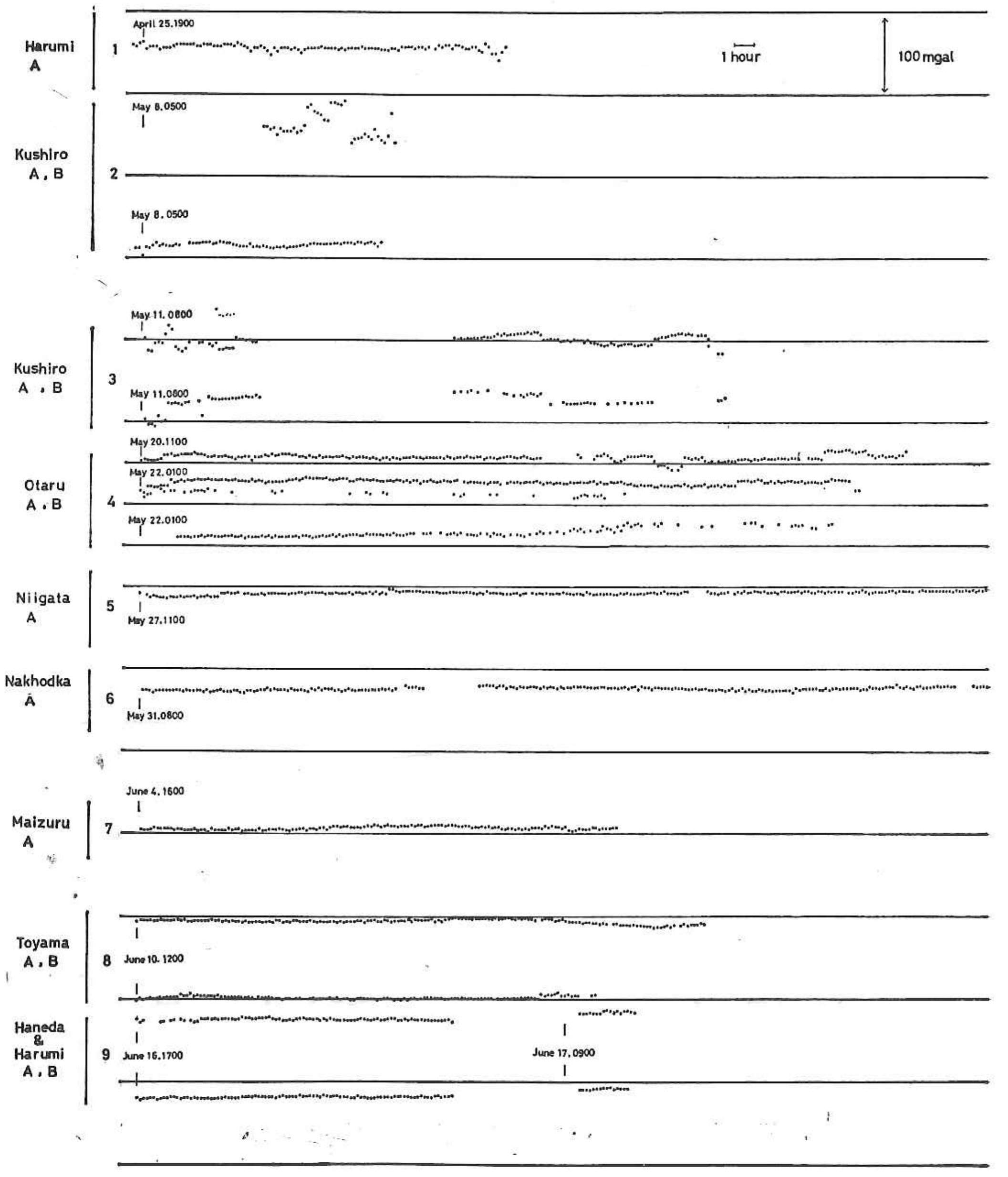


Fig. 5-5

gyroscope. The measurement was carried out under almost the same condition as in the actual observation except the use of an integration counter. Though a small fluctuation caused by a fluctuation of the vertical gyroscope is recognized, it is difficult to estimate the drift rate.

Kushiro (1):

Fig. 5-5-2 is the result of measurement of the drift rate when the ship was anchored at the Kushiro harbour on the 8th of May. After this, the two gravity meters were connected on line with the electronic computer Facom-270-20 in real time. During the measurement in the harbour, a large fluctuation was seen in the gravity meter "A". This proved to be caused by the mis-adjustment of the vertical gyroscope, whose vertical had been set several tens of minutes deflected from the true vertical of the gravity meter axis. If the gravity meter is set deflected, a small fluctuation of the vertical gyroscope causes a large fluctuation of the gravity value. Drift of the gravity meter "B" at Kushiro was difficult to be measured.

Kushiro (2):

Fig. 5-5-3 is the result of the measurement of the drift rate also at Kushiro on the 11th of May. The value fluctuated so much that the variation due to the drift was masked. The main reason of the fluctuation was that electric noises were induced in the counter from the commutators of a 400 Hz motor generator which drived the spin motor of the gyroscope.

During the stay at Kushiro, a temperature regulating housing was made to keep the temperature of the exciting amplifier. The exciting amplifier of both "A" and "B" were placed in the housing whose temperature was kept to be 34.5 ± 0.5°C. This condition was kept till the ship arrived at Tokyo.

Otaru:

Fig. 5-5-4 is the results of measurement at Otaru from the 20th to the 23rd of May. The vertical of both gravity meters was adjusted again there. This adjustment produced an apparent increase in gravity values of 25 mgals and 5 mgals for "A" and "B" respectively.

Niigata:

Fig. 5-5-5 is the result obtained at Niigata harbour. Because the gyro erection amplifier had to be improved in this period, the measurement by the T.S.S.G.-B was not carried out.

Nakhodka:

Fig. 5-5-6 is the result of measurement of the drift rate at Nakhodka harbour. Its first half part is the result when the ship was anchored in the harbour and the following part is the result obtained at the passengers' pier. The measurement was carried out only by the gravity meter "A".

Maizuru:

Fig. 5-5-7 is the result of measurement of the drift rate of the gravity meter "A".

Toyama:

Fig. 5-5-8 is the results of both the gravity meters "A" and "B" at Toyama harbour. The gyro erection amplifier of the gravity meter "B" was improved before entering the Toyama harbour. At the rear portion of the curve is found a negative drift, which coincides with a sudden rise of the temperature at the gravity meter room (The room temperature reached 31°C) and therefore the drift is interpreted as caused by this temperature change.

Tokyo:

Fig. 5-5-9 is the drift rate when the ship was anchored at the entrance of the Tokyo harbour off Haneda. The last portion of the curve is the measurement made when the ship returned to the pier of the Ocean Res. Inst. at Harumi of Tokyo harbour.

From these measurements of the drift rate it was found that a true drift rate was difficult to be measured in such short period as 1 or 2 days, for both "A" and "B". This means that the drift rate of the gravity meter "A" and "B" is expected to be smaller than 1—3 mgals/day. And the problem seems to lie not in the drift rate with a certain tendency, but in the fluctuation of the frequency caused by the variation of the circumstances such as room temperature of the gravity meter room.

2. Date processing method

The oscillation period of the T.S.S.G.-A and B was measured by the use of binary counters and the output of the counters was fed to the electronic computer and processed by the use of the on-line real time processing program. The measured period is defined as the time required to count the 2^{10} pulses which are sent from the gravity meter. The value of the period is 0.5—0.65 sec. The following calculations are made by the real time date processing.

1) Translation of periods of the gravity meter into accelerations.

2) Digital low pass filtering by the use of the weighted mean to separate the acceleration of gravity from the acceleration caused by the vertical motion of the ship.

3) Second order corrections for the finite sampling intervals.

One set of the gravity value is obtained by processing the period informations from the counter in the period necessary to count 795×2^{10} pulses from the gravity meter (usually 400—500 sec). The processing is repeated every 10 min.

The actual method of data processing used in the present cruise is as follows.

If T_i represents a mean period of the string gravity meter oscillation at the i-th sampling interval (in this interval N times of oscillation occurs in the string gravity meter), then

$$T_i = \frac{1}{N}\int_{n_i-N/2}^{n_i+N/2} T(n)dn \tag{1}$$

where "n" is a variable representing the number of oscillation of the string. $T(n)$ represents the period of wave at n-th oscillation of the string. If $\overline{g_i}$ represents the mean vertical acceleation at the i-th interval, then

$$\overline{g_i} = \int_{n_i-N/2}^{n_i+N/2} \frac{K}{T(n)} dn \Big/ \int_{n_i-N/2}^{n_i+N/2} T(n)dn$$
$$= \frac{K}{T_i^2}\left\{1 + \frac{1}{T_i^2}\frac{1}{N}\int_{n_i-N/2}^{n_i+N/2} [T(n) - T_i]^2 dn\right\} \tag{2}$$

where "K" is a constant. Putting $n = N \cdot n'$, then $dn = N \cdot dn'$, and the T_i in the formula (1) is written as,

$$T_i = \int_{n_i'-1/2}^{n_i'+1/2} T(n')dn' \tag{3}$$

Applying the above formula to (2), the mean acceleration becomes as

$$\overline{g_i} = \frac{K}{T_i^2}\left\{1 + \frac{1}{T_i^2}\int_{n_i'-1/2}^{n_i'+1/2} [T(n') - T_i]^2 dn'\right\} \tag{4}$$

When the interpolation is made within the sampling interval by applying quadratic equation $T(n') = a_0 + an_1' + an_2'^2$, then the mean acceleration becomes as,

$$\overline{g_i} = \frac{K}{T_i^2}\left[1 + \frac{1}{T_i^2}\left(\frac{\Delta^2}{48} + \frac{\Delta'^2}{720}\right)\right] \tag{5}$$

The interpolation is made in the range of $n_i' - 1/2 < n' < n_i' + 1/2$ by the use of T_{i-1}, T_i and T_{i+1}, where $\Delta = T_{i+1} - T_{i-1}$ and $\Delta' = T_{i+1} + T_{i-1} - 2T_i$.

The error involved in the interpolation by the use of a quadratic formula is not so large as far as a usual ship is concerned. If the formula (5) is expressed by the sampling interval (S_i), instead of the mean period T_i, then, the formula (5) becomes as

$$\overline{g_i} = \frac{N^2 \cdot K}{S_i^2}\left[1 + \frac{1}{S_i^2}\left(\frac{\delta^2}{48} + \frac{\delta'^2}{720}\right)\right] \tag{6}$$

considering the relation $S_i = N \cdot T_i$, where $\delta = S_{i+1} - S_{i-1}$ and $\delta' = S_{i+1} + S_{i-1} - 2S_i$. The second term in the bracket expresses the second order correction for the finite sampling interval. The value of the $N^2 \cdot K$ is determined by the gravity value at a certain station.

As is described in sec. 5-4, the second order correction in the formula (6) is not sufficient, when the elasticity of the string of the gravity meter is taken into account, and generally, the effect is approximately corrected by multiplying the second order term by a factor α. That is, the formula (6) is modified as

$$\overline{g_i} = \frac{N^2 \cdot K}{S_i^2}\left[1 + \frac{\alpha}{S_i^2}\left(\frac{\delta^2}{48} + \frac{\delta'^2}{720}\right)\right] \tag{7}$$

The value of "α" varies with the gravity meters, but generally is approximated by

2 to 3. The value can be empirically determined.

As described before, $\overline{g_i}$ is a mean vertical acceleration in a time interval of 0.5—0.65 sec, so true vertical acceleration can be obtained as far as the period of the vertical acceleration is longer than 1 sec. The acceleration of gravity can be separated by filtering out the short period vertical acceleration caused by the motion of the ship by the use of a low pass filter. This operation is carried out according to the weighted mean method. That is, the acceleration of gravity $\tilde{g}$ is given by

$$\begin{aligned}\tilde{g} &= \Sigma \overline{g_i} \cdot S_i \cdot W_i / \Sigma S_i \cdot W_i \\ &= \Sigma W_i \cdot \frac{K'}{S_i}\left[1+\frac{\alpha}{S_i^2}\left(\frac{\delta^2}{48}+\frac{\delta'^2}{720}\right)\right] \Big/ \Sigma S_i \cdot W_i \\ &= \frac{K'\Sigma W_i/S_i + \alpha \cdot K' \Sigma (W_i/S_i^3)(\delta^2/48+\delta'^2/720)}{\Sigma S_i \cdot W_i} \\ &= g_1 + \Delta g_1 \end{aligned} \tag{8}$$

where $K'=N^2 \cdot K$. In the above formula, g_1 represents the gravity value calculated directly from the data of finite sampling interval and Δg_1 the second order correction for the finite sampling inteval. By choosing the time spread of the weight function properly to be more or less than 200 sec and by calculating the weighted mean under a proper amount of block shift of the weight function, a long period variation in 10 min can be obtained. If the gravity value calculated by the formula (8) using the weight function whose time spread is about 200 sec is represented by $\tilde{g}_S$, as

$$\tilde{g}_S = g_1^S + \Delta g_1^S, \tag{9}$$

the representative value in 10 min is given by averaging $\tilde{g}_S$ as

$$g_2 = \overline{\tilde{g}_S} = \overline{g_1^S} + \overline{\Delta g_1^S} \tag{10}$$

The method of calculating the gravity value mentioned above is true if the string of the gravity meter is tensioned only by the external acceleration. In the actual gravity meter, however, some amount of elastic force exists caused by the elasticity of the string itself and by the cross spring of the gravity meter. When such an elastic force acts on the string, it is not sufficient to determine the gravity meter constant by calibration at only a single station. In order to determine the elastic tension of the gravity meter, calibrations at least for two stations the gravity values of which are different are necessary, or the constant must be determined by the aid of an artificial variation of the acceleration.

When the external acceleration is not so large, the elastic tension is considered to be constant and the equation of the string gravity meter is modified as

$$g + a = \frac{K'}{T^2} \tag{11}$$

The elastic tension described in sec. 5-1 corresponds to "a" in the above formula.

When the gravity meter constant K' is determined at a certain station of the gravity g_S according to the formula $g_S = \frac{K'}{T^2}$, and at another place the gravity value is measured to be g_2 by the use of the constant, then the true gravity value g_3 of that place is calculated with a good approximation, as

$$g_3=g_2-(g_2-g_S)\frac{a}{g_S}\left(1-\frac{a}{g_S}\right) \tag{12}$$

According to the formula (12), it is sufficient to determine the "elastic tension" within accuracy of 1 gal when g_S and g_2 is known within accuracy of 1 mgal.

The result of the computation by the electronic computer is printed out according to the following format,

Data No.

$$g_1^{(1)} \quad g_1^{(2)} \cdots\cdots g_1^{(8)} \quad \overline{g_1^S}$$

$$\Delta g_1^{(1)} \quad \Delta g_1^{(2)} \cdots \Delta g_1^{(8)} \quad \overline{\Delta g_1^S} \quad g_2 \quad g_3$$

The Eötvös, Bouguer correction and the calculation of the anomalies are carried out in the second stage of the gravity analyses by the use of the batch processing program.

3. Gravity Log

Tokyo (April 26)—Kushiro (May 8)

Gravity values measured by La Coste Land gravimeter:

Pier of the Ocean Res. Inst. Harumi, Tokyo harbour ——979. 787 gals

The entrance of the Maritime Safety Board, Kushiro ——980. 609 gals

The ship departed from the pier of the Ocean Res. Inst. at 14^h00, on April 26th. In order to improve the real time data processing program, the measurement was carried out only for "A" by the use of the paper tape system till 20^h30, on April 28th. After that, the data were processd by a new real time processing program. For the sake of comparison, paper tape system was also continued until May 2nd. The T.S.S.G.-B was not used yet.

The constants used in this period are

$K_A'=410572\times10^5$ (410572+5 in Facom Format)

$\alpha_A=2, \qquad a_A=-98$ gals $\qquad g_S=979.787$ gals

where the constant K_A' is not the value determined by the calibration at Harumi. At 15^h20, on April 29th, the real time date processing program for T.S.S.G.-B was completed. However the measurement by "B" was not carried out owing to the troubles in the counter 702 S. This troubles proved to be caused by the timing miss of the read out pulses, and so a delay circuit was added to delay the pulses by 5 msec. From 23^h40, May 1st, the real time processing of the data from both "A" and "B" began. The following constants were used for "B",

$K_B'=471588\times10^5$

$\alpha_B=2, \qquad a_B=0, \qquad g_S=979.787$ gals

As the elastic tension of "B" was not determined yet, the value was temporarily assumed to be zero.

There were some troubles in the gyro erection devices of the T.S.S.G.-A. The reason was not certain but the troubles were recovered by re-inserting the base plate of the transister circuit or by switching on and off the power line.

The gravity values obtained at the Kushiro harbour are

T.S.S.G.-A —— 958. 570 gals
T.S.S.G.-B —— 980. 613 gals

These values are not corrected for the effect of the elastic tension. When this correction is made for the value of "A" it becomes 980. 656 gals.

Level of "A" was adjusted at the harbour (about 13^h00). The adjustment was carried out by the use of the "Zero Shift Dial" of the gyro erection amplifier with reference to a pair of level vials attached to the gravity meter. The gravity value after this adjustment is 980. 600 gals. The level was not so stable. Before starting from Kushiro, the constant for "A" was changed to fit the value of T.S.S.G. to that of Kushiro.

The gravity value of "B" was approximately equal to the value at Kushiro and no change in the constant was made.

The constants used from Kushiro are

$$K_A' = 410574 \times 10^5$$
$$a_A = -98 \text{ gals} \qquad g_S = 980.609 \text{ gals}$$

Kushiro (May 8th)—Kushiro (May 11th)

Left Kushiro at 17^h00, on May 8th and returned again to the Central pier of Kushiro at 08^h00, on May 11th.

Gravity value measured by La Coste Land gravimeter:

The Central pier of Kushiro harbour——980. 608 gals

The difference of this value from the gravity at the Maritime Safety Board building is less than 1 mgals. There was a large fluctuation in the value obtained by the T.S.S.G.-A, and it is difficult to determine an accurate value, but that obtained from a comparatively good portion of the record is

T.S.S.G.-A —— 980. 592 gals
T.S.S.G.-B —— 980. 618 gals

The level of "A" was adjusted again, and then the value became 980. 596 gals. According to these results, it seems that the drift rate of "A" and "B" is −12 mgals and +10 mgals respectively, but the apparent drift is interpreted as caused by the unstability of the vertical gyroscope.

At Kushiro, exciting amplifiers of both "A" and "B" were for the first time put into a temperature regulating housing. The A.G.C. circuit of the exciting amplifier is made to keep at a certain level the amplitude of the oscillation of the dynamic gravity meter. It was nevertheless suspected that the room temperature affected the pre-set level of A.G.C. and changed the amplitude of the dynamic gravity meter. The room temperature effect on the A.G.C. level was tested with respect to the exciting amplifier for "A", and the result is shown in Fig. 5-6. ±5% variation in the amplitude is caused by 1°C variation in the room temperature at 25°C. The temperature regulating housing was controlled by the use of a thermistor and a S.C.R. circuit. Temperature inside is kept at 34.5±0.5°C. The temperature regulation of the exciting amplifier was continued from May 11th to June 17th when the ship arrived at Tokyo. Just before starting from Kushiro, the commutator of the motor generator which drove the spin motor of the vertical gyroscope was worn out, resulting in miscounting of the frequency counter caused by the electric noises from the sparks at the commutator, and the part was repaired.

The gravity values at Kushiro at the time of departure are

T.S.S.G.-A —— 980.581 gals
T.S.S.G.-B —— 980.619 gals

These values are not corrected for the elastic tension and when the correction is made the value for "A" becomes 980.579 gals. The adjustment of the constants was not carried out here.

Kushiro (May 12th)—Otaru (May 20th)

The ship arrived at Otaru at 09^h00 on May 20th.

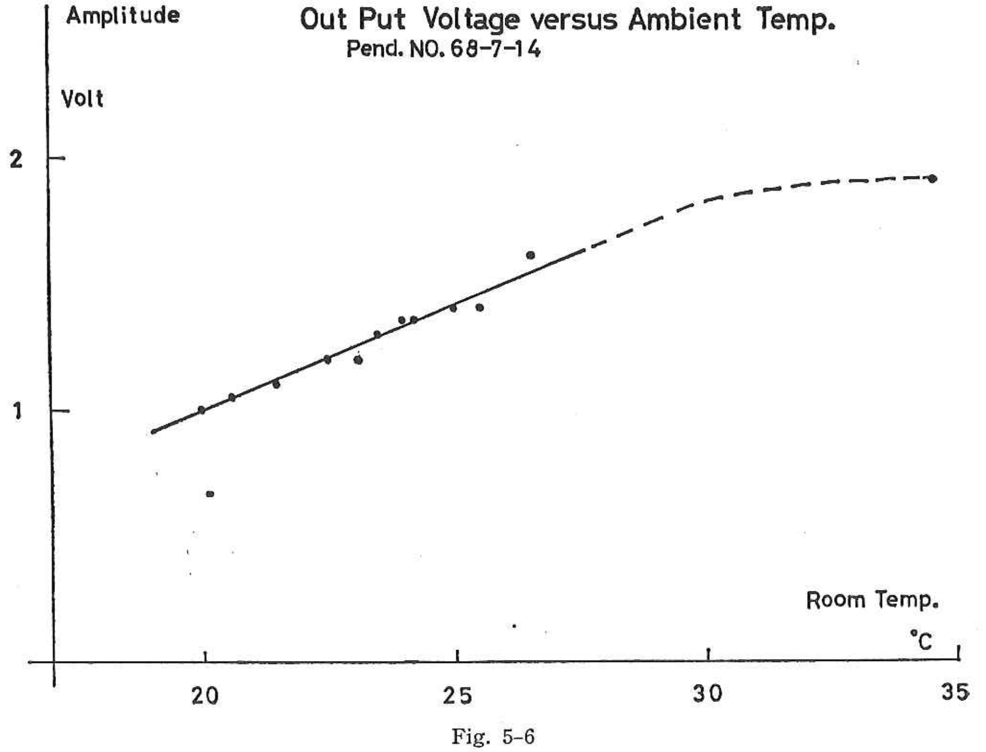


Fig. 5-6

Gravity value measured by La Coste Land gravimeter:

Pier No. 3, Otaru——980. 509 gals

Gravity values measured by T.S.S.G. at the time of arrival are

T.S.S.G.-A —— 980. 508 gals
T.S.S.G.-B —— 980. 553 gals

The value of "A" when corrected for elastic tension is 980. 496 gals.

The level of "A" and "B" was adjusted again. It was adjusted in such a way that the gravity value became maximum. By this adjustment the value apparently increased by +20 mgals and +5 mgals for "A" and "B" respectively. This means that the deflection of the gravity measuring axis is 20′ in "A" and 10′ in "B".

In Fig. 5-5-4 are seen several points where the gravity value are shifted due to the level.

Before leaving Otaru new constants were determined according to the gravity value on land. They are

$$K_A'=4105664\times10^4$$
$$a_A=-98 \text{ gals}$$
$$g_S=980.509 \text{ gals}$$
$$K_B'=4715556\times10^4$$
$$a_B=0$$
$$g_S=980.509 \text{ gals}$$

The ship departed from Otaru at 13^h00, on May 23rd.

Otaru (May 23rd)—Niigata (May 27th)

The ship arrived at Niigata at 10^h30 on May 27th.

Gravity value measured by La Coste Land gravimeter:

Berth H of the Central pier, Niigata——979. 990 gals

The values obtained by the T.S.S.G. at the time of the arrival are

T.S.S.G.-A —— 979. 989 gals
T.S.S.G.-B —— not measured

The value of "A" was corrected for the elastic tension.

After the level was adjusted again, the value became

979. 992 gals.

From 10^h00 on May 25th the ship was caught by an atmospheric depression and the motion of the ship became large. At 10^h30 the value of "B" suddenly shifted by −100 mgals, and since then, the fluctuation of the values became large. This proved to be caused by a defect in the gyro erection circuit and so it was greatly improved on the ship. The measurement by "B" was temporarily stopped till June 3rd. The T.S.S.G.-A worked quite well except in the case when the motion of the ship was too large. Some amount of fluctuation seen in the value of "A" is interpreted as the result of under-correction for the second order effect and also of 2—3 cycle bending motion of the floor caused by the water hammer, which is peculiarly strong in Hakuho-maru. The second order correction will be discussed in section 4.

Niigata (May 29th)—Nakhodka (May 31st)

The ship left Niigata at 06h30 on May 29th and arrived in Nakhodka at 08h00 on May 31st. The ship anchored at first at the entrance of the harbour and then arrived at the passengers' pier at 00h00 on June 1st. The permission of measuring the gravity on land was not given and so the gravity measurement by the use of the La Coste gravity meter was not carried out. The gravity value there measured by the use of T.S.S.G.-A is 980.479 gals (this is corrected for the elastic tension). The constant determined at Otaru was continuously used in the cruise but the factor for the second order correction $\alpha=3$ was used which is 1.5 times the former value.

Nakhodka (June 2nd)—Maizuru (June 4th)

Left Nakhodka at 11h40 on June 2nd and anchored at inspection point at the entrance of Maizuru harbour at 13h50 on June 4th. Arrived at the second pier No. 3 of west Maizuru at 16h00.

Gravity value by La Coste Land gravimeter:

West Maizuru harbour second pier No. 3 ——979.809 gals

The gravity value obtained by the T.S.S.G.-A is 979.805 gals and after re-adjusting the level it became 979.803 gals. These values are corrected for the effect of the elastic tension.

The improvement of the gyro erection amplifier for "B" was finished on June 3rd, and the measurement had been started. But just before arriving at Maizuru, a sudden rise in the room temperature caused troubles of the counter 702S and the calibration of "B" could not be carried out here.

After the calibration at Otaru, the value of the T.S.S.G.-A agrees quite well with the value obtained by the use of the La Coste Land gravimeter at Niigata and Maizuru. This suggests that the gravity value at Nakhodka is reliable within the accuracy of 1—2 mgals.

Sometimes there occured troubles in the gyro erection system of the T.S.S.G.-A. This seems to have been caused by some defects in the differential transformer used as a horizontal accelerometer; the core of the transformer may sometimes have had contact with the coil of the transformer, or there may have been imperfect connection between the differential transformer and the amplifier or imperfect contact in the phase detector circuit.

Another trouble occurred also in the frequency counter 702S.

Maizuru (June 5th)—Toyama (June 10th)

Left Maizuru at 16h00 on June 5th and arrived at Toyama, the pier No. 3 at

10^h00 on June 10th.

Gravity value measured by La Coste Land gravimeter:

Pier No. 3 Toyama harbour——979.893 gals

The value obtained by the T.S.S.G.-A is 979.894 gals (corrected for the effect of the elastic tension). The level adjustment was unnecessary here. The repair of the 702 S was finished and the measurement was carried out by both "A" and "B".

It was found that when the ship was cruising some amount of level shift was recognized by the level vials attached to the gravity meter. This phenomenon seems to have been caused by unsymmetrical erection power supplied to the torque motor of the vertical gyroscope, resulting in the shift of the mean value of horizontal acceleration. When the horizontal acceleration is not so large it is possible to know the deflection of the vertical gyroscope by the aid of the level vial. This deflection occuring when the ship was moving seemed larger in the T.S.S.G.-B, and so the gyroscope of "B" was adjusted by the Zero Shift Dial of the erection amplifier at 16^h30 on June 8th.

The adjustment was carried out again at 18^h40 on June 9th for "B", and a slight change also for "A". Variation in gravity caused by these adjustment are shown in Fig. 5-7. As seen in the figure the differences between "A" and "B" changed by 10 mgals. Compared with the result of "A", it was found that the level shift of "B" corresponded to −10 mgals shift in gravity.

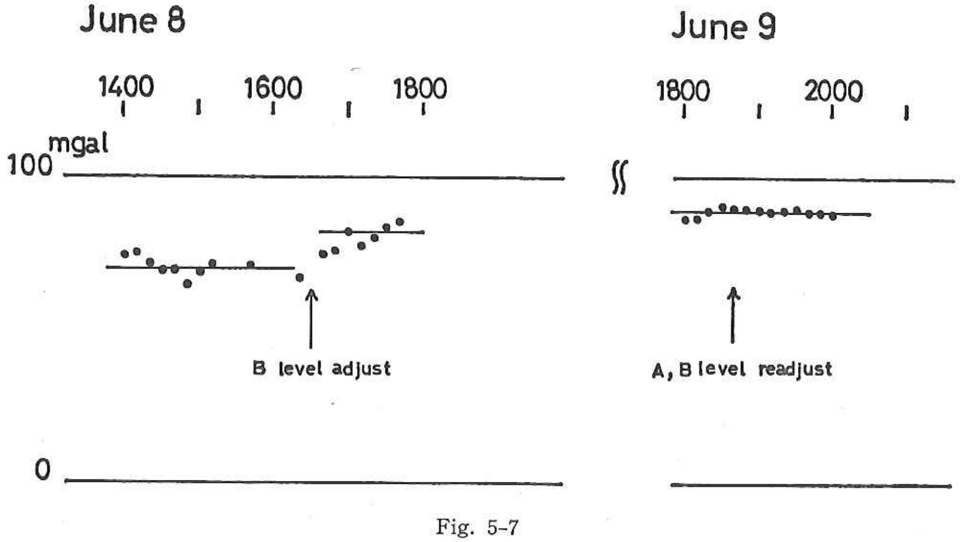


Fig. 5-7

Toyama (June 11th)—Tokyo (June 17th)

Left Toyama at 16^h00 on June 11th and anchored at the entrance of the Tokyo harbour off Haneda at 16^h00 on June 16th. At 10^h00 on June 17th arrived at the pier of the Ocean Res. Inst.

The constants of both T.S.S.G.-A and B were adjusted according to the land gravity value at Toyama. The value of the constants for "A" was not altered, but the constants for "B" are changed as

$$K_B' = 4715043 \times 10^4$$

$$a_B = 0, \qquad g_S = 979.893 \text{ gals}$$

The vertical of "A" and "B" were adjusted not only when the ship was standing at the pier but also when she was cruising. The adjustment was carried ont by the use of the Zero Shift Dial of the erection amplifiers with reference to the level vials. That is, the dials were set at different values according as either the ship was standing or cruising.

The values of "A" and "B" at the pier the Ocean Res. Inst. at Harumi are

T.S.S.G.-A —— 979.784 gals
(corrected for the elastic tension)

T.S.S.G.-B —— 979.807 gals
(not corrected for the elastic tension)

The result of the comparison measurement from Toyama to Tokyo is separately discussed in sec. 5-5. But, assuming that the value of the elastic tension is −70.6 gals, the corrected value of "B" at Harumi obtained from the land gravity value at Toyama, using the formula (12) in sec. 5-2, is 979.800 gals. The difference between the two gravity meters is 16 mgals. This difference is supposed to be caused by a sudden drift in "B", which occurred when the ship was not far from Tokyo.

During this leg the counter 702 S was replaced by a 16 bit counter made of I.C. and it became possible to send the signal of the counter to the computer in a period far shorter than before.

4. Problem of the second order correction

The second term in the bracket in expression (2) of section 2 is a correction originating from the finite sampling interval. To hold the expression good, however, it is required that the following relation is strictly applicable to the dynamic gravity meter as

$$\text{vertical acceleration} \propto \frac{1}{(\text{period of string vibration})^2} \tag{1}$$

With actual strings two other terms must be added in equation (1); a term which is attributable to intrinsic elasticity of the string and the other term by initial tension of cross springs. So, as a more appropriate equation connecting the period of the string to vertical accelerations we get the following expression

$$g(t) = \frac{K_1}{T^2} + \frac{K_2}{T} + K_3 \tag{2}$$

If we suppose the magnitude of the first term in equation (2) to be 1, then the second and third terms with string now in use amount to about 0.02 and 0.03∼0.1 in magnitude compared to the first respectively.

When vertical accelerations are measured by a sampling method of finite sampling intervals an average over "time" is interpreted as an average over "sampling number" or "number of oscillation". The time average of vertical acceleration in equation (2) can be formulated by use of number-dependent functions $g(n)$ and $T(n)$ as

$$\overline{g(t)}=\overline{g(n)\cdot T(n)}/\overline{T(n)}$$
$$=\frac{1}{\overline{T(n)}}\overline{\left(\frac{K_1}{T(n)}\right)}+\frac{K_2}{\overline{T(n)}}+K_3 \tag{3}$$

When the vertical acceleration g is constant or makes only a small variation such as caused by the variation of the earth's gravity field the second and third terms in equation (3) can be taken to be a constant value as an averaged effect. In sec. 5-2 these two terms are treated together to be involved in the "elastic tension". That is,

$$a=\text{elastic tension}=\overline{\left(-\frac{K_2}{T(n)}-K_3\right)} \tag{4}$$

When there is a large variation in vertical acceleration the second term in equation (3) can not be regarded to be steady. Let an averaged vertical acceleration in the i-th sampling interval be $\overline{g_i}$ and an averaged period T_i. Then equation (3) becomes

$$\overline{g_i}=\frac{K_1}{T_i^2}\left\{1+\frac{1}{T_i^2}\frac{1}{N}\int_{n_i-N/2}^{n_i+N/2}[T(n)-T_i]^2dn\right\}+\frac{K_2}{T_i}+K_3$$
$$=g_1{}^i+\Delta g_1{}^i+g_1{}^i\cdot\frac{K_2}{K_1}\cdot T_i+K_3 \tag{5}$$

where $g_1{}^i=\frac{K_1}{T_i^2}$ and $\Delta g_1{}^i=\frac{K_1}{T_i^4}\frac{1}{N}\int_{n_i-N/2}^{n_i+N/2}[T(n)-T_i]^2dn$

Let an average of $\overline{g_i}$ with respect to i (a long term average) be $\tilde{g}$. Then

$$\tilde{g}=\widetilde{\overline{g_i}\cdot T_i}/\tilde{T}_i$$
$$=\widetilde{g_1{}^i\cdot T_i}/\tilde{T}_i+\widetilde{\Delta g_1{}^i\cdot T_i}/\tilde{T}_i+\frac{K_2}{K_1}\cdot\widetilde{g_1{}^i(T_i)_2}/\tilde{T}_i+K_3$$
$$\simeq g_1+\Delta g_1+\frac{K_2}{\sqrt{K_1}}\cdot\sqrt{g_1}\left[1+\frac{4\widetilde{\Delta G^2}}{(g_1)^2}\right]+K_3$$
$$=g_1+\Delta g_1+\Delta g_2+\Delta g_3 \tag{6}$$

where

$$g_1=\widetilde{g_1{}^i\cdot T_i}/\tilde{T}_i$$
$$\Delta g_1=\widetilde{\Delta g_1{}^i\cdot T_i}/\tilde{T}_i$$
$$\Delta g_2=\frac{4K_2}{\sqrt{K_1}}\frac{\widetilde{\Delta G^2}}{g_1{}^{3/2}}$$
$$\Delta g_3=\frac{K_2}{\sqrt{K_1}}\sqrt{g_1}+K_3$$

$\widetilde{\Delta G^2}$=dispersion of vertical acceleration

g_1 is an apparent gravity directly obtained from sampled periods, Δg_1 is a second order correction for finite sampling intervals in case of a non-elastic string, Δg_2 is another second order correction due to the elasticity of a string, and Δg_3 is a term which is nearly constant with time.

The terms which are variable due to ship's motions are Δg_1 and Δg_2, and their effect has so far been corrected for as simply originated from the sampling intervals. Δg_1 and Δg_2 vary in phase with each other when spectra of ship's motion are stationary. In the way in sec. 5-2 in which second order corrections are made the effects of elasticity is not taken into account, but it is included in an empirical factor α in equation (7) in sec. 5-2, for reason that the characteristic constants K_1, K_2, K_3 of strings have not been definitely determined. It seems most legitimate to follow equation (2) in this section strictly for the future calculation of gravity values with no approximations involved in it.

The second order corrections applied according to the method mentioned in sec. 5-2 have been examined and compared with the preceding method. The date measured between 19^h00 on May 25th and 18^h00 on May 26th are those which were obtained under comparatively large ship's motions, and so they were processed in two different methods of the corrections at the same time; one is the method according to what has been described in sec. 5-2 and the other is the method in which the second order correction is calculated simply from averaged dispersions. In the calculations parameter α in sec. 5-2 is selected to be 2, and the constant of proportion to the dispersions of vertical acceleration is to be 0.025 mgals/(gal)^2. Comparison of the two methods

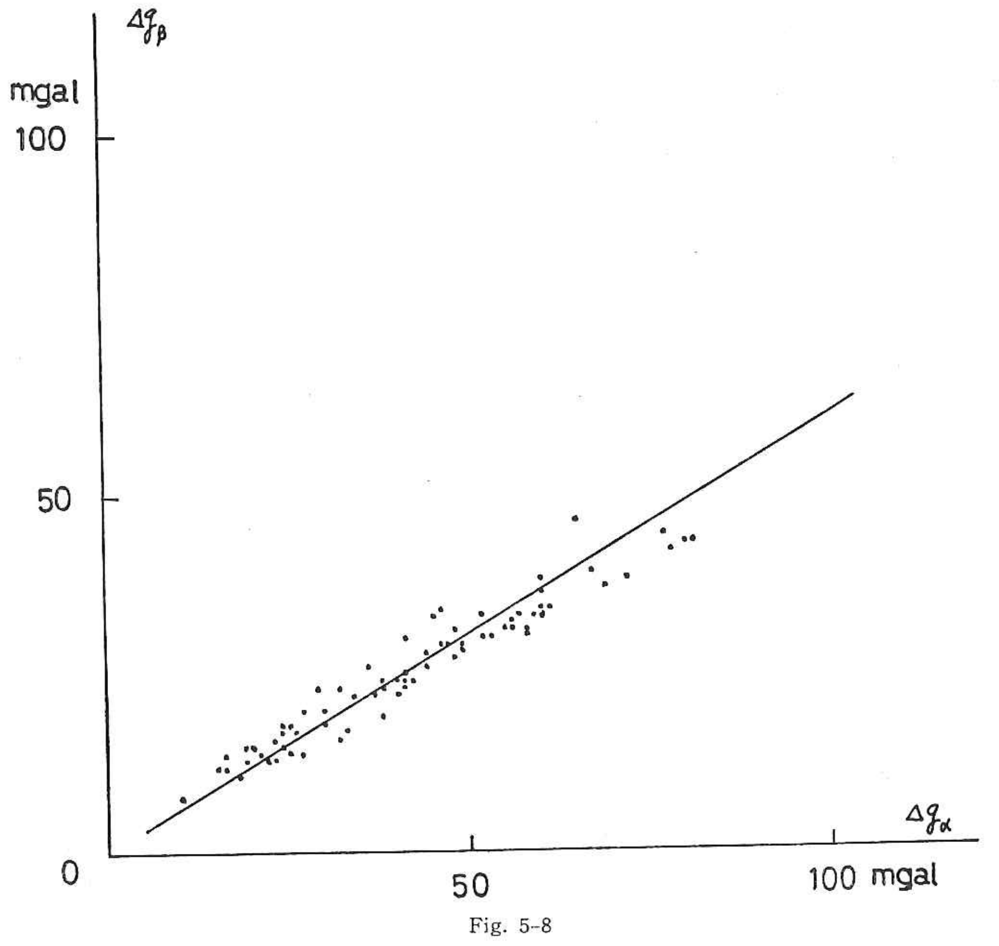


Fig. 5-8

is demonstrated in Fig. 5-8. Corrections according to the method described in sec. 5-2 in the case $\alpha=2$ have proved definitely to be "under-correction" but their values indicate a good linearity in relation to the corrections obtained from dispersions of vertical acceleration, showing that the ratio of the former values to the latter is 0.6. In order to fit the former corrections to the latter the value of α should be 3.3.

It might be important that an actual value of α be larger than 3 where as its value is 1 for an ideal string. The second order correction for finite sampling intervals is dependent on both the dispersions of acceleration and the ratio of the sampling interval to the period of accelerations. The second order effect due to elasticity of strings is, on the other hand, dependent only on dispersions. Criterion to test the legitimacy of the second order correction is simple that the corrected gravity should show a steady value not influenced by ship's motion. The second order correction coefficient thus determined from an idealized equation of a string on the basis of this criterion is more or less subject to incorrectness. For the improvement of these situations it is of importance to establish a more realistic equation of state of a dynamic gravity meter.

5. Comparison measurements in the ship's track from Toyama to Tokyo

Between Toyama and Tokyo we finally succeeded in comparison measurements by use of two T.S.S.G.'s independently operated with each other. The track measured is from Toyama harbour (June 11th) up northward to Tsugaru strait and down to Tokyo Bay (June 17th) along the north-eastern coast of Honshu. Fortunately the sea conditions were very favourable all through this measurement and made it unnecessary to correct for the second order effect larger than 10 mgals. Gravity meters were calibrated both at Toyama and Tokyo, and it was found that there was no drift in gravity meter A and a slight and abrupt shift just before Tokyo in gravity meter B. Corrections for elasticity of strings have been made by putting $a=-98$ gals in A and $a=-70.6$ gals in B respectively using equation (12) in section 2. In Fig. 5-9 are plotted gravity values of A and B at the same time. Averaged differences between the two values are within ± 5 mgals.

Memo. 5-1.

Land Gravity values at the calibration stations

Pier of the Ocean Research Institute, Harumi, Tokyo	979.787 gal	(La Coste G.)
Entrance of Kushiro Maritime Safety Board	980.609 〃	〃
Central Pier of Kushiro	980.608 〃	〃
Pier No. 3 of Otaru	980.509 〃	〃
Central Pier of Niigata, Berth H	979.990 〃	〃
Passengers' Pier of Nakhodka	980.479 〃	(T.S.S.G.)
2nd Pier, No. 3 of west Maizuru	979.809 〃	(La Coste G.)
Pier No. 3 of Toyama	979.893 〃	〃

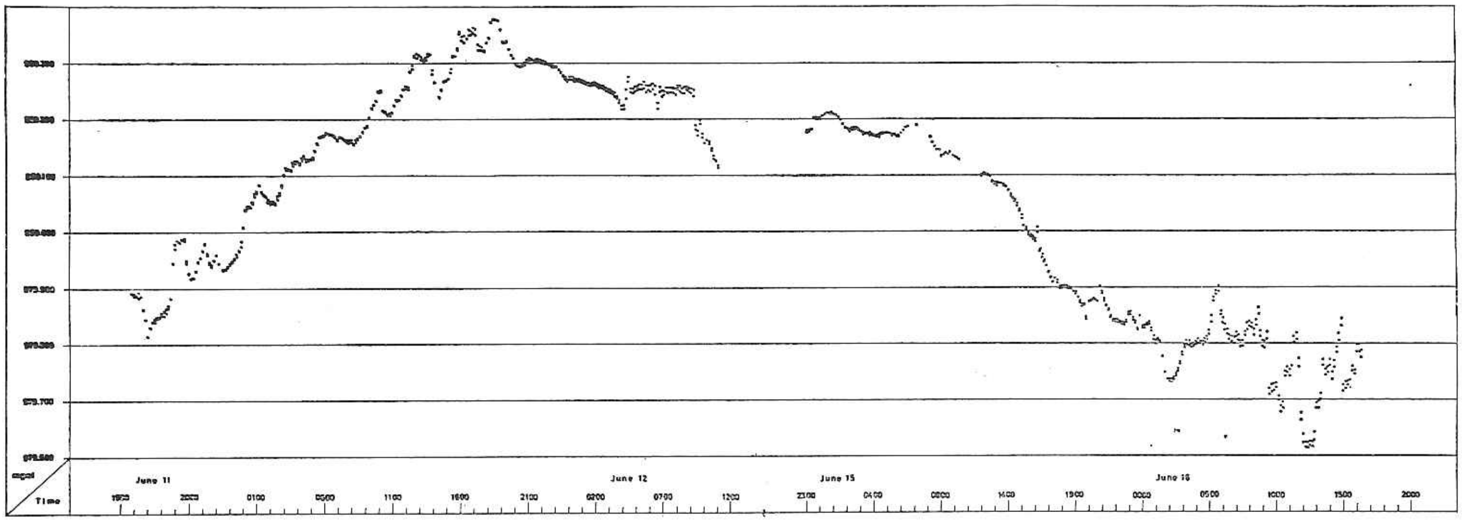

June 11
June 12
June 15
June 16
Time
1900
2000
0100
0600
1100
1600
2100
0200
0700
1200
2300
0400
1400
1900
0500
1000
1500
2000

Fig. 5-9

Memo. 5-2.

In gravity measurement of KH-69-2 frequent alterations in calculation constants and level adjustments were made. Some corrections are necessary in order to have the computer output fitted to real gravity values. In the following are described indications by which corrections have to be applied to the values from computer with appropriate divisions to which the date and the corresponding corrections are separated.

April 26th—May 8th Tokyo—Kushiro

A; Subtract 45 mgals from g_2, due to the wrong constant K.
Add a quantity not more than 30 mgals to data which seem subject to deflections of the gyroscope.
Multiply the second order corrections 1.5 times when there are large vertical accelerations.

B; No corrections are necessary for g_2.
Calculate g_3 by $a=-70.6$ gals and $g_S=980.609$.
Multiply the second order corrections 1.5 times when there are large vertical accelerations.

May 8th—May 11th Kushiro—Kushiro

A; Add 10 mgals to g_2.
Multiply the second order corrections 1.5 times when there are large vertical accelerations.

B; Subtract 8 mgals from g_2.
Calculate g_3 by $a=-70.6$ gals and $g_S=980.609$ gals.
Multiply the second order corrections 1.5 times when there are large vertical accelerations.

May 12th—May 20th Kushiro—Otaru

A; Add 15 mgals to g_2.
Multiply the second order corrections 1.5 times when there are large vertical accelerations.

B; Subtract 39 mgals (or 9 mgals?) from g_2.
Calculate g_3 by $a=-70.6$ gals and $g_S=980.609$ gals.
Multiply the second order corrections 1.5 times when there are large vertical accelerations.

May 23rd—May 27th Otaru—Niigata

A; Multiply the second order corrections 1.5 times when there are large vertical accelerations.

B; Not used.

May 29th—May 31st Niigata—Nakhodka

A; No corrections necessary.

B; Not used.

June 2nd—June 4th Nakhodka—Maizuru

A; No corrections necessary.

B; Not used.

June 5th—June 10th Maizuru—Toyama

A; No corrections necessary.

B; Not used.

June 11th—June 17th

A; No corrections necessary.

B; No corrections necessary unitil June 13th.
After that add 15 mgals to g_2.
Calculate g_3 by $a=-70.6$ gal and $g_S=979.893$ gal.

6. Gravity measurement by means of G.S.I. type surface ship gravity meter

Haruo Ishii

Geographical Survey Institute has carried out gravity survey on the whole land of Japan, but for the purpose of geodetic study, gravity survey in the adjacent seas of Japan is more important. Moreover, for determining the accuracy and reliability of our gravity meter, it is necessary to compare with the T.S.S.G. gravity meter through intercomparison measurement. For the above mentioned reason, gravity survey at sea was carried out by "HAKUHO MARU" as a part of co-operation research program with the Ocean Research Institute.

A gravity meter used is the G.S.I. type surface ship gravity meter which has three strings suspending one weight, intersecting at right angles to one another and passing through the center of gravity of the weight in their extension. The gravity meter is set on the free gimbal and measure total gravity including the effect of horizontal acceleration due to the ship's movement. Horizontal acceleration is measured by the accelerometer independently.

The signal frequencies from three vibrating strings were recorded on the four track magnetic tape with the standard frequency generated by crystal oscillator for 15 minutes for one station in every 30—120 minutes.

Three signal frequencies were added and counted for the period of 540 sec by a Gravity Analyser which consists of ten channels of frequency counters with a D-A converter. After that the signal was recorded on analogue in every 1 minute throughout whole term, while being punched on the paper tape for electronic computer only when sea was calm and correction due to horizontal acceleration and second order correction were negligible.

Integrated value of square of the horizontal acceleration was measured by accelerometers and printed on digital in every 15 minutes.

Operation of the gravity meter was good and the vertical gyroscope kept vertical within $\pm 5'$ in rough weather, but there were some troubles in the horizontal accelerometer;

1. lead wire which connects between stator and rotor of gyroscope was broken
2. pendulum of the differential transformer which detects the horizontal acceleration did not move

It took several hours to repair these trouble.

Preliminary results are obtained on several days. The records of punched tape

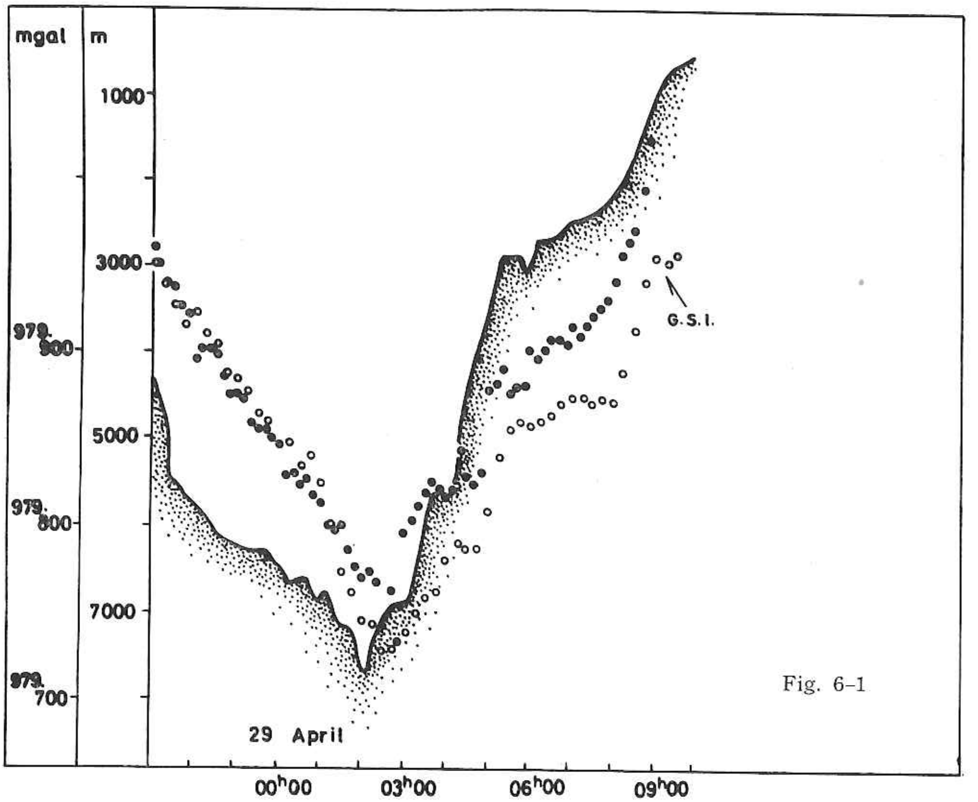

mgal
m
1000
3000
979.900
5000
979.800
7000
979.700
G.S.I.
29 April
00h00
03h00
06h00
09h00

Fig. 6-1

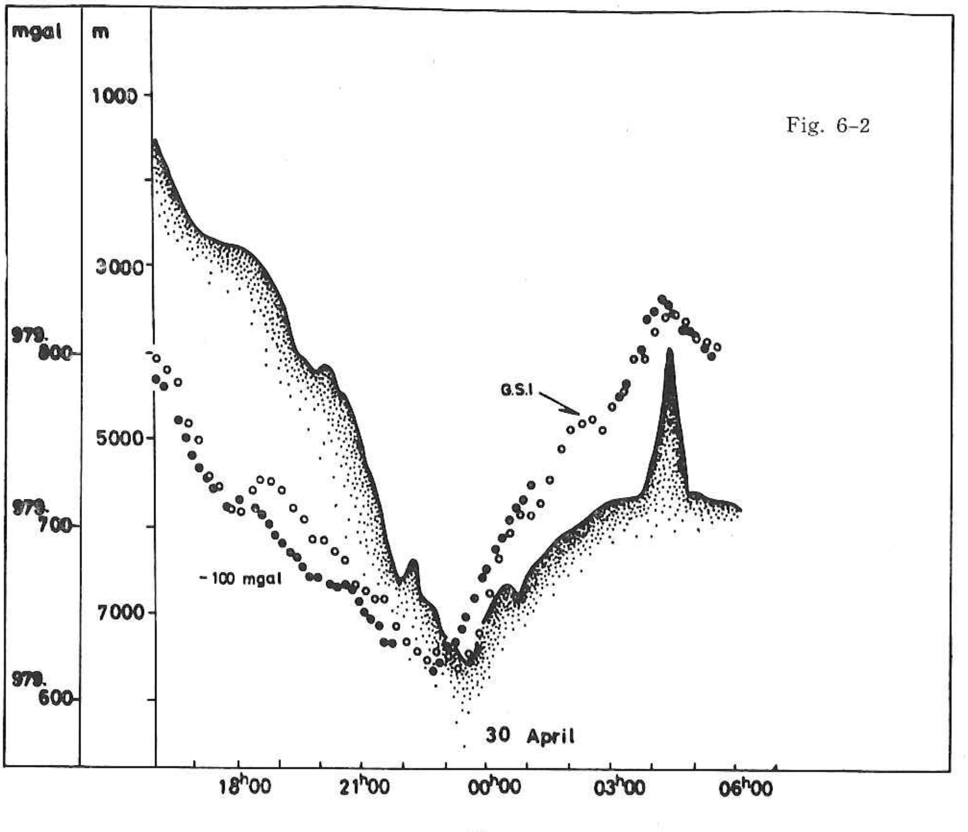
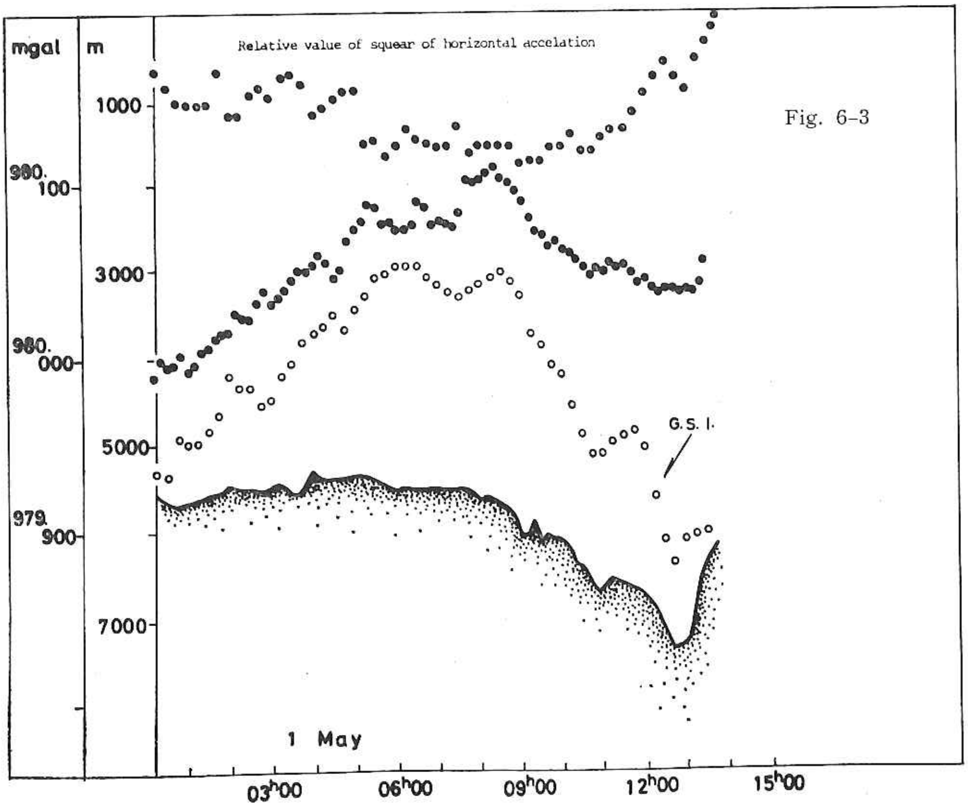
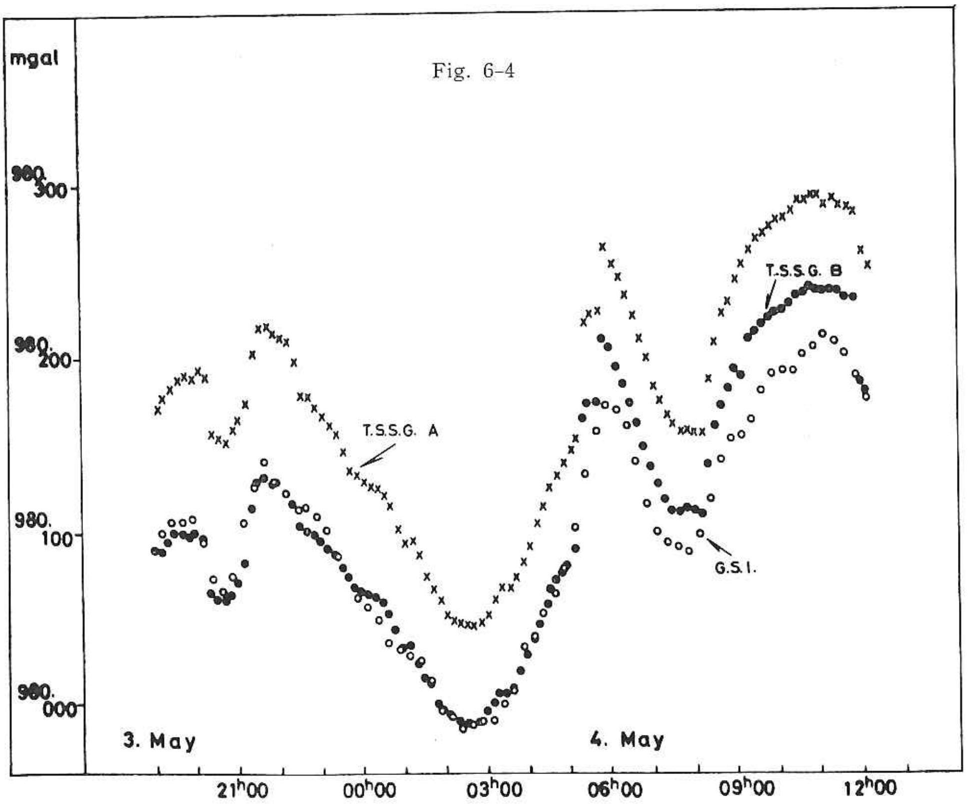

mgal
m
1000
3000
979.800
5000
979.700
7000
979.600
G.S.I
-100 mgal
30 April
18h00
21h00
00h00
03h00
06h00

Fig. 6-2



mgal
m
Relative value of squear of horizontal accelation
Fig. 6-3
1000
980.
100
3000
980.
000
5000
979.
900
7000
G.S.I.
1 May
03h00
06h00
09h00
12h00
15h00



mgal
Fig. 6-4
980.
300
980.
200
980.
100
980.
000
T.S.S.G. A
T.S.S.G. B
G.S.I.
3. May
4. May
21h00
00h00
03h00
06h00
09h00
12h00

on several days of good sea condition are computed by electronic computer on board. They are plotted with T.S.S.G.'s results as shown in Figs. 6-1 to 6-7. The most part of both results are equal or parallel, on the other hand there are some discrepancies in both results which may be caused from correction due to horizontal acceleration and the second order correction because any of corrections are not applied to these results. The characteristic of the G.S.I. gravity meter is insensible to the inclination of its body to the direction of the gravity, but owing to difficulty of the gravity meter, there may be caused error in observed results in spite of small inclination of the gravity meter.

The free air anomalies are obtained on profile across the Japan Trench and negative anomalies of about −200 mgals are observed as shown in Fig. 6-8.

According to intercomparison measurement between the T.S.S.G. and the G.S.I. gravity meters, accuracy of the G.S.I. gravity meter is expected as same as that of the T.S.S.G. gravity meter in good sea condition.

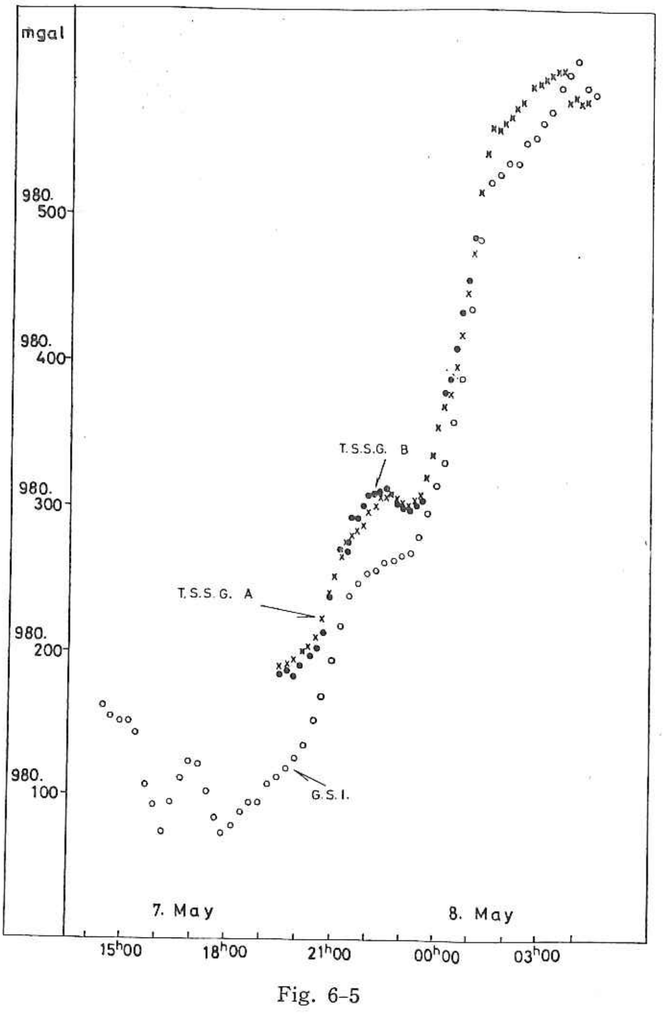


Fig. 6-5

Observed gravity values at each port are as follows;

Name of Port	True gravity value	Observed gravity value
Tokyo	979.787	
Kushiro	980.614	980.615
Otaru	980.515	980.490
Niigata	979.995	979.965
Maizuru	979.809	979.780
Toyama	979.893	
Tokyo	979.787	

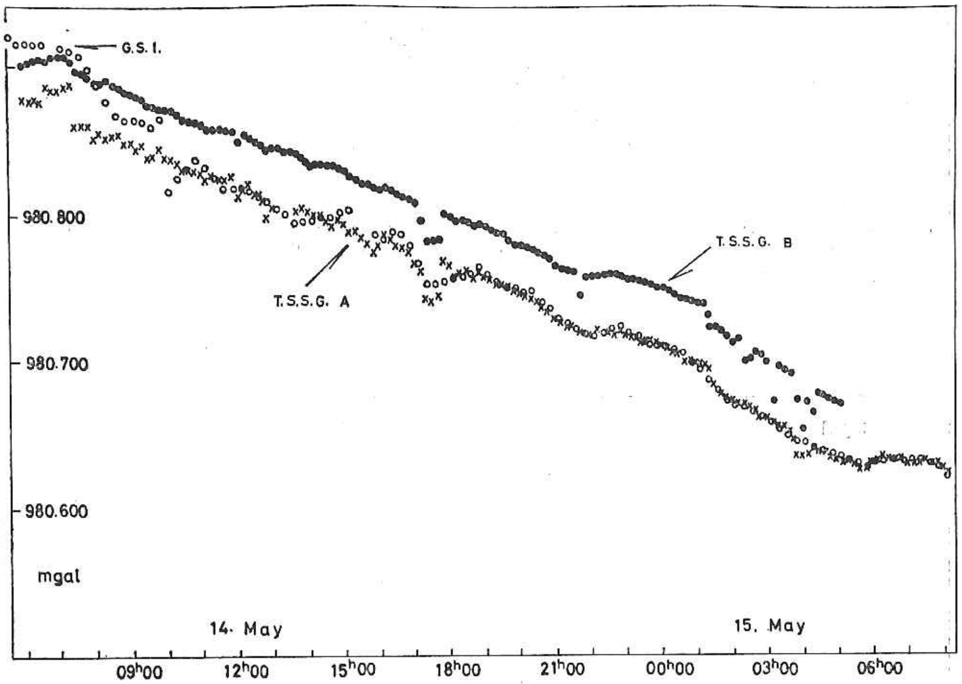


Fig. 6-6-1

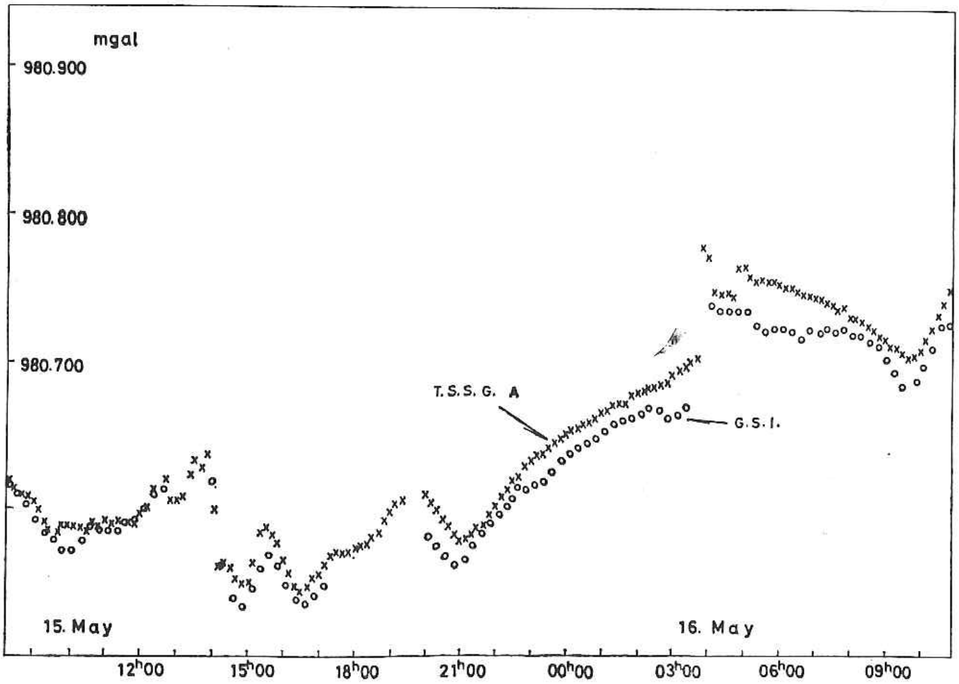


Fig. 6-6-2

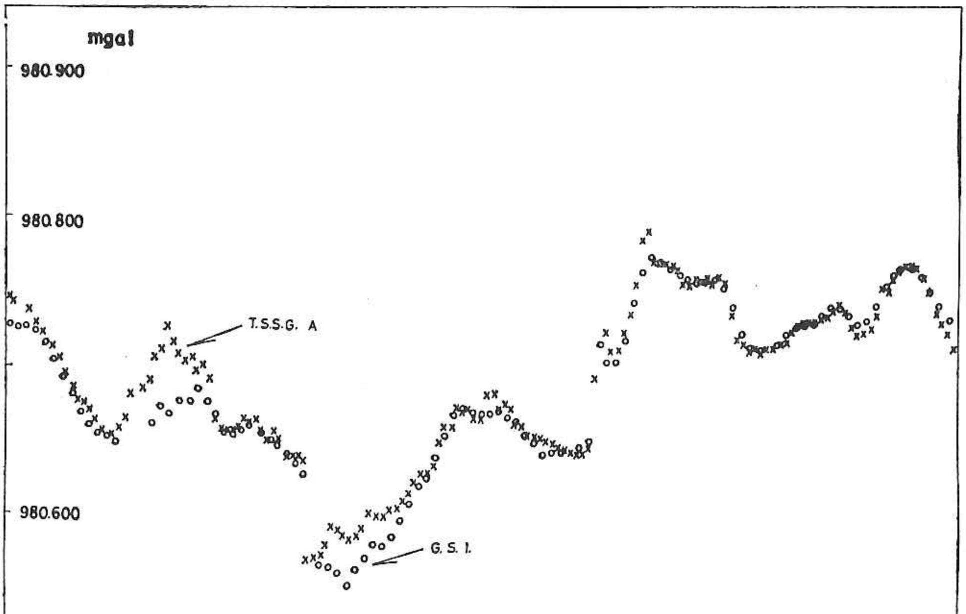


Fig. 6-6-3

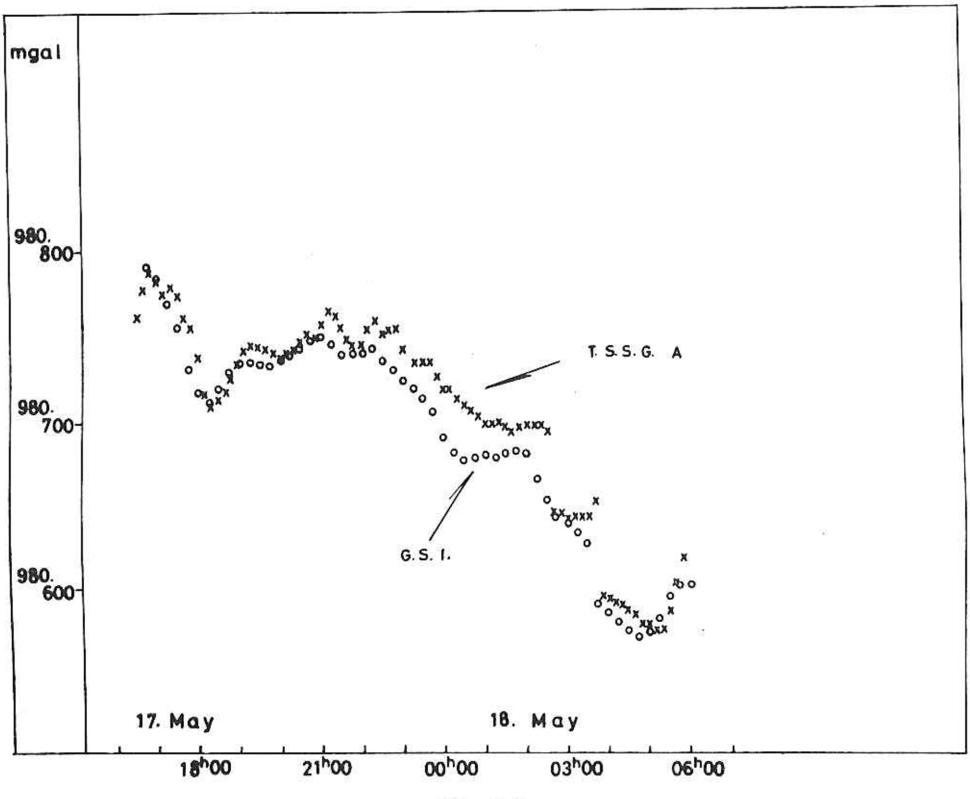

mgal
980.
800
980.
700
980.
600
T. S.S. G. A
G. S. I.
17. May
18. May
18h00
21h00
00h00
03h00
06h00

Fig. 6-7

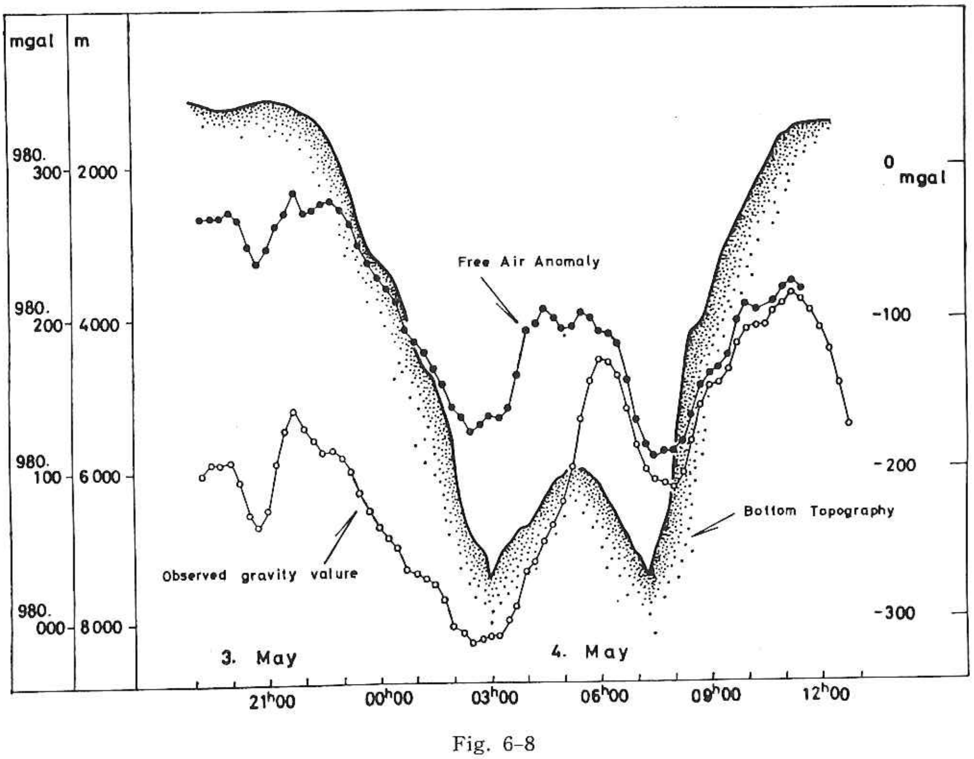

mgal
m
980.
300
2000
980.
200
4000
980.
100
6000
980.
000
8000
0
mgal
-100
-200
-300
Free Air Anomaly
Bottom Topography
Observed gravity value
3. May
4. May
21h00
00h00
03h00
06h00
09h00
12h00

Fig. 6-8

7. Topography

7-1. Notes on the topography of the Japan Trench and the adjacency

Ryuichi Tsuchi

Topography cross sections of the Japan Trench and the adjacency and the locations of traverses obtained from the cruise are shown in Fig. 7-1-1 and 7-1-2. These profiles were drawn along the ship tracks and traced from echograms of Precise Depth Recorder. The depths shown in Fig. 7-1-2 are uncorrected records directly read from echograms. Locations of the ship were determined by Loran or Radar in every half hours and also at every positions of the course change.

7-1-1. Continental side of the trench

Flat terrace-like features, "deep sea terraces (TAYAMA, 1950)" or Japanese Pacific sea shelf (NASU, 1964), are observed on the continental slope. As most of our profiles do not extend to the continental shelf, the writer could not attempt a topographic division of the whole continental slope. Among them, however, a "terrace" extending in the depth of 2000—2900 m is remarkable on the section B—B′ off Sioyasaki. The outer limit of the "terrace" marks a notable change in slope of the sea floor. As to the steep slope below that point we may call it the trench slope. "Terraces" correlatable with the above-mentioned one are more or less found in most sections, and the outer edges of them are located in the depth of 2600—3400 m. In the section G—G′, however, these scarcely develops the corresponding "terrace", but a slope break can be recognized at the depth of 3200 m.

On the trench slope, two sets of benches of hilly configuration, upper and lower ones, are found in general. Considering the origin of these features, it is probable that many of them are due not to abrasions but to faults.

Fig. 7-1-3 and 7-1-4 show an attempt of the topographic division of a part of the continental slope and inclinations of slopes in each section. Depths of main topographic features on the continental side of the trench in each section are shown in Fig. 7-1-4. Those of the deepest spot of the trench and the adjacent ocean floor are also given. As indicated by the Fig. 7-1-4, it is noticeable that the vertical arrangement of locations of these features seems to be changed laterally in parallel.

7-1-2. Ocean side of the trench

Remarkable topographic features found in the ocean side of the trench are small depressions suggesting grabens as refered by LUDWIG et al. (1966). According to records of sections F—F′, G—G′ and H—H′, one of these "grabens" is found continuously in 3 sections being parallel with the trench axis and having the length of 8 km at least, though others are not continuous. Generally speaking, "grabens" have following features in cross sections; i.e., trench-side slopes, or fault planes, are

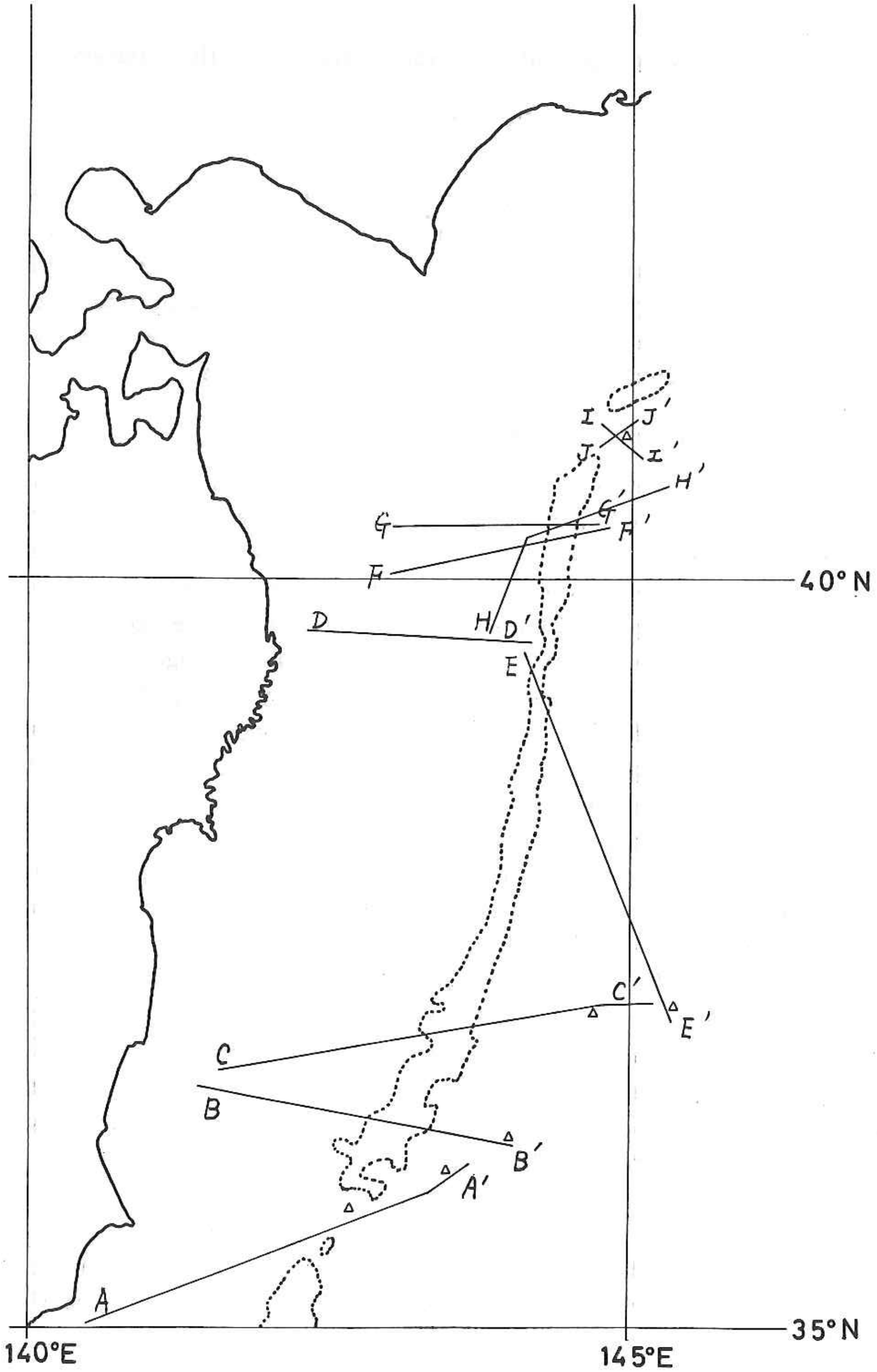


Fig. 7-1-1

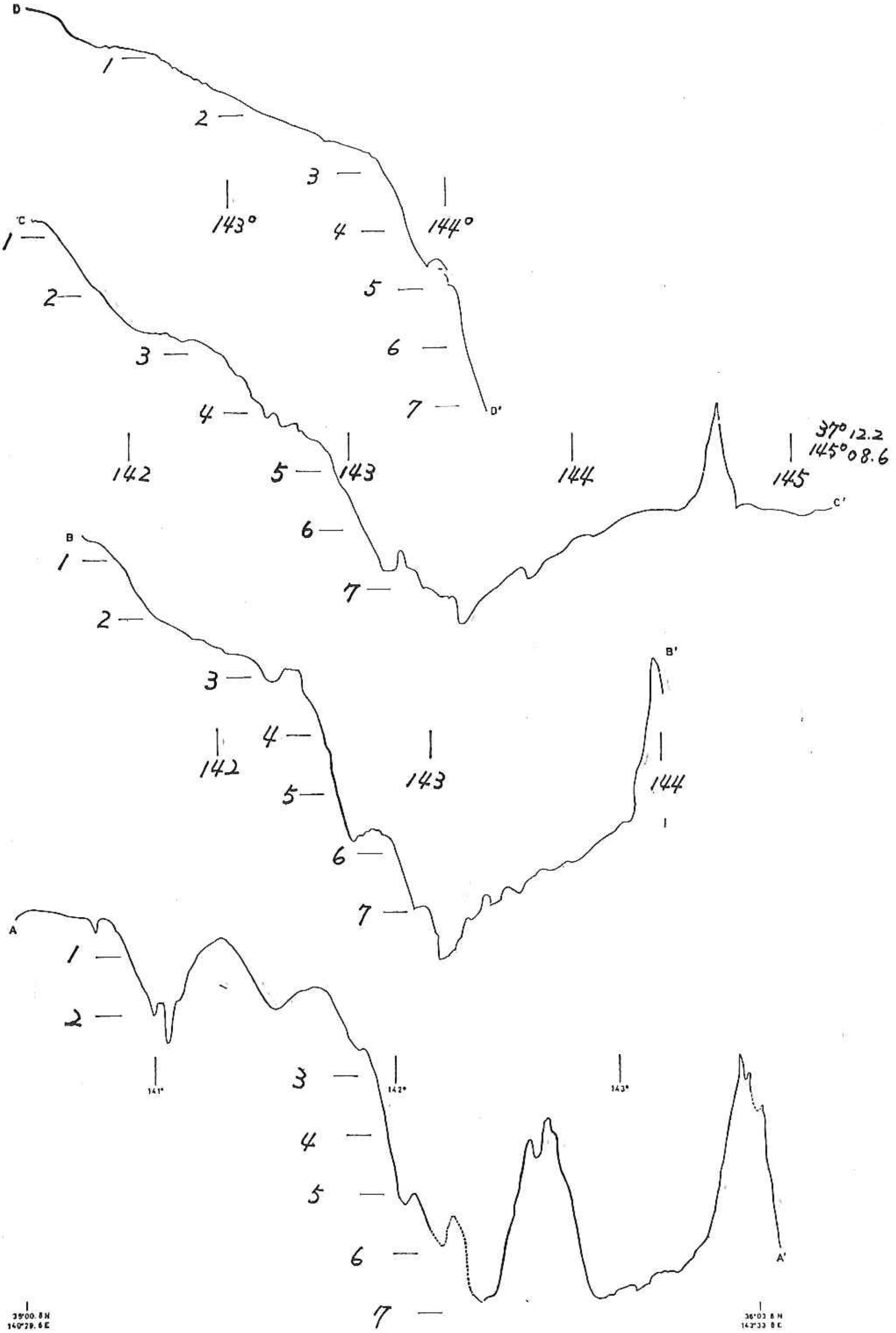
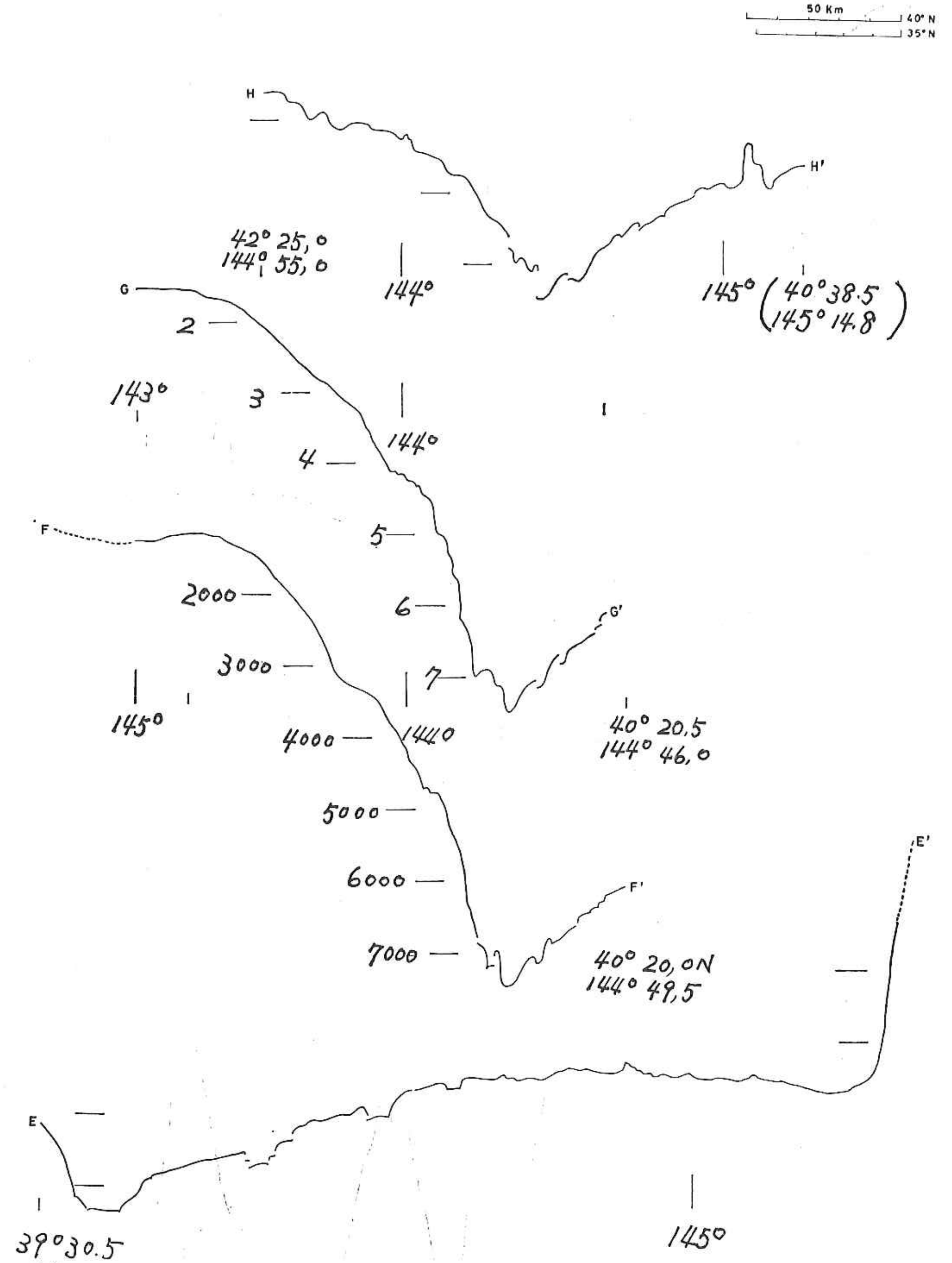

D
D'
143°
144°
C
C'
142
143
144
145
37° 12.2
145° 08.6
B
B'
142
143
144
A
A'
141°
142°
143°

Fig. 7-1-2-1



50 Km
40° N
35° N
H
H'
42° 25,0
144° 55,0
144°
145°
(40°38.5
145° 14.8)
G
G'
2
3
4
5
6
7
143°
144°
40° 20.5
144° 46.0
F
F'
2000
3000
4000
5000
6000
7000
145°
144°
40° 20,0N
144° 49,5
E
E'
39°30.5
144° 07.2
145°

Fig. 7-1-2-2

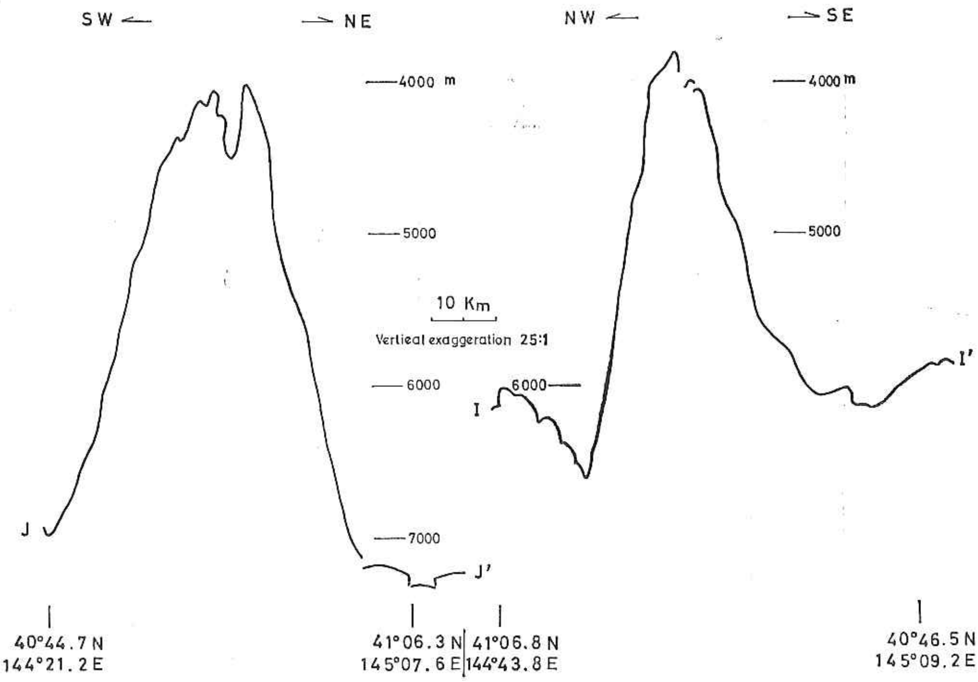


Fig. 7-1-2-3

Section (↑ S … ↓ N) \ Depth (km) 0–8	Upper-slope values	Lower-slope values	Main slope	Oceanic side
B - B'	27	52, 17	96	38
C - C'	43	58, 13	63	37
D - E'	19	11, 50, 13, 18	86	36
F - F'	47	53, 22	99	41
G - G'		6, 35	89	44

Fig. 7-1-3

Inclinations of slopes on the continental side in each section, in 0/00. Those of oceanic side slopes, from the axis of the trench to 30 km distant, are also given in the right side. The section A—A' is omitted for its oblique traverse.

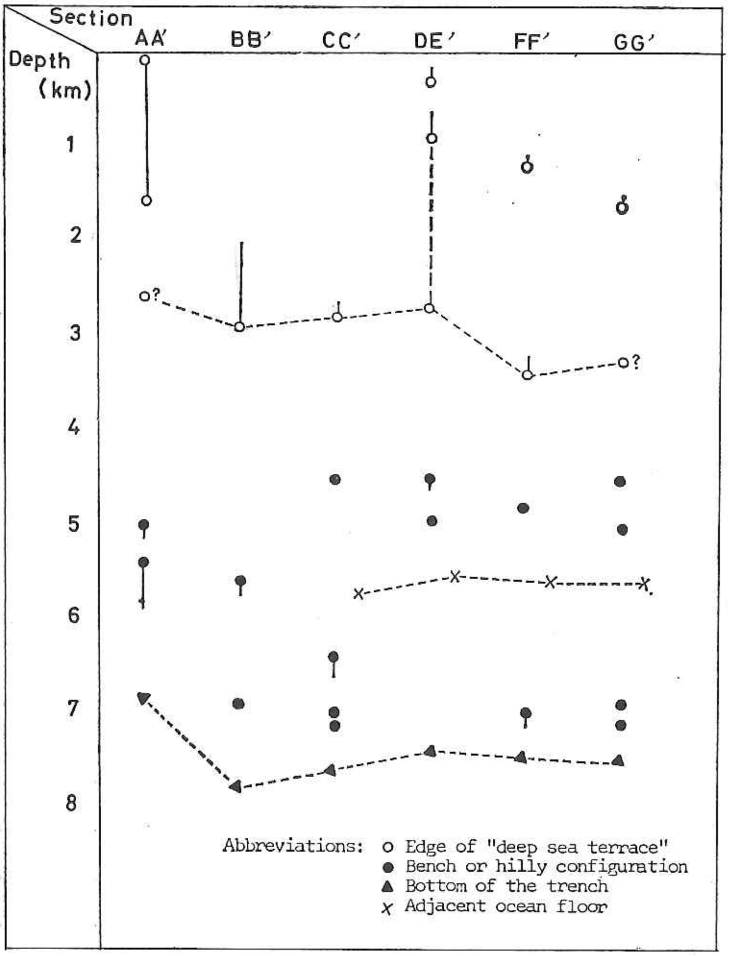


Fig. 7-1-4

Depths of "deep sea terraces" and benches or hilly configurations in each section on the continental side of the trench. Those of the deepest spot of the trench and the adjacent ocean floor are also given. The section AA′ may be unsuitable for the correlation because of its oblique traverse.

steeper than other-side ones, and bottom planes are more or less inclined to the trench being parallel with the adjacent ocean floor. As clearly shown in the section E—E′, there are 3 typical depressions of graben type on the marginal ocean floor, the farthest one of which is located in 60 km distant from the trench axis, and the scale of "grabens" looks like become small as goes far from the trench. The nearest and also the largest one has the width of about 3 km and its vertical dislocation with 2 or 3 step faults is measured about 200 m.

7-1-3. Seamounts

Six seamounts traversed during the cruise are as follows:

Name	Depth of the peak reported	Shallowest point traversed	Cross section	Date and location of the shallowest point traversed		Depth of adjacent ocean floor	Height from ocean floor
Kashima I	3600	3710	AA′	04 : 46 Apr. 27. 69	35°45. 4N 142°41. 3E	6750	3150
Kashima II	2662	2650	AA′	07 : 40 Apr. 27. 69	36°01. 1N 143°29. 2E	6300	3650
(Unnamed)	3530	2730	BB′	06 : 17 Apr. 28. 69	36°17. 1N 143°29. 2E	5500	2770
〃	3710	3900	CC′	04 : 22 Apr. 30. 69	37°10. 2N 144°39. 0E	5700	1990
〃	3310	2200	EE′	13 : 26 Apr. 30. 69	37°08. 0N 145°18. 9E	5700	3500
Sysoev (Erimo)	3735	3790	II′JJ′	17 : 00 May 07. 69	40°55. 6N 144°52. 4E	6100	2365

A periferal depression was recognized in the environ of the unnamed seamount 2200, the extension of which attains to 120 km and the depth is measured about 300 m in maximum. A few series of cuesta topography suggesting tilted block inclined to the seamount-side can be found in the depression as shown in the section E—E′.

As to the seamount Sysoev, it has been reported that the seamount may be a guyot because of a discovery of reefy limestone with Cretaceous Nerineid gastropods from the vicinity of the peak (TSUCHI and KAGAMI, 1963). During the cruise, some grid surveys and a dredging were made. By the dredging, basaltic rocks and tuff breccia were collected at 4200 m deep on the northwest side of the peak though more of limestone was obtained. A tentative bathymetric map and cross sections are shown in Figs. 7-1-5 and 7-1-6. As seen in the figures, present topography of the seamount has a ridge of the NE—SW trend with a gentle slope on the northwest side, and small benches or notches are fringing at the depth of about 4000 m. The bathymetric survey discloses, at present, that the seamount might be not a typical type of guyot but a submarine valcano with drowned fringing reefs.

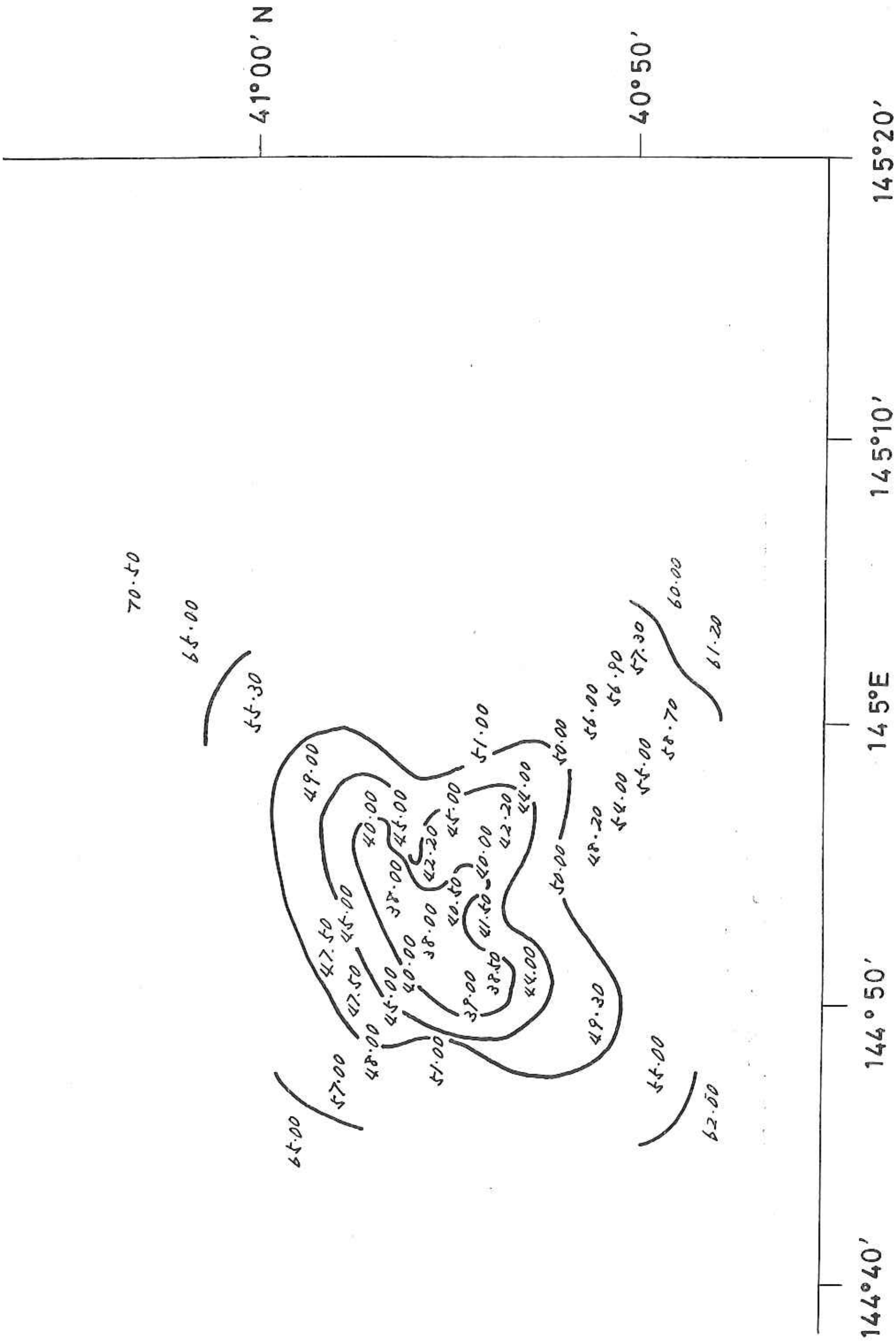


Fig. 7-1-5

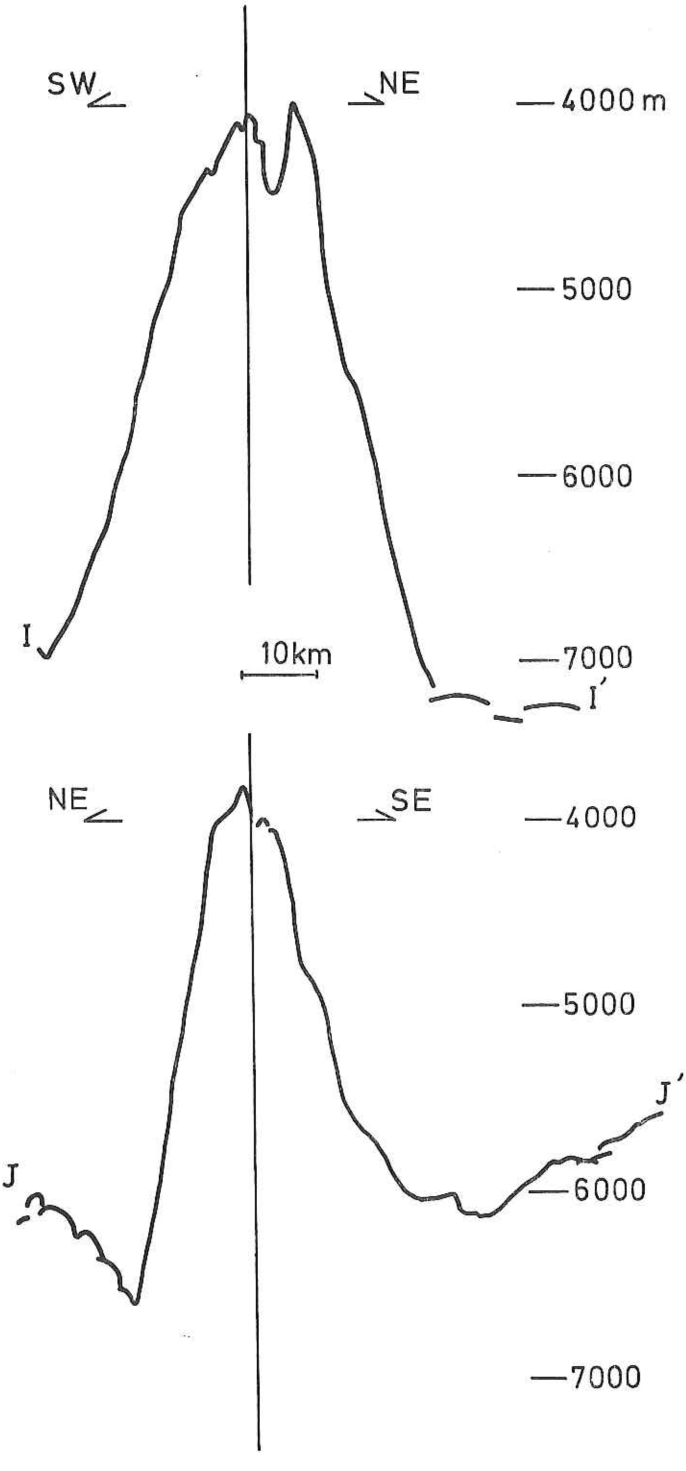


Fig. 7-1-6

7-2. Outline of submarine topography of KH-69-2 cruise from Otaru to Toyama

Shoji Fujii, Naoshi Kuroda, Masao Inoue, Victor F. Kanaev
and Noriyuki Nasu

This report is based on 1000 m and 6000 m depth range by precision depth recorder. The correction of the water depth for water temperature is not yet done.

In this cruise the track of Hakuho Maru is shown in Fig. 1. The Submarine topography is described as following six units; 1) continental shelves, 2) marginal plateau and continental slope, 3) bank, 4) seamount, 5) trough and 6) deep sea basin.

1) Continental shelves

We crossed the continental shelf at next five places. Critical point, terraces on them etc. are shown in Table 7-2-1.

Table 7-2-1

	Locality	Critical point (m)	Distance from land to critical point (km)	Terraces on continental shelf (m)	Successive topography
1.	off Otaru	110		50, 75	continental plateau
2.	off Niigata	130 150	> 76.8 ~769	depression	continental plateau
3.	off Maizuru	130	> 58 ~769.5	60—70 100	continental plateau
4.	off Toyama		5		continental slope
5.	off Nakhodka	150	> 31	65	continental slope

2) Marginal plateau and continental slope

Continental borderland is very complicated around Japanese Islands and usually there are about 150 m depth terraces on that.

The marginal plateau is absent off Nakhodka. The inclination of the continental slope is 8.3/100—15/100 off Nakhodka. There are two terraces on them about 250, 350 and 300, 600 m in depth each other.

3) Bank and submarine ridge

In this cruise we crossed following 6 banks. The Yamato Ridge consists of Kita-Yamato Tai, Yamato Tai and Takuyo Tai. Their details are shown in Table 7-2-2.

4) Seamount

Table 7-2-2

Locality	Shallowest point (m)	Comparative depth (m)	Width (km) in some depth (m)	Terrace (m)
East end of Yamato Ridge		1450		
Kita-Yamato Tai	760	3000	67 km (760 m) 133 km (2000 m)	1100(N) 950(S)
Yamato Tai	1310		3 km (1310 m)	1500(S) 1850(N)(S)
Kita-Oki Tai	1070	1750	42.8 km(2500 m)	1300(N) 2350(S) 2650(S)
Oki Tai	430	1300 1900	47 km (1700 m)	920(N)
East-bank Utsuryo-island			16 km (1000 m) 8.4 km(2000 m)	1350(N) 1420(S)

It is difficult to distinguish between the seamount and the peak of bank. We crossed the several seamounts. But only the Bogorov seamounts are described here.

The shallowest depth is 2145 m. There are 2600 m deep terraces in both sides of the seamount. Those terraces seem to be wave-cut terraces. We got several gravels of basalt, quartz porphyry and mudstone from this seamount by dredge. This seamount may consist of basalt and mudstone. Age of mudstone may be Pliocene and Pleistocene by consolidating condition. The shape of a gravel of quartz porphyry is round or subround and it looks like the Nohi Rhyolite occurred in the middle part of Japan.

5) Trough

We crossed several troughs and their characteristics are shown in Table 7-2-3.

Table 7-2-3

Name	Deepest depth (m)	Comparative depth	Terrace	Width (km) in some depth (m)
Oki trough	1777	1350		30 km (1600 m)
Yamato trough	1217	800	650(N)(S) 850(N)(S)	80 km (500 m) 151.5 km(1000 m)
Trough between Kita-Yamato Tai and Yamato Tai	2120	1450	1950(S) 1000(N)	61 km (700 m) 20 km (2000 m) 31 km (1900 m) 51 km (1000 m) 13.5 km(2100 m)

The Mogami trough is not clear as we ran parallel along that.

The Toyama deep sea channel.

We crossed the Toyama deep sea channel at $18^{h}00^{m}$, 29th May.

Comparative depth: 210 m

The Width in 2440 m depth: 10.5 km

Slope: 13/100 in west side, 2.2/100 in east side

2440, 2770, 2500 and 2570 m in depth in east side

This deep-sea channel may be one of the structural lines, because there are large difference of character between east side and west side that channel.

6) Japan deep sea basin

We crossed the Japan sea basin four times and their characteristics are shown in Table 7-2-4.

Table 7-2-4

Locality of deepest point	Deepest depth (m)	Common depth (m)
00^h35^m—55^m 24th May	3705	3690
02^h50^m—03^h00^m 26th May	3705	3635, 3665, 3695
08^h30^m—45^m 30th May	3577	3555, 3570
	3508	3500

From this table we can recognize that the Japan deep sea basin is very flat and the north-eastern part is deeper than other part.

8. Continuous seismic reflection profiling with the air-gun

8-1. The seismic profiler investingation off the coast of north-east Japan (Tokyo—Kushiro)

Eiichi Honza, Hiroshi Hotta and Hideo Kagami

The continuous reflection profiling survey by an air-gun as sound source was carried out in the region of the continental slope off the east coast of Honshu and the south coast of Hokkaido and also along several tracks crossing the Japan and Kuril Trench. Positions of both the starts and the ends of tracks are presented in Table 8-1-1.

Table. 8-1-1. Position of start and end of the line, and condition of towing

Leg No.	Lat.	Long.	High Pressure (kg/cm²)	Filter (c/s)
1	36°21. 0N 36°32. 0	143°28. 9E 142°20. 9	105	37. 5—150 53 —212
2	36°20. 2 36°41. 1	143°33. 4 141°24. 2	103	37. 5—212 75 —300
3	36°46. 8 37°12. 8	141°34. 0 145°01. 0	103	53 —212 53 —300
4	37°24. 3 39°25. 7	145°07. 1 144°10. 3	101	37. 5—150 37. 5—300
5	39°34. 9 39°33. 6	142°58. 8 142°07. 8	100	53 —150 75 —212
6	49°09. 0 40°20. 0	143°24. 0 144°52. 0	135	53 —212 106 —212
7	40°46. 8 39°47. 3	143°03. 0 143°01. 9	145	106 —212
8	39°40. 2 39°37. 5	143°18. 0 143°42. 6	145	53 —212
9	40°44. 4 40°57. 8	145°14. 8 145°47. 0	136	106 —300
10	42°43. 0 40°37. 0	144°52. 2 145°18. 3	135	106 —300
11	41°34. 8 43°04. 6	145°33. 9 145°31. 2	135	106 —212

The reflection profiling tracks are shown in Figure 8-1-1 and in Figure 8-4-1. Ship's speed during the survey was changed from 8 to 13 knots according to weather condition and the water depth. The obtained records are shown in Figure 8-4-2.

There were troubles of towing conditions at the beginning of the survey. A heavy air hose which was made of rubber, coated with stainless steel net was used at the previous survey, but in this cruise the light one made of tefron coating was used.

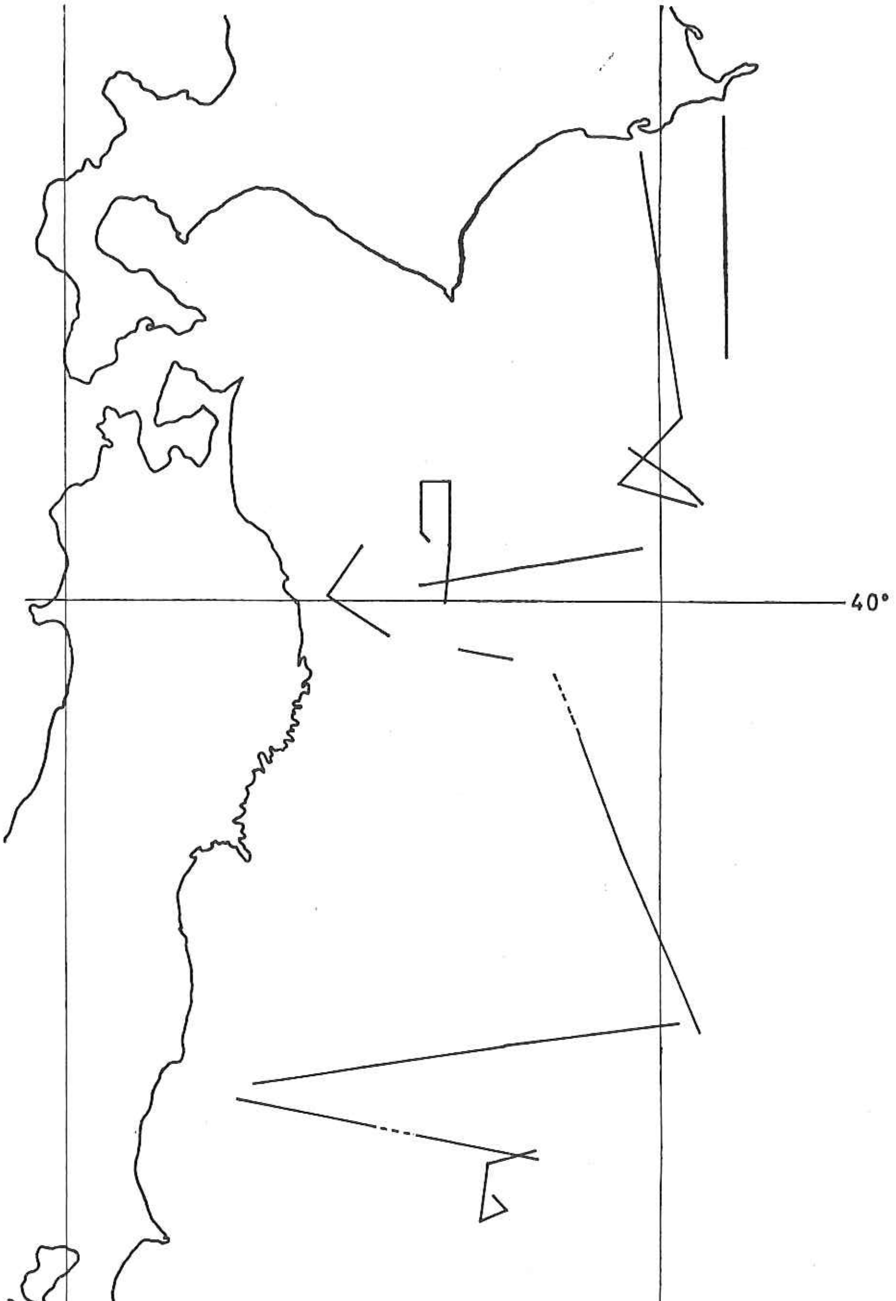


Fig. 8-1-1. Surveyed lines by air-gun

The light air hose makes gun float in the shallower depth comparing with the heavy one. Figure 8-1-2 shows the towing condition of the air-gun. The heavy hose may gradually sink apart from the ship, however the light one may be afloat at the middle part of the hose, hence the air-gun is in the shallow depth.

This trouble was solved by changing angle of horizontal wings of the gun-fish. It works well as a depresser with angle of about 1/15 (Fig. 8-1-3).

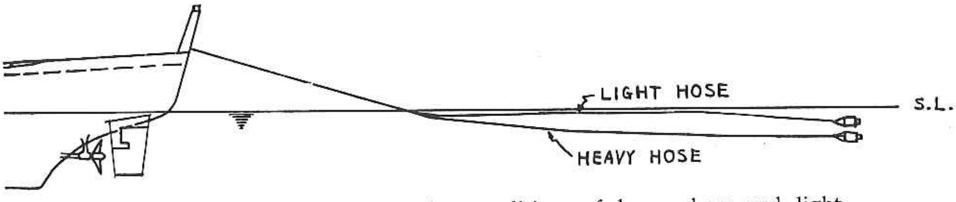


Fig. 8-1-2. Difference in towing conditions of heavy hose and light one. Comparing to the heavy hose, light one is afloat at the middle part.

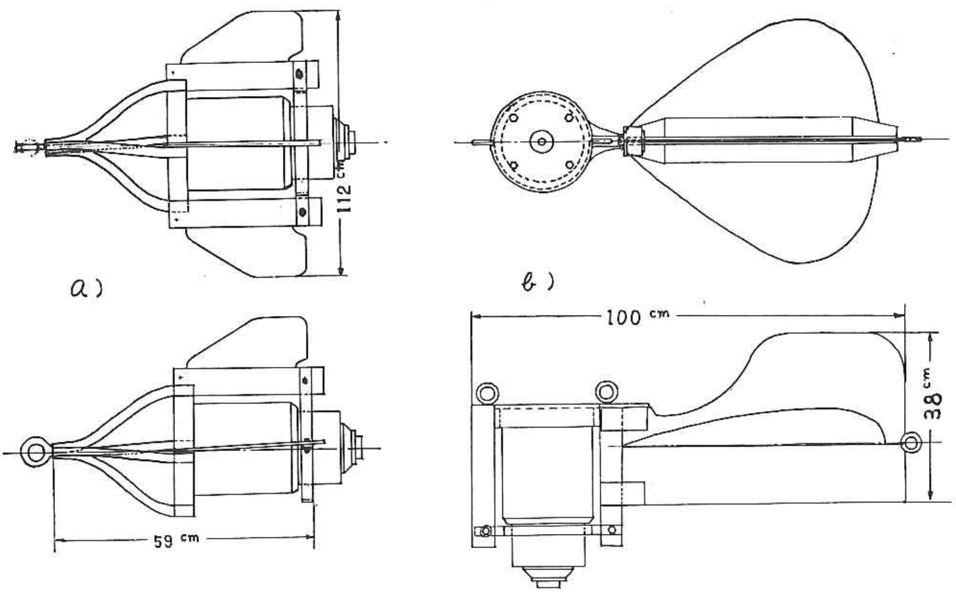


Fig. 8-1-3. Two types of gun-fishes
a) Lateral to sea level developed by Honza
b) Vertical to sea level developed by Lamont Observatory

Figure 8-1-4 shows a sketch of towing system of the sound source and hydrophone array. At first, the air-gun was towed from the center of the stern of the ship and then shifted 5.5 meters starboard from the center of the ship.

The hydrophone is very sensitive to foams produced by screw of ship. Therefore, it is necessary to keep hydrophone array apart from the ship. There are other noises which are produced by pitching of ship at the bow and by water shed of the hydrophone.

When hydrophone array was towed from the stern, the noise level increased ap-

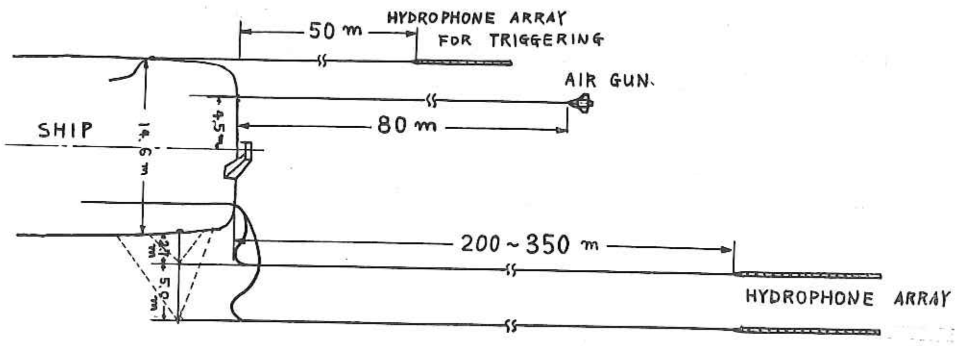


Fig. 8-1-4. Conditions of taking air-gun and hydrophone arrays in tow.

proximately by three times as compared with that observed as the hydrophone array towed from the ship's side.

Cable length of hydrophone was about 200 to 300 meters during the survey.

It was necessary to take another hydrophone in tow in order to receive the direct water wave from the air-gun when the cable length was more than about 200 meters. The trigger hydrophone was towed from the starboard side with the cable of 50 meters length.

8-2. The seismic profiler investigation in the Sea of Okhotsk and the northern part of the Sea of Japan (Kushiro—Otaru)

Hiroshi Hotta, Hideo Kagami, Masao Inoue and Chiaki Igarashi

The sea bottom topography and the thickness of sediments in the Sea of Okhotsk and the northern part of the Sea of Japan were investigated by the continuous seismic reflection profiling technique (seismic profiler) using an air gun. The survey was started from the Urup Strait and ended off near the Shakotan peninsula of the west coast of Hokkaido. The seismic profiler track in the neighbourhood of Hokkaido is appeared in Figure 8-2-1 and in Figure 8-4-1, in which small circles show the ship's position at every hour in the Japan Standard Time, and the solid line gives the range of measurements. The ship's speed during measurements was set in approximately 10 knots. There are comparatively long interruptions of measurements in the Soya Strait and in the Sea of Japan near the Vitiaz rise caused by troubles in the air-supplying devices, i.e., the second stage safety valve of the compressor and the pressure air to the pneumatic gun.

The pneumatic gun was towed astern in the distance of about 60 meters and operated at the air pressure of approximately 135 kg/cm^2 and the shot frequency of about one per 10 seconds. The hydrophone array system was towed generally in the distance of 350 meters, but sometimes 150 meters. In case of 350 meter-towing another hydrophone had to be towed to receive the direct sound generated by the gun.

Usually a filter with a frequency band between 150—300 Hz was used. At the be-

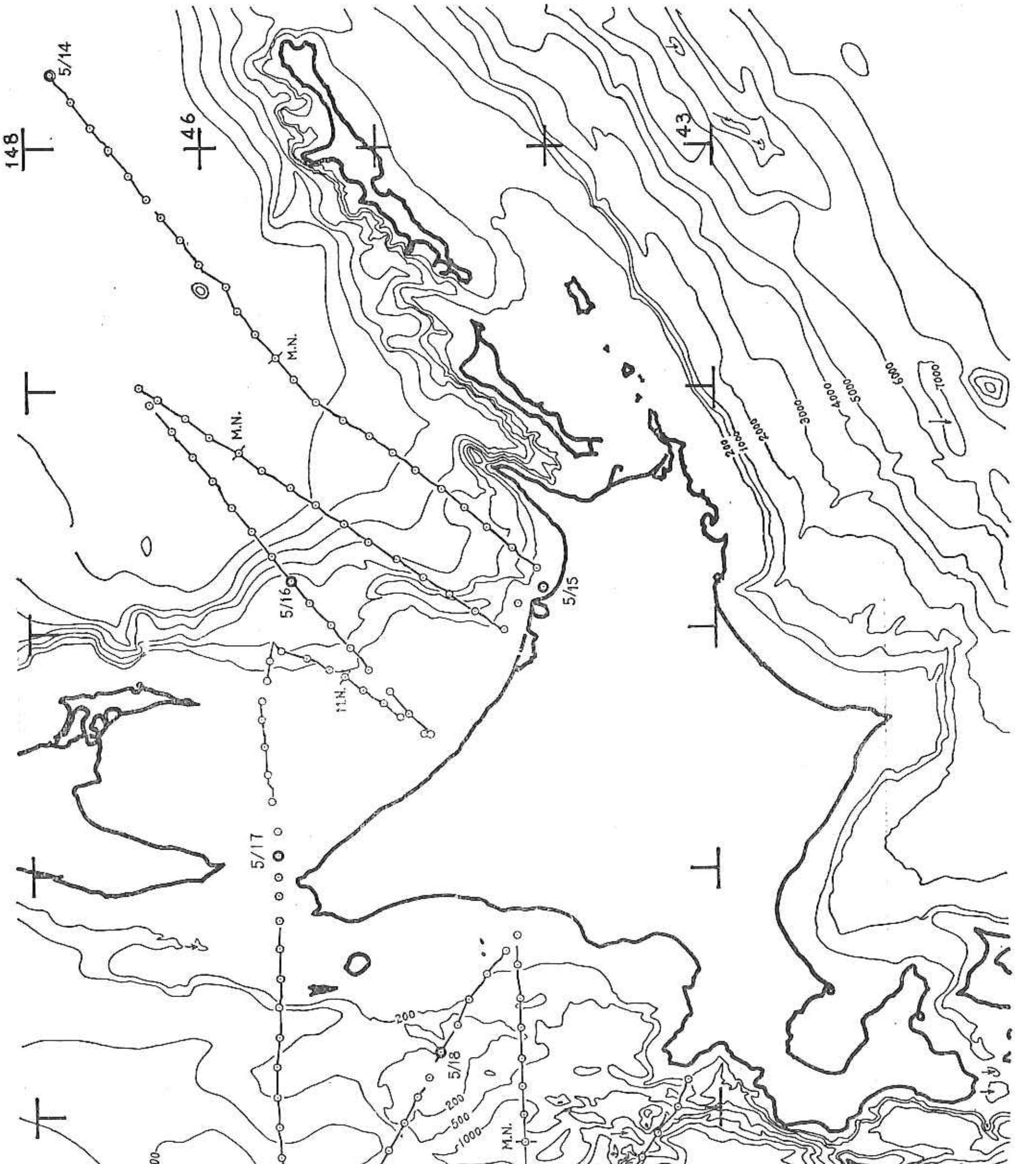

148
138
46
43
5/14
5/15
5/16
5/17
5/18
5/19
M.N.
200
500
1000
1500
2000
2500
3000
3500
4000
5000
6000
7000

Fig. 8-2-1

ginning of measurements the 106—212 Hz band was used, but was hardly free from the noise caused by the towed hydrophone system. The 150—300 Hz band was quite appropriate for the improvements of the S/N ratio in 10 knots navigation.

Examples of the records of profiles are exhibitted in Figure 8-4-2. Depths of the sea bottom and interfaces in the sediments are represented in the reflection time. The horizontal distance is shown in the ship's navigation time along the track.

8-3. Continuous seismic profiling survey in the Sea of Japan

Noriyuki Nasu, Nozomu Den, Shoji Fujii, Masao Inoue, Eiichi Honza, Chiaki Igarashi, Hirotaka Otobe, Victor Kanaev and Valery Zdorovenin

Continuous reflection profiling survey was also carried out in the Sea of Japan. The surveyed lines are shown in Fig. 8-3-1 and in Fig. 8-4-1. A brief topograpy is also presented in this Figure 8-3-1. The survey was done by an air-gun with high pres-

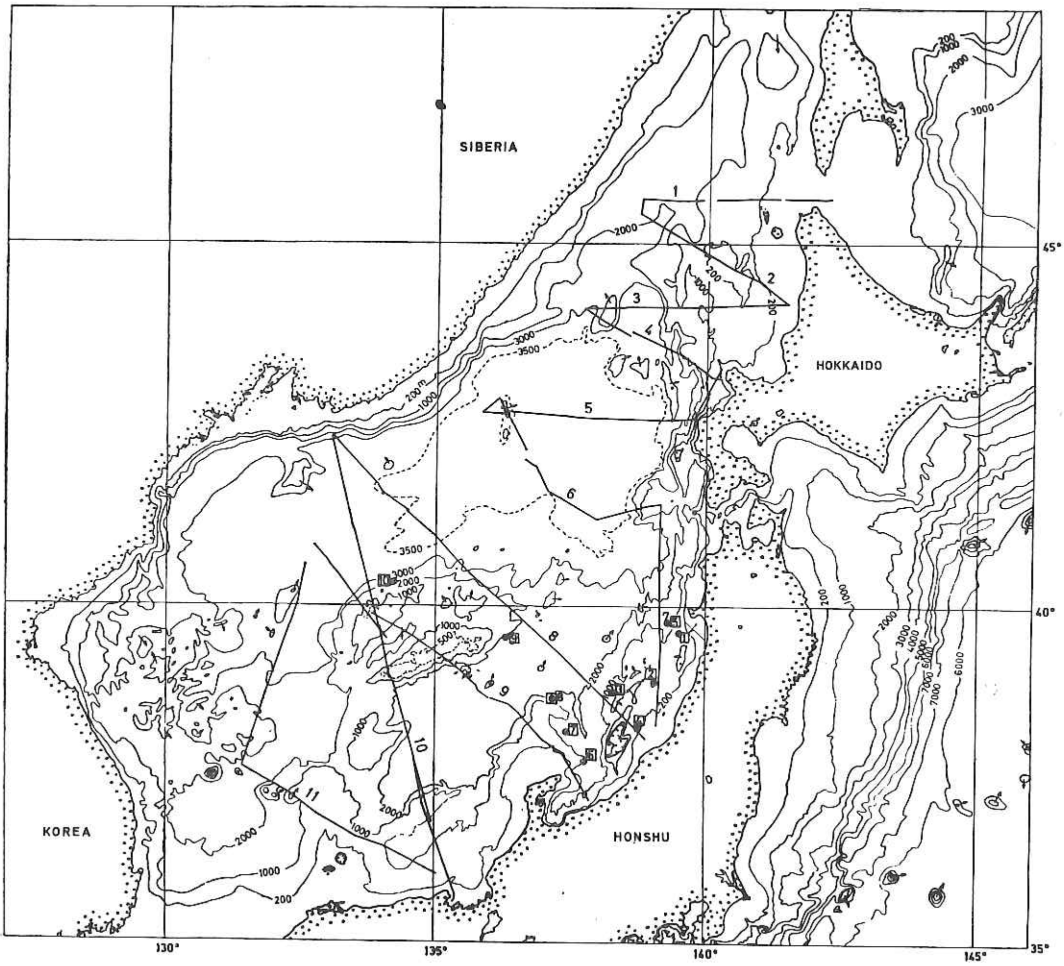


Fig. 8-3-1

sure of about 140 kg/cm^2. Filtering range of the sound was approximately between 150 and 300 cps. Profiling records are shown in Fig. 8-4-2.

Subsurface structure of the bottom of Sea of Japan seems to be divided into several layers by the results of air-gun survey. Those layers are a) upper opaque layer, b) upper transparent layer, c) lower opaque layer, d) lower transparent layer and e) basement successibly.

Topographically Sea of Japan is mainly divided into four provinces, namely, Japan Basin, Yamato Rise, Yamato Trough and marginal areas.

The upper opaque layer is widely distributed. At Japan Basin, it is thinly deposited towards Siberian coast and thickly deposited towards Japanese coast or towards Yamato Rise. This layer would be resulted by mass flows, namely turbidites mainly supplied from the Siberian coast, and partly from Japanese coast. On the other hand, at Yamato Trough, this layer is thickly deposited towards Yamato Rise and thinly deposited towards Japanese coast. The upper opaque layer deposited at Yamato Trough might be supplied mainly from Japanese coast.

The upper transparent layer is also widely distributed over Sea of Japan, and its thickness is fairly uniform overlaid on the topographic highs and lows. Therefore, this layer seems to be deposited rather uniformly prior to the tectonic deformation which caused the elevation of Yamato Rise and the formation of Japan Basin and Yamato Trough perhaps during upper Miocene or Pliocene. This layer would partly eroded at the topographic highs.

The distribution of lower two layers is rather limited in comparison with the wide distribution of upper two layers. Those lower layers are distributed in Japan Basin, Yamato Trough and on the continental slopes beneath the upper two layers off Japanese coast, at least.

8-4. Records of air-gun survey

Whole tracks are shown in Fig. 8-4-1. Records obtained by continuous air-gun survey are presented in Fig. 8-4-2, respectively from Kushiro (sec. 8-1), Kushiro to Otaru (sec. 8-2), and Otaru to Toyama (sec. 8-3).

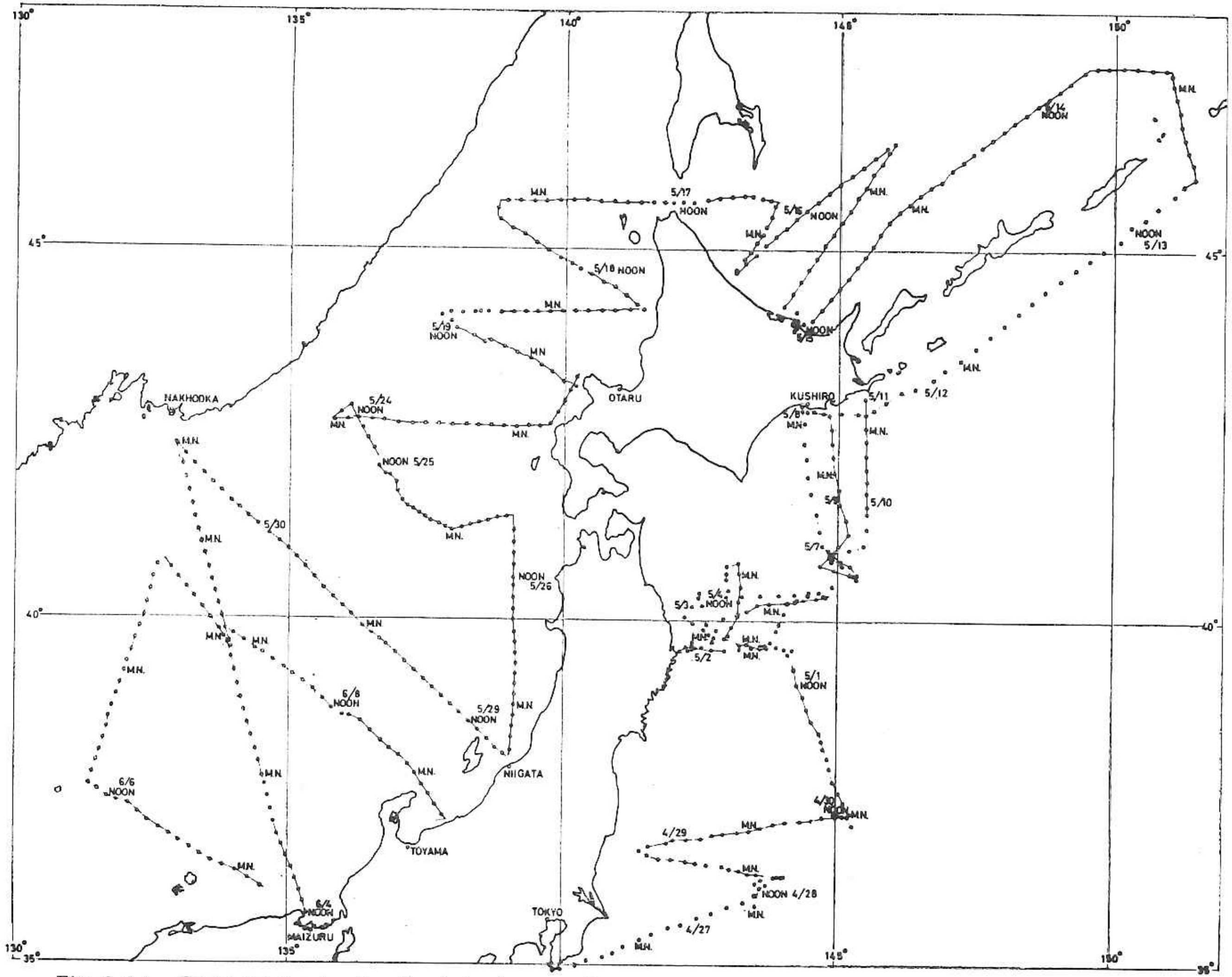


Fig. 8-4-1. Cruise tracks showing the date of survey for each track for the comparison with the obtained records

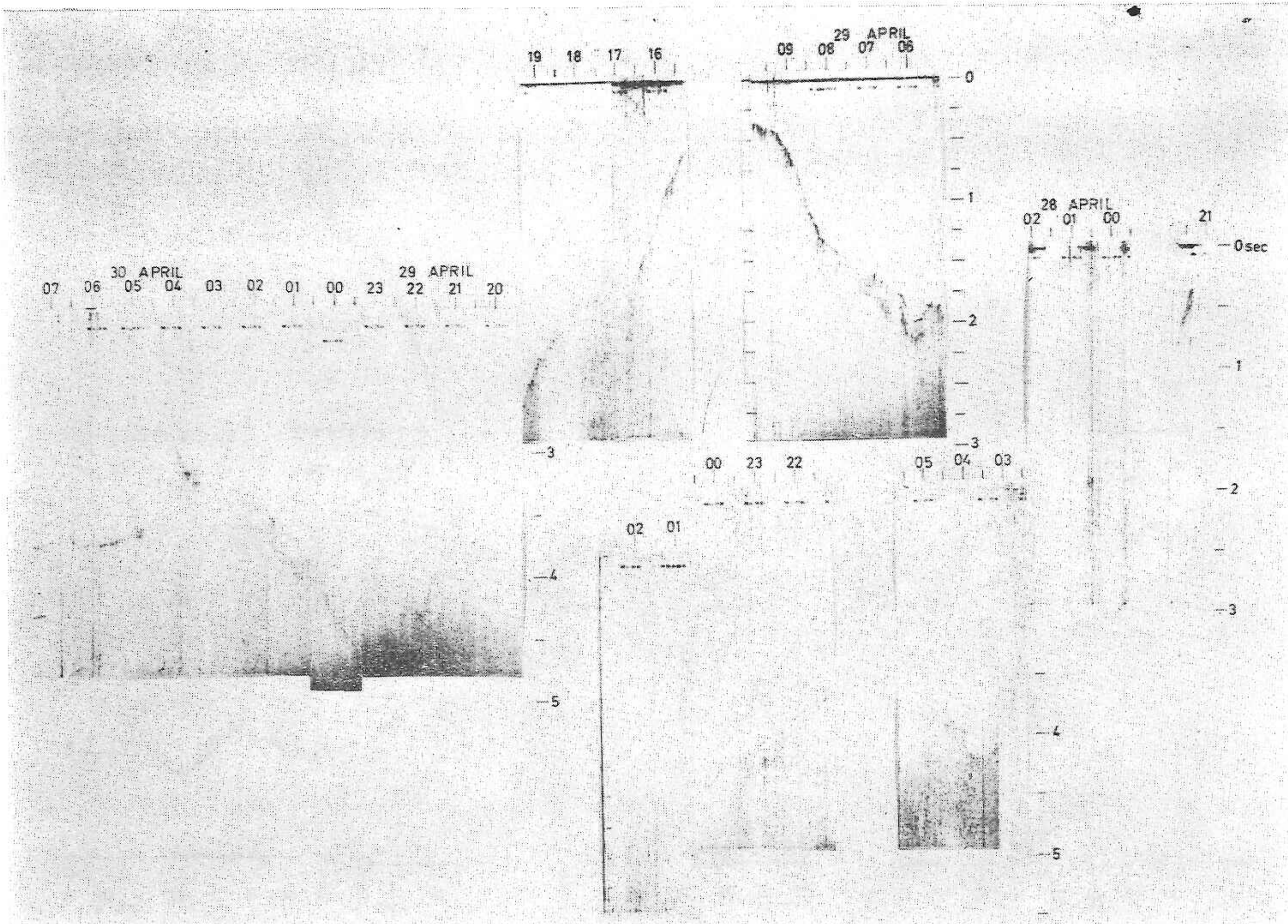


Fig. 8-4-2. Records of continuous profiling survey by air-gun in the vicinity of Japanese Islands (a)

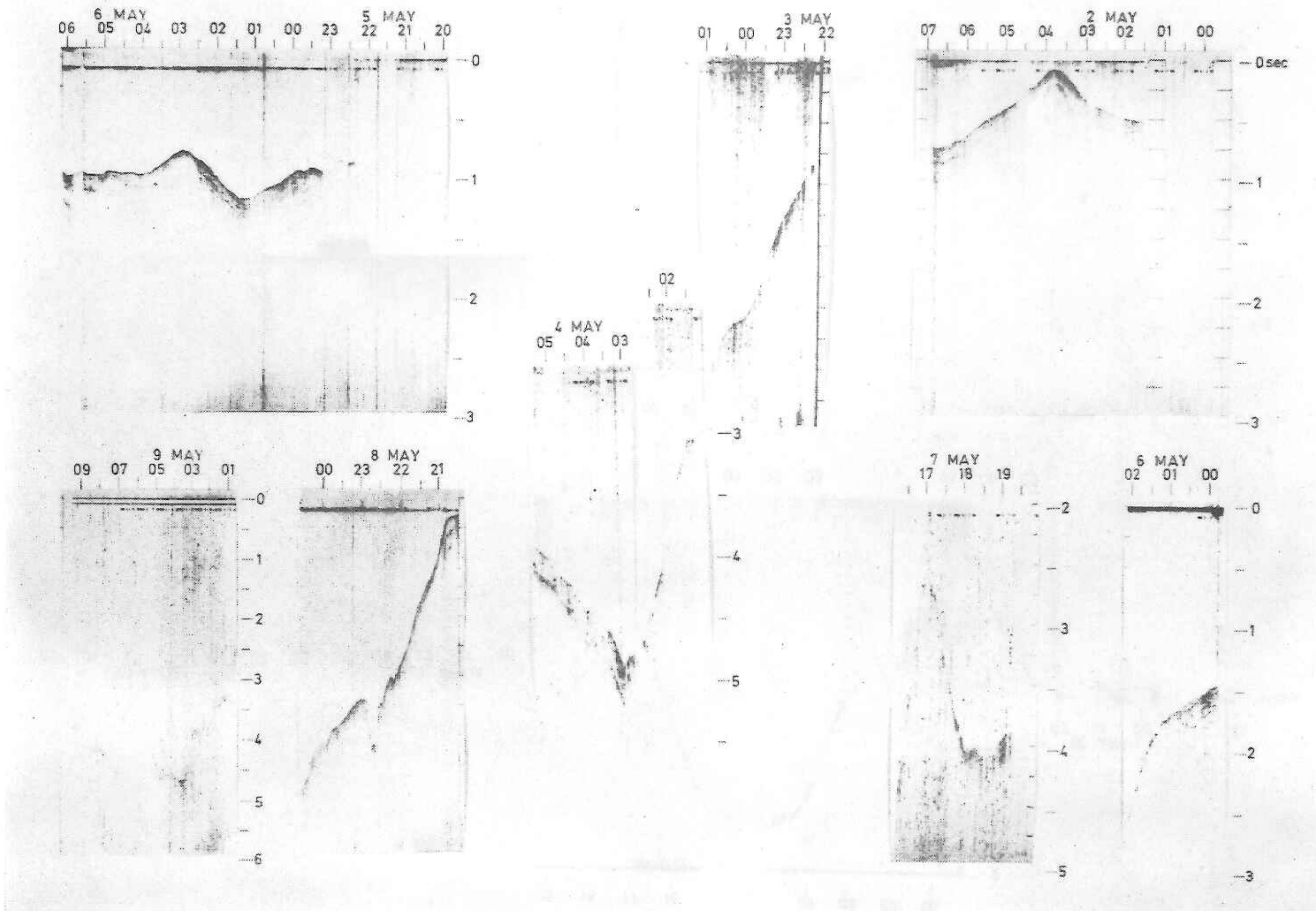


Fig. 8-4-2. (b)

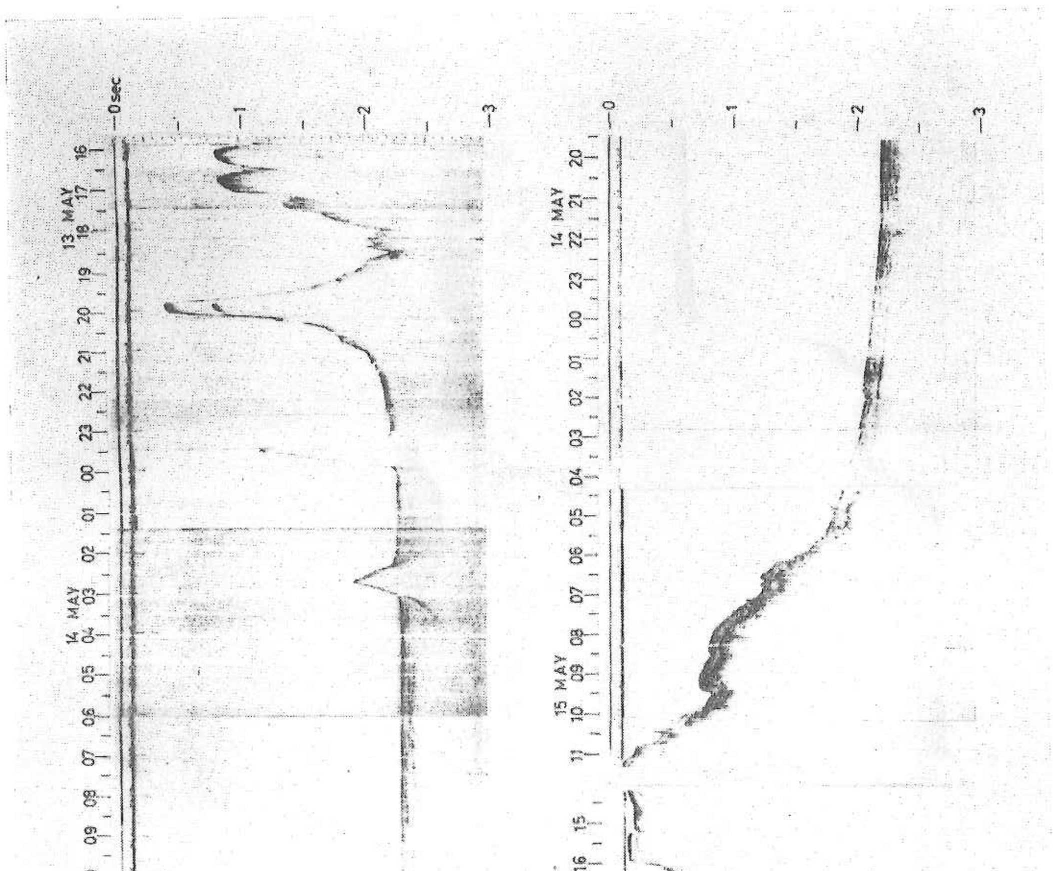


Fig. 8-4-2. (c)

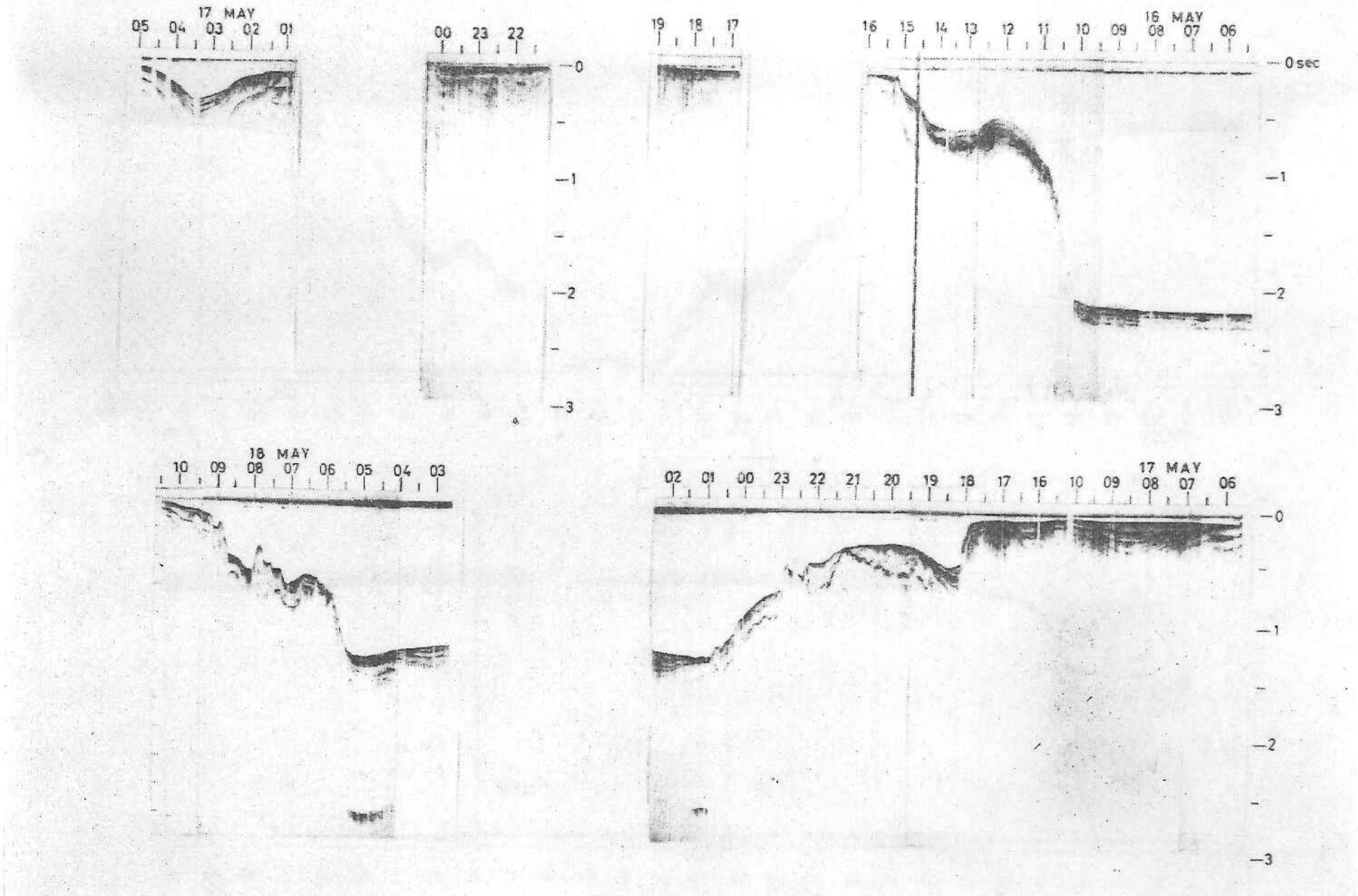

17 MAY
05 04 03 02 01
00 23 22
19 18 17
16 15 14 13 12 11 10 09 08 07 06
16 MAY
0 sec
-0
-1
-2
-3
18 MAY
10 09 08 07 06 05 04 03
17 MAY
02 01 00 23 22 21 20 19 18 17 16 10 09 08 07 06

Fig. 8-4-2. (d)

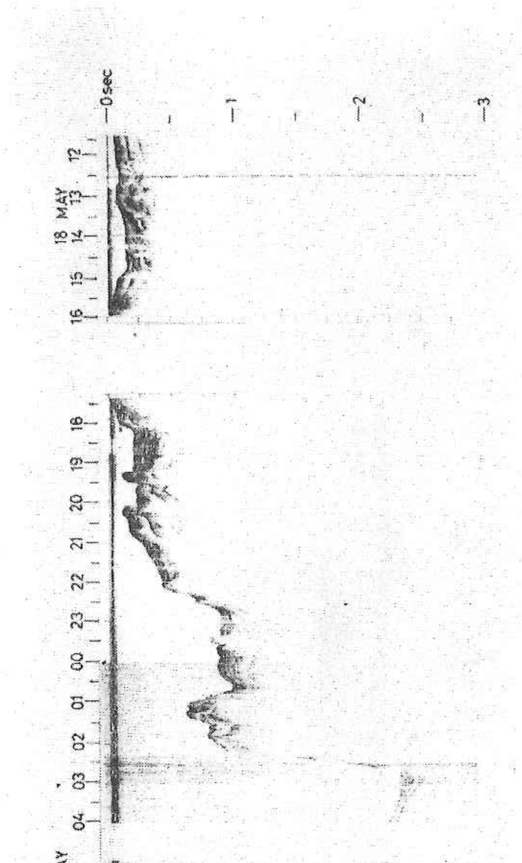


Fig. 8-4-2. (e)

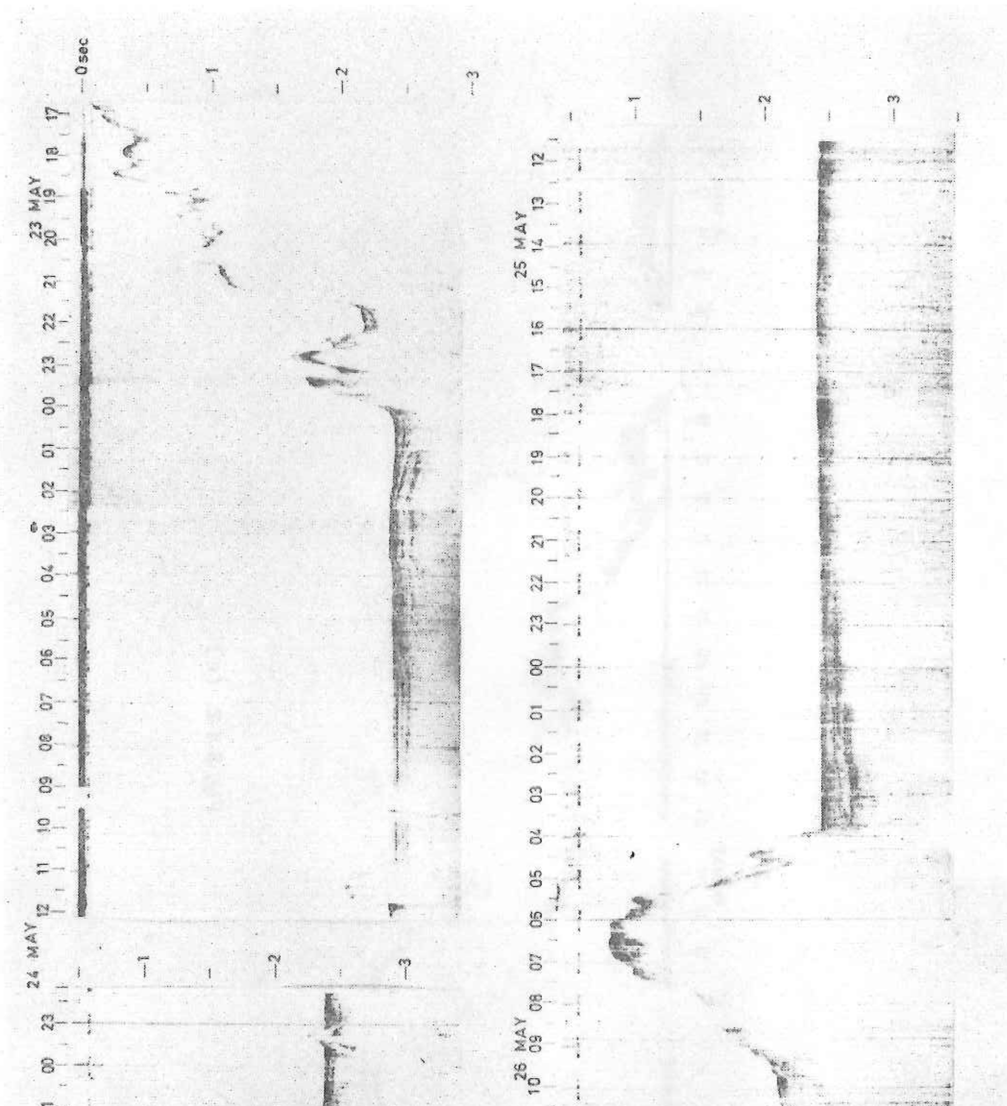


Fig. 8-4-2. (f)

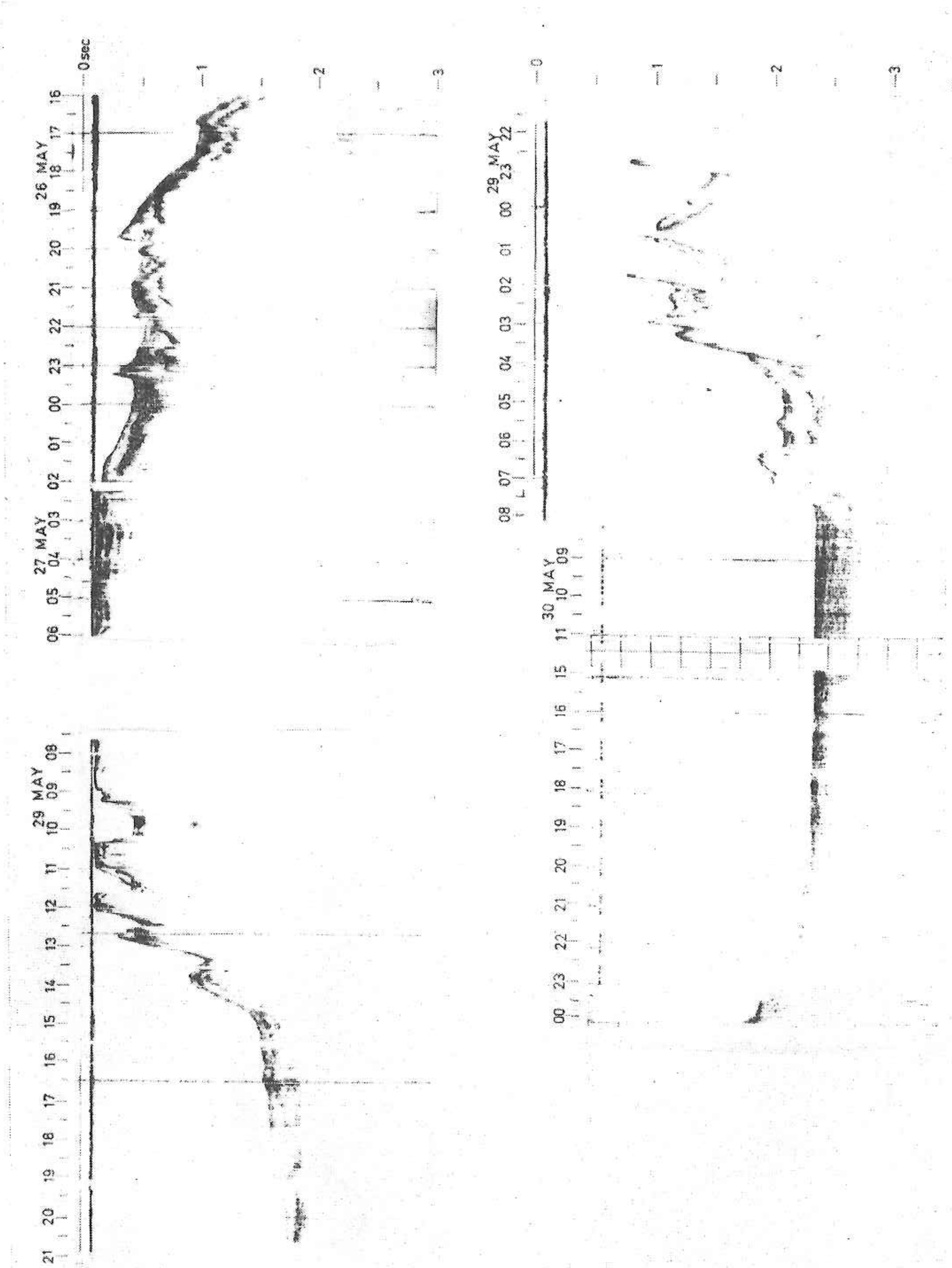


Fig. 8-4-2. (g)

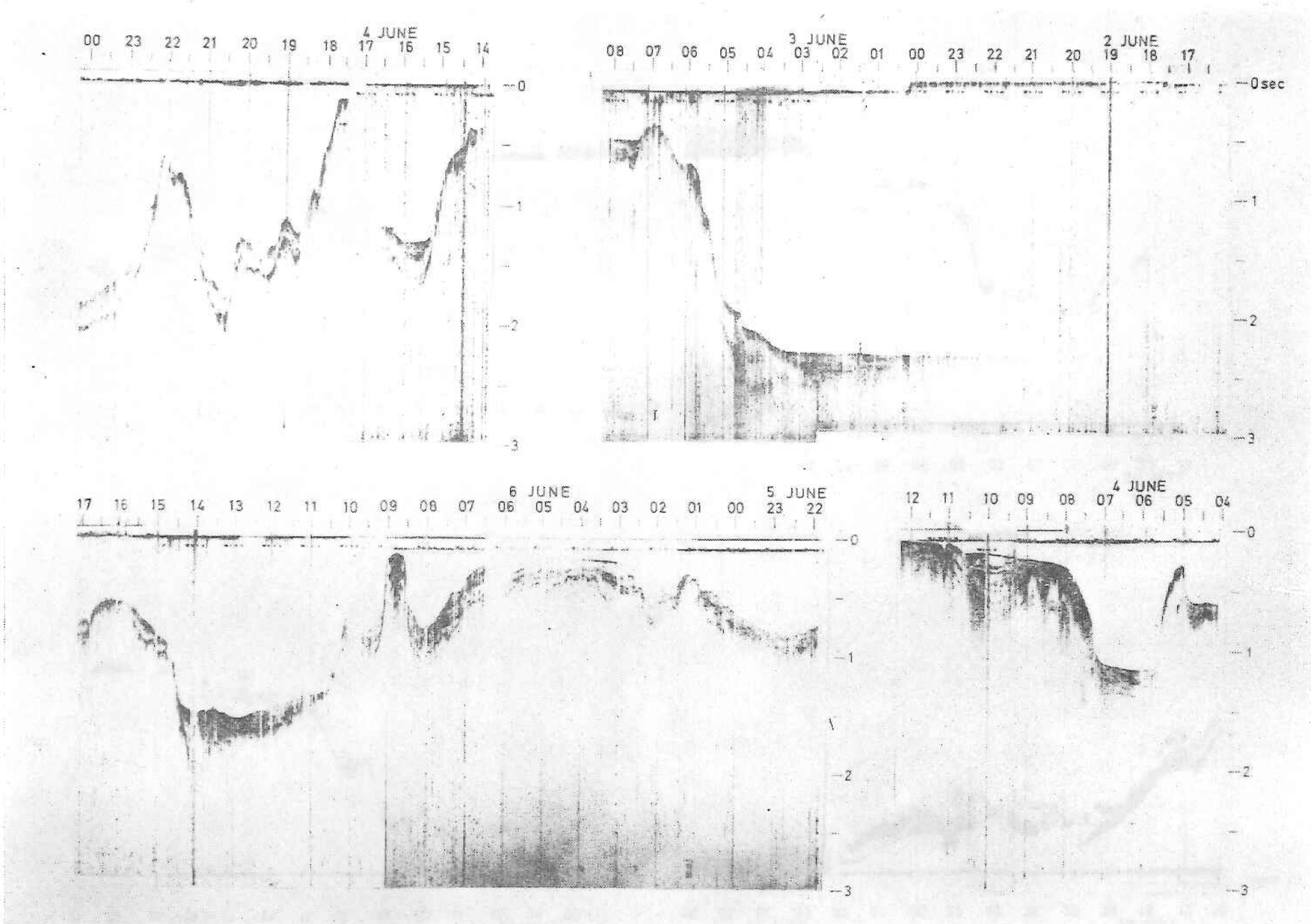

4 JUNE
00 23 22 21 20 19 18 17 16 15 14
3 JUNE
2 JUNE
08 07 06 05 04 03 02 01 00 23 22 21 20 19 18 17
0sec
1
2
3
6 JUNE
5 JUNE
17 16 15 14 13 12 11 10 09 08 07 06 05 04 03 02 01 00 23 22
4 JUNE
12 11 10 09 08 07 06 05 04

Fig. 8-4-2. (h)

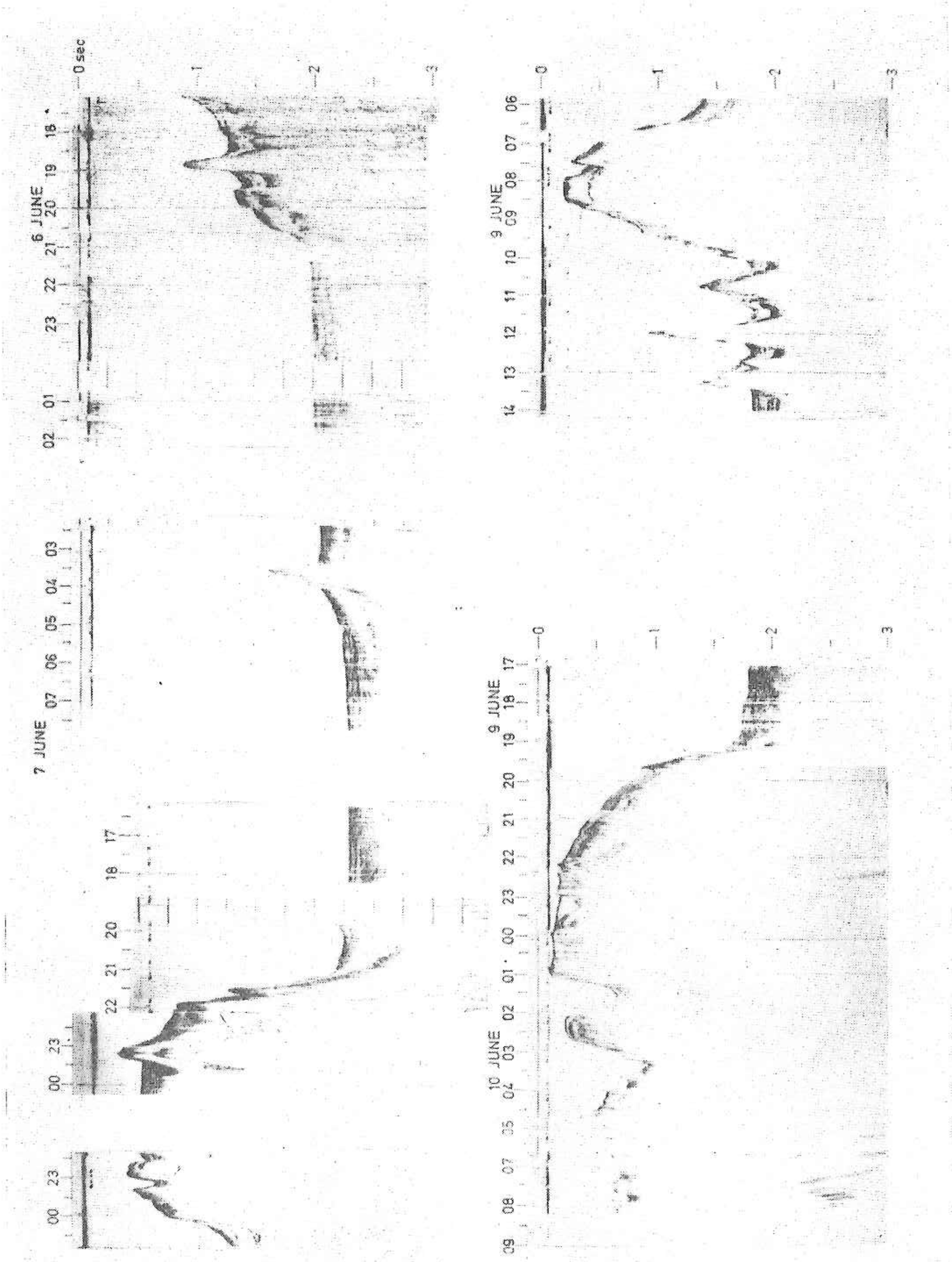


Fig. 8-4-2. (i)

9. Sampling of the bottom sediments by piston corers

9-1. Records of core logs

CORE LOG

Date April 30, '69 Ship Hakuho-maru Cruise KH-69-2 Station 4
Latitude 37°12.3′N Longitude 144°59.2′E
Location Pacific Basin east off the Japan Trench (southern end)
Sea slightly rough, low swell Weather rain Wind SSW 7.5 m/s
Bottom Topography flat bottom with slightly hilly areas between seamounts
Profiler hummocky structure
Ewing-type corer

Length Core Pipe	12 m	No. of Pipe 3	Material steel
I.D. of Pipe	mm	Wall Thickness	mm
Core Head Wt.	650 kg	Trigger Wt.	kg
Length Trigger Line	17 m	Length Main Line	m
Length Free Fall	3 m		
Time lowered	08 h 50 m;	Uncorrected Water Depth	5750 m
Time Hit	10 h 15 m;	Uncorrected Water Depth	5770 m
Wire Angle at Hit	8°	Wire-out at Hit	5825 m
Time Surfaced	11 h 23 m;	Uncorrected Water Depth	5770 m
Core Length	1046 cm		
Trigger Core Length	cm		

Method of Storage wrapped by vinyl sheets and packed in polyvinylchloride pipes
Length of Cores in Pipe 1. 119 cm, 2. 152 cm, 3. 190 cm, 4. 202 cm 5. 190 cm, 6. 193 cm
No. of Pipe Filled 6 (♯101–106)
No. of Cubic Samples for Paleomagnetism 404 (♯5000–5403)
Worked by H. Kagami et al.

Date May 19, '69 Ship Hakuho-maru Cruise KH-69-2 Station 20-1
Latitude 43°46.9′N Longitude 138°32.3′E
Location North Japan Sea (eastern flank of the Vitiaz Rise)
Sea calm, low swell Weather cloudy Wind W 4 m/sec
Bottom Topography flat
Profiler turbidite layer suspected?

Length Core Pipe	12 m	No. of Pipe 1	Material Al (Mg)
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	780 kg	Trigger Wt.	60 kg
Length Trigger Line	25 m	Length Main Line	23 m
Length Free Fall	10 m		
Time lowered	14 h 24 m;	Uncorrected Water Depth	3525 m
Time Hit	15 h 23 m;	Uncorrected Water Depth	3520 m
Wire Angle at Hit	5°	Wire-out at Hit	3499 m
Time Surfaced	16 h 45 m;	Uncorrected Water Depth	3520 m
Core Length	1191 cm		
Trigger Core Length	60 cm		

Method of Storage
Length of Cores in Pipe 1. 194 cm, 2. 192 cm, 3. 197 cm, 4. 187 cm, 5. 191 cm, 6. 187 cm, 7. 32 cm
No. of Pipe Filled 7 (♯107–113)
No. of Cubic Samples for Paleomagnetism 470 (♯5404–5873)
Worked by K. Kobayashi et al.

CORE LOG

Date May 25, '69 Ship Hakuho-maru Cruise KH-69-2 Station 22
Latitude 42°12.9′N Longitude 136°36.5′E
Location North Japan Sea
Sea slightly rough, moderate swell Weather cloudy to rain
Bottom Topography flat Wind E 10 m/sec
Profiler thick sediment detected

Length Core Pipe	12 m	No. of Pipe 1	Material Al (Mg)
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	780 kg	Trigger Wt.	60 kg
Length Trigger Line	25 m	Length Main Line	25 m
Length Free Fall	12 m		
Time lowered	07 h 30 m;	Uncorrected Water Depth	3650 m
Time Hit	08 h 48 m;	Uncorrected Water Depth	3650 m
Wire Angle at Hit	0~1°	Wire-out at Hit	3639 m
Time Surfaced	11 h 00 m;	Uncorrected Water Depth	3650 m

The pipe was bent as S-shape. 10° at 1 m from the top and 30° at 2 m from the bottom
Core Length 0 cm
Trigger Core Length ~5 cm (lost in part)
Sandy bottom suspected
Method of Storage
Length of Cores in Pipe
No. of Pipe Filled
No. of Cubic Samples for Paleomagnetism
Worked by K. Kobayashi et al.

Date May 30, '69 Ship Hakuho-maru Cruise KH-69-2 Station 23
Latitude 41°21.0′N Longitude 134°26.1′E
Location Central Japan Sea (northwest of the Yamato Tai)
Sea calm, no swell Weather cloudy, sometimes rain
Bottom Topography flat Wind NW 8~9 m/sec
Profiler

Length Core Pipe	12 m	No. of Pipe 1	Material Al (Mg)
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	540 kg	Trigger Wt.	60 kg
Length Trigger Line	20 m	Length Main Line	20 m
Length Free Fall	7 m		
Time lowered	11 h 34 m;	Uncorrected Water Depth	3575 m
Time Hit	12 h 55 m;	Uncorrected Water Depth	3575 m
Wire Angle at Hit	2°	Wire-out at Hit	3525 m
Time Surfaced	14 h 05 m;	Uncorrected Water Depth	3575 m
Core Length	1047 cm		
Trigger Core Length	88.5 cm		

Method of Storage
Length of Cores in Pipe 1. 200 cm, 2. 186 cm, 3. 184 cm, 4. 181 cm, 5. 184 cm, 6. 99+13 cm
No. of Pipe Filled 6 (#114-119)
No. of Cubic Samples for Paleomagnetism 396 (#5900-6295)
Worked by K. Kobayashi et al.

CORE LOG

Date June 7, '69 Ship Hakuho-maru Cruise KH-69-2 Station 25-1
Latitude 40°52.0'N Longitude 132°39.0'E
Location Southwest Japan Sea
Sea
Bottom Topography flat
Profiler

Length Core Pipe	12 m	No. of Pipe 1	Material Al (Mg)
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	780 kg	Trigger Wt.	60 kg
Length Trigger Line	25 m	Length Main Line	25 m
Length Free Fall	12 m		
Time lowered	10 h 07 m;	Uncorrected Water Depth	3440 m
Time Hit	11 h 30 m;	Uncorrected Water Depth	3440 m
Wire Angle at Hit	3°	Wire-out at Hit	3387 m
Time Surfaced	12 h 00 m;	Uncorrected Water Depth	3440 m
Core Length	0 cm		
Trigger Core Length	28 cm		

Pipe was bent, cutting edge was crushed in one side.
Method of Storage
Length of Cores in Pipe
No. of Pipe Filled
No. of Cubic Samples for Paleomagnetism
Worked by K. Kobayashi et al.

Date June 7, '69 Ship Hakuho-maru Cruise KH-69-2 Station 25-2
Latitude 40°53.0'N Longitude 132°40.2'E
Location Southwest Japan Sea
Sea calm
Bottom Topography flat
Profiler

Length Core Pipe	12 m	No. of Pipe 1	Material Al (Mg)
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	540 kg	Trigger Wt.	60 kg
Length Trigger Line	20 m	Length Main Line	20 m
Length Free Fall	7 m		
Time lowered	13 h 01 m;	Uncorrected Water Depth	3440 m
Time Hit	14 h 14 m;	Uncorrected Water Depth	3390 m
Wire Angle at Hit	1°	Wire-out at Hit	3390 m
Time Surfaced	15 h 07 m;	Uncorrected Water Depth	3390 m
Core Length	1060 cm		
Trigger Core Length	26 cm		

Method of Storage
Length of Cores in Pipe 1. 184 cm, 2. 188 cm, 3. 160 cm, 4. 132 cm, 5. 192 cm, 6. 187 cm, 7. 17 cm
No. of Pipe Filled 7 (#120-126)
No. of Cubic Samples for Paleomagnetism 340 (#6300-6639)
Worked by K. Kobayashi et al.
Pipe bent at 6 m
Remark Flow-in of the sediment is suspected except approx. 400 cm of the top. The influence of the flow-in on the paleomagnetic intensity is being examined.

CORE LOG

Date June 9, '69 Ship Hakuho-maru Cruise KH-69-2 Station 26-1
Latitude 39°35.9′N Longitude 134°24.8′E
Location basin between the North and South Yamato Tai (Japan Sea)
Sea calm, no swell
Bottom Topography flat
Profiler
Gravity Corer

Length Core pipe	m	No. of Pipe 1 Material inner tube (polyvinylchloride)	
I.D. of Pipe	mm	Wall Thickness	mm
Core Head Wt.	kg	Trigger Wt. no trigger	
Length Trigger Line	m	Length Main Line	m
Length Free Fall	0 m	Speed at Hit 0.3 m/sec	
Time lowered	01 h 13 m	Uncorrected Water Depth	2100 m
Time Hit	02 h 12 m	Uncorrected Water Depth	2100 m
Wire Angle at Hit	3°	Wire-out at Hit	2120 m
Time Surfaced	h m;	Uncorrected Water Depth	2100 m
Core Length	100 cm		
Trigger Core Length	cm		

Method of Storage
Length of Cores in Pipe 1. 95+5 cm
No. of Pipe Filled 1 (♯127)
No. of Cubic Samples for Paleomagnetism 30 (♯6640–6669)
Worked by K. Kobayashi et al.

Date June 9, '69 Ship Hakuho-maru Cruise KH-69-2 Station 28
Latitude 38°39.0′N Longitude 136°03.1′E
Location basin between the South Yamato Tai and Honshū (Japan Sea)
Sea calm
Bottom Topography flat
Profiler

Length Core Pipe	6 m	No. of Pipe 1 Material Al (Mg)	
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	540 kg	Trigger Wt.	60 kg
Length Trigger Line	15 m	Length Main Line	15 m
Length Free Fall	8 m		
Time lowered	14 h 35 m;	Uncorrected Water Depth	2730 m
Time Hit	15 h 41 m;	Uncorrected Water Depth	2730 m
Wire Angle at Hit	0°	Wire-out at Hit	2684 m
Time Surfaced	16 h 24 m;	Uncorrected Water Depth	2730 m
Core Length	305 cm		
Trigger Core Length	71 cm		

Method of Storage
Length of Cores in Pipe 1. 164 cm, 2. 131+10 cm
No. of Pipe Filled 2 (♯128–129)
No. of Cubic Samples for Paleomagnetism 121 (♯6670–6790)
Worked by K. Kobayashi et al.

9-2. Columnar description of the core samples at Station 4

Kazuo Taguchi, Takeshi Sato and Masaharu Watanabe

Sampling by the piston corer was carried out at St. 4 as shown in Table 9-2-1.

The values of redox potential, Eh, which were measured at the several points of the core, showed about +70～+125 mV near the surface and −110～−130 mV at the lower parts.

The core samples taken were divided into these parts and preserved for the future studies of paleomagnetism, clay minerals and some organic analysis in laboratory.

Macroscopic observations on all cores obtained, then, were made and small pieces of samples cut off at intervals of about 10 centimeter were provided and the coarse fraction consisting of larger particles than 250 mesh size was separated from each piece sample by the water sieving. Subsequently the coarse fractions of samples were observed preliminarily under the stereoscopic and the polarizing microscopes.

Those results of observations are given briefly in Figure 9-2-1 and Table 9-2-2.

Table 9-2-1. Core Log

Date April 30, '69 Ship Hakuho-maru Cruise KH-69-2 Station 4

Latitude 37°12.3'N Longitude 144°59.2'E

Length Core Pipe 12 m No. of Pipe 3

Core Length 1046 cm

Method of Storage wrapped by vinyl sheets and contained in polyvinylchloride pipes.

No. of Pipe Filled 3

No. of Samples for Microscopic observation and Clay analysis 104

No. of Samples for Organic Analysis 16

Table 9-2-2. Description of coarse fraction (>250 mesh) samples under stereoscopic microscope
(observed by Masaharu Watanabe)

Number of samples	*Volcanic Glass **Vitric shard and pumice		*Light Minerals **Quartz and Feldspar		Heavy Minerals			*Organisms **Radiolaria, Diatom and others		Remarks and large pumice fragments (2—16 mm) P.F.
	*	** V.S≷P	*	** Qz≷Fel	Bi., Hb., Hy., Aug., Oliv., etc.		Magnetite, Ilmenite and other opaque Minerals	*	** Rd≷Dt	
1	D	<	C	<	R		R	C	>	
2	D	<	C	<	R	Hb Hy	R	C	>	fine
3	C	<	C	>	R		C	C	>	
4	D	<	C		R	Hy	C	R	>	P.F.
5	D	=	C		R	Hy Bi Hb	C	C	>	P.F.
6	D	<	C	>	R		C	R	>	fine
7	D	<	C	>	R		C	C	>	P.F.
8	D	<	C		R		C	R	>	P.F.
9	D	<	C		R	Hy	C	R		P.F.
10	D	<	C		R		C	R		P.F.
11	D	<	C	<	R	Hb Hy Glauconite?	C	R		
12	D	<	C	<	R	Hb Hy Glauconite?	C	C	>	P.F.
13	D	<	C		R	Hy	C	R		P.F.
14	D	≪	C		R	Hy	C	C	>	P.F.
15	D	<	C		R	Hy	C	C	>	P.F.
16	D	<	C		R	Hy Hb	R	R		P.F.
17	D	=	C		R	Hy Hb	R	C	>	
18	D	>	C	>	R	Hy Hb	R	R	>	
19	D	>	C		R		R	R	>	P.F.
20	D	<	C		R	Hy Hb Bi	R	C	>	P.F.
21	D	<	C		R	Hy	R	R	>	fine, P.F.
22	D	=	C		R	Hy Bi	R	C	=	limonite, P.F.
23	D	<	C		R	Hy Bi	C	C	>	P.F.
24	D	<	C		R	Hy Bi	C	C	>	fine, P.F.

25	D	=	C		R	Hy Bi	R	R	>	
26	D	=	C		R	Hy Bi	R	R	>	
27	D	≪	C		R	Hy Bi	R	R		
28	D	≪	C		R	Hy Bi Hb	R	R		
29	D	<	C		R	Hb Hy	R	C	>	
30	C	<	C		R	Hy	C	R		
31	D	<	C	>	R	Hy Bi	R	C	>	
32	D	≪	C		R	Hb	R	R		
33	D	<	C		R	Hy	C	C	>	
34	D	<	C		R	Hy	C	C	>	fine
35	D	<	C		R		C	C	>	fine
36	C	<	C	>	R	Hy	C	C	>	
37	D	≪	C		R	Hb Bi	R	R	>	
38	D	≪	C	>	R	Hy	C	R		
39	D	<	C		R	Hy Glauconite?	C	C	>	
40	C	<	C		R	Hy	C	R	>	
41	D	≪	C		R	Hy	C	R		P.F.
42	D	≪	C		R	Hy	C	R	>	
43	D	<	C	>	R	Hy Aug	C	R	>	
44	D	<	C		R	Hy Aug	C	R	>	
45	D	<	C		R	Hy	C	C	>	
46	D	<	C		R	Hy Hb	C	R	>	
47	D	<	C		R	Hy Bi	C	R	>	
48	D	<	C		R	Hy	C	C	>	
49	D	<	C		R	Hy Bi	C	R		fine
50	D	<	C	=	R	Hy	C	R		fine

Number of Samples	*Volcanic Glass **Vitric shard and pumice		*Light Minerals **Quartz and Feldspar		Heavy Minerals			*Organisms **Radiolaria, Diatom and others		Remarks and large pumice fragments (2—16 mm) P.F.
	*	** V.S≷P	*	** Qz≷Fel	Bi., Hb., Hy., Aug., Oliv., etc.		Magnetite, Ilmenite and other opaque Minerals	*	** Rd≷Dt	
51	D	$<$	D	$>$	R	Hy Bi	C	R	$>$	
52	D	$<$	C		R	Hy Bi	C	C	$>$	
53	D	$<$	C		R	Hy	C	C	$>$	
54	D	$<$	C		R	Hy	C	C	$>$	
55	D	$\ll$	C		R	Hy	C	R	$>$	
56	D	$=$	C		R	Hy Glauconite?	R	C	$>$	
57	D	$=$	C		R		C	R		
58	D	$>$	C		R		R	R		
59	D	$\gg$	C		R		R	R		
60	D	$<$	C	$<$	R	Hy	R	R		fine
61	D	$<$	D	$<$	R	Hb Aug	C	C	$>$	
62	D	$<$	C		R	Hy Hb	C	R		
63	D	$<$	C	$<$	R	Hy	C	C	$>$	limonite?
64	D	$\ll$	C	$=$	R	Bi	C	R		
65	D	$=$	C		R		C	R		
66	D	$=$	C		R		C	R		fine
67	D	$<$	C		R	Hy	C	R	$>$	
68	D	$\ll$	C		R	Hy	C	R		
69	C	$<$	C		R	Hy	C	C	$>$	
70	C	$<$	D	$=$	R	Hy	C	C	$>$	fine
71	C	$<$	C		R	Hy	C	C	$<$	
72	D	$<$	C		R	Hy	C	C	$=$	
73	D	$<$	C		R	Hy	C	C	$>$	
74	D	$<$	C		R	Aug	C	R	$>$	P.F.
75	D	$<$	C	$>$	R	Hb	C	C	$>$	
76	D	$<$	C	$>$	R		C	C	$>$	

77	D	<	C	>	R	Bi	C	C	=	
78	D	<	C		R		C	C	>	fine
79	D	<	C	>	R	Hy Aug	C	R	=	
80	D	<	C	>	R		C	C	>	
81	D	>	C		R	Hy	R	R		tuffaceous part
82	D	<	C		R		R	R	>	
83	D	<	C		R	Hy	R	C	>	limonite?
84	D	=	C		R		R	C	>	
85	D	<	C	<	R		C	C	>	
86	D	<	C		R	Hy Hb	C	C	>	
87	D	=	C		R		C	C	>	
88	D	=	C		R		R	C	>	tuffaceous part
89	D	>	C		R		R	C	>	tuffaceous part
90	D	>	C		R		R	C	>	tuffaceous part
91	D	≫	C		R		R	C	>	tuffaceous part
92	D	≫	C		R		R	R		fine
93	D	>	C		R	Bi	C	C	>	
94	D	=	C	<	R	Hy	R	C	>	
95	D	>	C		R	Bi	C	C	>	
96	C	=	C		R		C	C	>	fine
97	D	>	C		R		C	C	>	
98	D	=	C		R	Hy	C	C	>	
99	C	=	C		R		C	R		
100	D	≫	C		R		R	R		tuffaceous part, fine
101	D	<	C		R	Bi	C	R	>	
102	D	<	C		R	Hy	C	C	>	fine
103	C	<	C		R		C	R	>	fine
104	D	=	C		R	Bi	R	C	>	

General features of core samples

Mineralogical composition has no remarkable difference from the top to the bottom parts of the core, but the core intercalates several thin layers consisting of volcanic ashes mainly, as shown in schematic column of Fig. 9-2-1.

Samples contain in general volcanic glass, light minerals, some organisms (Radiolaria+Diatom), and a small quantity of "heavy minerals".

Judging from the observations, volcanic activities seem to be acidic to intermediate in composition.

Legend

Volcanic glass	{transparent vitric shards {small particle of pumice
Light mineral	{Quartz {Feldspar
D :	Dominant
C :	Common
R :	Rare
$A \gg B$	A is much more abundant than B
$A > B$	A is more abundant than B

Schematic columnar section of the core
(1 ~ 5)

1

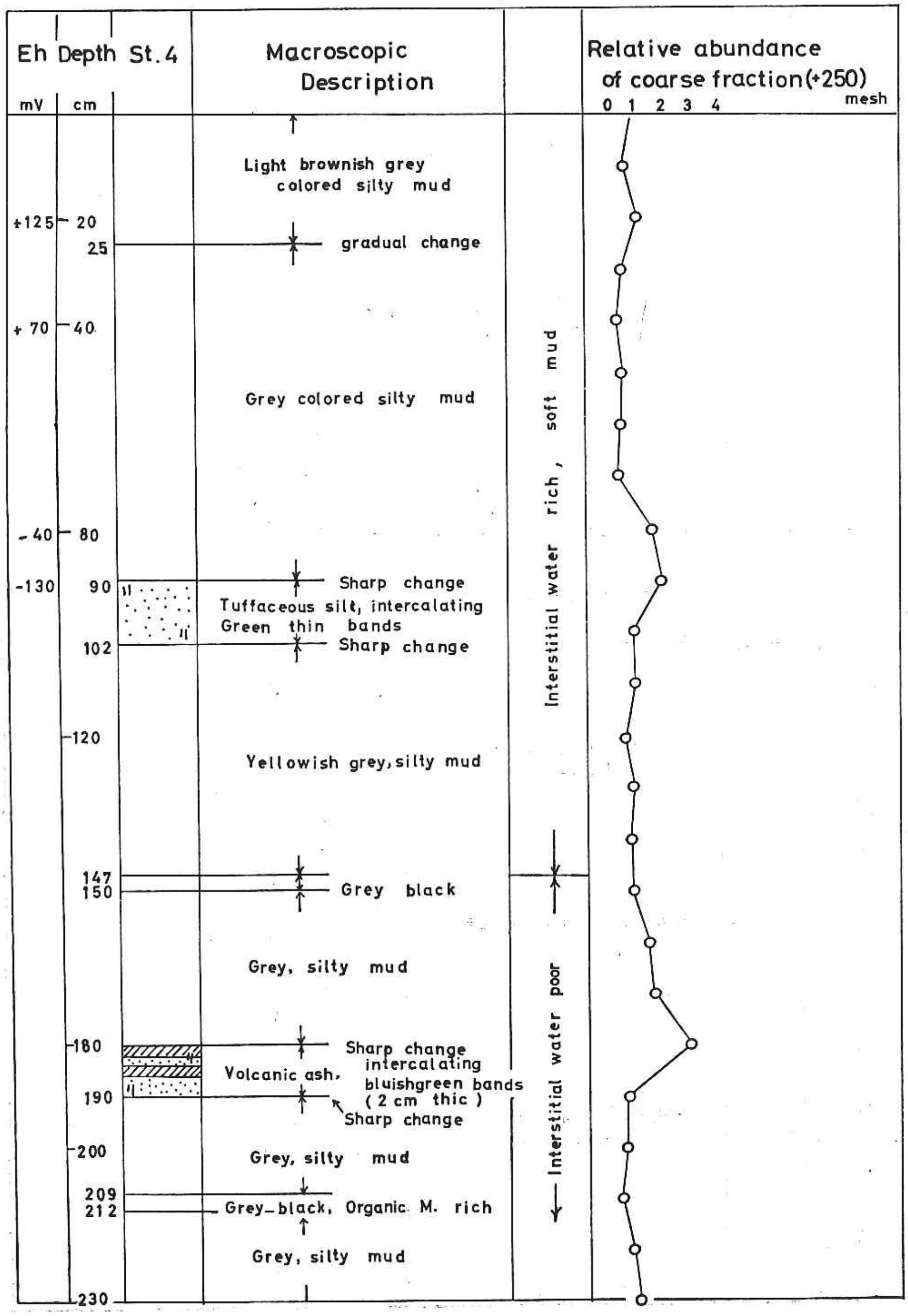


Fig. 9-2-1

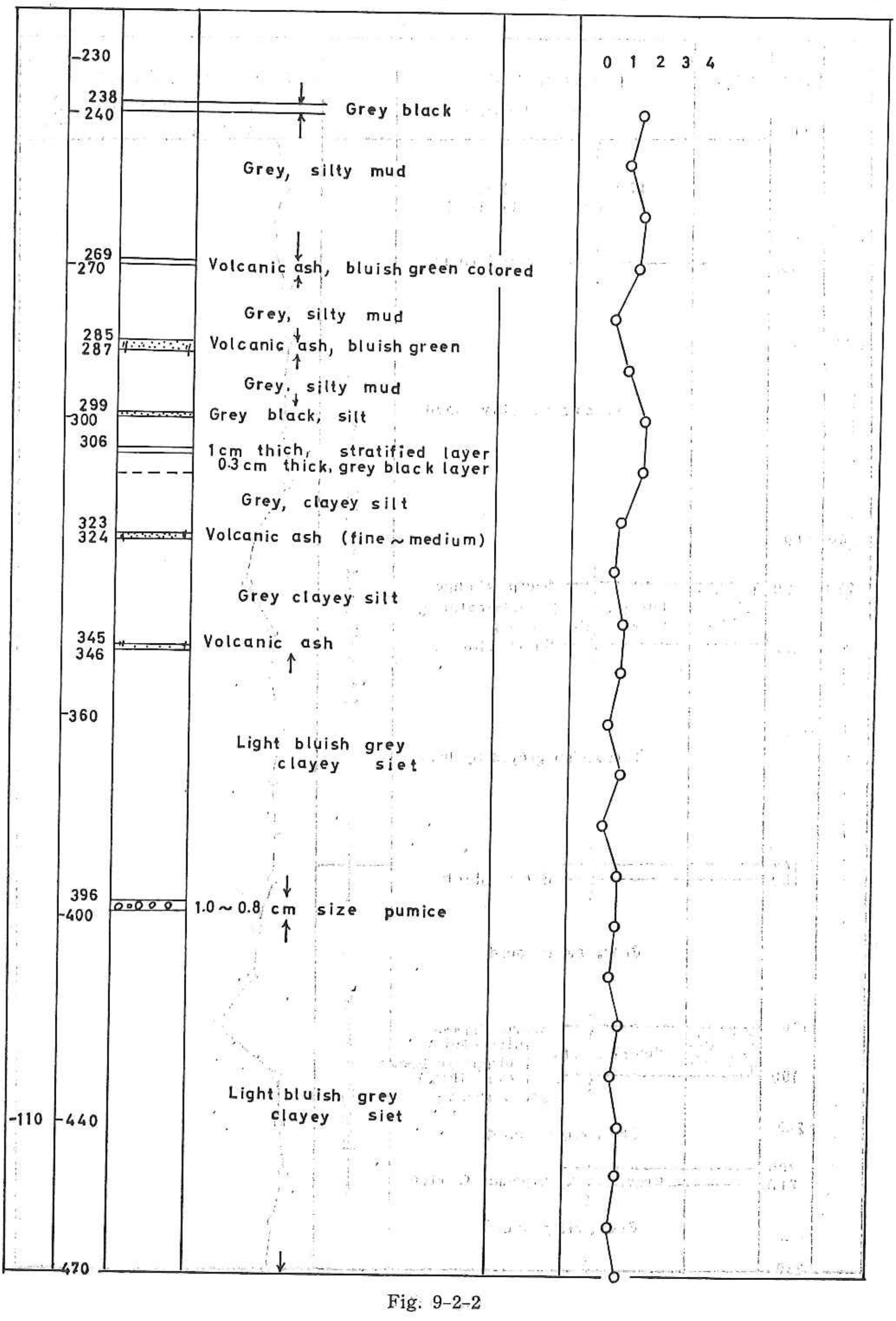
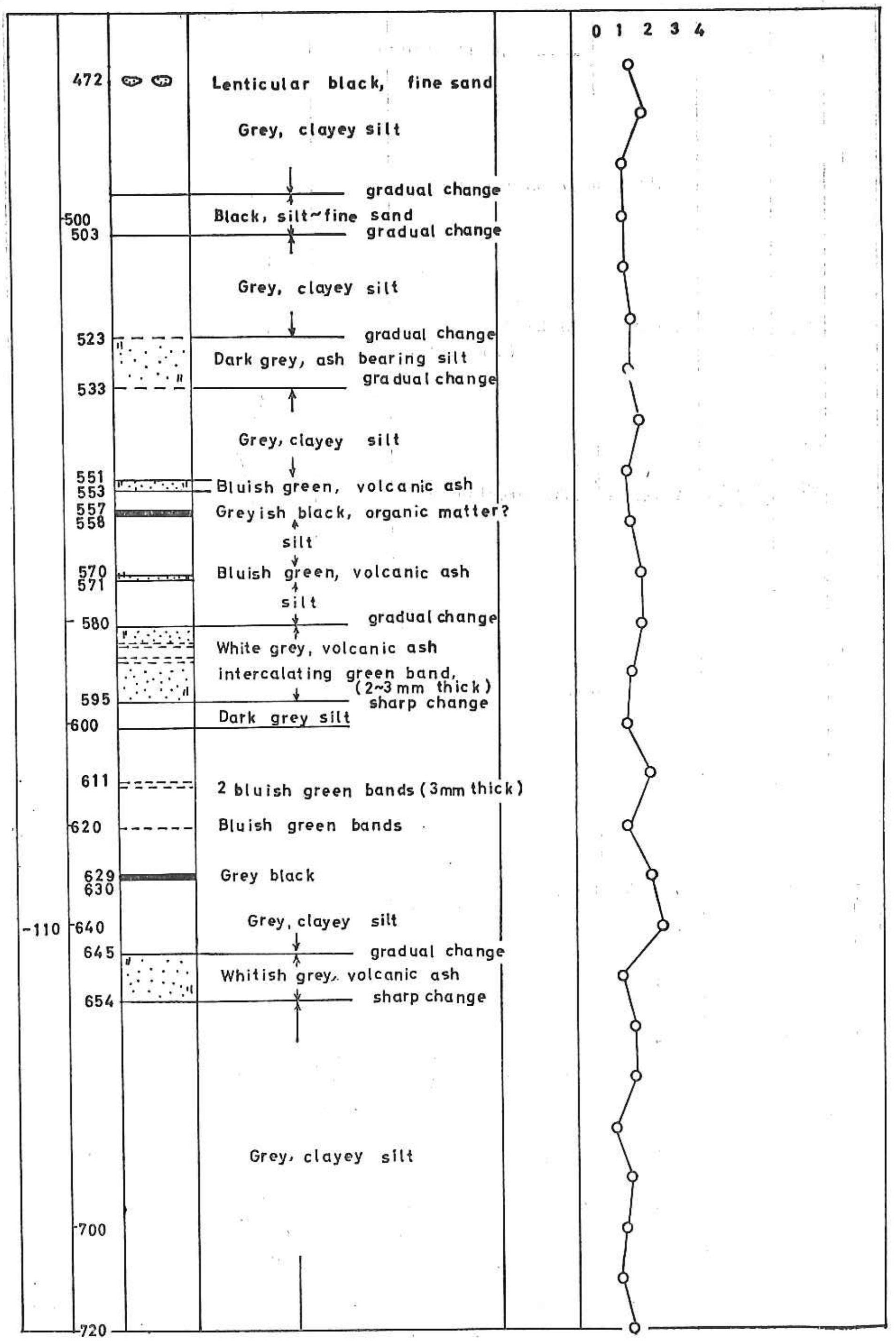

-230
238
240
Grey black
Grey, silty mud
269
270
Volcanic ash, bluish green colored
Grey, silty mud
285
287
Volcanic ash, bluish green
Grey, silty mud
299
300
Grey black, silt
306
1cm thich, stratified layer
0.3cm thick, grey black layer
Grey, clayey silt
323
324
Volcanic ash (fine ~ medium)
Grey clayey silt
345
346
Volcanic ash
360
Light bluish grey clayey siet
396
400
1.0 ~ 0.8 cm size pumice
Light bluish grey clayey siet
-110
440
470
0 1 2 3 4

Fig. 9-2-2



0 1 2 3 4
472
Lenticular black, fine sand
Grey, clayey silt
gradual change
500
Black, silt~fine sand
503
gradual change
Grey, clayey silt
523
gradual change
Dark grey, ash bearing silt
533
gradual change
Grey, clayey silt
551
553
Bluish green, volcanic ash
557
558
Greyish black, organic matter?
silt
570
571
Bluish green, volcanic ash
silt
580
gradual change
White grey, volcanic ash
intercalating green band,
(2~3 mm thick)
595
sharp change
600
Dark grey silt
611
2 bluish green bands (3mm thick)
620
Bluish green bands
629
630
Grey black
-110
640
Grey, clayey silt
645
gradual change
Whitish grey, volcanic ash
654
sharp change
Grey, clayey silt
700
720

Fig. 9-2-3

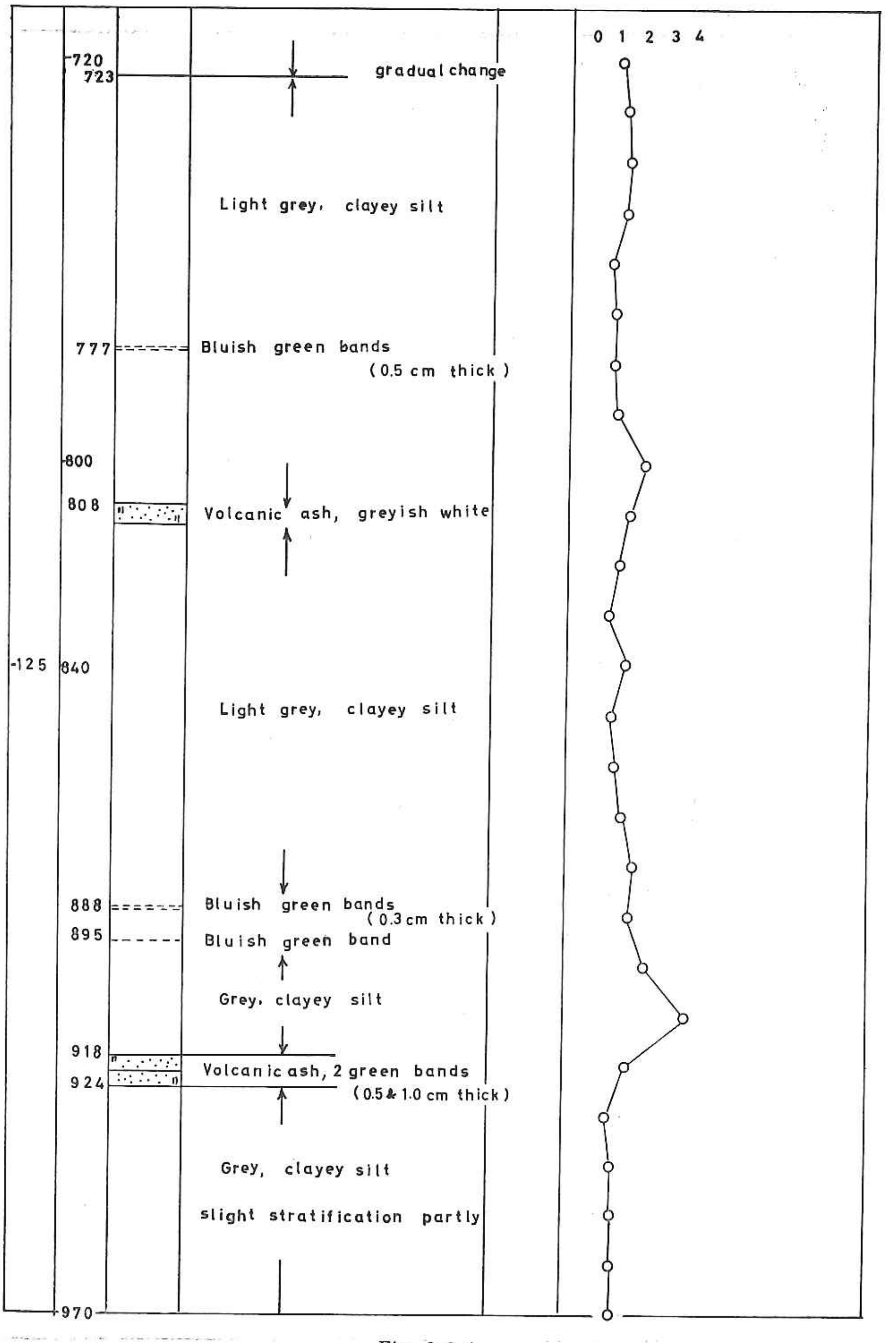

0 1 2 3 4
720
723
gradual change
Light grey, clayey silt
777
Bluish green bands
(0.5 cm thick)
800
808
Volcanic ash, greyish white
-125
840
Light grey, clayey silt
888
Bluish green bands
(0.3 cm thick)
895
Bluish green band
Grey, clayey silt
918
924
Volcanic ash, 2 green bands
(0.5 & 1.0 cm thick)
Grey, clayey silt
slight stratification partly
970

Fig. 9-2-4

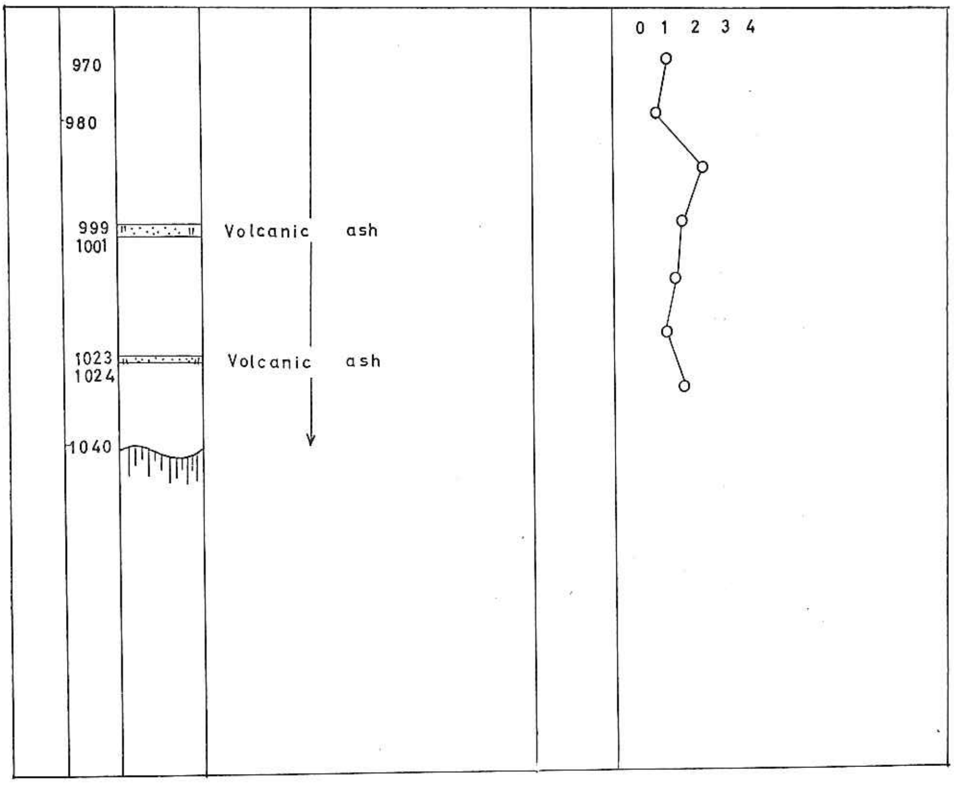


Fig. 9-2-5

9-3. Descriptions of core samples from the Sea of Japan

Masao Inoue

Descriptions of visual properties of core samples (St. 20, 23, 25, 27 and 28) collected in the cruise from Kushiro to Maizuru are shown in Fig. 9-3-1 to 9-3-20. At the stations 23, 25 27 and 28, pH and Eh measurements were performed by T. Mochizuki, S. Nakao and A. Mizuno. Their results of measurements are added to descriptions of core samples.

Abbreviations used in descriptions are as follows;

bl. ; black	br. ; brown	c. ; coarse
d. ; dark	f. ; fine	gn. ; green
gray. ; grayish	m. ; medium	ol. ; olive
s. ; sand	y. ; yellow	

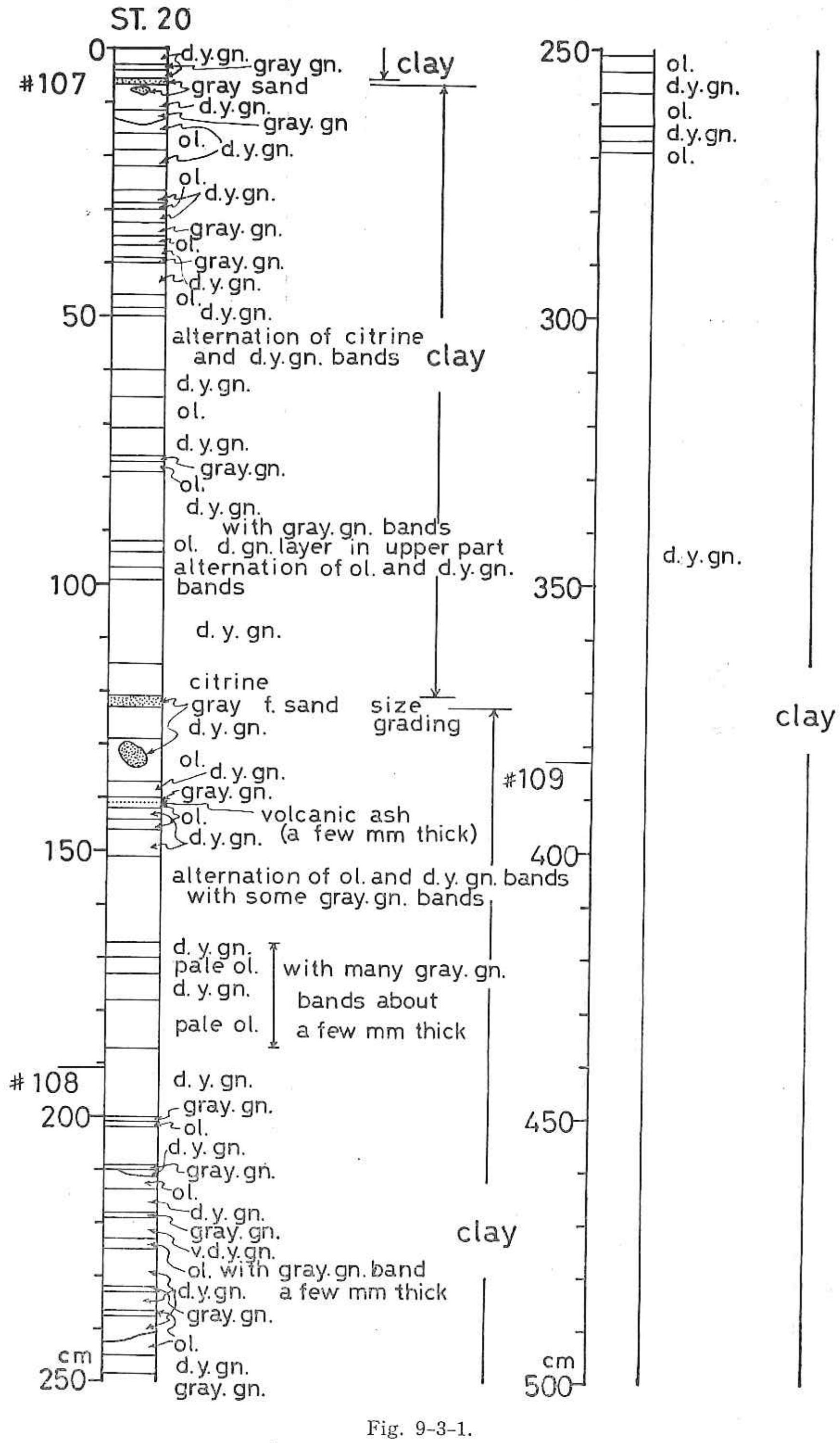

ST. 20
0
#107
d.y.gn.
gray gn.
clay
gray sand
d.y.gn.
gray. gn
ol.
d.y.gn.
ol.
d.y.gn.
gray. gn.
ol.
gray. gn.
d. y. gn.
ol.
d.y.gn.
50
alternation of citrine
and d.y.gn. bands
clay
d. y. gn.
ol.
d. y. gn.
gray. gn.
ol.
d. y. gn.
with gray. gn. bands
ol. d. gn. layer in upper part
alternation of ol. and d.y.gn.
bands
100
d. y. gn.
citrine
gray f. sand
size
grading
d. y. gn.
ol.
d. y. gn.
gray. gn.
volcanic ash
(a few mm thick)
ol.
d. y. gn.
150
alternation of ol. and d. y. gn. bands
with some gray. gn. bands
d. y. gn.
pale ol.
d. y. gn.
pale ol.
with many gray. gn.
bands about
a few mm thick
#108
d. y. gn.
200
gray. gn.
ol.
d. y. gn.
gray. gn.
ol.
d. y. gn.
gray. gn.
v. d. y. gn.
ol. with gray. gn. band
d. y. gn. a few mm thick
gray. gn.
ol.
d. y. gn.
gray. gn.
clay
cm
250
250
ol.
d.y.gn.
ol.
d.y.gn.
ol.
300
d. y. gn.
350
#109
400
450
cm
500
clay

Fig. 9-3-1.

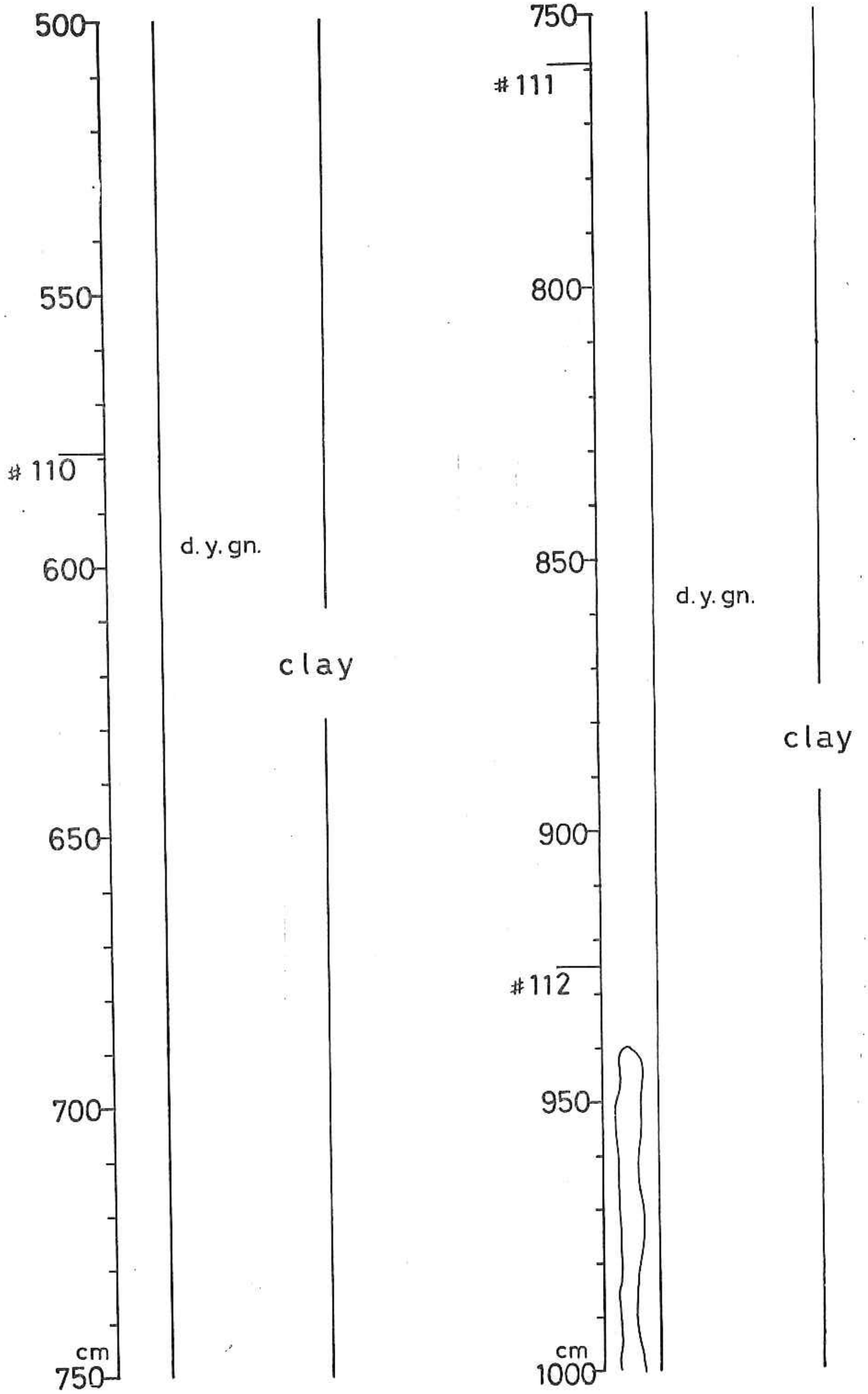

500
550
#110
600
650
700
cm
750
d. y. gn.
clay
750
#111
800
850
900
#112
950
cm
1000
d. y. gn.
clay

Fig. 9-3-2

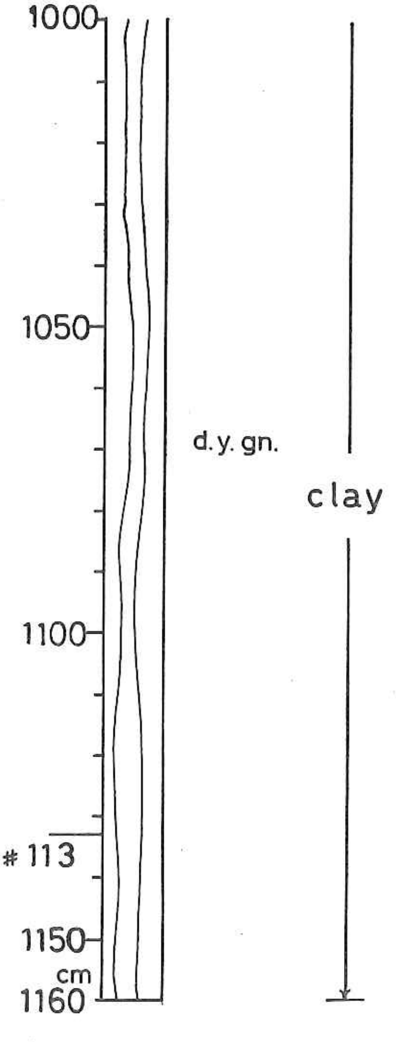


Fig. 9-3-3

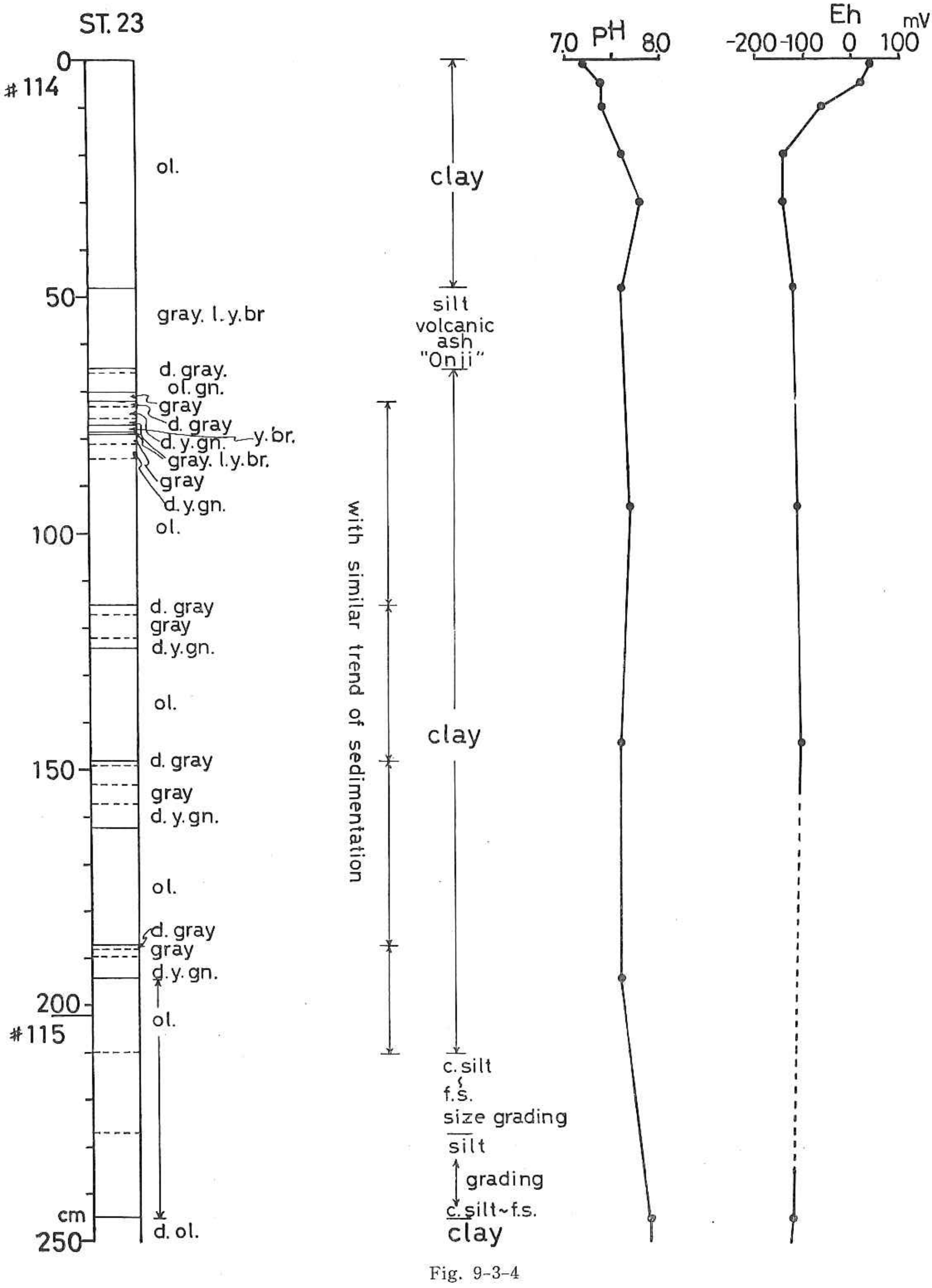

ST. 23
#114
#115
cm
0
50
100
150
200
250
ol.
gray. l.y.br
d. gray.
ol. gn.
gray
d. gray
y. br.
d. y. gn.
gray. l.y.br.
gray
d. y. gn.
ol.
d. gray
gray
d. y. gn.
ol.
d. gray
gray
d. y. gn.
ol.
d. gray
gray
d. y. gn.
ol.
d. ol.
with similar trend of sedimentation
clay
silt
volcanic
ash
"Onji"
clay
c. silt
f. s.
size grading
silt
grading
c. silt ~ f.s.
clay
7.0 PH 8.0
Eh mV
-200 -100 0 100

Fig. 9-3-4

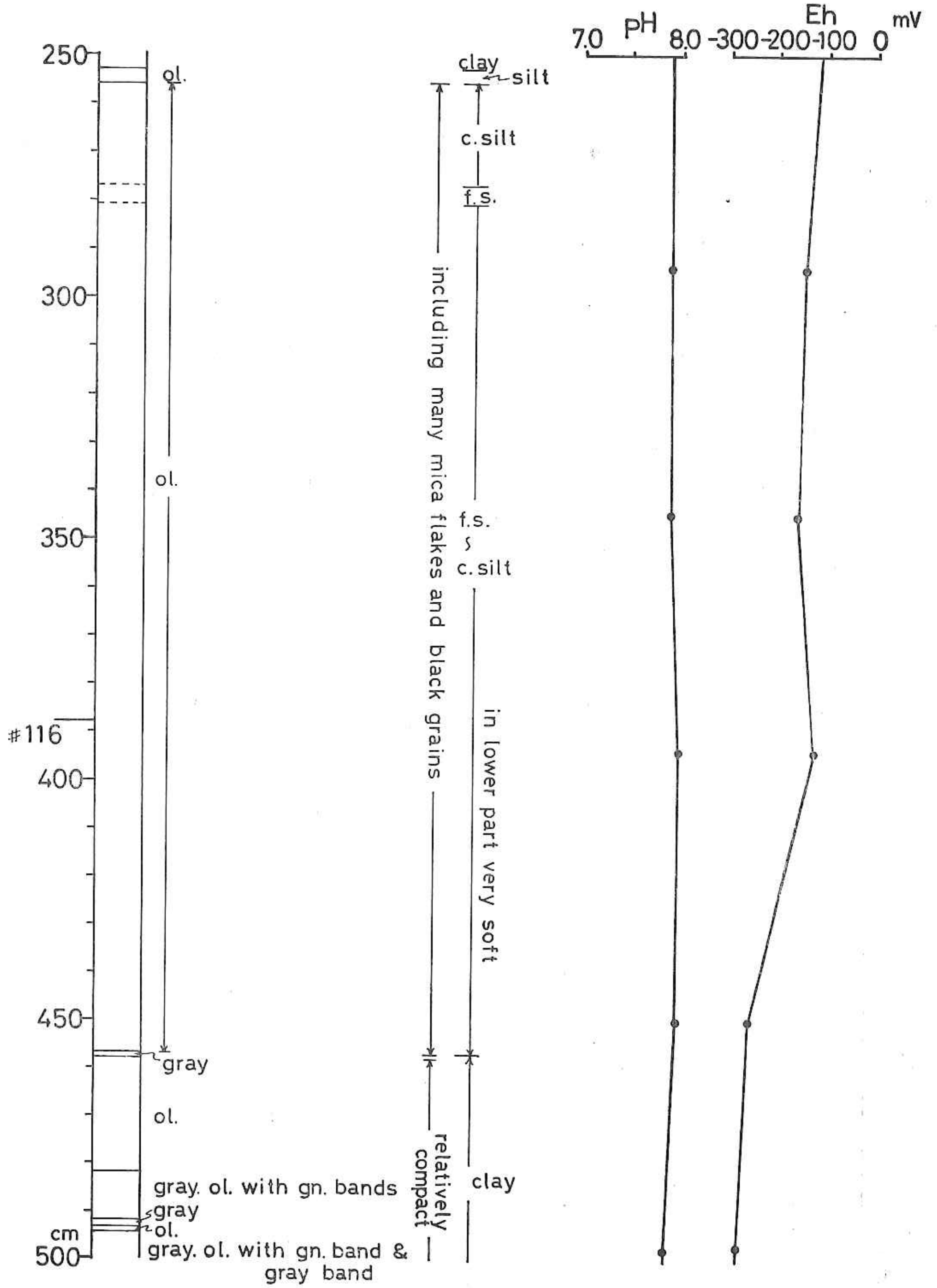
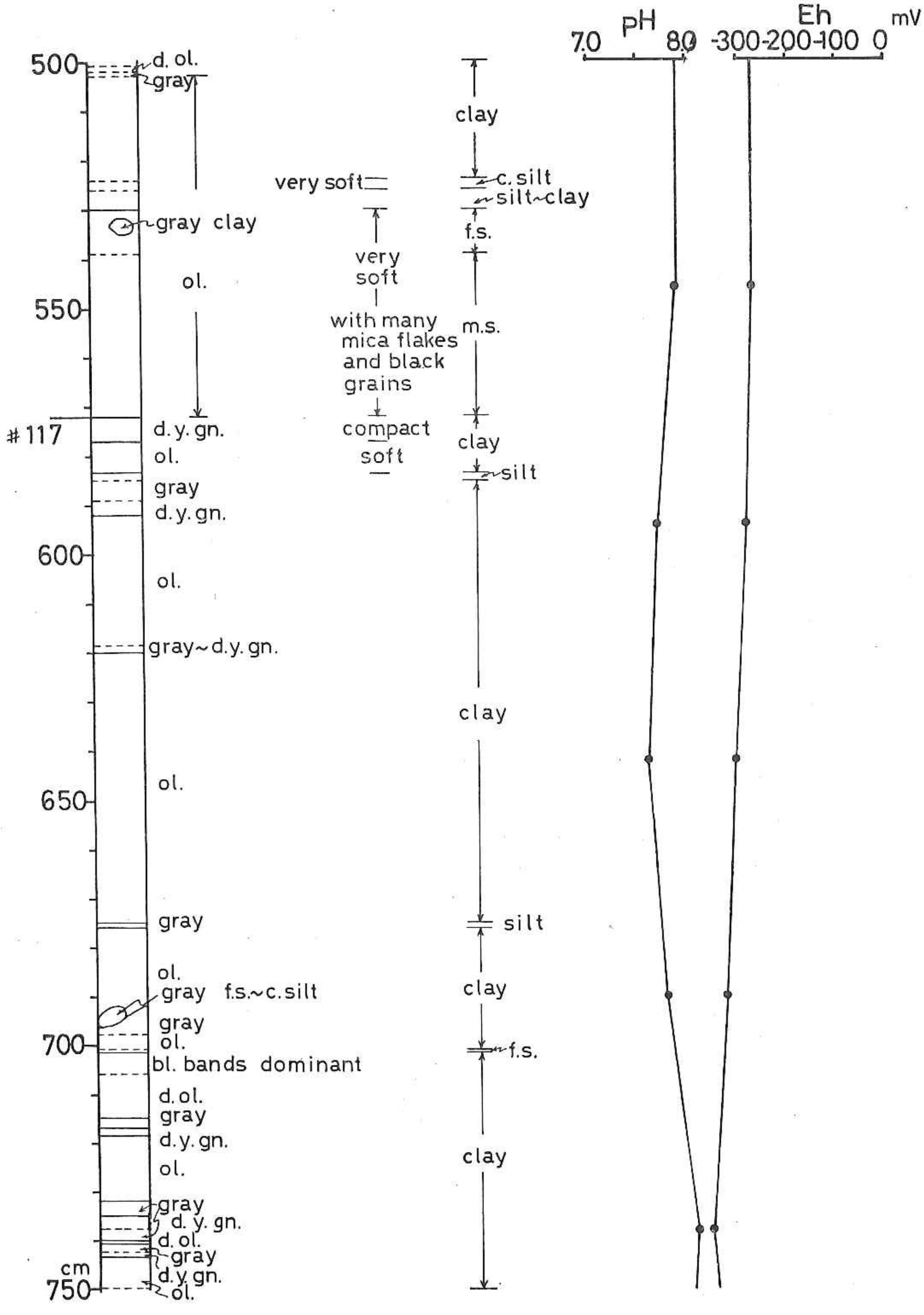
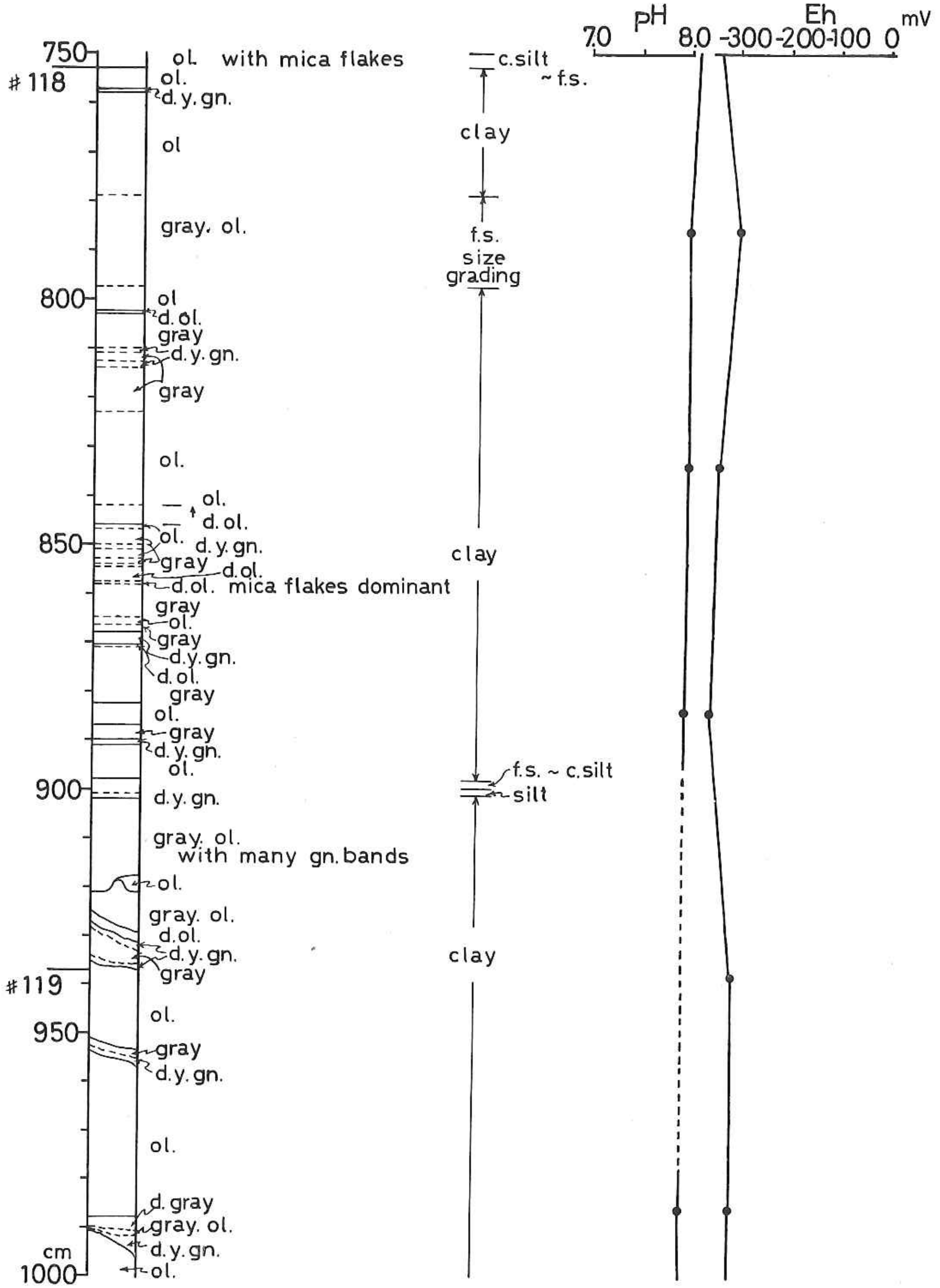

7.0
pH
8.0
-300
-200
-100
0
Eh
mV
250
300
350
#116
400
450
cm
500
ol.
ol.
gray
ol.
gray. ol. with gn. bands
gray
ol.
gray. ol. with gn. band & gray band
including many mica flakes and black grains
relatively compact
clay
silt
c. silt
f.s.
f.s.
c. silt
in lower part very soft
clay

Fig. 9-3-5



500
550
600
650
700
750
cm
#117
d. ol.
gray
gray clay
ol.
d. y. gn.
ol.
gray
d. y. gn.
ol.
gray～d. y. gn.
ol.
gray
ol.
gray f.s.～c. silt
gray
ol.
bl. bands dominant
d. ol.
gray
d. y. gn.
ol.
gray
d. y. gn.
d. ol.
gray
d. y. gn.
ol.
very soft
very soft
with many mica flakes and black grains
compact
soft
clay
c. silt
silt～clay
f.s.
m.s.
clay
silt
clay
silt
clay
f.s.
clay
pH
7.0
8.0
Eh
-300 -200 -100 0
mV

Fig. 9-3-6



pH
Eh
mV
7.0
8.0
-300
-200
-100
0
750
118
800
850
900
119
950
cm
1000
ol. with mica flakes
ol.
d. y. gn.
ol
gray. ol.
ol
d. ol.
gray
d. y. gn.
gray
ol.
ol.
d. ol.
ol.
d. y. gn.
gray
d. ol.
d. ol. mica flakes dominant
gray
ol.
gray
d. y. gn.
d. ol.
gray
ol.
gray
d. y. gn.
ol.
d. y. gn.
gray. ol.
with many gn. bands
ol.
gray. ol.
d. ol.
d. y. gn.
gray
ol.
gray
d. y. gn.
ol.
d. gray
gray. ol.
d. y. gn.
ol.
c. silt
~ f.s.
clay
f.s.
size
grading
clay
f.s. ~ c. silt
silt
clay

Fig. 9-3-7

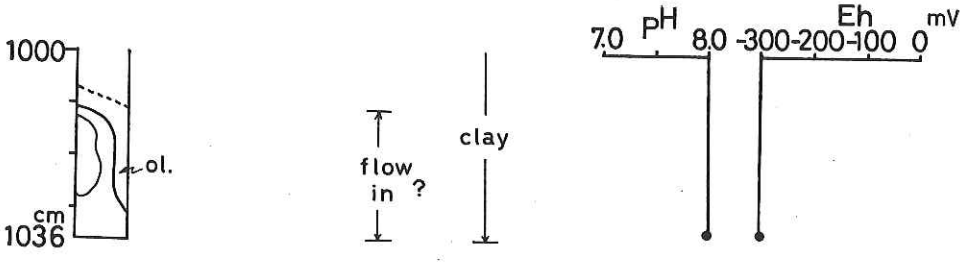


Fig. 9-3-8

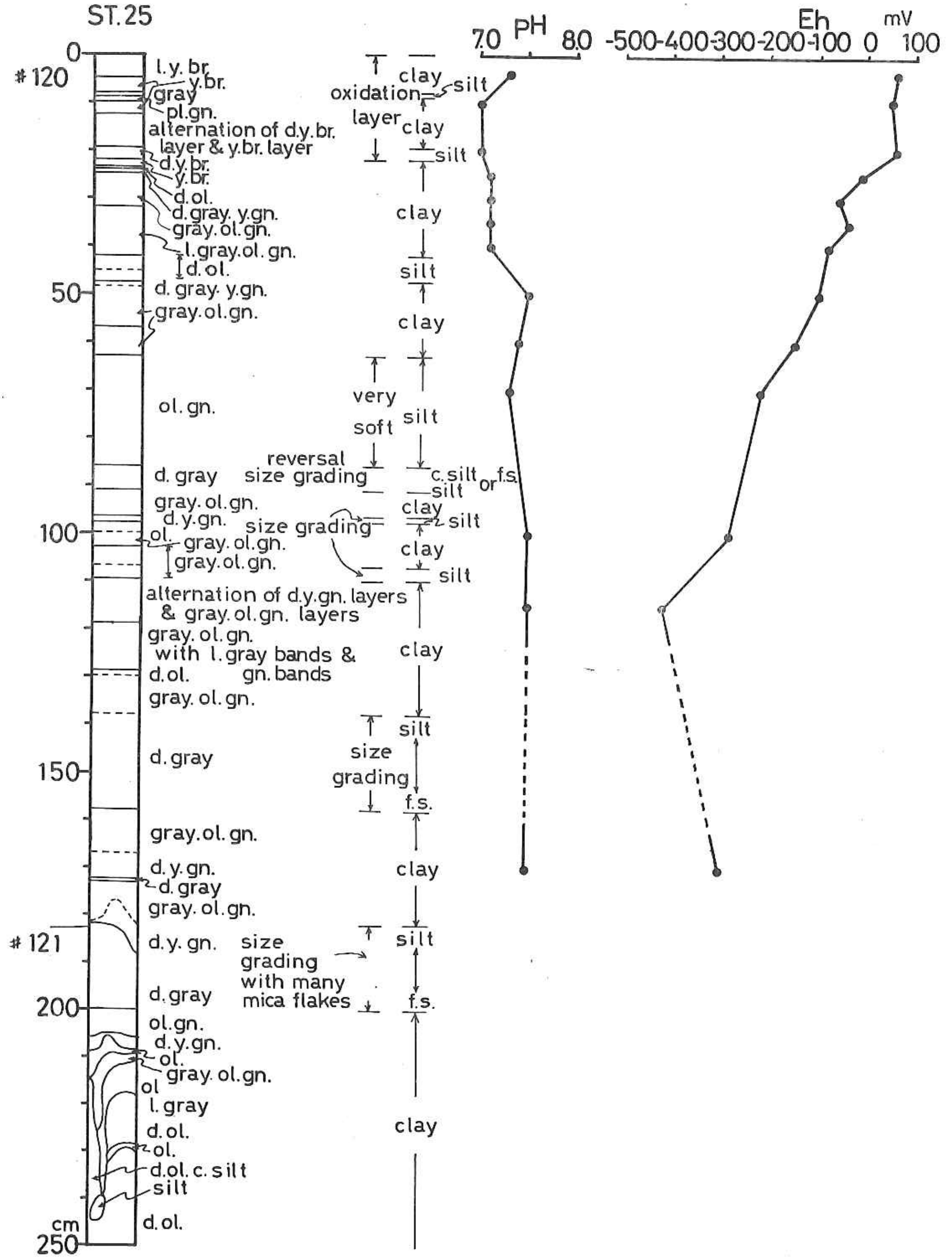

ST.25
7.0 PH 8.0
Eh mV
-500-400-300-200-100 0 100
#120
l.y.br.
y.br.
gray
pl.gn.
alternation of d.y.br. layer & y.br. layer
d.y.br.
y.br.
d.ol.
d.gray. y.gn.
gray.ol.gn.
l.gray.ol.gn.
d.ol.
d.gray. y.gn.
gray.ol.gn.
ol.gn.
d.gray
gray.ol.gn.
d.y.gn.
ol.
gray.ol.gn.
gray.ol.gn.
alternation of d.y.gn. layers & gray.ol.gn. layers
gray.ol.gn. with l.gray bands & gn. bands
d.ol.
gray.ol.gn.
d.gray
gray.ol.gn.
d.y.gn.
d.gray
gray.ol.gn.
#121
d.y.gn.
d.gray
ol.gn.
d.y.gn.
ol.
gray.ol.gn.
ol
l.gray
d.ol.
ol.
d.ol.c.silt
silt
d.ol.
oxidation layer
very soft
reversal size grading
size grading
size grading
size grading with many mica flakes
clay
silt
clay
silt
clay
silt
clay
silt
c.silt or f.s.
silt
clay
silt
clay
silt
clay
silt
f.s.
clay
silt
f.s.
clay
0
50
100
150
200
cm
250

Fig. 9-3-9

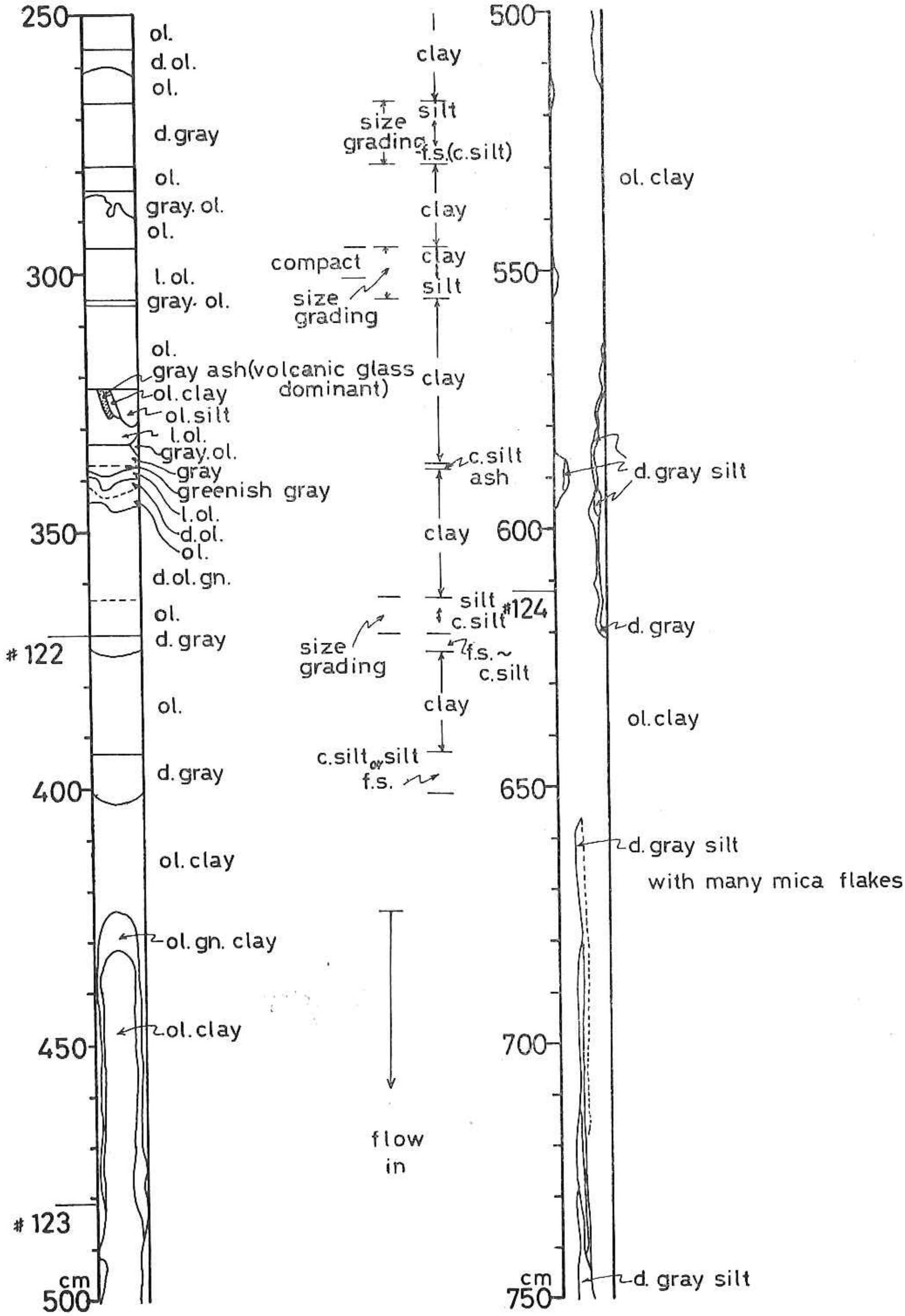

250
300
350
#122
400
450
#123
cm
500
ol.
d.ol.
ol.
d.gray
ol.
gray.ol.
ol.
l.ol.
gray.ol.
ol.
gray ash(volcanic glass dominant)
ol.clay
ol.silt
l.ol.
gray.ol.
gray
greenish gray
l.ol.
d.ol.
ol.
d.ol.gn.
ol.
d.gray
ol.
d.gray
ol.clay
ol.gn. clay
ol.clay
clay
silt
size grading
f.s.(c.silt)
clay
compact
clay
silt
size grading
clay
c.silt
ash
clay
silt
c.silt
size grading
f.s.~ c.silt
clay
c.silt or silt
f.s.
flow in
500
550
600
#124
650
700
cm
750
ol.clay
d.gray silt
d.gray
ol.clay
d.gray silt
with many mica flakes
d.gray silt

Fig. 9-3-10

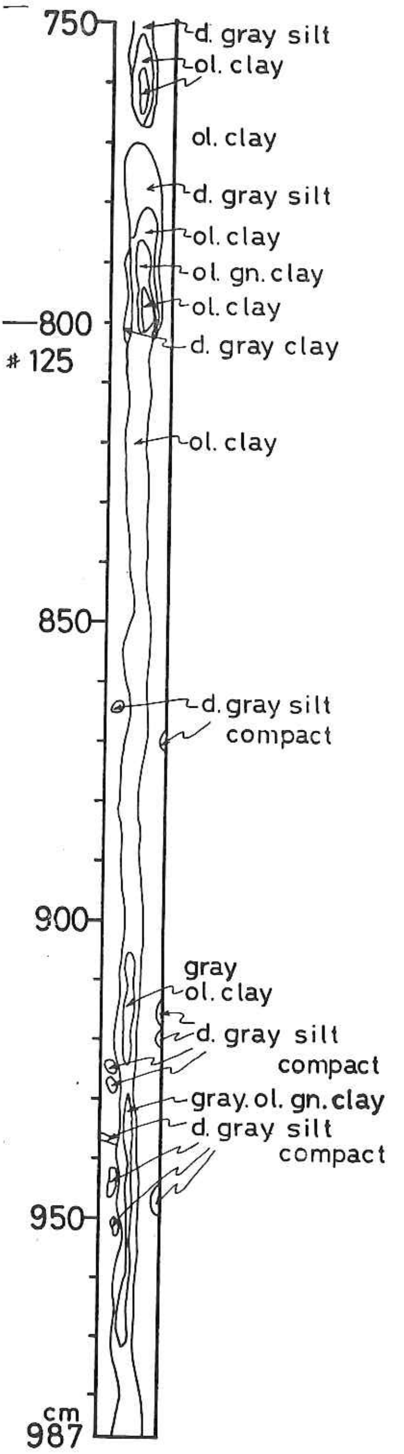

750
d. gray silt
ol. clay
ol. clay
d. gray silt
ol. clay
ol. gn. clay
ol. clay
800
125
d. gray clay
ol. clay
850
d. gray silt
compact
900
gray
ol. clay
d. gray silt
compact
gray. ol. gn. clay
d. gray silt
compact
950
cm
987

Fig. 9-3-11

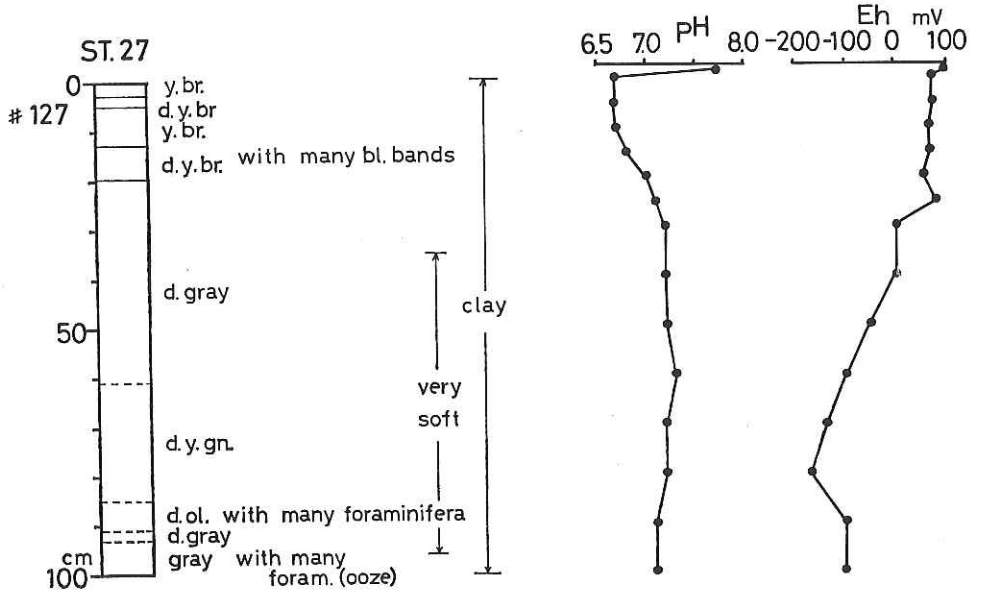
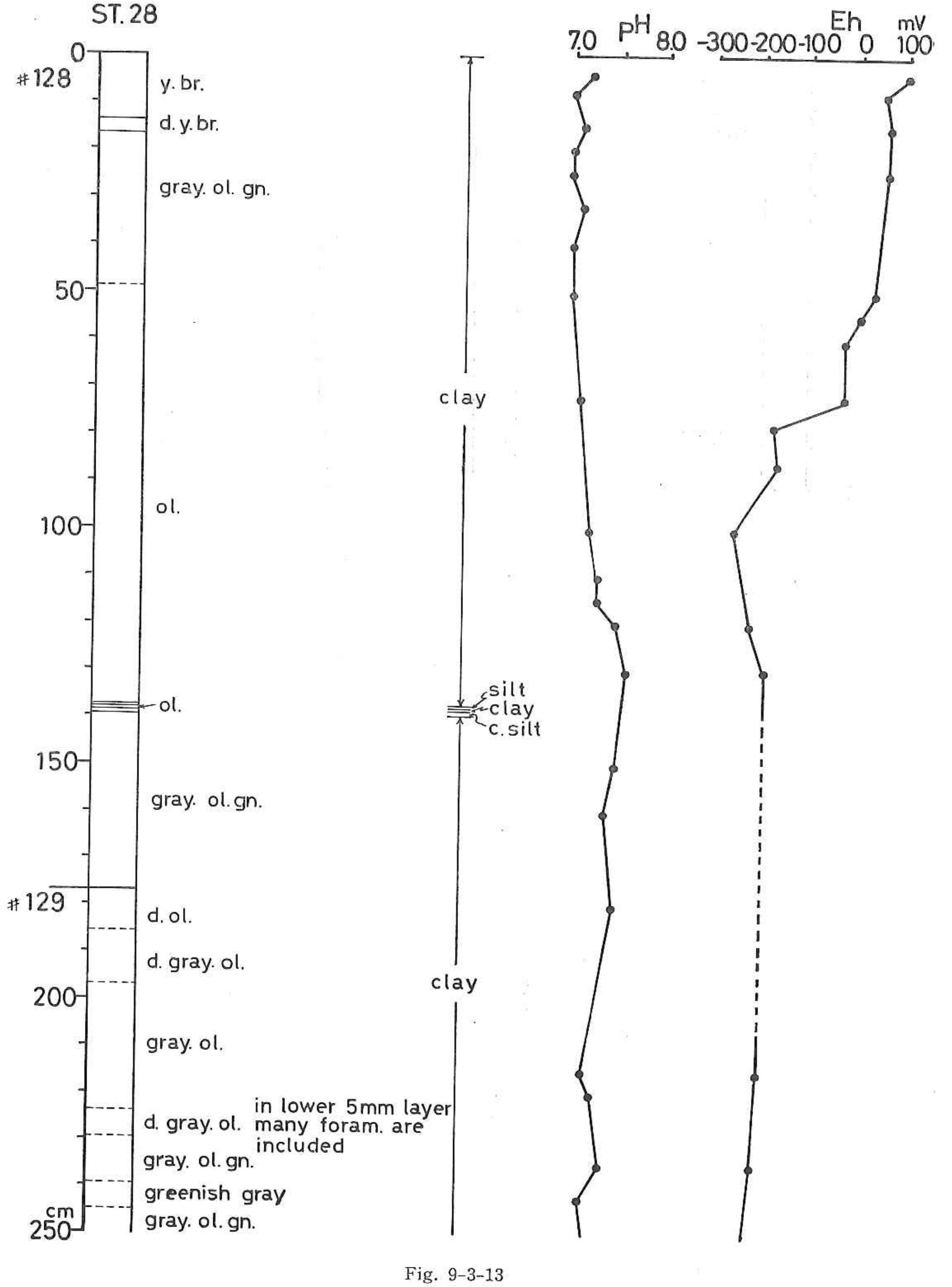
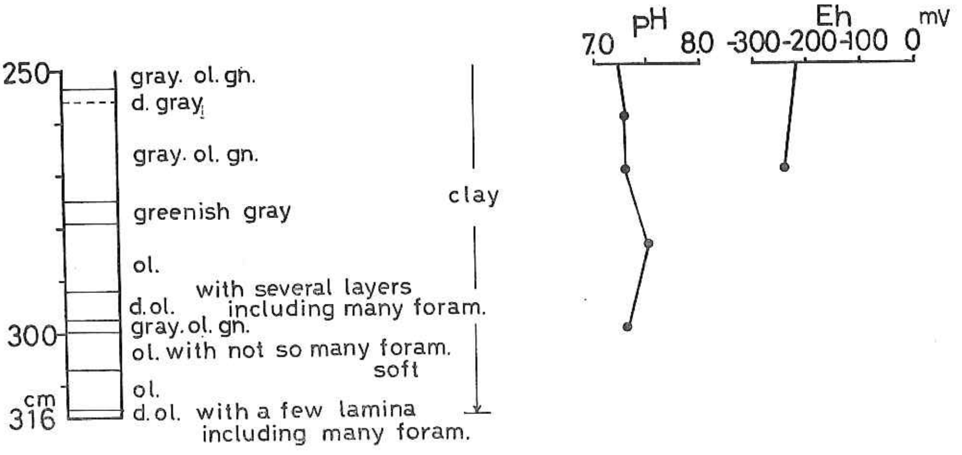

ST. 27
#127
0
50
cm
100
y. br.
d. y. br
y. br.
d. y. br. with many bl. bands
d. gray
d. y. gn.
d. ol. with many foraminifera
d. gray
gray with many foram. (ooze)
very soft
clay
6.5 7.0 PH 8.0
Eh mV
-200 -100 0 100

Fig. 9-3-12



ST. 28
0
#128
50
100
150
#129
200
cm
250
y. br.
d. y. br.
gray. ol. gn.
ol.
ol.
gray. ol. gn.
d. ol.
d. gray. ol.
gray. ol.
d. gray. ol.
in lower 5mm layer many foram. are included
gray. ol. gn.
greenish gray
gray. ol. gn.
clay
silt
clay
c. silt
clay
7.0
pH
8.0
Eh
mV
-300
-200
-100
0
100

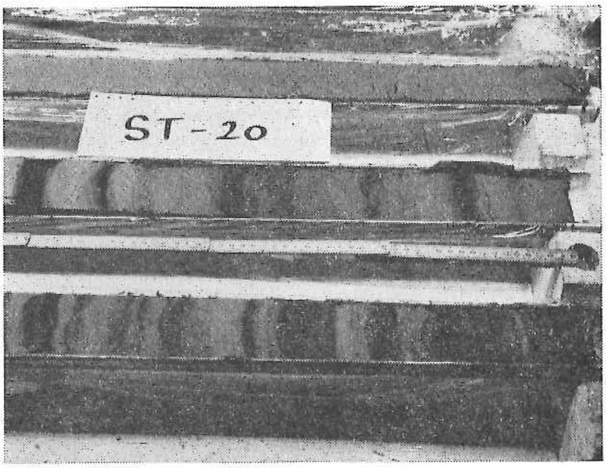
Fig. 9-3-13



250
300
cm
316
gray. ol. gn.
d. gray
gray. ol. gn.
greenish gray
ol.
d. ol. with several layers including many foram.
gray. ol. gn.
ol. with not so many foram. soft
ol.
d. ol. with a few lamina including many foram.
clay
pH
7.0
8.0
Eh
-300
-200
-100
0
mV

Fig. 9-3-14

Several photographs of core samples



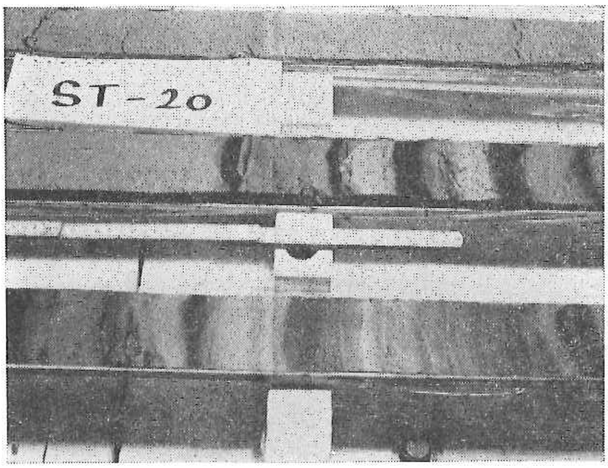
♯109

♯108

→ top

♯107

middle

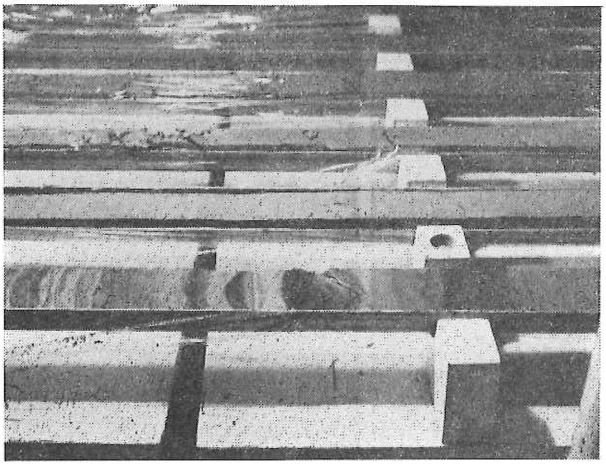


♯109

♯108

♯107

← bottom



♯111

♯110

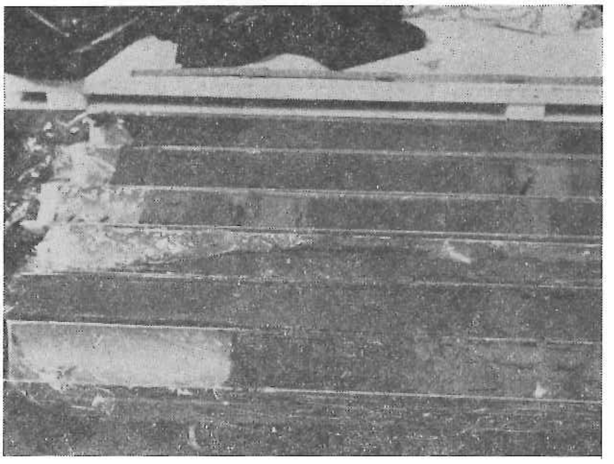
♯109

♯108

♯107

Fig. 9-3-15

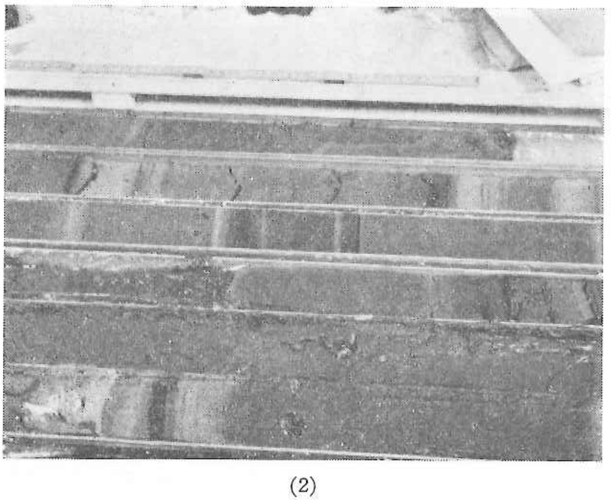
KH-69-2-23



#119
#118
#117
#116
#115
#114

←
top
(30cm lost)

(1)

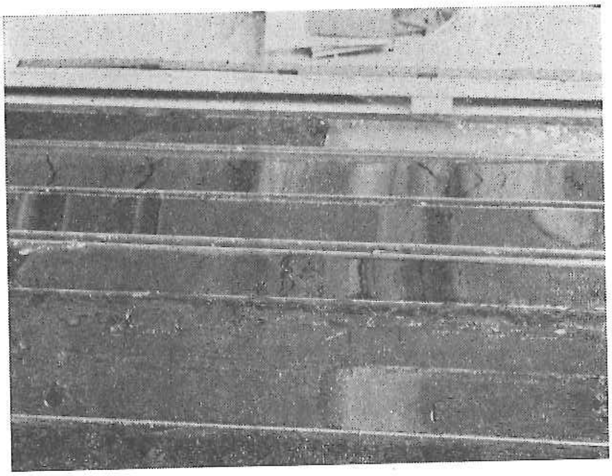


bottom
#119
#118
#117
#116
#115
#114

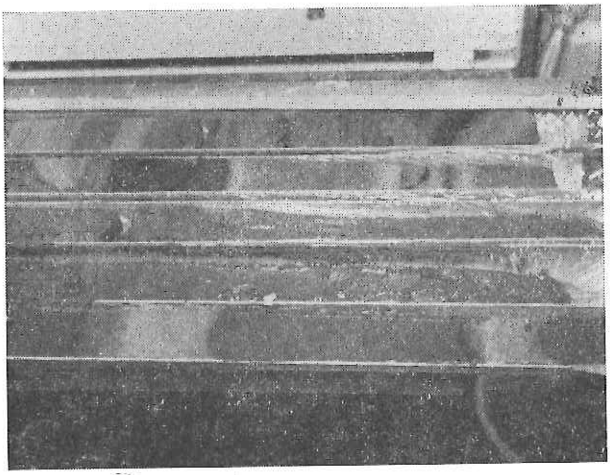
(2)

Fig. 9-3-16

KH-69-2-23

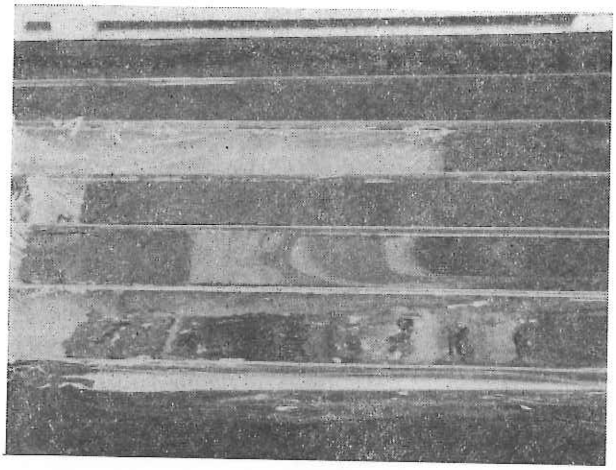


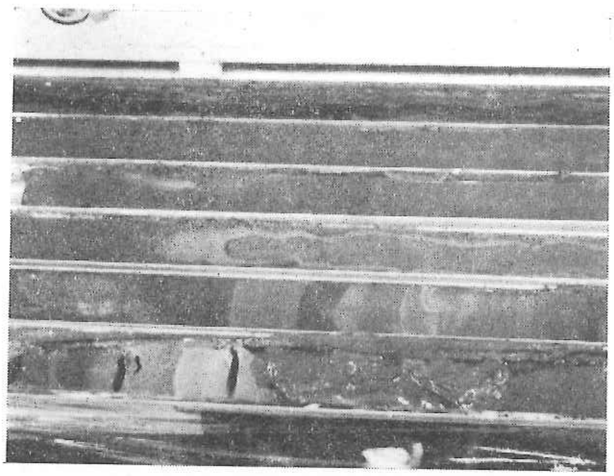
(3)



(4)

Fig. 9-3-17


#125
#124
#123
#122
#121
#120
top
←


middle
#125
#124
#123
#122
#121
#120

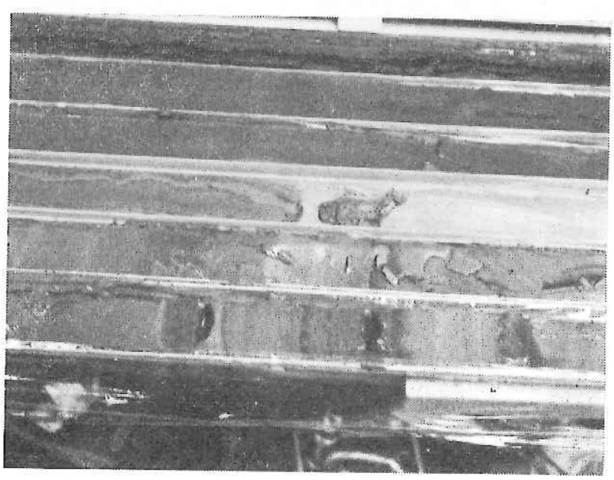

→
bottom
#125
#124
#123
#122
#121
#120

Fig. 9-3-18

← top
#128
#129

middle
#128
#129

#128
#129
bottom
→

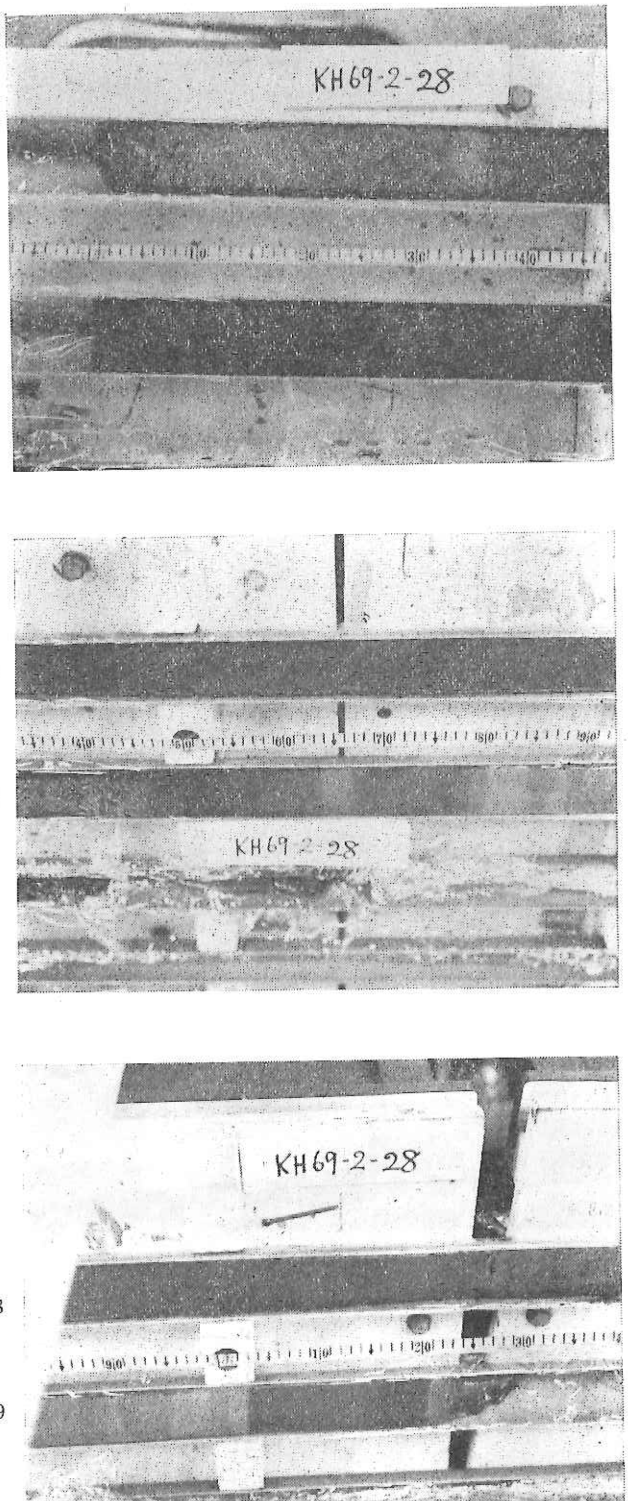
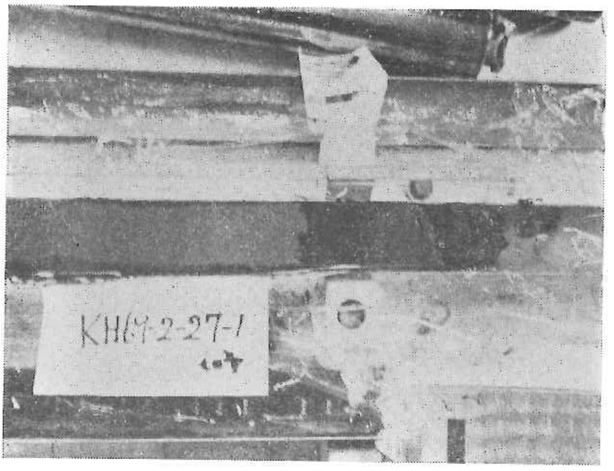


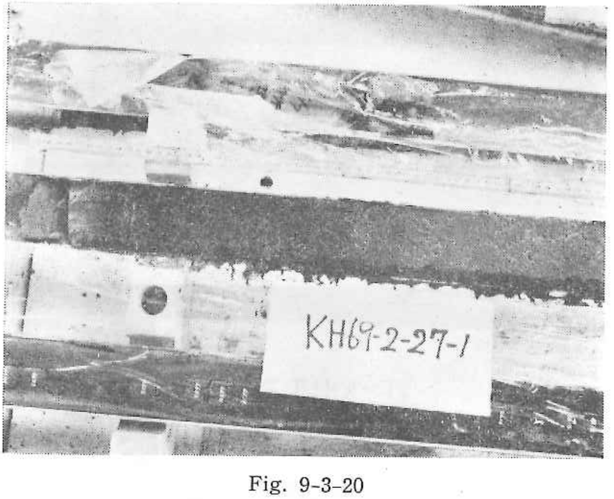
Fig. 9-3-19



top

♯127

bottom



♯127

Fig. 9-3-20

10. Dredging

10-1. Records of dredge logs

DREDGE LOG

Date April 27, '69 Ship Hakuho-maru Cruise KH-69-2 Station 1-1
Location southeast slope toward the crest of the Seamount Kashima II
Weather Wind Sea calm, low swell
Bottom Topography rugged

Type of Dredge Nalwalk's chain-bag No. 1 Add. Wt. 30 kg
Time lowered 09 h 15 m Uncorr. Water Depth 4300 m
Initial Time on Bottom 14 h 15 m Uncorr. Water Depth 3350 m
Wire Length 6000 m Wire Angle 50°
Ship Position: Lat. 36°04.2'N; Long. 143°32.2'E
Direction of Haul 0° Ship Speed 0 kt (till 16 h 45 m)
Speed Wire-in 10 m/min (from 14 h 36 m) Winch No. 1
Final Time on Bottom 16 h 45 m Uncorr. Water Depth 3600 m
Wire Length 4300 m Wire Angle 35°
Ship Position: Lat. 36°02.8'N; Long. 143°32.7'E
Time surfaced 17 h 45 m

Condition of Haul: 2 to 3 tons of tension increases were several times observed at the wire length between 5700 m and 5000 m. No great damage with the dredge.
Dredged Materials: 200 kgs of volcanic rocks (83 large pieces and 500 small ones). Mostly with porous surface. Small amount of Mn-nodules. No Mn-coatings.

Worked by K. Kobayashi et al.

Date April 28, '69 Ship Hakuho-maru Cruise KH-69-2 Station 2-1
Location southeast slope toward the crest of a seamount, NE of Kashima II
Water Wind Sea rough, moderate swell
Bottom Topography rugged

Type of Dredge Nalwalk's chain-bag No. 2 Add. Wt. kg
Time lowered 07 h 45 m Uncorr. Water Depth 4300 m
Initial Time on Bottom 11 h 00 m Uncorr. Water Depth 2800 m
Wire Length 6285 m Wire Angle 46°
Ship Position: Lat. 36°17.3'N; Long. 143°58.7'E
Direction of Haul 340° Ship Speed 2-0 kt (till 13 h 50 m)
Speed Wire-in 20 m/min (from 14 h 05 m) Winch No. 1
Final Time on Bottom 14 h 20m Uncorr. Water Depth 3270 m
Wire Length 3200 m Wire Angle 0°
Ship Position: Lat. 36°14.1'N; Long. 143°59.9'E
Time surfaced 15 h 26 m

Condition of Haul: kinks and scratched wires seen at the wireout of 27 m, 508 m, 603 m, 653 m, 738 m and 1322 m. Very high tension-increase was observed between 4840 m and 4718 m of the wire-out.
Dredged Materials: 3.0 kgs of pumices (4 whity pieces) and 3.0 kgs of Mn-coated altered rocks.
Worked by K. Kobayashi et al.

DREDGE LOG

Date April 30, '69 Ship Hakuho-maru Cruise KH-69-2 Station 5-1
Location Mizunagi Seamount east of the Japan Trench
Weather Wind Sea
Bottom Topography smooth slope

Type of Dredge Nalwalk's chain-bag No. 1 Add. Wt. 60 kg
Time lowered 14 h 15 m Uncorr. Water Depth 3650 m
Initial Time on Bottom 15 h 59 m Uncorr. Water Depth 2630 m
Wire Length 4500 m Wire Angle 30°
Ship Position: Lat. 37°07.2′N; Long. 145°18.0′E
Direction of Haul 38° Ship Speed 1.0 kt (till 17 h 05 m)
Speed Wire-in 1–3 m/min (from 17 h 05 m) Winch No. 1
Final Time on Bottom 19 h 10 m Uncorr. Water Depth 2200 m
Wire Length 2500 m Wire Angle 9°
Ship Position: Lat. 37°07.3′N; Long. 145°18.6′E
Time surfaced 19 h 50 m

Condition of Haul: No damage in dredge. More than 2.0 tons increase in tension was observed at the wire-out of 2200 m (1.0 kt shift) and 3700 m, 2930 m.

Dredged Materials: Mn-coated small rocks and pumices (30 kgs, 36 pieces). Mn-nodules.

Worked by K. Kobayashi et al.

Date May 1, '69 Ship Hakuho-maru Cruise KH-69-2 Station 6
Location off Sanriku, Honshu Island, Japan
Weather Wind 6 m/sec SSW Sea
Bottom Topography smooth slope (landward) of Japan Trench

Type of Dredge Nalwalk's chain-bag No. 2 Add. Wt. 60 kg
Time lowered 14 h 38 m Uncorr. Water Depth 5700 m
Initial Time on Bottom 16 h 22 m Uncorr. Water Depth 5650 m
Wire Length 7500 m Wire Angle 27°
Ship Position: Lat. 39°33.4′N; Long. 144°06.0′E
Direction of Haul 270° Ship Speed 1–2 kt (till h m)
Speed Wire-in m/min (from h m) Winch No. 1
Final Time on Bottom 18 h 27 m Uncorr. Water Depth 5900 m
Wire Length 6270 m Wire Angle 20°
Ship Position: Lat. 39°34.7′N; Long. 144°07.2′E
Time surfaced 19 h 40 m

Condition of Haul

Dredged Materials: no rocks.

Worked by E. Honza et al.

DREDGE LOG

Date May 2, '69   Ship Hakuho-maru   Cruise KH-69-2   Station 12-2
Location off Sanriku, Honshu Island, Japan
Weather   Wind S 10-12 m/sec   Sea moderate, low swell
Bottom Topography slightly rugged

Type of Dredge Nalwalk's chain-bag No. 2   Add. Wt. kg
Time lowered   19 h 09 m   Uncorr. Water Depth 1225 m
Initial Time on Bottom 19 h 45 m   Uncorr. Water Depth 1210 m
  Wire Length 1834 m   Wire Angle 42°
  Ship Position: Lat. 39°36.8′N; Long. 142°46.3′E
Direction of Haul 270°   Ship Speed 2 kt (till 20 h 52 m)
Speed Wire-in 0-35 m/min (from 21 h 10 m)   Winch No. 1
Final Time on Bottom 21 h 29 m   Uncorr. Water Depth 1120 m
  Wire Length 1600 m   Wire Angle 30°
  Ship Position: Lat. ; Long.
Time surfaced 21 h 53 m   Max. Wire-out 2200 m

Condition of Haul: grinded by sand and mud

Dredged Materials: no rocks.

Worked by E. Honza et al.

Date May 5, '69   Ship Hakuho-maru   Cruise KH-69-2   Station 11-1
Location off Sanriku, Honshu Island, Japan
Weather   Wind 8 m/sec   Sea calm, no swell
Bottom Topography appr. 10 m hill

Type of Dredge Stainless steel pipe   Add. Wt. kg
Time lowered   06 h 18 m   Uncorr. Water Depth 1440 m
Initial Time on Bottom 07 h 34 m   Uncorr. Water Depth 1452 m
  Wire Length 1550 m   Wire Angle 20°
  Ship Position: Lat. 39°49.2′N; Long. 143°02.7′E
Direction of Haul 248°   Ship Speed 2 kt (till h m)
Speed Wire-in 0 m/min (from h m)   Winch No. 1
Final Time on Bottom 08 h 17 m   Uncorr. Water Depth 1460 m
  Wire Length 1500 m   Wire Angle 35°
  Ship Position: Lat. ; Long.
Time surfaced 08 h 40 m

Condition of Haul: no change.

Dredged Materials: sediment and gravels.

Worked by E. Honza et al.

DREDGE LOG

Date May 6, '69 Ship Hakuho-maru Cruise KH-69-2 Station 8
Location off Sanriku, northeastern Honshu Island, Japan
Weather Wind S 10 m/sec Sea calm, no swell
Bottom Topography slope

Type of Dredge Nalwalk's chain-bag No.2 Add. Wt. kg
Time lowered 02 h 44 m Uncorr. Water Depth 3300 m
Initial Time on Bottom 05 h 30 m Uncorr. Water Depth 3050 m
Wire Length 4800 m Wire Angle 33°
Ship Position: Lat. 39°37.8'N; Long. 143°43.4'E
Direction of haul 220° Ship Speed 2 kt (till h m)
Speed Wire-in 0 m/min (from h m) Winch No. 1
Final Time on Bottom 06 h 25 m Uncorr. Water Depth 3100 m
Wire Length 4100 m Wire Angle
Ship Position: Lat. 39°36.8'N; Long. 143°43.1'E
Time surfaced 07 h 18 m

Condition of Haul

Dredged Materials: Rocks (appr. 16 kgs) 34 pieces. Including granodiorite, pumice

Worked by H. Kagami et al.

Date May 9, '69 Ship Hakuho-maru Cruise KH-69-2 Station 18
Location northwestern slope near the crest of Seamount Erimo
Weather Wind SW Sea calm, low swell
Bottom Topography terrace

Type of Dredge Nalwalk's chain-bag No. 2 Add. Wt. kg
Time lowered 20 h 37 m Uncorr. Water Depth 4120 m
Initial Time on Bottom 22 h 30 m Uncorr. Water Depth 3950 m
Wire Length 4900 m Wire Angle 27°
Ship Position: Lat. 40°56.7'N; Long. 144°54.4'E
Direction of Haul 160° Ship Speed 1.5 kt (till h m)
Speed Wire-in 6 m/min (from h m) Winch No. 1
Final Time on Bottom 01 h 20 m Uncorr. Water Depth 4200 m
Wire Length 4100 m Wire Angle 5°
Ship Position: Lat. 40°56.6'N; Long. 144°54.5'E
Time surfaced 02 h 35 m (May 10)

Condition of Haul

Dredged Materials: Rocks (32 pieces, appr. 100 kgs).

Worked by R. Tsuchi et al.

DREDGE LOG

Date May 24, '69　Ship Hakuho-maru　Cruise KH-69-2　Station 21
Location western slope of Vogorov Seamount, Sea of Japan
Weather　Wind　Sea calm, low swell
Bottom Topography smooth slope

Type of Dredge Nalwalk's chain-bag No. 1　Add. Wt. 100 kg
Time lowered　13 h 30 m　Uncorr. Water Depth 3000 m
Initial Time on Bottom 15 h 50 m　Uncorr. Water Depth 3100 m
Wire Length 4500 m　Wire Angle 15°
Ship Position: Lat. 42°43.6′N; Long. 136°19.2′E
Direction of Haul 90°　Ship Speed 0 kt (till h m)
Speed Wire-in 10 m/min (from h m)　Winch No. 1
Final Time on Bottom 17 h 29 m　Uncorr. Water Depth 3150 m
Wire Length 3390 m　Wire Angle 16°
Ship Position: Lat. 42°43.7′N; Long. 136°19.9′E (16 h 00 m)
Time surfaced 18 h 20 m

Condition of Haul: several shocks over 3 ton after the second hit on bottom, max. 4.0 ton tension increase)

Dredged Materials: 5 pieces of solid rocks (appr. 1 kg in total), many gravels and pebbles of several mm, and 9 mud rocks.

Worked by K. Kobayashi et al.

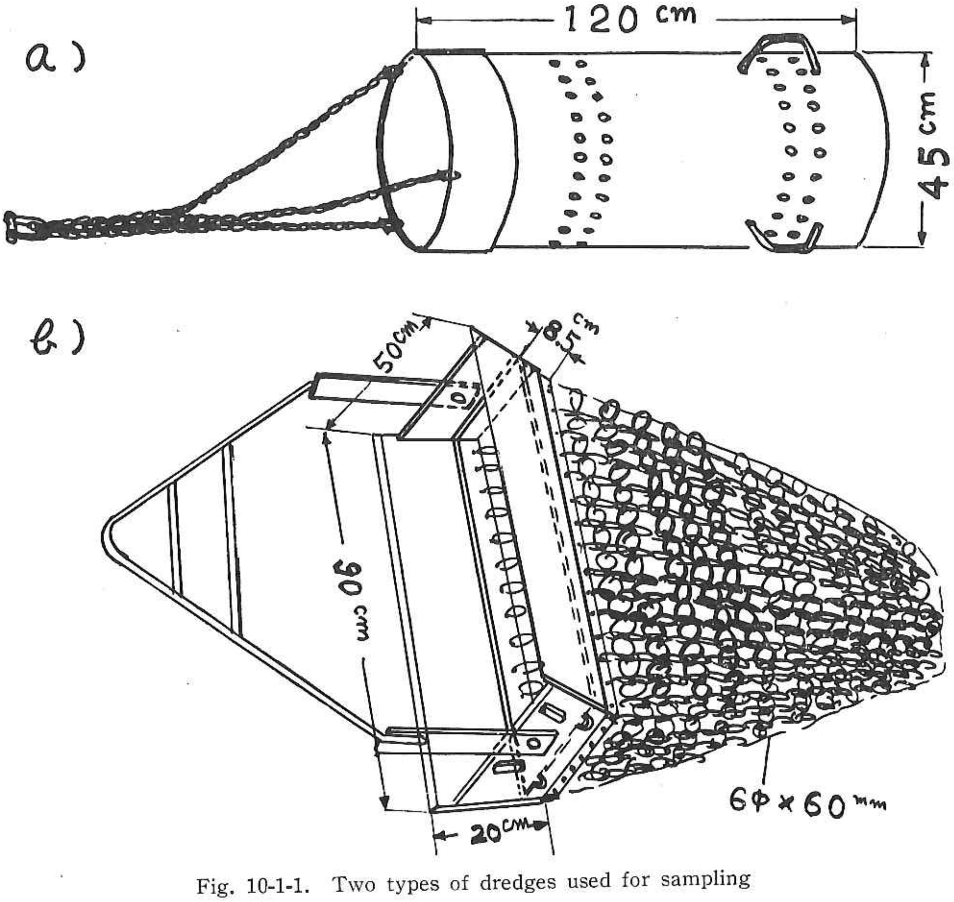


Fig. 10-1-1. Two types of dredges used for sampling

10-2. List of dredged materials

Sample No.	Size (cm) a b c	Round-ness	Weight (kg)	Mn-coating	Porosity	Descriptions
1-1	16 ×13 × 7	S R	1.0	0	l	Basaltic rock
1-2	13 ×10 × 7	S A	0.4	0	l	//
1-3	14 ×11 × 7	S A	0.6	0	l	//
1-4	13 × 8 × 6	R	0.5	0	l	//
1-5	18 ×18 × 9	M	2.2	0	h	//
1-6	29 ×19 ×10	M	4.4	0	h	//
1-7	14 ×11 × 6	S A	1.0	0	h	//
1-8	9 × 8 × 5		0.2	0	h	//
1-9	15 ×14 ×14	M		0	l	//
1-10	20 ×14 ×12	M	2.8	0	l	//
1-11	19 ×12 ×10	S A	2.0	0	l	//
1-12	13 ×13 × 8	S A	0.6	0	l	//
1-13	11 × 9 × 8	A	0.6	0	h	//
1-14	19 ×11 × 8	A	0.6	0	l	//
1-15	14 ×10 × 7	A	0.5	0	h	//
1-16	15 × 9 × 7	A	0.6	0	l	//
1-17	10 × 8 × 8	A	0.5	0	h	//
1-18	13 ×12 × 8	A	1.0	0	h	//
1-19	12 × 9 × 8	A	1.0	0	l	//
1-20	15 ×13 × 7	A	0.9	0	h	//
1-21	15 ×10 × 8	A	1.3	0	h	//
1-22	16 × 9 × 8	A	1.6	0	h	//
1-23	12 × 9 × 7	A	0.7	0	h	//
1-24	18 ×14 × 8	A	2.0	0	l	//
1-25	16 × 8 × 7	A	1.0	0	l	//
1-26	18 ×11 × 6	A	1.1	0	l	//
1-27	15 × 7 × 6	A	0.6	0	l	//
1-28	15 × 8 × 6	A	0.9	0	h	//
1-29	12 ×10 × 8	A	1.0	0	h	//
1-30	12 ×10 × 9		1.1	0	l to h	//
1-31	12 × 9 × 8		1.0	0	l to h	//
1-32	12 × 9 × 6		0.9	0	l to h	//
1-33	14 × 7 × 5		0.6	0	h	//

Sample No.	Size (cm) a × b × c	Roundness	Weight (kg)	Mn-coating	Porosity	Descriptions
1-34	15 × 8 × 7		0.9	0	h	Basaltic rock
1-35	13 × 8 × 8		0.7	0	h	〃
1-36	11 ×10 × 5		0.4	0	h	〃
1-37	11 × 8 × 5		0.5	0	h	〃
1-38	14 × 6 × 6		0.5	0	h	〃
1-39	16 × 8 × 8		1.1	0	h	〃
1-40	20 ×15 ×10	SR	3.2	0	h	〃
1-41	19 ×16 ×10	M	2.5	—	n	Mn-nodule
1-42	18 ×10 ×10					
1-43	24 × 6 × 6		1.0			
1-44	14 ×11 ×10		1.3	0	h	Basaltic rock
1-45	16 ×14 ×13		3.2			
1-46	13 ×13 × 7		0.6	0	h	Basaltic rock
1-47	24 ×15 ×15	SR	5.0	0	h	〃
1-48	16 ×12 × 8		1.1	0	h	〃
1-49	15 ×10 × 7	SR	0.9	0	h	〃
1-50	11 ×10 × 6	SA	0.5	0	h	〃
1-51	12 ×10 × 7	A	0.6	0	h	〃
1-52	17 ×12 × 7	A	1.3	0	h	〃
1-53	22 ×15 ×15		5.0		h	〃
1-54	17 ×11 × 9	SA	1.6	0	h	〃
1-55	21 ×17 ×15					〃
1-56	15 × 8 × 6	M	0.7	0	h	〃
1-57	18 ×15 ×12	A	2.2	0	h	〃
1-58	12 ×10 × 7	M	0.7	0	l	〃
1-59	10 × 7 × 6	SR	0.7	0	l	〃
1-60	10 × 8 × 7	SA	0.5	0	h	〃
1-61	9 × 7 × 7	A	0.3	0	l	〃
1-62	10 × 8 × 7	A	0.3	0	l	〃
1-63	11 × 8 × 7	SA	0.5	0	l	〃
1-64	14 × 8 × 6	A	0.5	0	h	〃
1-65	11 × 8 × 5	M	0.4	0	h	〃
1-66	9 × 8 × 8	M	0.5	0	l	〃
1-67	8 × 5 × 4	SR	0.2	0	h	〃
1-68	10 × 7 × 5	R	0.5	0	h	〃

Sample No.	Size (cm) a b c	Round-ness	Weight (kg)	Mn-coating	Porosity	Descriptions
1-69	7 × 5 × 4	R	0.1	0	h	Basaltic rock
1-70	8 × 5 × 4	SR	0.1	0	l	//
1-71	10 × 9 × 4	A	0.2	0	l	//
1-72	6 × 4 × 3		0.01?			
1-73	7 × 4 × 4	SR	0.05	0	l	Pumice
1-74	9 × 7 × 6		0.2			
1-75	12 × 6 × 5	SR	0.3	a	h	Mn coated altered rock
1-76	14 ×10 × 6	M	0.7	a	h	//
1-77	8 × 6 × 5	R	0.4	a		Mn-nodule
1-78	8 × 6 × 5	M	0.1	a		//
1-79	7 × 5 × 1.5		0.01?			Mn slab
1-80	10 ×10 × 3	M	0.3	a		//
1-81	10 × 6 × 5	SA	0.3	a		//
1-82	25 ×22 ×13	SR	5.5	a	h	Mn coated basaltic (?)
1-83	17 ×13 ×12	R	2.0	a	h	//
2-1-1	32 ×18 ×13	M	3.0	p~0	h	Pumice
2-1-2	18 ×16 ×13	M	2.0	p~0	h	//
2-1-3	12 ×10 × 5	SR	0.6	a	n	Mn slab
5-1	21 ×12 × 4		3.5	—	n	Mn-nodule
5-2	22 ×18 × 8	n. d	3.5	—	n	Mn slab
5-3	16 ×13 × 6	SA	1.0	—	n	//
5-4	22 ×15 × 8	A	2.0	—	n	//
5-5	24 ×16 × 7		2.5	—	n	//
5-6	15 ×11 × 7		0.6			
5-7	30 ×18 ×11		4.0	—	n	Mn-nodule
5-8	14 ×11 × 6	M	1.0	—	n	//
5-9	15 ×11 × 8		1.0			
5-10	14 ×10 × 9	A	0.8	—	n	Mn-nodule
5-11	16 ×13 × 8	M	1.5	—	n	//
5-12	9 × 8 × 8	SA	0.6	—	n	//
5-13	10 × 6 × 6	A	0.4	—	n	//
5-14	10 ×10 × 6	M	0.6	—	n	//
5-15	13 × 6 × 6					

Sample No.	Size (cm) a b c	Round-ness	Weight (kg)	Mn-coating	Porosity	Descriptions
5-16	14 × 8 × 8	M	0.6	—	n	Mn-nodule
5-17	11 × 7 × 6	A	0.4	—	n	//
5-18	11 × 8 × 4	P	0.5	—	n	//
5-19	13 × 7 × 5	M	0.7	—	n	//
5-20	14 ×11 × 4	n. d	0.6	—	n	//
5-21	8 × 7 × 5	A	0.5	—	n	//
5-22	11 × 9 × 4	M	0.6	—	n	//
5-23	12 × 6 × 5	A	0.6	—	n	//
5-24	9 × 6 × 5	M	0.4	—	n	//
5-25	7 × 7 × 3	M	0.2	0	n	Altered rock
5-26	10 × 9 × 2	P	0.5	0	n	//
5-27	7 × 6 × 5	M	0.4	—	n	Mn-nodule
5-28	7 × 6 × 5	n. d	0.3	0	h	Basaltic ?
5-29	9 × 7 × 2		0.4			
5-30	7 × 6 × 4	M	0.1	—	n	Mn-nodule
5-31	7 × 6 × 4	SA	0.1	—	n	//
5-32	8 × 7 × 5	n. d	0.4	0	l to n	Altered rock
5-33	7 × 7 × 4	M	0.5	0	//	//
5-34	9 × 6 × 2		0.3			
5-35	4 × 3 × 2		?			
5-36	6 × 4 × 3	n. d	0.1	0	l to n	Altered rock
8-1	16 ×10 × 5	M	1.0	0	n	Solid rock (unidentified)
8-2	11 ×10 × 3.5	?	0.5	0	n	//
8-3	8.5× 8.5× 5	SR	0.4	0	n	//
8-4	9 × 8 × 1.5	P	0.3	0	n	//
8-5	10 × 9.5× 6	SR	1.0	0	n	//
8-6	7 × 7 × 2		0.1	0	n	//
8-7	11 × 7 × 6.5	SR	1.0	0	n	//
8-8	13 × 6.5× 5		1.0	0	n	//
8-9	7.5× 6 × 6	A	0.5	0	n	//
8-10	13 × 8 × 7	R	1.4	0	n	//
8-11	8 × 6 × 3	M	0.2	0	n	//
8-12	7 × 6.5× 3		0.3	0	n	
8-13	6 × 5 × 4		0.4	0	n	Solid rock (unidentified)

Sample No.	Size (cm) a b c	Round-ness	Weight (kg)	Mn-coating	Porosity	Descriptions
8-14	9.5× 5 × 5	M	0.5	0	n	Solid rock (unidentified)
8-15	7 × 4 × 2.5		0.2	0	n	
8-16	10 × 7 × 4.5	?	0.2	0	h	Pumice
8-17	5 × 5 × 1.5		0.1	0	n	
8-18	9 × 8 × 4	A	0.5	0	n	n.d
8-19	7 × 5 × 3.5	M	0.4	0	n	//
8-20	5.5× 4.5× 2	SR	0.1	0	n	//
8-21	9.5× 6 × 2.5	M	0.1	0	n	//
8-22	8 × 6.5× 2		0.4	0	n	
8-23	5.5× 4.5× 2.5		0.1	0	n	
8-24	6 × 4 × 3	M	0.5	0	n	
8-25	11 × 8 × 7	M	1.0	0	n	Granodiorite
8-26	12.5× 6 × 3.5	?	0.6	0	n	
8-27	9 × 7 × 1	n. d	0.4	0	n	
8-28	9 × 6 × 6		0.6	0	n	
8-29	6.5× 4.5× 0.5		0.1	0	n	
8-30	7 × 6.5× 5		0.5	0	n	
8-31	7.5× 4.5× 0.5		0.1	0	n	
8-32	8.5× 7.5× 4	A	0.5	0	n	
8-33	8.5× 5.5× 1		0.1	0	n	
8-34	5 × 4.5× 1.5		0.1	0	n	
18-1	50 ×30 ×25	SA	29	0	partly h	Very altered tuff breccia
18-2	26 ×23 ×13	A	6.7	0	l	Lava, crystal in cavity
18-3	25 ×23 ×13	SA	8.7	0	l to h	Basalt lava, brecciated-vein found
18-4	30 ×15 ×10	M	5	0	n	Fine-grained chilled margin? brecciated lava (basalt)
18-5	30 ×10 × 7	A	2.5	0	l	Fine-grained basalt (slight alteration)
18-6	20 ×15 ×10	M	3.1	0	h	Tuff breccia (Palagonite?)
18-7	18 ×18 × 8	M	3.8	0	h	
18-8	15 ×10 ×10	SA	1.8	0	l to h	Tuff breccia
18-9	20 ×12 × 8	SR	1.9	0	l	//
18-10	22 ×13 ×10	SR	2.6	0	l	//
18-11	20 ×18 ×10	SA	2.9	0	h	Basaltic lava (porous)

Sample No.	Size (cm) a b c	Round-ness	Weight (kg)	Mn-coating	Porosity	Descriptions
18-12	16 ×10 ×10	M	1.4	0	l	Tuff breccia
18-13	18 ×12 × 7	SA	1.5	0	l	Tuff
18-14	13 × 8 × 6	SA	1.0	0	h	Fresh basaltic lava
18-15	12 × 6 × 5	SA	1.4	0	h	〃
18-16						
18-17						
18-18						
18-19	15 ×12 ×10	M	1.3	0		Tuff breccia, zeolite
18-20	12 × 8 × 8	?	0.7	0	n	Fresh basaltic lava
18-21	9 × 9 × 7	SR	0.6	0	l	
18-22	8 × 5 × 4	SA	/	0		
18-23	6 × 5 × 4	SA	/	0		
18-24	7 × 4 × 4	SA	/	0	n	
18-25	15 ×10 × 8	M	1.1	0	l	Green colored, coarse (zeolitized tuff breccia)
18-26	12 ×10 × 7	A	0.9	0	n	
18-27	13 ×10 × 7	M	0.6	0	h	Scoria
18-28	8 × 6 × 6	?	0.3	0	n	
18-29	3 × 3 × 3				n	
18-30	13 ×10 × 7		0.7	0	l	Fresh basaltic lava
18-31	15 ×14 ×10	A	2.6	0	l	coarse, altered
18-32	14 ×14 × 8	?	1.4	0	n	Fresh basaltic lava
21-1-1	10 ×7~5× 8	A		0	h	
21-1-2	9 × 6 × 4	R		0		Acidic large phenocryst
21-1-3	6 × 6 × 5	SA		0	n	Volcanic rock
21-1-4	7.5× 4.5× 1.5	R		0		Welding? Quartz porphyry
21-1-5	5 × 3 × 2	R		0		
21-1-6	many pebbles (a few mm)			0		
mud rocks						
1	13 × 8.5× 2.5	SR		0	h	
2	10.5× 6 × 2.5	R		0	h	
3	13 × 7 × 3	SR		0	h	
4	10 × 7.5× 3	SR		0	h	

Sample No.	Size (cm) a b c	Round-ness	Weight (kg)	Mn-coating	Porosity	Descriptions
5	11.5× 5.5× 2.2	S R		0	h	
6	6.5× 4 × 2.5	S R		0	h	
7	4.5× 3.5× 3.5	M		0	h	
8	4 × 5.5× 2.5	M		0	h	
9	more than 10 (a few cm)					

Notation; R : round, SR : subround, M : mediate, SA : subangular, A : angular
P : platy, h : high, l : low, n : none, a : all coated
p : partly coated, 0 : no coating, n.d : not determined

10-3. A remark on the dredge stations 1-1, 2-1 and 5-1

Kazuo Kobayashi

One of the principal interests of the dredge project during the early half of this cruise is to find if there is any distinction of bottom materials between the station 2-1 and stations 2-1, 5-1. It has been found by the previous magnetic and bathymetric survey (KH-67-2) that the seamount Kashima II is strongly magnetic, while a seamount (unnamed but tentatively called the seamount Mizunagi) is not. The present investigation of local magnetic anomaly and bathymetry confirms the above conclusion. Furthermore, another nonmagnetic seamount has been discovered in the northeast neighborhood of the seamount Kashima II during the present cruise. The station 1-1 is the southeastern flank of the seamount Kashima II (normally magnetic), while the stations 2-1 and 5-1 are the southeastern flank of a seamount beside Kashima II and southeastern flank of the Mizunagi seamount, respectively.

Number of dredge hauls was unfortunately limited due to the restriction in time and only one haul was possible for one seamount. Total amount recovered by the dredge was not sufficiently large to provide any significant conclusion in the station 2-1. However, a remarkable contrast of dredged rocks at station 1-1 to those at station 5-1 seems important, because it may have some relevance to the difference in their magnetic anomaly. From the list of dredged materials (§ 10-2), weight percentage of the recovered samples is calculated and shown below:

Station	Basaltic (fresh) rocks	Altered rocks	Mn-nodules and slabs	Pumice	Total wt.
1-1 (magnetic seamount)	84%	10%	6%	0.1%	82kg
2-1 (non-magnetic seamount)			11%	89%	6kg
5-1 (non-magnetic seamount)	1%	5%	94%		30kg

Basaltic rocks collected at station 1-1 are highly magnetic. Their natural remanent magnetization is in the order of 10^{-3} emu/cc according to the reconnaissance measurement on board this ship. Such a high intensity of remanence can naturally explain the magnetic anomaly observed on the ocean surface above the seamount on an assumption that the seamount is uniformly magnetized. On the contrary, manganese nodules have no remanent magnetization. The pumices and altered rocks are also weak in natural remanent magnetization. Therefore, if these seamounts are mostly composed of such "non-magnetic" materials, they can be naturally non-magnetic.

Comprehensive studies of other non-magnetic seamounts have been previously reported by Black et al. (Quart. J. Geol. Soc. Lond. *120*, 477-517, 1964). Their conclusion that the non-magnetic seamounts are composed of limestone seems feasible because they lie in the continental margins off the Iberian coast. Two non-magnetic seamounts described here are different from the Iberian ones as the present seamounts are located in the oceanic side of the Japan Trench. More plausible origin of the non-magnetic seamounts may be their distinct mode of volcanic activity. As Bonatti pointed out (in Res. in Geochem. vol. II, ed. Abelson, 1966), more viscous magma coming out into the sea water in an explosive manner wili be strongly influenced with the sea water. It may be unlikely in such a case that usual highly magnetic basaltic lavas containing fine-grained titanomagnetite occur. Much amounts of ferro-manganese oxides, altered rocks and pumices are more likely to be formed there. The result of the observation of dredged materials seems consistent with this conception. Of course, there is no available evidence exhibiting the composition and structure of the interior of the seamounts. Only one dredge haul is too little to deduce any conclusive statement, concerning any distinction of the origin of the seamounts but it may stimulate further studies from the viewpoint mentioned here.

10-4. Bottom sampling by dredges at the continental slope off Sanriku district, northeastern part of the main island of Japan

Eiichi Honza and Hideo Kagami

Bottom materials were collected by dredge hauls at the regions off Sanriku district, northeastern part of the main land of Japan to study the tectonic development of the continental terrace and the Japan Trench. Dredging sites were decided considering the profiling data. They are shown in Table 10-4-1.

1. Station 6 (Dredge No. 4)

This station is located on the lower continental slope. Chain dredge (No. 2) was used. No rock sample was obtained because the bottom slope was covered by thick soft or semiconsolidated sediment. It was observed that blue clay was stuck to the frame of dredge.

2. Station 11-1 (Dredge No. 6)

At this station located near the top of a small hill on the submarine spur a stainless bucket-type dredge was tried. A large quantity of soft sediment amounting to about 3/4 of the bucket was obtained. It contained tiny granules of sedimentary rocks and igneous rocks. They are divided into three types; soft sediment, pebbles of 1～3 millimeter in grain size and larger than 3 millimeter.

Benthic animals larger than 1 millimeter were picked up by benthos-studying group. Soft sediment was sampled by K. Taguchi to study organic carbon.

3. Station 8 (Dredge No. 7)

This station is located at the upper continental slope and the chain dredge was used there. Thirty-five pieces of rock fragments and one piece of semiconsolidated sediment were obtained.

Rock fragments range from a few centimeters to about 10 centimeters in length and from 0.1 to 1.4 kilograms in weight (see Table of dredged materials). They are sandstones, slates, altered igneous rocks and granodiorite and granitic porphyry. These assemblages are very similar to rocks at Kitakami Mountains in the Sanriku district.

Relatively larger fragments were cut on the ship and delibered to three research groups; K. Kobayashi and M. Kinoshita for rock magnetism and radioisotope dating; H. Aoki for petrology of volcanic rocks; and H. Kagami and E. Honza for petrology of sedimentary rocks.

Table 10-4-1. Position of dredging sites and bottom topography

St. No.	Dredge No.	Lat.	Long.	Depth	Bottom Topography
6	4	39°33.4′N	144°06.0′E	5650m	lower continental slope
11-1	6	39°49.2′	143°02.7′	1450	hill on the submarine spur
8	7	39°37.8′	143°43.4′	3050	upper continental slope

11. Deep-sea photography

11-1. General remarks

Toshisuke Nakai, Hiroshi Hasumoto, Chiaki Igarashi and Shigeo Tanaka
(from St. 1–2 to St. 19)
Hirotaka Otobe, Chiaki Igarashi and Shigeo Tanaka
(from St. 20–2 to St. 26–4)

Photographies of the bottom of the sea were taken at seamounts, continental slope and trench near and around north east of Japan and Japan Sea, usually near the position for dredging, core sampling and beam trawling.

Number of observation by the deep sea camera combining with dredging, core sampling and beam trawling is each 6, 1 and 4. In addition to this, observation was tried at the axis of the trench.

Camera (EG and G Model 200 underwater camera), flash (EG and G Model 210 underwater light source), sonar pinger (EG and G Model 220 sonar pinger) were mounted on a rack with tilt switch (EG and G Model 293A tilt switch), and operated by the use of No. 1 or 6 winch of the Hakuho-maru. The operation of the camera was tried in two ways, one was using tilt switch and the other was using the time delay switch. In this cruise, the tilt switch was replaced by non return switch to keep the switch on when the pilot weight once touches the bottom. The tilt switch was used 8 times and the time delay switch was used 4 times.

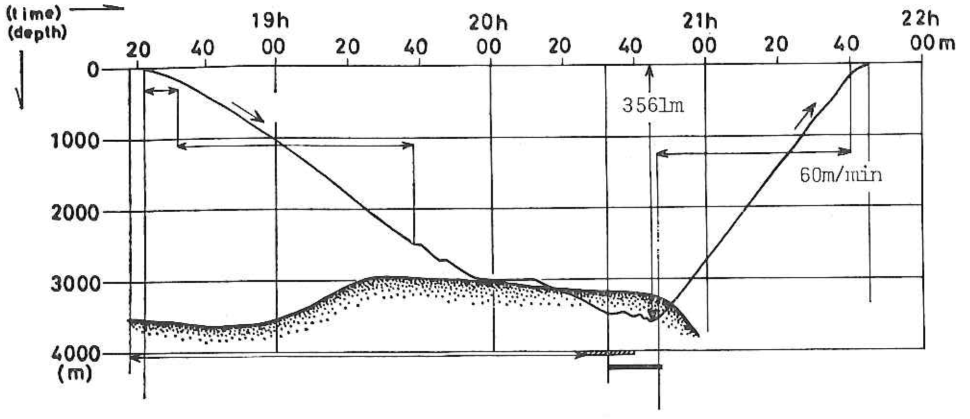
Among 12 observations, 9 were successfull, 2 were not successfull and gave up 1 in the midst of wire lowering due to the bad condition of the sea. The causes of the two failures are clear. In the first case, non return tilt switch became on due to the flapping of the rack by heavy swell while lowering. The second case was mis-setting of the shutter.

In order to see the dimension of the object at the bottom, three kinds of target were suspended from the rack by ropes, in such a way to be photograph taken with the bottom. These targets are small weight, with diameter of 80 mm, 50 mm and of 20 cm length and suspended respectively by ropes of 4.75 m, 2 m and 1.5 m length. Brief results are shown in Table 11-1-1. The operation log is shown in the following records (§11-2). Results are also shown in Photos. 11-3.

Table 11-1-1. Result

St. 1-2	duration of photography	20 : 30—20 : 47
	number of frames	78
	number of exposure	14
	important object	Bottom with scattering nodules and rocks.
	remarks	63 frames were not exposed and 1 frame was multiplex exposed because of a not good condition of the flashing system.
St. 2-2	duration of photography	18 : 47—19 : 05
	number of frames	91
	number of exposure	15
	important object	pebbly bottom
	remarks	The flash was not good condition. The time delay switch was delayed about 10 min to the pre-set time.
St. 5-2	duration of photography	21 : 55—22 : 08
	number of frames	94
	number of exposure	90
	important object	starfish
	remarks	Some amount of water was leaked inside the camera case.
St. 12-3	duration of photography	22 : 42—23 : 02
	number of frames	94
	number of exposure	90
	important object	Umishida, Sokounagi, Kaimen, Ebi, Kasago, Umitengu-dake.
	remarks	A target was hanged from the rack, but its photograph was not taken because the weight of the target was so light that the string suspending the target was coiled around the racks.
St. 16-3	duration of photography	18 : 31—18 : 51
	number of frames	100
	number of exposure	93
	important object	Starfish, Sokounagi, Sokodara, etc.
	remarks	The target photography was taken.
St. 11-4	duration of photography	18 : 10—18 : 18
	number of frames	39
	number of exposure	37
	important object	Muchiyagi, Kinugasamozuru, Umishida, Kumohitode, Gokai.
St. 9-3	remarks	The signal from the pinger was not caught due to the bad condition of the sea and the operation was given up in the midst of wire lowering.
St. 18-2	duration of photography	05 : 14—05 : 33
	number of frames	93
	number of exposure	90
	important object	Pebbly bottom with starfish, makigai, sea urchin, fishes.
St. 19	duration of photography	14 : 35—15 : 07
	number of frames	161
	number of exposure	50
	important object	Muddy bottom with numerous tracks showing activity of animals on the surface.
St. 20-2	remarks	The non return tilt switch became on because of flapping of the rack by heavy swell while wire lowering, so the pictures were all sea-water.
St. 21-2	remarks	Film was not exposed because of our mis-setting of the shutter.
St. 26-4	duration of photography	17 : 06—17 : 20
	number of frames	55
	number of exposure	42
	important object	Starfish, Ei, Isoginchaku, fishes and benthic animals.

11-2. Records of operation

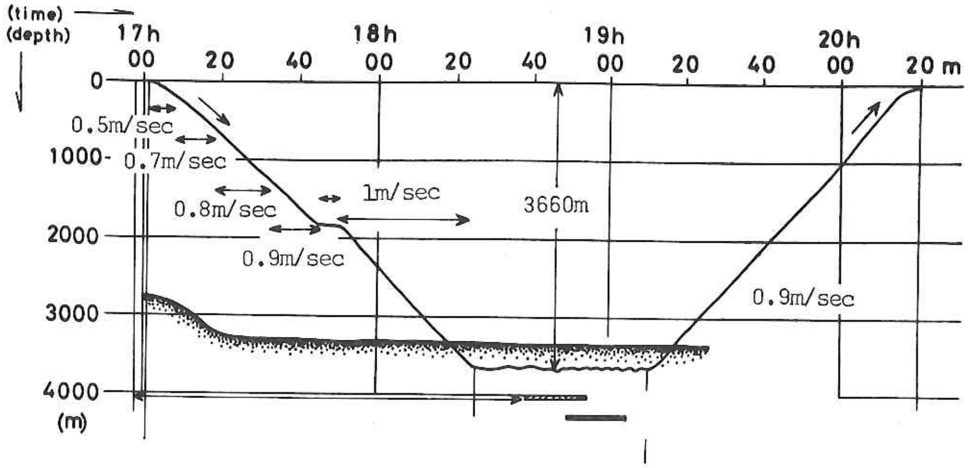


Schedule duration of photographing

Actual duration of photographing

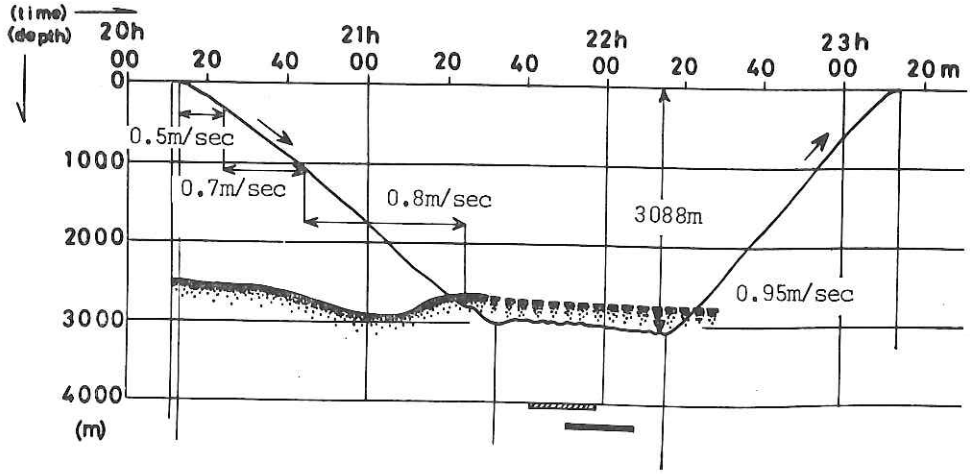
Operation number of underwater camera: 1

Cruise No.: KH-69-2 Station No.: 1-2 Date: April 27 '69
Time: 18: 15—20 : 30—21 : 50
Location: 36°02.7 N, 143°32.8 E, (near the peak of Kashima II seamount)
Depth: 3150 m Weather: cloudy Wind: ENE-2 Sea: ENE-2 Swell: 3
Air temp.: 15.2 Sea temp.: 19.1 Film: Kodak TRI×PAN Film length: about 5 m
Lens focused: 12 feet Iris: F/8 Shutter: 1/50
Operation: automatic triggering with shutter, time delay switch was preset at 120 min, mounted with pinger
Remarks: performed the pre-immersion checkout, used the No. 1 winch, combined with dredging



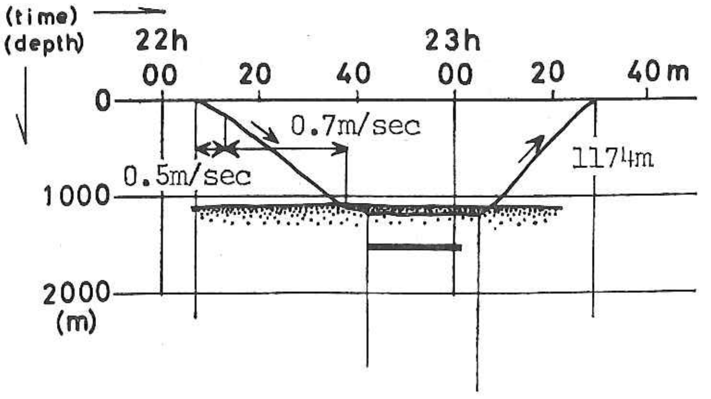
Operation number of underwater camera: 2

Cruise No.: KH-69-2 Station No.: 2-2 Date: April 28 '69
Time: 16: 51—18: 40—20: 20
Location: 36°17.6 N, 144° 00.3 E, (80° 1.5 nautical mile off the peak of seamount)
Depth: 3350 m Weather: fine Wind: NE-2 Sea: NE-2 Swell: 3 Air temp.: 15.8
Sea temp.: 17.0 Film: Kodak TRI×PAN Film length: about 6 m
Lens focused: 12 feet Iris: F/8 Shutter: open
Operation: shutterless operation, time delay switch was preset at 100 min, mounted with pinger
Remarks: hanged a small marking weight and added two heavy iron bars to mounting rack, used the No. 5 winch, combined with dredging



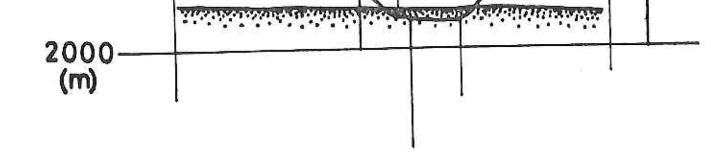
Operation number of underwater camera: 3

Cruise No.: KH-69-2 Station No.: 5-2 Date: April 30 '69
Time: 20: 10-21: 50-23: 11 Location: 37°07.8 N, 145°18.8 E, (near the peak of sea mountain)
Depth: 2750 m Weather: fine Wind: NNW-2 Sea: NNW-2 Swell: 3
Air temp.: 14.8 Sea temp.: 15.8 Film: Kodak TRI×PAN Film length: about 6 m
Lens focused: 12 feet Iris: F/9.5, Shutter: open
Operation: shutterless operation, time delay switch was preset at 90 min, mounted with pinger
Remarks: microswitch replaced, flash bulb replaced, combined with dredging, used No. 5 winch



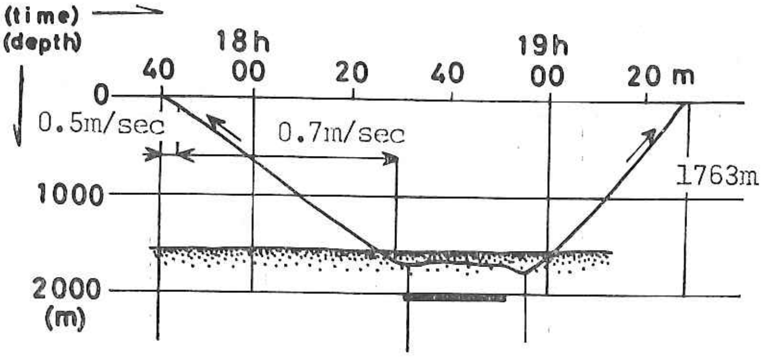
Operation number of underwater camera: 4

Cruise No.: KH-69-2 Station No.: 12-3 Date: May 02 '69
Time: 22: 00—22: 43—23: 40 Location: 39° 39.4 N, 142° 45.0 E (continental slope off Sanriku)
Depth: 1100 m Weather: clear Wind: SW-4 Sea: SW-4 Swell: 4 Air temp.: 13.8
Sea temp.: 9.9 Film: Kodak TRI×PAN Film length: 6 m Lens focused: 8 feet
Iris: F/9.5 Shutter: 1/25
Operation: automatic triggering with shutter, mounted with non return tilt switch and pilot weight
Remarks: O-ring replaced, camera window repaired, hanged three marking ropes from mounting rack, used the No. 5 winch combined with beam trawling



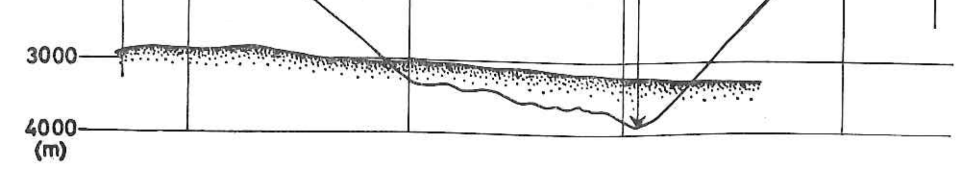
Operation number of underwater camera: 5

Cruise No.: KH-69-2 Station No.: 16-3 Date: May 04 '69
Time: 17: 30—18: 32—19: 35 Location: 40° 21.7 N, 143° 03.9 E (continental slope off Sanriku)
Depth: 1570 m Weather: fine Wind: S-6 Sea: S-4 Swell: 3 Air temp.: 13.5
Sea temp.: 10.0 Film: Fuji Neopan SS Film length: 6 m Lens focused: 8 feet
Iris: F/4.5 Shutter: 1/25
Operation: automatic triggering with shutter, mounted with non return tilt switch and pilot weight
Remarks: hanged three marking ropes from mounting rack, used the No. 5 winch, combined with trawling



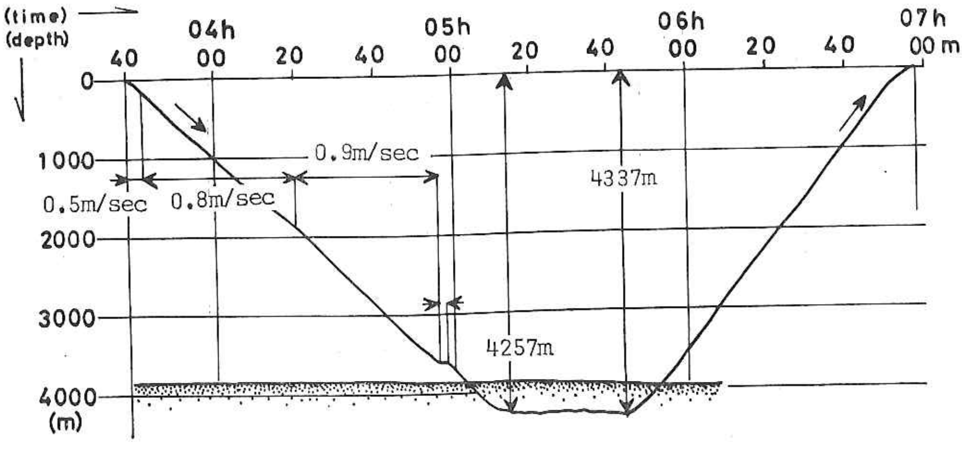
Operation number of underwater camera: 6

Cruise No.: KH-69-2 Station No.: 11-4 Date: May 05 '69
Time: 17: 15—18: 10—18: 54 Location: 39° 40.0 N, 142° 59.9 E (continental slope off Sanriku)
Depth: 1558 m Weather: fine Wind: S-5 Sea: S-4 Swell: 4 Air temp.: 15.4
Sea temp.: 15.5 Film: Kodak TRI×PAN Film length: 3 m Lens focused: 6 feet
Iris: F/9.5 Shutter: 1/50
Operation: automatic triggering with shutter, mounted with non return tilt switch and pilot weight
Remarks: shutter lever repaired, connected film, hanged 20 cm scale weight from rack, used No. 5 winch, combined with trawling



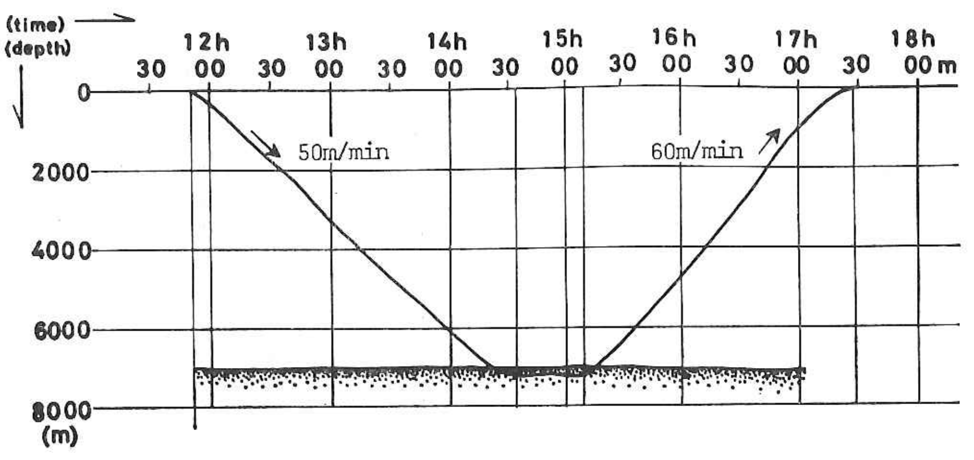
Operation number of underwater camera: 7

Cruise No.: KH-69-2 Station No.: 9-3 Date: May 06 '69
Time: 17: 33—21: 30 Location: 39° 42.4 N, 143° 47.8 E
Depth: 3000—3245 m Weather: clear Wind: NW-7 Sea: NW-5, Swell: 6
Air temp.: 11.8 Sea temp.: 14.5 Film: Fuji Neopan SS+colour N 100
Film length: 7.5 m Lens focused: 6 feet Iris: F/4.5 Shutter: 1/25
Operation: automatic triggering with shutter, mounted with non return tilt switch and pilot weight
Remarks: colour film connected with monochrome film, used No. 5 winch, combined with trawling



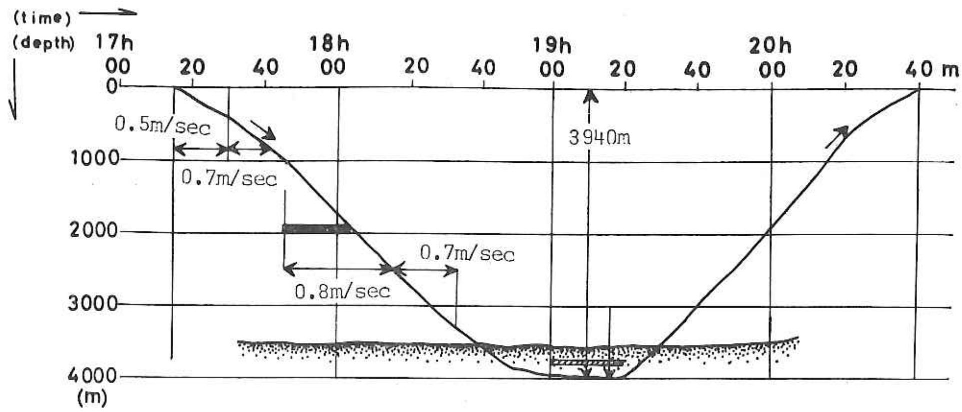
Operation number of underwater camera: 8

Cruise No.: KH-69-2 Station No.: 18-2 Date: May 10 '69
Time: 03: 35—05: 14—06: 58 Location: 40° 57.0 N, 144° 55.4 E
Depth: 3846 m Weather: fine Wind: S-4 Sea: S-2 Swell: 2 Air temp.: 11.2
Sea temp.: 8.7 Film: Fuji Neopan SS+colour N 100 Film length: 7.5 m
Lens focused: 6 feet Iris: F/4.5 Shutter: 1/25
Operation: automatic triggering with shutter, mounted with non return tilt switch and pilot weight
Remarks: combined with dredging, used No. 5 winch



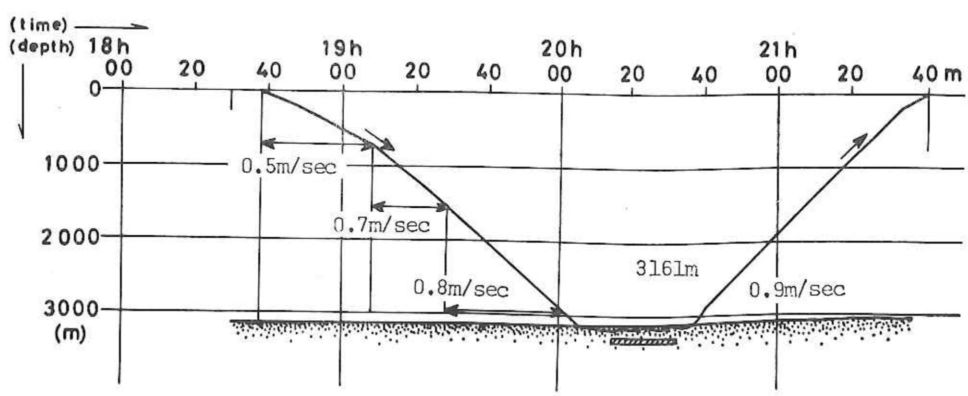
Operation number of underwater camera: 9

Cruise No.: KH-69-2 Station No.: 19 Date: May 10 '69
Time: 11: 48—14: 30—17: 28 Location: 41° 29.3 N, 145° 32.8 E
Depth: 7000 m Weather: fine Wind: SW-3 Sea: SW-2 Swell: 2 Air temp.: 11.5
Sea temp.: 10.9 Film: Kodak TRI×PAN Film length: 9 m Lens focused: 6 feet
Iris: F/9.5 Shutter: open
Operation: shutterless, triggered by non return tilt switch
Remarks: research at axis of the trench



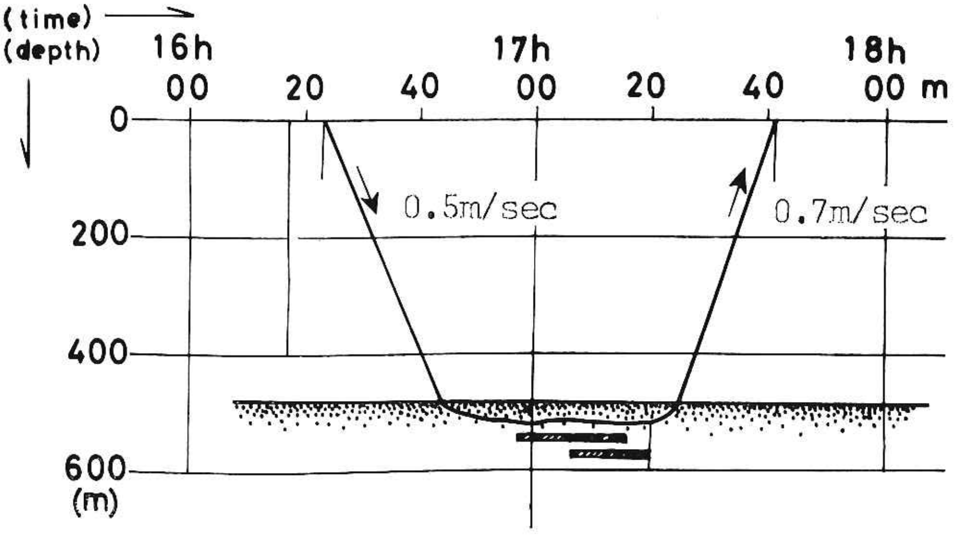
Operation number of underwater camera: 10

Cruise No.: KH-69-2 Station No.: 20-2 Date: May 19 '69
Time: 17: 15—19: 00—20: 40 Location: 43°46.8 N, 138° 33.5 E
Depth: 3550 m Weather: partly cloudy Wind: W-9 Sea: W-3 Swell: 4
Air temp.: 7.0 Sea temp.: 5.0 Film: Kodak TRI×PAN Film length: about 6 m
Lens focused: 6 feet Iris: F/9.5 Shutter: open
Operation: shutterless operation, used time delay switch (preset at 30 min) and non return tilt switch with pilot weight
Remarks: hanged 20 cm scale weight from rack, used No. 5 winch, combined with core sampling



Operation number of underwater camera: 11

Cruise No.: KH-69-2 Station No.: 21-2 Date: May 24 '69
Time: 18: 30—20: 15—21: 41 Location: 42° 44.0 N, 136° 18.8 E
Depth: 3140 m Weather: overcast Wind: Sea: Swell: 3
Air temp.: 6.8 Sea temp.: 6.2 Film: Kodak TRI×PAN
Film length: about 6 m Lens focused: 6 feet Iris: F/9.5 Shutter: open
Operation: shutterless operation, mounted with non return tilt switch with pilot weight
Remarks: exchange the pilot weight for 5 kg one, combined with dredging

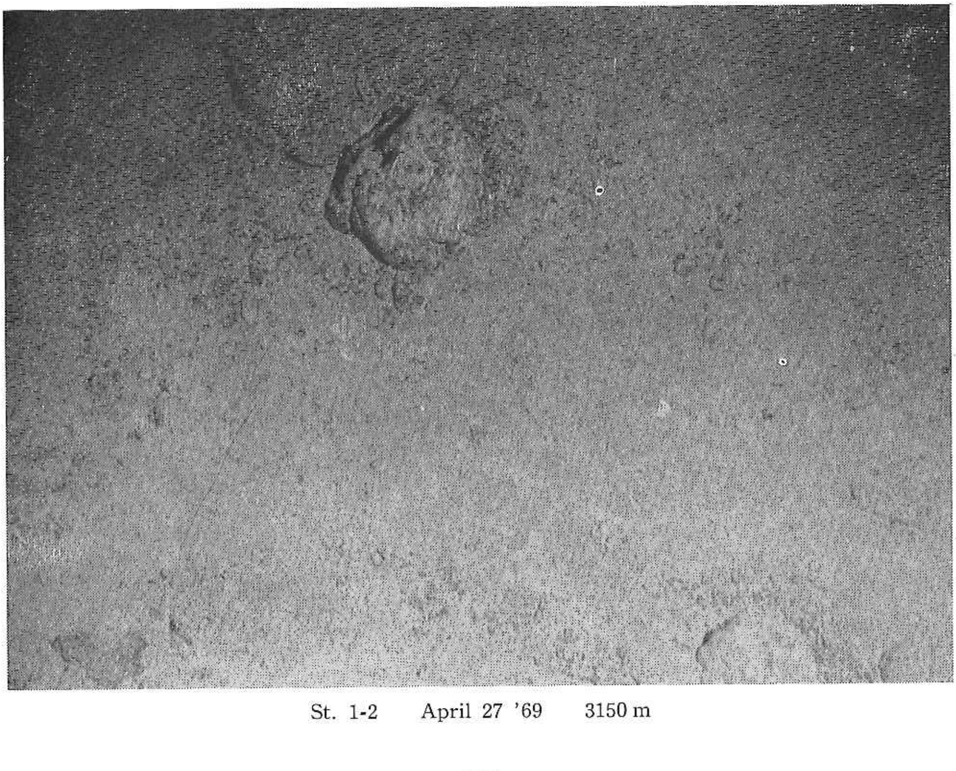


Operation number of underwater camera: 12

Cruise No.: KH-69-2 Station No.: 26-4 Date: June 08 '69
Time: 16: 17—17: 00—17: 41
Location: 39° 50.6 N, 133° 48.2 E (near the peak of Kita Yamato Tai)
Depth: 485 m Weather: partly cloudy Wind: WSW-10 Sea: WSW-4 Swell: 4
Air temp.: 15.2 Sea temp.: 13.2 Film: Kodak TRI×PAN Film length: about 6 m
Lens focused: 6 feet Iris: F/9.5 Shutter: open
Operation: shutterless operation, used time delay switch preset at 40 min
Remarks: combined with dredging, used No. 5 winch

11-3. Photographs

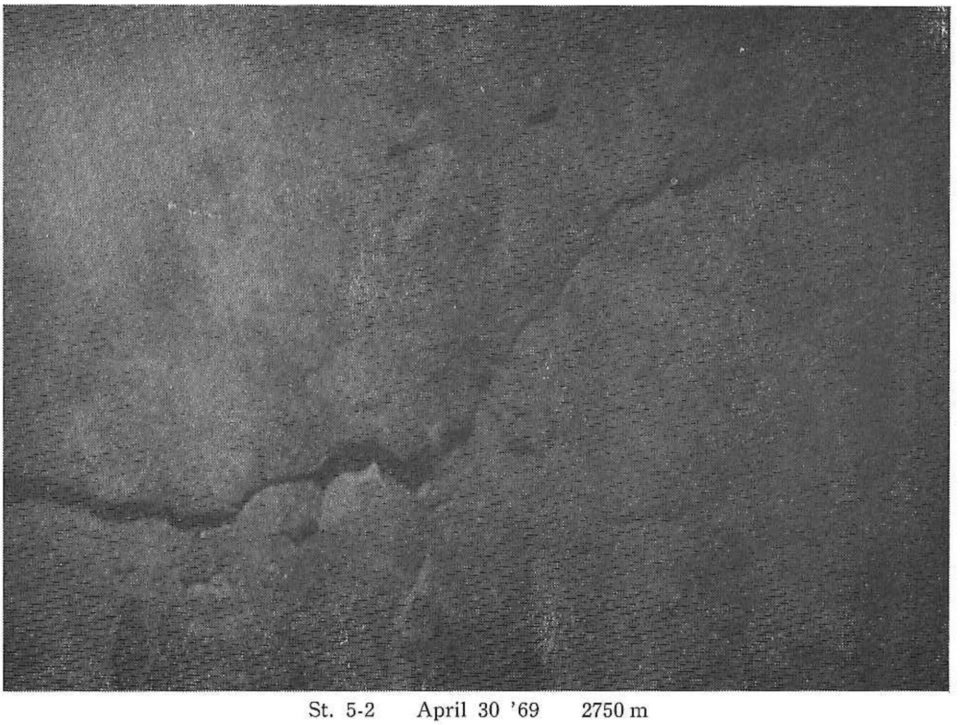
St. 1-2 April 27 '69 3150 m



St. 1-2 April 27 '69 3150 m

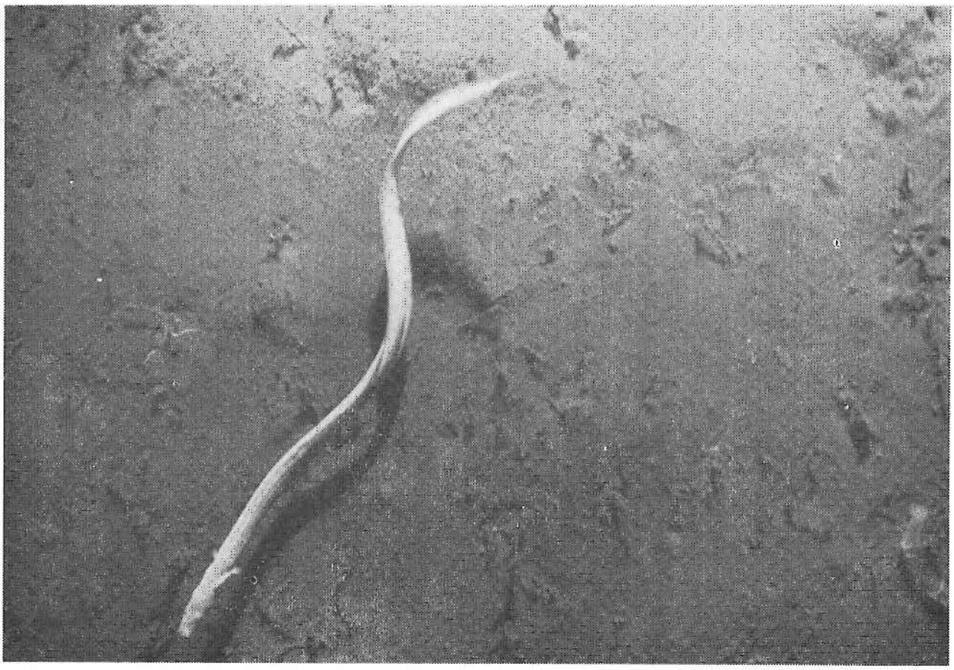
St. 2-2 April 28 '69 3350 m

St. 2-2 April 28 '69 3350 m

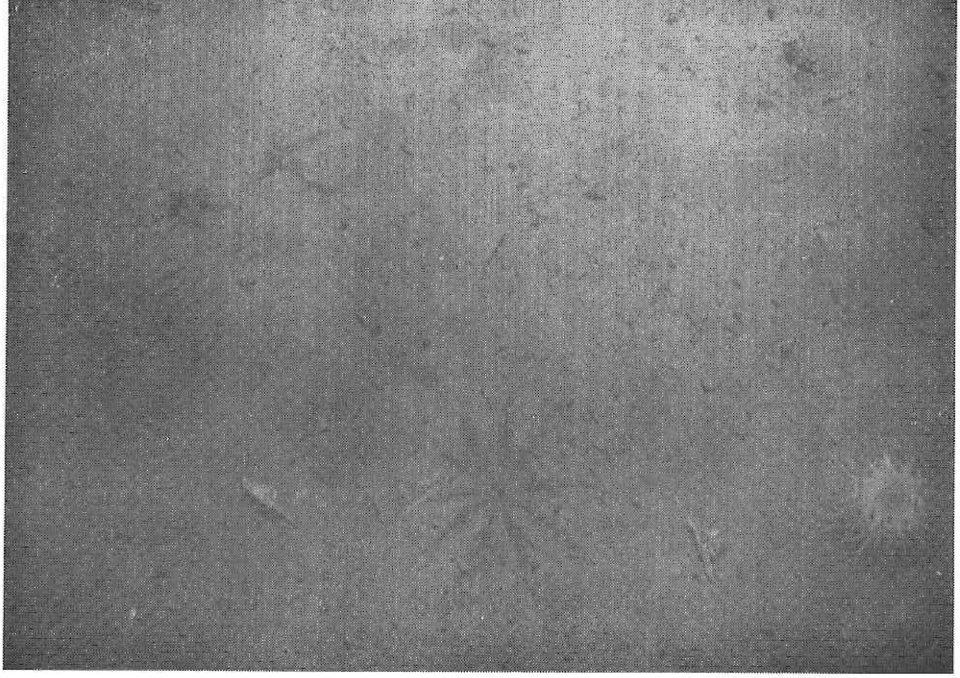


St. 5-2 April 30 '69 2750 m

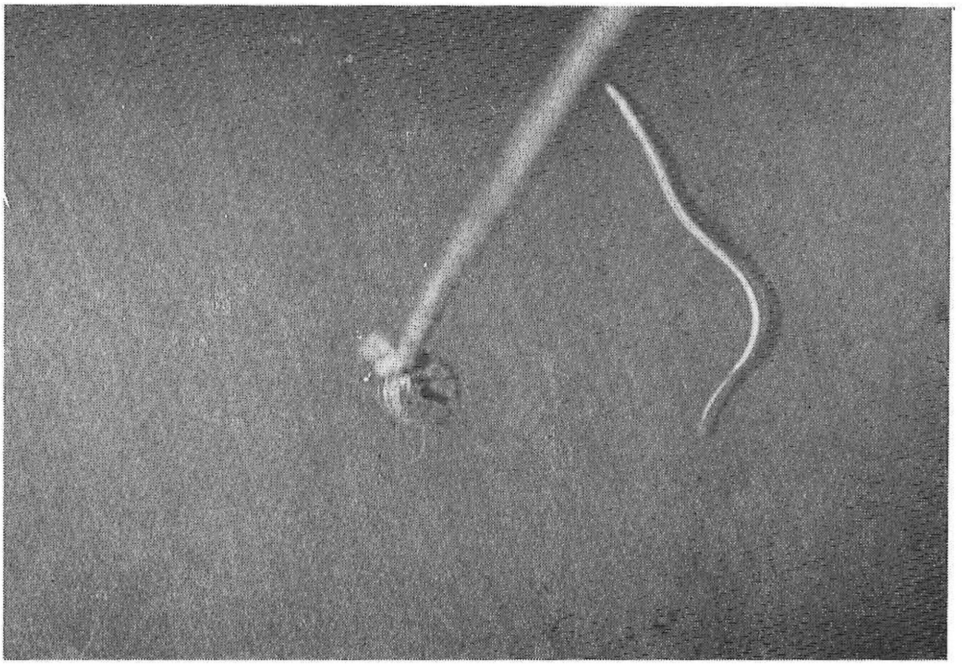
St. 5-2 April 30 '69 2750 m



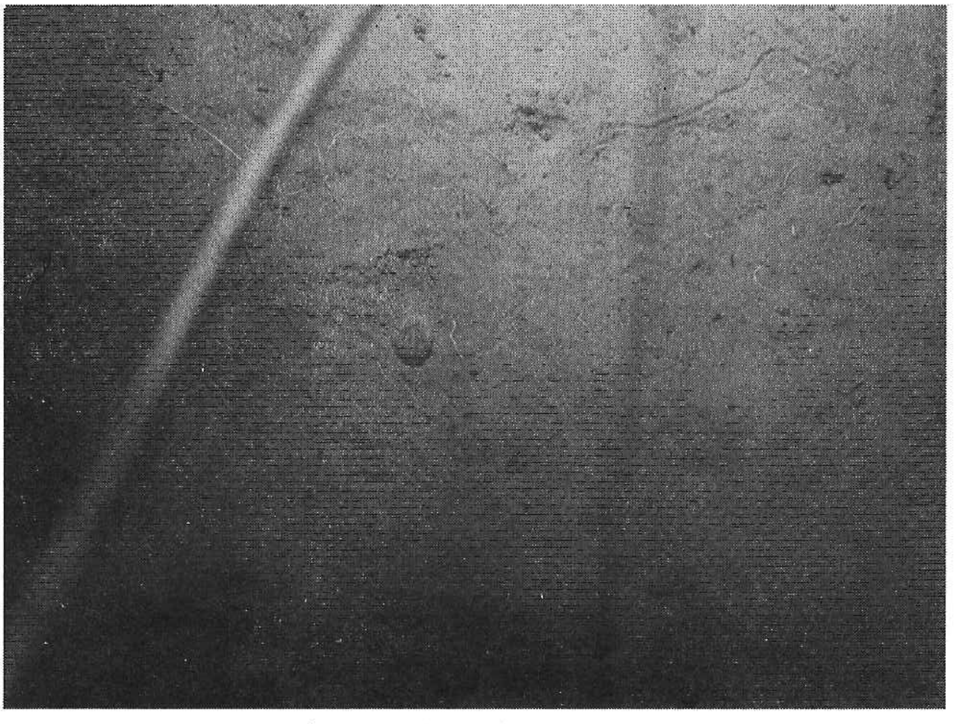
St. 12-3　　May 2 '69　　1100 m



St. 12-3　　May 2 '69　　1100 m



St. 16-3 May 4 '69 1555 m

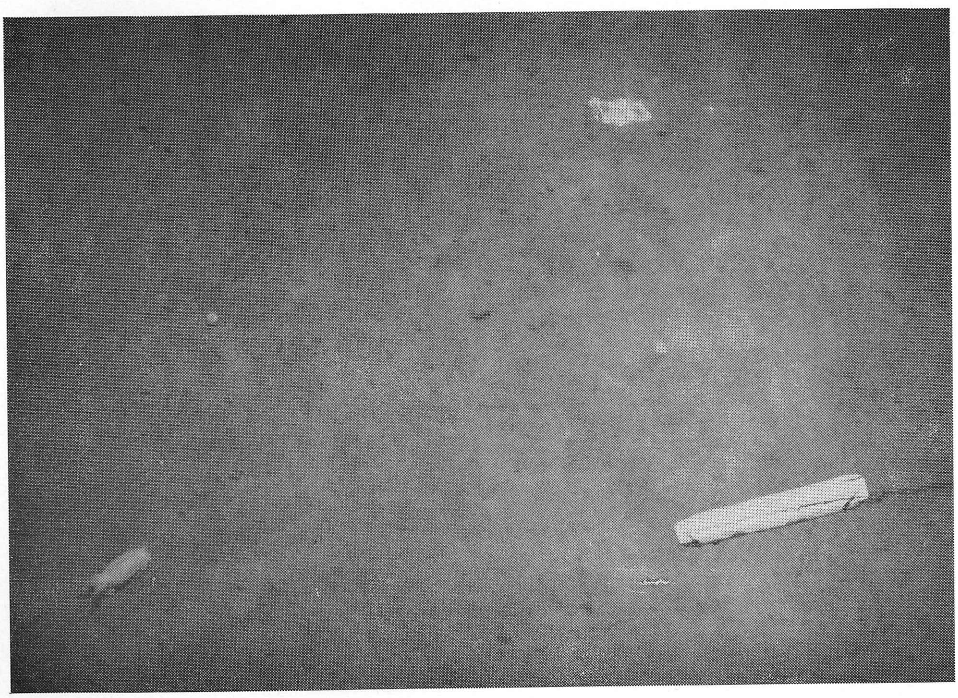


St. 16-3 May 4 '69 1555 m

St. 11-4 May 5 '69 1560 m

St. 11-4 May 5 '69 1560 m

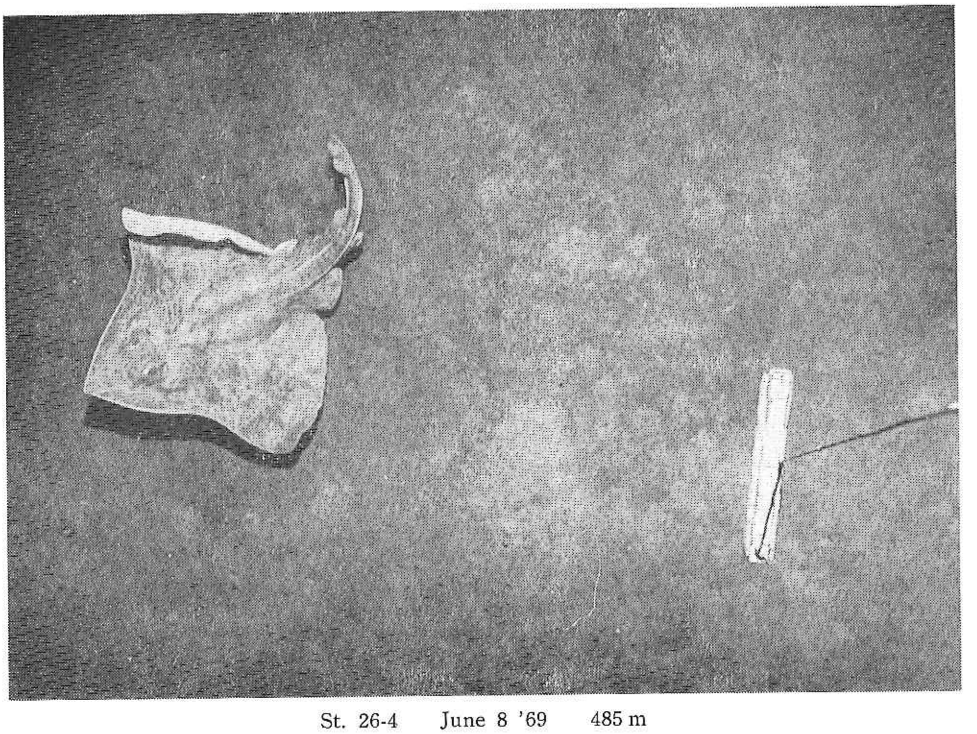
St. 18-2　May 10 '69　3846 m



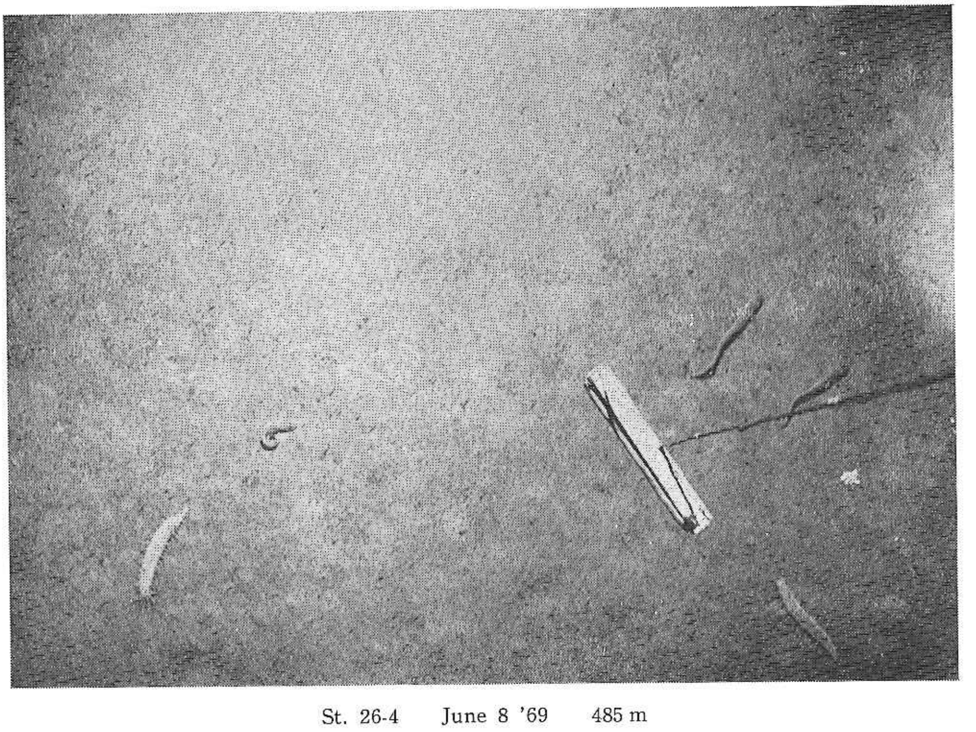
St. 18-2　May 10 '69　3846 m

St. 19 May 10 '69 7000 m

St. 19 May 10 '69 7000 m



St. 26-4 June 8 '69 485 m



St. 26-4 June 8 '69 485 m

11-4. Biological notes on the bottom photographs

Masuoki Horikoshi

St. 1-2 (3150 m)

Photos. 1, 2: Macro-benthos is not discernible.

St. 2-2 (3350 m)

Photo. 3: Several spherical objects (upper left and lower right) are seemed to be sponges, and tubes protruding from the bottom are probably those of polychaet worms. Tracks and holes are recognized.

Photo 4: One short and thick tube (center), two long tubes, and many short and thin tubes are seen. Several mounds are also recognized.

St. 5-2 (2750 m)

Photo. 5: Two comatulid (feather star) are expanding their arms (center), probably in feeding posture.

Photo. 6: A comatulid is seen in the lower center, and arms of another individual are also seen.

St. 12-3 (1100 m)

Photo. 7: A deep-sea eel (probably *Synaphobranchs*) is swimming along the bottom. Many polychaet tubes and a holothurian (sea cucumber: lower right corner) are seen.

Photo. 8: Two comatulids spreading their arms, a sea anemone, a shrimp (upper right corner, a fish (*Sebastolobus*), several ophiuroids (brittle star) and many polychaet tubes are seen. The presence of many and various animals in a single photo like this indicates the richness of the benthic fauna in this area.

St. 16-3 (1555 m)

Photo. 9: From this photograph together with No. 7, it is known that the deep-sea eels are distributed widely, if not abundant, in the bathyal zone on the Japanese Pacific Sea-shelf.

Photo. 10: Two spatangoid sea urchins are on the surface of the bottom. Many, white, string-like objects are arms of ophiurodeans (probably *Amphiura*). They are burrowing in the soft sediments, concealing their central disc, and only protrude their arms.

St. 11-4 (1560 m)

Photo. 11: On the spirally twisting stem of a gorgonian (sea whip), an epizoic ophiuroidean (probably *Asteronyx*) is climbing. A comatulid, closing their arms, is seen in between the gorgonian and its shadow. Three sea anemones are seen in the upper-most part of this photo.

Photo. 12: A large sea star (*Astropecten*) is burrowing halfly in the soft sediment. A gastropod snail and another individual of a gorgonian with epizoic ophiuroid are seen in the lower right corner. Burrowing ophiuroideans are dominant species also at this station as well as St. 16-3.

St. 18-2 (3846 m)

Photo. 13: A large ophiuroid and a sponge are seen in the lower-most part of this photograph. Many polychaet tubes are also seen.

Photo. 14: On the left side, there are seen a sea urchin and a holothurian. Note the bifurcated tail appendage of the holothurian, which is raised obliquely.

St. 19 (7000 m)

Photo. 15: Two isopod crustaceans are crawling on the bottom (top). Many tracks indicate a fairly rich fauna in this hadal depth.

Photo. 16: Unidentified spherical objects might be a benthic organism. A high mound and two types of tracks are recognized.

St. 26-4 (485 m)

Photo. 17: A skate (Rajiidae) is swimming along the bottom. Two sea stars are also seen (above the fish).

Photo. 18: Two brotulid fishes are swimming along the bottom, while another unidentified fish rests on the bottom, coiling its tail. Two elasipod holothurians are also seen.

11-5. Geological notes on the bottom photographs

Hideo Kagami and Noriyuki Nasu

St. 1-2

Photos. 1 and 2: Those photographs were obtained near the top of Kashima II Seamount. Eighty-three dredged samples at this station, consist with basaltic rocks, manganese nodules and slabs. Bottom sediment is composed of a few boulder-gravels, abundant pebble-gravels and lutite. The boulder-gravels are either manganese nodules or basaltic rocks. The pebble-gravels are identified as manganese nodules from their conglomeratic shapes. They appear to concentrate around the boulder-gravels, which may be winnowed by scouring lutite around the boulder-gravels by currents.

St. 2-2

Photos. 3 and 4: The photographs were obtained on the slope of the seamount. Approximately 700 m below the peak. Only three dredged samples consisted with pumices and a manganese slab were obtained at the station.

Lutite and organic debris cover the fairly smooth bottom surface. A few pebble–cobble size gravel sit afloat on the lutite surface. It may be a pumice.

St. 5-2

The photographs were obtained at the top of the seamount. Thirty-six dredged samples at the station were composed of altered volcanic rocks, manganese nodules and manganese slabs.

Photo. 5 shows outcrop of the volcanic rocks coated with manganese. From the step-like features of the outcrop, these rocks could be basaltic lava or basaltic clastic rocks.

Photo. 6 shows smooth surface covered by lutite and pebble size manganese nodules.

St. 12-3

Photos. 7 and 8: They were obtained on the continental slope off the Sanriku coast. No rocks were obtained by the sampling at this station.

St. 16-3

Photos. 9 and 10: Continental slope off the Sanriku coast. No sampling of the bottom sediment.

St. 11-4

Photos. 11 and 12: Continental slope off the Sanriku coast. Several gravels were sampled with soft sediment at this station. However, there are no significant appearance of existing gravels. Bottom surface seems to be mixed deposits of terrigenous and some pelagic ones. It can be called as semi-pelagic deposit.

St. 18-2

Photos. 13 and 14: Top of the Erimo Seamount. Rocks with sediment were obtained at this station. Formerly Cretaceous index fossils cemented in a calcareous sediment were obtained with olivine basalt rocks in the neighbourhood of this station.

St. 19

Photos. 15 and 16: Bottom of the Kurile Trench. No samples were obtained. However, semi-pelagic sediment was collected at several locations along the axis of the Trench.

Judging by the content of these formerly obtained samples, it is expected that the deposit under photo will be consisted of mixed sediment of terrigenous materials with red clay, and will contain a lot of diatomaceous remains.

St. 26-4

Photos. 17 and 18: Top of the Kita-Yamato Bank, Sea of Japan. Bottom surface seems to be consisted of rather coarse materials with silt-clay sediment.

12. Studies on the deep sea benthos in the bathyal zone on the Japanese Pacific Sea-shelf

Masuoki Horikoshi, Shigeo Gamo, Minoru Imajima and Sadao Kosuge

For the quantitative study of the smaller macro-benthos, two Smith-McIntyre bottom samplers were set within an iron frame together with a sonar pinger and two Van Dorn water samplers (ORI Double Sampler Frame: Horikoshi, M. 1968: Jour. Mar. Geol., 4 (1): 40-45). The contents of each sampler were divided into two halves by means of an iron plate after the samplers had been hauled in. Accordingly, four samples were obtained in one and the same location at one time. The sediments thus obtained were washed through sieves of 1.0 and 0.5 mm mesh, and were preserved with formalin neutralized by hexamin.

The touching bottom of the frame-sampler complex was detected by the sonar pinger. Just before touching bottom, the frame-sampler complex was hauled in for 30 m (wire length), and then it was let go down again slowly to the sea floor. This process of touching bottom was found effectual for successful operation. In this cruise, it was found that, when the wind velocity was over 10 m/sec, operations were not successful. This failure of sampling seemed to be due to the untimely action of the samplers in the midwater caused by the tossing of the gear at the time of an abrupt heavy pitching of the vessel.

To obtain larger macrobenthos including demersal fish, a beam-trawl (Agassiz-Sigsbee type: 3 m span) was operated at four stations. All the specimens collected by the trawl were roughly sorted on boad, and were preserved with formalin (neutralized with hexamin or 70% alcohol). The dominant and/or characteristic animals collected by trawling at each station are briefly enumerated as follows:

St. 3 (615-620 m)

Porifera: 5 spp., fairly many specimens. **Alcyonaria:** several primnoids. **Polychaeta:** *Amphicteis* sp. (85), *Maldane sarsi* (72), *Onuphis* sp. (68), *Lumbrinereis* sp. (21), *Sigarion* sp. (15). **Mollusca:** *Neironella soyoae* (214), *Platyschides opportuna* (25), *Aforia circinata* (13+6 empty shells), **Crustaces:** *Pandalopsis* (coccinata ?) (36), *Paracrangon* (aff. *abei*) (7), *Chionectes* sp. (5), *Hyas*? (5). **Echinodermata:** *Ctenodiscus* sp. (745), *Ceramaster japonica* (35), *Zoroaster orientalis* (14), *Solaster* (2 spp.?, 17), large holothurian (42), large irregularians (16+innumerable fragments). **Pisces:** *Sebastolobus macrochir* (47), *Coelorhynchus* (26).

St. 9-2 (2530-2540 m)

Actiniaria: larger actiniarian (31), smaller actiniarian (23), **Polychaeta:** *Aphrodita* (*japonica*?) (72), *Cirriformia* sp. (43), *Travisia* sp. (13), *Nephtys* sp. (11), *Amphicteis* sp. (8). **Mollusca:** *Machaeroplax* sp. (151+8), *Lunatia* sp. (21), *Obestoma* sp. (20), turrid sp. (15+14), 14 other gastropod species, *Neironella* sp. (401+14), *Portlandia* sp. α (29+20), *Neironella* sp. α (19), *Neironella* sp. β (10). **Pycnogonida:** *Ascorhynchus japonicus* (93), *Colossendeis colossea* (29). **Pisces:** *Bassogigas* sp. (*grandis* type) 120 cm (1), 9 other demersal fishes (17).

St 11-3 (1655-1645 m)

Polychaeta: sabellid sp. (42), *Nephtys* sp. (37), *Sternaspis* (large form: scutata?) (12), *Travisia* sp. (9), *Lumbrinereis brevicirra* (8). **Mollusca:** *Obestoma* sp. (13), *Laevidentalium* (2 spp.?) (14+10), *Cardiomya* (*behringensis*) (7+1). **Pyconogonida:** *Corossendeis colossea* (11). **Crustacea:** *Eudorella* (cumacean) (10). **Echinodermata:** *Ctenodiscus* (11), smaller irregularian (76), *Amphiura* sp. (abundant: dominant sp.), smaller holothurian (21), comatulid (1).

St. 13-1 (640-620 m)

Actiniaria: actiniarian sp. (33). **Polychaeta:** *Lumbrinereis brevicirra* (ca. 400-500), *Sigalion* (ca. 100), *Arabella iricolor* (32), *Sphaerodoridum* sp. (28). **Mollusca:** *Cadulus opportuna* (202+37), *Macoma* sp. (42+1), *Octopus* sp. (8), *Opisthoteuthis depressa* (1). **Crustacea:** *Pandalopsis* sp. (*coccinata*?) (27). **Pycnogonida:** pycnogonid sp. α (322), sp. β (235), sp. γ (19), *Corossendeis colossea* (8). **Echinodermata:** geratinous holothurian (37), large holothurian (same sp. collected at St. 3) (24), ophiuroidean (269), *Ceramaster japonica* (87), *Ctenodiscus* (56), *Astropecten* (*polyacanthus*?) (31), goniasterid(?) (28), *Luidia*(?) (33), **Pisces:** *Sebastolobus macrochir* (156).

Table 12-1. Records of Operations of Smith-McIntyre Bottom Sampler

Station No.	Date	Time of shooting	Time of striking bottom	Time of hauling in	Position	Depth (in m)	Quantity of sediment (*l*) A	B	C	D
9-1	1969-V-6	09h 03m	10h 03m	11h 50m	39°40.2′N, 143°36.8′E	2525	—	—	—	—
10	1969-V-5	10h 58m	21h 46m	23h 06m	39°38.2′N, 143°13.1′E	2100	—	—	—	—
11-2	1969-V-5	11h 04m	12h 06m	13h 14m	39°35.5′N, 142°59.1′E	1630	6.5	7	—	—
12-1	1969-V-2	14h 47m	15h 33m	16h 10m	39°37.4′N, 142°31.8′E	840	8	7	7	8
13-2	1969-V-2	11h 46m	12h 25m	13h 03m	39°41.5′N, 142°21.3′E	642	7	7	—	—
15-1	1969-V-3	11h 18m	12h 15m	13h 05m	40°19.5′N, 142°29.0′E	1089	7.5	7	4	3
16-2	1969-V-4	15h 06m	16h 29m	17h 35m	40°22.0′N, 143°02.8′E	1550	—	—	—	—

Table 12-2 Records of Operations of Beam Trawl

Station No.	Date	Time of shooting	Time of towing	Time of hauling in	Position of towing	Depth (in m)	payout (m)
3	1969-IV-29	10h 50m	12h 54m-13h 30m	14h 42m	36°44.5′N, 141°28.6′E-36°45.8′N, 141°30.3′E	615-620	2750
9-2	1969-V-6	12h 03m	14h 20m-15h 03m	17h 33m	39°43.2′N, 143°38.2′E-39°44.8′N, 143°38.0′E	2530-2540	5200
11-3	1969-V-5	13h 27m	14h 50m-15h 28m	17h 15m	39°36.2′N, 142°59.2′E-39°36.2′N, 142°58.4′E	1655-1645	3200
13-1	1969-V-2	08h 28m	09h 14m-09h 52m	10h 34m	39°39.0′N, 142°20.7′E-39°40.0′N, 142°20.4′E	640-620	1500

13. Ocean-bottom seismographic observation

Reporter
Shozaburo Nagumo

Participants
Heihachiro Kobayashi, Sadayuki Koresawa and Shuji Hasegawa

1. Introduction

During this cruise KH-69-2, ocean-bottom seismographic observations were performed at 5 stations. They are (1) 3 stations network observation off Sanriku upon the continental slope along Japan Trench, (2) 1 station off Japan Trench upon the oceanic basin, southeastern off Erimo Seamount, and (3) 1 station upon the Kita-Yamato Bank in the central part of Japan Sea.

The positions and periods of these seismographic observations are shown in Table 13-1.

Table 13-1. Positions and periods of seismographic observation during the cruise KH-69-2

Station	Lattitude (N)	Longitude (E)	Water depth (M)	Mooring period From	To	Total
Off-Sanriku A	40°21.0′	143°00.8′	1525	May 4	Unrecovered	
Off-Sanriku B	40°19.3′	142°28.7′	1000	May 3	June 13	41 days
Off-Sanriku C	39°46.9′	142°44.7′	1050	May 3	June 14	42 days
Off-Erimo Seamount ER	40°37.0′	145°18.3′	5610	May 7	May 9	2 days
Kita-Yamato Bank	39°42.5′	133°53.0′	755	June 3	June 8	5 days

The purpose of these ocean-bottom seismographic observations are as follows.

Off-Sanriku Network Observation

This observation is to study the seismic activity of aftershocks of 1968 Tokachi-oki earthquake, which occurred on May 16, 1968. The locations of these stations are almost the same places as used in the last year, except the station A, which was performed by us by the sister ship "R/V Tansei-maru", Ocean Research Institute, University of Tokyo.

Kita-Yamato Bank

This observation is to study the presence of the activity of micro-earthquakes in the central part of Japan Sea. If occurrence of micro-earthquakes is observed, it will be the evidence of the active crustal deformation in that area.

From these observation, it is expected to study the present-day tectonic activity of boundary regions between geophysical continent and geophysical ocean.

2. Instrumentation

Ocean-bottom seismographs are shown in Figs. 13-1~4. A pressure vessel for 6000 m water depth observation was newly prepared for this cruise. It contains geophones, one vertical component, one horizontal component, amplifiers, magnetic tape recorder, crystal clock and batteries. The magnetic tape recorder is FM, 4-track, 1/4″ tape width recorder and can record for 133 hours by 7″ reel tape, length 740 m.

Deep Sea Monthly Recorder consists of two pressure vessels. One vessel contains batteries. The other vessel contains recording instruments. These two are electrically connected by special connector. One-month magnetic recorders are specially developed. They runs about 1000 hours the tape, length 550 m. They are DR, 4-track recorders.

3. Mooring-and-Recovery rope system

Mooring-and-Recovery rope system is specially designed for the ship "Hakuho maru", 3200 ton. The arrangements of various ropes are shown in Fig. 13-1~4. They were originally designed by Captain Magoshichi Sato, M/S "Tokai Univ. Maru II".

4. Operation at sea

Study by

After leaving Tokyo on April 26, 1969, preparation of rope systems for mooring-and-recovery of ocean-bottom seismograph has been done during the sailing. Materials such as synthetic ropes, wire ropes, floats and others are not ready to use. They must be prepared for the practical operation. Several branch ropes were attached to the necessary position of ropes. Practical procedures of mooring-and-recovery operation are discussed and compiled. It took about 4 days for such preparations.

Instruments which would be installed in pressure vessels were composed and checked in the evening and night. Conditions of instruments for each station were shown in Table 13-2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 respectively.

Deployment Off-Sanriku Network Stations

From May 3rd to 4th, three ocean-bottom seismographs were deployed off Sanriku. Operation logs and sea conditions are tabulated in Table 13-2, 3, 4, 5 and 6. Operations o deployment were carried out very smoothly as we have planned. Sea conditions wer calm and very helpful.

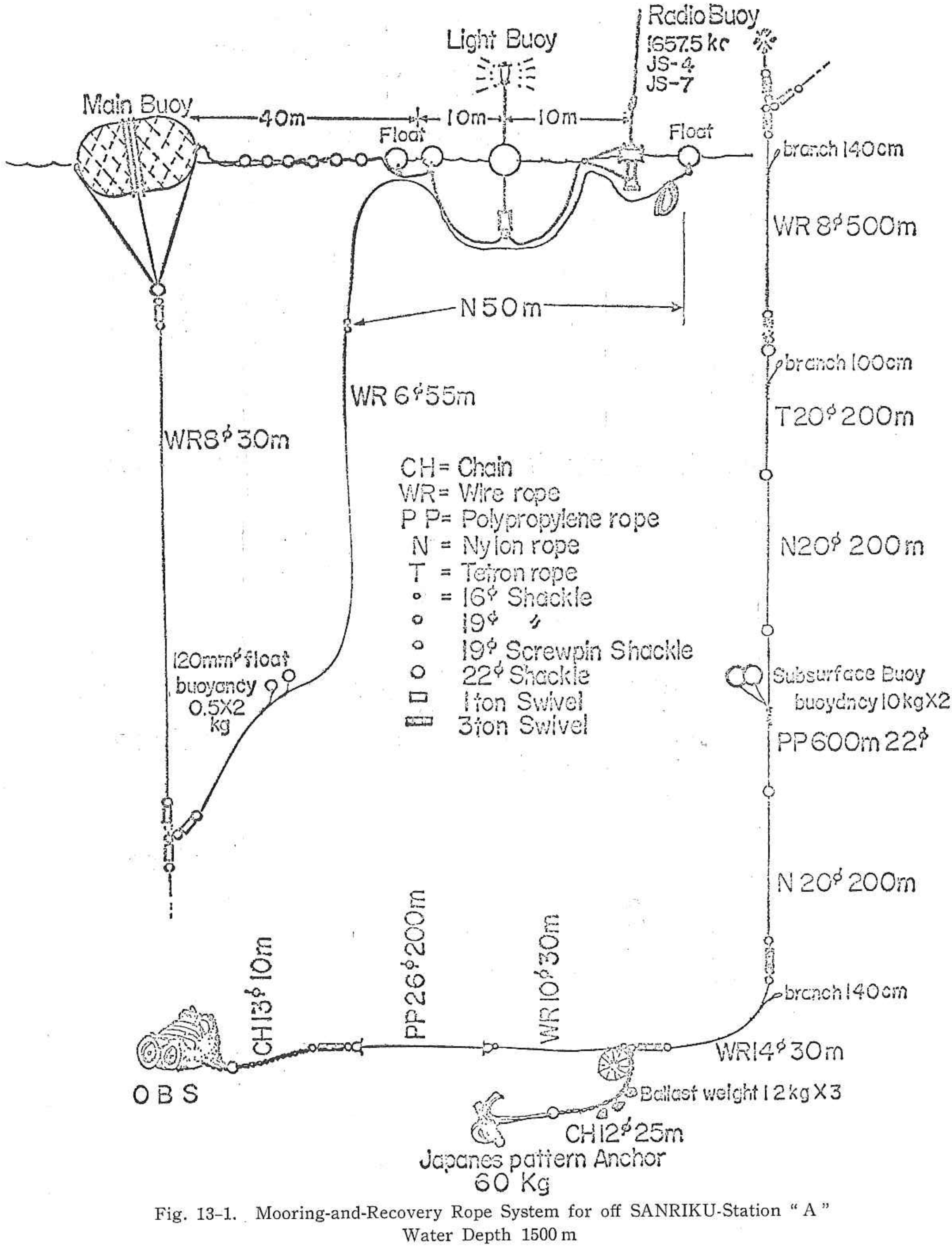


Fig. 13-1. Mooring-and-Recovery Rope System for off SANRIKU-Station "A"
Water Depth 1500 m

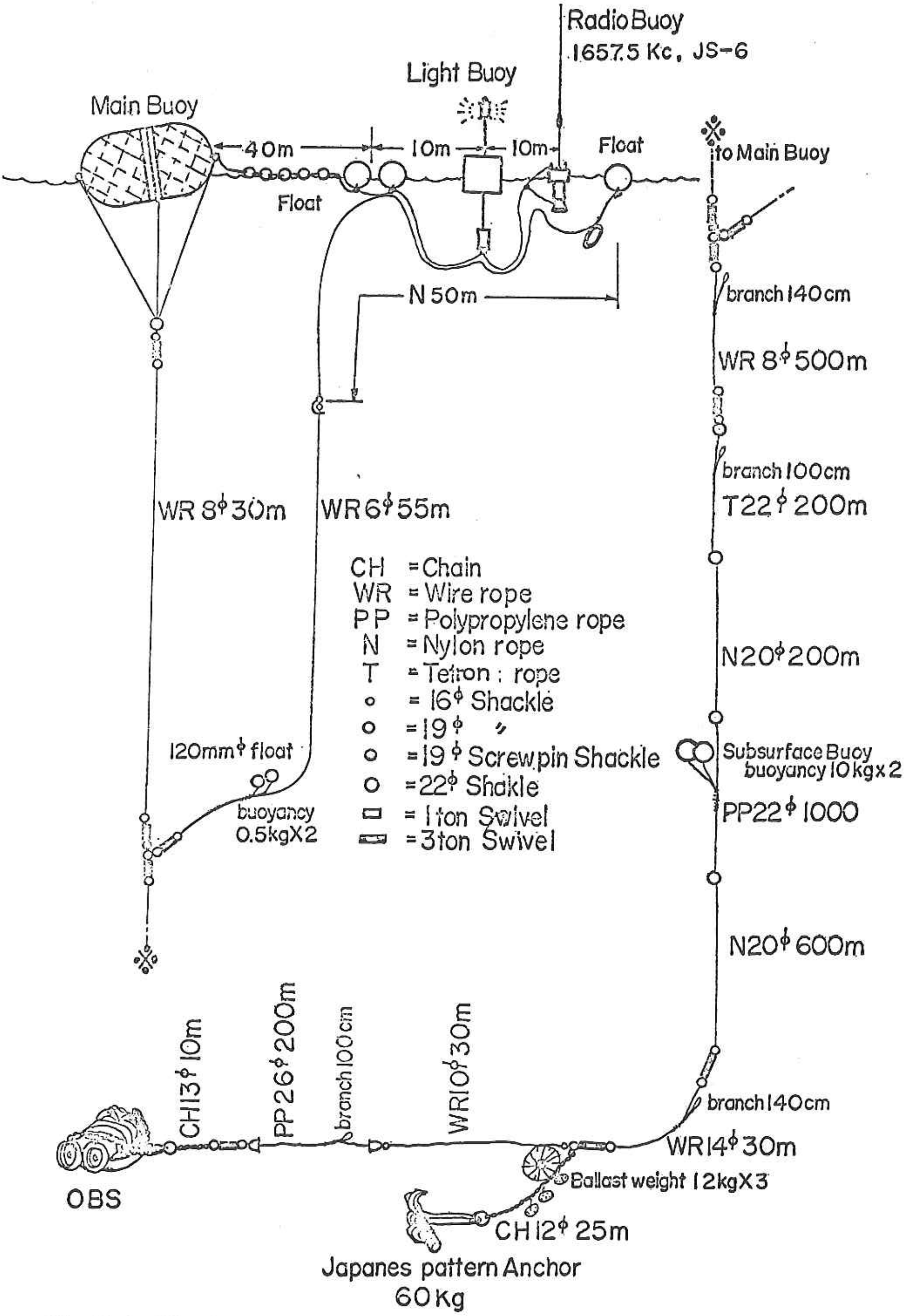


Fig. 13-2. Mooring-and-Recovery Rope System for off SANRIKU-Station " B " " C "
Water Depth 1000 m

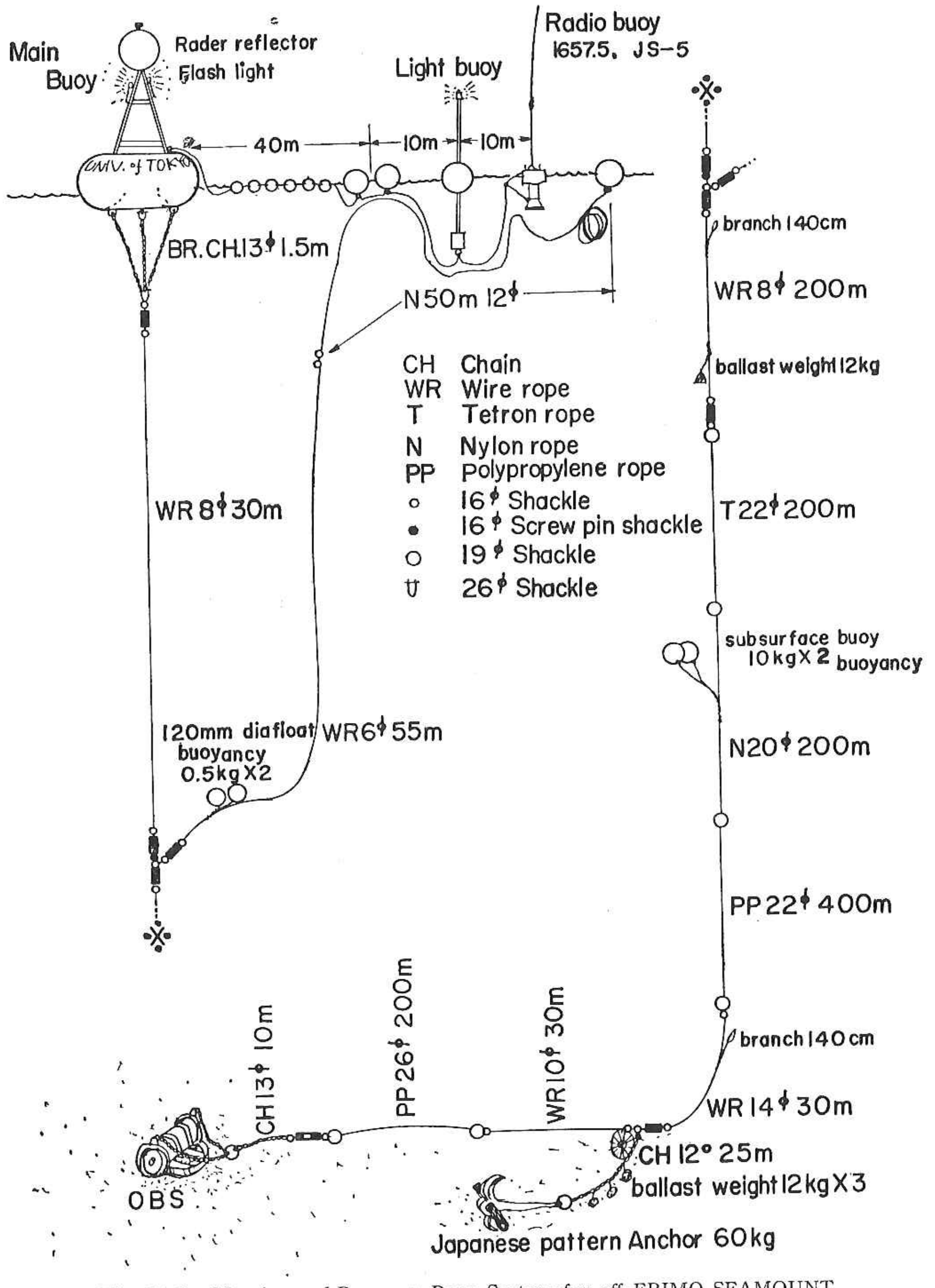


Fig. 13-3. Mooring-and-Recovery Rope System for off ERIMO SEAMOUNT. Water Depth 6000 m

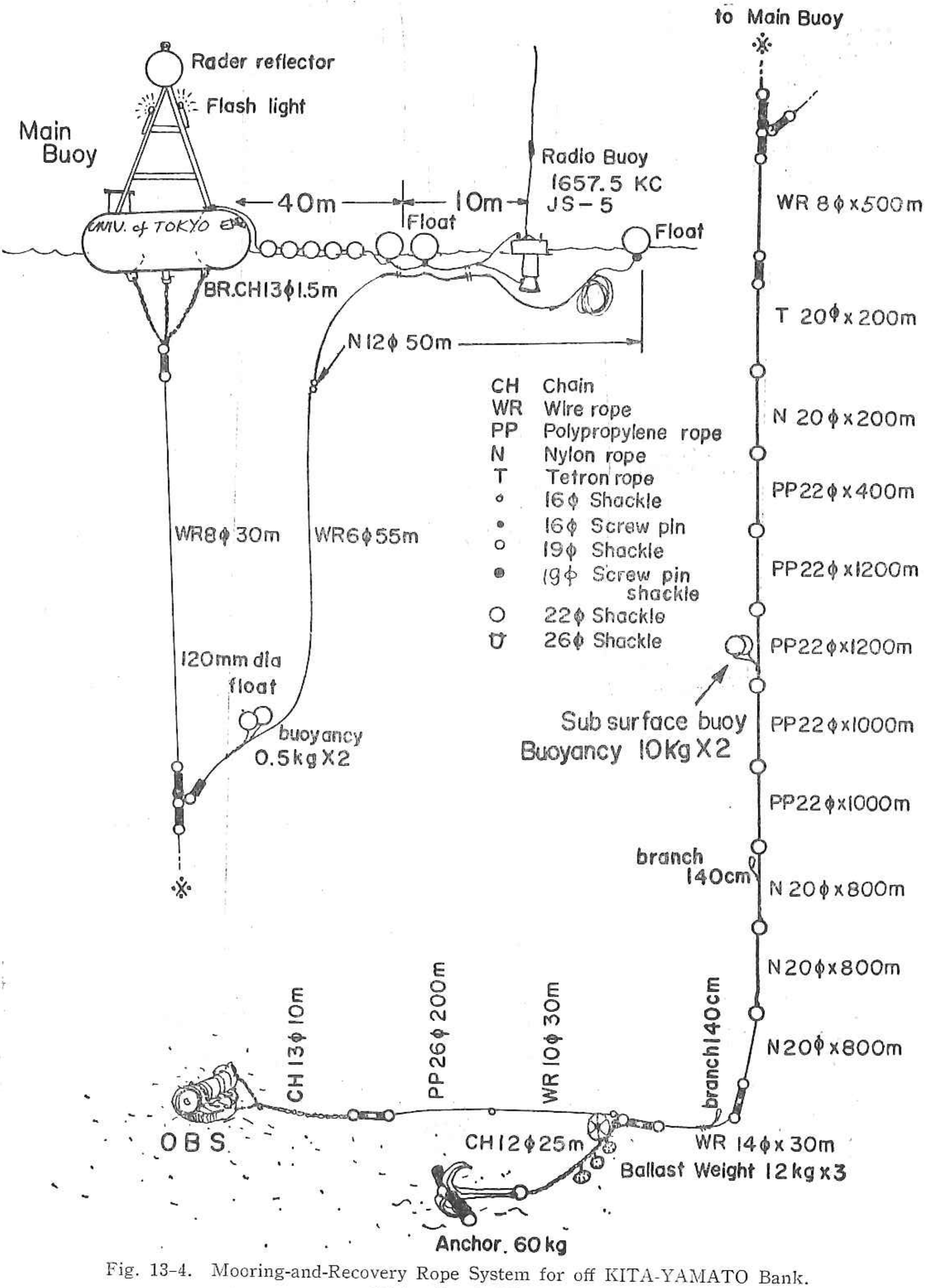


Fig. 13-4. Mooring-and-Recovery Rope System for off KITA-YAMATO Bank. Water Depth 750 m

Table 13-2

Instrument

Observation Station off SANRIKU B Date 1969 May 3

Pressure Vessel DSM - 2000 REC A, Batt B Reporter

Geophone				to Amp.#	Shunt	UP→Amp out
Geospace 8D - L4B	V	4.5	Hz	1, #2	∞ Ω	(-)
"	H	4.5		3	2K	

Amplifier #1	gain
KRE--650	80 dB
"	60
"	80

Tape Recorder NISSO DR - 1000 Tape SCOTCH # 499

Content
- track #1 V (80 dB)
- 2 V (60 dB)
- 3 H (80 dB)
- 4 Time mark

Clock SEIKO TF - 7

SEC mark ⊖ pulse 0.2 sec.

MIN mark 0.5 sec.

HOUR mark longer duration

1/2 day mark higher frequency

Initial MIN mark 1969 May 2 09:44

Final MIN mark 1969 June 15 09:00

Buoy
- main Fender buoy
- light RYOKUSEISHA sea light
- radio TAIYO MUSEN, JS - 4, 1657.5 Az, W

Table 13-3. Operation RECOVERY

Observation Station Off SANRIKU B

Date 1969 June 13

Reporter Nagumo

Ship position and Water depth

Date time	Operation	Lat.	Long.	Loran	Water depth
June 13 04: 36	on station finding then drifting	Near the buoy		Main, light buoy to be seen no radio buoy	
07: 15	take a rope	40°18.6N	142°30.0E		
08: 22	anchor off from Bottom	40°18.2N	142°30.0E	2S1-3704	1010m
09: 15	Finish	40°18.7N	142°29.6E	2S1-3702	

Sea condition

Date time	Wind D	Wind F		Weather		Barr	Vis	Sea sea	Sea swell	Temp. air	Temp. sea
June 13 04	SE	2_1	△	F	10	1004.0	2	0	2	11.5	8.6
05	calm		△	F	10	1005.0	2	0	2	11.8	8.1
07	calm		△	F	10	1005.0	2	0	2	11.5	7.5
08	S	2_2	△	F	10	1005.8	2	1	2	11.1	8.0
09	SE	1_1	△	F	10	1005.5	2	1	2	11.4	8.2
10	E	1.5_2	△	F	6	1005.7	2	1	2	14.2	9.7

Table 13-4. Operation DEPLOYMENT

Observation Station off SANRIKU B

Date 1969 May 3

Reporter Nagumo

Ship position and Water depth

Date time	Operation	Lat.	Long.	Loran	Water depth
May 3 09: 15	Launching	40°19. 4N	142°28. 4E	2S1-3700 Kurosaki 31. 2′ Misaki 29. 5′ Benten 30. 0′	1000m
10: 13	onto Bottom	40°19. 3N	142°28. 7E	2S1-3702 Kurosaki 31. 3′ Misaki 29. 7′ Benten 30. 2′	1000m
11: 00	Finish	40°19. 6N	142°29. 4E		

Sea condition

Date time	Wind			Weather		Barr	Vis	Sea		Temp.	
	D	F						sea	swell	air	sea
May 3 09	S	6_4	∆	b	1	1022. 0	6	2	2	9. 2	6. 9

Table 13-5

Instrument

Observation Station off SANRIKU c   Date ~~1969 May 3~~

Pressure Vessel DSM - 2000 REC F, Batt H   Reporter ______

Geophone	Geospace 8D - L4B	V	4.5 Hz,	to Amp.# 1, #2,	Shunt ∞ Ω,	UP	Amp out ⊖
	"	H	4.5	3	2K		—
							—

Amplifier #1	KPE 650,	gain	80 dB
	",		60
	",		80

Tape Recorder TEAC DR - 915 - 01   Tape SCOTCH #499

Content
- track #1 V (80 dB)
- 2 V (60 dB)
- 3 H (80 dB)
- 4 Time mark

Clock SEIKO TF - 7

SEC mark ⊖ pulse 0.2 sec

MIN mark 0.5 sec

HOUR mark longer duration

1/2 day mark higher frequency

Initial MIN mark 1969 May 2 12:41

Final MIN mark 1969 June 16 09:00

Buoy main Doughnut type, with 2 Maglights

light ______

radio TAIYO MUSEN, JS - 7, 1657.5 Az, ______ W

Table 13-6. Operation DEPLOYMENT

Observation Station off SANRIKU C

Date 1969 May 3

Reporter Nagumo

Ship position and Water depth

Date time	Operation	Lat.	Long.	Loran	Water depth
May 3 17: 07	launching	39°46.3N	142°43.8E	2S1-3948 Benten 37.2′ Todo 33.3′	
18: 00	onto Bottom	39°46.9N	142°44.7E	2S1-3939 Benten 37.6′ Todo 34.0′ Myozinbana 34.5′	1050m
18: 23	Finish	39°47.3N	142°45.3E	2S1-3931 Benten 37.6′ Todo 34.7′	

Sea condition

Date time	Wind D	Wind F		Weather		Barr	Vis	Sea sea	Sea swell	Temp. air	Temp. sea
May 3 17	S	6_4	∆	b	2	1021.0	4	2	3	14.8	8.8

Table 13-7. Operation RECOVERY

Observation Station off SANRIKU C

Date 1969 June 14

Reporter Nagumo

Ship position and Water depth

Date time	Operation	Lat.	Long.	Loran	Water depth
June 14 05 : 05	on station finding then drifting	39°48. 1N	142°44. 9E	Main, Radio buoy to be seen	
07 : 15	take a rope	39°48. 0N	142°43. 2E		
08 : 28	off from Bottom	39°47. 3N	142°44. 9E		
09 : 17	Finish	39°49. 6N	142°45. 1E		

Sea condition

Date time	Wind D	Wind F		Weather		Barr	Vis	Sea sea	Sea swell	Temp. air	Temp. sea
June 14 07	N	4_3	∆	F	10	1004. 7	0	1	2	13. 3	15. 9
08	N	6_4	∆	F	10	1004. 9	0	1	2	13. 1	15. 9
09	N	8_5	∆	F	10	1005. 0	0	2	2	13. 4	15. 6
10	N	8_5	∆	F	10	1005. 0	1	2	2	13. 3	15. 7

Table 13-8

Instrument

Observation Station off SANRIKU A Date 1969 May 4.

Pressure Vessel DSM - 2000 Reporter

Geophone Geospace 8D - L4B , V , 4.5 Hz, to Amp.#1, #2 , Shunt ∞ Ω , UP Amp out ⊖

" , H , 4.5 , 3 , 2K , —

, , , , , —

Amplifier #1 KRE - 650 , gain 80 dB

" , 60

" , 80

Tape Recorder TEAC DR - 915 - 02 Tape SCOTCH #499

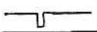
Content track #1 V (80 dB)

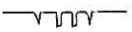
2 V (60 dB)

3 H (80 dB)

4 Time mark

Clock SEIKO TF - 7

SEC mark  ⊖ pulse 0.2 sec

MIN mark  0.5 sec

HOUR mark " longer duration

1/2 day mark higher frequency

Initial MIN mark 1969 May 2 15:26

Final MIN mark

Buoy main Fender buoy ,

light RYOKUSEISHA sea light

radio TAIYO MUSEN , JS - 6 , 1657.5 Az, W

Table 13-9. Operation DEPLOYMENT

Observation Station off SANRIKU A

Date 1969 May 4

Reporter Nagumo

Ship position and Water depth

Date time	Operation	Lat.	Long.	Loran	Water depth
May 4 13 : 20					
14 : 20	onto Bottom	40°21. 0N	143°00. 8E	2S1-3518. 5 2S2-3748	1525m
14 : 50	Finish				

Sea condition

Date time	Wind D	Wind F		Weather		Barr	Vis	Sea sea	Sea swell	Temp. air	Temp. sea
May 4 13	S	11. 5	△	bC	7	1021. 9	7	4	3	13. 2	8. 9
14	S	7	△	bC		1020. 4	7	4	3	13. 1	9. 3
15	S	6	△	bC		1019. 4	7	4	3	12. 3	9. 4

Table 13-10

Instrument

Observation Station off Japan Trench ERIMO   Date 1969 May 9

Pressure Vessel DS - 6000   Reporter ______

Geophone Geospace 8D - L4B, V, 4.5 Hz, to Amp.# 1,#2, Shunt ∞ Ω, UP Amp out (+)

" , H, 4.5 , 3 , 2K , —

, , , , , —

Amplifier #1 KRE - 650, gain 80 dB

", 60

", 80

Tape Recorder TEAC R - 915 - 04   Tape SONY 200

Content track #1 V (80 dB)

2 V (60 dB) + Time mark

3 H (80 dB)

4 Null

Clock SEIKO TF - 6

SEC mark ⊖ pulse 1/20 sec

MIN mark 1.5 sec

HOUR mark 2.5 sec

1/2 day mark —

Initial MIN mark 1969 May 7 09:35

Final MIN mark 1969 May 9 19:05

Buoy main Doughnut type, with 2 Maglights

light —

radio RYOKUSEISHA, JS - 5, 1657.5 Az, ______ W

Table 13-11. Operation DEPLOYMENT

Observation Station off Japan Trench ERIMO

Date 1969 May 7

Reporter Nagumo

Ship position and Water depth

Date time	Operation	Lat.	Long.	Loran	Water depth
May 7 09 : 00	on station	40°36.0N	145°17.4E	2S1-2638 2S2-3568	
10 : 08	Launching	40°37.0N	145°18.0E	2S1-2626 2S2-3570	
12 : 55	onto Bottom	40°37.0N	145°18.3E	2S1-2624 2S2-3569	5610m
13 : 57	Finish	40°37.2N	145°20.7E	2S1-2610 2S2-3507	

Sea condition

GEK 352° 0.57′

Date time	Wind D	Wind F	Weather	Barr	Vis	Sea: sea	Sea: swell	Temp.: air	Temp.: sea
May 7 10	SW	75_5	b 0	1015.7	9	4	4	9.8	8.3
11	SSW	7_4	b 0	1015.4	9	4	4	9.6	8.3
12	SSW	12_6	b 0	1014.6	9	5	4	10.6	8.4
13	SSW	12_6	b 0	1014.3	9	5	5	10.4	8.4
14	SSW	12_6	b 0	1013.4	9	5	5	10.7	8.4

Table 13-12. Operation RECOVERY

Observation Station off Japan Trench ERIMO

Date 1969 May 9

Reporter Nagumo

Ship position and Water depth

Date time	Operation	Lat.	Long.	Loran	Water depth
May 9 10 : 00	take rope				5570m
12 : 50	off from Bottom	40°36.2N	145°18.8E		
15 : 30	Finish	40°34.8N	145°20.6E		

Sea condition

Date time	Wind D	Wind F	Weather	Barr	Vis	Sea sea	Sea swell	Temp. air	Temp. sea
May 9 09	W	11_6 △	bC 4	1012.2	8	4	4	11.0	9.9
10									
11	WNW	8_5 △	bC 4	1014.2	8	4	4	11.5	10.0
12	WNW	9_5 △	bC 4	1014.2	8	4	4	10.6	10.1
13	WNW	9_5 △	bC 5	1014.9	8	4	4	10.0	10.0
14	NW	8_5 △	bC 7	1014.3	8	4	4	11.1	10.0
15	NW	75_4 △	bC 7	1013.8	8	4	4	10.9	10.0

Table 13-13

Instrument

Observation Station North YAMATO Bank Date 1969 June 8

Pressure Vessel DS - 2000 Reporter

Geophone Geospace 8D - L4B, V, 4.5 Hz, to Amp.#1,#2, Shunt ∞ Ω, UP Amp out (+)

" , H, 4.5, 3, 2K,

Amplifier #1 KRE - 650, gain 80 dB

" , 60

" , 80

Tape Recorder TEAC R - 915 - 04 Tape SONY 200

Content track #1 V (80 dB)

2 V (60 dB) + Time mark

3 H (80 dB)

4 Null

Clock

SEC mark 1/20 sec ⊖ pluse

MIN mark 1.5 sec

HOUR mark 2.5 sec

1/2 day mark

Initial MIN mark 1969 June 3 10:56

Final MIN mark 1969 June 8 17:08

Buoy main Doughnut Type, with 2 Maglights

light RYOKUSEISHA sea light

radio RYOKUSEISHA, JS-5, 1657.5 Az, W

Off Japan Trench

On May 7th, an ocean-bottom seismograph was deployed off Japan Trench, upon oceanic crust, about 28 miles south-eastern off of Erimo Seamount, at water depth 5610 m. After 2 days mooring, it was safely recovered on May 9th. Operation logs and sea conditions for deployment and recovery are shown in Table 13-11 and 13-12 respectively.

It was the first experience for us to deploy such deep seismographic stations. However, operations were very smooth and took only 4.5 hours for deployment and 6.5 hours

Kita-Yamato Bank

From June 3rd to 8th, an ocean-bottom seismographic observation was carried out at the Kita-Yamato Bank at the central part of Japan Sea at water depth 755 m.

A seismograph was deployed in the morning of June 3rd on our way back to Maizuru from Nakhodka. After 5 days morning, it was safely recovered on June 8th before calling on Toyama.

A bottom current meter observation was carried out at the same station of seismograph being placed side by side about 2 miles apart.

Operation logs and sea conditions are shown in Table 13-14 and 13-15. Operations were very smooth and speedy.

Recovery of Seismographs of Off-Sanriku network stations

The final course of this cruise KH-69-2 from Toyama to Tokyo was for recovering ocean-bottom seismographs deployed off-Sanriku.

Around 21 : 20 of June 12, we received radio beacon JS-7 of station C. It was about 80 miles away from the nearest station B and about 115 miles away from the station C. Other two radio beacons were not received.

In the morning 03 : 50 of June 13, we arrived at the station B, and found the main buyo at about 04 : 00 by radar. Approaching in dense fog, observed main buoy and light buoy. Radio buoy was not attached there.

Waiting until the morning, we started recovery operation from 07 : 00. Sea conditions were very calm with dense fog. Without much difficulties, ocean-bottom seismograph was successfully recovered at 09 : 15.

It was evident that the radio-buoy and 4 small floats were stolen. The shackle which connected radio-buoy to the taking rope was disconnected, rope was not being out. The eyes of rope for attaching small floates were cut by knife. Moveover, arrangement of taking ropes has been changed from the original one,

Conditions of recovered main-buoy was very good, almost fresh, and there were very few trace of fatigues of mooring.

Moving to the station A, we arrived at 11 : 30 of June 13. It was still dense fog. The sea conditions were so calm that sea-surface reflections on radar screen were very few only near the ship within about 0.3 miles. We did not find buoy on the radar. We decided to make search cruise. Along the Loran line 2S1, which is very accurate in this area, we have swept area of 8×8 miles by 3 radars. What we found by radar were small bamboo pole with small red flags on the top of them and one small steel

Table 13-14. Operation DEPLOYMENT

Observation Station Kita-YAMATO Bank

Date 1969 June 3

Reporter Nagumo

Ship position and Water depth

Date time	Operation	Lat.	Long.	Loran	Water depth
June 3 12 : 10	on station	39°43.6N	133°52.5E	2S3-2568 2S4-2872	755m
12 : 26	Launching	39°42.6N	133°53.2E	2S3-2570 2S4-2873	〃
12 : 49	onto Bottom	39°42.5N	133°53.0E	2S3-2571 2S4-2871	〃
13 : 12	Finish	39°42.2N	133°53.6E	2S3-2572 2S4-2873	〃

Sea condition

Date time	Wind D	Wind F	Weather		Barr	Vis	Sea sea	Sea swell	Temp. air	Temp. sea
June 3 12	NW	7_4	Q	10	1000.5	8	3	3	9.0	12.3
13	NW	7_4	Q	10	1000.5	8	3	3	9.0	12.4

Table 13-15. Operation RECOVERY

Observation Station Kita-YAMATO Bank

Date 1969 June 8

Reporter Nagumo

Ship position and Water depth

Date time	Operation	Lat.	Long.	Loran	Water depth
June 8 14 : 00	on station				
14 : 25	take a rope	39°42. 8N	133°53. 6E		
14 : 47	take off from Bottom	39°42. 8N	133°53. 3E		
15 : 10	Finish	39°42. 8N	133°53. 4E		

Sea condition

Date time	Wind D F	Weather	Barr	Vis	Sea sea	Sea swell	Temp. air	Temp. sea
June 8 13	WSW 7_5	b 1	1009. 9	8	4	4	14. 6	13. 3
14	WSW 9_5	b 1	1009. 5	8	4	4	15. 2	13. 2
15	WSW 10_5	b 1	1010. 0	8	4	4	14. 8	13. 4

light buoy for fishing. However, we could not find our main buoy of station A. We searched for 9 hours. Since the sea conditions were extremely calm, and sea-surface reflections were very little, and since we have found several small obstacles, it was concluded that the main buoy would not exist on the sea-surface near the station. We left for station C at 20:30.

On station C, we arrived at around 05 : 00 in the early morning on June 14. We started the recovering operation from 07 : 00. Without much difficulties, the seismograph was taken aboard back successfully at 09 : 17. The sea condition was very calm. Four small floats which were attached to the taking rope have been stolen by someone else being out at the connecting eyes.

Leaving station C at 09 : 20, we arrived at station A again at 13 : 00 of June 14. We tried dredging of ocean-bottom seismograph and its rope system. The first dredge was done along the Loran line 2S1—3518.5. The second dredge was done almost crossing perpendicular to the Loran line 2S1 passing upon the OBS station. Distance of one dredging was 4 miles. In the first dredge, wire out was 3200 m, ship speed 2.0 kt, water depth 1500 m—1550 m. In the second dredge, wire out was 3500 m, ship speed 1.5 kt. Average tension 2.3 t, sometime reaching 1.85 t for ten minutes. In the second dredge we picked up 2 pieces of wood, but not seismograph. Dredging was carried out for about 10 hours until 23 : 05.

Judging from the good and fresh conditions of recovered buoy of station B and C, it was quite probable that the buoys at station A were stolen by someone else.

It was a valuable instruction that we could know the necessity of people's cooperator for performing long period mooring of seismographic station buoy upon the open.side ocean.

5. Data Processing and Preliminary Results

Off Japan Trench

The magnetic tape of station Erimo, off Japan Trench was played back. 2 days record was transcribed into 7 reels for the purpose of speed transformation. From these transcribed tape, ink paper record was made. The play back speed is 5 times faster than the real recording speed.

More than 70 earthquakes were registered for 48 hours recording time. These include large and small, distant and near earthquakes. An example of reproduced paper record is shown in Fig. 13-5. It was very impressive that Japan Trench is really active. There exist many small earthquakes in and around Japan Trench.

Japan Trench seems to be the essential element of present-day tectonic deformation along the boundary of continent and ocean. It will not be active boundary. It may be the main cause of crustal deformation associated with great earthquakes along Japan Trench.

Kita-Yamato Bank

5 days record was transcribed into 14 tapes. From these tapes, ink paper records were produced.

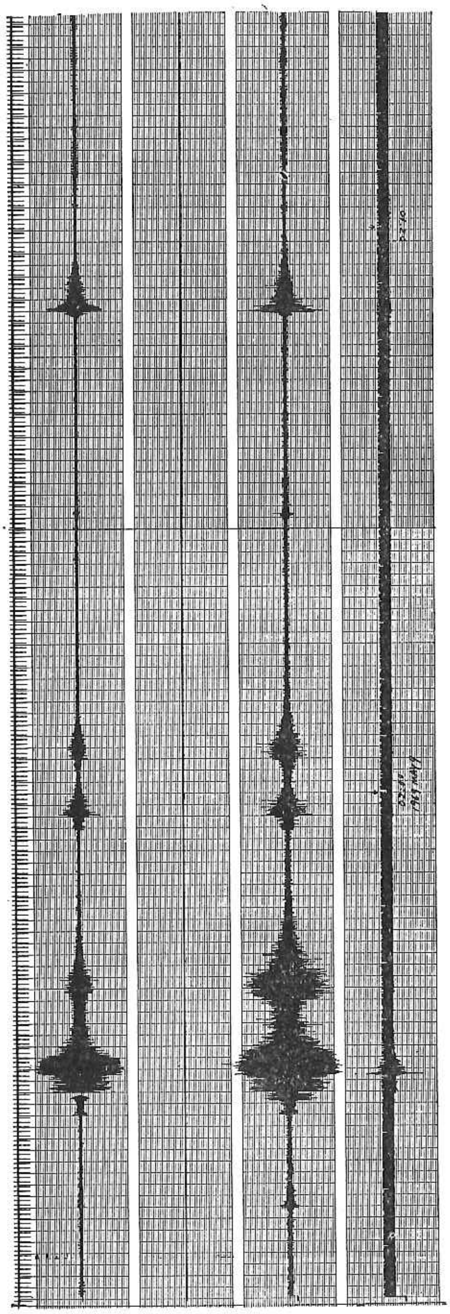


Fig. 13-5. Example of earthquake record

The seismic activity in and around the Kita-Yamato Bank is very quiet. There are almost none earthquake within 5 days except several small doubtful events.

Very often, however, microseisms were recorded very well. These microseisms seem to be associated with low atmospheric pressure, 992 mb, which has passed over the station during the mooring period. It will be very interesting that microseism was observed upon the bank in the central part of the ocean.

In this station, seismographs were disturbed by cable shocks very often.

Off-Sanriku

Because the recovery of the seismographs off-Sanriku was final part of this cruise, only visual inspection of recorded tape was performed by the synchroscope.

A lot of earthquakes have been recorded at station B. This indicates that the focal region for the 1968 Tokachi-Oki earthquake is still active.

6. Summary and conclusions

During this cruise KH-69-2, the followings have been found.

1) Many small- and micro- earthquakes are taking place in and around Japan Trench.
2) Japan Trench seems to be tectonically active at present.
3) Off-Sanriku, earthquake activity seems to be still very high after one year from 1968 Tokachi-Oki earthquake.
4) The central part of Japan Sea seems to be tectonically very quiet at present.
5) The strength of the mooring-and-recovery system for one month observation seems to be sufficient.
6) Much more cautions and devices should be paid for preventing the mooring-buoy from stealing upon open-wide ocean.

14. Measurement of deep sea current

Yasuhiro Sugimori

In the KH-69-2 cruise, time variation of vertical profile of current was measured. by the use of two sets of current meters in Japan Sea.

Two sets of Richardson Type current meters (Geodyne model 102) were moored on June 3, 1969, at site 39°45.4 N, 133°51.8 E, on the North Yamato Bank, about 2 miles apart from the ocean bottom seismograph station. Water depth was about 770m, and one set was placed at 47cm above the bottom and the other set was 200m above the former (Fig. 14-1).

After 5 days observation, the instruments were safely recovered on June 8, with data recorded on 16 mm film.

The results of the analysis of the data will be reported in another paper.

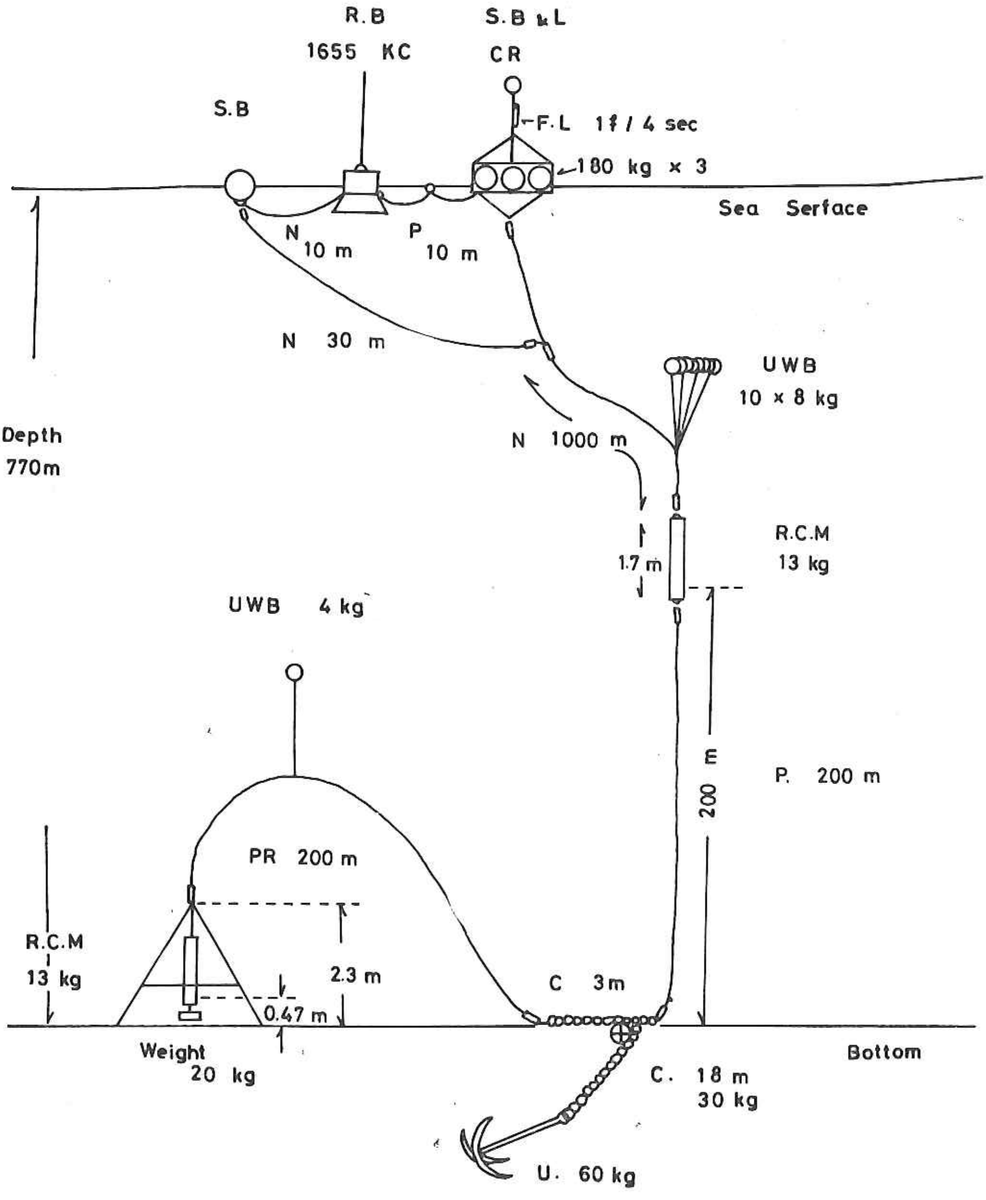


Fig. 14-1. Mooring System of Current Meter

15. Some physical and chemical data of sea water at the Yamato Rise

Atsuyuki Mizuno, Tsunekazu Mochizuki, Seizo Nakao,
Hiromi Mitsushio and Hirotaka Otobe

This cruise revealed some physical and chemical and chemical properties of sea water at the Yamato Rise of the central area of Japan Sea under the writers' water sampling and water analysis on the vessel.

Purpose of study:

The present study was carried out for the following purposes: 1) clarifying the chemical and physico-chemical influence of bottom water on the properties of bottom sediments; 2) clarifying the relationship between hydro-chemical and hydrokinetic properties of bottom water, the latter of which was surveyed with a current meter by Y. Sugimori; and 3) clarifying the vertical distribution pattern of major chemical components, besides some minor components including uranium in sea water.

Stations:

As the first step of the investigation, the three stations were prefered at the western area of Yamato Rise as shown in Fig. 15-1. They are as follows;

St. 24-2 39°45.4′N, 133°51.8′E

St. 26-3 39°44.9′N, 133°53.7′E

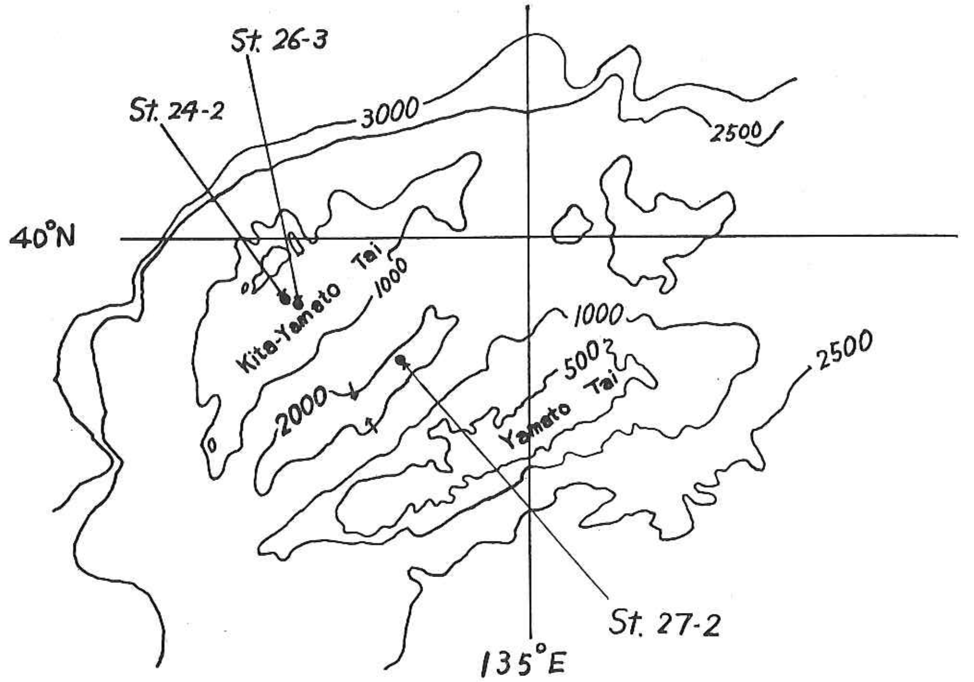


Fig. 15-1. Location map

St. 27-2 39°35.9′N, 134°24.8′E

St. 24-2 and St. 26-3 are very closely situated to each other on depth 700m± level flat, bottom sediments of which consist of very fine-grained sands, on the central portion of Kita-Yamato Tai. Near both the stations the bottom water current was measured by Y. Sugimori. On the other hand, St. 27-2 is on the NE-SW direction trough, 2060m in depth between the Kita-Yamato Tai and Yamato Tai. Here, the core of bottom material of about 1 m length was obtained with a gravity corer.

Water sampling:

At each station, 1.3-2.0 *l* sea water was obtained for analyses from the depths shown in the following lines, using the Nansen reversing water bottles, except the surface water by a water-sampling bucket.

St. 24-2. 0, 20, 49, 98, 147, 196, 246, 296 m. (Date: June 3, 1969)

St. 26-3. 0, 19, 38, 57, 77, 96, 145, 248, 343, 440, 538, 635, 684, 713 m. (Date: June 8, 1969)

St. 27-2. 0, 20, 49, 98, 195, 291, 483, 718, 906, 1187, 1474, 1764, 1860, 1957, 2005, 2034 m. (Date: June 9, 1969)

Moreover, the very bottom water enclosed in the uppermost part of gravity core tube at St. 27-2 was examined for comparison.

Method of analysis:

Immediately after the water sampling, the water temperature was measured by the reversing thermometer, and also some chemical components were quantitatively determined with the usual methods of analyses in the laboratory of vessel. They are as follows: 1) dis. O_2, HCO_3^-, Ca^{2+}, Mg^{2+} and alkali consumption value to pH 9.0, with a titration methods; 2) dis. P and dis. SiO_2, with a colorimetric methods; 3) hydrogen ion concentration (pH)*, redox potential (Eh)** and salinity***, with directly measuring instruments.****

* by pH-meter PT-1 of Toyo Kagaku Sangyo Kaisha, Ltd.

** by RM-1 redox meter of Toa Electronics, Ltd.

*** by Inductively Coupled Salinometer, Model 601, MKIII.

**** These elements were analyzed by M. Mochizuki, except water temperature by M. Mizuno, S. Nakao and H. Otobe, and salinity by H. Otobe.

Result of analyses:

The result of the present marine chemical analyses presents some interesting aspects concerning the problems said before. In Figs. 15-2 and 15-3, a part of the result is summarized. The figures only show the vertical distribution pattern of temperature (T), pH, dis. P, dis. SiO_2, dis. O_2, salinity and alkali consumption value to pH 9.0, which all exhibit remarkable curved line from surface to underlying layers.

The *water temparature* at the three stations shows about 13° C at the sea surface and less than 1° C at the depth deeper than 300 m in depth. In detail, the temperature of 12.5-13° C at 0-20 m depth abruptly decreases to 10° ± C at 40-50 m depth, and the strong decrease continues to about 100 m depth where the temperature measures about

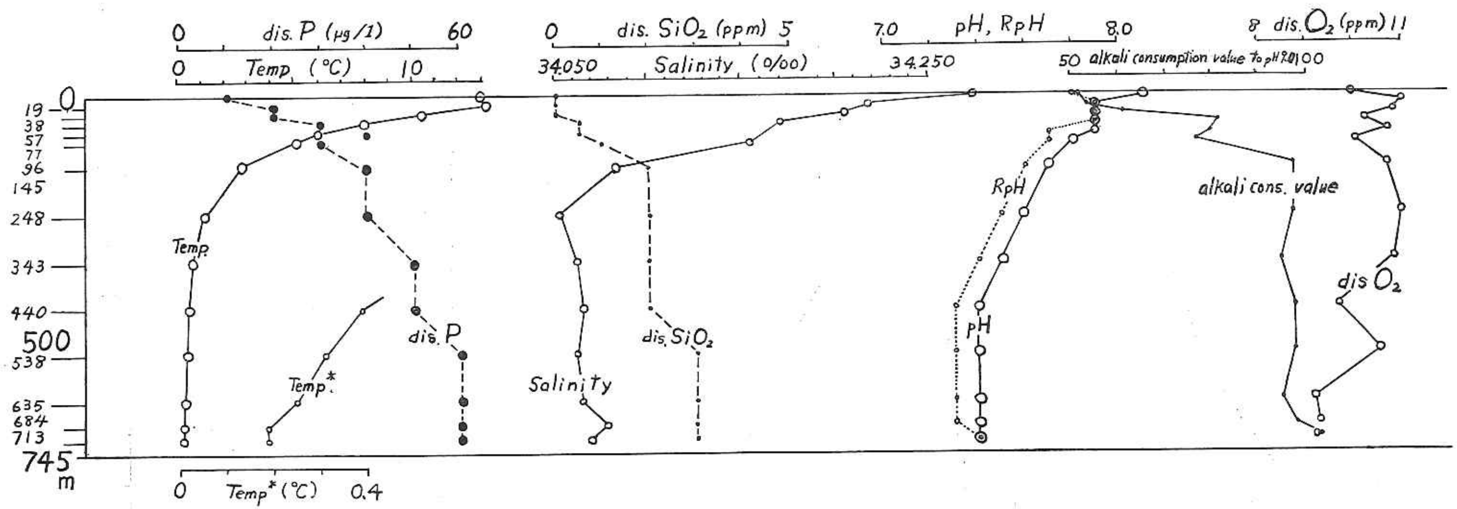


Fig. 15-2. Vertical distribution of chemical components in sea water at St. 26-3

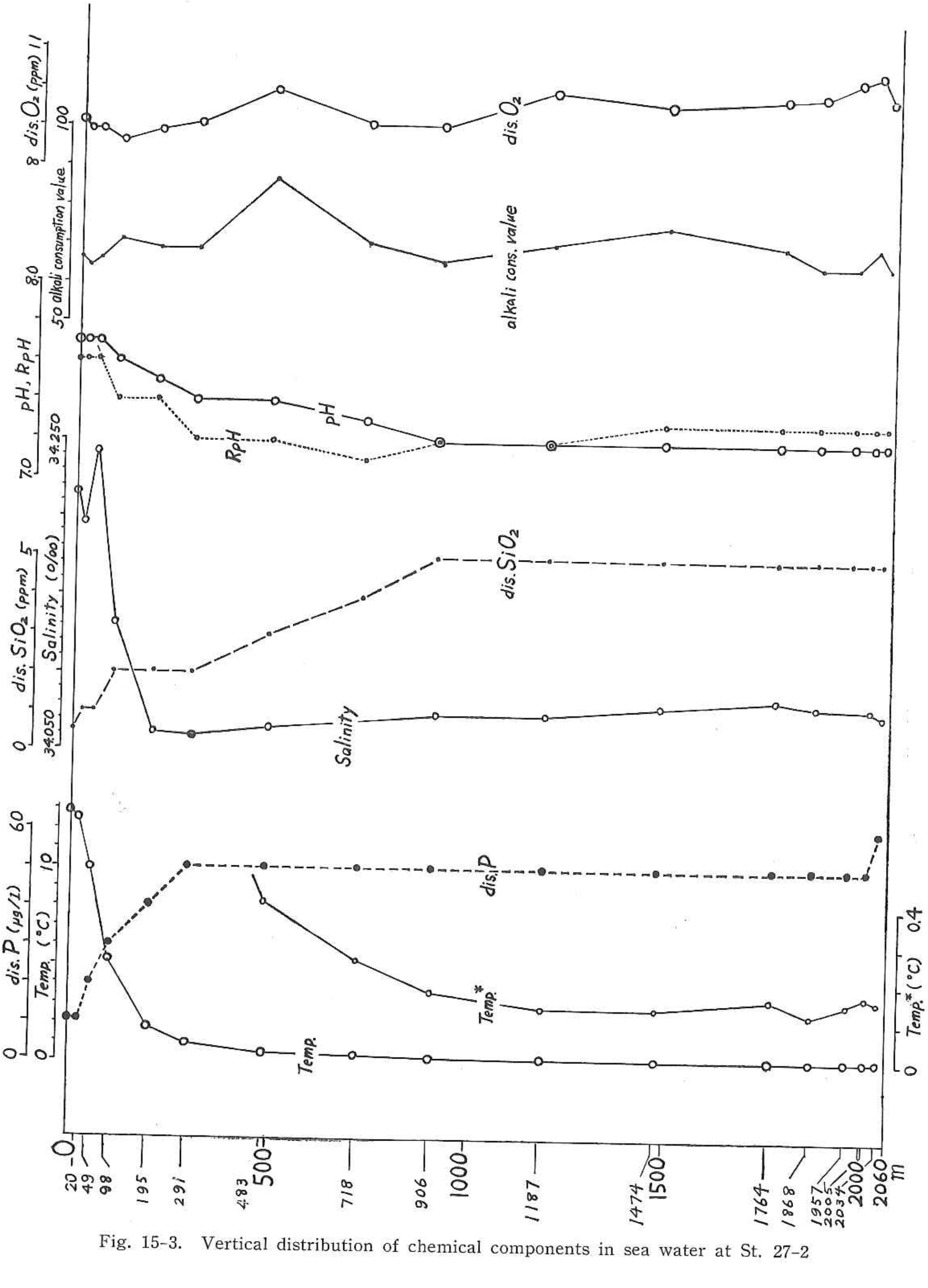


Fig. 15-3. Vertical distribution of chemical components in sea water at St. 27-2

5° C. At the level lower than 100 m it shows less strong decreasing and reaches to about 1° C at 250-300 m depth. Although the temperature measures less than 1° C everywhere below the depth, it is interesting that the temperature progressively decreasing to 0.14° C of about 1180 m depth turns to downward increasing below the level and also shows somewhat irregular distribution below about 1800 m depth. Thus, the water temperature exhibits the presence of marked thermocline layer of water mass between 20 m and about 250 m, and its general distribution pattern at the levels in question seems to represent the characteristic feature of mixing of the warm and cold currents.

The *salinity* measures about 34 ‰ everywhere. Its detailed feature of vertical distribution, however, is of interest; that is; the salinity to about 34.200-34.250 at 0-50 m depth strongly decreases to 34.030-34.050 at about 200-300 m, but tends to turn to increasing in general, thus forming the minimum salinity layer at 200-300 m depth, although its depth and value are somewhat different at each station. The deep layer at St. 27-2 exhibits the tendency of slight downward decreasing in salinity, and thus it forms the particular characteristics together with the temperature cited before.

The *pH* value is somewhat interesting, in showing a different distribution type in the stations. At St. 26-3, pH gradually decreases downwards from 7.9-8.1 of the uppermost layer to 7.5 of about 450 m level, and the latter value continues to the bottom (713 m). While, at St. 27-2, pH of 7.7 at the uppermost layer gradually decreases to that of 7.2 at 900 m level, which continues to the bottom (2034m). Also, noteworthy is that the pH values at St. 27-2 are all lower than those at St. 26-3, comparing 0-700 m levels in general. This fact may be of some significant, but the meaning is obscure in present.

The *reserved pH (RpH)* was measured, too. As a whole, it tends to be somewhat lower than pH value at the levels above 900 m depth, but somewhat higher at those below 1400 m depth. This fact probably shows that organic materials are decomposed in the lower water mass.

The *dis. SiO_2 and dis. P* are distributed in somewhat similar pattern to each other. Their small amounts at the upper layer gradually increase downwards, and become quite constant at the depth of 900 m, though dis. P abruptly increases at the bottom layer (2034 m) of St. 27-2. Their general tendency of vertical distribution coincides with a general pattern in the ocean.

The *dis. O_2 and alkali consumption value to pH 9.0* also show the similar distribution type to each other, but the amounts and patterns are somewhat different in each station, concerning the levels shallower than 700 m. Moreover, the water mass seems to be vertically divided into some parts according to the relative abundance of the elements, concerning St. 27-2.

Those other than the elements cited above, such as Ca^{2+}, Mg^{2+}, HCO_3^-, and Eh, do not show a significant vertical and local fluctuation nor departure from the general values reported in the ocean so far.

The *HCO_3^-* measures 140-153 ppm everywhere. *Ca^{2+}* and *Mg^{2+}* range from 390 to 420 ppm and from about 1250 to 1350 ppm respectively in all samples.

The *Eh* measures the positive value everywhere, namely about $+80 \sim +110$ mv. This shows a perfectly aerated environment of the area from the surface to the bottom, in adding to the abundant presence of dis. O_2 as shown precedingly.*

* For the purpose of obtaining some data on the very bottom water at St. 27-2, the enclosed water in the uppermost part of gravity core tube was examined. As its result, Eh measured +100 mv and pH measured 7.7. In the uppermost about 20 cm thick part of core, we found a strongly oxidized brownish-coloured clay.

Conclusion:

From the our physical and chemical examination of the three stations on the vessel, the following is suggested.

1) In spite of the slight fluctuation or departure more or less existing through the all stations as to many components distributions, there is shown a general hydrochemical tendency of oceans, and the temperature distribution pattern of rather shallow water may represents that of the area influenced by the mixing of warm and cold currents.

2) Regardless of a topographic feature of trough at St. 27-2, it does hardly have any influence on the good aeration at the interface of water and sediments. But the physics and chemistry of water represented by minor fluctuations of temperature, dis. P, salinity, dis. O_2 and alkali consumption value to pH 9.0 may possibly show the particular characteristics of the water mass in the trough, different from that of the upper layer.

16. Sighting records of mammals and birds in the Sea of Japan

Toshio Kasuya and Kazuo Kureha

1. Introduction

The principal purpose of this study is to get some information on the distribution and migration of the marine mammals in the waters adjacent to Japan and to accumulate the basic data for stock assessment.

The sightings of birds are also recorded, for the abundance of oceanic birds can be a help to find the area of high productivity in the sea.

Table 16-1. Effort of sighting observation expressed by cruising distance and hours

Area	Date	Nautical miles	Hours-minutes
N 21-3	23, May	43	3-50
N 20-3	30, May	82	8-15
	31, 〃	30	3-05
	2, June	12	1-15
	3, 〃	14	1-20
	7, 〃	74	7-00
	Total	212	20-55
N 20-4	24, May	92	9-05
	25, 〃	21	2-20
	26, 〃	110	11-50
	30, 〃	21	1-45
	Total	287	28-50
M 20-1	26, May	19	2-00
	27, 〃	53	5-05
	29, 〃	118	11-00
	4, June	64	6-30
	5, 〃	27	2-10
	9, 〃	88	8-10
	10, 〃	47	5-30
	Total	416	40-35
M 20-2	3, June	98	9-30
	4, 〃	27	2-30
	6, 〃	144	14-00
	8, 〃	33	3-10
	9, 〃	26	2-20
	Total	328	31-30
Grand Total		1286	121-50

2. Method and Total effort

The observation was made concurrently by the authors with binoculars usually at the upper deck, which situates about 11.8 m above the water surface. The observation was conducted during the cruising hours in daytime except the case of poor visibility. In the case of marine mammals the position and the number of individuals in each school were recorded, but in birds the position of the ship at every hour and the number of birds sighted in the preceding one hour were recorded.

The cruising course with observation is shown by the thick solid lines in Fig. 16-1, in which the dotted line indicates the course where observation was not conducted. Although the observed area covers central area of the Sea of Japan, the observation on the continental shelf is rather scarce.

The effort of sighting, expressed by the nautical miles of observed distance and

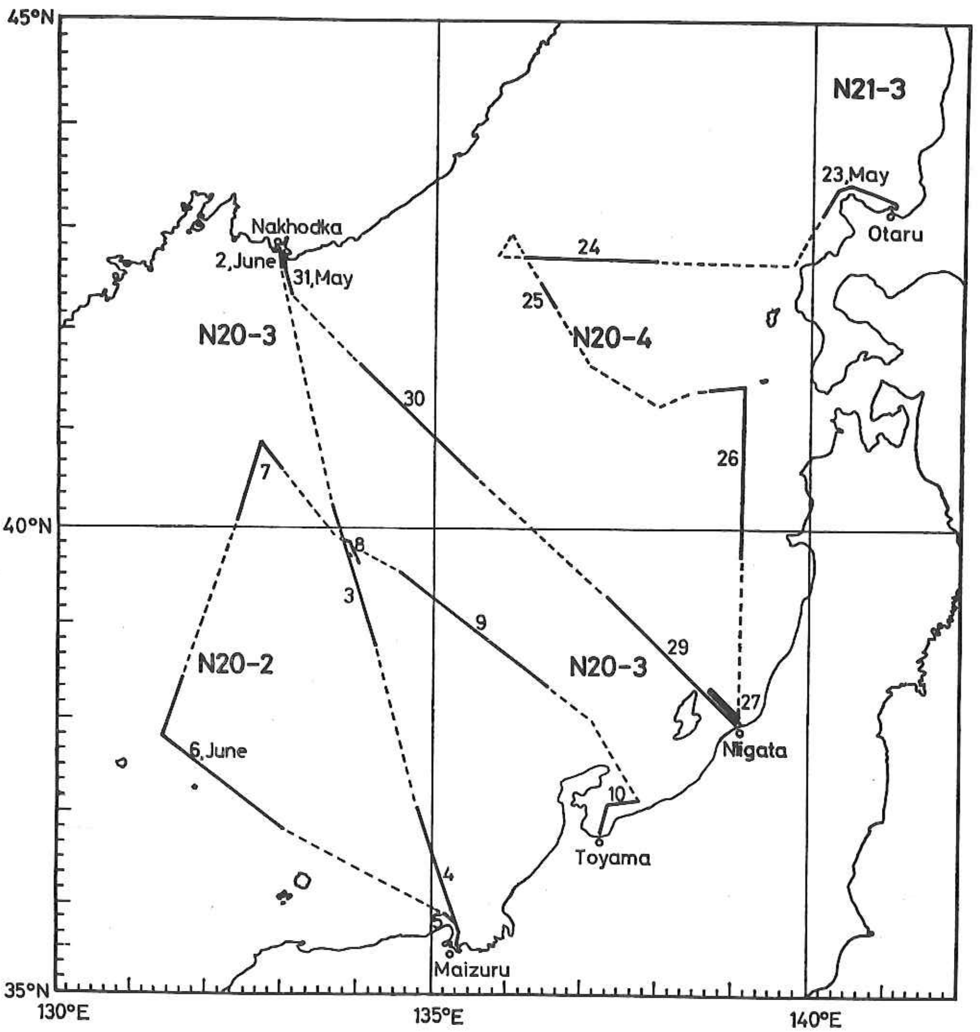


Fig. 16-1. Map showing the course of the Hakuho-maru in the Sea of Japan. Thick line indicates the course where observation was conducted. The number by the line means the date. The abbreviations for each 5 degree squares are also shown.

totalized in each 5 degree squares, is tabulated in Table 16-1. The vessel usually cruised at the speed of about 10 knots.

The total hours spent for observation is 121 hours 50 minutes and the distance is 1286 nautical miles.

In the most of hours of this cruise was towed a air gun of seismic profiler which emits periodically a strong underwater sound of low frequency. Though the response of marine mammals to this sound is not clarified at present, it will not be negligible.

3. Results

Marine mammals: The sighting records are tabulated in Table 16-2. The species of marine mammals observed in this cruise are *Phocaenoides dalli* and *Callorhinus ursinus*. The former species was observed at the coastal waters of Hokkaido on 23, May and at Yamato Tai on 9, June. The latter species was observed on 8, June at Yamato Tai. The sighting of dolphins in the Sea of Japan was unexpectedly scarce. One reason of this will be that the most part of the course of the vessel was far from coastal waters where dolphins are usually abundant. The other probable reason is the unknown effects of the sound from air gun to dolphins.

Table 16-2. Sighting records of marine mammals

Species	Number in a school	Position sighted	Date
Phocaenoides dalli	5	43°24′ N, 140°36′ E	23, May
〃	4	36°26′ N, 140°29′ E	〃 〃
〃	5	43°25′ N, 140°25′ E	〃 〃
〃	1	43°17′ N, 140°14′ E	〃 〃
〃	2	39°18′ N, 134°58′ E	9, June
Callorhinus ursinus	1	39°54′ N, 133°43′ E	8, 〃

Though at KT-68–10 cruise in the Sea of Japan and Okhotsk Sea, operated in May and June 1968, *Lagenorhynchus* and *Phocaena* were sighted numerously in coastal waters of Hokkaido, these species were not sighted at this cruise.

Birds: The sighting records of birds in the Sea of Japan is tabulated in Table 16-3. Among 10 species of identified sea birds, *Larus crassirostris* and *Puffinus pacificus* were the most abundant. And they were sighted mostly in the coastal waters off Niigata, Toyama and Maizuru, especially the large flocks of *Puffinus pacificus* were commonly found in the waters off Toyama and Maizuru. 8 species of land birds were identified.

Several land birds were sighted at the middle area in the Sea of Japan on the 30th of May, 3rd and 8th of June. Some of these would have been on migratory course, but some individuals sighted on the 3rd of June would have been drifted by the storm prevailed that area on the preceding day.

Table 16-3. Birds observed in the Sea of Japan

Species	Number	Area	Date
Stercorarius parasiticus	3	N 20-4	24, May
	2	〃	26, 〃
	5	〃 , Total	
Catharacta skua	2	N 20-4	26, May
	1	M 20-2	6, June
Larus canus	7	N 20-4	26, May
L. argentatus	3	N 20-4	26, May
L. crassirostris	3	N 20-3	31, May
	13	N 20-4	26, May
	3	M 20-1	〃 〃
	3	〃	27, 〃
	68	〃	29, 〃
	27	〃	4, June
	67	〃	5, 〃
	168	〃 , Total	
	13	M 20-2	6, June
	2	〃	8, June
	15	〃 , Total	
Larus sp.	1	N 20-3	3, June
Pterodroma leucoptera	39	M 20-1	27, May
Puffinus pacificus	459	M 20-1	4, June
	2850	〃	5, 〃
	10	〃	9, 〃
	231	〃	10, 〃
	3550	〃 , Total	
	25	M 20-2	
P. tenuirostris	1	N 20-3	7, June
	7	M 20-2	6, 〃
P. carneipes	7	M 20-2	6, June
Puffinus spp.	4	N 20-3	7, June
	1	M 20-2	3, June
	13	〃	6, 〃
Colonectris leucomelas	2	M 20-1	4, June
	1	〃	19, 〃
	3	〃 , Total	
Alcidae spp.	4	N 20-3	30, May
	22	〃	31, 〃
	2	〃	2, June
	1	M 20-1	26, May
	2	〃	29, 〃
Hydrobatidae spp.	1	N 20-3	3, June
	7	M 20-1	4, 〃
Sea birds, unspecified	33	N 20-3	31, May

	20	N 20-4	26, 〃
Phalacrocorax capillatus	2	N 20-3	30, May
	2	M 20-1	27, 〃
Hyrundo daurica (?)	4	M 20-2	3, June
Hyrundinidae sp.	2	M 20-2	3, June
Streptopelia orientalis	2	N 20-3	6, June
	4	N 20-4	30, May
	1	M 20-2	8, June
Eurystomus orientalis	1	M 20-2	3, June
Anser albifrons	1	N 20-3	7, June
Erithacus calliope (♂)	1	N 20-4	26, May
Phylloscopus borealis	1	M 20-2	3, June
Sylviidae sp.	1	M 20-2	8, June
Caprimulgus indicus	1	N 20-3	3, June
Land birds, unspecified	3	N 20-3	31, May
	1	〃	3, June
	2	M 20-2	〃 〃
	1	〃	4, 〃
	1	〃	8, 〃