PART I

I. OUTLINE OF THE GH78-1 CRUISE AND ITS RESULTS

Tomoyuki Moritani, Koji Onodera, Keiji Handa, Takemi Ishihara, Yasumasa Kinoshita, Kiyokazu Nishimura, Taisuke Suzuki, Katsuya Tsurusaki* and Makoto Yuasa*

Introduction

The GH78-1 cruise of the R/V Hakurei-Maru (1,821.6 t) was carried out from 7th of January to 7th of March, 1978, as the fourth phase field work of five year research program of the Geological Survey of Japan (GSJ) on "Study on the manganese nodule deposits of the northern Central Pacific Basin", and as a part of research program of National Research Institute for Pollution and Resources (NRIPR) on "Study on Mining Technology for Marine Mineral Resources". The GSJ's five year program was carried out from fiscal year 1974 to fiscal year 1978, aiming at providing basic data on the manganese nodule distribution and their origin on the deep ocean floor of the northern Central Pacific Basin bounded by the Marshall Ridge to the west, the Christmas Ridge to the east and the Mid-Pacific Mountains to the north (MIZUNO and MORITANI, 1978).

These field surveys were done as GH74-5 cruise for the eastern part area in 6°N–10°30′N and 164°30′W–171°30′W (MIZUNO and CHUJO eds., 1975); GH76-1 cruise for the central-eastern part area in 5°N–10°N, 170°W–175°W (MIZUNO and MORITANI eds., 1977); GH77-1 cruise for the central-western part area in 6°N–11°N and 175°30′W–179°W (MORITANI ed., 1979); GH78-1 cruise for the western part area in 7°30′N–13°N and 179°W–177°30′E (MORITANI and NAKAO eds., this report); and GH79-1 cruise for the northern part area in 10°N–13°N and 165°W–180° (MIZUNO ed., 1981) (Fig. I-1).

This cruise report of GH78-1 consists of Part I, Part II and Appendix. Part I includes the results of the on-board surveys and observations in the survey area of the eastern part of the northern Central Pacific Basin, and Part II contains the results of the onshore laboratory works on the obtained samples. While in Appendix some results of instrumental tests both for samplers and 3.5 kHz sub-bottom profiler, and of geophysical works along the tracks in the South Pacific to and from Fiji are included.

Outline of GH78-1 cruise

Scientific staffs participated in the GH78-1 cruise includes eleven scientists from Geological Survey of Japan (GSJ), National Research Institute for Pollution and Resources (NRIPR) and Metal Mining Agency of Japan (MMAJ), and nine graduate and undergraduate students as technical assistant from Hokkaido University, the University of Tokyo, Kobe University, Ryukyu University and Tokai

* National Research Institute for Pollution and Resources, Tsukuba

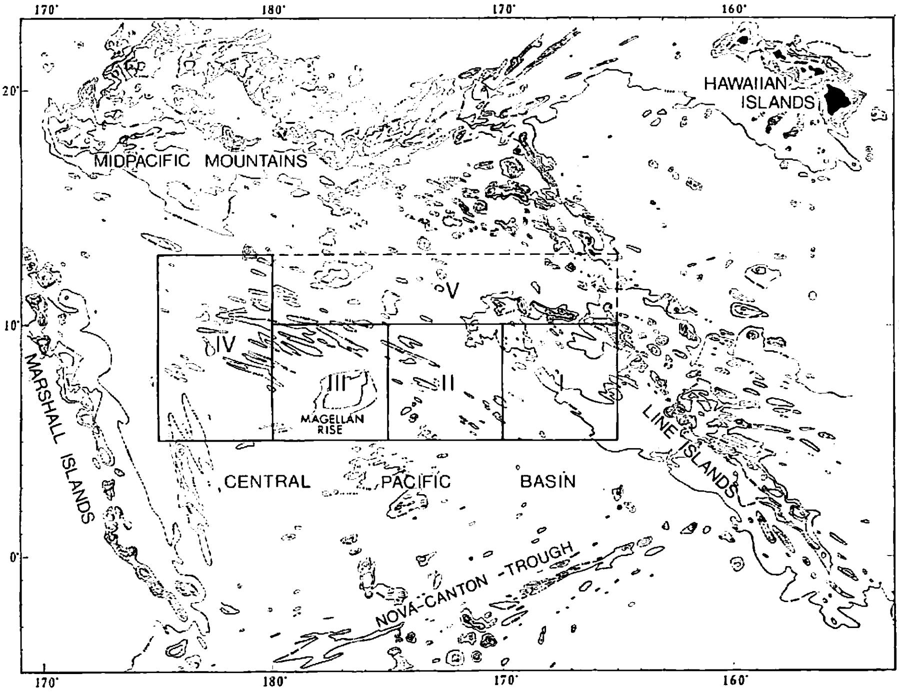

Fig. I-1 Submarine topography and survey areas of five year program. I: GH74-5, II: GH76-1, III: GH77-1, IV: GH78-1, V: GH79-1. Data source of topographic map; Winterer, Ewing et al. (1973).

University, and one trainee scientist from Mineral Resources Division of Fiji under UN fellowship (Table I-1).

The R/V Hakurei-Maru commanded by Captain H. Okumura started from Funabashi Port, Tokyo Bay on 7th of January, first called at Majuro Port, for three days, then arrived at the survey area and made the earlier half survey for 14 days. After that she left there once a while for South Pacific to call at Suva Port, Fiji for five days. Then she came back to the survey area and did the later half survey for nine days, and returned to Funabashi on 7th of March of the same year finishing its 60 days cruise (Tables I-2 and I-3).

The total sailing distance amounted to 22,387 km (12,088 n.m.). Of that sailing distance, 5,988 km (3,233 n.m.) was spent for geological, optical and geophysical observations in the survey area for twenty-three days in total. Along tracks between Japan and the survey area and then between the survey area and Fiji, a geophysical survey was continuously carried out by means of 12 kHz PDR (Precision Depth Recorder) and 3.5 kHz PDR or SBP (Subbottom Profiler), and proton magnetometer, and on-board gravity meter.

On the way during the course from the survey area to Fiji and then back to the survey area, a test of submersible type 3.5 kHz subbottom profiling system at St. 1062, a continuous sismic reflection profiling survey near Fiji, and a sampling at St. 1063 were carried out.

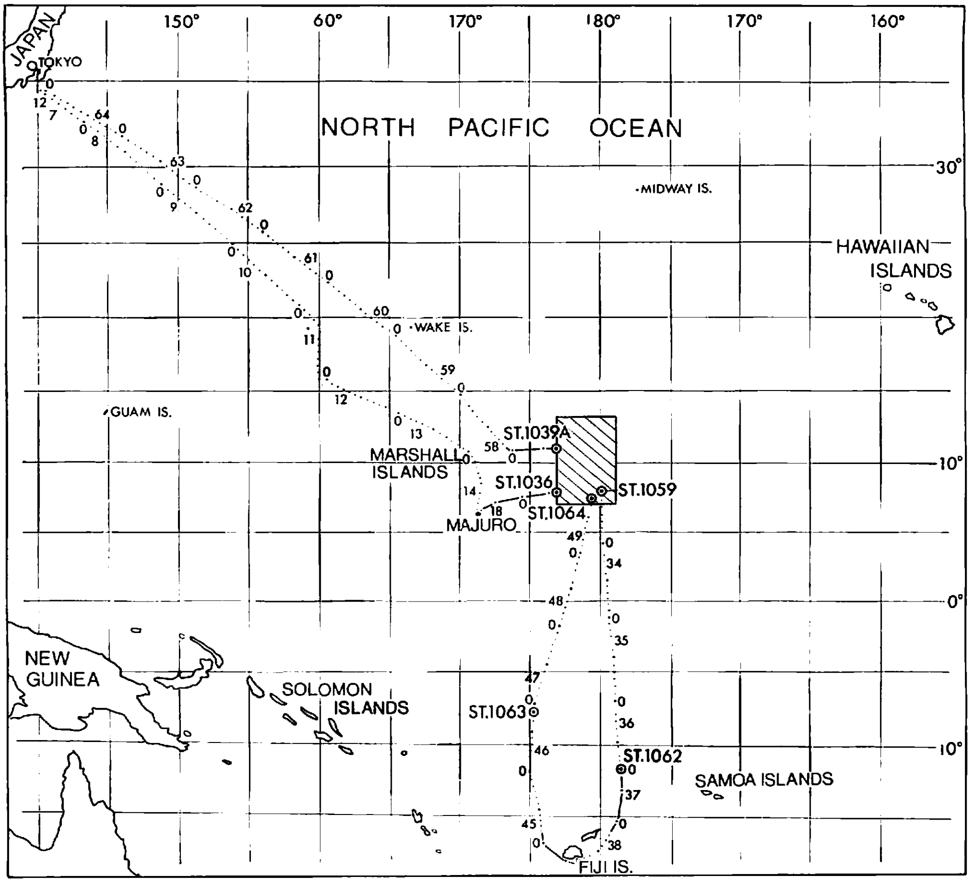

Fig. I-2 Index map of the survey areas and tracks.

On-board surveys in GH78-1 area and onshore laboratory works

The survey methods used in the survey area are shown in Table I-4. These include sailing survey of various geophysical methods, stationary or on-sits observations such as geological sampling, sea bottom photographing and STD measurement, and on-board observations and analysis of obtained sediments and manganese nodules.

Fundamental stations were arranged firstly in grids of about 110 km (1° in latitude and longitude) and these were covered in earlier half survey of the cruise, and secondly some additional stations were set in the middle of the above-mentioned grids in the previously recognized high nodule abundance area of the southwestern part during the later half survey (Fig. I-3). The geophysical survey tracks were arranged to connect each neighboring station, mainly in north-south direction so as to cut the general trend of topographic relief (WINTERER, EWING *et al.*, 1973) (Figs. I-4 and 5).

At each fundamental station, there were regularly made sampling by a wire-

Table I-1 On-board scientific staffs

Name	Organization	Speciality and responsibility
Tomoyuki MORITANI	G.S.J.	Chief scientist; geology and mineralogy
Koji ONODERA	G.S.J.	Co-chief scientist; topography
Yasumasa KINOSHITA	G.S.J.	Scientist; geology and sedimentology in relation to optical survey
Makoto YUASA	G.S.J.	Scientist; geology and mineralogy
Takemi ISHIHARA	G.S.J.	Scientist; gravimetric survey and NNSS positioning
Kiyokazu NISHIMURA	G.S.J.	Scientist; magnetic and continuous seismic reflection survey
Taisuke SUZUKI	G.S.J.	Senior scientist; geology and sedimentology
Katsuya TSURUSAKI	N.R.I.P.R.	Senior scientist; exploitation techniques of nodules and engineering property of sediments
Keiji HANDA	N.R.I.P.R.	Scientist; exploitation techniques of nodules and engineering property of sediments
Tsunekazu AJIKI*	M.M.A.J.	Scientist; survey techniques
Eiji KUBOKI**	M.M.A.J.	Scientist; survey techniques
Masatoshi YAMADA	Hokkaido Univ.	Graduate student; technical assistant
Kokichi IIZASA	Univ. of Tokyo	Undergraduate student; technical assistant
Toshihito NAKAJIMA	Kobe Univ.	*Ibid.*
Toshiki ISHIZAWA	Kobe Univ.	*Ibid.*
Manabu UENO	Kobe Univ.	*Ibid.*
Minoru YOSHIDA	Ryukyu Univ.	*Ibid.*
Ken AOKI	Ryukyu Univ.	*Ibid.*
Masaru UCHIDA	Ryukyu Univ.	*Ibid.*
Keiichi KUSHIDA	Tokai Univ.	*Ibid.*
Eroni TUPUA	M.R.D., Fiji	Scientist; trainee on marine geological survey

* On-board from Funabashi to Suva.
** On-board from Suva to Funabashi.

Table I-2 Rough summary of cruise program

Jan. 7	Lv.	Funabashi (14:00)
		Geophysical survey from off Boso Peninsula to Majuro
Jan. 15	Ar.	Majuro (11:00)
Jan. 18	Lv.	Majuro (14:00)
		Geophysical survey from Majuro to the survey area
Jan. 20	Ar.	the survey area
		Geological and geophysical survey
Feb. 2	Lv.	the survey area
		Geophysical survey from the survey area to Suva
Feb. 8	Ar.	Suva (10:00)
Feb. 13	Lv.	Suva (16:00)
		Geophysical survey from Suva to the survey area
Feb. 18	Ar.	the survey area
		Geological and geophysical survey
Feb. 26	Lv.	the survey area
		Geophysical survey from the survey area to Funabashi
Mar. 7	Ar.	Funabashi (09:00)

Table I-3 Daily program of cruise

Date		Weather	Cruising time	Cruising distance*	Remarks**
Jan.	7	Fine	10.00	143.1	Lv. Funabashi (14:00)
	8	Fine	23.30	354.1	(Geophysical survey) from off Boso Peninsula to north of Majuro
	9	Cloudy	23.30	351.4	(Geophysical survey)
	10	Fine	23.30	353.5	(Geophysical survey)
	11	Cloudy	23.30	346.9	(Geophysical survey)
	12	Cloudy	23.30	336.0	(Geophysical survey)
	13	Fine	23.30	326.3	(Geophysical survey)
	14	Rainy	24.00	321.7	(Geophysical survey)
	15	Fine	11.00	93.6	(Geophysical survey); ar. Majuro (11:00)
	16	Fine	—	—	——
	17	Cloudy	—	—	——
	18	Cloudy	10.00	107.5	Lv. Majuro (14:00); (Geophysical survey)
	19	Cloudy	24.00	237.0	(Geophysical survey)
	20	Cloudy	24.00	140.5	(Geophysical survey); ar. the survey area; geophysical survey and sampling (Sts. 1036, 1037 and 1037-1)
	21	Fine	24.00	177.8	Geophysical survey and sampling (Sts. 1038 and 1039)
	22	Fine	24.00	151.1	Geophysical survey and sampling (Sts. 1040 and 1041)
	23	Fine	24.00	148.5	Geophysical survey and sampling (Sts. 1042 and 1043)
	24	Fine	24.00	137.8	Geophysical survey and sampling (Sts. 1044, 1044-1 and 1045)
	25	Fine	24.00	140.8	Geophysical survey and sampling (Sts. 1046 and 1047)
	26	Fine	24.00	143.1	Geophysical survey and sampling (Sts. 1048 and 1048-1)
	27	Cloudy	24.00	147.9	Geophysical survey and sampling (Sts. 1049 and 1050)
	28	Fine	24.00	147.1	Geophysical survey and sampling (Sts. 1051 and 1052)
	29	Cloudy	24.00	158.4	Geophysical survey and sampling (Sts. 1053 and 1954)
	30	Fine	24.00	148.7	Geophysical survey and sampling (Sts. 1060 and 1061)
	31	Fine	24.00	143.5	Geophysical survey and sampling (Sts. 1055 and 1056)
Feb.	1	Fine	24.00	84.2	Geophysical survey and sampling (Sts. 1057, 1057-1 and 1057-2)
	2	Fine	24.00	167.2	Geophysical survey and sampling (Sts. 1058 and 1059); lv. the survey area; (Geophysical survey) to Suva
	3	Cloudy	24.00	334.8	(Geophysical survey)
	4	Fine	24.00	334.6	(Geophysical survey)
	5	Fine	24.00	364.0	(Geophysical survey)
	6	Fine	24.00	239.8	(Geophysical survey); test of submersible 3.5 kHz transducer
	7	Fine	24.00	272.0	(Geophysical survey)

Table I-3 (Continued)

Date	Weather	Cruising time	Cruising distance*	Remarks**
8	Fine	10.00	113.3	(Geophysical survey); ar. Suva (10:00)
9	Fine	—	—	Calibration of gravimeter
10	Cloudy	—	—	——
11	Fine	—	—	——
12	Fine	—	—	——
13	Fine	08.00	81.4	Lv. Suva; (Geophysical survey)
14	Fine	24.00	274.3	(Geophysical survey)
15	Cloudy	24.00	340.6	(Geophysical survey)
16	Cloudy	24.00	302.4	(Geophysical survey); test of sampling with spade corer at St. 1063
17	Rainy	24.00	346.2	(Geophysical survey)
18	Fine	24.00	317.5	(Geophysical survey)
19	Fine	24.00	171.0	(Geophysical survey); geophysical survey and sampling (Sts. 1064 and 1065)
20	Fine	24.00	134.1	Geophysical survey and sampling (Sts. 1066 and 1067)
21	Fine	24.00	126.4	Geophysical survey and sampling (Sts. 1068 and 1069)
22	Fine	24.00	133.9	Geophysical survey and sampling (Sts. 1036-A and 1070)
23	Cloudy	24.00	138.5	Geophysical survey and sampling (Sts. 1071 and 1072)
24	Fine	24.00	165.1	Geophysical survey and sampling (Sts. 1073 and 1074)
25	Fine	24.00	149.7	Geophysical survey and sampling (Sts. 1075 and 1076)
26	Fine	24.00	188.0	Geophysical survey and sampling (Sts. 1038A and 1039A); lv. the survey area; (Geophysical survey)
27	Fine	24.30	291.8	(Geophysical survey)
28	Fine	24.30	373.6	(Geophysical survey)
Mar. 1	Fine	24.30	354.7	(Geophysical survey)
2	Fine	24.30	347.2	(Geophysical survey)
3	Fine	24.30	307.9	(Geophysical survey)
4	Cloudy	24.30	339.5	(Geophysical survey)
5	Cloudy	24.00	314.7	(Geophysical survey)
6	Fine	17.00	226.5	(Geophysical survey); ar. off Chiba (17:00)
7	Fine	01.15	7.0	Ar. Funabashi (09:00)

* Showing in n.m. (nautical miles).

** (Geophysical survey) showing the survey without continuous seismic profiling, and sampling usually accompanies simultaneous photographing by freefall camera sampler.

Table I-4 Observation methods at the survey area. The right-hand column shows a survey line length and an observation number of respective works

Cruising and positioning by NNSS	ca. 5,988 km (3,233 n.m.)
Geophysical methods	
Bathymetric survey by 12 kHz PDR	ca. 5,241 km (2,830 n.m.)
Subbottom profiling by 3.5 kHz PDR	ca. 5,241 km (2,830 n.m.)
Continuous seismic reflection profiling by air-gun	ca. 4,871 km (2,630 n.m.)
Magnetic survey by proton magnetometer	ca. 5,241 km (2,830 n.m.)
Gravimetric survey by on-board gravimeter	ca. 5,988 km (3,233 n.m.)
Geological methods	
Bottom sampling by Okean-70 grab of box corer	G604–641
Bottom sampling by large box dredge	D261–262
Bottom sampling by freefall (photo) grab	FG73–114
Optical methods	
Observation by seep sea still camera	C13–14
Observation by freefall photo grab one-shot camera	FG73C–114C
Others	
Water measurement by STD	S11–28
On-board examination on sediments and nodule samples	
Compositional analysis of sediment; soft X-ray photography of sediment; sampling of interstitial water in the sediments by low pressure squeezer; size and type classification of nodules; X-ray diffractometer analysis of nodules; measurement of engineering property of sediments.	

lined sampler usually of Okean-70 grab or double-spade box corer and associated simultaineous sampling and photographing of the bottom by two sets of freefall (boomerang) photograb. This aimed at providing the reliable data for checking the horizontal variation of manganese nodules and to some extent surficial sediments over a very limited one station area. Then, at the additional stations, besides the above-mentioned usual sampling, there were carried out two bottom samplings of large amount of nodule by large box dredge, two sea bottom continuous photographings, and one continuous sampling and photographing by freefall photograb for detailed survey. As an improvement in sampling method, the success of the above-mentioned double-spade box corer which was first applied to the actual use was very important for obtaining undisturbed bottom sediments.

Also, water measurement by STD graphic recorder was carried out at the fundamental stations along 178°E meridian (Sts. 1043–1047), 179°E meridian (Sts. 1048–1053) and at Sts. 1054–1057, 1060–1061, concurrently with the operation of wire-lined samplers of Okean-70 grab or double-spade box corer.

The geophysical surveys were regularly carried out along the tracks connecting the neighboring two stations by means of 12 kHz PDR and 3.5 kHz PDR or SBP, continuous seismic reflection profiling, proton magnetometer, and on-board gravity meter.

Ship's position was determined mainly by NNSS with auxiliary use of OMEGA system throughout the survey area. A method of calculation of position from OMEGA reading with correction by PPC value, and then compound fixes of

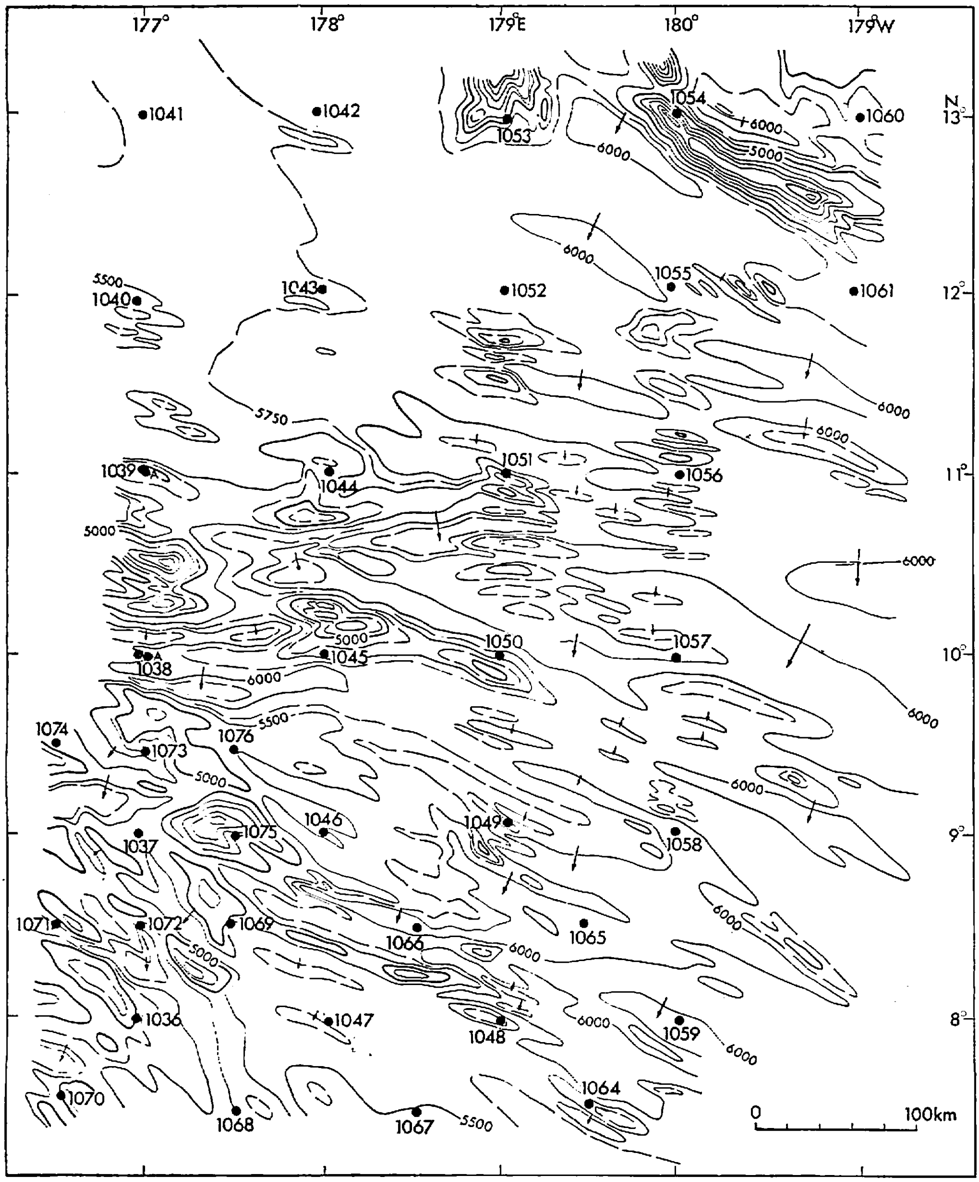

Fig. I-3 Bathymetric map and stations of on-site observation in GH78-1 area.

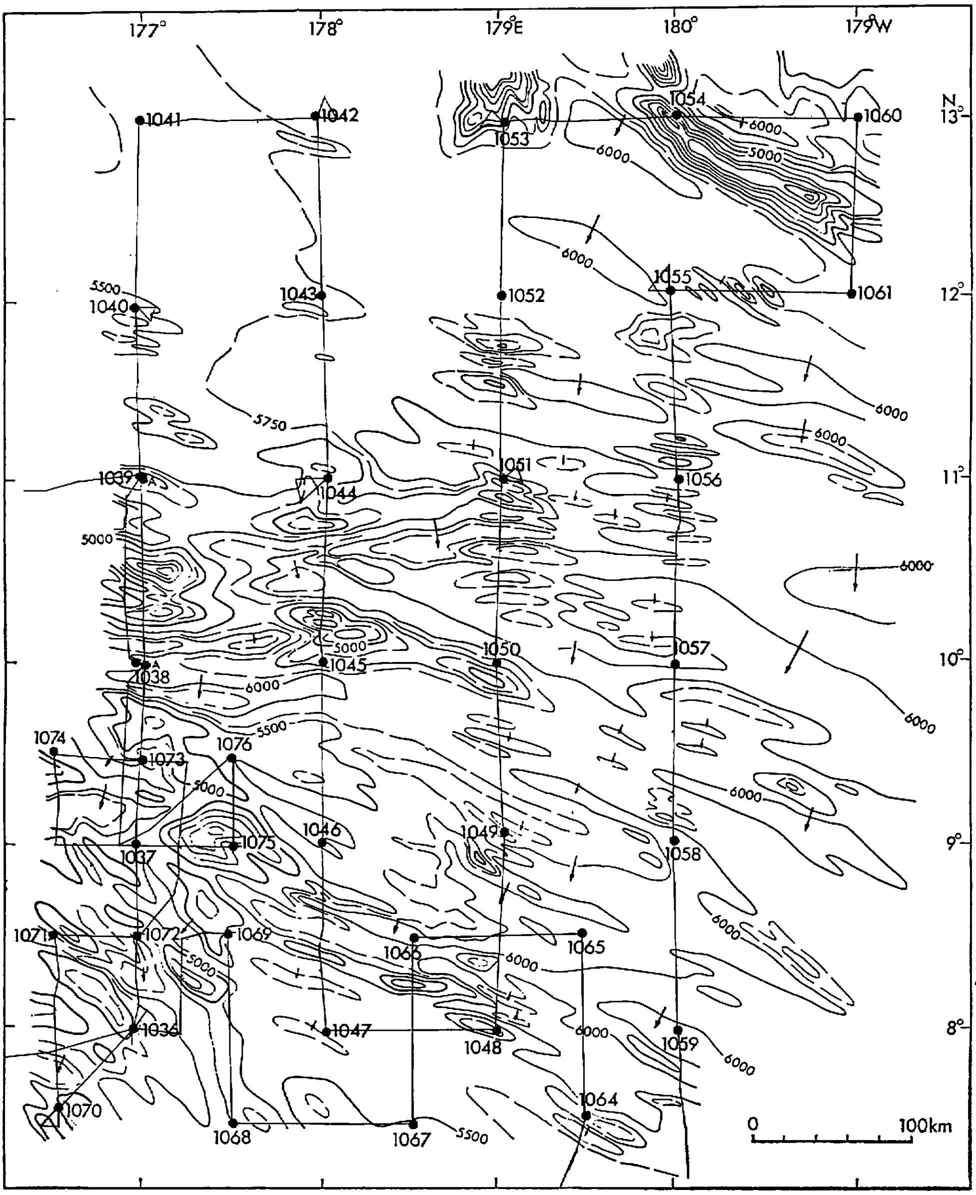

Fig. I-4 Geophysical survey tracks shown on bathymetric map in GH78-1 area.

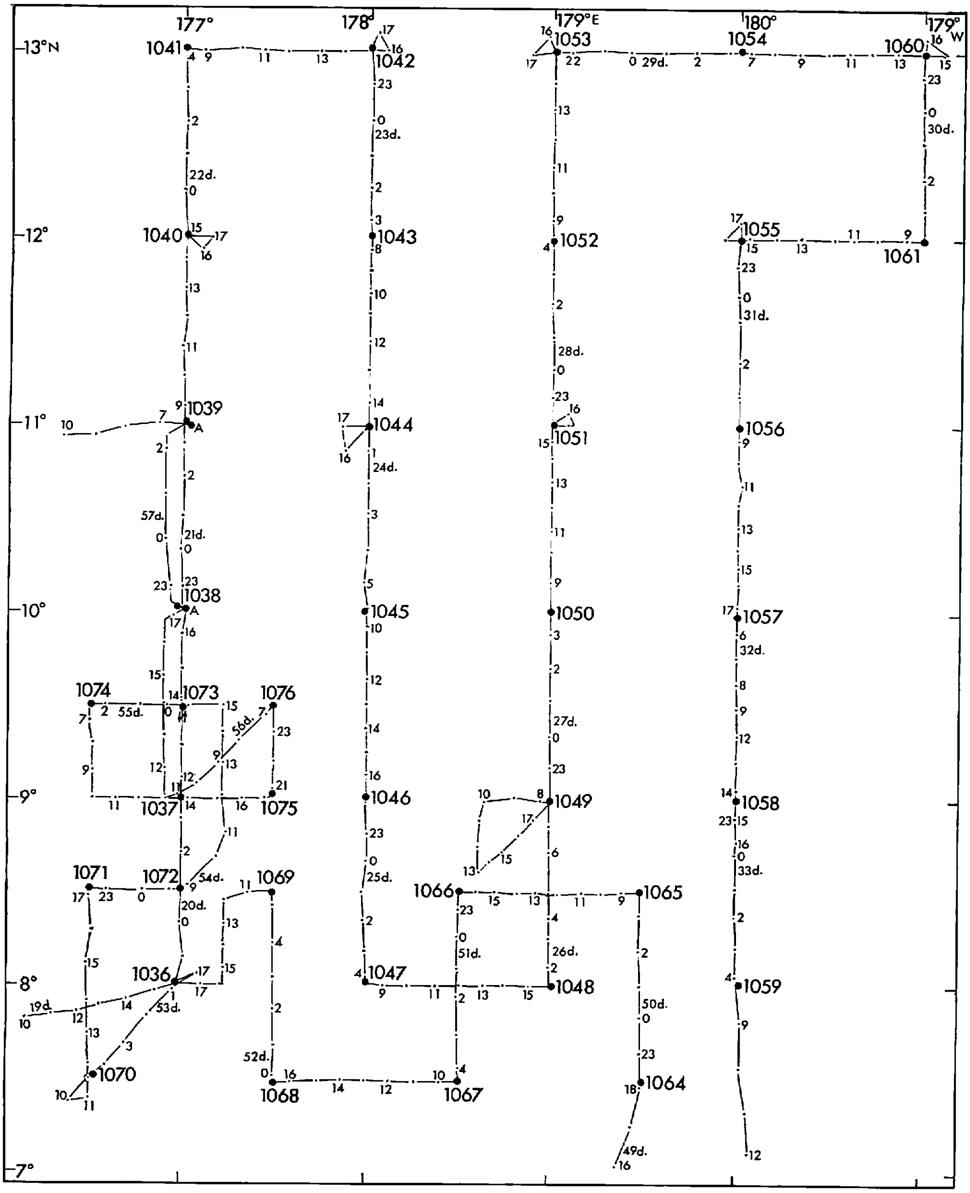

Fig. I-5 Details of stations of on-site observation (solid circle) and geophysical survey tracks (lines with dots showing GMT date and time).

position both from recalculated NNSS and the OMEGA calculation were tried.

After the cruise, various onshore laboratory works or analyses were made by GSJ staffs and other ones including non-on-board members. These participants in onshore laboratory works were as follows; sedimentological analysis of sediments by S. NAKAO; chemical analysis of sediments by K. KATO; chemical analysis of manganese nodules by T. MOCHIZUKI and S. TERASHIMA; X-ray diffractometer analysis of manganese nodules by M. FAKIOGLU, a visiting scientist at GSJ from Mineral Research and Exploration Institute (MTA) of Turkey; radio-chemical analysis of sediments by S. Tsunogai of Hokkaido University; chemical analysis of interstitial water by M. KUSAKABE and S. TSUNOGAI of the above University; and instrumental study on the test result of submersible type 3.5 kHz SBP system by M. JOSHIMA.

In addition, S. NAKAO joined the editing work of this report.

Summary of investigation results of GH78-1 cruise

The results of the whole on-site observations are summarized in Table 1-5 together with corrected depth as for the verosity of sound in sea water according to MATTHEWS' Table and the compoundly determined position from NNSS recalcuration and OMEGA calculation. The recalculated position of satellite fix was estimated to have an error of 0.1–0.7 nautical mile, while the calculated OMEGA position had the standard deviation of 0.25–0.62 nautical mile in longitudinal direction and of 0.86–1.41 nautical mile in latitudinal direction.

The details of results on each study theme are described in each chapter. Here are summarized the main points on the property and distribution of manganese nodule deposits, and their relation to the geological factors such as topography, surface sediments, and acoustic stratigraphy and structure of substrate layers.

The topography of the GH78-1 area is characterized generally by the topographic trend in WNW-ESE direction, and the whole area is divisible into four topographic areas as the northeastern seamounts, southwestern mountainous area, northwestern abyssal plain and central-southeastern deep sea basin with predominant repeated linear troughs and hills.

The acoustic features of substrate layers were understood from the records of air-gun and 3.5 kHz PDR or SBP. On the seismic profiling record, the substrate is divided into Layer 1 and Layer 2 (acoustic basement) in descending order. The Layer 1 is classified into Unit I or upper transparent layer with subtypes of Type A (clearly transparent) and Type C (acoustic turbidites with densely laminated reflectors), and Unit II or lower semiopaque layer. The thickness of Unit I is thinner in the northern area, being less than 50 m, while it becomes thicker towards south from around the latitude 10°N. Especially in the southeastern deep sea basin, which represents a northeastern extension of the basin to the northeast of the foot of Magellan Rise, the thickness of Unit I attains to 200 m. The upper transparent layer on the 3.5 kHz PDR record also tends to be thinner in the north and to thicken towards south, showing contrast between relatively more thickening in troughs and thinning in hills in the prevailing repeated linear troughs and hills topography trending in WNW-ESE direc-

St. No.	Observ.[1] No.	Julian Day	Local Day	Local Time ▼[2]	Local Time ▲	Position Lat. ▼	Position Long. ▼	Position Lat. ▲	Position Long. ▲
1036	G(B)604	019	1.20	08 : 11		08 00 3N	176 57 1E		
	FG73-1	〃	〃	06 : 10		08 00 1N	176 57 0E		
	〃 C	〃	〃	〃		〃	〃		
	FG73-2	〃	〃	06 : 15		08 00 1N	176 56 7E		
	〃 C	〃	〃	〃		〃	〃		
1036A	D261	052	2.22	08 : 45	10 : 20	08 00 9N	176 57 1E	08 01 0N	176 55 7E
1037	(G(B)605)	020	1.20	17 : 43		09 04 3N	176 58 1E		
	FG74-1	〃	〃	15 : 48		09 03 1N	176 58 6E		
	〃 C	〃	〃	〃		〃	〃		
	FG74-2	〃	〃	15 : 52		09 03 3N	176 58 5E		
	〃 C	〃	〃	〃		〃	〃		
1037-1	G(B)605-1	〃	〃	21 : 14		08 59 9N	176 58 2E		
1038	(G(B)606)	020	1.21	08 : 00		09 59 6N	176 58 1E		
	FG75-1	〃	〃	06 : 06		09 59 5N	176 58 1E		
	〃 C	〃	〃	〃		〃	〃		
	FG75-2	〃	〃	06 : 09		09 59 5N	176 58 0E		
	〃 C	〃	〃	〃		〃	〃		
1038-A	G640	056	2.26	07 : 43		10 00 2N	176 59 3E		
	FG113-1	〃	〃	05 : 44		09 59 8N	176 59 5E		
	〃 C	〃	〃	〃		〃	〃		
	FG113-2	〃	〃	05 : 47		09 59 9N	176 59 6E		
	〃 C	〃	〃	〃		〃	〃		
1039	(G(B)607)	021	1.21	17 : 47		11 01 7N	177 00 3E		
	FG76-1	〃	〃	15 : 37		11 00 3N	177 00 3E		
	〃 C	〃	〃	〃		〃	〃		
	FG76-2	〃	〃	15 : 41		11 00 5N	177 00 4E		
	〃 C	〃	〃	〃		〃	〃		
1039-A	G641	057	2.26	16 : 26		11 00 4N	176 59 6E		
	FG114-1	〃	〃	14 : 48		11 00 5N	176 59 5E		
	〃 C	〃	〃	〃		〃	〃		
	FG114-2	〃	〃	14 : 50		11 00 5N	176 59 6E		
	〃 C	〃	〃	〃		〃	〃		
1040	G(B)608	021	1.22	07 : 50		11 57 5N	176 57 4E		
	FG77-1	〃	〃	05 : 59		11 57 2N	176 57 8E		
	〃 C	〃	〃	〃		〃	〃		
	(FG77-2)	〃	〃	06 : 02		11 57 3E	176 57 6E		
	(〃 C)	〃	〃	〃		〃	〃		
1041	G(B)609	022	1.22	18 : 06		12 58 9N	177 00 1E		
	FG78-1	〃	〃	16 : 08		12 59 2N	177 00 3E		
	〃 C	〃	〃	〃		〃	〃		
	FG78-2	〃	〃	16 : 11		12 59 4N	177 00 3E		
	〃 C	〃	〃	〃		〃	〃		
1042	G(B)610	022	1.23	08 : 04		12 59 9N	177 58 4E		

on-site observation

Depth (m) Corrected	Mn-nodule abundance[3]	kg/m²	Results and remarks: Bottom materials[4] [ ] showing results of sediment type analysis	Remarks[5] Topography, ( ) showing 3.5 kHz transparent layer
5,251	●	32.5	[Calcareous-siliceous clay] ISs, Ss	Upper slope of a small hill in rolled area.
5,174	●	32.0	SPs	
〃		[65%]		
5,184	●	30.3	ISs, Ss	
〃		—		
5,174–5,329			ISs, SPs, Ss, DPs	Gently sloped and depressed plane.
4,875		—		Slope of a hill with 400m relative height in rolled area.
5,020	●	20.8	ISs, Ss, Vs	
〃		[70%]		
5,040	●	26.0	ISs, Ss, Vs	
〃		[70%]		
5,225	⊙	10.6	[Deep sea clay]	Flat bottom of the above hill.
6,034		—		Ragged surface top of a lower hill in trough and hill area.
5,952	⊙	13.0	ISs, Vs	
〃		[75%]		
5,952	◬	6.9	ISs, SPs, Ss, Vs	
〃		[75%]		
6,140	⊙	16.7	[Siliceous clay] Vs, DPs, IDPs, SPs, Ss	〃
6,140	⊙	18.2	ISs, SPs, Vs	
〃		[75%]		
6,160	●	20.7	ISs, SPs, IDPs, Vs	
〃		[70%]		
5,205		—		Upper slope of a small hill in gently rolled area.
5,020	△	2.2	DPs, Vs	
〃		[85%]	Pavement of rock fragments	
5,030	×	0.0		
〃		[85%]	Pavement of rock fragments	
5,245	⊙	13.5	[Siliceous clay] IDPs	〃
5,225	⊙	15.1	SPs, IDPs, DPs	
〃		[80%]		
5,215	+	trace	IDs	
〃				
5,381	◬	7.5	[Deep sea clay] IDPs, DPs, chert fragments	Uneven surface top of a small hill in gently rolled to plain area.
5,256		—		
〃			Larger rock fragments outcrop	
5,277		—		
〃		—		
5,690	+	trace	[Zeolitic mud] SPs, Ss	Extensively flat abyssal plain.
5,680	+	trace	Ss, Vs	
〃		—		
5,680	+	trace		
〃		[0%]		
5,803	+	trace	[Deep sea clay] SPr, Sr, shark's teeth	Extensively flat abys-

St. No.	Observ.[1] No.	Julian Day	Day	Local Time ▼[2]	Local Time ▲	Position Lat. ▼	Position Long. ▼	Position Lat. ▲	Position Long. ▲
1042	F G79-1	〃	〃	05 : 59		13 00 0N	177 58 3E		
	〃 C	〃	〃	〃		〃	〃		
	F G79-2	〃	〃	06 : 03		13 00 0N	177 58 5E		
	〃 C	〃	〃	〃		〃	〃		
1043	G611	023	1.23	17 : 52		12 00 9N	178 00 0E		
	F G80-1	〃	〃	15 : 37		12 00 9N	177 59 4E		
	〃 C	〃	〃	〃		〃	〃		
	F G80-2	〃	〃	15 : 41		12 00 9N	177 59 6E		
	〃 C	〃	〃	〃		〃	〃		
1044	(G612)	023	1.24	07 : 49		11 00 2N	178 01 2E		
	F G81-1	〃	〃	06 : 00		11 00 5N	178 00 7E		
	〃 C	〃	〃	〃		〃	〃		
	F G81-2	〃	〃	06 : 03		11 00 5N	178 00 8E		
	C 〃	〃	〃	〃		〃	〃		
1044-1	G612-1	〃	〃	10 : 53		11 00 3N	178 00 6E		
1045	G613	024	1.24	19 : 36		09 59 3N	178 00 6E		
	F G82-1	〃	〃	17 : 52		09 59 5N	178 00 6E		
	〃 C	〃	〃	〃		〃	〃		
	(F G82-2)	〃	〃	17 : 55		09 59 5N	178 00 7E		
	〃 C	〃	〃	〃		〃	〃		
1046	G614	024	1.25	07 : 49		09 01 3N	177 59 8E		
	F G83-1	〃	〃	06 : 01		09 01 4N	178 00 2E		
	〃 C	〃	〃	〃		〃	〃		
	F G83-2	〃	〃	06 : 07		09 01 5N	178 00 4E		
	〃 C	〃	〃	〃		〃	〃		
1047	G615	025	1.25	18 : 03		07 59 2N	178 01 7E		
	F G84-1	〃	〃	16 : 15		07 59 1N	178 00 9E		
	〃 C	〃	〃	〃		〃	〃		
	F G84-2	〃	〃	16 : 18		07 59 1N	178 01 0E		
	〃 C	〃	〃	〃		〃	〃		
1048	G(B)616	025	1.26	08 : 16		07 59 2N	179 00 2E		
	F G85-1	〃	〃	06 : 00		07 59 7N	179 00 0E		
	〃 C	〃	〃	〃		〃	〃		
	F G85-2	〃	〃	06 : 04		07 59 7N	179 00 2E		
	〃 C	〃	〃	〃		〃	〃		
1048-1	G616-1	〃	〃	11 : 31		07 59 6N	179 00 2E		
1049	G617	026	1.27	08 : 01		09 04 4N	179 02 4E		
	F G86-1	〃	〃	06 : 01		09 04 5N	179 01 4E		
	〃 C	〃	〃	〃		〃	〃		
	F G86-2	〃	〃	06 : 04		09 04 5N	179 01 6E		
	〃 C	〃	〃	〃		〃	〃		
1050	G618	027	1.27	17 : 34		09 59 7N	179 00 7E		
	F G87-1	〃	〃	15 : 46		09 59 3N	178 59 9E		
	〃 C	〃	〃	〃		〃	〃		
	F G87-2	〃	〃	15 : 49		09 59 3N	179 00 1E		
	〃 C	〃	〃	〃		〃	〃		

(Continued)

Depth (m)	Results and remarks				
	Mn-nodule abundance[3)]		Bottom materials[4)] [ ] showing results of sediment type analysis		Remarks[5)] Topography ( ) showing 3.5 kHz, transparent layer
Corrected		kg/m²			
5,813	+	trace		SPr	sal plain.
〃		[2%]			
5,813	+	trace		Sr, Db	
〃		[2%]			
5,608	△	1.8	[Deep sea clay]	Sr, Vr, shark's teeth	Top of a small hill
5,608	◇	0.9		Sr, Vr, skark's teeth	in abyssal plain.
〃		[15%]			
5,618	◇	0.9		Sr, SPr, Dr, Vr, sharks teeth, Otolith	
〃		[5%]			
5,381		—			Uneven top to upper
5,360	△	2.9		SPs, Ss	slope of a lower hill
〃		[10%]			in hilly area with 200-
5,370	△	2.1		SPs, Ss	400-600m relative
〃		[10%]			heights.
5,322	△	3.9	[Deep sea clay]	Ss·r, SPs·r	
5,380	●	20.2	[Deep sea clay]	DPs, SPs, Ss	Bottom of a hill with
5,246	+	trace		DPs	300-450m relative
〃			Rock outcrop		heights.
5,246		—			
〃			Rock outcrop		
5,474		(2.2)	[Siliceous clay]	Ss·r, SPs·r	Upper slope to top of
5,463	◬	6.0		Ss·r, SPs·r	a hill in repeated
〃		[30%]			small trough and hill
5,433	◬	7.7		Ss·r, SPs·r	area with 500m rela-
〃		[30%]			tive heights.
5,660	△	2.9	[Siliceous clay]	Sr, SPr	Flat abyssal plain
5,660	△	2.6		Sr, Spr	with sporadical hills
〃		[15%]			and well developed
5,649	△	4.3		Sr, SPr	transparent layer.
〃		[15%]			
5,183	◬	8.1		SPs, DPs	Upper slope of a linear
5,153	+	trace		SPs	hill in trough and hill
〃			Rock outcrop		area.
5,153	◬	6.9		SPs	
〃		[55%]			
5,143	●	25.5	[Siliceous clay]	ISs, IDPs, DPs, Ss	
5,983	△	(3.5)	[Deep sea clay]	Sr, SPr	Flat valley bottom in
5,983	◬	9.5		Sr, SPr	trough and hill area
〃		—			with 200-500m rela-
5,973	◬	9.5		Sr	tive heights.
〃		[20%]			
5,603	◬	6.2	[Siliceous clay]	SPs, DPs	Slope of a ragged hill
5,618	⊙	12.1		DPs	in hill dominant area.
〃		—			
5,618	+	trace			
〃					

St. No.	Observ.[1] No.	Julian Day	Local Day	Local Time ▼[2]	Local Time ▲	Position Lat. ▼	Position Long. ▼	Position Lat. ▲	Position Long. ▲
1051	G619	027	1.28	07 : 57		10 59 1N	179 01 1E		
	F G88-1	〃	〃	06 : 06		10 59 5N	179 01 1E		
	〃 C	〃	〃	〃		〃	〃		
	F G88-2	〃	〃	06 : 09		10 59 6N	179 01 2E		
	〃 C	〃	〃	〃		〃	〃		
1052	G620	028	1.28	18 : 12		12 00 3N	179 01 5E		
	F G89-1	〃	〃	16 : 20		12 00 1N	179 01 7E		
	〃 C	〃	〃	〃		〃	〃		
	F G89-2	〃	〃	16 : 23		12 00 1N	179 01 8E		
	〃 C	〃	〃	〃		〃	〃		
1053	G621	028	1.29	07 : 38		12 57 5N	179 01 3E		
	F G90-1	〃	〃	05 : 57		12 58 8N	179 00 6E		
	〃 C	〃	〃	〃		〃	〃		
	F G90-2	〃	〃	06 : 01		12 58 8N	179 00 8E		
	〃 C	〃	〃	〃		〃	〃		
1054	G622	029	1.29	17 : 00		12 59 6N	179 59 8E		
	F G91-1	〃	〃	15 : 30		12 59 8N	179 59 6E		
	〃 C	〃	〃	〃		〃	〃		
	F G91-2	〃	〃	15 : 34		12 59 8N	179 59 8E		
	〃 C	〃	〃	〃		〃	〃		
1055	G(B)625	030	1.31	08 : 07		12 01 1N	179 58 7E		
	F G94-1	〃	〃	05 : 58		12 00 0N	179 59 3E		
	〃 C	〃	〃	〃		〃	〃		
	F G94-2	〃	〃	06 : 02		12 00 0N	179 59 3E		
	〃 C	〃	〃	〃		〃	〃		
1056	G(B)626	031	1.31	18 : 10		10 58 8N	179 58 6W		
	F G95-1	〃	〃	16 : 10		10 58 5N	179 59 0W		
	〃 C	〃	〃	〃		〃	〃		
	F G95-2	〃	〃	16 : 13		10 58 5N	179 58 9W		
	〃 C	〃	〃	〃		〃	〃		
1057	(G(B)627)	031	2.1	07 : 51		09 59 6N	179 59 9W		
	F G96-1	〃	〃	05 : 54		09 59 9N	180 00 0		
	〃 C	〃	〃	〃		〃	〃		
	F G96-2	〃	〃	05 : 57		09 59 9N	180 00 0		
	〃 C	〃	〃	〃		〃	〃		
1057-1	(G627-1)	〃	〃	11 : 30		09 59 2N	179 59 6E		
1057-2	G627-2	032	〃	14 : 37		09 59 4N	180 00 0		
1058	G(B)628	032	2.2	08 : 33		09 01 1N	179 59 8W		
	F G97-1	〃	〃	06 : 03		09 01 5N	179 59 9W		
	〃 C	〃	〃	〃		〃	〃		
	F G97-2	〃	〃	06 : 08		09 01 6N	179 59 8W		
	〃 C	〃	〃	〃		〃	〃		

(Continued)

Depth (m) Corrected	Mn-nodule abundance[3)]	kg/m²	Results and remarks: Bottom materials[4)] [ ] showing results of sediment type analysis		Remarks[5)] Topography ( ) showing 3.5 kHz transparent layer
5,235	⊙	14.9	[Deep sea clay]	DPs, IDPs, Vs	Uneven top of a hill in
5,245	⊙	13.8		DPs, Vs	hill dominant area
〃		—			
5,245	◇	0.9		Vs; harden sediments	
〃			Rock outcrop		
5,926	△	3.1	[Deep sea clay]	Sr, SPr	Extensively flat plain.
5,931	◇	0.9		Sr, SPr	
〃		[1%]			
5,931	+	trace		Sr, SPr	
〃		[0%]			
4,910	△	(1.8)	[Deep sea clay]	Ss, DPs; basalt fragments	Slope base of a larger seamount.
4,782	△	2.6		Ss, SPs, DPs; basalt fragments	
〃					
4,813	+	trace		Ss, SPs, DPs; basalt fragments	
〃					
5,053	●	23.9	[Deep sea clay]	Ss, SPs, Vs	Lower slope of a sea-
4,875	×	0.0			mount.
〃			Rock outcrop?		
4,762	◬	5.2		SPs, Ss; shark's teeth	
〃			Rock outcrop?		
5,962	◇	0.6	[Deep sea clay]	Sr, SPr	Nearly flat floor of a
5,952	◇	0.9		Sr, SPr	trough in trough and
〃		[5%]			hill area with 500–
5,952	+	trace		Sr, SPr	600m relative heights.
〃		[5%]			
5,930	◬	9.4	[Deep sea clay]	Ss·r, SPs·r, DPs·r	Valley bottom in hilly
5,952	⊙	11.2		Ss·r, SPs·r, DPs·r, IDPs·r	area with 300–600–1000m relative heights.
〃		[75%]			
5,930	⊙	17.3		SPs·r, DPs·r, IDPs·r	
〃		[75%]			
5,952		—			
5,942	⊙	10.4		Ss, SPs, DPs	Uneven top to slope
〃		—			of a hill in hill domi-
5,952	⊙	19.0		Ss, SPs	nant area.
〃		[55%]			
5,838		—			
5,952	⊙	A 15.3 B 5.1	[Deep sea clay]	A: DPs, ISs, Ss, SPs B: IDPs, DPs, Ss, SPs	A—on surface B—buried
6,150	×	0.0	[Siliceous clay]		Flat plain with spo-
6,150	×	0.0			radical small hills.
〃		[0%]			
6,150	×	0.0			
〃		[35%]	Slab?		

Table I-V

St. No.	Observ.[1] No.	Julian Day	Day	Local Time ▼[2]	Local Time ▲	Position Lat. ▼	Position Long. ▼	Position Lat. ▲	Position Long. ▲
1059	G629	033	2.2	18 : 19		07 59 6N	179 59 4W		
	F G98-1	〃	〃	16 : 34		07 59 3N	179 59 9W		
	〃 C	〃	〃	〃		〃	〃		
	F G98-2	〃	〃	16 : 37		07 59 3N	179 59 8W		
	〃 C	〃	〃	〃		〃	〃		
1060	G(B)623	029	1.30	08 : 01		12 59 1N	178 59 5W		
	F G92-1	〃	〃	06 : 00		12 59 4N	179 00 1W		
	〃 C	〃	〃	〃		〃	〃		
	F G92-2	〃	〃	06 : 09		12 59 5N	179 00 1W		
	〃 C	〃	〃	〃		〃	〃		
1061	G(B)624	030	1.30	18 : 08		11 59 8N	179 02 6W		
	F G93-1	〃	〃	16 : 03		11 59 9N	179 03 0W		
	〃 C	〃	〃	〃		〃	〃		
	F G93-2	〃	〃	16 : 06		11 59 9N	179 02 9W		
	〃 C	〃	〃	〃		〃	〃		
1062	3.5K-1	036-037	2.6	11 : 28	12 : 32	11 57 2 S	178 40 6W	11 57 4 S	178 40 8W
1063	(G(B)630)	046	2.16	08 : 09		07 52 5 S	175 16 4 E		
	F G99-1	〃	〃	05 : 53		07 52 8 S	175 15 0 E		
	〃 C	〃	〃	〃		〃	〃		
	F G99-2	〃	〃	05 : 58		07 52 9 S	175 15 0 E		
	〃 C	〃	〃	〃		〃	〃		
1064	(G631)	049	2.19	08 : 13		07 33 2N	179 29 8 E		
	F G100-1	〃	〃	06 : 28		07 33 2N	179 30 0 E		
	〃 C	〃	〃	〃		〃	〃		
	F G100-2	〃	〃	06 : 31		07 33 2N	176 30 1 E		
	〃 C	〃	〃	〃		〃	〃		
1065	G632	050	2.19	17 : 48		08 32 2N	179 28 4 E		
	F G101-1	〃	〃	15 : 48		08 31 6N	179 28 7 E		
	〃 C	〃	〃	〃		〃	〃		
	F G101-2	〃	〃	15 : 50		08 31 7N	179 28 7 E		
	〃 C	〃	〃	〃		〃	〃		
1066	(G633)	050	2.20	08 : 02		08 30 4N	178 31 0 E		
	F G102-1	〃	〃	05 : 50		08 30 7N	178 31 0 E		
	〃 C	〃	〃	〃		〃	〃		
	F G102-2	〃	〃	05 : 53		08 30 7N	178 31 2 E		
	〃 C	〃	〃	〃		〃	〃		
1067	G634	051	2.20	19 : 24		07 29 1N	178 31 3 E		
	F G103-1	〃	〃	16 : 33		07 29 4N	178 30 7 E		
	〃 C	〃	〃	〃		〃	〃		
	F G103-2	〃	〃	16 : 36		07 29 5N	178 30 8 E		
	〃 C	〃	〃	〃		〃	〃		
1068	C13	051	2.21	08 : 08	09 : 45	07 29 4N	177 30 7 E	07 29 5N	177 30 3 E
	F G104-1	〃	〃	05 : 51		07 29 6N	177 30 4 E		

(Continued)

Depth (m) Corrected	Mn-nodule abundance[3]	kg/m²	Bottom materials[4] [ ] showing results of sediment type analysis		Remarks[5] Topography, ( ) showing 3.5 kHz transparent layer
6,056	△	1.8	[Silicecus ooze]	Sr, SPr, SEr	Depression in very gently rolled abyssal plain.
6,056	×	0.0			
〃		[10%]	Slab?		
6,056	◇	0.9		Sr, SPr, SEr	
〃		—			
5,720	△	7.5	[Deep sea clay]	Ss, SPs, DPs	Flat basin floor with sporadical hills.
5,700	△	2.2		DPs	
〃		[15%]			
5,710	△	4.3		DPs	
〃		[3%]			
5,632	△	3.1	[Deep sea clay]	Ss·r, SPs·r, IDPs·r, Ds·r	Nearly flat plain
〃					
5,639	△	6.1		Ss, SPs, IDPs	
		[20%]			
5,634	△	4.3		Ss, SPs, DPs	
〃		—			
1,938					(Outside the survey area); Deep tow 3.5 kHz transducer test.
5,433		—			(〃): abyssal plain to the south of Ellice Islands; Larger single spade box corer test.
5,433	×	0.0			
〃		[0%]			
5,433	×	0.0			
〃		[0%]			
5,300		—			Upper most slope of a hill with 1000 m relative heights.
5,245	△	1.7		Vs, SPs, DPs	
〃		[40%]			
5,328	●	33.7		Ss, SPs, Vs, IDPs (slab)	
〃		[60%]			
6,159	△	1.3	[Siliceous clay]	SEr, SPr, Dr	Nearly flat floor of very gently rolled abyssal plain.
6,159	+	trace		Sr	
〃		[0%]			
6,159	+	trace		SEr, SPr, Dr	
〃		[0%]			
6,263		—			Flat floor of broad trough in gentle trough and hill area.
6,263	⊙	17.3		SPs, Vs	
〃		[70%]			
6,263	⊙	15.5		SPs, Vs	
〃		[70%]			
5,250	⊙	18.6	[Siliceous clay]	SPs, Ss, ISs, Vs, Ds	Top of very gentle low hill in plateau like plane.
5,370	●	28.5		SPs, Vs	
〃		[60%]			
5,340	●	33.7		SPs, Ss, ISs	
〃		[65%]			
5,443–5,448					Nearly flat floor of a broad trough in gently rolled trough and hill
5,433	⊙	17.7		SPs	

Table I-V

St. No.	Observ.[1] No.	Julian Day	Day	Local Time ▼[2]	Local Time ▲	Position Lat. ▼	Position Long. ▼	Position Lat. ▲	Position Long. ▲
1068	F G104–1C	051	2.21	05 : 51		07 29 6N	177 30 4E		
	F G104–2	〃	〃	05 : 55		07 29 6N	177 30 6E		
	〃 C	〃	〃	〃		〃	〃		
1069	G635	052	2.21	19 : 40		08 30 7N	177 29 5E		
	F G105–1	〃	〃	17 : 35		08 30 4N	〃		
	〃 C	〃	〃	〃		〃	〃		
	F G105–2	〃	〃	17 : 37		08 30 5N	177 29 7E		
	〃 C	〃	〃	〃		〃	〃		
1070	G636	053	2.22	18 : 40		07 33 8N	176 33 0E		
	F G106–1	〃	〃	17 : 00		07 33 4N	176 33 3E		
	〃 C	〃	〃	〃		〃	〃		
	F G106–2	〃	〃	17 : 03		07 33 6N	176 33 4E		
	〃 C	〃	〃	〃		〃	〃		
1071	G637	053	2.23	08 : 27		08 30 5N	176 30 4E		
	F G107–1	〃	〃	05 : 52		08 29 4N	176 30 1E		
	〃 C	〃	〃	〃		〃	〃		
	F G107–2	〃	〃	05 : 56		08 29 5N	176 30 3E		
	〃 C	〃	〃	〃		〃	〃		
1072	D262	054	2.23	16 : 35	18 : 06	08 30 1N	176 59 4E	08 29 8N	176 57 8E
	F G108–1	〃	〃	13 : 40		08 29 8N	177 00 8E		
	〃 C	〃	〃	〃		〃	〃		
	F G108–2	〃	〃	13 : 43		08 29 8N	177 01 0E		
	〃 C	〃	〃	〃		〃	〃		
1073	F G109–1	054	2.24	05 : 59		09 30 0N	177 00 0E		
	〃 C	〃	〃	〃		〃	〃		
	F G109–2	〃	〃	06 : 14		09 28 0N	177 00 0E		
	〃 C	〃	〃	〃		〃	〃		
	F G109–3	〃	〃	06 : 29		09 26 1N	176 59 9E		
	〃 C	〃	〃	〃		〃	〃		
	F G109–4	〃	〃	06 : 44		09 24 2N	176 59 8E		
	〃 C	〃	〃	〃		〃	〃		
	F G109–5	〃	〃	07 : 03		09 25 2N	177 01 8E		
	F G109–6	〃	〃	07 : 18		09 27 2N	177 01 7E		
	F G109–7	〃	〃	07 : 32		09 29 3N	177 01 7E		
	F G109–8	〃	〃	07 : 46		09 31 4N	177 01 7E		
1073	〃 C	054	2.24	07 : 46		09 31 4N	177 01 7E		
1074	(G(B)638)	055	2.24	16 : 30		09 31 0N	176 30 1E		
	F G110–1	〃	〃	14 : 32		09 30 7N	176 30 5E		
	〃 C	〃	〃	〃		〃	〃		
	F G110–2	〃	〃	14 : 34		09 30 7N	176 30 3E		
	〃 C	〃	〃	〃		〃	〃		
1075	G639	055	2.25	07 : 15		09 00 2N	177 30 1E		
	F G111–1	〃	〃	05 : 48		09 00 0N	177 29 9E		

(Continued)

Depth (m)	Results and remarks			
Corrected	Mn-nodule abundance[3)]	kg/m²	Bottom materials[4)] [ ] showing results of sediment type analysis	Remarks[5)] Topography, ( ) showing 3.5 kHz transparent layer
5,433		[65%]		area.
5,423	●	32.9	SPs	
〃		[65%]		
5,443	×	0.0	[Siliceous clay] Basalt fragments	Transitional part from
5,464	●	38.1	SPs, Ss	slope base of a sea-
〃		[70%]		mount to gently rolled
5,433	●	26.8	Ss, SPs, ISs, Vs	plateau like plane.
〃		[75%]		
4,947	●	48.2	[Calcareous-siliceous ooze] Ss, SPs	Lower slope of a
4,968	⊙	16.4	Ss, SPs	seamount.
〃		[75%]		
4,948	△	(5.2)	Ss, SPs, Vs, IDPs	
〃		[70%]		
5,020	●	31.0	[Calcareous-siliceous clay] SPs, ISs, Vs	Edge of a terrace like
4,919		(—)		plane or top of trough
〃			Larger block outcrop	bank
4,989	●	20.7	Vs, ISs	
〃		[60%]		
5,723-			Ss, SPs, ISs, Vs	Very gently sloped
5,536				depressed plane among
5,754	●	38.1	SPs, Vs, ISs	rolled area.
〃		[55%]		
5,774	●	34.6	SPs, ISs, Vs	
〃		[55%]		
5,164	●	26.8	SPs, ISs, Vs	A series of parts along
〃		[70%]		slope of a hill in sea-
5,287	⊙	12.1	SPs, Vs	mounts area;
〃		[45%]		FG109-1; Upper part,
5,329	×	0.0		(15 m)
〃		[30%]	Larger block outcrop	-2: Middle part, (25 m)
5,464	●	32.0	ISs, SPs, Vs, IDPs	-3: Lower part, (0 m)
〃		[60%]		-4: Lowermost part,
5,350	●	32.8	Vs, ISs, SPs	(15 m)
5,329	⊙	14.7		-5: Lower part, (30 m)
5,183	●	26.8	SPs, ISs, Vs	-6: Middle part, (20 m)
5,123	⊙	19.0	SPs, ISs, Vs	-7: Upper part, (20 m)
				-8: Uppermost part,
				(20 m)
5,123		—		
5,184		—		Gently sloped terrace
5,235	●	25.9	SPs, Vs (pype shape);	like plane in trough
			otolith	and hill area.
〃		[85%]		
5,225	●	24.2	SPs, ISs	
〃		[75%]		
4,028	×	0.0	[Calcareous ooze]	Upper slope of a sea-
3,825	×	0.0		mount.

St. No.	Observ.[1] No.	Julian Day	Day	Local Time ▼[2]	Local Time ▲	Position Lat. ▼	Position Long. ▼	Position Lat. ▲	Position Long. ▲
1075	FG111-1C	055	2.25	05 : 48		09 00 0N	177 29 9E		
	FG111-2	〃	〃	05 : 51		09 00 1N	177 30 0E		
	〃 C	〃	〃	〃		〃	〃		
1076	C14	056	2.25	15 : 00	16 : 25	09 28 6N	177 30 0E	09 29 2N	177 29 8E
	FG112-1	〃	〃	13 : 19		09 28 6N	177 30 1E		
	〃 C	〃	〃	〃		〃	〃		
	FG112-2	〃	〃	13 : 21		〃	177 30 2E		
	〃 C	〃	〃	〃		〃	〃		

1: G, Okean-70 grab; G(B), Box corer; D, Large box dredge; FG, Freefall photo grab (sample); FG-C, Freefall photo grab (photograph); C, Deep sea camera.
2: ▼, on bottom; ▲, roll up start.
3: Abundance is shown in kg/m^2; Marks show abundance grade, ×0, +<0.1, ◇, 0.1–1.0, △, 1.0–5.0, ▲, 5.0–10.0, ⊙, 10.0–20.0, ●, >20.0 kg/m^2; Parenthese ( ) indicate uncertain value probably due to imperfect sampling; Parentheses [ ] show cover ratio by a sea bottom photograph.

tion.

The distribution of surface sediments shows a broad zonal trend. Namely, calcareous ooze or calcareous-siliceous ooze is confined to the topographic highs both in the northern seamounts and the southwestern mountainous area, while deep sea clay lies in a vast area of the northwestern abyssal plain and central deep sea basin, with wider development of siliceous clay between the above two areas and very limited spot of siliceous ooze.

The classification of manganese nodules was made on the basis of the schema established in the GH76-1 area. However, there was recognized an intermediate s·r type on surface structure between s(smooth) type and r(rough) type as fundamental groups. Generally speaking, in the GH78-1 area the s type group is predominant. Perticularly Ss type with well-developed sphericity and of larger size, which had not been known in the previous GH76-1 or GH77-1 areas, was found in the southwestern mountainous area.

The distribution of manganese nodule abundance (in kg/m^2) shows a marked tendency. The highest grade abundance (>20 kg/m^2) is recognized remarkably in the southwestern mountainous area in which the maximum value of 48.2 kg/m^2 was found (St. 1070), and locally in the northeastern seamounts and in the hilly parts of the central-southeastern deep sea basin area. Also, the higher grade abundance (10–20 kg/m^2) is characteristically shown over the broad zone lying in E-W direction around the latitudes 10°–11°N, which corresponds to the extension of the higher grade abundance zone in the neighboring GH77-1 area. On the contrary, lower grade abundance characterizes the southeastern deep sea basin and the northwestern abyssal plain.

The above-mentioned tendencies in the distribution of manganese nodule abun-

(Continued)

Depth (m)	Results and remarks			
	Mn-nodule abundance[3]		Bottom materials[4] [ ] showing results of sediment type analysis	Remarks[5] Topography, ( ) showing 3.5 kHz transparent layer
Corrected		kg/m²		
3,825			Rock outcrop	
3,916	×	0.0		
〃				
5,454– 5,464		[0%]		Floor of a trough at the foot of a seamount.
5,454	◇	0.35	Sr, SPr	
〃		[0%]		
5,464	△	2.9	Sr, SPr, Vr	
〃		[0%]		

4: Sediment types are determined principally on the samples by Okean-70 grab (G) and box coreo (G(B)); Manganese nodules, shown in the type symbols (See Chap. IX, in this report).
5: Topographic description is mainly made on the observation of features of 3.5 kHz PDR profilling record on site survey.

dance indicate that high abundance is likely to be confined to the seamount or hill predominant part without or with thin Unit I, while low abundance including barren case is related to the trough predominant part with relatively thicker Unit I, and then that, however, there is the case even the part with thin Unit I shows low abundance as in the northwestern abyssal plain. These coinside with the relationship recognized in the previous GH cruise areas between the twickness of transparent layer (on seismic and 3.5 kHz PDR records) and the nodule abundance, namely high abundance is confined to the part with the layer thickness thinner than 40–50 m.

On the other hand, there is no marked correlation between the nodule abundance or types and the surface sediment types, except that calcareous ooze and siliceous ooze generally relate to low or barren abundance. The relationship is rather represented in the preference of s type group nodules to high abundance and r type group to low abundance in the areal distribution pattern. In connection with these tendencies, it is noteworthy that the already-mentioned manganese nodules with the maximum abundance value of 48.2 kg/m² are accompanied with calcareous-siliceous ooze at St. 1070 in the southwestern mountainous area.

The abundance and types of manganese nodule seem to be controlled by the sedimentation rate as a total effect of topography, biogenic productivity or sediments supply, and existence of bottom current. It is necessary further to study these relations to clarify the geologic environment and formation mechanism of manganese nodules both for the resources evaluation and genesis study of manganese nodules.

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