Geological Survey of Japan Cruise Report No. 22, p. 1–17, 1992

I. OUTLINE OF THE GH82-4 CRUISE

Masato Nohara, Akira Usui, Akira Nishimura, Manabu Tanahashi, Toshitsugu Yamazaki, Ken Ikehara and Kazuaki Watanabe

Introduction

The Geological Survey of Japan (GSJ) has been carried out research on marine mineral resources in the Central Pacific Basin since 1974. The GH82-4 cruise is the forth phase of the second five-year program "Geological Study of Deep-Sea Mineral Resources" (1979 to 1983) funded by the Agency of Industrial Science and Technology, MITI. The aim of this research program is to clarify geological background which affect the regional and local variations of various properties of manganese nodule deposits along the Wake-Tahiti Transect (from the Mid-Pacific Mountains, the Central Pacific Basin, the Manihiki Plateau, to the Penrhyn Basin, South Pacific; Fig. I-1). Seven GSJ scientists, three visiting scientists from the Ministry of Foreign Affairs of Japan, the Metal Mining Agency of Japan, and Korea Institute of Energy and Resources, and nine students from five Japanese universities participated in the cruise together with two professional photographers (Table I-1). The results of the previous cruises, GH80-1 (Mizuno and Nakao, 1982), GH80-5 (Nakao and Moritani, 1984), and GH81-4 (Nakao, 1986) have been published as GSJ Cruise Reports and in other scientific journals (e.g., Usui, 1983; Usui *et al.*, 1987). The report of GH83-3 is to be published next year.

Program and Schedule

The R/V Hakurei-maru commanded by Captain H. Okumura set sail from Funabashi Port, Tokyo Bay on August 14, 1982 for the survey area in the south of the Nova-Canton Trough, Equatorial Pacific. She called at Apia, Western Samoa on September 10 between two legs and returned to Funabashi on October 12 of the same year. The sixty-day program of the cruise is shown in Table I-2.

Area of study

The survey area is located between the Nova-Canton Trough and Manihiki Plateau in the equatorial central Pacific, which was selected based on previous manganese nodule data on the Wake-Tahiti Transect of the GH80-1 cruise (Mizuno and Nakao, 1982) and the preliminary geophysical data of GH81-4 cruise (Nakao, 1986). The first leg was spent for a reconnaissance survey and the second leg for a small-scale sampling in a detailed survey area. Figure I-2 shows topography of the GH82-4 area, and sample locations are plotted on topographic maps of the whole area (Fig. I-3) and of the detailed survey area (Fig. I-4).

Keywords: manganese nodule, geophysics, geochemistry, deep-sea sediment, seismic profile, Wake-Tahiti Transect, Manihiki Plateau, Central Pacific Basin, Hakurei-Maru, Nova-Canton Trough

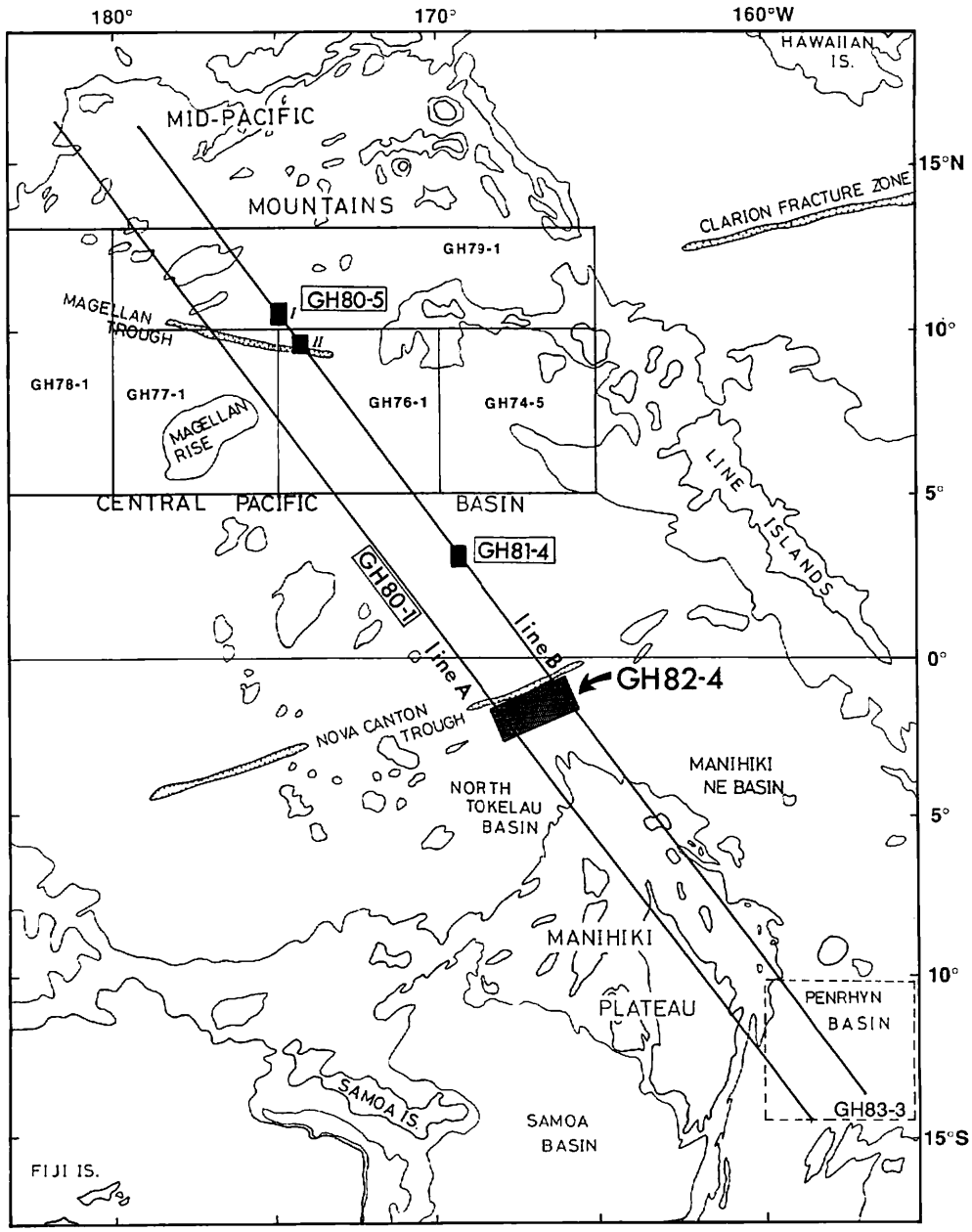

Fig. I-1 Survey areas of GH82-4 Cruise and previous cruises of the first and second 5-year programs. Contours 2000 and 2600 fathoms in water depth.

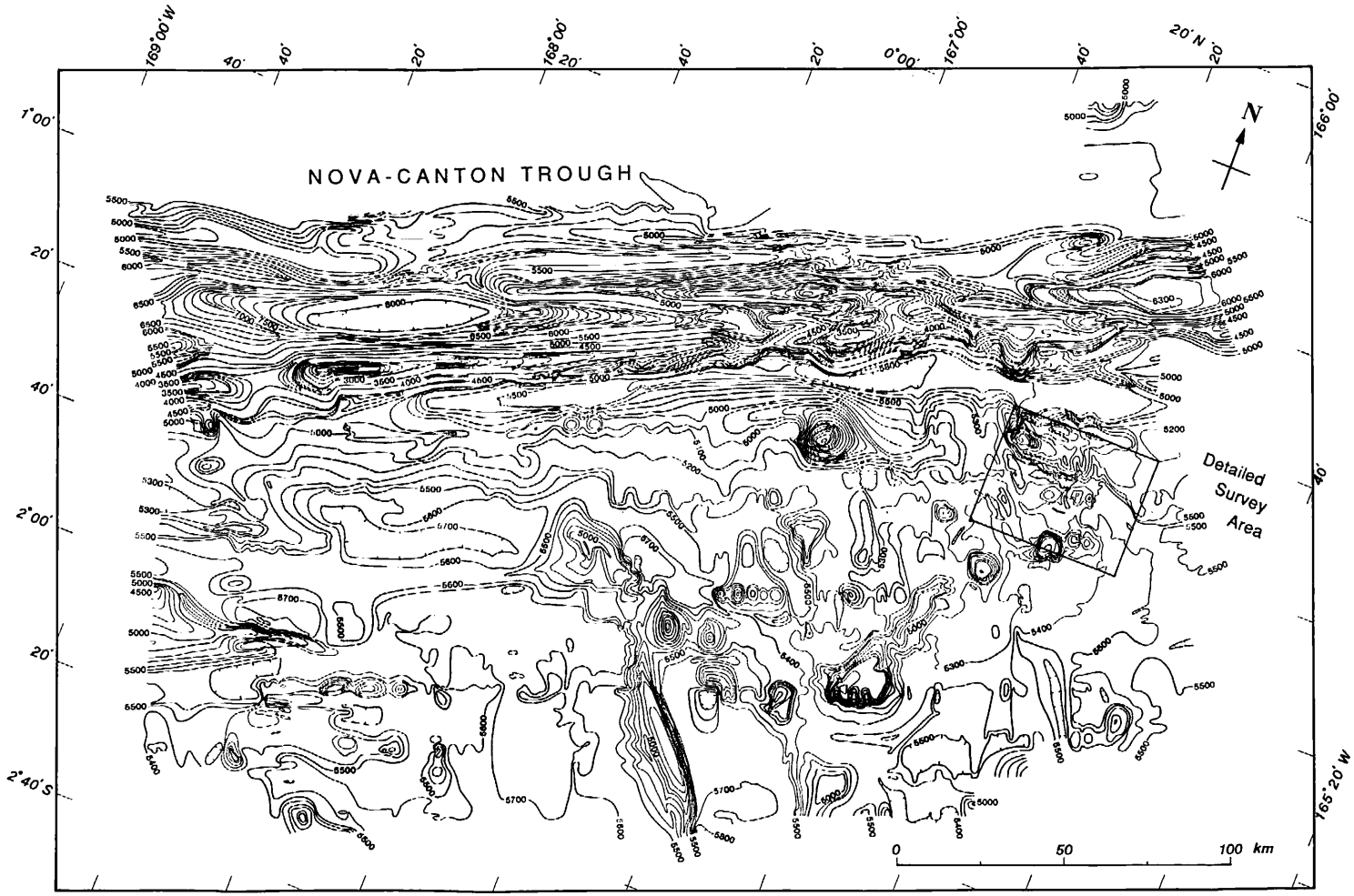

Fig. I-2 Topography of the GH82-4 Area. Compiled by Kazuaki Watanabe of GSJ.

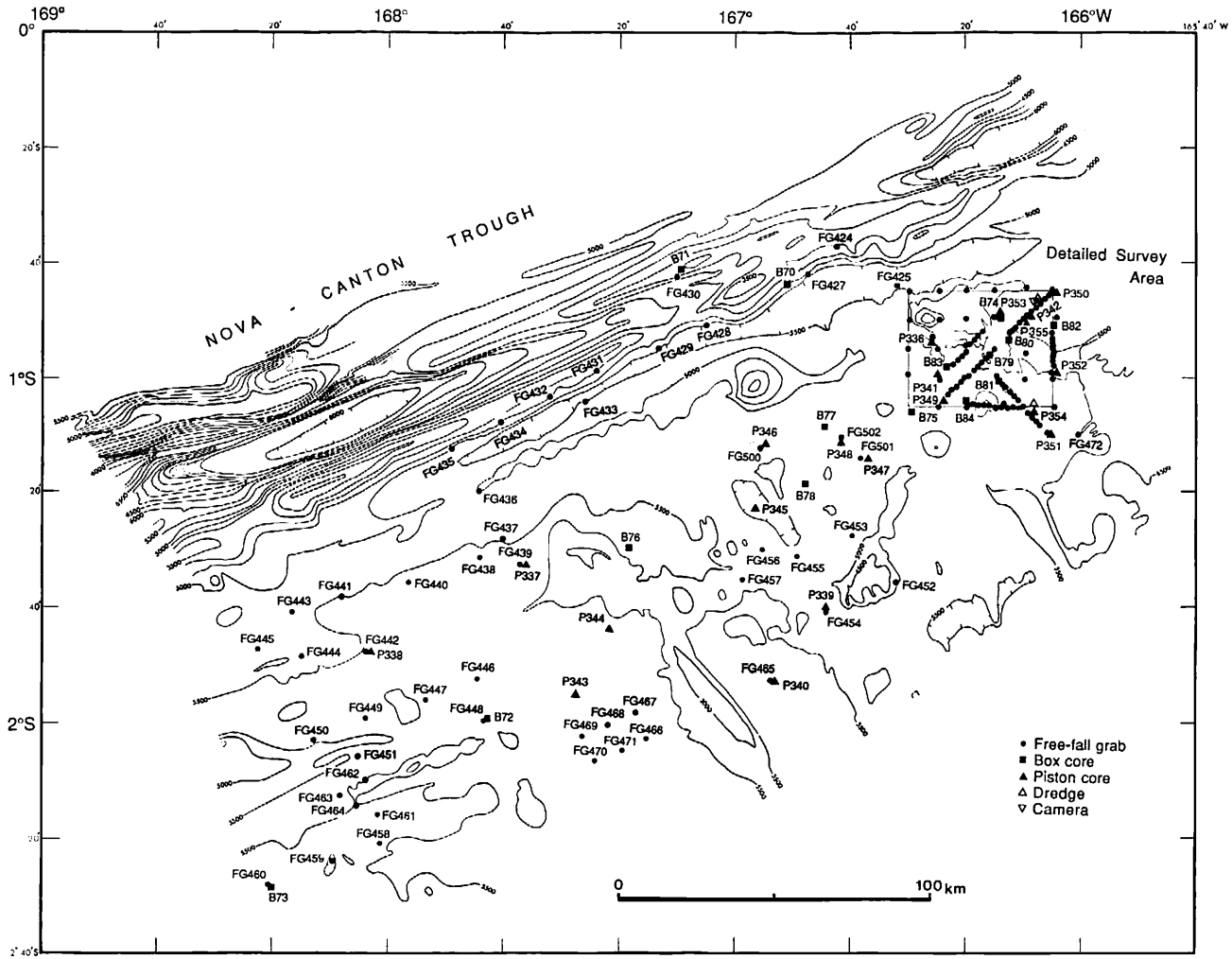

Fig. 1-3 Sampling locations and a camera station in the GH82-4 Area.

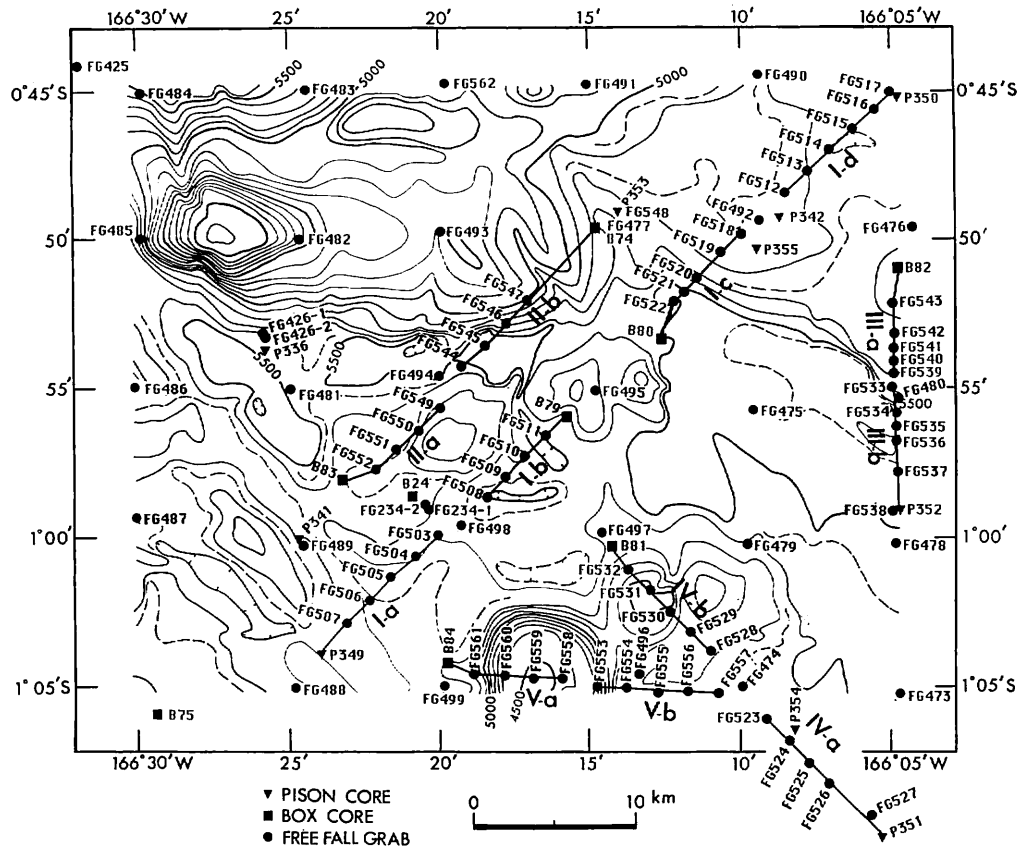

Fig. I-4 Sampling locations of free-fall grabs and cores in the detailed survey area.

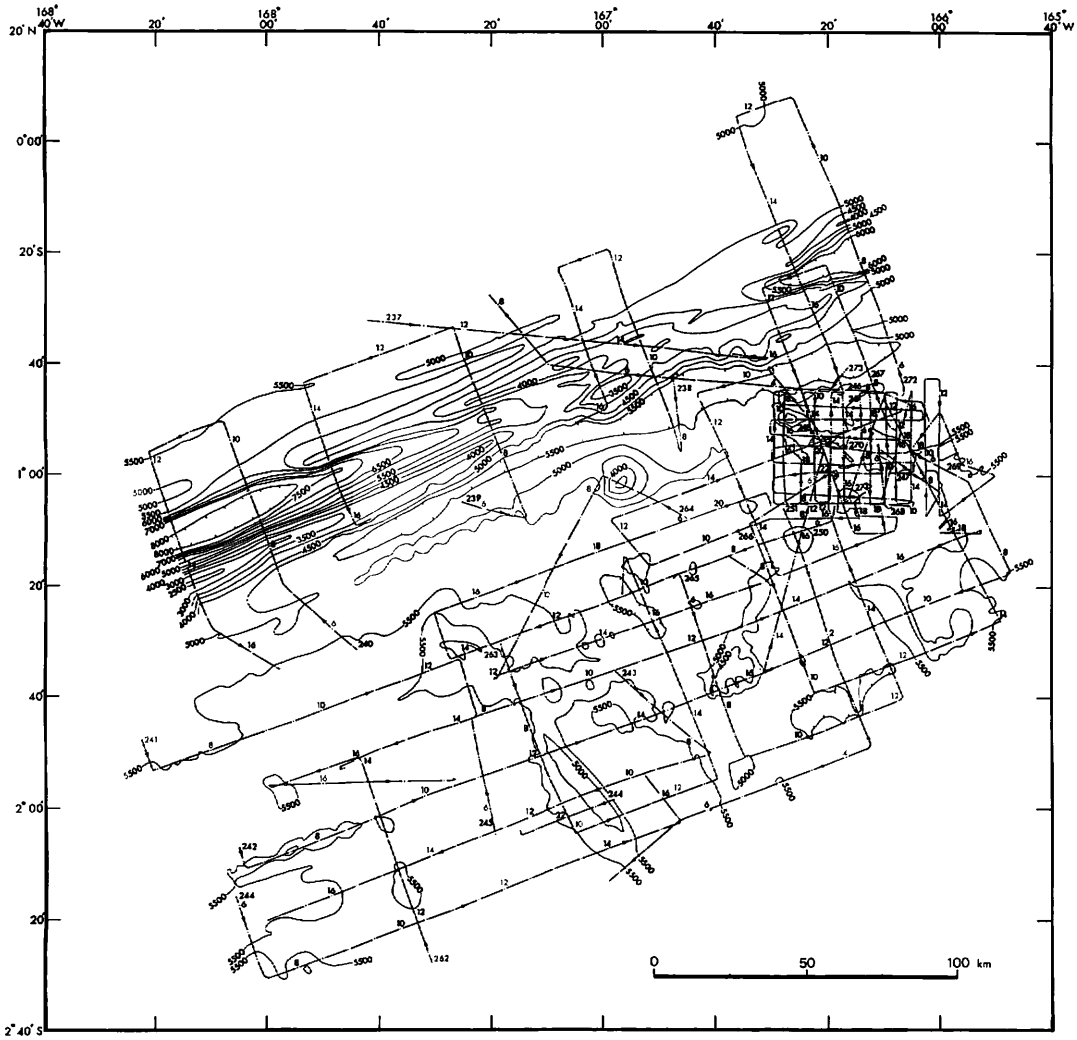

Fig. I-5 Ship track of seismic survey by 3.5 kHz SBP and air guns. See in Chapters III and IV by Tanahashi.

Table I-1 Scientific staff of GH82-4 Cruise.

Name	Organization	Speciality and resposibility
Masato Nohara	Geological Survey of Japan	chief scientist: geochemistry
Akira Nishimura	Geological Survey of Japan	co-chief scientist: sedimentology
Akira Usui	Geological Survey of Japan	scientist; geochemistry and mineralogy
Manabu Tanhashi	Geological Survey of Japan	scientist; geology and geophysics
Toshitsugu Yamazaki	Geological Survey of Japan	scientist; geology and geophysics
Ken Ikehara	Geological Survey of Japan	scientist; sedimentology
Kazuaki Watanabe	Geological Survey of Japan	scientist; topography
Kazuchika Hamuro*	Ministry of Forein Affairs of Japan	visiting scientist
Kenji Otani**	Metal Mining Agency of Japan	visiting scientist
Chang Jeong Hae**	Korea Institute of Energy and Resources	visiting scientist
Tokio Matsushita*	Educational Film Corporation	photographer
Kenji Ino*	Educational Film Corporation	photographer
Mitsuru Sakamoto	Tsukuba Univ.	student; technical assistant
Eiji Nakayama	Tsukuba Univ.	do.
Yasuo Nishizawa	Chiba Uiv.	do.
Masayuki Hasui	Univ. Tokyo	do.
Akira Iwakoshi	Kobe Univ.	do.
Masatake Matsutani	Ryukyu Univ.	do.
Wataru Sasaki	Ryukyu Univ.	do.
Tetsuo Tsutsui	Ryukyu Univ.	do.
Masayuki Uchimura	Ryukyu Univ.	do.

* : from Funabashi (Tokyo) to Apia
** : from Apia to Funabashi (Tokyo)

Methods

The general survey methods are similar to those in the previous Hakurei-Maru cruises (Table I-3). More details are described in the following chapters in this volume. In the first leg, bottom sampling was done every 5-7 mile grids by a set of two free-fall grabs and one wire-lined sampler (a piston corer installed with a heat-flow meter or a box corer with one-shot camera), along parallel lines to the Trough axis at 10-mile intervals (Fig. I-5). The second leg includes small-scale (less than 1-km intervals) sampling in the detailed survey area. The results of on-site observation and description are shown in Table I-4.

Summary of results

Acoustic profiles by 3.5 kHz subbottom profiler and air guns revealed general geologic structure of the area in comparison with previous DSDP core stratigraphy. Tanahashi (Chapters III and IV) discusses the origin of the Nova-Canton Trough, the possibility of volcanic intrusion, and relationship of acoustic character of sediments to nodule deposits. Yamazaki and Tanahashi (Chapter II) and Nakanishi *et al.* (Chapter XIV) provide new magnetic and gravity anomaly data which can suggest the age of the sea floor and the formation process of the Trough. Yamazaki suggests a postdated tectonic activity based on higher heat flow than theoretical prediction after evaluation with E.Q.F (Chapter V). The bottom water temperature measured by heat-flow meter assumes eastward flow of the Antarctic Bottom Water controlled by local topography of this area (Chapter XIII).

Table I-2 Results of survey and observation of GH82-4 cruise.

Date		Weather	Cruising time	Cruising mileage	Works
Aug.	14	fine	9.5 hr	123.3 n.m.	leave Funabashi port (2:30 pm)
	15	fine	23.5	322.3	geophysical survey in transit*
	16	cloudy	23.5	326.8	geophysical survey in transit*
	17	rainy	23.5	338.6	geophysical survey in transit*
	18	fine/cloudy	23.5	311.1	geophysical survey in transit*
	19	fine/cloudy	24.0	316.4	geophysical survey in transit*
	20	fine	23.5	323.3	geophysical survey in transit*
	21	fine/cloudy	23.5	323.2	geophysical survey in transit*
	22	fine/cloudy	23.5	324.9	geophysical survey in transit*
	23	fine/cloudy	23.5	335.5	geophysical survey in transit*
	23	rainy	24.0	359	geophysical survey in transit*
	24	fine/cloudy	24.0	343.9	geophysical survey in transit*
	25	fine	24.0	189.9	geophysical survey ** and sampling (Sts.3246-3250)
	26	fine	24.0	206.1	geophysical survey ** and sampling (Sts.3251-3256)
	27	fine	24.0	202.6	geophysical survey ** and sampling (Sts.3257-3262)
	28	fine	24.0	206	geophysical survey ** and sampling (Sts.3263-3268)
	29	fine	24.0	201.4	geophysical survey ** and sampling (Sts.3269-3274)
	30	fine	24.0	204.5	geophysical survey ** and sampling (Sts.3275-3280)
	31	fine	24.0	192.8	geophysical survey ** and sampling (Sts.3281-3287)
Sept.	1	cloudy	24.0	194.3	geophysical survey ** and sampling (Sts.3288-3294)
	2	cloudy	24.0	196.7	geophysical survey ** and sampling (Sts.3295-3300)
	3	rainy	24.0	225	geophysical survey ** and sampling (Sts.3301-3303)
	4	fine	24.0	185.8	geophysical survey ** and sampling (Sts.3304-3312)
	5	cloudy	24.0	193	geophysical survey ** and sampling (Sts.3313-3318)
	6	fine/cloudy	4.0	167.2	geophysical survey ** and sampling (Sts.3319-3323)
	7	fine	24.0	249.5	geophysical survey ** and sampling (St.3324)
	8	fine	24.0	331.8	geophysical survey in transit*
	10	fine	0.9	30.9	arrive at Apia (9:00 am)
	11	fine			in port
	12	fine			in port
	13	fine			in port
	14	fine			in port
	15	fine			in port
	16	cloudy	8.0	102.2	leave Apia (2:00 pm), geophysical survey in transit*
	17	fine	24.0	334.4	geophysical survey in transit*
	18	cloudy	24.0	334.9	geophysical survey in transit*
	19	cloudy	24.0	171.6	geophysical survey ** and sampling (Sts.3325-3327)
	20	fine	24.0	145.2	geophysical survey ** and sampling (Sts.3328-3330)
	21	fine	24.0	144.4	geophysical survey ** and sampling (Sts.3331-3334)
	22	cloudy	24.0	143.3	geophysical survey ** and sampling (Sts.3334-3343)
	23	rainy	24.0	137.2	geophysical survey ** and sampling (Sts.3344-3355)
	24	fine	24.0	149.5	geophysical survey ** and sampling (Sts.3356-3366)
	25	fine	24.0	149.7	geophysical survey ** and sampling (Sts.3367-3378)
	26	fine	24.0	129.8	geophysical survey ** and sampling (Sts.3379-3388)
	27	cloudy	24.0	148	geophysical survey ** and sampling (Sts.3389-3399)
	28	fine	24.0	151	geophysical survey ** and sampling (Sts.3400-3401)
	29	fine	24.0	211	geophysical survey ** and sampling (Sts.3402-3403)
	30	fine	24.5	359.5	geophysical survey in transit*
Oct.	1	cloudy	24.5	330.3	geophysical survey in transit*
	2	cloudy	24.5	353.4	geophysical survey in transit*
	4	fine	24.5	364.2	geophysical survey in transit*
	5	cloudy	24.5	352	geophysical survey in transit*
	6	cloudy	24.5	363.3	geophysical survey in transit*
	7	fine	24.5	363.7	geophysical survey in transit*
	8	cloudy	24.5	346.8	geophysical survey in transit*
	9	cloudy	24.5	328.6	geophysical survey in transit*
	10	fine	24.0	340	geophysical survey in transit*
	11	rainy/cloudy	19.3	244.2	geophysical survey in transit*
	12	fine	1.5	6.5	arrive at Funabashi Port (9:00 am)

Note: * = magnetic measurement and gravity measurement.
** = continuous reflection profiling, magnetic and gravity measurements.
Sampling includes sea-bed photography and heat flow measurement.

Table I-3 Survey methods during GH82-4 cruise.

Positioning by NNSS	
Bathymetric survey by 12kHz PDR	13508.4 n.m.
Subbottom profiling by 3.5kHz SBP	13508.4 n.m.
Continuous seismic reflection profiling by air-gun	2580.9 n.m.
Magnetic survey by proton magnetometer	11578.9 n.m.
Gravimetric survey by on-board gravimeter	13508.4 n.m.
Heat flow measurement	20 stations
Sediment sampling by box corer	14 stations (B70-84)
Sediment sampling by piston corer	20 stations (P336-354)
Nodule sampling by free-fall grab with camera	140 stations (FG424-562)
Nodule sampling by dredge	2 stations (D513-514)

Note: Right column shows total mileage of survey and number of stations.

Deep-sea sediments of box cores, piston cores, and free-fall grabs are lithologically, paleontologically, and chemically described. Nishimura specified the ages and intervals of sedimentary hiatus and relates them to sedimentary environment and nodule formation (Chapter VI). Yamazaki estimates from paleomagnetism of sediments the sedimentation rates and suggests dominant hiatuses in the early Pleistocene (Chapter VII). He also attempts to specify the depth of acquisition of depositional remanent magnetization from vertical changes of water contents in box cores (Chapter VIII). Mita and Kato discuss the ultimate source of surface sediments and behaviors of metallic elements in the sediment cores (Chapter IX).

Shipboard description of manganese nodules reveals regional and small-scale variation of manganese nodule facies in relation to topography (Chapter X) and acoustic stratigraphy (Chapter XI). The idea that high sedimentation rate prevents nodule growth and diagenetic process controls nodule type, is again applied in this area, which results in a significant relationship of nodule facies to acoustic stratigraphy (Usui and Tanahashi). Usui and Mita (Chapter XII) chemically and minerallogically describe nodules of type s and type r, and reveal great microscopic variations of mineral components within nodules. Morphology, chemistry, and mineralogy of buried nodules in deep cores are within the range of those on the sea bed.

Table I-4 Results of on-site observation during GH82-4 Cruise.

Sta. no.	Sample no.	Date (Julian)	Time (GMT)	Location (hit bottom) latitude (°S)	longitude (°W)	Depth (m)	Sediment	Unit I thick. (m)	type	Manganese nodules morphology	abund. (kg/m^2)	cov. (%)	Topography [buried nodules]
3246	FG424	237d	17:23	0°37.32'	166°42.40'	4000	-	- -		-	0.0	0	nearly flat floor
3247	FG425		18:43	0°44.01'	166°31.97'	5434	sC	15	A	SPs, ISPs, Ts	16.0	-	gently slope of a small seamount
3248	FG426-1		19:43	0°53.13'	166°25.81'	5408	sC	0	A	IDs, Fs, Is	4.0	1	nearly flat floor
	FG426-2		19:46	0°53.23'	166°25.74'	5424	sC	0	A	IDs, Is	3.4	1	nearly flat floor
	P336		21:16	0°53.63'	166°25.77'	5434	sC	0	A	IDs	-	-	nearly flat floor
3249	FG427		02:15	0°42.15'	166°47.42'	5135	sC	0	A	DPs	tr	0	rough floor
3250	B70*	238d	04:28	0°43.74'	166°50.91'	4878	-	0	A	-	-	-	rugged top of hill
3251	FG428		17:03	0°50.84'	167°04.89'	5558	sC	0	A	IDs, IDPs, Ts, Fs	5.7	-	flat floor
3252	FG429		18:04	0°54.89'	167°13.45'	5305	-	0	A	-	0.0	R/C	top of hill
3253	FG430		19:20	0°42.72'	167°10.07'	4152	cO	- -		Vs	tr	0	top of seamount
	B71		20:49	0°41.03'	167°09.31'	3595	cO	- -		Vs	tr	0	top of seamount
3254	FG431	239d	01:10	0°58.78'	167°24.05'	4448	cO	0	A	IDs, DPs	0.4	1	rugged top of seamount
3255	FG432		02:08	1°03.38'	167°32.12'	4509	cO	0	A	-	0.0	0	rugged
3256	FG433		02:51	1°04.20'	167°26.17'	5455	-	0	A	-	0.0	-	rugged top of seamount
3257	FG434		16:57	1°07.63'	167°40.57'	4576	cO	0	A	-	0.0	0	rugged top of seamount
3258	FG435		17:58	1°12.26'	167°49.20'	4760	-	0	A	IDs, Fs	1.5	R/C	rugged
3259	FG436		18:56	1°19.91'	167°44.29'	5042	-	0	A	-	0.0	R/C	rough slope of hill
3260	FG437		23:07	1°28.12'	167°40.27'	5424	sC	101	A	Sr?	tr	0	flat floor near hill
3261	FG438		23:45	1°31.39'	167°44.20'	5630	sC	105	A	-	0.0	0	nearly flat floor
3262	FG439	240d	00:36	1°32.63'	167°37.22'	5662	sC	45	A	-	0.0	-	flat floor
	P337		02:12	1°32.97'	167°36.36'	5667	sC	45	A	IDs.r	-	-	flat floor
3263	FG440		16:49	1°35.69'	167°56.51'	5579	sC	- -		-	0.0	0	flat floor
3264	FG441		18:13	1°38.33'	168°08.20'	5620	sC	45	A	-	0.0	0	nearly flat foot of a hill
3265	FG442		19:12	1°47.65'	168°03.78'	5537	sC	56	A	Sr?	tr	0	flat floor
	P338		20:41	1°47.70'	168°03.61'	5537	sC	60	A	-	-	-	flat floor
3266	FG443	241d	01:58	1°40.97'	168°16.67'	5367	cO	90	A	-	0.0	0	rough floor
3267	FG444		02:45	1°48.30'	168°15.00'	5217	cO	0	A	IDs, IDPs, Ts, Fs	15.8	15	rough floor of hill
3268	FG445		03:39	1°47.19'	168°22.52'	5279	sC	0	A	Ds, IDPs, Fs	0.4	0	shourlder of hill
3269	FG446		16:52	1°52.25'	167°44.55'	5641	sC	52	B	-	0.0	0	slope of hill

Table I-4 (continued)

Sta. no.	Sample no.	Date (Julian)	Time (GMT)	Location (hit bottom) latitude (°S)	longitude (°W)	Depth (m)	Sediment	Unit I thick. (m)	type	Manganese nodules morphology	abund. (kg/m^2)	cov. (%)	Topography [buried nodules]
3270	FG447		17:56	1°55.83'	167°53.51'	5641	-	0	B	-	0.0	-	rugged floor
3271	FG448		19:00	1°59.43'	167°43.34'	5703	sC	97	B	-	0.0	0	flat floor
	FG72		20:45	1°59.34'	167°42.89'	5693	sC	90	B	-	0.0	0	flat floor
3272	FG449	242d	13:31	1°59.13'	168°03.97'	5770	sC	0	A	-	0.0	0	boundary of rugged and flat floors
3273	FG450		02:30	2°02.85'	168°13.02'	5848	sC	90	A	-	0.0	0	nearly flat floor
3274	FG451		03:21	2°05.62'	168°05.25'	5693	sC	232	A	(Ir)	tr	0	flat floor near hill
3275	FG452		16:55	1°35.82'	166°31.98'	4919	sC	0	A	IDs, Ts, Is	2.3	1	upper slope of hill
3276	FG453		18:05	1°27.68'	166°39.65'	5331	sC	120	A	Ir, Sr	0.1	0	flat floor
3277	FG454		19:25	1°40.73'	166°44.22'	5382	sC	67	A	Sr	3.5	-	bottom of trough
	P339		20:50	1°40.52'	166°44.32'	5403	sC	67	A	-	-	-	bottom of trough
3278	FG455	243d	02:06	1°31.30'	166°49.25'	5310	sC	56	A	Sr	0.1	-	flat floor
3279	FG456		02:44	1°30.14'	166°55.09'	5305	sC	26	A	Sr, Ir	tr	-	upper slope of seamount
3280	FG457		03:26	1°35.22'	166°59.65'	5444	sC	33	A	Vr, Sr	tr	0	gentle slope of a hill
3281	FG458		17:39	2°20.84'	168°01.46'	5434	sC	82	A	-	0.0	0	gentle slope of hill
3282	FG459		18:31	2°23.97'	168°09.60'	5558	sC	7	A	IDs, IDPs	18.6	50	flat floor near hill
3283	FG460		19:41	2°28.12'	168°20.48'	5393	sC	60	A	Sr, Vr	tr	0	top of hill
	B73		21:21	2°28.22'	168°01.81'	5387	sC	60	A	Vr	tr	0	top of hill
3284	FG461	244d	01:19	2°15.82'	168°01.81'	5279	sC	0	A	Is.r, Ds.r	9.3	3	rugged top of seamout
3285	FG462		01:59	2°09.93'	168°04.03'	5460	-	0	A	-	0.0	R/C	rugged top of seamout
3286	FG463		02:34	2°12.60'	168°08.43'	5703	sC	22	A	-	0.0	0	flat floo, foot of hill
3287	FG464		03:01	2°14.24'	168°05.48'	5408	sC	0	A	IDPs, DPs	19.8	30	upper slope of seamout
3288	FG465		16:57	1°52.54'	166°53.54'	5687	sC	0	B	-	0.0	0	flat floor with stratification
	P340		18:25	1°52.67'	166°53.31'	5687	sC	0	B	-	-	-	flat floor with stratification
3289	FG466		23:01	2°02.58'	167°15.27'	5713	sC	0	B	-	0.0	0	nearly flat floor
3290	FG467		23:34	1°58.08'	167°17.22'	5696	sC	18	B	-	0.0	0	gentle slope of a hill
3291	FG468	245d	00:11	2°00.21'	167°22.06'	5755	sC	0	B	-	0.0	0	flat floor
3292	FG469		00:44	2°02.18'	167°26.52'	5765	sC	0	B	-	0.0	0	flat floor
3293	FG470		01:17	2°06.35'	167°24.36'	5744	sC	0	B	-	0.0	0	flat floor
3294	FG471		01:53	2°04.63'	167°19.58'	5744	sC	0	B	-	0.0	0	flat floor

Table I-4 (continued)

Sta. no.	Sample no.	Date (Julian)	Time (GMT)	Location (hit bottom) latitude (°S)	longitude (°W)	Depth (m)	Sediment	Unit I thick. (m)	type	Manganese nodules morphology	abund. (kg/m^2)	cov. (%)	Topography [buried nodules]
3295	FG472		18:38	1°09.96'	166°00.53'	5517	sC	45	A	Sr	0.4	0	rolled floor
3296	FG473		19:20	1°05.23'	166°04.73'	5444	sC	90	A	-	0.0	0	nearly flat floor
3297	FG474		19:57	1°05.04'	166°09.93'	5346	sC	22	A	Sr	2.9	0	flat floor
3298	FG475		23:29	0°54.81'	166°09.59'	5517	sC	112	A	-	0.0	0	gentle slope
3299	FG476	246d	16:16	0°49.67'	166°04.33'	5258	sC	52	A	Ss.r	7.1	0	top of rugged seamount
3300	FG477		01:25	0°49.67'	166°14.90'	5248	sC	18	A	SPs	8.7	10	slope of a hill
	B74		02:59	0°49.62'	166°14.73'	5300	sC	18	A	SPs	11.2	8	slope of a hill
3301	FG478	247d	00:05	1°00.20'	166°04.86'	5497	sC	108	A	(Vr)	tr	0	flat floor
3302	FG479		00:40	1°00.25'	166°09.78'	5377	-	18	A	-	0.0	R/C	rugged top of hill
3303	FG480		01:26	0°55.32'	166°04.76'	5475	-	0	A	ISs	30.3	40	rugged top of hill
3304	FG481		18:26	0°55.03'	166°24.88'	5479	sC	0	A	IDs	1.2	0	gentle slope of hill
3305	FG482		19:00	0°49.98'	166°24.57'	4491	cO	0	A	-	0.0	0	rugged top of hill
3306	FG483		19:34	0°44.93'	166°24.37'	5155	pC	0	A	ISs, IDPs, Fs	11.0	1	middle slope of seamount
3307	FG484		20:15	0°44.98'	166°29.85'	5522	-	0	A	IDPs,IDs, ISs	1.3	1	gentle slope of hill
3308	FG485		20:49	0°49.96'	166°29.83'	5197	scO	15	A	IDs, Fs	20.1	15	slope of small seamount
3309	FG486		21:22	0°54.93'	166°30.01'	5356	sC	7	A	-	0.0	R/C	rugged top of hill
3310	FG487	248d	01:35	0°59.35'	166°30.01'	5288	scO	11	A	IDs, IDPs	6.0	5	nearly flat top of hill
3311	FG488		02:21	1°05.03'	166°24.77'	5276	scO	0	A	ISs, IDs	20.8	30	flat floor near hill
3312	FG489		02:55	1°00.18'	166°24.56'	5290	-	3	A	IDs, Ds, IDPs	14.7	5	shoulder of a seamount
	P341		04:44	1°00.05'	166°24.68'	5377	sC	-	-	Ss, SPs	-	-	foot of a seamount
3313	FG490		18:51	0°44.45'	166°09.42'	5147	scO	0	A	SPs, DPs	9.5	15	top of terrace
3314	FG491		19:29	0°44.77'	166°14.99'	4880	cO	0	A	Ss	0.2	0	top of hill
3315	FG492		20:17	0°49.46'	166°09.34'	5166	scO	45	A	Sr	5.1	0	nearly flat floor
	P342		21:39	0°49.18'	166°08.68'	5174	csC	30	A	-	-	-	nearly flat floor [3 horizons]
3316	FG493	249d	01:57	0°49.75'	166°19.95'	4747	-	0	A	ISs	0.2	0	slope of seamount
3317	FG494		02:33	0°54.57'	166°20.00'	5527	csC	7	A	Ds.r, DPs.r	4.3	0	lower slope of seamount
3318	FG495		03:04	0°55.10'	166°14.84'	5222	cO	0	A	IDPs, Ts	8.2	2	rugged slope of seamount
3319	D513		20:28	1°05.22'	166°10.05'	5341	-	-	-	Sr	-	-	rough floor
			22:30	1°04.82'	166°08.44'	5385				-			rough floor

Table I-4 (continued)

Sta. no.	Sample no.	Date (Julian)	Time (GMT)	Location (hit bottom) latitude (°S)	longitude (°W)	Depth (m)	Sediment	Unit I thick. (m)	type	Manganese nodules morphology	abund. (kg/m^2)	cov. (%)	Topography [buried nodules]
3320	FG496	250d	00:52	1°04.56'	166°13.29'	5365	-	26	A	IDs.r, IDPr	13.2	0	foot of seamount
3321	FG497		01:25	0°59.84'	166°14.57'	5363	cO	22	A	Sr, SPr	9.5	2	flat floor near seamount
3322	FG498		02:03	0°59.65'	166°19.30'	5425	sC	45	A	Sr	4.4	1	gentle slope of hill
3323	FG499		02:42	1°04.98'	166°19.79'	5318	-	0	A	ISPs, IDs	14.2	5	slope of a small seamount
3324	B75		22:43	1°05.86'	166°29.37'	5167	sC	7	A	IDr, Dr, IDPr, Sr	6.3	0	flat floor
	B75X						-	-	-	IDr, IDPr, Dr	-	-	[-15 cm depth]
3325	P343	262d	19:35	1°54.65'	167°27.55'	5791	sC	0	B	-	-	-	flat floor
3326	P344	263d	00:08	1°43.48'	167°21.77'	5791	sC	0	B	-	-	-	flat floor
3327	B76		04:45	1°29.60'	167°18.53'	5765	sC	0	B	-	0.0	0	flat floor
3328	P345		18:13	1°22.65'	166°56.40'	5648	sC	60	A	-	-	-	flat floor
3329	FG500		22:17	1°11.95'	166°55.61'	5650	sC	67	A	-	0.0	0	flat floor
	P346		23:40	1°11.87'	166°55.25'	5323	csC	67	A	-	-	-	flat floor
3330	B77	264d	04:10	1°08.26'	166°44.45'	5367	sC	60	B	-	0.0	0	flat floor
3331	FG501		18:10	1°13.95'	166°38.22'	5197	-	0	A	IDs, IDPs	5.2	1	nearly flat floor
	P347		19:40	1°14.37'	166°37.33'	5169	csC	30	A	Ss, DPs	-	-	nearly flat floor
3332	FG502		22:06	1°10.67'	166°41.66'	5280	sC	7	A	-	0.0	0	flat floor
	P348		23:34	1°10.83'	166°41.65'	5292	sC	7	A	-	-	-	flat floor
3333	B78	265d	02:19	1°18.51'	166°47.80'	5225	sC	45	A	Sr	0.1	0	flat floor near a hill
3334	FG503		17:35	0°59.95'	166°20.04'	5346	sC	0	A	IDs, IDPs	13.6	30	upper slope of a seamount
3335	FG504		17:47	1°00.66'	166°20.79'	5426	sC	67	A	ISs.r, Sr	1.4	0	nearly flat floor
3336	FG505		18:01	1°01.38'	166°21.57'	5386	sC	37	A	Ss.r, SPs.r	12.8	10	gentle slope of a hill
3337	FG506		18:13	1°02.09'	166°22.28'	5353	sC	7	A	Ss.r, SPs.r	6.0	3	top of a hill
3338	FG507		18:25	1°02.81'	166°23.03'	5345	sC	0	A	-	0.0	-	top of a hill
	P349		19:55	1°03.94'	166°23.94'	5309	sC	0	A	SPs, ISPs	-	-	slope of a hill [1 horizon]
3339	FG508	266d	00:30	0°58.65'	166°18.45'	5336	-	3	A	IDPs, IDs	18.2	5	top of seamount
3340	FG509		00:44	0°57.98'	166°17.80'	5416	-	0	A	-	-	N/C	slope of seamount
3341	FG510		00:57	0°57.28'	166°17.12'	5429	-	0	A	IDs	>0.3	N/C	top of seamount
3342	FG511		01:09	0°56.62'	166°16.44'	5455	sC	0	A	IDs, IDPs	12.6	15	rough slope of seamount

Table 1-4 (continued)

Sta. no.	Sample no.	Date (Julian)	Time (GMT)	Location (hit bottom) latitude (°S)	longitude (°W)	Depth (m)	Sediment	Unit I thick. (m)	type	Manganese nodules morphology	abund. (kg/m^2)	cov. (%)	Topography [buried nodules]
3343	B79		03:01	0°55.96'	166°15.77'	5405	sC	3	A	IDs, IDPs	16.4	5	flat floor near seamount
	B79X						-	-	A	IDr+s	12.2	-	[-12 cm depth]
3344	FG512		19:14	1°48.45'	166°08.51'	5105	sC	33	A	Sr, SPr	7.9	-	flat floor
3345	FG513		19:56	0°47.48'	166°07.75'	5209	sC	37	A	Ss.r	16.1	-	flat floor
3346	FG514		20:10	0°47.02'	166°07.00'	5253	scC	30	A	Ss.r, SPs.r	9.6	2	nearly flat floor
3347	FG515		20:22	0°47.31'	166°06.25'	5249	scC	18	A	Sr	5.1	0	nearly flat floor
3348	FG516		18:25	1°02.81'	166°23.03'	5345	scC	15	A	Sr	7.2	0	nearly flat floor
3349	FG517		20:43	0°45.02'	166°05.00'	5207	-	18	A	SPs.r, ISs.r	0.6	2	flat floor
	P350		22:08	0°45.17'	166°04.76'	5219	sC	18	A	Ss.r	-	-	flat floor [1 horizon]
3350	FG518	267d	15:54	0°49.89'	166°09.92'	5163	scO	37	A	SPs, Ss, ISPs	7.1	0	upper gentle slope of hill
3351	FG519		02:06	0°50.44'	166°10.62'	5163	scO	41	A	Ss.r	2.8	0	flat floor
3352	FG520		02:19	0°51.35'	166°11.39'	5300	sC	0	A	IDPs, IDs, ISPs	4.0	25	middle slope of hill
3353	FG521		02:28	0°51.78'	166°11.81'	5475	sC	37	A	Sr, Dr, Vr	0.5	0	flat floor
3354	FG522		02:34	0°52.10'	166°12.13'	5486	sC	3	A	Sr, Dr	3.1	0	flat floor
3355	B80		04:24	0°53.25'	166°12.59'	5514	sC	15	A	IDPs, ISPs, IDs	10.9	10	flat floor
	B80X						-	-	-	ISs, IDs	10.9	-	[-15 cm depth]
3356	FG523		17:48	1°06.12'	166°09.10'	5342	-	0	A	(Sr)	tr	0	flat floor
3357	FG524		17:58	1°06.86'	166°08.40'	5333	sC	3	A	Ts, IDs, Ts+r	14.3	5	flat floor
3358	FG525		18:08	1°07.55'	166°07.75'	5334	sO	-	-	Ts, IDs	4.0	5	flat floor
3359	FG526		18:18	1°08.27'	166°07.07'	5342	sC	15	A	IDs, Ts, Ts+r	10.0	2	flat floor
3360	FG527		18:35	1°09.71'	166°05.71'	5384	sC	15	A	Sr, Dr	4.9	0	flat floor
	P351		19:55	1°10.01'	166°05.35'	5382	sC	15	A	-	-	-	flat floor
3361	FG528		23:41	1°03.82'	166°11.00'	5288	sC	0	A	Sr, Dr	10.5	2	lower gentle slope of seamount
3362	FG529		23:55	1°03.17'	166°11.65'	5238	sC	18	A	Ss.r, SPs.r	10.1	5	pper slope of seamount
3363	FG530	268d	00:08	1°02.46'	166°12.33'	4982	-	0	A	-	0.0	R/C	top of seamount
3364	FG531		00:20	1°01.75'	166°13.01'	5004	sC	7	A	ISs	11.6	2	rugged floor on seamount
3365	FG532		00:42	1°00.31'	166°14.22'	5323	sC	0	A	IDs, TS, IDPs	10.8	5	top of seamount
3366	B81		02:22	1°00.31'	166°14.22'	5359	sC	30	A	SPs, Ss	10.1	7	flat floor near foot of seamount
3367	FG533		18:39	0°54.95'	166°04.93'	5335	sC	0	A	IDs, IDPs	14.4	40	slope of seamount

Table 1-4 (continued)

Sta. no.	Sample no.	Date (Julian)	Time (GMT)	Location (hit bottom) latitude (°S)	longitude (°W)	Depth (m)	Sediment	Unit I thick. (m)	Unit I type	Manganese nodules morphology	abund. (kg/m^2)	cov. (%)	Topography [buried nodules]
3368	FG534		18:53	0°55.82'	166°04.85'	5547	-	0	A	-	0.0	R/C	rough floor of hill
3369	FG535		19:00	0°56.32'	166°04.83'	5589	sC	0	A	IDPs, IDs	14.9	5	rough floor of hill
3370	FG536		19:07	0°56.78'	166°04.82'	5555	-	63	A	-	0.0	0	rough floor of hill
3371	FG537		19:18	0°57.82'	166°04.93'	5512	sC	101	A	-	0.0	0	rough slope
3372	FG538		19:32	0°59.04'	166°04.70'	5517	sC	123	A	-	0.0	0	flat to rugged floor
	P352		21:01	0°59.05'	166°04.70'	5517	sC	78	A	-	-	-	flat to rugged floor
3373	FG539	269d	00:37	0°54.50'	166°04.92'	5243	sC	3	A	IDs, IDPs	10.5	5	near top of terrace
3374	FG540		00:45	0°54.09'	166°04.91'	5217	sC	0	A	IDs, IDPs	6.5	8	near top of terrace
3375	FG541		00:52	0°53.65'	166°04.91'	5229	-	3	A	ISs, IDs	23.1	10	nearly flat floor on terrace
3376	FG542		00:59	0°53.17'	166°04.88'	5278	sC	15	A	IDs, ISs, IDPs	18.3	5	nearly flat floor on terrace
3377	FG543		11:11	0°53.11'	166°04.96'	5323	sC	3	A	Is.r, Fs.r	2.3	0	nearly flat floor on terrace
3378	B82		02:57	0°50.89'	166°04.81'	5302	sC	52	A	Ss.r, SPs.r, Ds.r	6.3	1	nearly flat floor on terrace
3379	FG544		17:52	0°54.25'	166°19.25'	5490	sC	7	A	ISs, IDs, Fs	6.0	5	near top of seamount
3380	FG545		18:03	0°53.53'	166°18.50'	5511	sC	0	A	Sr	0.1	0	slope of seamount
3381	FG546		18:14	0°52.78'	166°17.77'	5094	-	0	A	IDs, Fs	1.9	2	slope of seamount
3382	FG547		18:24	0°52.04'	166°17.04'	4975	-	3	A	-	0.0	R/C	slope of seamount
3383	FG548		18:52	0°49.41'	166°14.36'	5314	cC	18	A	SPs, ISPs	13.2	5	flat floor on terrace
	P353		20:14	0°49.07'	166°14.03'	5249	sC	11	A	IDs, IDPs, ISPs	-	-	nearly flat terrace [1 horizon]
3384	FG549	270d	00:56	0°55.66'	166°20.01'	5280	sC	0	A	IDPs, ISPs, IDs	13.8	2	near top of seamount
3385	FG550		01:08	0°56.35'	166°20.71'	5353	sC	15	A	Is	tr	0	shoulder of seamount
3386	FG551		01:21	0°57.04'	166°21.40'	5395	sC	52	A	Sr	tr	0	flat top of hill
3387	FG552		01:33	0°57.72'	166°22.08'	5343	sC	45	A	Sr, Dr	1.1	0	flat top of hill
3388	B83		03:27	0°58.10'	166°23.20'	5359	sC	45	A	Sr	1.0	-	flat floor of a hill
3389	FG553		18:49	1°05.03'	166°14.76'	4696	-	45	A	(Tr, Vr)	1.1	4	upper slope of large seamount
3390	FG554		19:01	1°05.13'	166°13.71'	5372	sC	11	A	Sr	0.7	0	foot of large seamount
3391	FG555		19:11	1°05.15'	166°12.70'	5279	-	120	A	(Vr)	tr	0	flat to rough floor
3392	FG556		19:21	1°05.19'	166°11.74'	5325	sC	82	A	Vr, Sr	0.2	0	flat to rough floor
3393	FG557		19:32	1°06.33'	166°10.74'	5334	sC	15	A	Sr, Vr, Fr	0.1	0	flat to rough floor
3394	P354		21:33	1°06.33'	166°08.23'	5353	sC	-	-	-	-	-	flat floor

Table I-4 (continued)

Sta. no.	Sample no.	Date (Julian)	Time (GMT)	Location (hit bottom) latitude (°S)	longitude (°W)	Depth (m)	Sediment	Unit I thick. (m)	type	Manganese nodules morphology	abund. (kg/m)	cov. (%)	Topography [buried nodules]
3395	FG558	271d	01:25	1°04.75'	166°15.88'	4494	cO	3	A	-	0.0	0	top of large seamount
3396	FG559		01:38	1°04.71'	166°16.83'	4453	cO	0	A	-	0.0	0	upper slope of large seamount
3397	FG560		01:51	1°04.66'	166°17.83'	5302	cO	0	A	Fs.r, Sr	0.3	0	foot of large seamount
3398	FG561		02:03	1°04.61'	166°18.18'	5302	sC	0	A	ISs, IDs, Fs	5.6	20	lower slope of large seamount
3399	B84		03:50	1°04.22'	166°19.78'	5305	sC	11	A	IDPs, IDs	11.8	10	top of hill
	B84X						-	-	-	IDPs, IDs	>3.8	-	[-15 cm depth]
3400	P355		19:51	0°50.34'	166°09.43'	5164	sC	0	A	IDs	-	-	flat floor of plateau [1 horizon]
3401	C19	272d	02:12	0°46.94'	166°07.67'	5224	-	-	-	-	-	-	flat floor of plateau
3402	FG562		18:15	0°44.73'	166°19.77'	4944	scO	0	A	ISs, IDs	1.2	2	rugged floor of seamounts
3403	D514		21:28	0°47.21'	166°07.98'	5200	-	-	-	SPs.r, Ss.r	-	-	flat floor of plateau
	off		23:29	0°45.89'	166°07.05'	5225				-			

Notes:

Sample no.: FG=free-fall grab, B=box core, P=piston core, D=dredge, C=towed camera. X means ocurrence of buried nodules. *:unsuccessful.
Unit I: Acoustic stratigraphy by SBP (see chapter III). thick.=estimated thickness of Unit I.
Sediment: c=cancareous, s=siliceous, p=pelagic, C=clay, O=ooze
Nodules: abund.=abundance, tr=less than 0.1 kg/m , cov.=sea-floor coverage, R/C/N=rock/crust/nodule.

References

Mizuno, A. (1981) Regional and local variabilities of manganese nodules in the Central Pacific Basin. In: Mizuno A. (ed.) *Geol. Surv. Japan Cruise Rept.*, no. 15, p. 281–296.

——— and Nakao, S. (eds.) (1982) Regional data of marine geology, geophysics, and manganese nodules: the Wake-Tahiti Transect in the Central Pacific (GH80–1 Cruise). *Geol. Surv.Japan Cruise Rept.* no. 18, p. 1–399.

Nakao, S. and Moritani, T. (eds.) (1984) Marine geology, geophysics, and manganese nodules in the northern vicinity of the Magellan Trough (GH80–5 Cruise). *Geol. Surv. Japan Cruise Rept.*, no. 20, p. 1–272.

——— (ed.) (1986) Marine geology, geophysics, and manganese nodules around deep-sea hills in the Central Basin (GH81–4 Cruise). *Geol. Surv. Japan Cruise Rept.*, no. 21, p. 1–257.

Usui, A. (1983) Regional variation of manganese nodule facies on the Wake–Tahiti Transect: morphological, chemical and mineralogical study. *Mar. Geol.*, vol. 54, p. 27–51.

———, Nishimura, A., Tanahashi, M. and Terashima, S. (1987) Local variability of manganese nodule facies on small abyssal hills of the Central Pacific Basin. *Mar. Geol.*, vol. 74, p. 237–275.