

#### 4-4 Discussions

There are many seamounts and atolls in the waters of Tuvalu and a good potential of cobalt crust occurrence was anticipated. The results, however, were disappointing and the potential is generally low in the area. The only area which warrant resources assessment is the Seamount SB08. Even this SB08, only four out of twelve sampling points had crusts thicker than 1cm, and FDC survey shows that a large part of the seamount has crust coverage of less than 50% even in the slopes. Further, the topographic conditions would also decrease the minable area.

There are submerged seamounts other than SB08 (SB03 excluding banks, SB05 and east of SB07) where the thickness of the crust exceeds 1cm locally. But the potential of these seamounts is very low considering the average thickness and the crust coverage. Also there are crusts developed in the atolls (SB06, west of SB07), banks (SB02, SB04) and parts of submerged seamounts (SB01), but the collected samples all have thickness of less than 5 mm with general coating of 1 mm. It is inferred that the many of the atolls and banks which were not surveyed have similar conditions. Shallow sea coral limestone is widely developed in these areas, and with secondary collapses the environment is not favourable for crust development. It is noted, however, that in parts of the middle and lower slope of seamounts below 1,000 m, high quality crusts with botryoidal surface is developed in various places (example SB06 Funafuti Is). But the continuity of the crust is not very good. With higher density of survey, the acquisition of over 1cm thick crust samples is highly possible.

The reason for the formation of high-quality cobalt crusts at SB08 in the northeastern part of the survey area is not clear. It is noted, however, that manganese nodules are also well developed in this area and it suggests the environment which affects the formation of manganese nodules, namely biological productivity, topography, bottom current and other factors also controls the genesis and development of cobalt crusts. Regarding the water depth, crusts tend to be well developed near the summits (around 1,200 m) of the submerged seamounts (SB08 and SB07) and nodular material were collected from below 2,000 m of the SB05 slope.

Concerning the thickness of the crusts, the maximum value of 6.5 cm from the sample obtained during this survey is greater than those reported in the past (De Carlo, 1987). Regarding the grade of the crusts, the following has become clear.

- a) The maximum Co content of 1.70% is very high. Generally, high Co content of over 1.0% occur in thin (1 mm±) crust, the inner side of platy crusts and the outermost layer of the crusts. From this, it is inferred that the high Co content of the crusts in this area pointed out by De Carlo (1988) is due to the relative abundance of young crusts.
- b) The grade of the crusts differ in the northern and southern parts of the area. The Ni and Mn content is higher in the north and Fe is higher in the southern part. The variation of Cu and Co content cannot be generalized.
- c) The Mn/Fe ratio is 1.21 and is the lowest value compared to other marine areas (Table 4-3-17). The reasoning of a) might be applicable to b) and c) as follows. "Young, thin, Fe-Co-rich and Mn-Ni-poor crusts are developed throughout the area while the old crusts with the opposite chemical characteristics are developed only in the northern part".
- The age of the basalt of SB02 was determined as 0.2 Ma and there is a possibility that the seamount chain of this region the Samoa-Vitiaz Chain is very young. This age poses very important problems regarding the development of seamounts and cobalt crusts, however, more measurements are necessary for further consideration.

## Chapter 5. Summary

### 5-1 Methods of the Survey

The first half of the survey was carried out for manganese nodules, and the latter half for cobalt crusts (the total survey period; 43 days, the first half; 13 days and the latter half; 30 days). The reconnaissance survey (the primary survey) did not yield favourable results and thus the detailed survey (the secondary survey) was not carried out. The methods of the survey were mainly acoustic sounding and sampling by Free Fall Grab. The acoustic sounding includes sea bottom topographical survey by PDR and NBS, surficial sediments survey by SBP, and exploration for manganese nodules by MFES. Most sampling was carried out by Free Fall Grab, and also partly by Spade Corer. Photographing of the sea bottom was carried out by deep-sea camera mounted on each FG sampling equipment. The number of sampling stations was 24 and the sampling interval was 60 mile-grid, three samplings were carried out on each sampling station, and the total sampling was 72. The major five elements were analysed by XFA on board. Analysed elements amounted to 87.

Eight seamounts were selected for the survey of cobalt crusts on the basis of various data. Two atolls are included among these eight seamounts. Various acoustic sounding for the survey of topography and surficial sediments, and the dredge sampling were mainly carried out, and the sea bottom observation and photography by FDC (Continuous Deep-sea Camera with Finder) were also partly carried out. A part of the sampling was done using FPG. Total sampling time was 89 times, and its average is 10 sampling per seamount. 74 samplings were successful. The total sampled amount was 2,695 kg including substrates. 169 crust samples from 49 points were assayed on board. Of this, data from 43 points were processed statistically.

### 5-2 Topography and Geology

The survey area is on the southern fringe of the Central Pacific Basin and the area adjoining it to the south. there is a seamount chain in the central part of the area and it is divided into four topographic zones.

- a) Ellice Basin: Western plain. 5,000~5,400 m deep.
- b) Ellice Islands: Seamount chain extending N-S. Topographically mountainous zone.

- c) Tokelau Basin: Eastern quasi plain. 5,200~6,000 m.
- d) Central Pacific Basin: Plain in the northeastern margin of the area. 5,400~6,000 m deep.

Nova Canton Trough is developed between c) and d). There are two topographic trends NNW-SSE of the main seamount chain and ENE-WSW of the Nova Canton Trough. There are a number of seamounts in the area, the major ones amount to approximately 25 of which nine are atolls. In the southeastern part, there are many banks (flat summits with summit depth of several tens of meters).

The sea bottom geology is described by two characteristics. One is the exposure of basalt and limestone on the surface of the mountainous and seamounts, and the other is the development of the unconsolidated sediments on the plain and the quasi plain. The kinds of rock are basalt (lava and hyaloclastite), limestone, and phosphorite. The unconsolidated sediments is expressed in the SBP survey as e<sub>1</sub> and c type dominant zones. The thicknesses are, 10~16 m for e<sub>1</sub> and several meters to 20 m for c zone. The surficial part of the 90% of the samples contained brown clay. The remainder is calcareous clay. The CCD of the area is inferred to be 4,900~5,000 m.

### 5-3 Mode of Manganese Nodule Occurrence

The continuity of distribution and the development of manganese nodules are generally very poor in the survey area. Only five out of 24 sampling points had average abundance of over 7.5 kg/m<sup>2</sup>. These high abundance points are at hilly parts of the quasi plain and the extension is limited. The average abundance of the total area is 2.74 kg/m<sup>2</sup>. The simple mean of the major elements of all sample is, Ni 0.54%, Cu 0.47%, Co 0.20%, Mn 17.01%, Fe 12.73%.

The average abundance of the three elements Ni, Cu, Co calculated from the above is 22.6 g/m<sup>2</sup>. The metal existing in the sampled area is calculated to be 2.76 million tons, the figure, of course, merely satisfies very rough curiosity.

The manganese nodules are generally gravelly with small size. The surface morphology and the chemical features (low Ni, Cu content and low Mn/Fe:1.34) indicate "S-type" characteristics. Regular change of nodular characteristics in N-S direction such as those in the Cook and Kiribati waters was not observed.

The cause of the low manganese nodule abundance of the present survey area is inferred to be as follows.

- a) Low biological productivity.
- b) Development of seamounts and knolls.
- c) Lack of flat sea floor near CCD.

#### 5-4 Mode of Cobalt Crust Occurrence

Eight seamounts were surveyed for cobalt crust and one seamount contained evidence of the development of crusts which can be considered as concentration in the magnitude of resources. In other seamounts, including atolls, three contained crusts with average thickness, at sampling points, of between 1 mm and 1 cm, four had crusts of less than 1mm thick. They were generally poor. The surveyed water depth was between 810 m and 2,930 m and the survey was frequently carried out around the depth of 1,200~2,800 m. The total sampled crusts with substrates weighs 2,695 kg.

The mode of occurrence of cobalt crusts of this area can be described as follows (cf. Table 5-1 for summary).

- a) The confirmed bearing depth is around 1,900~2,800 m, and the bearing zone would extend further.
- b) The shapes are mainly crust type, and rarely slab, massive, cobble, nodule and film.
- c) The surface structure is mostly botryoidal, but thin ones reflect the substrate surface.
- d) The inner structure has single, double or triple layers. The crusts in the inner zone have more compact characteristics.
- e) The constituent minerals are mostly  $\delta$ -MnO<sub>2</sub>, and the cores (the inner layer) have 10Å manganite.
- f) The substrates are mainly basalt, limestone and phosphorite.
- g) The thickness of crusts varies from less than 1 mm of thin coating to several centimeters and the average value of the 89 sampling points is 0.3 cm. The average of crust-rich SB08 is 1.0 cm with maximum of 6.5 cm (the highest of all seamounts). SB08 is followed by peaked seamount east of SB07 and SB05.
- h) The crust coverage is low on atolls and banks, and is high on submerged seamounts. The average coverage was calculated along the track lines on the basis of FDC observation on five seamounts out of eight, but the values range from 0% to 100% and accurate values cannot be obtained.

Table 5-1 General Occurrences of Cobalt Crusts at Individual Seamount (1)

Seamount	SB O1	SB O2	SB O3	SB O4
Position	4° 41' S, 176° 35' E	12° 00' S, 179° 35' W	11° 20' S, 179° 05' W	10° 40' S, 179° 10' W
Survey Period	Sep. 04 - Sep. 08	Sep. 26 - Sep. 27	Sep. 28 - Oct. 01	Oct. 02 - Oct. 04
Topographic-survey	354.1 miles	568 miles	716 miles	471 miles
Dredge Sampling	13 points	9 points	9 points	9 points
Power Grab Sampling	0 point	0 point	1 point	0 point
Photography(FDC)	5.6 miles	6.2 miles	7.9 miles	0 mile
Survey Depth Range*	1,470 ~ 2,530 m	810 ~ 1,815 m	920 ~ 1,780 m	940 ~ 2,580 m
Topographic Feature	Flat top(21x11 km)*2 1,390 m ~ 3,000 m. Average inclination of upper slope 12° (3°~25°)	Flat top(>810 - 1,815 m ?)*2 30 ~ 3,500 m 11° (4° - 23°)	Flat top (15 x 6 km, 15 x 14km)*2 830 ~ 2,500 m 5° (0° - 21°)	Flat top (31 x 26 km)*2 20 ~ 3,500 m 21° (12° - 30°)
Geology	Ls(coral fossils, phosphatized semi-consolidated Ss), Bs(porous, some pillow, both weathered), Hy(some calc matrix). Coating 60% followed by rough, botryoidal, crust.	Ls dominant(coral fossils, semi-consolidated foram Ls) Bs(porous, calc matter in pores, very compact, part vitreous). Coating 75%, then crust, pebbles 12.5% each. Very thin by FDC, no botry structure.	Reefal Ls and semi-consolidated foraminiferal Ls. Traces on surface.	Reefal Ls (partly compact Ls). Some semi-consolidated foraminiferal Ls. Many foram soft mud on slope.
Occurrence of Cobalt Crust	Coating 60% followed by rough, botryoidal, crust.	Coating 75%, then crust, pebbles 12.5% each. Very thin by FDC, no botry structure.	Crust 50%, slabs, nodules coating. Crust rough surface, botry, locally in deep waters.	Coating 80%, rough surface. Some crusts botry.
Coverage of Cobalt Crust	Simple average on track line 18% by FDC, but infer 9% ± actual coverage. Botryoidal low ≤ 1%	FDC average 4%. Actual cov. inferred 2%. Foram sand cover cont. crust intermittent.	FDC average 8%. Actual 4%. Co crust from shoulder to 1,300 m. Sediments on top and below 1,300 m.	Basement and crust largely covered by foram sand and mud.
Thickness of Cobalt Crust ( ) : Average mm	Coating 0.3 - 0 (0.1) Pebble 3 - 0 (0.3 - 0.1) Crust 6 - 0 (0.1) Tot.av. 0.4	Coating 0.5 - 0 (0.1) Crust 1.5 - 0.1 (1.0) Pebble 1 - 0 (0.5) Tot.av. 0.4	Crust 20 - 0.5 (7) Slab 3 - 0.5 (1) Coating 0.2 - 0 (0.1) Nodule 10 - 0 (2) Tot.av. 4.1	Coating 0.1 - 0 (0.1) Crust 3 - 0 (1.2) Tot.av. 0.1
Average Grade of Cobalt Crust (%) ( ) : Highest value	Co 0.81 ± 0.06 (1.04) Ni 0.47 ± 0.04 (0.52) Cu 0.05 ± 0.01 (0.06) [n=4] Mn 22.26 ± 0.80 (23.97) Fe 18.23 ± 0.66 (19.19)	Co 0.95 ± 0.57 (1.53) Ni 0.40 ± 0.16 (0.61) Cu 0.13 ± 0.15 (0.34) [n=3] Mn 19.10 ± 1.57 (23.64) Fe 16.23 ± 2.79 (21.86)	Co 0.57 ± 0.28 (1.25) Ni 0.39 ± 0.06 (0.94) Cu 0.06 ± 0.01 (0.16) [n=8] Mn 19.33 ± 1.71 (25.06) Fe 20.55 ± 1.83 (22.83)	Co 0.70 (1.12) Ni 0.34 (0.35) Cu 0.05 (0.08) [n=1] Mn 19.12 (19.59) Fe 19.73 (19.87)
Evaluation	Exposure is good, but the crust development poor. Not promising except N. slope.	Coating-type except one locality lected. But foram cover wide, large amount of crust not expected.	Some good thick crust collected. But foram cover wide, large amount of crust not expected.	Crust development poor. Almost all coating. Flat top shallow, only Ls, foram, mud cover, not promising.

\* : Sampling depth. \*2 : Areal extent of 2,500 m depth contour. [Abbreviation -- Ls : Limestone. Calc : Calcareous. Bs : Basalt. Ss : Sandstone  
H : Hyaloclastite. Botry : Botryoidal. P : Pebble. S : Slab. N : Nodule. av. : Average]

Table 5-1 General Occurrences of Cobalt Crusts at Individual Seamount (2)

Seamount	SB 05	SB 06	SB 07	SB 08
Position	08° 20' S, 177° 10' E	08° 30' S, 179° 08' E	(E) 07° 27' S, 179° 30' E (W) 07° 29' S, 178° 41' E	(S) 05° 31' S, 179° 31' E (N) 05° 13' S, 179° 17' E
Survey Period	Oct. 05	Oct. 06 - Oct. 09	Oct. 10 - Oct. 12	Oct. 13 - Oct. 16
Topographic-survey	92 miles	310 miles	348.5 miles	357 miles
Dredge Sampling	5 points	12 points	16 points	14 points
Power Grab Sampling	0 point	1 point	0 point	0 point
Photography(FDC)	0 miles	10.2 miles	0 miles	7.3 mile
Survey Depth Range*	2,340 - 2,930 m	950 - 2,650 m	805 - 2,220 m	1,875 - 2,800 m
Topographic Feature	Peaked(22 x 3 km)* 1,950 - 4,000 m av.inclination of upper slope 10° (0° - 21°)	Atoll(Funafuti 30 x 26 km)* 0 - 4,500 m 24° (8° - 40°)	(E) Peaked(16 x 12 km, 17 x 15km)* 470 - 3,500 m (W) Atoll(Vaitupu 25 x 17 km) 0 - 3,500 m, 19° (2° - 36°)	(S) Flat top(23 x 8 km)* 1,230 - 4,500 m, 16° (6° - 26°) (N) Peaked(7.5 x 7 km) 1,450 - 4,500 m
Geology	Ls(foram Ls) Hy(porous Bs pebbles, matrix altered)	Ls dominant(coral fossils, forams, semi-consolidated) Hy(porous meta Bs some matrix calc.). Mudstone.	Ls(coral fossils) Hy(include porous Bs) Bs(somewhat porous, altered) only 1 point.	Hy,tuff breccia,porous P., Ls(compact & coral fossils) Bs lava. Phos. forms core, accompany Bs.,Ls.
Occurrence of Cobalt Crust	Crust 40 %, Coating 30 %, rough surface, P.,S.,N.	Coating 77 % rough surface Crust 15 % shark skin-botry. Pebble 8 % rough surface	Coating 55 % Crust 38 %, botry., pitch structure. Pebble 8 % botry.,slight rough	Crust 57 %, Pebble 28.5 %, Coating 9.5 % Botry.~ rough surface. Also large slabs.
Coverage of Cobalt Crust	Very minor crust collected except central western slope. Coverage probably uneven.	FDC simple av. 11 %, actual 5 % ±	(E) Thick foram sand cover locality in W peak.	FDC simple av. 13 %, actual 7 % ±
Thickness of Cobalt Crust	Crust 30 - 2 (28 - 3) Coating (0.1) Slab 20 - 13 (19) Nodule 15 - 2.5 Tot.av. 3.8	Coating (0.5) Crust (5.0 ±) Pebble (0.5) Tot.av. 0.4	Coating (0.1) Crust 12 - 2 (5) Pebble 9 - 1 (2.7) Tot. av. 1.9	Crust 48 - 1 (3.9 - 2.9) Pebble 65 - 0.5 (52 - 1.4) Slab 60 - 25 (51 - 4) Tot.av. 10.2
Average Grade of Cobalt Crust (%)	Co 0.33 ± 0.20 (0.84) Ni 0.47 ± 0.22 (1.12) Cu 0.13 ± 0.06 (0.31) [n=4] Mn 21.77 ± 1.68 (25.48) Fe 19.89 ± 1.02 (20.76)	0.62 ± 0.05 (0.69) 0.41 ± 0.04 (0.45) 0.06 ± 0.01 (0.07) [n=4] 19.91 ± 1.72 (21.78) 18.29 ± 1.29 (20.95)	1.08 ± 0.43 (1.70) 0.61 ± 0.14 (0.83) 0.07 ± 0.02 (0.11) [n=7] 23.89 ± 3.34 (29.64) 16.41 ± 2.20 (20.28)	0.89 ± 0.27 (1.59) 0.62 ± 0.13 (0.95) 0.11 ± 0.06 (0.29) [n=12] 23.28 ± 3.14 (29.31) 16.84 ± 1.70 (20.53)
Evaluation	Small scale, limited distribution, crusts and nodules. Further survey may result in wider crust distribution.	Thick crust collected on W slope. Botry. crust observed by FDC on NE slope. Otherwise thin coating. Not promising.	(W) Crust collected in spite of atoll. (E) Crust developed on W peak. Crust may be found in E peak.	Highest potential of 6 seamounts. Almost totally covered by crust, thickness good. Further survey may find wider distribution.

\* : Sampling depth. \*2 : Areal extent of 2,500 m depth contour. [Abbreviation -- Ls : Limestone, Calc : Calcareous, Bs : Basalt, Ss : Sandstone  
H : Hyaloclastite, Botry : Botryoidal, P : Pebble, S : Slab, N : Nodule, av. : Average]

- i) The average grade of the 43 sampling points used for statistical analysis is 0.78% Co, 0.50% Ni, 0.09 Cu, 21.86% Mn, and 18.03% Fe. There is a positive correlation among the contents of Co, Ni and Mn, and there is a negative correlation between the water depth and the Co content, Co-Fe and Fe-Ni.
- j) The major component (Co, Ni, Cu), grade of the crusts of this area is very similar to that of the other areas of the central Pacific Ocean. The characteristic features are abundance of the high Co content (over 1.0%) material and the low Mn/Fe value of 1.21.

Thus, the general occurrence of manganese nodules and cobalt crusts of this area have been clarified by this survey. Regarding manganese nodules, abundant zones with favourable topographic conditions cannot be expected. For cobalt crusts fair concentration of over 1 cm thickness is expected in the submerged seamounts of the northeastern part.



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# ***APPENDIX***



# List of the Survey Results

## Data List around Tuvvalu

(No. 1)

Sample No. (Station)	Location				Manganese										Nodules					Geology	
	Latitude	Longitude	Depth (m)	Topography	Size distribution (%)					Abundance (kg/m <sup>2</sup> )	Shape	S.G. wet	H <sub>2</sub> O (%)	XRF Analyses (%)				Sediment	I.P.L.* type	I.P.L.* thick. (#)	
					0-2 cm	2-4 cm	4-6 cm	6-8 cm	8-16 cm					16- cm	Ni	Cu	Co				Mn
88S0674F601	04° 59.896'	174° 29.996'	5.214	(Plain)Seamount	3	1			96	9.42	Ot	1.68	21.1	0.49	0.35	0.20	15.15	11.99	BC	dl	0
88S0674F602	04° 59.04'S	174° 28.991'	5.207	(Plain)Flat	20	80				0.08	E								BC	ds	0
88S0674F603	04° 58.99'S	174° 30.996'	5.170	(Plain)Seamount	2	25	43	19	11	14.82	P,Sp	2.00	30.7	0.52	0.46	0.24	18.02	13.98	BC	dl	0
(401) Average			5.197		1	16	26	11	7	7.84	Ot,P	1.87	26.8	0.51	0.41	0.22	16.78	13.12			
88S0774F601	05° 59.98'S	174° 29.99'E	5.530	(Plain)Flat	100					0.07	E	1.80	27.8	1.22	1.15	0.29	24.45	6.20	BC	c	0
88S0774F602	05° 58.89'S	174° 29.02'E	5.526	(Plain)Flat	100					0.04	P								BC	c	0
88S0774F603	05° 58.60'S	174° 31.04'E	5.527	(Plain)Flat						0.00	--								BC	c	0
(402) Average			5.528		36	64				0.04	E,P	1.75	27.8	1.22	1.15	0.29	24.45	6.20			
88S0874F601	06° 59.97'S	174° 30.03'E	5.400	(Plain)Flat	68	32				5.75	P,M	2.03	27.4	0.60	0.53	0.18	19.99	13.44	BC	el	40
88S0874F602	06° 58.99'S	174° 29.02'E	5.389	(Plain)Flat	64	36				0.11	Ot								BC	el	50
88S0874F603	06° 58.98'S	174° 30.98'E	5.408	(Plain)Flat	20	80				0.15	E	1.88	40.6	0.47	0.48	0.12	14.31	13.18	BC	el	40
(403) Average			5.399		2	68	31			2.00	P,M	2.02	27.7	0.59	0.53	0.18	19.87	13.43			
88S0974F601	08° 00.14'S	174° 30.01'E	5.243	(Plain)Seamount	28	72				0.22	P	1.76	42.9	0.50	0.50	0.10	16.82	11.77	BC	dl	0
88S0974F602	07° 59.22'S	174° 29.04'E	5.334	(Plain)Flat	--	--	--	--	--	(---									--	el	40
88S0974F603	07° 59.38'S	174° 30.97'E	5.345	(Plain)Flat	23	40	37			0.44	P,Ot	1.78	37.1	0.52	0.55	0.11	19.13	11.72	BC	el	40
(404) Average			5.307		25	51	25			0.33	P,Ot	1.77	39.0	0.51	0.53	0.11	18.41	11.74			
88S0975F601	07° 59.953'	175° 29.970'	5.390	(Plain)Flat	30	70				0.08	P,Ot	1.75	35.7	0.54	0.56	0.09	17.26	10.04	BC	el	20
88S0975F602	07° 58.98'S	175° 29.04'E	5.423	(Plain)Flat	21	79				0.15	P,P	2.14	46.7	0.54	0.57	0.09	19.86	10.28	BC	el	30
88S0975F603	07° 58.99'S	175° 31.01'E	5.400	(Plain)Flat						0.00	--								BC	el	30
(405) Average			5.404		24	76				0.08	P,P	2.00	42.9	0.54	0.57	0.09	18.84	10.19			
88S0875F601	07° 00.34'S	175° 30.05'E	4.277	(Plain)Seamount						0.00	--								--	dl	0
88S0875F602	06° 59.43'S	175° 28.99'E	4.881	(Plain)Seamount	--	--	--	--	--	(---									--	dl	0
88S0875F603	06° 59.54'S	175° 31.01'E	4.818	(Plain)Seamount	2	91	7			17.75	P,Sp	2.05	28.3	0.42	0.29	0.29	19.87	18.92	BC	dl	0
(406) Average			4.659		2	91	7			8.88	P,Sp	2.05	28.3	0.42	0.29	0.29	18.87	18.92			

\* I.P.L. : Transparent Layer

Data List around Iuvvalu

(No. 2)

Sample No. (Station)	Location				Main analyses										Nodules					Geology	
	Latitude	Longitude	Depth (m)	Topography	Size distribution (%)					Abundance (g/m <sup>2</sup> )	Shape	S.G. wet	H <sub>2</sub> O (%)	XRF Analyses (%)				Sediment	T.P.L.*		
					0-2 cm	2-4 cm	4-8 cm	8-16 cm	16- cm					Ni	Cu	Co	Mn		Fe	type	thick- (m)
88S0775F601	05° 59.97' S	175° 29.99' E	5.514	(Plain) Flat						0.00	--	---	---	---	---	---	---	---	BC	c	0
88S0775F602	05° 59.99' S	175° 28.95' E	5.516	(Plain) Flat	100					0.02	0t	---	---	---	---	---	---	---	BC	c	0
88S0775F603	05° 58.97' S	175° 30.96' E	5.516	(Plain) Flat						0.00	--	---	---	---	---	---	---	---	BC	c	0
(407) Average			5.515		100					0.01	0t	---	---	---	---	---	---	---			
88S0675S001	05° 00.41' S	175° 29.55' E	5.480	(Plain) Flat						0.00	--	---	---	---	---	---	---	---	BC	c	0
88S0675F602	04° 59.17' S	175° 28.91' E	5.478	(Plain) Flat	100					0.12	0t, P	0.10	9.23	10.06	10.06	10.06	10.06	10.06	BC	c	0
88S0675F603	04° 59.24' S	175° 30.85' E	5.488	(Plain) Flat						0.00	--	---	---	---	---	---	---	---	BC	e1	10
(408) Average			5.475		100					0.04	P, 0t	0.32	9.23	10.06	10.06	10.06	10.06	10.06			
88S0678F601	04° 59.99' S	178° 29.91' E	5.246	(Quasi) Seakno1	1	56	35	8		16.19	P, Sp	0.47	18.47	16.24	16.24	16.24	16.24	16.24	BC	d1	0
88S0678F602	04° 59.00' S	178° 29.00' E	5.480	(Quasi) Flat	1	29	65	5		5.04	P, Sp	0.62	21.32	13.33	13.33	13.33	13.33	13.33	BC	ds	0
88S0678F603	04° 58.99' S	178° 30.95' E	5.604	(Quasi) Flat						0.00	--	---	---	---	---	---	---	---	BC	ds	0
(409) Average			5.443		1	50	42	7		7.08	P, Sp	0.51	19.18	15.52	15.52	15.52	15.52	15.52			
88S0778F601	05° 59.97' S	178° 29.78' E	5.514	(Quasi) Flat	100					0.03	P	---	---	---	---	---	---	---	BC	d2	0
88S0778F602	05° 58.35' S	178° 29.99' E	5.587	(Quasi) Flat						0.00	--	---	---	---	---	---	---	---	BC	b	10
88S0778F603	05° 58.99' S	178° 31.18' E	5.004	(Quasi) Seakno1						0.00	--	---	---	---	---	---	---	---		d1	0
(410) Average			5.352		100					0.01	P	---	---	---	---	---	---	---			
88S0679F601	05° 00.00' S	179° 29.33' E	5.658	(Quasi) Flat	3	34	6	57		3.04	E, P	0.53	11.15	8.29	8.29	8.29	8.29	8.29	BC	e1	10
88S0679F602	04° 59.02' S	179° 28.97' E	5.597	(Quasi) Flat	1	22	54	23		16.35	M, P	0.52	19.75	13.53	13.53	13.53	13.53	13.53	BC	ds	0
88S0679F603	04° 59.02' S	179° 30.96' E	5.607	(Quasi) Flat	1	30	69			9.75	M, P	0.44	19.14	14.89	14.89	14.89	14.89	14.89	BC	e1	10
(411) Average			5.621		1	26	53	14	6	9.71	M, P	0.50	18.61	13.41	13.41	13.41	13.41	13.41			
88S0779F601	06° 00.09' S	179° 30.34' E	5.031	(Quasi) Flat						0.00	--	---	---	---	---	---	---	---	BC	b	10
88S0779F602	05° 59.12' S	179° 29.33' E	5.083	(Quasi) Flat	2	56	28	14		10.84	M, P	0.47	18.57	14.93	14.93	14.93	14.93	14.93	BC	ds	0
88S0779F603	05° 59.16' S	179° 31.56' E	4.827	(Quasi) Seakno1	49	41	4	6		1.67	P, P1	0.44	16.46	18.33	18.33	18.33	18.33	18.33	BC	ds	0
(412) Average			4.980		8	54	25	13		4.17	P, M	0.47	18.30	15.37	15.37	15.37	15.37	15.37			

\* T.P.L. : Transparent Layer

Data List around Tuvalu

(No. 3)

Sample No. (Station)	Location				Main Gannesse										Nodules						Geology			
	Latitude	Longitude	Depth (m)	Topography	Size distribution (%)					Abundance (kg/m <sup>2</sup> )	Shape	S.G. wet	H <sub>2</sub> O (%)	XRF Analyses (%)				Sedi-ment	T.P.L.* thick. (m)					
					0-2 cm	2-4 cm	4-6 cm	6-8 cm	8-16 cm					16- cm	Ni	Cu	Co			Mn	Fe			
88S0680FG01	04° 59.72'S	179° 30.09'W	5.750	(Quasi)Flat	--	--	--	--	--	0.00	---	---	---	---	---	---	---	---	---	---	---	ds	9	
88S0680FG02	04° 59.01'S	179° 31.02'W	5.676	(Quasi)Flat	1	56	34	9		10.98	P,PI	2.03	27.8	0.57	0.48	0.18	15.21	11.40	11.40	11.40	11.40	BC	9	
88S0680FG03	04° 59.02'S	179° 29.01'W	5.624	(Quasi)Flat	1	56	34	9		5.49	P,PI	2.03	27.8	0.57	0.48	0.18	15.21	11.40	11.40	11.40	11.40	BC	9	
(413) Average			5.683																					
88S0780FG01	06° 00.07'S	179° 29.99'W	5.339	(Quasi)Flat	27	73				0.20	E,P	2.00	26.3	0.69	0.65	0.18	19.80	11.81	11.81	11.81	11.81	BC	10	
88S0780FG02	05° 59.16'S	179° 31.02'W	5.126	(Quasi)Seakno	2	31	13	21	33	13.23	P,E	2.01	26.8	0.57	0.46	0.24	17.57	12.04	12.04	12.04	12.04	BC	0	
88S0780FG03	05° 59.13'S	179° 28.98'W	5.404	(Quasi)Flat	2	32	13	21	33	4.48	P,E	2.01	26.8	0.57	0.46	0.24	17.60	12.03	12.03	12.03	12.03	BC	0	
(414) Average			5.290																					
88S0879FG01	06° 59.45'S	178° 30.09'W	5.310	(Quasi)Flat	4	26	68	6		19.22	Sp,P	1.99	30.2	0.35	0.27	0.31	16.91	16.70	16.70	16.70	16.70	BC	10	
88S0879FG02	06° 59.02'S	178° 31.01'W	5.307	(Quasi)Flat	1	16	83		59	4.78	Ef,P	1.98	28.9	0.57	0.47	0.19	17.26	12.20	12.20	12.20	12.20	BC	0	
88S0879FG03	06° 59.02'S	178° 28.99'W	5.464	(Quasi)Flat	1	16	83		83	1.29	0t,P	2.26	24.1	0.83	0.81	0.13	21.35	9.49	9.49	9.49	9.49	BC	0	
(415) Average			5.360																					
88S0880FG01	07° 00.03'S	179° 30.04'W	5.682	(Quasi)Flat	100					0.02	P	---	---	---	---	---	---	---	---	---	---	---	el	50
88S0880FG02	06° 58.92'S	179° 31.08'W	5.708	(Quasi)Flat		100				0.02	P	---	---	---	---	---	---	---	---	---	---	---	el	50
88S0880FG03	06° 58.93'S	179° 29.11'W	5.700	(Quasi)Flat						0.00	---	---	---	---	---	---	---	---	---	---	---	---	el	50
(416) Average			5.697																					
88S0979FG01	08° 00.05'S	178° 30.02'W	5.285	(Quasi)Flat	7	93				0.21	P	2.08	28.2	0.74	0.68	0.13	20.28	10.48	10.48	10.48	10.48	BC	0	
88S0979FG02	07° 59.02'S	178° 31.00'W	5.286	(Quasi)Flat	100					0.02	PI	---	---	---	---	---	---	---	---	---	---	---	el	0
88S0979FG03	07° 58.99'S	178° 26.91'W	5.264	(Quasi)Flat	13	48		39		2.41	P,E	2.00	35.0	0.61	0.54	0.15	17.13	11.69	11.69	11.69	11.69	---	0	
(417) Average			5.278																					
88S0980FG01	07° 59.94'S	179° 30.70'W	5.490	(Quasi)Flat						0.00	---	---	---	---	---	---	---	---	---	---	---	---	el	30
88S0980FG02	07° 58.95'S	179° 31.84'W	5.452	(Quasi)Flat						0.00	---	---	---	---	---	---	---	---	---	---	---	---	el	10
88S0980FG03	07° 58.89'S	179° 30.11'W	5.473	(Quasi)Flat	14	86				0.05	0t,P	---	---	---	---	---	---	---	---	---	---	---	el	10
(418) Average			5.472																					

\* T.P.L. : Transparent Layer

Data List around Tuvalu

(No. 4)

Sample No. (Station)	Location			Manganese										Nodules					Geology	
	Latitude	Longitude	Depth (m)	Size distribution (%)					Abundance (kg/m <sup>2</sup> )	Shape	S.G. wet	H <sub>2</sub> O (%)	XRF Analyses (%)				Sediment	T.P.L.*		
				0-2 cm	2-4 cm	4-6 cm	6-8 cm	8-16 cm					16- cm	Ni	Cu	Co		Mn	Fe	type
88S1079FG01	08° 59.99' S	178° 30.03' W	5.196	100					0.04	0t	---	---	---	---	---	---	BC	el	10	
88S1079FG02	08° 59.12' S	178° 30.61' W	5.177	10	62	28			1.68	P, 0t	1.88	32.5	0.48	0.11	14.29	12.37	BC	ds	0	
88S1079FG03	08° 59.17' S	178° 28.52' W	5.187						0.00	--	---	---	---	---	---	---	BC	b	40	
( 419) Average			5.187	10	63	27			0.57	P, 0t	1.88	32.5	0.48	0.11	14.29	12.37				
88S1080FG01	09° 00.05' S	179° 30.06' W	5.090	100					0.03	P	---	---	---	---	---	---	BC	b	20	
88S1080FG02	08° 59.22' S	179° 31.11' W	5.066						0.00	--	---	---	---	---	---	---	BC	b	30	
88S1080FG03	08° 59.36' S	179° 29.23' W	5.079	12	88				0.19	P, 0t	2.00	27.3	0.47	0.15	16.36	13.34	BC	b	20	
( 420) Average			5.078	10	90				0.07	P, 0t	2.00	27.3	0.47	0.15	16.36	13.34				
88S1179SG01	10° 00.06' S	178° 29.92' W	4.470						0.00	--	---	---	---	---	---	---	CC	c	0	
88S1179FG02	09° 58.99' S	178° 31.01' W	4.430						0.00	--	---	---	---	---	---	---	CC	c	0	
88S1179FG03	09° 59.05' S	178° 29.01' W	4.482						0.00	--	---	---	---	---	---	---	CC	ds	0	
( 421) Average			4.461						0.00	--	---	---	---	---	---	---				
88S1180FG01	10° 00.11' S	179° 30.12' W	4.169						0.00	--	---	---	---	---	---	---	CC	d2	0	
88S1180FG02	09° 59.09' S	179° 31.22' W	4.132						0.00	--	---	---	---	---	---	---	CC	d2	0	
88S1180FG03	09° 59.14' S	179° 29.21' W	4.168						0.00	--	---	---	---	---	---	---	CC	d2	0	
( 422) Average			4.156						0.00	--	---	---	---	---	---	---				
88S0781FG01	05° 59.99' S	178° 30.06' W	5.604	14	86				0.05	E	---	---	---	---	---	---	BC	el	30	
88S0781FG02	05° 58.98' S	178° 31.00' W	5.321						( 0.00)	--	---	---	---	---	---	---		ds	0	
88S0781FG03	05° 59.02' S	178° 29.02' W	5.481	100					( 0.04)	E	---	---	---	---	---	---		d2	0	
( 423) Average			5.469	14	86				0.05	E	---	---	---	---	---	---				
88S0681FG01	04° 59.93' S	178° 29.57' W	5.548	18	53	20	9		14.92	0t, M	2.03	25.2	0.28	0.21	4.61	11.72		d1	0	
88S0681FG02	04° 58.93' S	178° 30.58' W	5.309						0.00	--	---	---	---	---	---	---		d1	0	
88S0681FG03	04° 58.93' S	178° 28.51' W	5.357	7	50	10	7	26	11.18	P, Ef	2.07	25.8	0.52	0.43	14.37	11.08	BC	d1	0	
( 424) Average			5.403	13	52	16	8	11	8.70	0t, P	2.05	25.5	0.38	0.30	8.78	11.45				

\* T.P.L. : Transparent Layer



Data List around Tuvalu (Cobalt rich crust.)

(P. 1)

No.	Sample No.	Sampling Position		Depth (m)	Topography	Weight (kg)	Thickness (mm)	S.G.	H <sub>2</sub> O (%)	X. R. F. Analysis (%)					Chip Code	Crust Type	Substrate or Core	Surface Texture	Sample Part
		Latitude	Longitude							Co	Ni	Cu	Mn	Fe					
1	88SB01AD01	4°42.360'S	176°33.720'E	1.610	Sip (Up)	0.245 0.945	0.1 0.1	—	15.69	0.00	0.02	0.00	1.86	2.83	20	Coated	Calc.rk	Rough	Bulk
2	88SB01AD02	4°44.060'S	176°33.870'E	2.150	Sip (Md)	0.026 0.092 0.275	0.1 0.1 0.1	—	40.00	0.21 0.21	0.06 0.06	0.37 0.37	11.72 11.72	16.05 16.05	20	Coated	Hyaloc.	Rough	Bulk
3	88SB01AD03	4°44.100'S	176°33.830'E	2.180	Sip (Md)	13.000 24.500	0.1 0.1	—	58.33	0.52 0.52	0.04 0.04	0.79 0.79	23.02 23.02	17.50 17.50	20	Coated	Limest.	Rough	Bulk
4	88SB01AD04	4°46.280'S	176°35.140'E	2.460	Sip (Md)	0.007	0.1	2.000	—	—	—	—	—	—	20	Coated	Basalt	Rough	Bulk
5	88SB01AD05	4°43.130'S	176°35.880'E	2.085	Sip (Md)	2.400 0.260 2.760 2.760	0.1 0.1 0.2 0.2	—	25.00 44.44 27.54	0.12 0.30 0.14 0.14	0.03 0.03 0.03 0.03	0.38 0.51 0.40 0.40	9.19 14.24 9.86 11.63	10.79 17.21 11.63 11.63	20	Coated	Calc.rk	Rough	Bulk
6	88SB01AD06	4°41.490'S	176°36.790'E	1.570	Sip (Up)	23.000 28.000 2.700 64.500 64.500 37.500 313.000	2.0 1.5 1.0 0.1 0.1 0.1	—	36.36	0.50 0.44 0.50 0.44 0.45	0.04 0.05 0.05 0.04 0.05	0.79 0.80 0.69 0.76 0.73 0.75	23.97 23.75 24.04 19.14 18.86 22.60	18.70 19.17 18.88 19.14 18.54 19.00	20	Cobble	Basalt	Rough	Bulk
7	88SB01AD07	4°42.280'S	176°34.940'E	1.470	Sip (Up)	3.900 0.155 0.450 71.500 143.000	1.0 1.5 1.0 0.3 0.3	—	20.00	0.39 0.41 0.40 0.43 0.43	0.04 0.03 0.04 0.03 0.04	0.73 0.91 0.80 0.87 0.91 0.89	16.99 22.28 18.60 20.81 21.51 21.16	17.72 19.19 17.79 18.45 18.54 18.50	20	Cobble	Basalt	Botry'd	Bulk
8	88SB01AD08	4°41.100'S	176°33.020'E	2.000	Sip (Up)	0.000	0.0	—	—	—	—	—	—	—	20	Coated	—	—	Bulk
9	88SB01CB09	4°40.930'S	176°32.560'E	2.170	Sip (Md)	0.000	0.0	—	—	—	—	—	—	—	20	Coated	—	—	Bulk
10	88SB01CB10	4°39.810'S	176°31.660'E	2.530	Sip (Md)	0.200 0.016 0.216	4.0 2.0 3.0	—	32.14	0.41 0.52 0.47	0.06 0.05 0.06	0.60 1.04 0.82	20.97 23.55 22.26	18.50 17.32 17.91	20	Crust	Limest.	Rough	Bulk
11	88SB01CB11	4°38.000'S	176°34.830'E	2.350	Sip (Md)	0.600	0.1	—	—	—	—	—	—	—	20	Coated	Limest.	Rough	Bulk
12	88SB01CB12	4°38.920'S	176°33.960'E	1.980	Sip (Up)	4.180	0.1	—	—	—	—	—	—	—	20	Coated	Limest.	—	Bulk
13	88SB01CB13	4°39.820'S	176°35.290'E	1.930	Sip (Up)	0.000	0.0	—	—	—	—	—	—	—	20	Coated	—	—	Bulk
14	88SB02CB01	11°51.950'S	179°55.340'W	1.815	Sip (Lw)	0.513 0.003 0.516	0.1 0.3 0.2	—	44.68	0.23 0.33 0.28	0.25 0.34 0.30	0.25 0.34 0.30	14.38 20.34 17.36	15.27 21.86 18.57	20	Coated	Coral	Rough	Bulk
15	88SB02CB02	11°51.750'S	179°50.040'W	885	Sip (Lw)	0.400	0.0	—	—	—	—	—	—	—	20	Coated	—	—	Bulk
16	88SB02CB03	11°47.910'S	179°55.110'W	900	Sip (Lw)	0.056	0.1	—	—	—	—	—	—	—	20	Coated	Limest.	Rough	Bulk
17	88SB02CB04	11°40.160'S	179°58.090'E	1.680	Sip (Lw)	0.100 0.007 1.058	1.0 1.0 1.0	—	40.00	0.15 0.16 0.16	0.04 0.06 0.05	0.42 0.19 0.31	11.78 11.91 11.85	15.02 17.44 16.23	20	Crust	Calc.ss	Rough	Bulk
18	88SB02CB05	11°40.000'S	179°59.850'E	940	Sip (Lw)	0.960 0.960	0.5 0.5	—	50.91	0.34 0.34	0.03 0.03	1.19 1.19	19.56 19.56	16.98 16.98	20	Cobble	Basalt	—	Bulk
19	88SB02CB06	11°43.810'S	179°35.250'W	850	Sip (Lw)	2.100	0.1	—	—	—	—	—	—	—	20	Coated	Limest.	—	Bulk





Data List around Tuvalu ( Cobalt rich Crust )

No.	Sample No.	Sampling Position		Depth (m)	Topography	Weight (kg)	Thickness (cm)	S.G. wet	H <sub>2</sub> O (%)	X. R. F. Analysis (%)				Chip Code	Crust Type	Substrate or Core	Surface Texture	Sample Part
		Latitude	Longitude							Co	Ni	Cu	Mn					
135	88SB06C004	8°26.760'S	179°13.480'E	2,410	Sip (Md)	33.000	0.0	—	—	—	—	—	—	20	Coated	—	—	—
136	88SB06C005	8°24.610'S	179°8.740'E	1,160	Sip (Up)	9.284	0.1	—	—	—	—	—	—	20	Coated	Limest.	—	—
137	88SB06C006	8°41.170'S	179°2.300'E	2,010	Sip (Md)	0.180	0.1	—	—	—	—	—	—	20	Coated	Limest.	Rough	—
138	88SB06C007	8°37.020'S	178°59.660'E	2,650	Sip (Low)	0.002 0.004	0.5 0.5	43.48 43.48	0.43 0.43	0.06 0.06	20.91 20.91	17.93 17.93	X0 Z0	Coated Coated	Hyaloc. Hyaloc.	Rough Rough	Bulk Bulk	—
140	88SB06A008	8°31.270'S	178°58.480'E	2,150	Sip (Md)	0.960 0.007 0.017 0.011 0.017 22.000 1.600 23.600	0.5 1.0 9.0 4.0 0.3 0.3 0.3	20.00 40.83 33.33 33.33 40.59 41.43 43.75 45.83 40.90	0.34 0.25 0.29 0.41 0.40 0.28 0.30 0.42	0.05 0.06 0.06 0.05 0.07 0.07 0.06	16.31 21.56 13.64 21.78 21.11 13.56 14.31 21.49	15.36 19.56 13.64 20.96 19.29 15.69 14.97 19.93	00 00 00 00 00 00 00 00	Cobble Crust Crust Crust Crust Cobble Cobble Cobble	Calc.ss Limest. Limest. Limest. Limest. Calc.ss Calc.ss Calc.ss	Rough Rough Rough Rough Rough Rough Rough	Bulk Bulk Bulk Bulk Bulk Bulk Bulk	—
148	88SB06A009	8°26.810'S	179°1.760'E	2,050	Sip (Md)	3.500	0.1	—	—	—	—	—	—	20	Coated	—	—	—
149	88SB06A010	8°24.730'S	179°2.340'E	1,830	Sip (Md)	0.074 0.021 0.011 0.037 0.050 0.950	5.0 7.6 5.8 2.0 3.0 2.0	23.53 39.05 41.00 40.00 38.00 39.00	0.33 0.34 0.34 0.36 0.35	0.07 0.06 0.05 0.06 0.06	18.65 13.85 19.78 17.59 17.62 17.61	20.39 16.20 19.46 18.47 18.47	00 00 00 00 00 00	Crust Crust Crust Crust Crust Crust	Limest. Limest. Limest. Limest. Limest.	Botry'd Botry'd Botry'd Botry'd	Bulk Bulk Bulk Bulk	—
155	88SB06A011	8°22.950'S	179°3.860'E	2,090	Sip (Md)	6.000 13.000	0.3 0.3	42.86 42.86	0.44 0.44	0.04 0.04	19.61 19.61	16.83 16.83	X0 Z0	Crust Crust	Hyaloc. Hyaloc.	Rough Rough	Bulk Bulk	—
157	88SB06A012	8°22.730'S	179°6.680'E	1,910	Sip (Md)	3.700	0.1	—	—	—	—	—	—	20	—	—	—	—
158	88SB06FP13	8°24.480'S	179°7.590'E	950	Sip (Up)	225.000	0.0	—	—	—	—	—	—	20	—	—	—	—
159	88SB07A001	7°25.960'S	178°59.170'E	1,770	Sip (Md)	0.440 0.022 0.017 0.484 0.484	5.0 5.0 7.0 5.0 5.0	34.82 35.96 50.00 34.29 34.75	0.51 0.48 0.67 0.46 0.49	0.06 0.06 0.09 0.08 0.07	21.83 21.22 25.25 18.33 20.13	19.07 19.25 16.88 17.51 18.26	00 00 00 00 00	Crust Crust Crust Crust Crust	Hyaloc. Hyaloc. Hyaloc. Hyaloc.	Botry'd Botry'd Botry'd Botry'd	Bulk Bulk Bulk Bulk Bulk	—
164	88SB07A002	7°24.060'S	179°1.020'E	1,990	Sip (Md)	0.006 0.015	2.0 2.0	32.56 32.56	0.54 0.54	0.10 0.10	23.91 23.91	18.57 18.57	X0 Z0	Crust	Hyaloc.	Rough Rough	Bulk Bulk	—
166	88SB07A003	7°26.000'S	179°2.670'E	1,500	Sip (Up)	0.019 0.019 0.019	12.0 3.0 3.0	33.68 47.37 40.53	0.83 0.79 0.81	0.06 0.07 0.07	23.64 28.49 29.07	14.52 14.84 14.68	00 00 00	Crust Crust Crust	— — —	— — —	Bulk Bulk Bulk	—
167	88SB07A004	7°28.340'S	179°0.800'E	1,630	Sip (Md)	0.015 0.004 0.004	5.0 3.0 3.0	30.00 47.37 30.69	0.69 0.77 0.73	0.07 0.11 0.09	23.57 26.17 24.87	13.00 16.26 14.63	00 00 00	Crust Crust Crust	Limest.	Botry'd Rough Botry'd	Bulk Bulk Bulk	—
172	88SB07A005	7°27.810'S	178°59.320'E	1,350	Sip (Up)	0.071	0.0	—	—	—	—	—	—	20	Coated	—	—	—
173	88SB07A006	7°31.080'S	178°38.520'E	2,010	Sip (Md)	269.000	0.1	—	—	—	—	—	—	20	Coated	Coral	Smooth	—
174	88SB07A007	7°31.160'S	178°42.370'E	1,510	Sip (Md)	148.000	0.1	—	—	—	—	—	—	20	Coated	Coral	Smooth	—
175	88SB07A008	7°27.170'S	178°44.480'E	2,220	Sip (Md)	6.000 8.000 61.000	4.5 2.7 3.3	33.33 41.67 37.50	0.41 0.48 0.48	0.06 0.08 0.06	20.97 20.72 21.79	20.23 20.07 18.84	00 00 00	Crust Cobble Cobble	Hyaloc. Hyaloc. Limest.	Botry'd Botry'd Rough	Bulk Bulk Bulk	—

Data List around Tuvalu (Cobalt rich Crust) (P. 5)

No.	Sample No.	Sampling Position		Depth (m)	Topography	Weight (kg)	Thickness (mm)	S.G. wet	H <sub>2</sub> O (%)	X. R. F. Analysis (%)				Chip Code	Crust Type	Substrate or Core	Surface Texture	Sample Part
		Latitude	Longitude							Co	Ni	Cu	Hb					
178	88SB07AD08	7°27.170'S	178°44.480'E	2.220	Sip (Md)	0.013	2.0	—	34.61	0.47	0.07	0.69	20.51	17.51	Crust	—	Rough	Bulk
179						37.506	3.4	—	43.75	0.44	0.07	0.65	20.11	19.11	—	—	—	Bulk
180						57.500	3.4	—	43.23	0.45	0.07	0.65	20.61	19.31	—	—	—	Bulk
181						75.000	3.4	—	43.54	0.45	0.07	0.65	20.36	19.21	—	—	—	Bulk
182	88SB07CB09	7°25.140'S	178°39.420'E	1.650	Sip (Md)	1.290	0.1	—	—	—	—	—	—	—	Coated	Limest.	—	—
183	88SB07CB10	7°29.110'S	178°37.070'E	1.960	Sip (Md)	1.700	0.3	—	38.89	0.28	0.03	0.61	13.64	12.27	Coated	Limest.	Rough	Bulk
184						1.900	0.3	—	38.89	0.28	0.03	0.61	13.64	12.27	Coated	Limest.	Rough	Bulk
185	88SB07AD11	7°27.230'S	179° 6.720'E	1.400	Sip (Up)	0.008	4.0	—	36.36	0.54	0.05	1.47	21.77	15.60	Crust	Hyaloc.	Botry'd	Bulk
186						0.023	4.0	—	36.36	0.54	0.05	1.47	21.77	15.60	Crust	Hyaloc.	Botry'd	Bulk
187	88SB07AD12	7°26.040'S	179°11.380'E	1.800	Sip (Md)	0.250	0.3	—	—	—	—	—	—	—	Coated	Hyaloc.	Rough	—
188	88SB07AD13	7°28.820'S	179°12.760'E	1.230	Sip (Up)	0.185	2.6	—	30.00	0.70	0.04	1.70	27.12	13.93	Crust	Basalt	Smooth	Bulk
189						0.008	1.8	—	30.36	0.68	0.05	1.56	20.02	9.62	Crust	Basalt	Smooth	Bulk
190						0.193	2.6	—	30.00	0.70	0.04	1.70	27.12	13.93	Crust	Basalt	Smooth	Bulk
191	88SB07AD14	7°29.110'S	179° 9.060'E	865	Sip (Up)	124.000	0.2	—	—	—	—	—	—	—	Coated	Limest.	Rough	—
192	88SB07AD15	7°30.540'S	179° 7.120'E	2.190	Sip (Md)	42.000	0.2	—	—	—	—	—	—	—	Coated	Limest.	Rough	—
193	88SB07AD16	7°29.210'S	179° 7.920'E	1.610	Sip (Md)	121.700	0.1	—	—	—	—	—	—	—	Coated	Limest.	Rough	—
194	88SB08AD01	5°32.050'S	179°28.470'E	2.030	Sip (Md)	0.141	0.3	—	—	—	—	—	—	—	Coated	Limest.	Rough	—
195	88SB08AD02	5°36.180'S	179°29.820'E	2.500	Sip (Md)	5.500	13.0	1.870	35.00	0.49	0.08	0.67	23.61	20.53	Cobble	—	Botry'd	Outer
196						5.500	25.0	1.890	31.71	0.85	0.14	0.67	16.02	16.02	Cobble	—	—	Middle
197						5.500	18.0	2.060	27.27	0.50	0.15	0.35	16.96	10.36	Cobble	Other	—	Inner
198						5.500	15.0	—	50.00	0.79	0.11	1.59	28.63	13.27	Cobble	Other	—	Lower
199						5.500	52.0	1.940	36.11	0.76	0.12	1.04	27.20	16.27	Cobble	Other	—	Bulk
200						3.500	20.0	—	35.00	0.68	0.14	1.04	27.20	16.27	Crust	—	—	Bulk
201						0.160	4.0	—	40.63	0.50	0.09	0.58	22.01	13.44	Crust	—	—	Bulk
202						0.027	5.0	1.900	31.58	0.42	0.12	0.70	22.93	20.04	Crust	—	—	Bulk
203						3.375	31.0	—	35.56	0.55	0.12	0.74	23.48	15.27	—	—	—	Bulk
204						6.750	31.0	—	34.38	0.61	0.12	0.74	23.48	15.27	—	—	—	Bulk
205						—	31.0	1.940	37.19	0.62	0.11	0.94	25.93	17.20	Crust	—	—	Bulk
206	88SB08AD03	5°40.050'S	179°38.490'E	2.800	Sip (Md)	0.022	3.0	—	33.33	0.64	0.17	0.88	20.85	18.90	Cobble	Hyaloc.	Rough	Bulk
207						0.015	4.0	—	28.57	0.52	0.09	0.68	24.04	19.69	Crust	Hyaloc.	Rough	Bulk
208						0.026	2.0	—	33.33	0.35	0.08	0.88	24.64	18.97	Crust	Hyaloc.	Rough	Bulk
209						0.077	3.9	—	31.74	0.57	0.11	0.81	23.18	19.19	—	Hyaloc.	Rough	Bulk
210	88SB08AD04	5°36.010'S	179°35.150'E	2.180	Sip (Md)	1.731	1.0	—	—	—	—	—	—	—	Crust	Limest.	—	—
211	88SB08AD05	5°14.110'S	179°19.020'E	2.050	Sip (Md)	0.086	10.0	1.800	38.89	0.94	0.16	1.19	29.20	13.60	—	—	Botry'd	Outer
212						0.086	15.0	—	46.34	0.89	0.20	0.53	29.17	13.61	—	—	—	Middle
213						0.086	25.0	—	40.18	0.89	0.14	1.27	29.31	14.00	Crust	—	—	Bulk
214						0.112	25.0	1.800	40.18	0.89	0.14	1.27	29.31	14.00	Crust	—	—	Bulk
215	88SB08AD06	5°12.080'S	179°18.430'E	2.120	Sip (Md)	0.800	39.0	1.950	35.37	0.71	0.07	0.99	26.79	15.49	Crust	Hyaloc.	Botry'd	Bulk
216						6.900	2.9	—	25.45	0.76	0.22	0.74	12.28	12.28	Crust	Hyaloc.	Rough	Bulk
217						0.700	10.0	—	36.00	0.51	0.04	0.62	24.52	16.44	Cobble	Hyaloc.	Botry'd	Bulk
218						5.885	10.0	—	35.16	0.69	0.09	0.94	26.16	16.44	—	—	—	Bulk
219						5.885	10.0	—	34.31	0.72	0.08	0.91	26.50	15.59	—	—	—	Bulk
220						11.870	10.0	1.950	34.74	0.71	0.09	0.93	26.38	16.02	—	—	—	Bulk
221	88SB08AD07	5°12.070'S	179°15.290'E	2.500	Sip (Md)	0.219	2.7	—	42.86	0.45	0.07	0.79	19.19	16.70	Crust	Hyaloc.	Rough	Bulk
222						1.100	1.0	—	40.00	0.36	0.08	0.59	17.11	17.62	—	Hyaloc.	—	Bulk

Data List around Tuvalu (Cobalt rich Crust)

( P. 6 )

No.	Sample No.	Sampling Position		Depth (m)	Topography	Weight (kg)	Thickness (mm)	S.G. wet	H <sub>2</sub> O (%)	X. R. F. Analysis (%)				Chip Code	Crust Type	Substrate or Core	Surface Texture	Sample Part
		Latitude	Longitude							Co	Ni	Cu	Mn					
223	88SB08A007	5°12.070'S	179°15.290'E	2.500	SIP (Md)	0.010	3.0	—	42.22	0.35	0.07	0.48	18.66	19.07	Crust	Hyaloc.	Rough	Bulk
224						1.055	1.0	—	41.43	0.41	0.08	0.69	18.15	17.16				Bulk
225	88SB08A008	5°13.100'S	179°16.340'E	1.875	SIP (Up)	102.000	0.0	2.050	36.26	0.63	0.06	0.87	26.63	17.07	Slab	Tuf.bre	Botry'd	Outer
226						2.070	0.0	2.070	25.49	0.70	0.08	0.66	21.40	10.55	Slab	Tuf.bre	Rough	Inner
227						2.000	1.5	2.000	40.00	0.79	0.07	1.51	27.22	14.77	Slab	Tuf.bre	Botry'd	Lower
228						102.000	51.6	2.050	35.22	0.64	0.07	0.99	23.65	13.20	Slab	Tuf.bre	Botry'd	Bulk
229						48.000	0.0	—	40.77	0.73	0.11	0.81	23.55	15.00	Slab	Tuf.bre	—	Outer
230						49.000	0.0	1.970	32.77	0.81	0.12	0.98	27.02	14.05	Slab	Tuf.bre	—	Inner
231						49.000	50.3	2.150	43.45	0.76	0.09	0.99	26.17	17.34	Slab	Tuf.bre	Botry'd	Lower
232						49.000	4.6	2.220	36.00	0.63	0.08	0.99	24.84	16.07	Slab	Tuf.bre	Botry'd	Bulk
233						0.380	1.0	—	46.00	0.80	0.15	0.85	17.76	17.10	Cobble	Tuf.bre	Smooth	Lower
234						76.000	12.8	1.970	34.35	0.81	0.13	0.81	26.07	16.03	Cobble	Tuf.bre	Botry'd	Bulk
235						76.000	52.0	1.950	31.40	0.64	0.07	0.81	24.20	14.87	—	Tuf.bre	Botry'd	Bulk
236						76.000	52.0	2.000	27.02	0.68	0.08	0.82	24.16	13.88	—	Tuf.bre	Botry'd	Bulk
237						152.100	52.0	1.880	29.24	0.66	0.08	0.86	24.18	14.28	—	Tuf.bre	Botry'd	Bulk
238	88SB08A009	5°14.480'S	179°16.360'E	2.240	SIP (Md)	0.420	2.6	—	42.31	0.37	0.06	0.61	21.21	20.26	Crust	Tuf.bre	Rough	Bulk
239						0.700	2.7	—	45.36	0.38	0.05	0.51	20.57	18.99	Crust	Tuf.bre	Rough	Bulk
240						0.632	16.3	1.800	38.33	0.48	0.09	0.71	22.61	19.07	Crust	Hyaloc.	Botry'd	Bulk
241						0.928	15.0	1.630	42.31	0.73	0.09	1.26	26.94	14.94	Crust	Hyaloc.	Rough	Bulk
242						1.350	4.2	—	40.74	1.73	0.09	1.18	26.20	16.33	Crust	—	Rough	Bulk
243						1.350	4.2	—	40.80	0.38	0.05	0.79	20.34	19.35	Crust	—	Rough	Bulk
244						9.500	4.0	1.720	40.77	0.56	0.07	0.99	23.27	17.34	Crust	—	Rough	Bulk
245	88SB08A010	5°32.080'S	179°27.520'E	2.490	SIP (Md)	2.500	3.2	—	34.78	0.41	0.05	0.56	23.63	20.48	Crust	Other	Rough	Bulk
246						0.250	12.0	1.900	31.58	0.62	0.23	0.71	23.05	18.01	Crust	Limest.	Botry'd	Bulk
247						0.410	6.1	—	26.24	0.95	0.27	0.75	24.42	13.56	Crust	Basalt	Botry'd	Bulk
248						2.770	5.0	—	34.03	0.71	0.25	0.67	23.36	16.66	Cobble	—	Botry'd	Bulk
249						7.215	5.0	1.900	33.93	0.59	0.13	0.63	23.47	18.15	Crust	—	Botry'd	Bulk
250	88SB08A011	5°28.260'S	179°27.260'E	2.660	SIP (Md)	0.200	1.5	—	37.69	0.25	0.20	0.87	27.95	15.48	Cobble	Hyaloc.	Rough	Bulk
251						0.300	3.0	—	38.26	0.47	0.07	0.72	23.14	18.63	Cobble	Basalt	Rough	Bulk
252						0.091	5.0	—	45.71	0.49	0.06	1.09	23.53	18.60	Crust	Basalt	Rough	Bulk
253						0.857	1.0	—	34.29	0.54	0.09	0.77	22.32	17.59	Cobble	—	Rough	Bulk
254						1.393	1.0	—	35.75	0.59	0.11	0.79	23.53	17.35	—	—	Rough	Bulk
255	88SB08A012	5°30.360'S	179°31.420'E	2.150	SIP (Md)	0.775	2.4	—	37.50	0.44	0.05	0.84	22.87	19.12	Crust	Hyaloc.	Rough	Bulk
256						0.775	2.4	—	34.36	0.44	0.05	0.84	22.85	19.32	Crust	Hyaloc.	Rough	Bulk
257						1.550	2.0	—	35.94	0.44	0.05	0.84	22.86	19.22	Crust	Hyaloc.	Rough	Bulk
258	88SB08A013	5°32.070'S	179°33.680'E	2.190	SIP (Md)	0.007	2.0	—	30.77	0.66	0.24	0.47	18.84	15.96	Crust	Hyaloc.	Rough	Bulk
259						0.032	2.0	—	30.77	0.66	0.24	0.47	18.84	15.96	Crust	Hyaloc.	Rough	Bulk
260	88SB08A014	5°36.650'S	179°33.800'E	2.060	SIP (Md)	0.057	5.0	—	43.33	0.72	0.05	1.49	26.76	15.72	Crust	Hyaloc.	Rough	Bulk
261						0.059	5.0	—	43.33	0.72	0.05	1.49	26.76	15.72	Crust	Hyaloc.	Rough	Bulk

### Monthly Frequency Distribution of Wind Velocity in 1988

(W.V : m/sec)

W.V Month	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
July	4		4	15	42	47	64	52	117	104	67	40	17	2	1				576
%	0.69		0.69	2.60	7.29	8.16	11.11	9.03	20.37	18.07	11.63	6.94	2.95	0.35	0.17				100
August	2	1	8	31	36	48	50	66	61	33	47	31	11	4			1	2	432
%	0.46	0.23	1.85	7.18	8.33	11.11	11.57	15.28	14.12	7.24	10.88	7.18	2.55	0.93			0.23	0.46	100

### Monthly Frequency Distribution of Wind Direction in 1988

W.D Month	C A L M	N	N N E	N E	E N E	E	E S E	S E	S S E	S	S S W	S W	W S W	W	W N W	N W	N N W	Total
July	5	1	4	37	106	196	185	33	3	5							1	576
%	0.87	0.17	0.69	6.42	18.40	34.03	34.03	5.73	0.52	0.88							0.17	100
August	2	41	45	123	68	87	58	2								1	5	493
%	0.46	9.49	10.42	28.47	15.74	20.15	13.42	0.46								0.23	1.16	100

### Monthly Frequency Distribution of Wether in 1988

Weather Month	Fine	Cloudy	Rain	Total	Light rain
July	20	1	3	24	14
%	83.33	4.17	12.5	100	58.33
August	12	2	4	18	9
%	66.67	11.11	22.22	100	50

### Monthly Frequency Distribution of Atmospheric Pressure (daily average) in 1988

(A.P : mb)

A.P Month	1005.1 S	1006.1 S	1007.1 S	1008.1 S	1009.1 S	1010.1 S	1011.1 S	1012.1 S	1013.1 S	1014.1 S	1015.1 S	1016.1 S	1017.1 S	1018.1 S	Total
	1006.0	1007.0	1008.0	1009.0	1010.0	1011.0	1012.0	1013.0	1014.0	1015.0	1016.0	1017.0	1018.0	1019.0	
July		2	16	78	141	157	111	60	10	1					576
%		0.35	2.78	13.54	24.48	27.26	19.27	10.41	1.74	0.17					100
August	6	17	63	73	104	90	63	16							432
%	1.39	3.94	14.58	16.90	24.07	20.83	14.58	3.71							100

### Monthly Frequency Distribution of Swell Direction in 1988

Month \ S.D	Swell Direction																Not Clear	Total	
	N	NNE	NE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	NNW			
July				10	20	18	24											72	144
%				6.94	13.89	12.5	16.67											50.0	100
August	1	2	21	13	12	3	1										1	54	108
%	0.93	1.85	19.44	12.03	11.11	2.78	0.93										0.93	50.0	100

### Monthly Frequency Distribution of Swell Cycle in 1988

(S.C. : sec)

Month \ S.C	Swell Cycle (sec)											Not clear 99	Total		
	5	6	7	8	9	10	11	12	13	14	15				
July		18	11	31	7	4	1							72	144
%		12.5	7.63	21.53	4.86	2.79	0.69							50.0	100
August		31		22	1									54	108
%		28.70		20.37	0.93									50.0	100

### Monthly Frequency Distribution of Swell Height in 1988

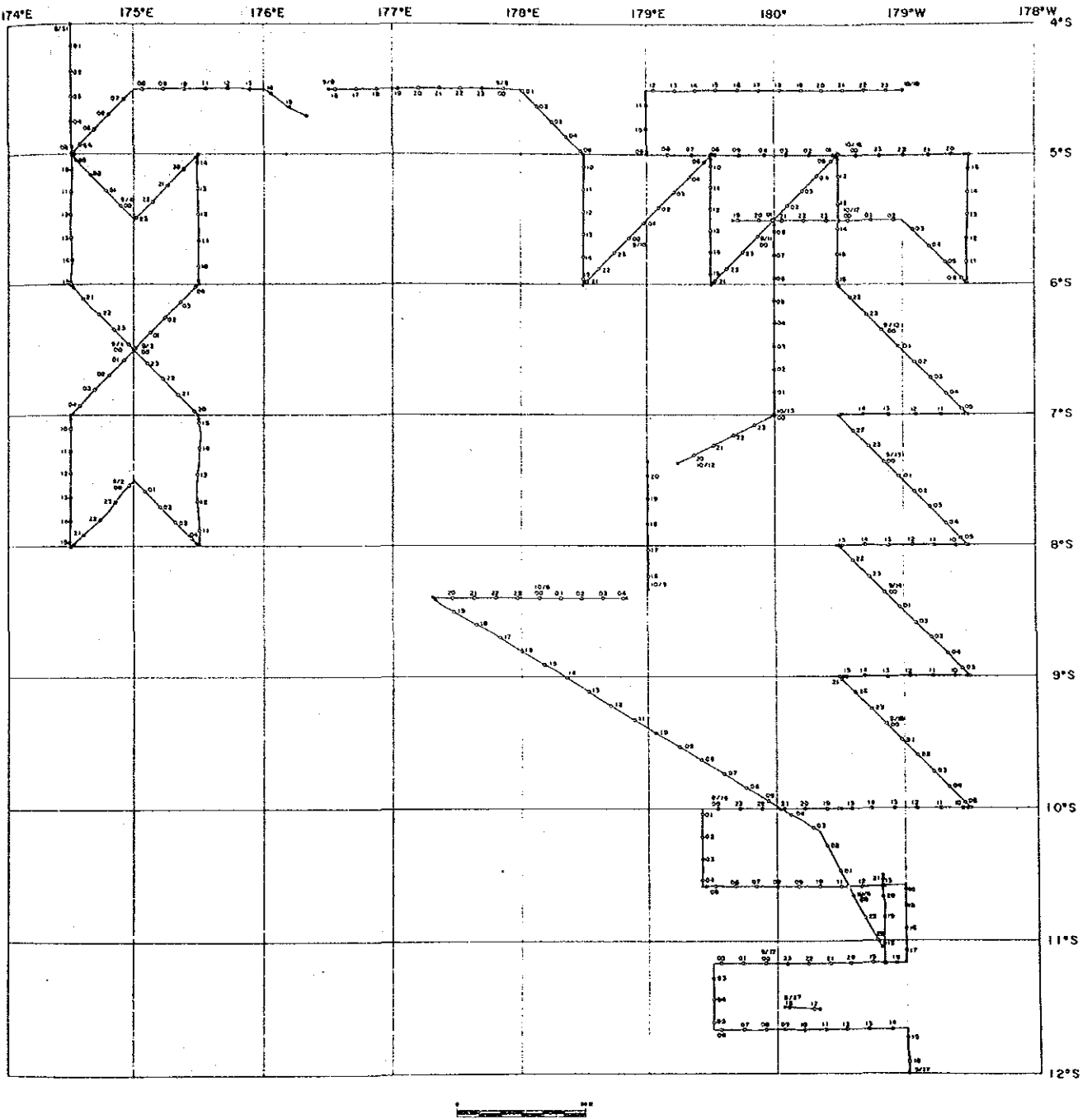
(S.H : m)

Month \ S.H	Swell Height (m)					Not Clear 99	Total
	1	2	3	4	5		
July		10	55	7		72	144
%		6.94	38.19	4.87		50.0	100
August	2	16	30	6		54	108
%	1.85	14.81	27.78	5.56		50.0	100

### Monthly Frequency Distribution of Degree of Cloudiness in 1988

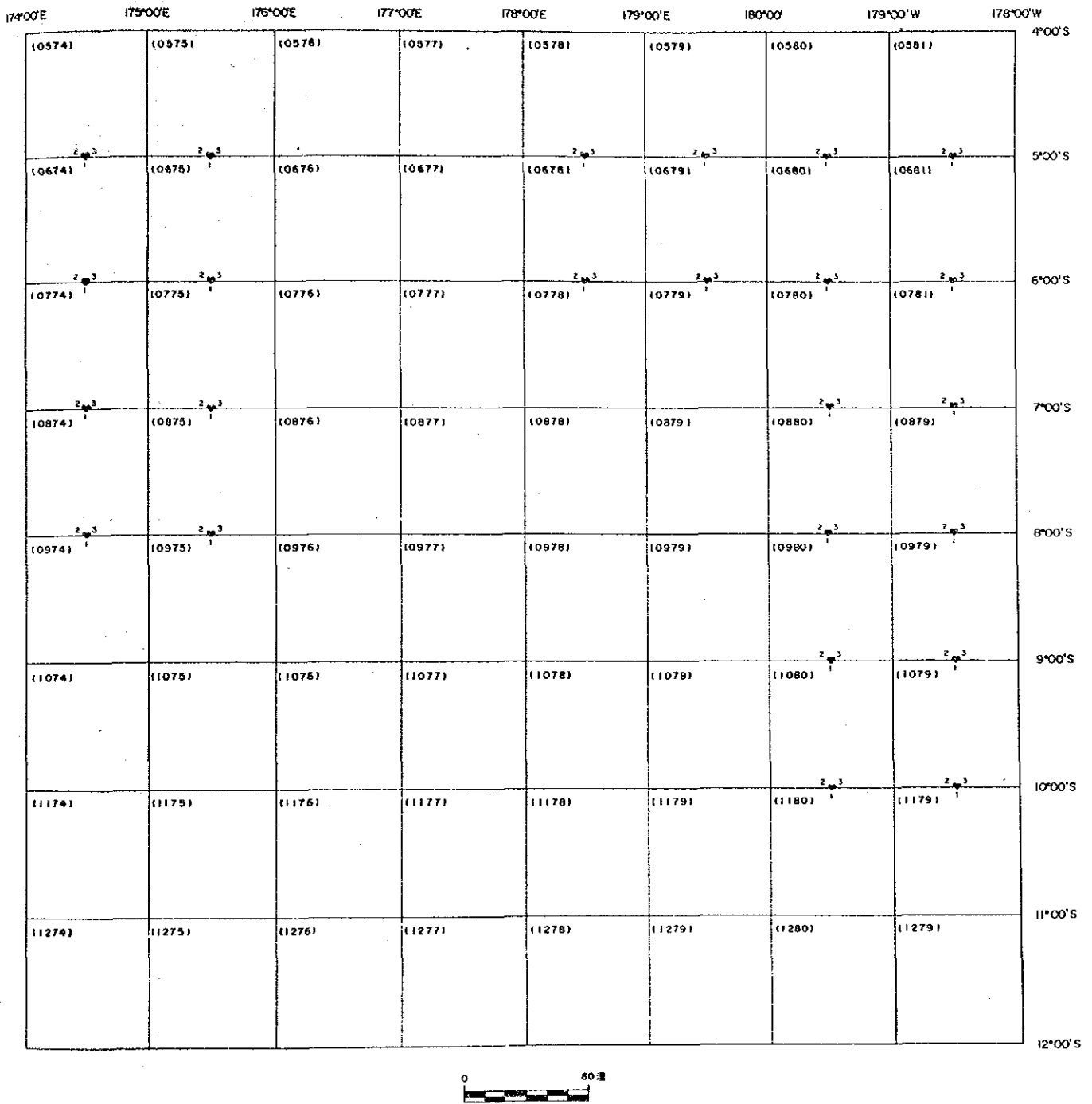
Month \ D.C	Degree of Cloudiness										Total
	0	1	2	3	4	5	6	7	8	9	
July		7	43	180	116	106	45	33	4		576
%		1.22	7.47	31.25	20.14	18.40	7.81	5.72	7.99		100
August			11	84	91	93	66	36	50	1	432
%			2.55	19.44	21.06	21.54	15.28	8.33	11.57	0.23	100



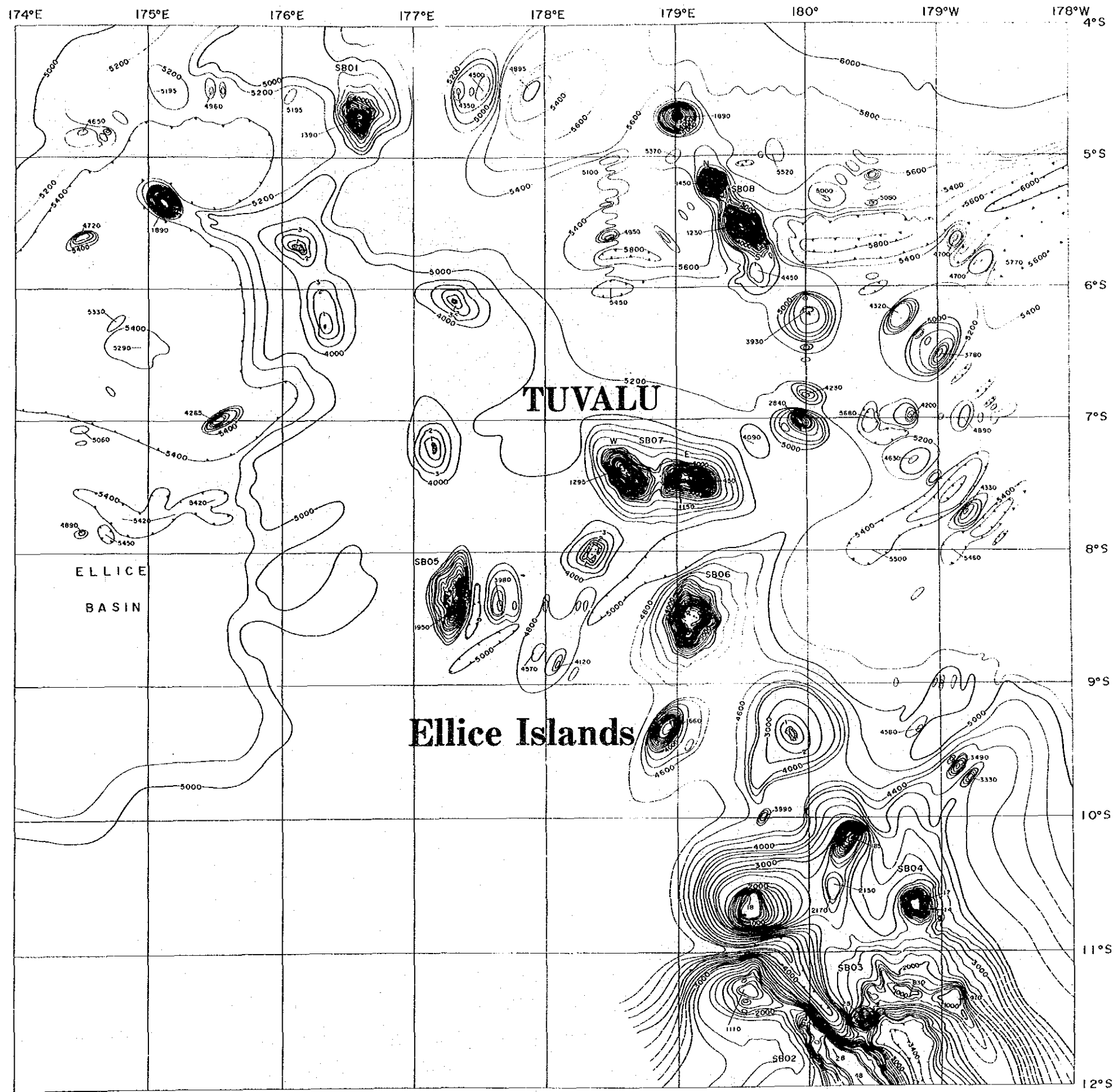


Annexed Figure 1 Trackline Map



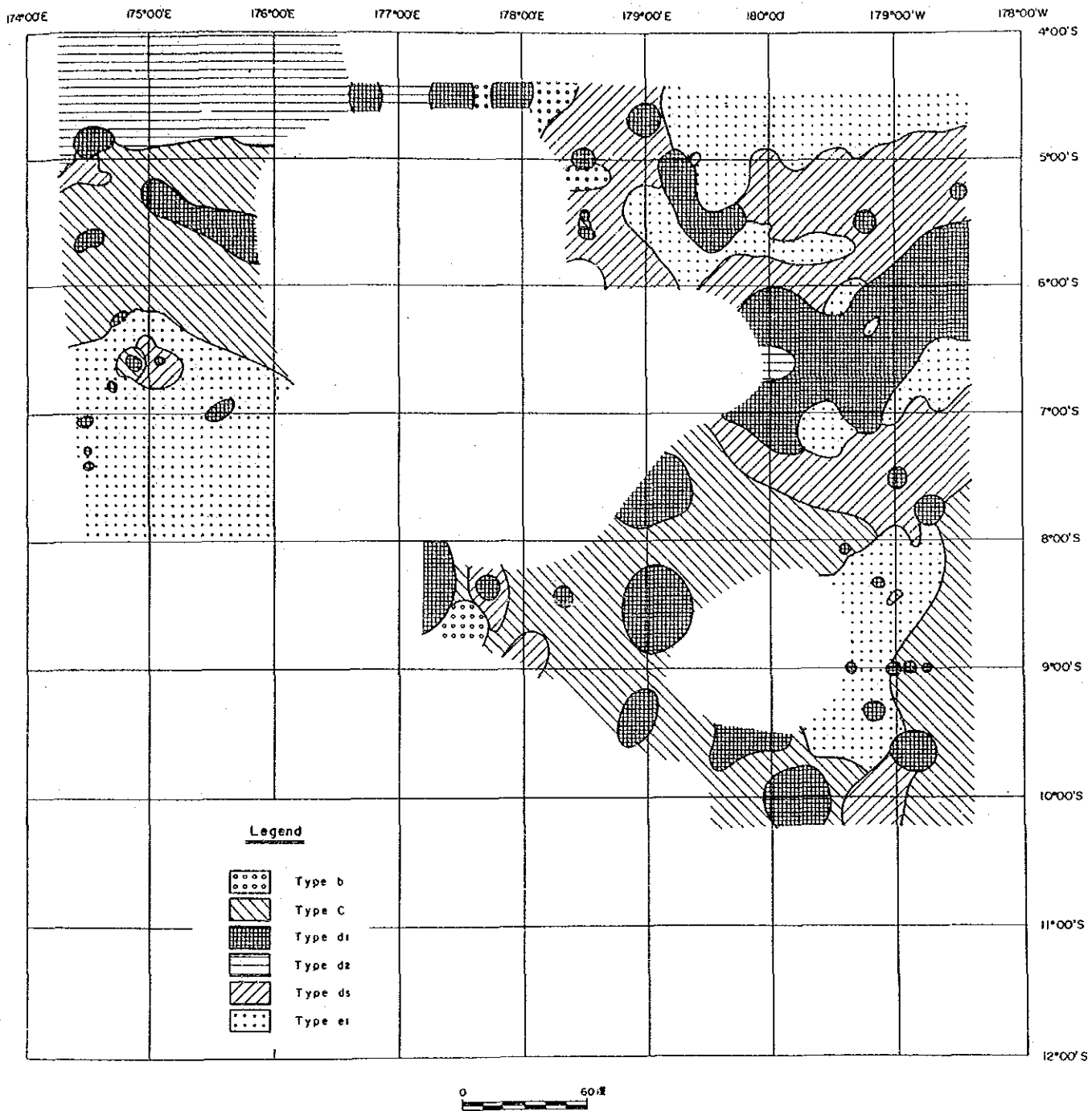


Annexed Figure 2 Positions of Sampling Points



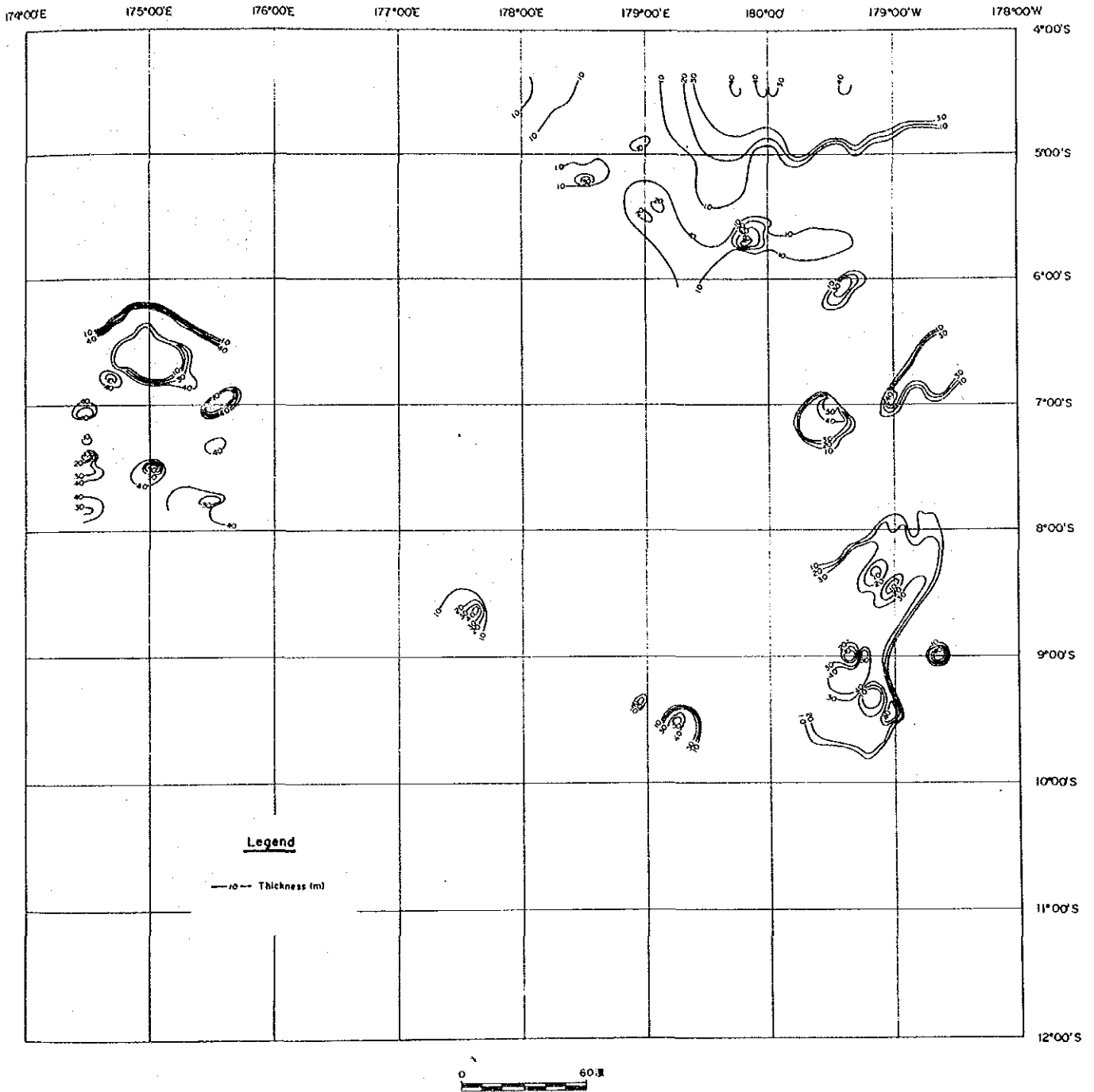
Annexed Figure 3 Sea Floor Topography





Annexed Figure 4 Distribution of SBP Types

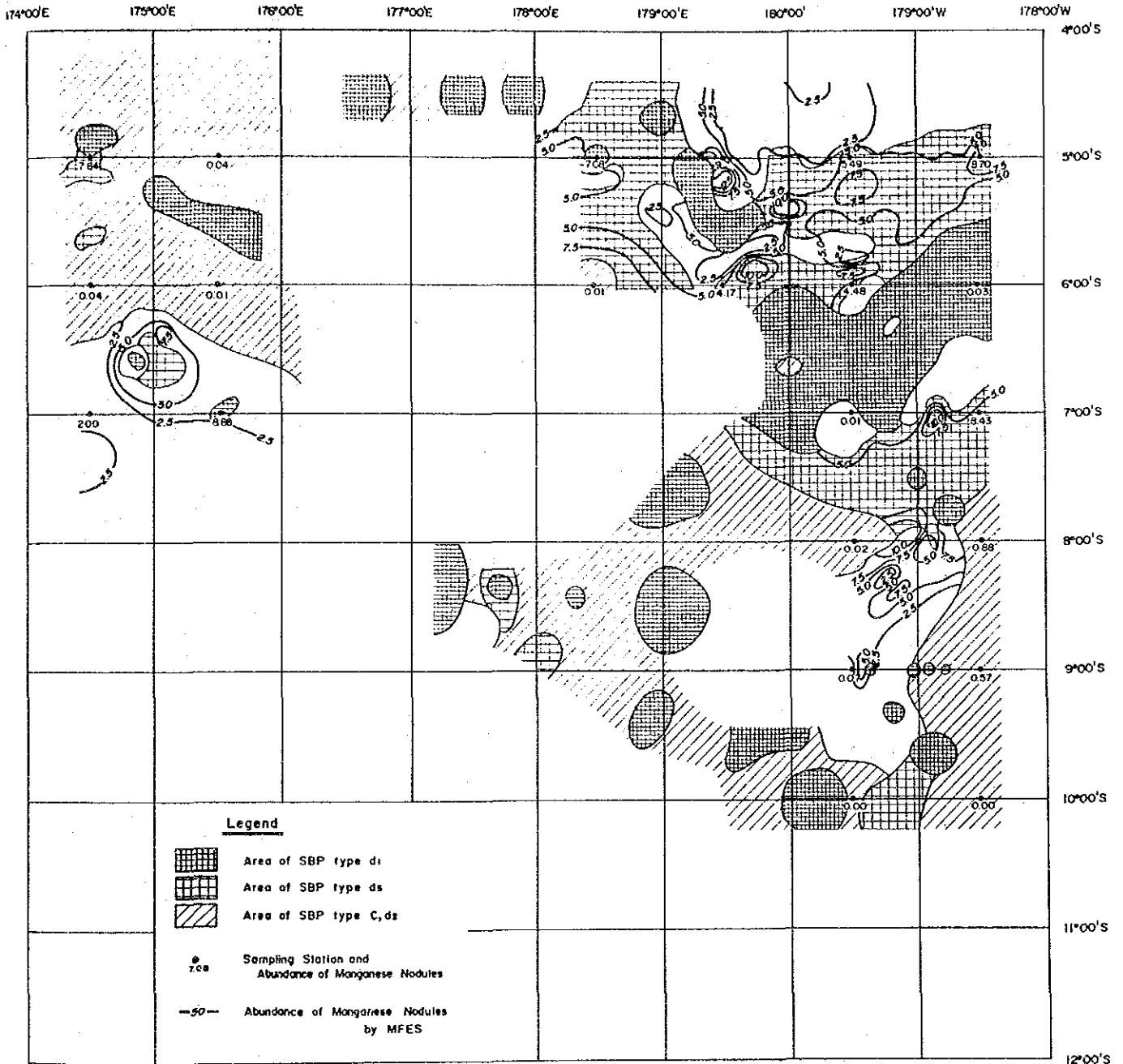




Annexed Figure 5  
 Acoustic Thickness of Upper Transparent  
 Layers Obtained by SBP Survey



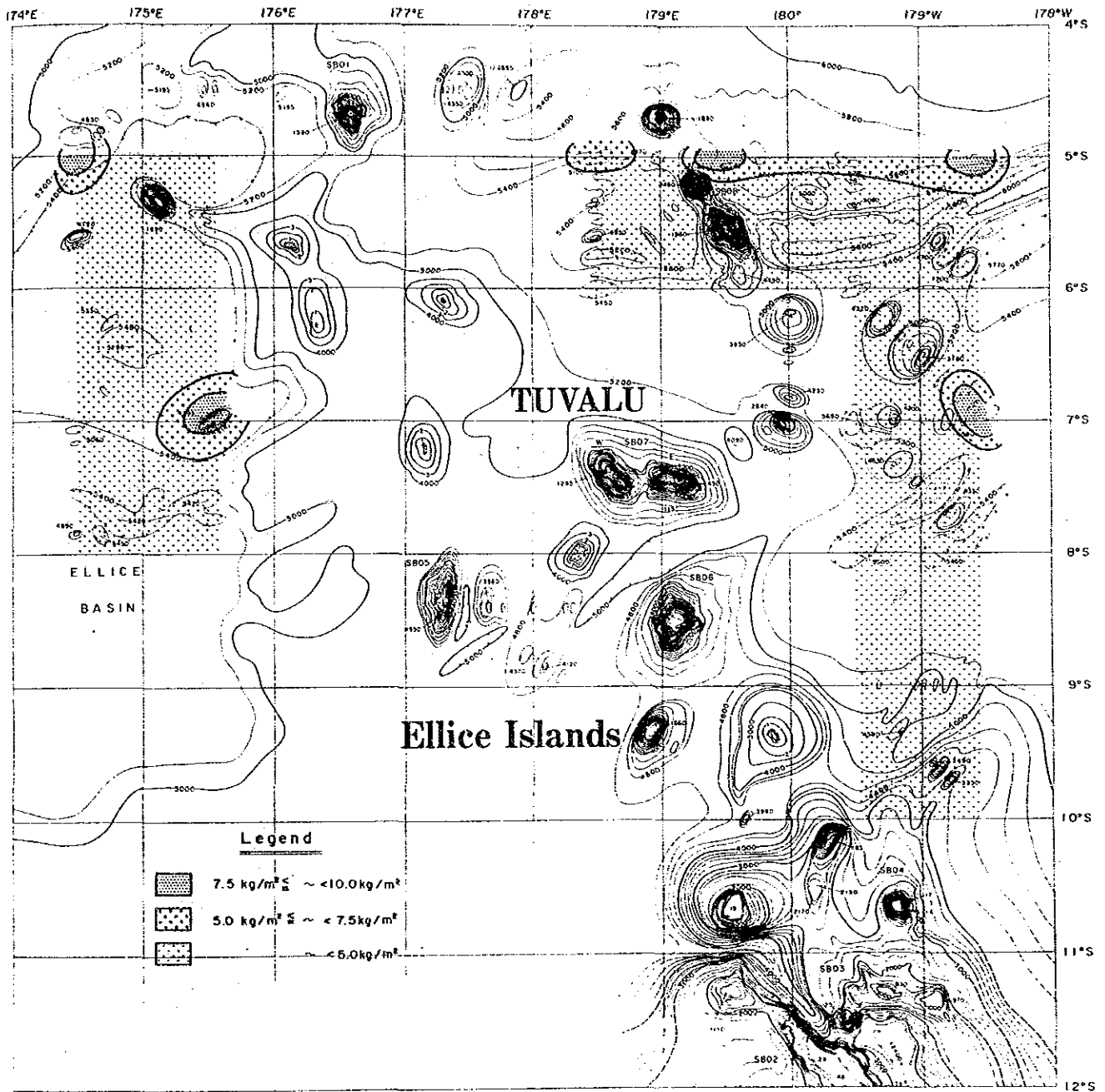




0 60.M

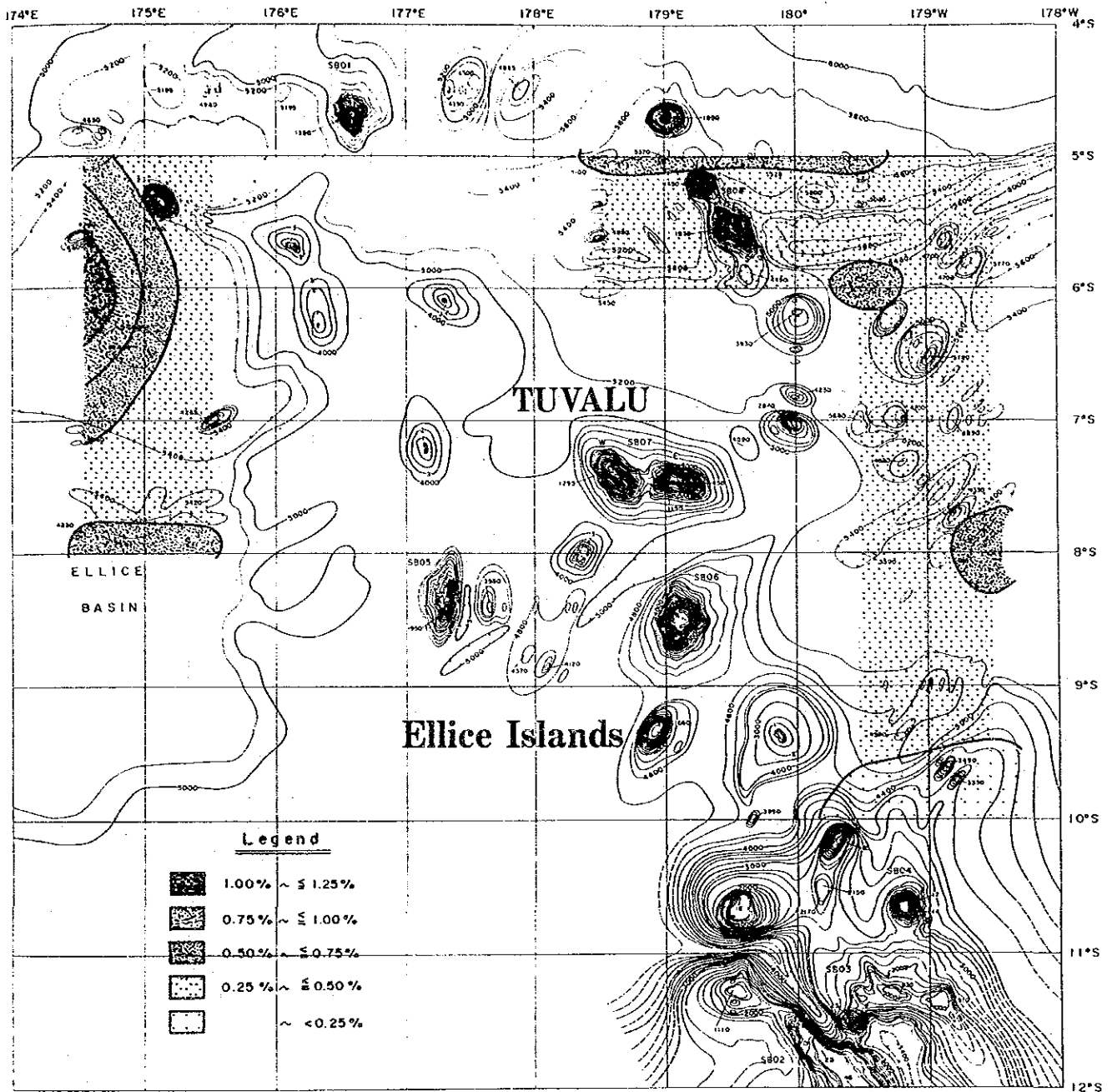
Annexed Figure 6  
Estimated Abundance Map of Manganese  
Nodules by MFES





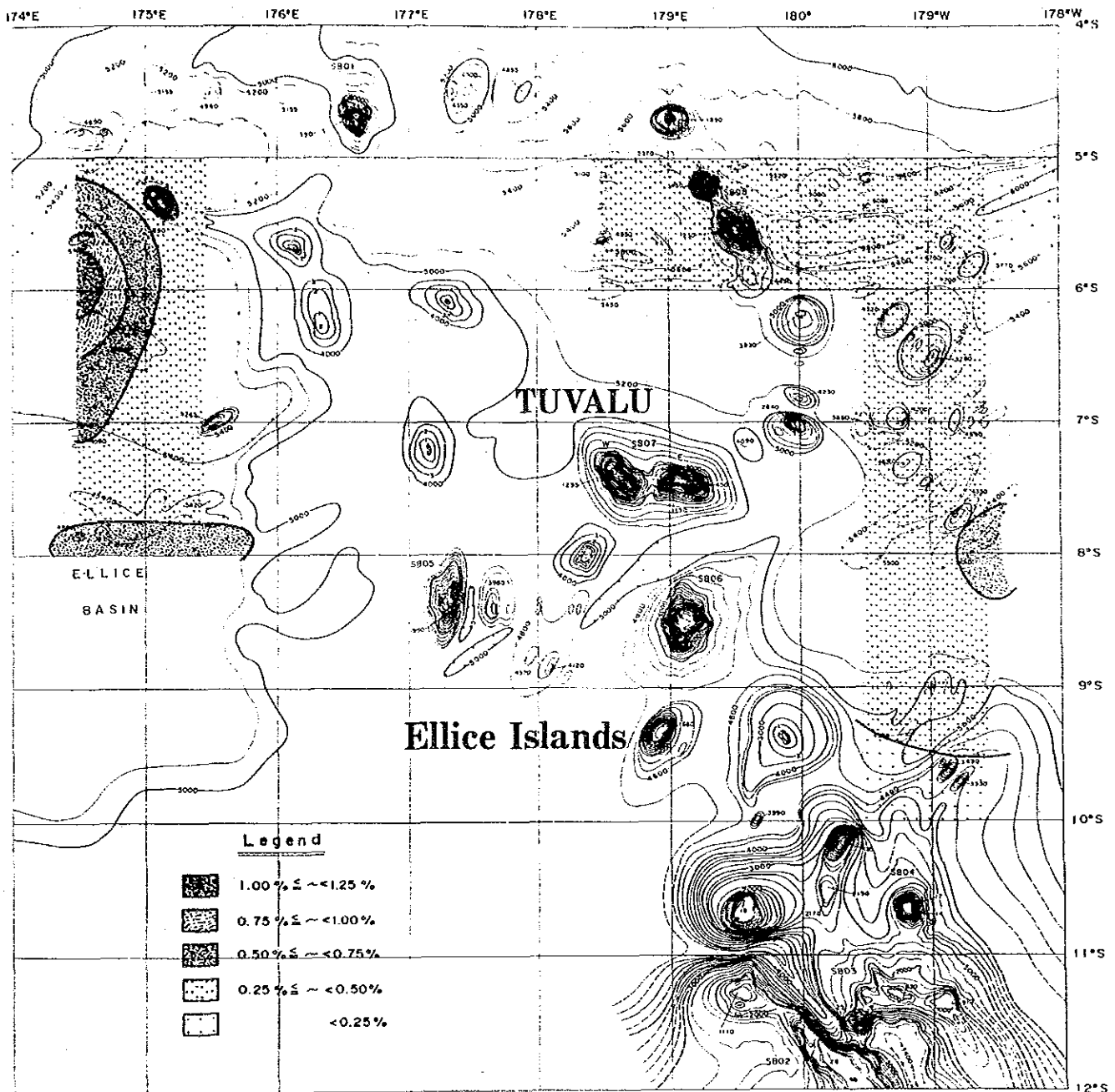
Annexed Figure 7  
 Abundance Map of Manganese Nodules





Annexed Figure 8  
 Ni Grade Map of Manganese Nodules

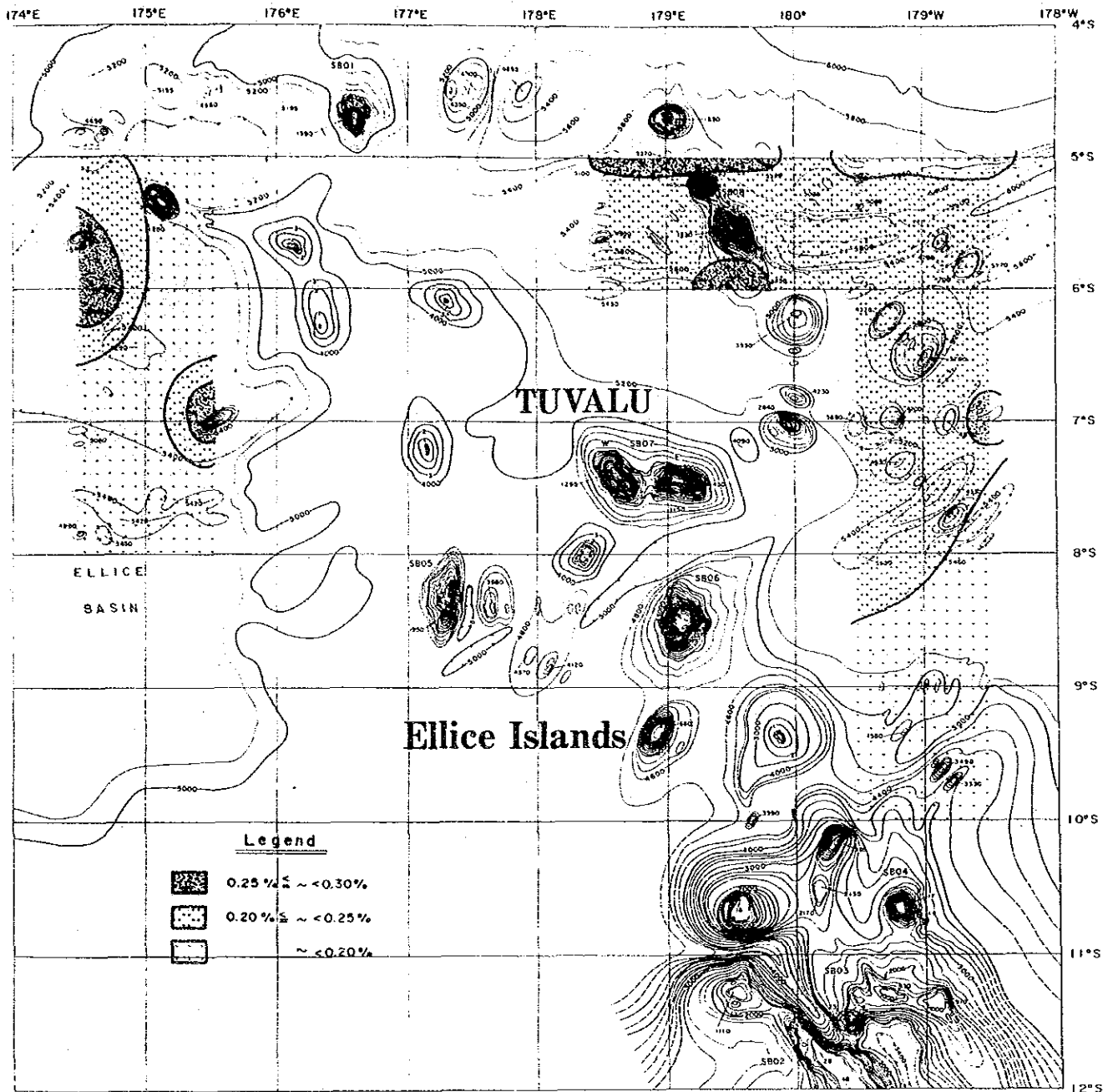




Annexed Figure 9  
Cu Grade Map of Manganese Nodules

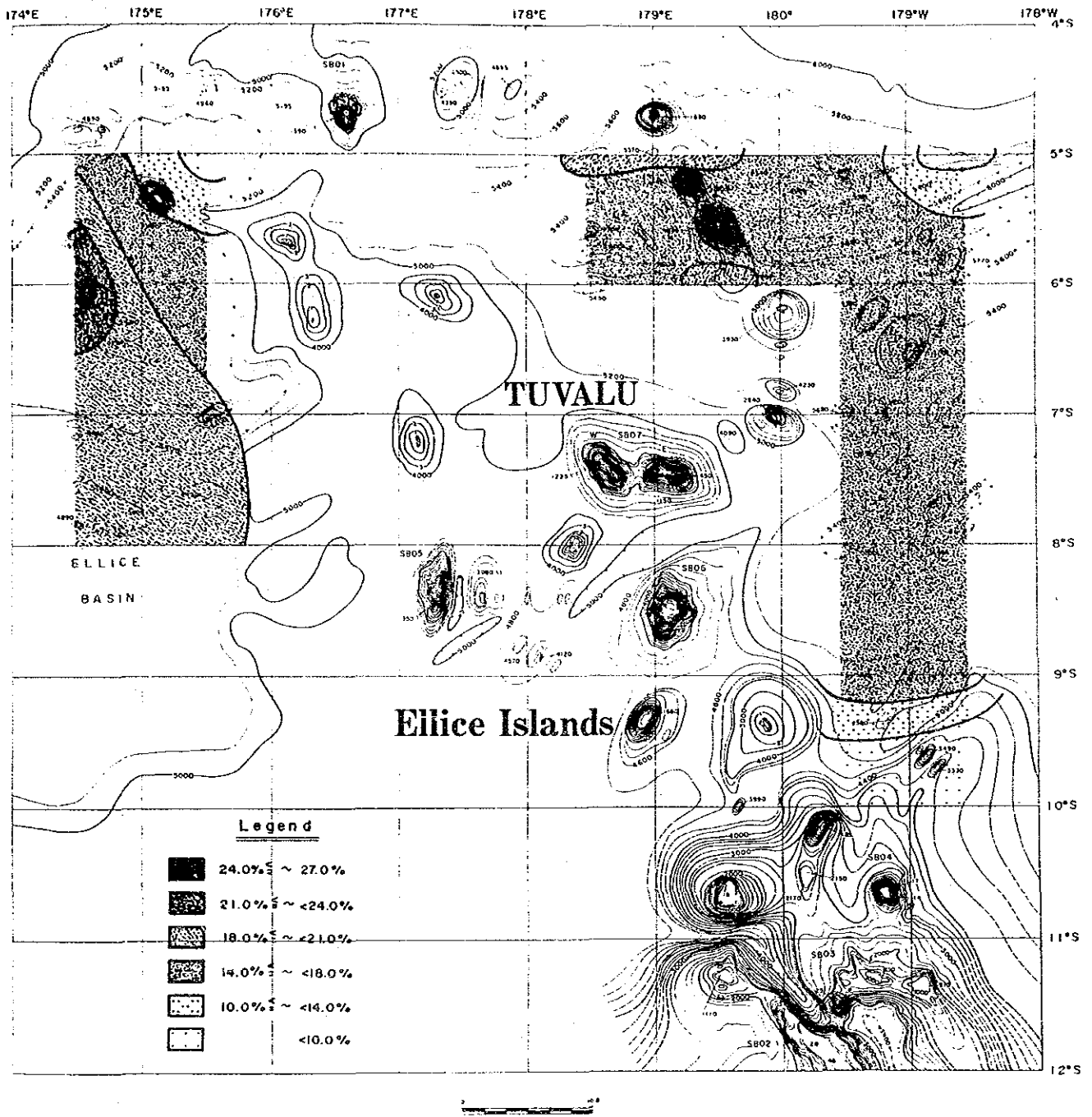






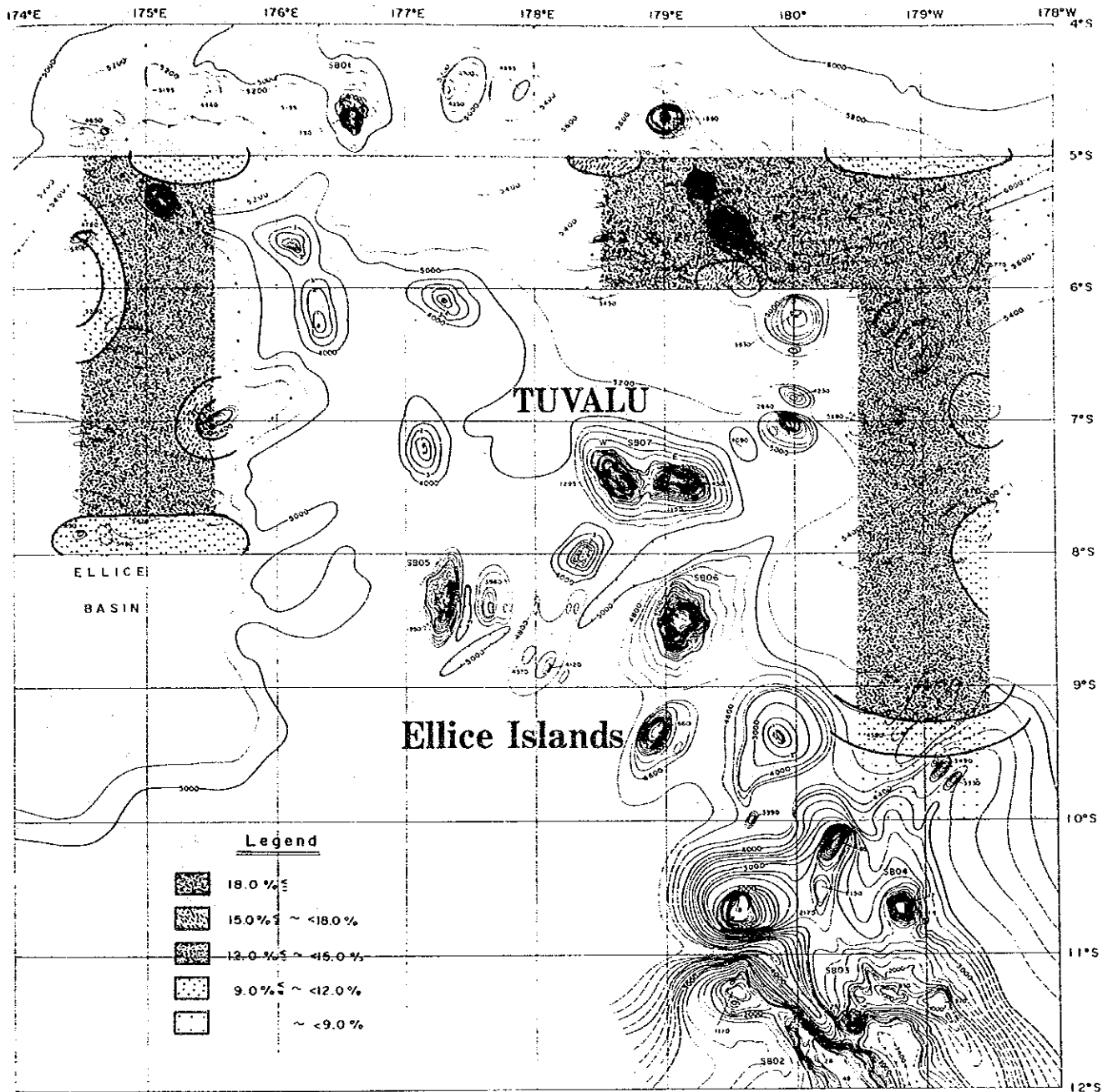
Annexed Figure 10  
Co Grade Map of Manganese Nodules





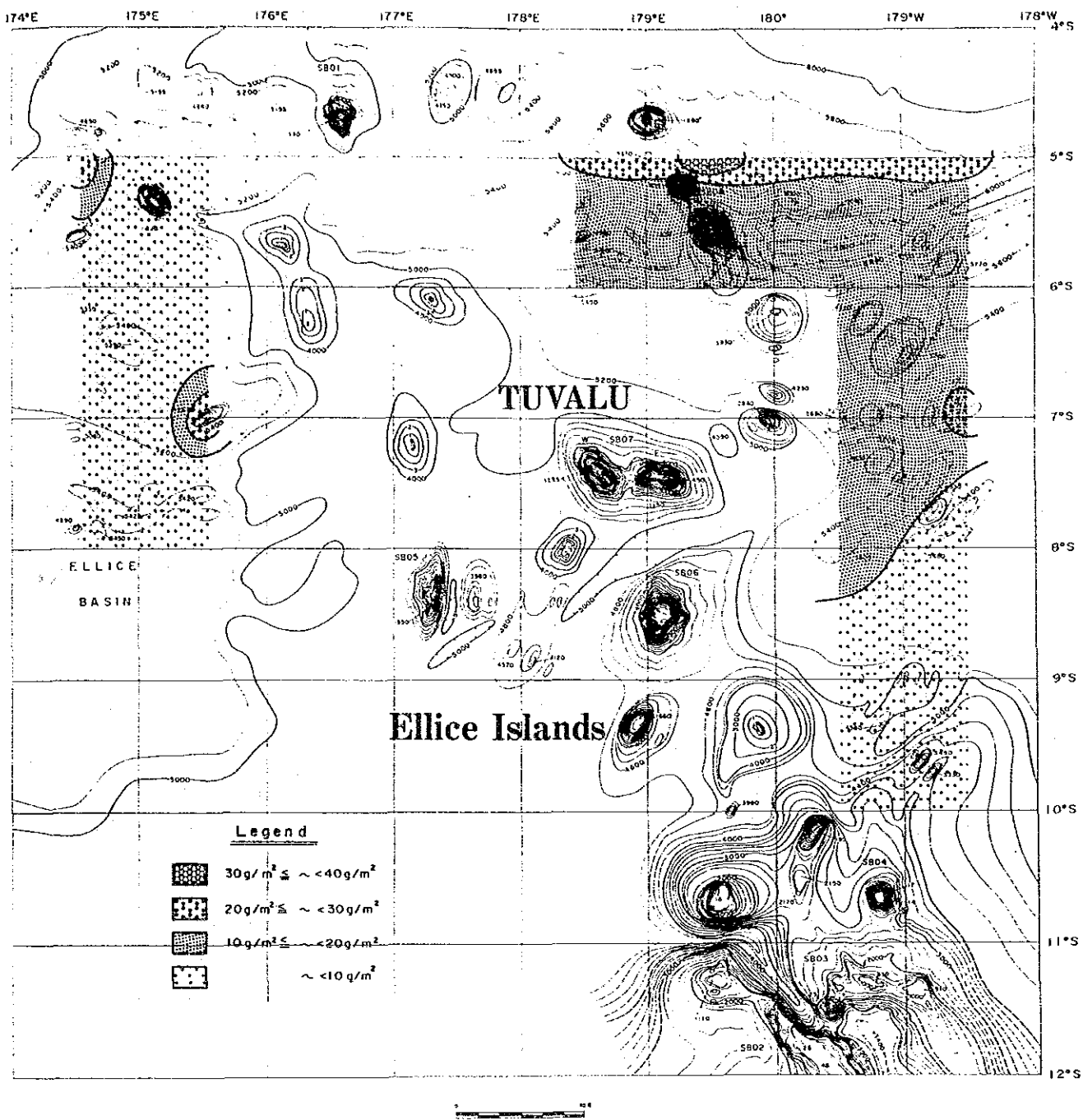
Annexed Figure 11  
 Mn Grade Map of Manganese Nodules





Annexed Figure 12  
 Fe Grade Map of Manganese Nodules

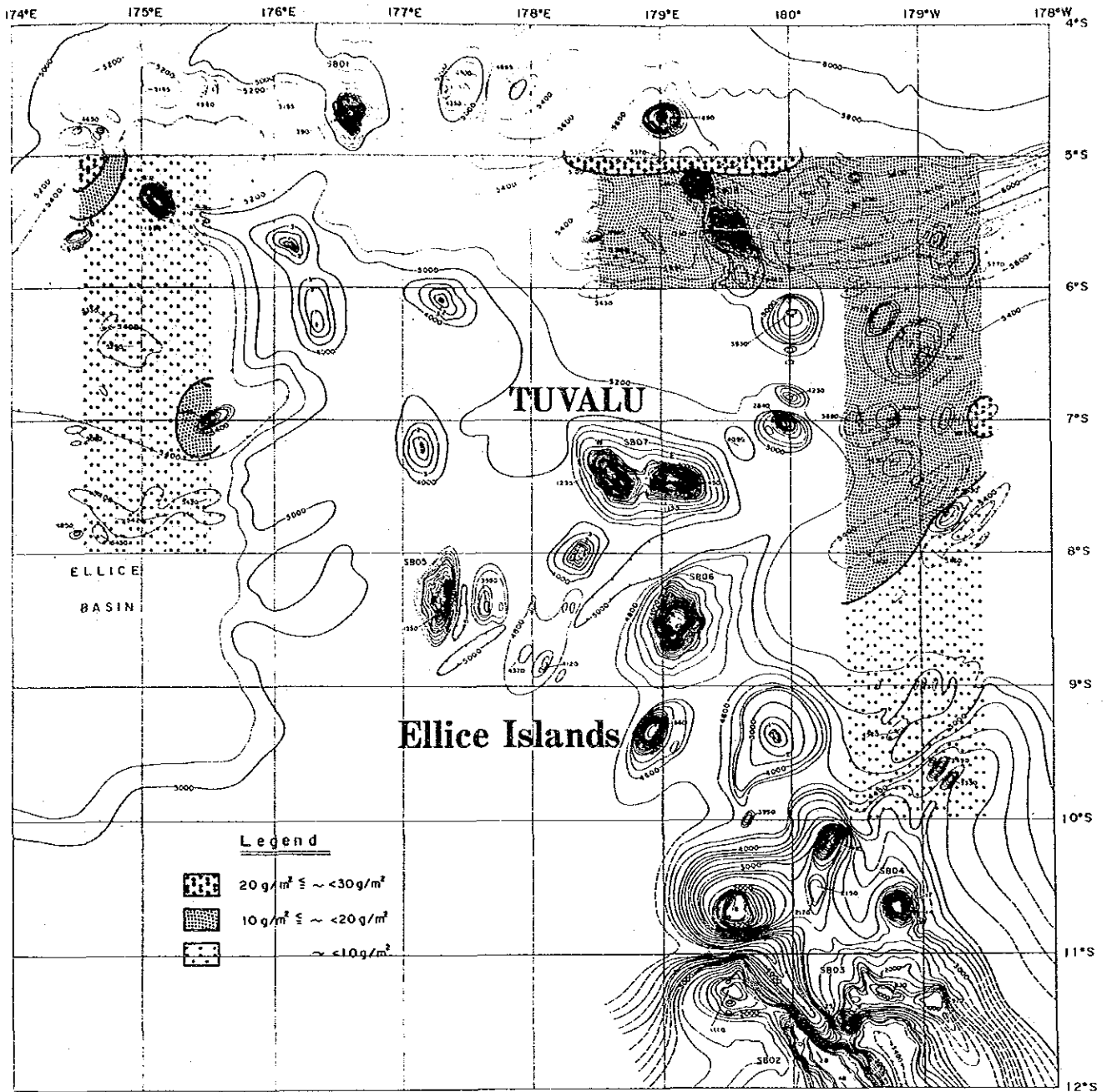




Annexed Figure 13 Ni Metal Quantity Map

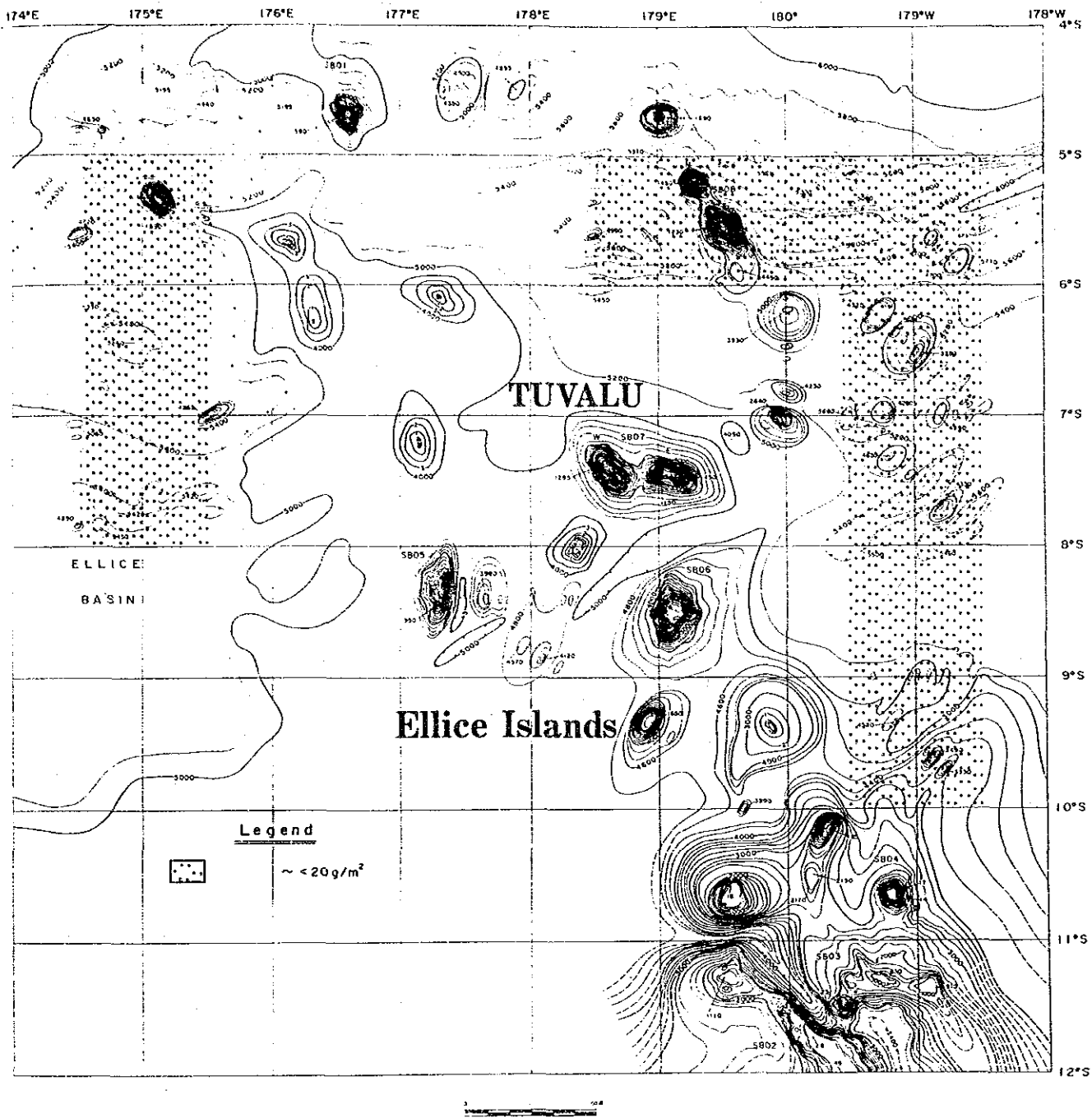






Annexed Figure 14 Cu Metal Quantity Map

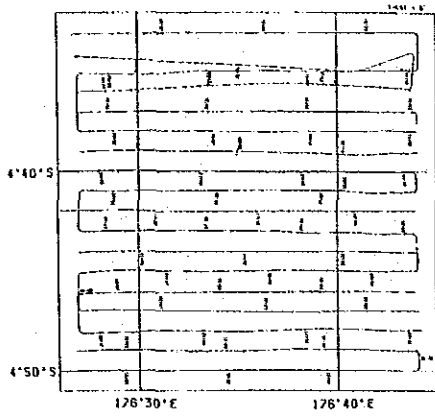




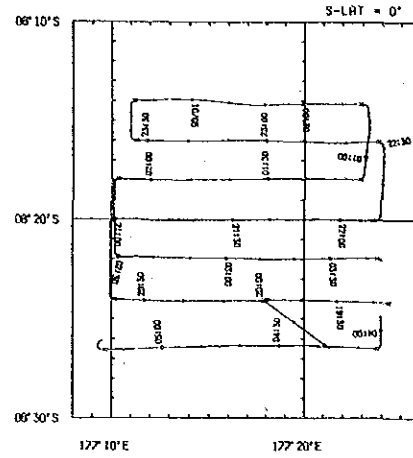
Annexed Figure 15 Co Metal Quantity Map



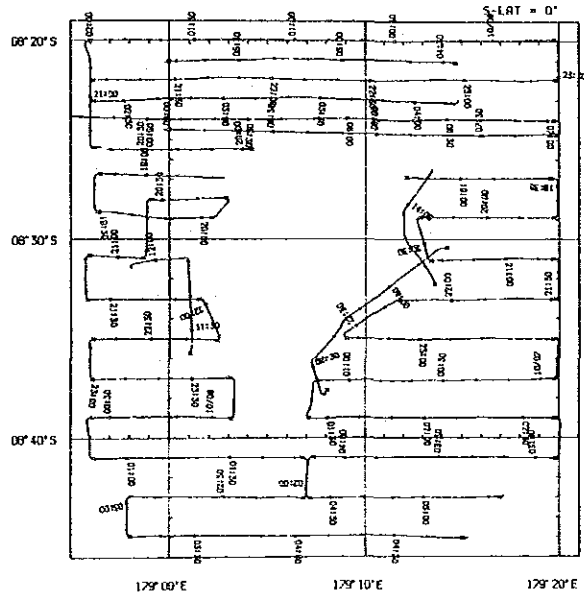
SB 01



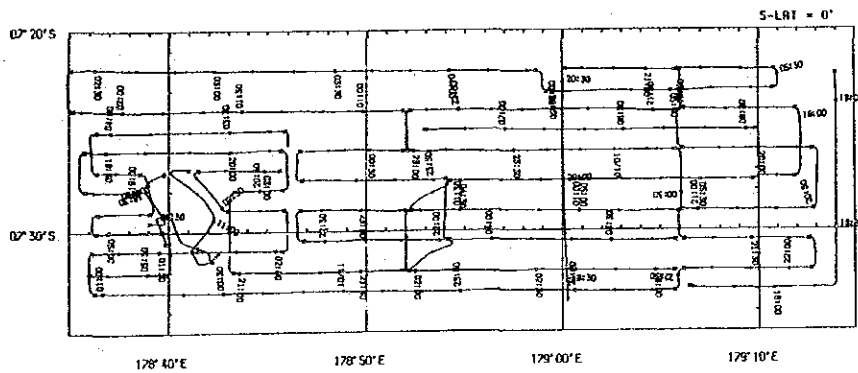
SB 05



SB 06



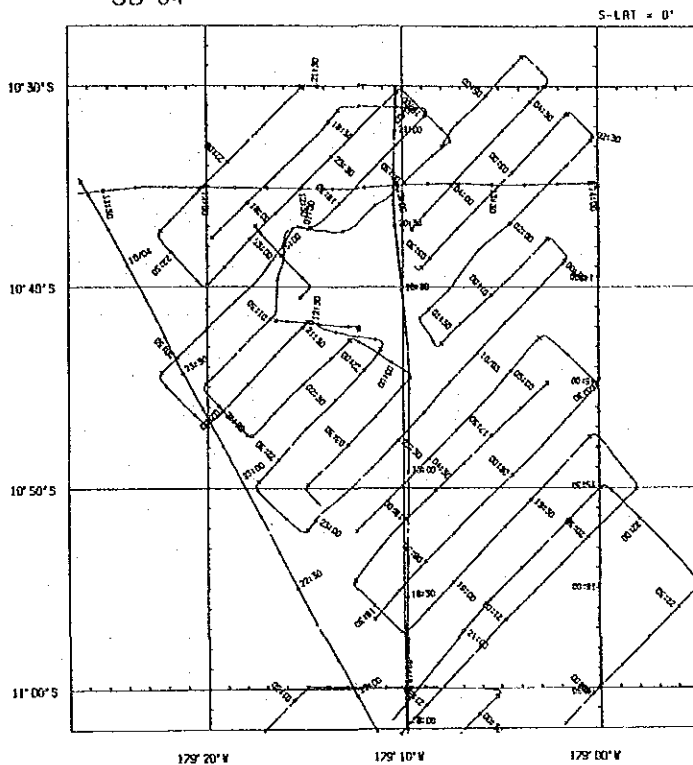
SB 07



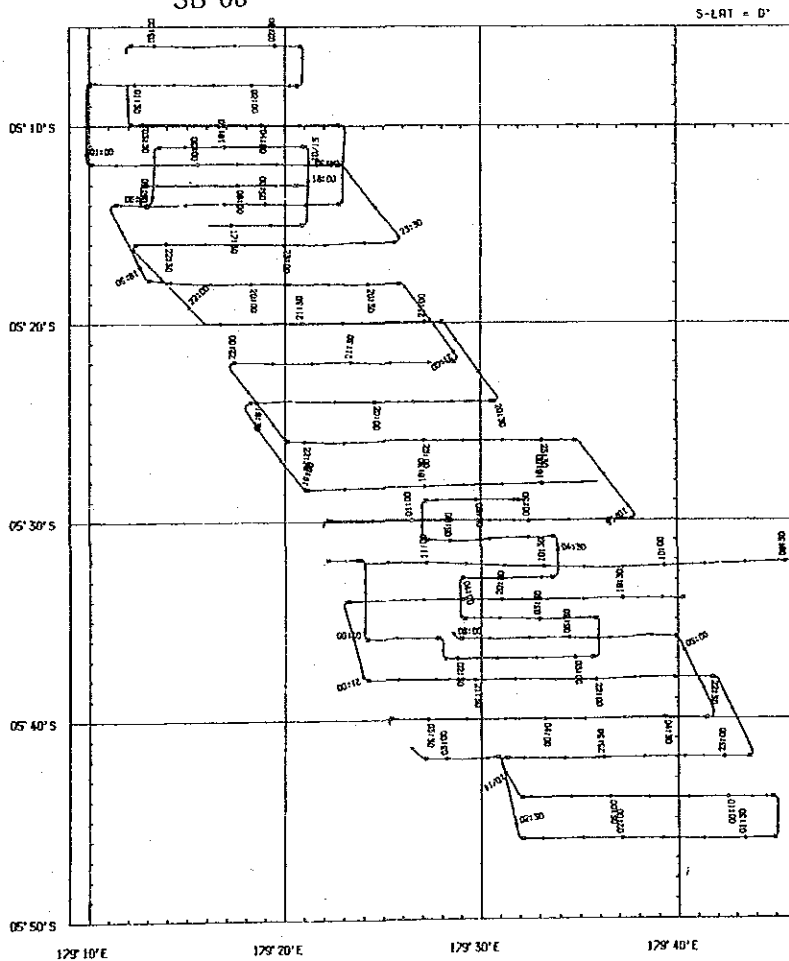
Annexed Figure 16  
Trackline Maps of Individual Seamount (1)



SB 04



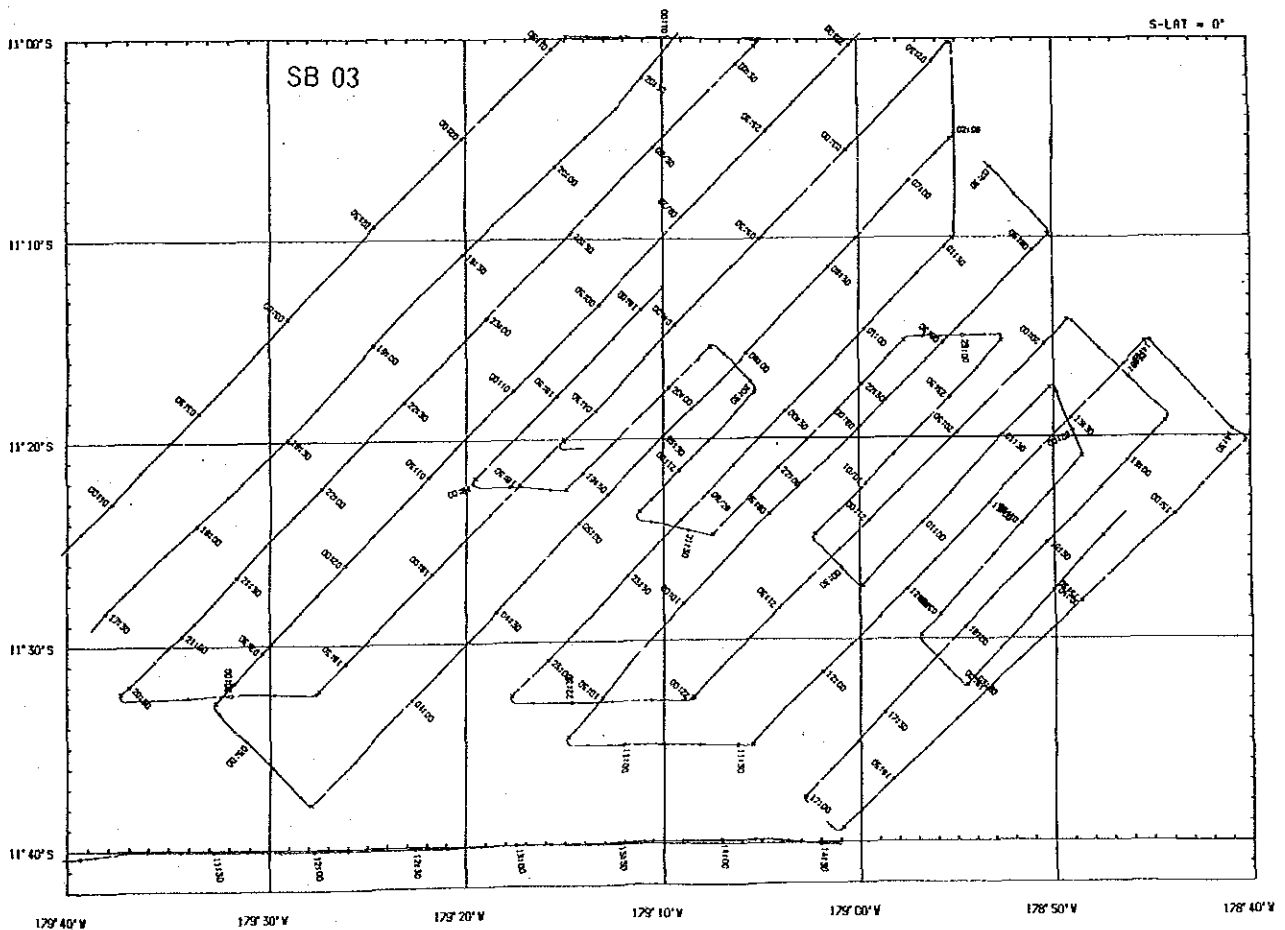
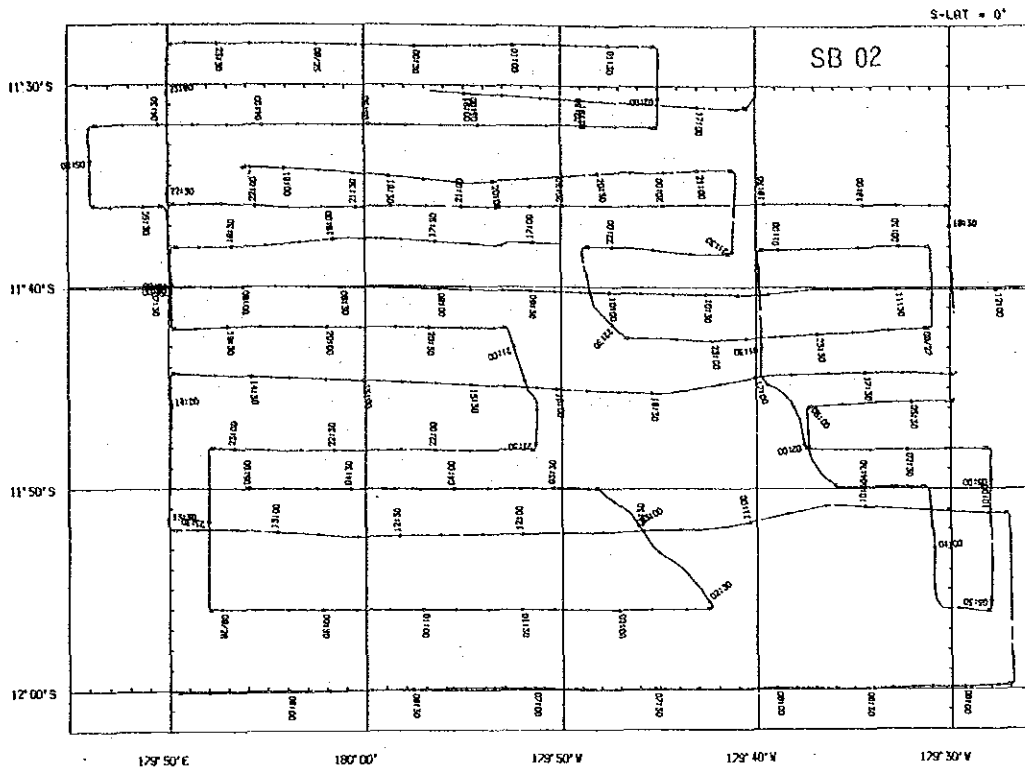
SB 08



Annexed Figure 16  
Trackline Maps of Individual Seamount (2)

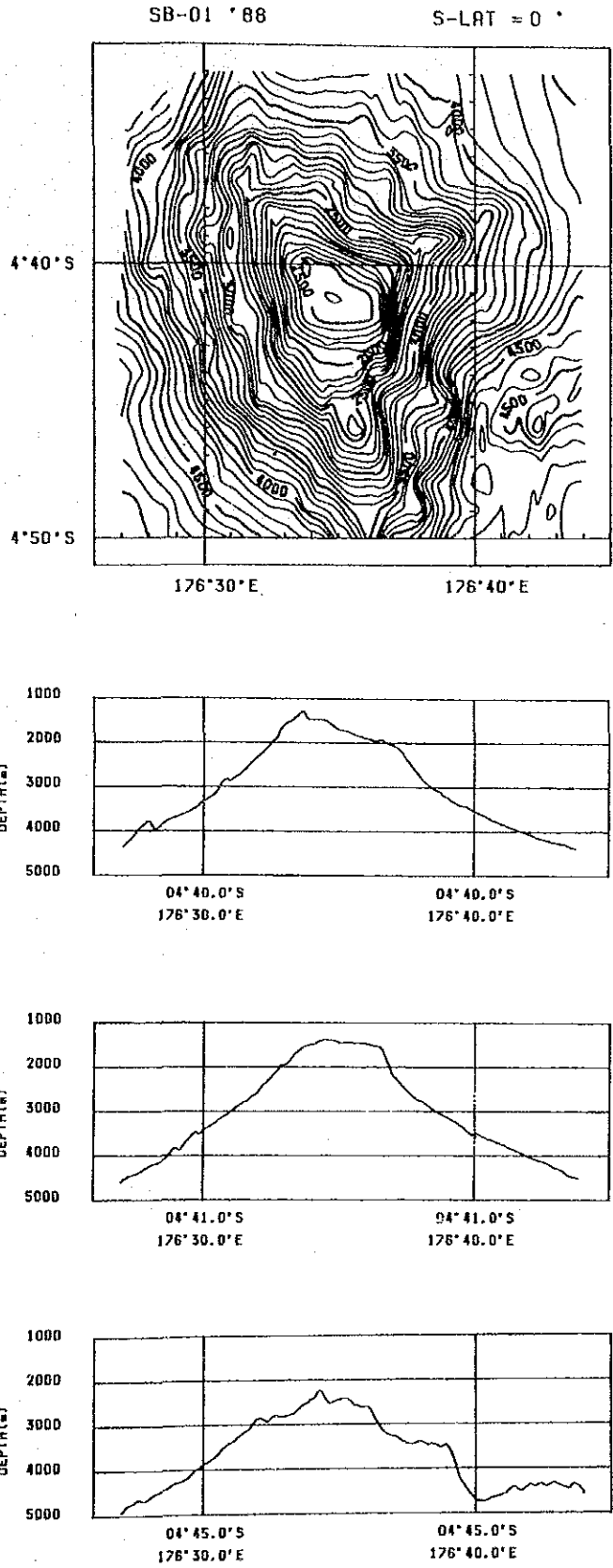






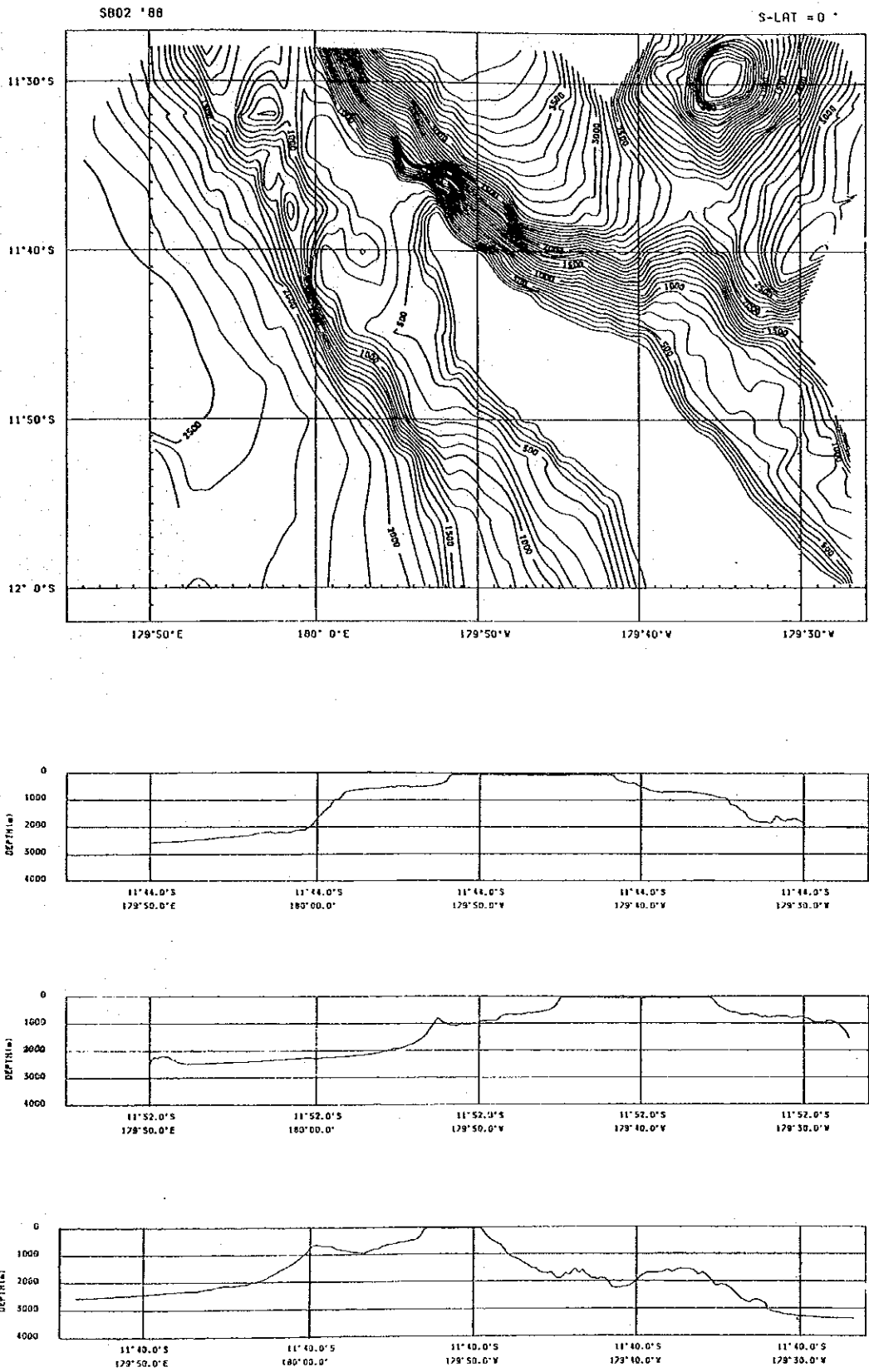
Annexed Figure 16  
Trackline Maps of Individual Seamounts (3)





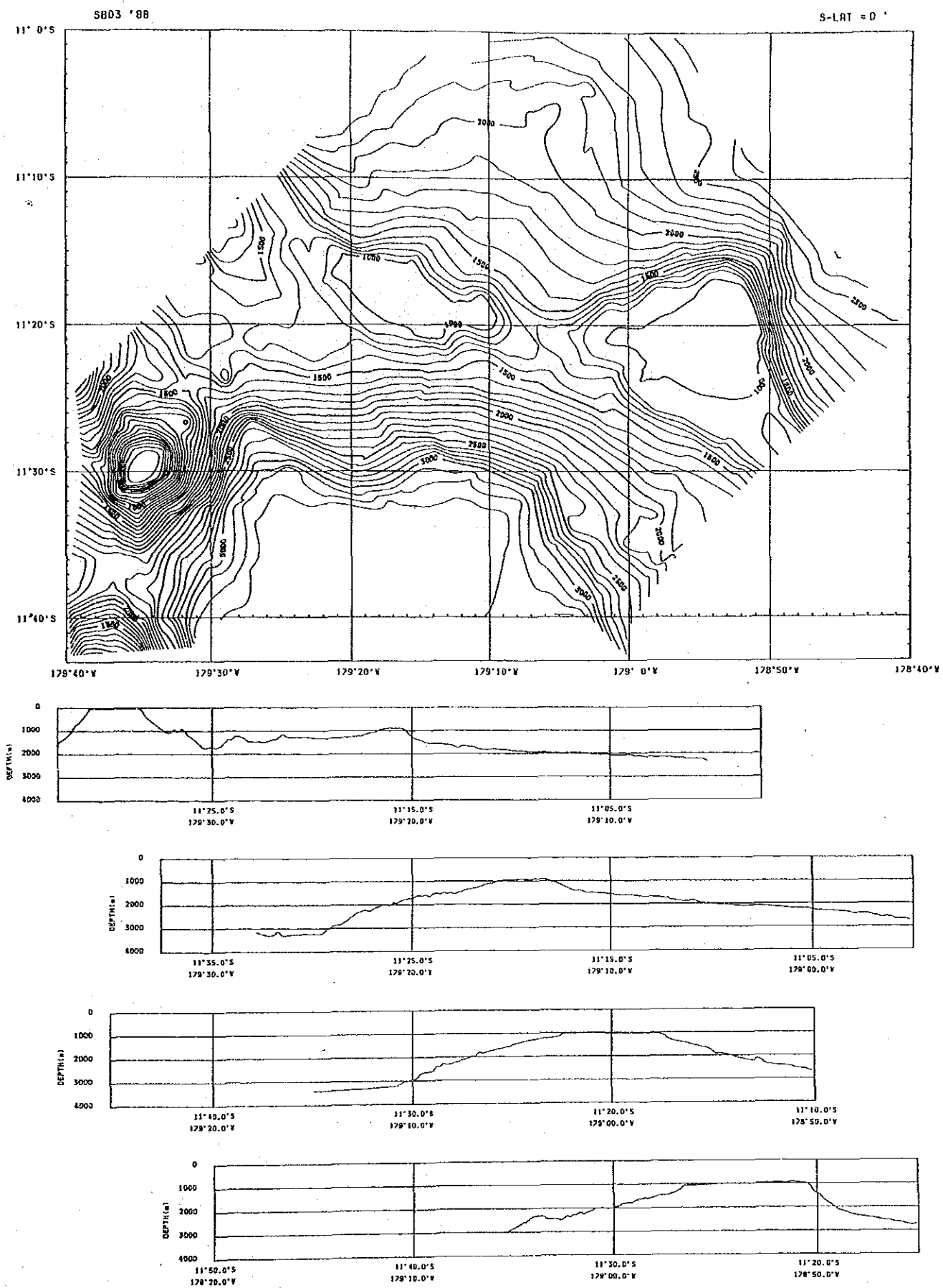
Annexed Figure 17 Topographic Plans and Sections of Individual Seamount (1)





Annexed Figure 17 Topographic Plans and Sections of Individual Seamount (2)





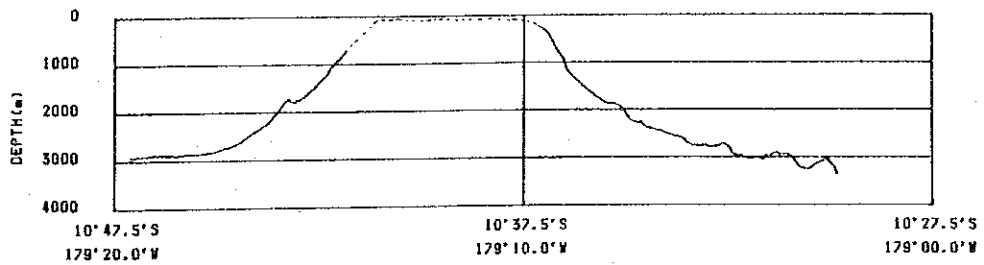
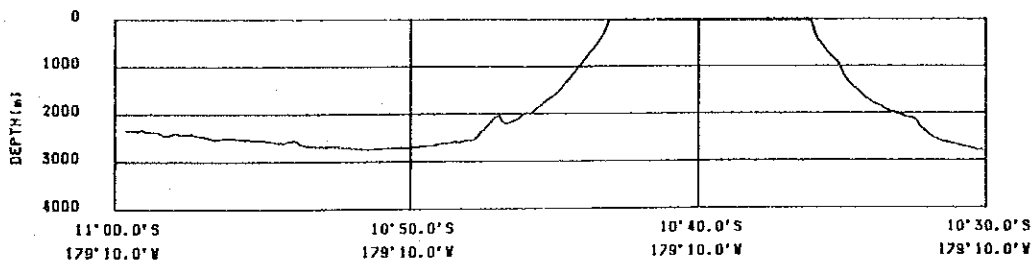
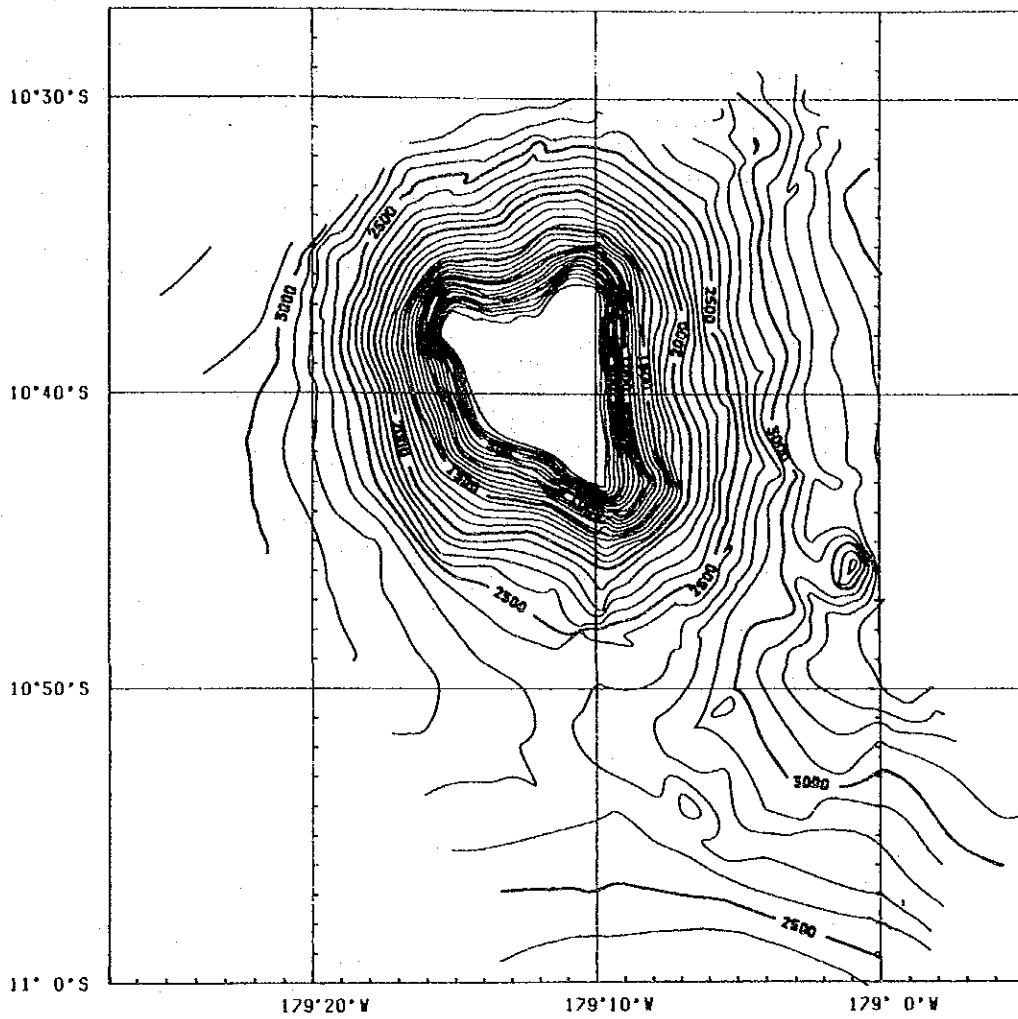
Annexed Figure 17 Topographic Plans and Sections of Individual Seamount (3)





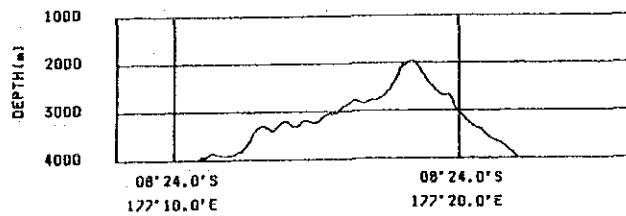
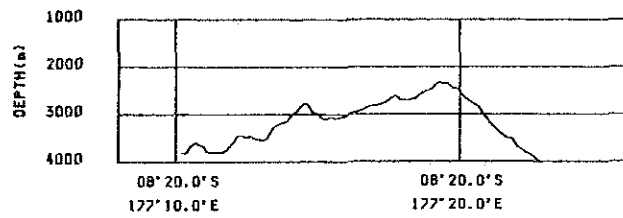
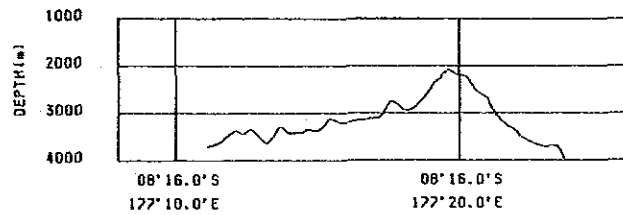
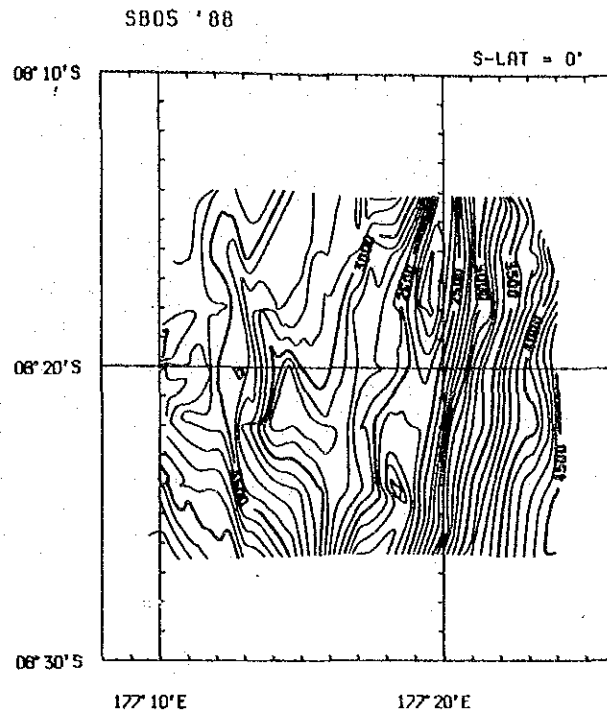
SB04 '88

S-LAT = 0 °



Annexed Figure 17 Topographic Plans and Sections of Individual Seamount (4)



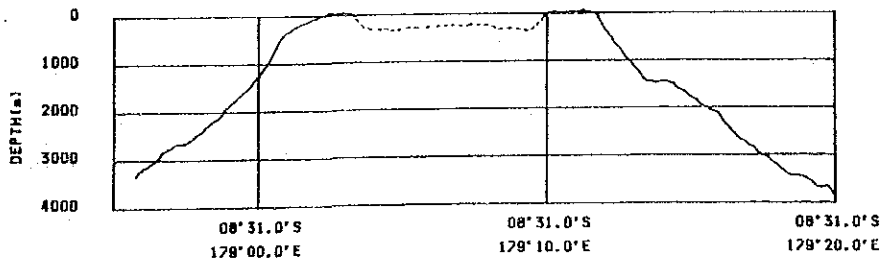
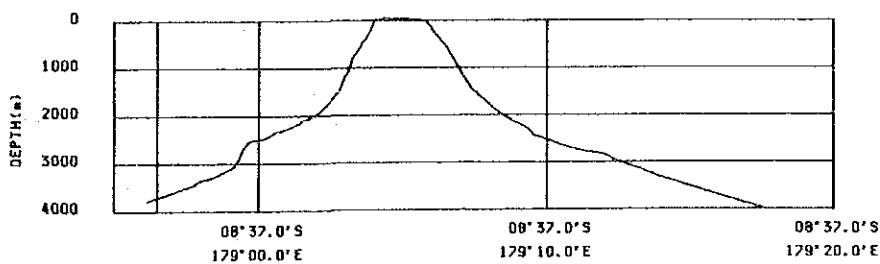
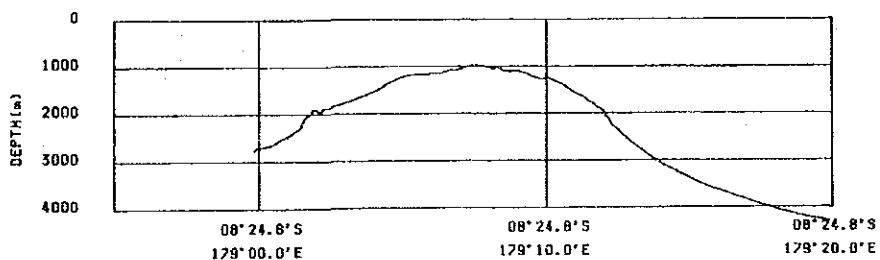
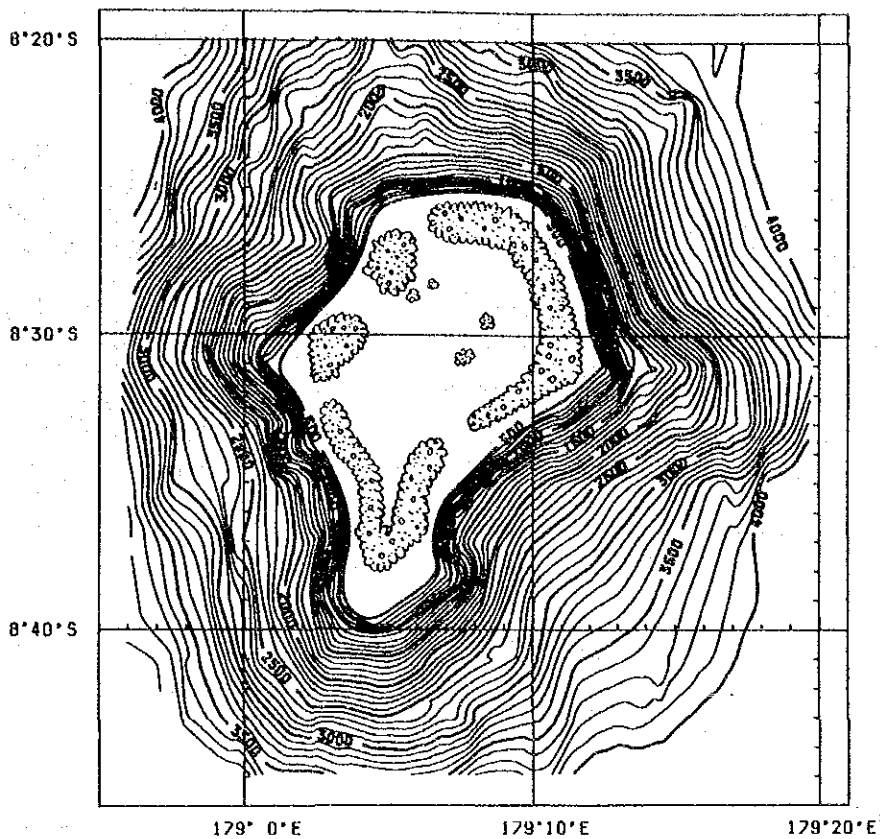


Annexed Figure 17 Topographic Plans and Sections of Individual Seamount (5)



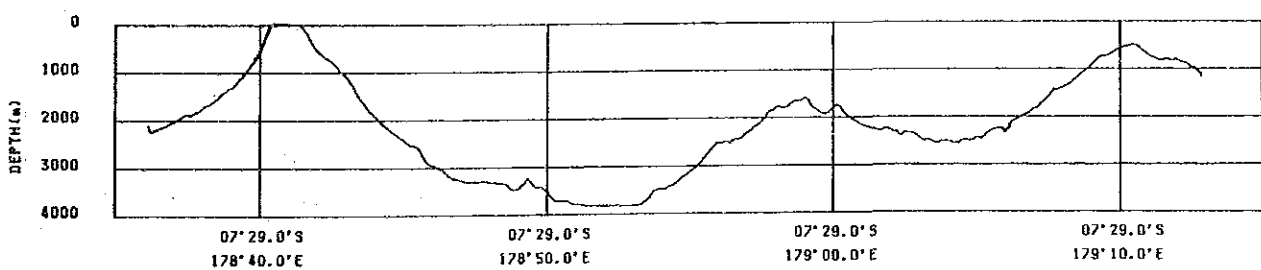
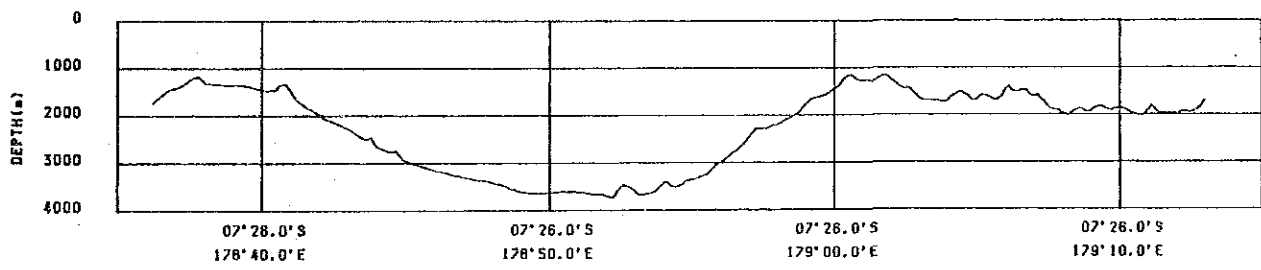
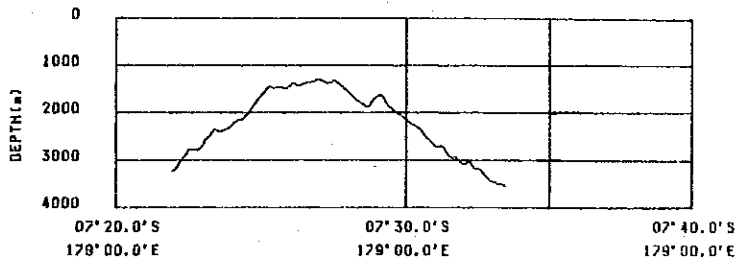
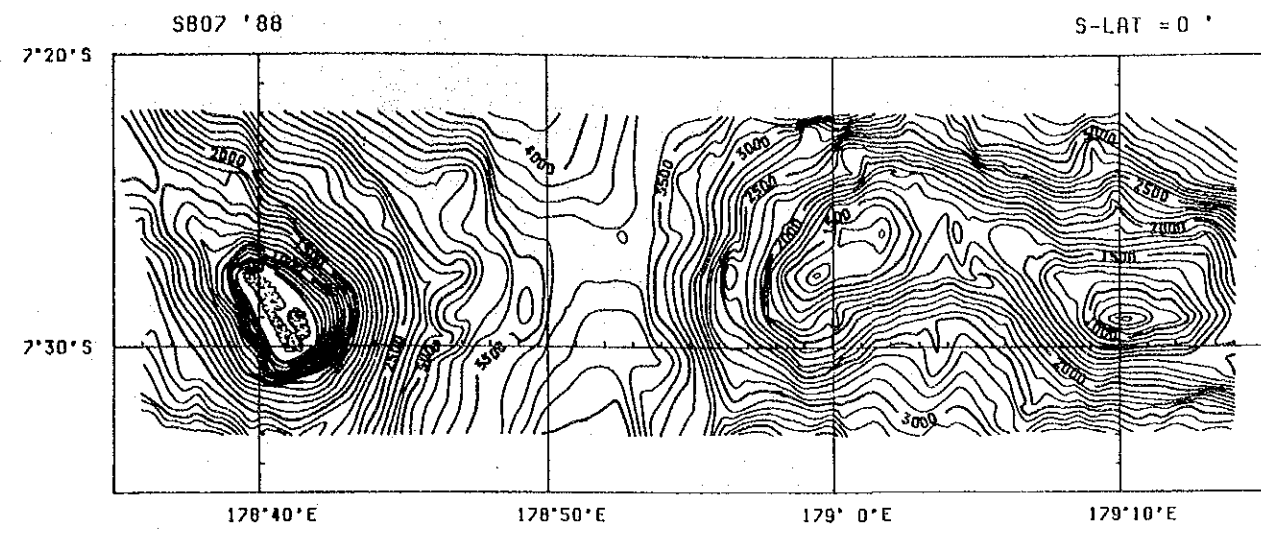
S806 '88

S-LAT = 0 °



Annexed Figure 17 Topographic Plans and Sections of Individual Seamount (6)

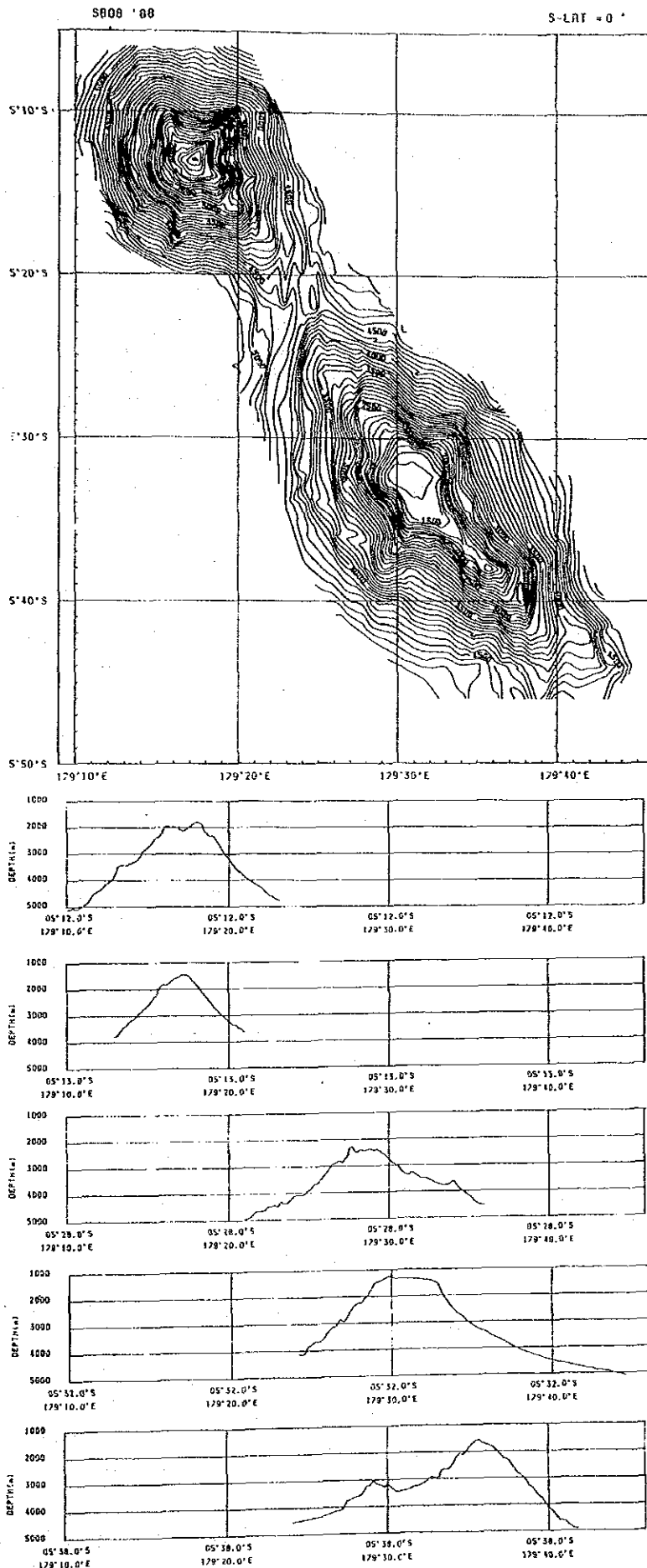




Annexed Figure 17 Topographic Plans and Sections of Individual Seamount (7)



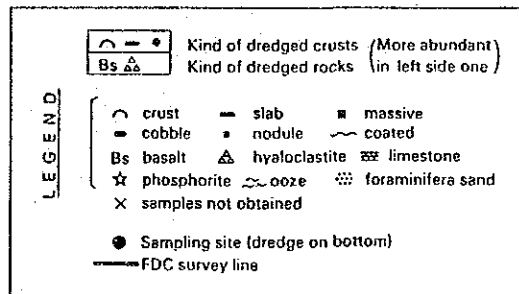
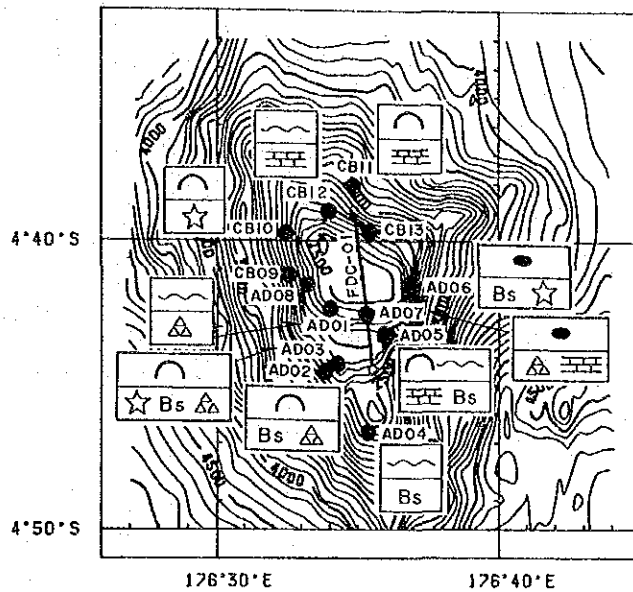




Annexed Figure 17 Topographic Plans and Sections of Individual Seamount (8)



SB 01 SEAMOUNT  
SB-01 '88 S-LAT = 0 °



Sample Number	Sample Weight (kg)	Thickness(mm)		Assay Value (%)					
		Range	Ave.	H <sub>2</sub> O	Co	Ni	Cu	Mn	Fe
ADO1	0.945	0.0--0.1	0.1	--	--	--	--	--	--
ADO2	0.275	0.0--0.3	0.1	40.00	0.37	0.21	0.06	11.72	16.05
ADO3	24.5	0.0--0.3	0.1	58.33	0.79	0.52	0.04	23.02	17.50
ADO4	0.007	--	--	--	--	--	--	--	--
ADO5	2.76	0.0--5.0	0.1	27.54	0.40	0.14	0.03	9.86	11.63
ADO6	318.0	0.0--3.0	0.1	35.42	0.75	0.45	0.05	22.60	19.00
ADO7	143.0	0.0--2.0	0.3	32.98	0.89	0.43	0.04	21.16	18.50
ADO8	0.0	--	--	--	--	--	--	--	--
ADO9	0.0	--	--	--	--	--	--	--	--
CB10	0.216	1.0--6.0	3.0	26.07	0.82	0.47	0.06	22.26	17.91
CB11	0.6	0.0--0.3	0.1	--	--	--	--	--	--
CB12	4.18	0.0--0.1	0.1	--	--	--	--	--	--
CB13	0.0	--	--	--	--	--	--	--	--

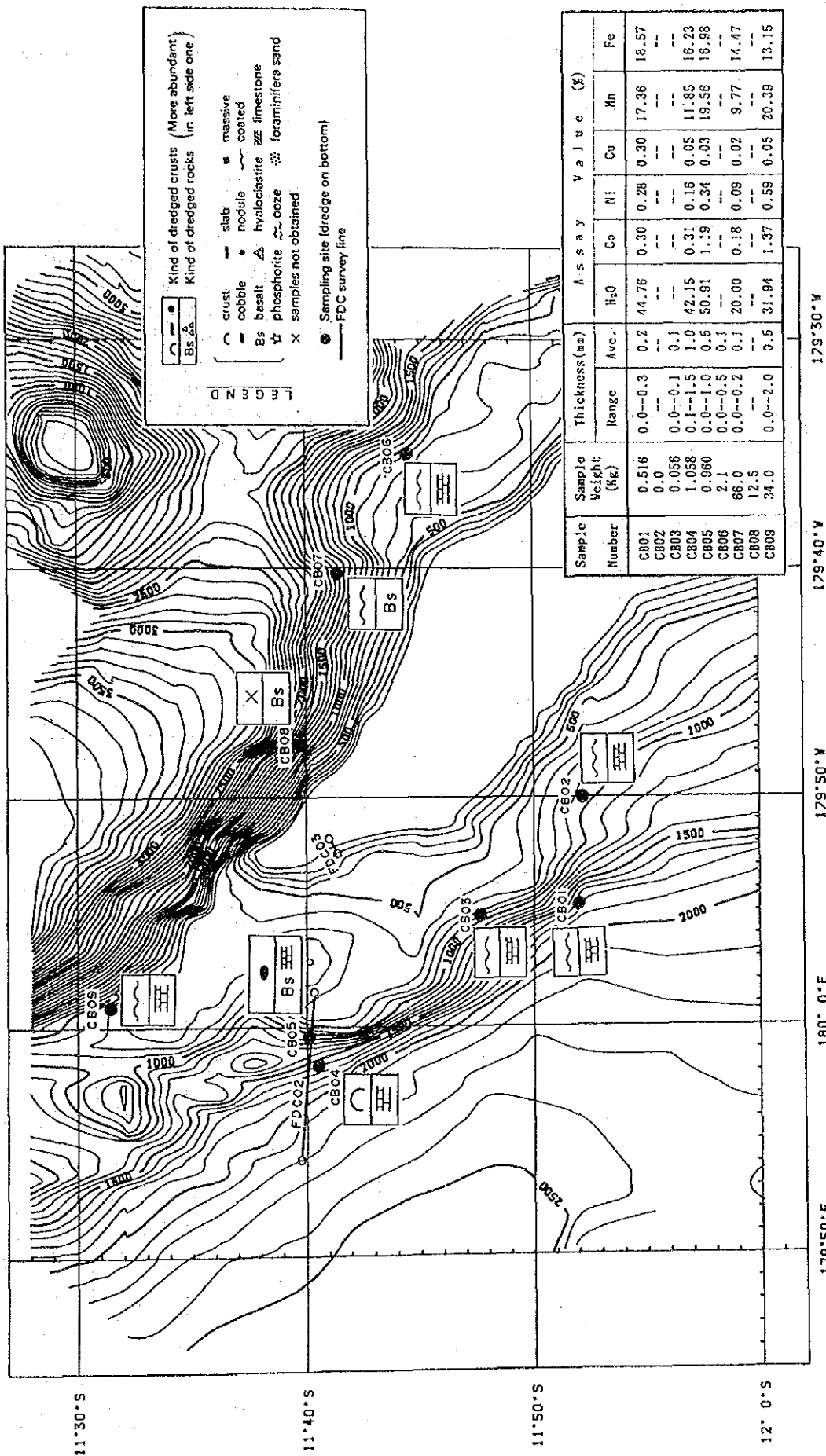
Annexed Figure 18  
Geology and Distribution of Cobalt Crusts  
of Individual Seamount (1)



SB 02 SEAMOUNT (BAYONNAISE BK)

SB02 '88

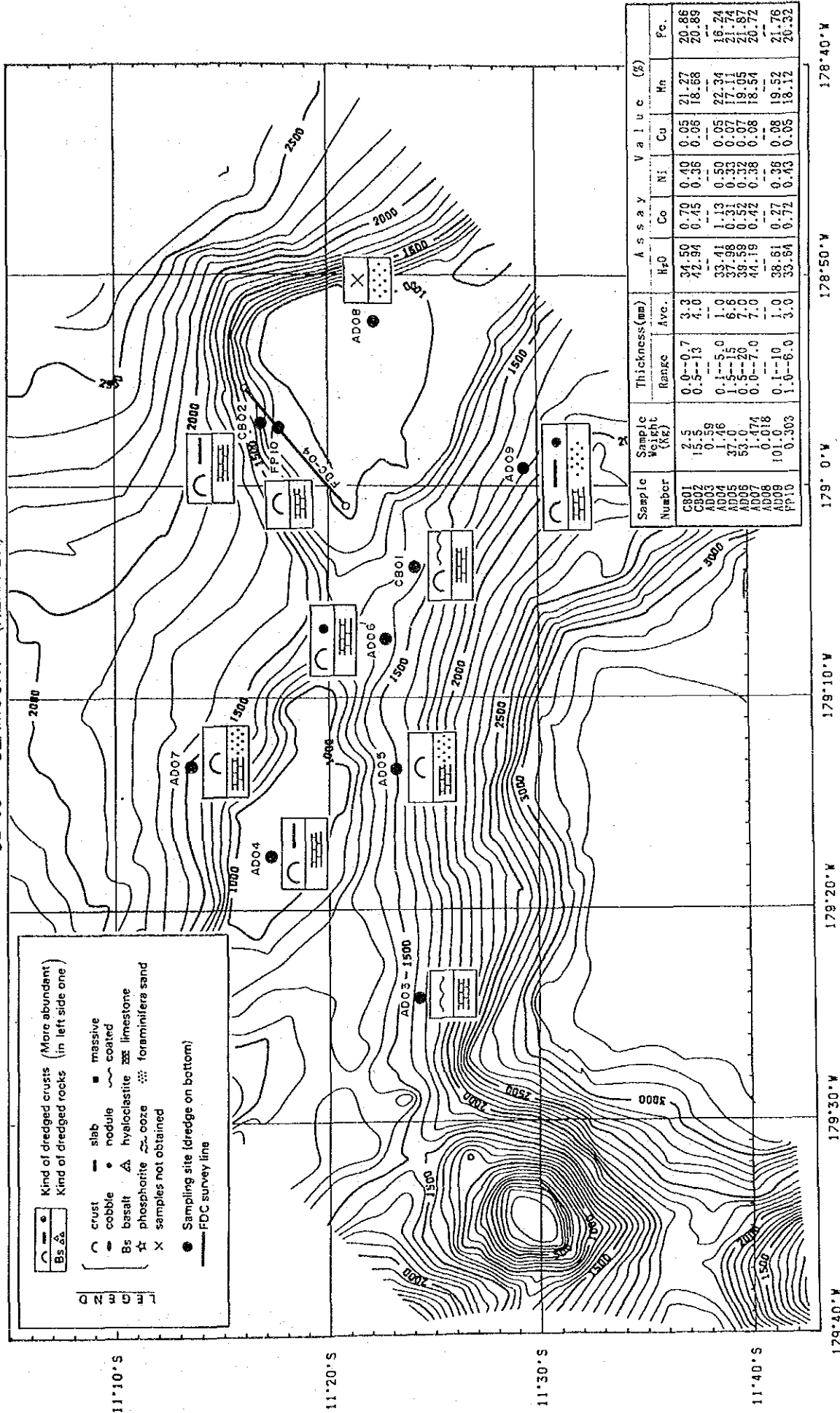
S-LAT = 0°



Annexed Figure 18 Geology and Distribution of Cobalt Crusts of Individual Seamount (2)



SB 03 SEAMOUNT (HERA BK)



Annexed Figure 18 Geology and Distribution of Cobalt Crusts of Individual Seamount (3)

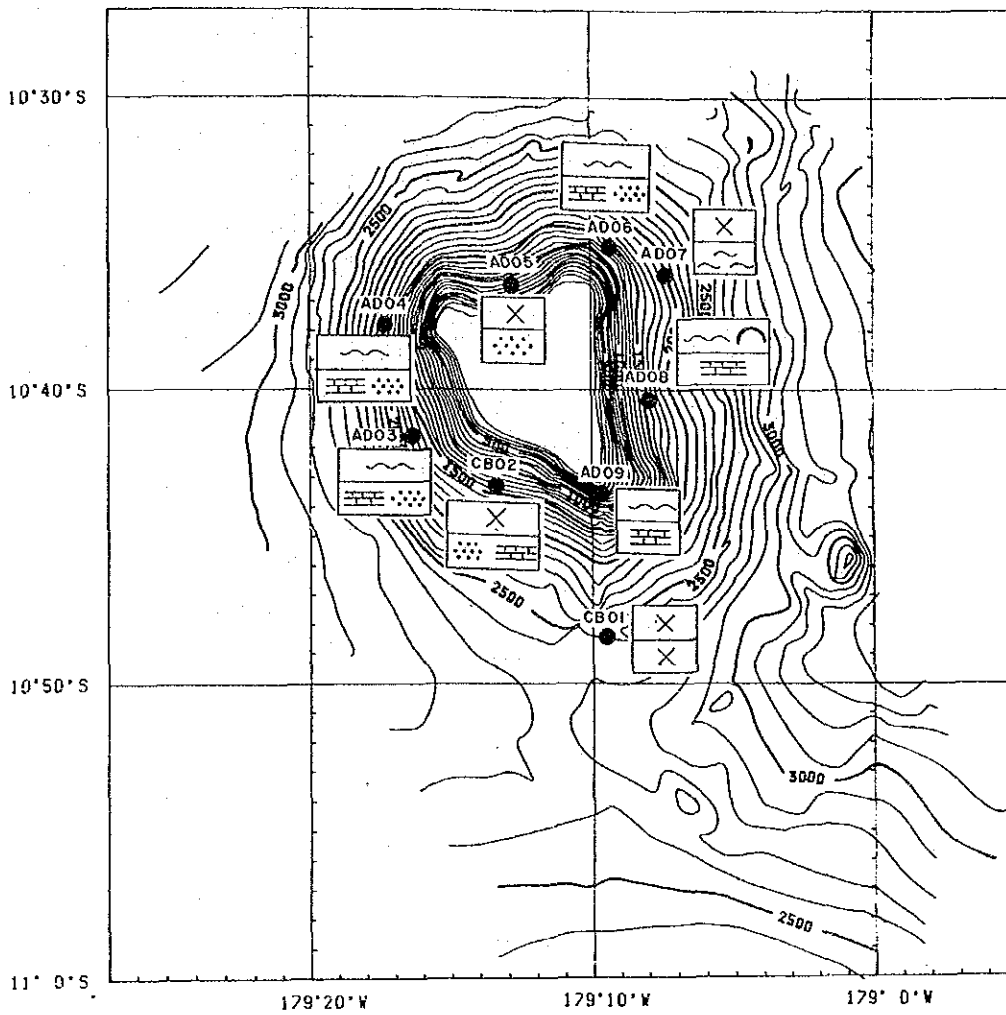




SB04 '88

SB 04 SEAMOUNT (MACAW BK)

S-LAT = 0 °



Legend

	Kind of dredged crusts (More abundant)
	Kind of dredged rocks (in left side one)

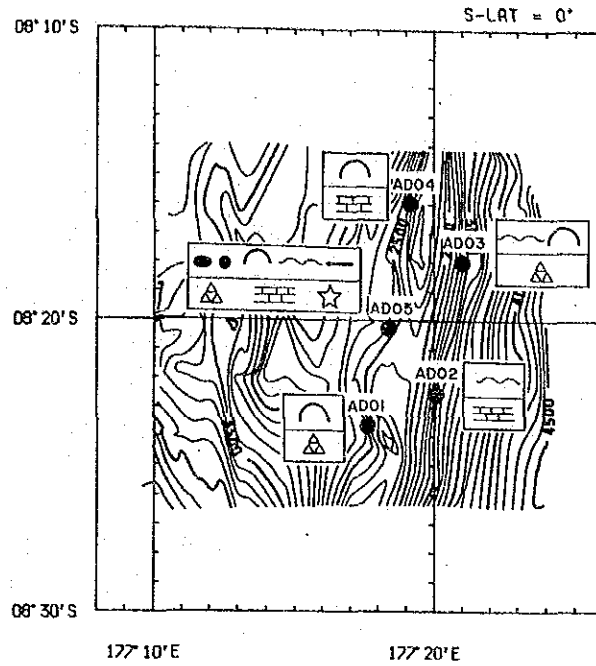
L E G E N D		crust		slab		massive
		cobble		nodule		coated
		Bs basalt		hyaloclastite		limestone
		☆ phosphorite		ooze		foraminifera sand
		X samples not obtained				
		● Sampling site (dredge on bottom)				
		— FDC survey line				

Sample Number	Sample Weight (kg)	Thickness (mm)		Assay Value (%)					
		Range	Ave.	H <sub>2</sub> O	Co	Ni	Cu	Mn	Fe
CR01	0.002	--	--	--	--	--	--	--	--
CR02	96.0	--	--	--	--	--	--	--	--
ADO3	2.323	0.0-0.05	0.7	--	--	--	--	--	--
ADO4	164.0	0.0-0.1	0.1	--	--	--	--	--	--
ADO5	0.0	--	--	--	--	--	--	--	--
ADO6	53.0	0.0-0.1	0.1	--	--	--	--	--	--
ADO7	0.0	--	--	--	--	--	--	--	--
ADO8	68.5	0.0-3.0	0.1	44.65	0.70	0.35	0.05	19.12	19.73
ADO9	77.142	0.0-0.1	0.1	46.67	1.12	0.26	0.02	13.70	12.58

Annexed Figure 18  
 Geology and Distribution of Cobalt Crusts  
 of Individual Seamount (4)



SB 05 SEAMOUNT



S-LAT = 0°

Kind of dredged crusts (More abundant)

Kind of dredged rocks (in left side one)

**LEGEND**

- crust      — slab      ■ massive
- cobble    ● nodule    ~ coated
- Bs basalt    △ hyaloclastite    ▨ limestone
- ☆ phosphorite    ~ ooze    ⊞ foraminifera sand
- × samples not obtained

● Sampling site (dredge on bottom)

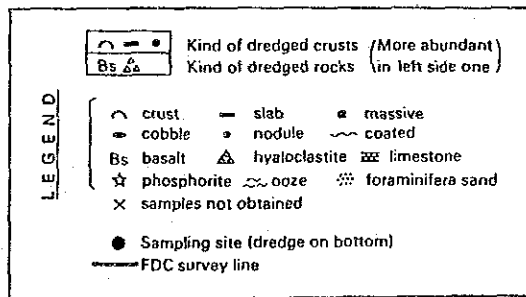
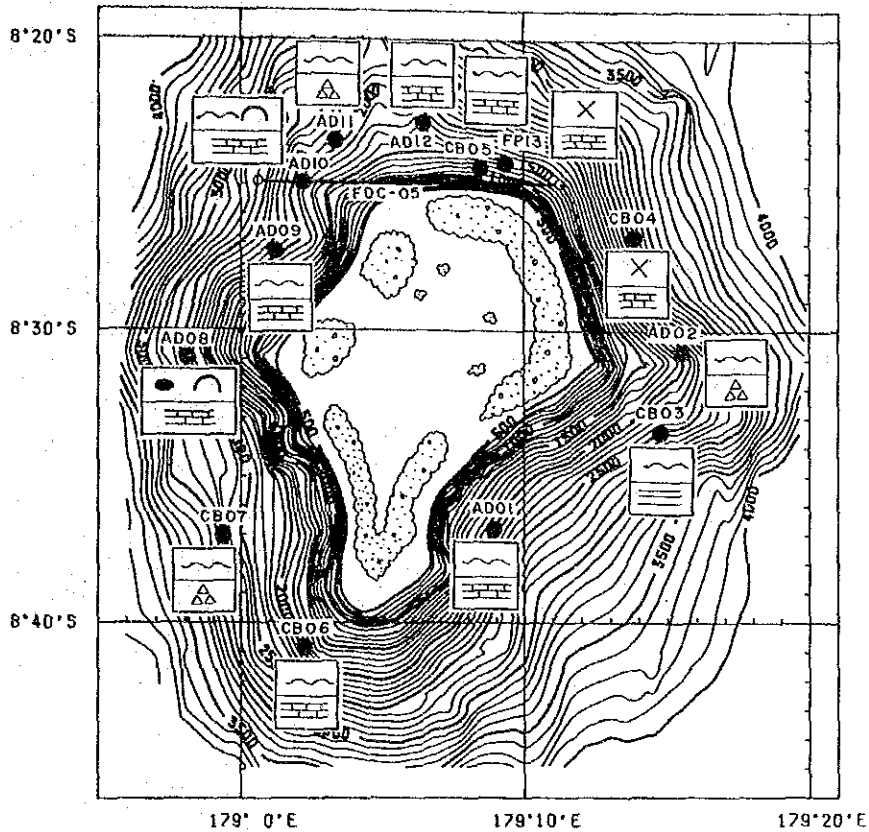
— FDC survey line

Sample Number	Sample Weight (Kg)	Thickness(mm)		Assay Value (%)					
		Range	Ave.	H <sub>2</sub> O	Co	Ni	Cu	Mn	Fe
ADO1	0.003	1.0--5.0	3.0	44.00	0.05	0.36	0.08	20.66	20.73
ADO2	0.013	0.0--0.1	0.1	--	--	--	--	--	--
ADO3	0.314	0.1--8.0	1.4	34.02	0.36	0.29	0.17	21.83	20.76
ADO4	0.048	2.0--18.0	11.0	39.98	0.39	0.78	0.19	24.12	18.76
ADO5	101.0	0.1--30.0	3.5	39.07	0.53	0.43	0.11	20.46	19.29

Annexed Figure 18  
 Geology and Distribution of Cobalt Crusts  
 of Individual Seamount (5)



SB 06 SEAMOUNT (FUNAFUTI ATOLL)  
 SB06 '88 S-LAT = 0'



Sample Number	Sample Weight (Kg)	Thickness (cm)		Assay Value (%)					
		Range	Ave.	H <sub>2</sub> O	Co	Ni	Cu	Mn	Fe
AD01	18.0	0.0--1.0	0.1	--	--	--	--	--	--
AD02	0.017	0.1--1.5	0.5	--	--	--	--	--	--
CB03	0.191	0.1--0.5	0.1	--	--	--	--	--	--
CB04	33.0	--	--	--	--	--	--	--	--
CB05	9.284	0.0--0.1	0.1	--	--	--	--	--	--
CB06	0.18	0.0--0.5	0.1	--	--	--	--	--	--
CB07	0.004	0.1--2.0	0.5	43.48	0.58	0.43	0.06	20.91	17.93
AD08	23.6	0.0--10.0	0.3	40.90	0.60	0.42	0.06	21.49	19.83
AD09	3.5	0.0--0.1	0.1	--	--	--	--	--	--
AD10	0.95	0.1--12.0	2.0	39.00	0.61	0.35	0.06	17.61	18.47
AD11	13.0	0.0--1.0	0.3	42.86	0.69	0.44	0.04	19.61	16.83
AD12	3.7	0.0--0.3	0.1	--	--	--	--	--	--
FP13	225.0	--	--	--	--	--	--	--	--

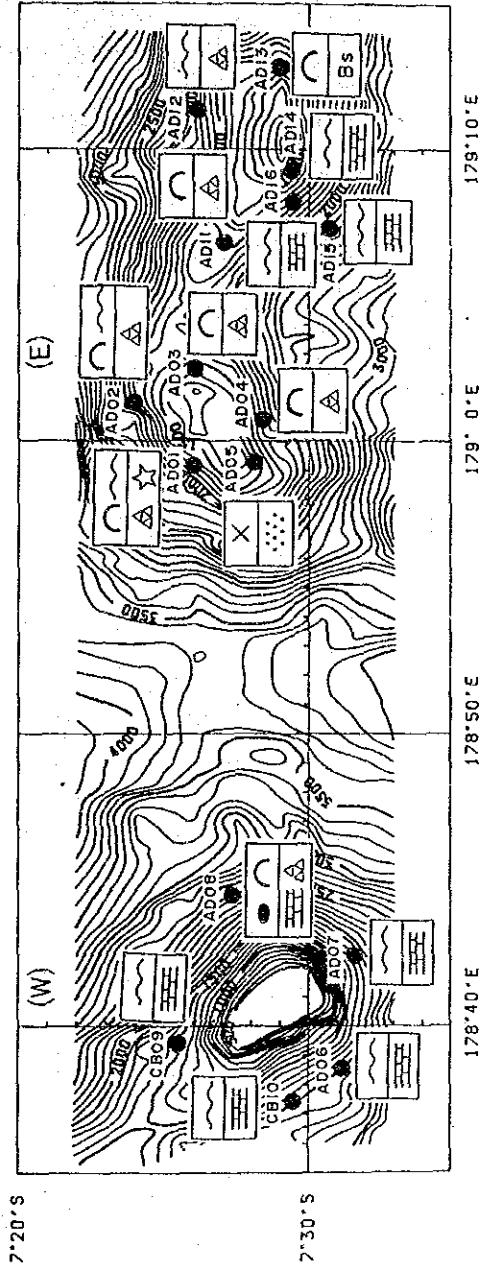
Annexed Figure 18  
 Geology and Distribution of Cobalt Crusts  
 of Individual Seamount (6)



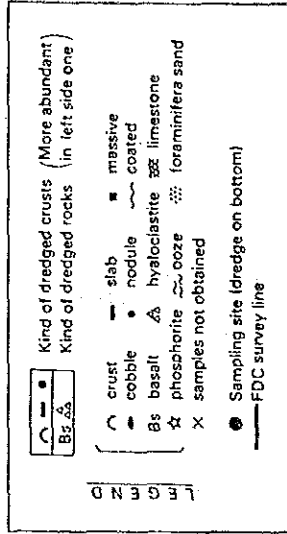
SB 07 SEAMOUNT (VAITUPU IS)

S-LAT = 0°

SB07 '88



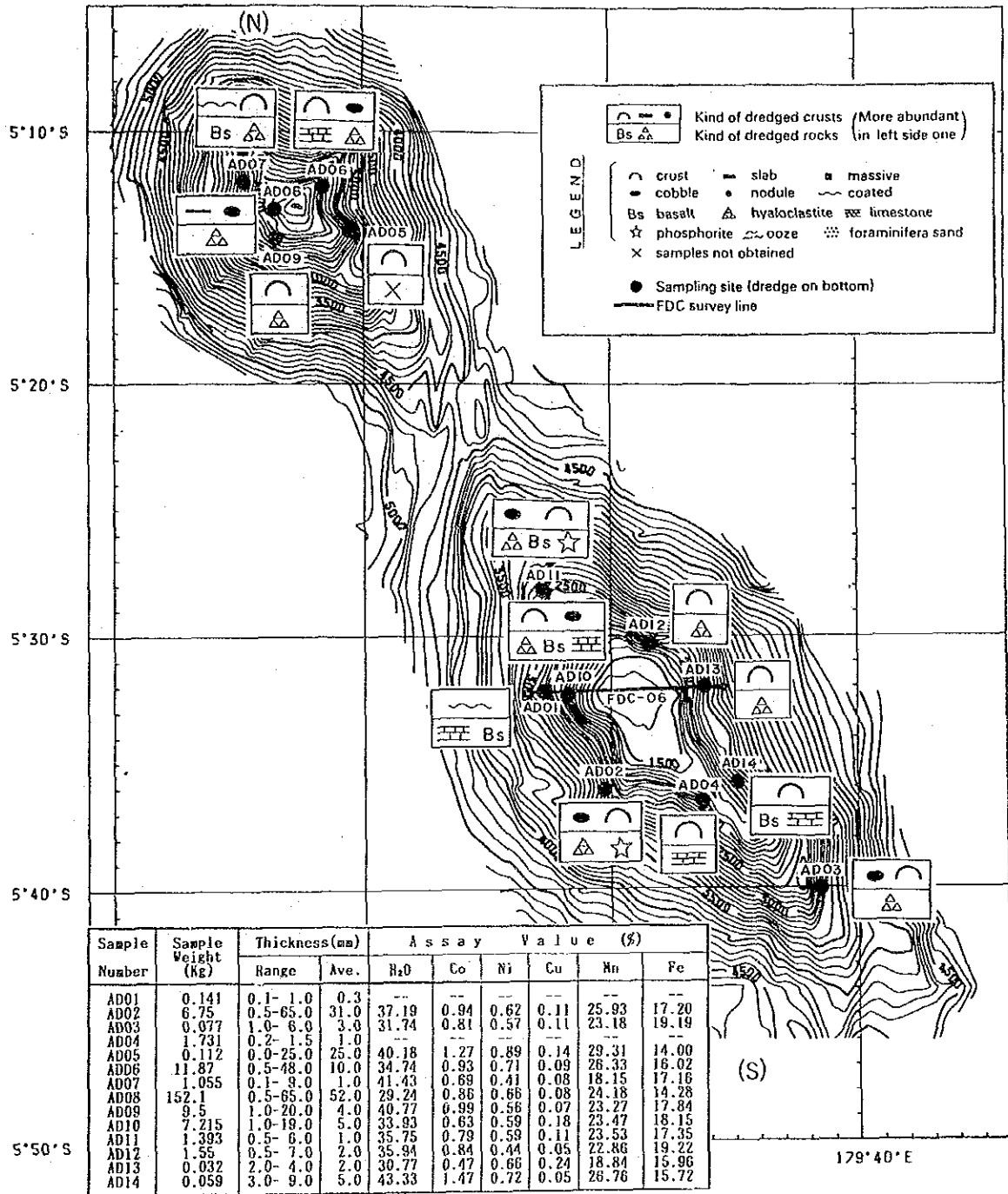
Sample Number	Sample Weight (kg)	Thickness (mm)		Assay Value (%)						Value (%)		
		Range	Ave.	Co	Ni	Cu	Mn	Fe	Co	Ni	Fe	
AD01	0.484	1.0-10.0	5.0	34.75	0.72	0.49	0.07	20.13	18.25			
AD02	0.038	0.0-2.0	2.0	32.58	0.54	0.10	0.10	21.91	16.84			
AD03	0.081	1.0-12.0	7.5	46.23	1.45	0.51	0.07	28.07	14.84			
AD04	0.071	0.5-12.0	3.0	30.89	0.37	0.13	0.08	24.87	14.83			
AD05	268.0	0.0-0.1	0.1	---	---	---	---	---	---			
AD06	178.0	0.0-0.0	0.0	43.54	0.65	0.45	0.07	20.36	19.21			
AD07	73.0	0.0-0.0	0.0	---	---	---	---	---	---			
AD08	1.79	0.1-2.0	0.3	38.89	0.61	0.28	0.03	13.64	12.27			
AD09	0.023	0.1-0.0	0.0	38.36	1.47	0.54	0.05	21.77	15.66			
AD10	0.25	0.1-0.0	0.0	30.00	1.70	0.70	0.04	27.12	13.93			
AD11	0.183	0.1-0.0	0.0	---	---	---	---	---	---			
AD12	124.0	0.1-0.0	0.0	---	---	---	---	---	---			
AD13	42.0	0.0-0.0	0.0	---	---	---	---	---	---			
AD14	121.7	0.0-0.0	0.0	---	---	---	---	---	---			



Annexed Figure 18  
Geology and Distribution of Cobalt Crusts  
of Individual Seamount (7)







Annexed Figure 18  
 Geology and Distribution of Cobalt Crusts  
 of Individual Seamount (8)





JICA