XVI. STD OBSERVATION IN GH77-1 CRUISE

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Introduction

Sea-water environment is one of the important basic data in considering the history of geologic development, genesis and exploitation of manganese nodule deposits. For this reason, a preliminary observation by STD graphic recorder was carried out in this cruise as the preparation for the future full-scaled studies. Some results of them are reported here.

Instrumentation and observation method

The instrument used was the Model 9060 Graphic Self-contained Salinity/Temperature/Depth Recorder of the Plessey Environmental Systems, U.S.A. This can automatically and continuously record the salinity, temperature and water depth on a graph, during its down and up travel in the water.

In practice, the instrument was hung with a deviced attachment at the wire rope about 20 m above a larger type Okean grab sampler at the end, and the measurement was done simultaneously with the bottom sampling, without any difficulties (Fig. XVI–1).

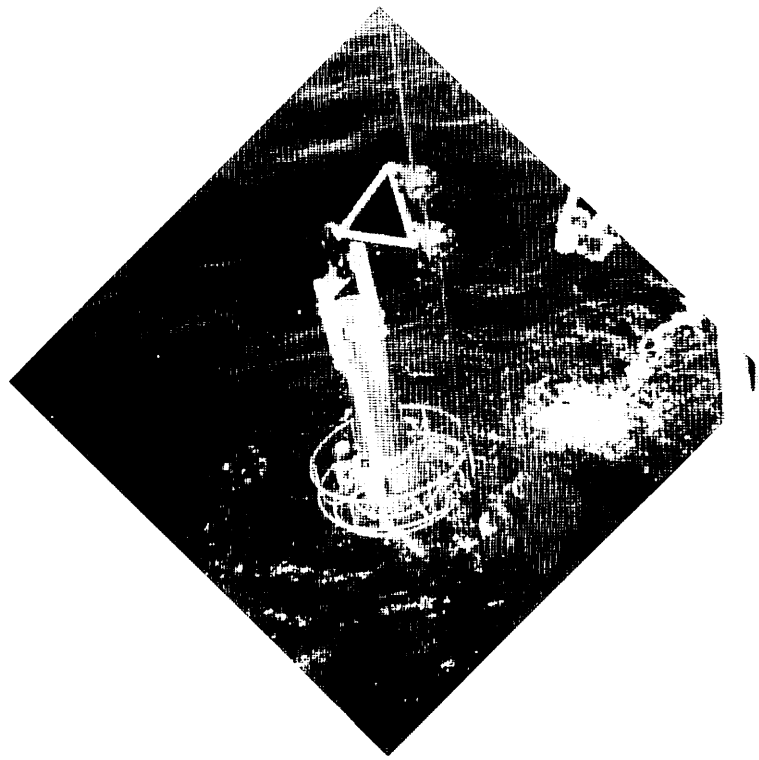

Fig. XVI–1 Model 9060 Graphic STD Recorder hung on the wire rope.

Stations

25 main sampling stations in the present survey area (7°–11°N, 175°–179°W) were arranged at each crossing of main latitude and longitude lines spaced with 1° span. Among them STD measurements were made at five stations (St. 706–St. 710) along the longitude 178°W.

Results

An example of the obtained record is shown in Fig. XVI–2. As seen in the figure, though there are sometimes unstabilities in record as the abrupt step like changes on the lines, these were read by making correction. The reading was done in every 50 m interval at the depth from surface to 400 m, in every 100 m interval at 400–1,000 m, in every 250 m interval at 1,000–2,000 m and in every 500 m interval below than 2,000 m.

From the reading data of water depth, temperature and salinity, ΔD and density in situ to estimate the current direction and velocity as the essential purpose of the present study were calculated, following the manual of STD observation by the Hydrographic Department (Table XVI–1).

Characteristic point is that the values of water depth by the STD record are always smaller than that by PDR record, being 0.7–2.0% more in the range of 5,000–6,000 m depth.

From the above calculated data, distribution patterns of temperature (Fig. XVI–3), salinity (Fig. XVI–4) and current direction of water (Fig. XVI–5) were depicted on the profile along the 178°W longitudinal line. Among them the current direction was tentatively estimated as gross current direction of water mass by deducing from differences in the relative values of the density in situ between the upper and lower depth parts defined each as the same depth at two observational stations. The characteristic points of the three profiles are summarized as follows:

Temperature distribution

Temperature of this area is about 26°C at the surface, which decreases abruptly around 100 m depth down to 15°C at around 200 m depth (thermocline), and becomes about 8°C at the depth of 400–500 m. Below the depth of 1,500 m, the temperature grades down with very slight changes, from about 3°C to 1.4–1.5°C at the depth of 5,000 m. But it again rises very slightly further below 5,000 m. Differing from the general tendency, the temperature along the vertical column of St. 708 shows slightly higher values than those of other stations.

Salinity distribution

Salinity of the survey area ranges from 33.76‰ to 34.45‰. There are recognized two layers higher than 34‰, both at the depths of 50–200 m and 200–350 m. The former corresponds to the lower half part of the thermocline in the northern area and upper half part of it in the southern area. The latter layer of higher salinity exists only in the southern area (St. 706 and St. 707), and thins out northward. Between these two layers, except around St. 707, a water mass of lower salinity of the level of 33.8‰ (with thickness of about 100 m) is intercalated, forming a sort of halocline zone.

Below the depth of 1,000 m, there is recognized a relatively higher salinity part at St. 708 (2,000–3,000 m), and relatively lower salinity parts at St. 707 (1,000–2,000 m), St. 710 (2,000–3,000 m), and Sts. 709 and 707 (4,500–5,500 m). The higher salinity part

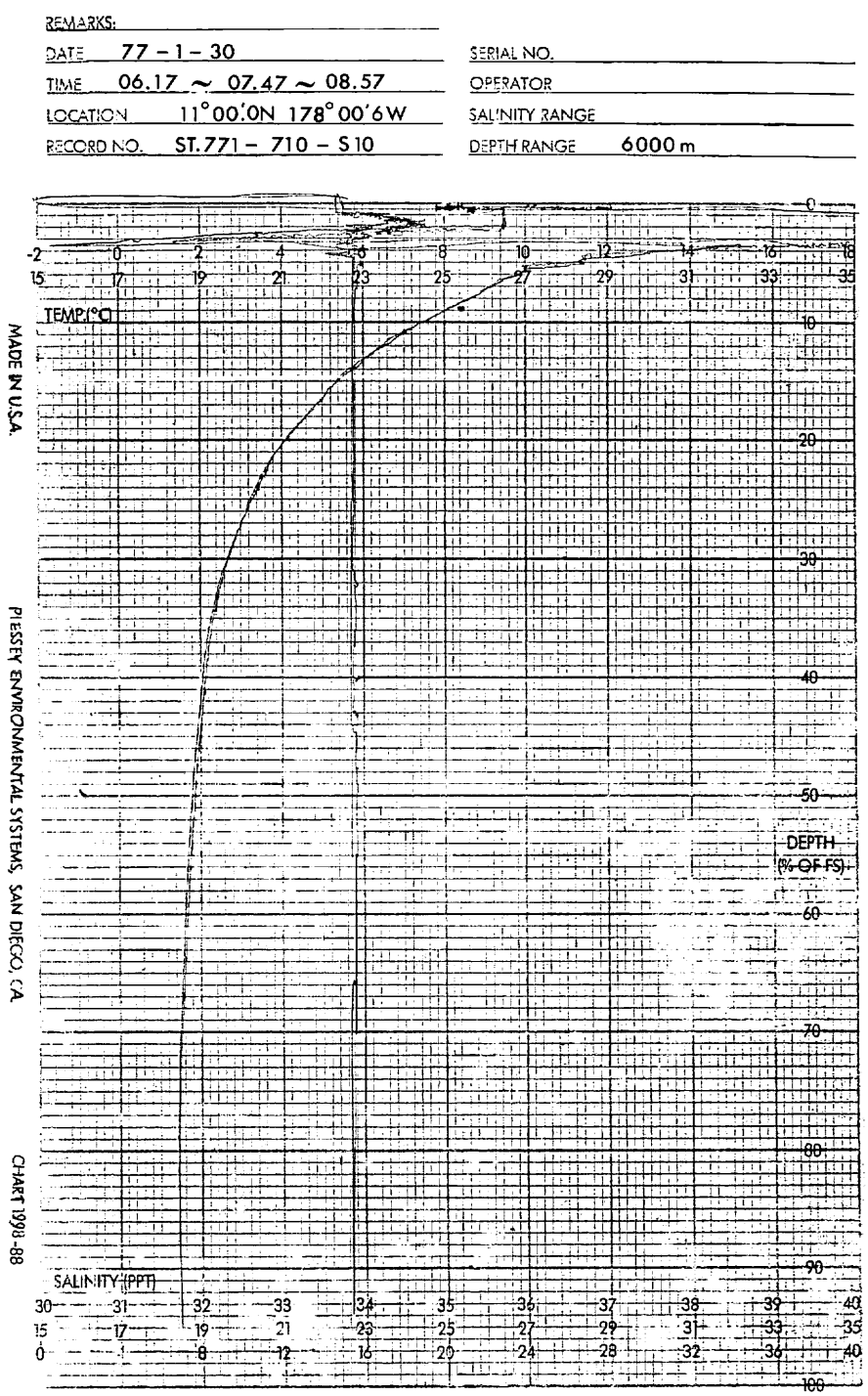

Fig. XVI-2 A graph record of STD observation.

Table XVI–1 Reading and calculated values from STD record.

St. GH–771–706–S6 06°59.2′N 178°00.1 WD 5,225 m (by PDR) 1977 028 18.13～20.50 WIND NE–9 m SWELL about 3 m						St. GH–771–707–S7 08°00.0′N 178°01.1 WD 5,590 m (by PDR) 1977 029 03.06～05.48 WIND E–8 m SWELL about 3 m					
Depth (m)	Temp (°C)	S (‰)	δt (g/cm³)	ΔSt (10^{-5} cm³/g)	ΔD (Dyn.m.)	Depth (m)	Temp (°C)	S (‰)	δt (g/cm³)	ΔSt (10^{-5} cm³/g)	ΔD (Dyn.m.)
0	27.95	33.88	21.55	625	0.000	0	25.25	34.04	22.53	533	0.000
50	27.95	33.88	21.55	625	0.313	50	27.95	34.09	21.71	611	0.286
100	25.10	34.45	22.89	498	0.595	100	27.00	34.23	22.17	567	0.582
150	15.75	33.80	24.90	307	0.798	150	16.00	33.99	24.94	303	0.801
200	12.55	33.94	25.68	232	0.935	200	13.50	34.01	25.54	246	0.940
250	10.75	34.03	26.08	194	1.044	250	11.20	34.00	25.98	204	1.055
300	10.00	33.98	26.17	186	1.142	300	10.35	34.00	26.13	190	1.156
350	9.60	33.97	26.22	181	1.237	350	9.70	34.00	26.29	180	1.251
400	8.95	33.95	26.32	172	1.328	400	9.25	33.98	26.39	174	1.342
500	8.35	33.92	26.39	165	1.504	500	8.65	33.94	26.50	165	1.519
600	7.45	33.88	26.49	155	1.672	600	7.70	33.90	26.62	154	1.687
700	6.35	33.87	26.63	142	1.829	700	6.55	33.88	26.68	143	1.844
800	5.85	33.86	26.69	136	1.977	800	6.05	33.86	26.72	137	1.993
900	5.35	33.85	26.74	132	2.121	900	5.35	33.82	26.75	134	2.138
1000	4.85	33.85	26.79	127	2.260	1000	4.85	33.79	26.83	131	2.279
1250	3.85	33.85	26.91	116	2.588	1250	3.95	33.77	26.91	123	2.620
1500	3.20	33.84	26.97	110	2.895	1500	3.25	33.78	26.96	116	2.942
1750	2.70	33.84	27.00	107	3.190	1750	2.75	33.79	26.99	111	3.248
2000	2.35	33.84	27.03	104	3.476	2000	2.40	33.80	27.06	108	3.543
2500	2.00	33.83	27.05	102	4.033	2500	2.00	33.84	27.07	101	3.824
3000	1.80	33.82	27.06	101	4.585	3000	1.85	33.84	27.07	100	4.095
3500	1.65	33.81	27.07	100	5.125	3500	1.70	33.83	27.07	100	4.632
4000	1.45	33.80	27.07	100	5.657	4000	1.55	33.81	27.07	100	5.167
4500	1.40	33.80	27.08	99	6.187	4500	1.40	33.80	27.07	100	5.704
5000	1.40	33.80	27.08	99	6.717	5000	1.40	33.76	27.04	103	6.249
5260	1.40	33.80	27.08	99	6.993	5500	1.45	33.76	27.03	104	6.806
						5660	1.50	33.78	27.04	103	6.975

Table XVI-1 (Continued)

St. GH771-708-S8 08°59.5'N 177°59.5 WD 5,760 m (by PDR) 1977 029 18.09～20.49 WIND ENE-9 m SWELL 2～3 m						St. GH771-709-S9 10°01.2'N 178°02.1 WD 5,850 m (by PDR) 1977 030 02.47～05.34 WIND ENE-8 m SWELL 2 m					
Depth (m)	Temp (°C)	S (‰)	δt (g/cm^3)	ΔSt (10^{-5} cm^3/g)	ΔD (Dyn.m.)	Depth (m)	Temp (°C)	S (‰)	δt (g/cm^3)	ΔSt (10^{-5} cm^3/g)	ΔD (Dyn.m.)
0	27.65	33.83	21.61	621	0.000	0	27.25	33.86	21.78	604	0.000
50	27.65	33.83	21.61	621	0.311	50	27.05	33.86	21.83	600	0.301
100	26.95	34.00	21.98	585	0.614	100	20.10	34.35	24.23	370	0.544
150	19.00	34.40	24.64	331	0.845	150	13.70	33.83	25.37	262	0.704
200	16.70	34.10	25.00	297	0.998	200	11.70	33.85	25.78	223	0.827
250	12.80	33.84	25.55	245	1.136	250	10.85	33.96	26.01	201	0.935
300	11.30	33.95	25.59	210	1.253	300	10.10	33.96	26.14	189	1.035
350	10.40	33.99	26.12	191	1.356	350	9.60	33.96	26.21	182	1.130
400	9.90	33.99	26.19	184	1.453	400	9.00	33.96	26.32	172	1.221
500	9.15	33.96	26.29	174	1.640	500	8.25	33.93	26.42	162	1.395
600	8.35	33.92	26.39	165	1.819	600	7.45	33.91	26.51	154	1.561
700	7.40	33.88	26.49	155	1.989	700	6.35	33.90	26.67	138	1.716
800	6.55	33.84	26.58	147	2.151	800	5.80	33.90	26.73	133	1.861
900	5.75	33.83	26.68	137	2.303	900	5.15	33.89	26.80	126	2.000
1000	5.15	33.83	26.74	132	2.447	1000	4.65	33.88	26.86	120	2.132
1250	4.15	33.81	26.84	122	2.789	1250	3.80	33.88	26.94	113	2.447
1500	3.70	33.85	26.93	114	3.110	1500	3.15	33.88	27.00	107	2.747
1750	2.95	33.82	26.97	110	3.416	1750	2.70	33.87	27.03	104	3.034
2000	2.55	33.83	27.00	107	3.711	2000	2.35	33.87	27.06	101	3.312
2500	2.10	33.87	27.08	99	4.271	2500	2.05	33.87	27.08	99	3.854
3000	1.95	33.90	27.12	96	4.803	3000	1.85	33.87	27.10	98	4.386
3500	1.80	33.90	27.13	95	5.325	3500	1.70	33.87	27.11	97	4.911
4000	1.60	33.90	27.13	95	5.845	4000	1.55	33.84	27.10	98	5.436
4500	1.55	33.89	27.14	94	6.360	4500	1.45	33.82	27.08	99	5.966
5000	1.50	33.88	27.13	95	6.872	5000	1.45	33.81	27.07	100	6.501
5500	1.55	33.84	27.09	98	7.402	5500	1.50	33.82	27.00	107	7.063
5840	1.60	33.90	27.05	102	7.781	5920	1.55	33.82	26.99	108	7.556

Table XVI–1 (Continued)

St. GH771–710–S10
10°59.4′N 178°00.2 WD 5,550 m (by PDR)
1977 030 18.21～20.54
WIND ENE–5 m SWELL 2 m

Depth (m)	Temp (°C)	S (‰)	δt (g/cm^3)	ΔSt (10^{-5} cm^3/g)	ΔD (Dyn.m.)
0	26.45	33.83	22.00	583	0.000
50	26.45	33.86	22.01	582	0.291
100	21.70	34.35	23.80	411	0.540
150	17.30	34.35	24.96	301	0.720
200	16.50	34.03	24.89	307	0.875
250	12.60	33.68	25.47	252	1.018
300	10.30	33.92	26.08	194	1.132
350	9.50	33.90	26.19	184	1.229
400	9.00	33.90	26.28	175	1.322
500	8.30	33.89	26.38	166	1.500
600	7.20	33.88	26.52	153	1.668
700	6.35	33.88	26.64	141	1.824
800	5.90	33.88	26.70	135	1.971
900	5.25	33.88	26.78	128	2.112
1000	4.80	33.88	26.83	123	2.247
1250	3.80	33.87	26.93	114	2.568
1500	3.20	33.87	26.98	109	2.873
1750	2.75	33.86	27.02	105	3.164
2000	2.35	33.85	27.05	102	3.445
2500	2.05	33.84	27.06	101	3.995
3000	1.85	33.84	27.07	100	4.537
3500	1.65	33.89	27.13	95	5.062
4000	1.55	33.85	27.11	97	5.577
4500	1.45	33.83	27.10	98	6.099
5000	1.45	33.83	27.10	98	6.629
5500	1.48	33.83	27.07	100	7.174
5660	1.50	33.83	27.09	98	7.335

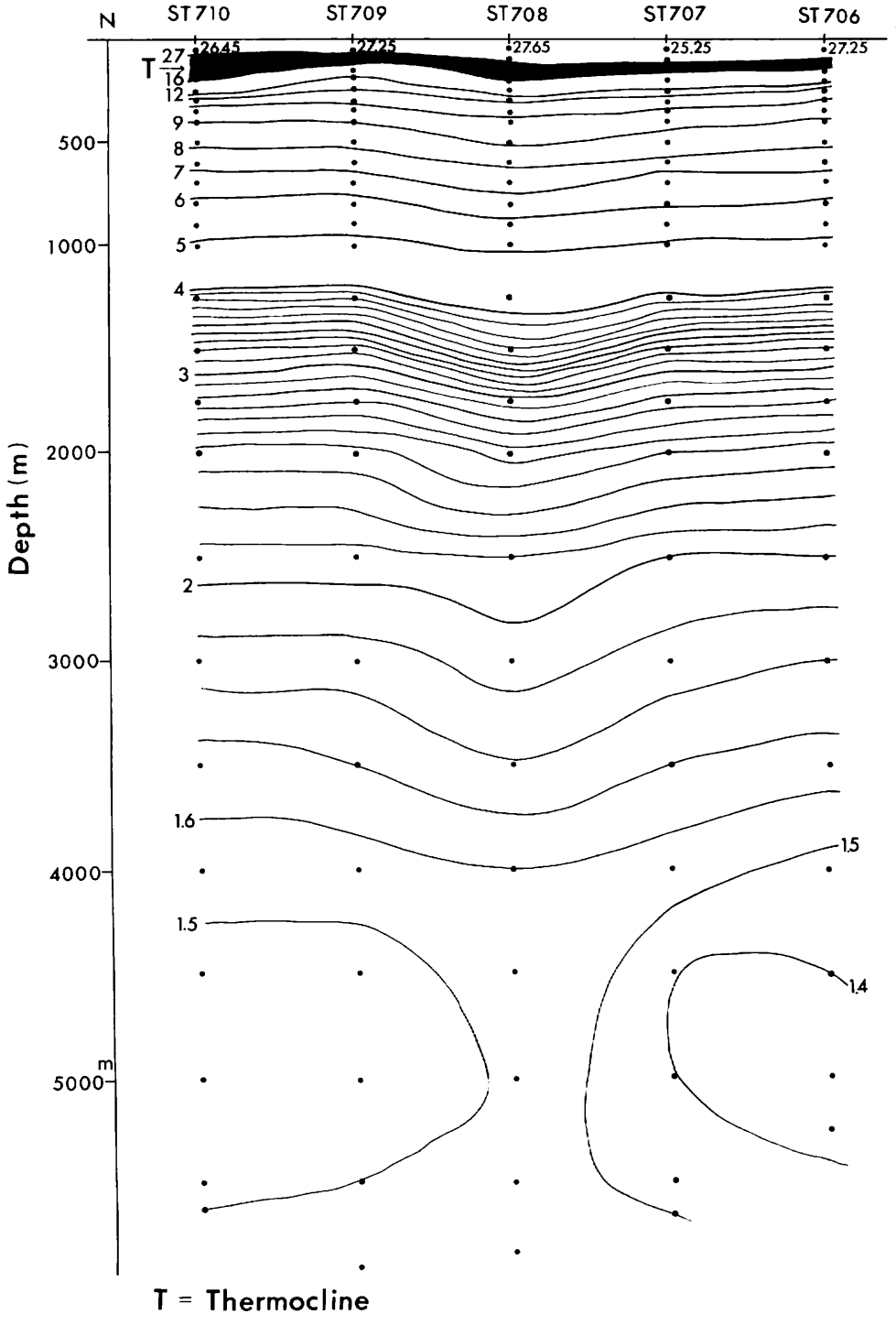

Fig. XVI-3 Temperature (in °C) distribution along 178°W profile.

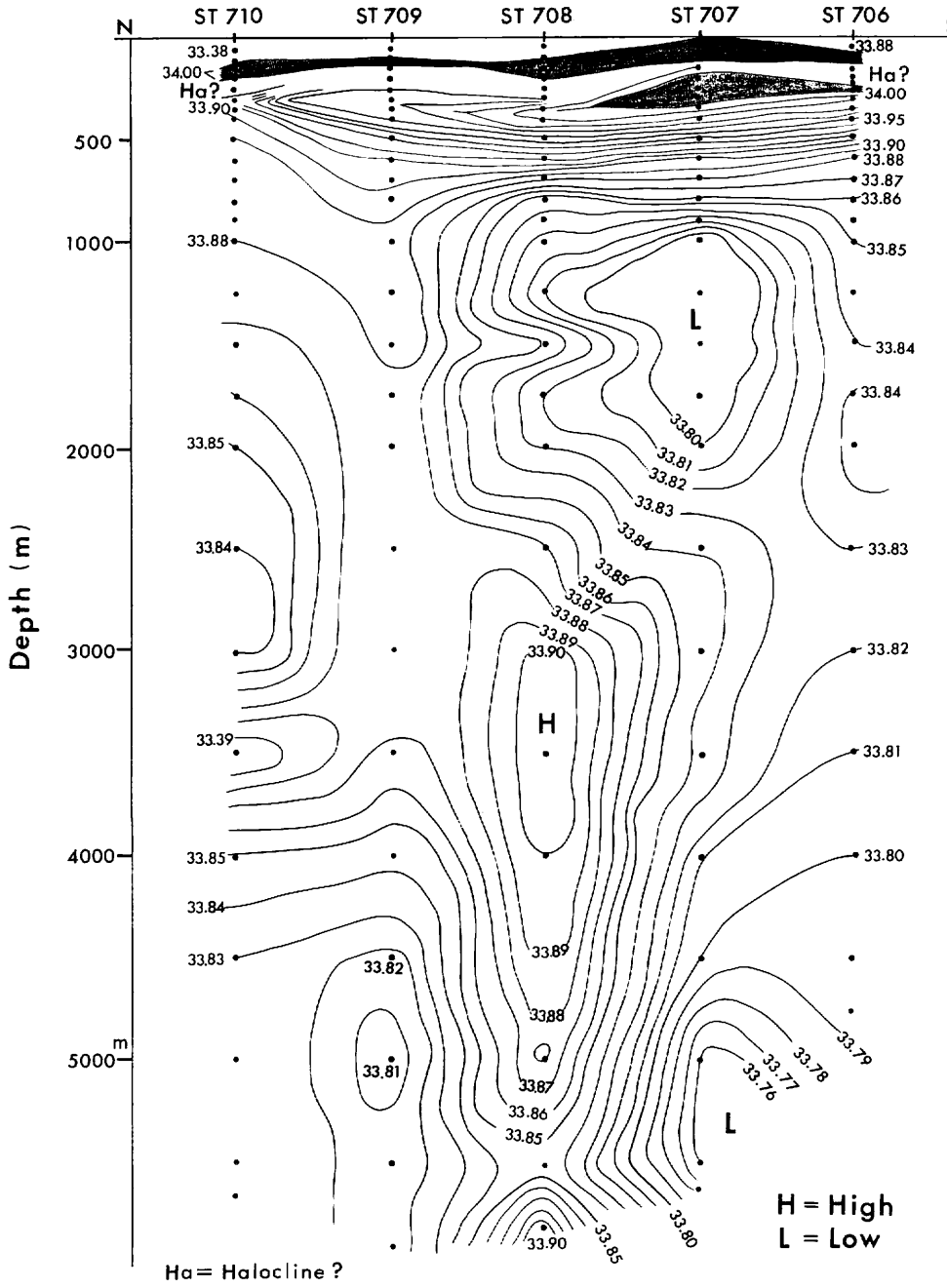

Fig. XVI-4 Salinity (in ‰) distribution along 178°W profile.

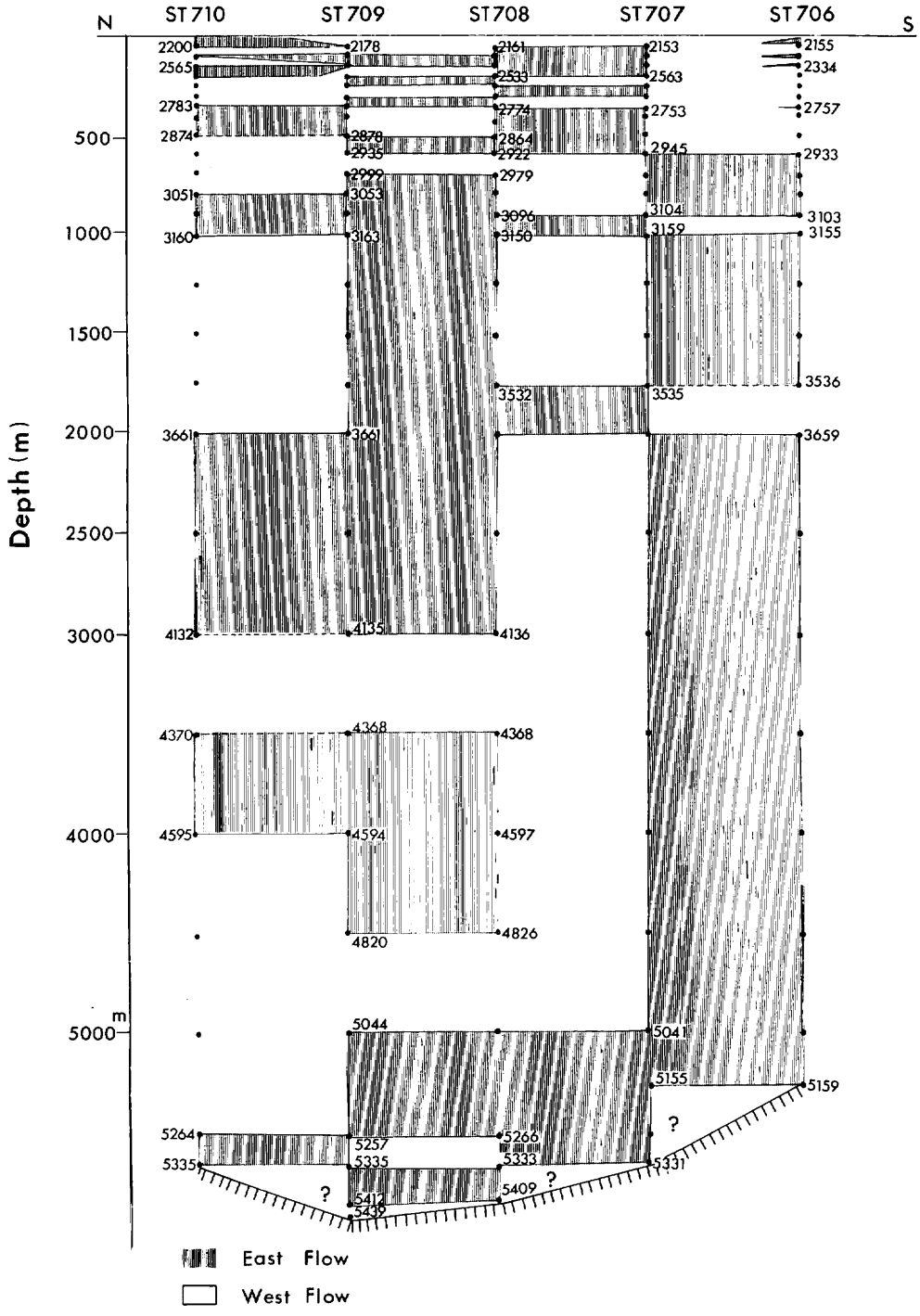

Fig. XVI–5 Tentatively estimated current direction of water along 178 °W profile.

at St. 708 corresponds to the higher temperature mass above mentioned.

Density in situ

The profile of the density in situ (Fig. XVI–4) shows that most surface currents flow westward, and most water in depth flows eastward, though there are some ones flowing westward, such as higher salinity part below the depth of 2,500 m at St. 708, lower salinity parts around the depth of 1,700 m at St. 702 and around 4,700 m at St. 709, and then water mass near 1,000–2,000 m depth at St. 710.

In conclusion, though we succeeded in trying to get the STD record data for understanding sea-water environment, these data are very limited in quality and quantity, and further investigation will be necessary for that purposes, on the basis of the present results including the increase in the number of stations in future survey.