

## XII. S.T.D. OBSERVATION IN THE GH78-1 AREA

*Keiji Handa\* and Katsuya Tsurusaki\**

As one of the fundamental studies on the development of manganese nodules, observation of sea water environment comes up as an important study.

In this context, we measured some properties of ocean water during the GH78-1 cruise. Measured properties were salinity, temperature and depth of sea water from the surface to the deep sea bottom.

The instrument used was a model 9060 Graphic Self-Contained Salinity/Temperature/Depth Recorder for 6,000 m use manufactured by Plessey Environmental Systems, U.S.A. This battery operated instrument automatically and continuously measured salinity, temperature and depth, and recorded the data on a cylindrical graphic plotter during its down and up travel in the water. In practice, it was attached to the main wire rope at position of 50 m above a grab sampler as shown in Fig.XII-1.

As a result, S.T.D. data could be obtained at fifteen stations. From these measured values, water density at a temperature in situ ( $\sigma_t$ ) and water density in situ ( $\sigma_{std}$ ) could be calculated. The results are summarized in Table XII-1 and illustrated in Fig. XII-2.

Temperature of each station at the surface is approximately 27°C, and it suddenly decreases in the 100 m–250 m water column, suggesting that the thermocline exists between these water depths. The temperature distribution below 250 m changes gradually and becomes down to 3°C at the 1,500 m depth. Below the depth of 1,500 m the temperature decreases more gradually to 1.40–1.55°C at the 5,000 m depth. The temperature of the deeper water below 5,000–5,500 m, however, rises very slightly.

The salinity distribution above 600 m, especially at the depths corresponding with the thermocline, has a wide variation from 33.30 to 34.50 ppt. Below 600 m, it has a little variation within 0.1 ppt as well as shows tendency to increase slightly down to about 3,000 m depth and to decrease slightly further below 3,000 m.

The vertical distribution of the water density in situ is almost constant at all stations, and it can be described with one curved line having a point of inflection at the depths of the thermocline.

Although these results suggest some rough sea water environment in this area and in this time, further analysis and consideration remain to be studied through more abundant S.T.D. data in future because the sea water environmental investigation requires to consider factors such as time and space.

\* National Research Institute for Pollution and Resources, Tsukuba

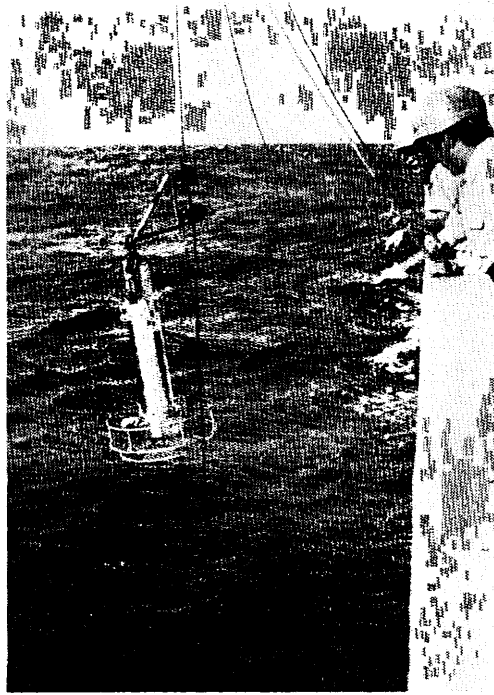


Fig. XII-1 Model 9060 Graphic STD Recorder.

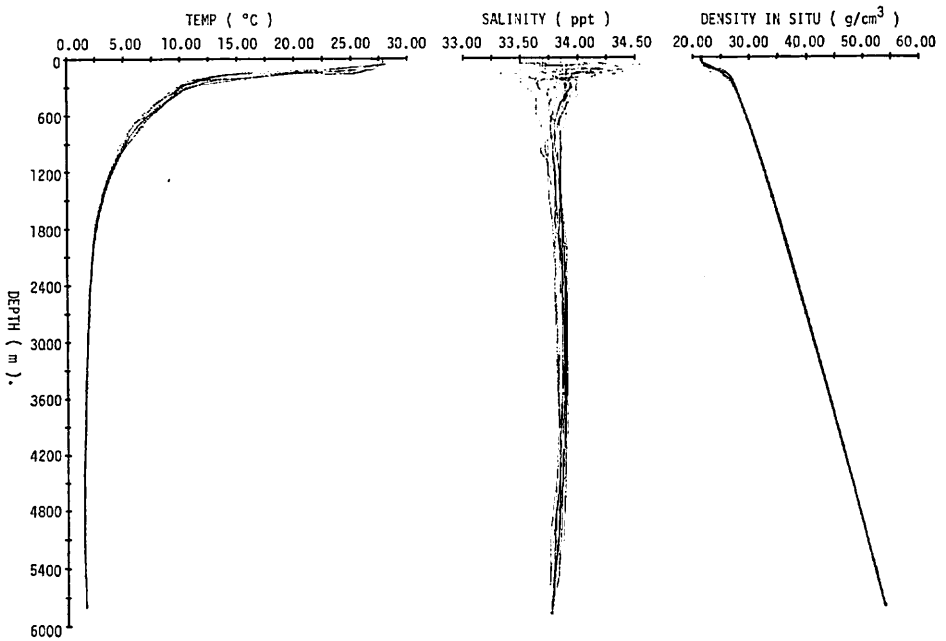


Fig. XII-2 Vertical distribution of measured data (from left: temperature, salinity and water density in situ  $\sigma_{sD}$ ).

Table XII-1 STD data and calculated values

Station St. 1043 S12				Station St. 1044 S13					
Position 12.0094N, 178.0000E				Position 11.0020N, 178.0106E					
Depth 5608 m (SID Depth 5555+50 m)				Depth 5381 m (STD Depth 5333+50 m)					
Date and Time 1978. 23. 0354-0658 GMT				Date and Time 1978. 23. 1811-2037 GMT					
Wind ENE 11 m/s Swell 6 m				Wind 9-11 m/s Swell 4 m					
Depth (m)	Temp (°C)	Salinity (ppt)	Sigma $t$	Sigma $\sigma_D$	Depth (m)	Temp (°C)	Salinity (ppt)	Sigma $t$	Sigma $\sigma_D$
0	27.80	33.50	21.36	21.36	0	27.85	33.44	21.29	21.29
50	27.80	33.50	21.36	21.58	50	27.90	33.49	21.32	21.53
100	24.60	34.00	22.73	23.18	100	27.90	33.90	21.62	22.07
150	19.00	34.10	24.35	25.04	150	17.00	33.80	24.61	25.30
200	13.60	34.02	25.53	26.46	200	12.20	33.79	25.63	26.57
250	11.10	33.83	25.87	27.03	250	10.80	33.90	25.98	27.14
300	9.80	33.80	26.07	27.47	300	10.20	33.90	26.08	27.48
350	9.10	33.83	26.21	27.86	350	9.80	33.90	26.15	27.80
400	8.70	33.89	26.32	28.20	400	9.30	33.90	26.23	28.11
500	7.60	33.84	26.44	28.80	500	8.20	33.88	26.39	28.75
600	6.90	33.83	26.53	29.37	600	7.20	33.78	26.45	29.29
700	6.10	33.83	26.64	29.96	700	6.30	33.74	26.54	29.87
800	5.50	33.83	26.71	30.52	800	5.70	33.74	26.62	30.43
900	5.00	33.83	26.77	31.06	900	5.20	33.74	26.68	30.97
1000	4.50	33.83	26.83	31.60	1000	4.75	33.74	26.73	31.49
1250	3.65	33.83	26.91	32.89	1250	3.70	33.74	26.84	32.81
1500	3.00	33.85	26.99	34.18	1500	3.05	33.75	26.91	34.10
1750	2.55	33.87	27.05	35.42	1750	2.50	33.78	26.98	35.36
2000	2.25	33.88	27.08	36.64	2000	2.30	33.79	27.00	36.56
2500	1.95	33.89	27.11	39.02	2500	2.00	33.80	27.03	38.96
3000	1.80	33.89	27.12	41.37	3000	1.80	33.81	27.06	41.31
3500	1.65	33.86	27.11	43.66	3500	1.65	33.82	27.08	43.63
4000	1.55	33.85	27.11	45.95	4000	1.55	33.84	27.10	45.94
4500	1.45	33.83	27.10	48.22	4500	1.45	33.84	27.11	48.23
5000	1.50	33.80	27.07	50.42	5000	1.50	33.84	27.10	50.45
5500	1.55	33.77	27.04	52.59	5500	1.55	33.84	27.10	51.92
5555	1.55	33.77	27.04	52.83	5555	1.55	33.84	27.10	51.92

Table XII-1 (Continued)

Station St. 1045 S14						Station St. 1046 S15					
Position 9.5931N, 178.0056E						Position 9.0102N, 177.5993E					
Depth 5380 m (STD Depth 5351+50 m)						Depth 5474 m (STD Depth 5403+50 m)					
Date and Time 1978. 24. 0606-0837 GMT						Date and Time 1978. 24. 1819-2112 GMT					
Wind NE 11 m/s Swell 4-5 m						Wind NE 10 m/s Swell 5 m					
Depth (m)	Temp (°C)	Salinity (ppt)	Sigma <i>t</i>	Sigma <i>σ<sub>D</sub></i>	Depth (m)	Temp (°C)	Salinity (ppt)	Sigma <i>t</i>	Sigma <i>σ<sub>D</sub></i>		
0	27.90	33.50	21.32	21.32	0	26.50	33.50	21.77	21.77		
50	27.95	33.50	21.31	21.53	50	28.00	33.50	21.29	21.52		
100	25.00	33.95	22.57	23.02	100	27.00	34.20	22.14	22.59		
150	16.20	33.90	24.88	25.56	150	17.80	33.70	24.35	25.03		
200	12.60	33.90	25.64	26.56	200	11.80	33.80	25.72	26.65		
250	11.00	33.94	25.97	27.13	250	10.40	33.88	26.03	27.20		
300	10.30	33.94	26.09	27.50	300	10.00	33.89	26.11	27.51		
350	9.80	33.92	26.16	27.81	350	9.40	33.89	26.21	27.85		
400	9.25	33.89	26.23	28.11	400	8.90	33.89	26.29	28.17		
500	8.50	33.85	26.32	28.67	500	8.00	33.87	26.41	28.77		
600	7.50	33.82	26.44	29.27	600	7.20	33.86	26.52	29.35		
700	6.70	33.80	26.54	29.85	700	6.30	33.83	26.61	29.94		
800	6.05	33.80	26.62	30.42	800	5.55	33.81	26.69	30.50		
900	5.45	33.81	26.70	30.98	900	5.10	33.80	26.74	31.03		
1000	4.80	33.82	26.79	31.55	1000	4.65	33.80	26.79	31.56		
1250	3.75	33.84	26.91	32.88	1250	3.70	33.80	26.89	32.85		
1500	3.10	33.84	26.97	34.16	1500	3.20	33.80	26.93	34.11		
1750	2.60	33.86	27.03	35.41	1750	2.70	33.80	26.98	35.35		
2000	2.30	33.87	27.07	36.62	2000	2.35	33.80	27.01	36.57		
2500	1.95	33.87	27.09	39.02	2500	1.95	33.81	27.05	38.97		
3000	1.80	33.88	27.11	41.37	3000	1.75	33.82	27.07	41.34		
3500	1.65	33.87	27.12	43.67	3500	1.60	33.83	27.09	43.65		
4000	1.55	33.86	27.12	45.96	4000	1.50	33.83	27.09	45.95		
4500	1.40	33.84	27.11	48.24	4500	1.40	33.84	27.11	48.24		
5000	1.45	33.80	27.07	50.44	5000	1.45	33.84	27.11	50.47		
5351	1.50	33.80	27.07	51.98	5403	1.50	33.82	27.09	52.22		

Table XII-1 (Continued)

Station St. 1047 S16				Station St. 1048 S17			
Position 7.5915N, 178.0167E				Position 7.5922N, 179.0019E			
Depth 5660 m (SID Depth 5615 + 50 m)				Depth 5183 m (SID Depth 5117 + 50 m)			
Date and Time 1978. 25, 0429-0706 GMT				Date and Time 1978. 25, 1826-2112 GMT			
Wind NE 10 m/s Swell 5 m				Wind NE 10-13 m/s Swell 6 m			
Depth (m)	Temp (°C)	Salinity (ppt)	Sigma <i>t</i>	Depth (m)	Temp (°C)	Salinity (ppt)	Sigma <i>t</i>
			<i>σ<sub>t</sub></i>				<i>σ<sub>t</sub></i>
0	28.20	33.64	21.33	0	28.30	33.86	21.46
50	28.20	33.65	21.34	50	28.35	33.86	21.45
100	24.20	34.23	23.02	100	25.00	33.71	22.39
150	16.20	34.10	25.03	150	15.50	33.80	24.96
200	12.60	33.85	25.60	200	12.20	33.86	25.69
250	10.70	33.95	27.19	250	10.45	33.87	26.01
300	10.10	33.95	26.14	300	9.90	33.91	26.14
350	9.70	33.96	26.21	350	9.50	33.91	26.21
400	9.25	33.94	26.27	400	9.10	33.91	26.27
500	8.40	33.91	26.38	500	8.40	33.90	26.37
600	7.40	33.86	26.49	600	7.70	33.90	26.48
700	6.70	33.84	26.57	700	6.85	33.88	26.58
800	5.90	33.84	26.67	800	6.10	33.86	26.66
900	5.30	33.84	26.74	900	5.40	33.86	26.75
1000	4.85	33.84	26.80	1000	4.70	33.85	26.82
1250	3.85	33.85	26.91	1250	3.95	33.85	26.90
1500	3.15	33.86	26.99	1500	3.25	33.85	26.97
1750	2.70	33.88	27.04	1750	2.75	33.86	27.02
2000	2.35	33.90	27.09	2000	2.35	33.86	27.05
2500	2.00	33.90	27.11	2500	2.05	33.86	27.08
3000	1.85	33.90	27.13	3000	1.80	33.88	27.11
3500	1.65	33.90	27.14	3500	1.70	33.89	27.13
4000	1.55	33.90	27.15	4000	1.55	33.89	27.14
4500	1.45	33.88	27.14	4500	1.45	33.89	27.15
5000	1.50	33.86	27.12	5000	1.50	33.88	27.13
5500	1.55	33.84	27.10	5500	1.50	33.88	27.13
5615	1.55	33.82	27.08	5117	1.50	33.88	27.13

Table XII-1 (Continued)

Station St. 1049 S18				Station St. 1050 S19				
Position 9.0451N, 179.0238E				Position 9.5965N, 179.0065E				
Depth 5983 m (STD Depth 5801+50 m)				Depth 5603 m (STD Depth 5567+50 m)				
Date and Time 1978. 26, 1812-2112 GMT				Date and Time 1978. 27, 0400-0640 GMT				
Wind ENE 10 m/s Swell 5 m				Wind NE 9 m/s Swell 5 m				
Depth (m)	Temp (°C)	Salinity (ppt)	Sigma $t$	Depth (m)	Temp (°C)	Salinity (ppt)	Sigma $t$	Sigma $_{\sigma D}$
0	28.00	33.67	21.42	0	27.80	33.60	21.43	21.43
50	28.00	33.70	21.44	50	27.80	33.65	21.47	21.69
100	26.40	34.05	22.21	100	20.10	34.10	24.07	24.52
150	19.80	33.85	23.96	150	15.20	34.00	25.18	25.87
200	12.80	33.81	25.53	200	12.80	33.95	25.64	26.56
250	11.20	33.92	25.92	250	11.20	34.00	25.98	27.14
300	10.60	33.95	26.05	300	10.50	33.99	26.10	27.49
350	10.10	33.93	26.12	350	10.10	33.99	26.17	27.80
400	9.40	33.92	26.23	400	9.50	34.00	26.28	28.15
500	8.30	33.85	26.35	500	8.40	33.90	26.37	28.73
600	7.30	33.82	26.47	600	7.40	33.87	26.50	29.33
700	6.40	33.80	26.58	700	6.60	33.87	26.61	29.92
800	5.70	33.79	26.66	800	5.90	33.85	26.68	30.48
900	5.20	33.79	26.72	900	5.40	33.85	26.74	31.02
1000	4.80	33.79	26.76	1000	4.90	33.85	26.80	31.56
1250	3.85	33.80	26.87	1250	3.85	33.84	26.90	32.87
1500	3.10	33.81	26.95	1500	3.15	33.84	26.97	34.14
1750	2.70	33.86	27.03	1750	2.70	33.84	27.01	35.38
2000	2.40	33.88	27.07	2000	2.35	33.85	27.05	36.60
2500	2.00	33.89	27.11	2500	2.00	33.90	27.11	39.03
3000	1.80	33.90	27.13	3000	1.80	33.90	27.13	41.38
3500	1.65	33.89	27.13	3500	1.60	33.90	27.14	43.71
4000	1.55	33.89	27.14	4000	1.50	33.88	27.13	45.99
4500	1.45	33.87	27.13	4500	1.45	33.86	27.12	48.24
5000	1.50	33.84	27.10	5000	1.45	33.82	27.09	50.46
5500	1.55	33.81	27.08	5500	1.50	33.80	27.07	52.64
5801	1.60	33.79	27.06	5567	1.50	33.80	27.07	52.94

Table XII-1 (Continued)

Station St. 1051 S20				Station St. 1052 S21			
Position 10.5921N, 179.0110E				Position 12.0027N, 179.0146E			
Depth 5235 m (STD Depth 5187+50 m)				Depth 5926 m (STD Depth 5874+50 m)			
Date and Time 1978. 27, 1821-2055 GMT				Date and Time 1978. 28, 0434-0719 GMT			
Wind NE 12-13 m/s Swell 5 m				Wind ENE 10 m/s Swell 5 m			
Depth (m)	Temp (°C)	Salinity (ppt)	Sigma $t$	Depth (m)	Temp (°C)	Salinity (ppt)	Sigma $t$
			Sigma $\sigma t/D$				Sigma $\sigma t/D$
0	27.50	33.54	21.48	0	27.30	33.70	21.67
50	27.55	33.60	21.51	50	27.30	33.70	21.67
100	26.20	34.50	22.62	100	27.20	33.70	21.70
150	21.00	34.28	23.97	150	24.60	33.36	22.25
200	17.00	33.95	24.73	200	18.60	34.14	24.49
250	12.20	33.92	25.73	250	13.20	33.50	25.21
300	10.80	33.94	26.01	300	10.90	33.54	25.68
350	10.00	33.92	26.13	350	10.00	33.60	25.88
400	9.40	33.90	26.21	400	9.50	33.79	26.11
500	8.45	33.84	26.32	500	8.10	33.75	26.30
600	7.25	33.84	26.49	600	7.10	33.75	26.44
700	6.35	33.84	26.61	700	5.60	33.82	26.69
800	5.70	33.85	26.70	800	5.60	33.80	26.68
900	5.30	33.85	26.75	900	5.20	33.72	26.66
1000	4.80	33.86	26.82	1000	4.75	33.72	26.71
1250	3.75	33.85	26.92	1250	3.75	33.75	26.84
1500	3.15	33.85	26.98	1500	3.15	33.80	26.94
1750	2.65	33.86	27.03	1750	2.70	33.80	26.98
2000	2.35	33.89	27.08	2000	2.35	33.84	27.04
2500	2.00	33.90	27.11	2500	2.00	33.88	27.10
3000	1.80	33.90	27.13	3000	1.80	33.89	27.12
3500	1.65	33.88	27.12	3500	1.70	33.89	27.13
4000	1.60	33.88	27.13	4000	1.60	33.88	27.13
4500	1.50	33.84	27.10	4500	1.55	33.86	27.12
5000	1.50	33.81	27.08	5000	1.55	33.84	27.10
5187	1.50	33.81	27.08	5500	1.60	33.80	27.06
				5874	1.65	33.78	27.04
							54.25

Table XII-1 (Continued)

Station St. 1053 S22				Station St. 1054 S23			
Position 12.5744N, 179.0119E				Position 12.5951N, 179.5992E			
Depth 4910 m (STD Depth 4903+50 m)				Depth 5053 m (STD Depth 5022+50 m)			
Date and Time 1978. 28, 1813-2031 GMT				Date and Time 1978. 29, 0344-0556 GMT			
Wind E-ENE 9 m/s Swell 4-5 m				Wind NEN 7 m/s Swell 4 m			
Depth (m)	Temp (°C)	Salinity (ppt)	Sigma $t$	Depth (m)	Temp (°C)	Salinity (ppt)	Sigma $t$
0	27.35	33.60	21.58	0	27.20	33.70	21.70
50	27.40	33.91	21.79	50	27.20	33.71	21.71
100	26.20	34.35	22.50	100	26.70	33.95	22.05
150	20.00	33.70	23.79	150	19.60	34.30	24.35
200	15.70	33.58	24.74	200	14.00	33.65	25.17
250	11.20	33.66	25.72	250	11.40	33.63	25.66
300	10.00	33.66	25.93	300	10.00	33.69	25.95
350	9.60	33.68	26.01	350	9.50	33.75	26.08
400	8.80	33.64	26.11	400	8.70	33.80	26.25
500	7.60	33.64	26.29	500	7.70	33.78	26.38
600	6.70	33.64	26.41	600	6.80	33.78	26.51
700	5.90	33.68	26.55	700	5.95	33.76	26.60
800	5.35	33.68	26.61	800	5.30	33.77	26.69
900	5.00	33.68	26.65	900	4.80	33.78	26.75
1000	4.60	33.68	26.70	1000	4.40	33.78	26.80
1250	3.60	33.82	26.91	1250	3.65	33.79	26.88
1500	3.00	33.86	27.00	1500	3.05	33.83	26.97
1750	2.60	33.87	27.04	1750	2.55	33.84	27.02
2000	2.30	33.88	27.07	2000	2.30	33.85	27.05
2500	2.00	33.89	27.11	2500	2.00	33.86	27.08
3000	1.80	33.88	27.11	3000	1.80	33.86	27.10
3500	1.70	33.88	27.12	3500	1.65	33.86	27.11
4000	1.60	33.86	27.11	4000	1.60	33.84	27.10
4500	1.55	33.86	27.12	4500	1.50	33.81	27.08
4903	1.55	33.86	27.12	5000	1.50	33.81	27.08
				5022	1.50	33.80	27.07
							<i>sigma</i> <sub>D</sub>
							21.70
							21.93
							22.50
							25.04
							26.09
							26.82
							27.35
							27.73
							28.13
							28.74
							29.34
							29.92
							30.50
							31.04
							31.57
							32.86
							34.14
							35.40
							36.60
							39.01
							41.35
							43.66
							45.94
							48.19
							50.44
							50.53



Table XII-1 (Continued)

Station St. 1060 S24				Station St. 1061 S25				
Position 12.5908N, 178.5946W				Position 11.5982N, 179.0260W				
Depth 5720 m (STD Depth 5660+50 m)				Depth 5632 m (STD Depth 5579+50 m)				
Date and Time 1978. 29, 1814-2112 GMT				Date and Time 1978. 30, 0421-0712 GMT				
Wind NE 9-10 m/s Swell 4 m				Wind 11 m/s Swell 4-5 m				
Depth (m)	Temp (°C)	Salinity (ppt)	Sigma <i>t</i>	Depth (m)	Temp (°C)	Salinity (ppt)	Sigma <i>t</i>	Sigma <i>σD</i>
0	26.80	33.82	21.92	0	26.95	34.05	22.04	22.04
50	26.80	33.90	21.98	50	26.95	34.06	22.05	22.27
100	26.60	34.05	22.15	100	26.90	34.14	22.12	22.58
150	20.20	34.13	24.07	150	21.50	34.40	23.92	24.60
200	16.20	33.77	24.78	200	16.20	34.10	25.03	25.94
250	12.00	33.68	25.59	250	13.00	33.65	25.37	26.53
300	9.80	33.72	26.01	300	10.50	33.65	25.83	27.24
350	9.40	33.77	26.11	350	9.20	33.70	26.09	27.74
400	8.90	33.82	26.23	400	8.50	33.76	26.25	28.13
500	7.70	33.80	26.40	500	7.45	33.78	26.42	28.79
600	7.00	33.79	26.49	600	6.60	33.78	26.53	29.38
700	6.20	33.79	26.59	700	5.90	33.77	26.62	29.94
800	5.45	33.80	26.70	800	5.40	33.77	26.68	30.47
900	5.00	33.80	26.75	900	5.10	33.78	26.72	31.01
1000	4.60	33.81	26.80	1000	4.60	33.78	26.78	31.55
1250	3.70	33.85	26.93	1250	3.70	33.81	26.89	32.86
1500	3.20	33.85	26.97	1500	3.10	33.81	26.95	34.12
1750	2.70	33.86	27.03	1750	2.65	33.82	27.00	35.38
2000	2.40	33.86	27.05	2000	2.35	33.84	27.04	36.60
2500	2.00	33.86	27.08	2500	2.00	33.84	27.07	38.99
3000	1.85	33.86	27.09	3000	1.80	33.84	27.08	41.34
3500	1.75	33.86	27.10	3500	1.70	33.82	27.07	43.63
4000	1.60	33.84	27.10	4000	1.60	33.82	27.08	45.92
4500	1.55	33.84	27.10	4500	1.50	33.81	27.08	48.19
5000	1.55	33.80	27.07	5000	1.50	33.77	27.05	50.41
5500	1.60	33.80	27.06	5500	1.55	33.77	27.04	52.61
5660	1.60	33.80	27.06	5579	1.55	33.77	27.04	52.96

Table XII-1 (Continued)

Station St. 1056 S27					
Position 10.5883N, 179.5862W					
Depth 5930 m (STD Depth —)					
Date and Time 1978. 31. 0424-0718 GMT					
Wind NE 10 m/s Swell 4-5 m					
Depth (m)	Temp (°C)	Salinity (ppt)	Sigma $t$	Sigma $\sigma_D$	
0	27.40	33.59	21.55	21.55	21.55
50	27.40	33.60	21.56	21.79	21.79
100	27.40	34.00	21.86	22.31	22.31
150	21.60	34.20	23.74	24.43	24.43
200	15.40	33.82	25.00	25.92	25.92
250	12.20	33.76	25.61	26.77	26.77
300	11.20	33.90	25.90	27.30	27.30
350	9.70	33.74	26.04	27.68	27.68
400	9.10	33.74	26.14	28.02	28.02
500	8.10	33.76	26.31	28.67	28.67
600	7.20	33.76	26.44	29.27	29.27
700	6.45	33.76	26.54	29.86	29.86
800	5.70	33.76	26.63	30.44	30.44
900	5.15	33.78	26.71	31.01	31.01
1000	4.70	33.78	26.77	31.54	31.54
1250	3.80	33.80	26.88	32.84	32.84
1500	3.10	33.81	26.95	34.12	34.12
1750	2.70	33.83	27.00	35.39	35.39
2000	2.35	33.84	27.04	36.60	36.60
2500	2.00	33.85	27.07	39.00	39.00