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NAVAL POSTGRADUATE SCHOOL

Monterey, California

HYDROGRAPHIC DATA FROM THE OPTOMA PROGRAM
OPTOMA20
OPTOMA20 P 16 March 1986
OPTOMA20 Leg MI 24 March - 3 April 1986
OPTOMA20 Leg MII 7 - 15 April 1986
OPTOMA20 Leg D 25 April - 6 May 1986

by

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The one AXBT flight, Leg P and the three cruises, Legs MI, MII and D, were undertaken in March, April and May. This report presents the hydrographic data accquired by AXBT, XBT and CTD casts from the flight and the cruises.

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Hydrographic Data from the OPTOMA Program:

OPTOMA20

16 March - 6 May, 1986

by

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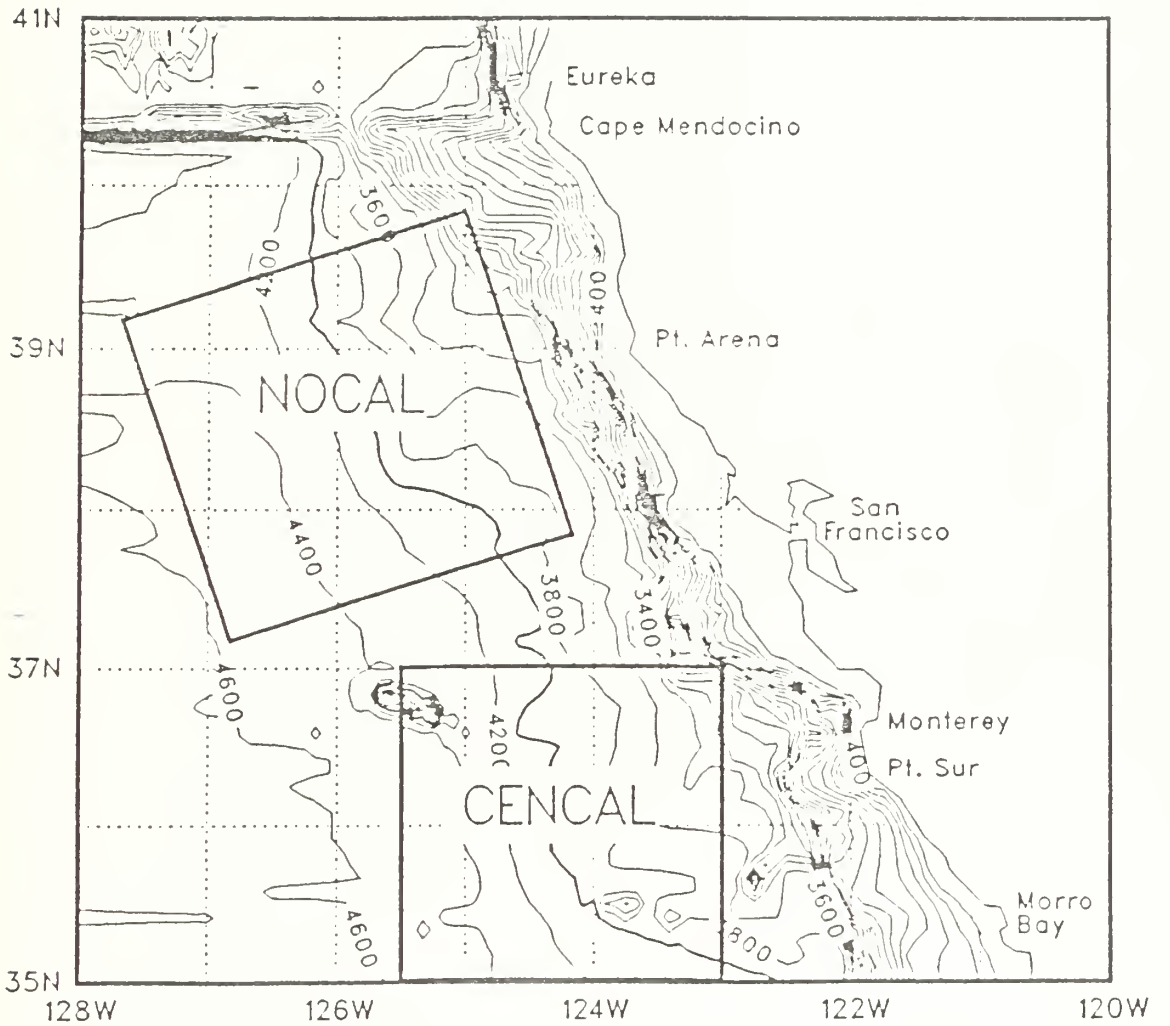

Figure 1: The NOCAL and CENCAL subdomains of the OPTOMA Program. Isobaths are shown in meters.

INTRODUCTION

The OPTOMA (Ocean Prediction Through Observation, Modeling, and Analysis) Program, a joint NPS/Harvard program sponsored by ONR, seeks to understand the mesoscale (fronts, eddies, and jets) variability and dynamics of the California Current System and to determine the scientific limits to practical mesoscale ocean forecasting. To help carry out the aims of this project, a series of cruises has been planned in two subdomains, NOCAL and CENCAL, shown in Figure 1.

Three cruises were undertaken during March, April and May 1986: two (Legs MI and MII) on the NOAA ship McARTHUR, one (Leg D) on the USNS De STEIGUER. In addition, one P-3 overflight (Leg P) was made one week before the first cruise.

Leg P, on 16 March, sampled a domain approximately 240km square centered about 280km off the coast between Pt. Arena and Cape Mendocino, with additional transects from and to San Francisco, as shown in Figure 2.

Leg MI was carried out from 24 March to 3 April (Figure 8), Leg MII from 7 to 15 April (Figure 20), and Leg D from 25 April to 6 May (Figure 32). Each cruise sampled the same domain as Leg P. On these cruises, oceanographic stations were occupied at approximately 18km along each track.

DATA ACQUISITION

Data acquired during Leg P, Legs MI and MII, and Leg D include XBT and CTD profiles. Bucket surface temperatures and water samples for salinity were taken at most CTD stations, and on Leg D, deep water samples for salinity were taken at four CTD stations. These surface values were used for calibration purposes as well as contributions to the data base. The deep water values were used solely for calibration purposes. Legs MI and MII also acquired continuous 2m thermosalinograph measurements, continuous meteorological data such as atmospheric pressure at a height of 2m and wind speed and direction at a height of 20m.

The XBT data on Legs MI, MII, and D were digitized using a Sippican MK9 unit; data were recorded, using an HP200 series computer, on data disks. The continuous "underway" data were digitized using an HP5328 frequency counter and a 40 channel digital voltmeter. The continuous data were averaged over two-minute intervals. All data were transferred to the IBM 3033 mainframe computer for editing and processing.

Station positions aboard ship were determined by LORAN C fixes and are claimed to be accurate to within about 0.1 km. Neil Brown CTDs and Sippican XBTs were used during Legs MI, MII, and D and Sippican AXBTs during Leg P. Their accuracies are stated in Tables 1 and 2. The AXBT accuracy is the same as that for the XBT. The bottle surface salinity samples from Legs MI and MII were determined onboard by a Plessey salinometer. Samples from Leg D were determined ashore by a Guildline Model 8400 "Autosal" salinometer. Accuracies from the two salinometers are given in Tables 1 and 2.

DATA PROCESSING

Data processing, such as estimating depth profiles for the XBT temperature profiles based on the descent speed, and conversion of CTD conductivity to salinity using the algorithm given in Lewis and Perkin (1981), was carried out on the IBM 3033 at the Naval Postgraduate School. The data were then edited by removing obvious salinity spikes and eliminating cast failures that were not identified during the cruise. Approximately 95%, 99%, 99% and 99% of casts were retained in the data sets of Legs P, MI, MII, and D, respectively. From a comparison of the CTD salinities with the salinity samples from the bottles, it was determined that the average salinity offsets were -.037, -.065, and +.017 ppt for Legs MI, MII, and D, respectively. Since these offset values were small, no corrections were made to the salinities. The CTD data were interpolated to 5m intervals and then up and down casts were averaged.

The data have been transferred on digital tape to the National Oceanographic Data Center in Washington, DC.

DATA PRESENTATION

The cruise track, station locations (with XBTs and CTDs identified) and station numbers are shown in the first three figures of each of the next four sections, which present the data from Legs P, MI, MII and D, respectively. These figures are followed by a listing of the stations, with their coordinates, the date and time when each station was occupied, and the surface information obtained at the station. On each cruise track figure, transect extremes are identified by letter to aid in cross-referencing the data presented in subsequent figures.

Vertical profiles of temperature from the XBT casts are shown in staggered fashion. The location of these profiles may be found by reference to the various maps of the cruise tracks. Transect extremes are identified as nearly as possible. The first profile on each plot is shown with its temperature unchanged; to each

subsequent profile, an appropriate multiple of 5C has been added. Vertical profiles from the CTDs follow. Profiles of temperature are staggered by 5C and those of salinity by 4 ppt.

Isotherms for each transect are shown in the next pages, followed by isopleths of temperature, salinity and sigma-t, from the CTDs, when four or more casts were acquired along a transect. Based on instrument accuracy and the vertical temperature gradient, it is estimated that depths of isotherms in the main thermocline are uncertain to ±20m. The tick marks identify station positions and, again, the transect extremes are shown on these plots.

Sections 1, 2, 3, and 4 include mean profiles of temperature from the AXBTs or the XBTs and CTDs. In addition mean profiles of temperature, salinity and sigma-t from the CTDs are given, as well as a scatter diagram of the T-S pairs and the mean S(T) curve, with the ± standard deviation envelope; the data presentation concludes with a plot of the mean N^2 (Brunt-Vaisala frequency squared) profile, with ± the standard deviation. On the sigma-t and N^2 plots, the appropriate profiles derived from the mean temperature and mean salinity profiles are also shown.

Table 1: Scientific instruments aboard the NOAA Ship McARTHUR

Instrument	Variable	Sensor	Accuracy	Resolution
Neil Brown CTD Mark IIIb	pressure temperature conductivity	strain gauge thermistor electrode cell	1.6 db 0.005 C 0.005 mmho	0.025 db 0.0005 C 0.001 mmho
Sippican XBT	temperature depth	thermistor descent speed	0.2 C greater of 4.6m and 2% of depth	
Plessey CTD	pressure temperature conductivity		±0.04% of depth ±0.005 C ±0.005 mmho	
Plessey salinometer	salinity		±0.003 ppt	
Sea-Bird Sensors	temperature conductivity at 2 meters	thermistor electrode cell	0.003 C 0.003 mmho	0.0005 C 0.0005 mmho
General Eastern Temperature Sensors	air temperature dew point temperature	thermometer condensation temp.sensor	0.01 C 0.2 C	
R.M. Young Wind Sensors	wind speed wind direction	anemometer vane	0.15 mph 2.5 degrees	
Internav LC 408 LORAN C	position	two chain LORAN receiver	100 meters	10 meters

Table 2: Scientific instruments aboard the USNS De STEIGUER

Instrument	Variable	Sensor	Accuracy	Resolution
Neil Brown CTD Mark IIIb	pressure temperature conductivity	strain gauge thermistor electrode cell	1.6 db 0.005 C 0.005 mmho	0.025 db 0.0005 C 0.001 mmho
Sippican XBT	temperature depth	thermistor descent speed	0.2 C greater of 4.6m and 2% of depth	
Internav LC 408 LORAN C	position	two chain LORAN receiver	100 meters	10 meters

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Section 1

OPTOMA20 Leg P

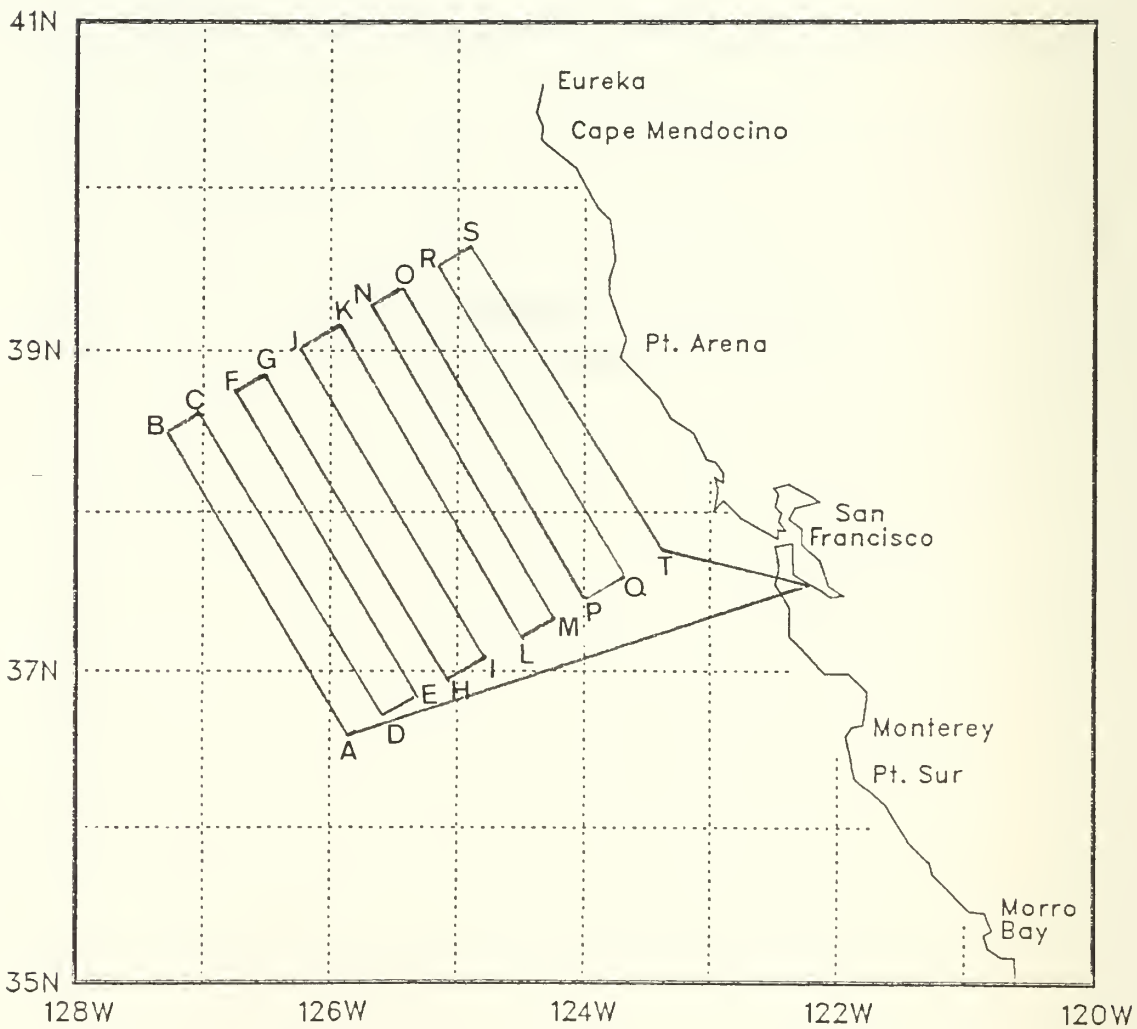


Figure 2: The flight track for OPTOMA20, Leg P.

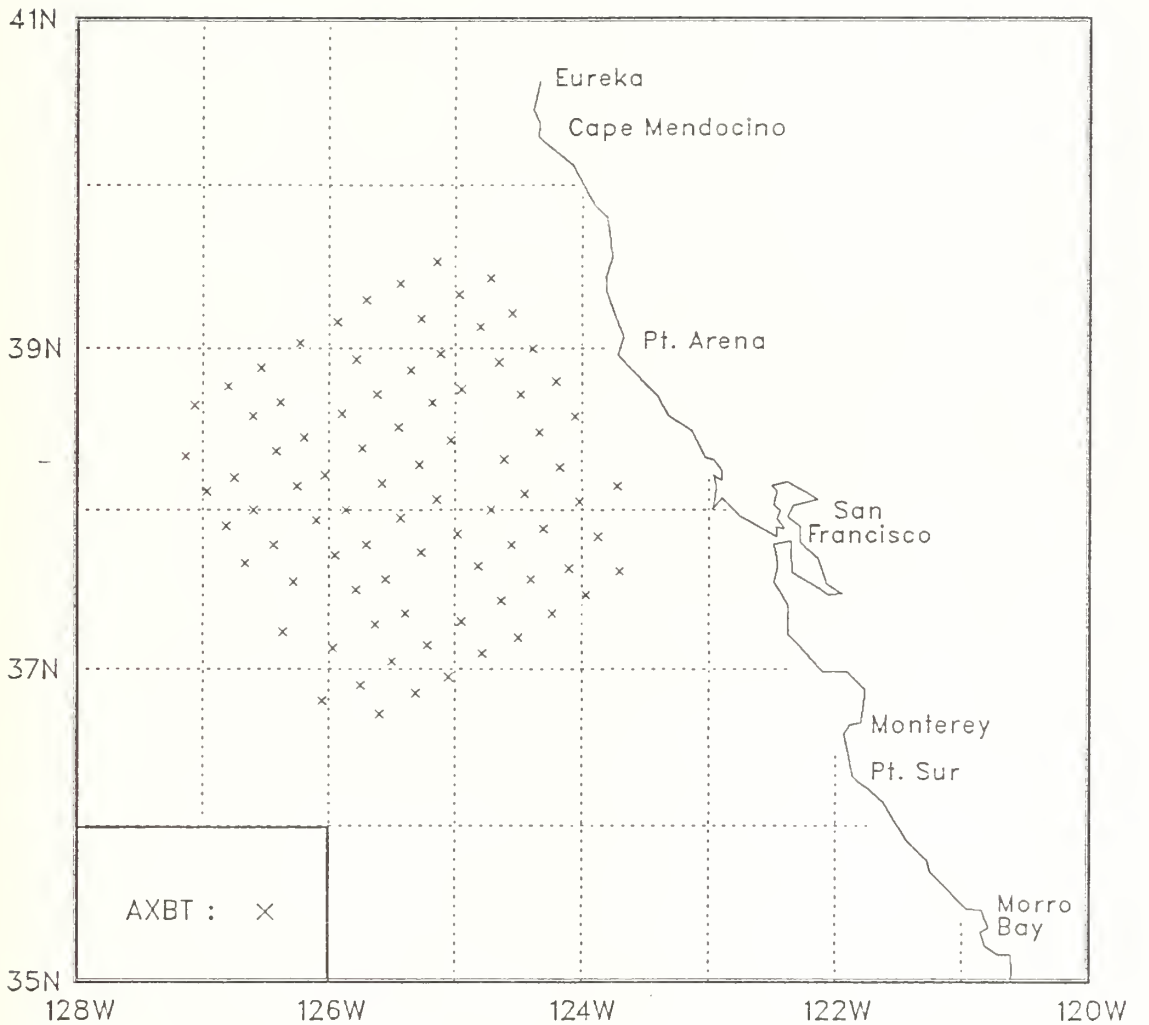


Figure 3: AXBT locations for OPTOMA20, Leg P.

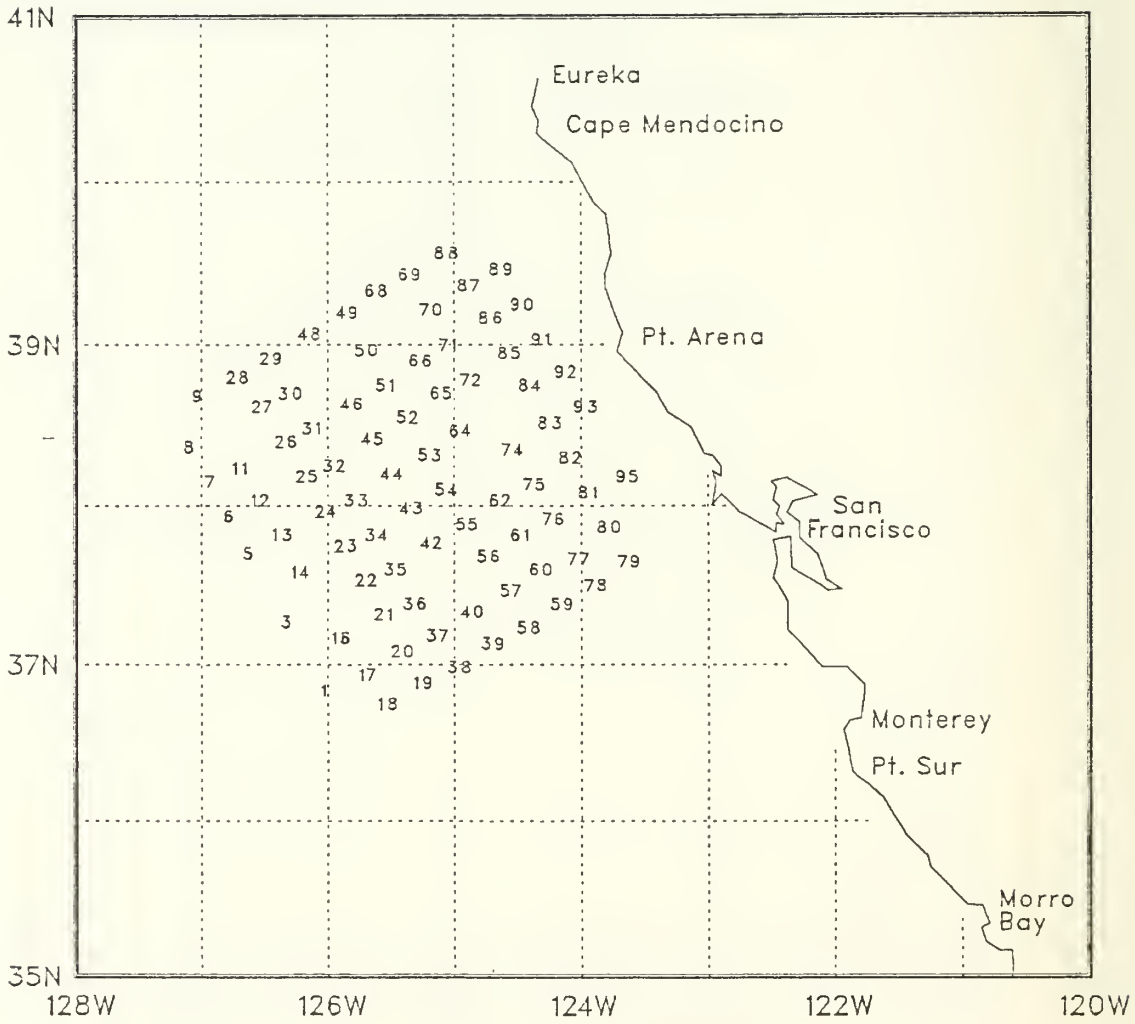


Figure 4: Station numbers for OPTOMA20, Leg P.

Table 3: OPTOMA20 Leg P Station Listing

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)
1	AXBT	86075	1819	36.48	126.03	13.8
3	AXBT	86075	1826	37.14	126.22	13.9
5	AXBT	86075	1837	37.40	126.40	13.0
6	AXBT	86075	1842	37.54	126.49	11.5
7	AXBT	86075	1847	38.07	126.58	12.3
8	AXBT	86075	1852	38.20	127.08	11.1
9	AXBT	86075	1900	38.39	127.04	11.3
11	AXBT	86075	1907	38.12	126.45	12.4
12	AXBT	86075	1910	38.00	126.36	12.4
13	AXBT	86075	1915	37.47	126.26	12.4
14	AXBT	86075	1918	37.33	126.17	13.2
15	AXBT	86075	1923	37.08	125.58	12.9
16	AXBT	86075	1926	37.08	125.58	13.0
17	AXBT	86075	1930	36.54	125.45	13.7
18	AXBT	86075	1935	36.43	125.36	13.5
19	AXBT	86075	1940	36.51	125.19	12.8
20	AXBT	86075	1943	37.03	125.30	13.9
21	AXBT	86075	1949	37.17	125.38	13.4
22	AXBT	86075	1953	37.30	125.47	13.5
23	AXBT	86075	1957	37.43	125.57	13.0
24	AXBT	86075	2001	37.56	126.06	13.3
25	AXBT	86075	2006	38.09	126.15	11.9
26	AXBT	86075	2008	38.22	126.25	13.0
27	AXBT	86075	2014	38.35	126.36	13.1
28	AXBT	86075	2017	38.46	126.48	11.9
29	AXBT	86075	2023	38.53	126.32	11.8
30	AXBT	86075	2026	38.40	126.23	12.6

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)
31	AXBT	86075	2031	38.27	126.12	12.3
32	AXBT	86075	2033	38.13	126.02	12.9
33	AXBT	86075	2039	38.00	125.52	13.3
34	AXBT	86075	2041	37.47	125.42	13.6
35	AXBT	86075	2046	37.34	125.33	13.2
36	AXBT	86075	2048	37.21	125.24	13.6
37	AXBT	86075	2054	37.09	125.13	13.1
38	AXBT	86075	2057	36.57	125.03	13.5
39	AXBT	86075	2103	37.06	124.47	13.0
40	AXBT	86075	2105	37.18	124.57	13.2
42	AXBT	86075	2115	37.44	125.16	12.9
43	AXBT	86075	2120	37.57	125.26	12.6
44	AXBT	86075	2123	38.10	125.35	13.0
45	AXBT	86075	2128	38.23	125.44	12.4
46	AXBT	86075	2130	38.36	125.54	13.0
48	AXBT	86075	2139	39.02	126.14	13.0
49	AXBT	86075	2150	39.10	125.56	12.6
50	AXBT	86075	2152	38.56	125.47	12.8
51	AXBT	86075	2157	38.43	125.37	12.7
52	AXBT	86075	2200	38.31	125.27	13.0
53	AXBT	86075	2204	38.17	125.17	12.8
54	AXBT	86075	2207	38.04	125.09	13.6
55	AXBT	86075	2211	37.51	124.59	13.0
56	AXBT	86075	2214	37.39	124.49	13.5
57	AXBT	86075	2219	37.26	124.38	13.0
58	AXBT	86075	2222	37.12	124.30	13.1
59	AXBT	86075	2229	37.21	124.14	13.0
60	AXBT	86075	2231	37.34	124.24	13.5
61	AXBT	86075	2236	37.47	124.33	13.2
62	AXBT	86075	2240	38.00	124.43	13.1

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)
64	AXBT	86075	2248	38.26	125.02	13.4
65	AXBT	86075	2254	38.40	125.11	13.1
66	AXBT	86075	2256	38.52	125.21	13.4
68	AXBT	86075	2306	39.18	125.42	13.0
69	AXBT	86075	2311	39.24	125.26	12.2
70	AXBT	86075	2313	39.11	125.16	12.7
71	AXBT	86075	2318	38.58	125.07	12.3
72	AXBT	86075	2321	38.45	124.57	13.4
74	AXBT	86075	2329	38.19	124.37	13.3
75	AXBT	86075	2332	38.06	124.27	12.8
76	AXBT	86075	2336	37.53	124.18	13.5
77	AXBT	86075	2340	37.38	124.06	13.4
78	AXBT	86075	2343	37.28	123.58	13.9
79	AXBT	86075	2347	37.37	123.42	13.3
80	AXBT	86075	2349	37.50	123.52	13.2
81	AXBT	86075	2354	38.03	124.01	12.4
82	AXBT	86075	2356	38.16	124.10	13.2
83	AXBT	86076	1	38.29	124.20	13.1
84	AXBT	86076	4	38.43	124.29	12.7
85	AXBT	86076	9	38.55	124.39	12.2
86	AXBT	86076	11	39.08	124.48	12.9
87	AXBT	86076	17	39.20	124.58	12.4
88	AXBT	86076	21	39.32	125.09	12.7
89	AXBT	86076	27	39.26	124.43	12.5
90	AXBT	86076	31	39.13	124.33	12.1
91	AXBT	86076	35	39.00	124.23	13.4
92	AXBT	86076	38	38.48	124.12	12.9
93	AXBT	86076	42	38.35	124.03	13.5
95	AXBT	86076	48	38.09	123.43	13.5

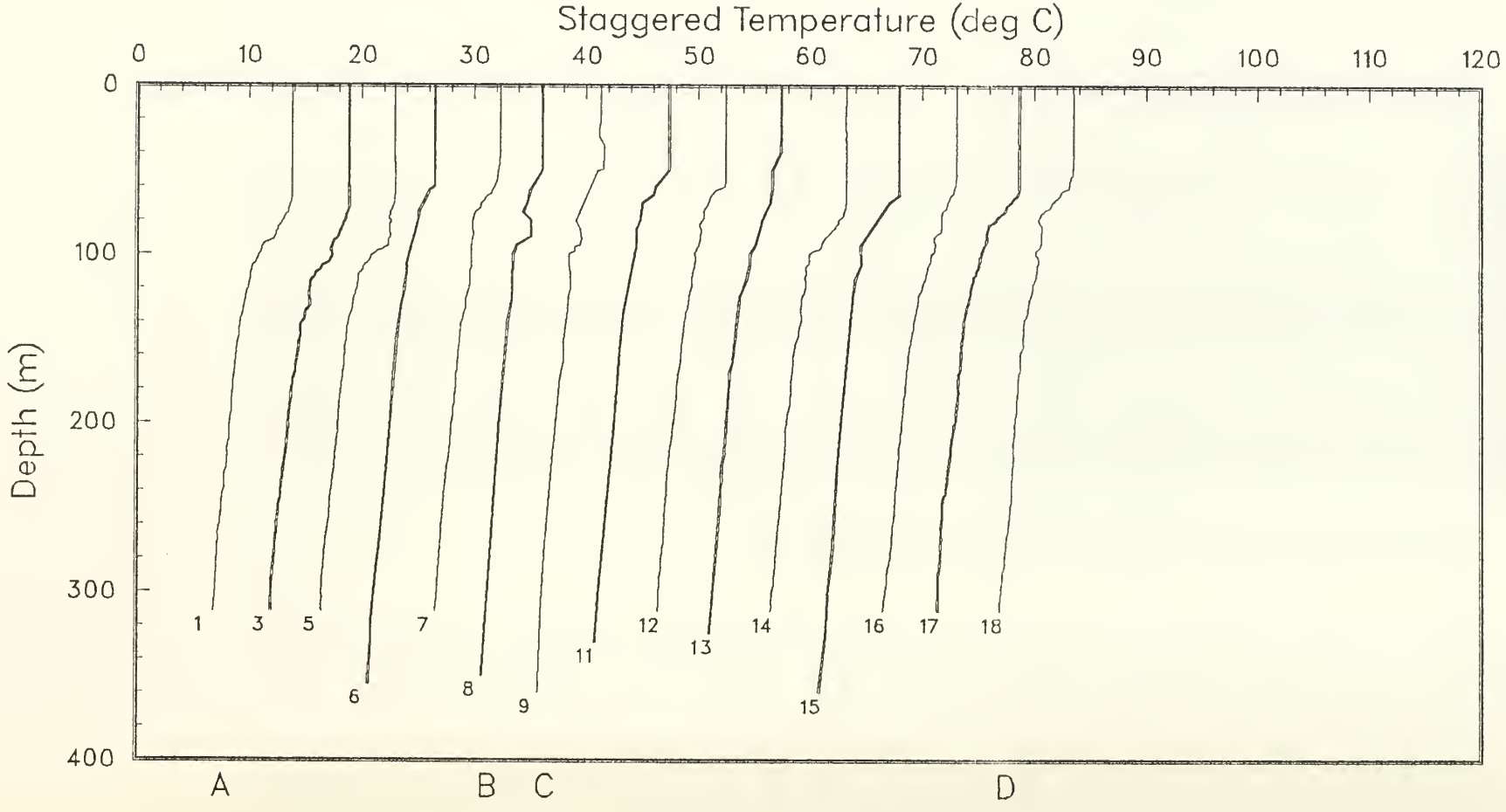
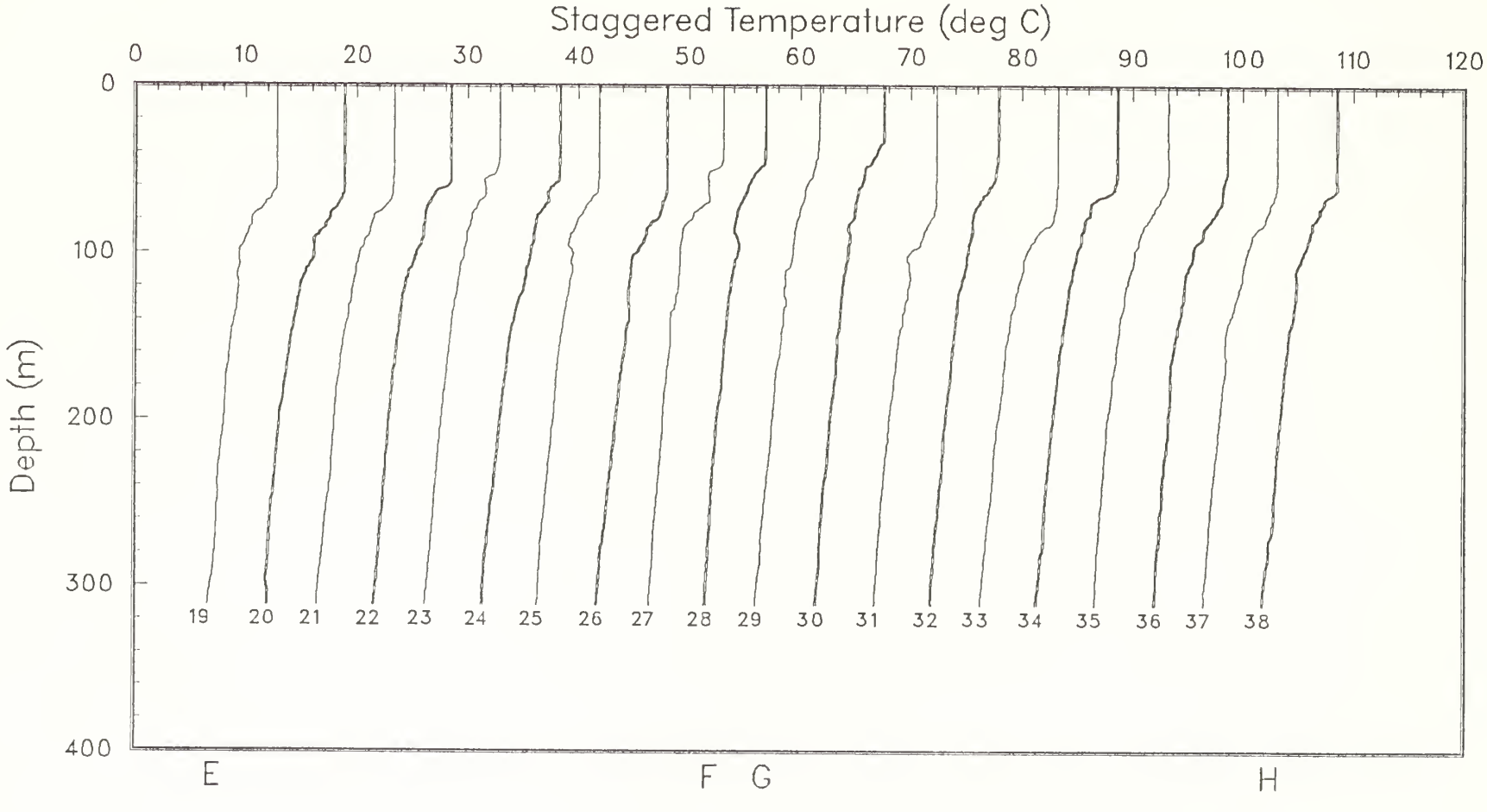


Figure 5(a): AXBT temperature profiles, staggered by multiples of 5C (OPTOMA20, Leg P).


Staggered Temperature (deg C)
0
10
20
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60
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80
90
100
110
120
Depth (m)
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H

Figure 5(b)

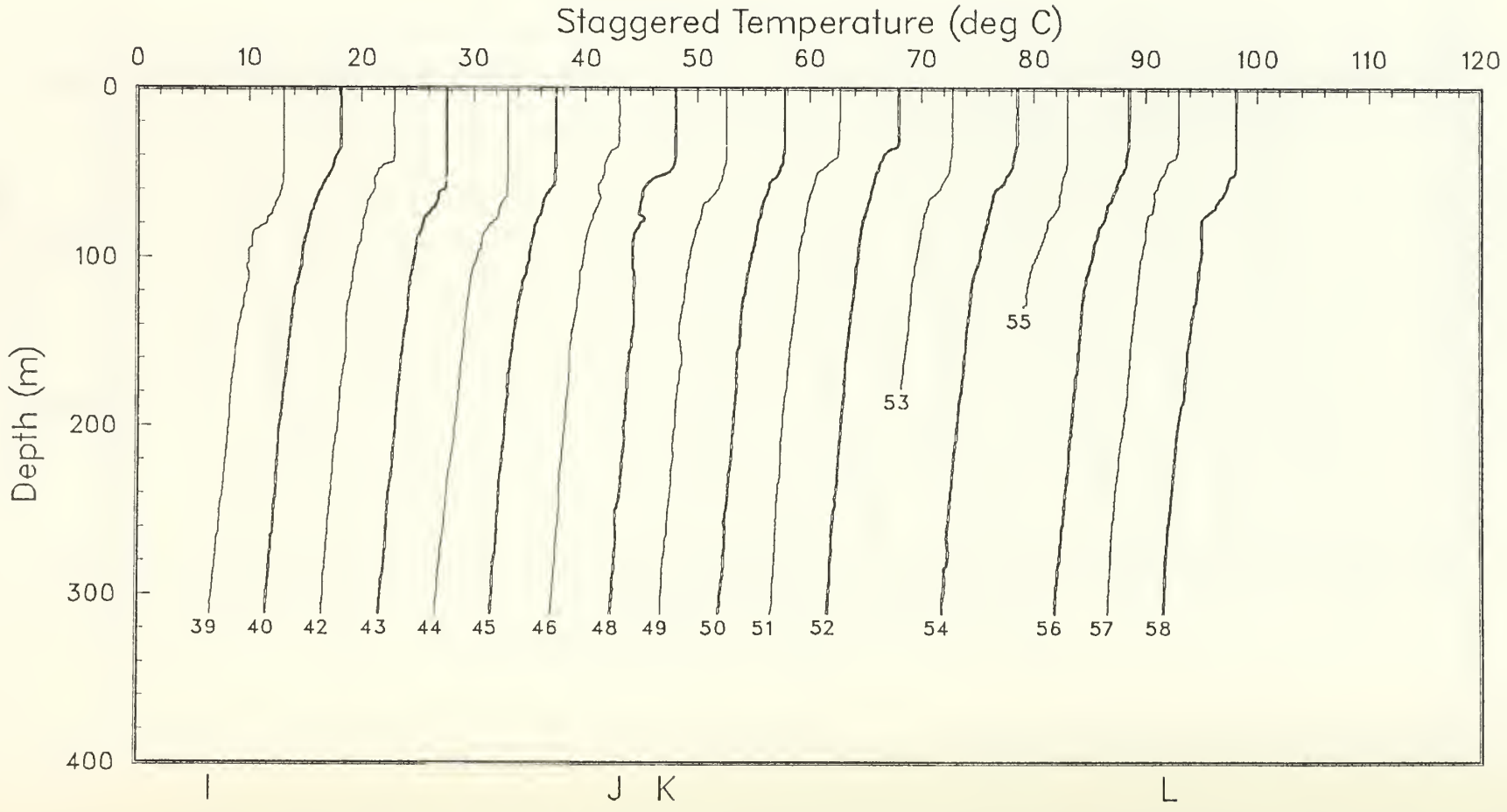
Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
39
40
42
43
44
45
46
48
49
50
51
52
53
54
55
56
57
58
I
J
K
L

Figure 5(c)

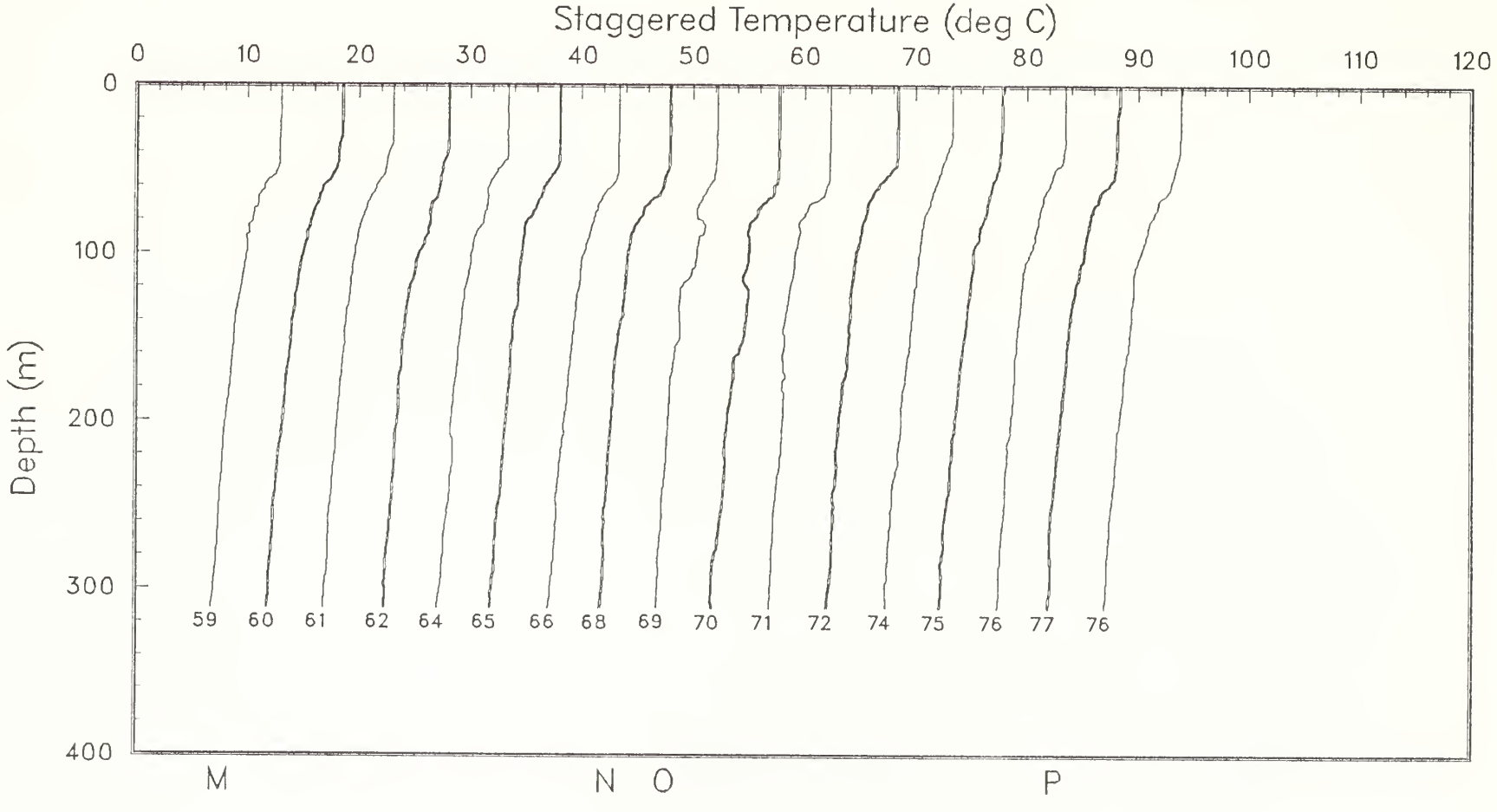
Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
59
60
61
62
64
65
66
68
69
70
71
72
74
75
76
77
76
M
N
O
P

Figure 5(d)

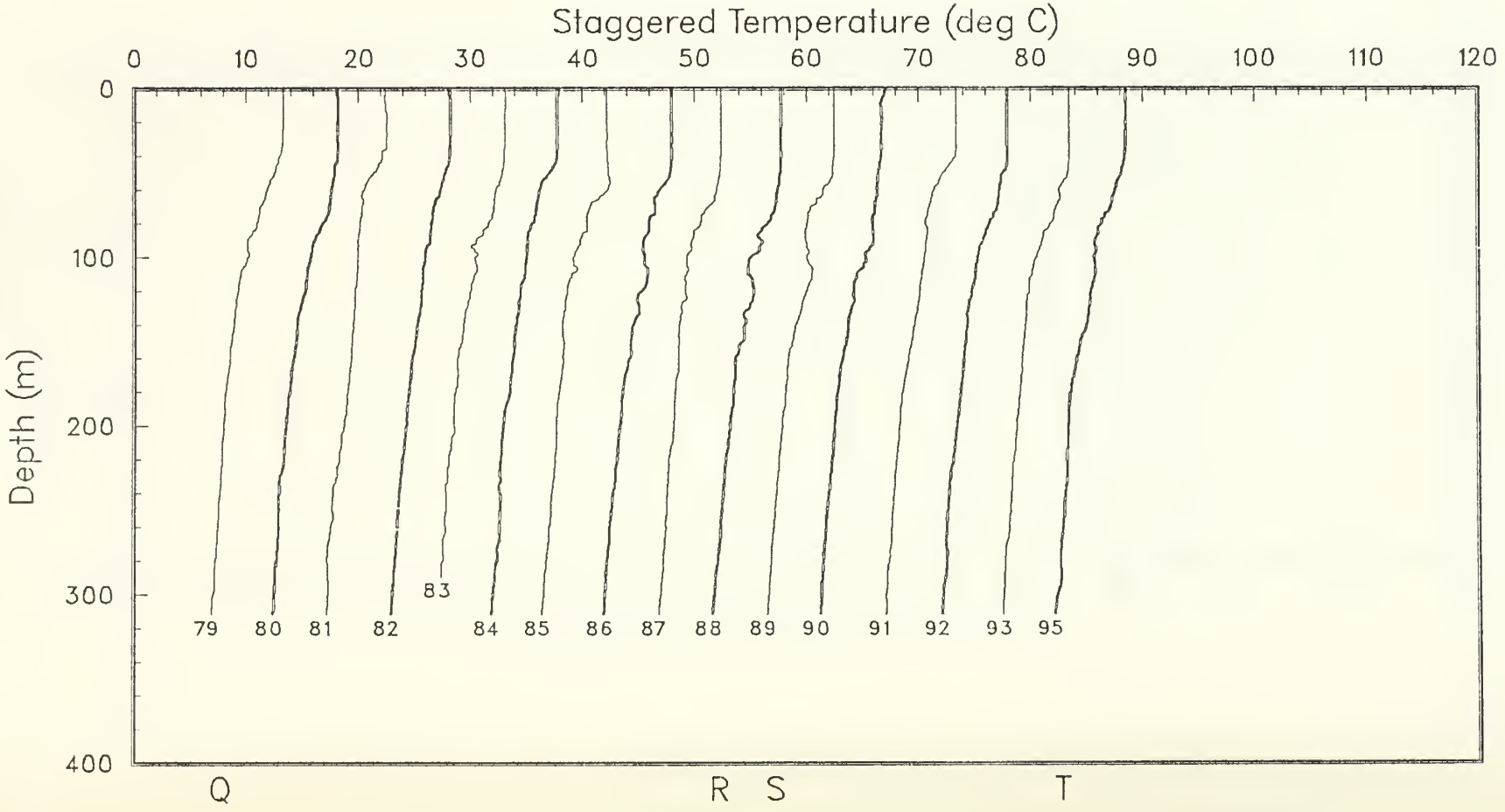
Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
95
Q
R
S
T

Figure 5(e)

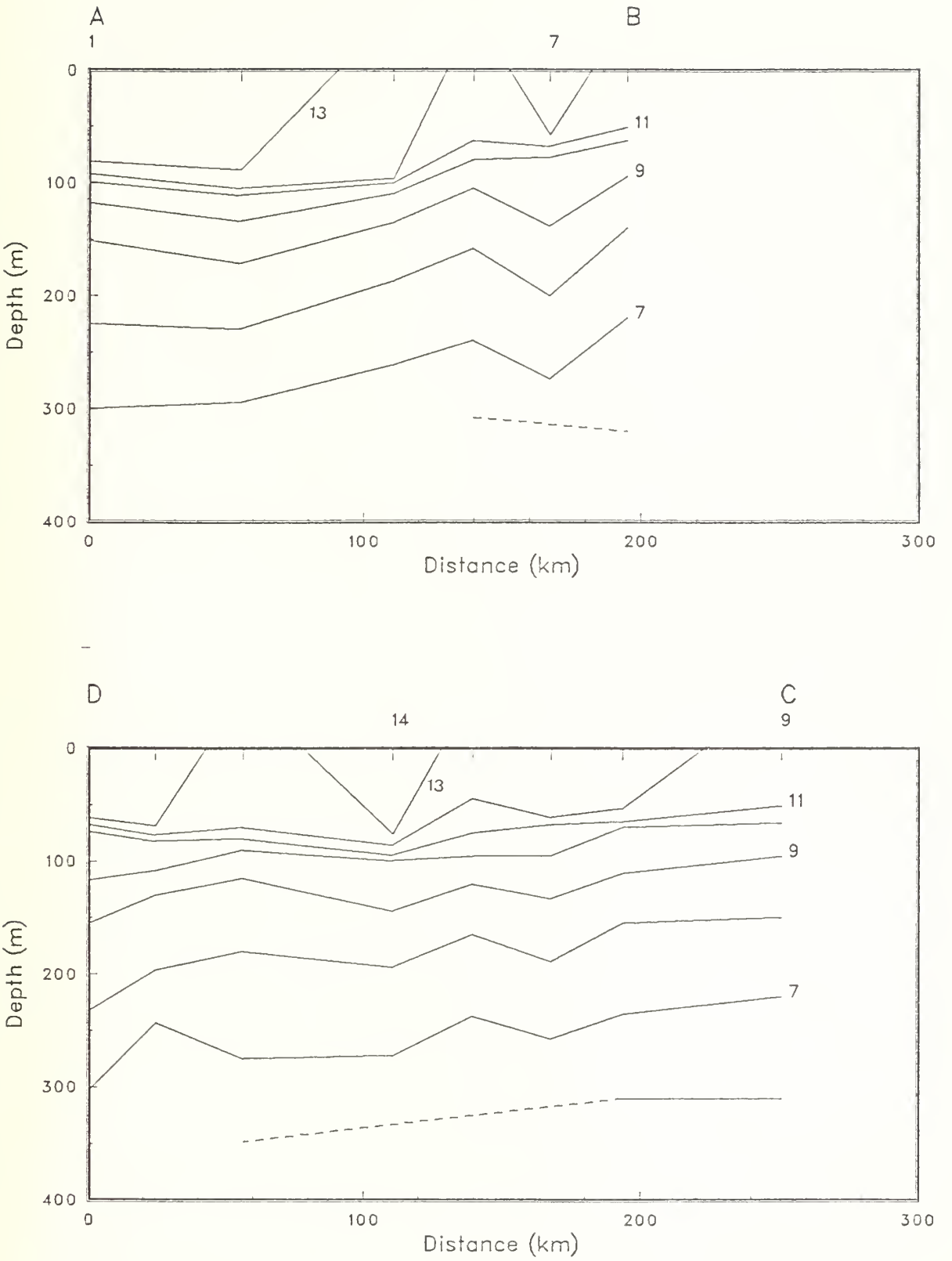

Figure 6(a)-(b): Along-track isotherms. Tick marks along the upper horizontal axis show station positions. Some station numbers are given. Dashed lines are used if the cast was too shallow (OPTOMA20, Leg P).

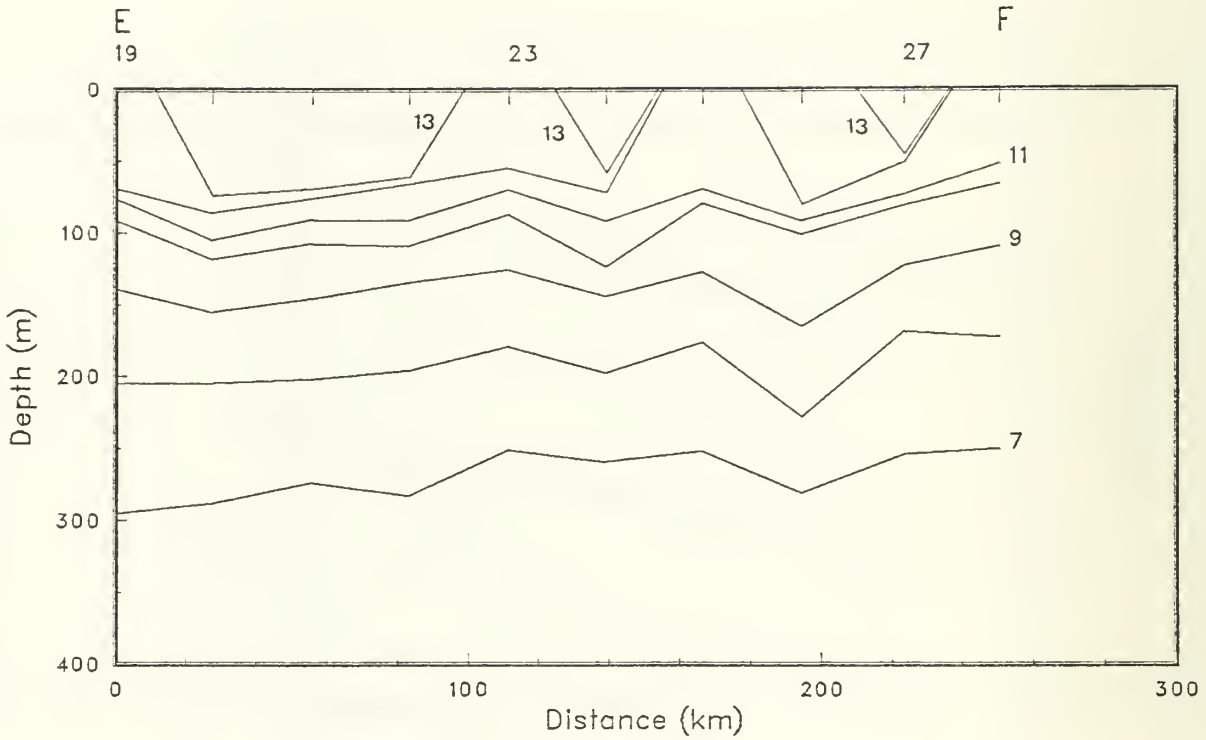

Figure 6(c)

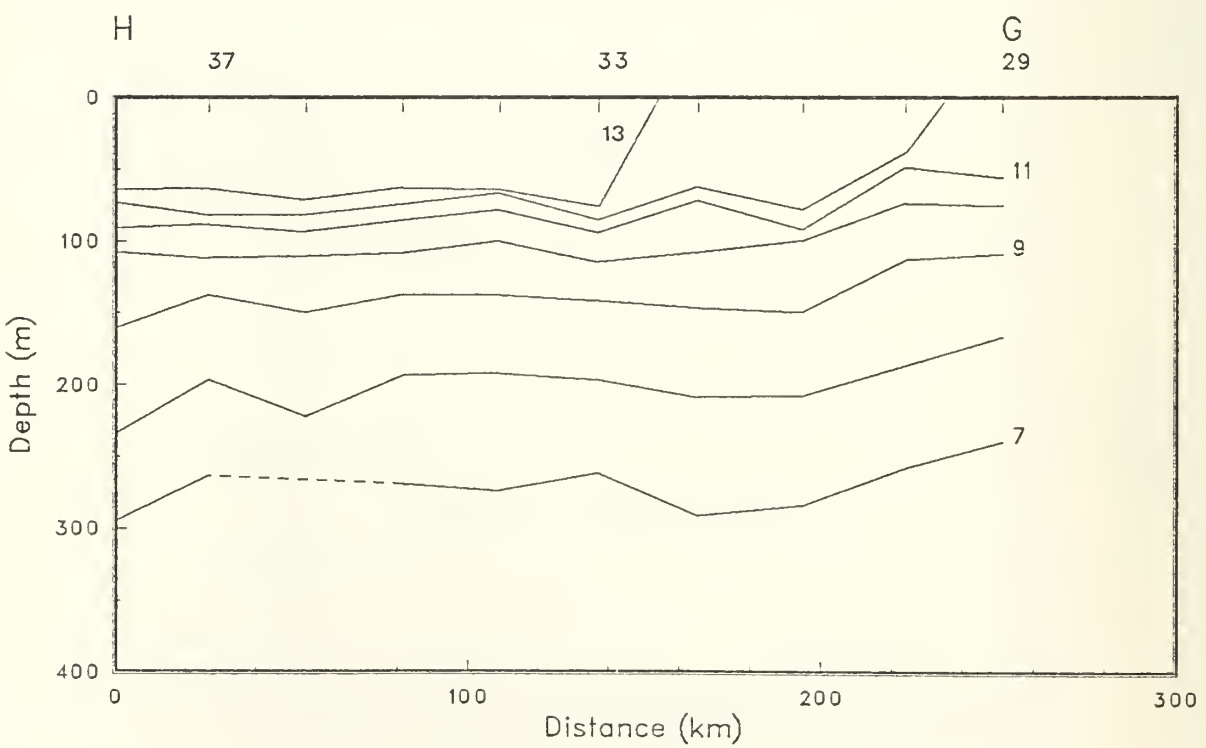

Figure 6(d)

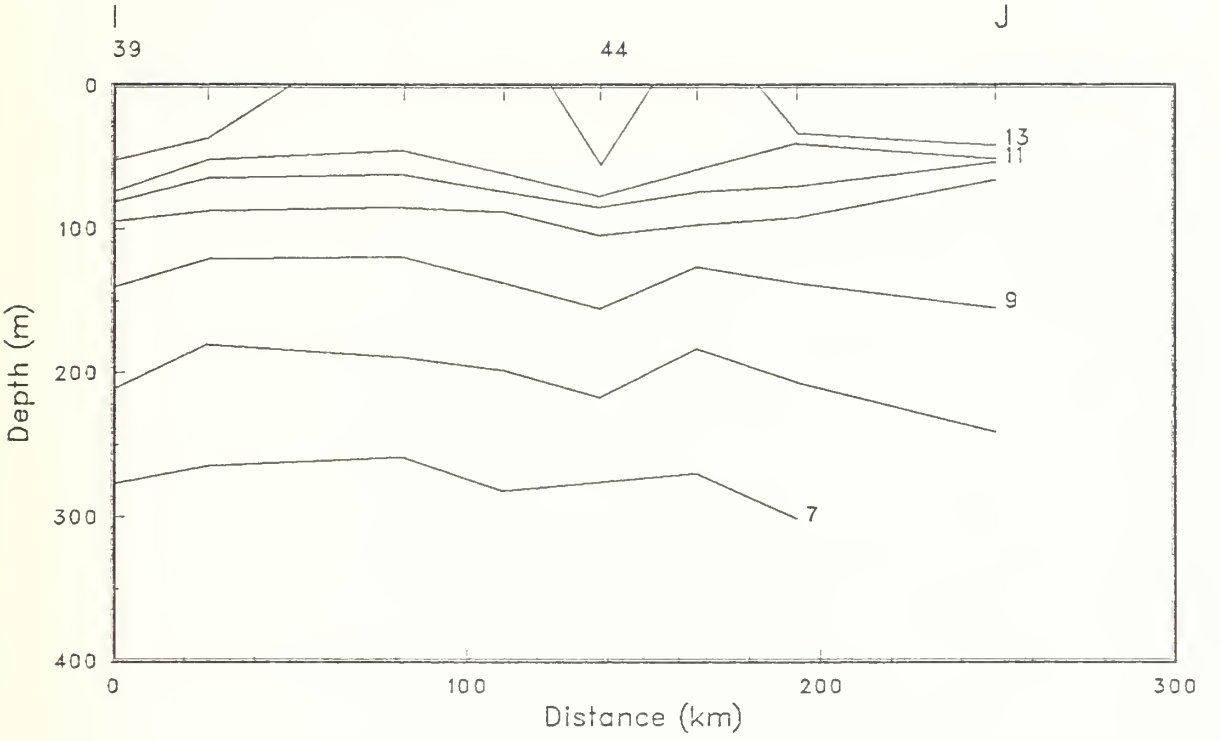

Figure 6(e)

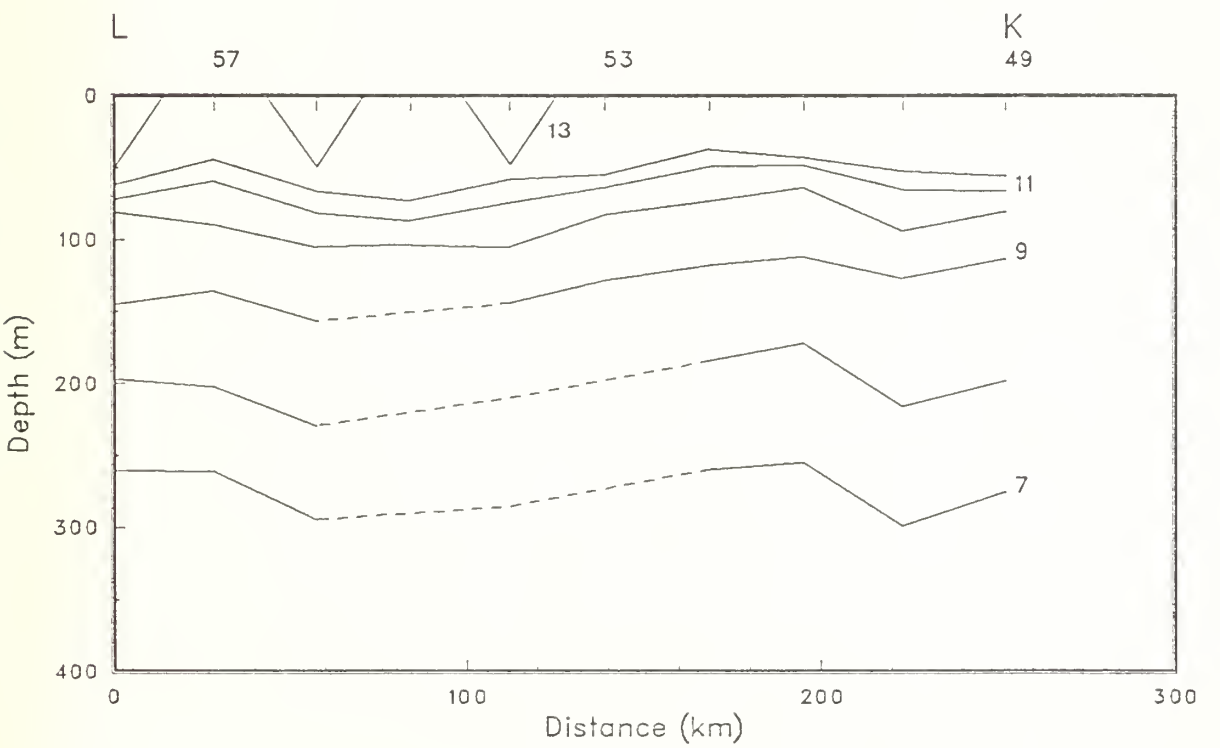

Figure 6(f)

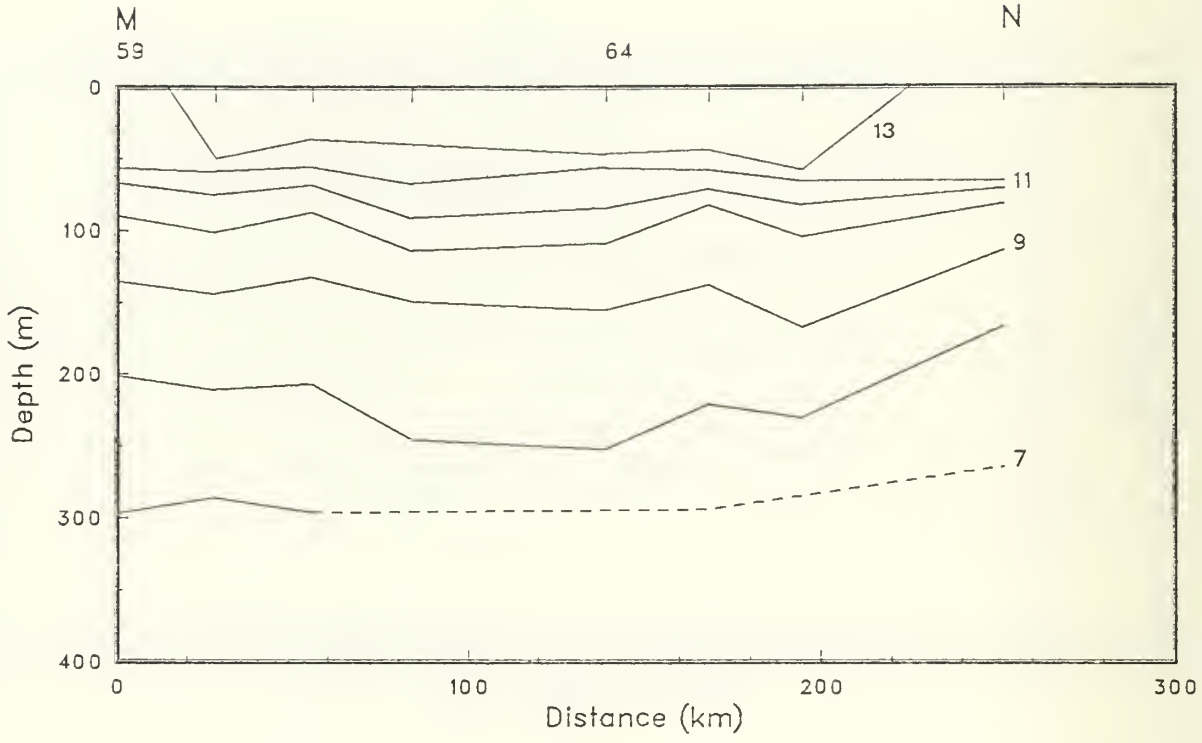

Figure 6(g)

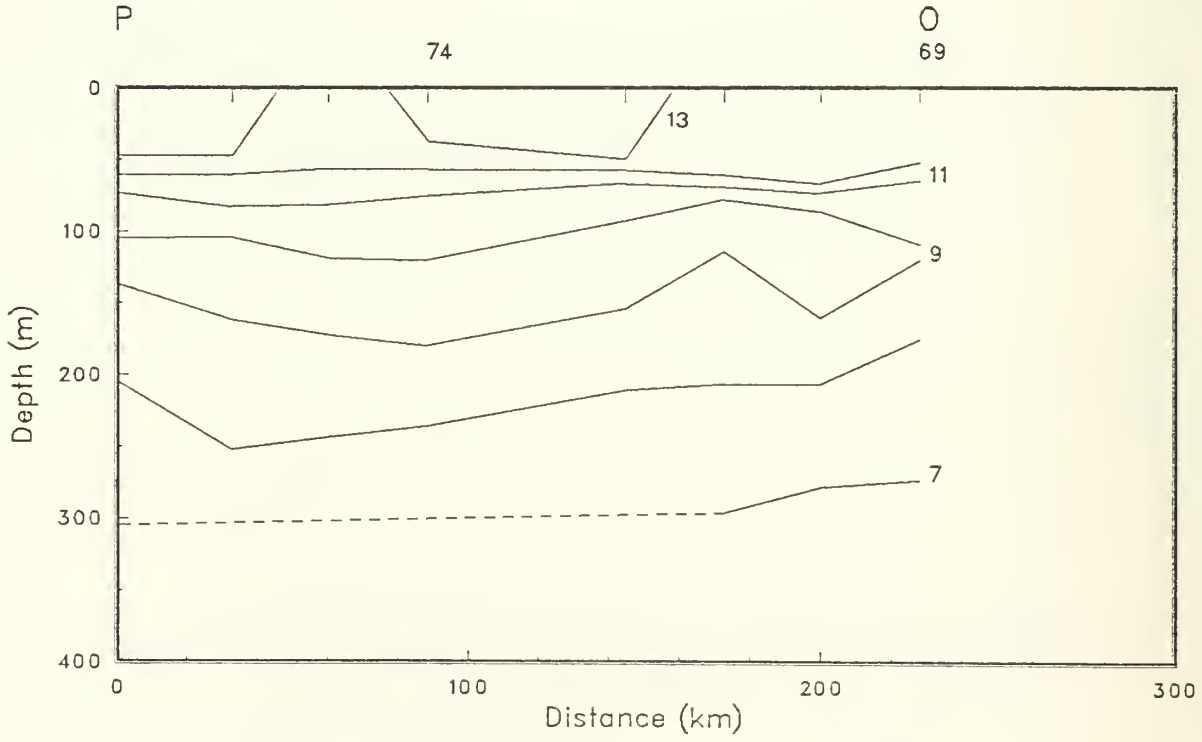

Figure 6(h)

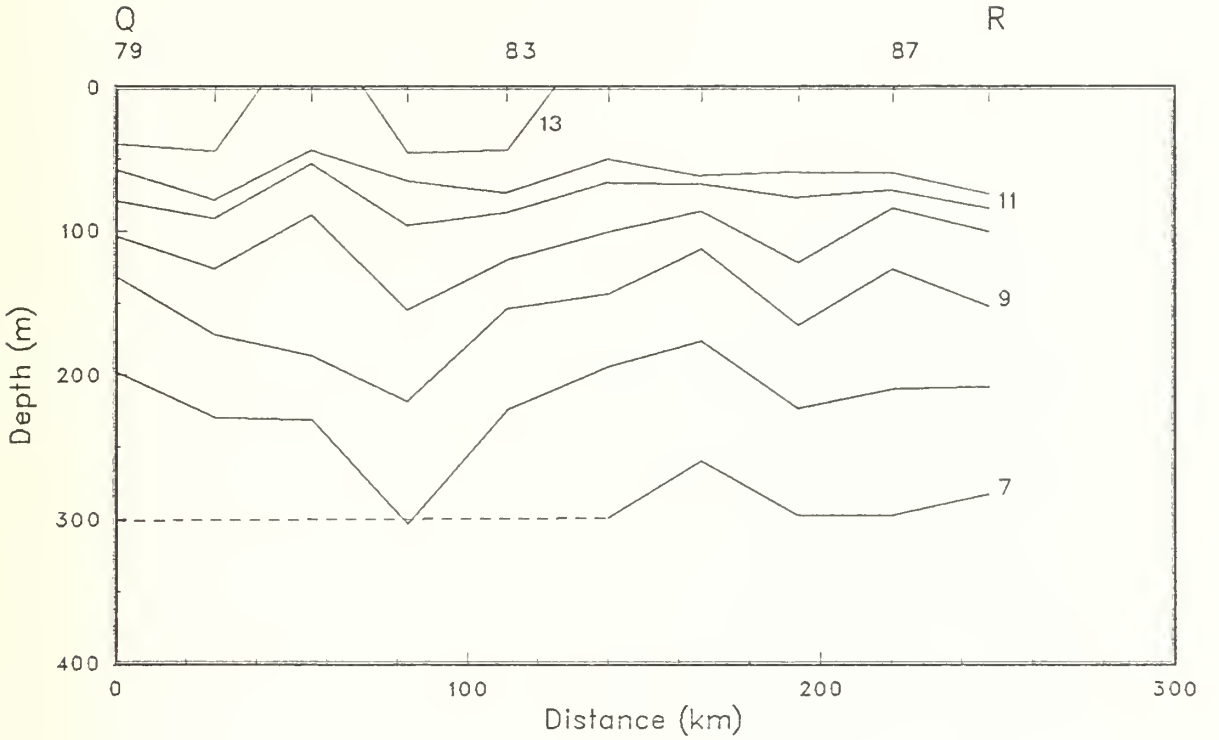

Figure 6(i)

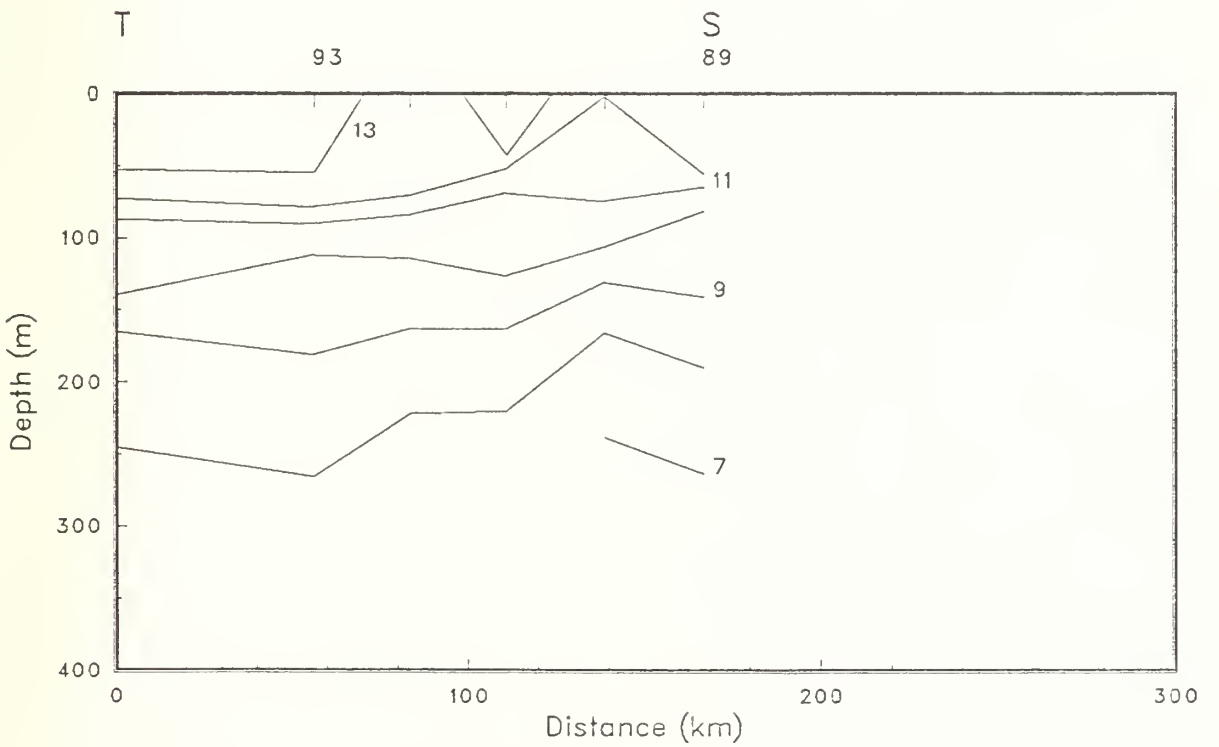

Figure 6(j)

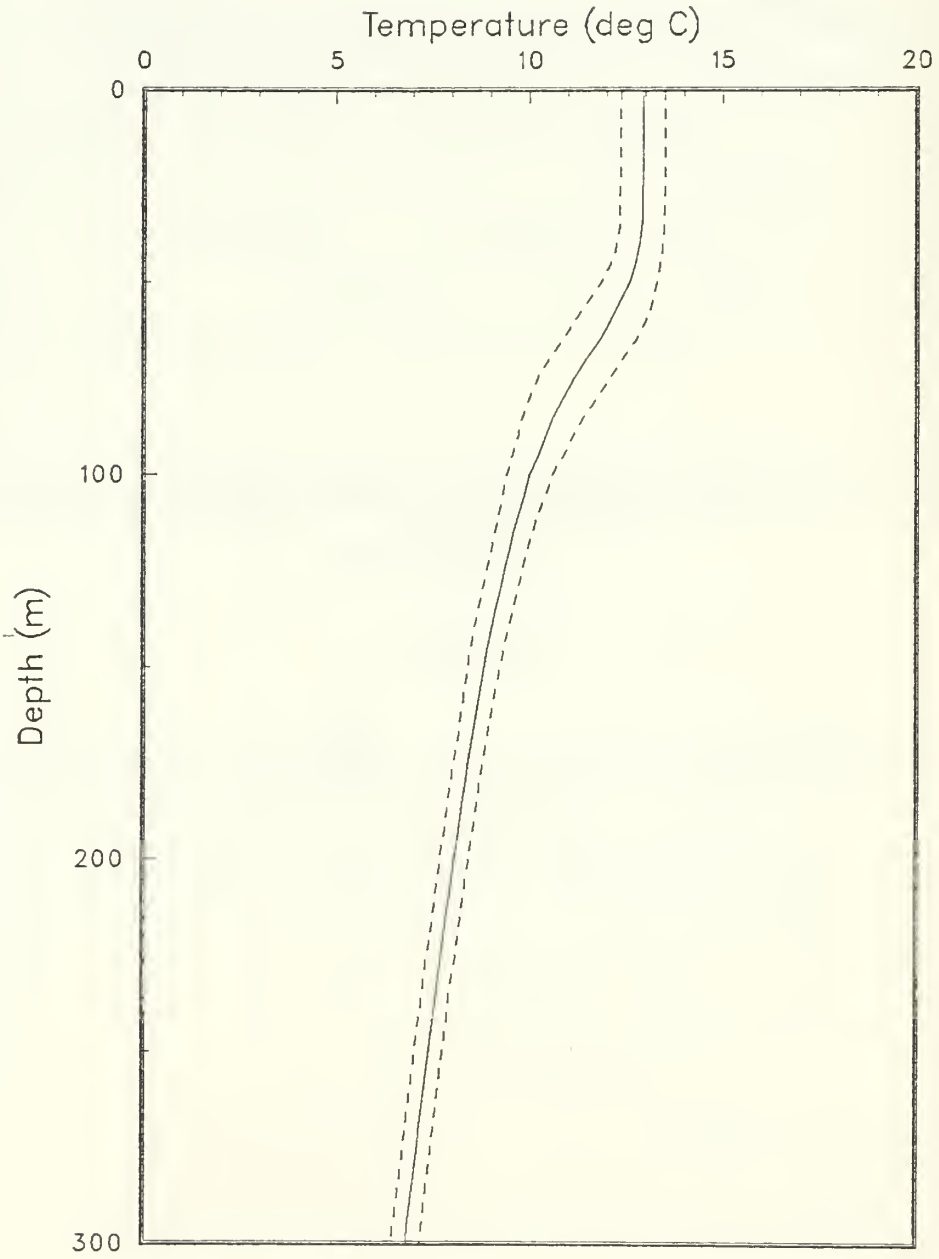

Figure 7: Mean temperature profile, with + and - the standard deviation (OPTOMA20, Leg P).

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Section 2

OPTOMA20 Leg MI

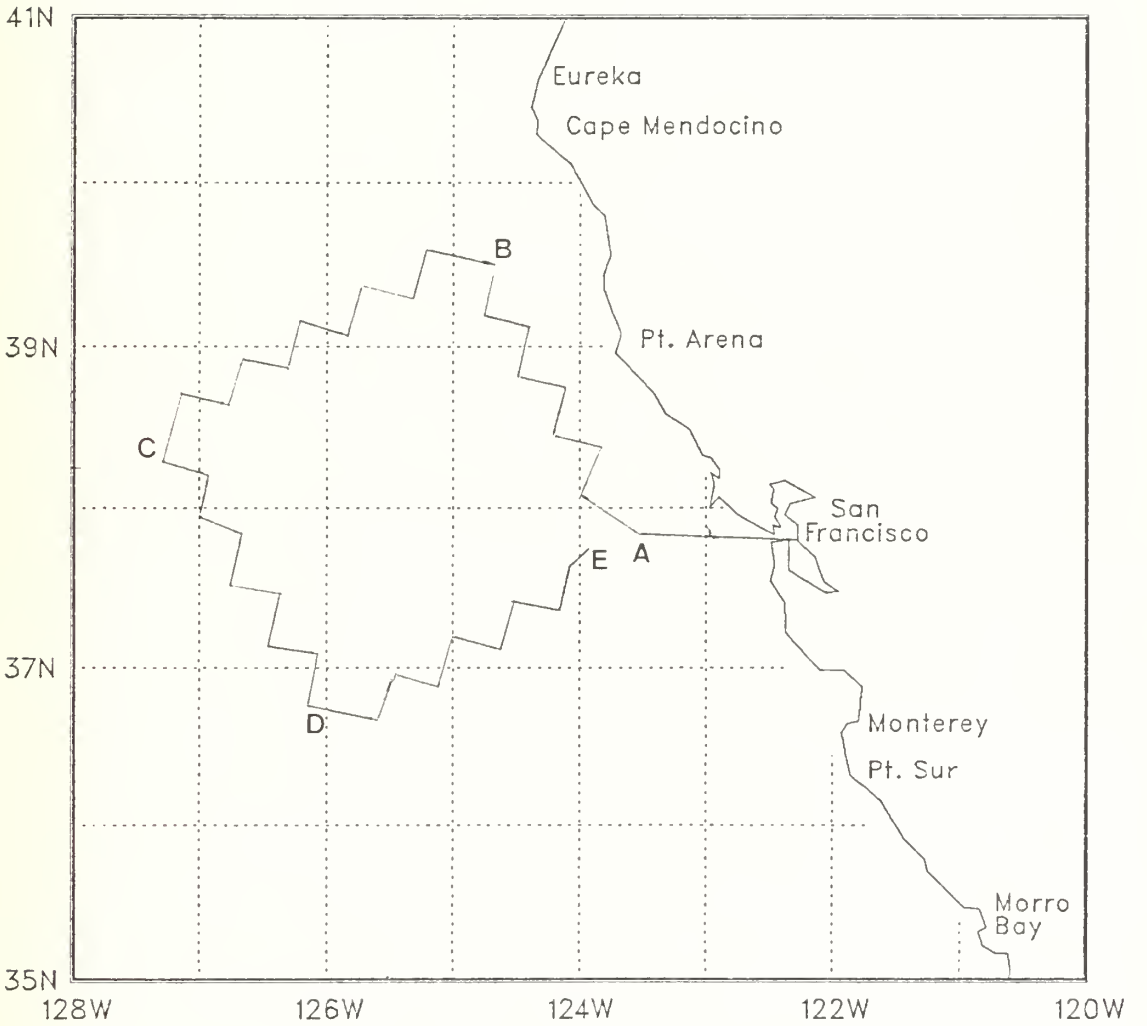


Figure 8(a): The cruise track for OPTOMA20, Leg MI.

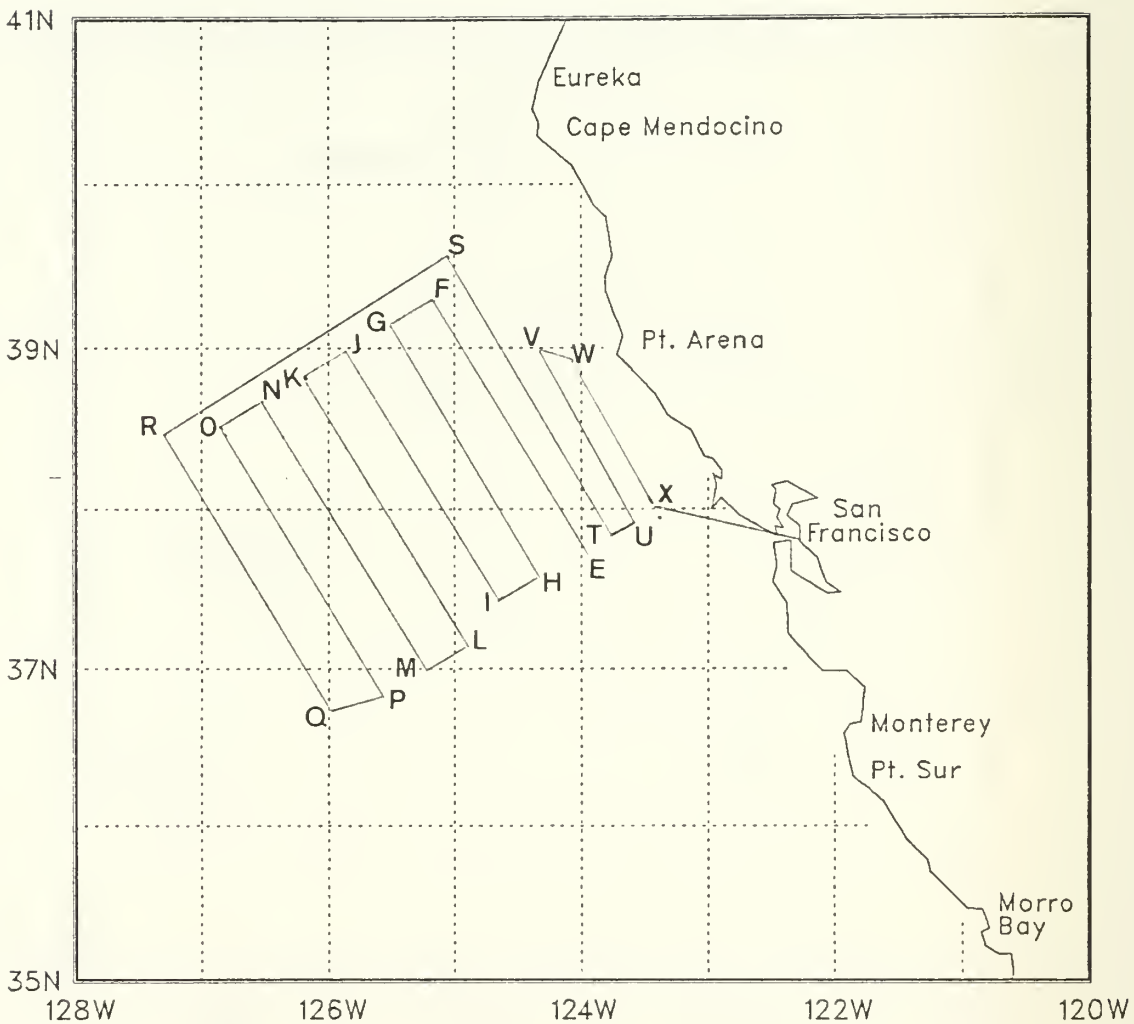

41N
39N
37N
35N
128W
126W
124W
122W
120W
Eureka
Cape Mendocino
Pt. Arena
San
Francisco
Monterey
Pt. Sur
Morro
Bay
S
F
G
J
V
W
K
N
R
O
X
T
U
E
H
I
L
M
Q
P

Figure 8(b)

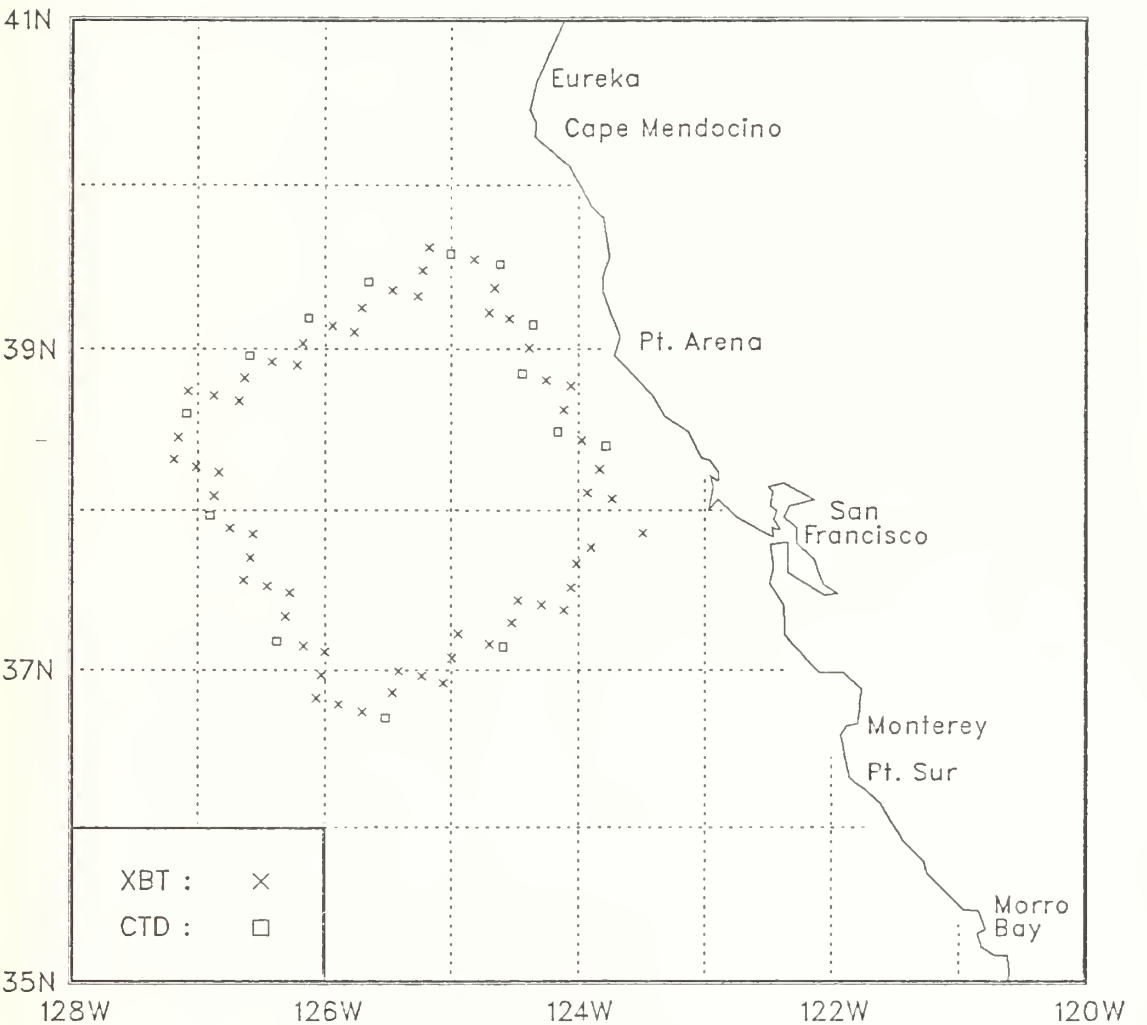


Figure 9(a): XBT and CTD locations for OPTOMA20, Leg MI.

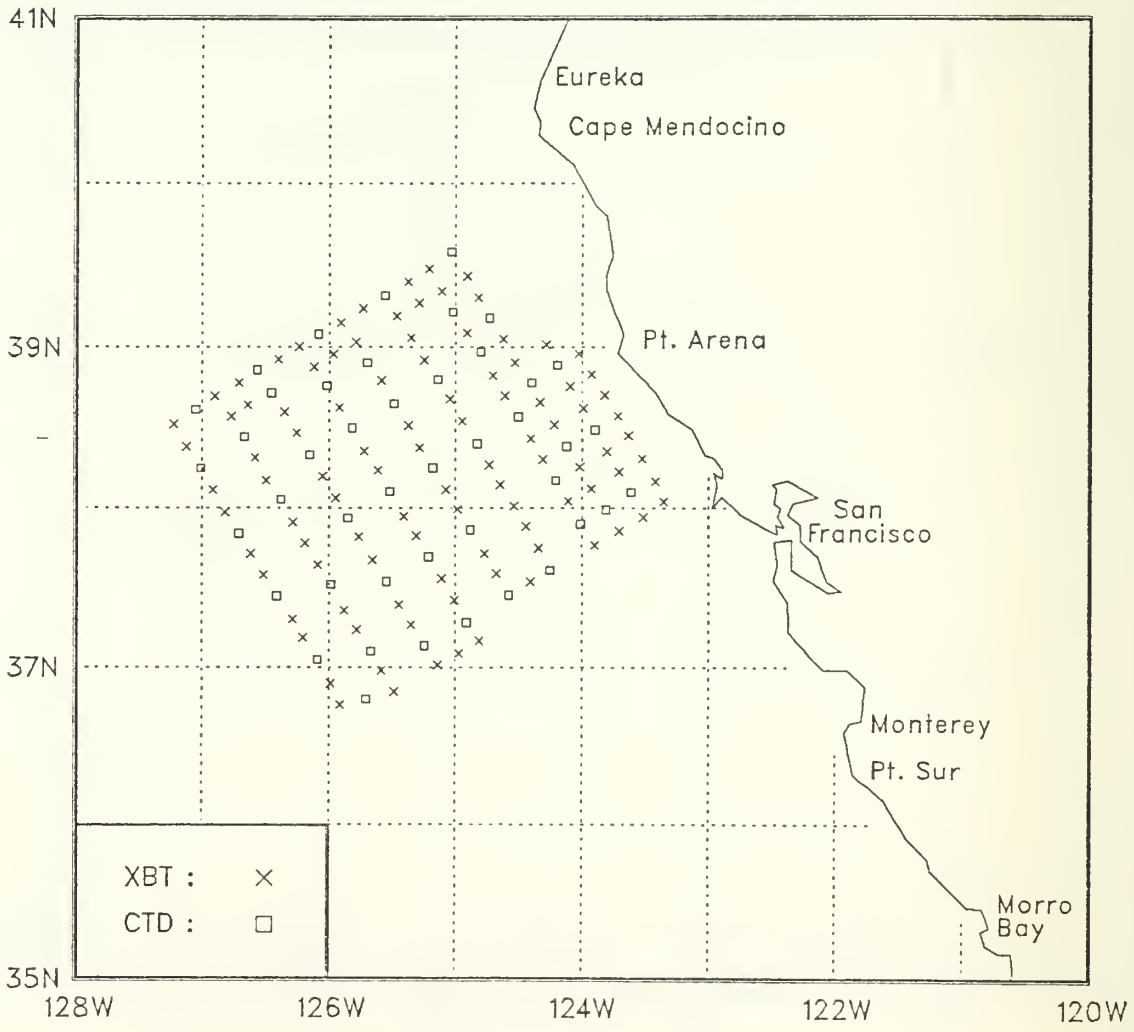

41N
39N
37N
35N
128W
126W
124W
122W
120W
Eureka
Cape Mendocino
Pt. Arena
San
Francisco
Monterey
Pt. Sur
Morro
Bay
XBT :
CTD :

Figure 9(b)

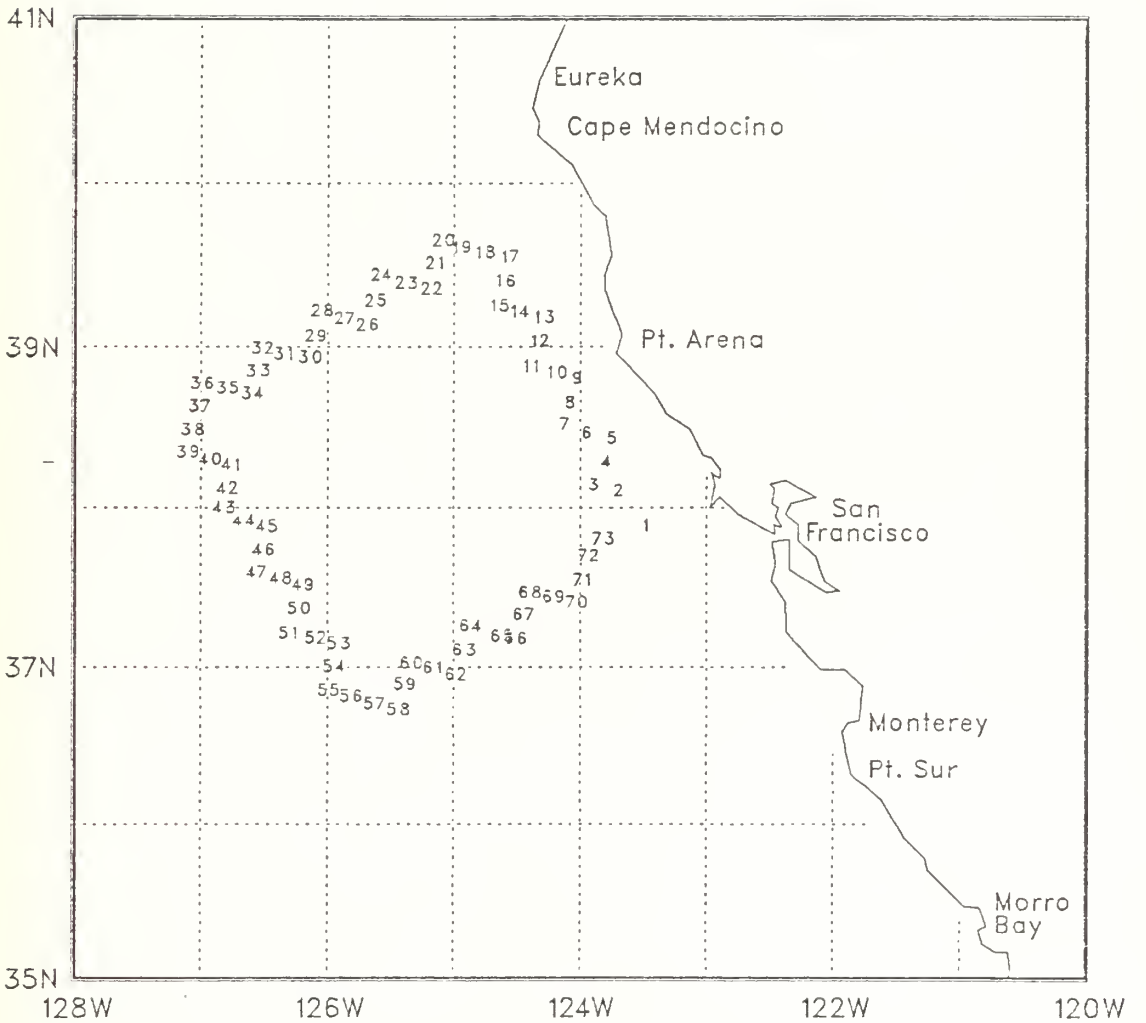


Figure 10(a): Station numbers for OPTOMA20, Leg MI.

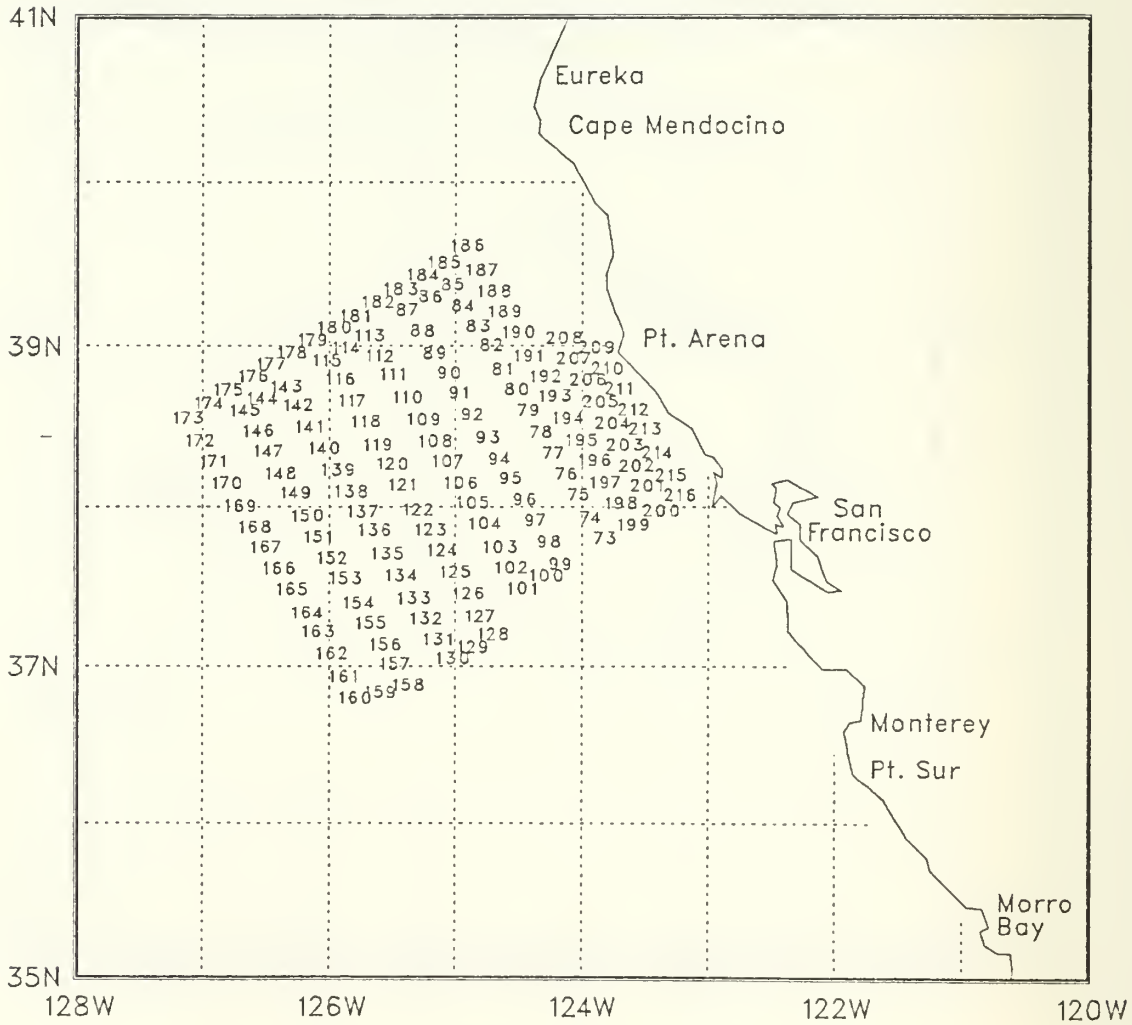

41N
39N
37N
35N
128W
126W
124W
122W
120W
Eureka
Cape Mendocino
Pt. Arena
San
Francisco
Monterey
Pt. Sur
Morro
Bay

Figure 10(b)

Table 4: OPTOMA20 Leg MI Station Listing

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
1	XBT	86083	2353	37.52	123.29	13.1			
2	XBT	86084	202	38.05	123.44	13.2			
3	XBT	86084	239	38.07	123.55	13.4			
4	XBT	86084	331	38.15	123.50	13.4			
5	CTD	86084	433	38.24	123.47	12.5	32.63	12.8	32.72
6	XBT	86084	535	38.26	123.58	13.2			
7	CTD	86084	648	38.29	124.09	12.4	32.61	12.8	32.65
8	XBT	86084	802	38.38	124.07	12.7			
9	XBT	86084	848	38.46	124.03	12.6			
10	XBT	86084	936	38.49	124.15	12.6			
11	CTD	86084	1057	38.51	124.03	12.2	32.48	12.6	32.46
12	XBT	86084	1219	39.00	124.23	12.5			
13	CTD	86084	1323	39.09	124.21	12.2	32.12	12.5	32.46
14	XBT	86084	1434	39.06	124.35	12.5			
15	XBT	86084	1519	39.13	124.42	12.5			
16	XBT	86084	1607	39.23	124.39	12.6			
17	CTD	86084	1702	39.31	124.37	12.3	32.61	12.7	32.65
18	XBT	86084	1806	39.33	124.49	12.8			
19	CTD	86084	1933	39.35	125.00	12.2	32.58	12.8	32.65
20	XBT	86084	2104	39.37	125.10	12.7			
21	XBT	86084	2152	39.29	125.13	12.7			
22	XBT	86084	2237	39.20	125.16	13.2			
23	XBT	86084	2325	39.22	125.28	13.6			
24	CTD	86085	23	39.25	125.39	12.5	32.74	*	32.77
25	XBT	86085	128	39.15	125.42	13.9			
26	XBT	86085	211	39.06	125.46	13.4			
27	XBT	86085	259	39.09	125.57	13.5			
28	CTD	86085	503	39.12	126.08	12.7	32.78	*	32.77
29	XBT	86085	554	39.02	126.11	13.4			
30	XBT	86085	638	38.54	126.13	13.1			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
31	XBT	86085	726	38.55	126.25	13.3			
32	CTD	86085	825	38.58	126.36	12.7	32.70	*	32.66
33	XBT	86085	931	38.49	126.38	12.9			
34	XBT	86085	1018	38.41	126.41	13.8			
35	XBT	86085	1108	38.43	126.52	12.3			
36	XBT	86085	1159	38.45	127.05	12.0			
37	CTD	86085	1321	38.36	127.05	11.9	32.63	*	32.60
38	XBT	86085	1457	38.27	127.09	13.0			
39	XBT	86085	1538	38.19	127.11	12.9			
40	XBT	86085	1622	38.16	127.01	12.5			
41	XBT	86085	1702	38.14	126.50	12.7			
42	XBT	86085	1747	38.06	126.53	13.3			
43	CTD	86085	1921	37.58	126.54	13.1	32.74	13.9	32.73
44	XBT	86085	2052	37.54	126.45	13.8			
45	XBT	86085	2136	37.51	126.34	12.9			
46	XBT	86085	2221	37.42	126.35	13.8			
47	XBT	86085	2306	37.34	126.38	14.7			
48	XBT	86086	1	37.32	126.27	13.7			
49	XBT	86086	33	37.29	126.17	12.8			
50	XBT	86086	122	37.20	126.19	14.4			
51	CTD	86086	255	37.11	126.23	13.8	32.95	*	32.94
52	XBT	86086	450	37.09	126.10	14.8			
53	XBT	86086	533	37.07	126.00	14.0			
54	XBT	86086	615	36.58	126.02	14.1			
55	XBT	86086	700	36.49	126.04	14.3			
56	XBT	86086	744	36.47	125.54	14.7			
57	XBT	86086	832	36.44	125.42	14.3			
58	CTD	86086	930	36.42	125.31	13.7	32.69	14.1	32.69
59	XBT	86086	1037	36.52	125.28	14.0			
60	XBT	86086	1123	37.00	125.25	14.0			
61	XBT	86086	1211	36.58	125.14	13.7			
62	XBT	86086	1253	36.55	125.03	13.8			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
63	XBT	86086	1339	37.05	125.00	13.8			
64	XBT	86086	1427	37.14	124.57	13.6			
65	XBT	86086	1530	37.10	124.41	13.5			
66	CTD	86086	1640	37.11	124.35	13.5	32.83	13.9	32.82
67	XBT	86086	1842	37.18	124.31	13.6			
68	XBT	86086	1924	37.26	124.29	13.8			
69	XBT	86086	2007	37.25	124.17	13.9			
70	XBT	86086	2052	37.23	124.07	13.8			
71	XBT	86086	2141	37.31	124.03	13.4			
72	XBT	86086	2230	37.40	124.01	13.4			
73	XBT	86086	2313	37.46	123.54	13.8			
74	CTD	86087	17	37.54	124.00	12.9	32.71	*	32.72
75	XBT	86087	132	38.03	124.06	13.2			
76	CTD	86087	228	38.11	124.12	12.9	32.67	13.3	32.69
77	XBT	86087	338	38.18	124.18	13.5			
78	XBT	86087	423	38.26	124.24	13.1			
79	CTD	86087	524	38.34	124.25	11.9	32.18	*	32.17
80	XBT	86087	632	38.42	124.36	12.9			
81	XBT	86087	717	38.50	124.42	12.7			
82	CTD	86087	815	38.58	124.48	12.6	32.57	13.1	32.60
83	XBT	86087	917	39.05	124.54	13.0			
84	CTD	86087	1014	39.13	125.01	12.7	32.68	13.2	32.70
85	XBT	86087	1115	39.21	125.06	13.4			
86	XBT	86087	1204	39.16	125.17	13.8			
87	XBT	86087	1251	39.12	125.28	13.7			
88	XBT	86087	1337	39.04	125.21	13.6			
89	XBT	86087	1421	38.55	125.15	13.3			
90	CTD	86087	1547	38.48	125.08	12.5	32.67	12.9	32.69
91	XBT	86087	1709	38.41	125.03	13.4			
92	XBT	86087	1754	38.33	124.57	13.7			
93	CTD	86087	1853	38.24	124.50	13.2	32.75	14.0	32.79
94	XBT	86087	1959	38.16	124.44	13.9			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
95	XBT	86087	2042	38.09	124.39	13.5			
96	XBT	86087	2141	38.01	124.32	13.8			
97	XBT	86087	2229	37.53	124.27	13.4			
98	XBT	86087	2314	37.45	124.21	13.4			
99	CTD	86088	16	37.37	124.15	13.1	32.85	*	32.88
100	XBT	86088	120	37.32	124.24	13.7			
101	CTD	86088	214	37.27	124.35	13.4	32.85	*	32.86
102	XBT	86088	327	37.35	124.40	13.9			
103	XBT	86088	410	37.43	124.46	14.1			
104	CTD	86088	511	37.52	124.53	13.5	32.64	13.9	32.63
105	XBT	86088	618	38.00	124.59	14.0			
106	XBT	86088	658	38.07	125.05	13.8			
107	CTD	86088	829	38.15	125.11	13.1	32.79	13.3	32.78
108	XBT	86088	956	38.23	125.17	13.6			
109	XBT	86088	1045	38.31	125.22	13.8			
110	CTD	86088	1149	38.39	125.29	13.0	32.76	13.1	32.71
111	XBT	86088	1315	38.48	125.35	13.3			
112	CTD	86088	1416	38.54	125.42	13.0	32.74	13.3	32.82
113	XBT	86088	1521	39.02	125.47	13.2			
114	XBT	86088	1612	38.57	125.58	13.2			
115	XBT	86088	1653	38.53	126.07	13.4			
116	CTD	86088	1746	38.46	126.01	12.9	32.83	13.3	32.83
117	XBT	86088	1847	38.38	125.55	13.3			
118	CTD	86088	1949	38.30	125.49	13.0	32.80	13.3	32.77
119	XBT	86088	2054	38.22	125.43	13.3			
120	XBT	86088	2141	38.14	125.37	13.4			
121	CTD	86088	2241	38.06	125.31	13.5	32.82	*	32.80
122	XBT	86088	2352	37.57	125.24	13.6			
123	XBT	86089	32	37.50	125.19	13.9			
124	CTD	86089	132	37.42	125.13	13.1	32.82	14.0	32.79
125	XBT	86089	241	37.34	125.07	14.2			
126	XBT	86089	327	37.25	125.00	14.0			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
127	CTD	86089	427	37.17	124.55	13.8	32.86	14.1	32.84
128	XBT	86089	528	37.10	124.49	14.5			
129	XBT	86089	619	37.05	124.58	14.1			
130	XBT	86089	710	37.01	125.09	14.3			
131	CTD	86089	828	37.08	125.15	13.8	32.80	14.1	32.76
132	XBT	86089	955	37.16	125.21	14.1			
133	XBT	86089	1043	37.24	125.27	13.8			
134	CTD	86089	1215	37.32	125.33	13.4	32.89	13.9	32.85
135	XBT	86089	1410	37.41	125.39	13.5			
136	XBT	86089	1504	37.49	125.46	13.6			
137	CTD	86089	1629	37.56	125.51	13.6	32.95	13.4	32.95
138	XBT	86089	1804	38.04	125.57	13.7			
139	XBT	86089	1859	38.12	126.03	13.9			
140	CTD	86089	2026	38.20	126.09	13.2	32.74	13.4	32.81
141	XBT	86089	2239	38.28	126.15	13.3			
142	XBT	86089	2333	38.36	126.21	13.1			
143	CTD	86090	221	38.43	126.27	13.4	32.78	13.6	32.75
144	XBT	86090	316	38.39	126.38	13.2			
145	XBT	86090	358	38.34	126.46	12.5			
146	CTD	86090	459	38.27	126.40	12.2	32.60	*	32.66
147	XBT	86090	607	38.19	126.35	12.8			
148	XBT	86090	657	38.11	126.30	13.1			
149	CTD	86090	802	38.03	126.22	13.2	32.72	13.4	32.76
150	XBT	86090	914	37.55	126.17	13.2			
151	XBT	86090	1002	37.47	126.11	13.4			
152	XBT	86090	1047	37.39	126.05	13.4			
153	CTD	86090	1152	37.31	125.59	13.3	32.78	13.4	32.67
154	XBT	86090	1312	37.22	125.53	13.2			
155	XBT	86090	1357	37.14	125.47	13.3			
156	CTD	86090	1457	37.06	125.40	13.7	32.84	13.9	32.75
157	XBT	86090	1607	36.59	125.35	13.9			
158	XBT	86090	1655	36.51	125.29	13.9			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
159	CTD	86090	1802	36.48	125.42	13.9	32.70	14.2	32.63
160	XBT	86090	1914	36.46	125.55	13.8			
161	XBT	86090	2002	36.54	125.59	13.9			
162	CTD	86090	2122	37.03	126.05	13.7	32.91	14.0	32.86
163	XBT	86090	2223	37.11	126.12	14.2			
164	XBT	86090	2310	37.18	126.17	13.4			
165	CTD	86091	21	37.27	126.24	13.4	32.80	13.7	32.80
166	XBT	86091	143	37.35	126.31	13.4			
167	XBT	86091	243	37.43	126.37	12.5			
168	CTD	86091	351	37.51	126.42	12.3	32.66	12.6	*
169	XBT	86091	514	37.58	126.49	12.3			
170	XBT	86091	617	38.07	126.55	12.7			
171	CTD	86091	731	38.15	127.01	13.0	32.74	13.2	32.73
172	XBT	86091	857	38.23	127.07	12.8			
173	XBT	86091	958	38.31	127.13	12.0			
174	CTD	86091	1123	38.37	127.03	12.1	32.62	12.4	32.60
175	XBT	86091	1234	38.42	126.54	12.5			
176	XBT	86091	1324	38.47	126.42	12.6			
177	CTD	86091	1423	38.51	126.34	12.8	32.63	13.1	32.71
178	XBT	86091	1523	38.56	126.24	12.9			
179	XBT	86091	1609	39.00	126.14	12.6			
180	CTD	86091	1708	39.05	126.05	13.0	32.83	13.3	32.89
181	XBT	86091	1818	39.09	125.54	13.3			
182	XBT	86091	1910	39.14	125.44	13.5			
183	CTD	86091	2010	39.19	125.34	13.1	32.93	13.3	32.91
184	XBT	86091	2118	39.24	125.23	13.4			
185	XBT	86091	2230	39.29	125.13	12.8			
186	CTD	86091	2336	39.35	125.02	12.4	32.22	12.8	32.21
187	XBT	86092	51	39.26	124.54	12.8			
188	XBT	86092	134	39.18	124.49	13.0			
189	CTD	86092	227	39.11	124.44	12.8	32.78	12.9	32.70
190	XBT	86092	331	39.03	124.37	13.2			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
191	XBT	86092	420	38.54	124.32	12.8			
192	CTD	86092	525	38.47	124.24	12.3	32.41	12.5	32.45
193	XBT	86092	623	38.40	124.20	12.1			
194	XBT	86092	706	38.31	124.13	11.8			
195	CTD	86092	805	38.23	124.07	11.7	32.00	12.1	32.52
196	XBT	86092	905	38.16	124.01	12.5			
197	XBT	86092	952	38.07	123.55	13.0			
198	CTD	86092	1054	38.00	123.48	12.7	32.61	12.9	32.59
199	XBT	86092	1200	37.51	123.43	12.4			
200	XBT	86092	1338	37.57	123.31	12.2			
201	CTD	86092	1514	38.06	123.37	12.3	32.55	12.6	32.54
202	XBT	86092	1655	38.14	123.42	13.1			
203	XBT	86092	1823	38.21	123.48	12.5			
204	CTD	86092	1957	38.29	123.54	12.2	32.49	12.4	32.45
205	XBT	86092	2123	38.38	123.59	11.8			
206	XBT	86092	2242	38.46	124.06	11.0			
207	CTD	86093	29	38.54	124.12	11.9	32.59	*	32.58
208	XBT	86093	208	39.01	124.17	12.0			
209	XBT	86093	319	38.58	124.01	11.3			
210	XBT	86093	402	38.50	123.55	10.7			
211	XBT	86093	446	38.42	123.49	11.1			
212	XBT	86093	530	38.34	123.43	11.3			
213	XBT	86093	607	38.27	123.38	11.8			
214	XBT	86093	658	38.19	123.31	12.1			
215	XBT	86093	736	38.10	123.25	11.5			
216	XBT	86093	818	38.03	123.21	11.1			

* Data not available

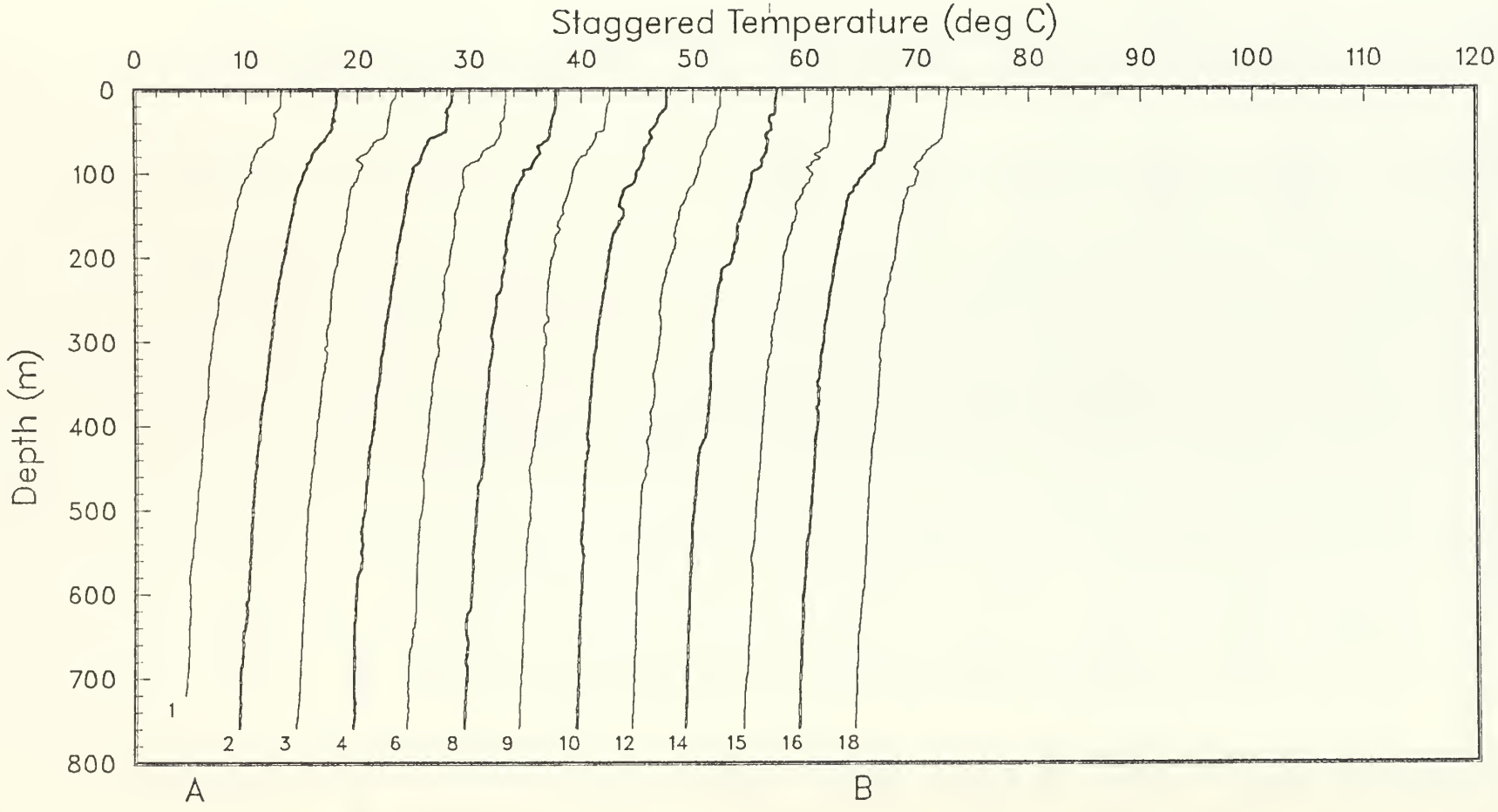


Figure 11(a): XBT temperature profiles, staggered by multiples of 5C (OPTOMA20, Leg MI).

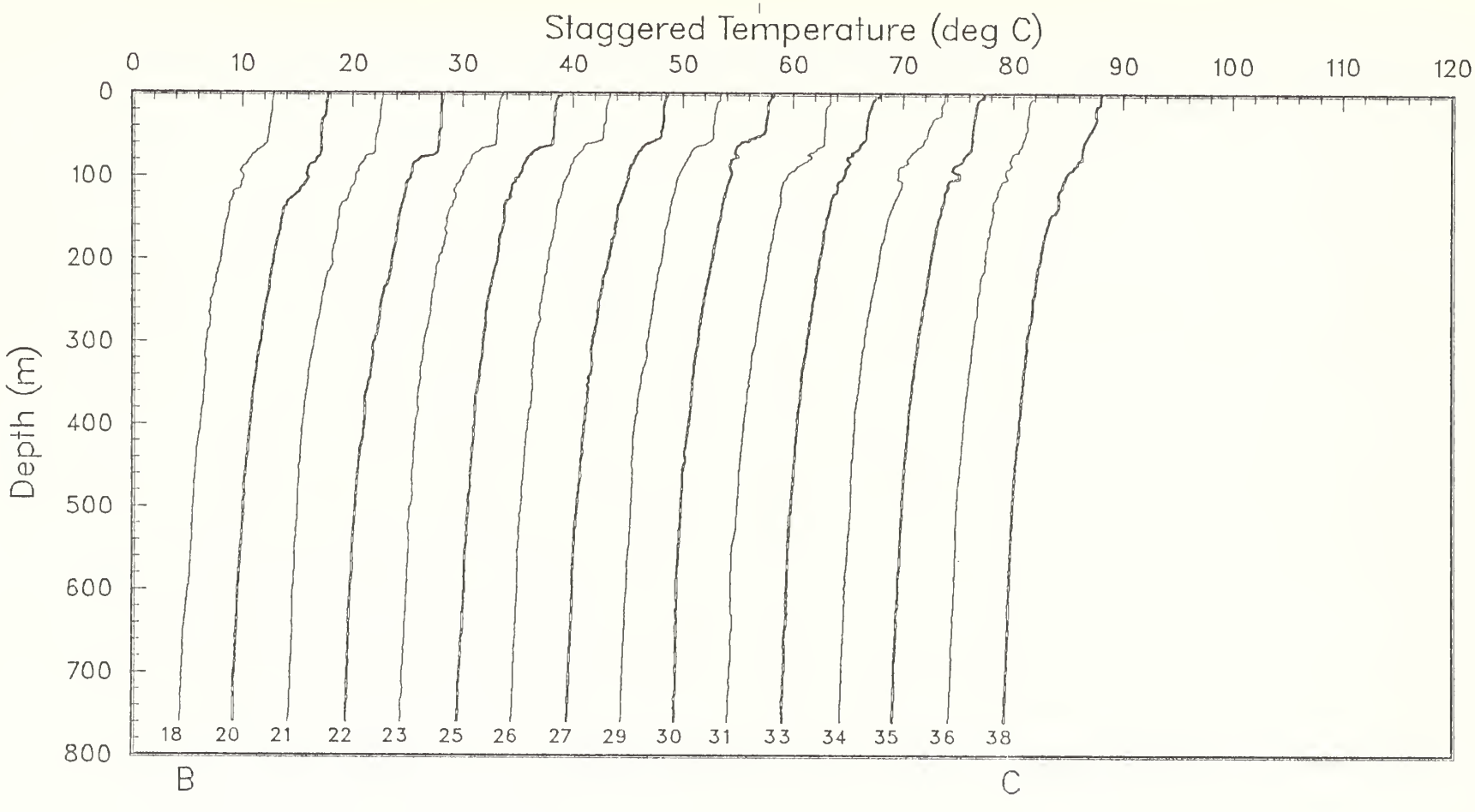

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
18
20
21
22
23
25
26
27
29
30
31
33
34
35
36
38
B
C

Figure 11(b)

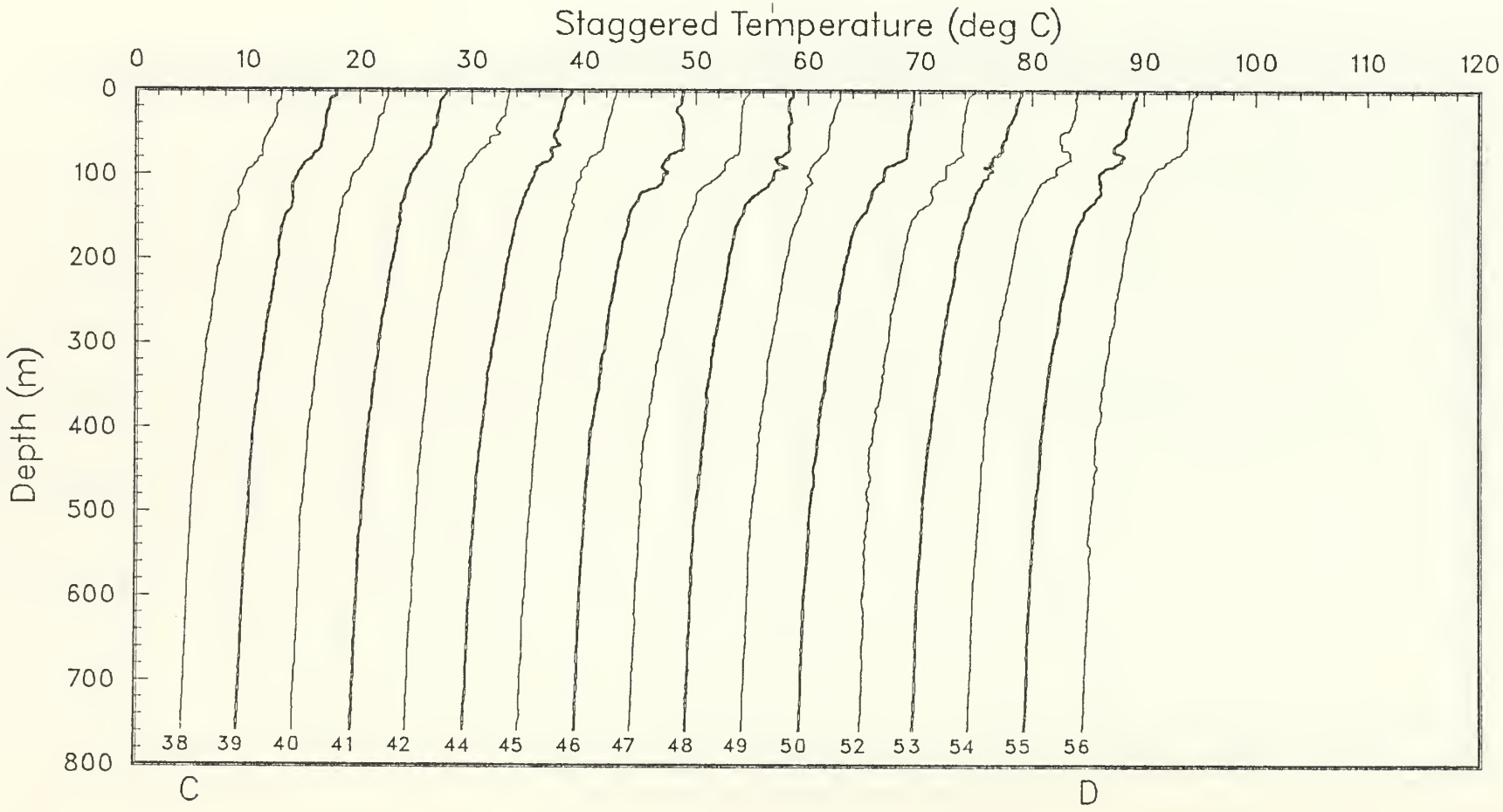

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
38
39
40
41
42
44
45
46
47
48
49
50
52
53
54
55
56
C
D

Figure 11(c)

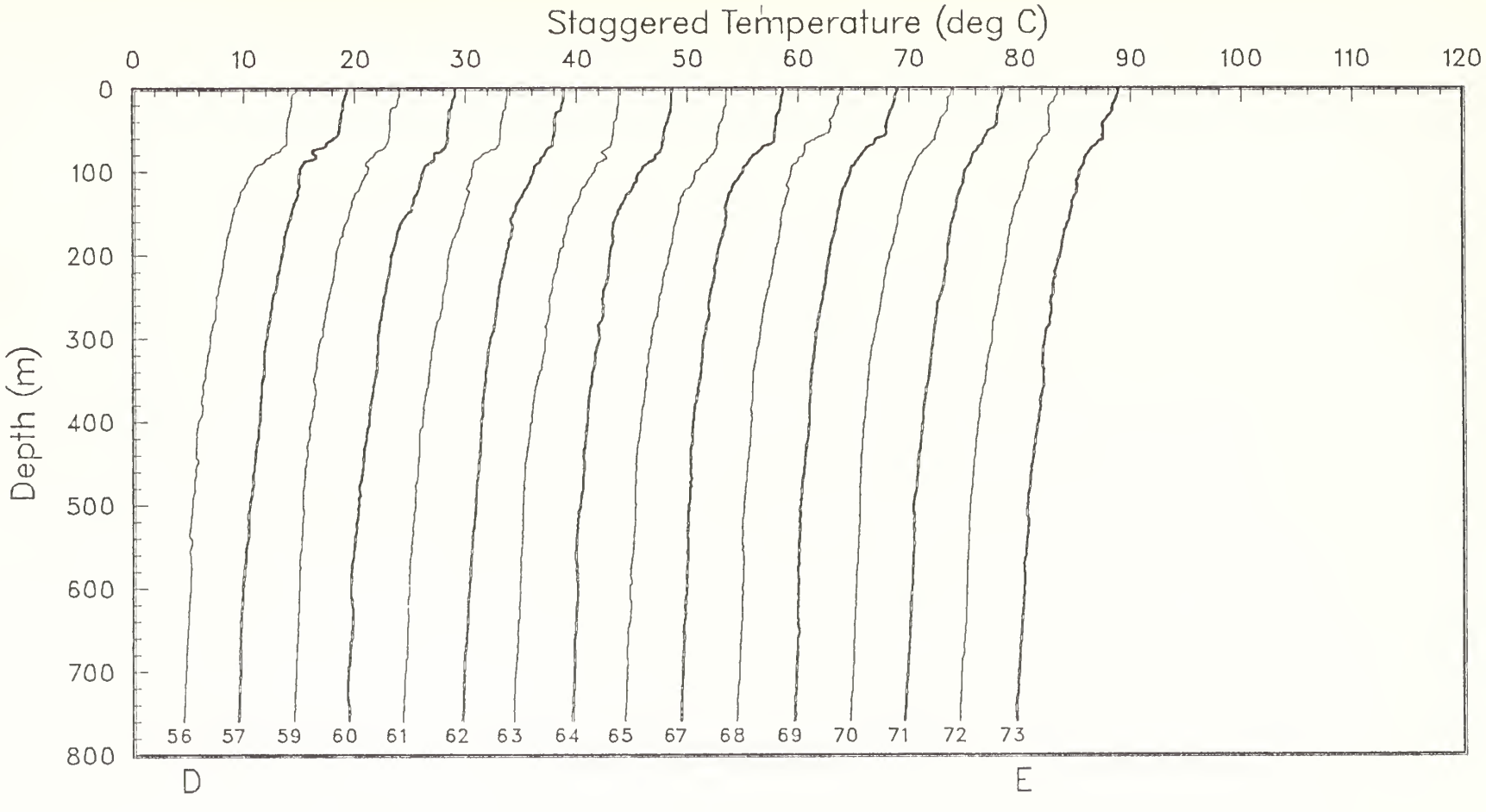

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
56
57
59
60
61
62
63
64
65
67
68
69
70
71
72
73
D
E

Figure 11(d)

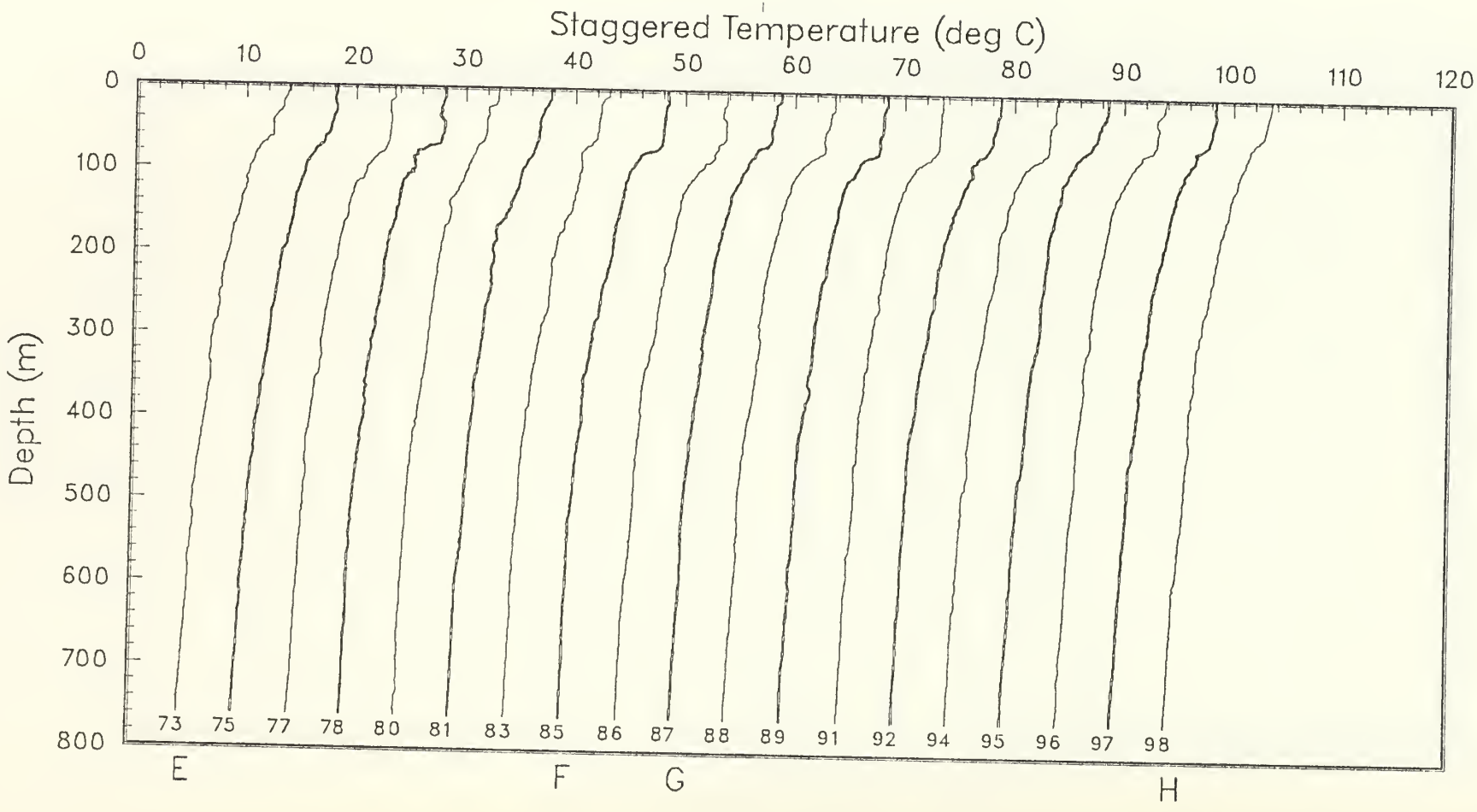

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
73
75
77
78
80
81
83
85
86
87
88
89
91
92
94
95
96
97
98
E
F
G
H

Figure 11(e)

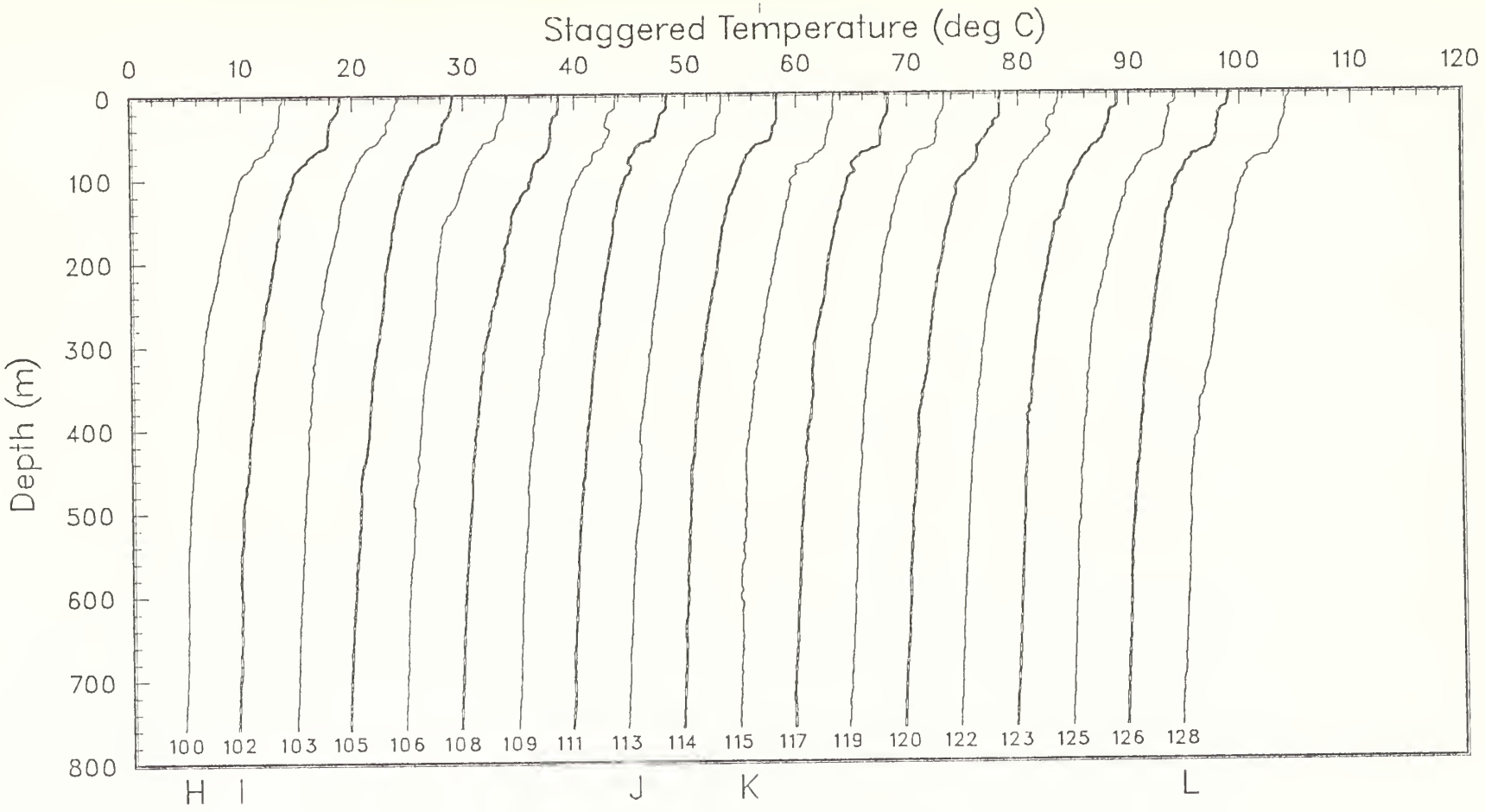

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
100 102 103 105 106 108 109 111 113 114 115 117 119 120 122 123 125 126 128
H
I
J
K
L

Figure 11(f)

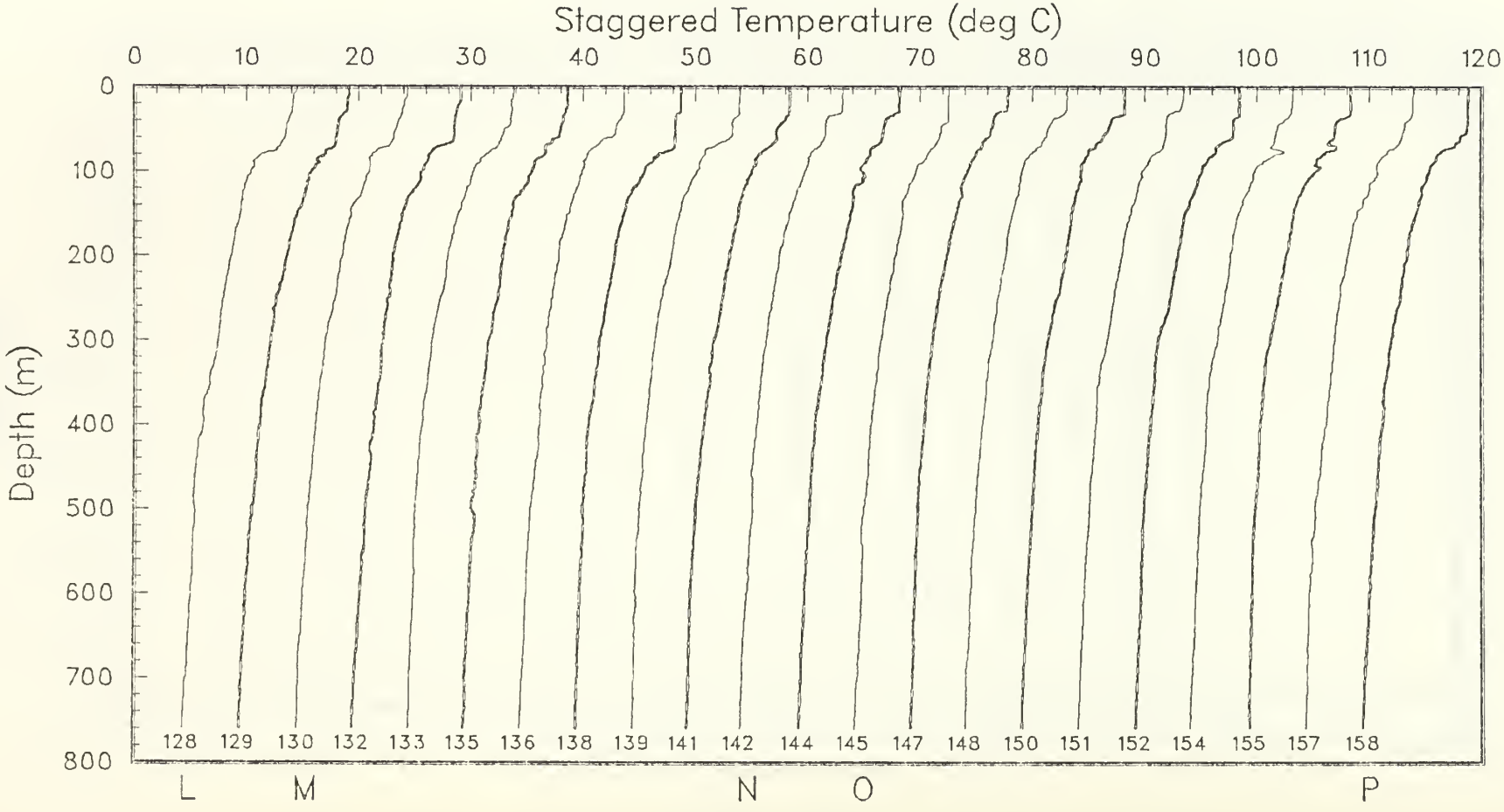

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
128
129
130
132
133
135
136
138
139
141
142
144
145
147
148
150
151
152
154
155
157
158
L
M
N
O
P

Figure 11(g)

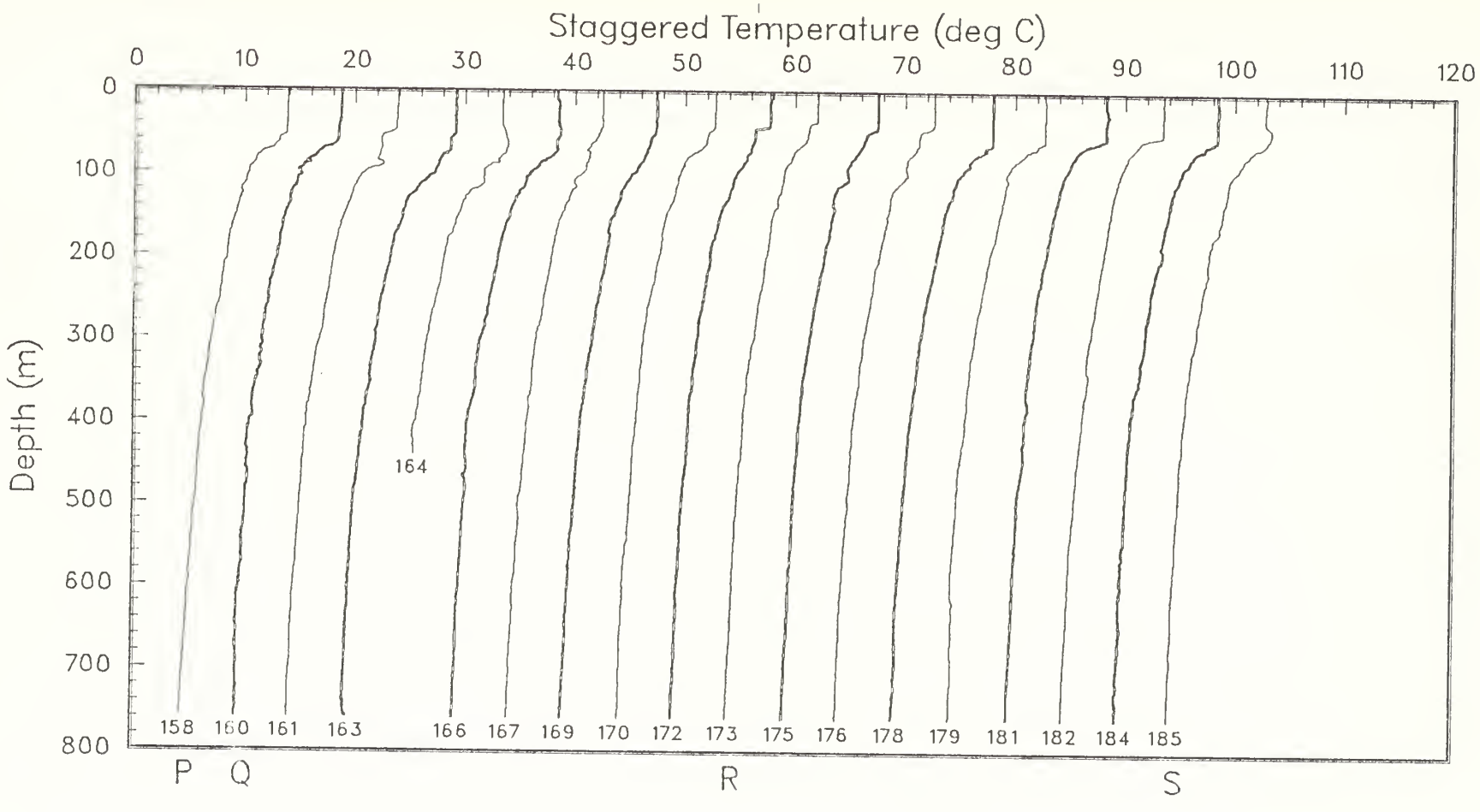

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
158
160
161
163
164
166
167
169
170
172
173
175
176
178
179
181
182
184
185
P
Q
R
S

Figure 11(h)

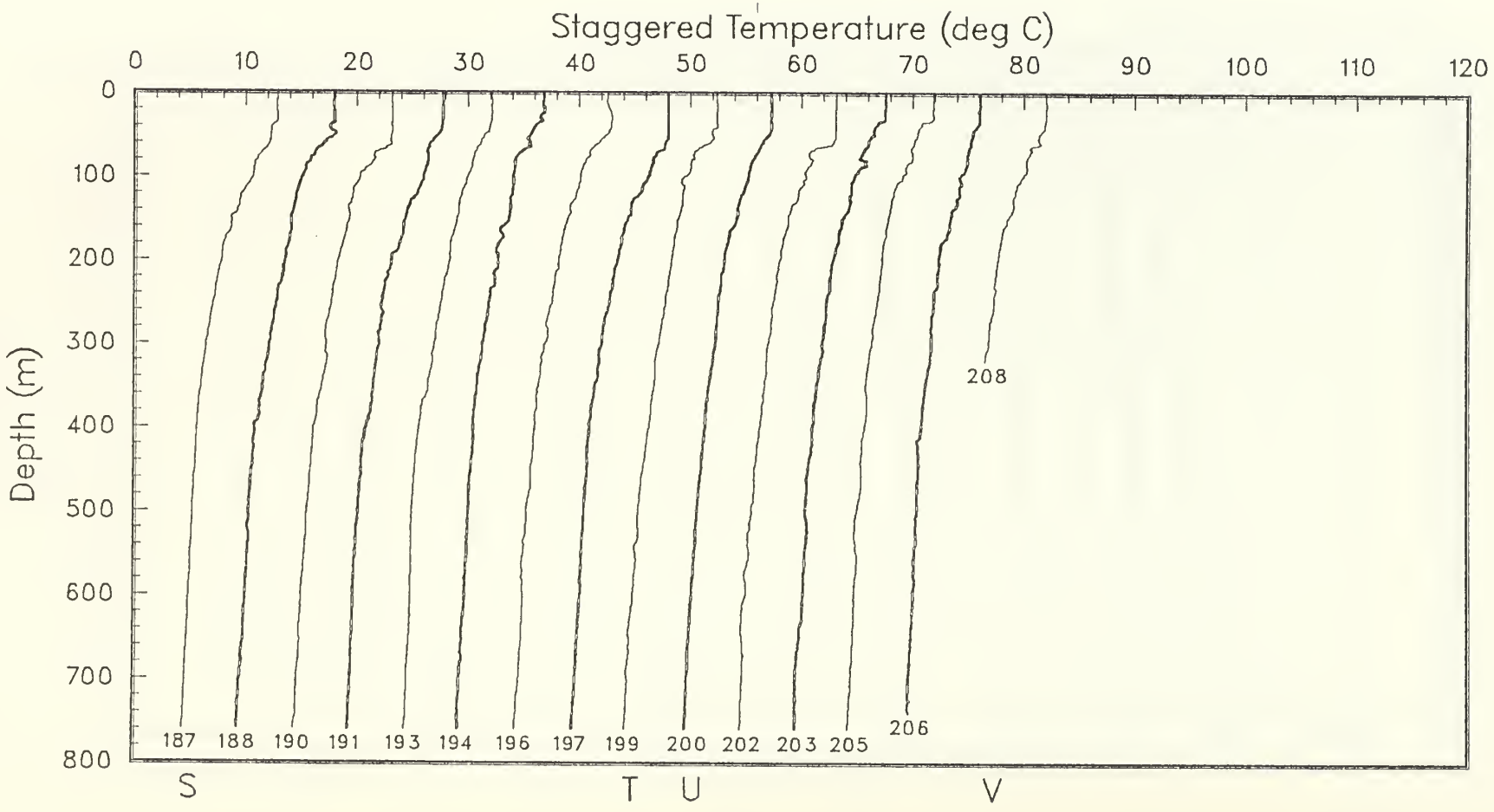

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
187
188
190
191
193
194
196
197
199
200
202
203
205
206
208
S
T
U
V

Figure 11(i)

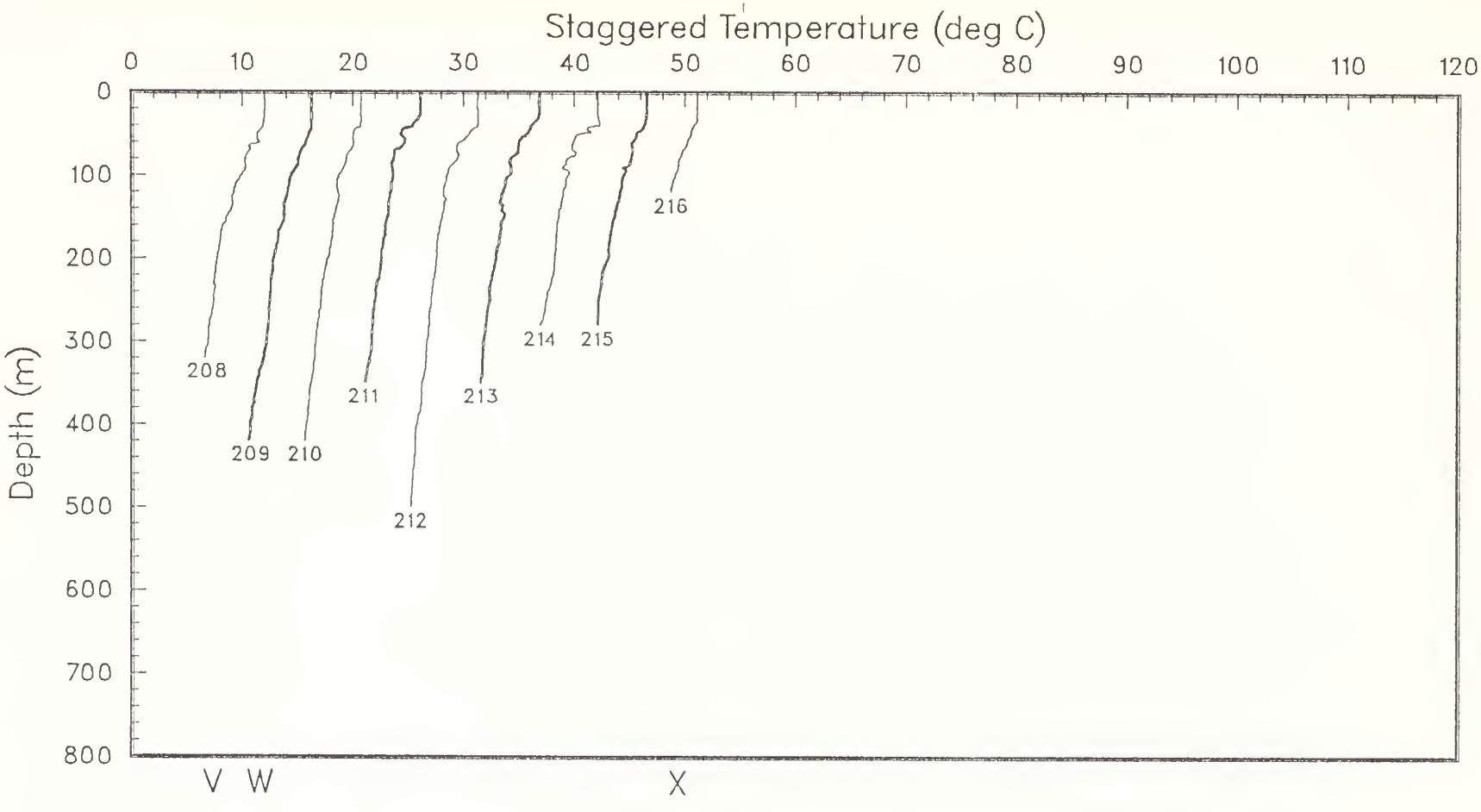

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
208
209
210
211
212
213
214
215
216
V
W
X

Figure 11(j)

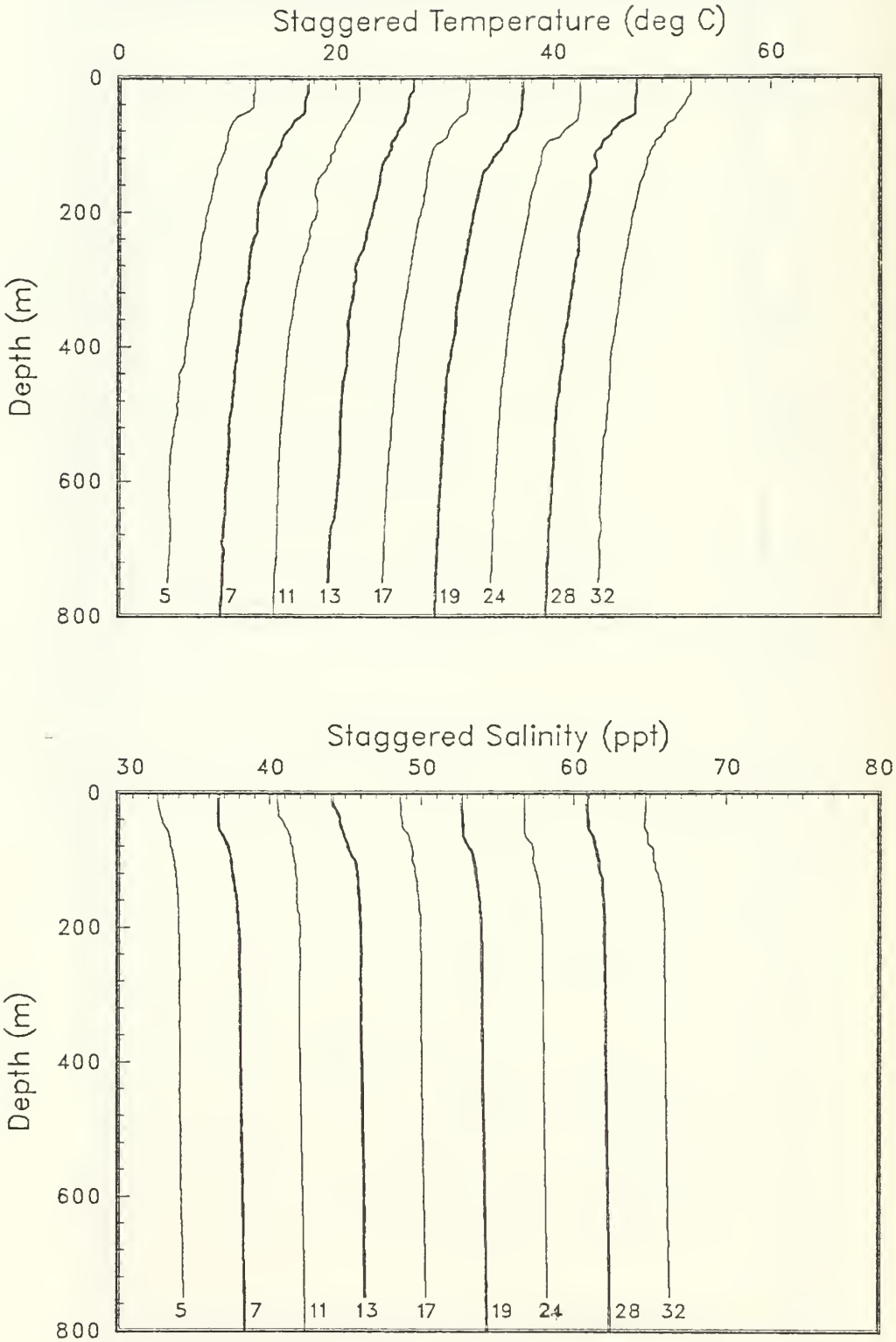
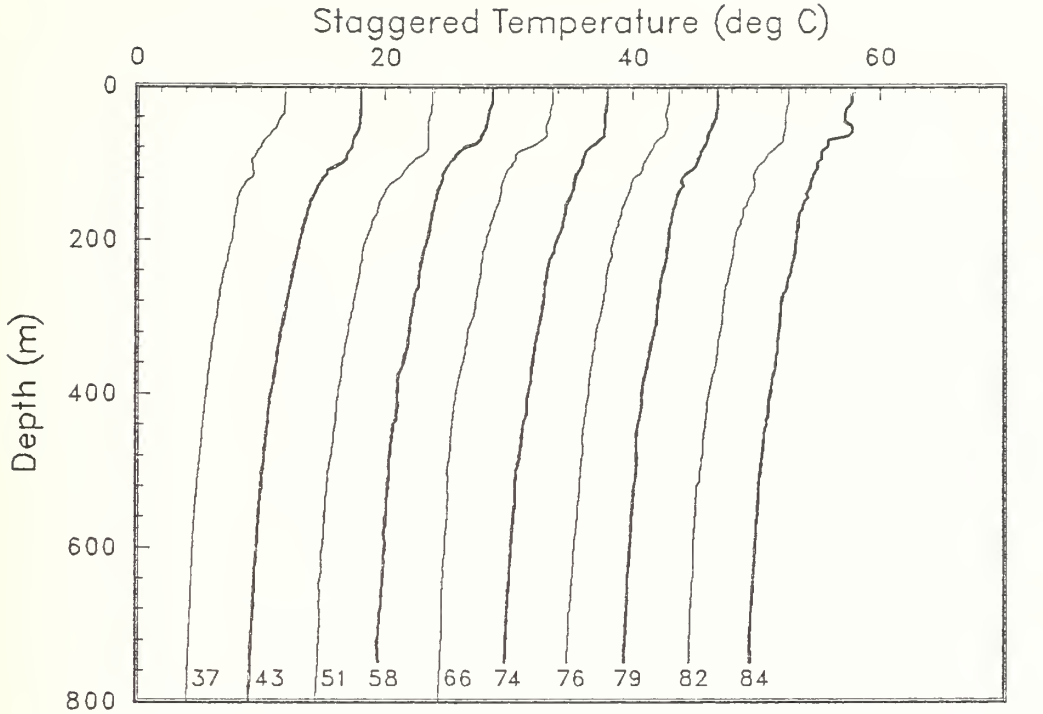


Figure 12(a): CTD temperature profiles, staggered by multiples of 5C, and salinity profiles staggered by multiples of 4 ppt (OPTOMA20, Leg MI).


Staggered Temperature (deg C)
0
20
40
60
0
200
400
600
800
Depth (m)
37
43
51
58
66
74
76
79
82
84

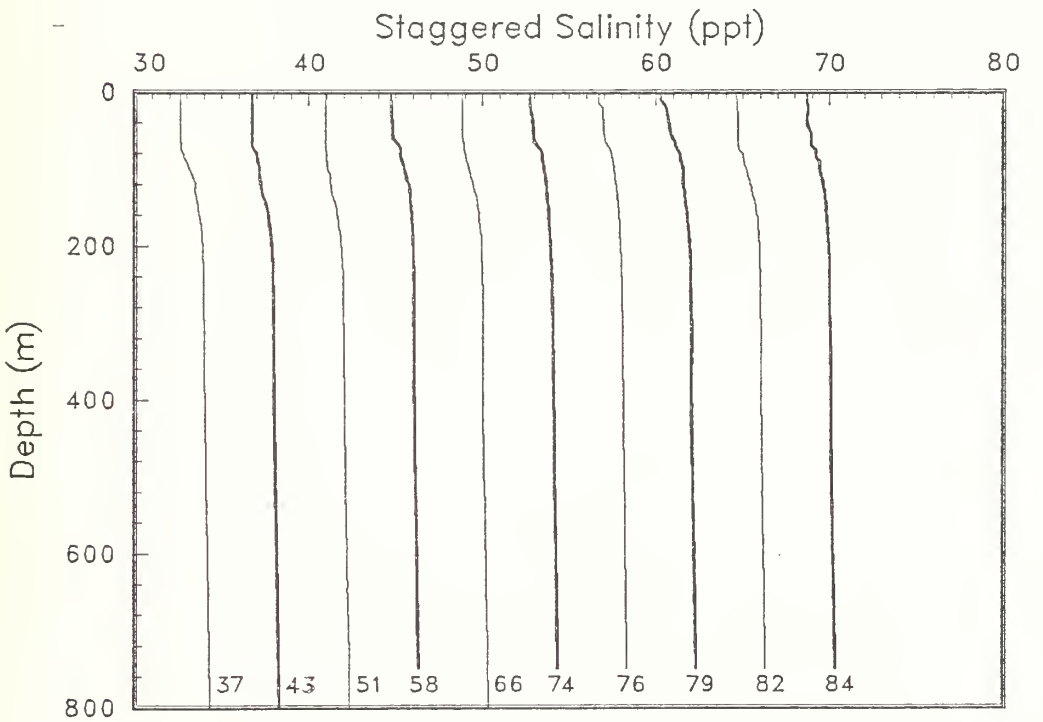

Staggered Salinity (ppt)
30
40
50
60
70
80
0
200
400
600
800
Depth (m)
37
43
51
58
66
74
76
79
82
84

Figure 12(b)

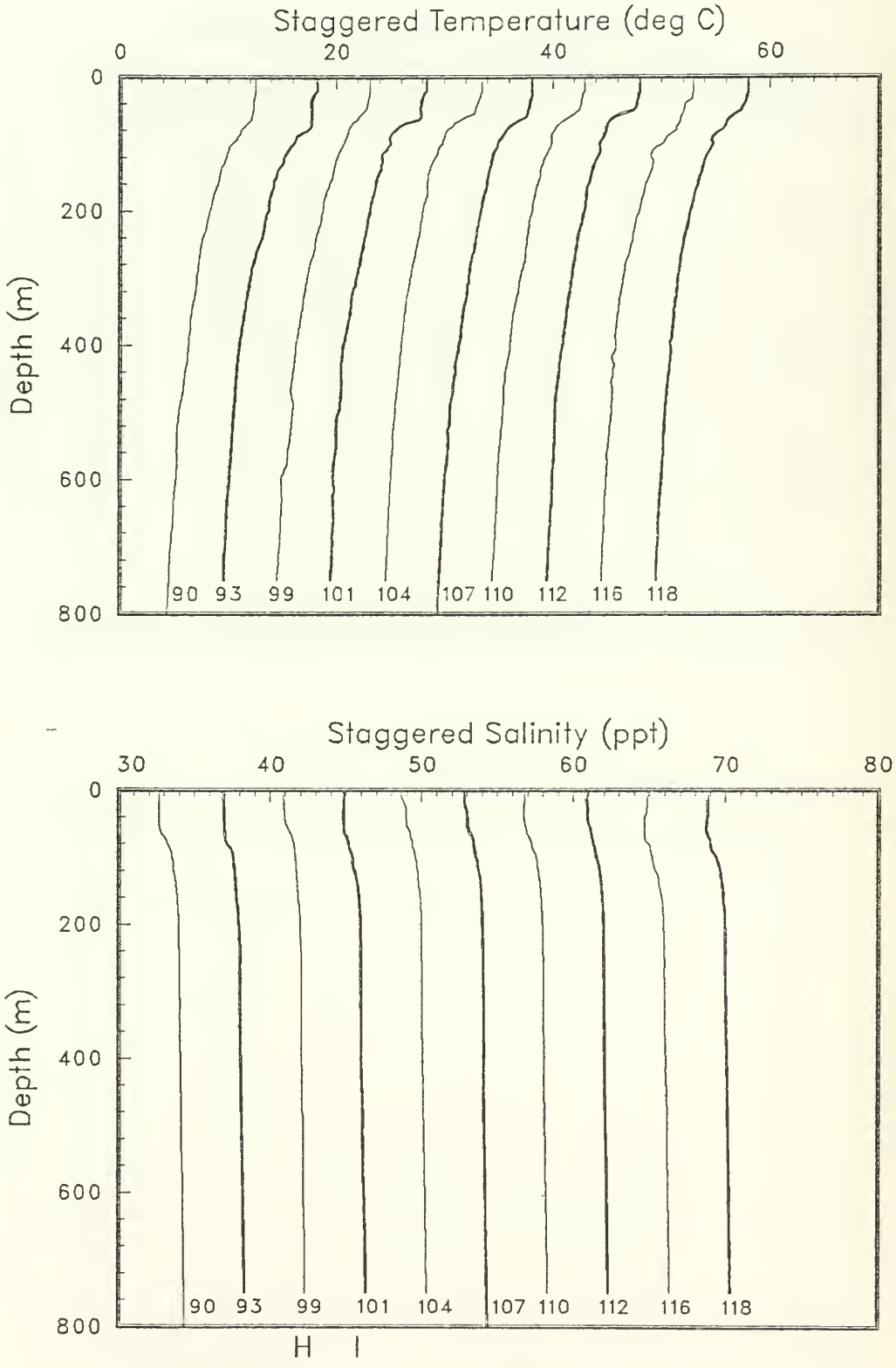

Staggered Temperature (deg C)
0
20
40
60
0
200
400
600
800
Depth (m)
90 93 99 101 104 107 110 112 116 118
Staggered Salinity (ppt)
30
40
50
60
70
80
0
200
400
600
800
Depth (m)
90 93 99 101 104 107 110 112 116 118
H I

Figure 12(c)

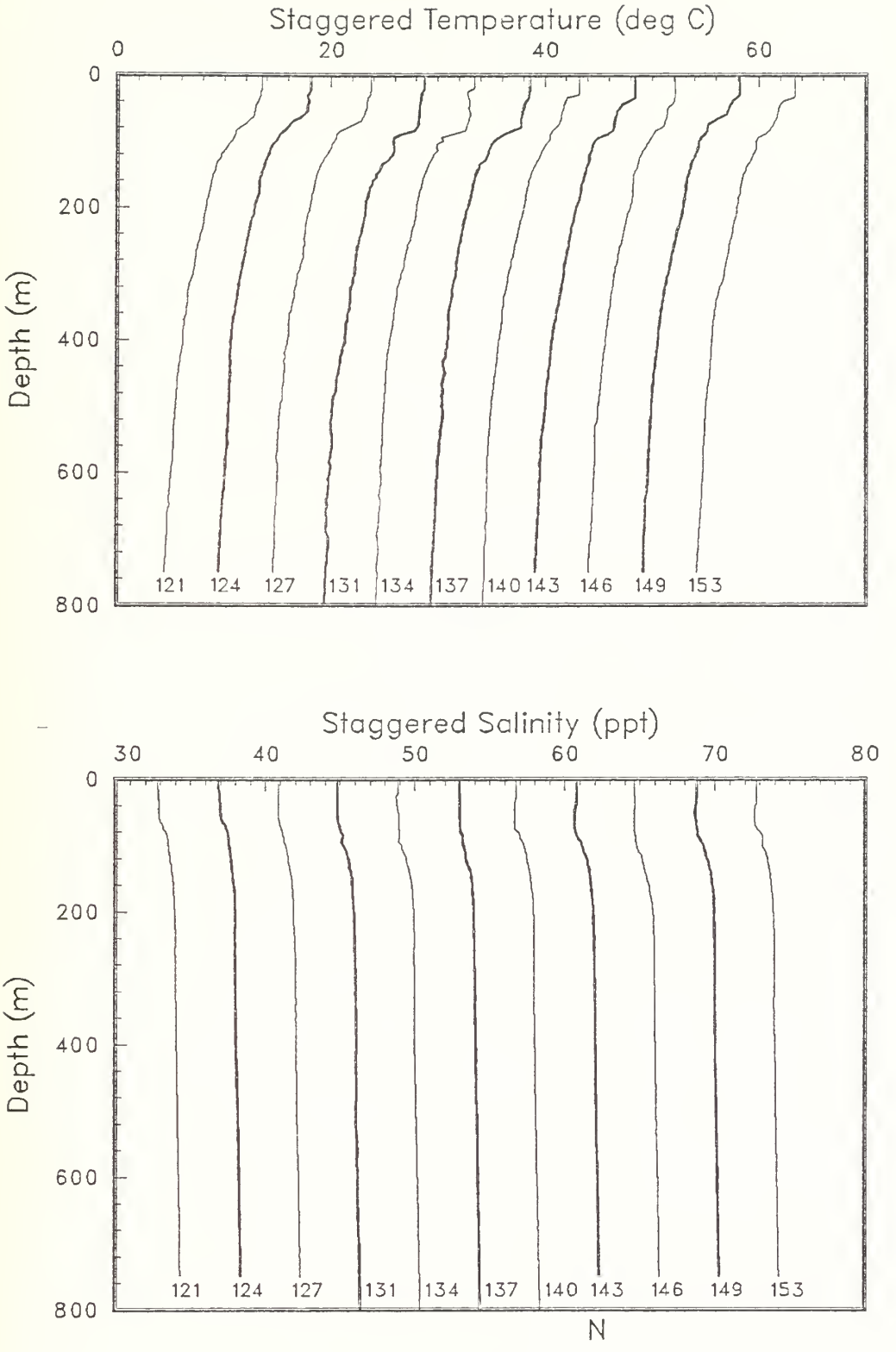

Staggered Temperature (deg C)
0
20
40
60
Depth (m)
0
200
400
600
800
121
124
127
131
134
137
140
143
146
149
153
Staggered Salinity (ppt)
30
40
50
60
70
80
Depth (m)
0
200
400
600
800
121
124
127
131
134
137
140
143
146
149
153
N

Figure 12(d)

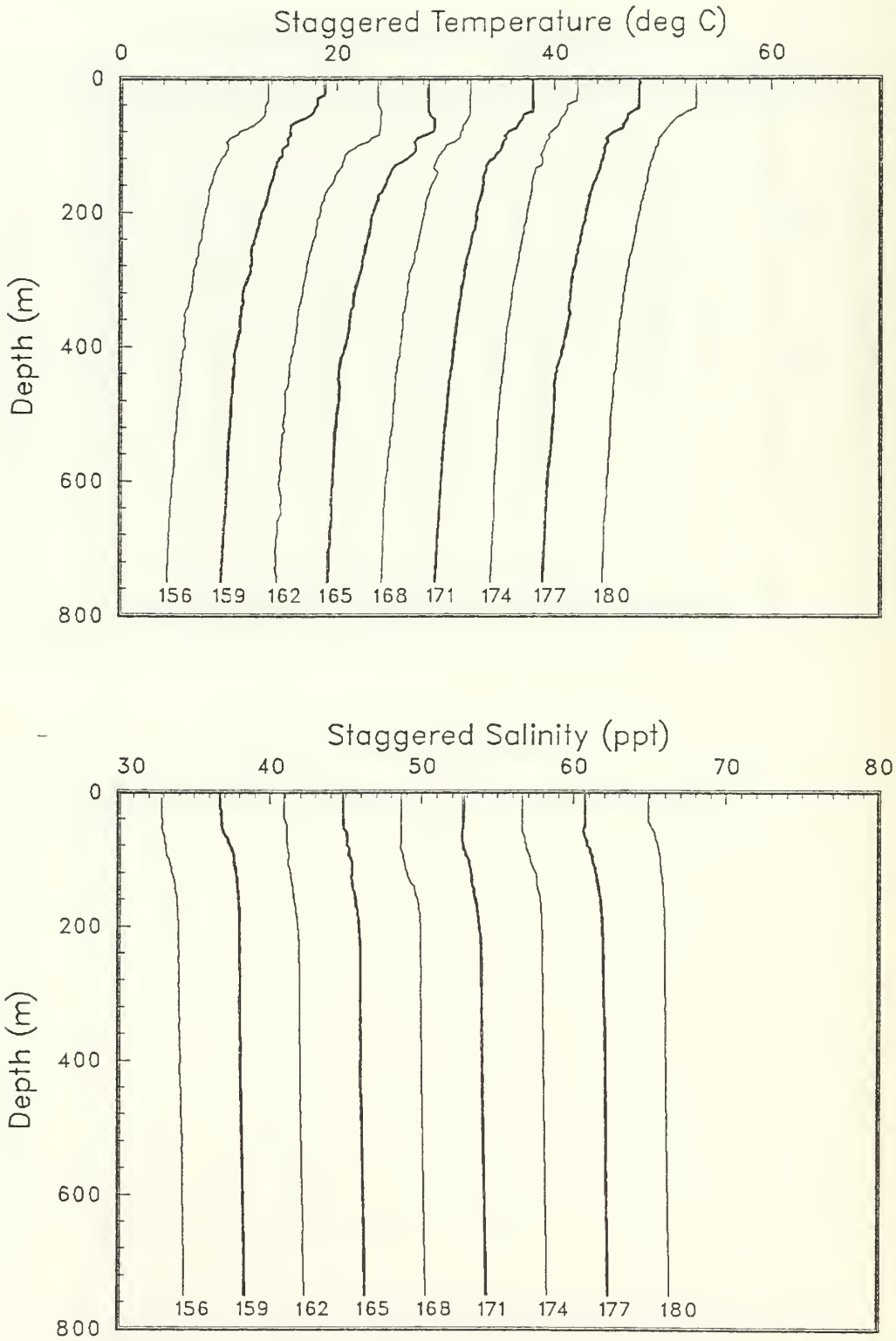
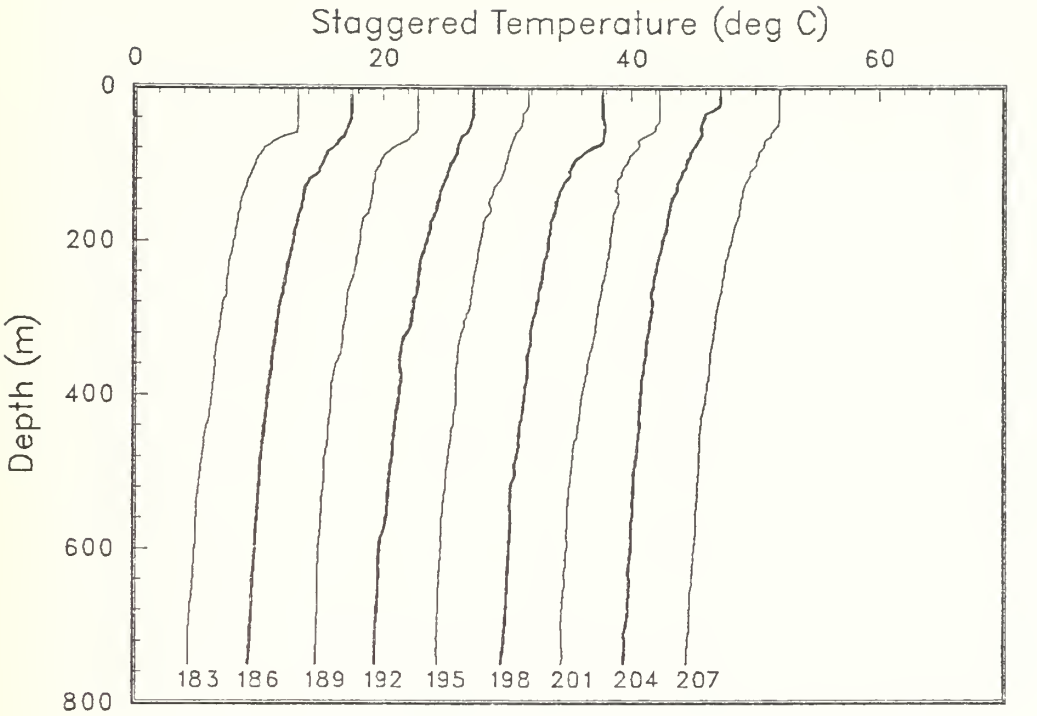

Staggered Temperature (deg C)
0
20
40
60
0
200
400
600
800
Depth (m)
156 159 162 165 168 171 174 177 180
Staggered Salinity (ppt)
30
40
50
60
70
80
0
200
400
600
800
Depth (m)
156 159 162 165 168 171 174 177 180

Figure 12(e)


Staggered Temperature (deg C)
0
20
40
60
0
200
400
600
800
Depth (m)
183 186 189 192 195 198 201 204 207

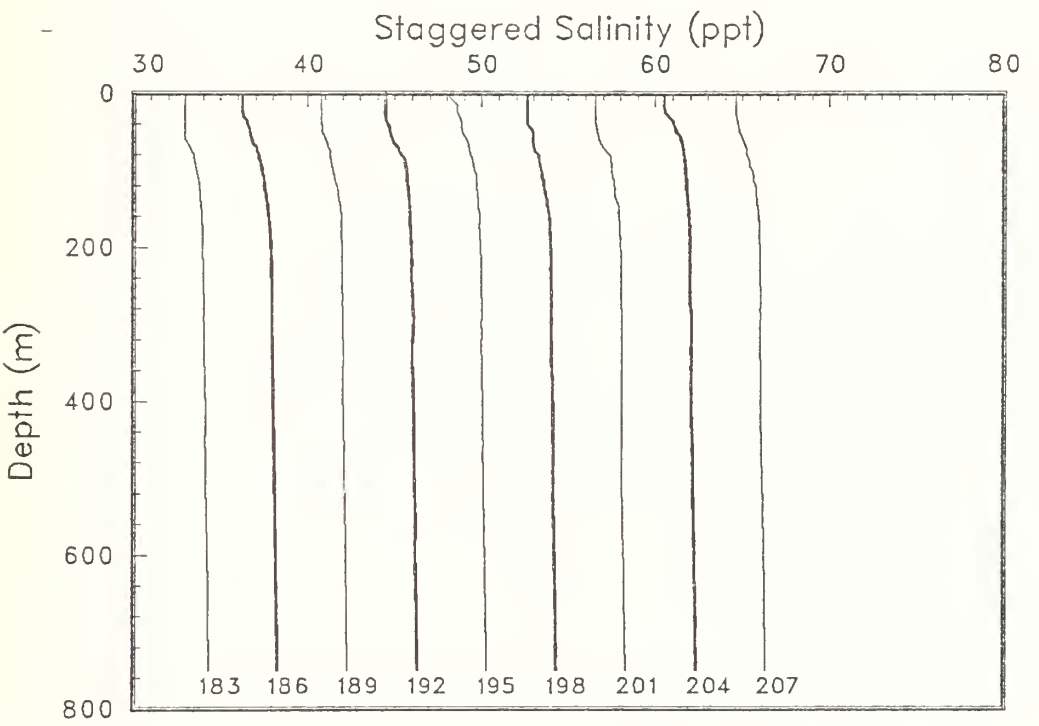

Staggered Salinity (ppt)
30
40
50
60
70
80
0
200
400
600
800
Depth (m)
183 186 189 192 195 198 201 204 207

Figure 12(f)

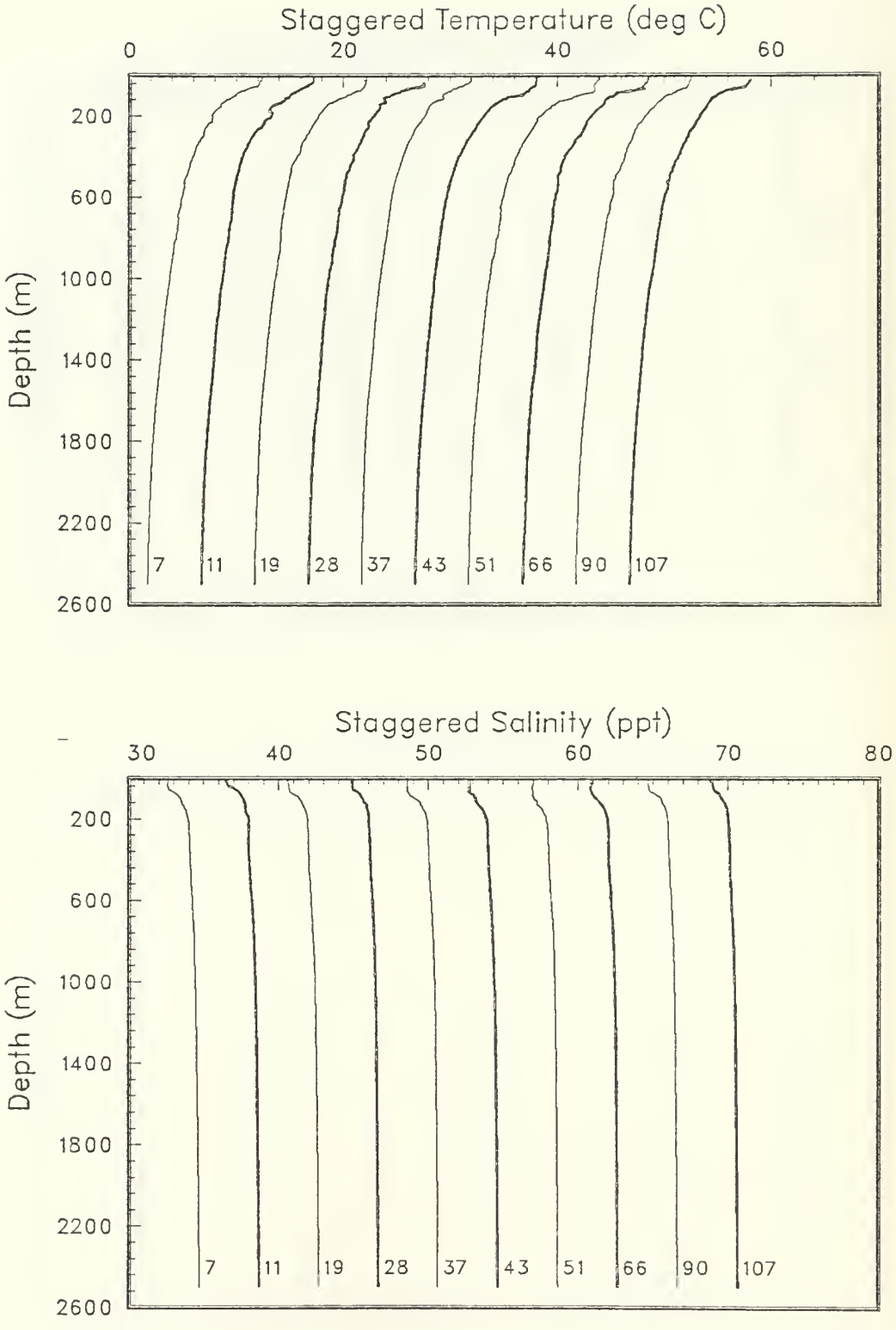
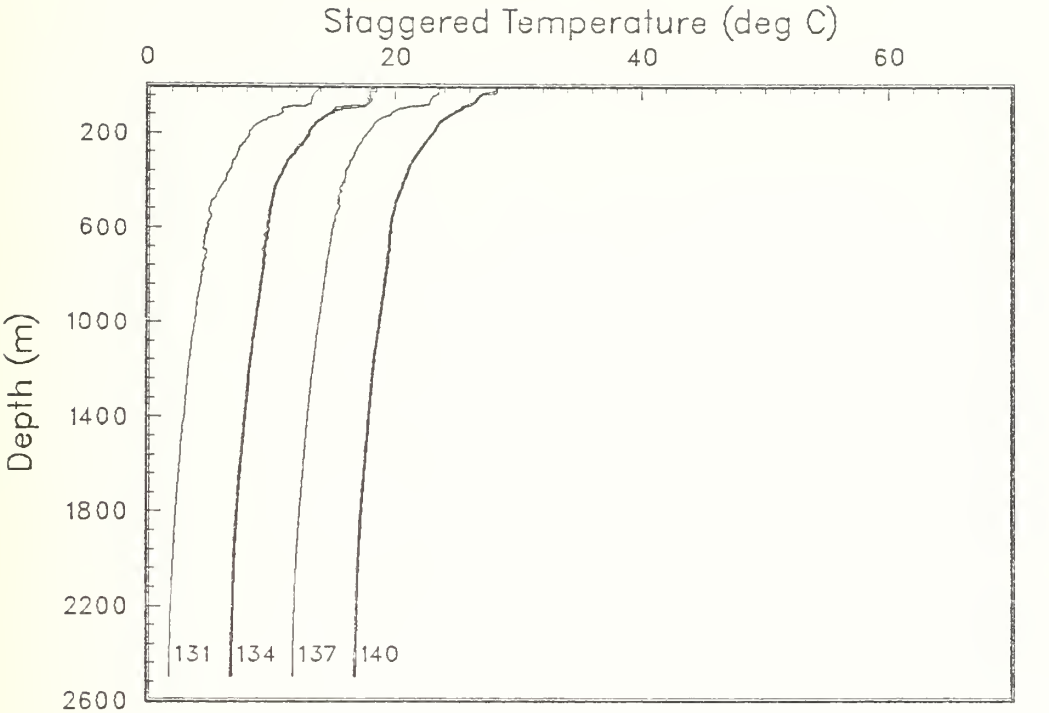


Figure 13(a): As for Fig. 12 but casts to 2600m (OPTOMA20, Leg MI).


Staggered Temperature (deg C)
0
20
40
60
Depth (m)
200
600
1000
1400
1800
2200
2600
131
134
137
140

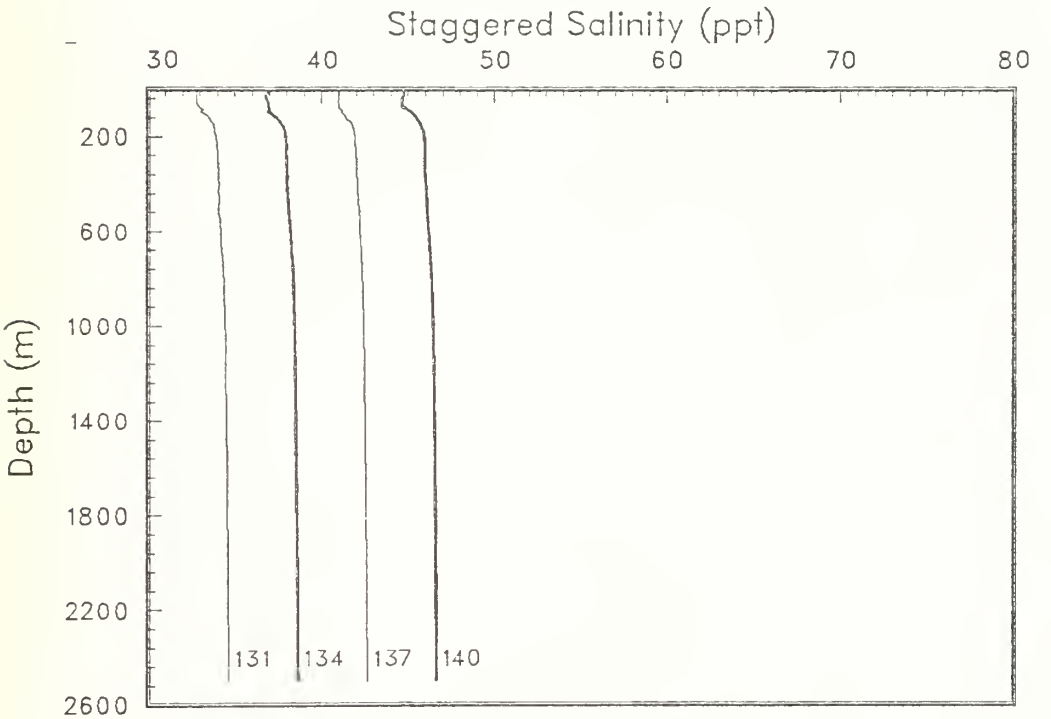

Staggered Salinity (ppt)
30
40
50
60
70
80
Depth (m)
200
600
1000
1400
1800
2200
2600
131
134
137
140

Figure 13(b)

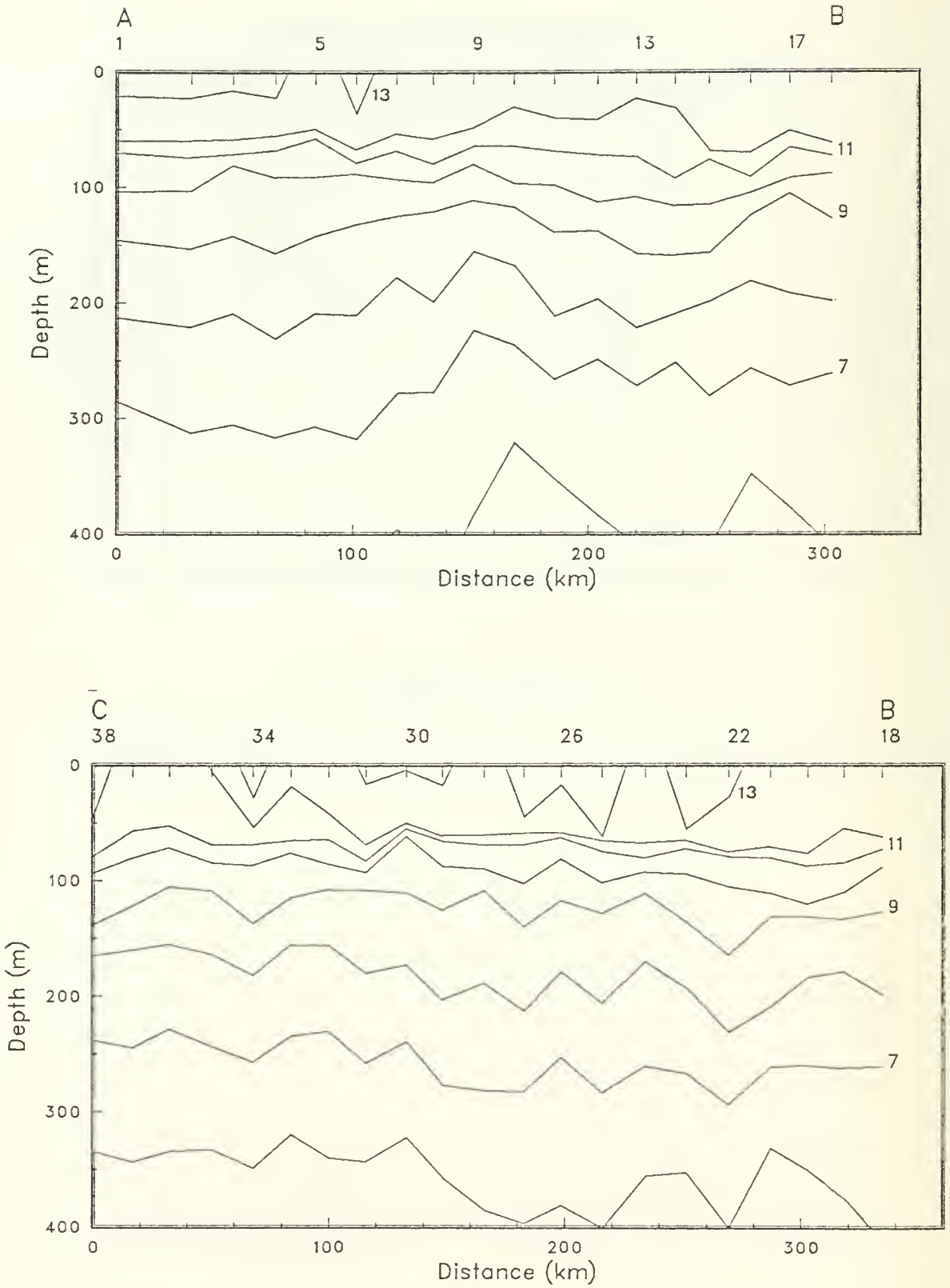


Figure 14(a)-(b): Along-track isotherms. Tick marks along the upper horizontal axis show station positions. Some station numbers are given. Dashed lines are used if the cast was too shallow (OPTOMA20, Leg MI).

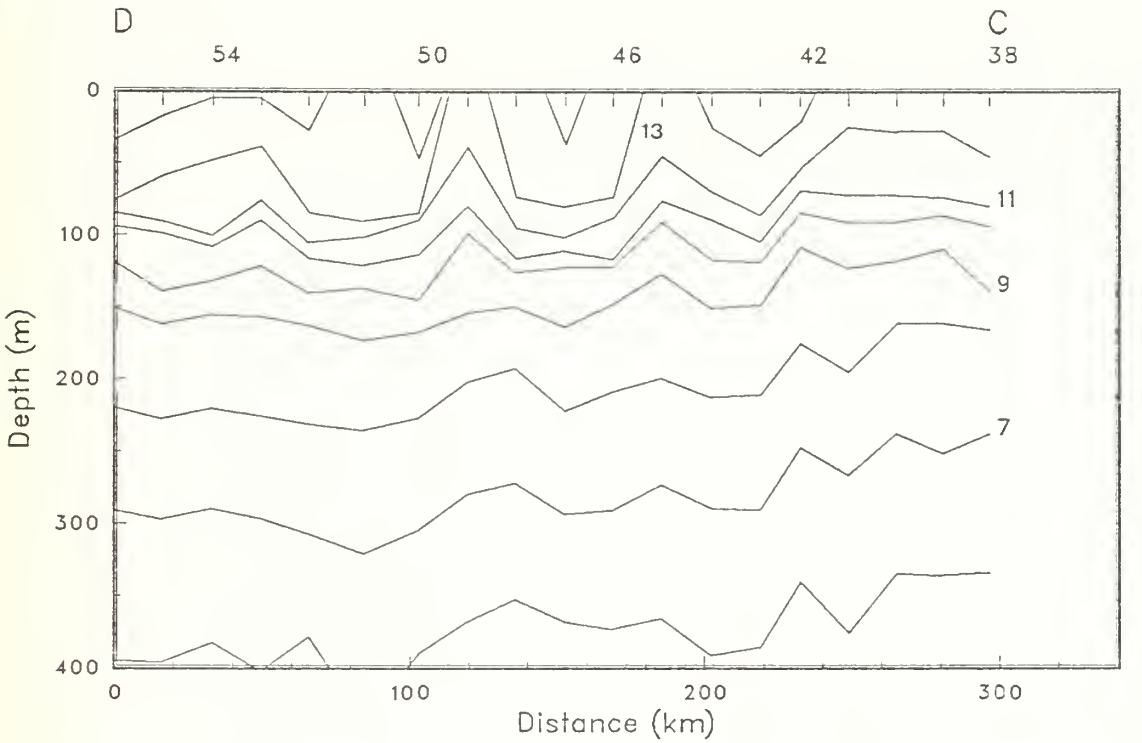


Figure 14(c)

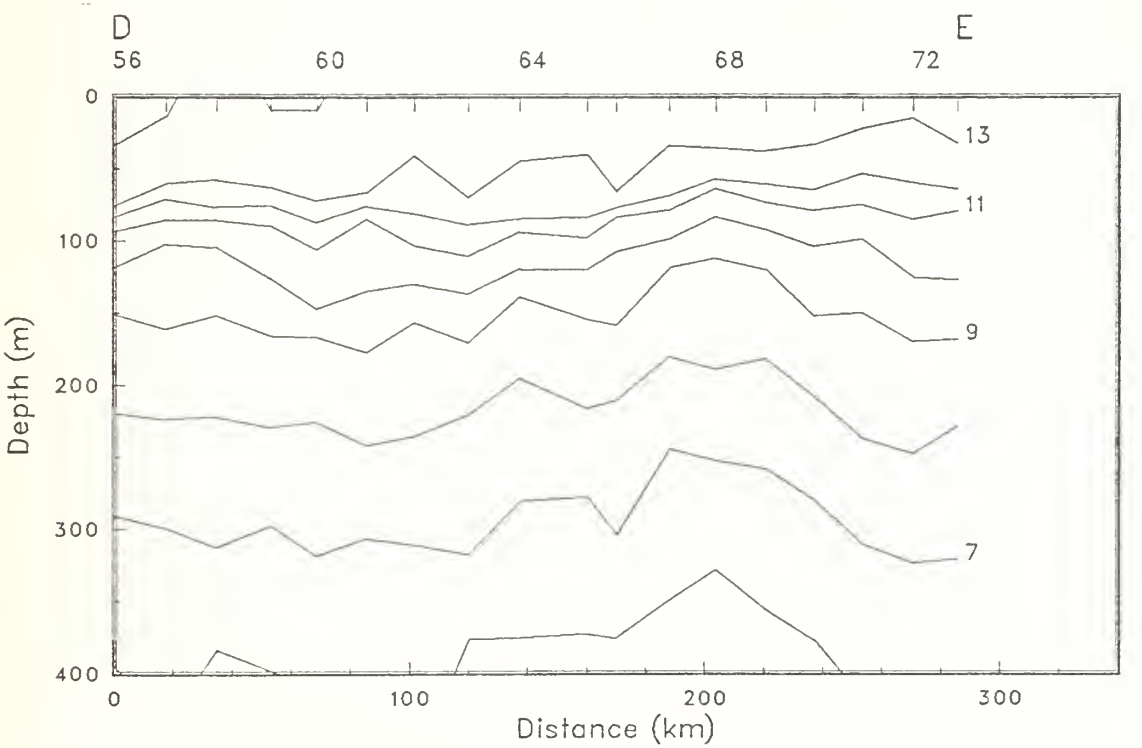


Figure 14(d)

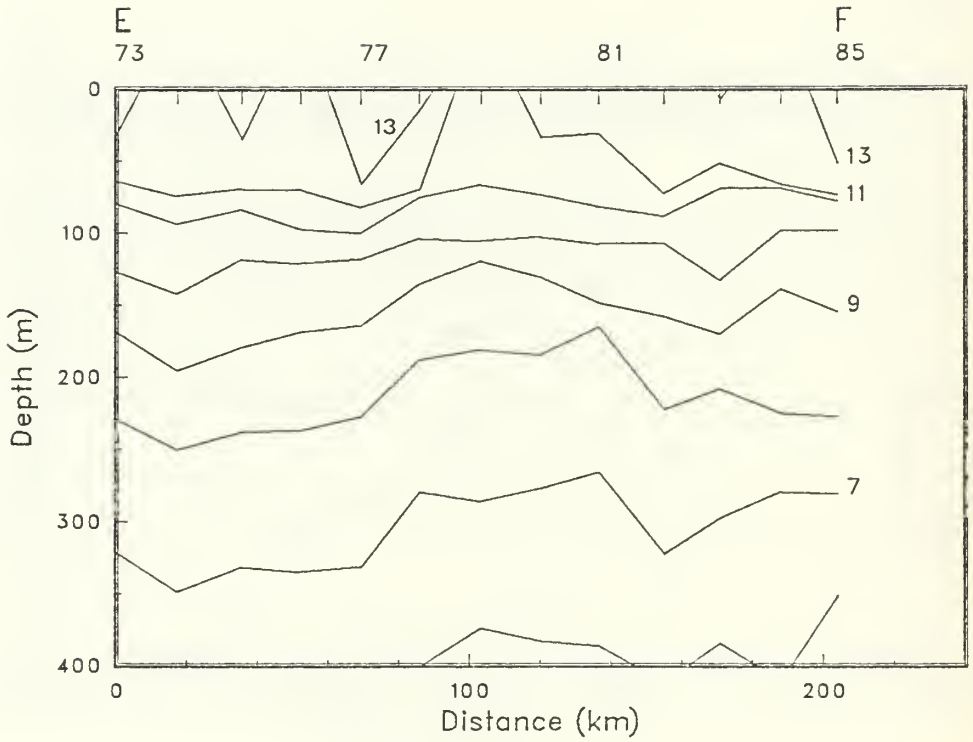


Figure 14(e)

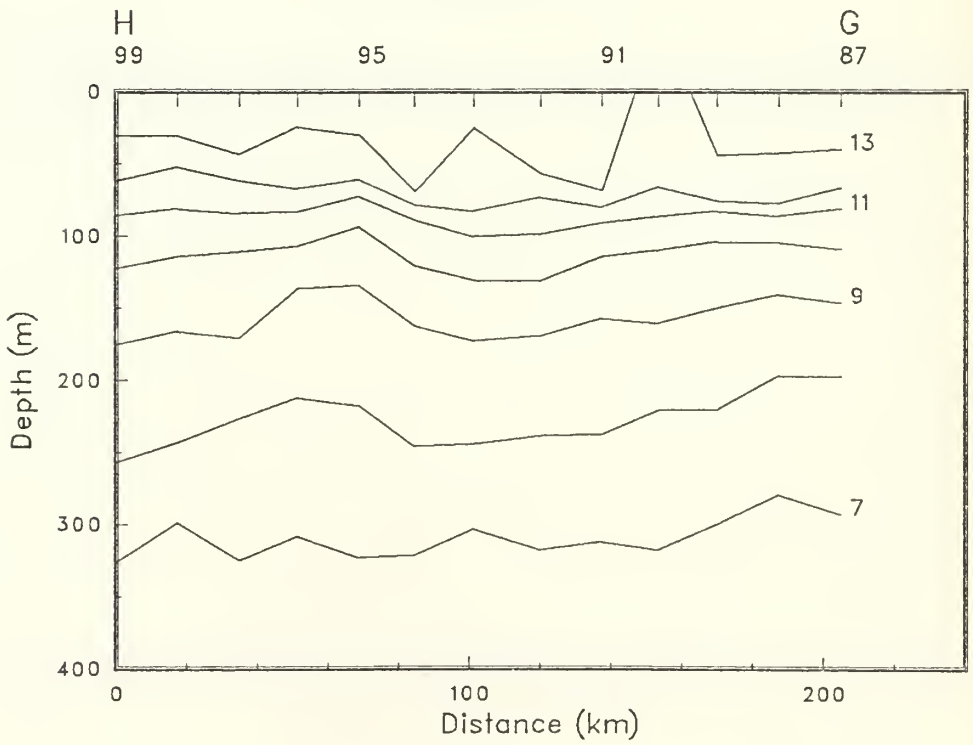


Figure 14(f)

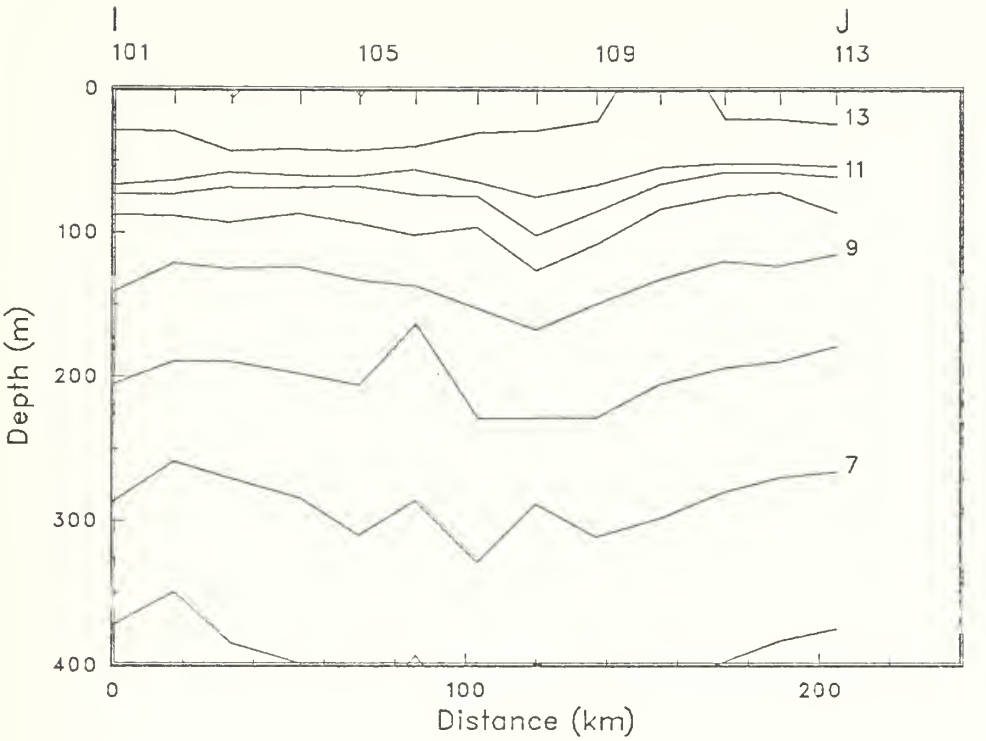


Figure 14(g)

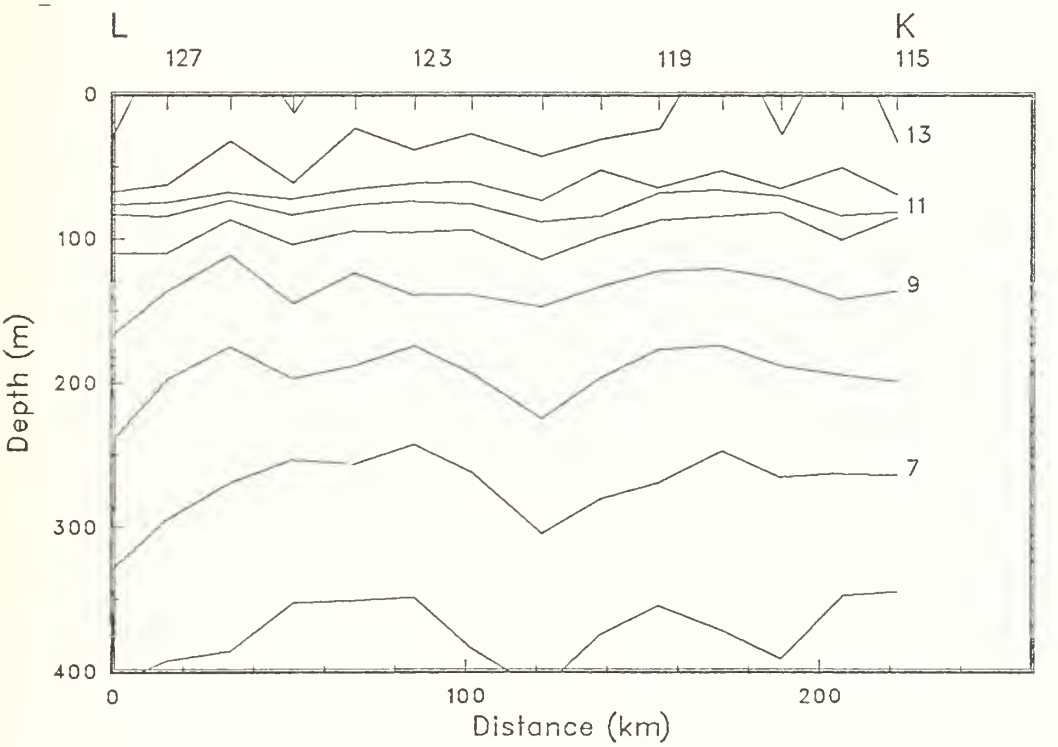


Figure 14(h)

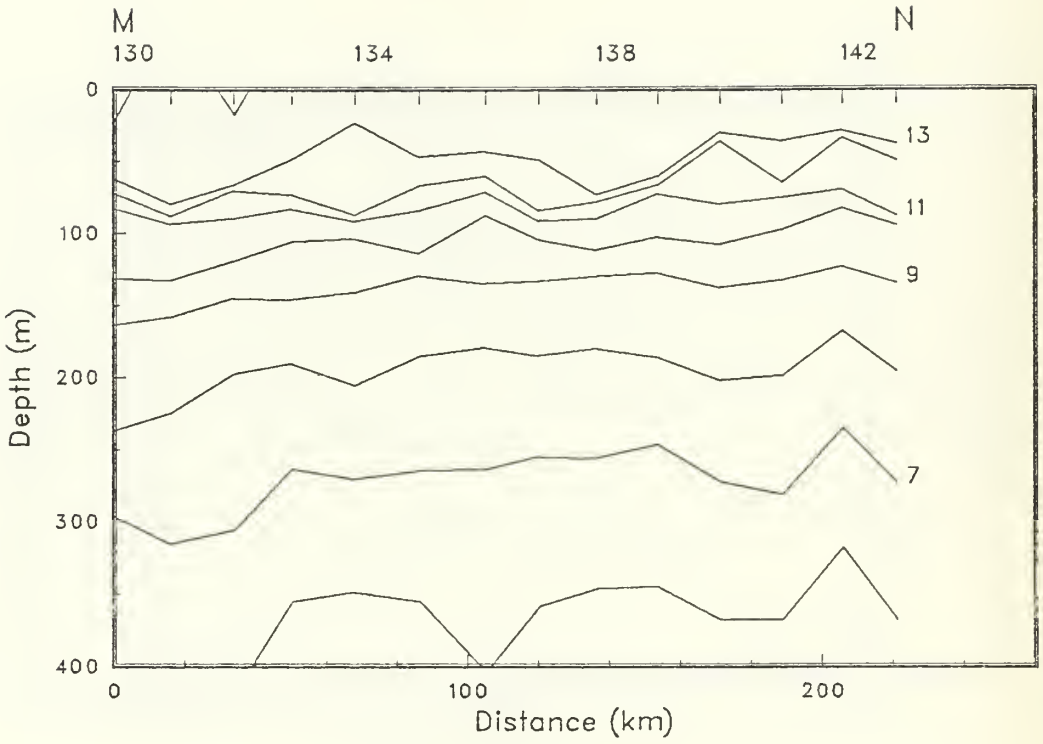


Figure 14(i)

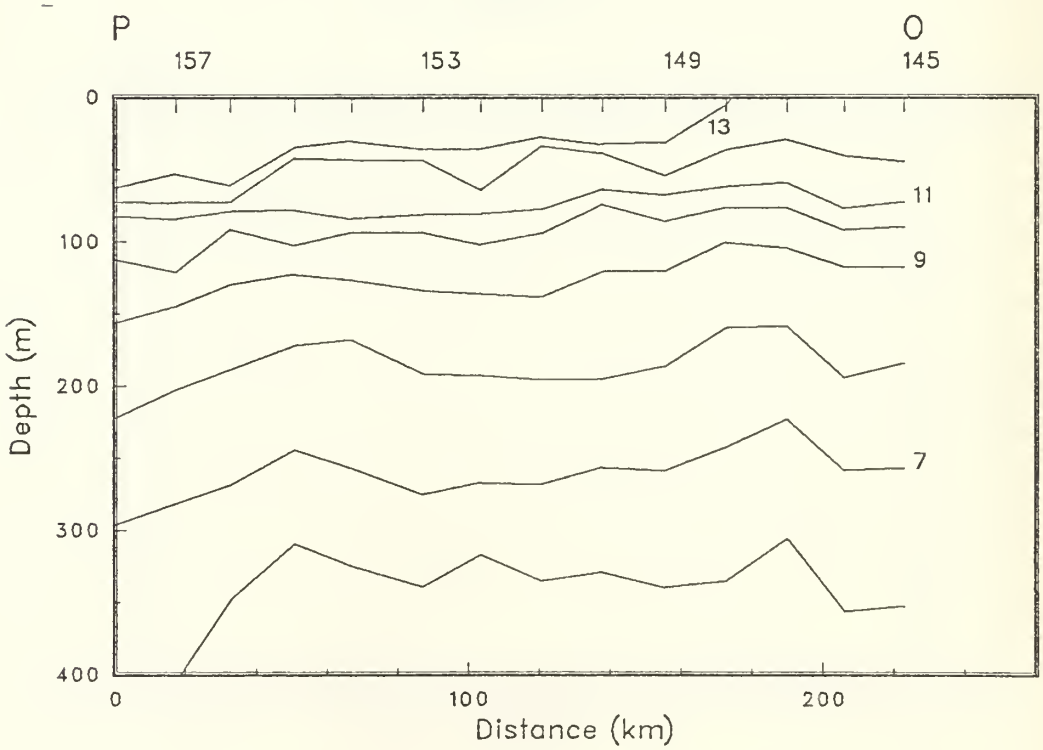


Figure 14(j)

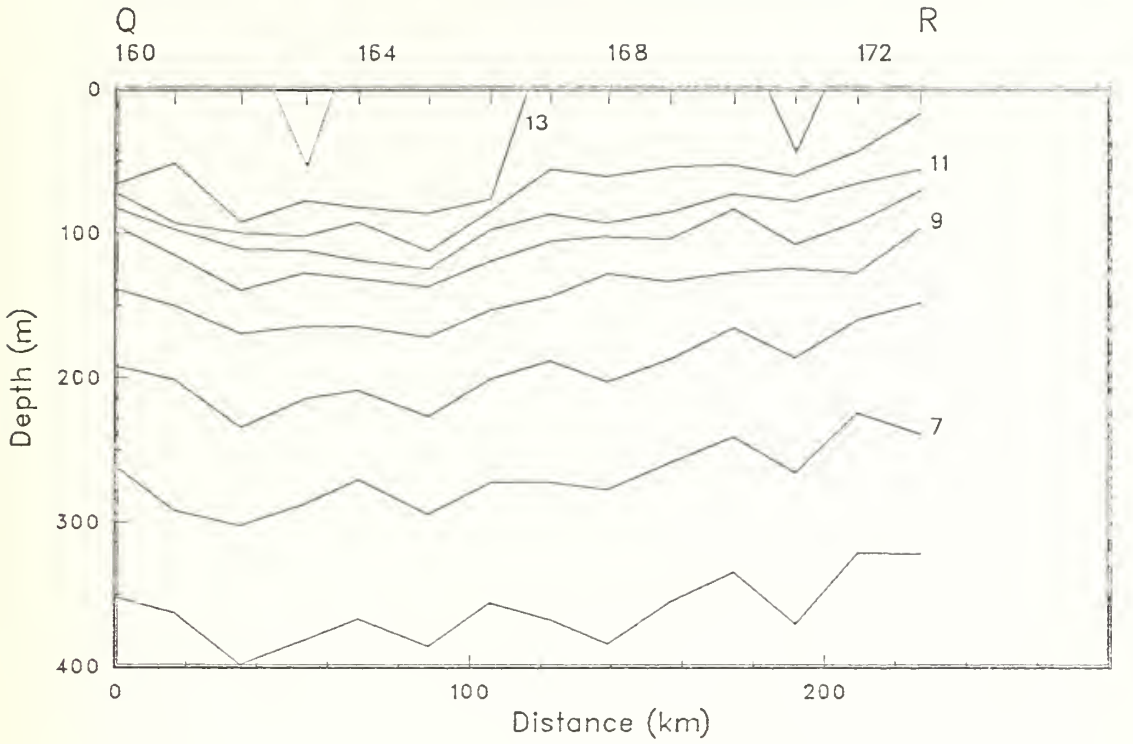


Figure 14(k)

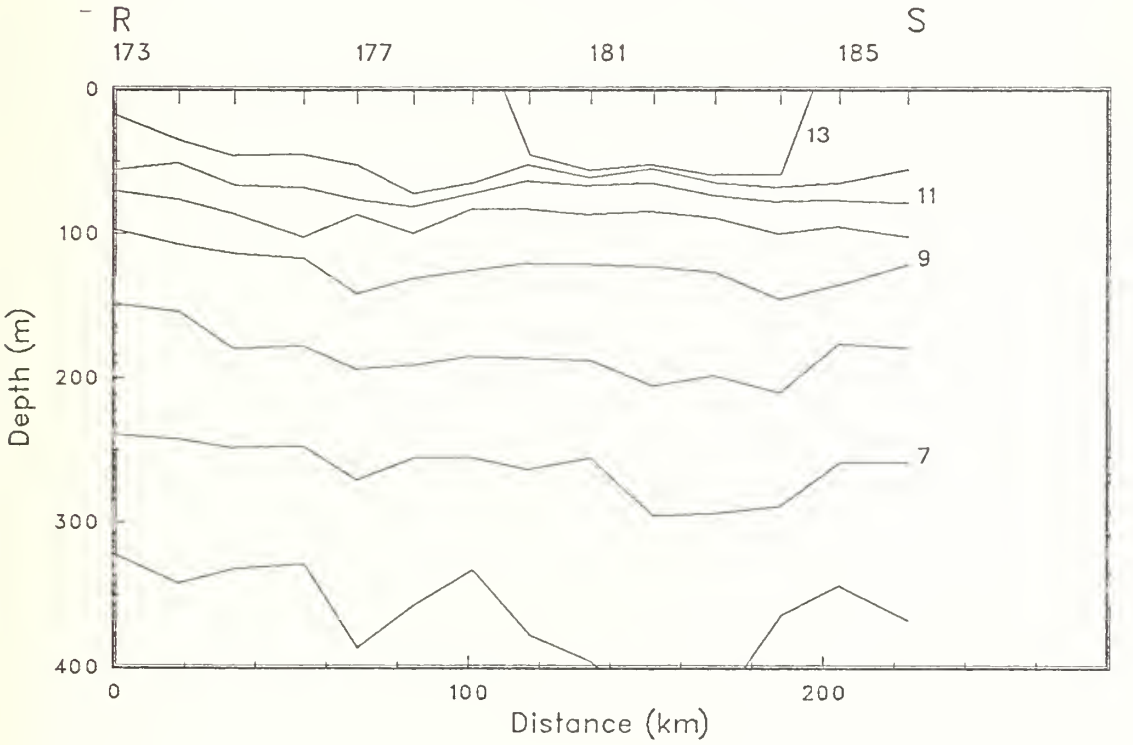


Figure 14(l)

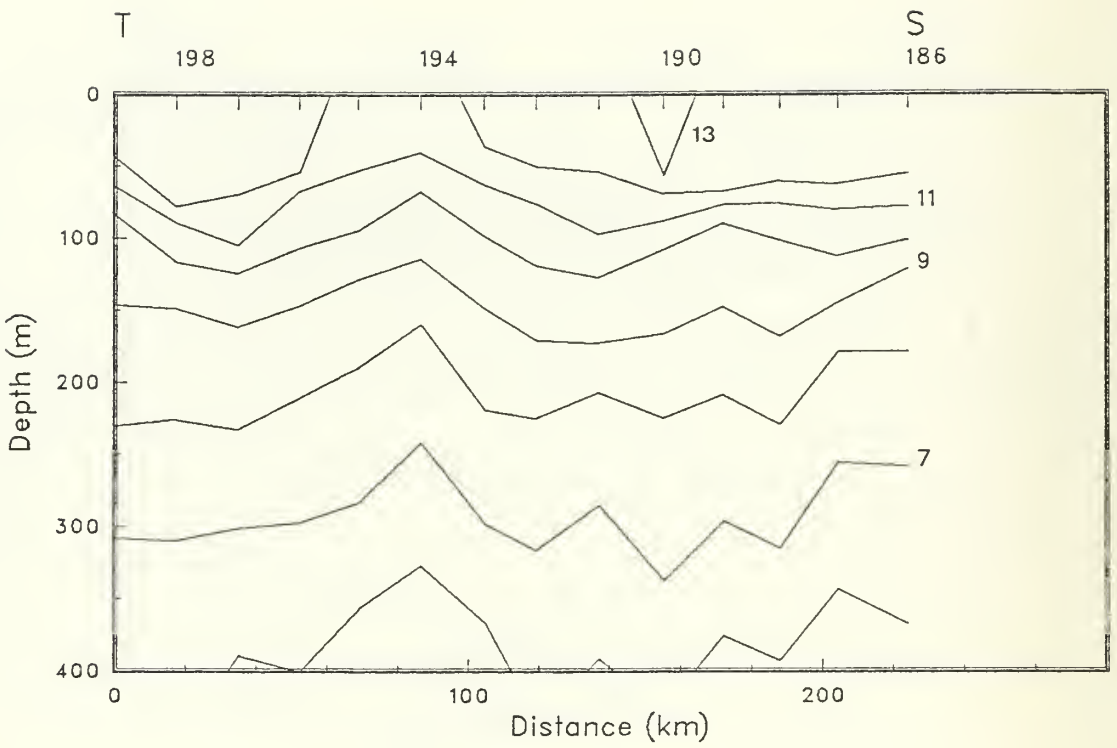


Figure 14(m)

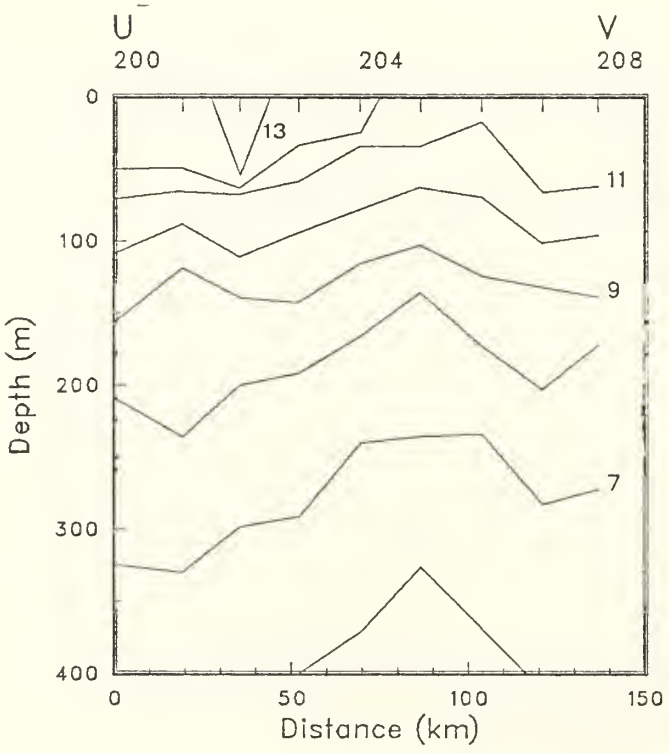


Figure 14(n)

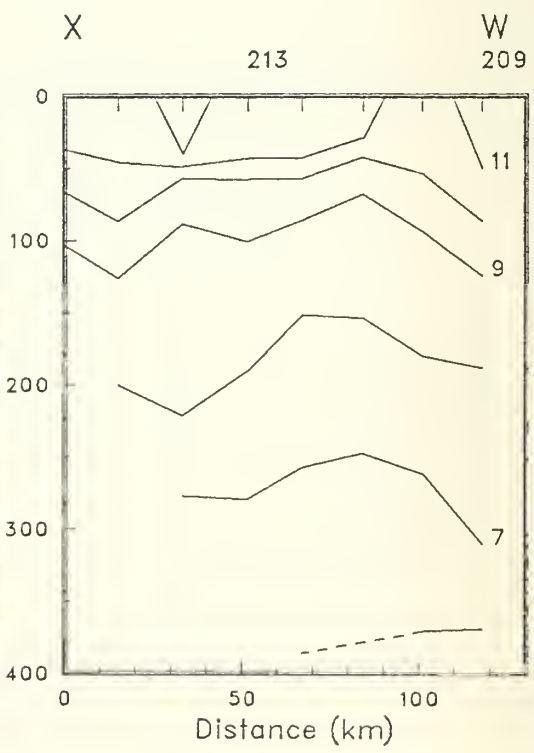


Figure 14(o)

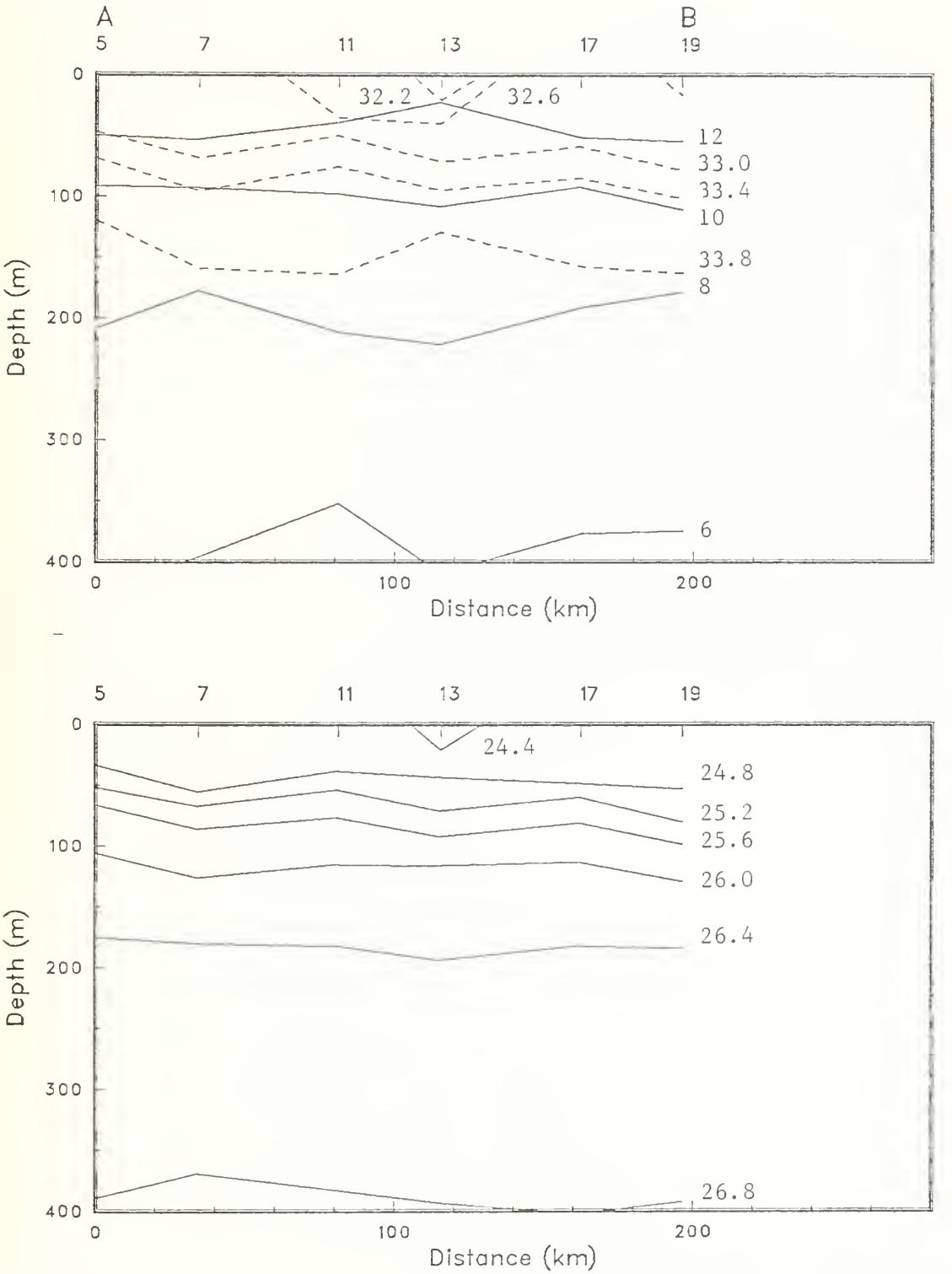


Figure 15(a): Isopleths of (1) temperature and salinity and (2) sigma-t from the CTDs (OPTOMA20, Leg MI).

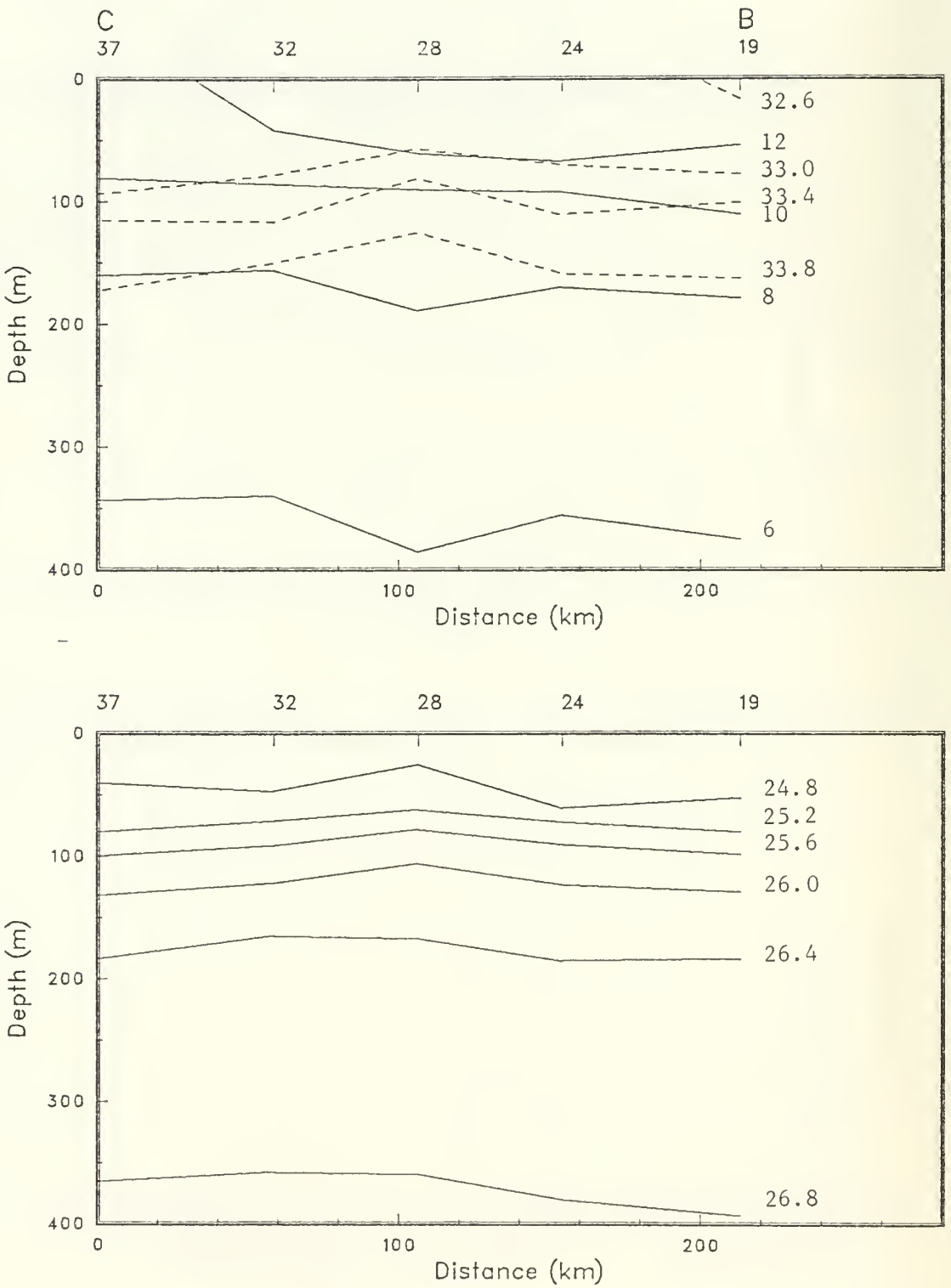

C
B
37
32
28
24
19
0
100
200
300
400
Depth (m)
32.6
12
33.0
33.4
10
33.8
8
6
0
100
200
Distance (km)
37
32
28
24
19
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 15(b)

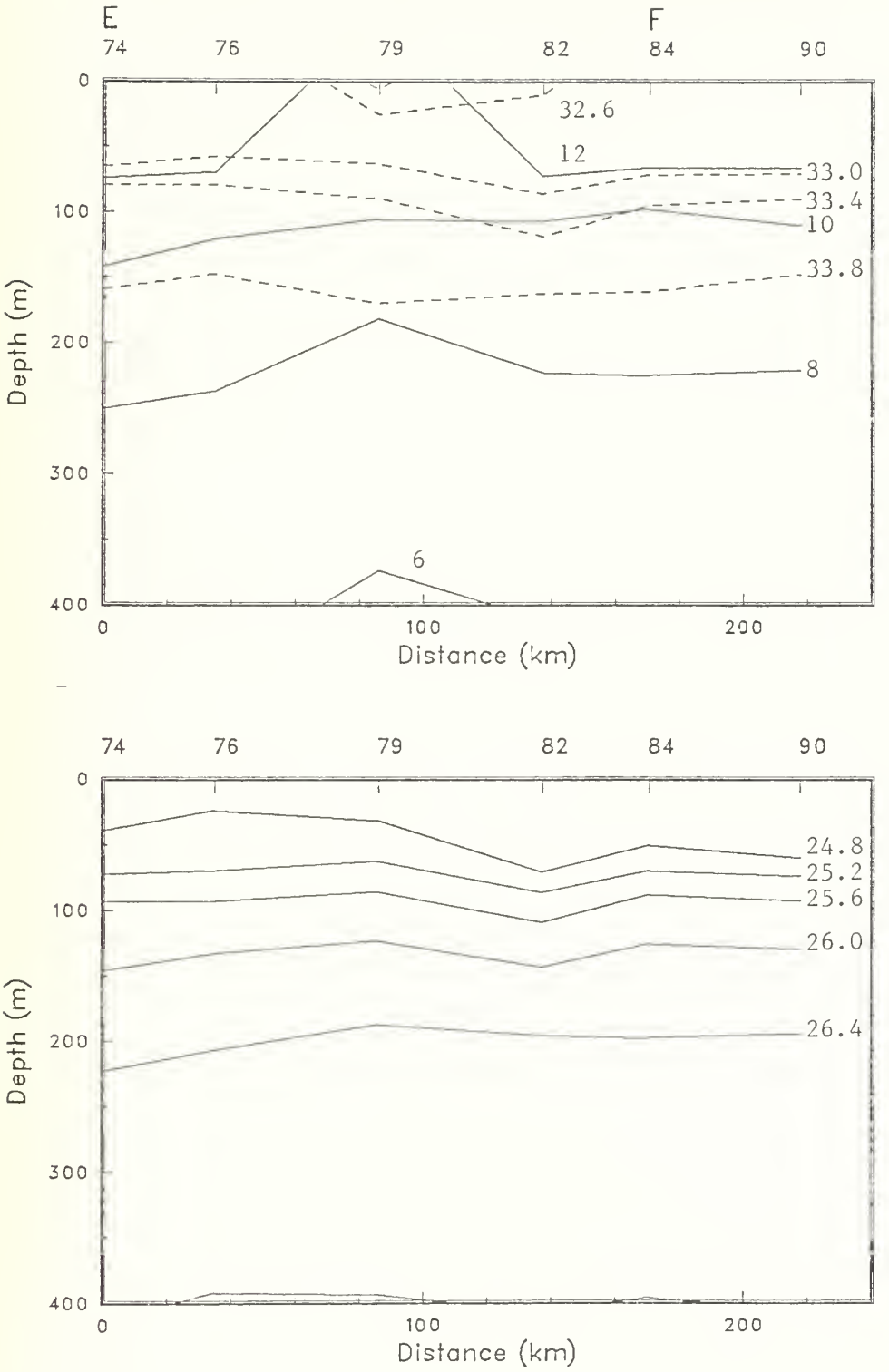

E
F
74
76
79
82
84
90
0
100
200
300
400
Depth (m)
32.6
12
33.0
33.4
10
33.8
8
6
0
100
200
Distance (km)
74
76
79
82
84
90
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
0
100
200
Distance (km)

Figure 15(c)

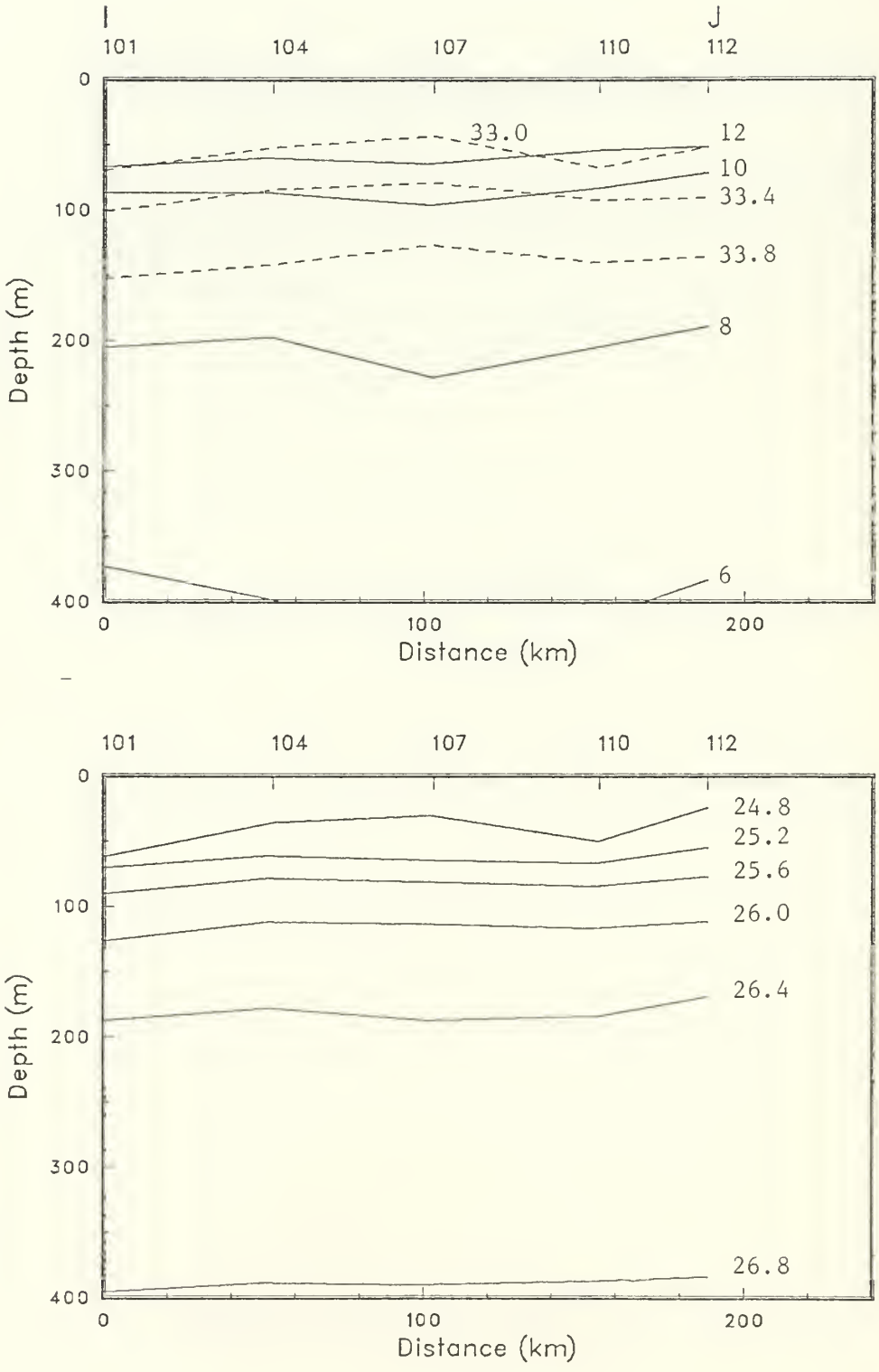

I
J
101
104
107
110
112
0
100
200
300
400
Depth (m)
33.0
12
10
33.4
33.8
8
6
0
100
200
Distance (km)
101
104
107
110
112
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 15(d)

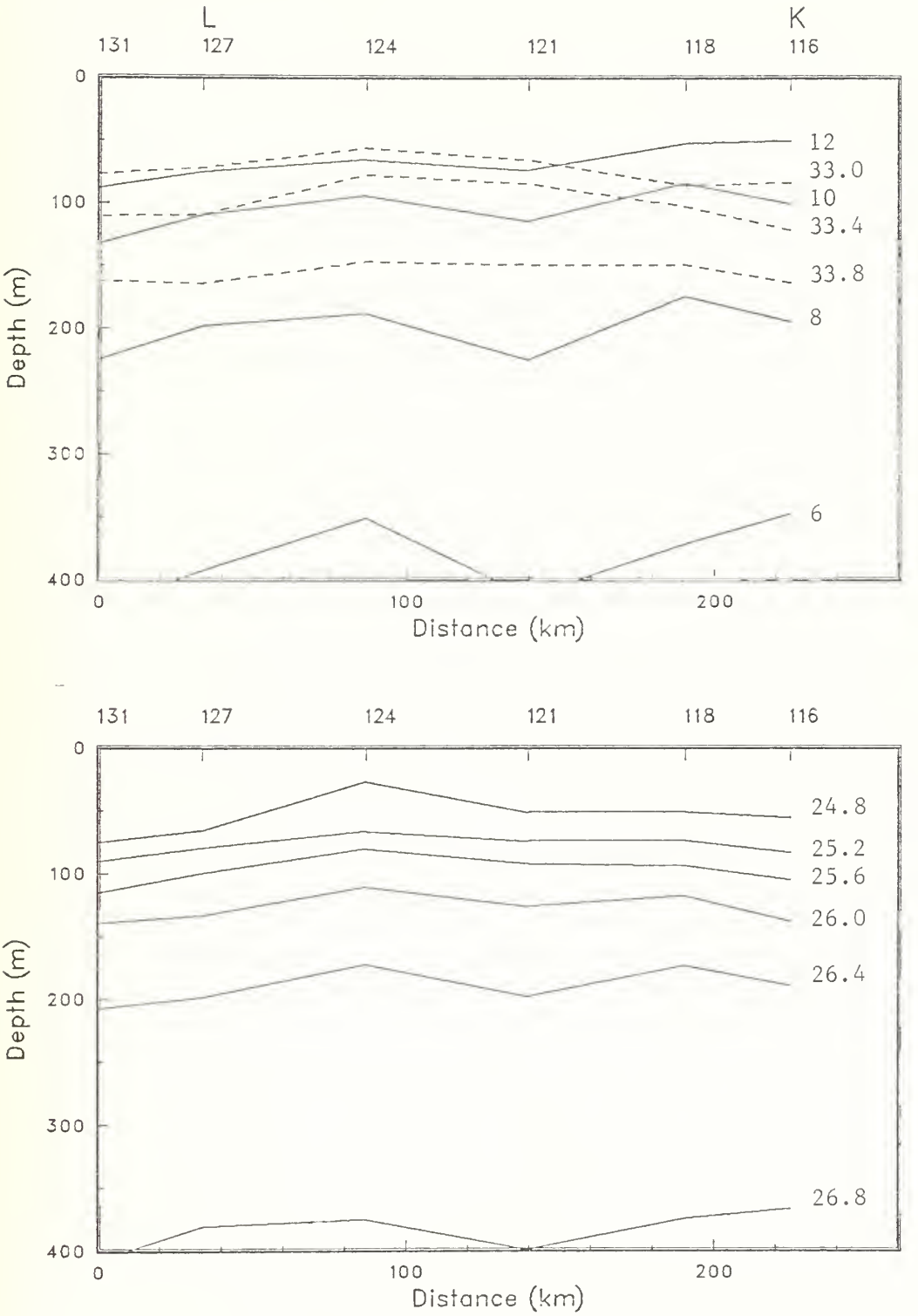

L
K
131
127
124
121
118
116
0
100
200
300
400
Depth (m)
12
33.0
10
33.4
33.8
8
6
0
100
200
Distance (km)
131
127
124
121
118
116
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 15(e)

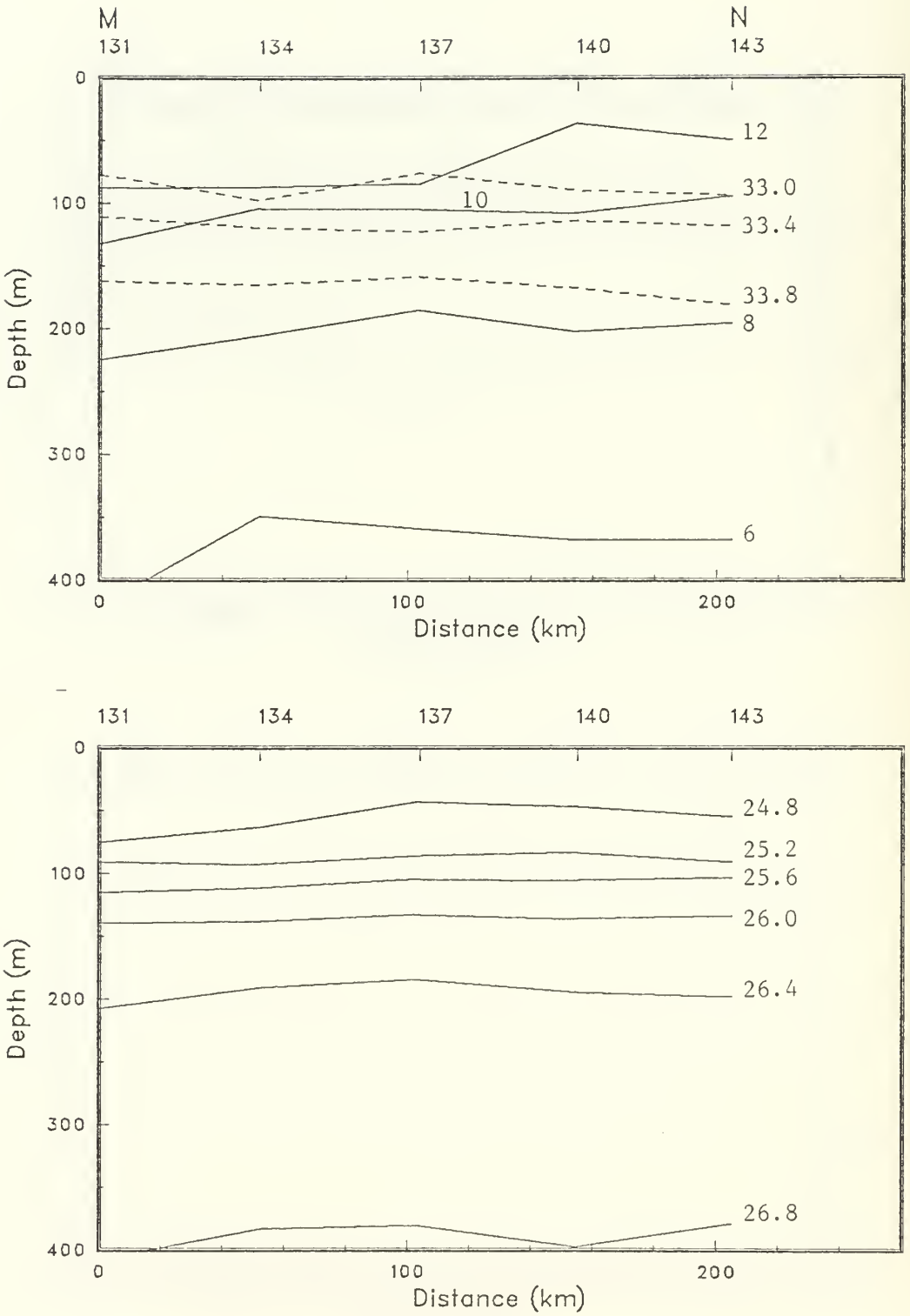

M
N
131
134
137
140
143
0
100
200
300
400
Depth (m)
12
33.0
10
33.4
33.8
8
6
0
100
200
Distance (km)
131
134
137
140
143
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 15(f)

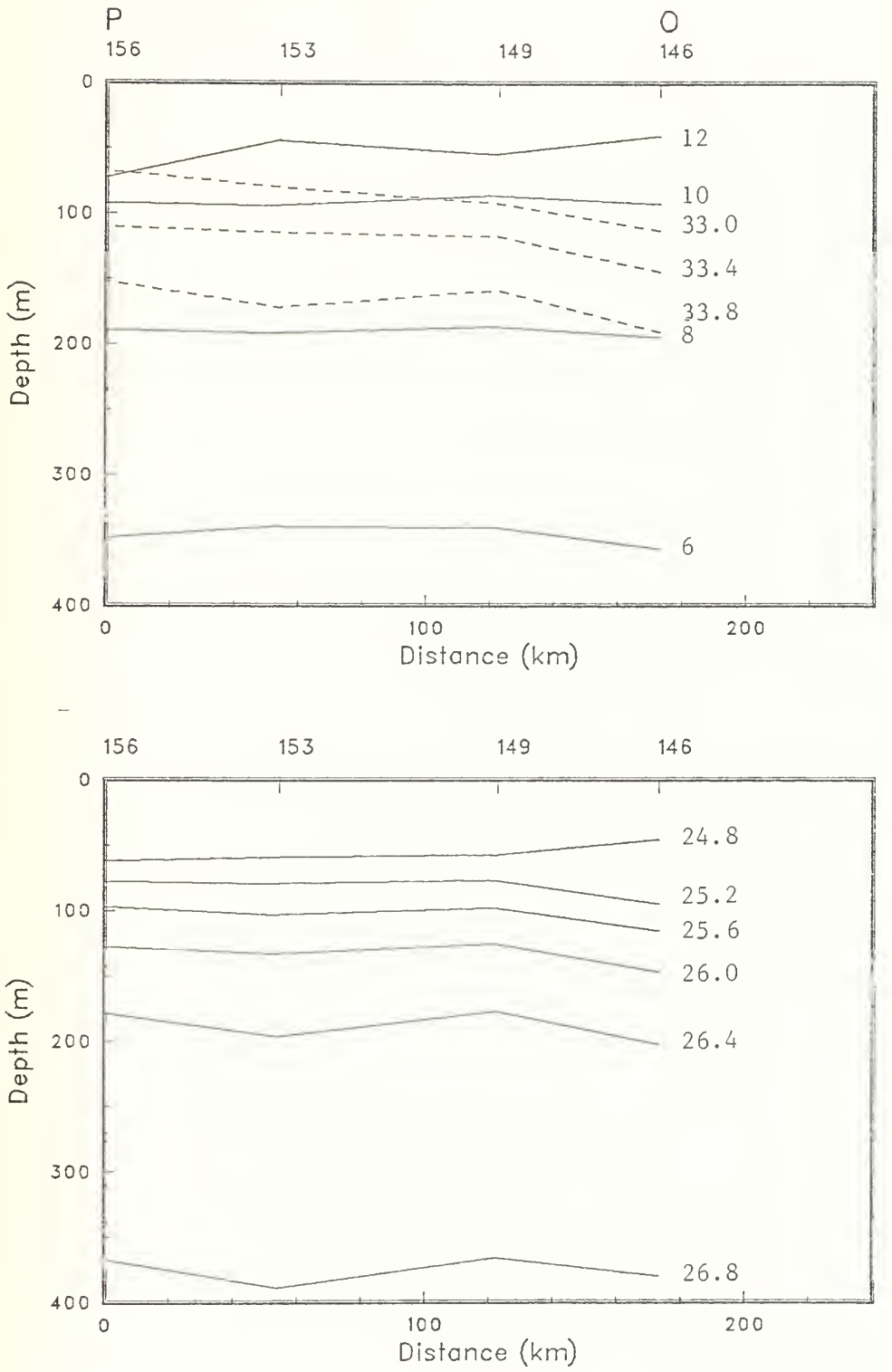
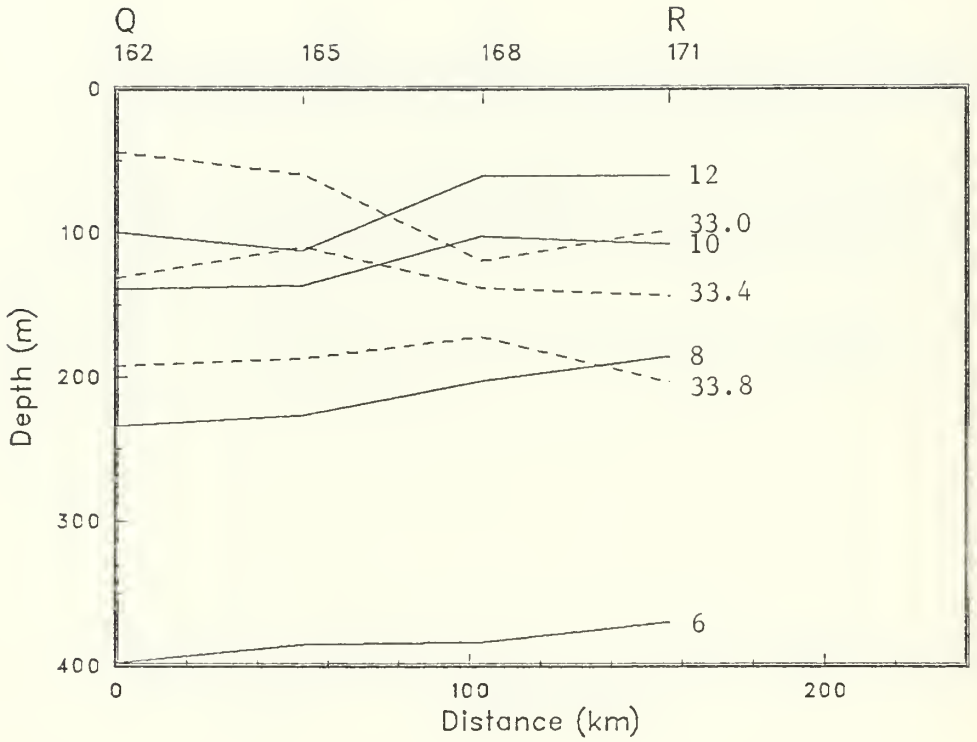

P
O
156
153
149
146
0
100
200
300
400
Depth (m)
12
10
33.0
33.4
33.8
8
6
0
100
200
Distance (km)
156
153
149
146
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 15(g)


Q
R
162
165
168
171
0
100
200
300
400
Depth (m)
12
33.0
10
33.4
8
33.8
6
0
100
200
Distance (km)

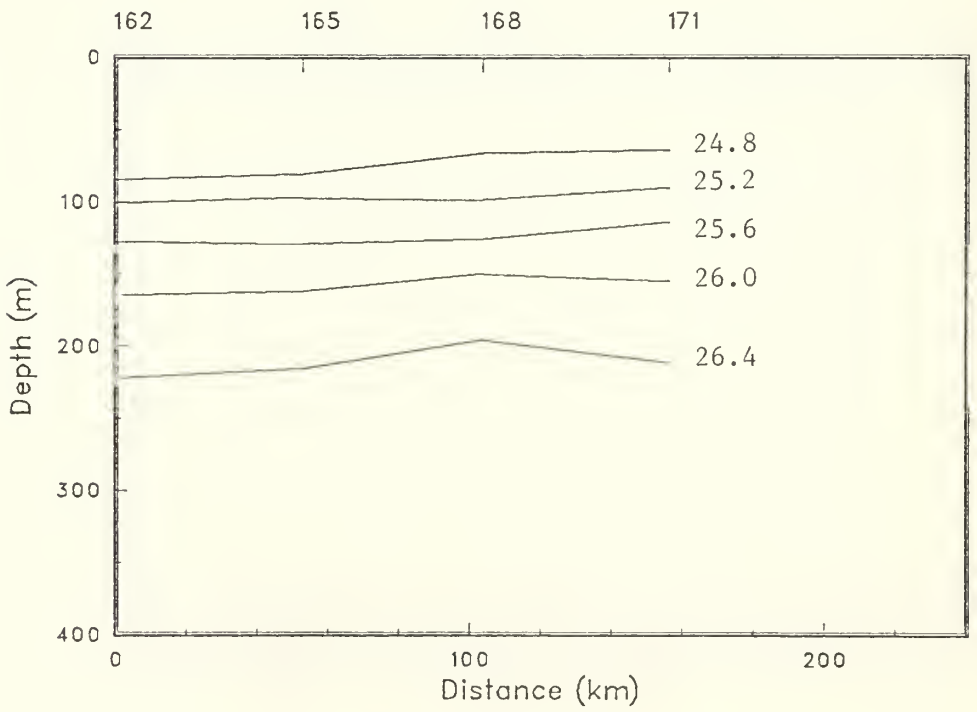
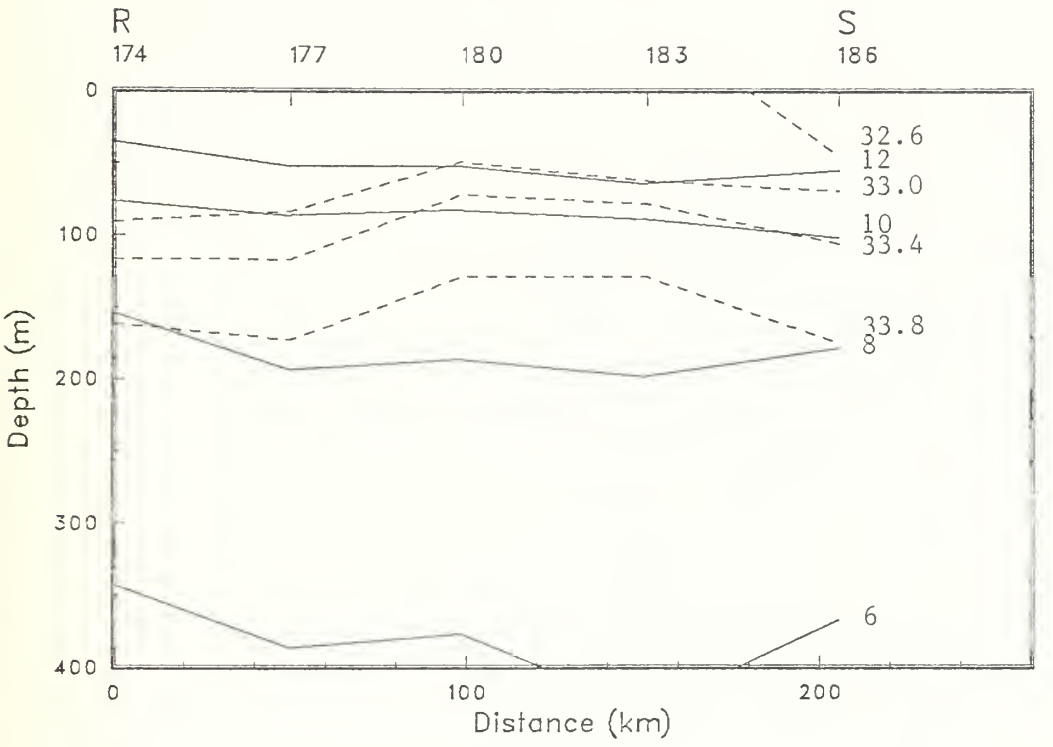

162
165
168
171
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
0
100
200
Distance (km)

Figure 15(h)


R
S
174
177
180
183
186
0
100
200
300
400
Depth (m)
32.6
12
33.0
10
33.4
33.8
8
6
0
100
200
Distance (km)

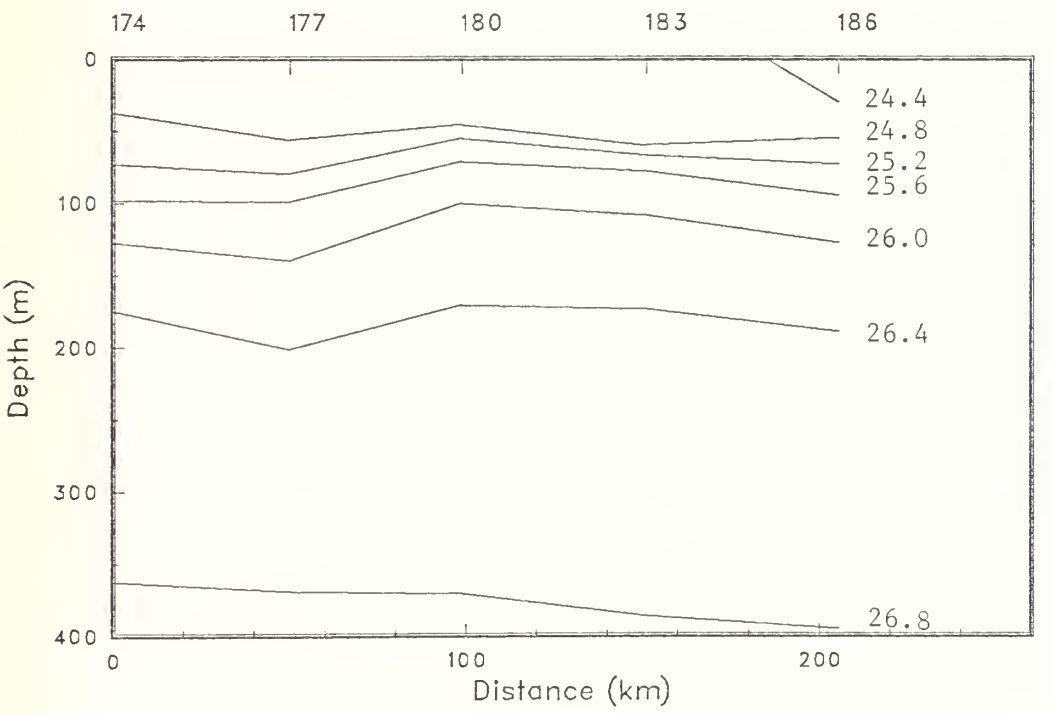

174
177
180
183
186
0
100
200
300
400
Depth (m)
24.4
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 15(i)

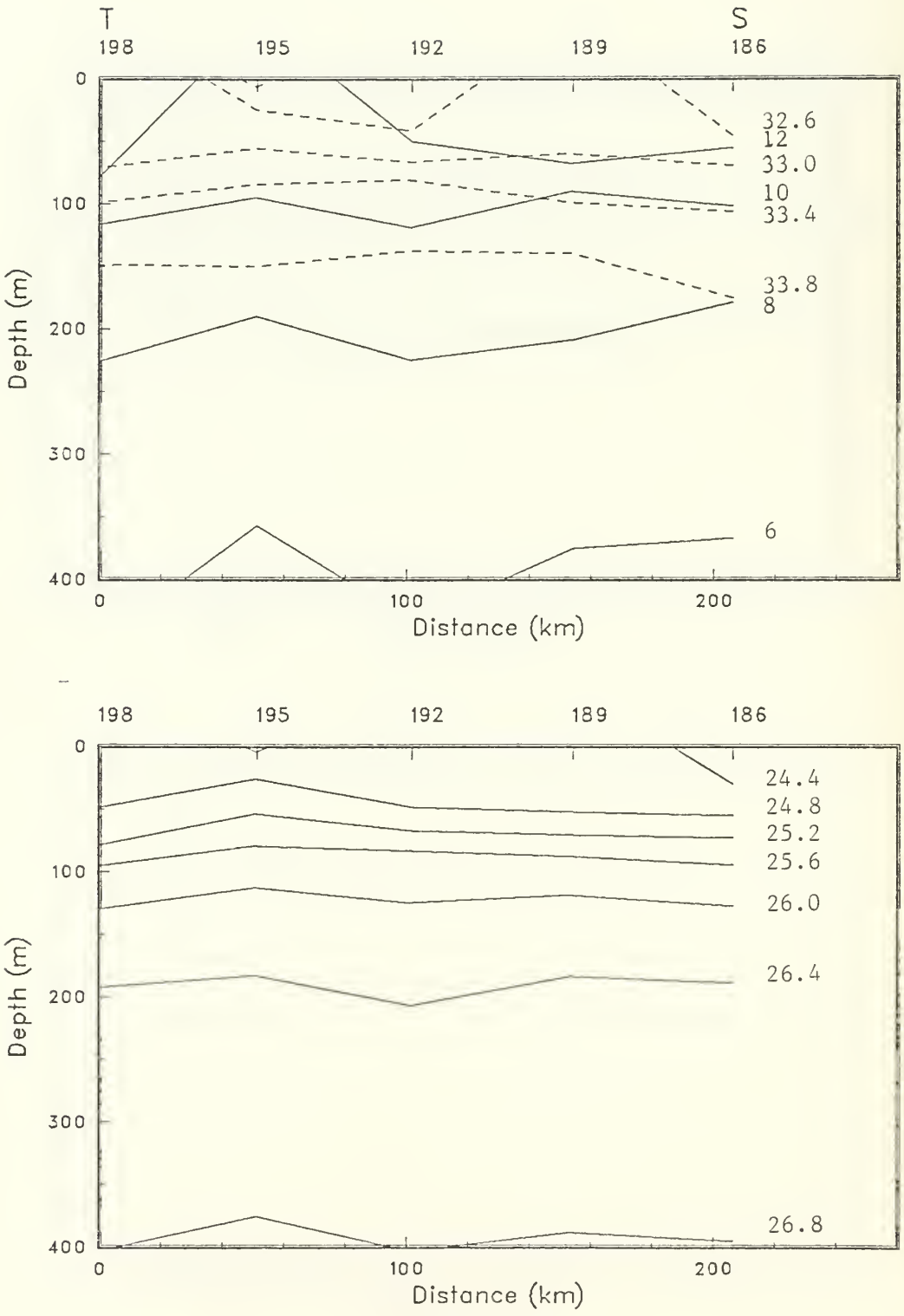

T
S
198
195
192
189
186
0
100
200
300
400
Depth (m)
32.6
12
33.0
10
33.4
33.8
8
6
0
100
200
Distance (km)
198
195
192
189
186
0
100
200
300
400
Depth (m)
24.4
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 15(j)

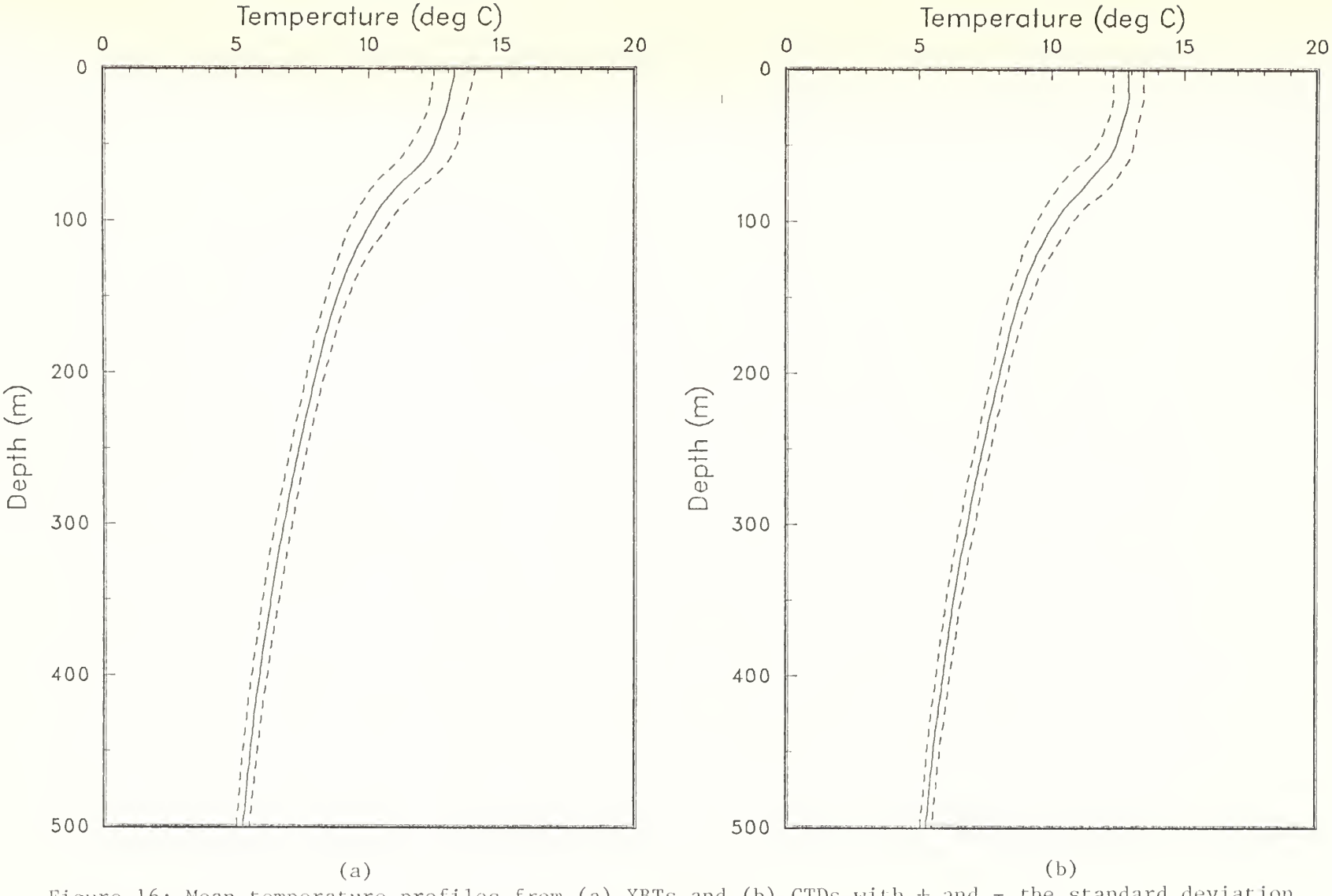


Figure 16: Mean temperature profiles from (a) XBTs and (b) CTDs with + and - the standard deviation (OPTOMA20, Leg MI).

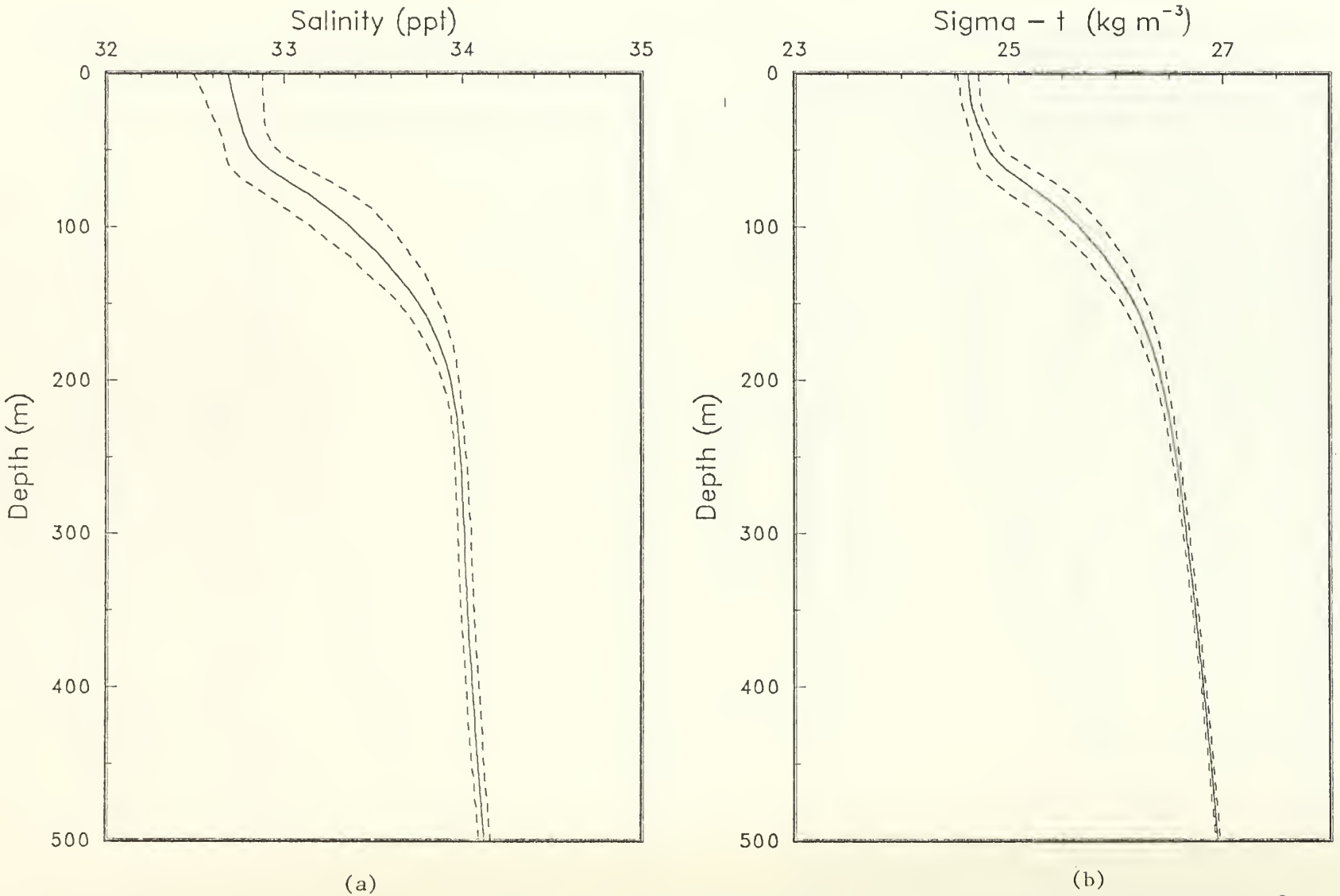


Figure 17: Mean profiles of (a) salinity and (b) sigma-t, with + and - the standard deviations, from the CTDs (OPTOMA20, Leg MI).

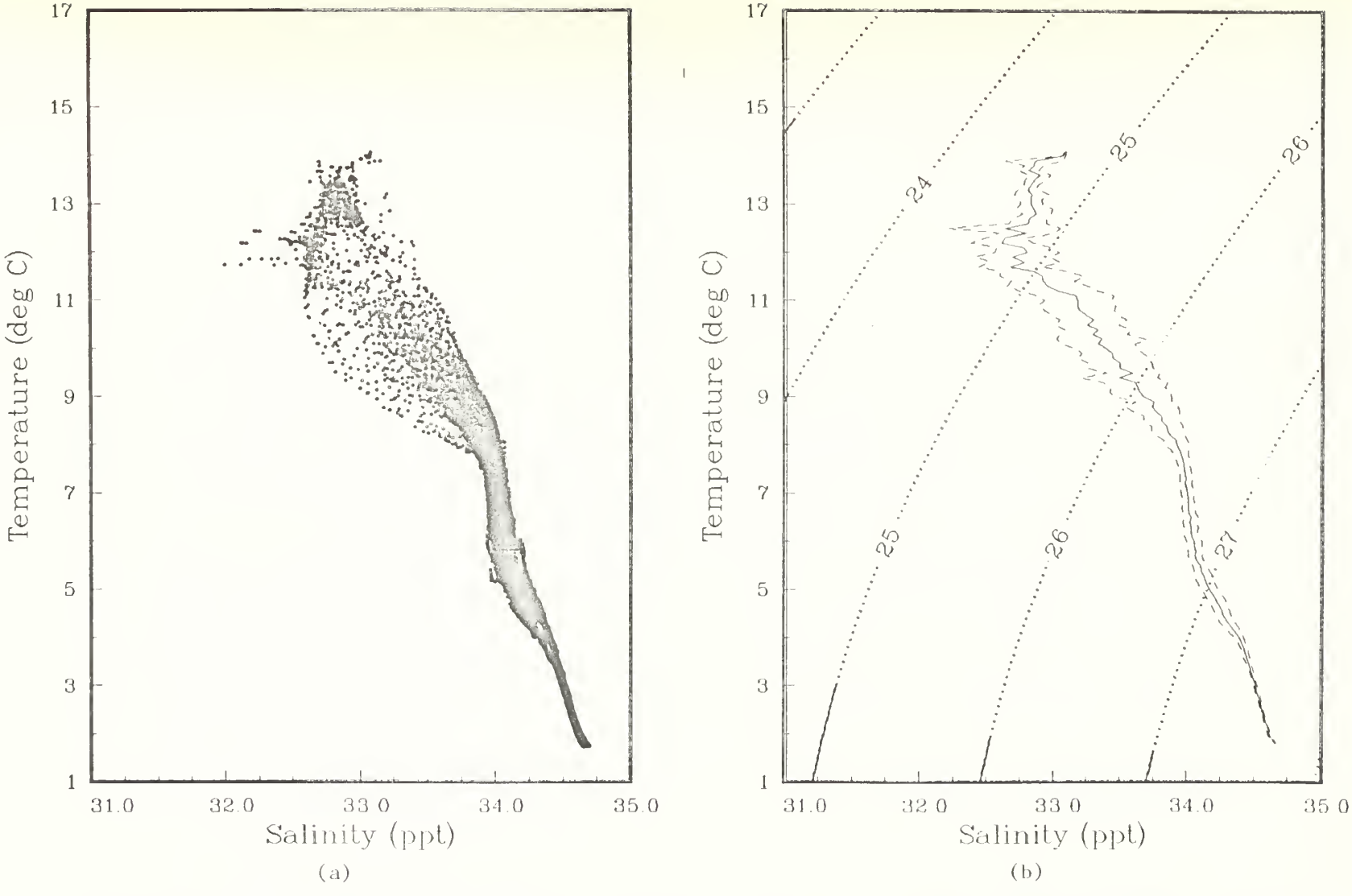


Figure 18: (a)T-S pairs and (b) mean T-S relation, with + and - the standard deviation, from the CTDs. Selected sigma-t contours are also shown (OPTOMA20, Leg MI).

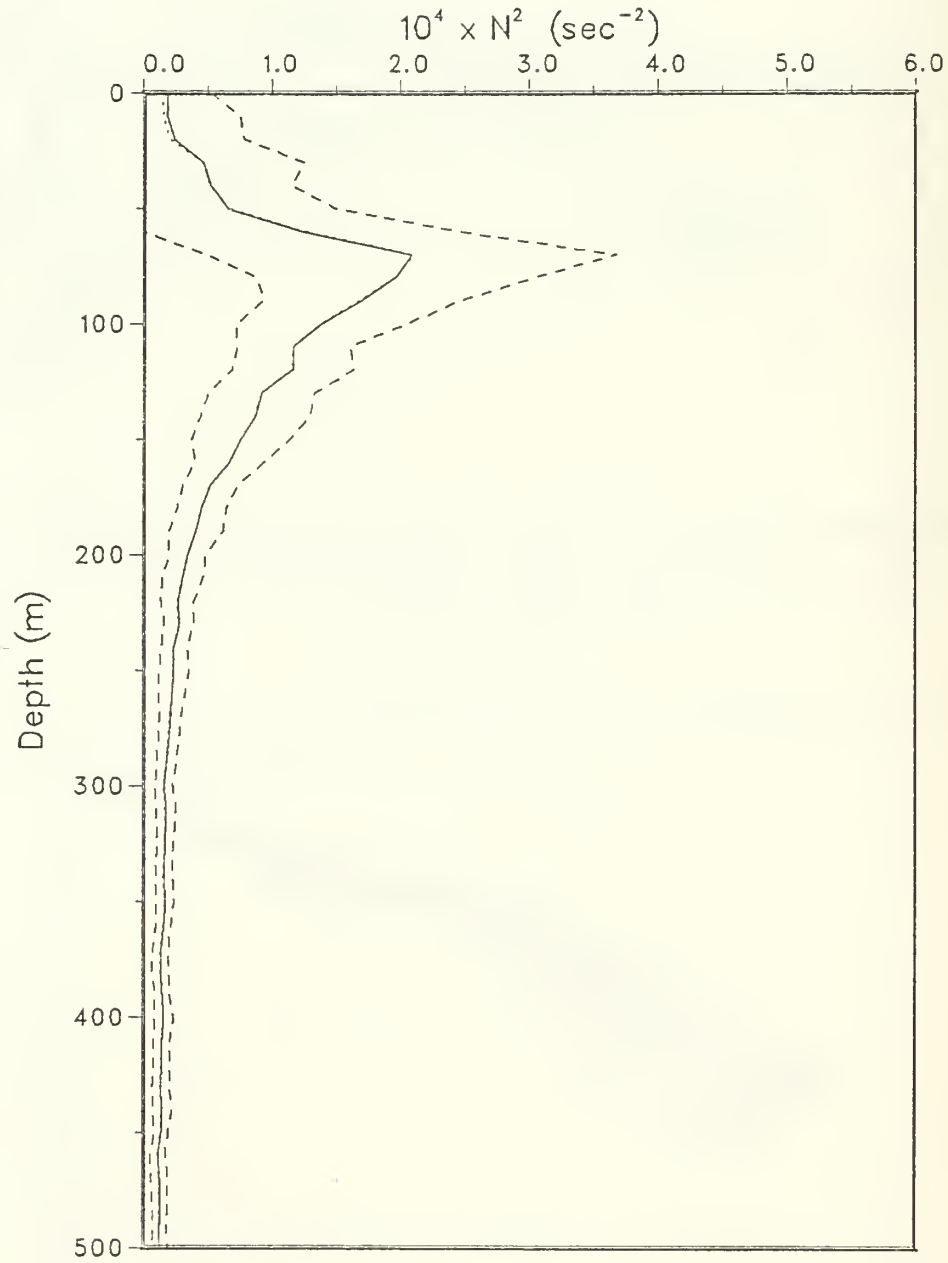


Figure 19: Mean N^2 profile (——) with + and - the standard deviation (----). The N^2 profile from $\overline{T(z)}$ and $\overline{S(z)}$ is also shown (····) (OPTOMA20, Leg MI).

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Section 3

OPTOMA20 Leg MII

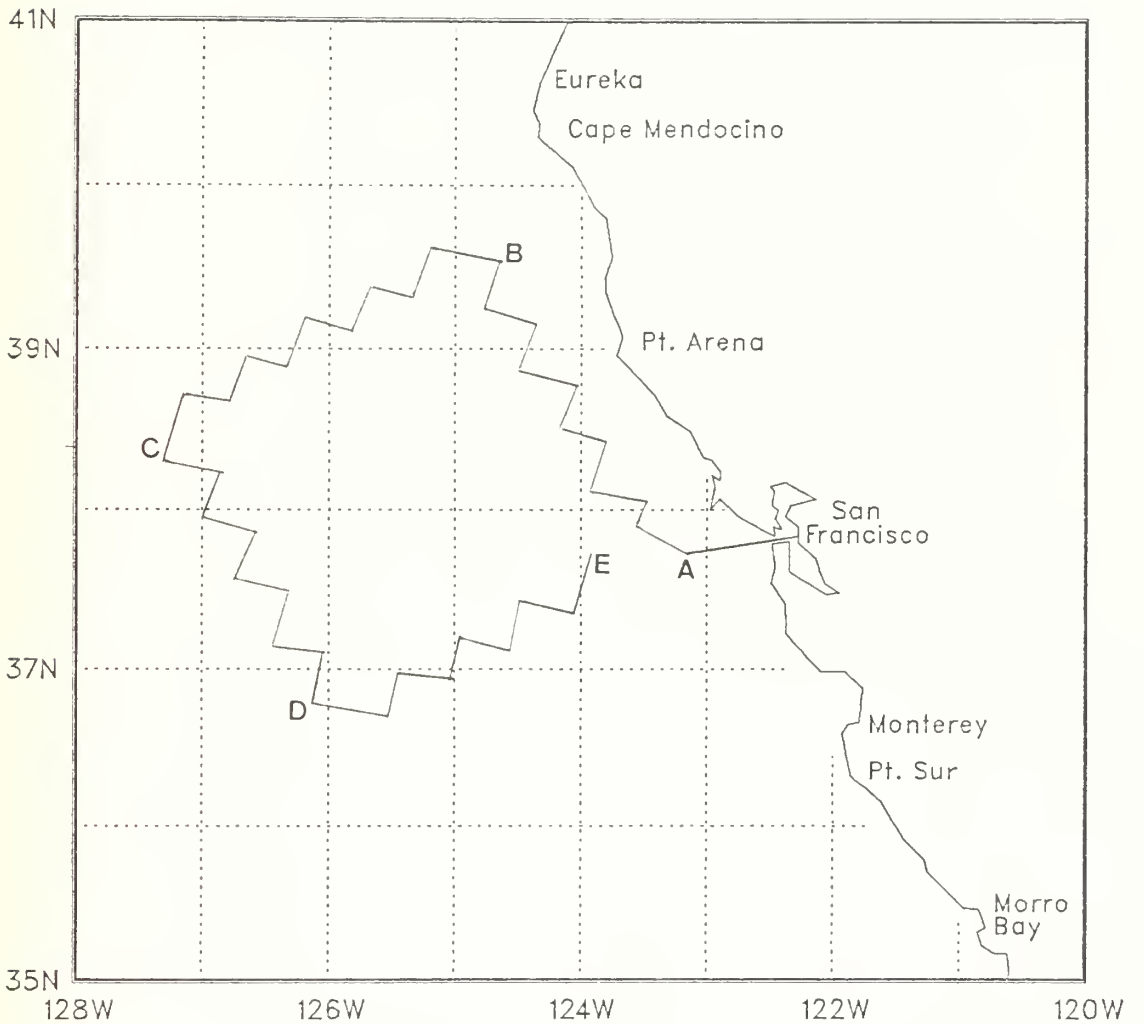


Figure 20(a): The cruise track for OPTOMA20, Leg MII.

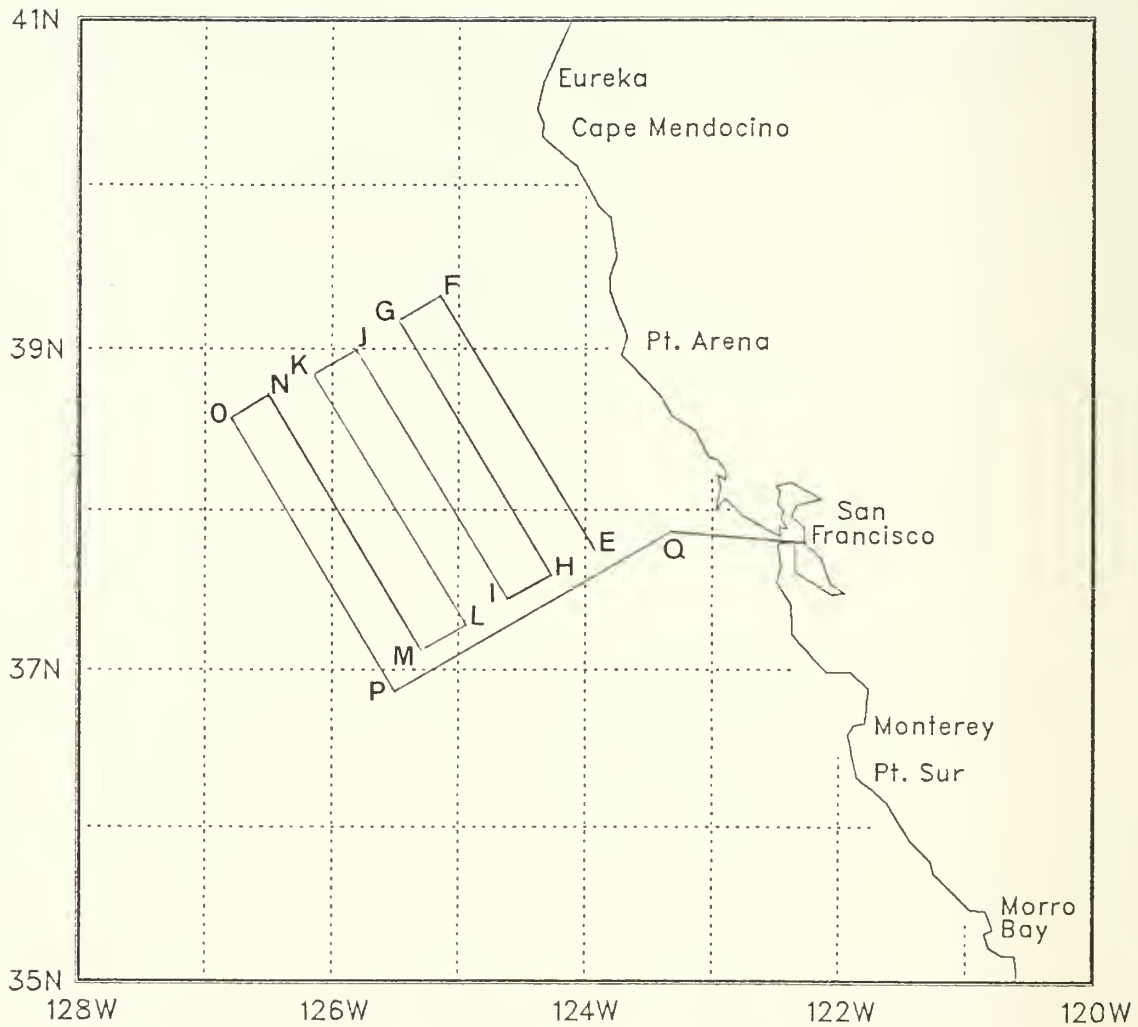

41N
39N
37N
35N
128W
126W
124W
122W
120W
Eureka
Cape Mendocino
Pt. Arena
San
Francisco
Monterey
Pt. Sur
Morro
Bay
F
G
J
K
N
O
E
Q
H
I
L
M
P

Figure 20(b)

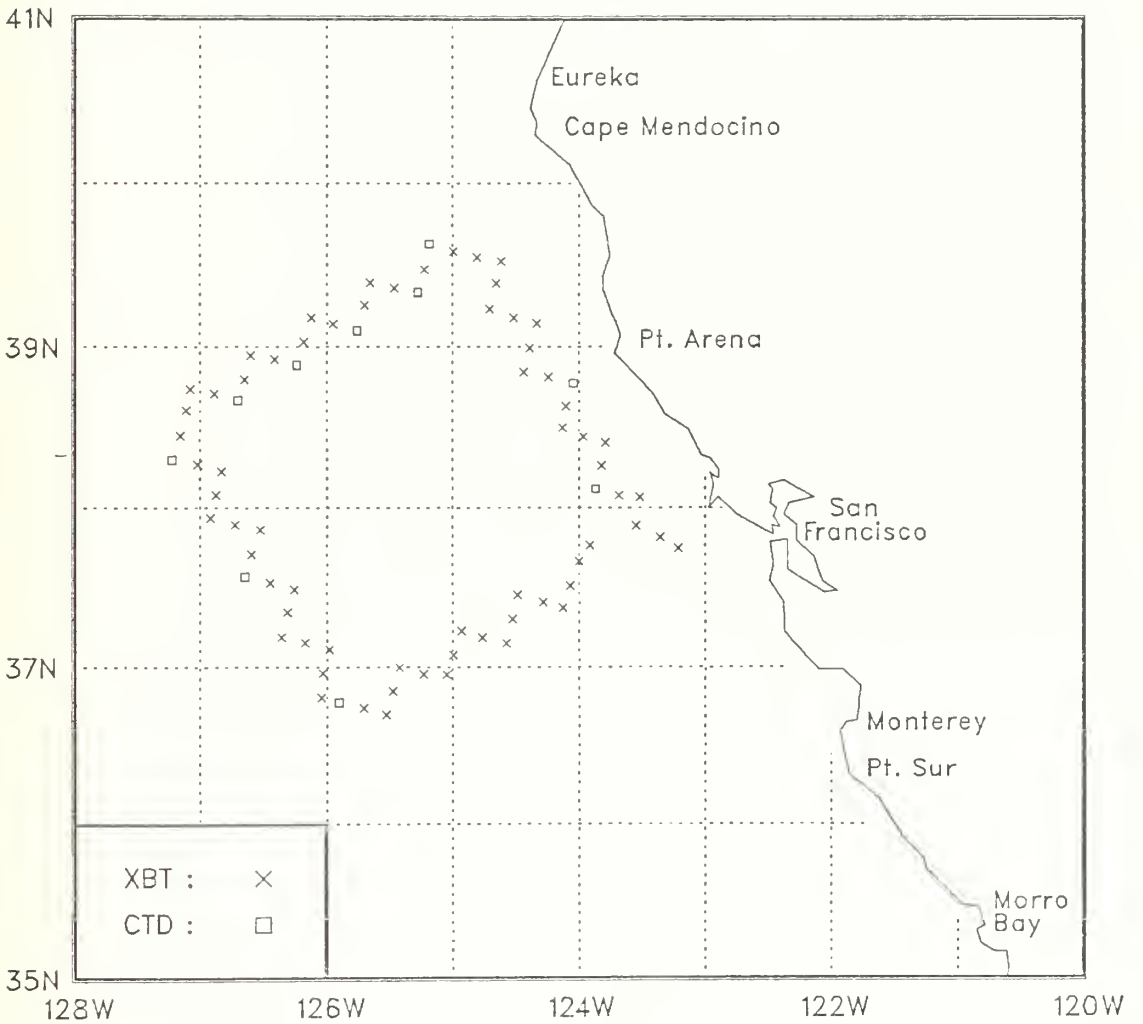


Figure 21(a): XBT and CTD locations for OPTOMA20, Leg MII.

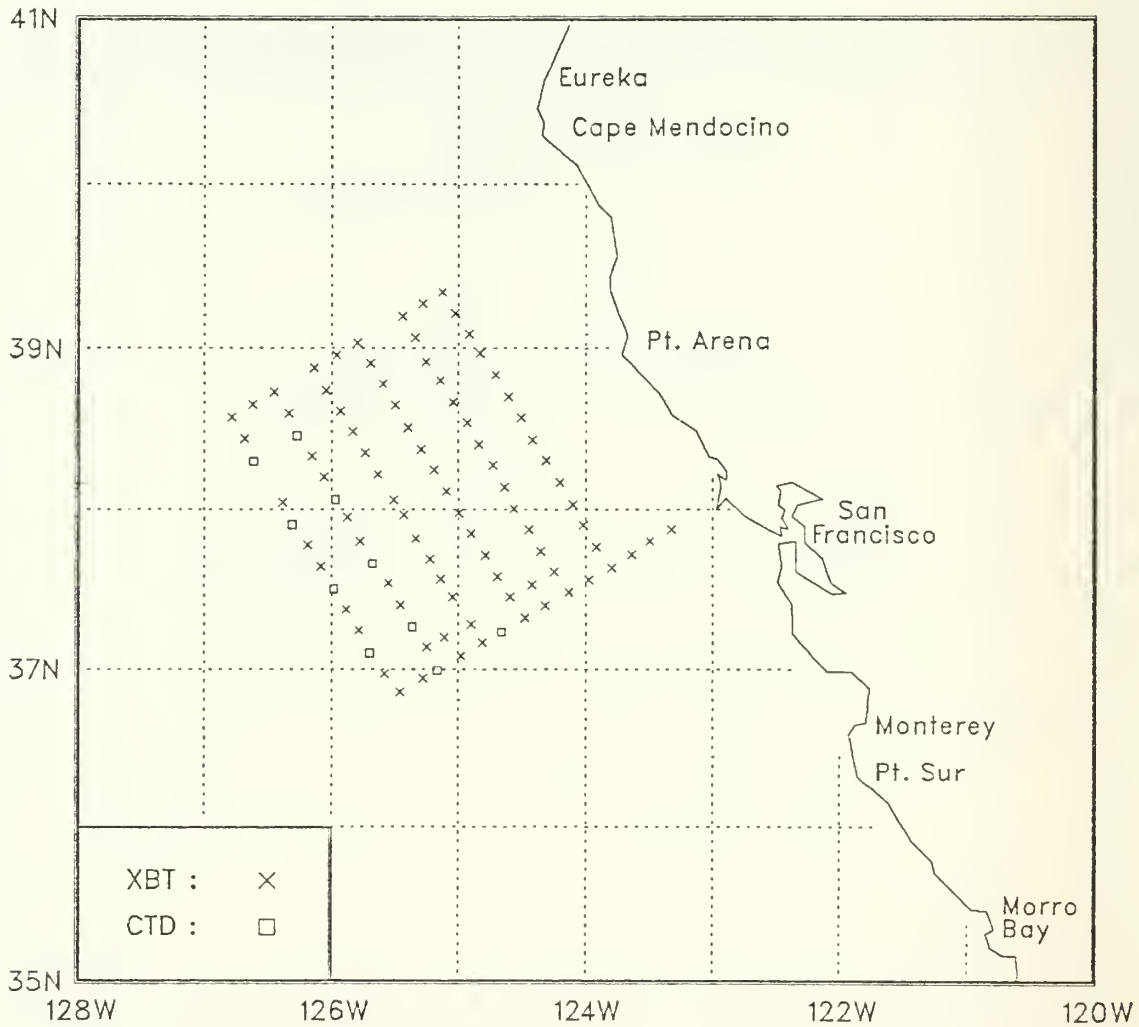

41N
39N
37N
35N
128W
126W
124W
122W
120W
Eureka
Cape Mendocino
Pt. Arena
San
Francisco
Monterey
Pt. Sur
Morro
Bay
XBT :
CTD :

Figure 21(b)

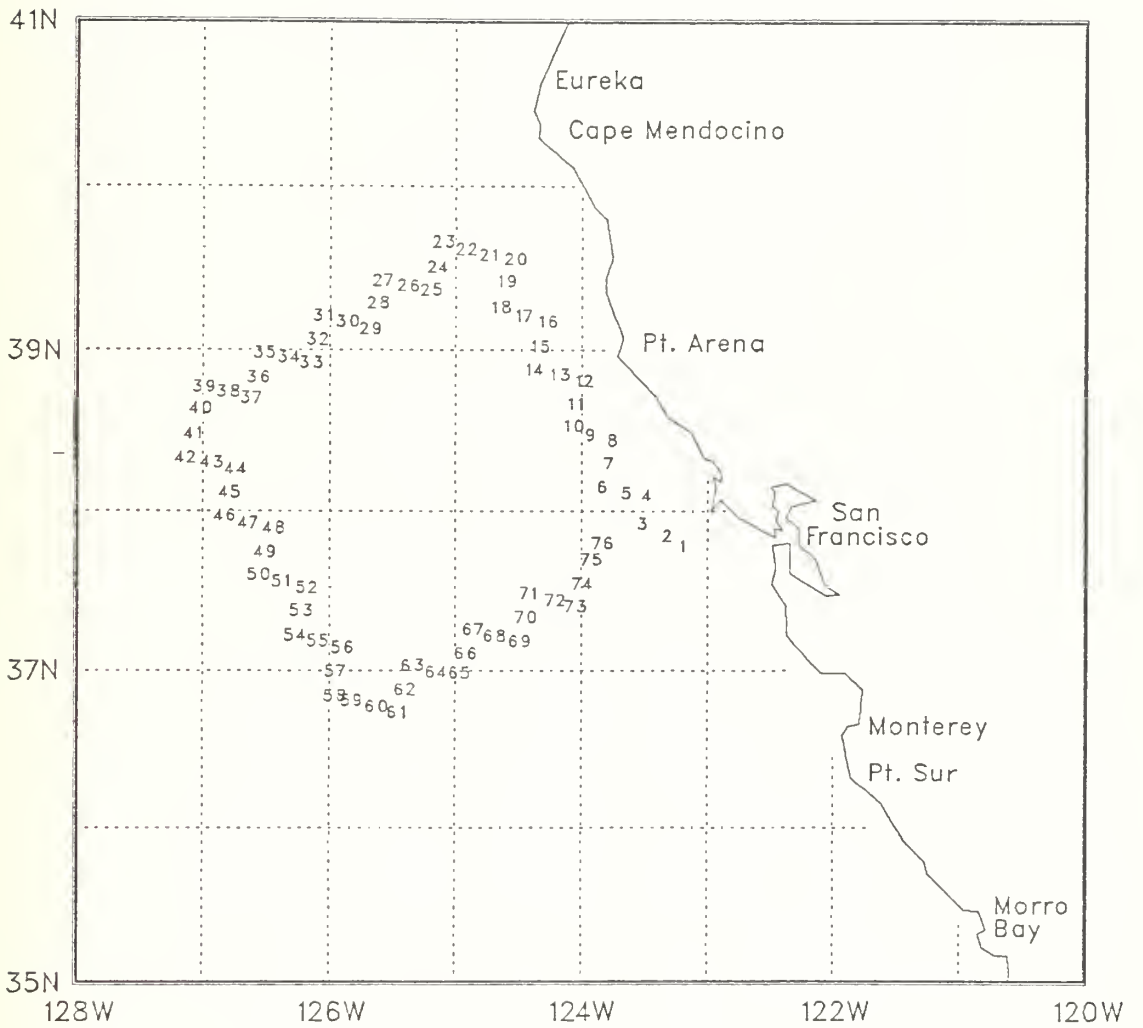


Figure 22(a): Station numbers for OPTOMA20, Leg MII.

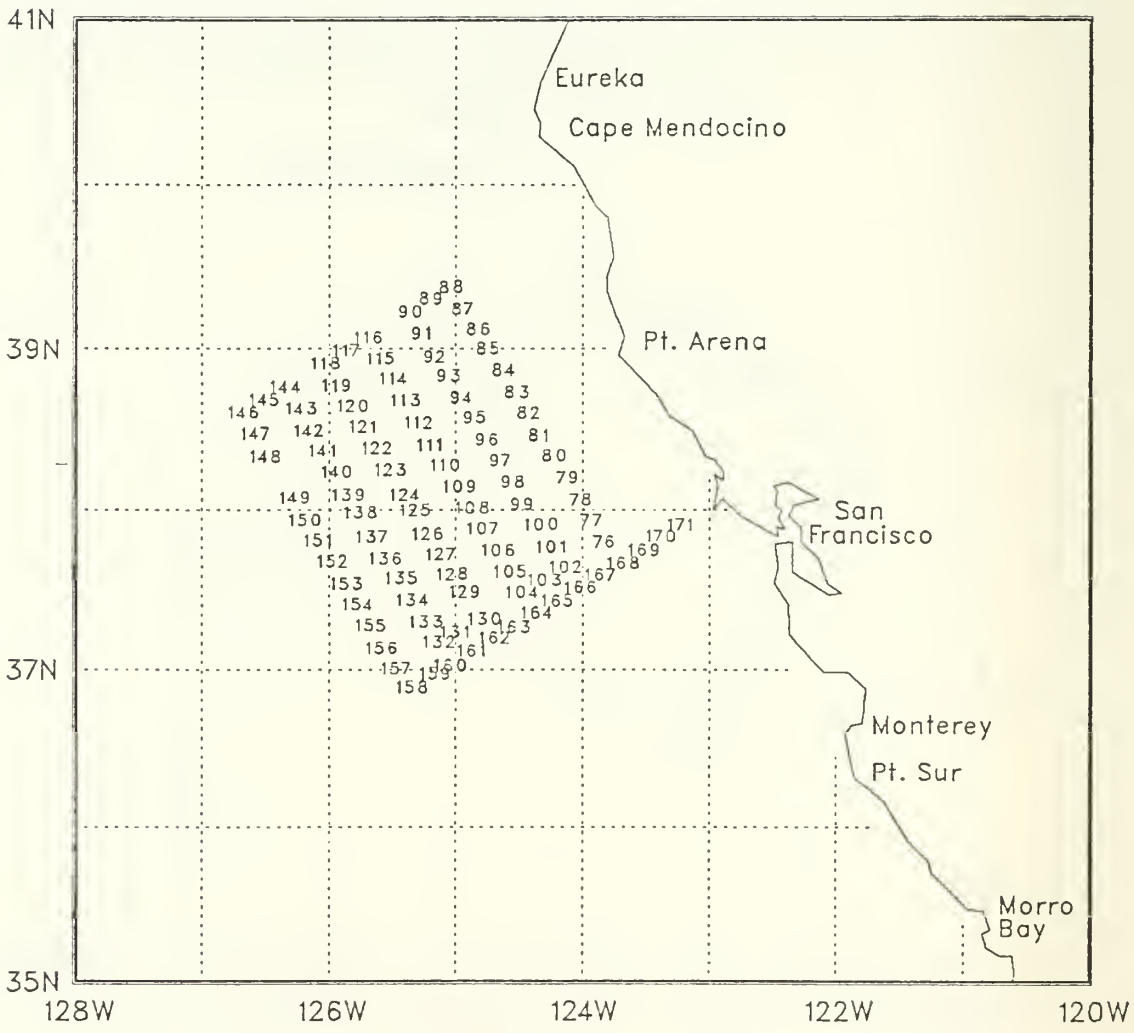

41N
39N
37N
35N
128W
126W
124W
122W
120W
Eureka
Cape Mendocino
Pt. Arena
San
Francisco
Monterey
Pt. Sur
Morro
Bay

Figure 22(b)

Table 5: OPTOMA20 Leg MII Station Listing

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
1	XBT	86097	2242	37.45	123.13	11.7			
2	XBT	86097	2321	37.49	123.21	12.1			
3	XBT	86098	11	37.53	123.33	12.1			
4	XBT	86098	111	38.04	123.31	12.3			
5	XBT	86098	152	38.05	123.41	13.0			
6	CTD	86098	306	38.07	123.52	11.6	32.85	11.8	32.82
7	XBT	86098	356	38.16	123.49	12.0			
8	XBT	86098	443	38.25	123.47	12.3			
9	XBT	86098	525	38.27	123.58	12.2			
10	XBT	86098	609	38.30	124.08	12.2			
11	XBT	86098	652	38.38	124.06	11.5			
12	CTD	86098	753	38.47	124.02	11.2	32.83	*	32.79
13	XBT	86098	902	38.49	124.14	12.1			
14	XBT	86098	951	38.51	124.26	12.9			
15	XBT	86098	1041	38.59	124.23	12.5			
16	XBT	86098	1130	39.09	124.20	12.4			
17	XBT	86098	1215	39.11	124.31	12.1			
18	XBT	86098	1302	39.14	124.42	12.9			
19	XBT	86098	1350	39.23	124.39	12.4			
20	XBT	86098	1431	39.32	124.37	12.5			
21	XBT	86098	1519	39.33	124.49	12.3			
22	XBT	86098	1604	39.35	125.00	13.2			
23	CTD	86098	1700	39.38	125.11	12.2	32.28	12.5	32.29
24	XBT	86098	1818	39.29	125.13	13.2			
25	CTD	86098	1916	39.20	125.17	13.1	32.83	13.3	32.85
26	XBT	86098	2023	39.22	125.28	13.4			
27	XBT	86098	2111	39.24	125.39	13.3			
28	XBT	86098	2153	39.16	125.42	13.2			
29	CTD	86098	2254	39.06	125.46	13.1	32.85	13.3	32.87
30	XBT	86098	2358	39.09	125.57	13.1			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
31	XBT	86099	45	39.11	126.08	13.5			
32	XBT	86099	129	39.02	126.11	12.9			
33	CTD	86099	226	38.53	126.14	12.9	32.70	12.9	32.72
34	XBT	86099	328	38.55	126.24	12.9			
35	XBT	86099	413	38.57	126.36	12.6			
36	XBT	86099	500	38.48	126.39	12.9			
37	CTD	86099	555	38.40	126.42	12.6	32.65	12.8	32.65
38	XBT	86099	659	38.43	126.53	13.1			
39	XBT	86099	744	38.44	127.05	12.5			
40	XBT	86099	826	38.36	127.06	12.5			
41	XBT	86099	914	38.27	127.09	12.0			
42	CTD	86099	1012	38.18	127.13	11.9	32.58	12.2	32.58
43	XBT	86099	1118	38.16	127.01	12.3			
44	XBT	86099	1204	38.14	126.50	12.9			
45	XBT	86099	1249	38.05	126.52	13.4			
46	XBT	86099	1334	37.56	126.55	13.4			
47	XBT	86099	1425	37.54	126.43	13.4			
48	XBT	86099	1510	37.52	126.32	13.1			
49	XBT	86099	1559	37.43	126.36	13.6			
50	CTD	86099	1659	37.34	126.39	13.1	32.58	13.3	32.74
51	XBT	86099	1813	37.32	126.27	13.3			
52	XBT	86099	1858	37.29	126.15	13.2			
53	XBT	86099	1946	37.21	126.19	13.2			
54	XBT	86099	2031	37.11	126.21	14.0			
55	XBT	86099	2117	37.09	126.10	14.0			
56	XBT	86099	2203	37.07	125.59	13.7			
57	XBT	86099	2247	36.58	126.02	13.1			
58	XBT	86099	2339	36.48	126.02	13.2			
59	CTD	86100	101	36.47	125.54	13.4	32.83	*	32.87
60	XBT	86100	249	36.44	125.42	13.9			
61	XBT	86100	334	36.42	125.32	14.1			
62	XBT	86100	425	36.51	125.28	14.0			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
63	XBT	86100	518	37.00	125.25	13.8			
64	XBT	86100	606	36.57	125.14	14.2			
65	XBT	86100	726	36.57	125.03	13.9			
66	XBT	86100	838	37.05	125.00	13.7			
67	XBT	86100	952	37.14	124.56	13.5			
68	XBT	86100	1042	37.11	124.46	13.7			
69	XBT	86100	1130	37.09	124.34	13.6			
70	XBT	86100	1248	37.18	124.31	13.2			
71	XBT	86100	1410	37.27	124.29	12.8			
72	XBT	86100	1516	37.25	124.17	13.2			
73	XBT	86100	1624	37.22	124.08	12.9			
74	XBT	86100	1742	37.31	124.04	13.3			
75	XBT	86100	1856	37.40	124.00	12.5			
76	XBT	86100	2020	37.46	123.55	12.4			
77	XBT	86100	2142	37.54	124.01	13.4			
78	XBT	86100	2306	38.02	124.06	12.6			
79	XBT	86101	33	38.10	124.12	11.5			
80	XBT	86101	203	38.18	124.19	11.9			
81	XBT	86101	358	38.26	124.25	12.8			
82	XBT	86101	501	38.34	124.30	12.7			
83	XBT	86101	845	38.42	124.36	12.4			
84	XBT	86101	1036	38.50	124.42	12.9			
85	XBT	86101	1227	38.58	124.50	12.9			
86	XBT	86101	1359	39.05	124.55	12.6			
87	XBT	86101	1546	39.13	125.02	12.7			
88	XBT	86101	1736	39.21	125.07	12.5			
89	XBT	86101	1910	39.16	125.17	13.0			
90	XBT	86101	2130	39.12	125.27	12.9			
91	XBT	86101	2225	39.04	125.21	13.0			
92	XBT	86101	2320	38.55	125.15	12.9			
93	XBT	86102	3	38.48	125.09	12.7			
94	XBT	86102	45	38.40	125.02	12.2			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
95	XBT	86102	131	38.32	124.56	12.4			
96	XBT	86102	218	38.24	124.50	12.3			
97	XBT	86102	304	38.17	124.44	12.8			
98	XBT	86102	347	38.08	124.38	13.3			
99	XBT	86102	438	38.00	124.34	13.3			
100	XBT	86102	521	37.53	124.27	13.2			
101	XBT	86102	609	37.44	124.21	13.3			
102	XBT	86102	654	37.37	124.15	13.3			
103	XBT	86102	753	37.32	124.25	12.8			
104	XBT	86102	922	37.27	124.36	13.0			
105	XBT	86102	1053	37.35	124.41	13.1			
106	XBT	86102	1230	37.43	124.47	13.4			
107	XBT	86102	1411	37.51	124.54	13.2			
108	XBT	86102	1654	37.59	125.00	13.2			
109	XBT	86102	1824	38.07	125.05	13.4			
110	XBT	86102	2002	38.15	125.11	13.1			
111	XBT	86102	2141	38.22	125.18	12.6			
112	XBT	86102	2318	38.31	125.24	12.7			
113	XBT	86103	59	38.39	125.30	12.6			
114	XBT	86103	214	38.47	125.36	13.0			
115	XBT	86103	335	38.54	125.42	12.9			
116	XBT	86103	456	39.02	125.48	13.1			
117	XBT	86103	604	38.57	125.58	13.0			
118	XBT	86103	706	38.53	126.08	12.6			
119	XBT	86103	803	38.44	126.03	12.3			
120	XBT	86103	849	38.37	125.56	12.7			
121	XBT	86103	932	38.29	125.50	12.5			
122	XBT	86103	1020	38.21	125.44	12.8			
123	XBT	86103	1106	38.13	125.38	12.9			
124	XBT	86103	1152	38.04	125.31	13.3			
125	XBT	86103	1235	37.58	125.26	13.0			
126	XBT	86103	1323	37.49	125.20	13.0			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
127	XBT	86103	1412	37.41	125.13	12.9			
128	XBT	86103	1457	37.34	125.08	13.3			
129	XBT	86103	1536	37.27	125.03	13.6			
130	XBT	86103	1652	37.17	124.54	13.6			
131	XBT	86103	1753	37.12	125.07	13.3			
132	XBT	86103	1831	37.08	125.15	13.6			
133	CTD	86103	1928	37.16	125.21	13.4	32.91	13.6	*
134	XBT	86103	2044	37.24	125.28	13.7			
135	XBT	86103	2148	37.33	125.33	13.1			
136	CTD	86103	2237	37.40	125.40	13.1	32.76	13.3	*
137	XBT	86104	50	37.48	125.46	13.0			
138	XBT	86104	148	37.57	125.52	12.8			
139	CTD	86104	230	38.04	125.58	12.6	32.75	12.8	*
140	XBT	86104	355	38.12	126.03	13.0			
141	XBT	86104	443	38.20	126.09	13.6			
142	CTD	86104	533	38.28	126.16	12.9	32.83	*	*
143	XBT	86104	657	38.36	126.20	13.1			
144	XBT	86104	744	38.44	126.27	12.9			
145	XBT	86104	830	38.39	126.37	13.1			
146	XBT	86104	918	38.34	126.47	13.1			
147	XBT	86104	1004	38.27	126.41	12.8			
148	CTD	86104	1056	38.18	126.37	12.5	32.80	*	*
149	XBT	86104	1307	38.03	126.23	12.8			
150	CTD	86104	1350	37.54	126.18	12.4	32.79	*	*
151	XBT	86104	1513	37.47	126.11	13.0			
152	XBT	86104	1558	37.39	126.05	13.1			
153	CTD	86104	1643	37.30	125.59	13.0	32.90	*	*
154	XBT	86104	1805	37.23	125.53	13.3			
155	XBT	86104	1851	37.15	125.47	13.5			
156	CTD	86104	1937	37.06	125.42	13.6	32.83	*	*
157	XBT	86104	2129	36.58	125.35	13.9			
158	XBT	86104	2218	36.51	125.28	13.8			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
159	XBT	86104	2312	36.56	125.17	14.0			
160	CTD	86104	2345	37.00	125.10	13.5	32.90	*	*
161	XBT	86105	106	37.05	124.59	13.4			
162	XBT	86105	151	37.10	124.48	13.3			
163	CTD	86105	236	37.14	124.40	13.0	32.84	*	*
164	XBT	86105	357	37.19	124.23	13.2			
165	XBT	86105	440	37.24	124.19	13.2			
166	XBT	86105	536	37.29	124.08	13.2			
167	XBT	86105	636	37.34	123.58	12.3			
168	XBT	86105	807	37.38	123.48	12.3			
169	XBT	86105	912	37.43	123.38	11.6			
170	XBT	86105	1013	37.48	123.29	11.1			
171	XBT	86105	1115	37.53	123.19	11.3			

* Data not available

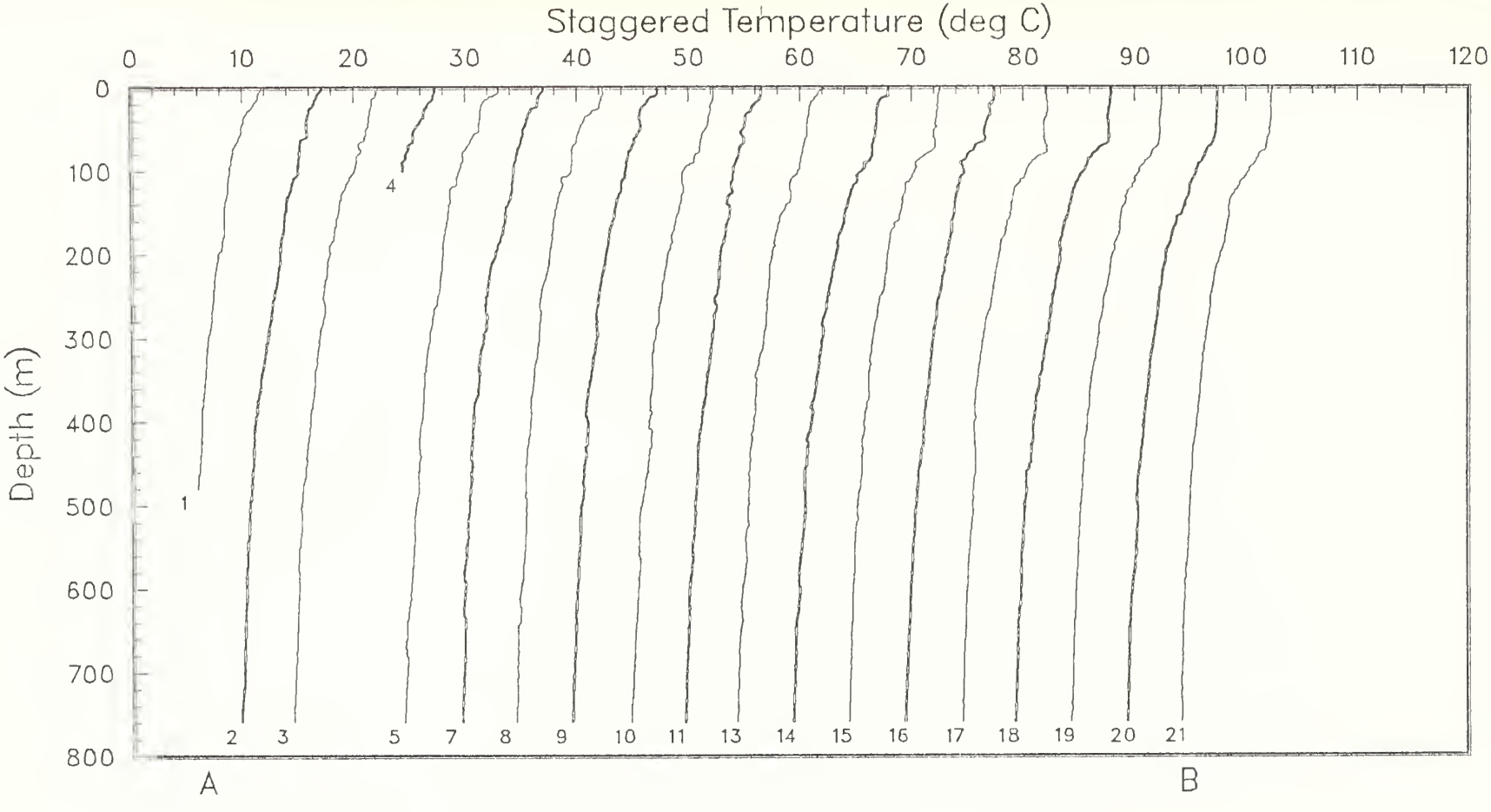


Figure 23(a): XBT temperature profiles, staggered by multiples of 5C (OPTOMA20, Leg MII).

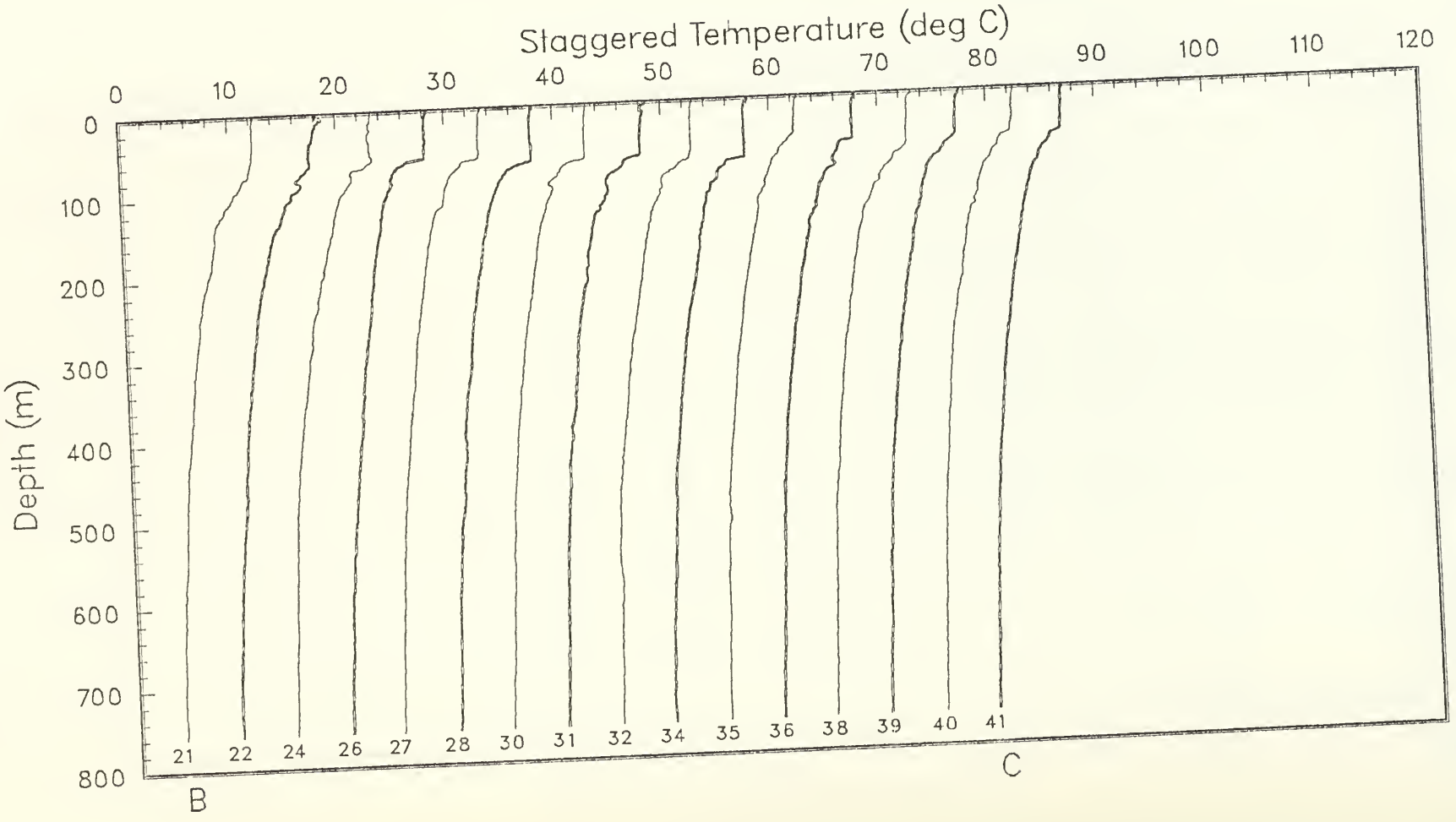

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
21
22
24
26
27
28
30
31
32
34
35
36
38
39
40
41
B
C

Figure 23(b)

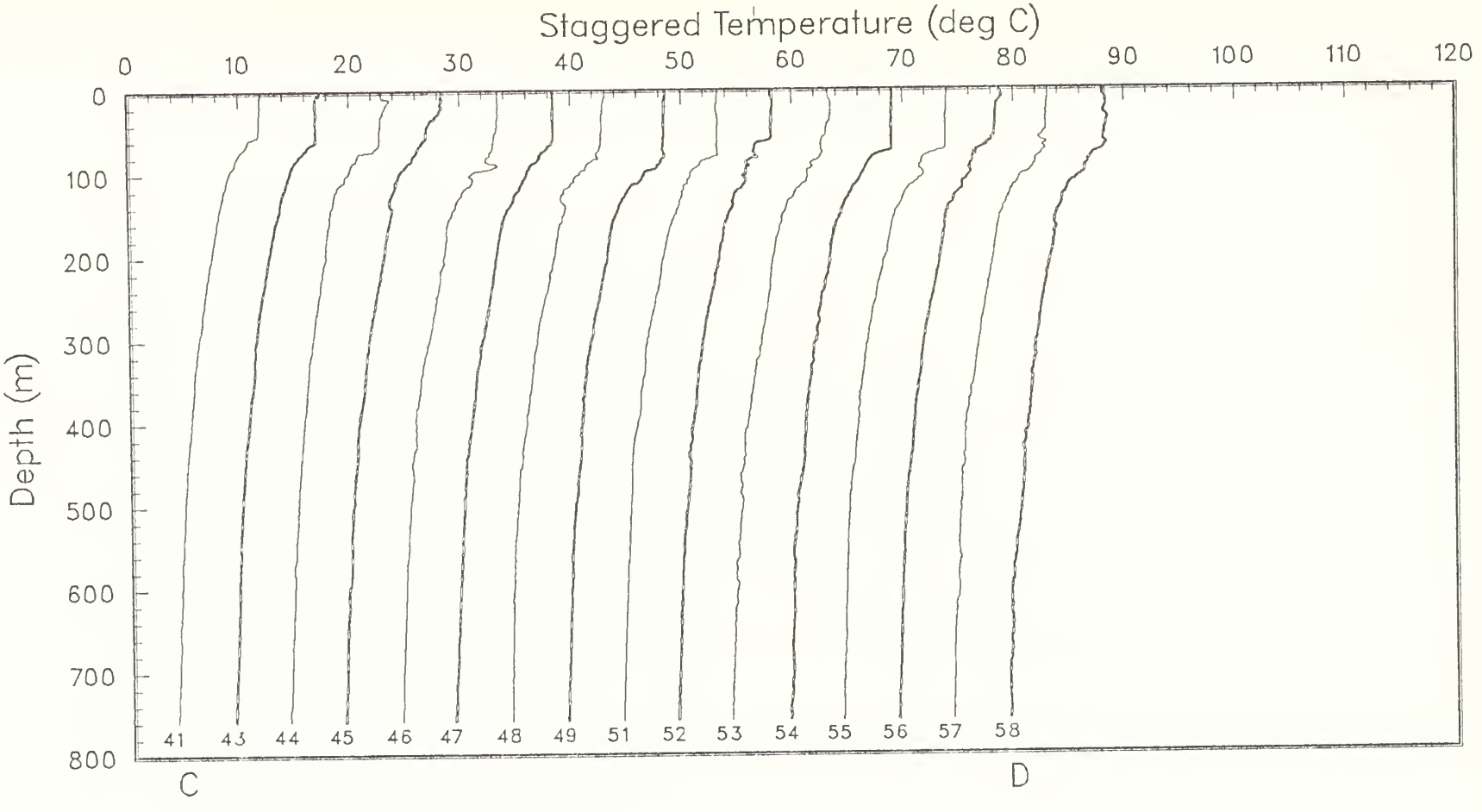

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
41
43
44
45
46
47
48
49
51
52
53
54
55
56
57
58
C
D

Figure 23(c)

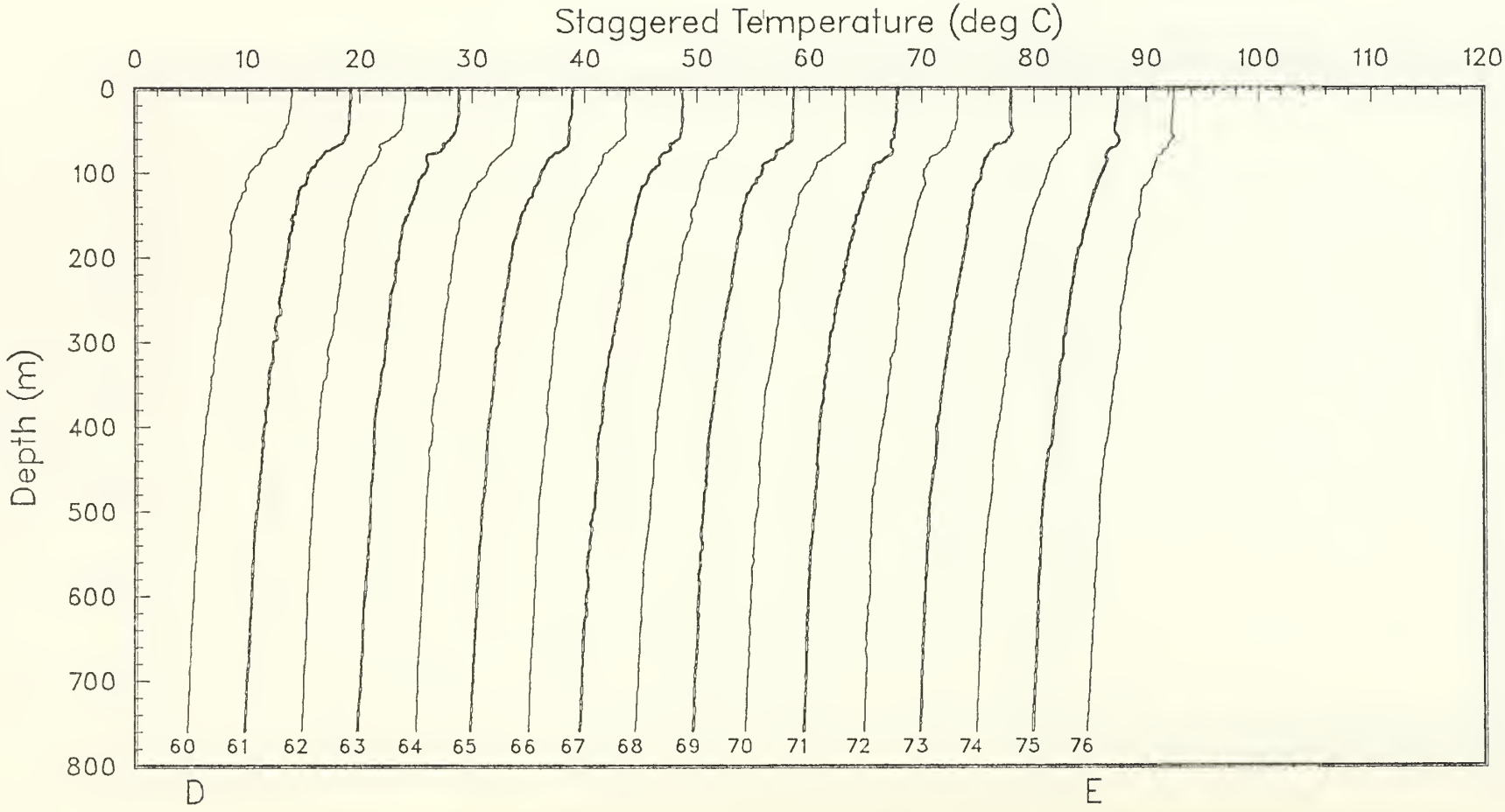

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
D
E

Figure 23(d)

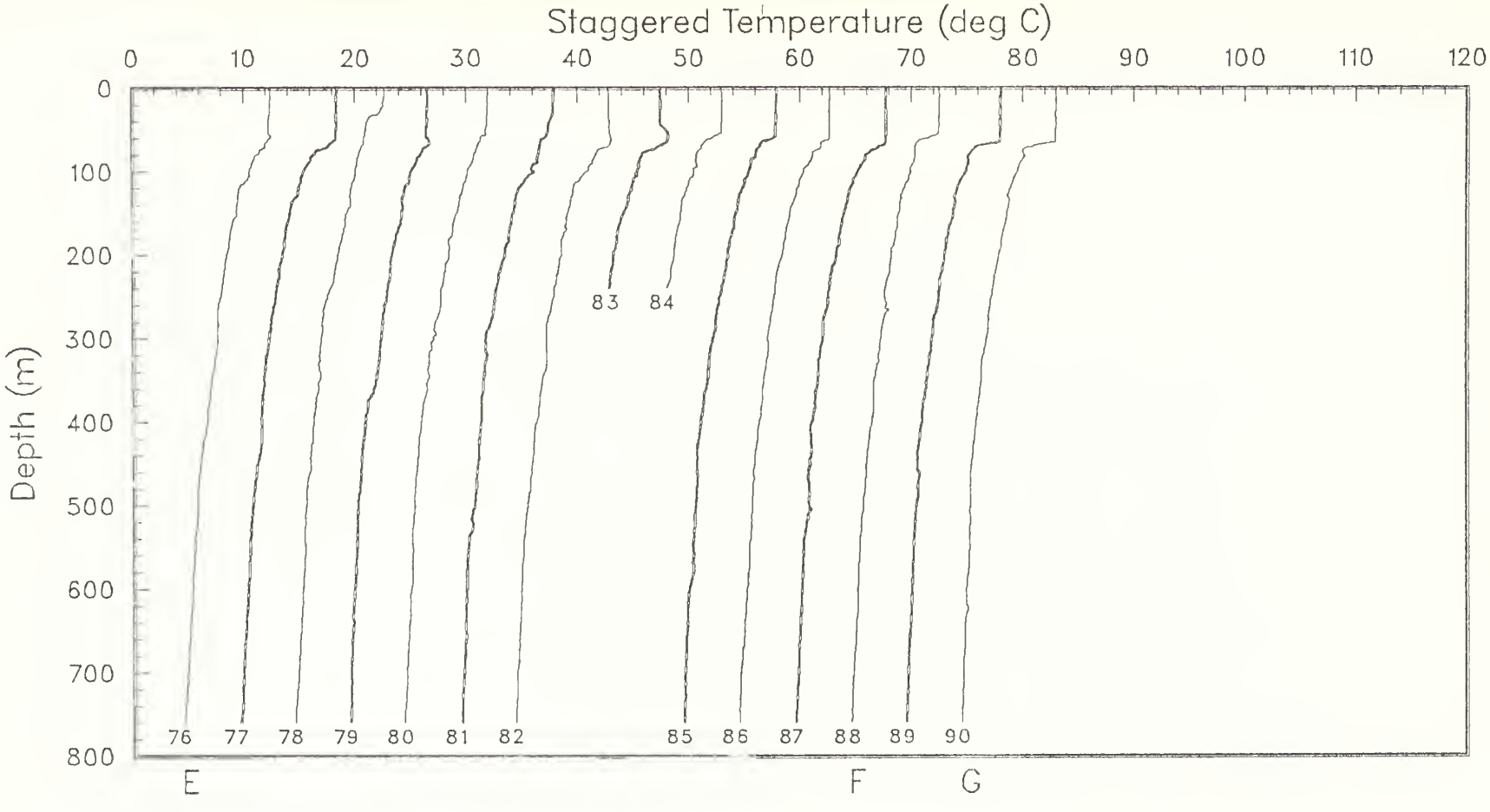

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
E
F
G

Figure 23(e)

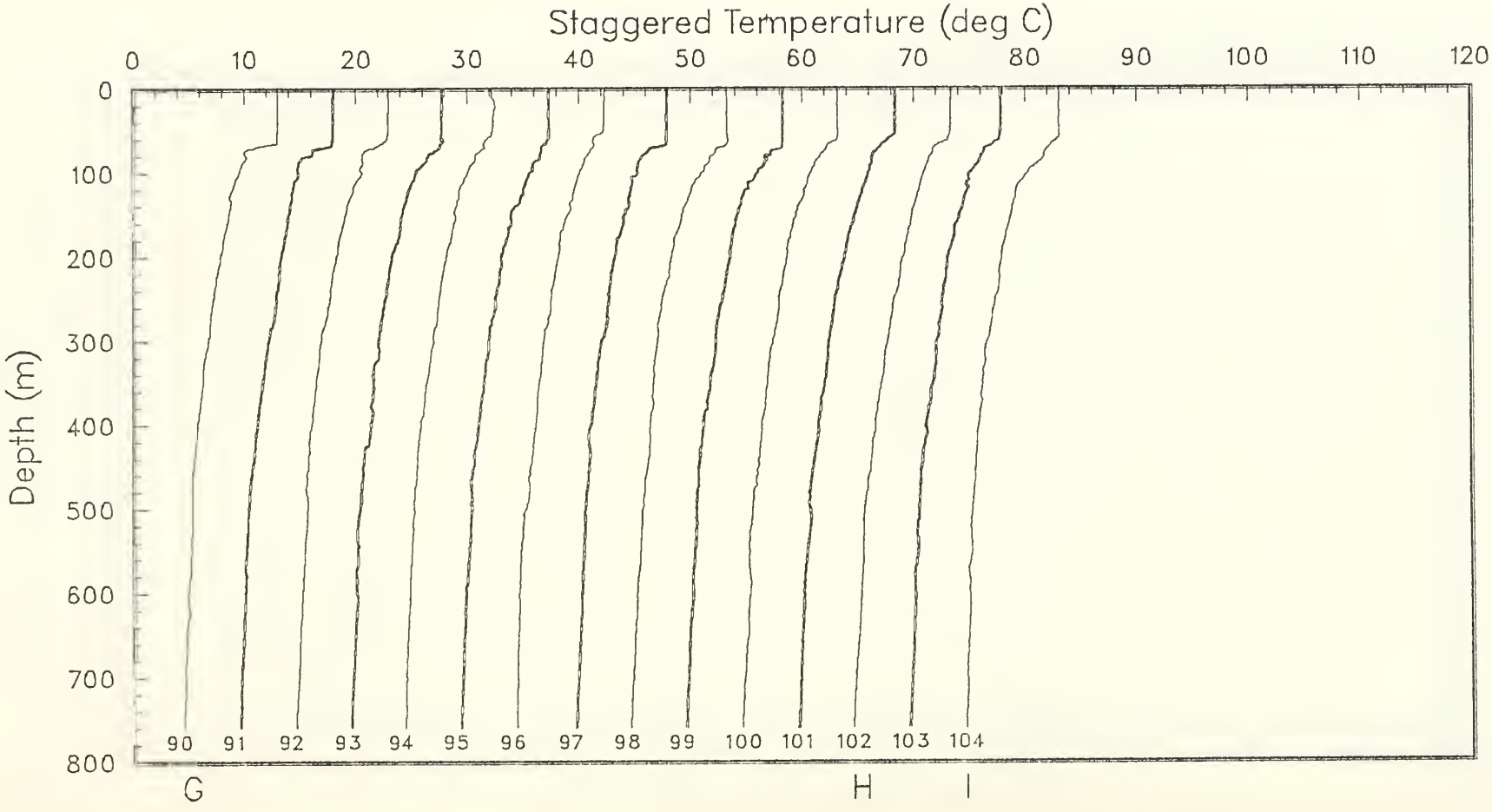

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
G
H
I

Figure 23(f)

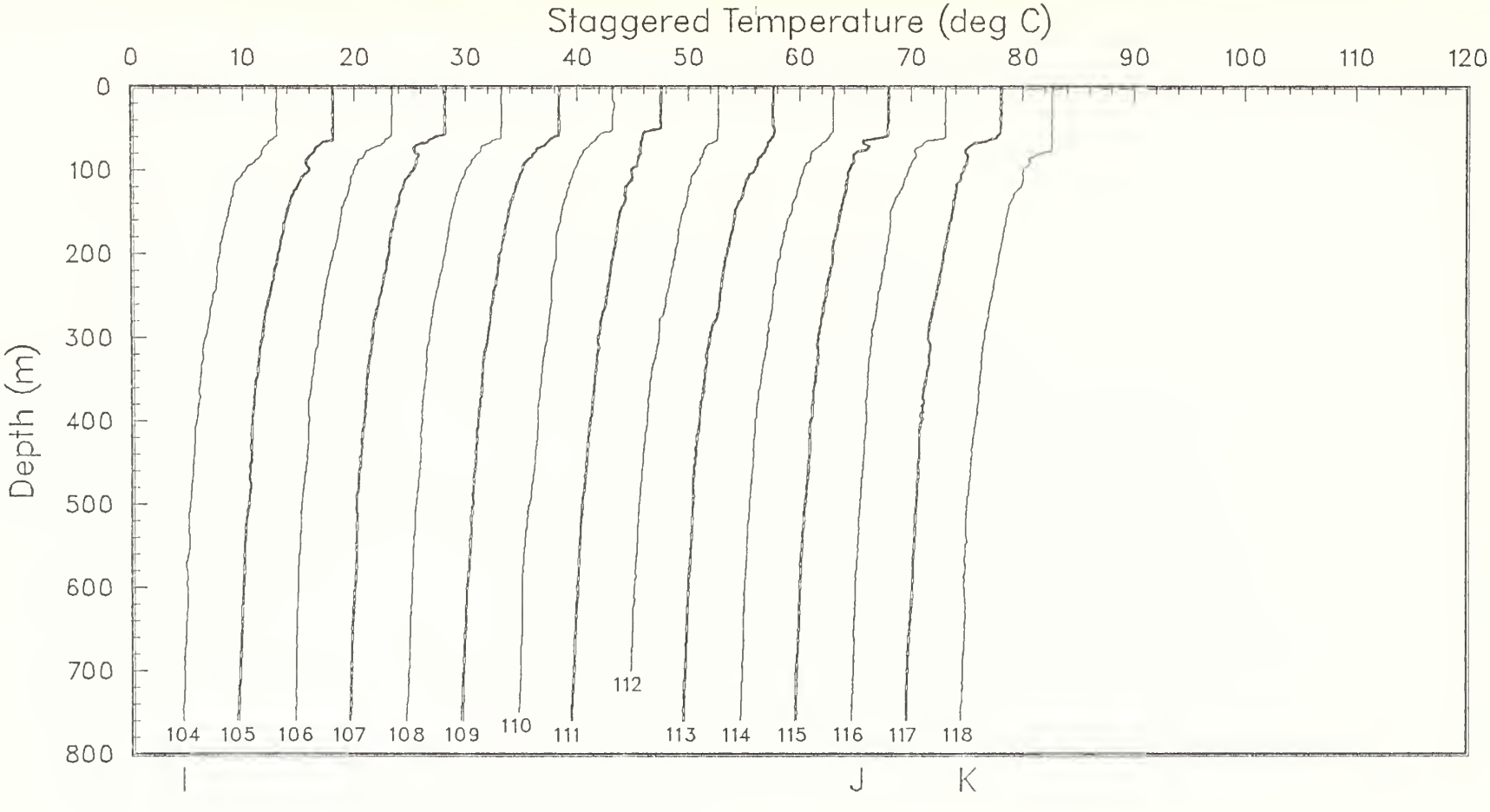

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
I
J
K

Figure 23(g)

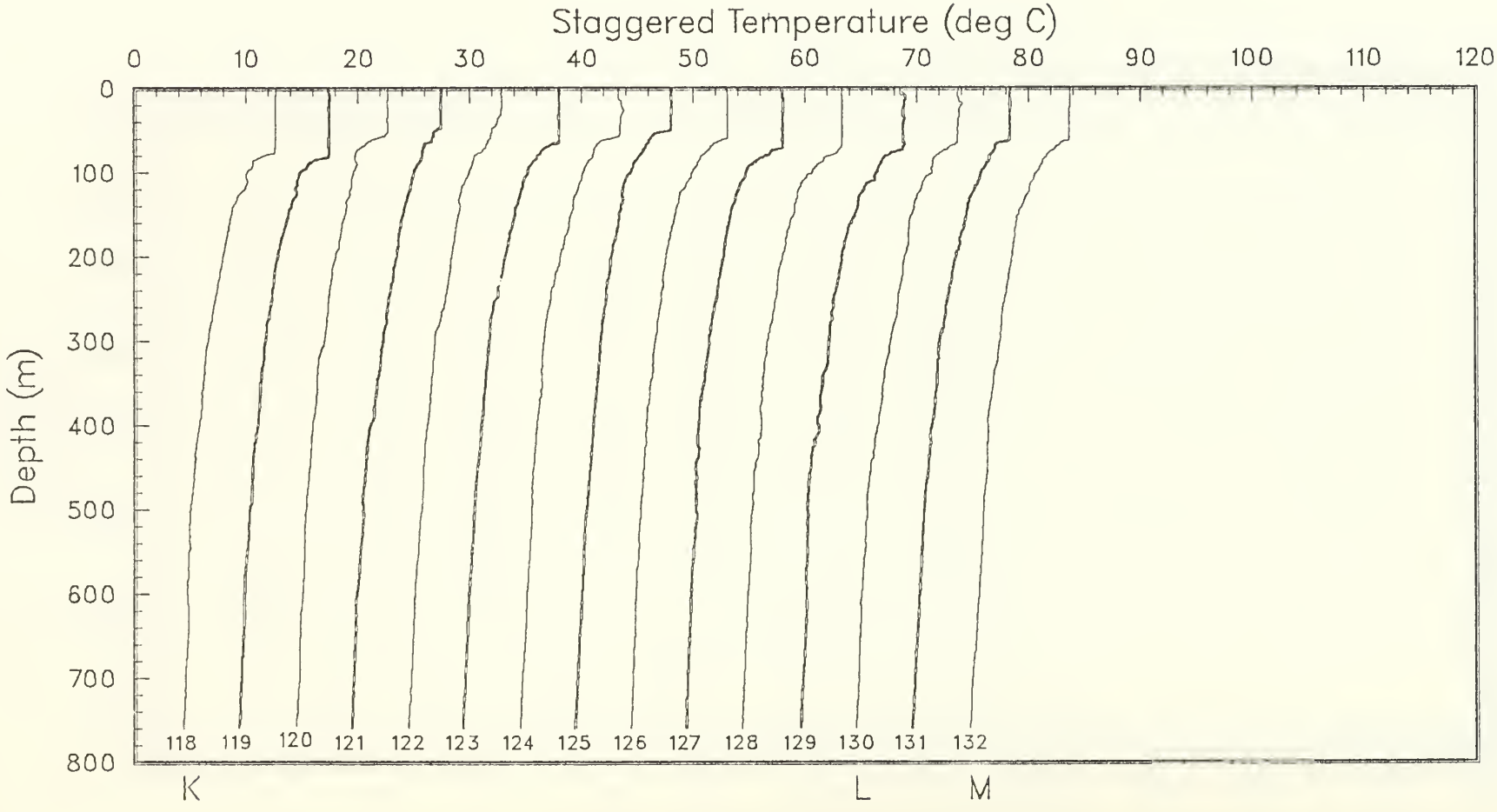

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
K
L
M

Figure 23(h)

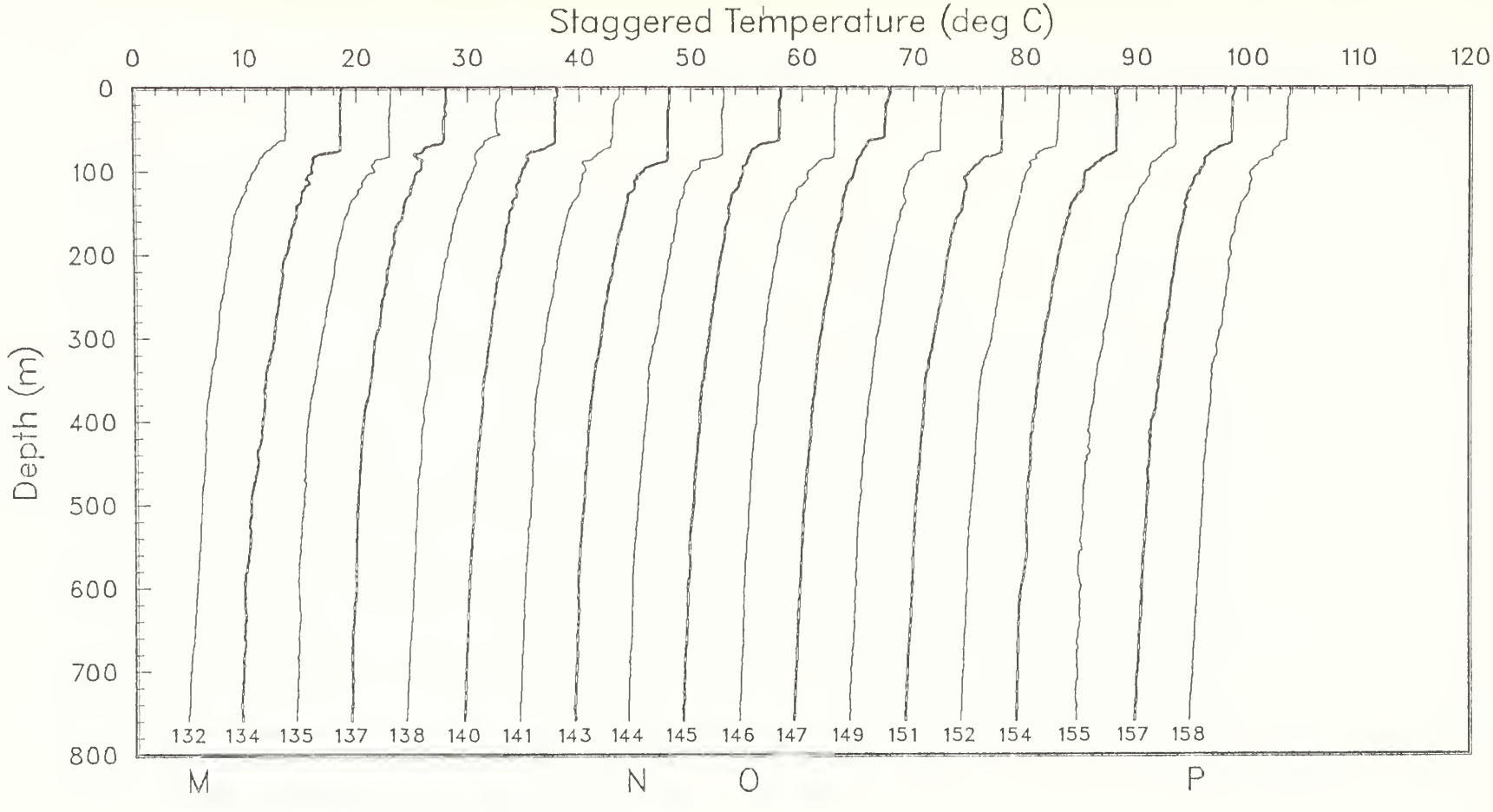

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
132
134
135
137
138
140
141
143
144
145
146
147
149
151
152
154
155
157
158
M
N
O
P

Figure 23(i)

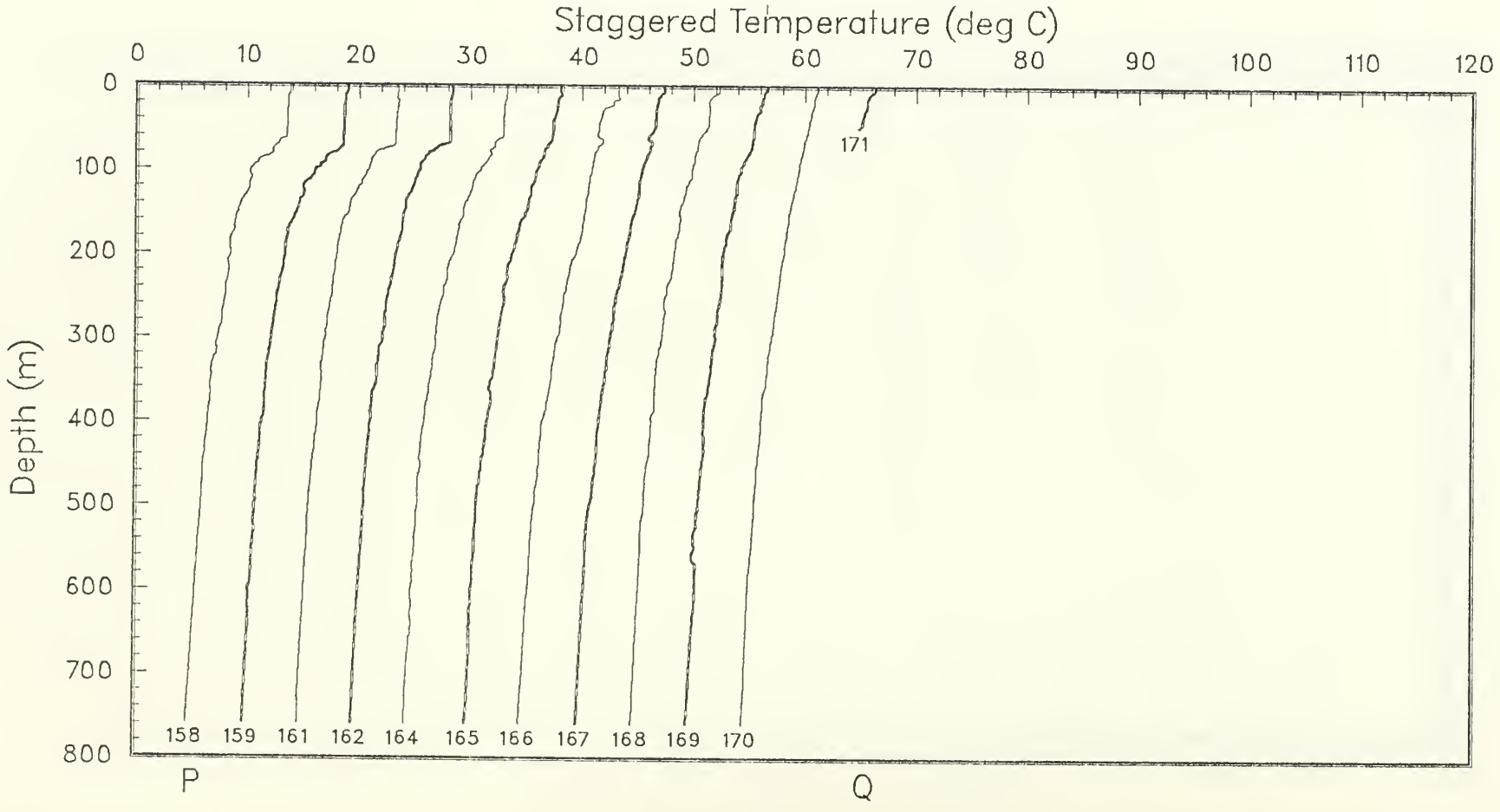

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
158
159
161
162
164
165
166
167
168
169
170
171
P
Q

Figure 23(j)

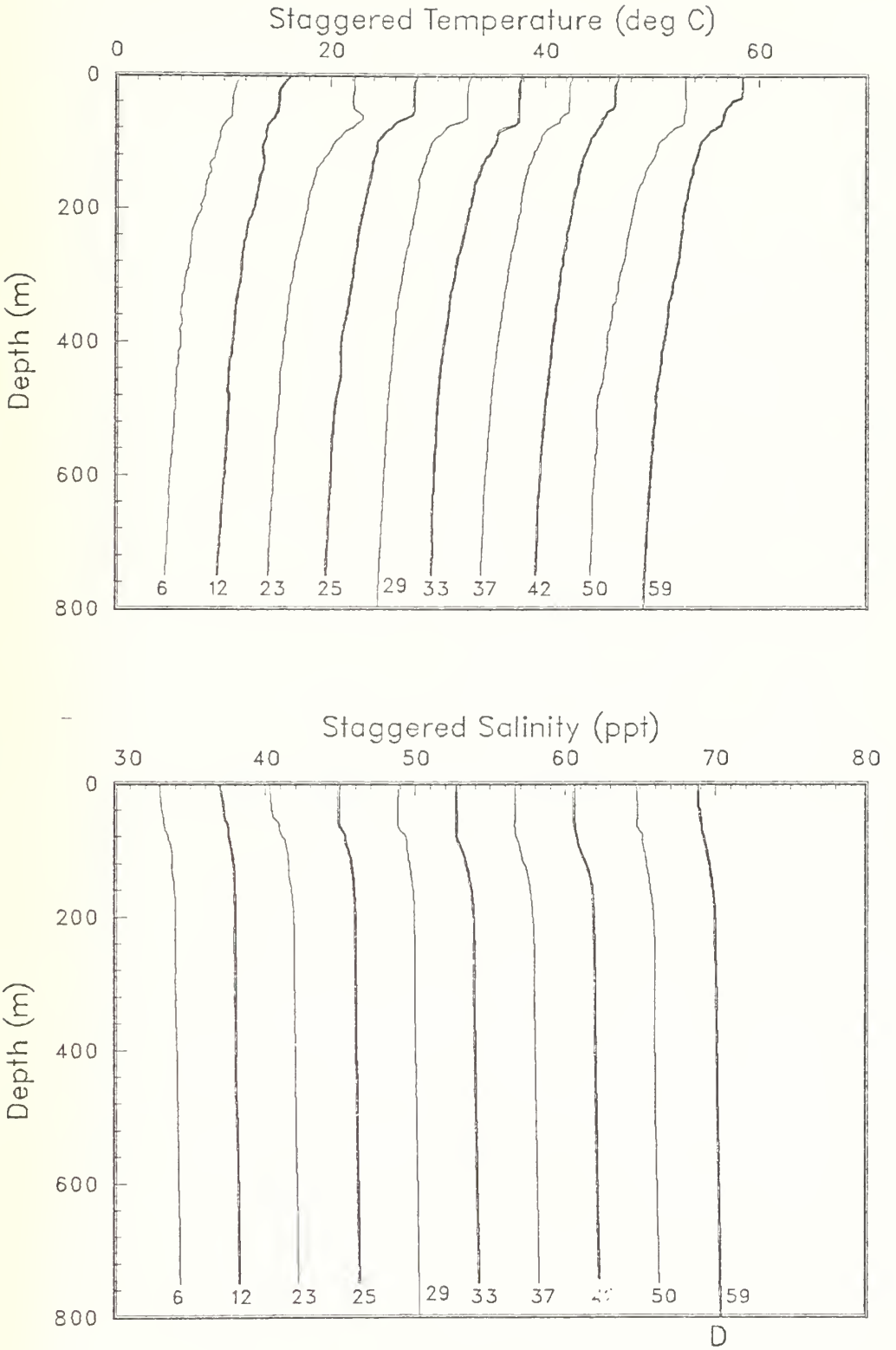
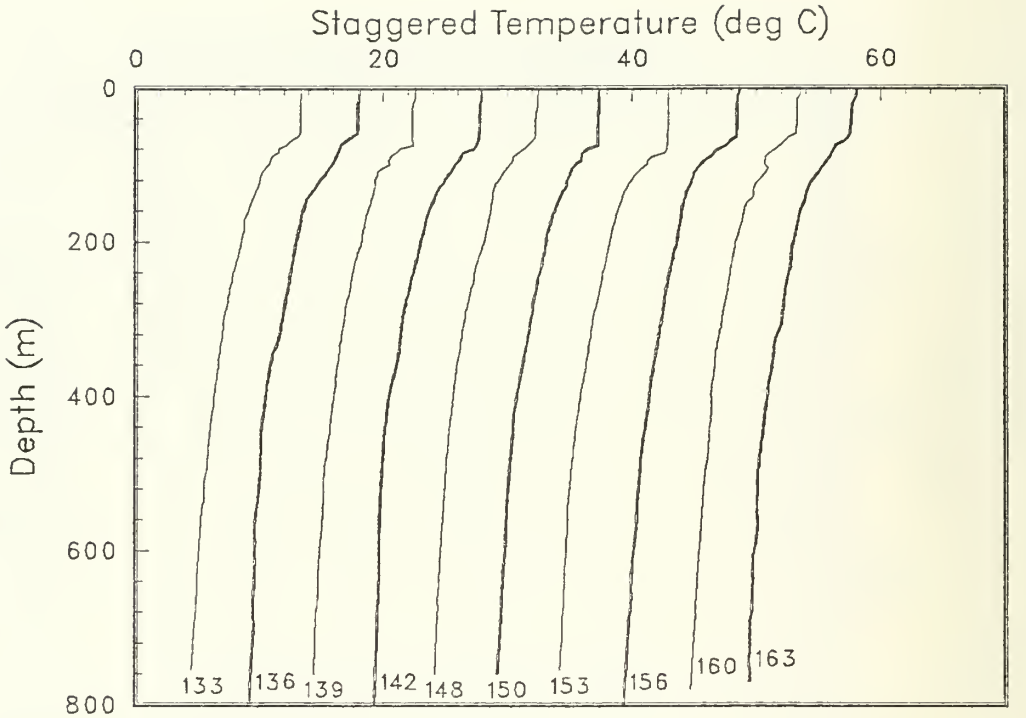


Figure 24(a): CTD temperature profiles, staggered by multiples of 5C, and salinity profiles staggered by multiples of 4 ppt (OPTOMA20, Leg MII).


Staggered Temperature (deg C)
0
20
40
60
0
200
400
600
800
Depth (m)
133
136
139
142
148
150
153
156
160
163

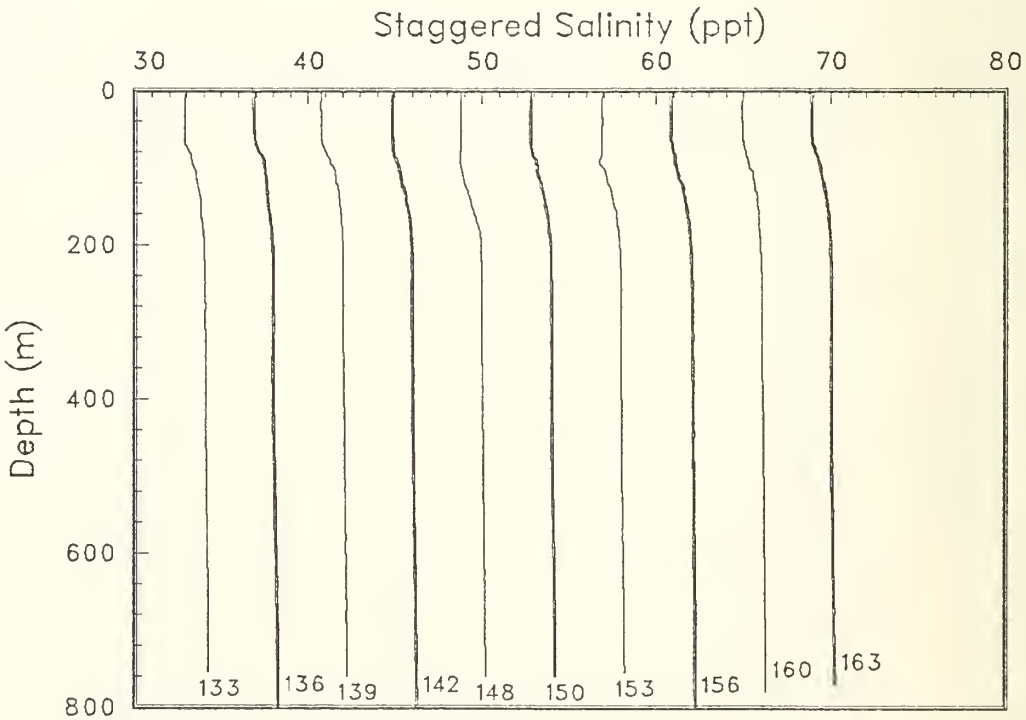

Staggered Salinity (ppt)
30
40
50
60
70
80
0
200
400
600
800
Depth (m)
133
136
139
142
148
150
153
156
160
163

Figure 24(b)

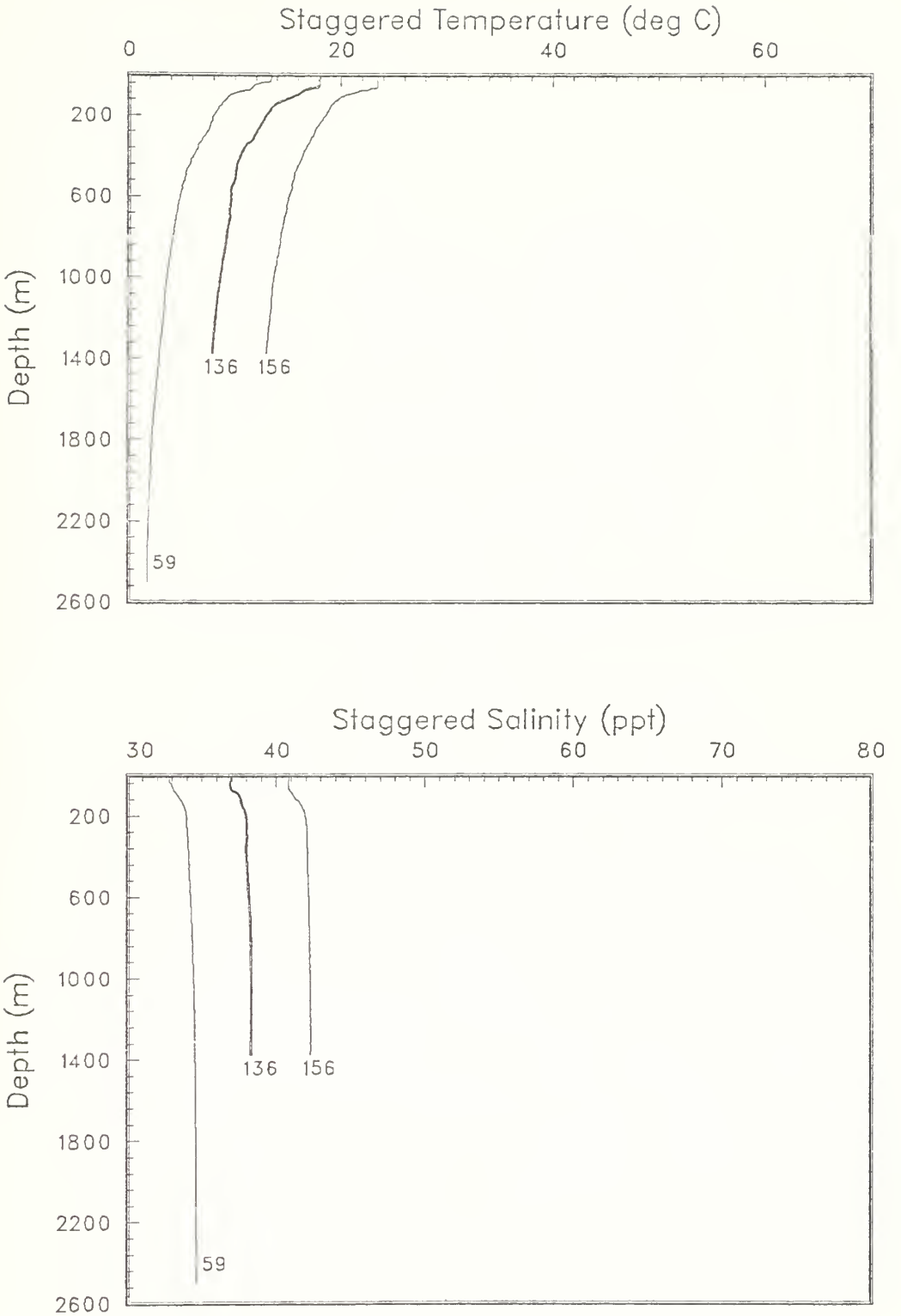
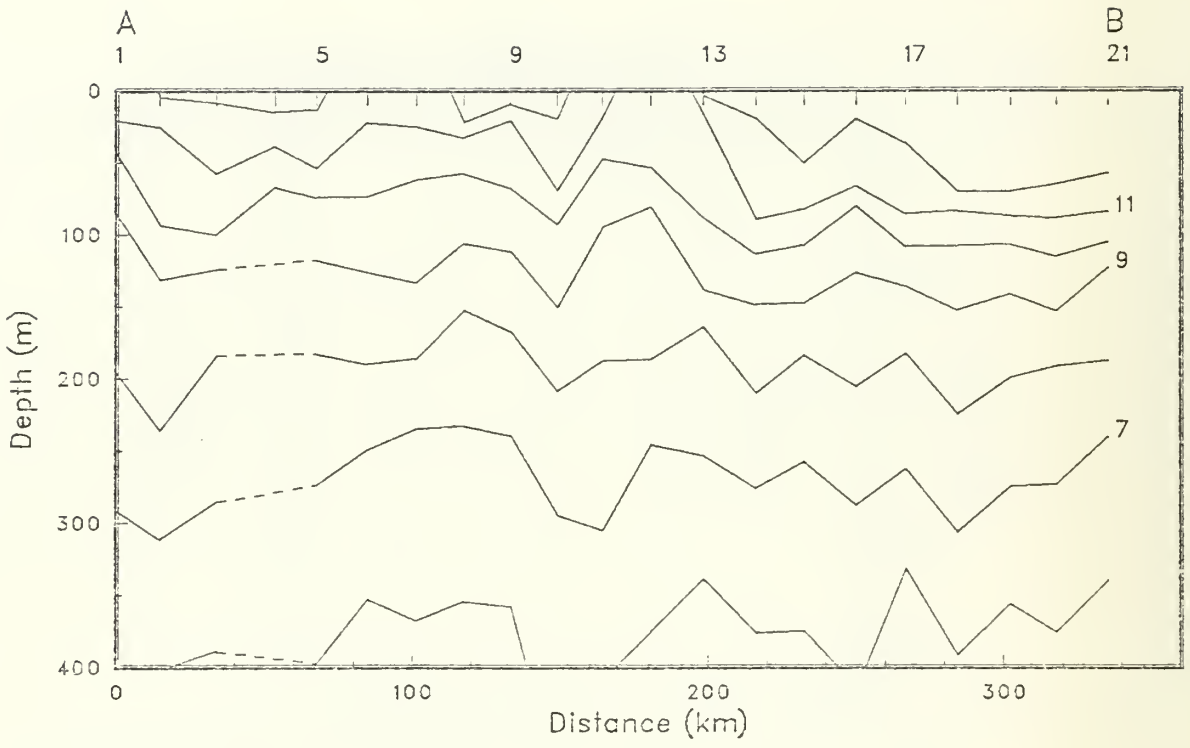


Figure 25: As for Fig. 24 but casts to 2600m (OPTOMA20, Leg MII).



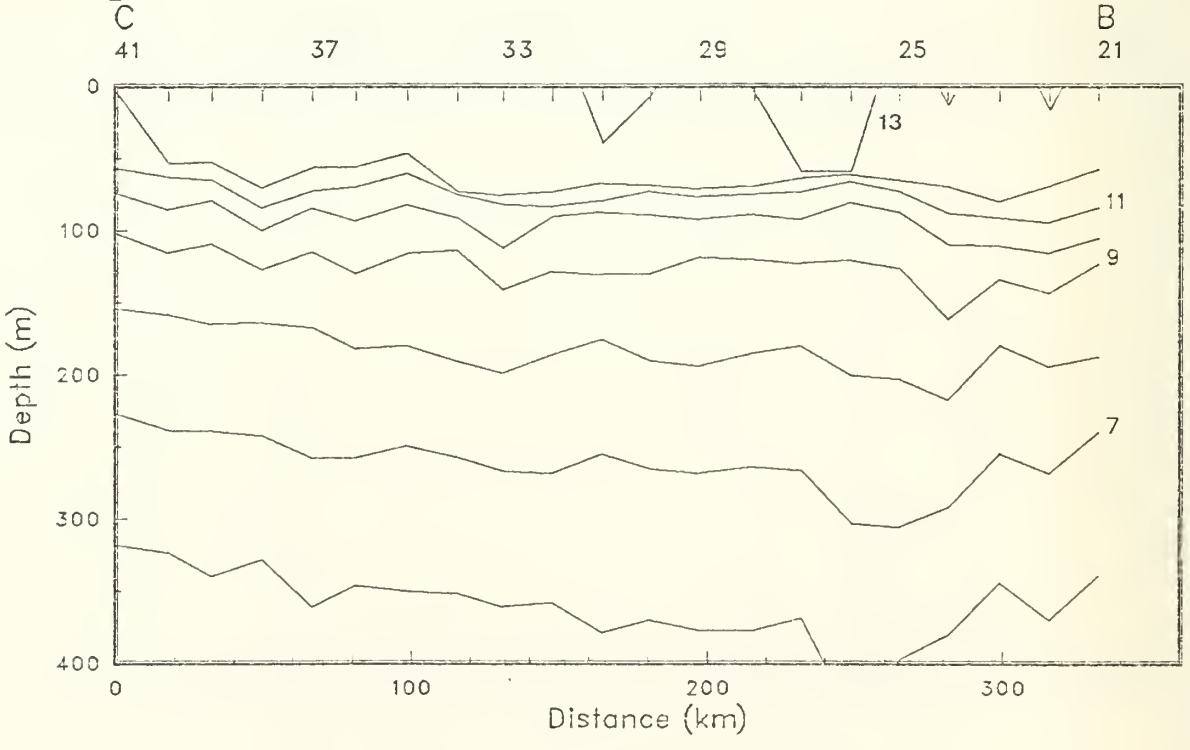


Figure 26(a)-(b): Along-track isotherms. Tick marks along the upper horizontal axis show station positions. Some station numbers are given. Dashed lines are used if the cast was too shallow (OPTOMA20, Leg MII).

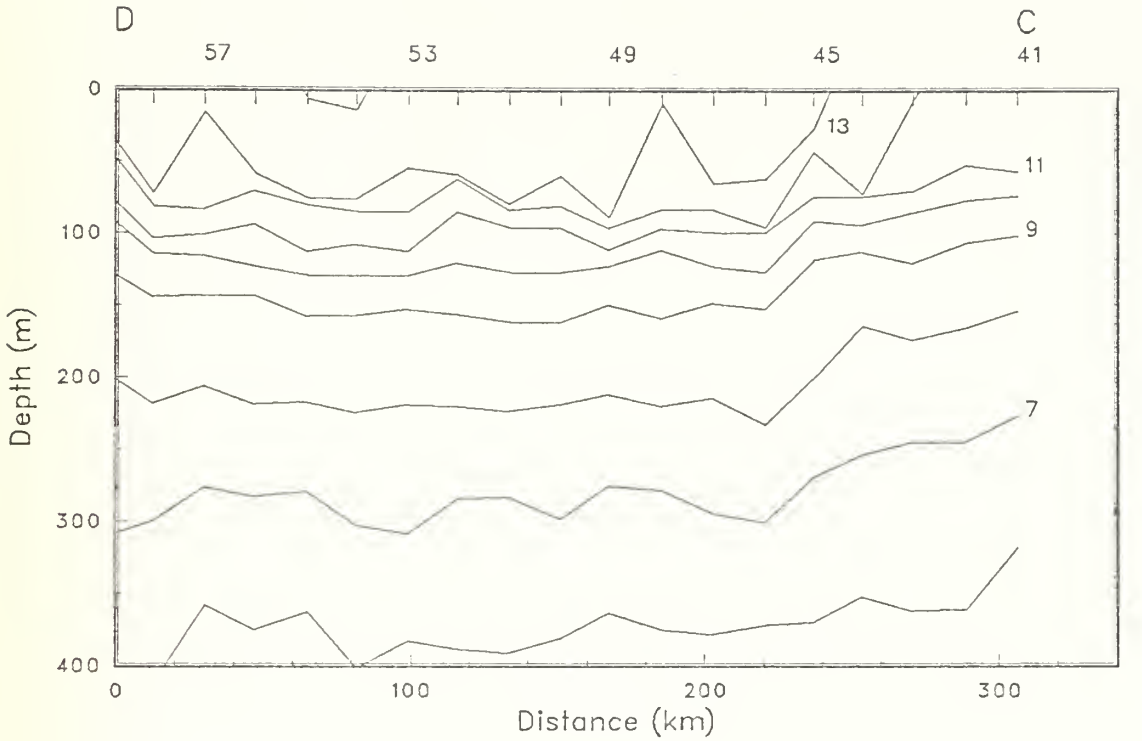


Figure 26(c)

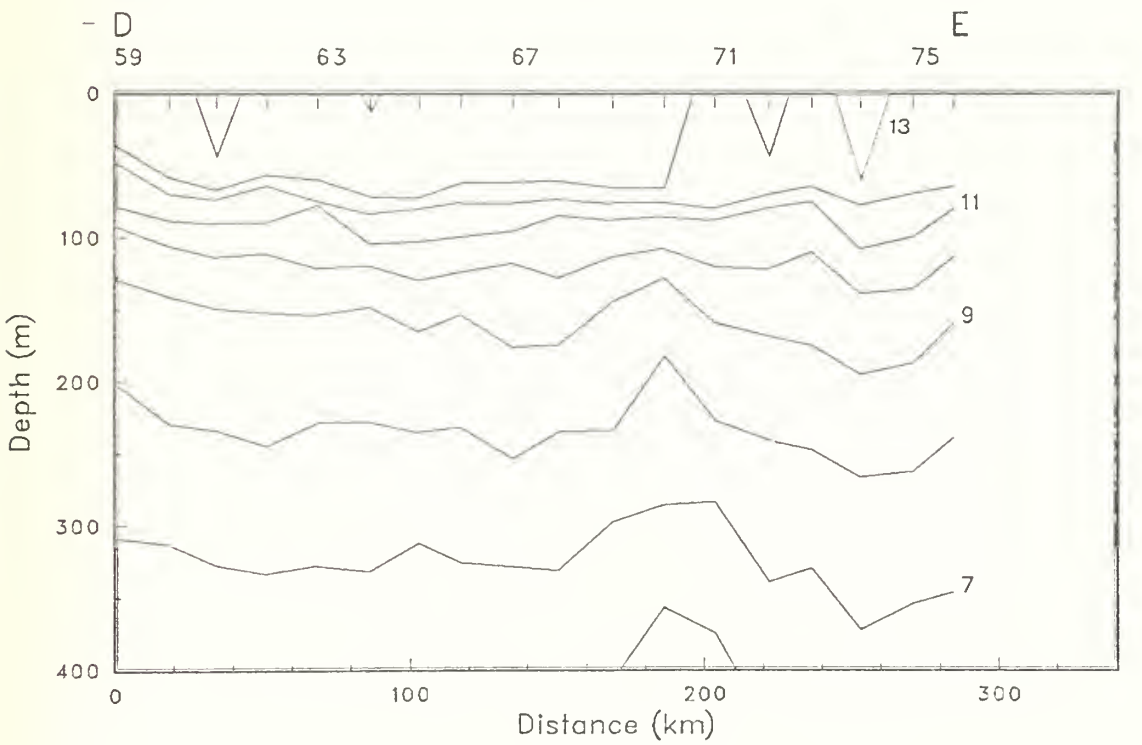


Figure 26(d)

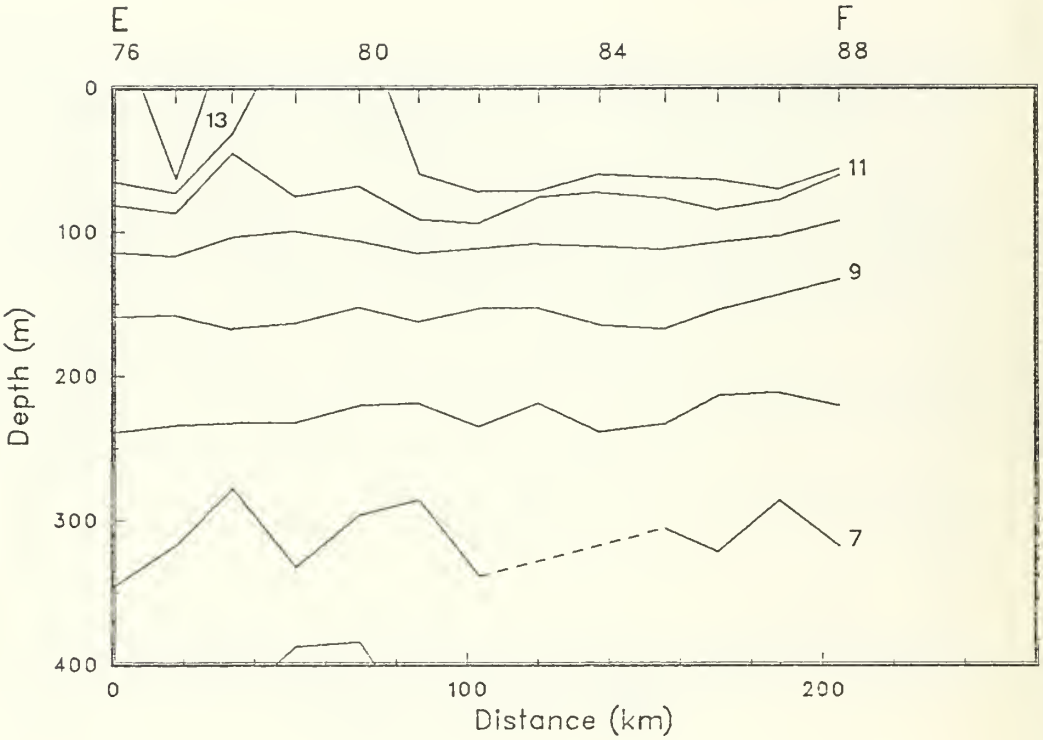


Figure 26(e)

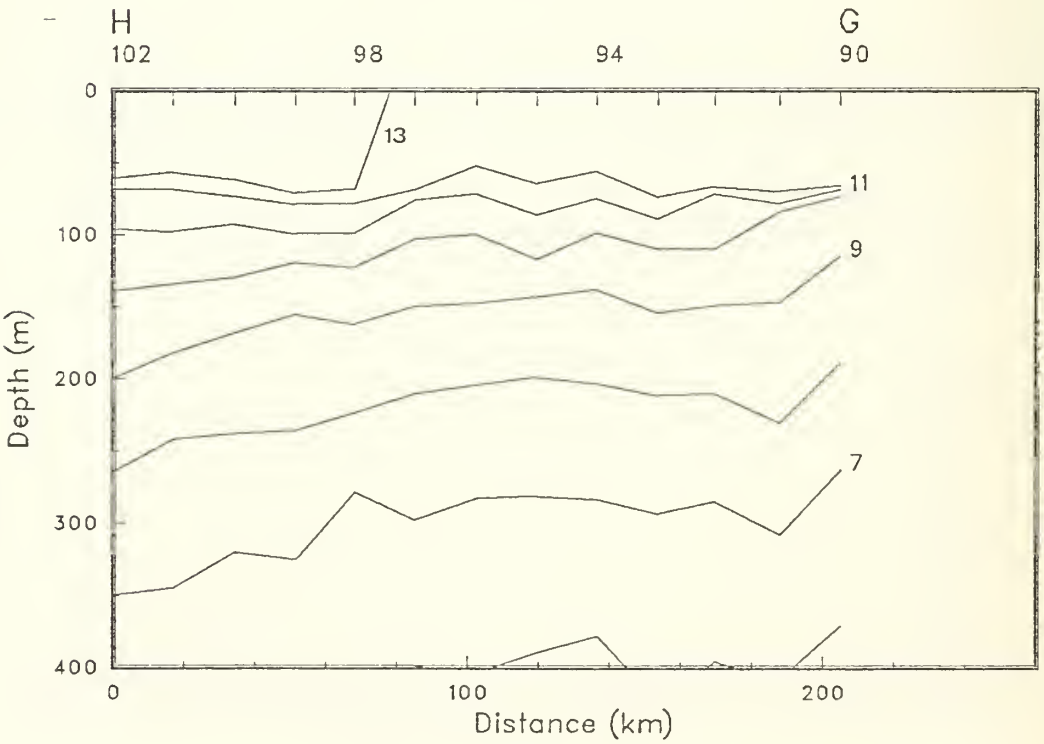


Figure 26(f)

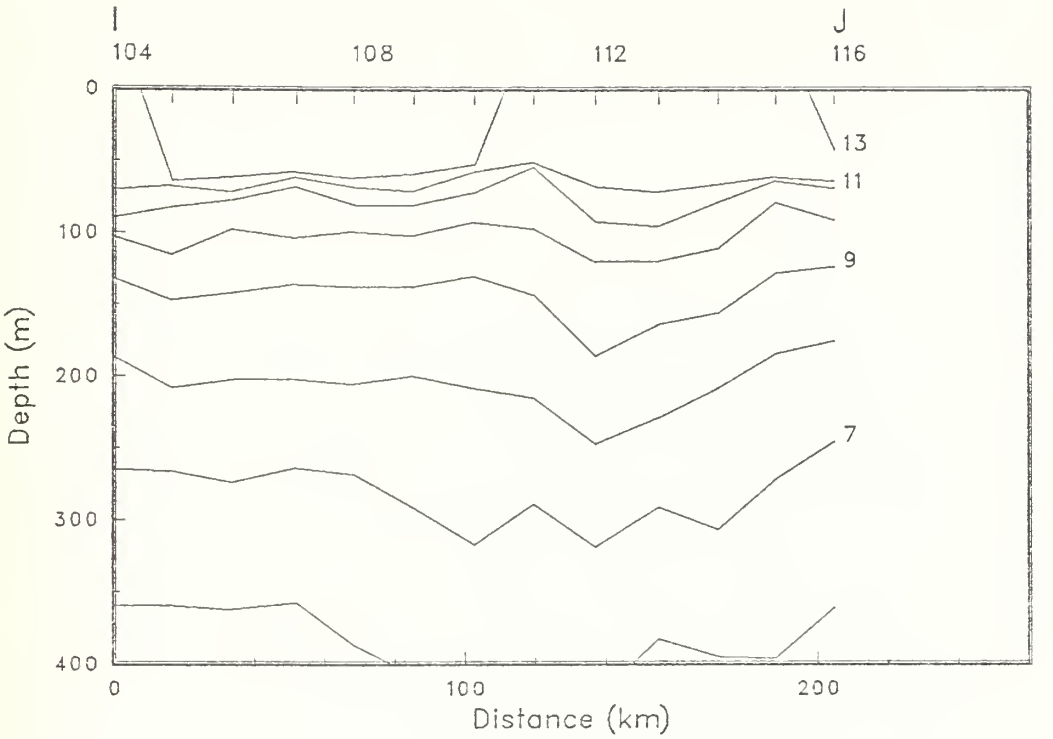


Figure 26(g)

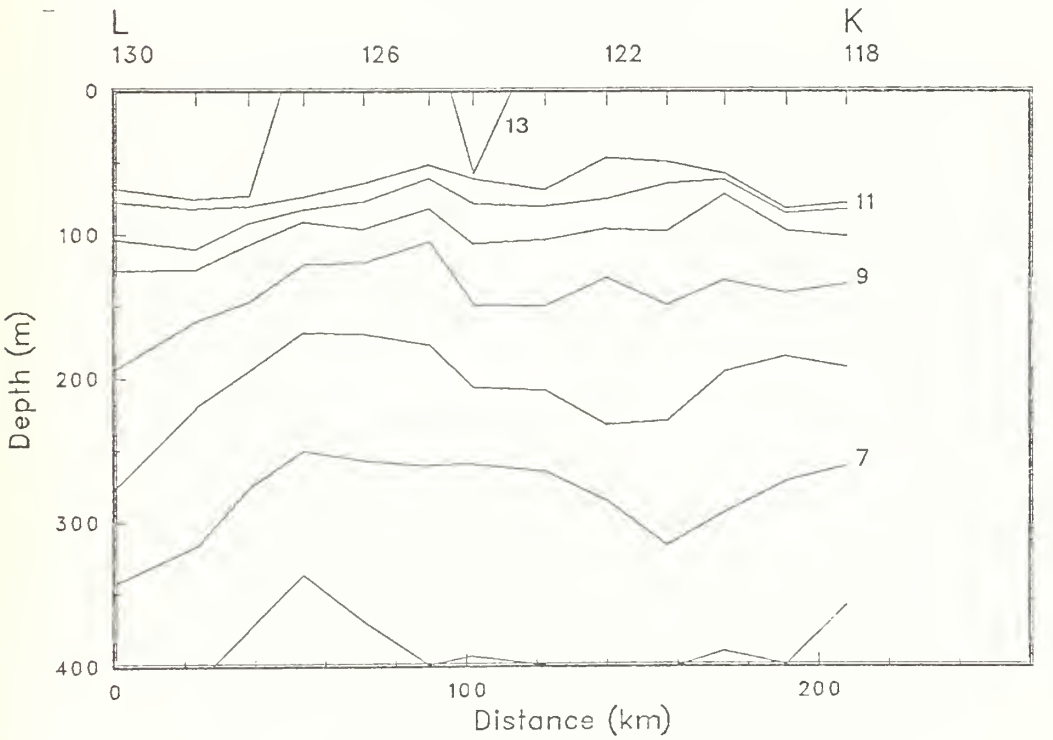


Figure 26(h)

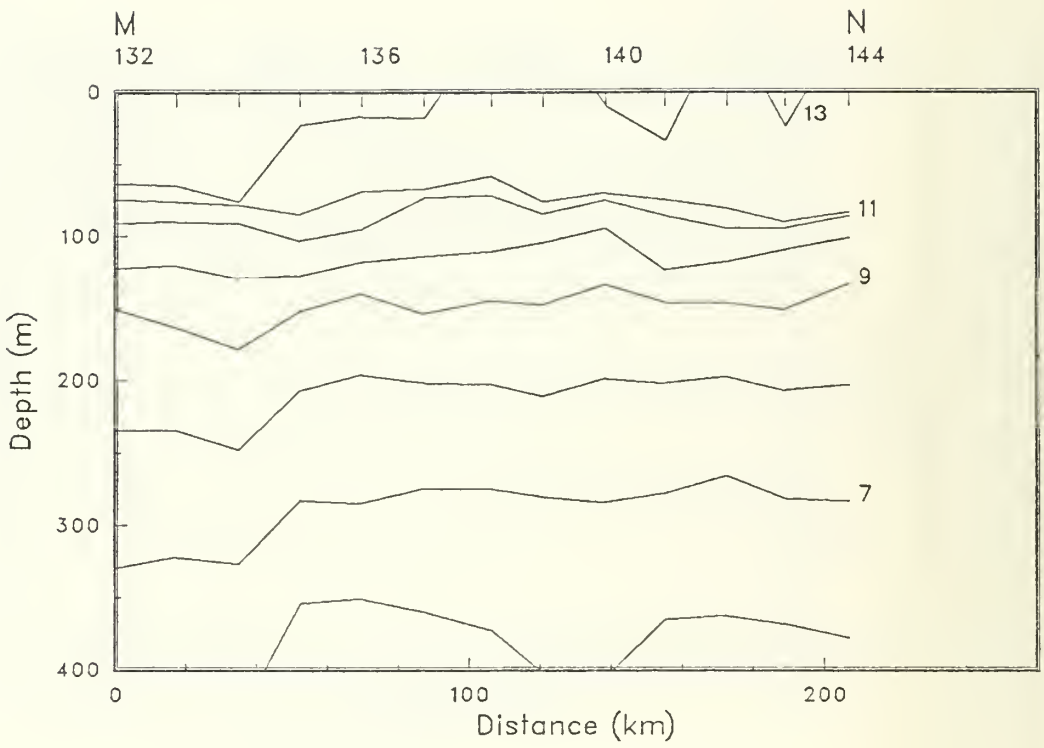


Figure 26(i)

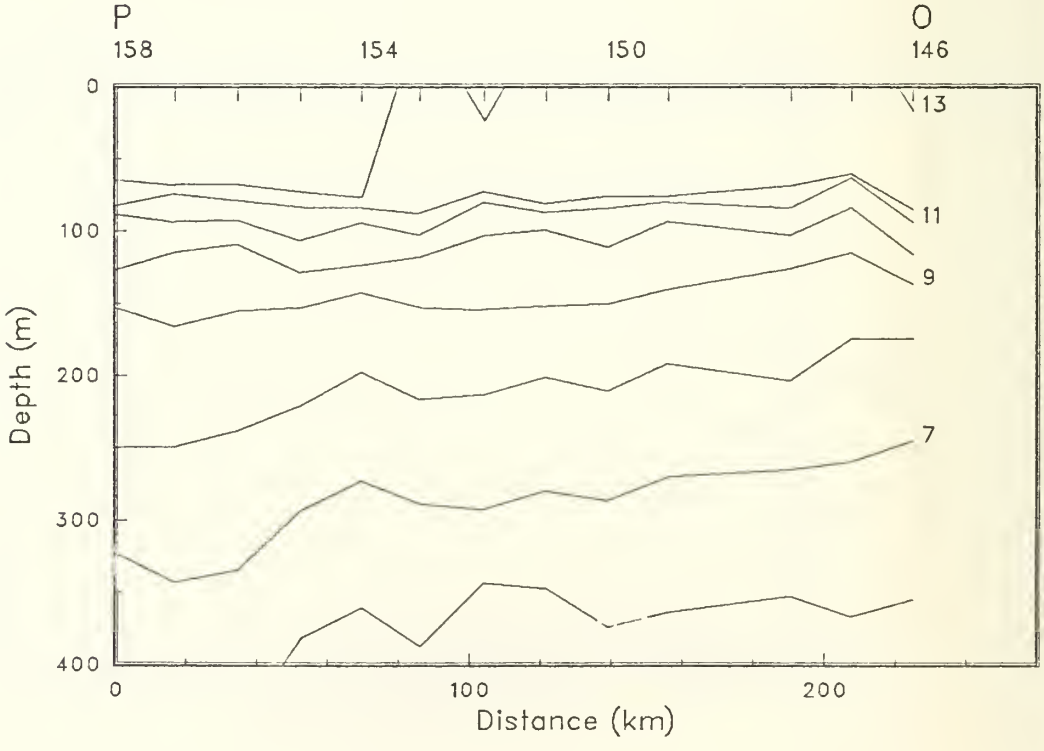


Figure 26(j)

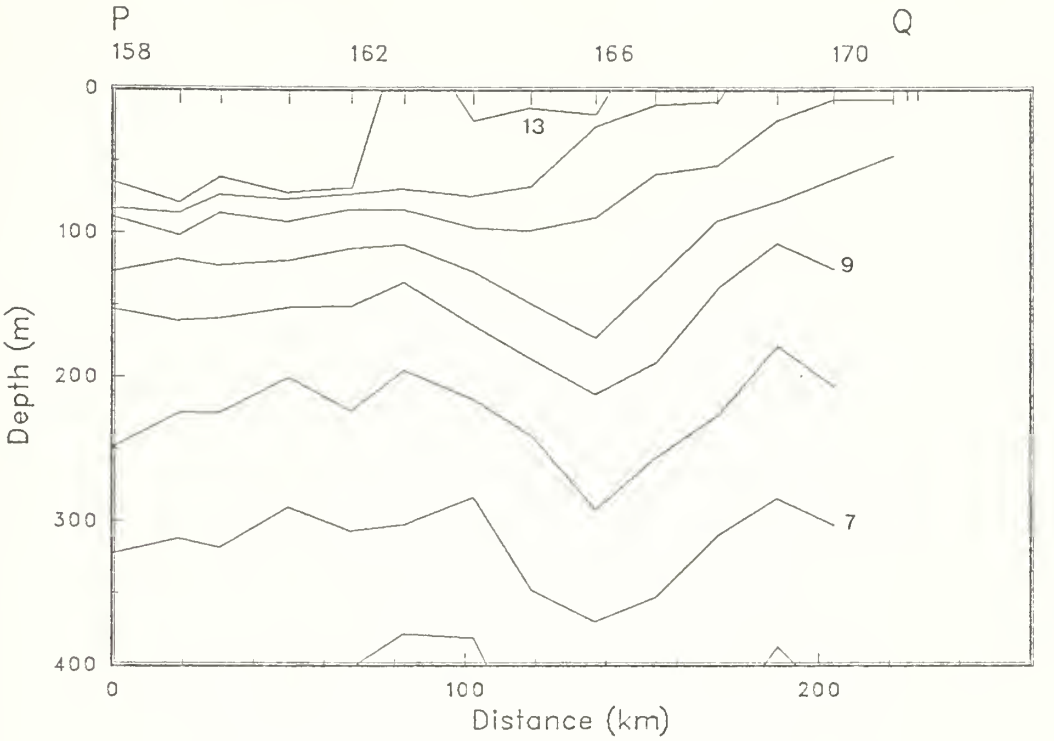

P
Q
158
162
166
170
0
100
200
300
400
Depth (m)
13
9
7
0
100
200
Distance (km)

Figure 26(k)

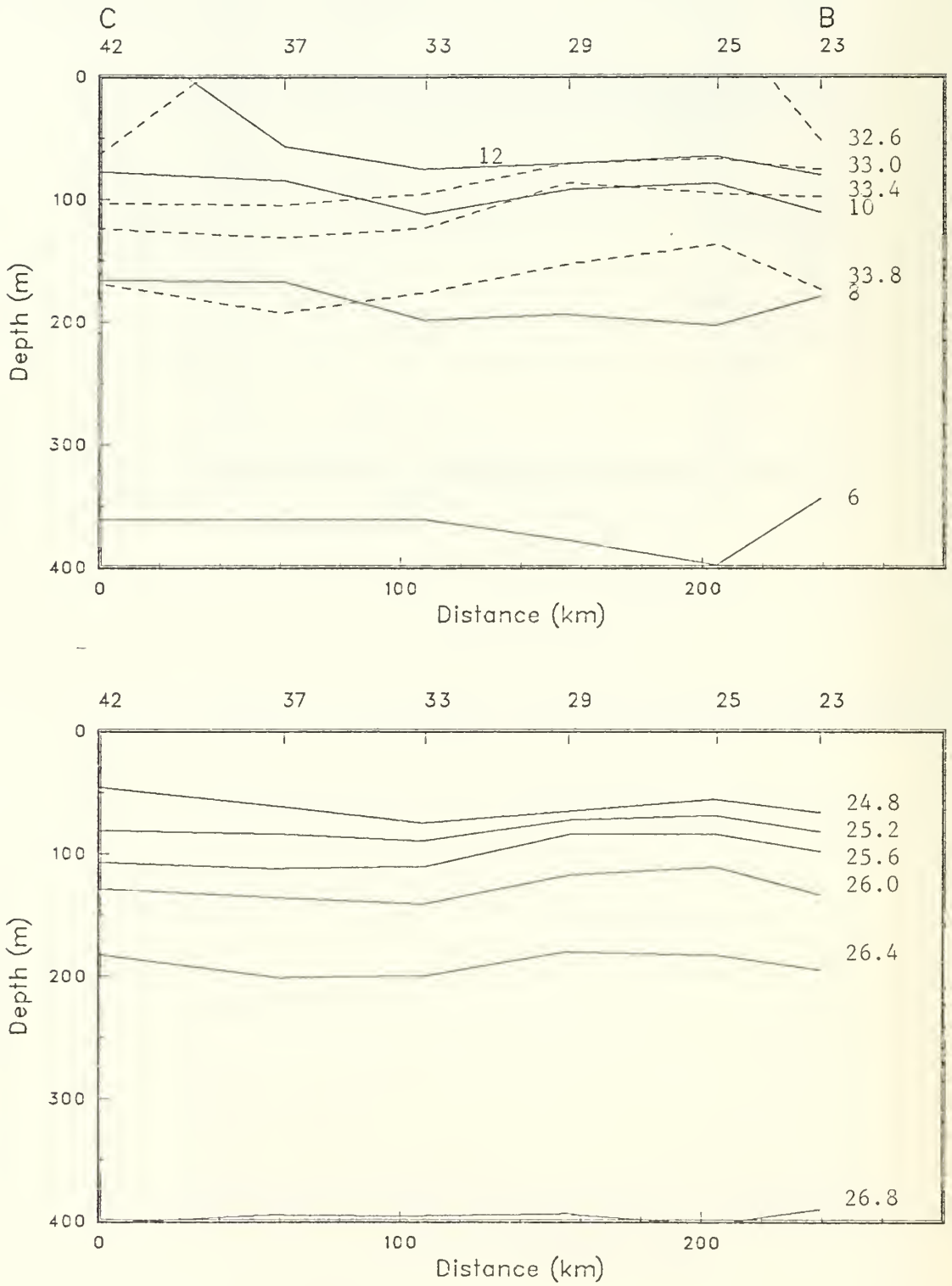


Figure 27(a): Isopleths of (1) temperature and salinity and (2) sigma-t from the CTDs (OPTOMA20, Leg MII).

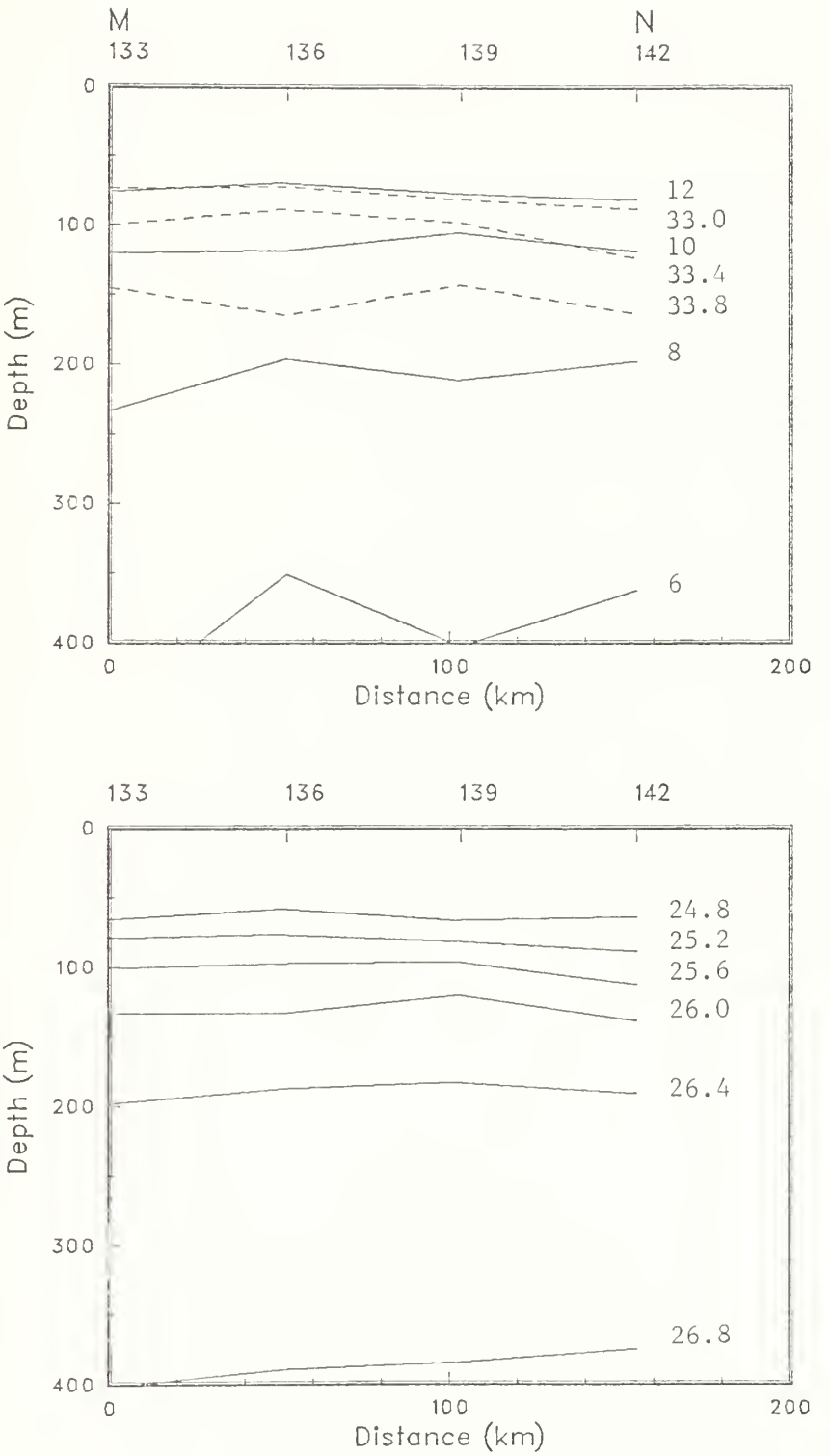
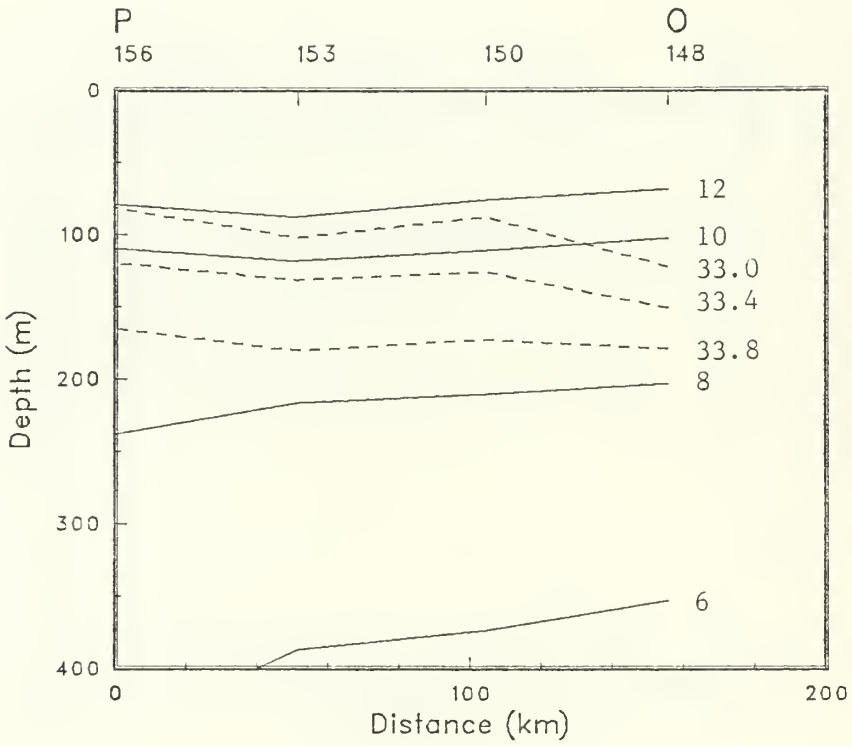

M
N
133
136
139
142
0
100
200
300
400
Depth (m)
12
33.0
10
33.4
33.8
8
6
0
100
200
Distance (km)
133
136
139
142
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 27(b)


P
O
156
153
150
148
0
100
200
300
400
Depth (m)
12
10
33.0
33.4
33.8
8
6
0
100
200
Distance (km)

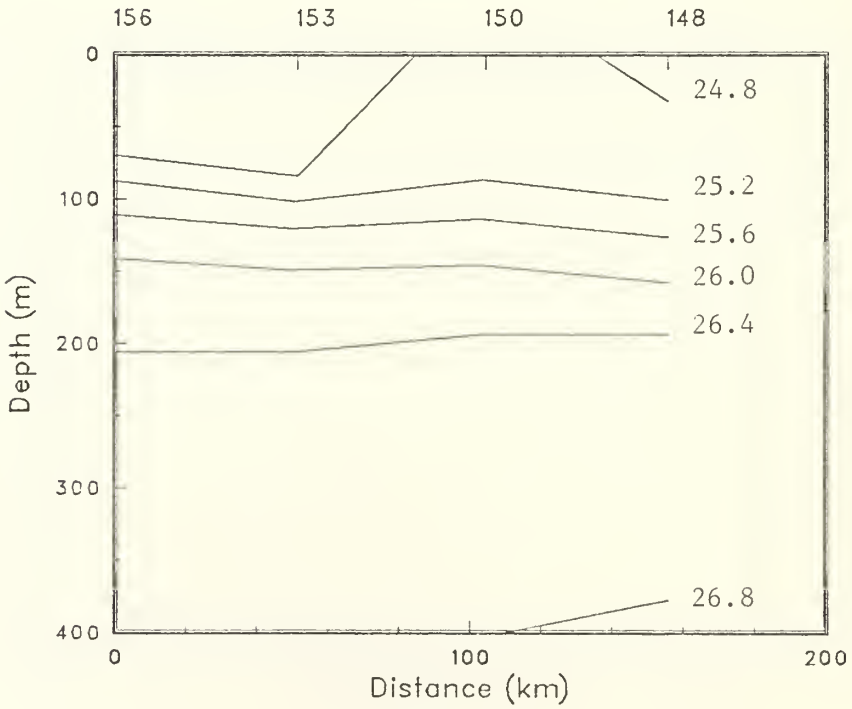

156
153
150
148
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 27(c)

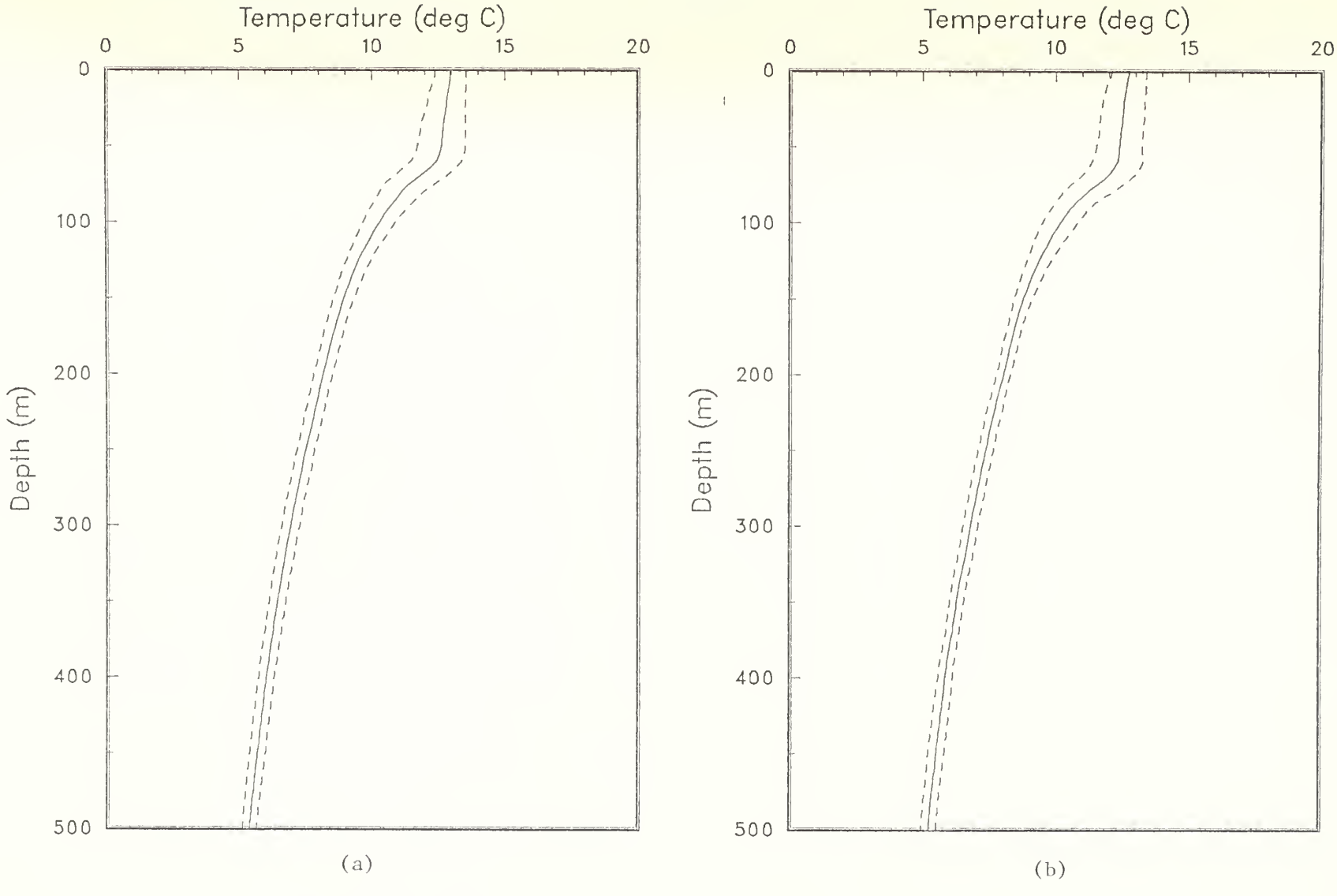


Figure 28: Mean temperature profiles from (a) XBTs and (b) CTDs with + and - the standard deviation (OPTOMA20, Leg MII).

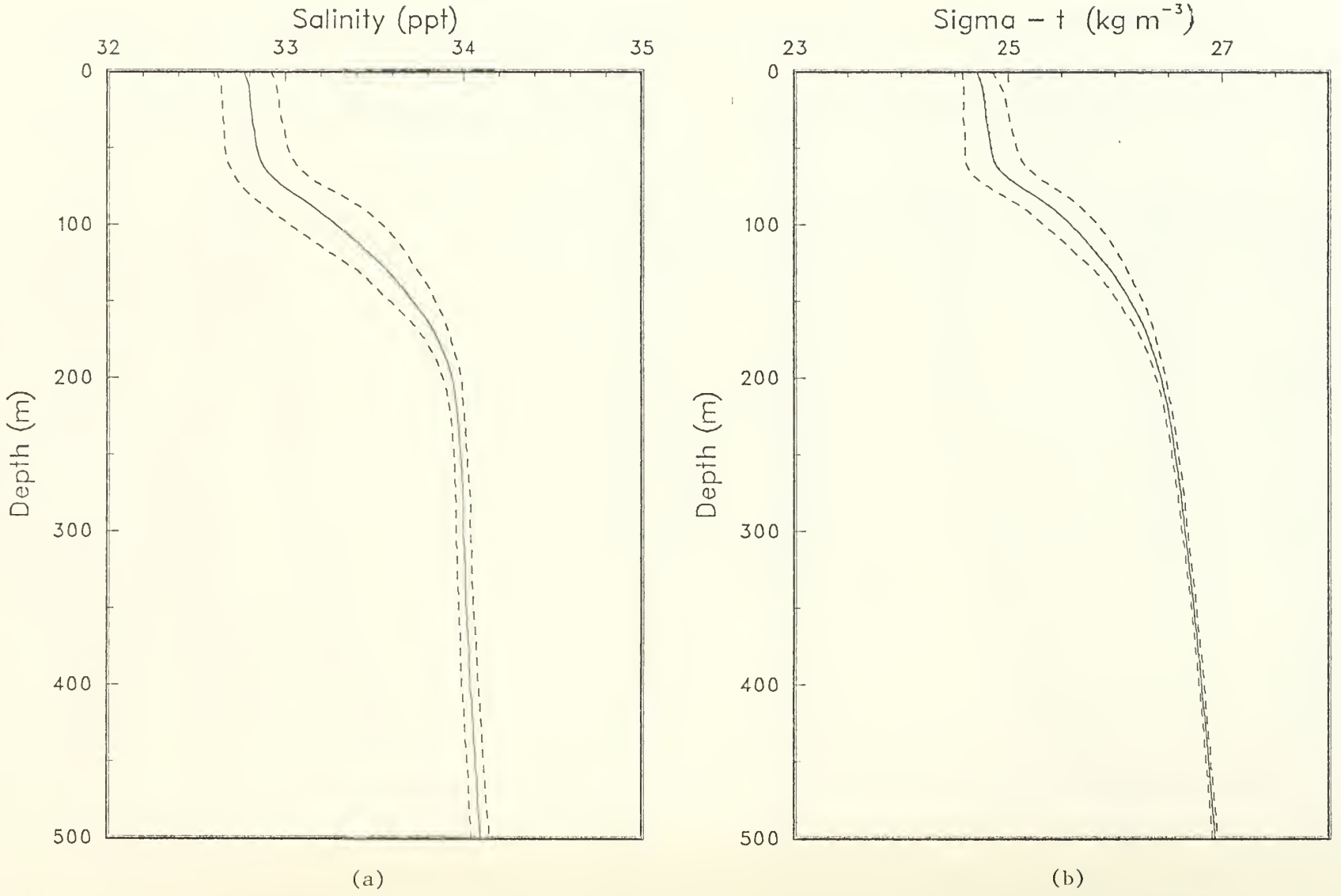


Figure 29: Mean profiles of (a) salinity and (b) sigma-t, with + and - the standard deviations, from the CTDs (OPTOMA20, Leg MII).

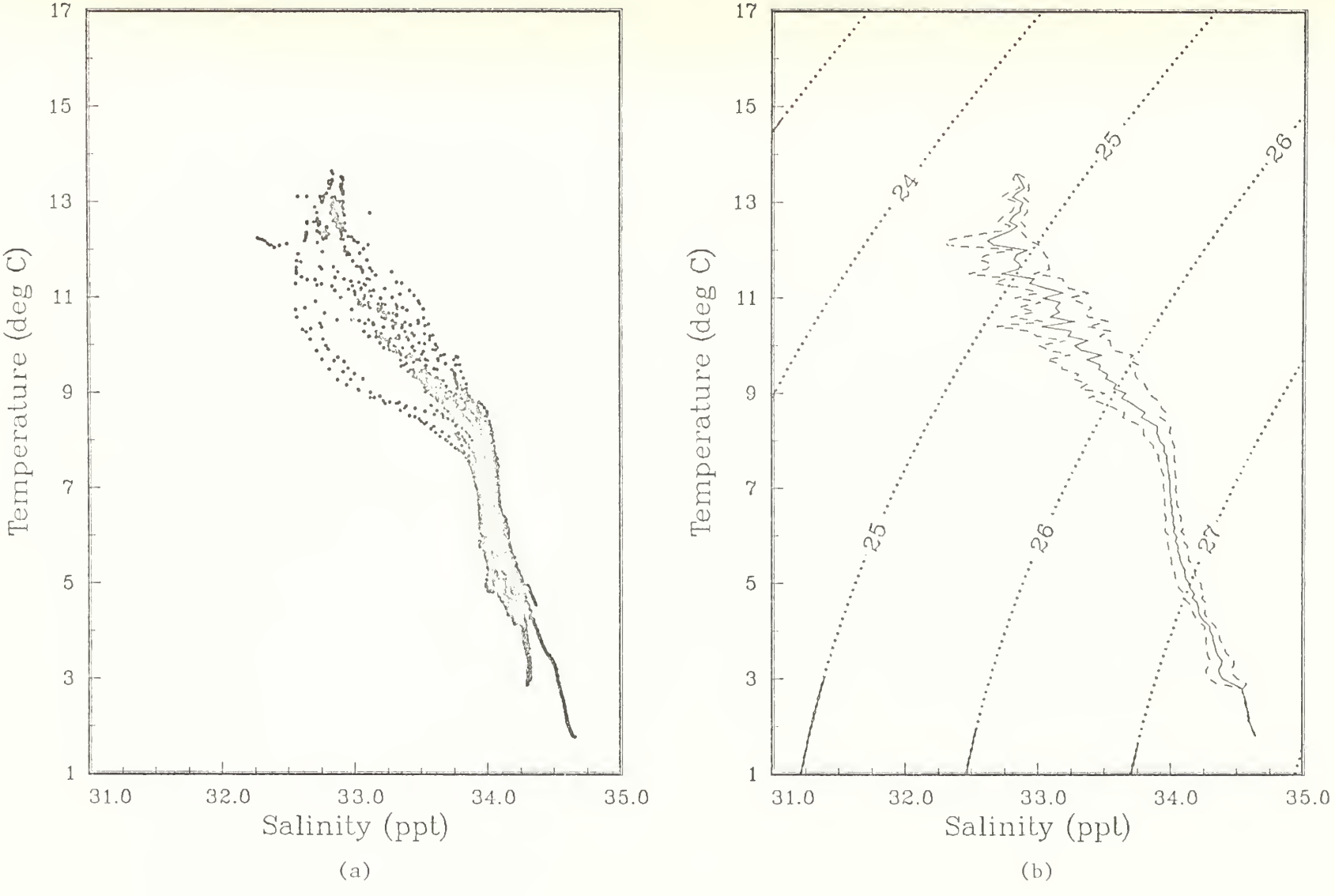


Figure 30: (a) T-S pairs and (b) mean T-S relation, with + and - the standard deviation, from the CTDs. Selected sigma-t contours are also shown (OPTOMA20, Leg MII).

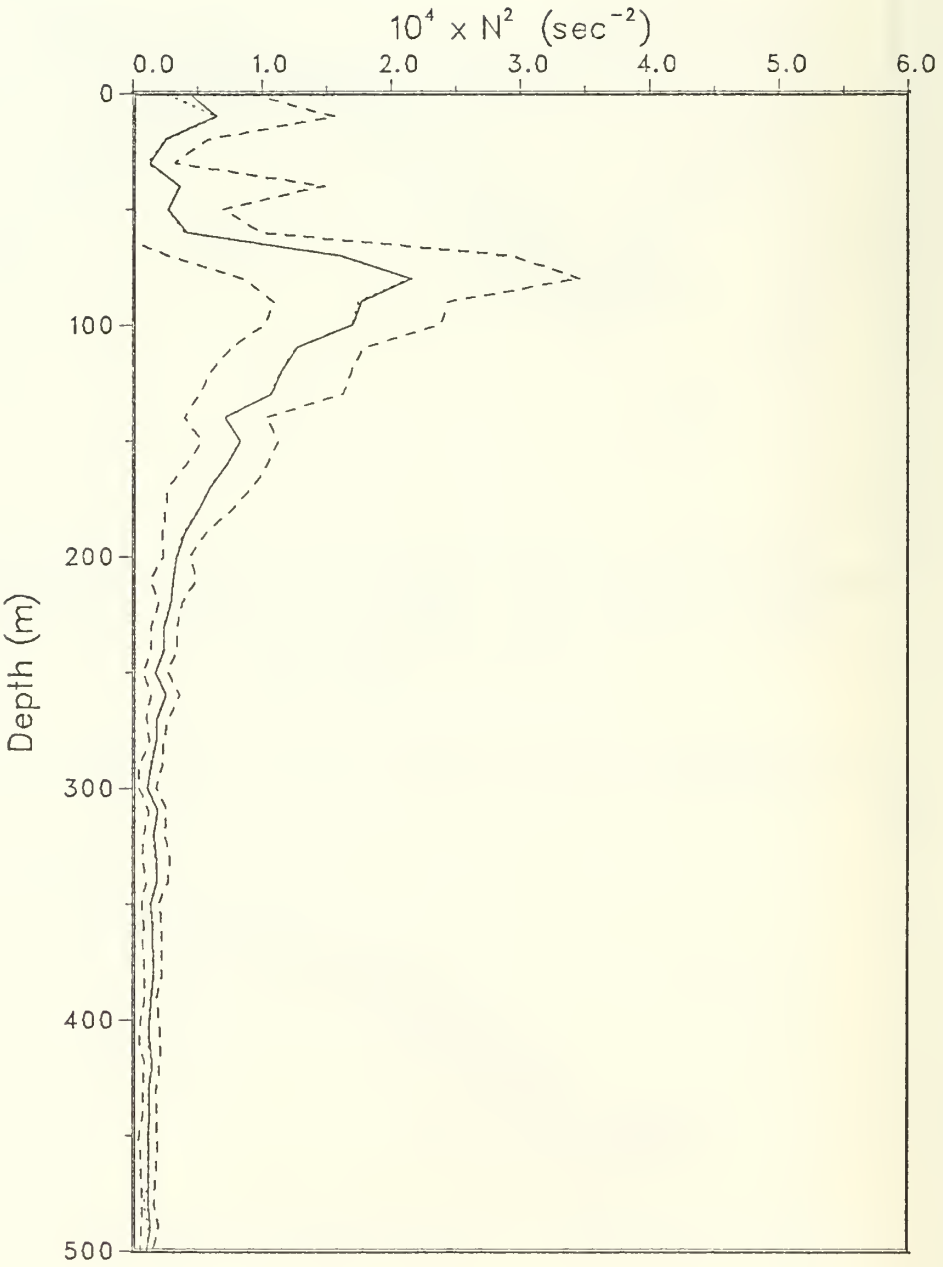


Figure 31: Mean N^2 profile (——), with + and - the standard deviation (----). The N^2 profile from $\overline{T(z)}$ and $\overline{S(z)}$ is also shown (·····) (OPTOMA20, Leg MII).

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Section 4

OPTOMA20 Leg D

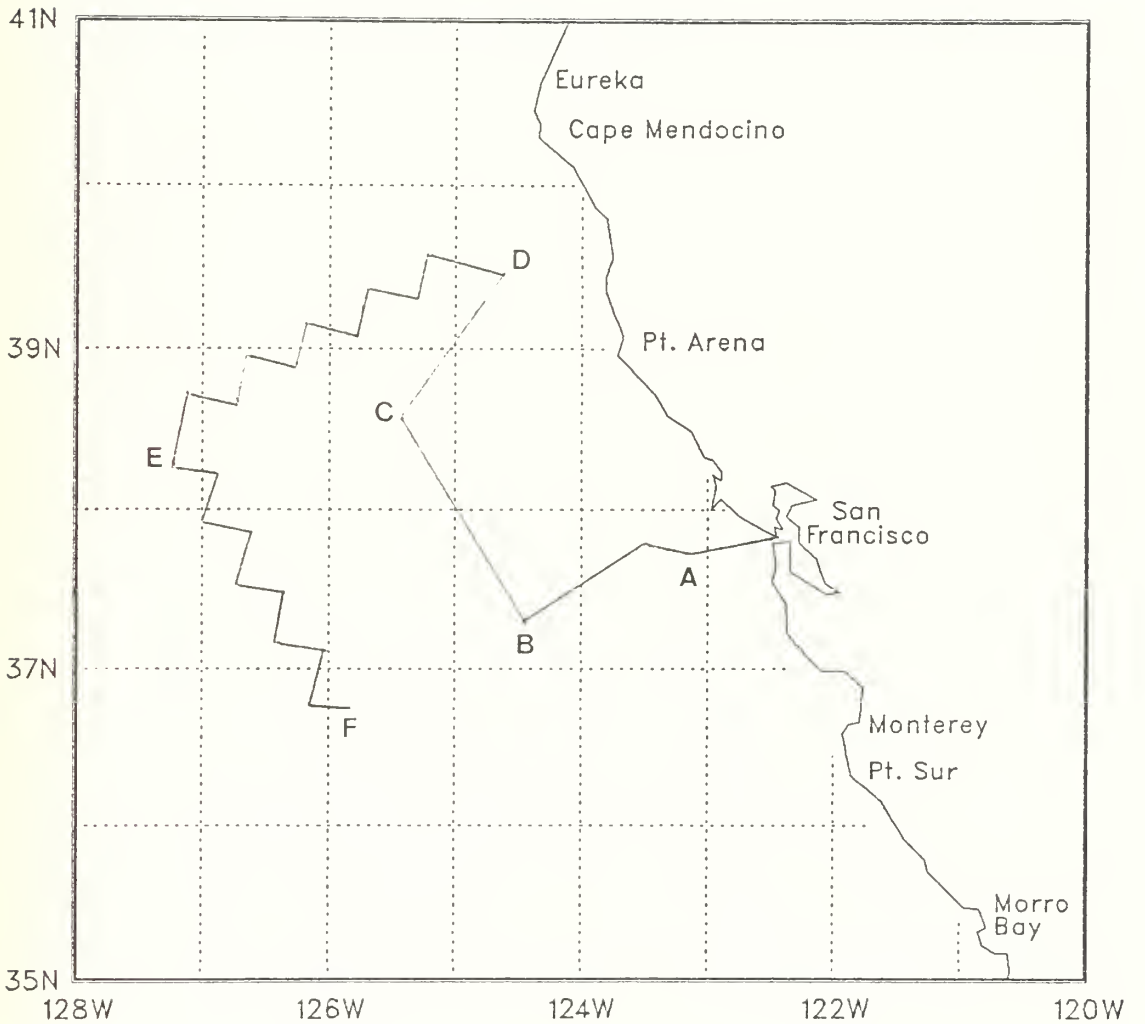


Figure 32(a): The cruise track for OPTOMA20, Leg D.

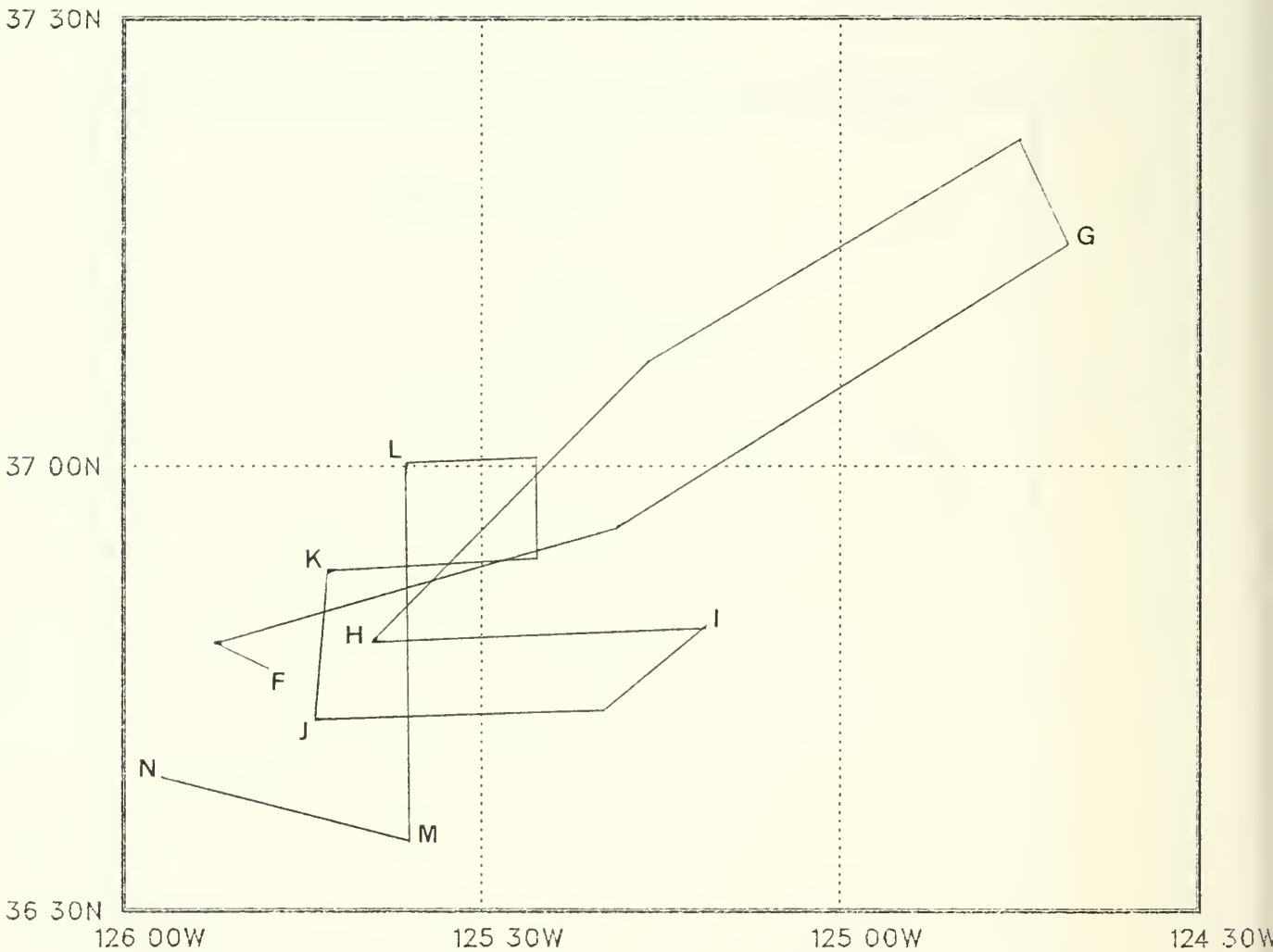


Figure 32(b)

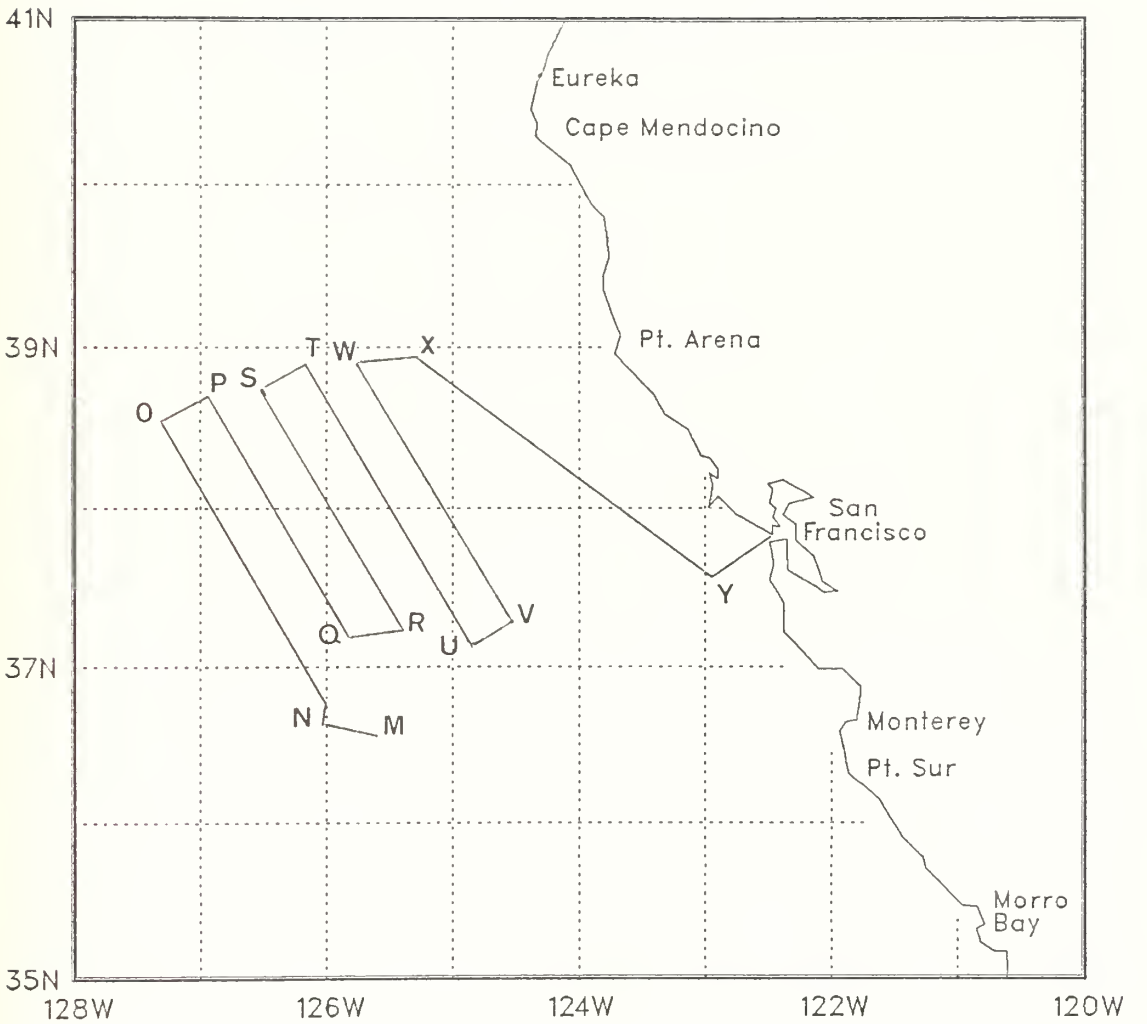

41N
39N
37N
35N
128W
126W
124W
122W
120W
Eureka
Cape Mendocino
Pt. Arena
San
Francisco
Monterey
Pt. Sur
Morro
Bay
O
P
S
T
W
X
Y
Q
R
U
V
N
M

Figure 32(c)

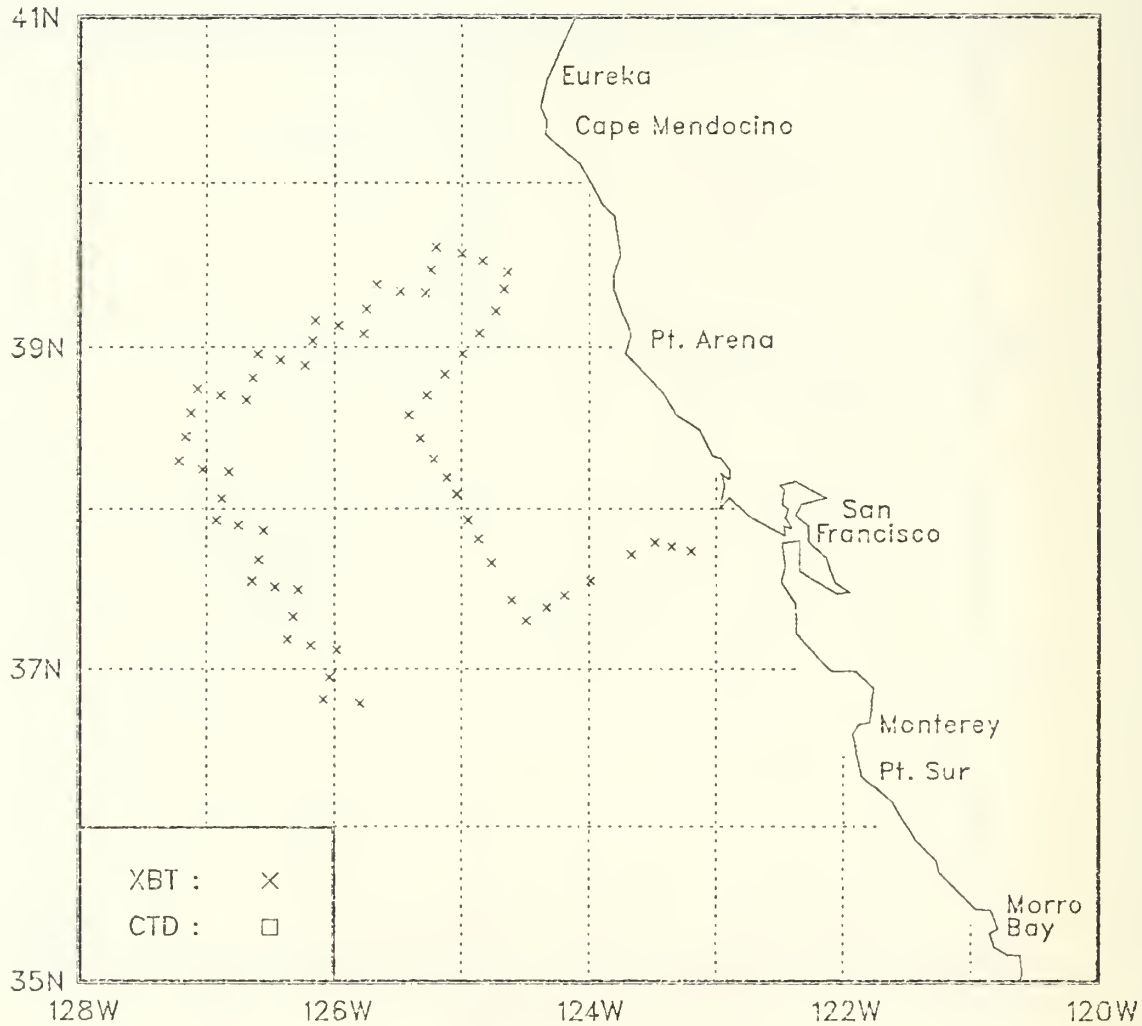


Figure 33(a): XBT and CTD locations for OPTOMA20, Leg D.

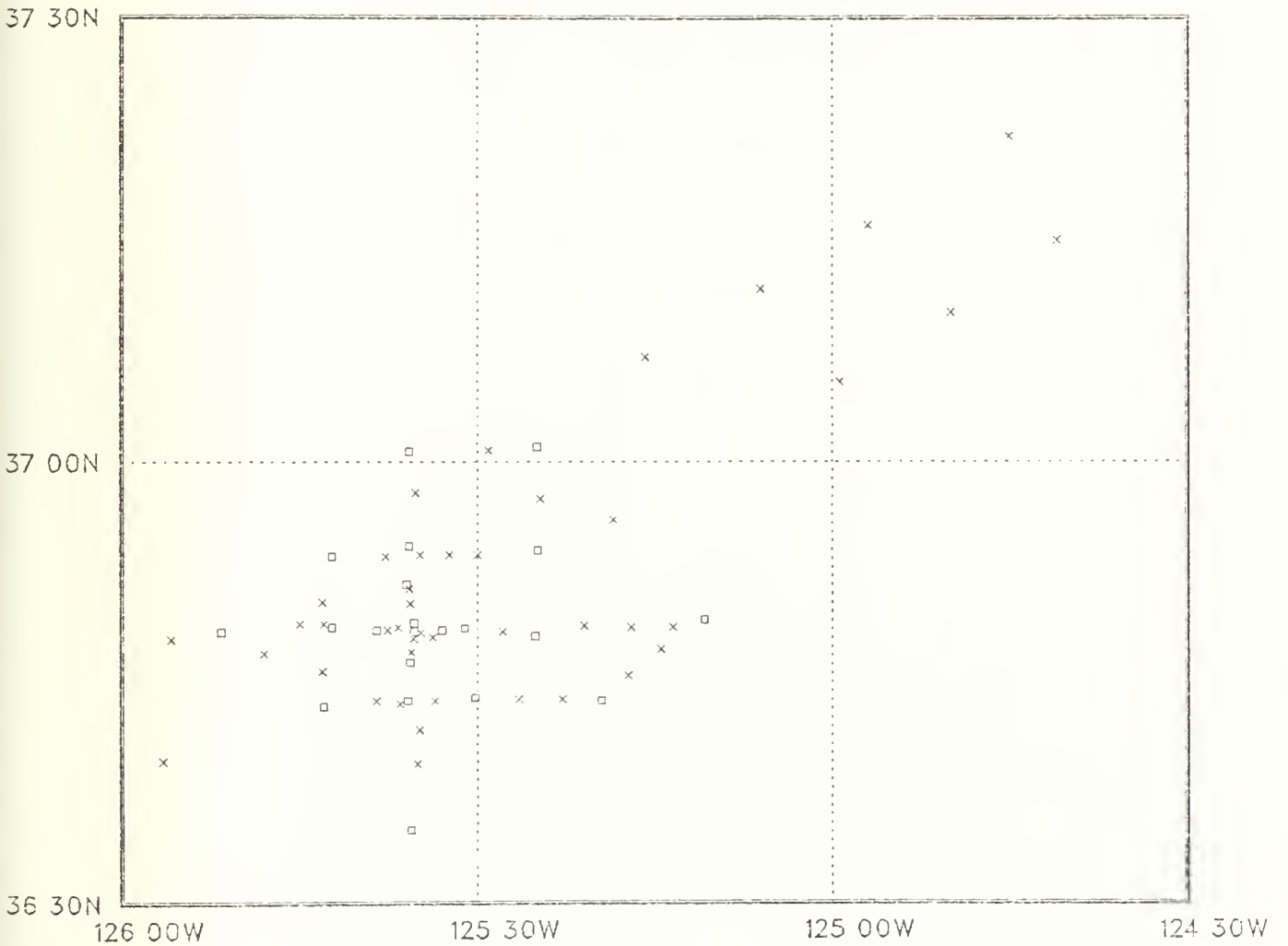


Figure 33(b)

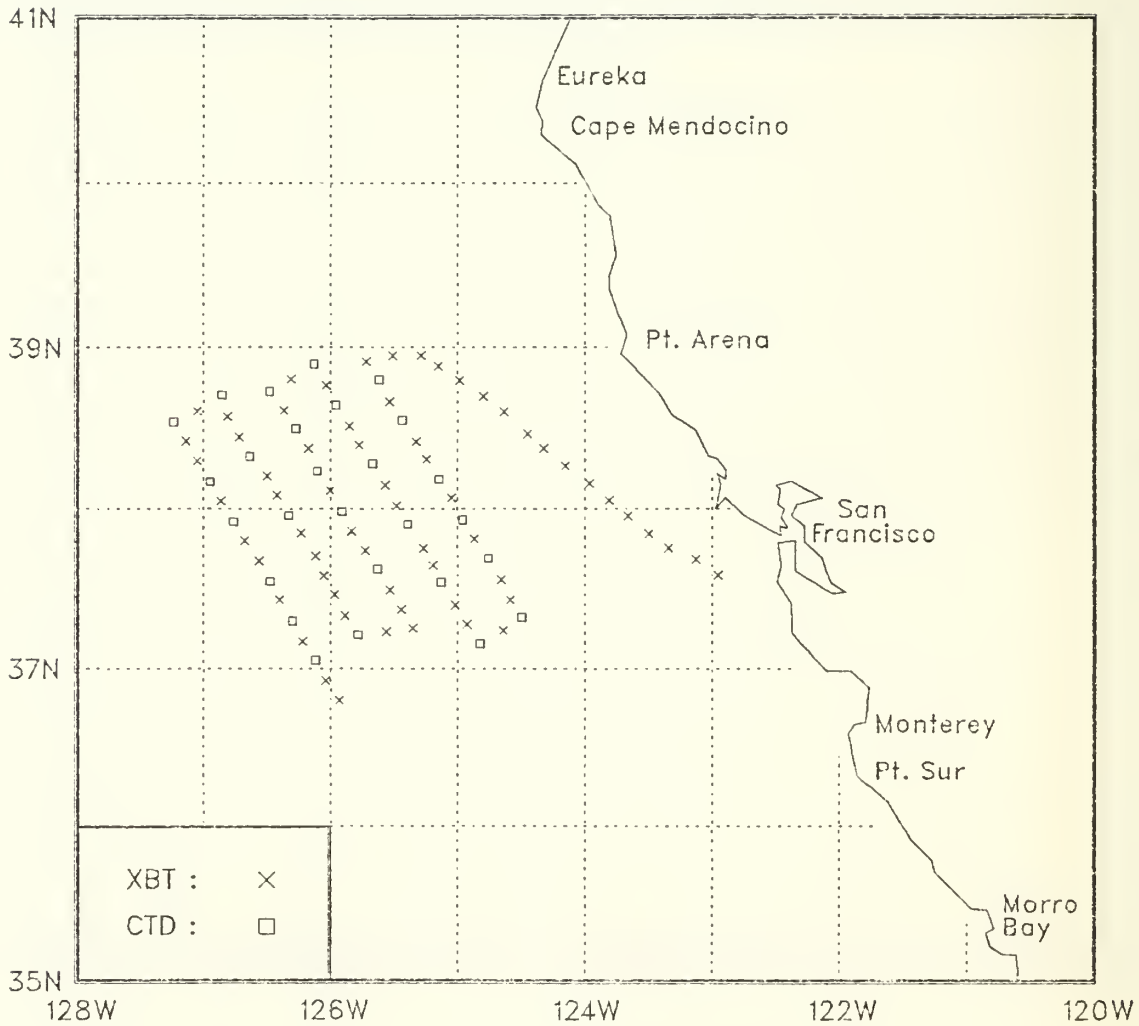

41N
39N
37N
35N
128W
126W
124W
122W
120W
Eureka
Cape Mendocino
Pt. Arena
San
Francisco
Monterey
Pt. Sur
Morro
Bay
XBT :
CTD :

Figure 33(c)

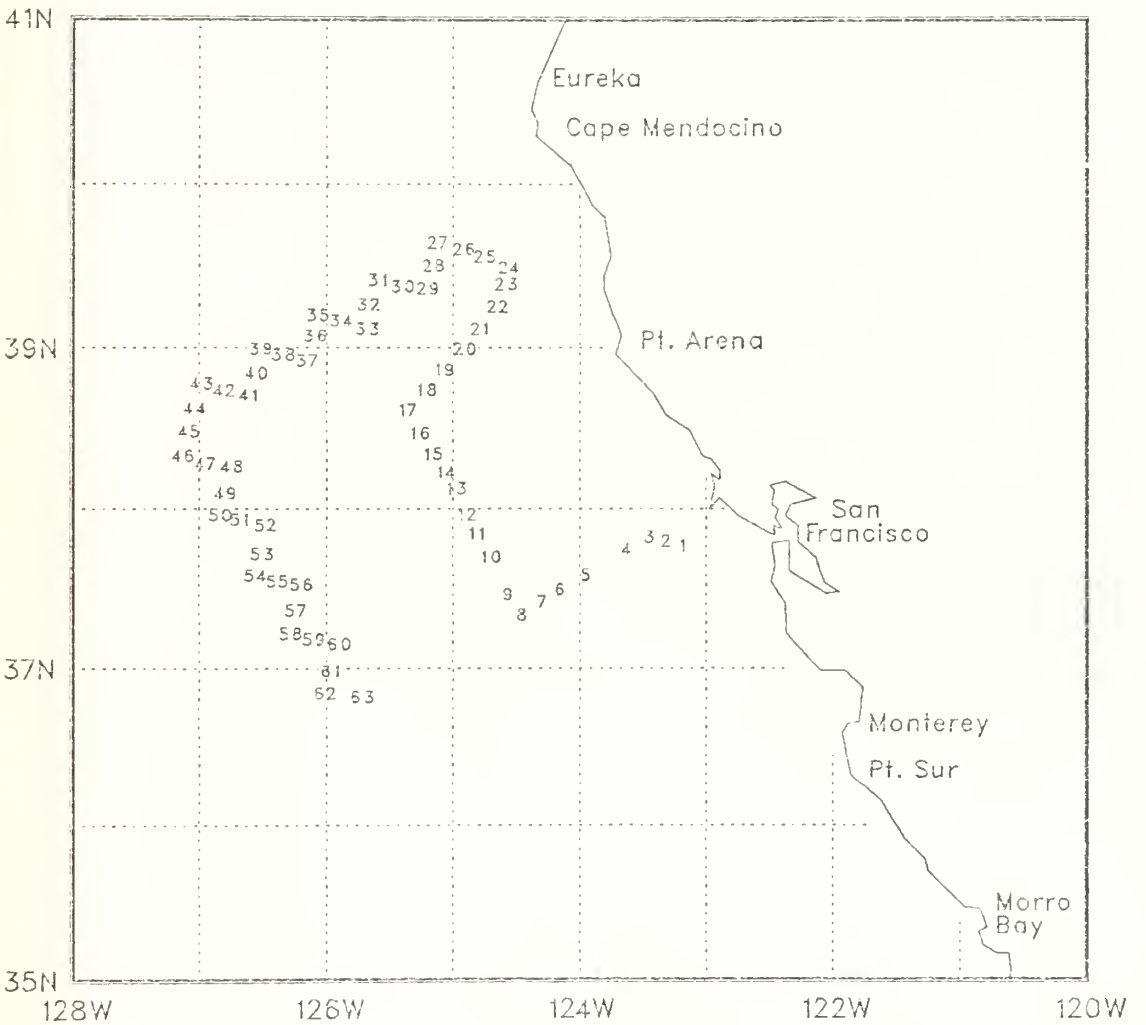


Figure 34(a): Station numbers for OPTOMA20, Leg D.

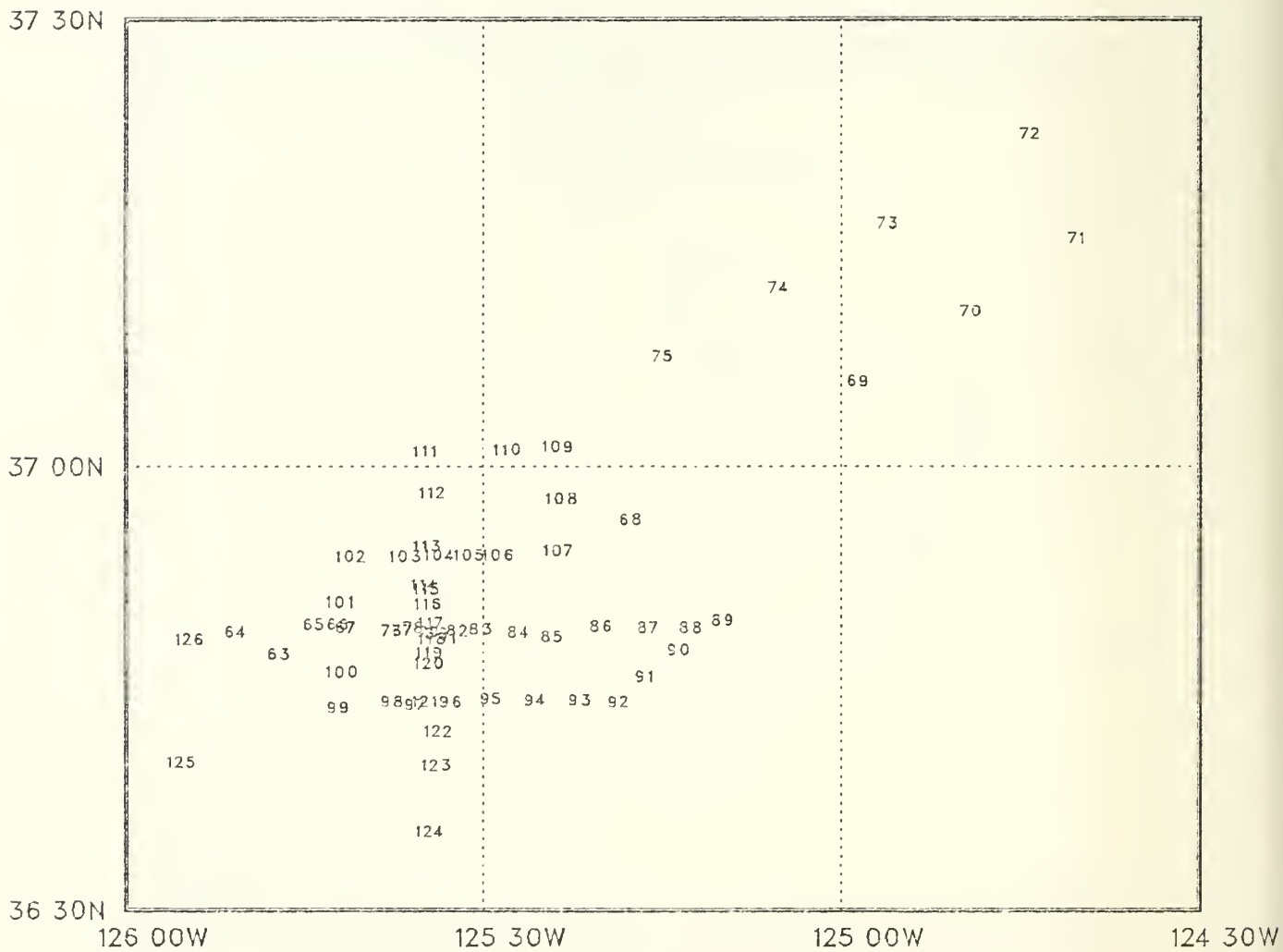

37 30N
37 00N
36 30N
126 00W
125 30W
125 00W
124 30W
72
73
71
74
70
75
69
111
110
109
112
108
68
102
103
104
105
106
107
101
115
126
64
65
66
67
73
84
85
86
87
88
89
63
90
100
120
91
99
98
97
96
95
94
93
92
122
125
123
124

Figure 34(b)

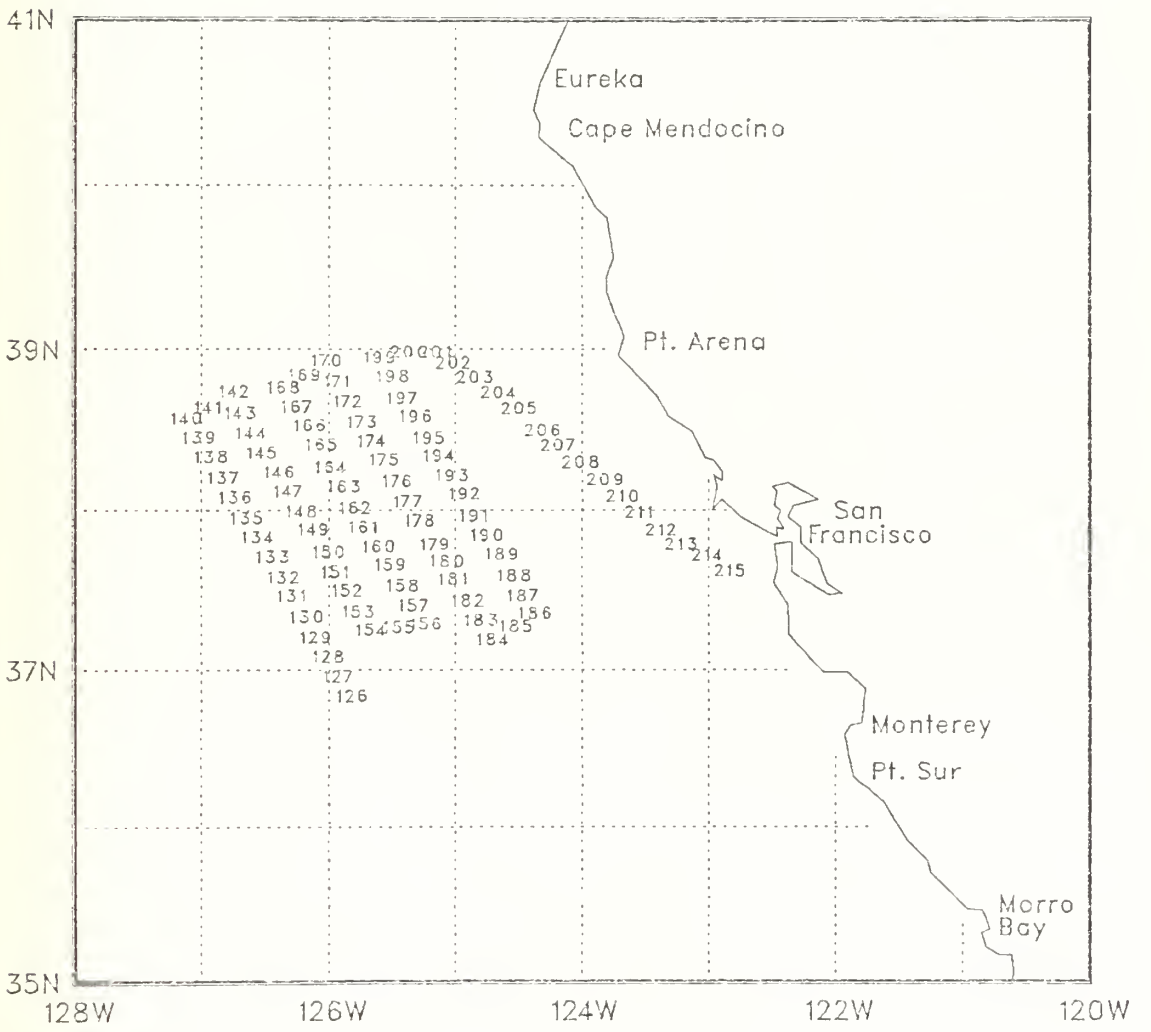

41N
39N
37N
35N
128W
126W
124W
122W
120W
Eureka
Cape Mendocino
Pt. Arena
San Francisco
Monterey
Pt. Sur
Morro Bay

Figure 34(c)

TABLE 6: OPTOMA20 LEG D STATION LISTING

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)
1	XBT	86115	2243	37.44	123.12	10.5	
2	XBT	86115	2341	37.46	123.21	10.2	
3	XBT	86116	27	37.47	123.29	10.3	
4	XBT	86116	139	37.43	123.40	10.6	
5	XBT	86116	315	37.33	123.59	11.5	
6	XBT	86116	931	37.28	124.11	11.5	
7	XBT	86116	1012	37.23	124.20	11.9	
8	XBT	86116	1102	37.18	124.29	12.1	
9	XBT	86116	1303	37.26	124.36	13.1	
10	XBT	86116	1638	37.40	124.46	13.5	
11	XBT	86116	1833	37.49	124.52	13.3	
12	XBT	86116	2007	37.56	124.57	13.4	
13	XBT	86116	2146	38.06	125.02	13.0	
14	XBT	86116	2247	38.12	125.07	12.6	
15	XBT	86117	11	38.19	125.13	13.0	
16	XBT	86117	120	38.26	125.20	12.9	
17	XBT	86117	232	38.35	125.25	13.1	
18	XBT	86117	332	38.42	125.16	13.0	
19	XBT	86117	427	38.50	125.08	12.9	
20	XBT	86117	529	38.58	125.00	11.3	
21	XBT	86117	630	39.05	124.52	11.8	
22	XBT	86117	730	39.13	124.44	12.0	
23	XBT	86117	821	39.21	124.40	12.0	
24	XBT	86117	912	39.28	124.38	12.0	
25	XBT	86117	1007	39.32	124.50	11.9	
26	XBT	86117	1056	39.34	125.00	12.1	
27	XBT	86117	1153	39.37	125.12	12.1	
28	XBT	86117	1242	39.28	125.14	12.1	
29	XBT	86117	1328	39.20	125.17	12.5	
30	XBT	86117	1422	39.21	125.29	12.6	

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)
31	XBT	86117	1516	39.23	125.40	12.8	
32	XBT	86117	1618	39.14	125.45	12.8	
33	XBT	86117	1700	39.05	125.46	12.8	
34	XBT	86117	1758	39.08	125.58	12.9	
35	XBT	86117	1846	39.10	126.09	13.1	
36	XBT	86117	1939	39.02	126.10	13.1	
37	XBT	86117	2034	38.53	126.14	13.2	
38	XBT	86117	2130	38.55	126.26	13.2	
39	XBT	86117	2218	38.58	126.36	13.5	
40	XBT	86117	2310	38.49	126.38	13.7	
41	XBT	86117	2358	38.40	126.41	13.7	
42	XBT	86118	104	38.42	126.53	12.9	
43	XBT	86118	151	38.45	127.04	12.9	
44	XBT	86118	246	38.36	127.07	12.9	
45	XBT	86118	336	38.27	127.10	12.7	
46	XBT	86118	428	38.18	127.13	13.6	
47	XBT	86118	527	38.15	127.02	12.8	
48	XBT	86118	614	38.14	126.50	13.4	
49	XBT	86118	711	38.04	126.53	13.4	
50	XBT	86118	803	37.56	126.55	13.3	
51	XBT	86118	849	37.54	126.45	13.5	
52	XBT	86118	940	37.52	126.34	13.3	
53	XBT	86118	1045	37.41	126.36	13.3	
54	XBT	86118	1131	37.33	126.39	13.5	
55	XBT	86118	1221	37.31	126.28	13.7	
56	XBT	86118	1314	37.30	126.17	13.4	
57	XBT	86118	1416	37.20	126.19	13.2	
58	XBT	86118	1501	37.11	126.22	13.7	
59	XBT	86118	1553	37.09	126.11	13.8	
60	XBT	86118	1647	37.07	125.59	13.8	
61	XBT	86118	1748	36.57	126.02	13.8	
62	XBT	86118	1836	36.48	126.05	13.8	

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)
63	XBT	86118	1935	36.47	125.48	13.9	
64	CTD	86118	2108	36.48	125.52	13.5	32.71
65	XBT	86118	2243	36.49	125.45	13.9	
66	XBT	86118	2255	36.49	125.43	13.9	
67	CTD	86119	3	36.49	125.42	13.6	32.89
68	XBT	86119	401	36.56	125.18	12.7	
69	XBT	86119	600	37.05	124.59	13.0	
70	XBT	86119	704	37.10	124.50	13.3	
71	XBT	86119	810	37.15	124.41	13.5	
72	XBT	86119	933	37.22	124.45	13.7	
73	XBT	86119	1036	37.16	124.57	13.6	
74	XBT	86119	1126	37.12	125.06	13.0	
75	XBT	86119	1219	37.07	125.16	12.9	
76	CTD	86119	1559	36.49	125.38	13.3	32.89
77	XBT	86119	1658	36.49	125.38	13.7	
78	XBT	86119	1711	36.49	125.37	13.5	
79	CTD	86119	1804	36.48	125.35	12.8	32.83
80	XBT	86119	1846	36.48	125.35	13.1	
81	XBT	86119	1854	36.48	125.34	13.1	
82	CTD	86119	2011	36.49	125.33	12.6	32.85
83	CTD	86119	2230	36.49	125.31	12.5	32.91
84	XBT	86119	2348	36.48	125.28	12.9	
85	CTD	86120	109	36.48	125.25	12.7	32.90
86	XBT	86120	217	36.49	125.21	12.9	
87	XBT	86120	234	36.49	125.17	12.9	
88	XBT	86120	251	36.49	125.13	12.7	
89	CTD	86120	403	36.49	125.11	12.3	32.91
90	XBT	86120	501	36.47	125.14	12.7	
91	XBT	86120	516	36.45	125.17	12.9	
92	CTD	86120	704	36.44	125.19	12.6	32.83
93	XBT	86120	726	36.44	125.23	13.0	
94	XBT	86120	743	36.44	125.26	13.0	

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)
95	CTD	86120	907	36.44	125.30	12.5	32.89
96	XBT	86120	1005	36.44	125.34	12.8	
97	XBT	86120	1019	36.44	125.36	13.0	
98	XBT	86120	1034	36.44	125.38	13.6	
99	CTD	86120	1201	36.43	125.43	13.4	32.89
100	XBT	86120	1302	36.46	125.43	13.7	
101	XBT	86120	1332	36.50	125.43	13.8	
102	CTD	86120	1446	36.54	125.42	13.4	32.90
103	XBT	86120	1547	36.54	125.38	13.1	
104	XBT	86120	1600	36.54	125.35	12.9	
105	XBT	86120	1611	36.54	125.32	12.9	
106	XBT	86120	1621	36.54	125.30	12.8	
107	CTD	86120	1741	36.54	125.25	12.6	32.85
108	XBT	86120	1845	36.57	125.25	13.2	
109	CTD	86120	2012	37.01	125.25	12.5	32.91
110	XBT	86120	2111	37.01	125.29	13.1	
111	CTD	86120	2240	37.01	125.36	13.0	32.83
112	XBT	86120	2340	36.58	125.35	13.4	
113	CTD	86121	100	36.54	125.36	12.8	32.83
114	CTD	86121	252	36.52	125.36	12.8	32.83
115	XBT	86121	332	36.51	125.36	13.2	
116	XBT	86121	342	36.50	125.36	13.2	
117	CTD	86121	434	36.49	125.35	12.8	32.84
118	XBT	86121	514	36.48	125.35	13.2	
119	XBT	86121	523	36.47	125.36	13.2	
120	CTD	86121	626	36.46	125.36	12.8	32.85
121	CTD	86121	821	36.44	125.36	12.7	32.86
122	XBT	86121	913	36.42	125.35	13.0	
123	XBT	86121	926	36.39	125.35	13.2	
124	CTD	86121	1057	36.35	125.36	12.8	32.83
125	XBT	86121	1303	36.40	125.56	13.9	
126	XBT	86121	1415	36.48	125.56	13.8	

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)
127	XBT	86121	1510	36.55	126.02	13.9	
128	CTD	86121	1617	37.03	126.07	13.5	32.84
129	XBT	86121	1742	37.10	126.13	14.0	
130	CTD	86121	2005	37.18	126.18	13.3	32.81
131	XBT	86121	2146	37.26	126.24	13.9	
132	CTD	86121	2313	37.33	126.28	13.5	32.86
133	XBT	86122	25	37.41	126.34	13.6	
134	XBT	86122	118	37.48	126.41	13.6	
135	CTD	86122	305	37.55	126.46	13.2	32.83
136	XBT	86122	453	38.03	126.52	13.6	
137	CTD	86122	601	38.10	126.57	13.3	32.82
138	XBT	86122	707	38.18	127.03	13.0	
139	XBT	86122	755	38.25	127.09	12.8	
140	CTD	86122	948	38.32	127.14	12.4	32.72
141	XBT	86122	1133	38.36	127.03	12.7	
142	CTD	86122	1245	38.42	126.51	12.4	32.74
143	XBT	86122	1739	38.34	126.49	13.4	
144	XBT	86122	1838	38.27	126.43	13.6	
145	CTD	86122	1541	38.20	126.38	13.1	32.83
146	XBT	86122	2019	38.12	126.30	13.6	
147	XBT	86122	2101	38.05	126.25	13.6	
148	CTD	86122	2156	37.58	126.20	13.5	32.81
149	XBT	86122	2308	37.51	126.14	13.7	
150	XBT	86122	2359	37.42	126.07	13.8	
151	XBT	86123	47	37.35	126.03	13.8	
152	XBT	86123	131	37.28	125.58	14.1	
153	XBT	86123	218	37.20	125.53	13.8	
154	CTD	86123	615	37.13	125.47	13.5	32.82
155	XBT	86123	439	37.14	125.33	14.0	
156	XBT	86123	534	37.15	125.21	13.5	
157	XBT	86123	624	37.22	125.26	13.8	
158	XBT	86123	715	37.30	125.32	13.8	

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)
159	CTD	86123	901	37.38	125.38	13.2	32.77
160	XBT	86123	1037	37.44	125.44	13.5	
161	XBT	86123	1121	37.52	125.50	13.8	
162	CTD	86123	1231	37.59	125.54	13.3	32.87
163	XBT	86123	1349	38.07	126.00	13.5	
164	CTD	86123	1553	38.14	126.06	13.0	32.77
165	XBT	86123	1727	38.23	126.10	13.5	
166	CTD	86123	1834	38.30	126.16	13.1	32.70
167	XBT	86123	1940	38.37	126.22	13.4	
168	CTD	86123	2127	38.44	126.29	13.0	32.62
169	XBT	86123	2303	38.48	126.19	12.5	
170	CTD	86124	15	38.54	126.08	13.0	32.70
171	XBT	86124	122	38.46	126.02	13.5	
172	CTD	86124	222	38.39	125.57	13.0	32.75
173	XBT	86124	322	38.31	125.51	13.4	
174	XBT	86124	412	38.24	125.46	13.3	
175	CTD	86124	515	38.17	125.40	13.1	32.76
176	XBT	86124	619	38.09	125.34	13.4	
177	XBT	86124	706	38.01	125.29	13.5	
178	CTD	86124	808	37.54	125.23	13.3	32.82
179	XBT	86124	926	37.45	125.16	13.7	
180	XBT	86124	1004	37.39	125.11	13.7	
181	CTD	86124	1103	37.32	125.08	13.5	33.02
182	XBT	86124	1211	37.24	125.01	13.2	
183	XBT	86124	1300	37.17	124.55	13.4	
184	CTD	86124	1400	37.09	124.49	13.3	32.87
185	XBT	86124	1511	37.14	124.38	13.7	
186	CTD	86124	1654	37.19	124.30	13.6	32.88
187	XBT	86124	1833	37.26	124.35	14.0	
188	XBT	86124	1930	37.34	124.40	13.7	
189	CTD	86124	2045	37.42	124.45	13.6	32.82
190	XBT	86124	2148	37.49	124.52	13.9	

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)
191	CTD	86124	2337	37.56	124.57	13.8	32.84
192	XBT	86125	117	38.04	125.03	14.0	
193	CTD	86125	217	38.11	125.09	12.8	32.72
194	XBT	86125	322	38.19	125.15	12.6	
195	XBT	86125	413	38.25	125.19	13.1	
196	CTD	86125	601	38.33	125.26	13.1	32.71
197	XBT	86125	739	38.40	125.32	13.1	
198	CTD	86125	915	38.48	125.37	13.0	32.67
199	XBT	86125	1102	38.55	125.43	13.2	
200	XBT	86125	1244	38.57	125.30	13.2	
201	XBT	86125	1407	38.57	125.17	13.2	
202	XBT	86125	1532	38.53	125.09	13.3	
203	XBT	86125	1647	38.48	124.59	13.4	
204	XBT	86125	1811	38.42	124.48	13.3	
205	XBT	86125	1932	38.36	124.38	13.4	
206	XBT	86125	2055	38.28	124.27	12.7	
207	XBT	86125	2206	38.23	124.19	12.5	
208	XBT	86125	2320	38.16	124.09	12.9	
209	XBT	86126	40	38.10	123.57	13.5	
210	XBT	86126	153	38.03	123.48	12.9	
211	XBT	86126	310	37.57	123.40	12.3	
212	XBT	86126	443	37.51	123.30	11.9	
213	XBT	86126	602	37.45	123.21	11.0	
214	XBT	86126	743	37.41	123.08	11.4	
215	XBT	86126	858	37.35	122.57	11.3	

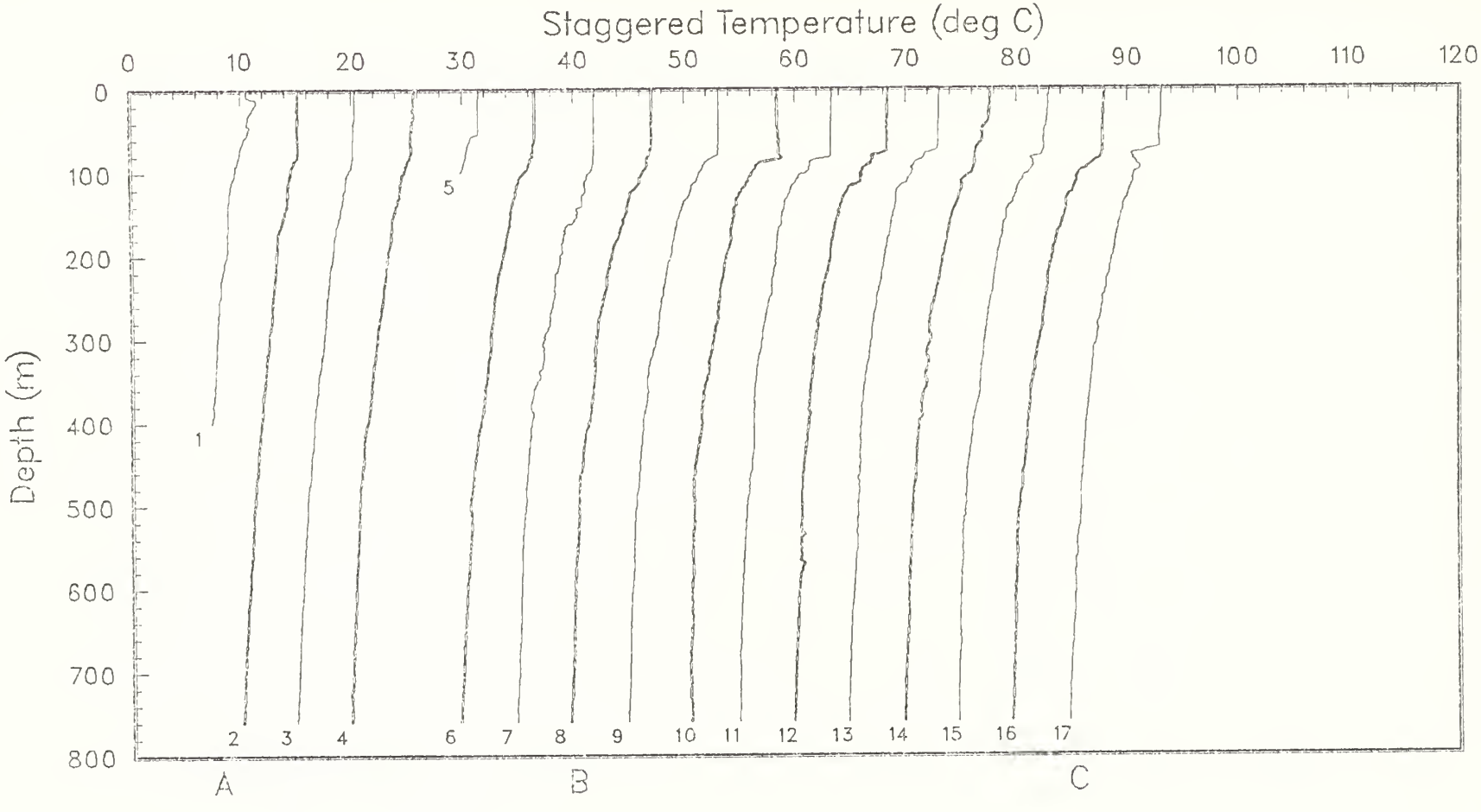


Figure 35(a): XBT temperature profiles, staggered by multiples of 5C (OPTOMA20, Leg D).

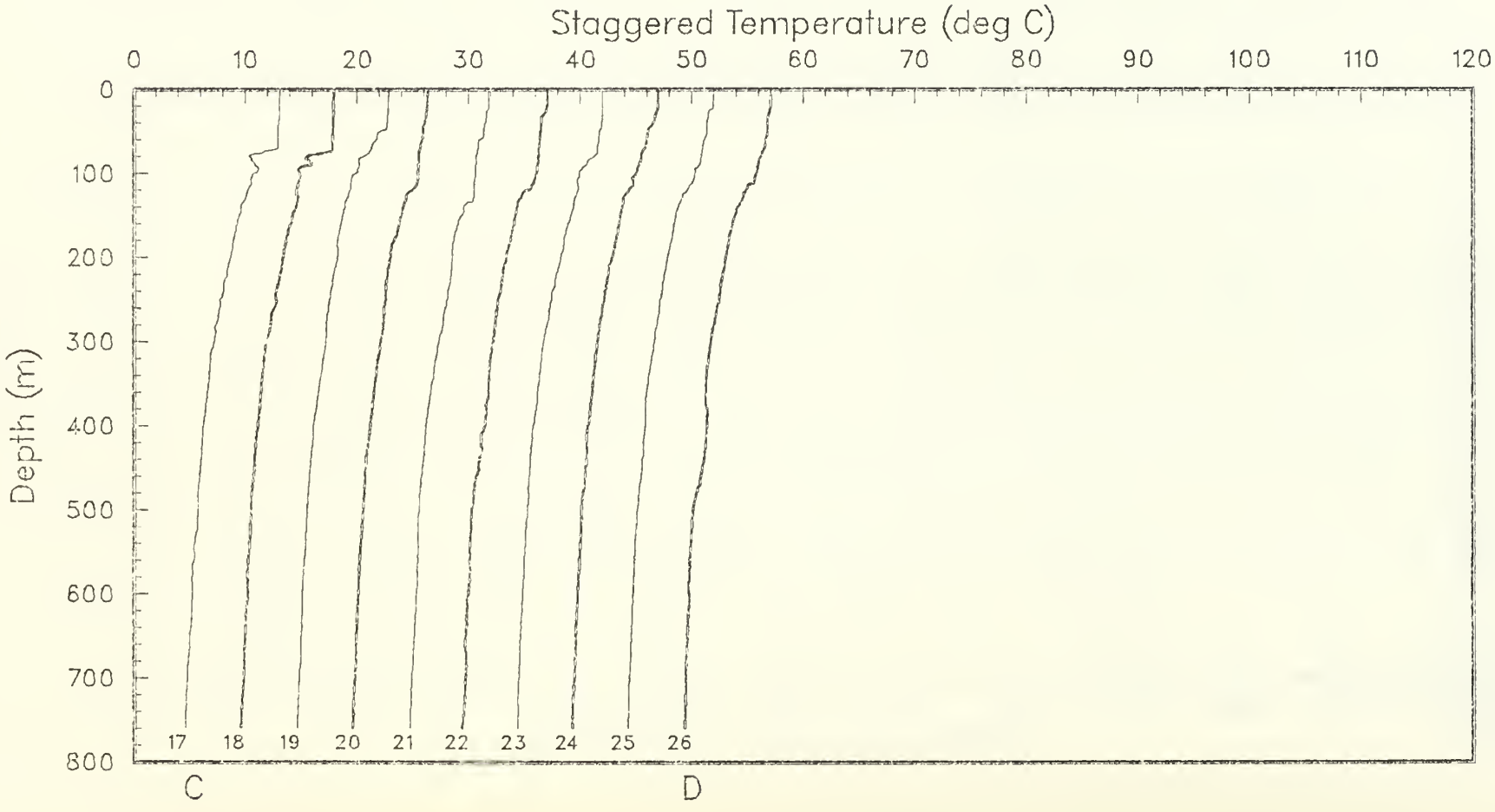

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
17
18
19
20
21
22
23
24
25
26
C
D

Figure 35(b)

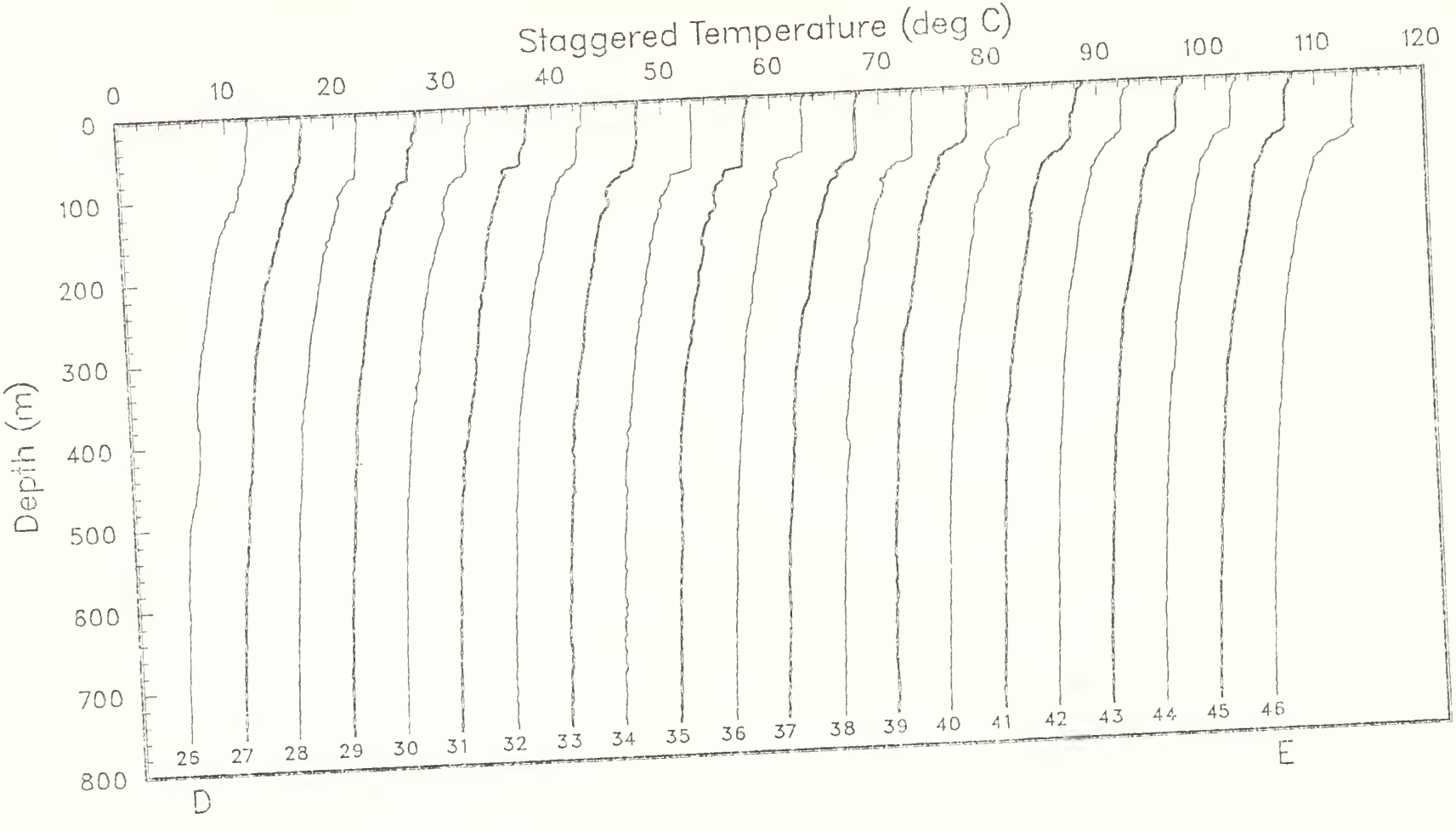

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
D
E

Figure 35(c)

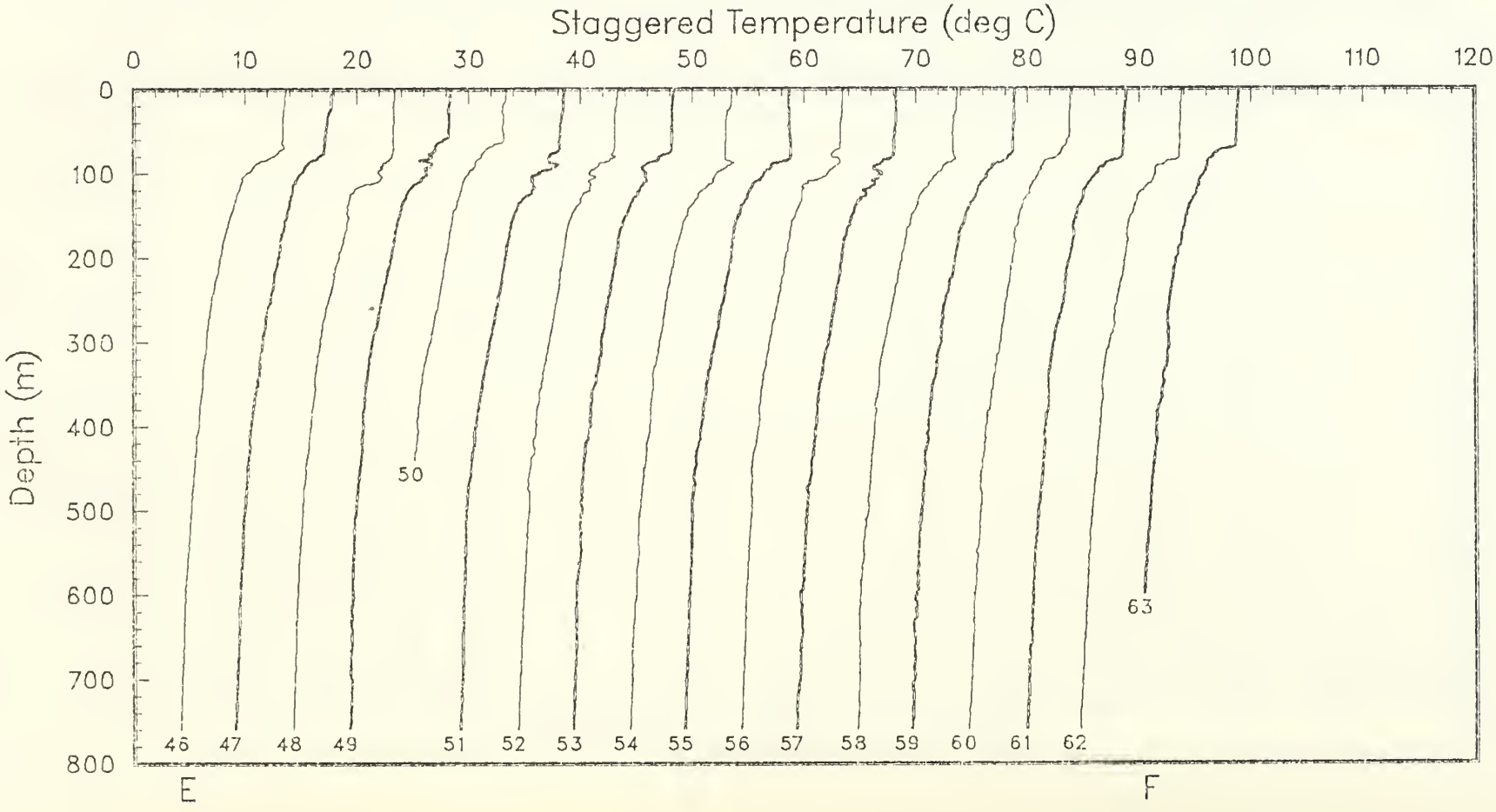

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
E
F

Figure 35(d)

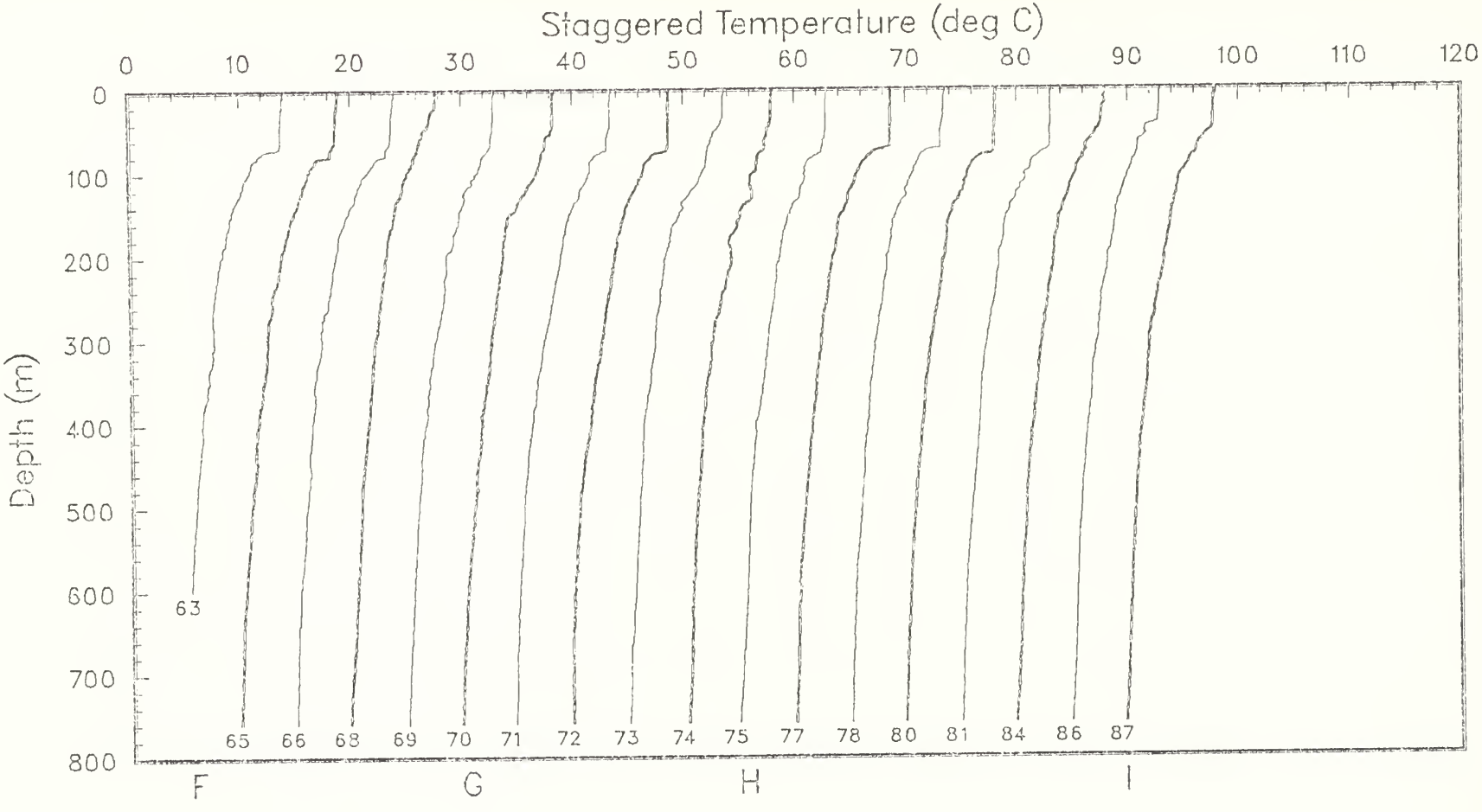

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
63
65
66
68
69
70
71
72
73
74
75
77
78
80
81
84
86
87
F
G
H
I

Figure 35(e)

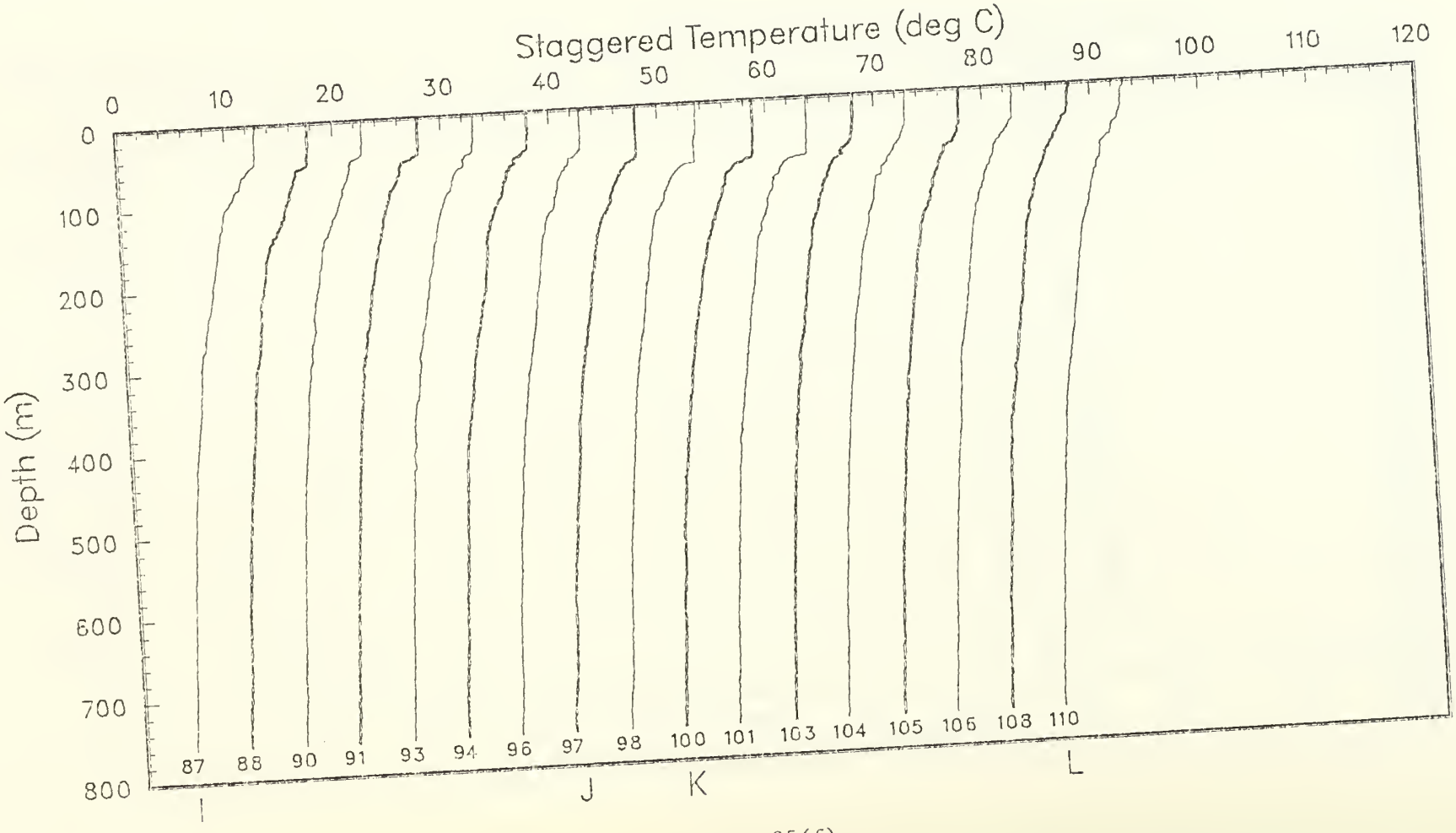

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
87
88
90
91
93
94
96
97
98
100
101
103
104
105
106
108
110
I
J
K
L

Figure 35(f)

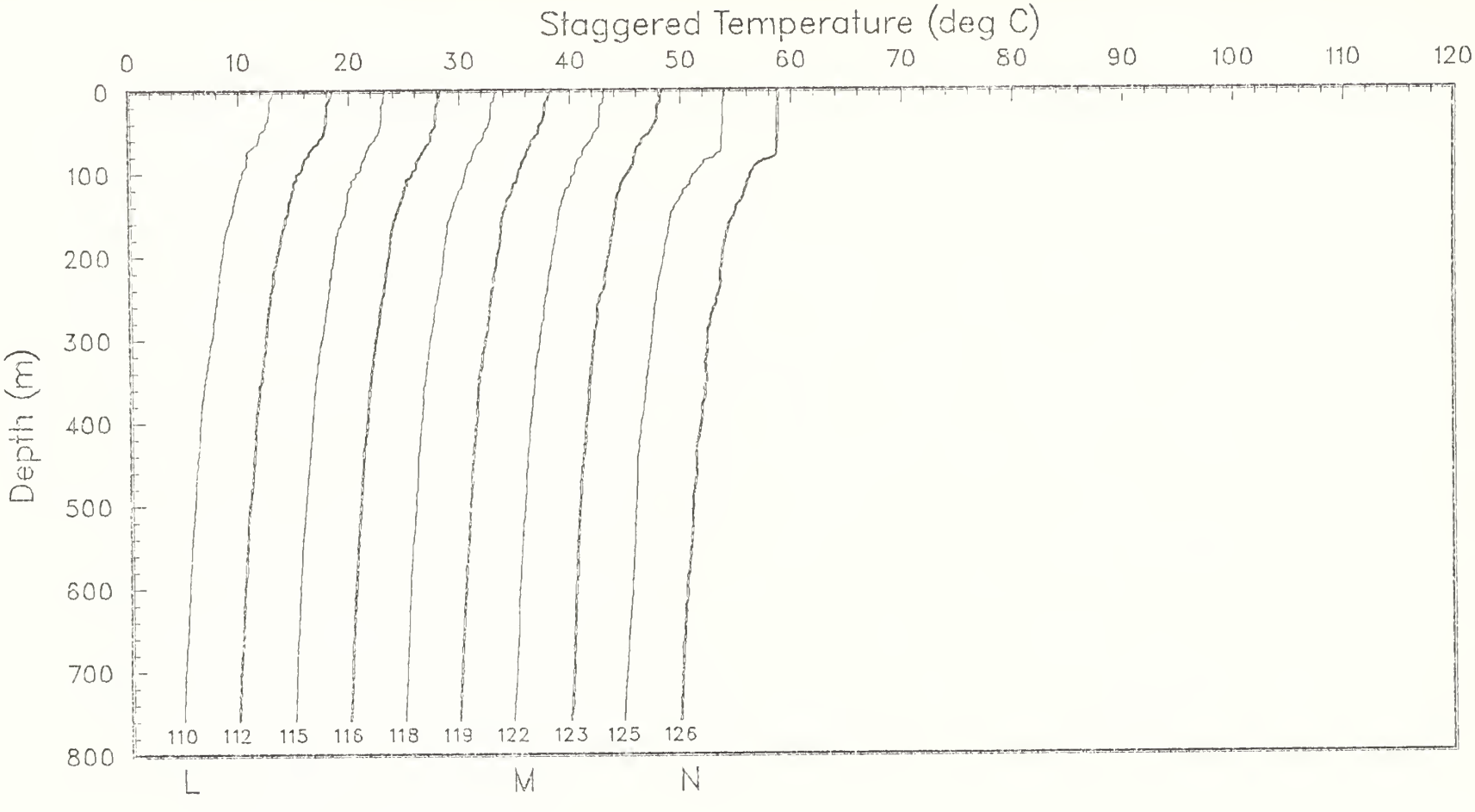

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
110
112
115
116
118
119
122
123
125
126
L
M
N

Figure 35(g)

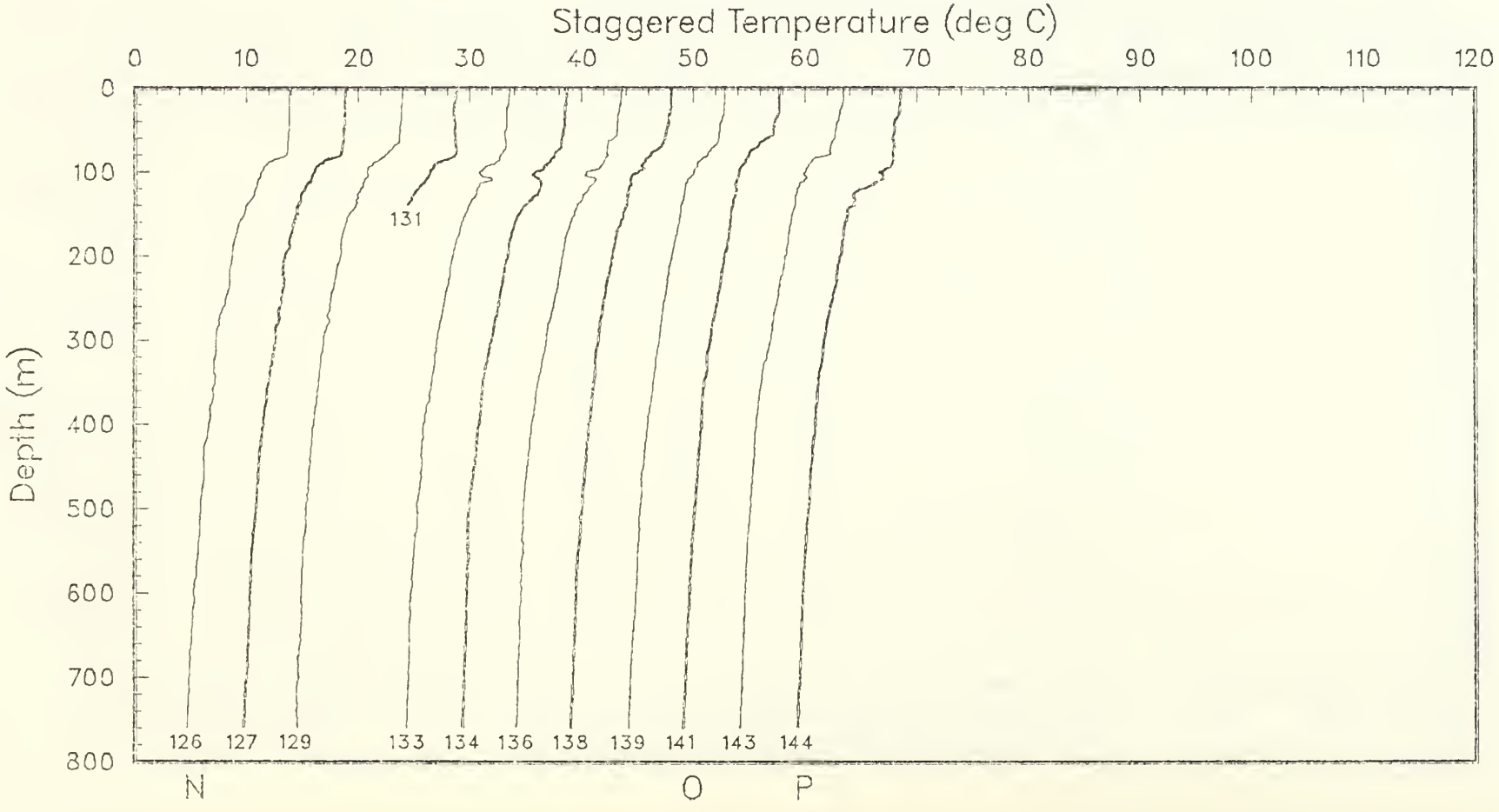

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
131
126
127
129
133
134
136
138
139
141
143
144
N
O
P

Figure 35(h)

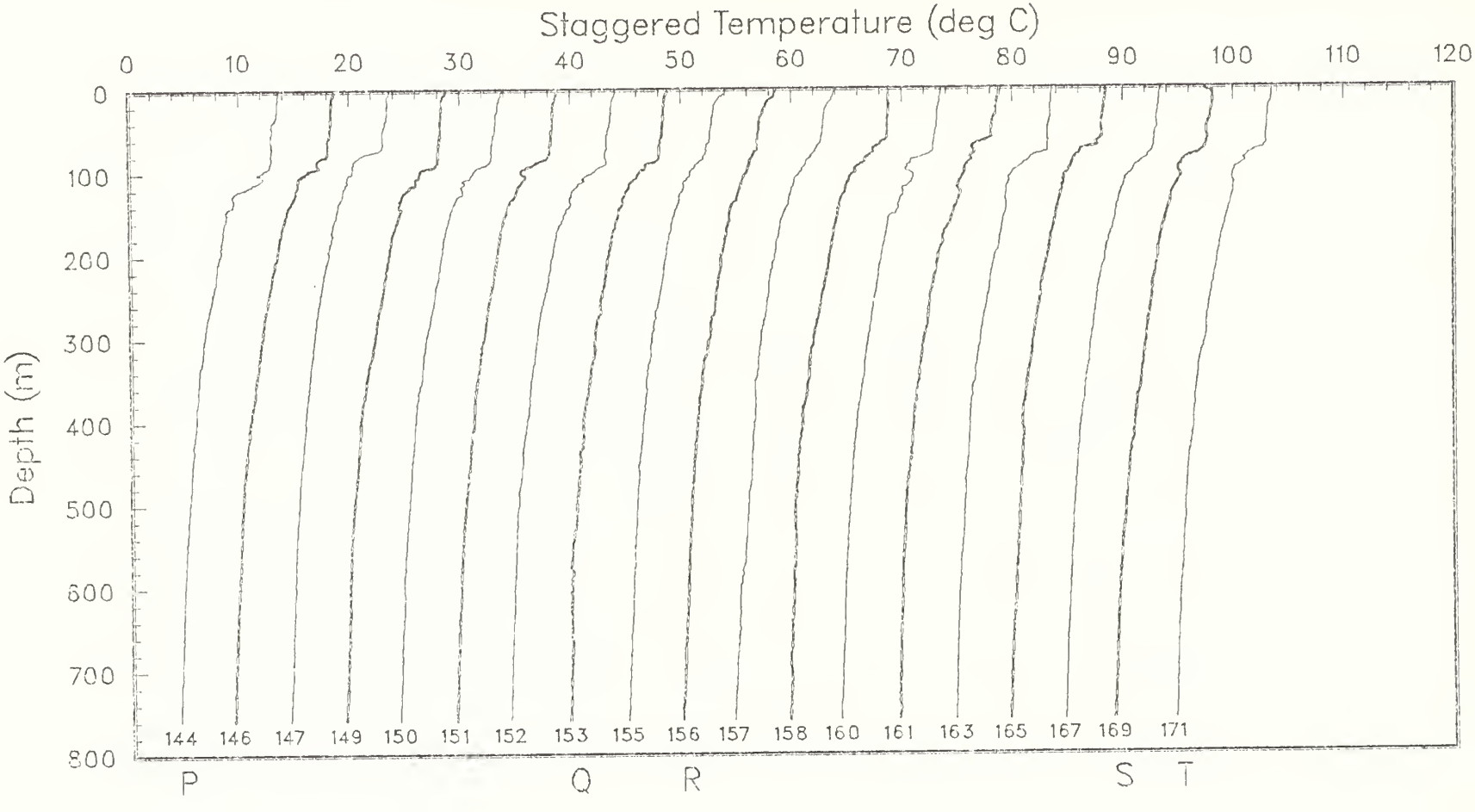

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
144
146
147
149
150
151
152
153
155
156
157
158
160
161
163
165
167
169
171
P
Q
R
S
T

Figure 35(i)

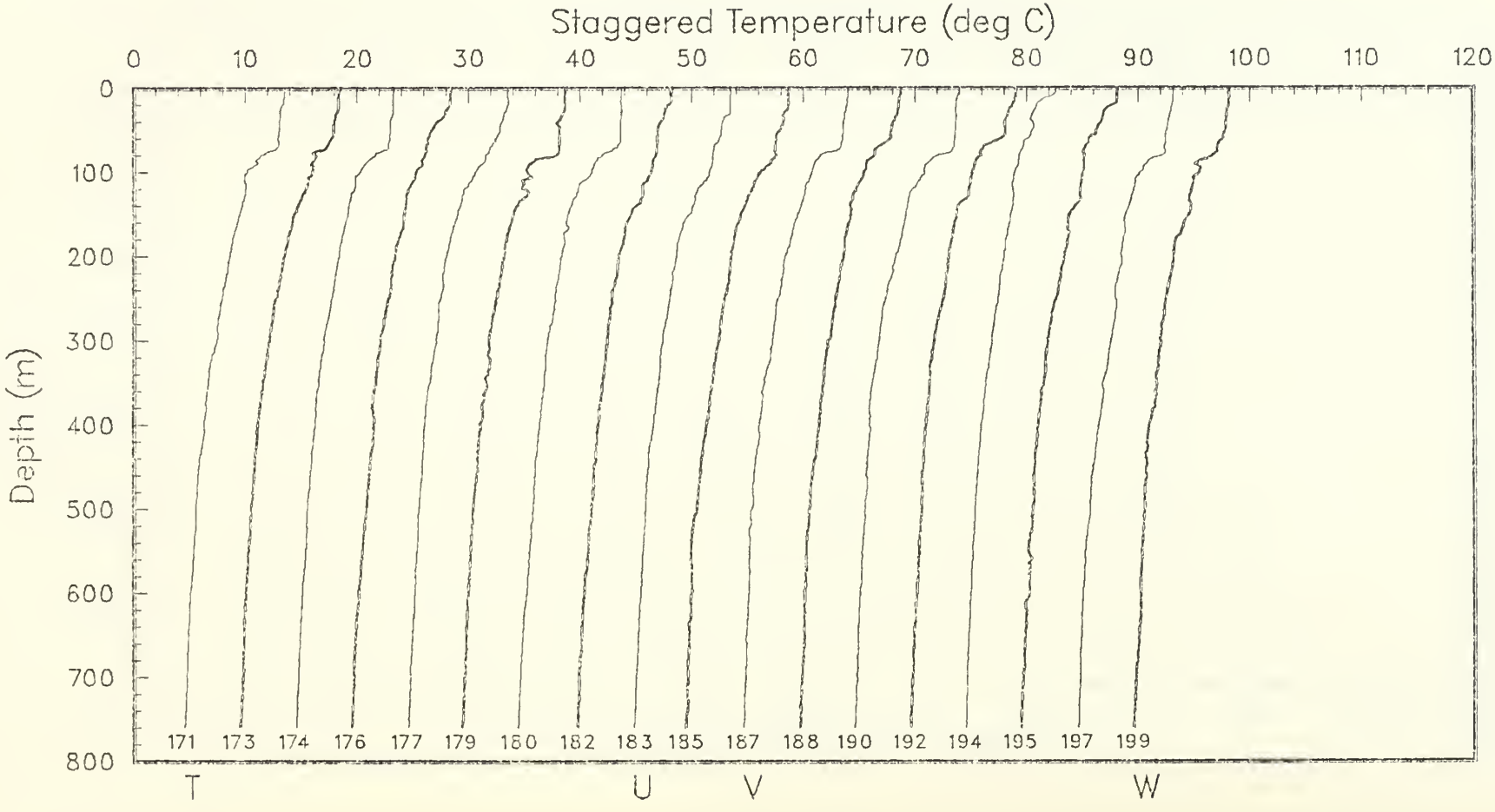

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
171
173
174
176
177
179
180
182
183
185
187
188
190
192
194
195
197
199
T
U
V
W

Figure 35(j)

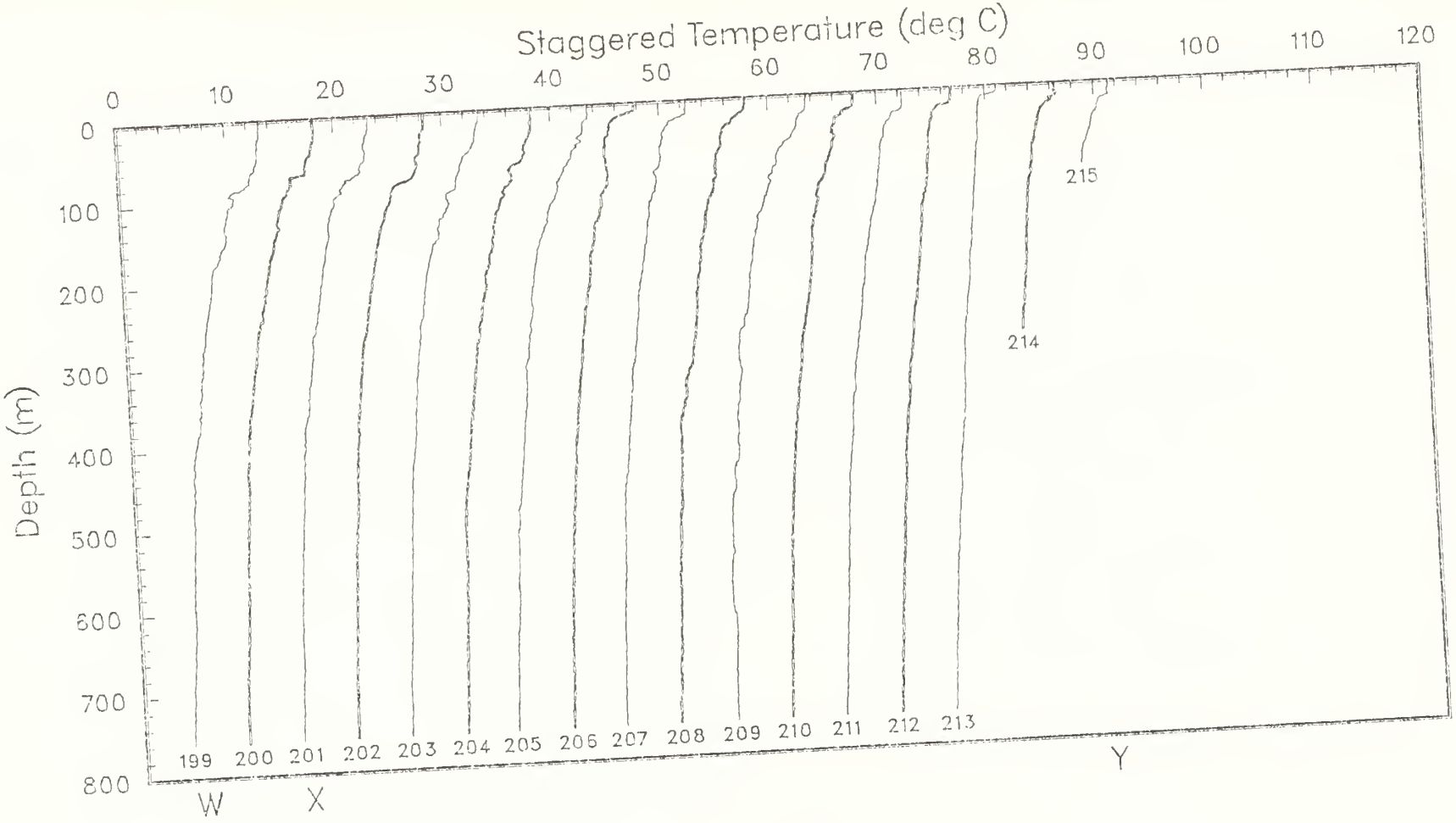

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
500
600
700
800
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
W
X
Y

Figure 35(k)

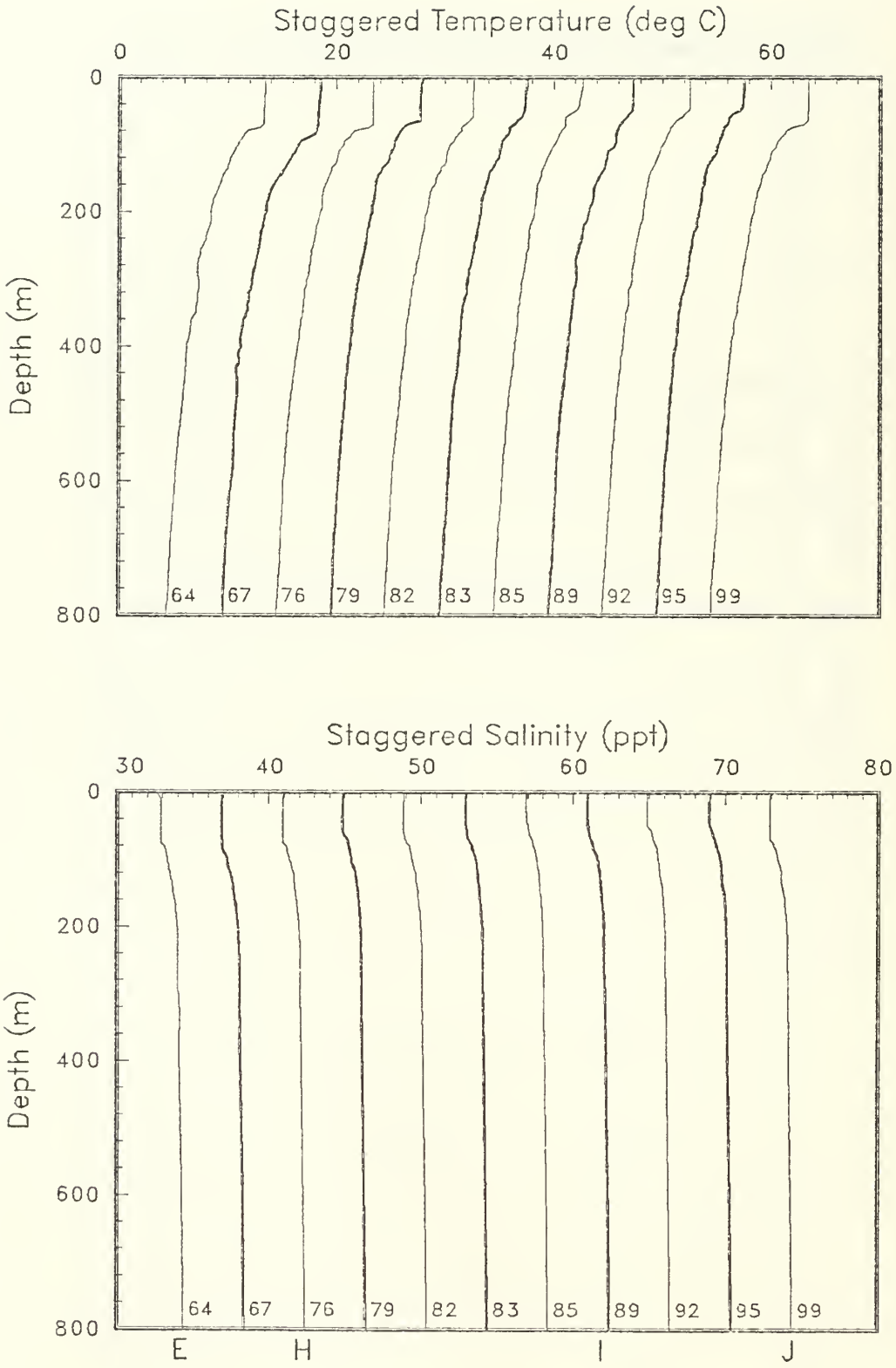


Figure 36(a): CTD temperature profiles, staggered by multiples of 5C, and salinity profiles staggered by multiples of 4 ppt (OPTOMA20, Leg D).

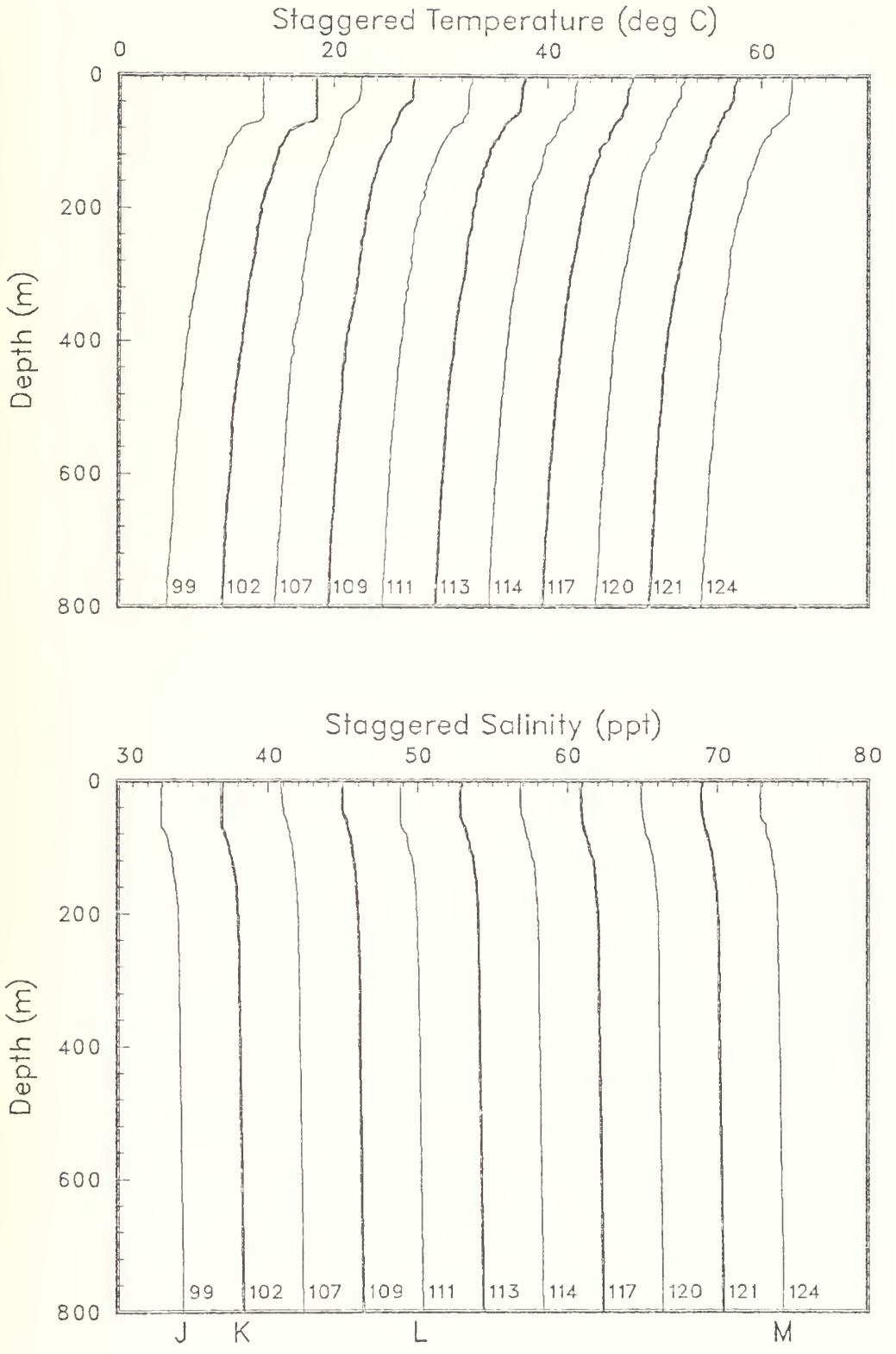

Staggered Temperature (deg C)
0
20
40
60
0
200
400
600
800
Depth (m)
99
102
107
109
111
113
114
117
120
121
124
Staggered Salinity (ppt)
30
40
50
60
70
80
0
200
400
600
800
Depth (m)
99
102
107
109
111
113
114
117
120
121
124
J
K
L
M

Figure 36(b)

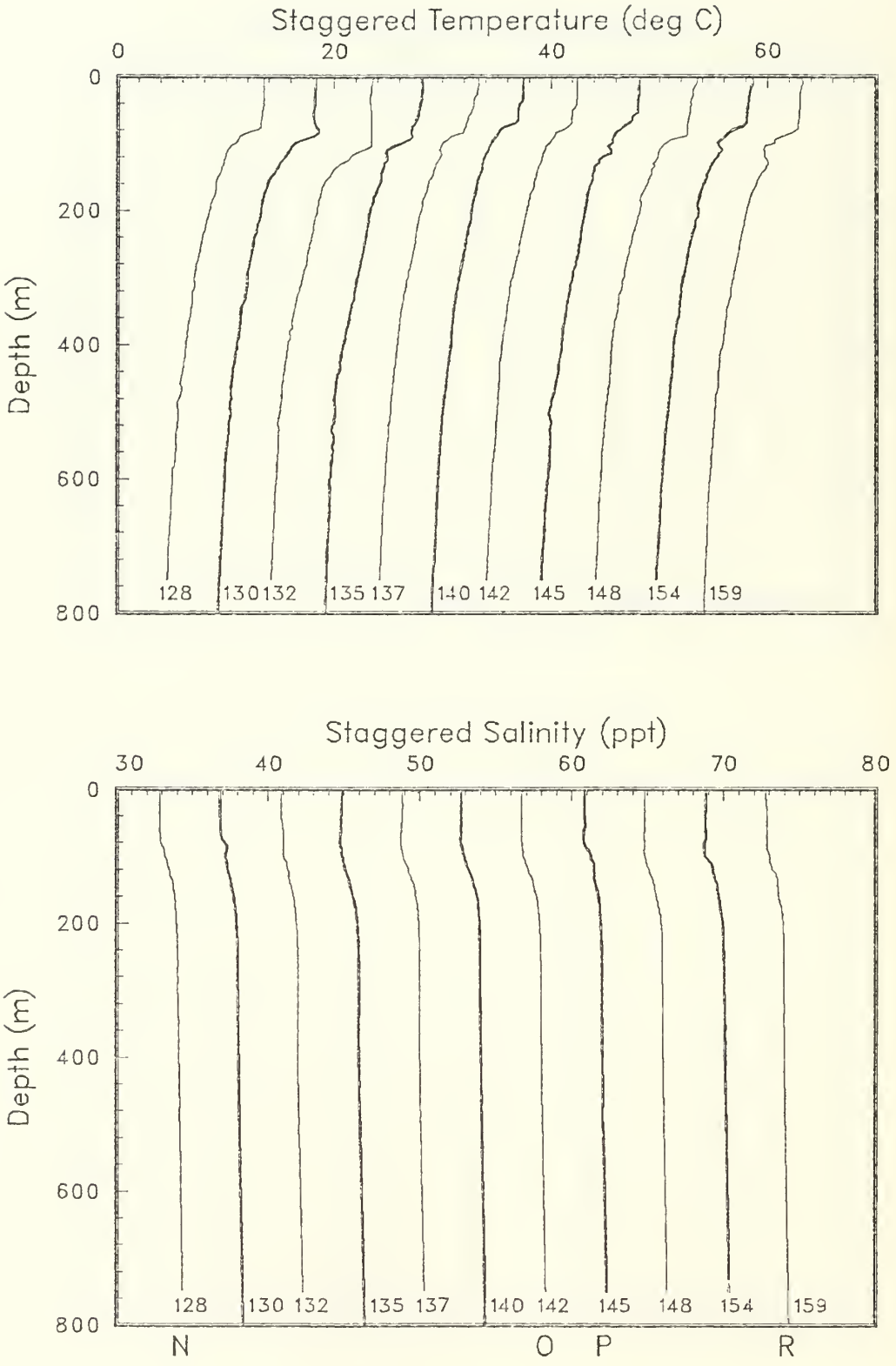

Staggered Temperature (deg C)
0
20
40
60
0
200
400
600
800
Depth (m)
128
130
132
135
137
140
142
145
148
154
159
Staggered Salinity (ppt)
30
40
50
60
70
80
0
200
400
600
800
Depth (m)
128
130
132
135
137
140
142
145
148
154
159
N
O
P
R

Figure 36(c)

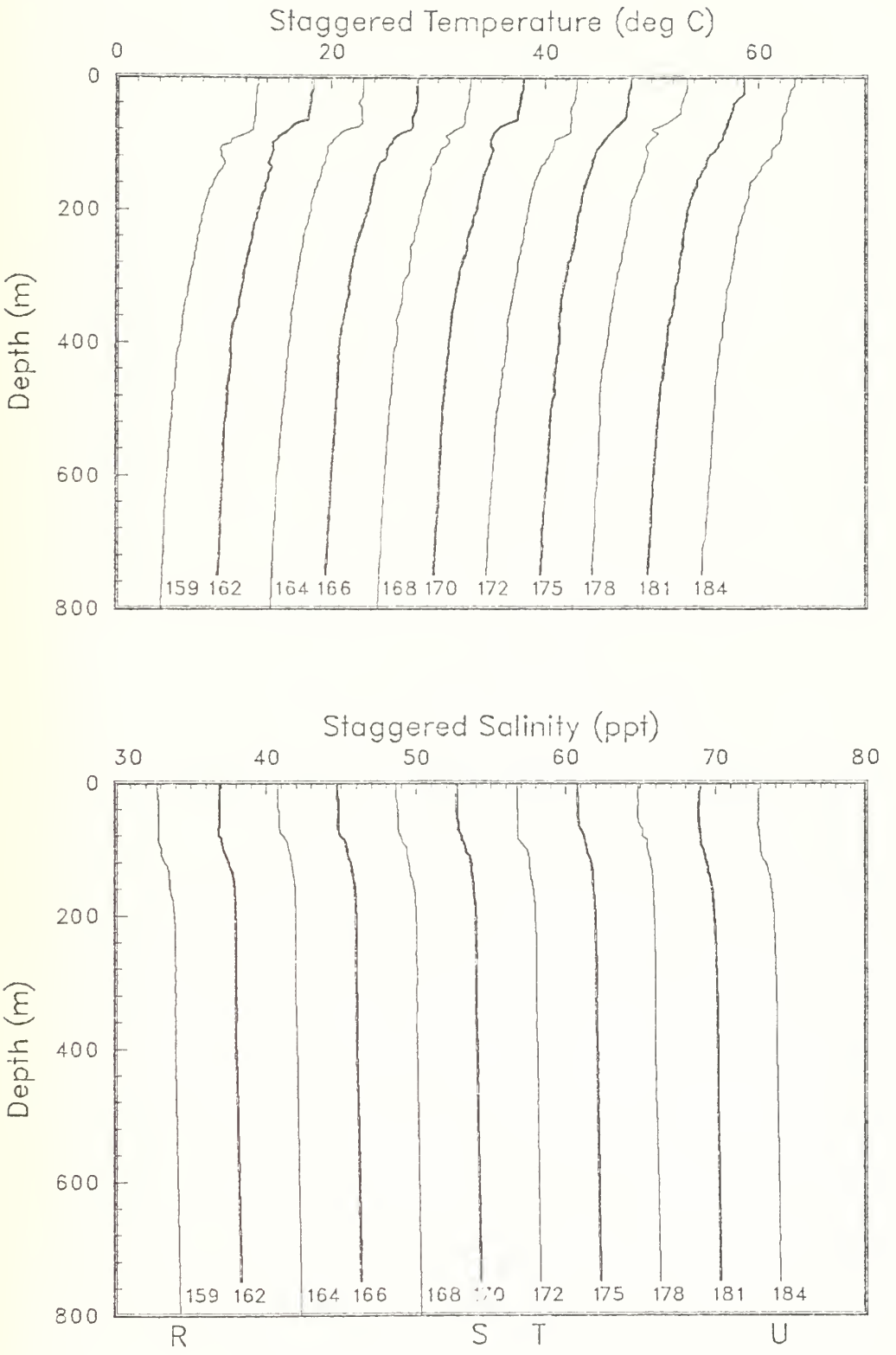

Staggered Temperature (deg C)
0
20
40
60
0
200
400
600
800
Depth (m)
159 162
164 166
168 170
172
175
178
181
184
Staggered Salinity (ppt)
30
40
50
60
70
80
0
200
400
600
800
Depth (m)
159 162
164 166
168
172
175
178
181
184
R
S
T
U

Figure 36(d)

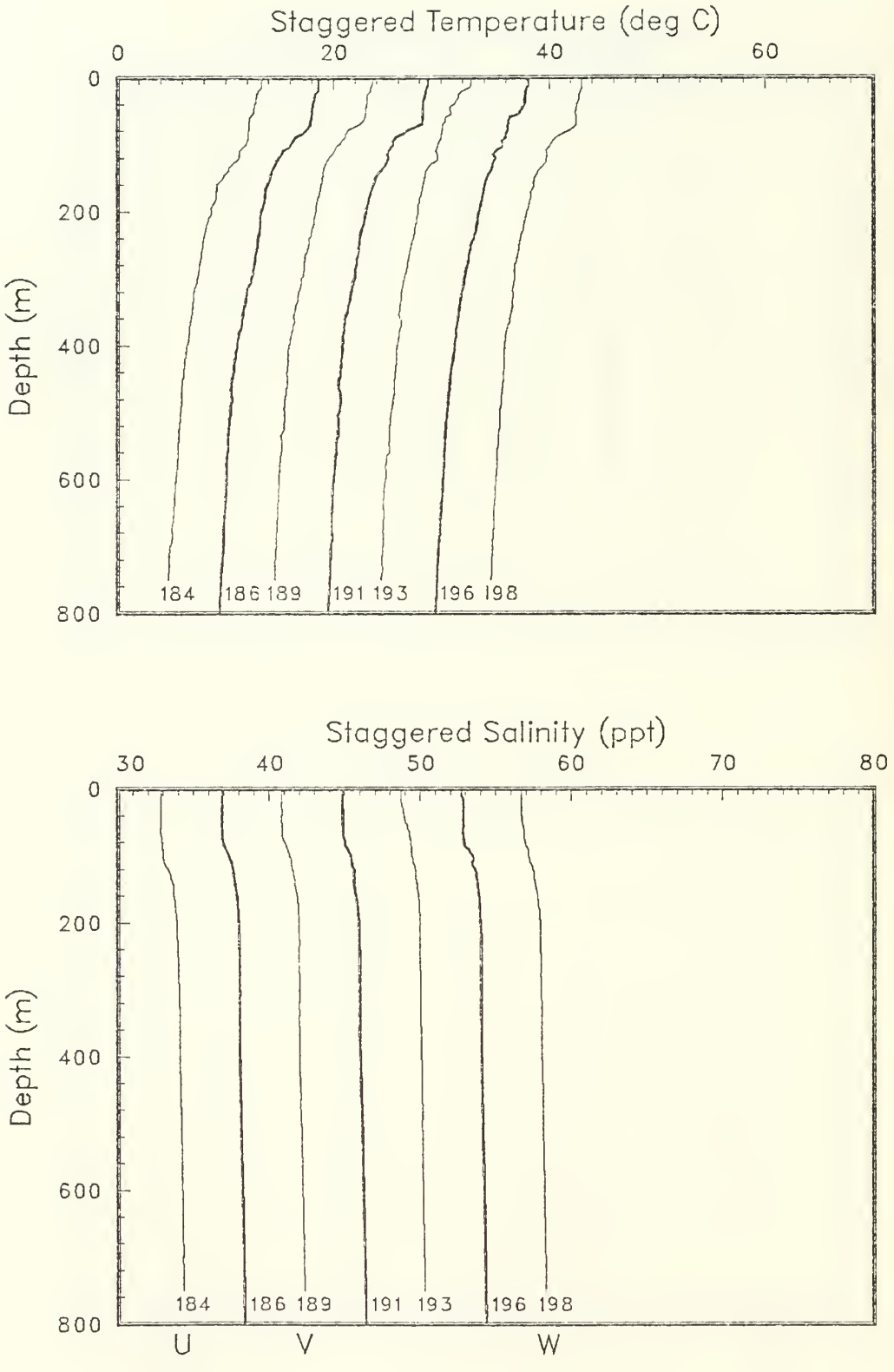

Staggered Temperature (deg C)
0
20
40
60
0
200
400
600
800
Depth (m)
184
186 189
191 193
196 198
Staggered Salinity (ppt)
30
40
50
60
70
80
0
200
400
600
800
Depth (m)
184
186 189
191 193
196 198
U
V
W

Figure 36(e)

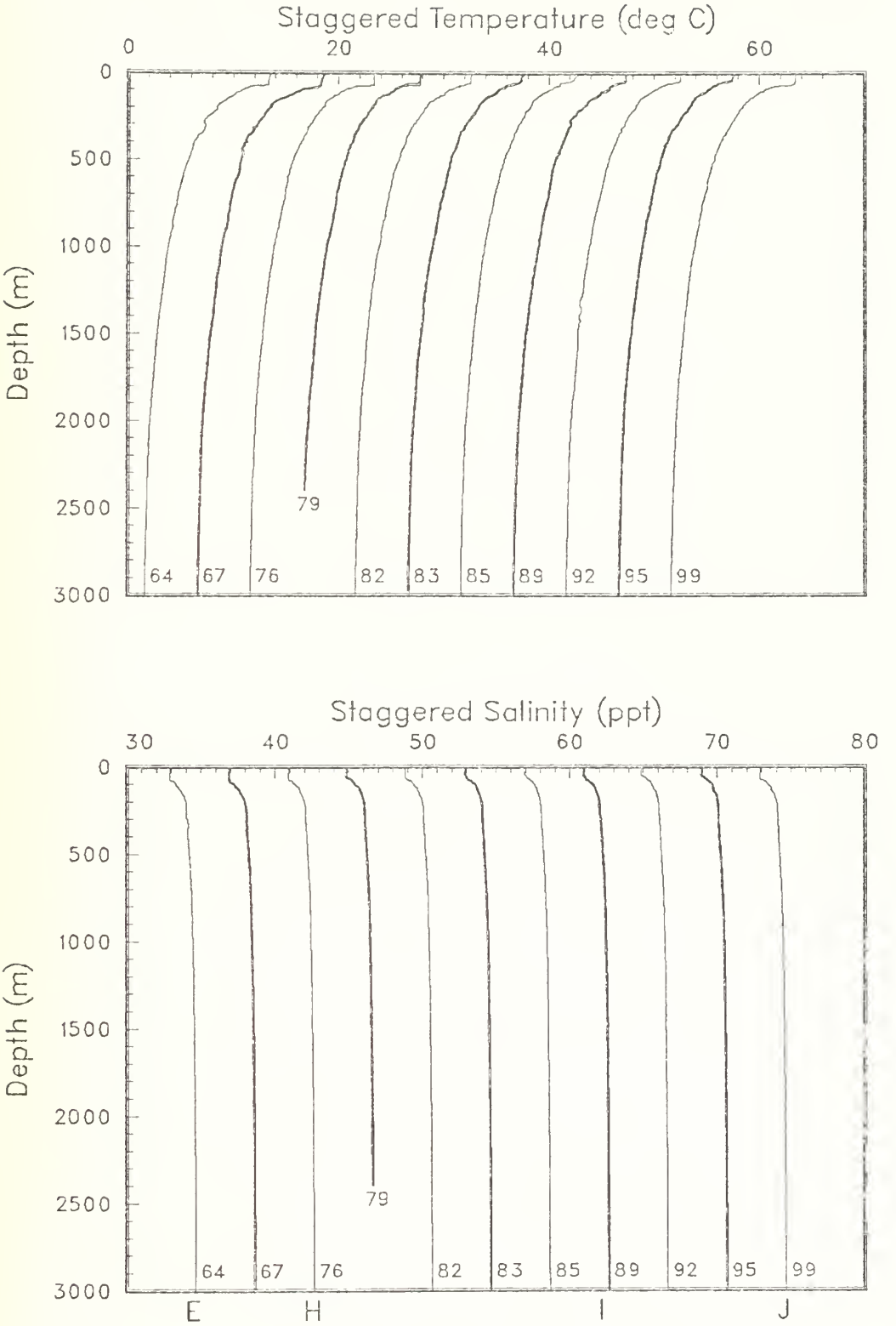


Figure 37(a): As for Fig. 36 but casts to 3000m (OPTOMA20, Leg D).

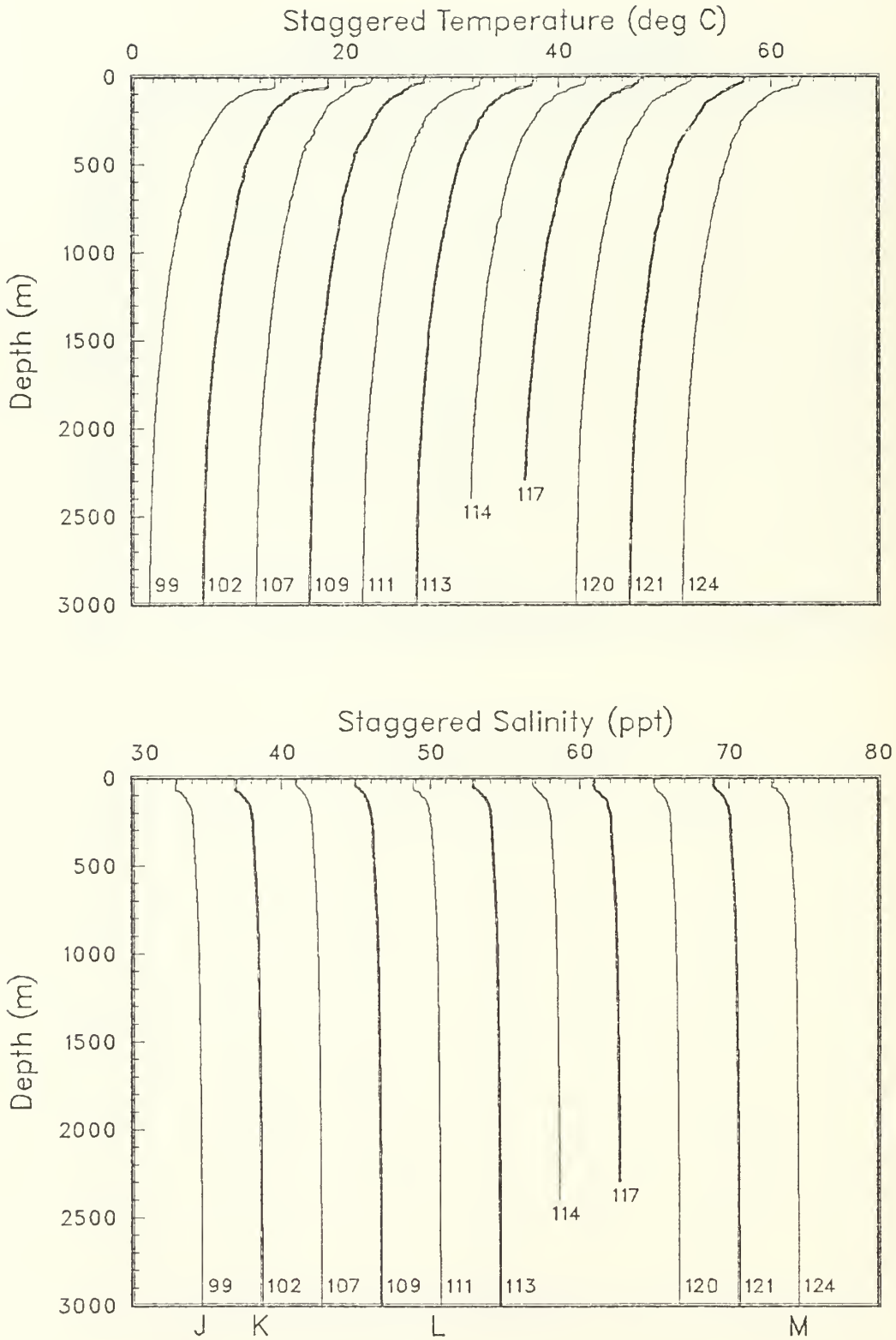

Staggered Temperature (deg C)
0
20
40
60
Depth (m)
0
500
1000
1500
2000
2500
3000
99
102
107
109
111
113
114
117
120
121
124
Staggered Salinity (ppt)
30
40
50
60
70
80
J
K
L
M

Figure 37(b)

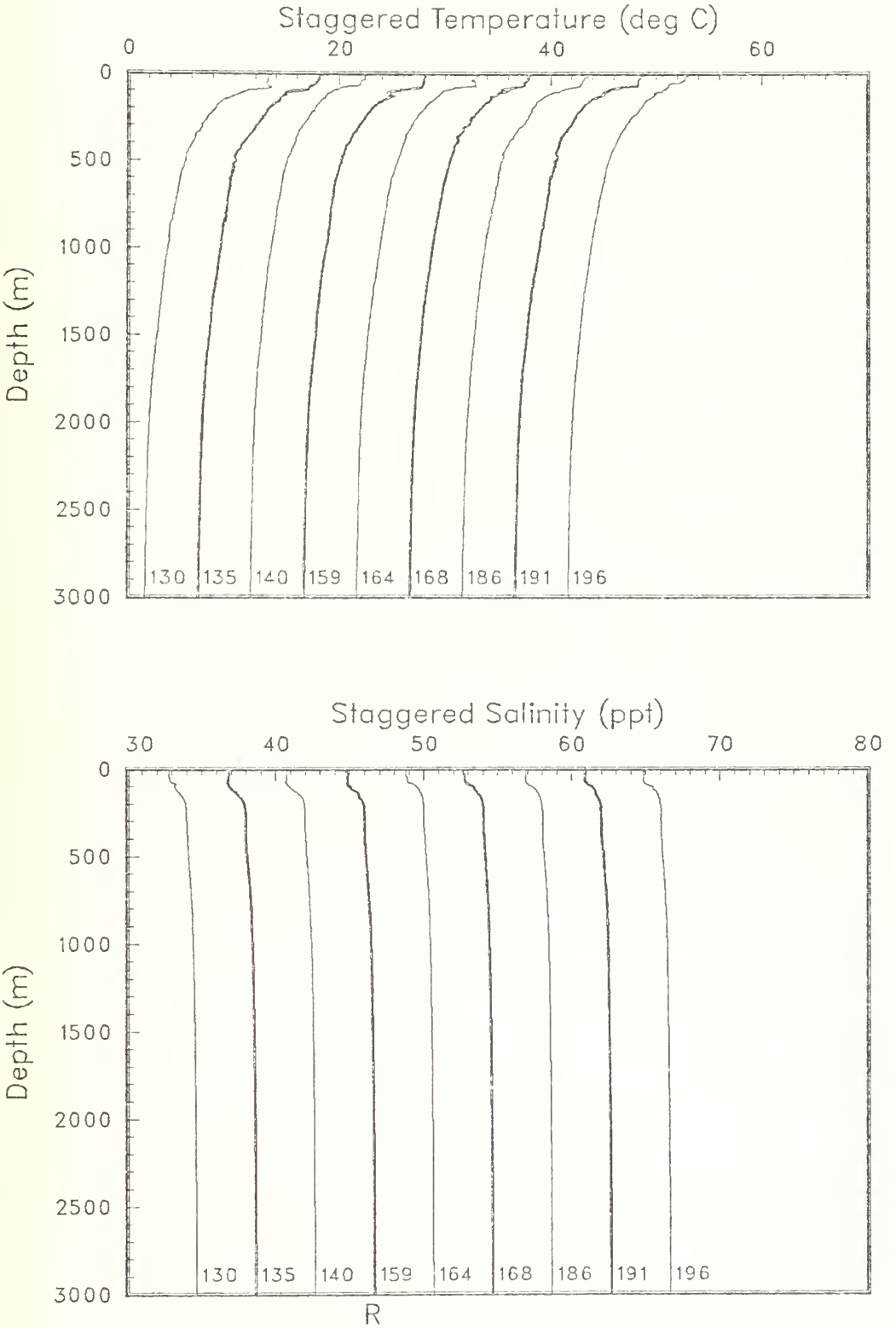
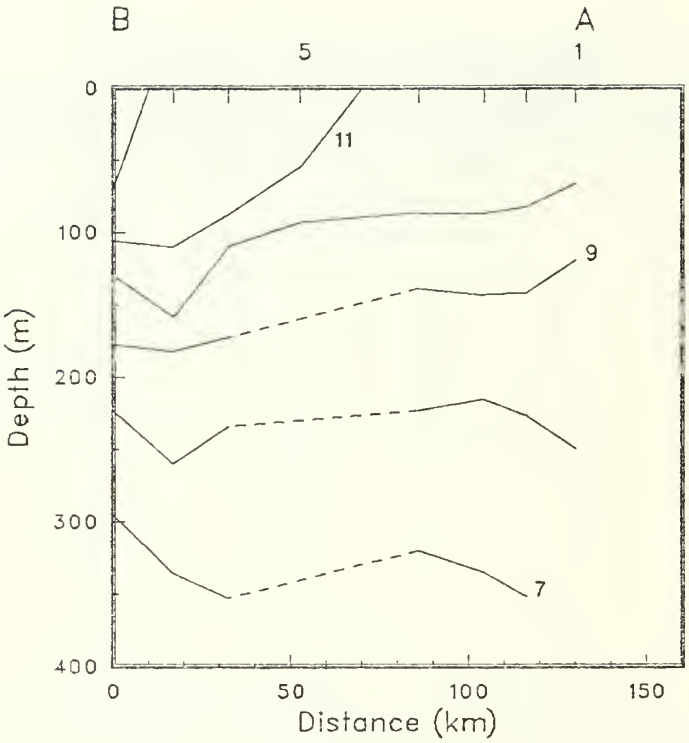

Staggered Temperature (deg C)
0
20
40
60
Depth (m)
0
500
1000
1500
2000
2500
3000
130
135
140
159
164
168
186
191
196
Staggered Salinity (ppt)
30
40
50
60
70
80
Depth (m)
0
500
1000
1500
2000
2500
3000
130
135
140
159
164
168
186
191
196
R

Figure 37(c)



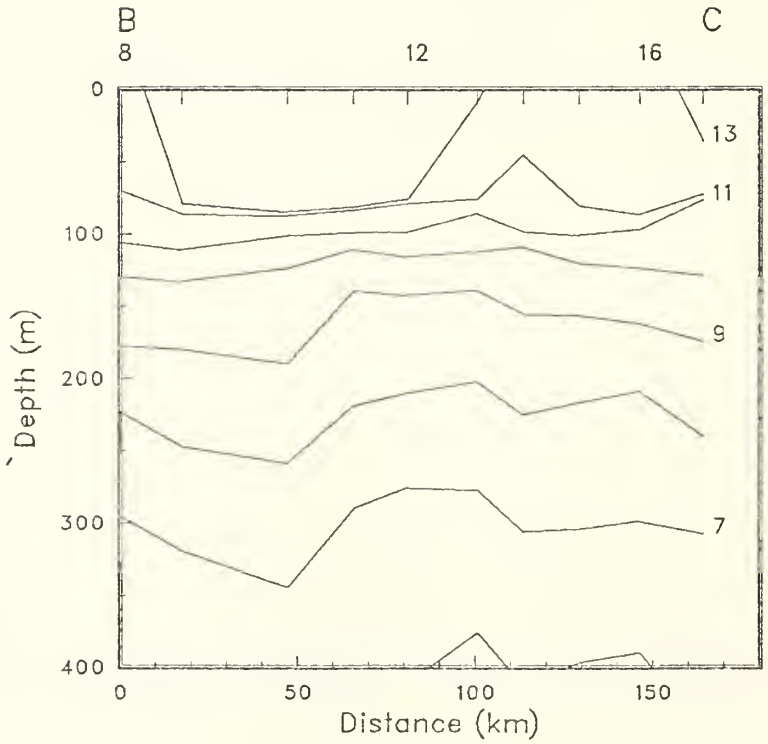


Figure 38(a)-(b): Along-track isotherms. Tick marks along the upper horizontal axis show station positions. Some station numbers are given. Dashed lines are used if the cast was too shallow (OPTOMA20, Leg D).

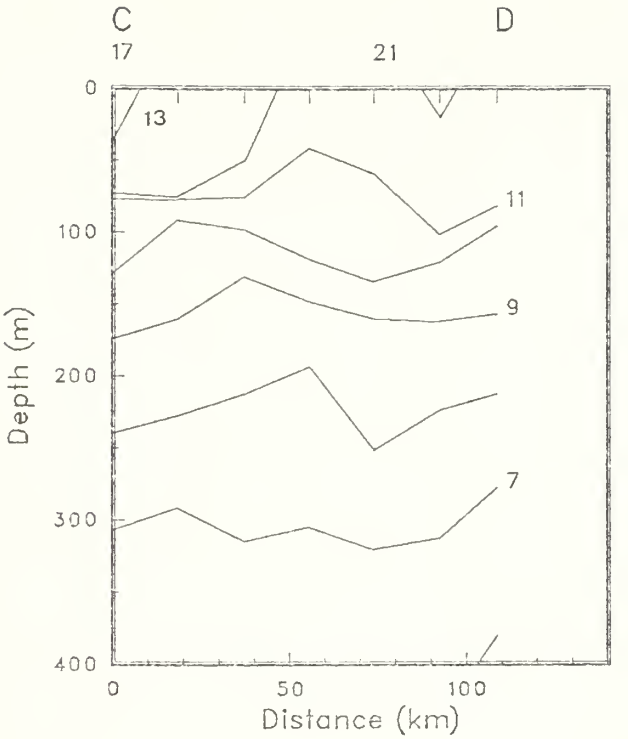


Figure 38(c)

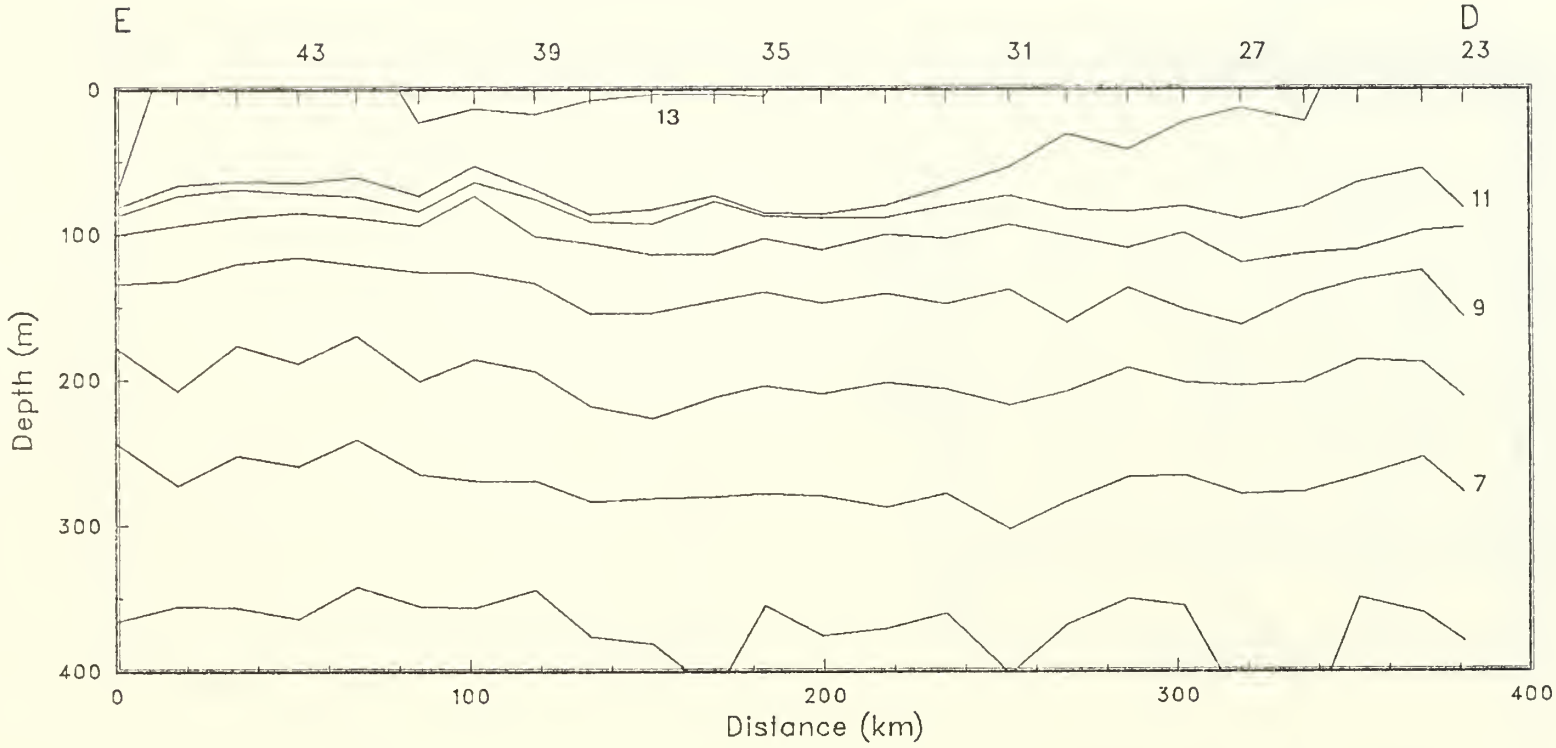

E
D
43
39
35
31
27
23
0
100
200
300
400
13
11
9
7
Depth (m)
0
100
200
300
400
Distance (km)

Figure 38(d)

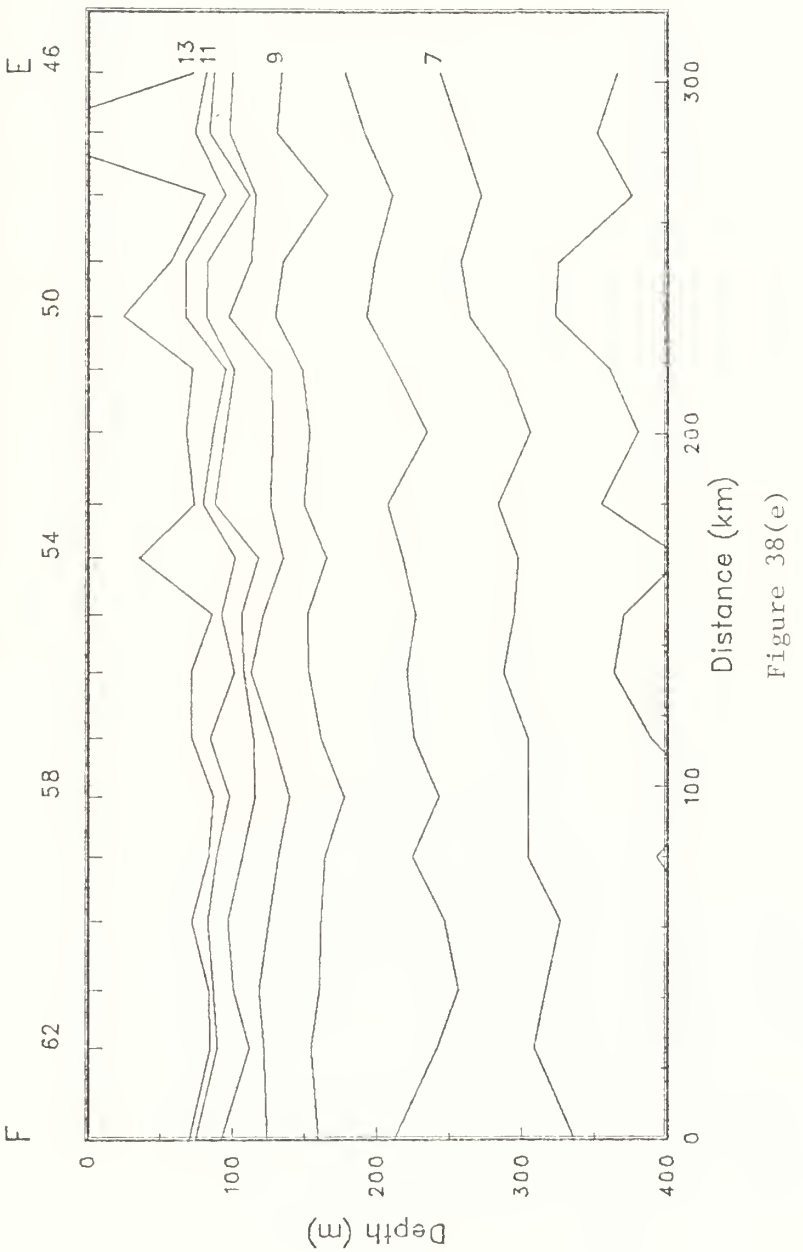

F
62
58
54
50
46
E
13
11
9
7
0
100
200
300
400
Depth (m)
0
100
200
300
Distance (km)

Figure 38(e)

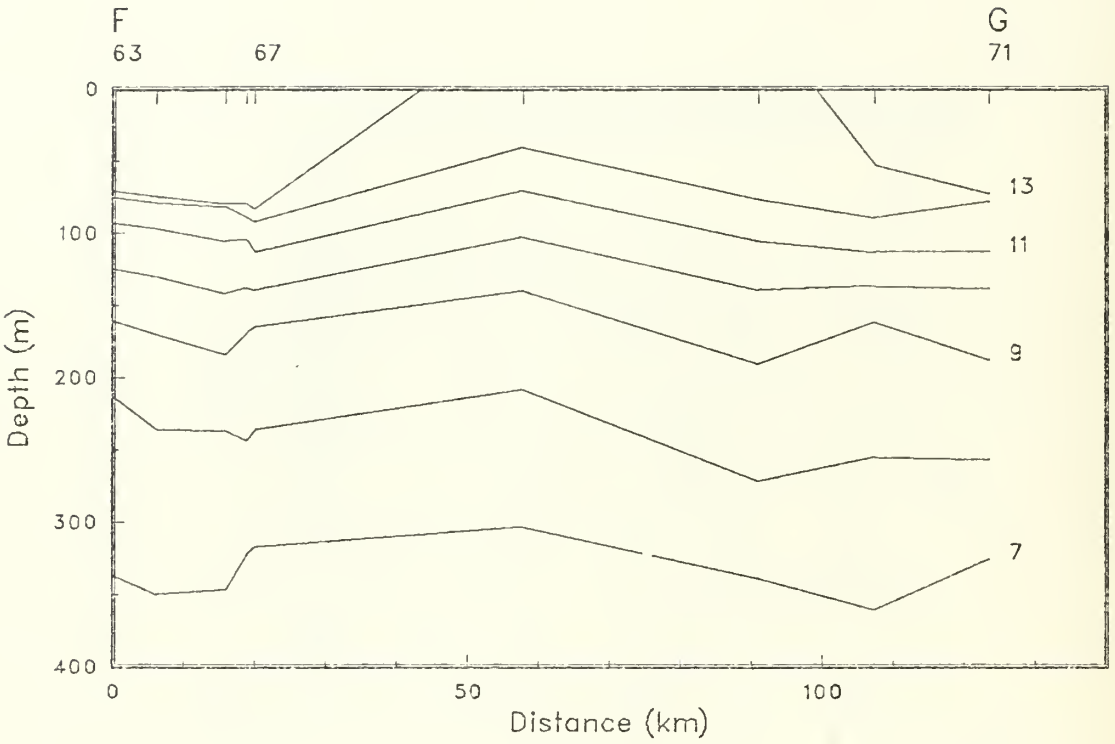


Figure 38(f)

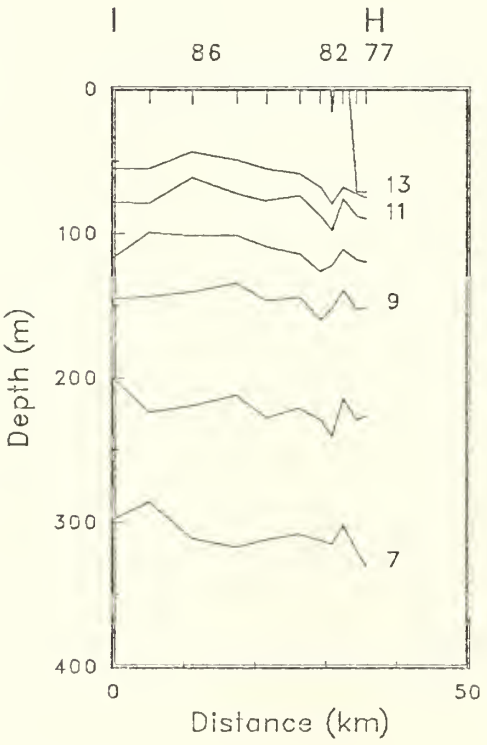


Figure 38(g)

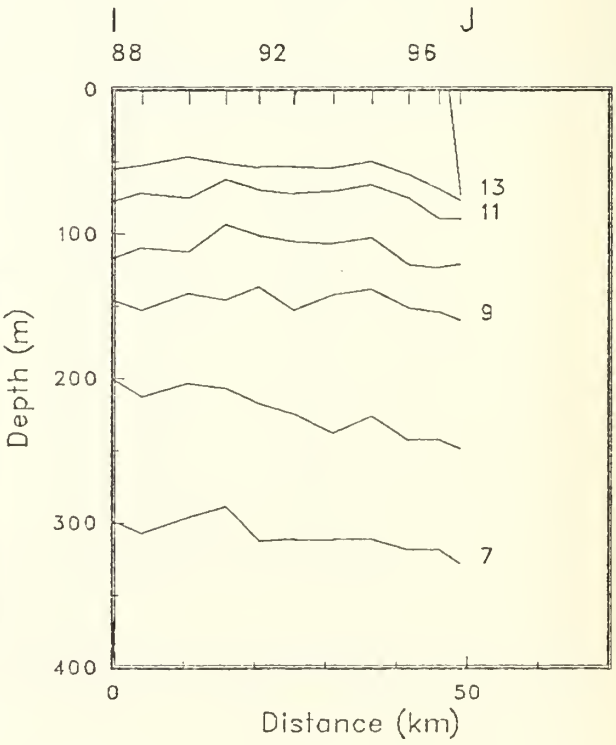


Figure 38(h)

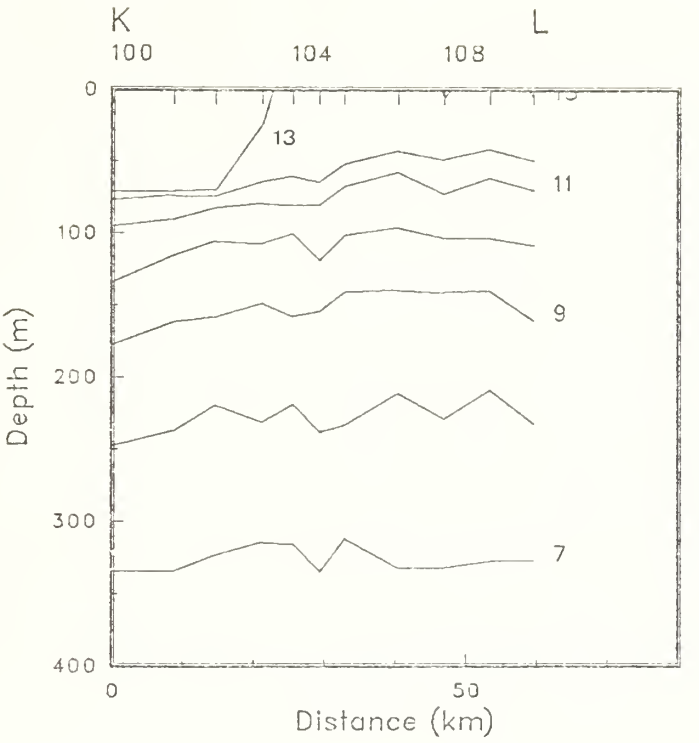


Figure 38(i)

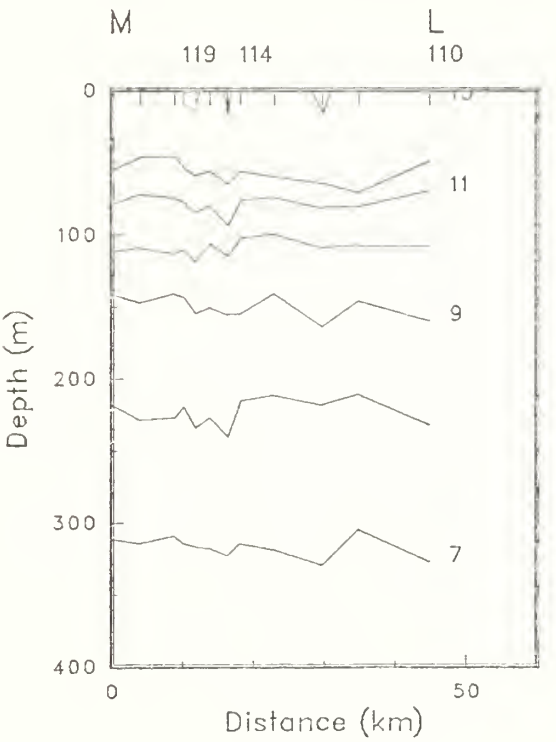


Figure 38(j)

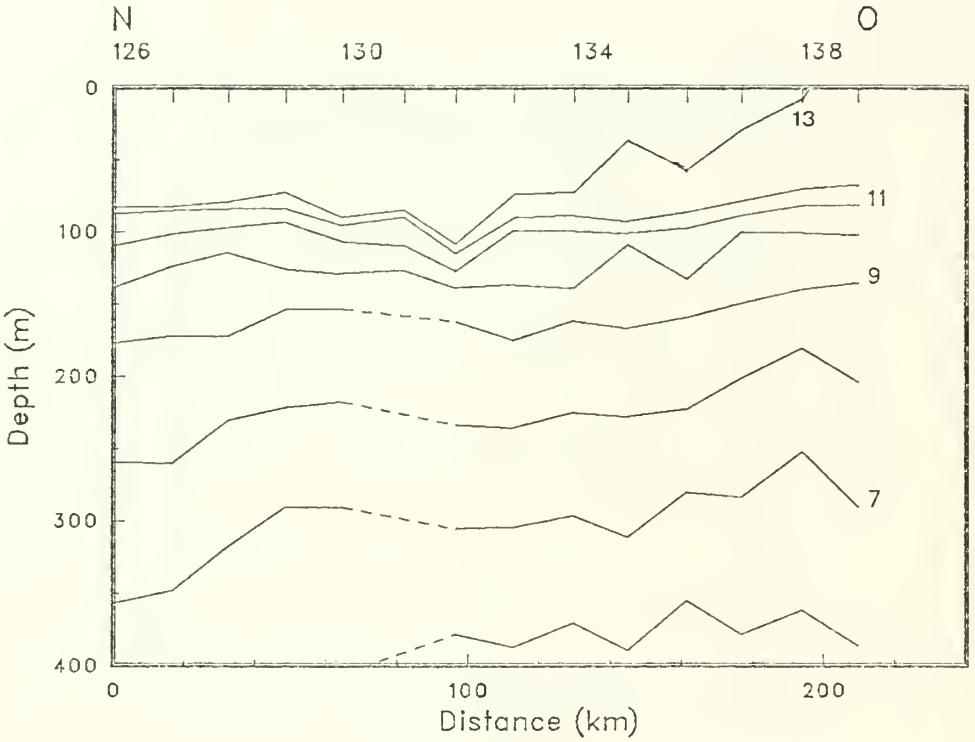


Figure 38(k)

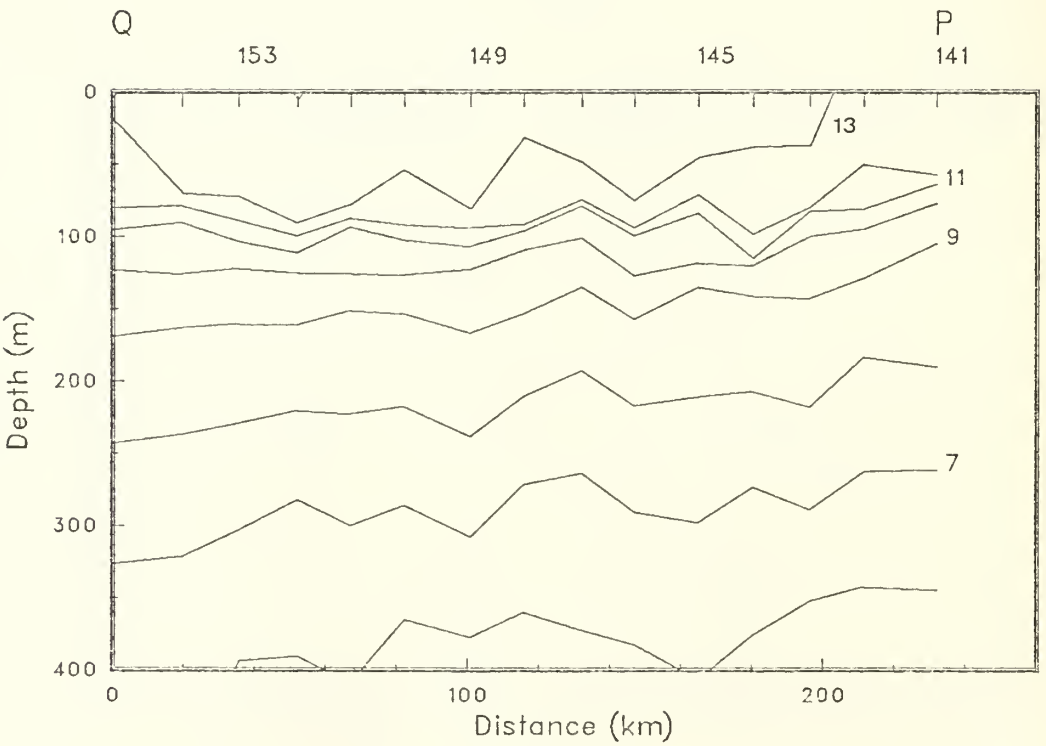


Figure 38(l)

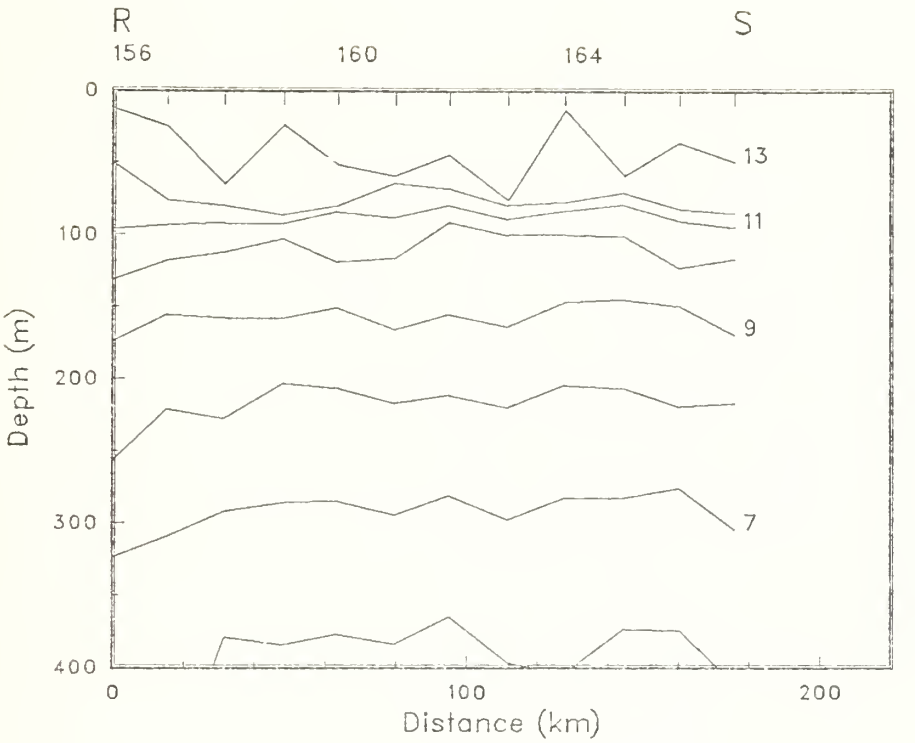


Figure 38(m)

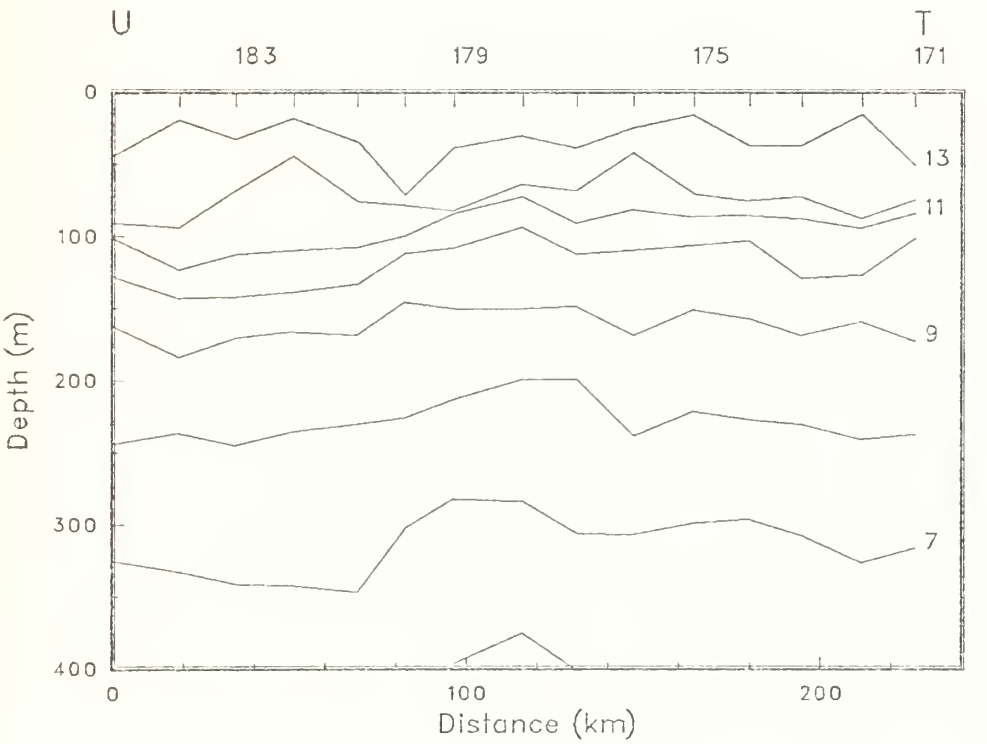


Figure 38(n)

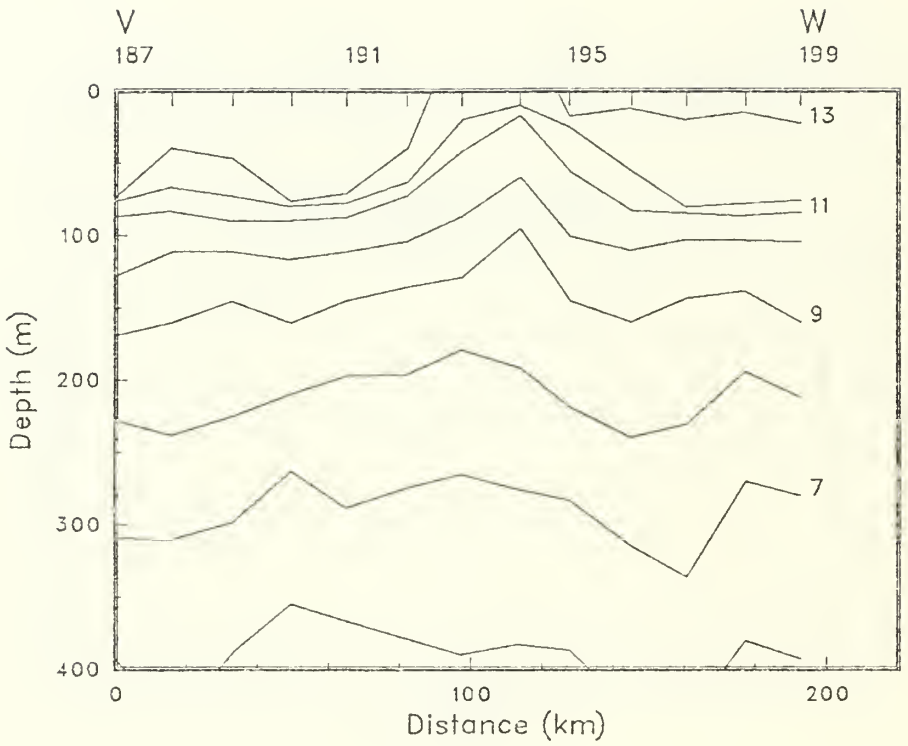


Figure 38(o)

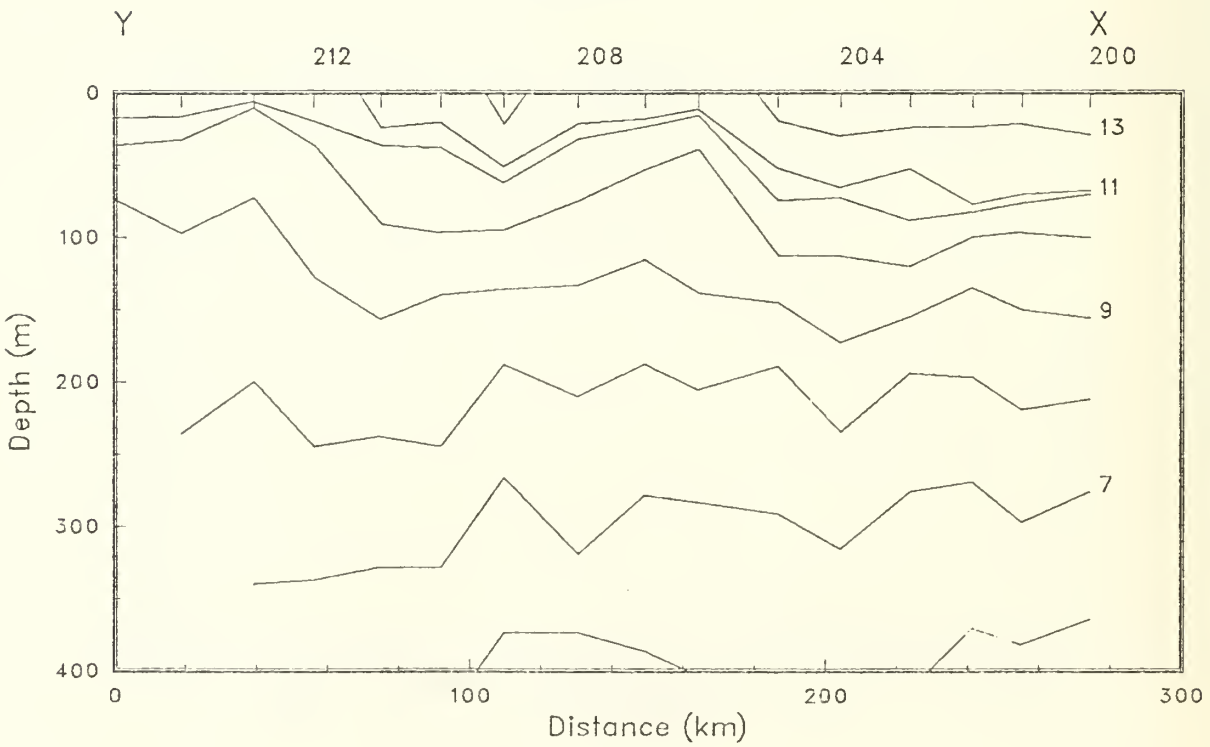


Figure 38(p)

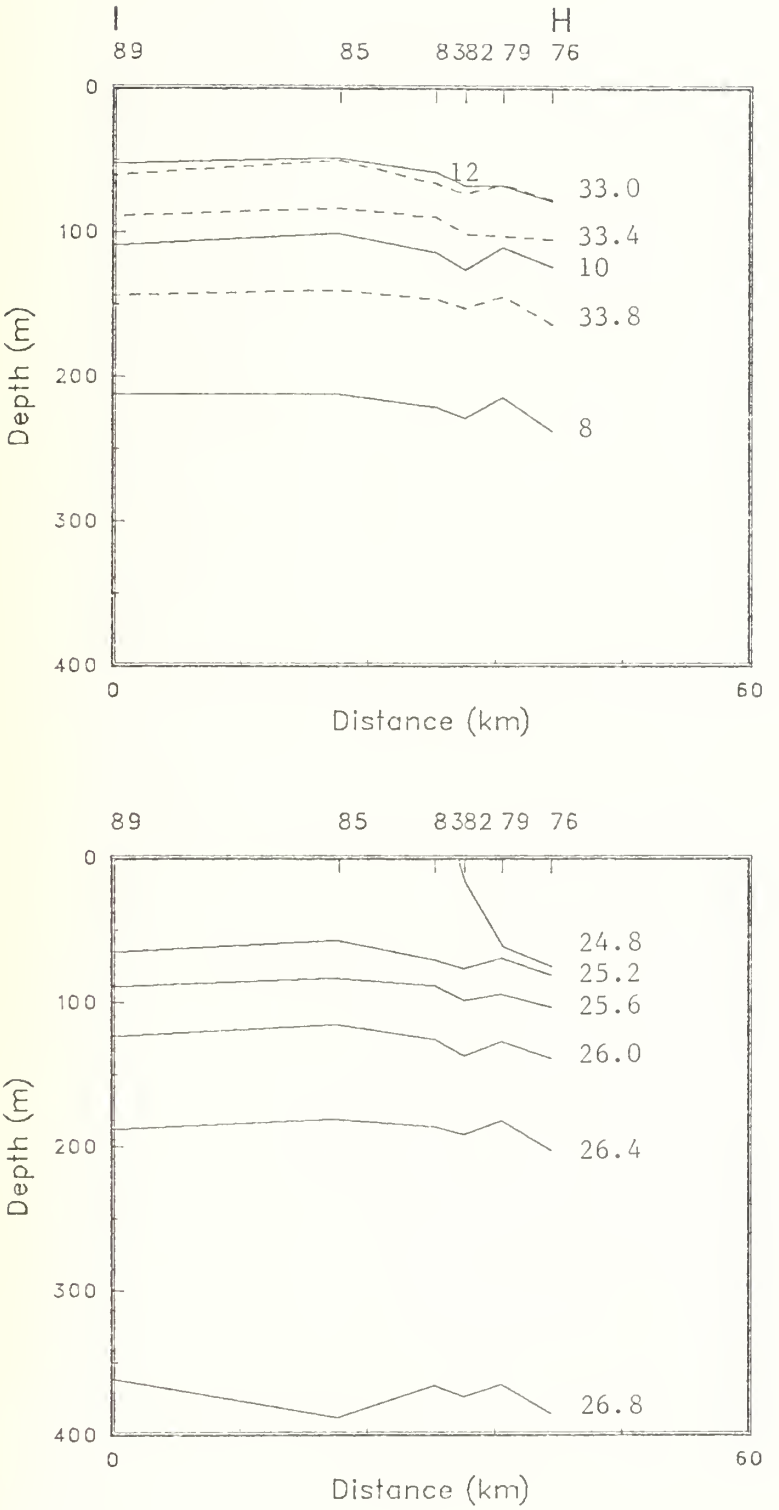
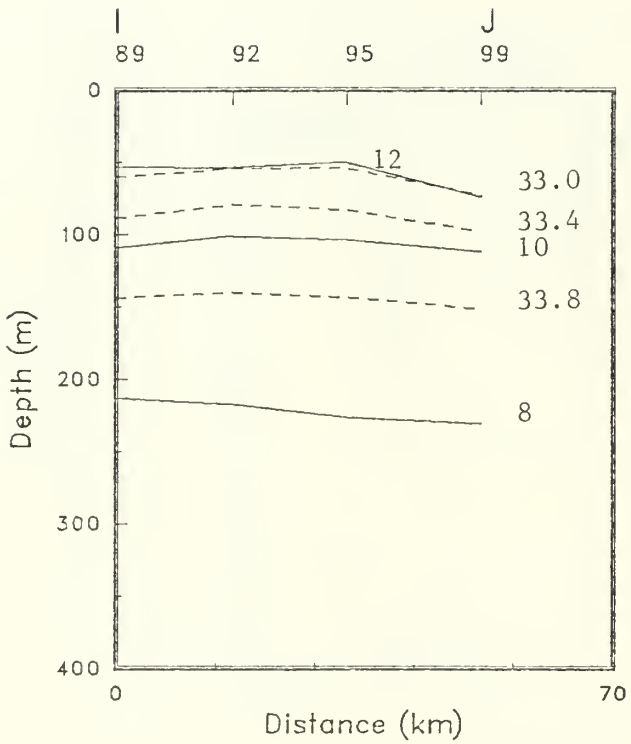


Figure 39(a): Isopleths of (1) temperature and salinity and (2) sigma-t from the CTDs (OPTOMA20, Leg D).


I
J
89
92
95
99
0
100
200
300
400
Depth (m)
12
33.0
33.4
10
33.8
8
0
70
Distance (km)

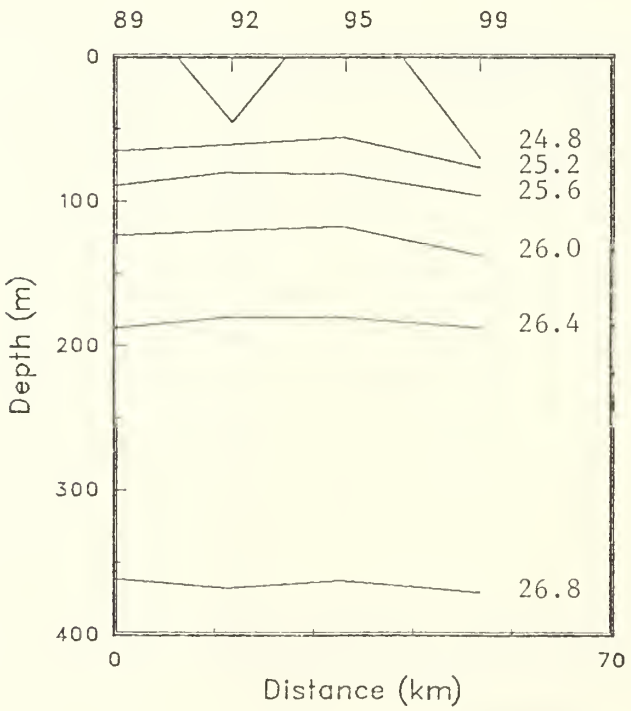

89
92
95
99
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
70
Distance (km)

Figure 39(b)

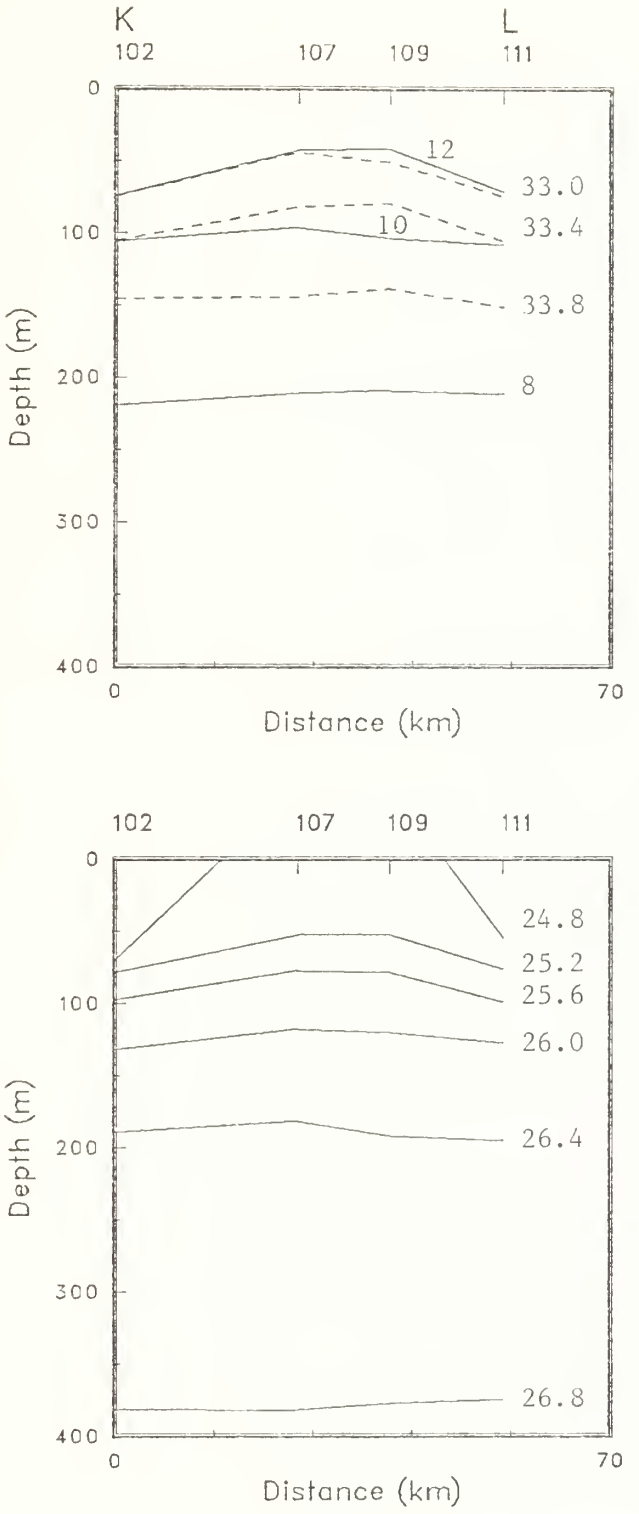
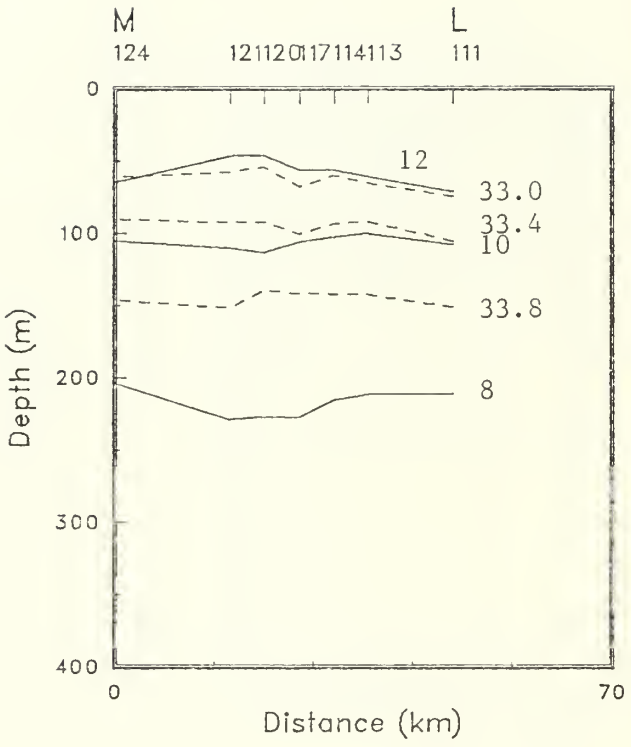

K
L
102
107
109
111
0
100
200
300
400
Depth (m)
12
10
33.0
33.4
33.8
8
0
70
Distance (km)
102
107
109
111
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
70
Distance (km)

Figure 39(c)


M
L
124
121120117114113
111
0
100
200
300
400
Depth (m)
12
33.0
33.4
10
33.8
8
0
70
Distance (km)

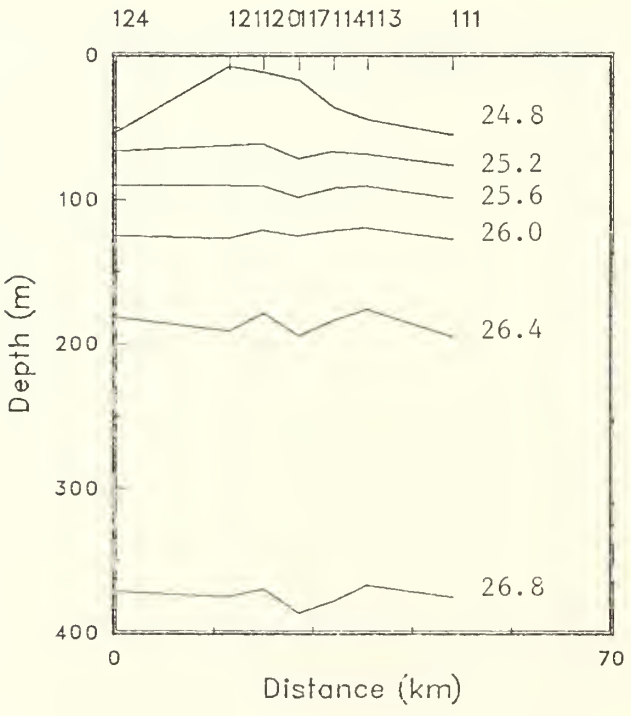
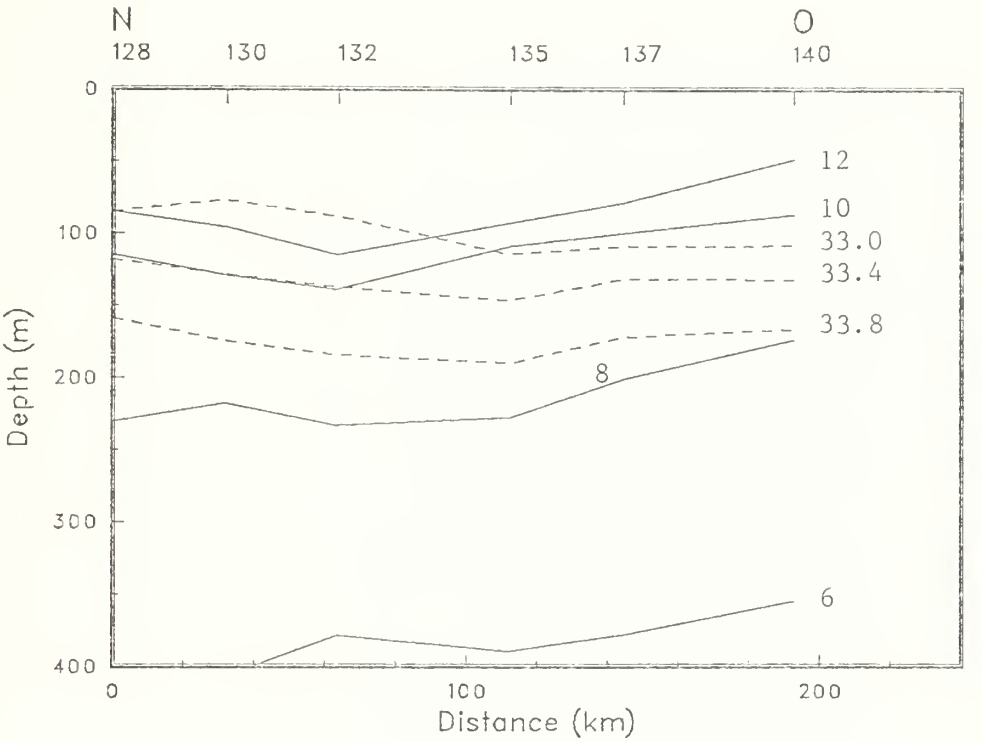

124
121120117114113
111
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
70
Distance (km)

Figure 39(d)


N
O
128
130
132
135
137
140
0
100
200
300
400
Depth (m)
12
10
33.0
33.4
33.8
8
6
0
100
200
Distance (km)

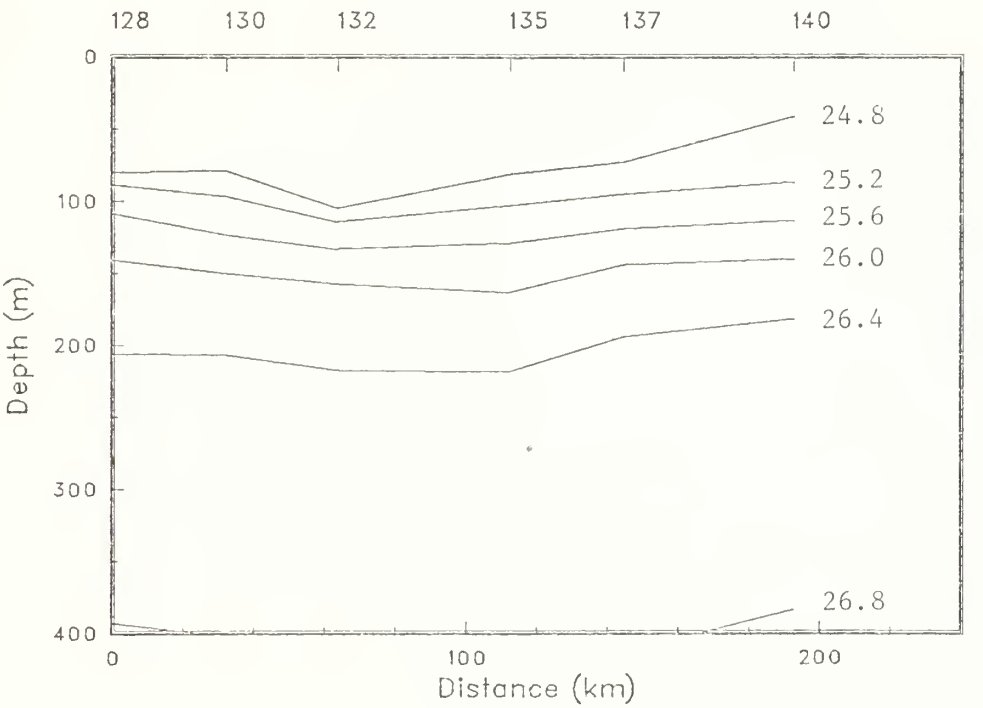
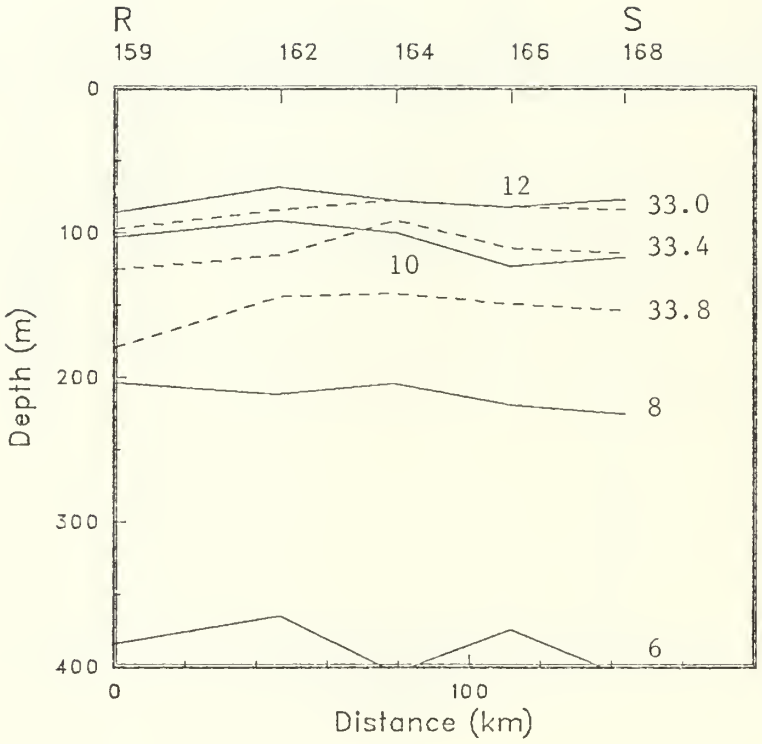

128
130
132
135
137
140
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 39(e)


R
S
159
162
164
166
168
0
100
200
300
400
Depth (m)
12
10
8
6
33.0
33.4
33.8
0
100
Distance (km)

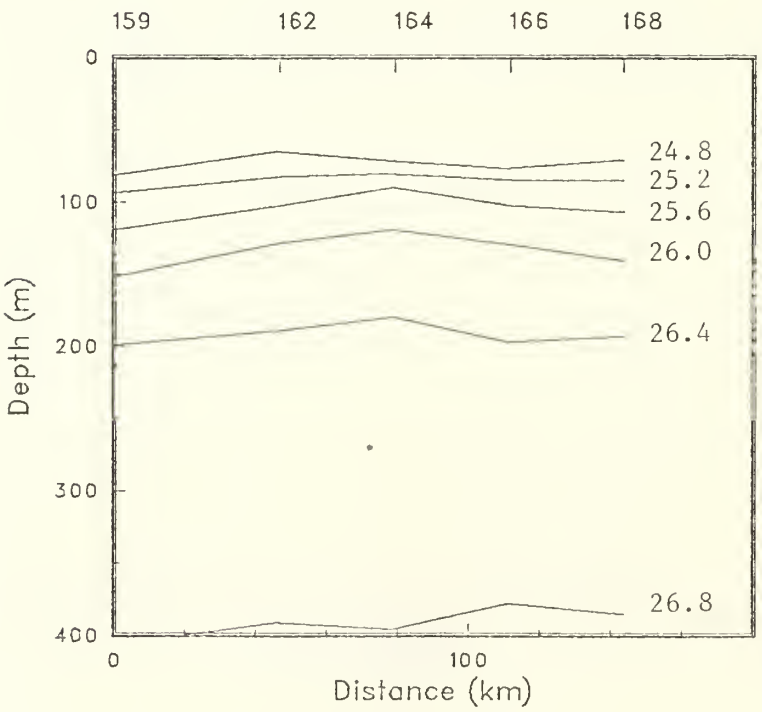

159
162
164
166
168
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
Distance (km)

Figure 39(g)

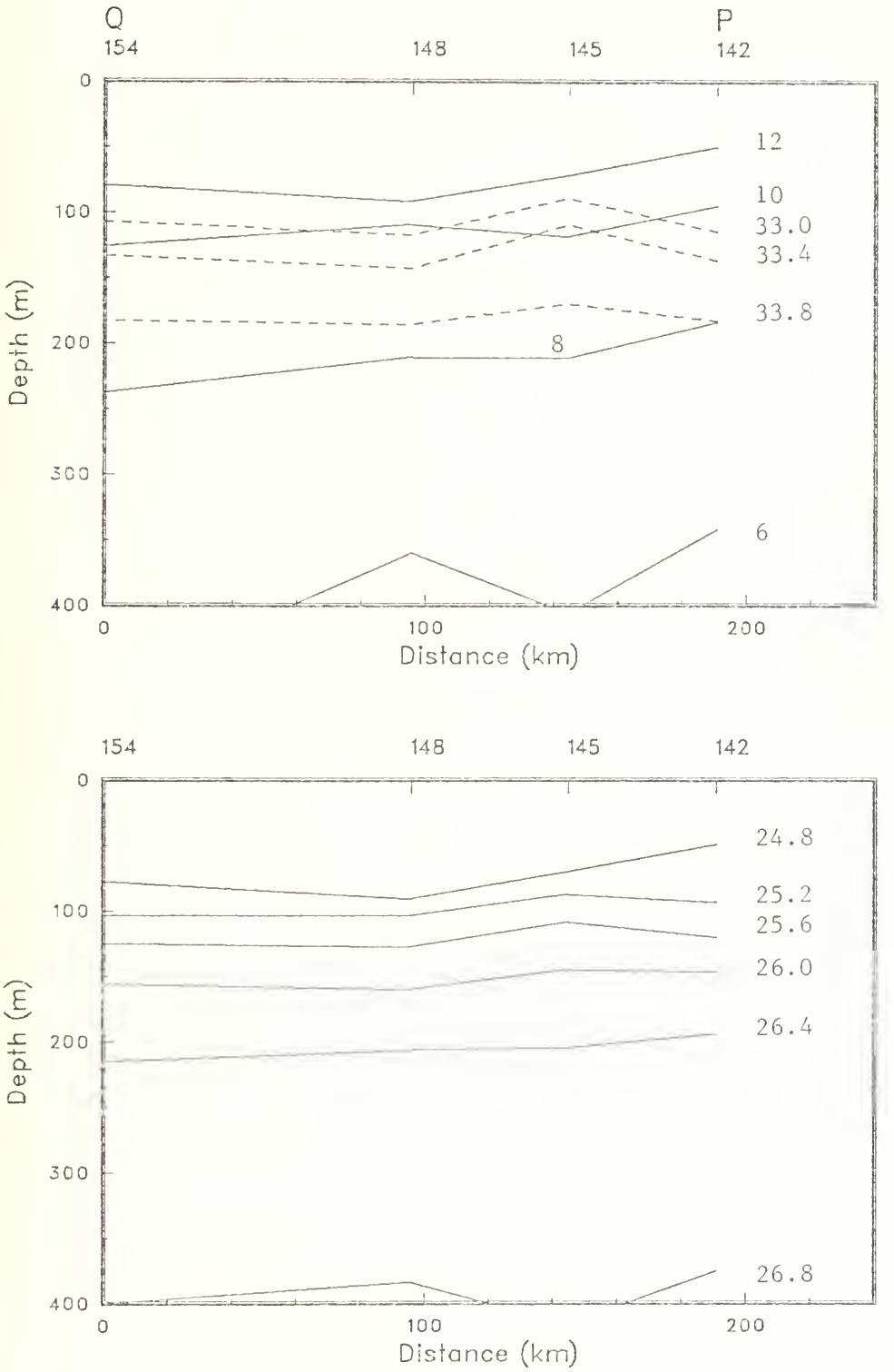
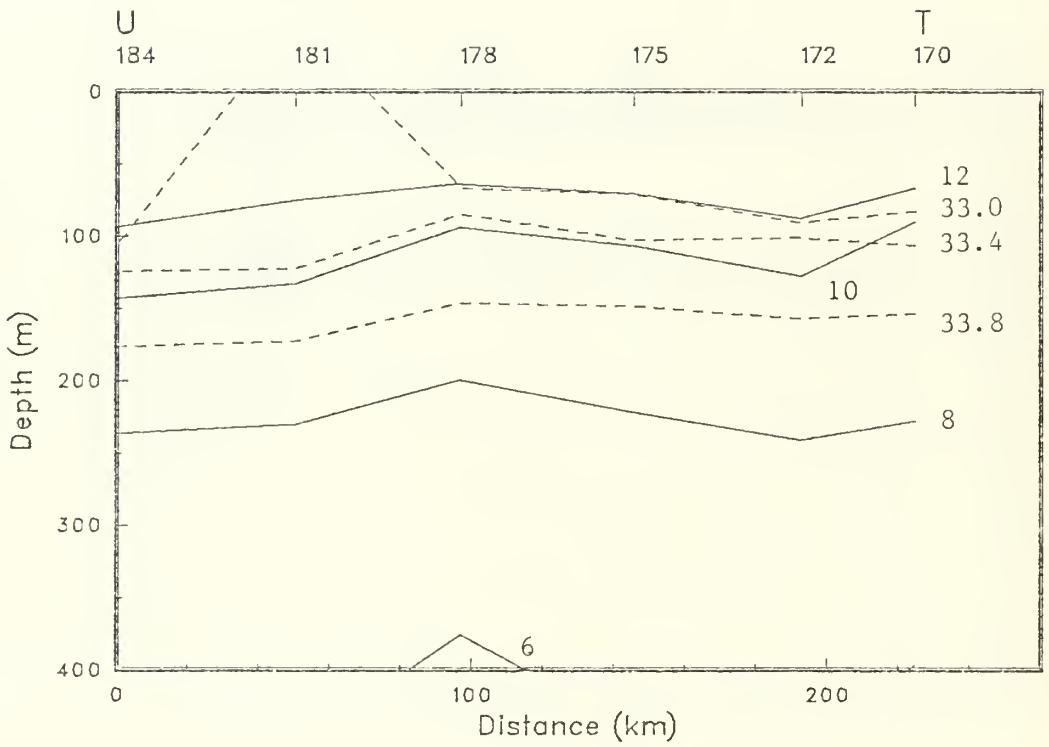

Q
P
154
148
145
142
0
100
200
300
400
Depth (m)
12
10
33.0
33.4
33.8
8
6
0
100
200
Distance (km)
154
148
145
142
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 39(f)


U
T
184
181
178
175
172
170
0
100
200
300
400
Depth (m)
12
33.0
33.4
10
33.8
8
6
0
100
200
Distance (km)

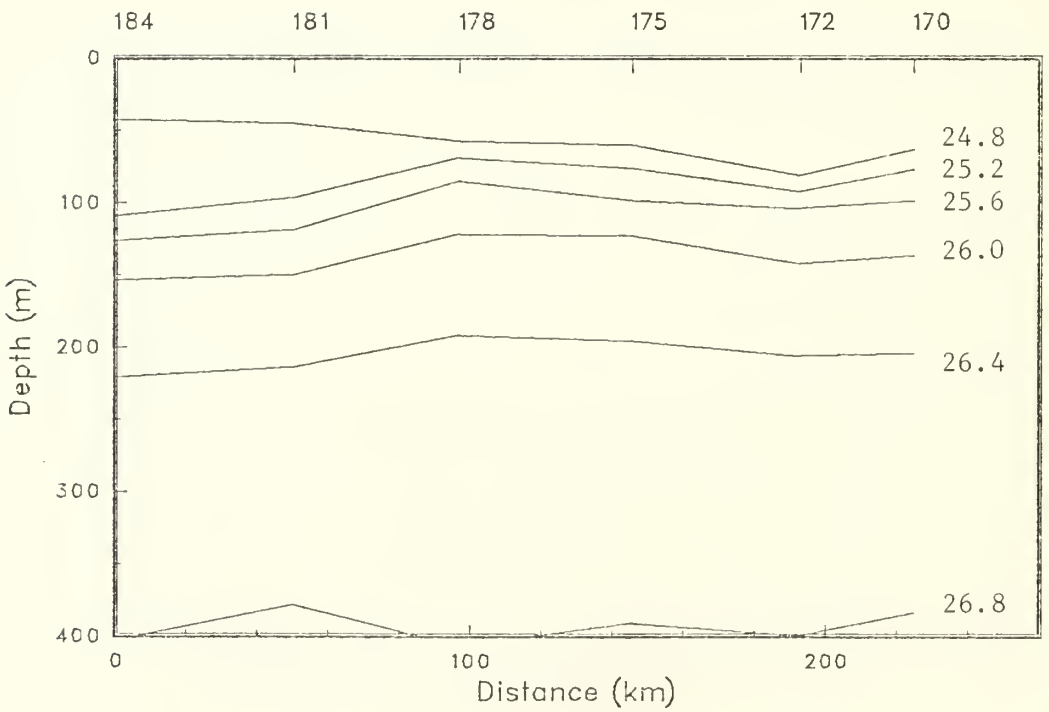

184
181
178
175
172
170
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 39(h)

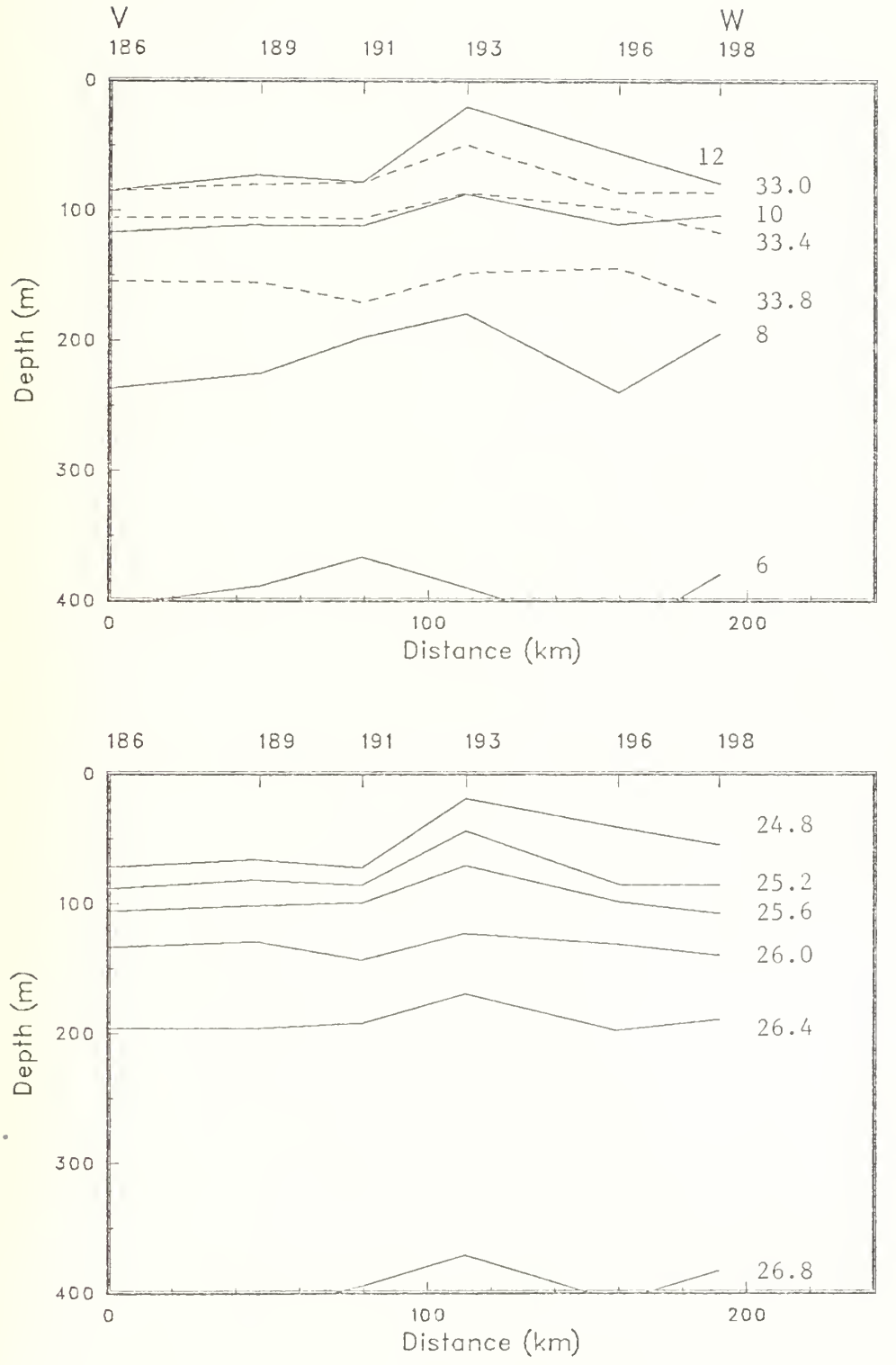

V
W
186
189
191
193
196
198
0
100
200
300
400
Depth (m)
12
33.0
10
33.4
33.8
8
6
0
100
200
Distance (km)
186
189
191
193
196
198
0
100
200
300
400
Depth (m)
24.8
25.2
25.6
26.0
26.4
26.8
0
100
200
Distance (km)

Figure 39(i)

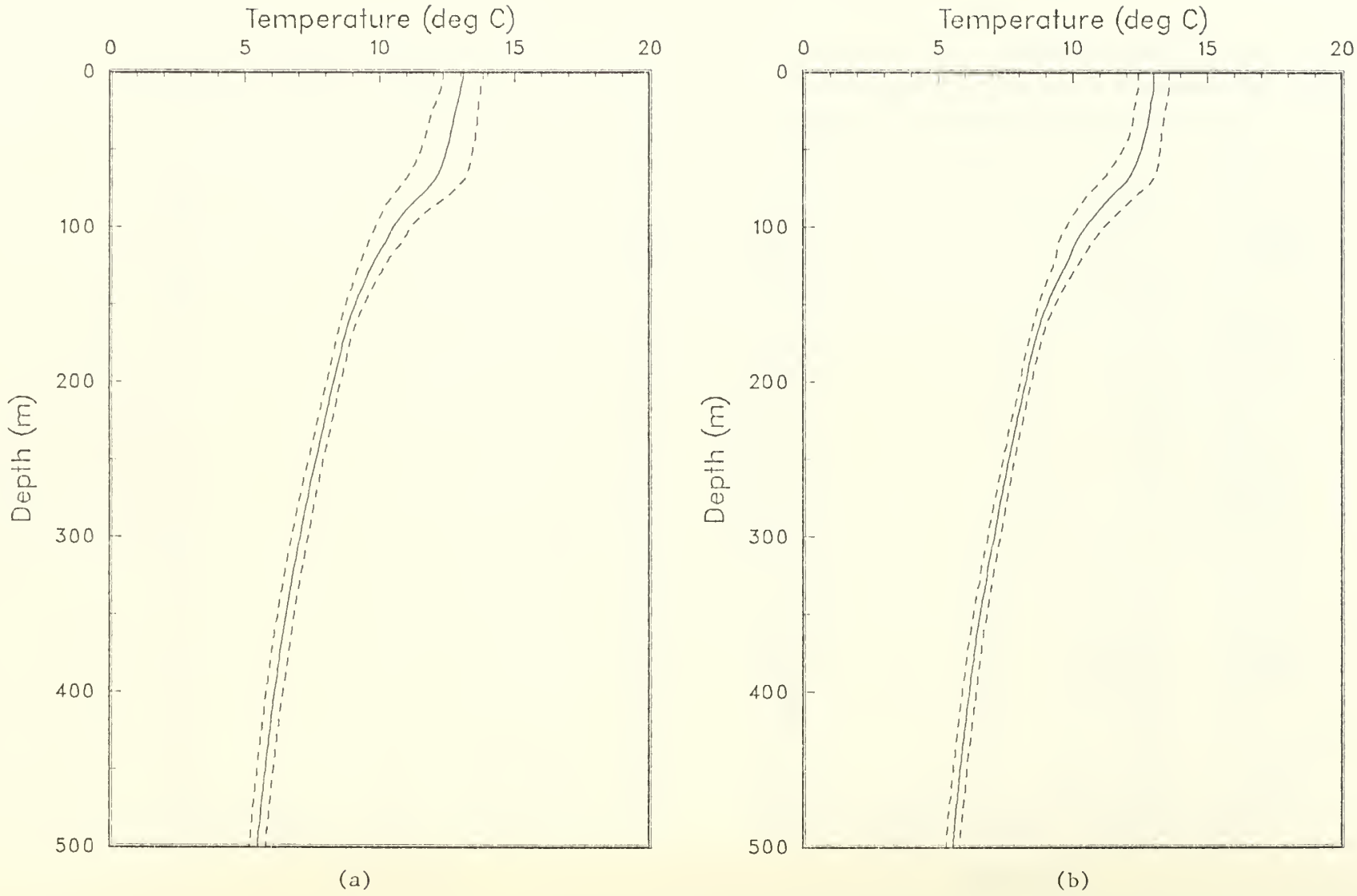


Figure 40: Mean temperature profiles from (a) XBTs and (b) CTDs with + and - the standard deviation (OPTOMA20, Leg D).

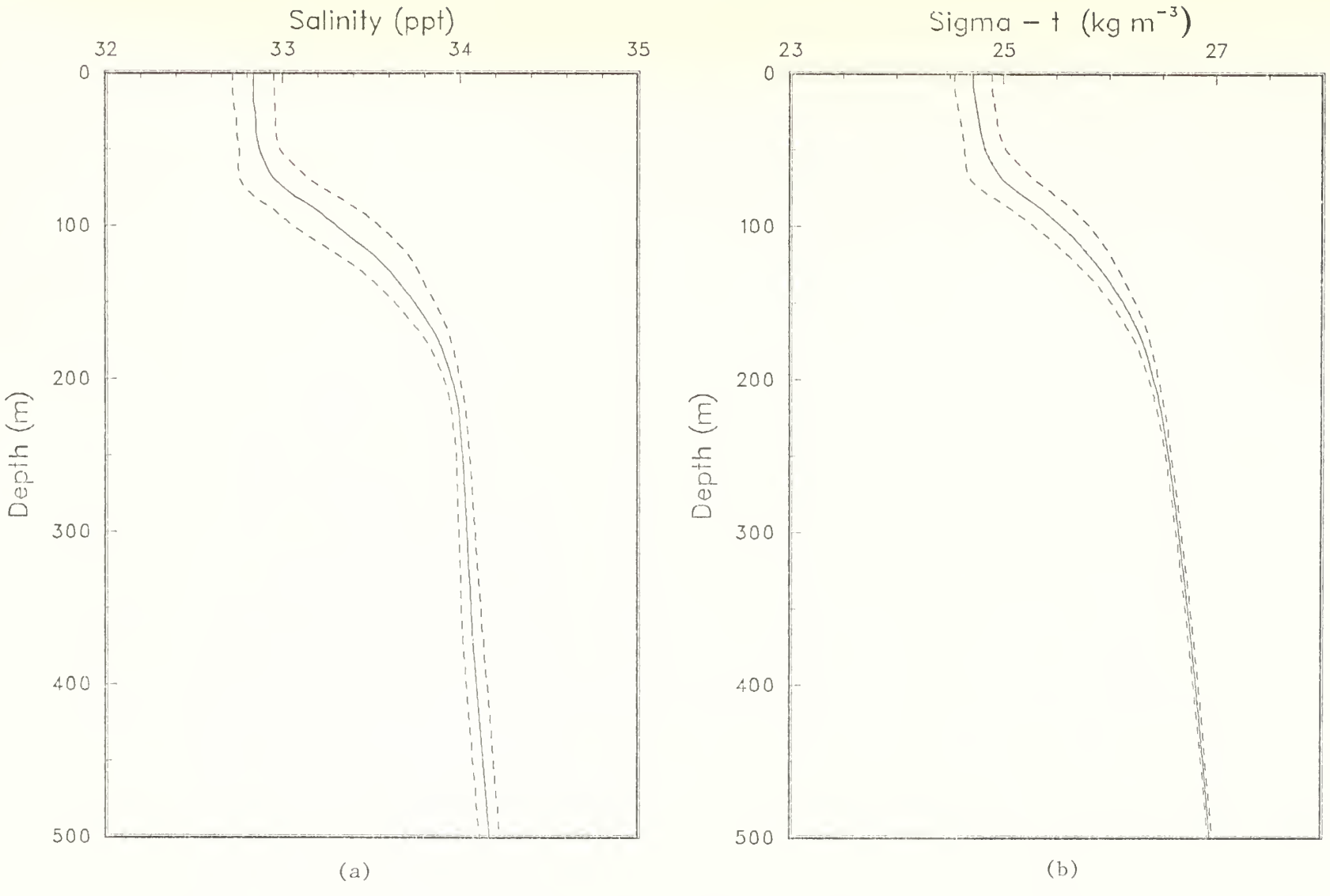


Figure 41: Mean profiles of (a) salinity and (b) sigma-t, with + and - the standard deviations, from the CTDs (OPTOMA20, Leg D).

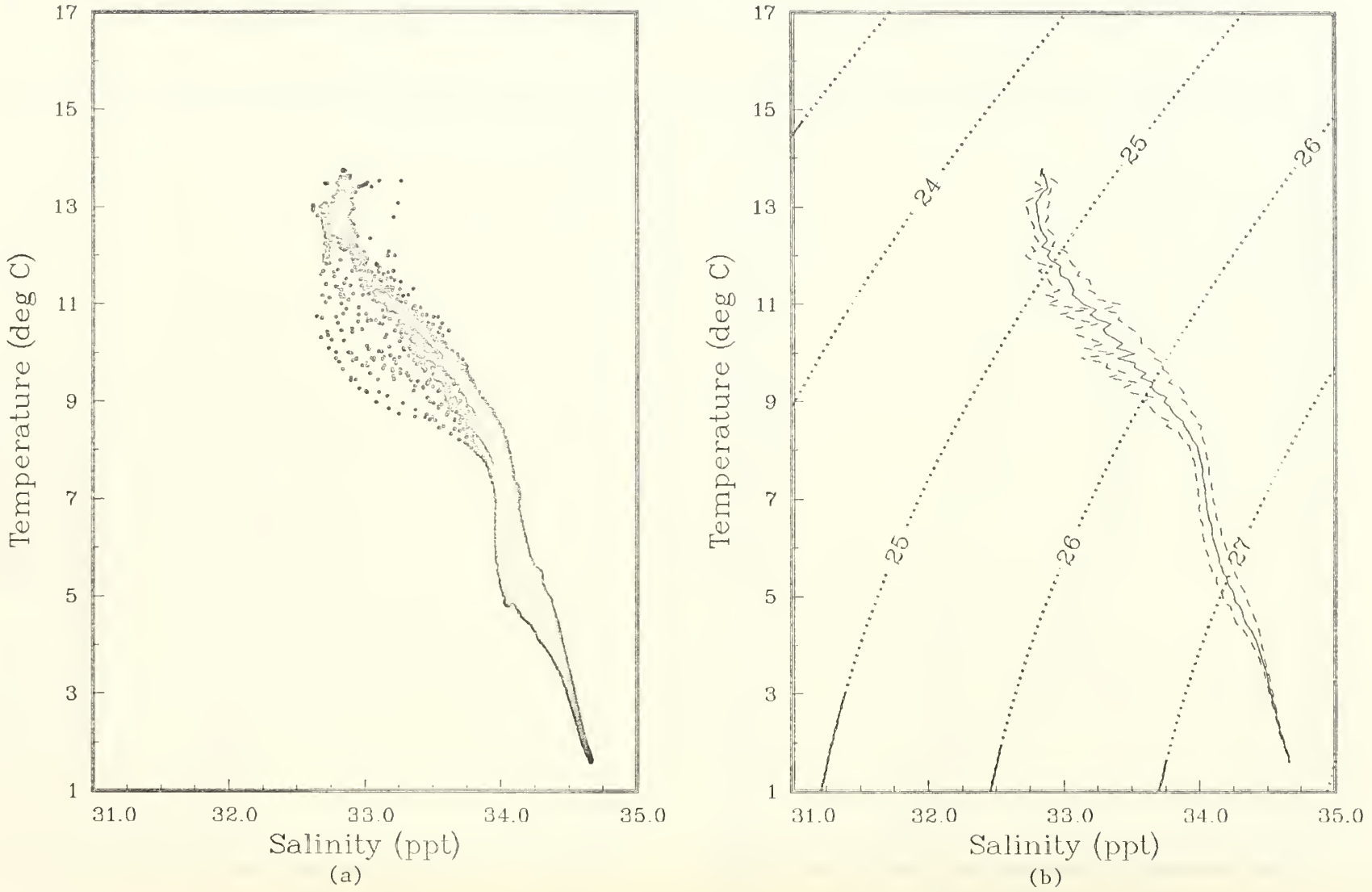


Figure 42: (a) T-S pairs and (b) mean T-S relation, with + and - the standard deviation, from the CTDs. Selected sigma-t contours are also shown (OPTOMA20, Leg D).

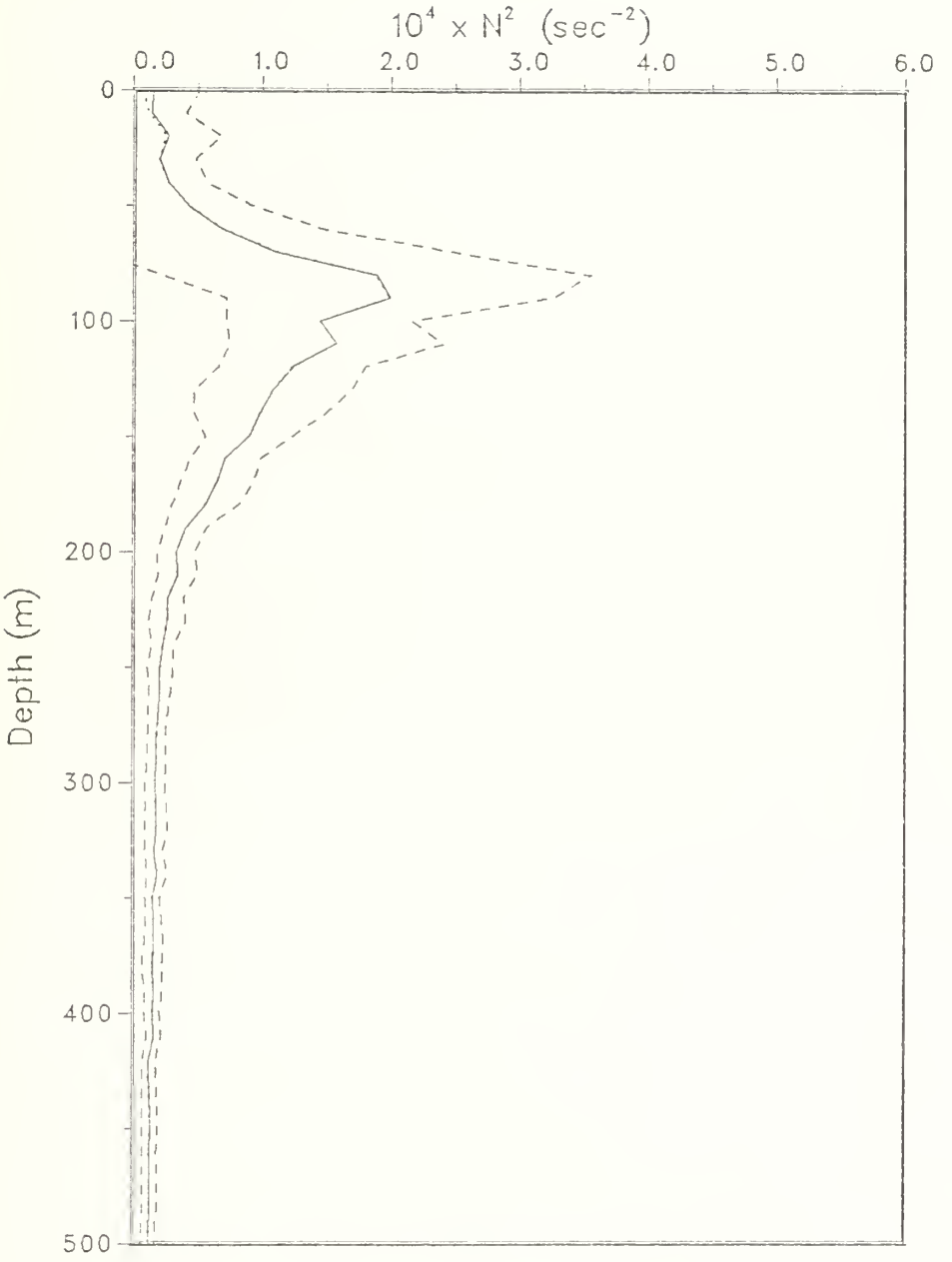


Figure 43: Mean N^2 profile (——), with + and - the standard deviation (----). The N^2 profile from $\overline{T(z)}$ and $\overline{S(z)}$ is also shown (····) (OPTOMA20, Leg D).

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