1985-03

Hydrographic data from the OPTOMA Program: OPTOMA12, 8-18 October 1984, OPTOMA13, 22 October-3 November 1984, OPTOMA13P, 27 October 1984, OPTOMA14, 3-14

NPS-68-85-012

NAVAL POSTGRADUATE SCHOOL

Monterey, California

HYDROGRAPHIC DATA FROM THE OPTOMA PROGRAM

OPTOMA12 8 - 18 October 1984
OPTOMA13 22 October - 3 November 1984
OPTOMA14 3 - 14 November 1984
OPTOMA13P 27 October 1984

by

Paul A. Wittmann
Edward A. Kelley, Jr.
Christopher N.K. Mooers

March 1985

Approved for public release; distribution unlimited.

epared for:
fice of Naval Research
vironmental Sciences Directorate (Code 420)
lington, VA 22217

NAVAL POSTGRADUATE SCHOOL

Monterey, California 93943

Commodore R.H. Shumaker
Superintendent

David A. Schrady
Provost

This report is for the research project "Ocean Prediction Through Observations, Modeling and Analysis" sponsored by the Physical Oceanography Program of the Office of Naval Research under Program Element 61153N.

This report was Prepared by:

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
NPS 68-85-012

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
HYDROGRAPHIC DATA FROM THE OPTOMA PROGRAM OPTOMA12, OPTOMA13, OPTOMA14 AND OPTOMA13P.

5. TYPE OF REPORT & PERIOD COVERED
REPORT FOR OCTOBER 1982 TO MARCH 1985

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
PAUL A. WITTMANN, EDWARD A. KELLEY, JR
CHRISTOPHER N.K. MOOERS

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CA 93943

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
61153N
N0001484NR24501

11. CONTROLLING OFFICE NAME AND ADDRESS
OFFICE OF NAVAL RESEARCH (CODE 420)
ARLINGTON, VA 22217

12. REPORT DATE
MARCH 1985

13. NUMBER OF PAGES
106

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
CALIFORNIA CURRENT SYSTEM
PHYSICAL OCEANOGRAPHY
DYNAMIC OCEANOGRAPHY

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The three cruises, OPTOMA12, OPTOMA13, and OPTOMA14, and one AXBT flight, OPTOMA13P, were under taken in October and November, 1984. This report presents the hydrographic data, acquired by XBT, AXBT and CTD casts, from the cruises and the flight.

Hydrographic Data from the **OPTOMA** *Program:*

OPTOMA12 *8 – 18 October, 1984*
OPTOMA13 *22 October – 3 November, 1984*
OPTOMA13P *27 October, 1984*
OPTOMA14 *3 – 14 November, 1984*

by

Paul A. Wittmann
Edward A. Kelley, Jr.
Christopher N. K. Mooers

Chief Scientists:
C. N. K. Mooers, E. A. Kelley, Jr.
A. A. Bird, M. C. Colton

The **OPTOMA** Program is a joint program of

Department of Oceanography
Naval Postgraduate School
Monterey, CA 93943.

Center for Earth and Planetary Physics
Harvard University
Cambridge, MA 02138.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

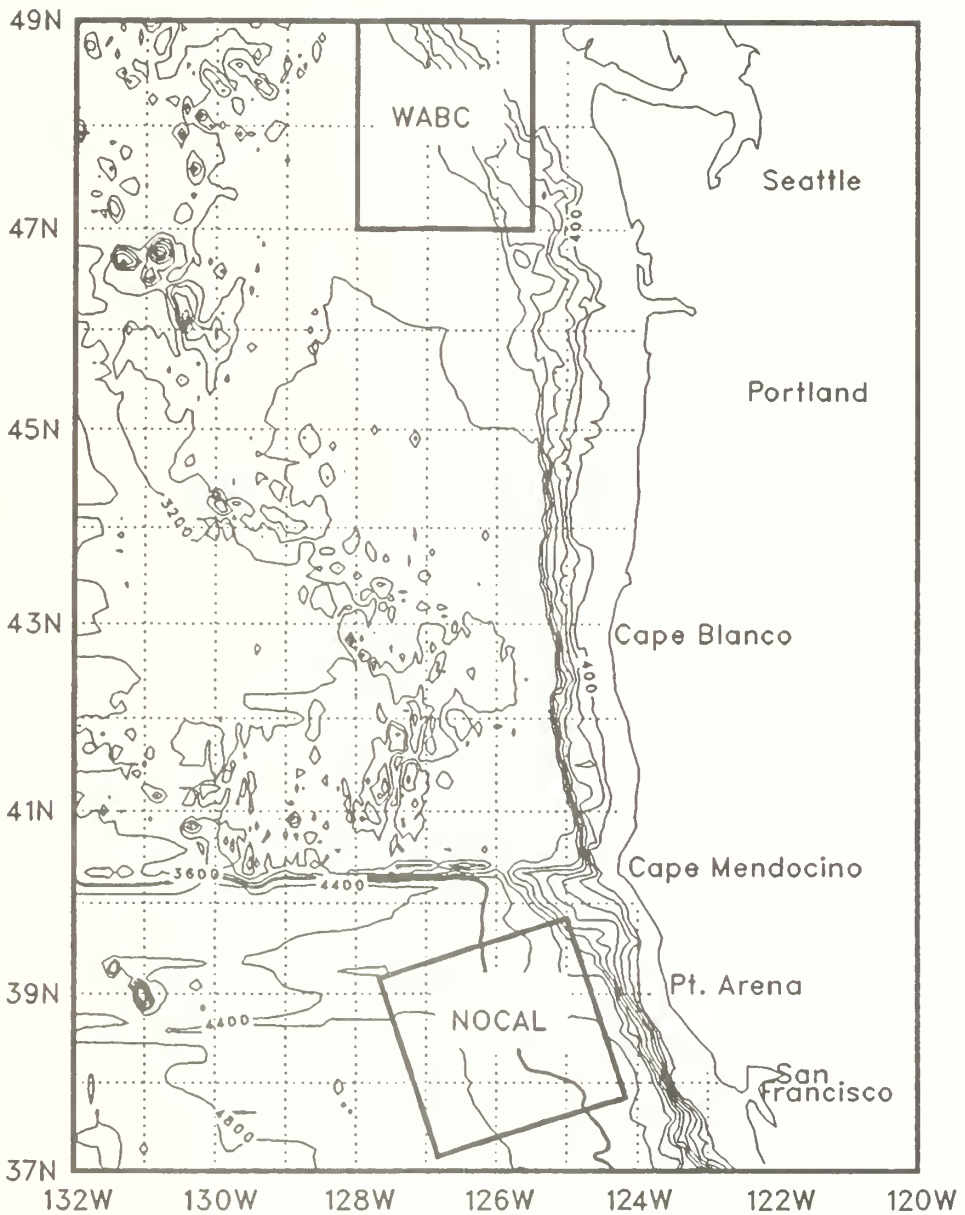


Figure 1: The NOCAL, CENCAL and WABC subdomains of the OPTOMA Program. Isobaths shown in meters.

INTRODUCTION

The OPTOMA (Ocean Prediction Through Observations, 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 three subdomains, NOCAL, CENCAL, and WABC shown in Figure 1.

The three cruises and one AXBT flight were undertaken, during October and November 1984, in the NOAA Ship McARTHUR and a Reserve Patrol Wing P3B aircraft. Hydrographic data were acquired off the coast of Washington, Oregon, and California in an area which covered and extended the WABC and NOCAL regions.

OPTOMA12 was carried out from 8 to 18 October and sampled the WABC subdomain, an area approximately 150km square about 150km west of the Straits of Juan de Fuca. An additional transect from the WABC area to Pt. Arena was sampled, as shown in Figure 2.

OPTOMA13 was carried out from 22 October to 3 November, and sampled an area approximately 200km square centered about 190km off the coast between Pt. Reyes and Pt. Arena in the NOCAL domain, with additional transects to and from Monterey, as shown in Figure 13.

OPTOMA14 was carried out from 3 to 14 November, and sampled the Mendocino escarpment area, off the coast of Cape Mendocino, with additional transects from Monterey and to Seattle, as shown in Figure 24.

OPTOMA13P was carried out on 27 October aboard a USNR P3B aircraft, and sampled an area approximately 250km square in the NOCAL area, as shown in Figure 34.

On each cruise track, transect extremes are identified by letter in these figures to aid in cross-referencing the data presented in subsequent figures. On each of these cruises, hydrographic stations were occupied at approximately 15 km along the track. For the AXBT flight, the along-track spacing was about 46km.

DATA ACQUISITION

Data acquired during OPTOMA12, OPTOMA13, and OPTOMA14 include XBT and CTD profiles; whereas data acquired during OPTOMA13P are AXBT profiles. Bucket surface temperature and water samples for salinity were taken at most CTD stations. These surface values were used for calibration purposes as well as contributions to the data base.

The XBT and AXBT data were digitized using a Sippican MK9 unit. All data were recorded, using an HP200 series computer, on data disks and 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. A Plessey CTD and Sippican XBT's were employed during OPTOMA12; a Neil Brown CTD and Sippican XBT's were used during OPTOMA13 and OPTOMA14. Their accuracies are stated in Table 1. The bottle surface salinity samples from OPTOMA12 and OPTOMA13 were determined onboard by a Plessy salinometer; its accuracy is contained in Table 1. Samples from OPTOMA14 were determined by a Guildline Model 8400 "Autosal" salinometer with an accuracy of $\pm$0.003ppt. Also during OPTOMA13, expendable current profiler (XCP) data were acquired, but will not be presented in this report.

Station positions for OPTOMA13P are accurate to within 1 km, temperature values to within 0.2C and depth values to within 2% or 5m (whichever is larger).

DATA PROCESSING

Data processing, such as estimating depth profiles for the XBT and AXBT 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 100%, 94%, 100% and 81% of casts were retained in the data set of OPTOMA12, OPTOMA13, OPTOMA14 and OPTOMA13P, respectively. During OPTOMA12 the conductivity cell appeared to be unstable during the first three CTD stations; only the temperature data from those stations appear in this report. The surface salinities for the next four CTD stations of OPTOMA12 were too high on average by 2.16 ppt and were adjusted accordingly. No corrections were made to the remaining two CTD's. For the OPTOMA13 and 14 salinities, no corrections were required. The CTD data were interpolated to 5 m 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 XBT's, CTD's and AXBT's identified) and station numbers are shown in the first three figures of each of the next four sections, which present the data from OPTOMA12, OPTOMA13, OPTOMA14 and OPTOMA13P respectively. These figures are followed by a listing of the stations, with their coordinates, the date and time at which the station was occupied, and the surface information obtained at the station.

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 CTD's follow (except Leg P). 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 (except for Leg P) by isopleths of temperature, salinity and sigma-t, from the CTD's, 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 $\pm$20m. The tick marks identify station positions and, again, the transect extremes are shown on these plots.

Sections 1, 2, and 3 include mean profiles of temperature from the XBT's and CTD's. In addition mean profiles of temperature, salinity and sigma-t from the CTD's are given, as well as a scatter diagram of the T-S pairs and the mean S(T) curve, with the $\pm$ standard deviation envelope; the data presentation concludes with a plot of the mean N^2 (Brunt-Vaisala frequency squared) profile, with $\pm$ 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.

Section 4 includes the mean profile of the temperature from the AXBT's.

Table 1: Scientific instruments aboard the NOAA Ship McARTHUR

Instrument	Variable	Sensor	Accuracy	Resolution
* Neil Brown CTD Mark IIIb	pressure	strain gage	1.6 db	0.025 db
	temperature	thermistor	0.005 C	0.0005 C
	conductivity	electrode cell	0.005 mmho	0.001 mmho
Sippican BT	temperature	thermistor	0.2 C	
	depth	descent speed	greater of 4.6 m and 2% of depth	
Plessey CTD	pressure		±0.04% of depth	
	temperature		±0.005 C	
	conductivity		±0.005 mmho	
Plessey salinometer	salinity		±0.003ppt	

* employed only during OPTOMA13 and OPTOMA14

Section 1
OPTOMA12

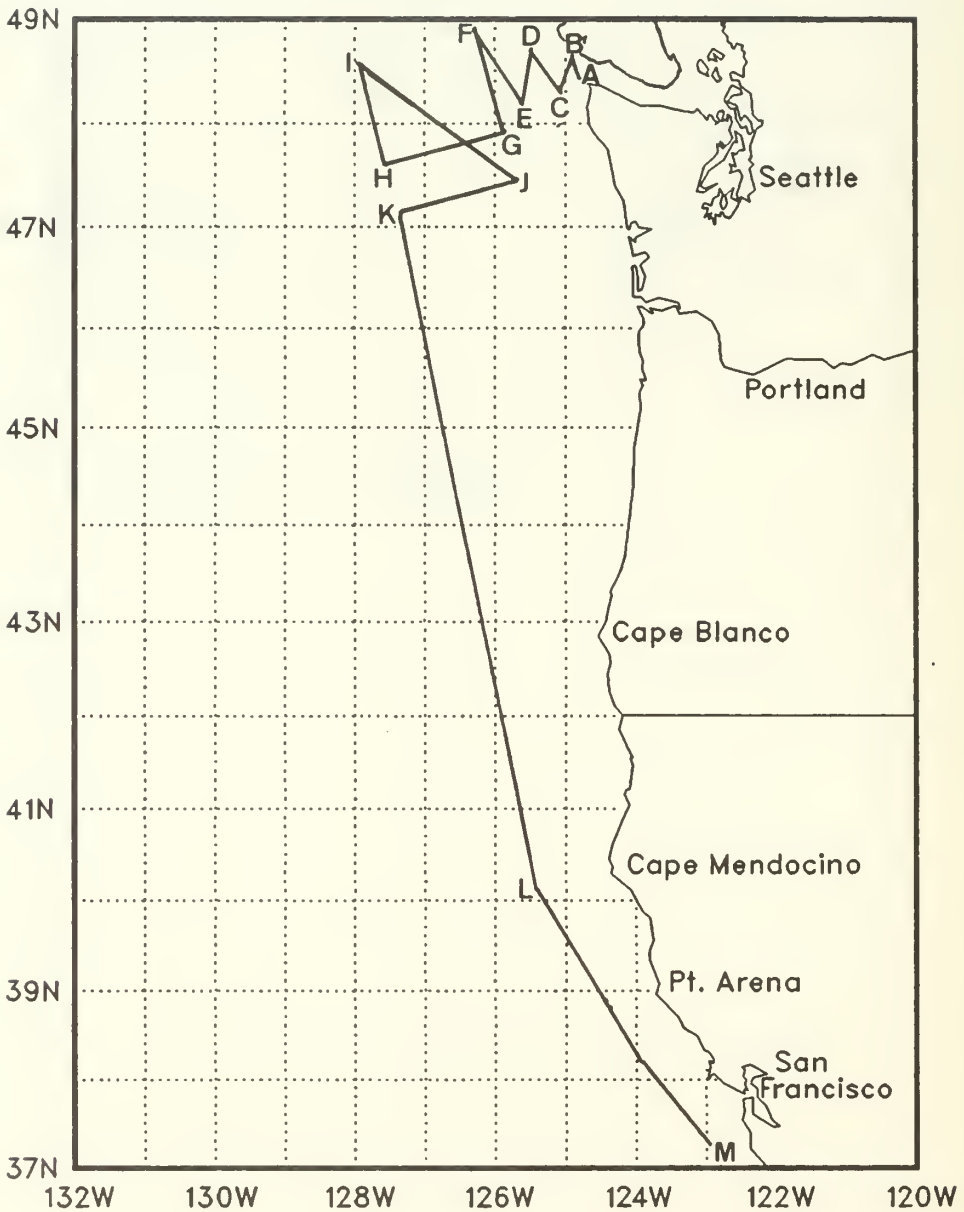


Figure 2: The cruise track for OPTOMA12.

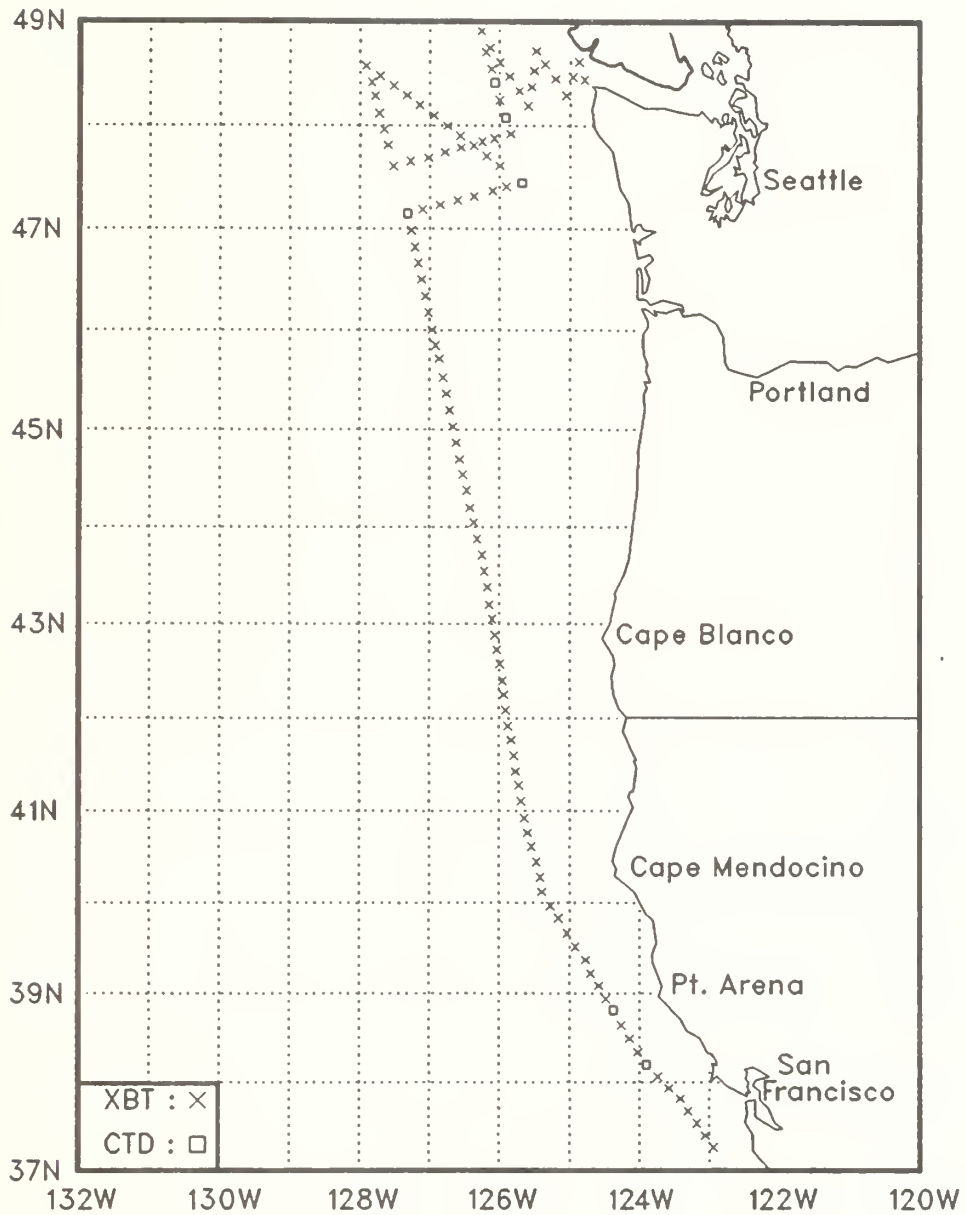


Figure 3: XBT and CTD locations for OPTOMA12.

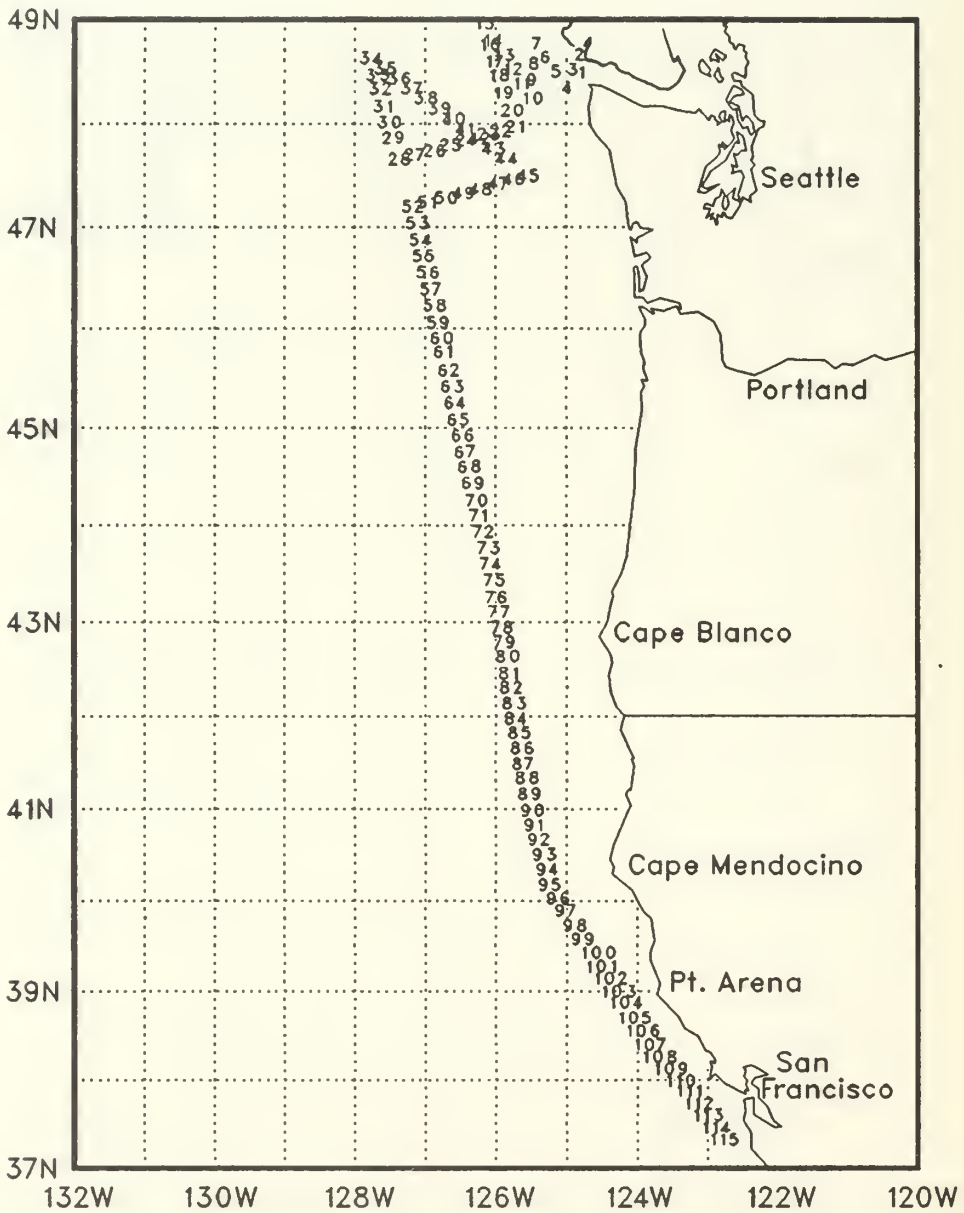


Figure 4: Station numbers for OPTOMA12.

Table 2: OPTOMA12 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	84283	407	48.27	124.48	13.1			
2	XBT	84283	511	48.37	124.52	13.1			
3	XBT	84283	605	48.28	124.57	13.2			
4	XBT	84283	722	48.18	125.03	13.1			
5	XBT	84283	812	48.27	125.12	13.0			
6	XBT	84283	918	48.36	125.21	12.6			
7	XBT	84283	1003	48.43	125.29	11.9			
8	XBT	84283	1110	48.32	125.31	13.1			
9	XBT	84283	1214	48.22	125.32	13.6			
10	XBT	84285	1800	48.12	125.35	12.7			
11	XBT	84285	1855	48.20	125.43	12.9			
12	XBT	84285	1947	48.29	125.52	13.9			
13	XBT	84285	2041	48.36	126.00	13.8			
14	XBT	84285	2119	48.45	126.08	13.6			
15	XBT	84285	2238	48.54	126.16	13.7			
16	XBT	84285	2350	48.43	126.12	14.1			
17	XBT	84286	43	48.33	126.07	14.1			
18	CTD	84286	125	48.25	126.04	14.1	32.05	*	*
19	XBT	84286	235	48.15	126.00	13.3			
20	CTD	84286	328	48.05	125.55	13.3	31.93	*	*
21	XBT	84286	802	47.55	125.51	12.6			
22	XBT	84288	922	47.53	126.05	12.3			
23	XBT	84288	1028	47.51	126.15	12.6			
24	XBT	84288	1228	47.48	126.33	13.4			
25	XBT	84288	1402	47.45	126.47	13.6			
26	XBT	84288	1536	47.42	127.01	14.1			
27	XBT	84288	1722	47.39	127.17	14.1			
28	XBT	84288	1850	47.37	127.31	14.2			
29	XBT	84288	2019	47.49	127.36	14.2			
30	XBT	84288	2110	47.58	127.39	13.8			
31	XBT	84288	2239	48.07	127.43	13.8			
32	XBT	84288	2307	48.17	127.47	13.4			
33	XBT	84288	2352	48.25	127.50	12.8			
34	XBT	84289	101	48.35	127.55	12.9			
35	XBT	84289	156	48.29	127.43	13.3			
36	XBT	84289	246	48.23	127.31	13.1			
37	XBT	84289	334	48.18	127.20	13.4			
38	XBT	84289	419	48.12	127.09	13.7			
39	XBT	84289	511	48.06	126.57	13.0			
40	XBT	84289	610	48.00	126.45	12.0			
41	XBT	84289	656	47.54	126.34	11.6			
42	XBT	84289	743	47.49	126.22	13.4			
43	XBT	84289	831	47.43	126.11	13.8			
44	XBT	84289	918	47.37	126.00	13.6			
45	CTD	84289	1130	47.27	125.41	14.0	32.08	*	32.03

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)
46	XBT	84289	1221	47.25	125.54	13.7			
47	XBT	84289	1309	47.23	126.06	14.1			
48	XBT	84289	1414	47.19	126.22	14.5			
49	XBT	84289	1513	47.17	126.36	14.4			
50	XBT	84289	1614	47.14	126.51	13.9			
51	XBT	84289	1711	47.12	127.06	14.0			
52	CTD	84289	1810	47.09	127.19	14.1	32.10	*	32.13
53	XBT	84289	2019	46.59	127.16	14.7			
54	XBT	84289	2110	46.49	127.13	14.6			
55	XBT	84289	2202	46.40	127.10	14.5			
56	XBT	84289	2253	46.30	127.07	14.8			
57	XBT	84289	2347	46.20	127.04	15.2			
58	XBT	84290	37	46.11	127.01	14.9			
59	XBT	84290	131	46.00	126.58	14.7			
60	XBT	84290	218	45.51	126.55	14.8			
61	XBT	84290	306	45.43	126.52	15.0			
62	XBT	84290	357	45.32	126.48	15.1			
63	XBT	84290	451	45.22	126.46	15.0			
64	XBT	84290	534	45.12	126.43	14.8			
65	XBT	84290	622	45.02	126.40	15.0			
66	XBT	84290	710	44.52	126.37	15.1			
67	XBT	84290	756	44.42	126.34	15.0			
68	XBT	84290	840	44.33	126.31	14.3			
69	XBT	84290	927	44.23	126.28	14.3			
70	XBT	84290	1021	44.12	126.25	14.9			
71	XBT	84290	1110	44.03	126.22	14.7			
72	XBT	84290	1200	43.53	126.19	15.3			
73	XBT	84290	1246	43.43	126.15	15.5			
74	XBT	84290	1335	43.33	126.13	15.7			
75	XBT	84290	1422	43.23	126.10	15.7			
76	XBT	84290	1518	43.12	126.09	15.3			
77	XBT	84290	1605	43.03	126.06	15.3			
78	XBT	84290	1655	42.53	126.04	15.8			
79	XBT	84290	1741	42.44	126.02	15.6			
80	XBT	84290	1830	42.35	125.59	14.7			
81	XBT	84290	1925	42.24	125.57	15.1			
82	XBT	84290	2011	42.15	125.56	15.1			
83	XBT	84290	2100	42.05	125.54	14.6			
84	XBT	84290	2150	41.55	125.52	14.6			
85	XBT	84290	2238	41.46	125.49	14.0			
86	XBT	84290	2328	41.36	125.47	13.9			
87	XBT	84291	18	41.26	125.46	14.6			
88	XBT	84291	106	41.17	125.43	14.1			
89	XBT	84291	200	41.06	125.41	14.4			
90	XBT	84291	256	40.56	125.38	14.5			

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)
91	XBT	84291	347	40.46	125.35	14.9			
92	XBT	84291	439	40.37	125.32	14.9			
93	XBT	84291	532	40.27	125.28	14.7			
94	XBT	84291	626	40.17	125.25	14.4			
95	XBT	84291	715	40.07	125.23	14.7			
96	XBT	84291	806	39.58	125.16	15.2			
97	XBT	84291	855	39.50	125.09	15.2			
98	XBT	84291	952	39.40	125.02	14.9			
99	XBT	84291	1047	39.31	124.55	13.2			
100	XBT	84291	1139	39.22	124.46	13.3			
101	XBT	84291	1235	39.13	124.42	12.8			
102	XBT	84291	1331	39.05	124.35	13.0			
103	XBT	84291	1425	38.56	124.29	12.6			
104	CTD	84291	1600	38.49	124.22	12.6	33.27	*	33.35
105	XBT	84291	1707	38.38	124.15	13.2			
106	XBT	84291	1758	38.30	124.08	13.4			
107	XBT	84291	1852	38.21	124.01	13.5			
108	CTD	84291	1942	38.12	123.54	12.8	33.45	*	33.45
109	XBT	84291	2141	38.04	123.44	14.4			
110	XBT	84291	2300	37.56	123.34	14.1			
111	XBT	84291	11	37.49	123.25	13.7			
112	XBT	84292	125	37.40	123.18	12.6			
113	XBT	84292	231	37.32	123.10	12.6			
114	XBT	84292	346	37.24	123.03	12.7			
115	XBT	84292	501	37.16	122.56	14.1			

* Data not available

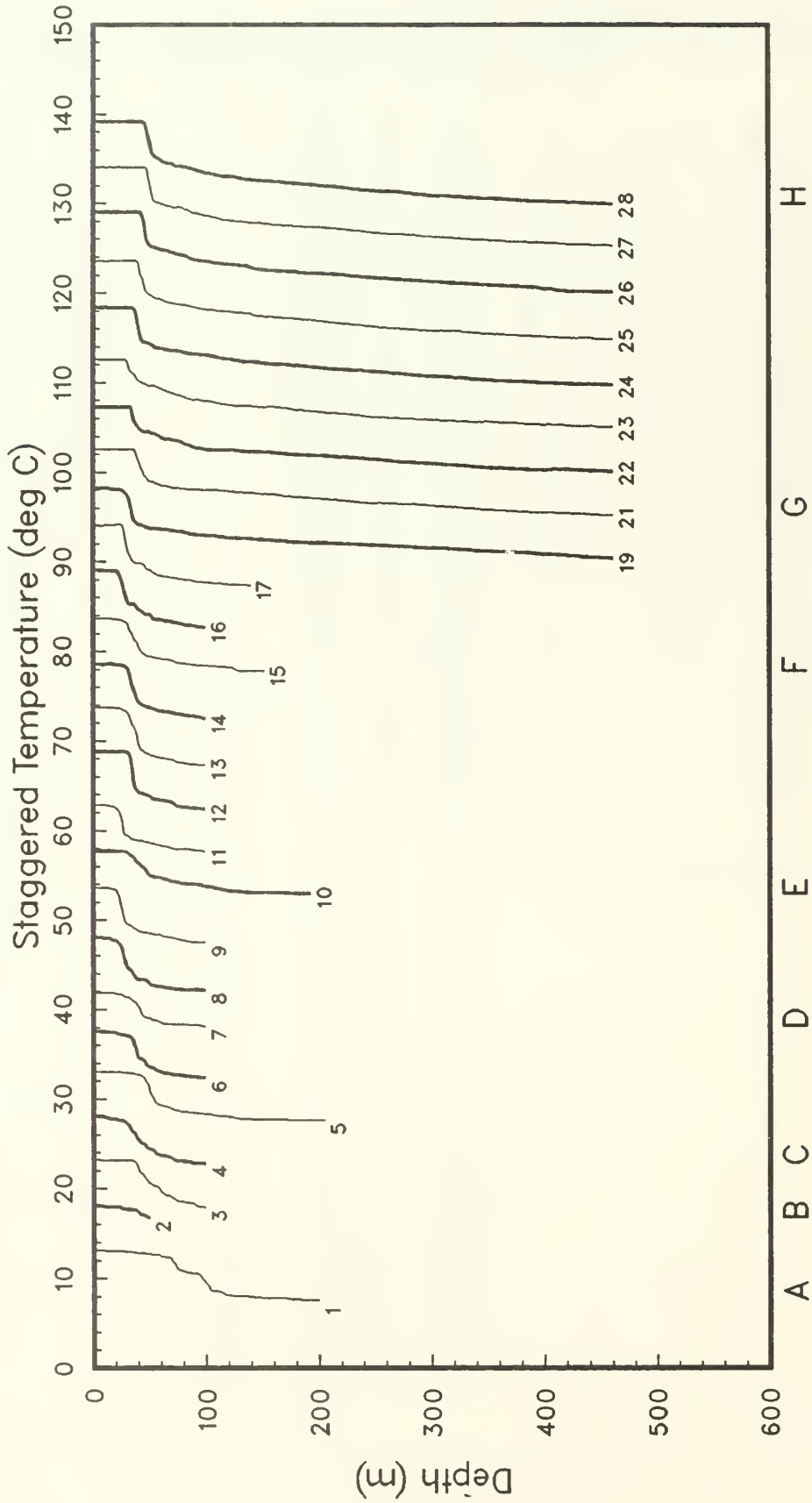


Figure 5(a): XBT temperature profiles, staggered by multiples of 5C (OPTOMA12).

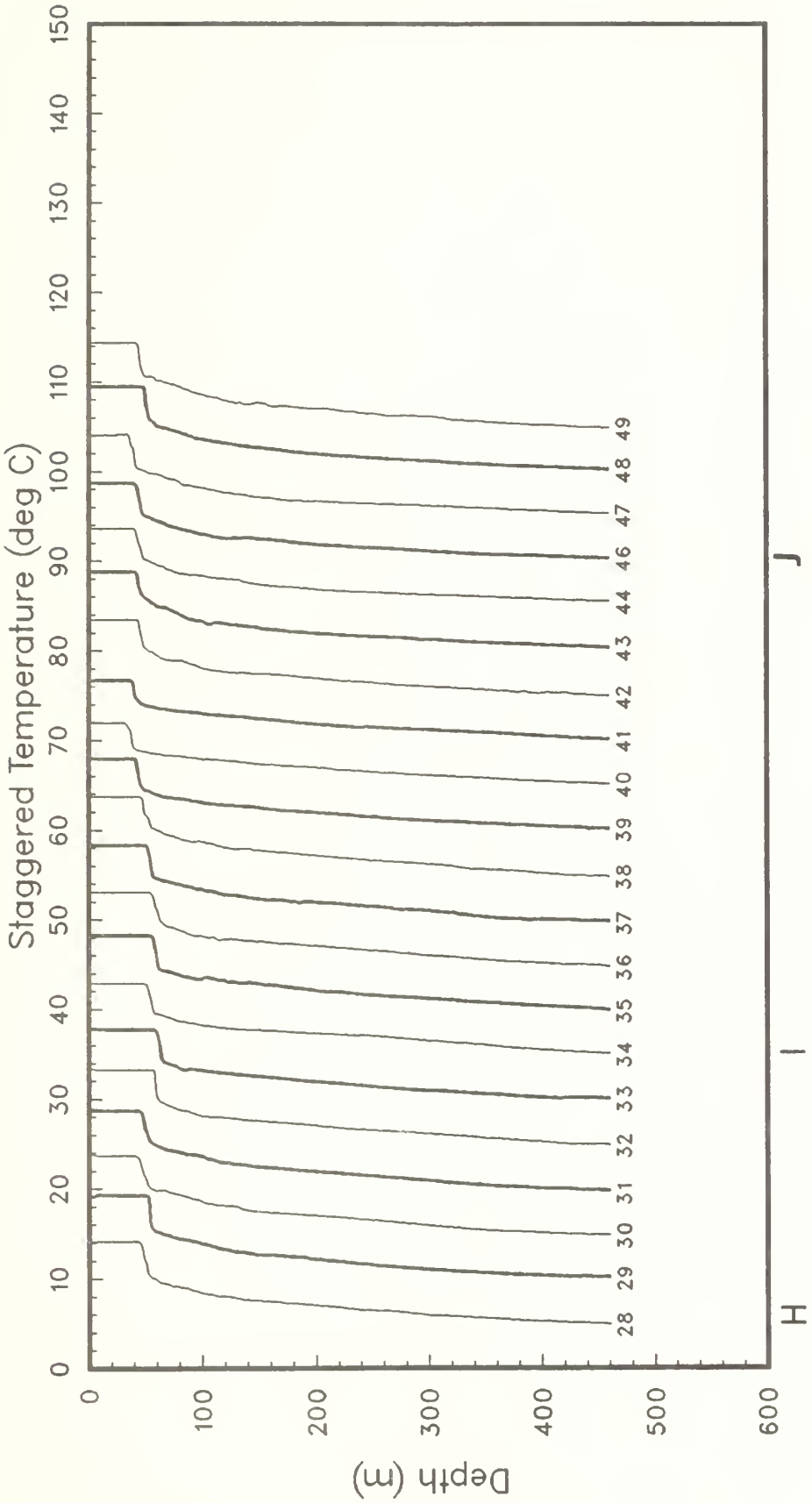

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
46
47
48
49
H
I
J

Figure 5(b)

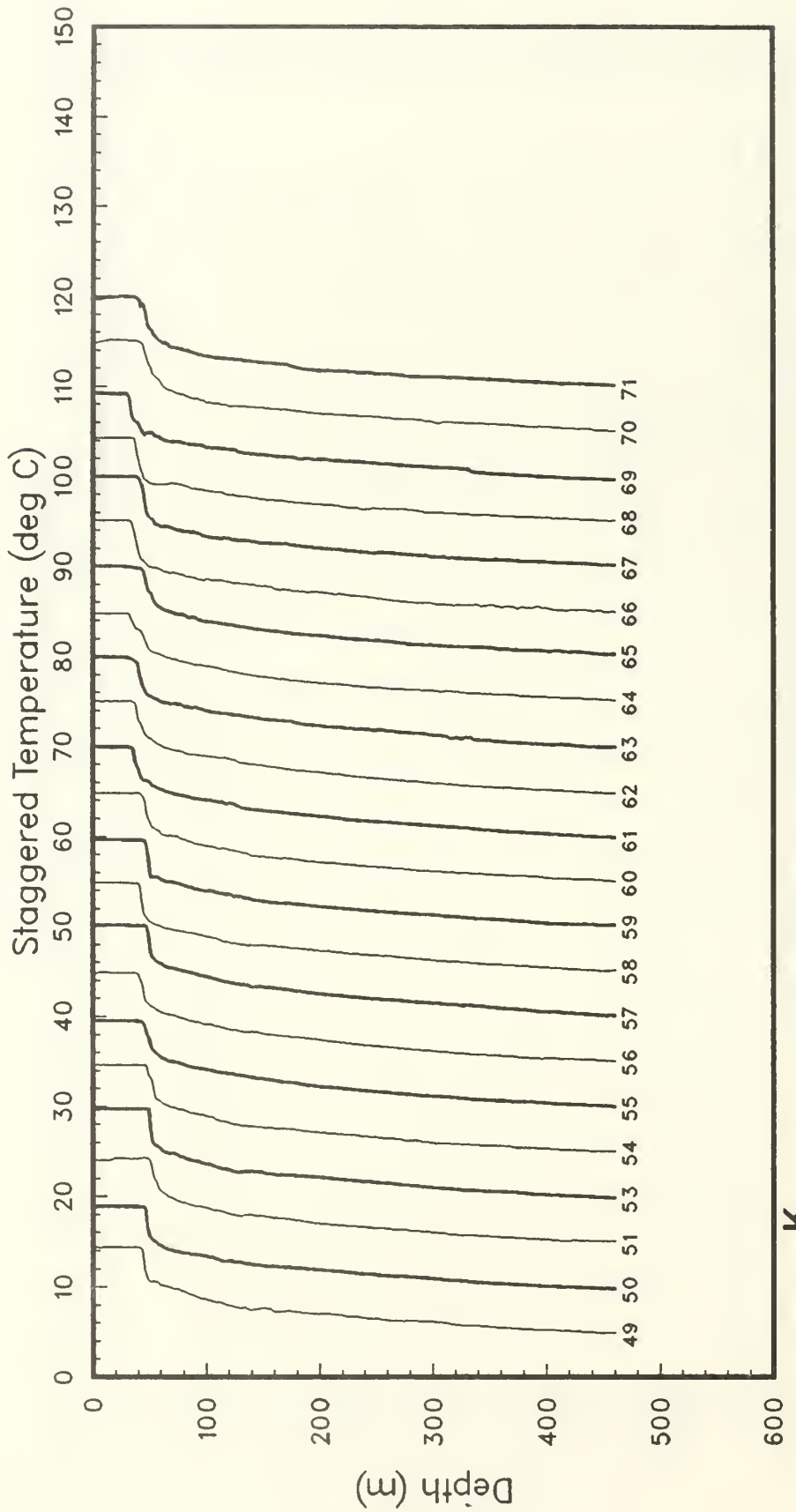

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
49
50
51
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
K

Figure 5(c)

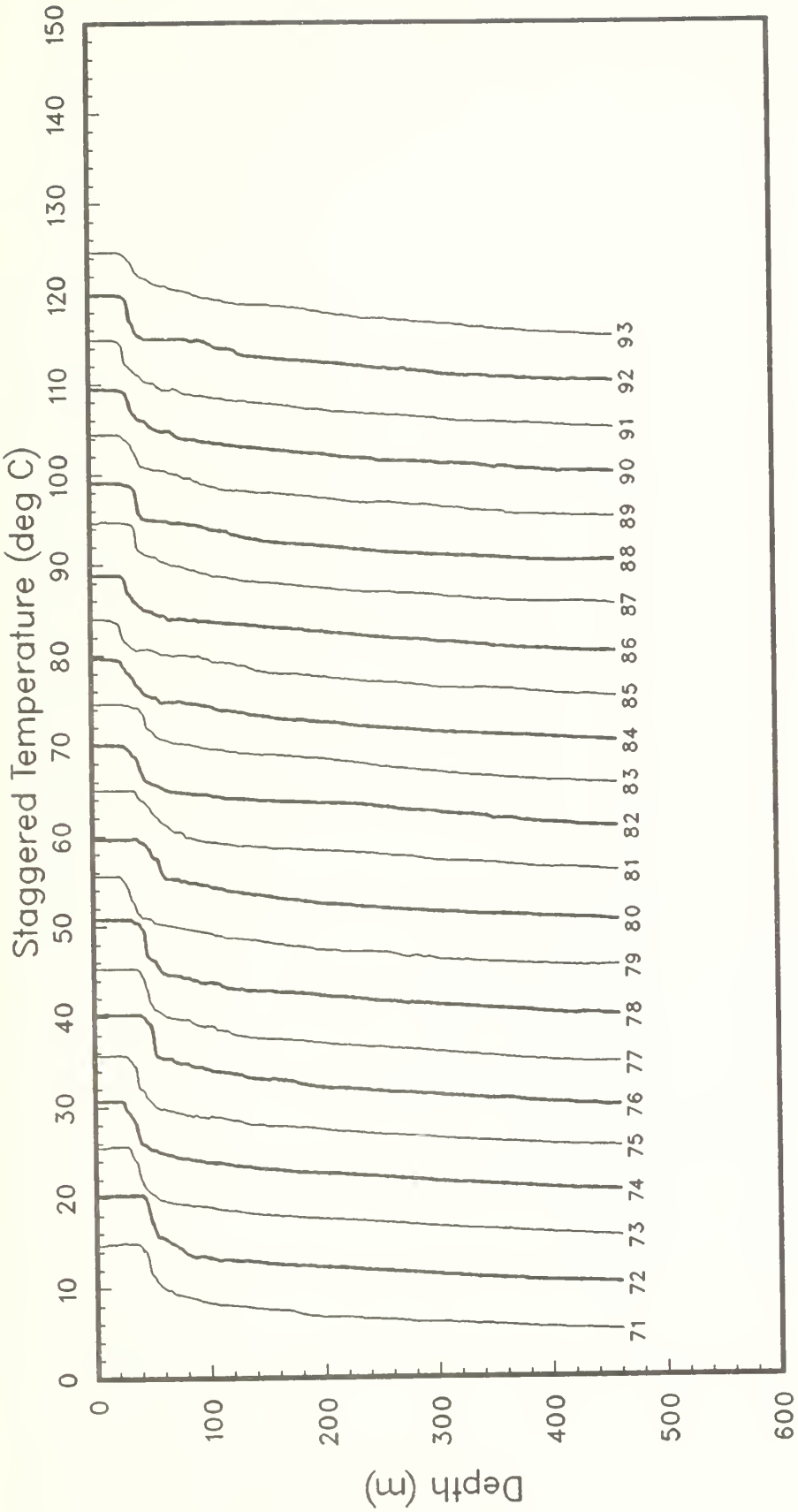

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93

Figure 5(d)

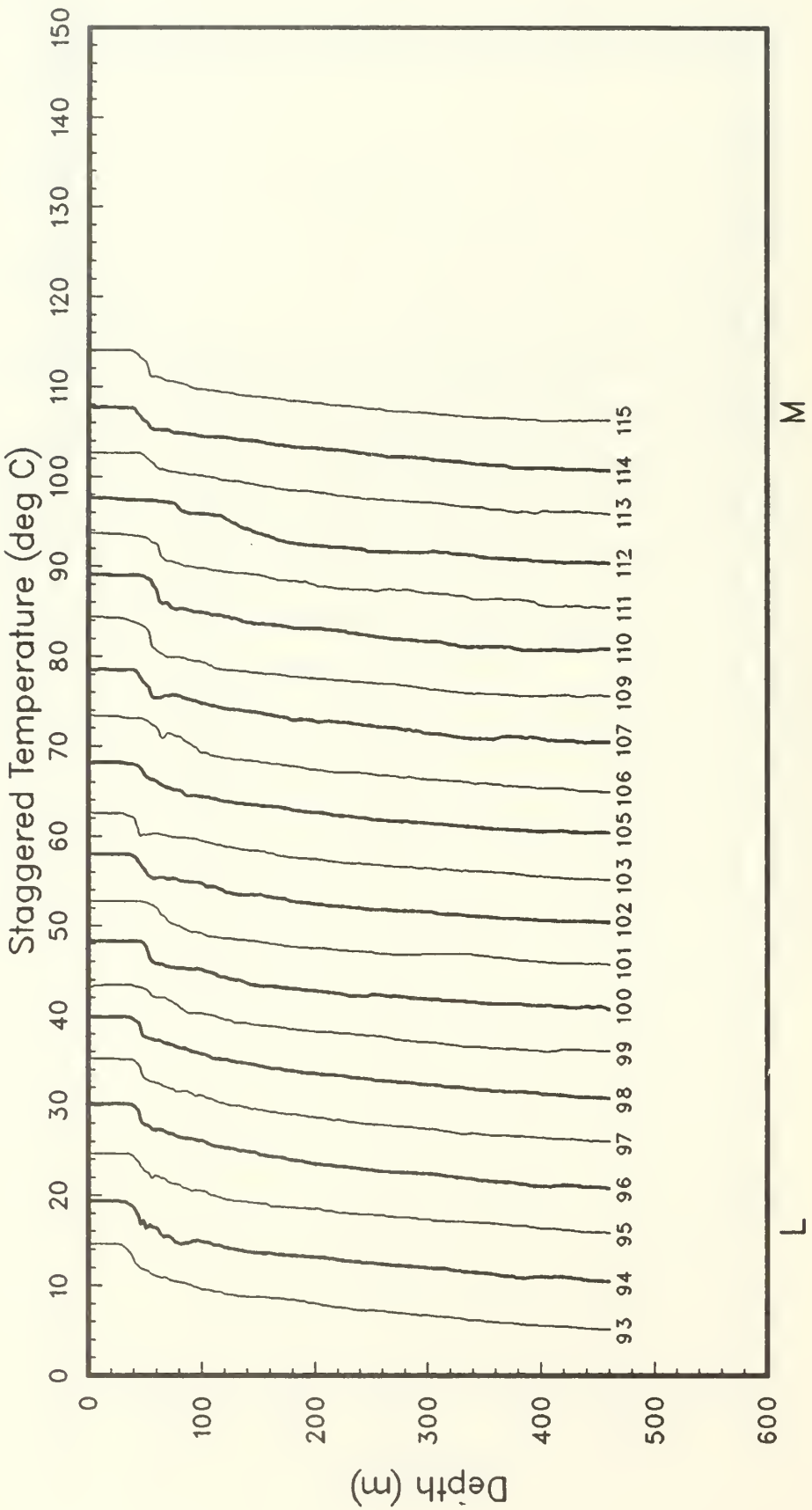

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
93
94
95
96
97
98
99
100
101
102
103
105
106
107
109
110
111
112
113
114
115
L
M

Figure 5(e)

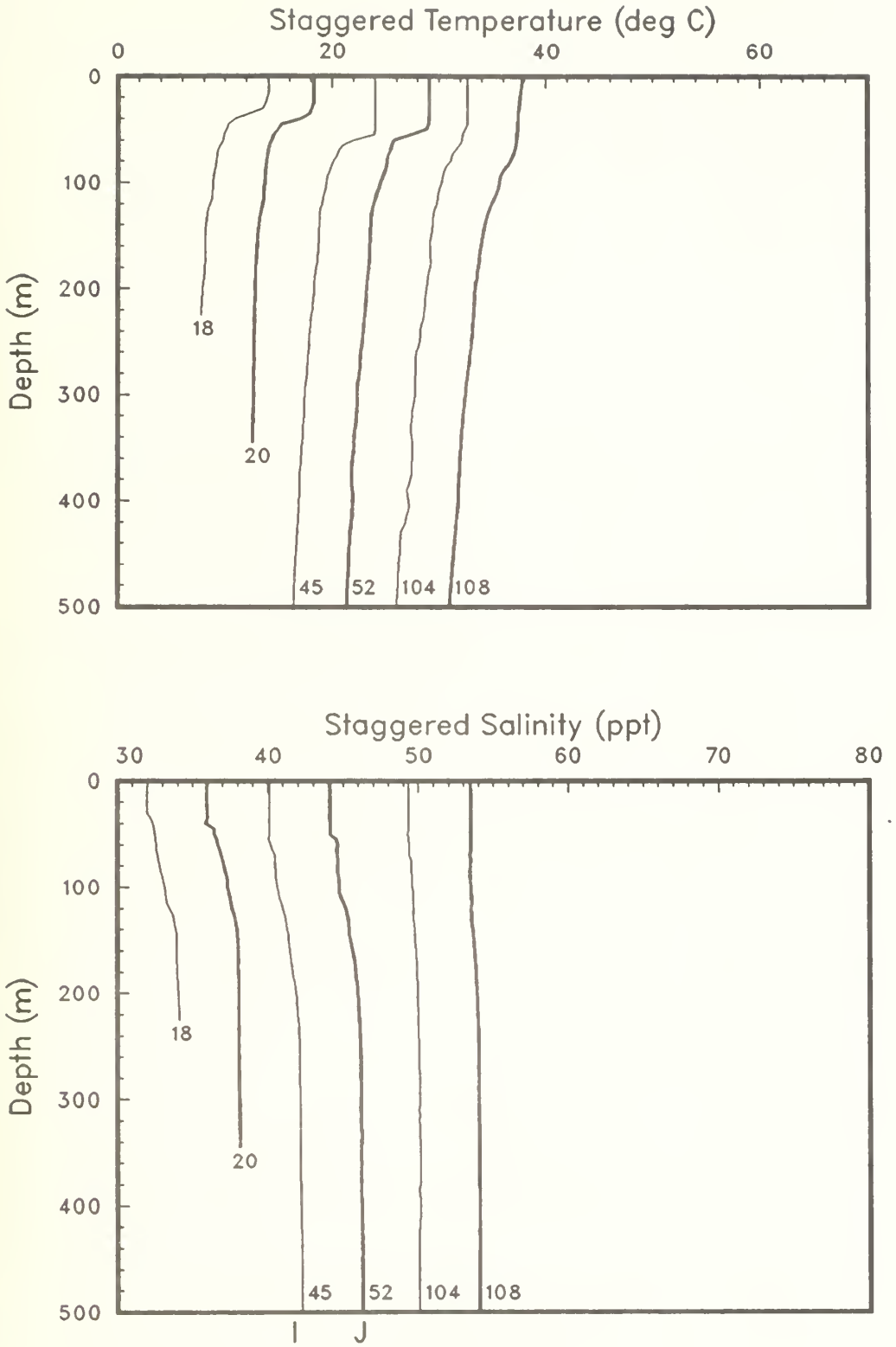


Figure 6: CTD temperature profiles, staggered by multiples of 5C, and salinity profiles staggered by multiples of 4 ppt (OPTOMA12).

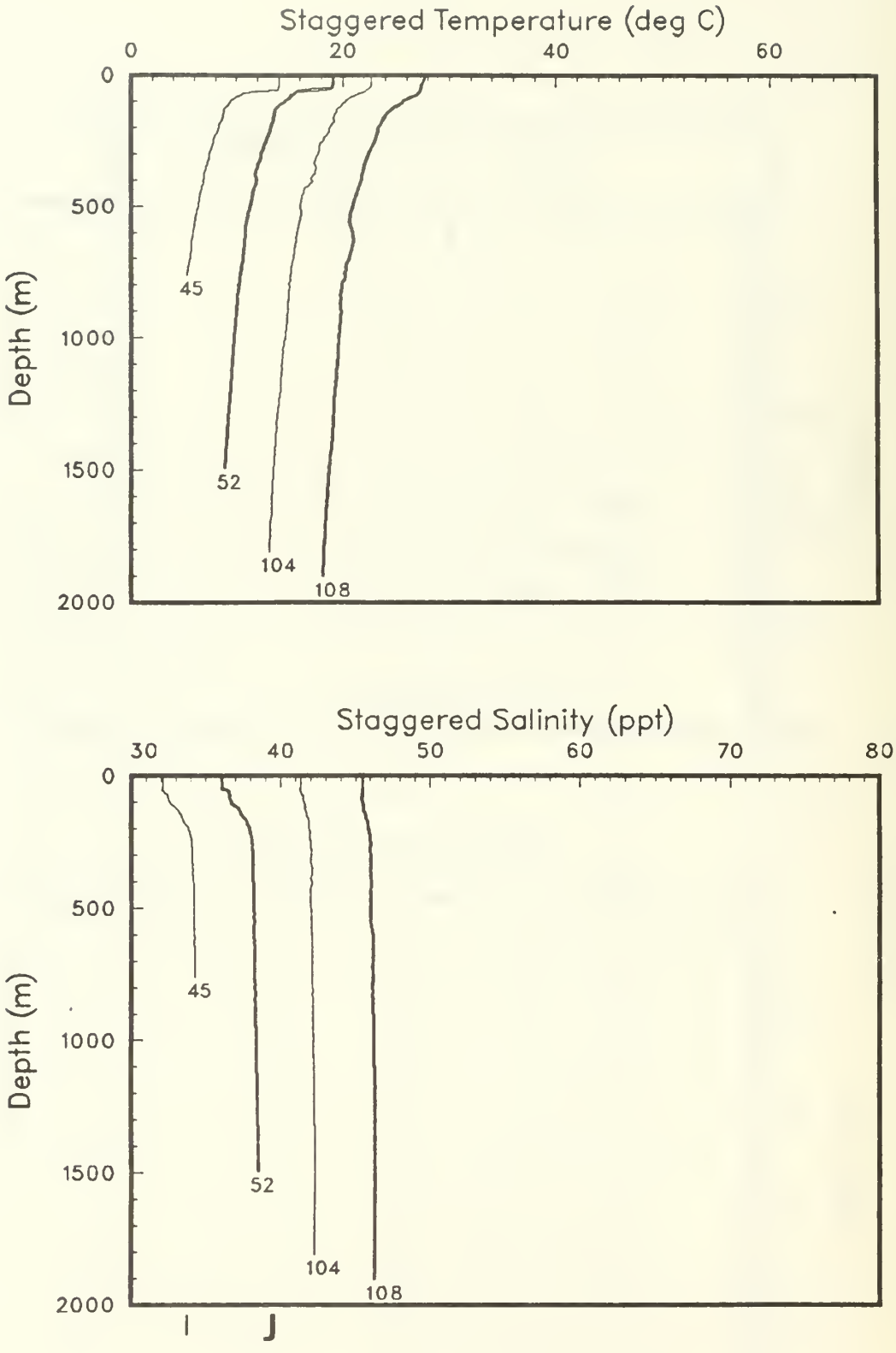


Figure 7: CTD casts deeper than 500m (OPTOMA12).

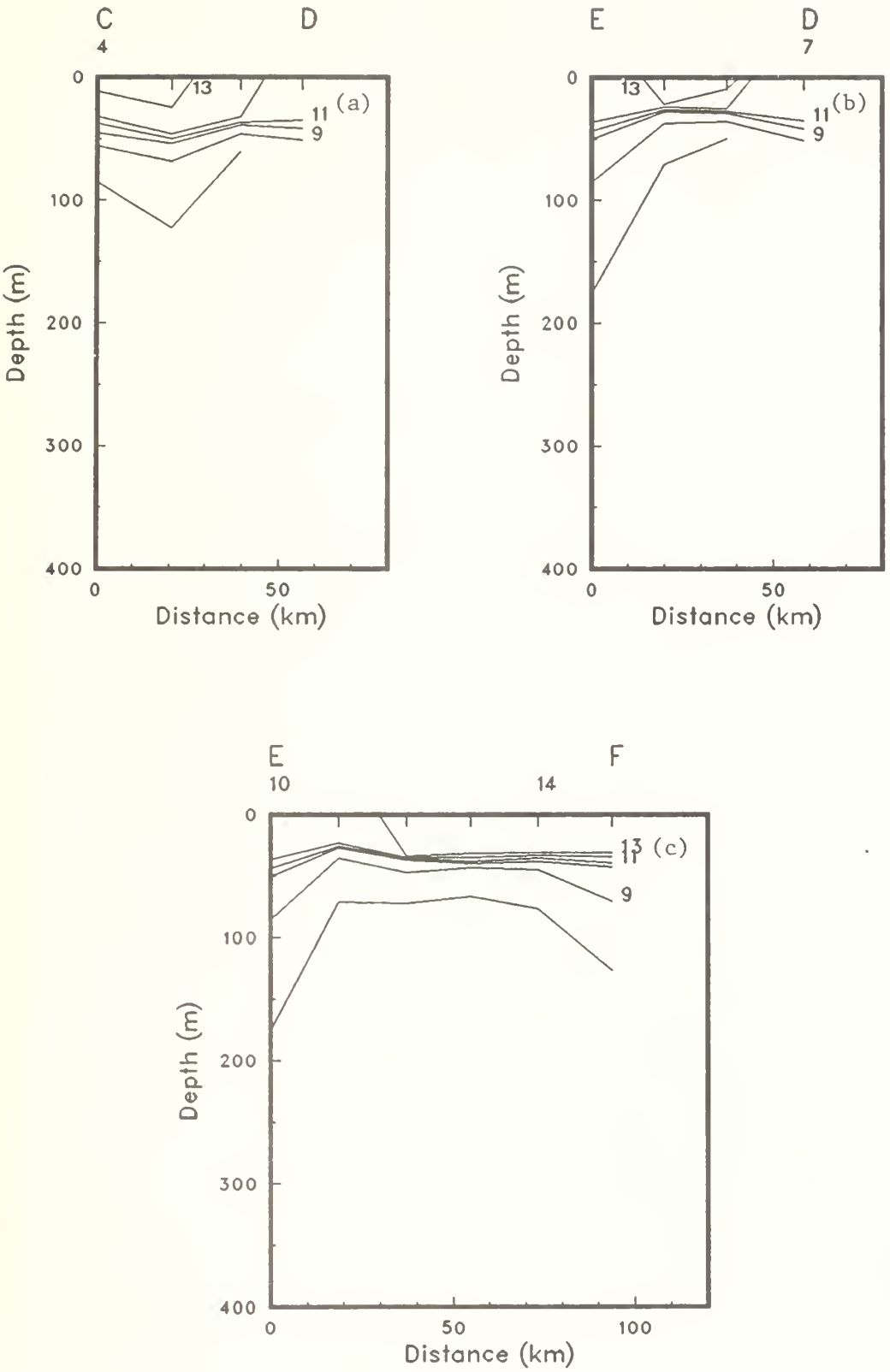


Figure 8(a)-(c): Along-track isotherms. Tick marks along the upper horizontal axis show station positions. Some station numbers are given. Dashed lines are used if the cast was too shallow (OPTOMA12).

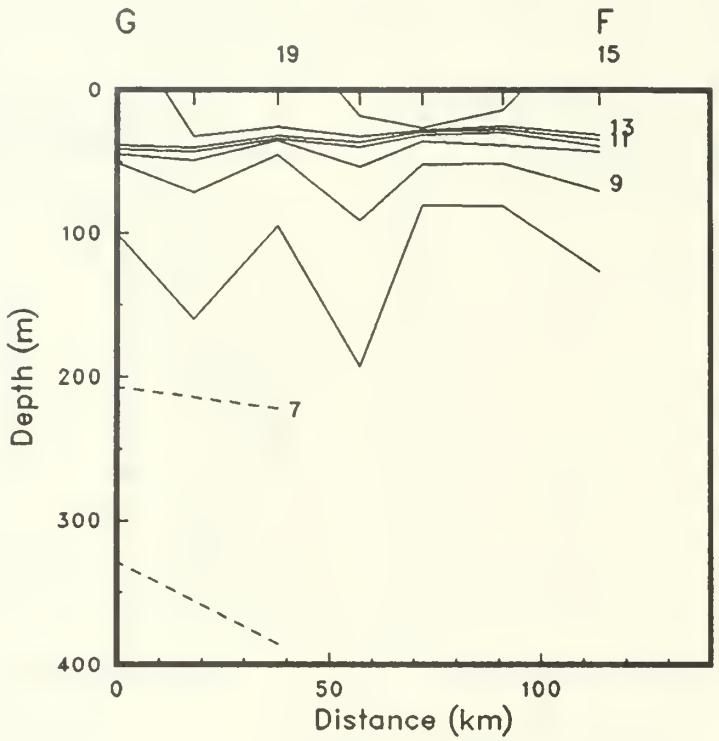


Figure 8(d)

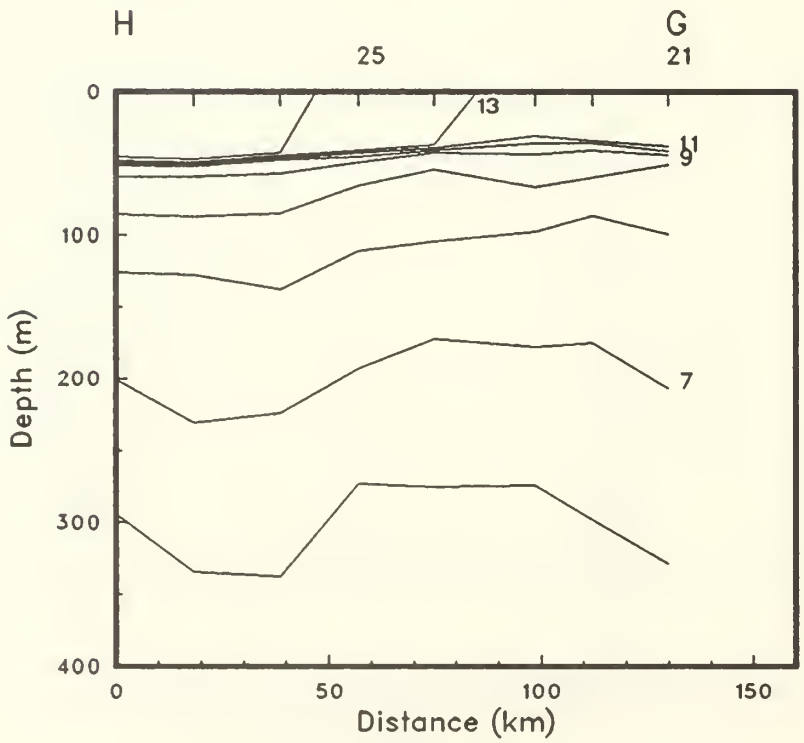


Figure 8(e)

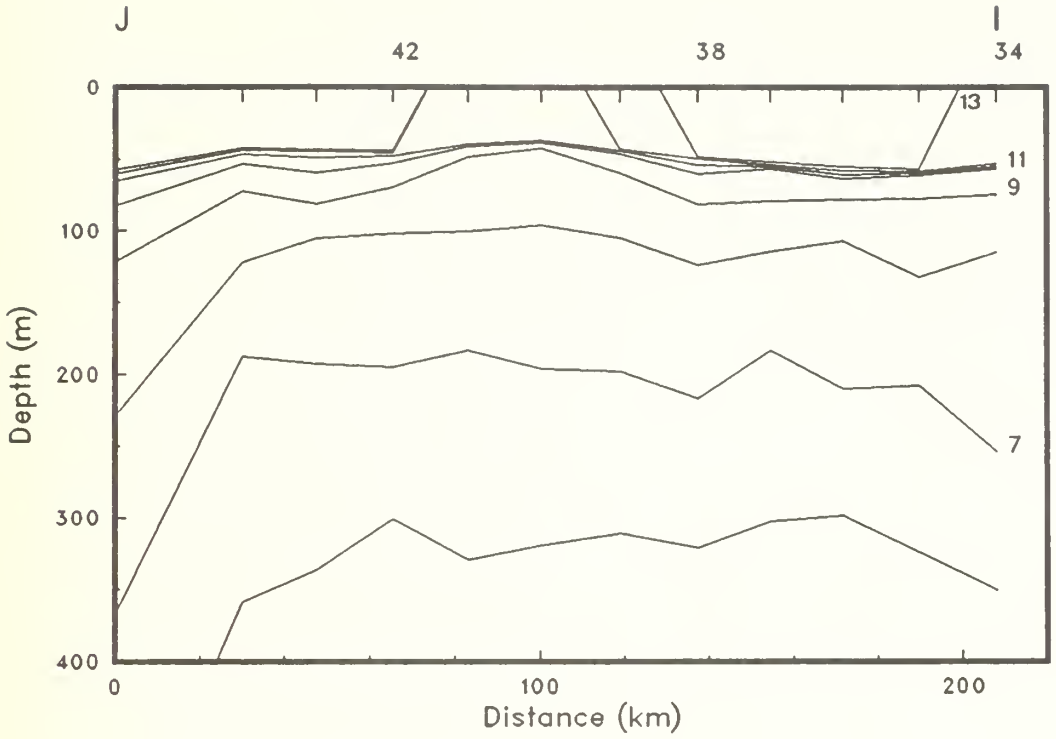

J
I
42
38
34
0
100
200
300
400
Depth (m)
13
11
9
7
0
100
200
Distance (km)

Figure 8(f)

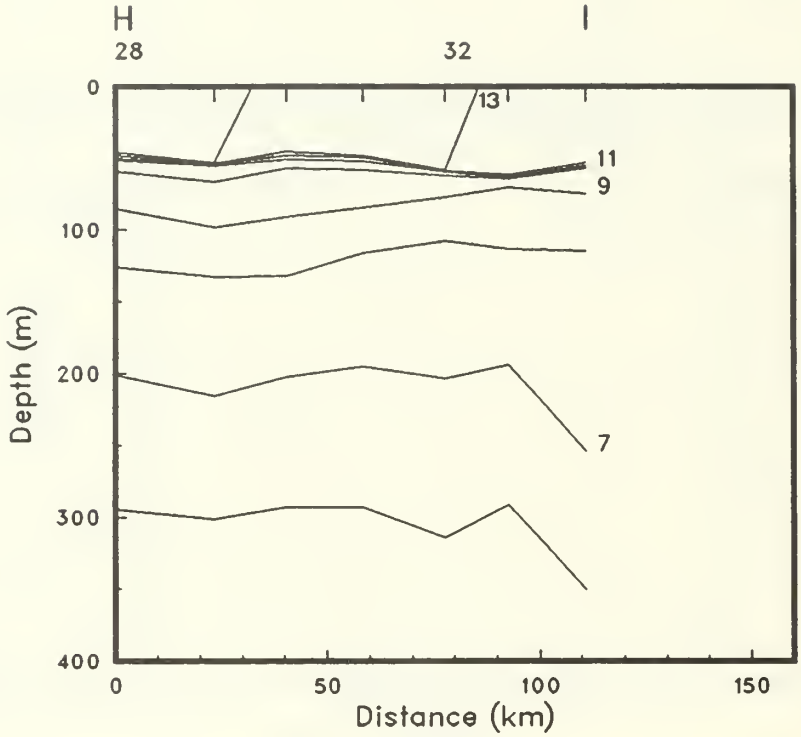


Figure 8(g)

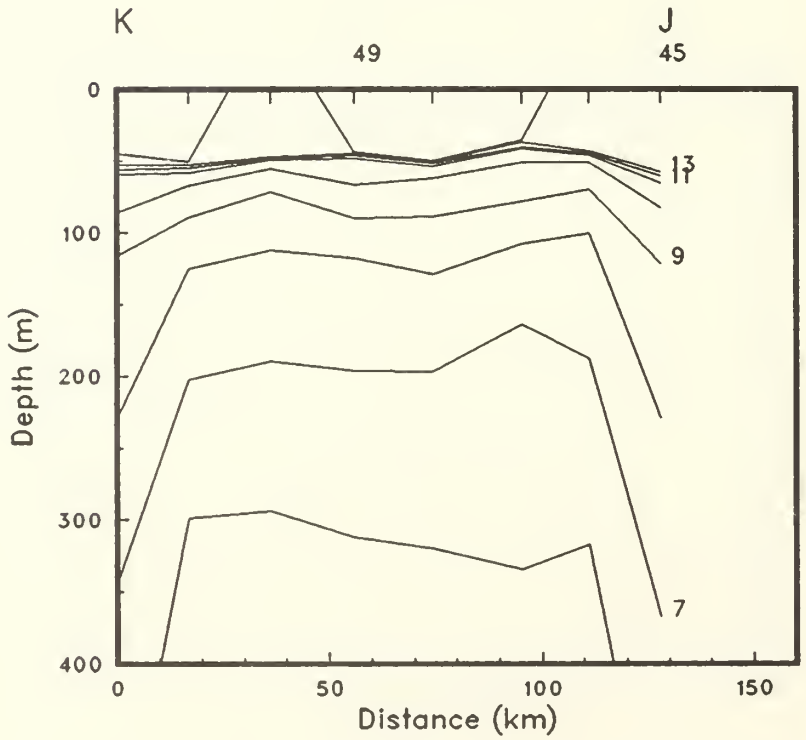


Figure 8(h)

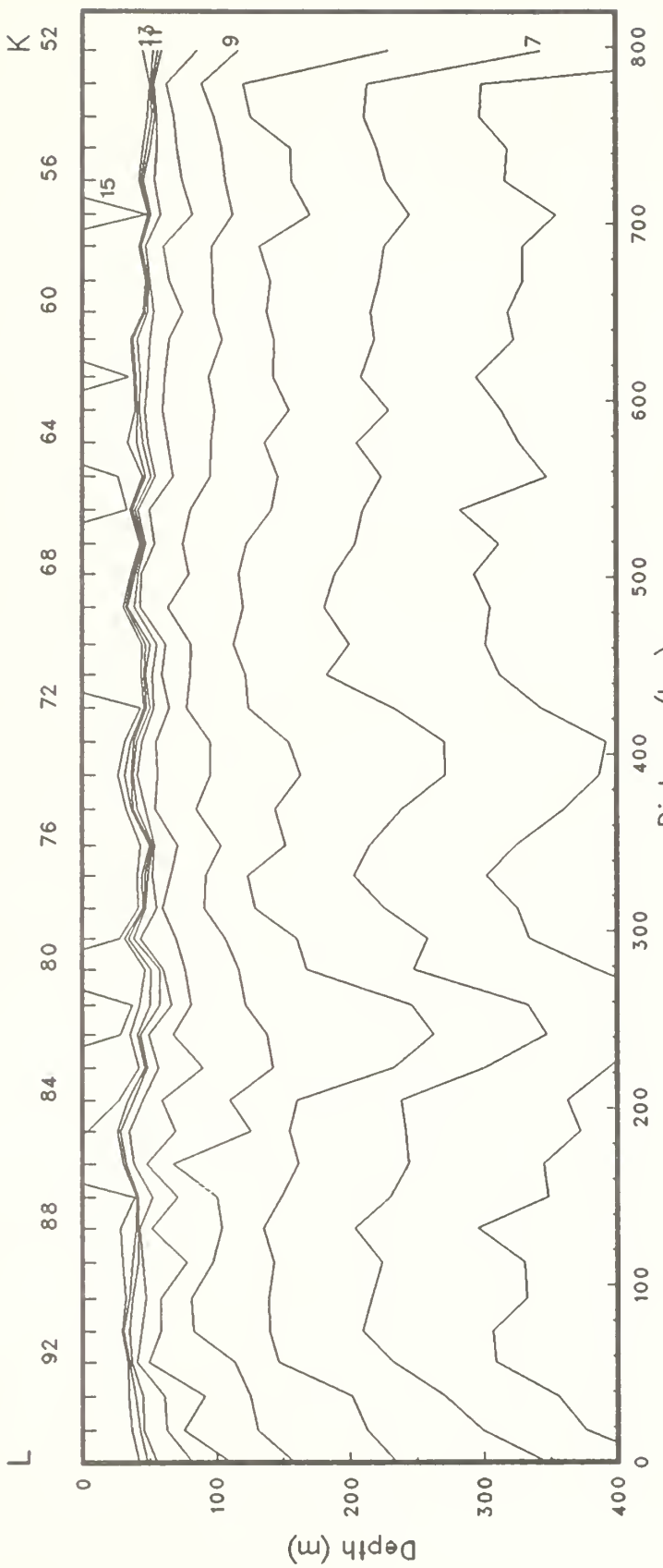

L
92
88
84
80
76
72
68
64
60
56
52
K
0
100
200
300
400
Depth (m)
0
100
200
300
400
500
600
700
800
Distance (km)
15
9
7

Figure 8(i)

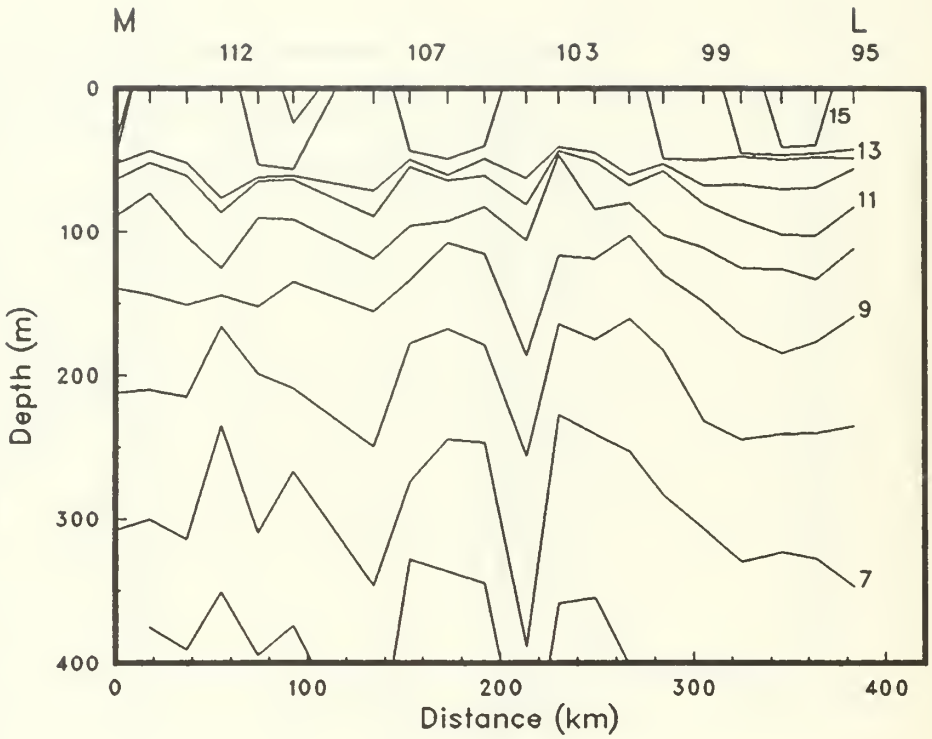

M
L
112
107
103
99
95
0
100
200
300
400
Depth (m)
15
13
11
9
7
0
100
200
300
400
Distance (km)

Figure 8(j)

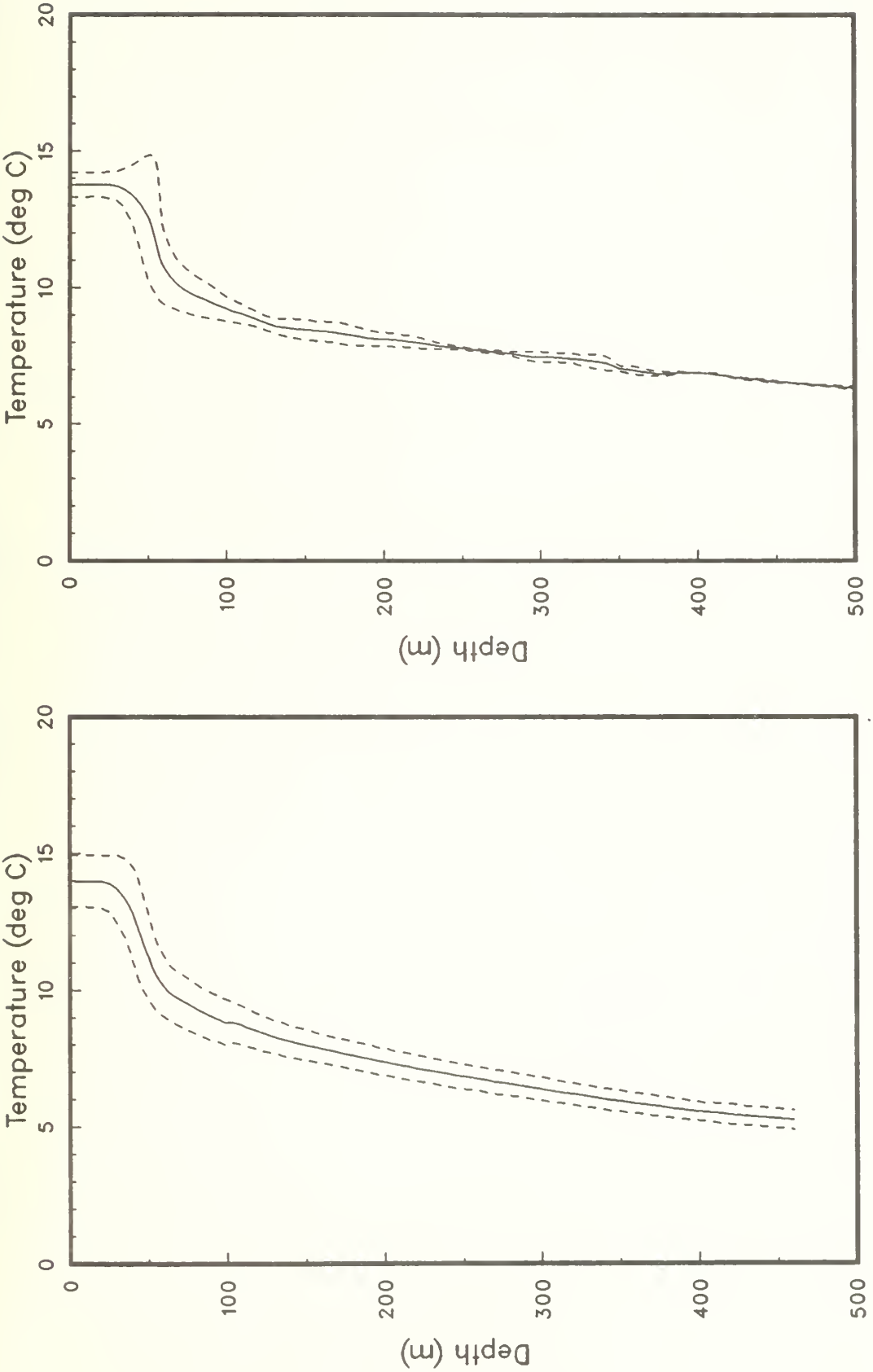


Figure 9: Mean temperature profiles from (a) XBT's and (b) CTD's, with + and - the standard deviation (OPTOMA12).

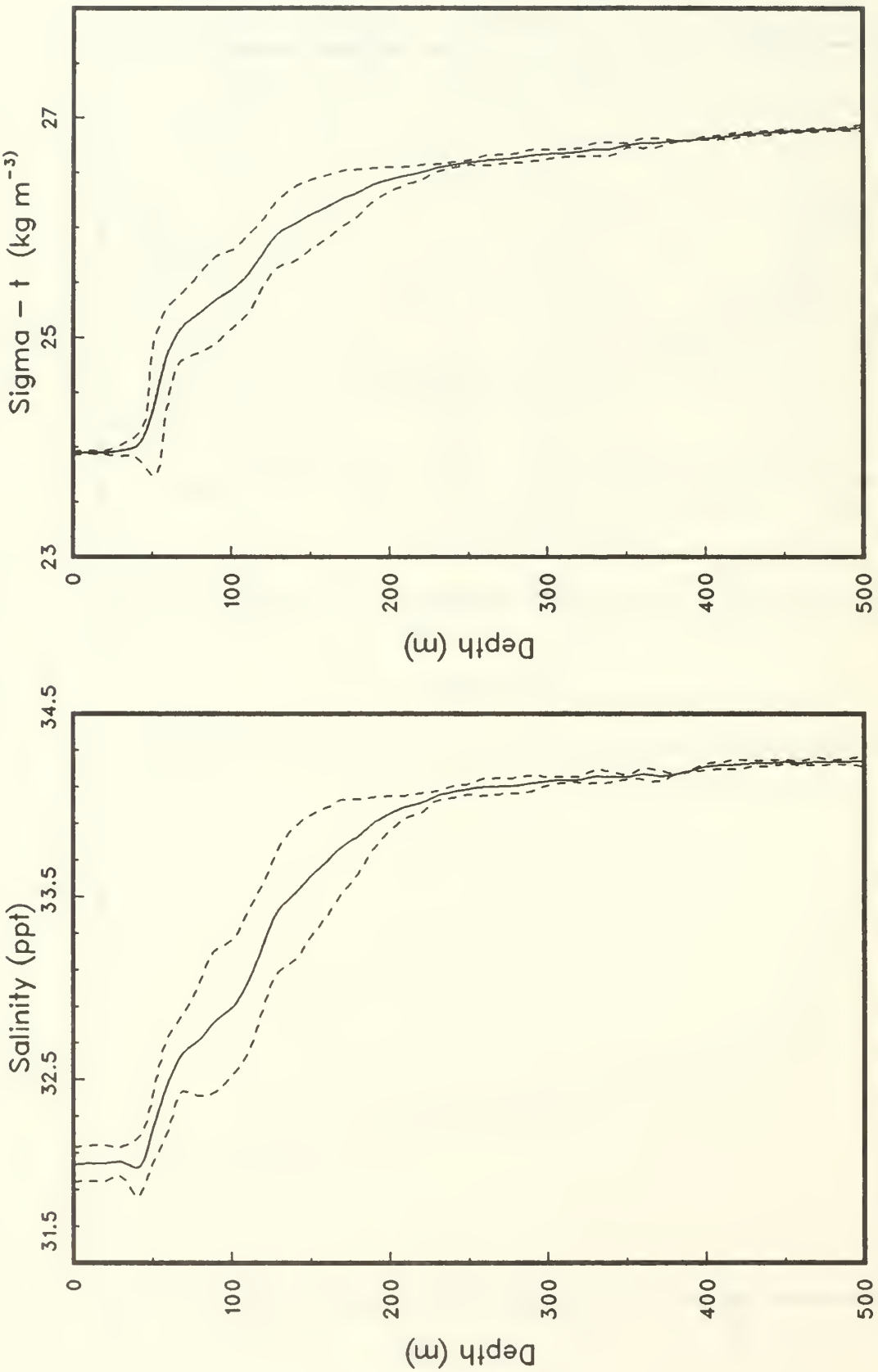


Figure 10: Mean profiles of (a) salinity and (b) sigma-t, with + and - the standard deviations, from the CTD's (OPTOMA12).

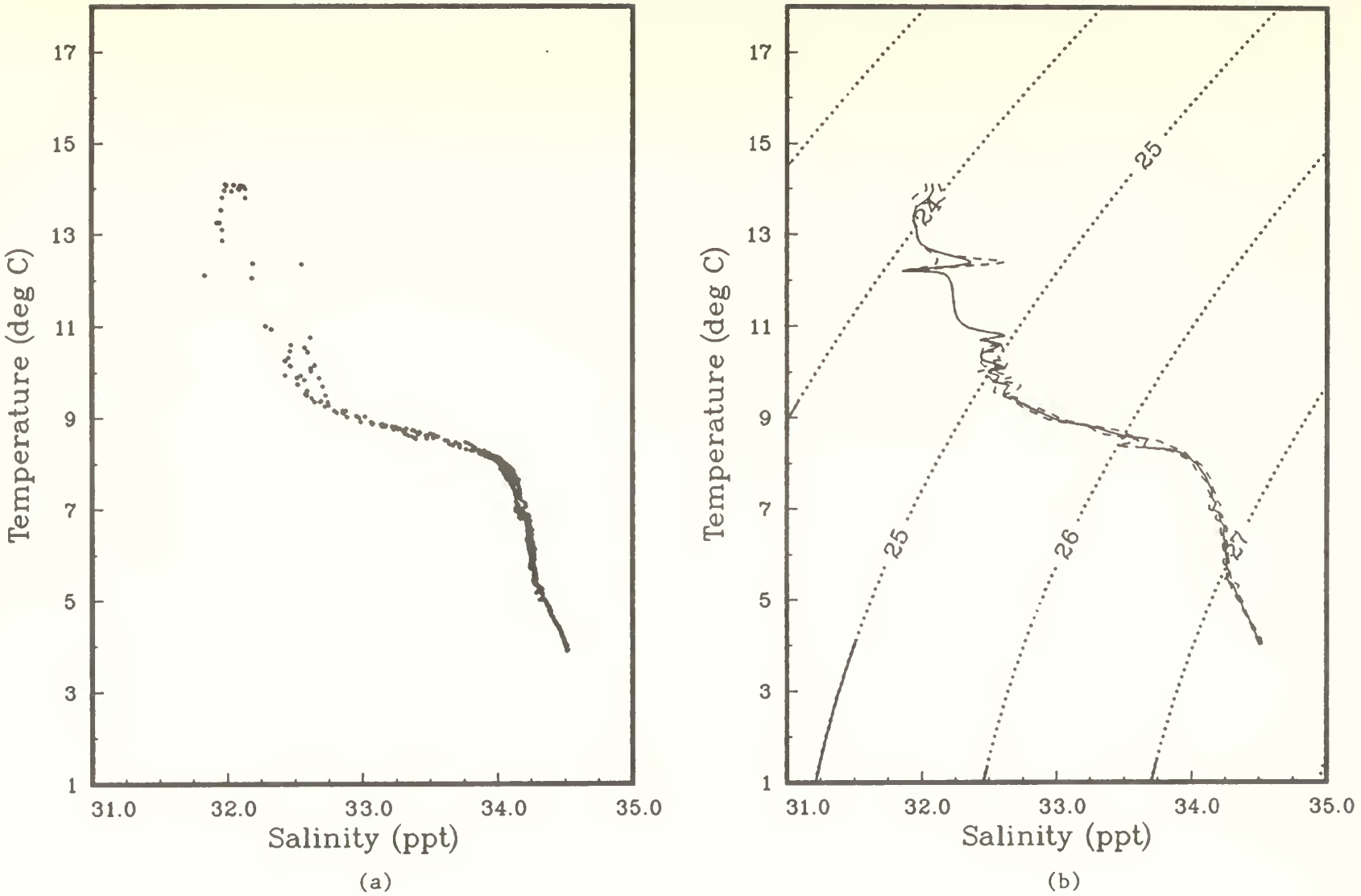


Figure 11: (a) T-S pairs and (b) mean T-S relation, with + and - the standard deviation, from the CTD's. Selected sigma-t contours are also shown (OPTOMA12).

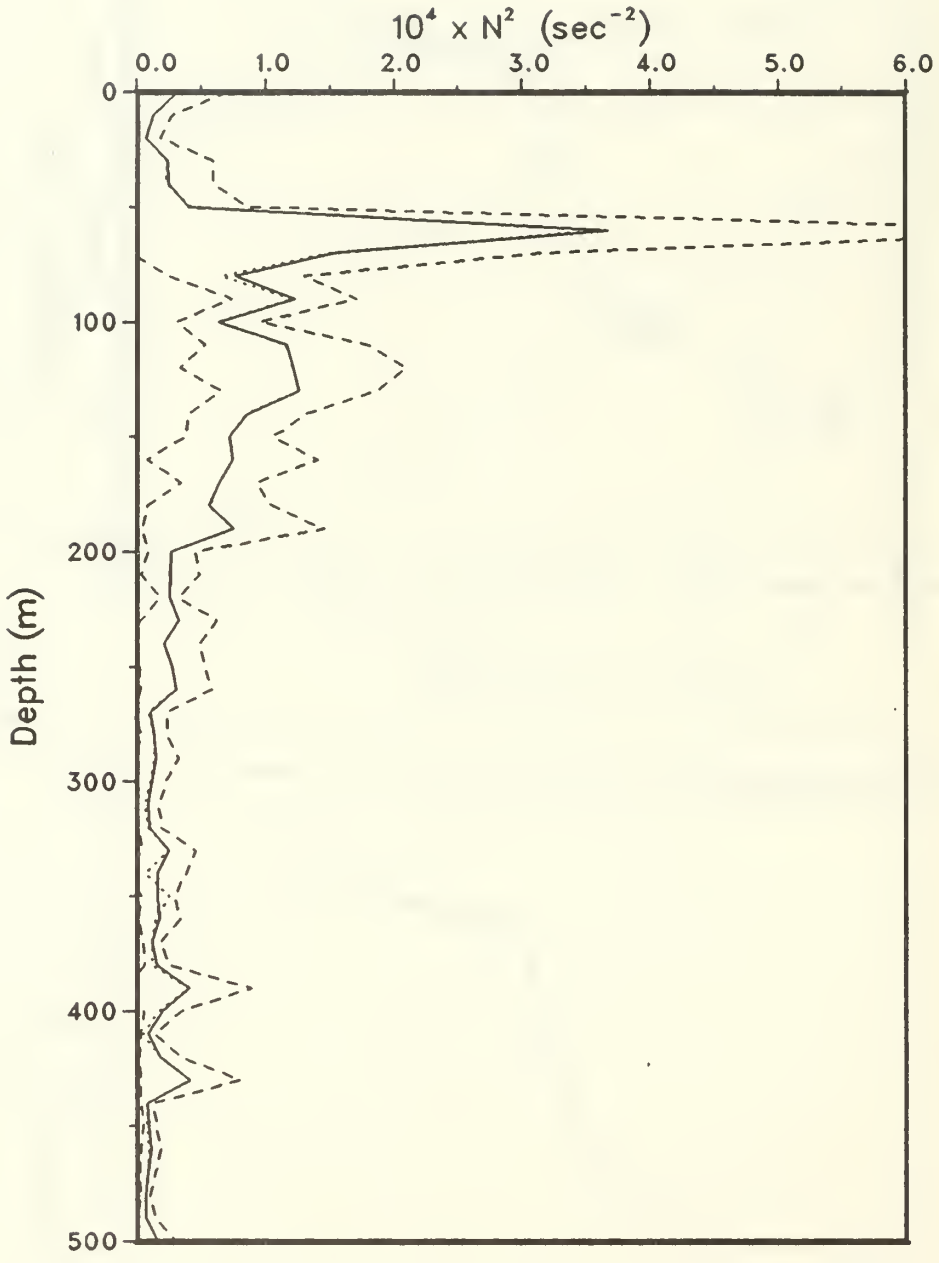


Figure 12: Mean N^2 profile(——), with + and - the standard deviation(----). The N^2 profile from $\overline{T(z)}$ and $\overline{S(z)}$ is also shown(....) (OPTOMA12).

Section 2

OPTOMA13

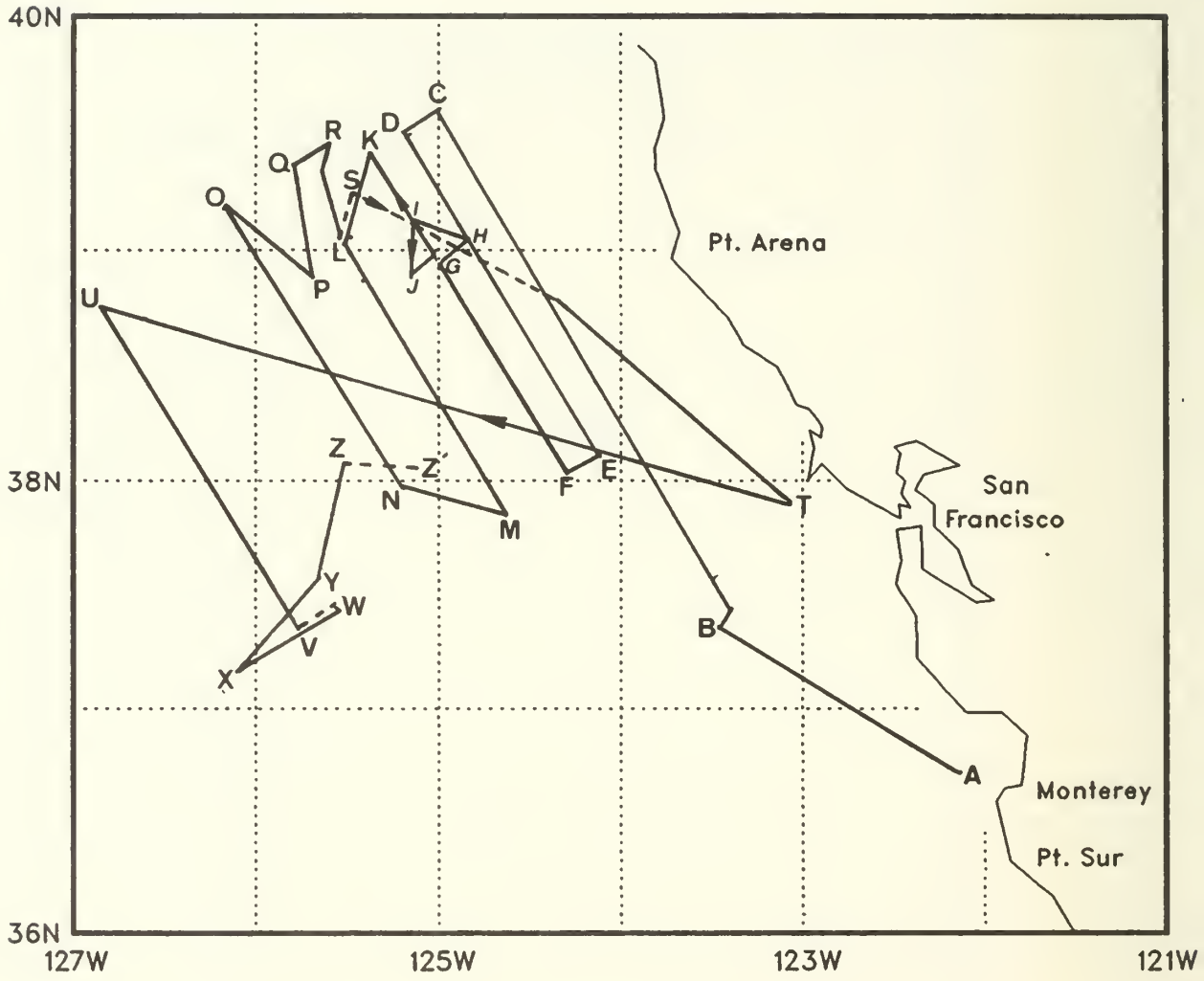


Figure 13: The cruise track for OPTOMA13. The first excursion of the track is shown as a solid line, the second excursion as a broken line.

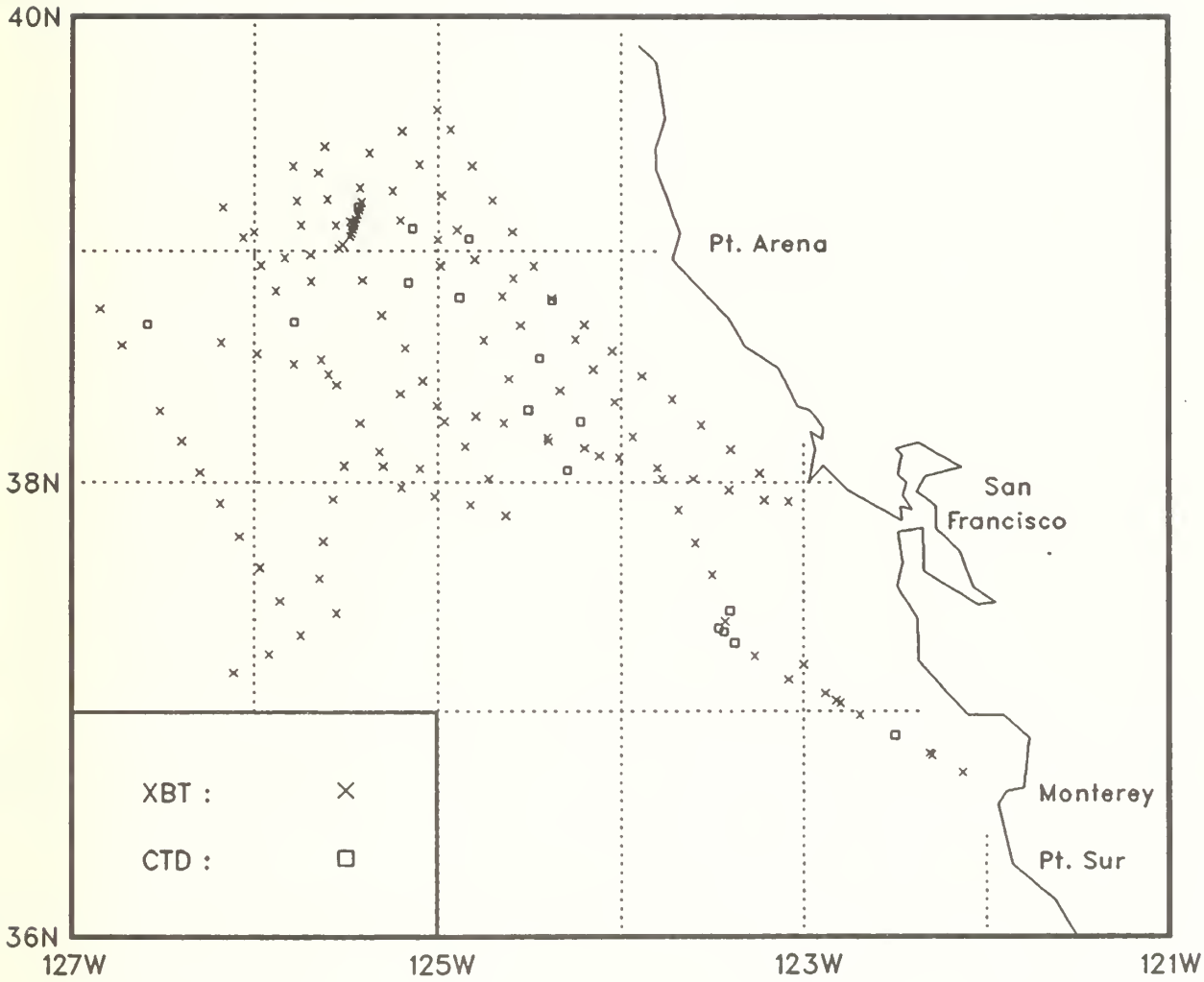


Figure 14: XBT and CTD locations for OPTOMA13.

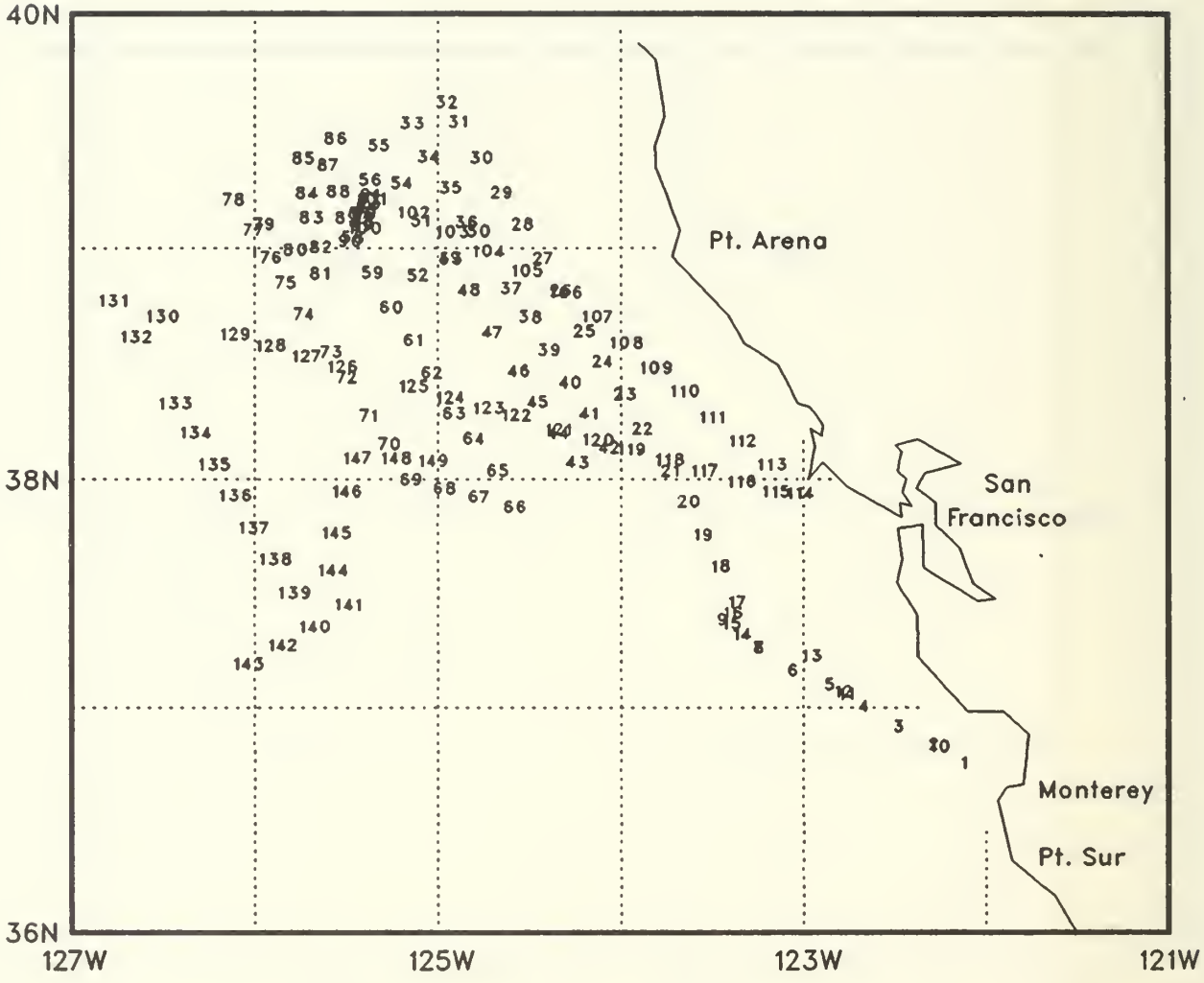


Figure 15: Station numbers for OPTOMA13.

Table 3: OPTOMA13 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	84296	1724	36.44	122.08	12.7			
2	XBT	84296	1816	36.49	122.19	14.4			
3	CTD	84296	1919	36.54	122.30	14.3	33.35	*	33.21
4	XBT	84296	2030	36.59	122.42	14.2			
5	XBT	84296	2127	37.05	122.53	15.0			
6	XBT	84296	2224	37.08	123.05	15.1			
7	XBT	84296	2322	37.15	123.16	14.4			
8	XBT	84297	3	37.15	123.16	14.1			
9	CTD	84297	122	37.22	123.28	13.6	33.27	13.8	33.23
10	XBT	84297	2250	36.48	122.18	14.7			
11	XBT	84278	115	37.02	122.48	14.3			
12	XBT	84298	122	37.03	122.49	14.4			
13	XBT	84298	302	37.12	123.00	15.2			
14	CTD	84298	415	37.18	123.23	13.2	33.32	13.9	33.42
15	CTD	84298	825	37.21	123.26	12.7	33.43	13.0	33.45
16	XBT	84298	910	37.24	123.26	14.3			
17	CTD	84298	1013	37.26	123.24	13.8	33.18	14.0	33.20
18	XBT	84298	1152	37.36	123.30	14.3			
19	XBT	84298	1302	37.44	123.35	13.8			
20	XBT	84298	1426	37.53	123.41	13.1			
21	XBT	84298	1547	38.01	123.46	13.1			
22	XBT	84298	1805	38.12	123.56	12.7			
23	XBT	84298	1949	38.21	124.02	13.1			
24	XBT	84298	2144	38.29	124.09	12.9			
25	XBT	84298	2341	38.37	124.15	11.7			
26	XBT	84299	201	38.48	124.23	11.6			
27	XBT	84299	344	38.56	124.28	12.6			
28	XBT	84299	531	39.05	124.35	12.7			
29	XBT	84299	702	39.13	124.42	12.7			
30	XBT	84299	836	39.22	124.49	12.7			
31	XBT	84299	1039	39.31	124.56	13.5			
32	XBT	84299	1147	39.36	125.00	14.1			
33	XBT	84299	1321	39.31	125.12	14.2			
34	XBT	84299	1409	39.22	125.06	13.4			
35	XBT	84299	1457	39.14	124.59	12.8			
36	XBT	84299	1603	39.05	124.54	12.6			
37	XBT	84299	1758	38.48	124.39	11.9			
38	XBT	84299	1841	38.41	124.33	11.4			
39	CTD	84299	1955	38.32	124.27	12.1	33.26	12.3	33.26
40	XBT	84299	2125	38.24	124.20	12.9			
41	CTD	84299	2235	38.16	124.13	13.8	33.10	14.0	33.16
42	XBT	84299	2352	38.07	124.07	13.4			
43	CTD	84300	128	38.03	124.18	14.0	32.98	13.8	32.99
44	XBT	84300	305	38.11	124.24	14.0			
45	CTD	84300	444	38.19	124.30	13.6	33.10	13.6	33.13

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)
46	XBT	84300	628	38.27	124.37	13.0			
47	XBT	84300	739	38.37	124.45	12.2			
48	CTD	84300	911	38.48	124.53	12.6	33.24	12.7	34.93
49	XBT	84300	1257	38.56	124.59	12.8			
50	CTD	84300	1521	39.03	124.50	12.5	33.07	*	33.50
51	CTD	84300	1702	39.06	125.08	12.5	33.11	12.8	33.07
52	CTD	84300	1911	38.52	125.10	13.0	33.22	12.8	33.21
53	XBT	84300	2222	38.56	124.59	13.0			
54	XBT	84301	122	39.15	125.15	12.9			
55	XBT	84301	240	39.25	125.22	14.3			
56	XBT	84301	326	39.16	125.25	13.6			
57	XBT	84301	410	39.08	125.29	12.7			
58	XBT	84301	439	39.02	125.31	12.7			
59	XBT	84301	531	38.52	125.25	13.1			
60	XBT	84301	622	38.43	125.18	13.1			
61	XBT	84301	710	38.35	125.11	14.2			
62	XBT	84301	757	38.26	125.05	14.6			
63	XBT	84301	847	38.16	124.58	14.1			
64	XBT	84301	935	38.09	124.51	13.1			
65	XBT	84301	1027	38.01	124.43	14.0			
66	XBT	84301	1118	37.51	124.38	14.1			
67	XBT	84301	1213	37.54	124.49	13.9			
68	XBT	84301	1302	37.56	125.01	13.4			
69	XBT	84301	1347	37.59	125.12	13.7			
70	XBT	84301	1447	38.08	125.19	13.8			
71	XBT	84301	1532	38.15	125.25	14.2			
72	XBT	84301	1633	38.25	125.33	14.3			
73	XBT	84301	1711	38.32	125.38	13.9			
74	CTD	84301	1836	38.42	125.47	13.6	33.12	13.8	33.07
75	XBT	84301	1958	38.50	125.53	13.8			
76	XBT	84301	2036	38.56	125.58	13.1			
77	XBT	84301	2119	39.03	126.04	13.6			
78	XBT	84301	2210	39.11	126.10	13.7			
79	XBT	84301	2303	39.05	126.00	13.8			
80	XBT	84301	2352	38.58	125.50	14.3			
81	XBT	84302	36	38.52	125.41	13.2			
82	XBT	84302	115	38.59	125.42	13.6			
83	XBT	84302	157	39.07	125.45	13.5			
84	XBT	84302	235	39.13	125.46	13.0			
85	XBT	84302	322	39.22	125.47	14.6			
86	XBT	84302	413	39.27	125.37	14.8			
87	XBT	84302	450	39.20	125.39	14.5			
88	XBT	84302	527	39.13	125.36	13.4			
89	XBT	84302	603	39.07	125.33	12.6			
90	XBT	84302	632	39.01	125.32	12.9			

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)
91	XBT	84302	917	39.13	125.25	13.7			
92	XBT	84302	939	39.12	125.25	13.3			
93	XBT	84302	955	39.10	125.26	13.2			
94	XBT	84302	1010	39.09	125.26	12.9			
95	XBT	84302	1026	39.08	125.27	12.8			
96	XBT	84302	1039	39.07	125.27	12.8			
97	XBT	84302	1052	39.07	125.28	12.8			
98	XBT	84302	1106	39.05	125.28	12.8			
99	XBT	84302	1118	39.05	125.28	12.8			
100	XBT	84302	1130	39.04	125.29	12.6			
101	CTD	84302	1602	39.11	125.26	13.2	33.03	13.2	33.06
102	XBT	84302	2005	39.08	125.12	12.7			
103	XBT	84302	2102	39.03	125.00	13.0			
104	XBT	84302	2155	38.58	124.48	12.9			
105	XBT	84302	2252	38.53	124.35	13.0			
106	CTD	84303	12	38.47	124.23	12.5	33.34	13.1	33.34
107	XBT	84303	214	38.41	124.12	12.4			
108	XBT	84303	338	38.34	124.03	12.2			
109	XBT	84303	501	38.28	123.53	12.0			
110	XBT	84303	625	38.22	123.43	13.5			
111	XBT	84303	810	38.15	123.34	13.2			
112	XBT	84303	934	38.09	123.24	12.9			
113	XBT	84303	1109	38.02	123.15	11.8			
114	XBT	84303	1243	37.55	123.05	11.8			
115	XBT	84305	2103	37.55	123.13	11.6			
116	XBT	84305	2200	37.58	123.24	11.3			
117	XBT	84305	2311	38.01	123.36	13.5			
118	XBT	84306	18	38.04	123.48	13.0			
119	XBT	84306	126	38.07	124.00	12.6			
120	XBT	84306	225	38.09	124.12	13.9			
121	XBT	84306	327	38.12	124.24	13.5			
122	XBT	84306	443	38.15	124.38	12.6			
123	XBT	84306	530	38.17	124.48	12.2			
124	XBT	84306	636	38.20	125.00	13.8			
125	XBT	84306	740	38.23	125.12	14.2			
126	XBT	84306	922	38.28	125.36	13.8			
127	XBT	84306	1010	38.31	125.47	13.3			
128	XBT	84306	1101	38.34	125.59	16.5			
129	XBT	84306	1152	38.37	126.11	16.8			
130	CTD	84306	1411	38.41	126.35	16.7	32.73	16.8	*
131	XBT	84306	1528	38.45	126.51	16.4			
132	XBT	84306	1644	38.36	126.43	17.3			
133	XBT	84306	1850	38.19	126.31	17.3			
134	XBT	84306	2000	38.11	126.24	17.2			
135	XBT	84306	2113	38.03	126.18	17.0			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)
136	XBT	84306	2213	37.54	126.11	17.0
137	XBT	84306	2311	37.46	126.05	16.6
138	XBT	84307	10	37.38	125.58	15.9
139	XBT	84307	109	37.29	125.52	16.6
140	XBT	84307	209	37.20	125.45	15.1
141	XBT	84307	309	37.26	125.33	15.3
142	XBT	84307	544	37.15	125.55	15.2
143	XBT	84307	702	37.10	126.07	15.1
144	XBT	84307	956	37.35	125.39	16.0
145	XBT	84307	1056	37.45	125.37	15.8
146	XBT	84307	1205	37.56	125.34	14.9
147	XBT	84307	1259	38.04	125.30	13.3
148	XBT	84307	1406	38.04	125.18	13.8
149	XBT	84307	1456	38.04	125.06	14.2

* Data not available

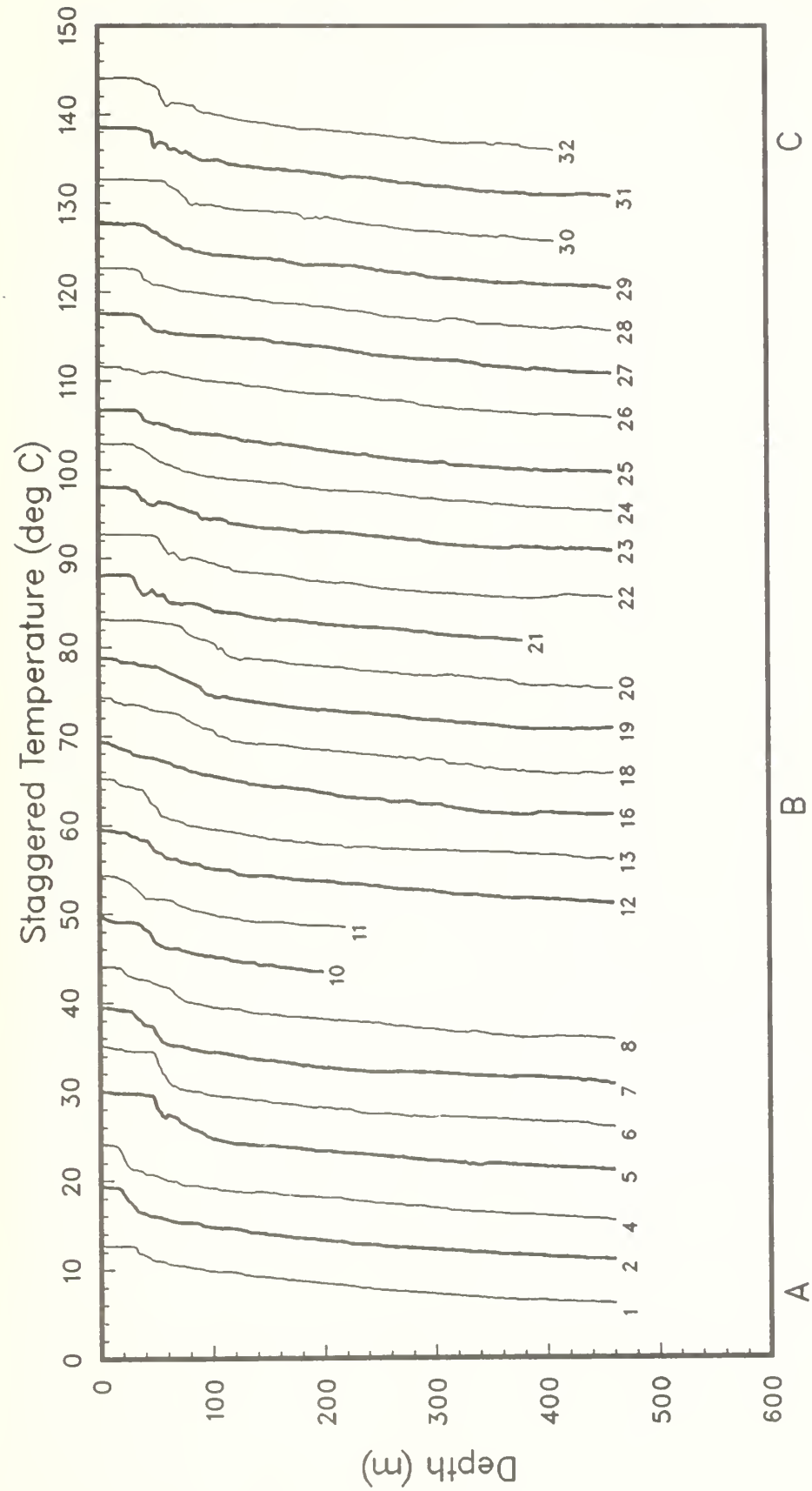


Figure 16(a): XBT temperature profiles, staggered by multiples of 5C (OPTOMA13).

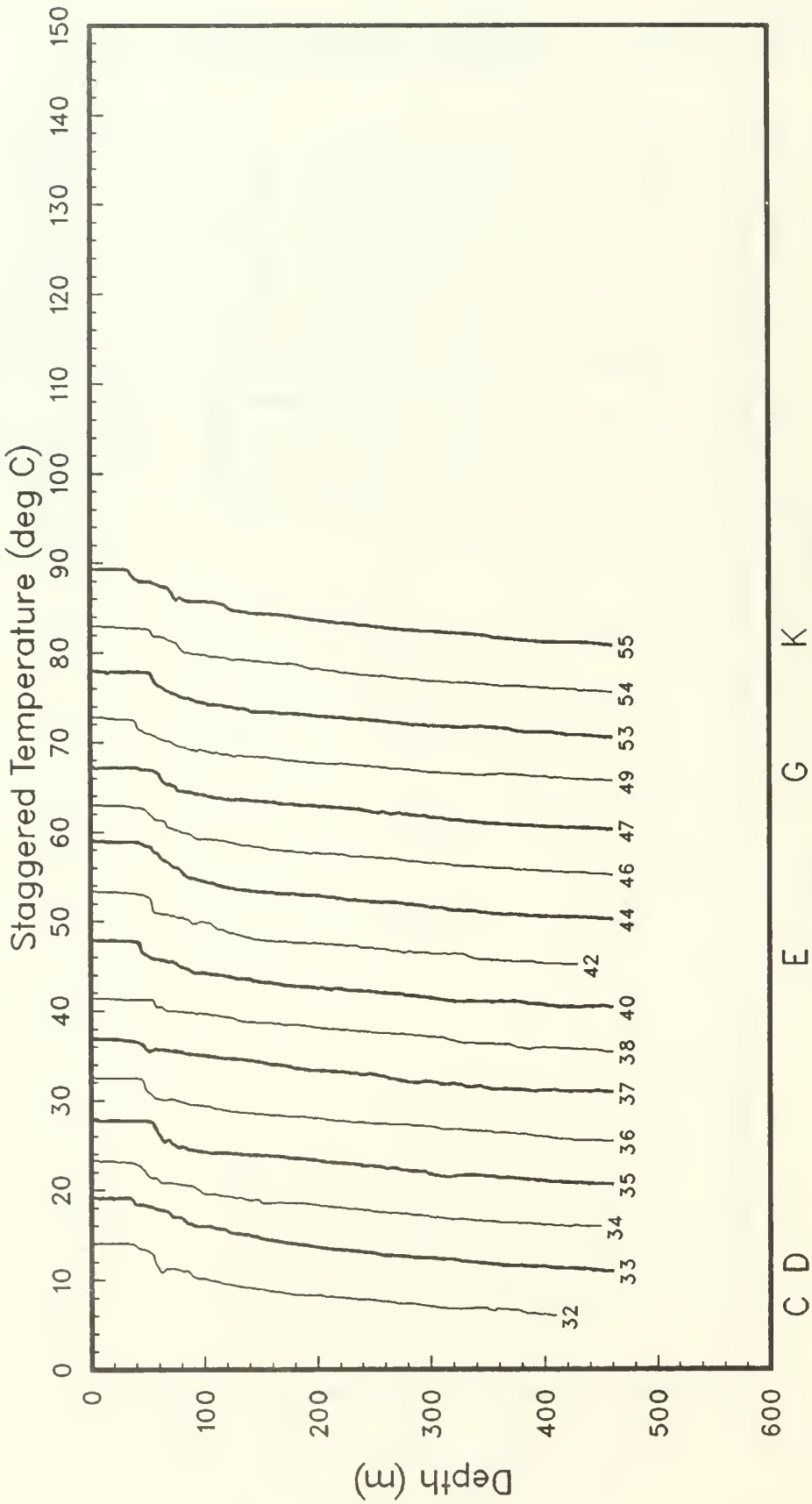

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
32
33
34
35
36
37
38
40
42
44
46
47
49
53
54
55
C D
E
G
K

Figure 16(b)

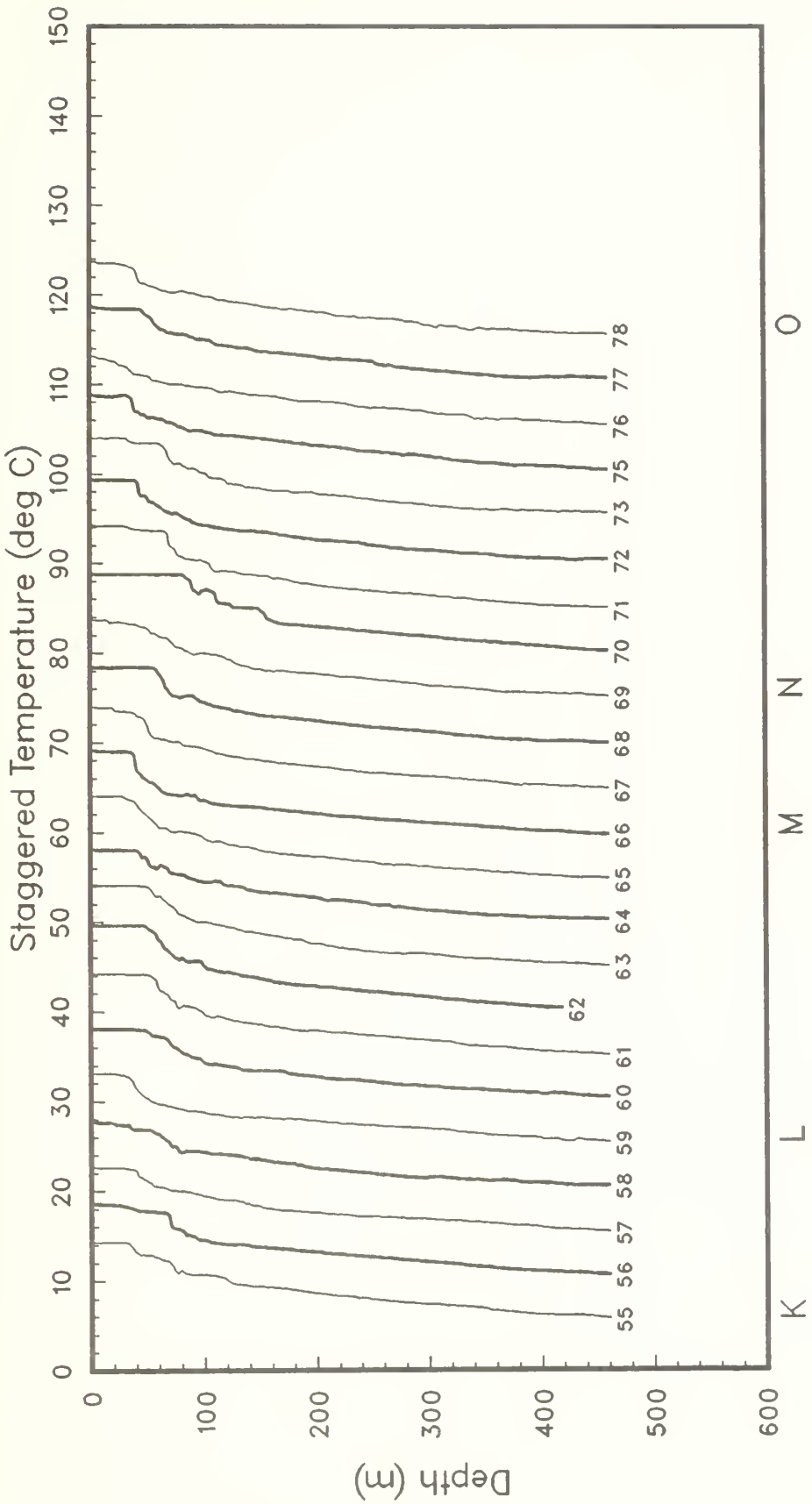

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
75
76
77
78
K
L
M
N
O

Figure 16(c)

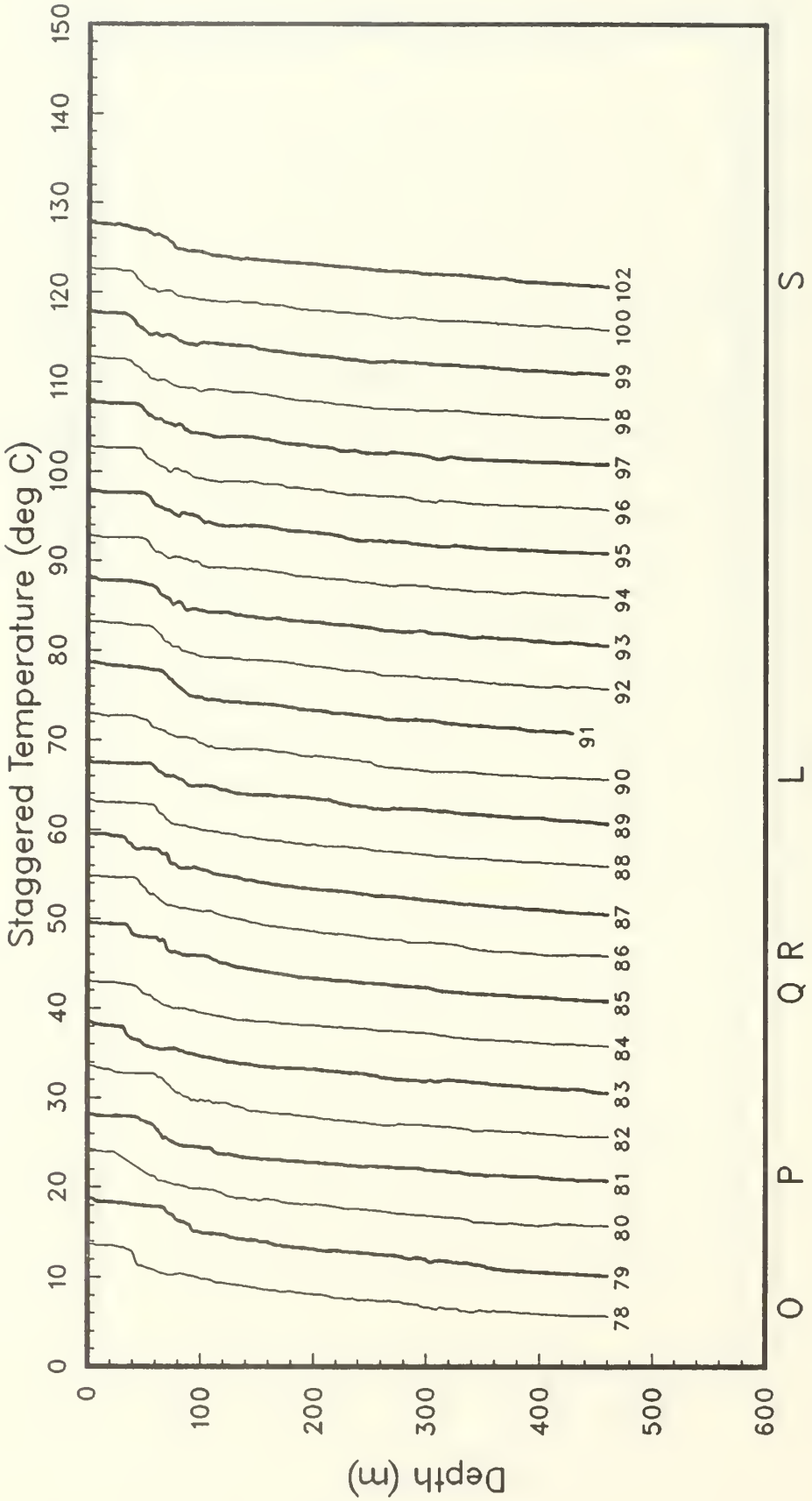

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 102
O P Q R L S

Figure 16(d)

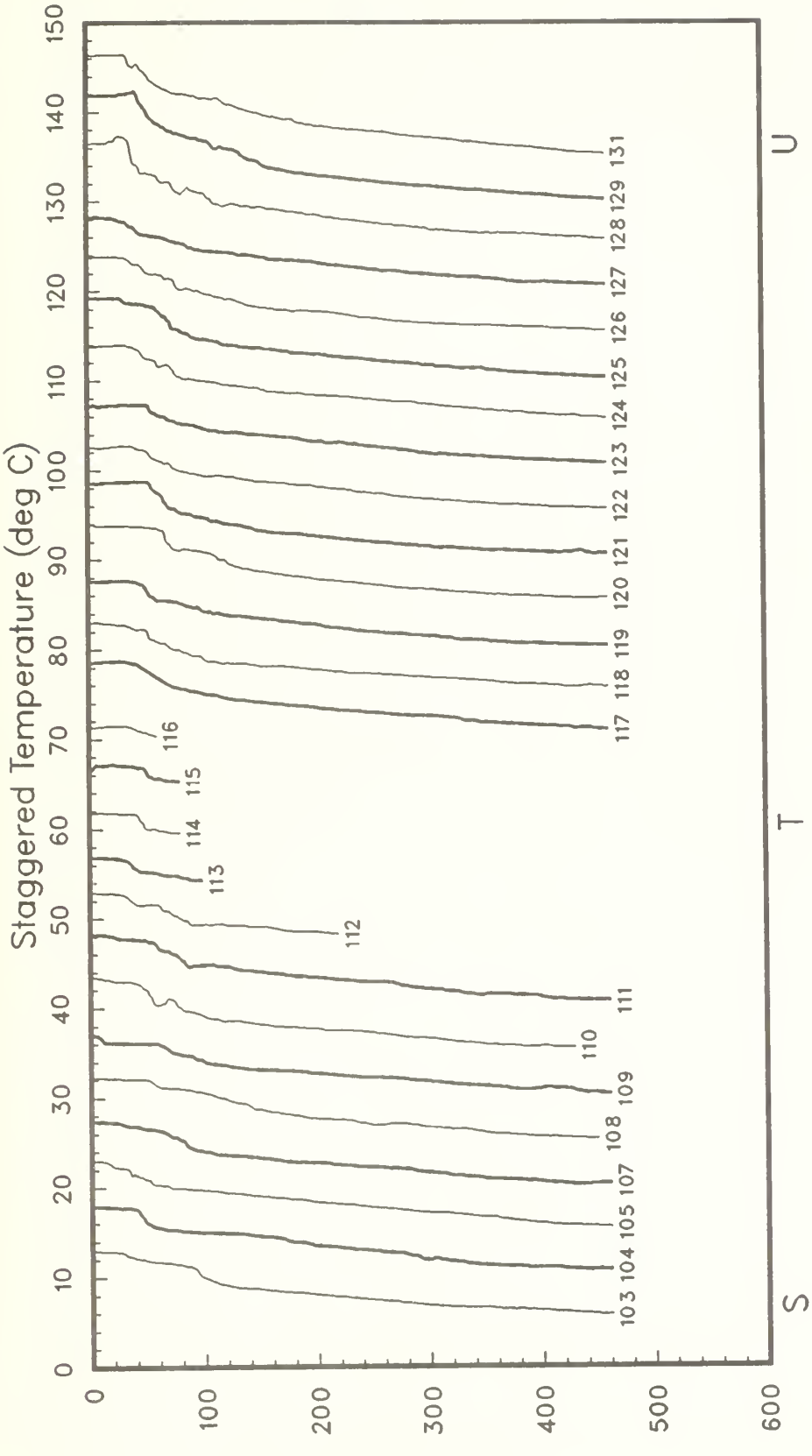

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
S
T
U
103 104 105 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 131

Figure 16(e)

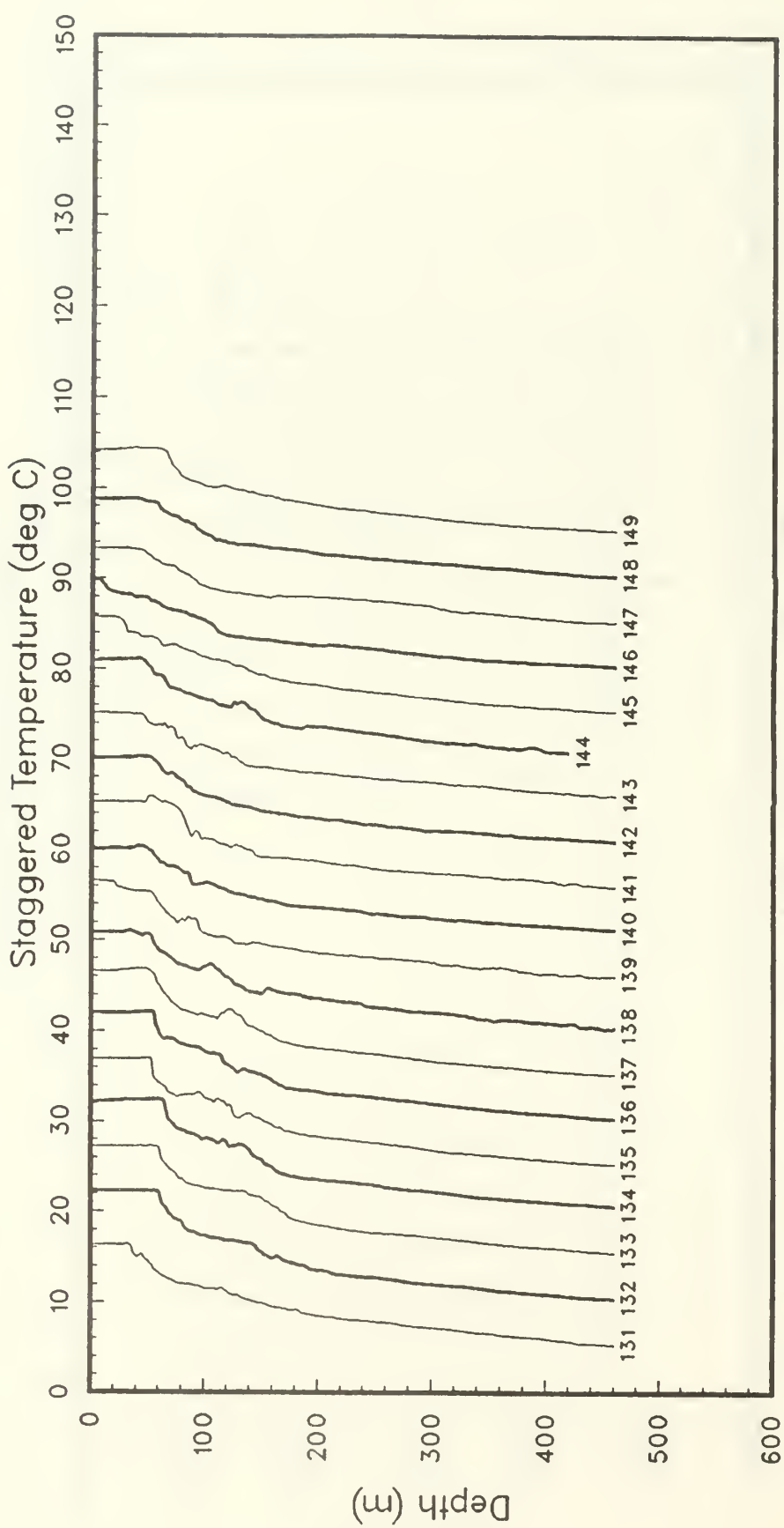

Staggered Temperature (deg C)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Depth (m)
0 100 200 300 400 500 600
131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149
U V W X Y Z Z'

Figure 16(f)

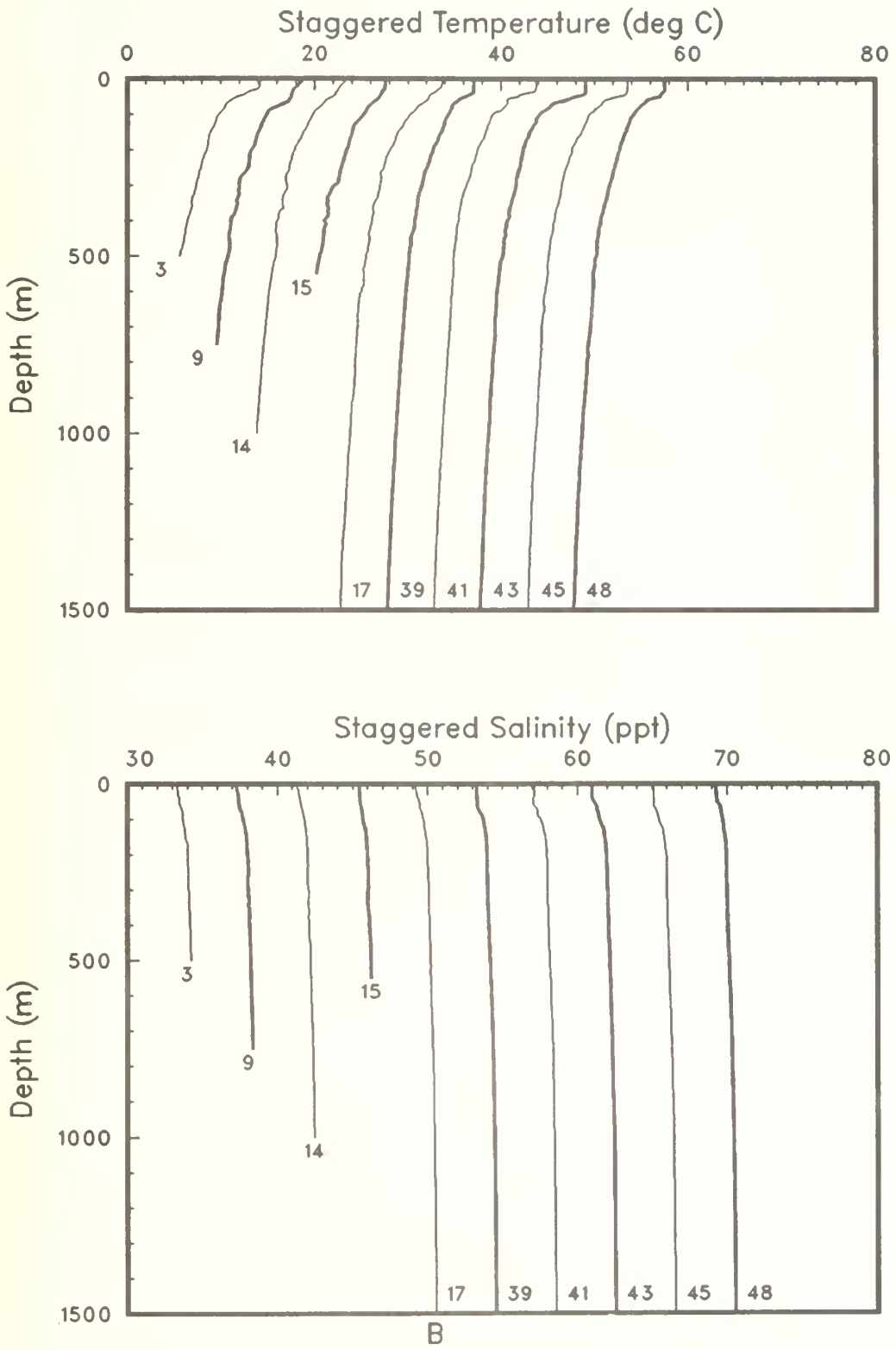


Figure 17(a): CTD temperature profiles, staggered by multiples of 5C, and salinity profiles staggered by multiples of 4 ppt. (OPTOMA13).

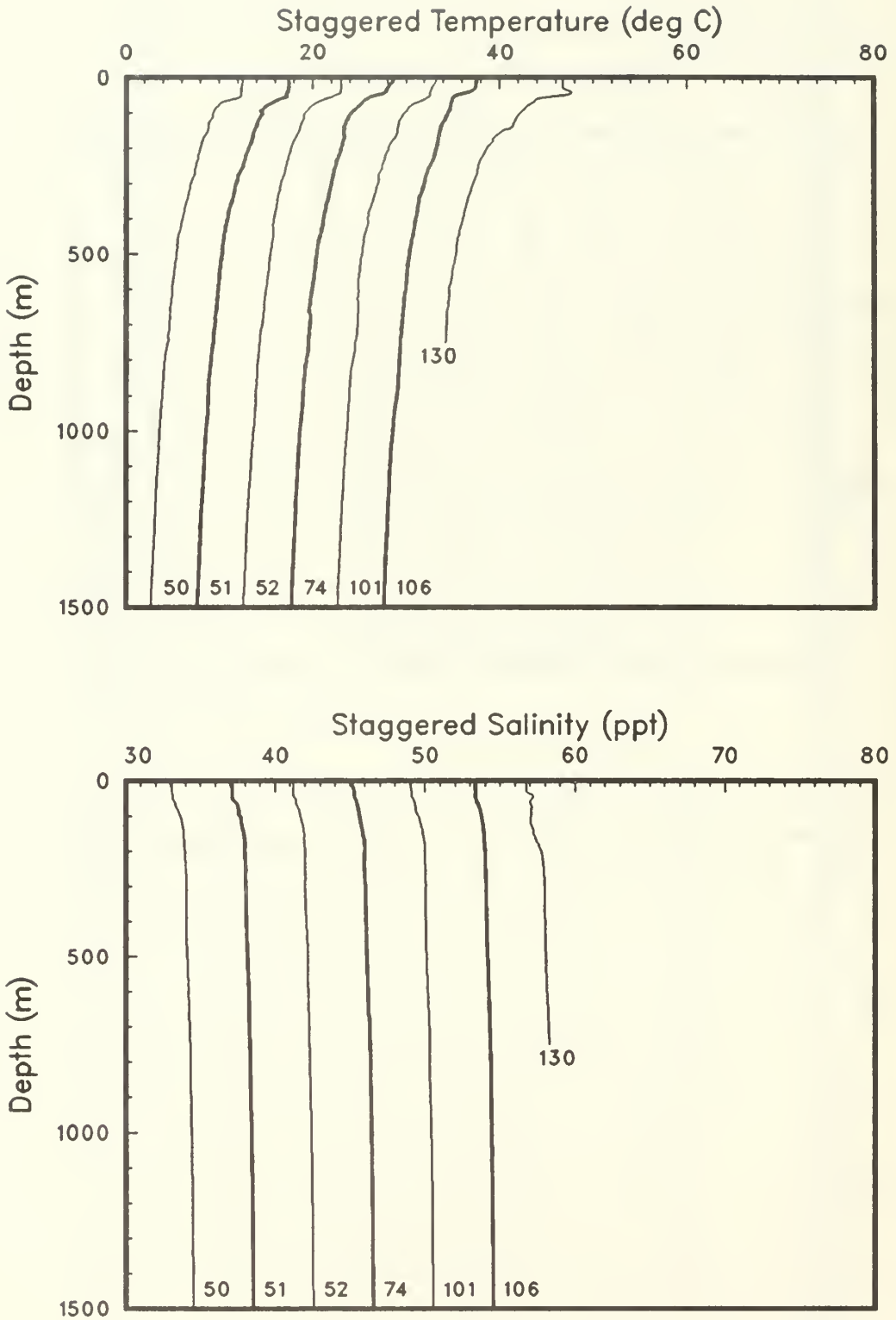

Staggered Temperature (deg C)
0
20
40
60
80
Depth (m)
0
500
1000
1500
130
50
51
52
74
101
106
Staggered Salinity (ppt)
30
40
50
60
70
80
Depth (m)
0
500
1000
1500
130
50
51
52
74
101
106

Figure 17(b)

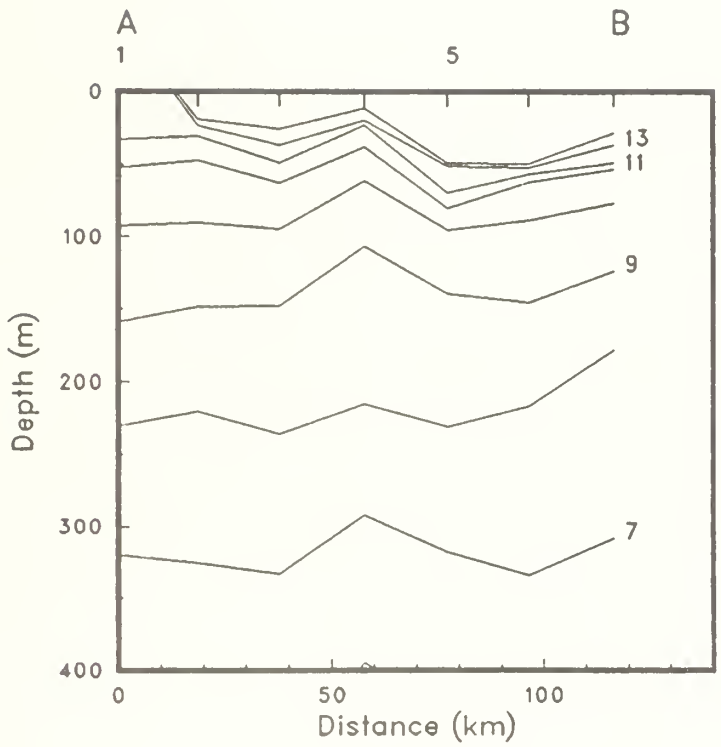


Figure 18(a): Along-track isotherms. Tick marks along the upper horizontal axis show station positions. Some station numbers are given. Dashed lines are used if the cast was too shallow (OPTOMA13).

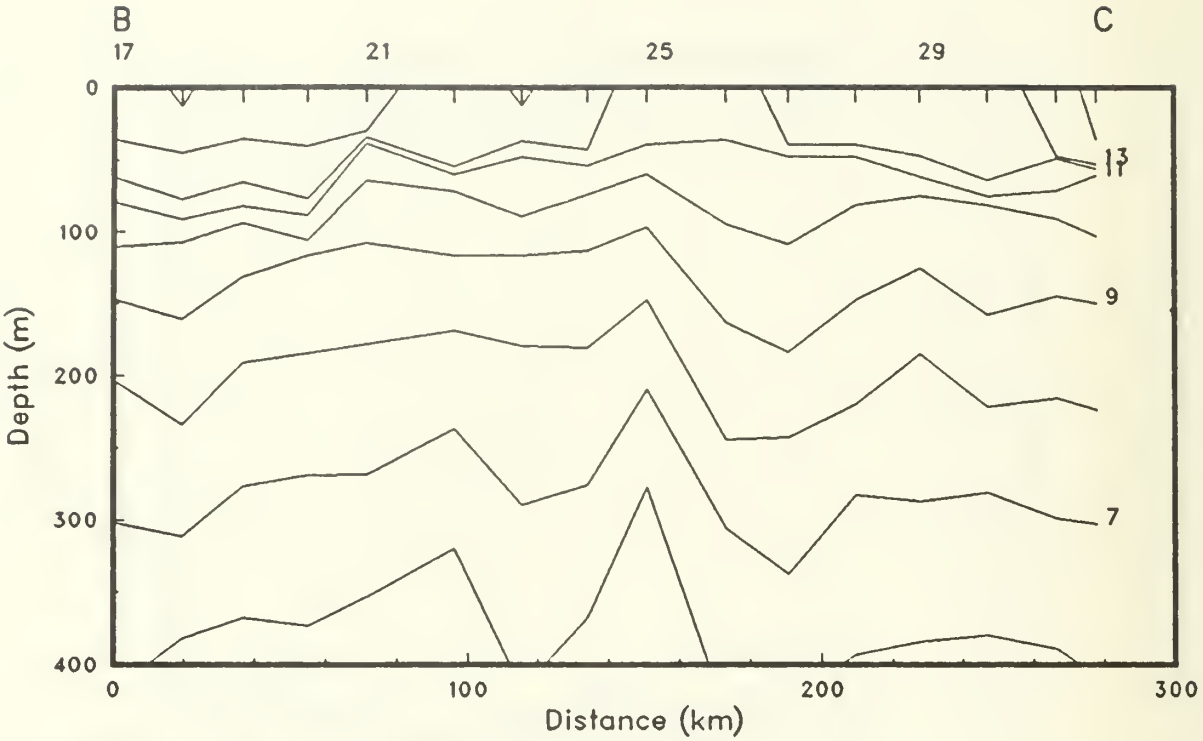


Figure 18(b)

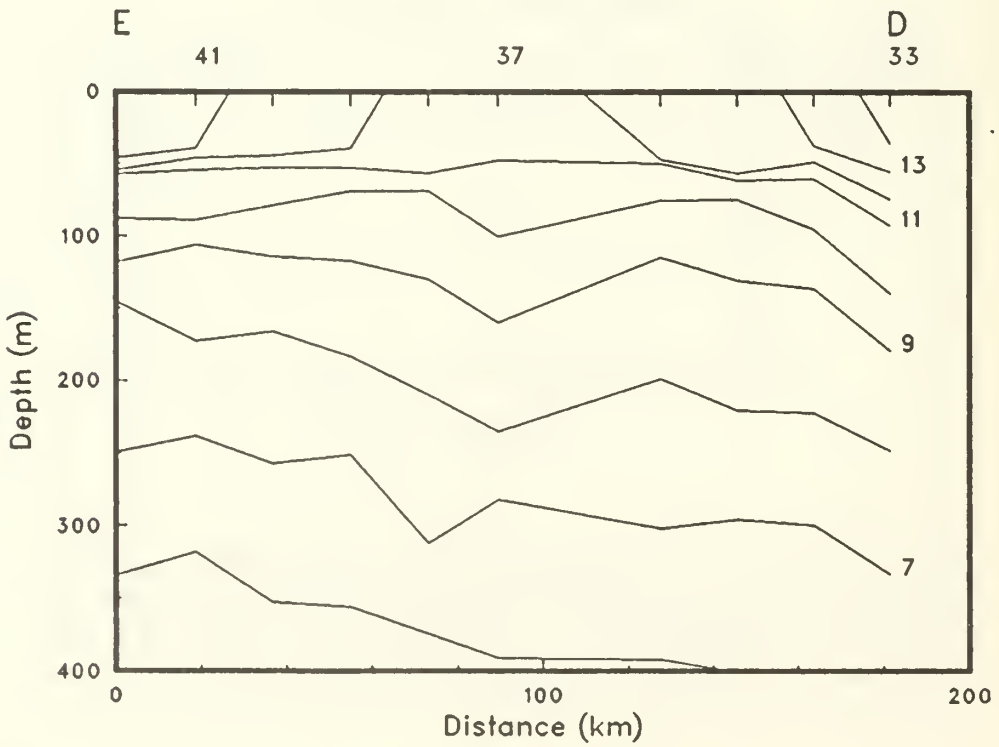


Figure 18(c)

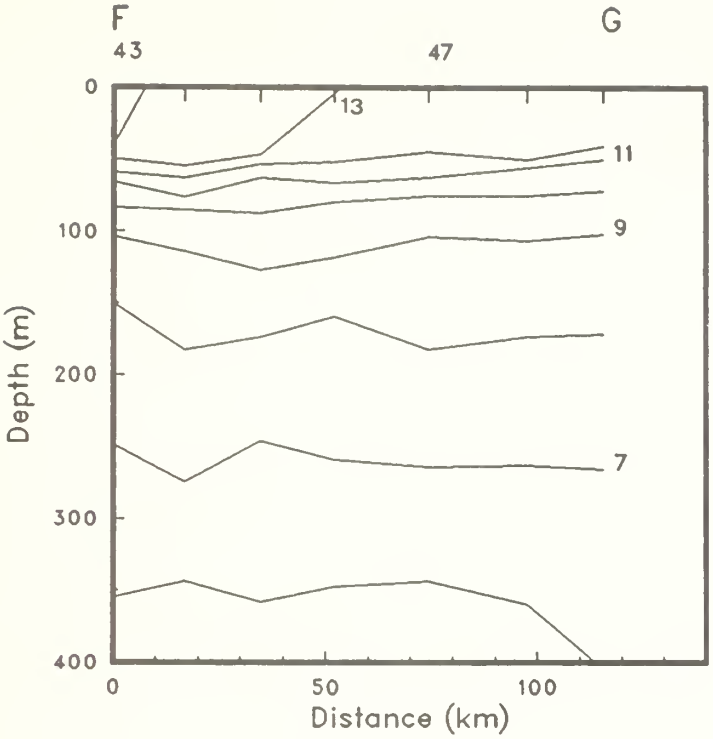


Figure 18(d)

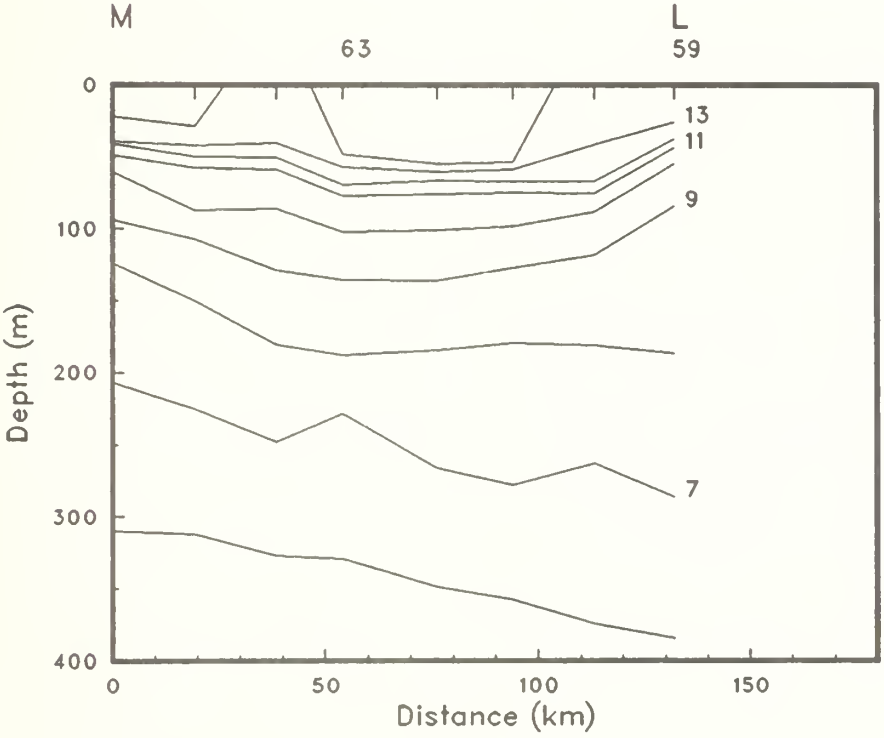


Figure 18(e)

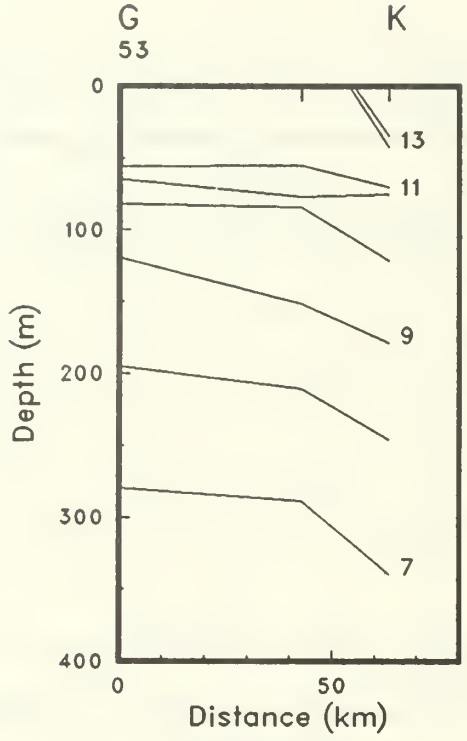


Figure 18(f)

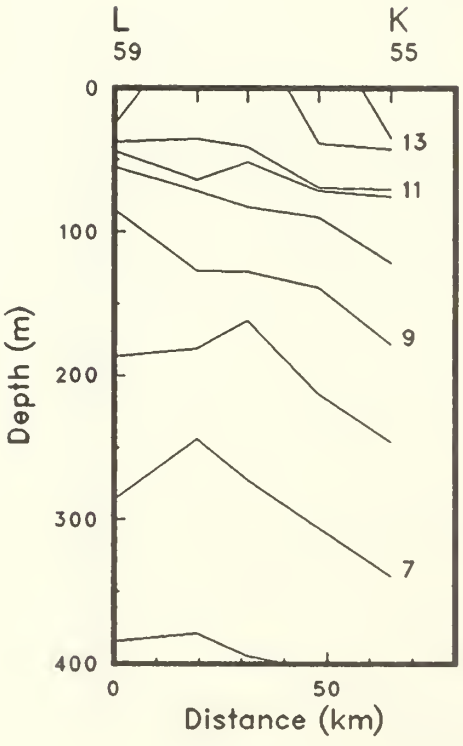


Figure 18(g)

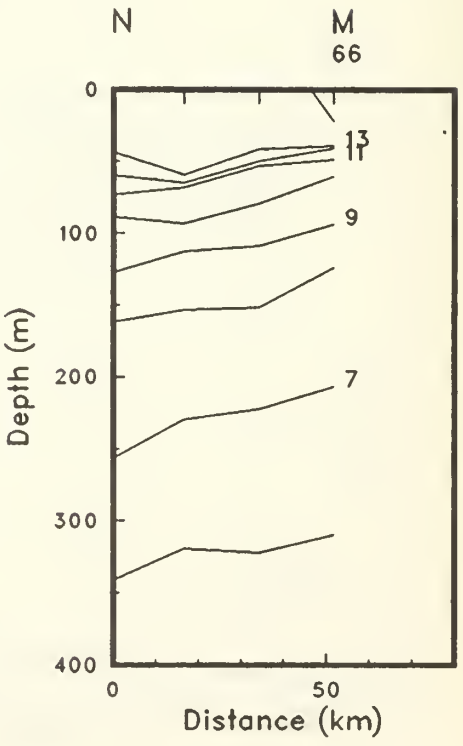


Figure 18(h)

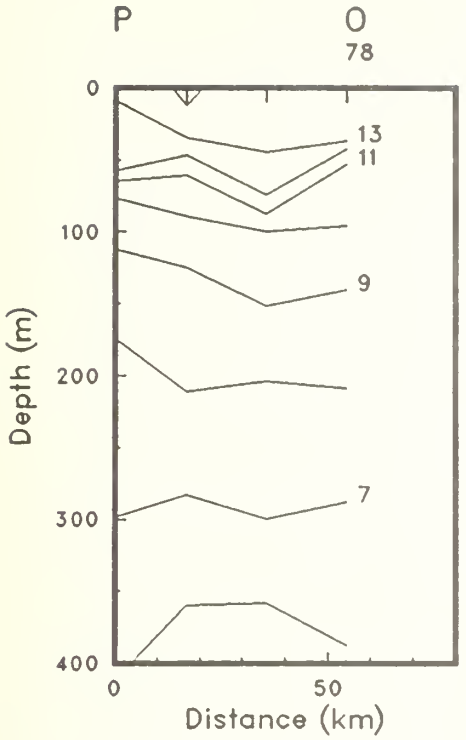


Figure 18(i)

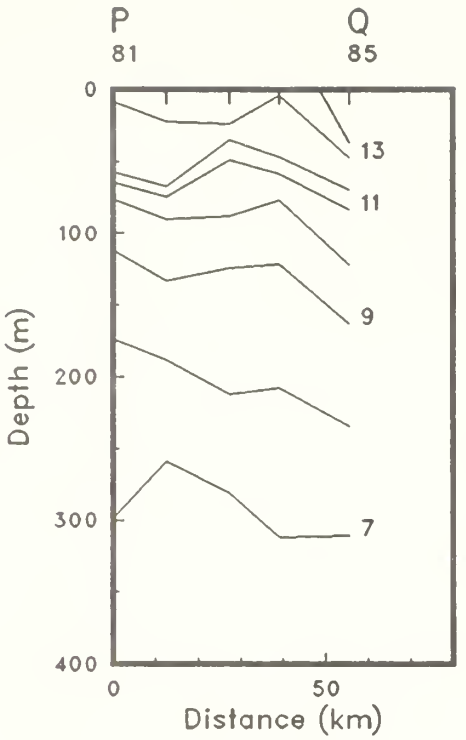


Figure 18(j)

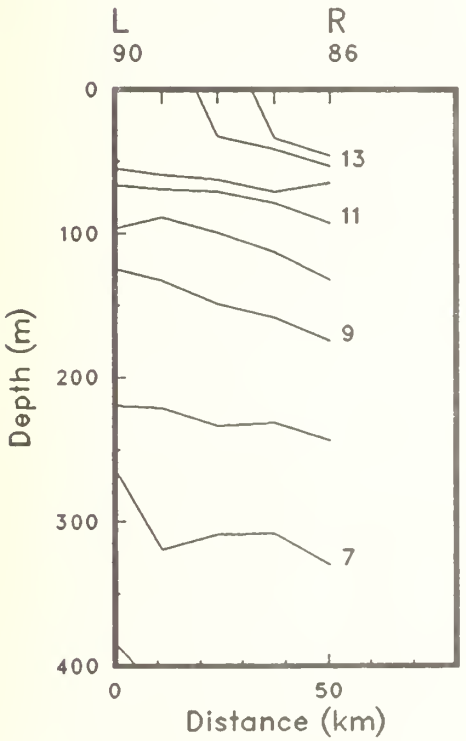


Figure 18(k)

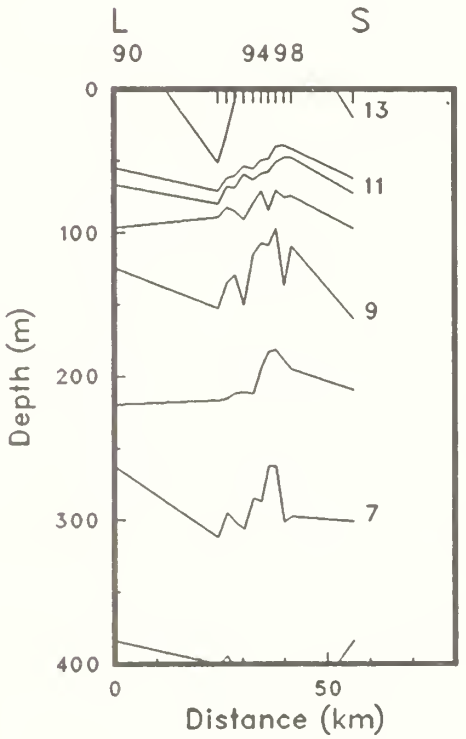


Figure 18(l)

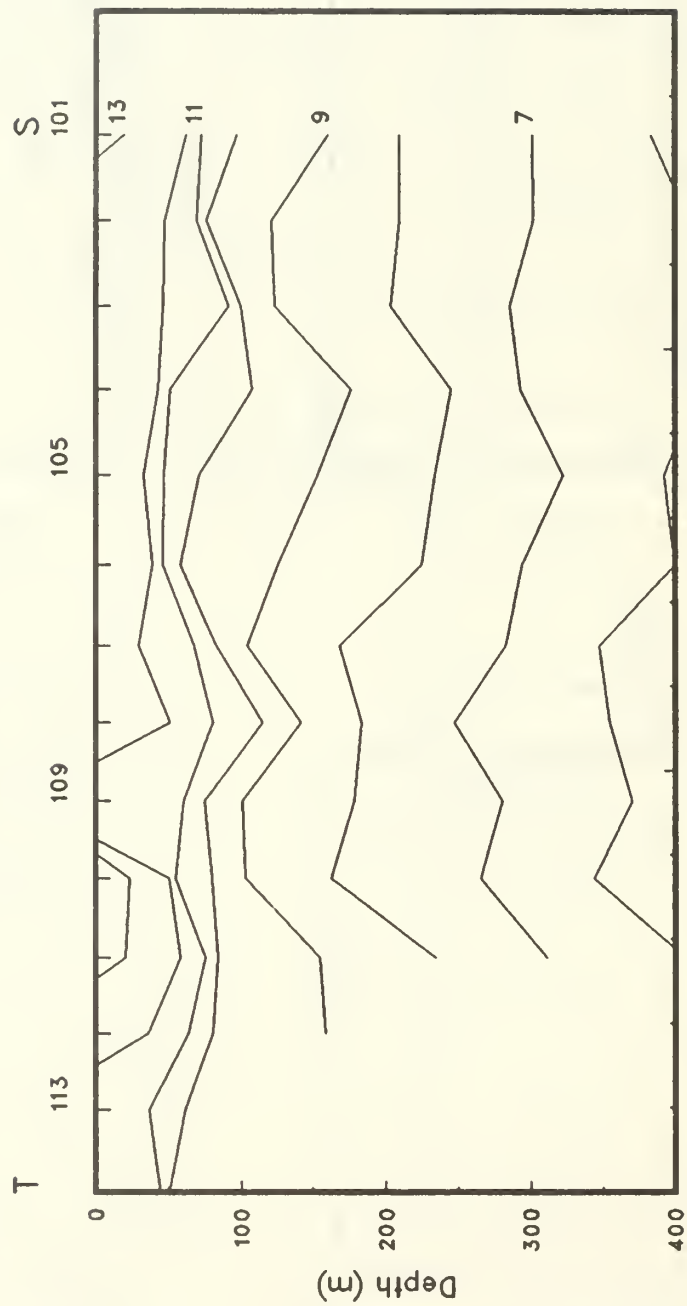

T
113
109
105
S
101
13
11
9
7
0
100
200
300
400
Depth (m)
0
100
200
Distance (km)

Figure 18(m)

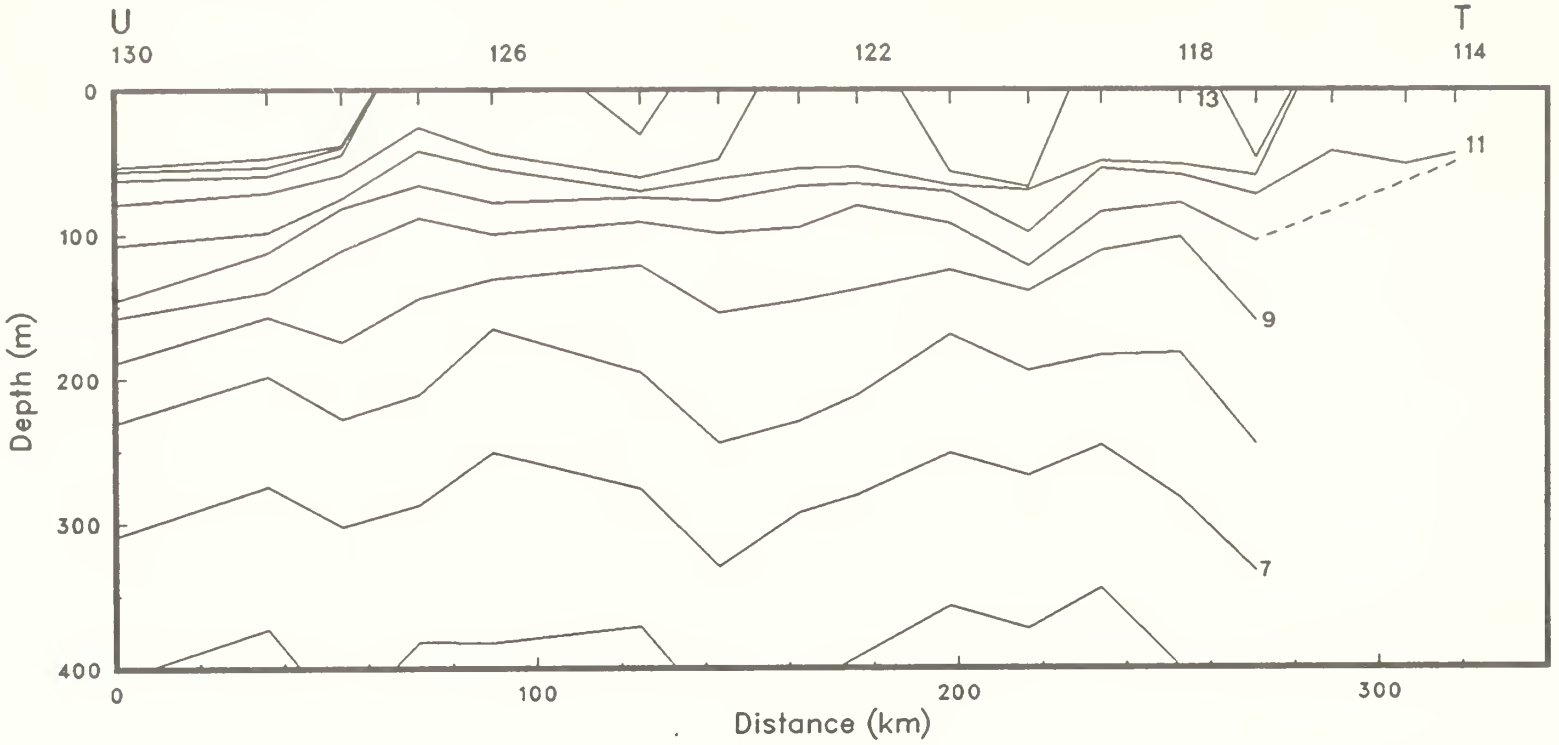

U
T
130
126
122
118
114
0
100
200
300
400
Depth (m)
13
11
9
7
0
100
200
300
Distance (km)

Figure 18(n)

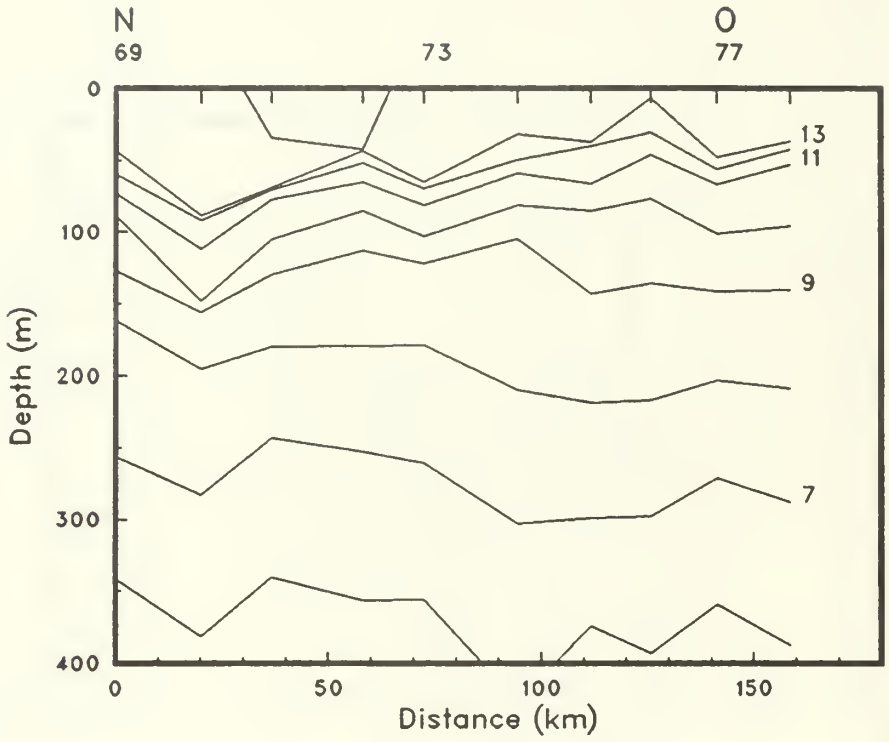


Figure 18(o)

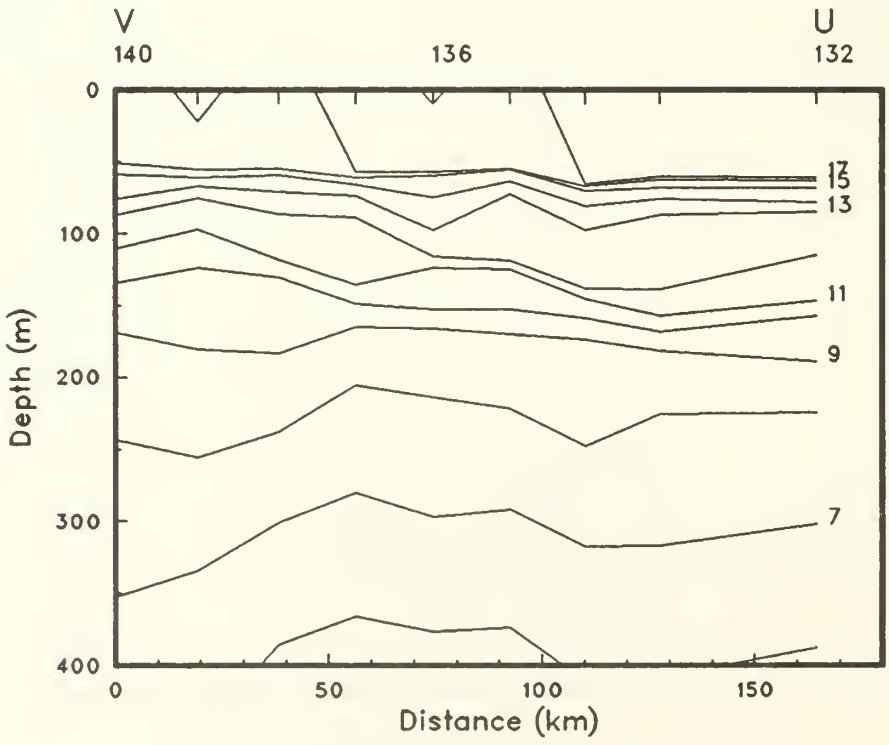


Figure 18(p)

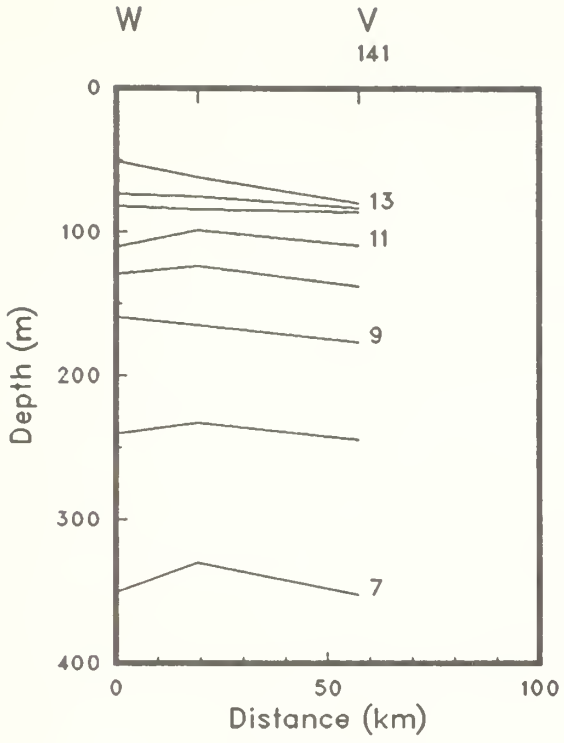


Figure 18(q)

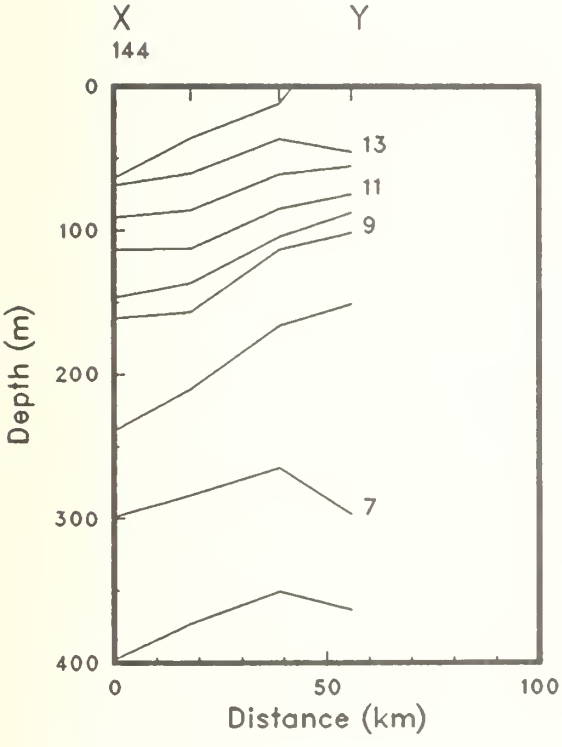


Figure 18(r)

Figure 18(s)

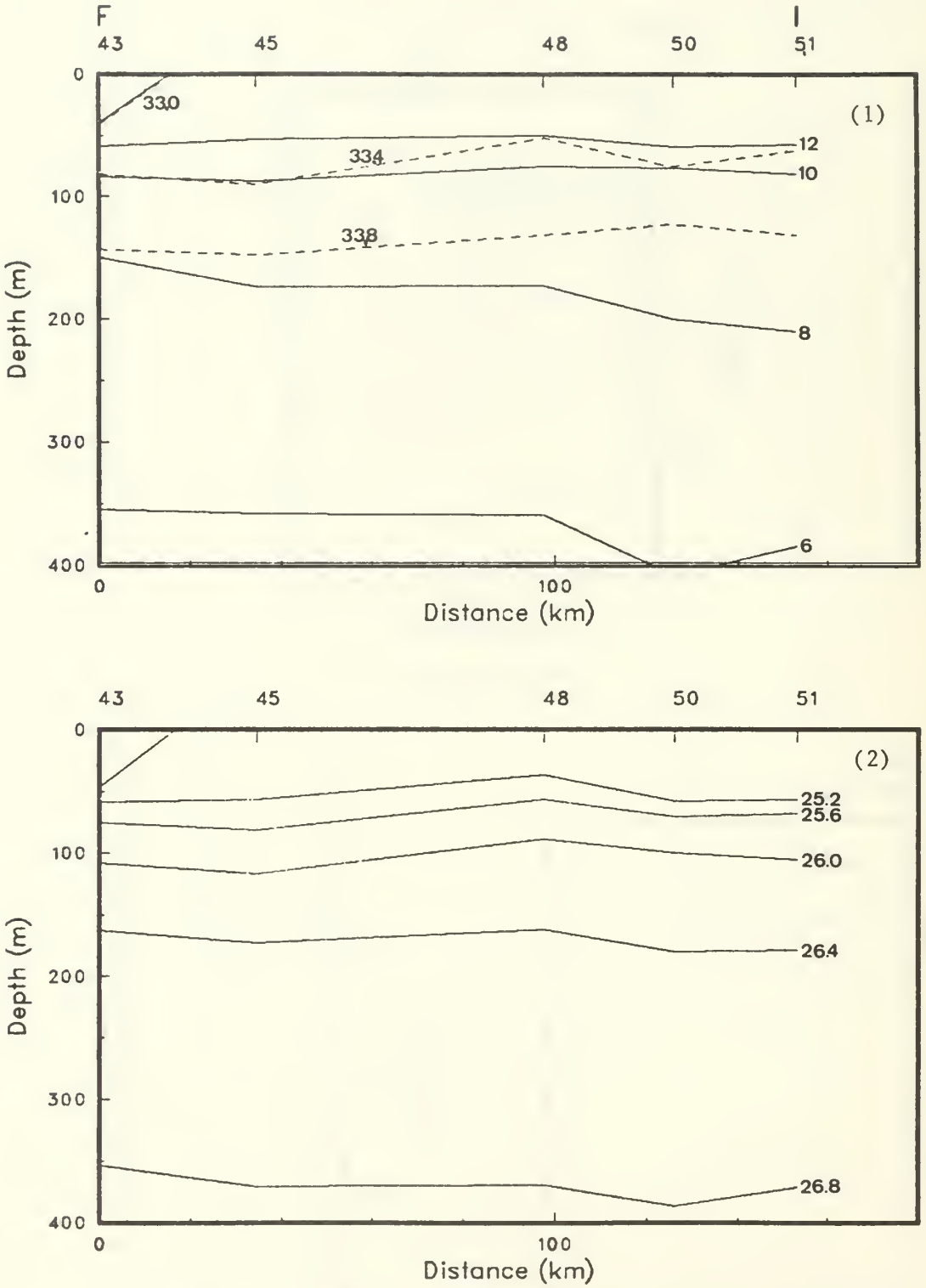


Figure 19: Isopleths of (1) temperature and salinity and (2) sigma-t from the CTD's (OPTOMA13).

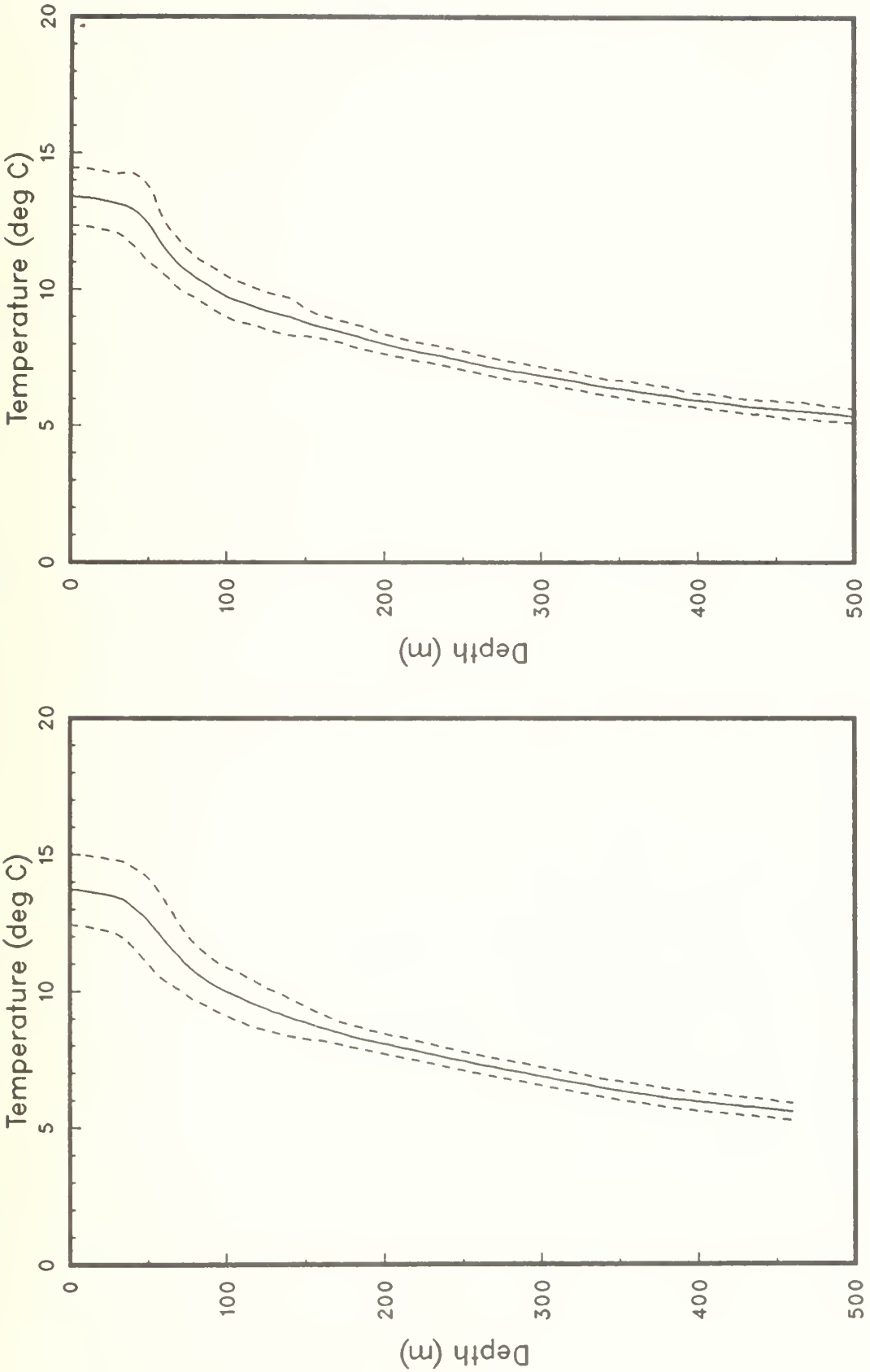
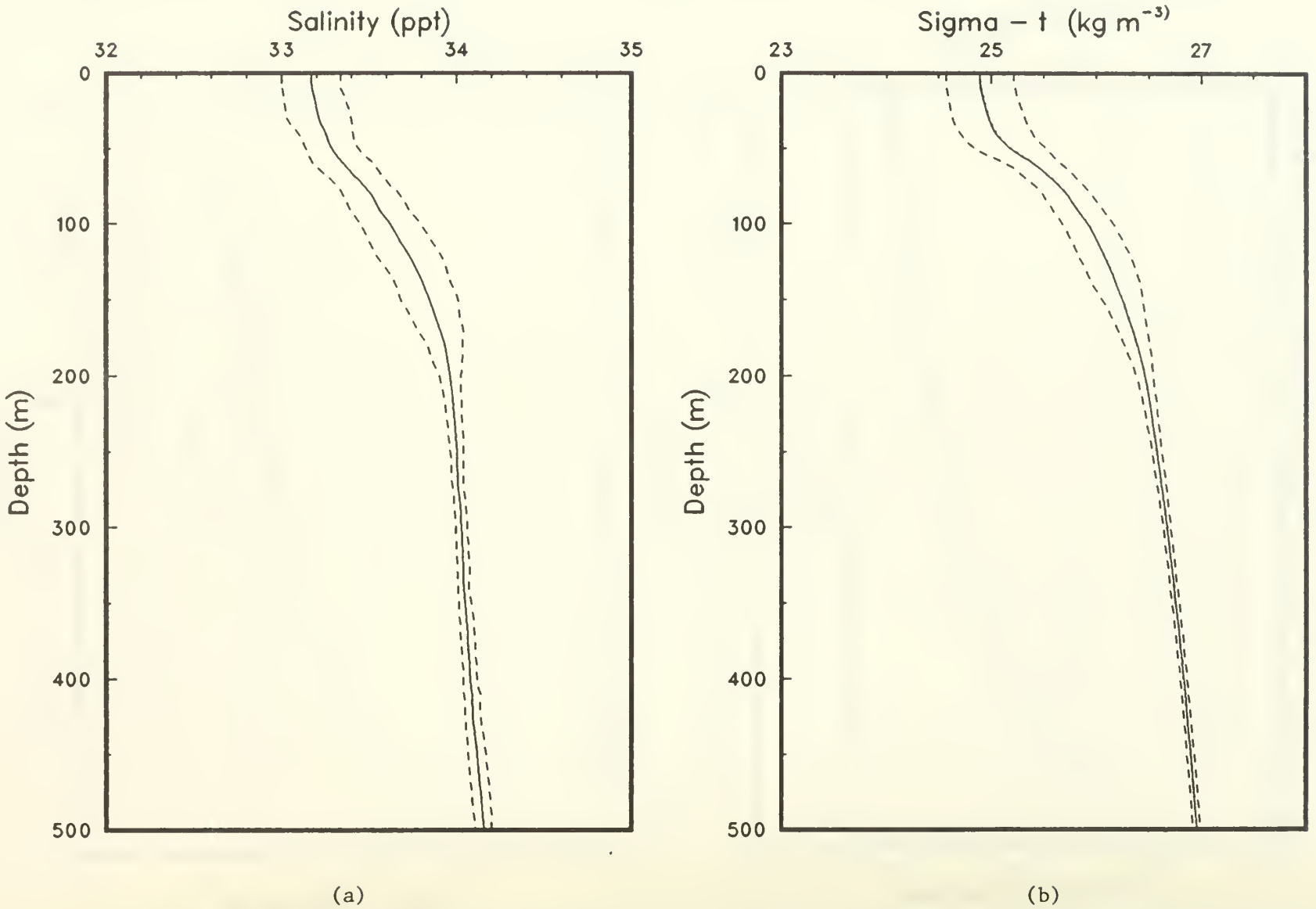


Figure 20: Mean temperature profiles from (a) XBT's and (b) CTD's, with + and - the standard deviation (OPTOMA13).



(a) (b)

Figure 21: Mean profiles of (a) salinity and (b) sigma-t, with + and - the standard deviations, from the CTD's (OPTOMA13).

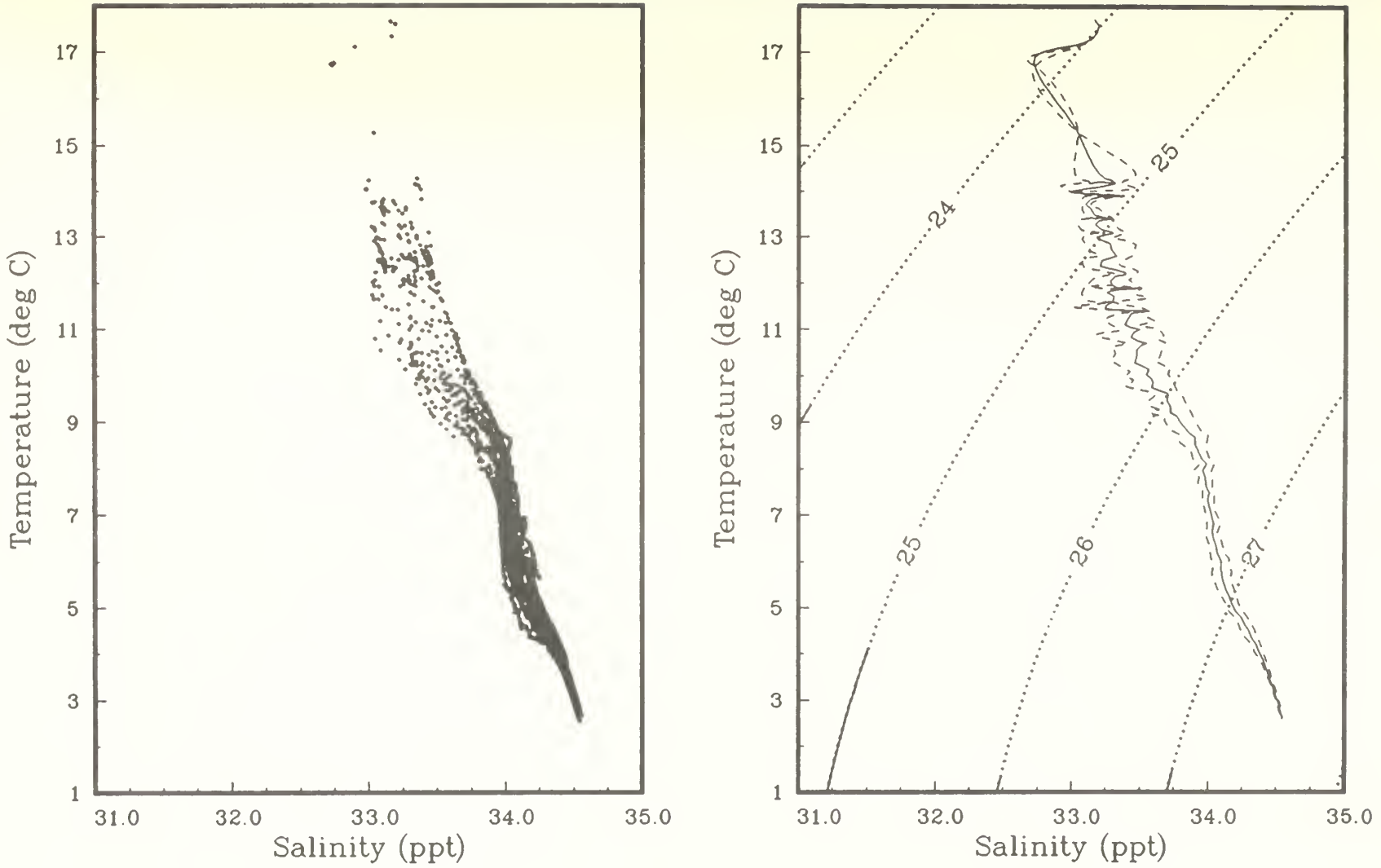


Figure 22: (a) T-S pairs and (b) mean T-S relation, with + and - the standard deviation, from the CTD's. Selected sigma-t contours are also shown (OPTOMA13).

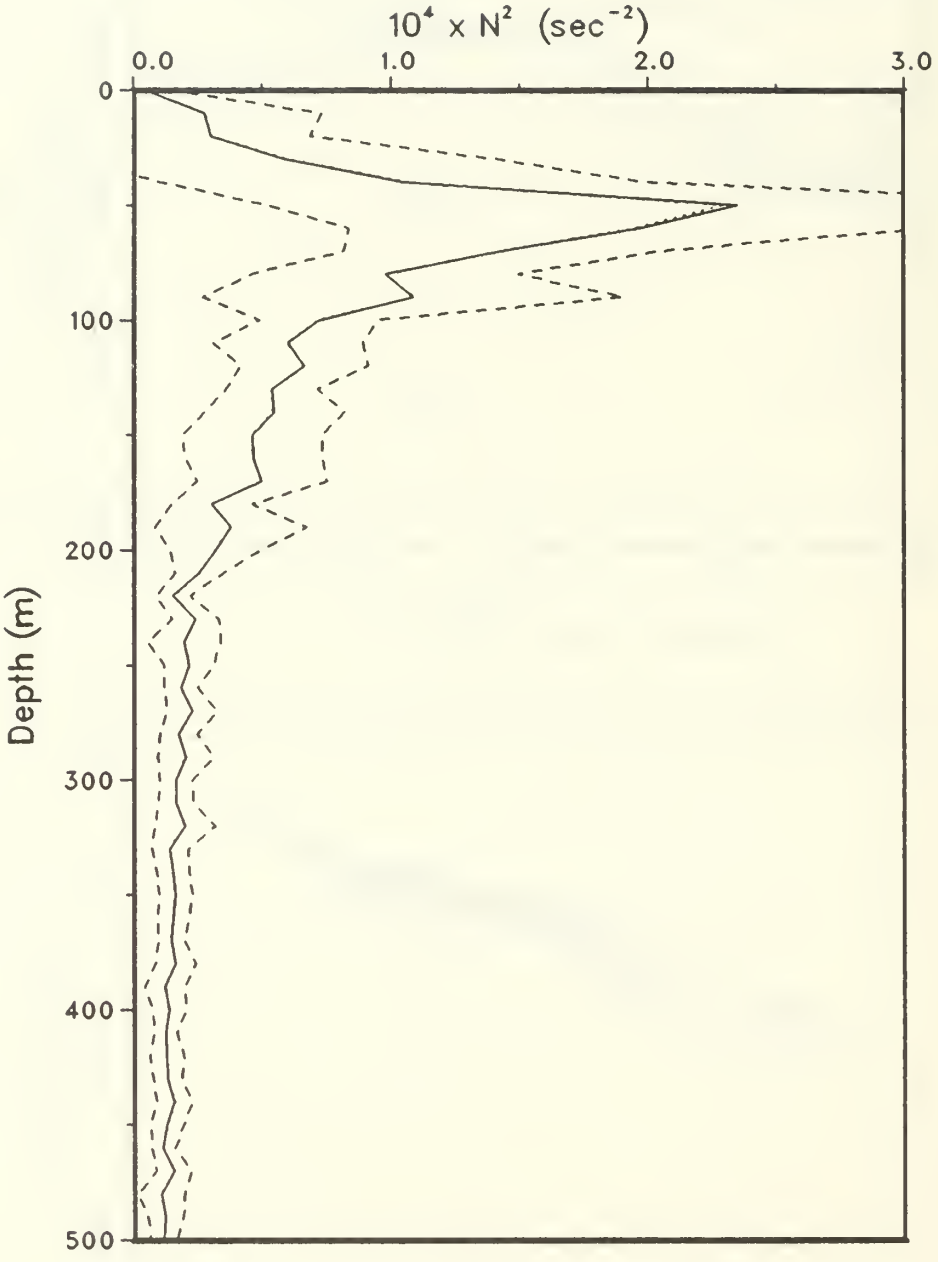


Figure 23: Mean N^2 profile(——), with + and - the standard deviation(----). The N^2 profile from $\overline{T(z)}$ and $\overline{S(z)}$ is also shown(....) (OPTOMA13).

Section 3

OPTOMA14

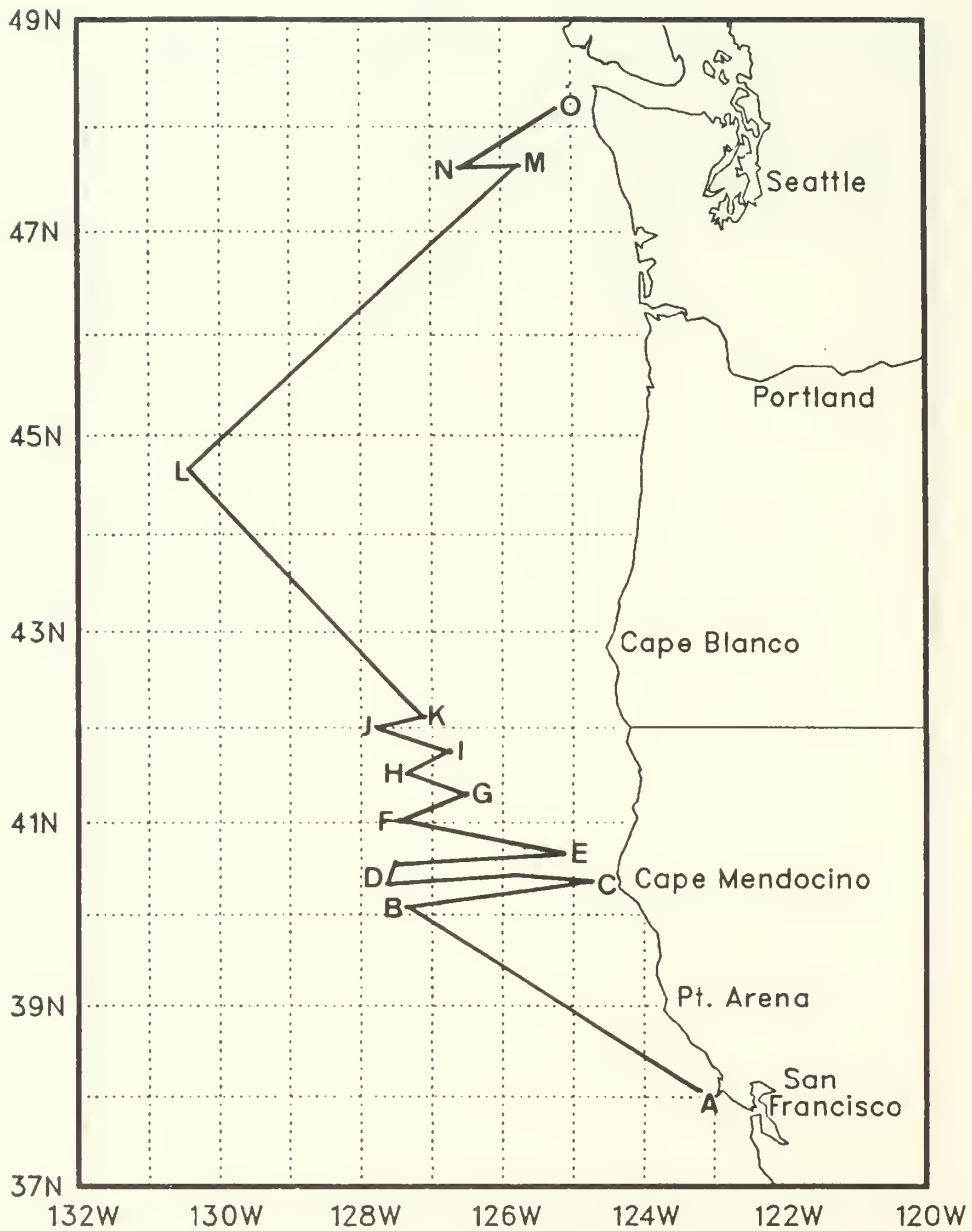


Figure 24: The cruise track for OPTOMA14.

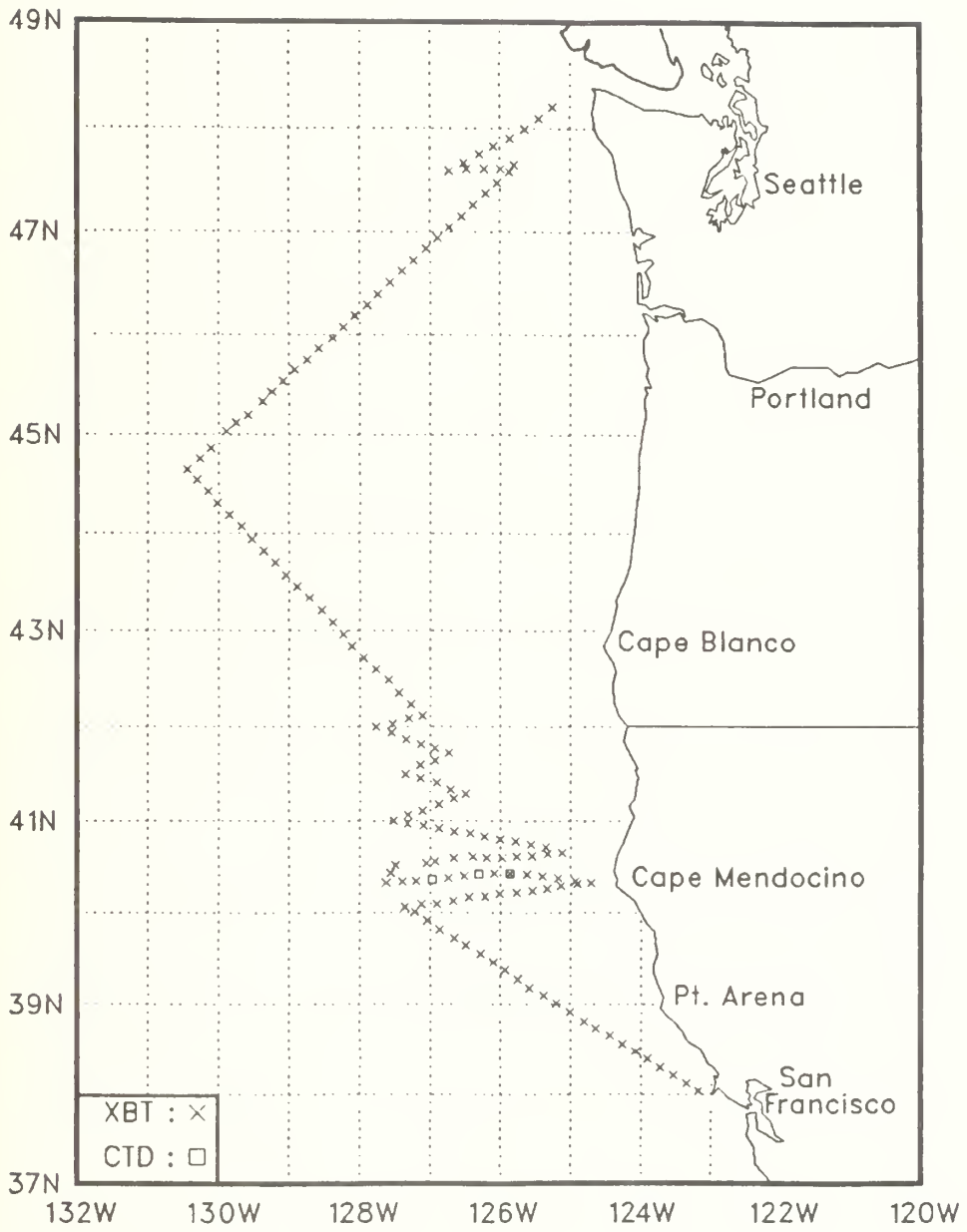


Figure 25: XBT and CTD locations for OPTOMA14.

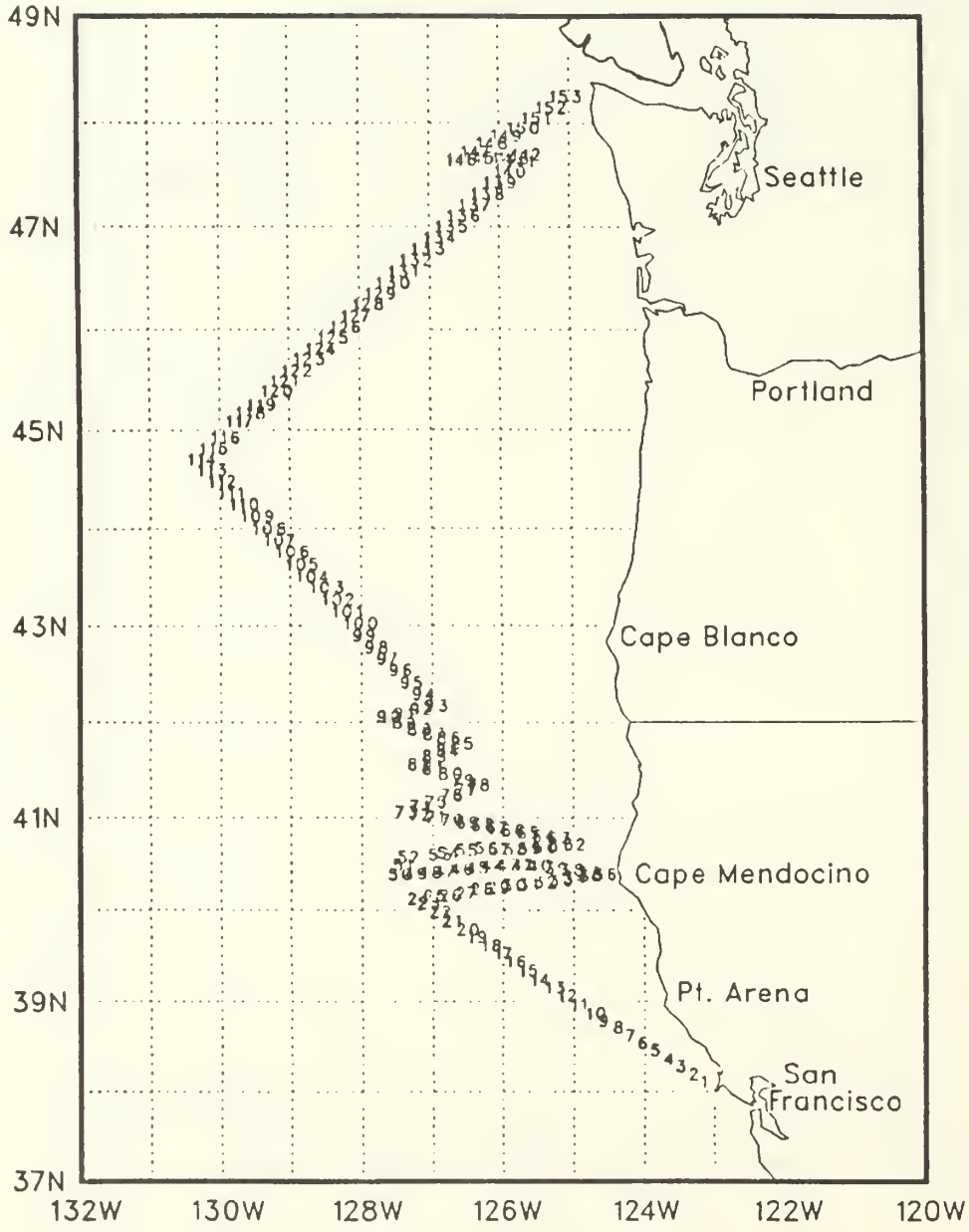


Figure 26: Station numbers for OPTOMA14.

Table 4: OPTOMA 14 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	84309	439	38.03	123.10	12.2			
2	XBT	84309	534	38.08	123.21	11.8			
3	XBT	84309	635	38.13	123.32	12.5			
4	XBT	84309	730	38.18	123.43	13.2			
5	XBT	84309	826	38.24	123.54	13.2			
6	XBT	84309	917	38.29	124.04	13.1			
7	XBT	84309	1009	38.34	124.15	12.3			
8	XBT	84309	1102	38.40	124.26	12.5			
9	XBT	84309	1156	38.44	124.38	12.3			
10	XBT	84309	1247	38.49	124.49	14.1			
11	XBT	84309	1344	38.55	125.01	14.3			
12	XBT	84309	1436	39.01	125.12	13.1			
13	XBT	84309	1530	39.06	125.23	12.6			
14	XBT	84309	1622	39.11	125.35	12.5			
15	XBT	84309	1719	39.17	125.45	13.6			
16	XBT	84309	1819	39.23	125.56	13.4			
17	XBT	84309	1916	39.28	126.06	13.1			
18	XBT	84309	2011	39.33	126.17	14.2			
19	XBT	84309	2108	39.39	126.29	15.0			
20	XBT	84309	2158	39.44	126.39	15.4			
21	XBT	84309	2255	39.50	126.51	14.5			
22	XBT	84309	2347	39.55	127.02	15.4			
23	XBT	84310	37	40.01	127.13	15.8			
24	XBT	84310	127	40.04	127.21	16.0			
25	XBT	84310	235	40.06	127.07	15.8			
26	XBT	84310	327	40.06	126.54	14.5			
27	XBT	84310	426	40.07	126.40	14.9			
28	XBT	84310	518	40.10	126.27	15.2			
29	XBT	84310	614	40.11	126.13	15.1			
30	XBT	84310	706	40.13	126.00	15.3			
31	XBT	84310	800	40.13	125.46	15.2			
32	XBT	84310	848	40.15	125.33	15.3			
33	XBT	84310	938	40.16	125.20	14.6			
34	XBT	84310	1022	40.18	125.08	14.2			
35	XBT	84310	1114	40.19	124.54	13.6			
36	XBT	84310	1202	40.20	124.42	12.4			
37	XBT	84310	1303	40.21	124.56	13.5			
38	XBT	84310	1406	40.23	125.10	14.1			
39	XBT	84310	1502	40.24	125.24	14.6			
40	XBT	84310	1600	40.26	125.38	14.9			
41	XBT	84310	1658	40.26	125.52	14.5			
42	CTD	84310	1724	40.26	125.52	14.5	32.14	*	32.23
43	XBT	84310	1838	40.26	126.05	14.7			
44	CTD	84310	1952	40.26	126.18	14.7	32.22	*	33.22
45	XBT	84310	2114	40.24	126.31	15.2			

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)
46	XBT	84310	2208	40.23	126.45	15.2			
47	CTD	84310	2319	40.22	126.58	15.4	32.42	*	33.42
48	XBT	84311	31	40.21	127.12	15.3			
49	XBT	84311	131	40.20	127.24	15.4			
50	XBT	84311	247	40.20	127.37	15.7			
51	XBT	84311	326	40.26	127.33	15.7			
52	XBT	84311	355	40.31	127.29	15.4			
53	XBT	84311	540	40.32	127.03	15.2			
54	XBT	84311	602	40.34	126.56	15.6			
55	XBT	84311	701	40.35	126.40	14.9			
56	XBT	84311	801	40.37	126.24	14.8			
57	XBT	84311	846	40.36	126.12	14.6			
58	XBT	84311	934	40.36	125.59	14.6			
59	XBT	84311	1022	40.37	125.46	14.5			
60	XBT	84311	1114	40.38	125.33	14.3			
61	XBT	84311	1210	40.38	125.20	13.8			
62	XBT	84311	1301	40.39	125.07	13.5			
63	XBT	84311	1411	40.43	125.21	13.4			
64	XBT	84311	1505	40.45	125.34	13.8			
65	XBT	84311	1559	40.46	125.47	13.7			
66	XBT	84311	1676	40.48	126.00	13.6			
67	XBT	84311	1803	40.50	126.13	13.3			
68	XBT	84311	1905	40.51	126.26	13.8			
69	XBT	84311	2011	40.53	126.39	14.1			
70	XBT	84311	2121	40.55	126.52	14.1			
71	XBT	84311	2236	40.57	127.05	14.6			
72	XBT	84311	2358	40.58	127.19	14.7			
73	XBT	84312	110	41.00	127.31	14.8			
74	XBT	84312	202	41.03	127.19	15.1			
75	XBT	84312	252	41.06	127.06	14.7			
76	XBT	84312	350	41.11	126.52	14.2			
77	XBT	84312	440	41.14	126.40	13.6			
78	XBT	84312	522	41.17	126.29	13.2			
79	XBT	84312	623	41.20	126.43	13.5			
80	XBT	84312	711	41.24	126.54	13.2			
81	XBT	84312	806	41.27	127.08	13.7			
82	XBT	84312	852	41.30	127.20	14.3			
83	XBT	84312	955	41.35	127.08	13.7			
84	XBT	84312	1043	41.38	126.56	13.2			
85	XBT	84312	1139	41.43	126.43	13.3			
86	XBT	84312	1230	41.47	126.55	13.2			
87	XBT	84312	1318	41.49	127.07	13.6			
88	XBT	84312	1414	41.52	127.21	13.7			
89	XBT	84312	1510	41.56	127.33	13.9			
90	XBT	84312	1608	42.00	127.46	14.4			

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)
91	XBT	84312	1707	42.02	127.32	14.0
92	XBT	84312	1758	42.05	127.18	14.0
93	XBT	84312	1844	42.07	127.06	13.8
94	XBT	84312	1944	42.14	127.16	14.0
95	XBT	84312	2041	42.21	127.26	13.9
96	XBT	84312	2138	42.29	127.35	13.8
97	XBT	84312	2233	42.36	127.46	13.9
98	XBT	84312	2327	42.43	127.56	14.1
99	XBT	84313	19	42.50	128.07	14.1
100	XBT	84313	109	42.58	128.14	13.7
101	XBT	84313	201	43.05	128.23	13.8
102	XBT	84313	253	43.13	128.32	14.1
103	XBT	84313	347	43.20	128.43	13.6
104	XBT	84313	438	43.27	128.54	13.5
105	XBT	84313	542	43.35	129.03	13.5
106	XBT	84313	646	43.43	129.12	13.3
107	XBT	84313	750	43.49	129.21	13.2
108	XBT	84313	856	43.57	129.31	13.2
109	XBT	84313	1007	44.04	129.41	13.1
110	XBT	84313	1114	44.12	129.51	12.9
111	XBT	84313	1222	44.18	130.00	12.9
112	XBT	84313	1328	44.26	130.09	12.6
113	XBT	84313	1439	44.33	130.18	12.6
114	XBT	84313	2005	44.39	130.26	12.5
115	XBT	84313	2100	44.46	130.16	12.7
116	XBT	84313	2200	44.52	130.06	12.5
117	XBT	84313	2300	45.02	129.53	12.2
118	XBT	84313	2341	45.07	129.45	12.3
119	XBT	84314	31	45.12	129.35	12.4
120	XBT	84314	121	45.20	129.23	12.3
121	XBT	84314	201	45.26	129.15	12.8
122	XBT	84314	250	45.32	129.05	12.9
123	XBT	84314	340	45.39	128.55	13.2
124	XBT	84314	427	45.45	128.45	12.8
125	XBT	84314	517	45.52	128.34	12.7
126	XBT	84314	603	45.58	128.23	12.6
127	XBT	84314	652	46.04	128.14	12.7
128	XBT	84314	742	46.12	128.04	12.4
129	XBT	84314	831	46.18	127.54	12.3
130	XBT	84314	918	46.24	127.44	12.4
131	XBT	84314	1009	46.31	127.33	12.2
132	XBT	84314	1059	46.38	127.24	12.3
133	XBT	84314	1146	46.44	127.14	12.3
134	XBT	84314	1228	46.51	127.03	12.1
135	XBT	84314	1322	46.57	126.53	11.9

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM)	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)
136	XBT	84314	1402	47.03	126.43	11.9
137	XBT	84314	1448	47.09	126.33	11.9
138	XBT	84314	1536	47.16	126.22	11.6
139	XBT	84314	1627	47.23	126.12	11.1
140	XBT	84314	1713	47.29	126.02	11.6
141	XBT	84314	1800	47.35	125.52	11.7
142	XBT	84314	1835	47.39	125.48	11.6
143	XBT	84314	1919	47.36	125.59	11.6
144	XBT	84314	2011	47.37	126.13	11.2
145	XBT	84314	2105	47.37	126.28	11.5
146	XBT	84314	2157	47.35	126.43	11.1
147	XBT	84314	2255	47.40	126.30	11.3
148	XBT	84314	2350	47.45	126.17	11.6
149	XBT	84315	41	47.49	126.05	10.4
150	XBT	84315	139	47.54	125.51	10.5
151	XBT	84315	235	48.00	125.39	10.8
152	XBT	84315	328	48.05	125.27	11.1
153	XBT	84315	422	48.12	125.15	11.3

* Data not available

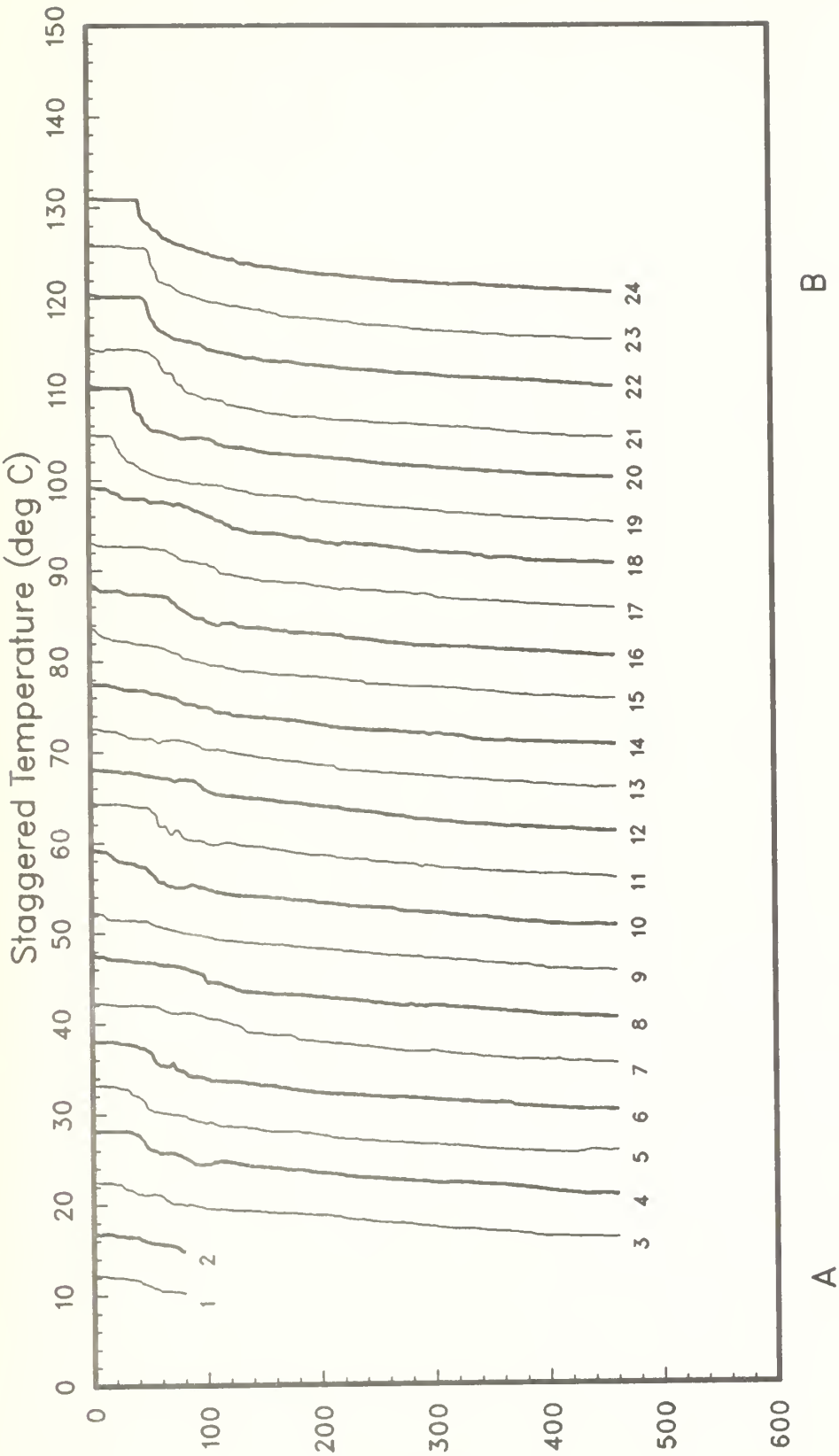


Figure 27(a): XBT temperature profiles, staggered by multiples of 5C (OPTOMA14).

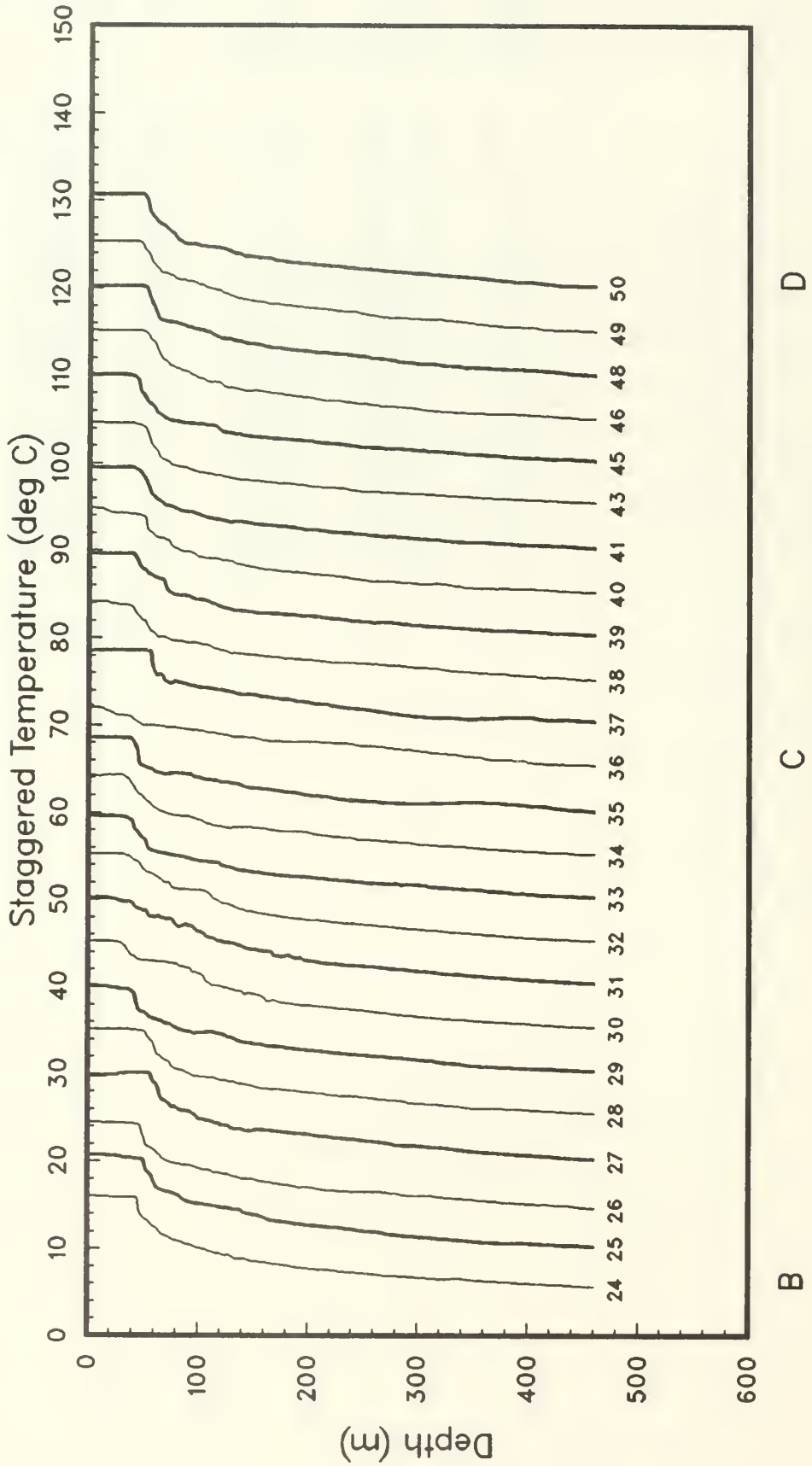

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 43 45 46 48 49 50
B
C
D

Figure 27(b)

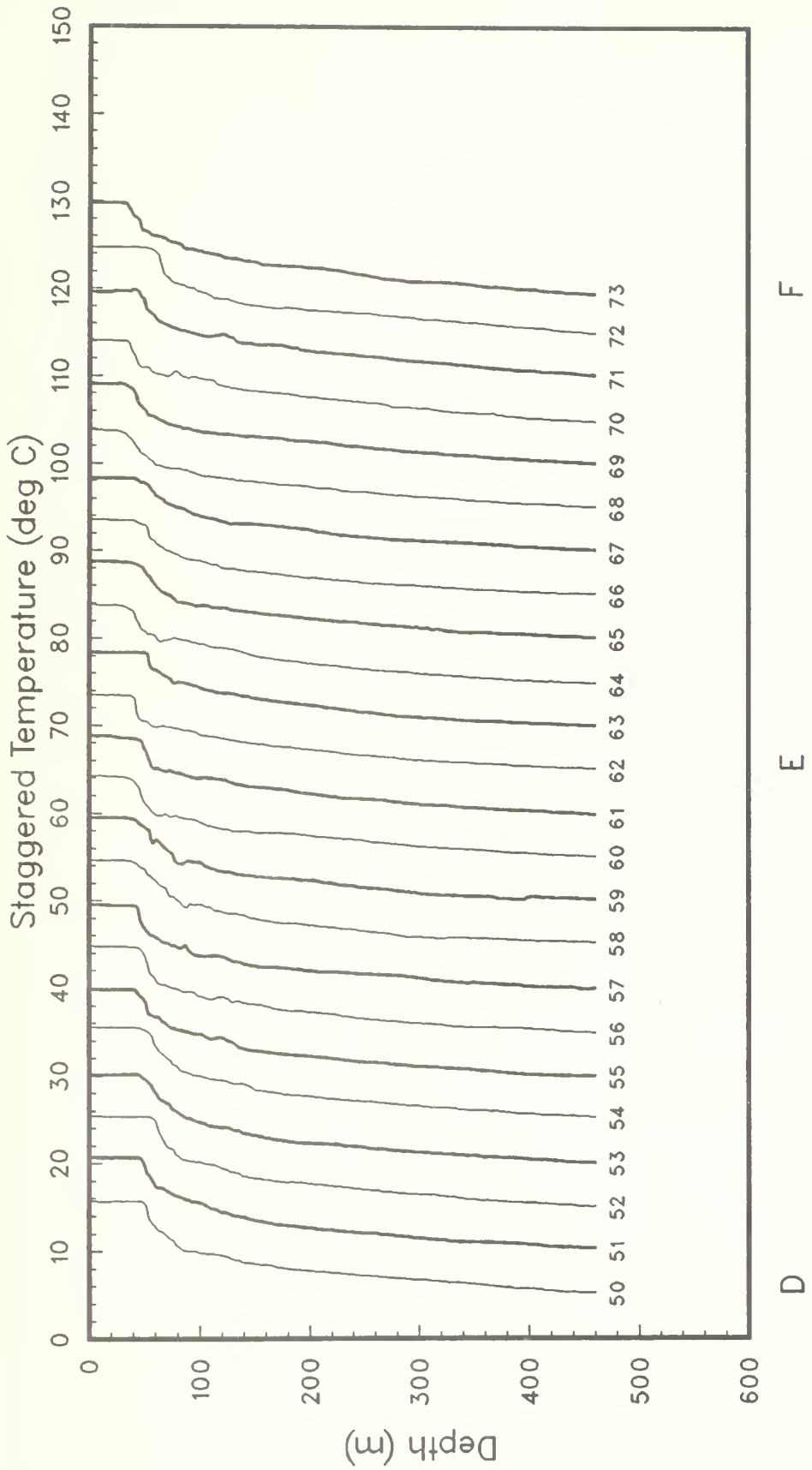

Staggered Temperature (deg C)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Depth (m)
0 100 200 300 400 500 600
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73
D
E
F

Figure 27(c)

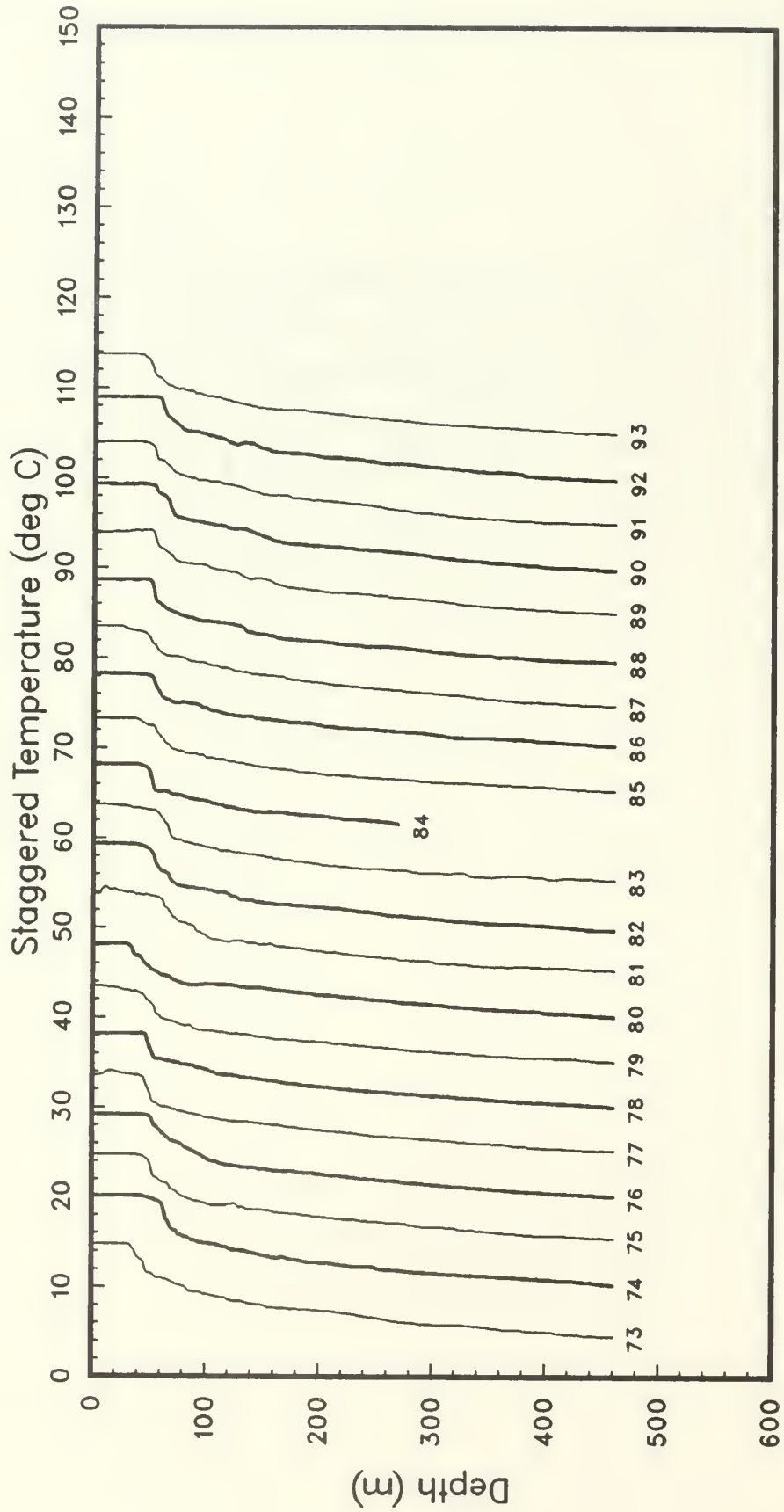

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
F
G
H
I
J
K

Figure 27(d)

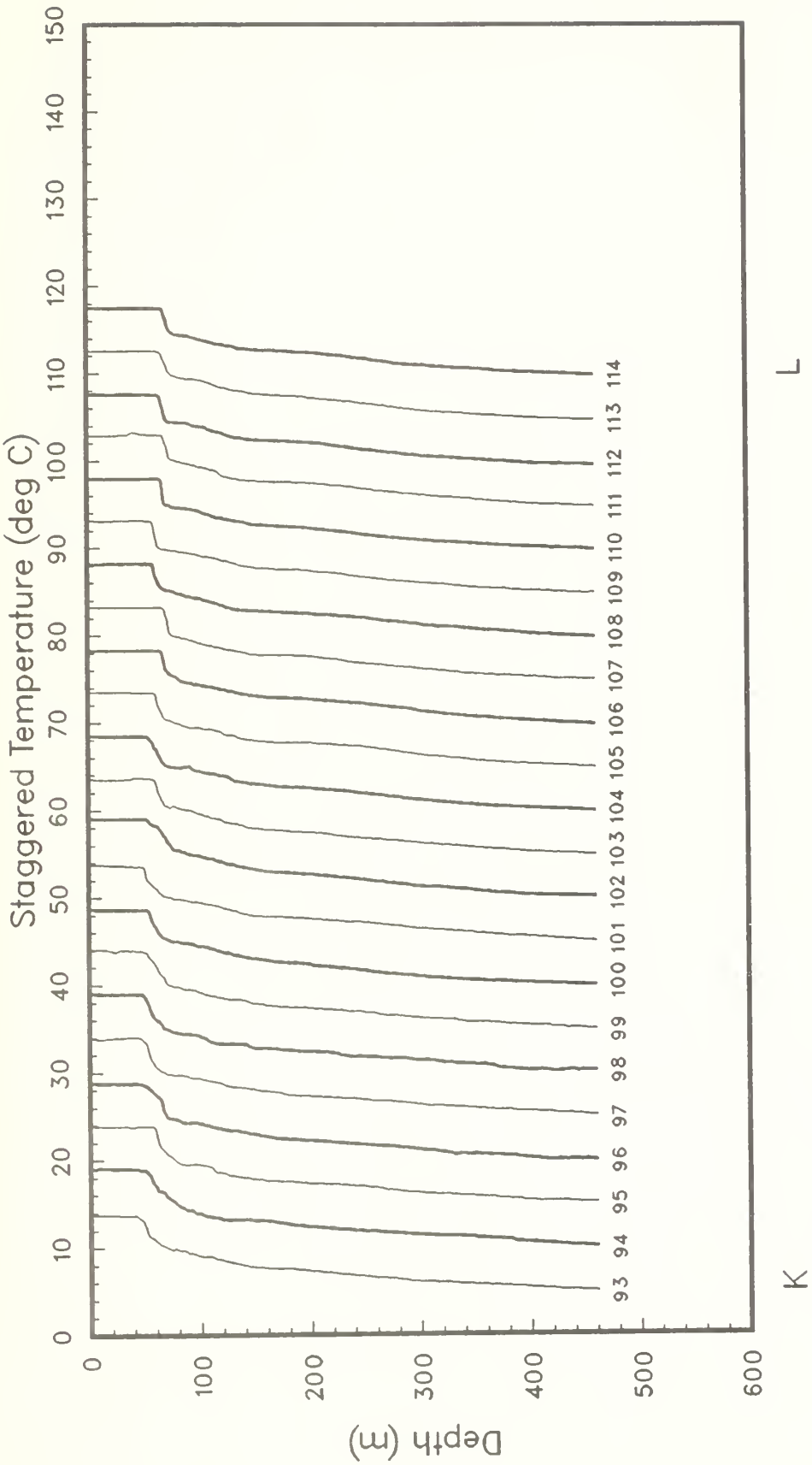
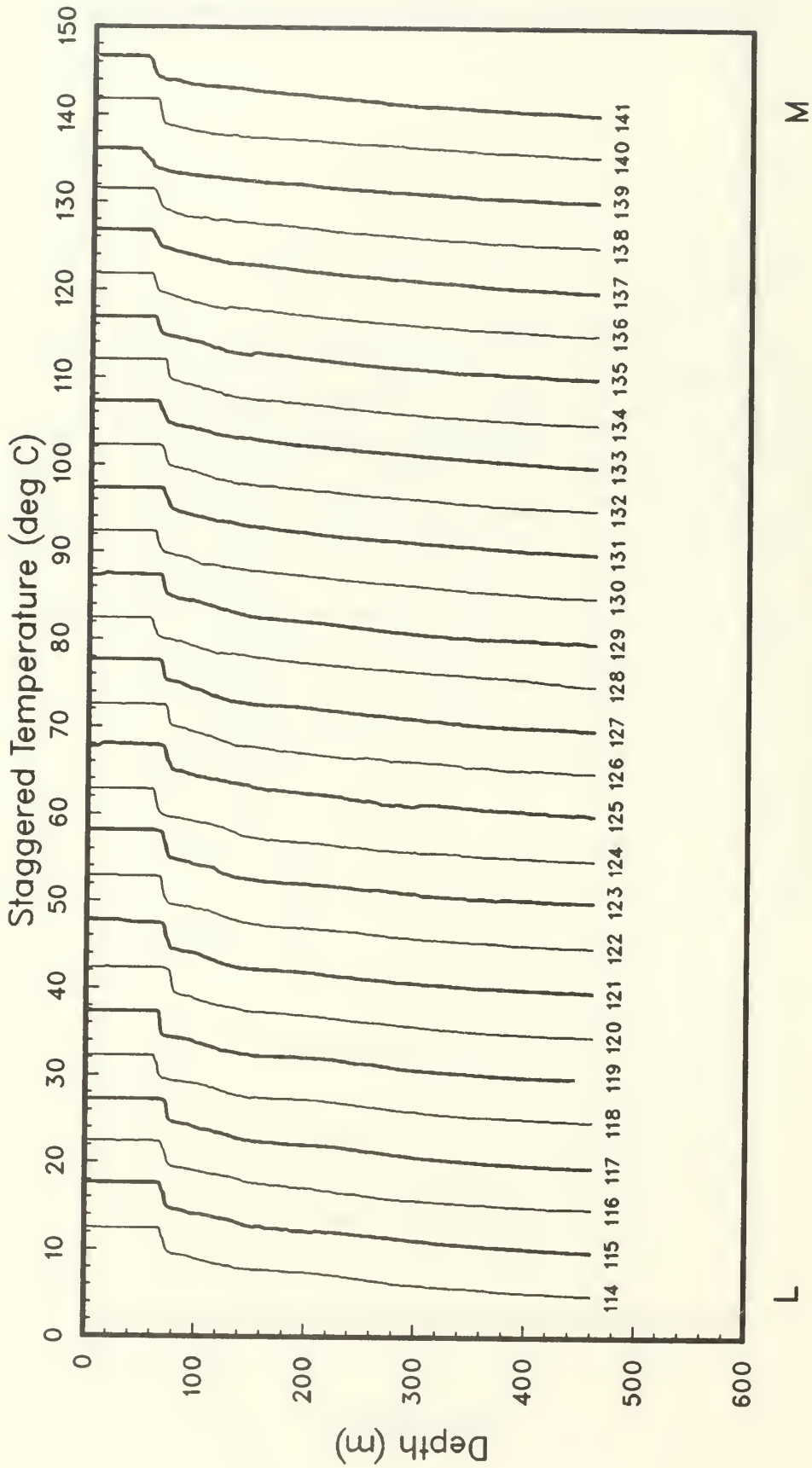

Staggered Temperature (deg C)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Depth (m)
0 100 200 300 400 500 600
93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114
K
L

Figure 27(e)


Staggered Temperature (deg C)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Depth (m)
0 100 200 300 400 500 600
114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141
L
M

. Figure 27(f)

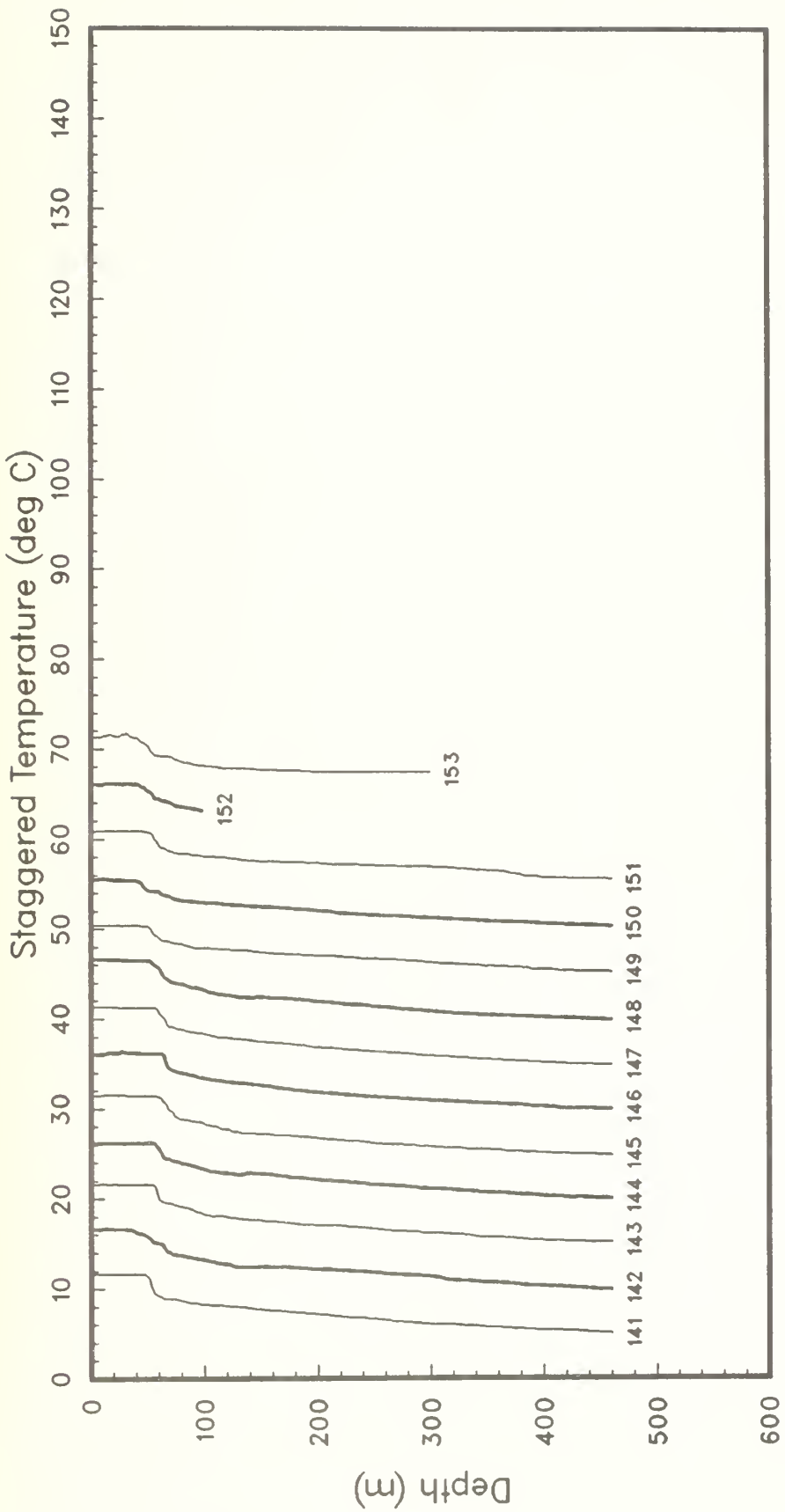

Staggered Temperature (deg C)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Depth (m)
0 100 200 300 400 500 600
141 142 143 144 145 146 147 148 149 150 151
152
153
M N O

Figure 27(g)

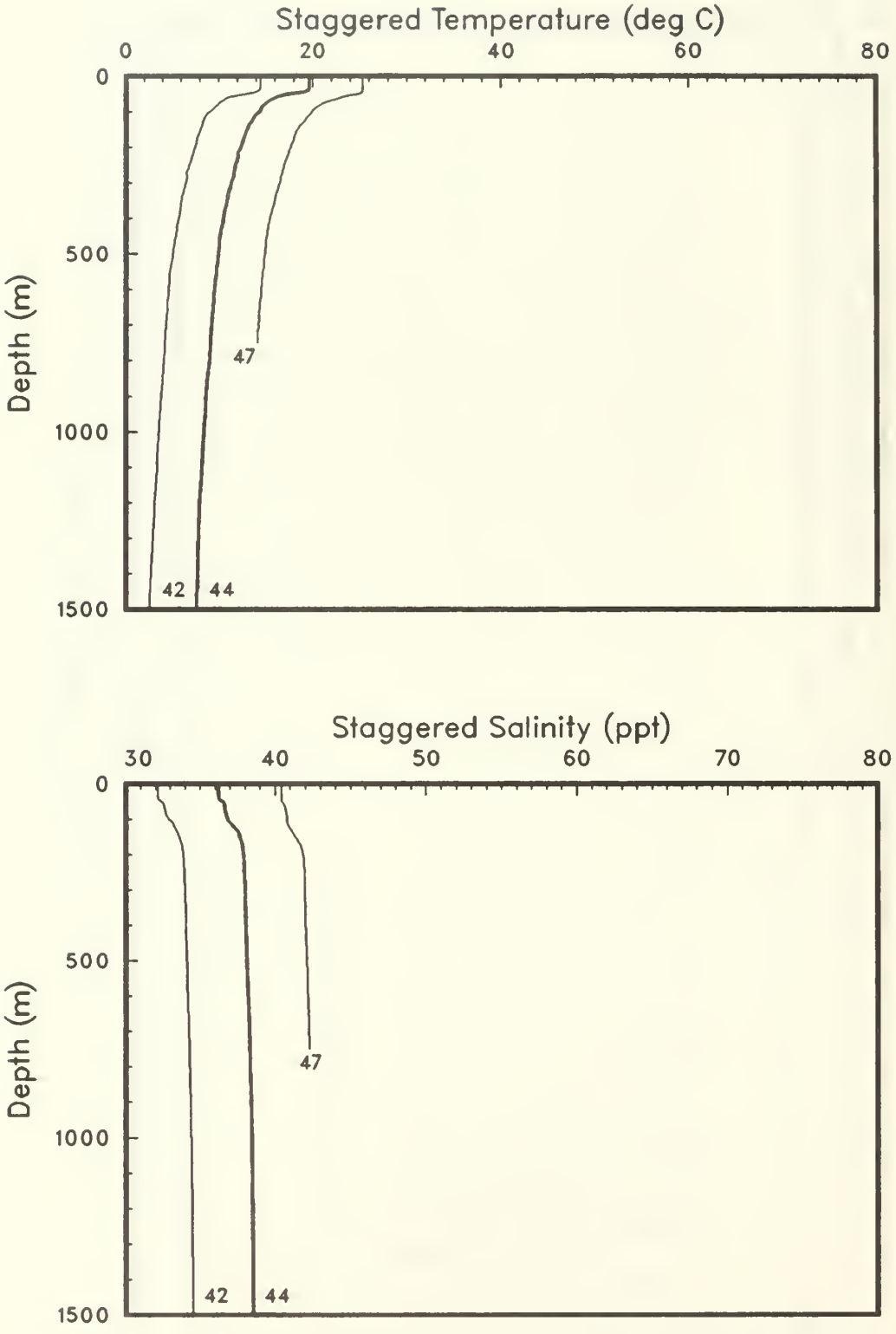


Figure 28: CTD temperature profiles, staggered by multiples of 5C, and salinity profiles staggered by multiples of 4 ppt. (OPTOMA14).

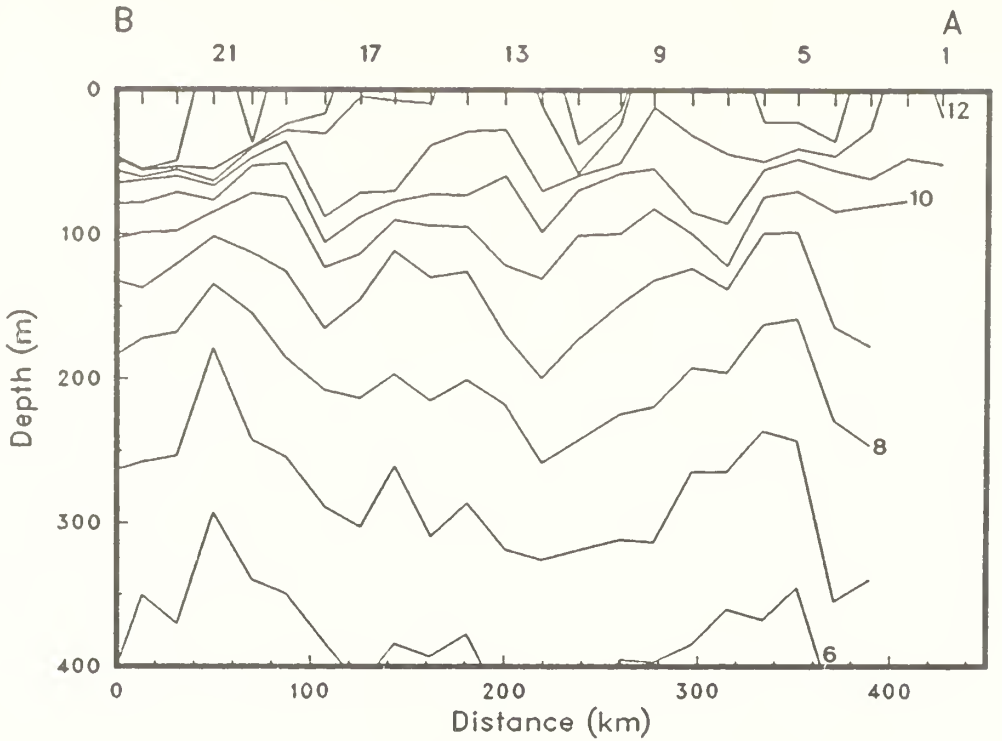


Figure 29(a): Along-track isotherms. Tick marks along the upper horizontal axis show station positions. Some station numbers are given. Dashed lines are used if the cast was too shallow (OPTOMA14).

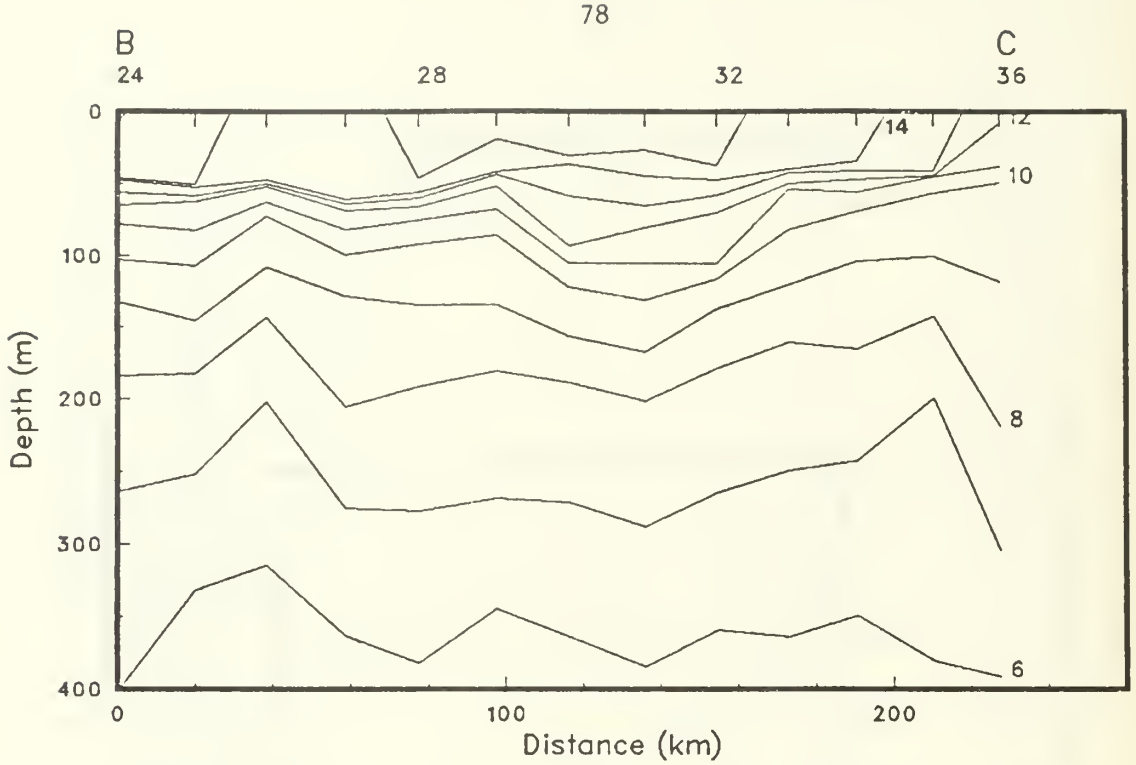


Figure 29(b)

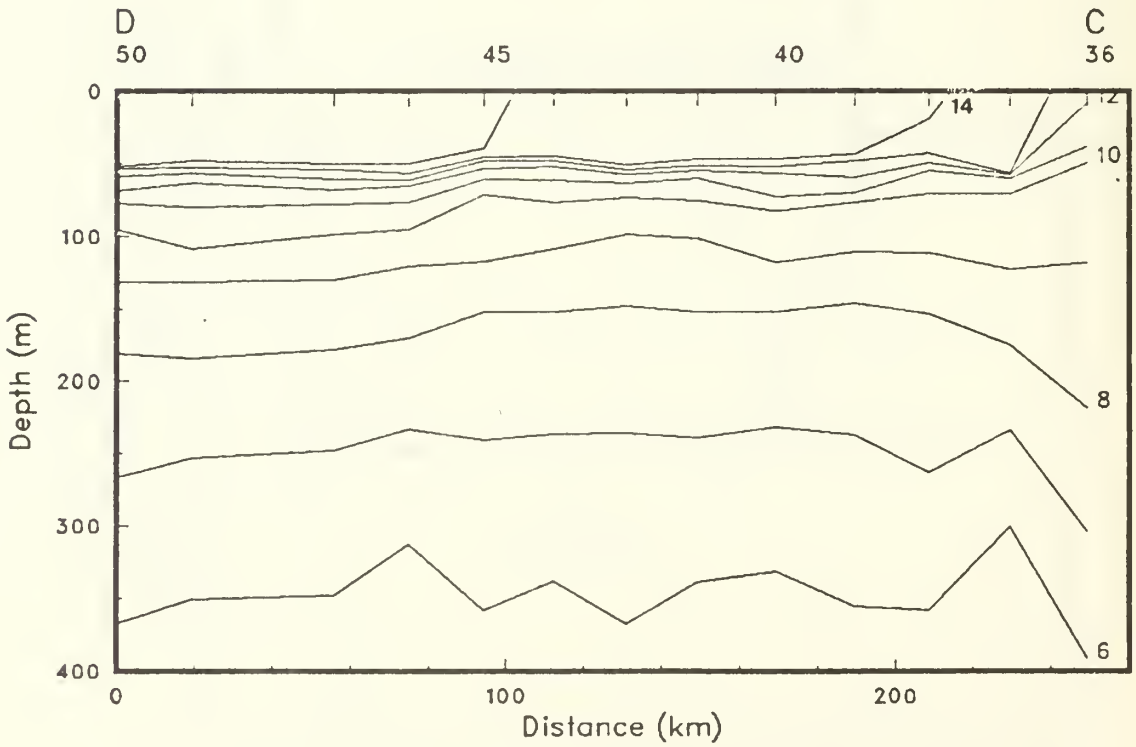


Figure 29(c)

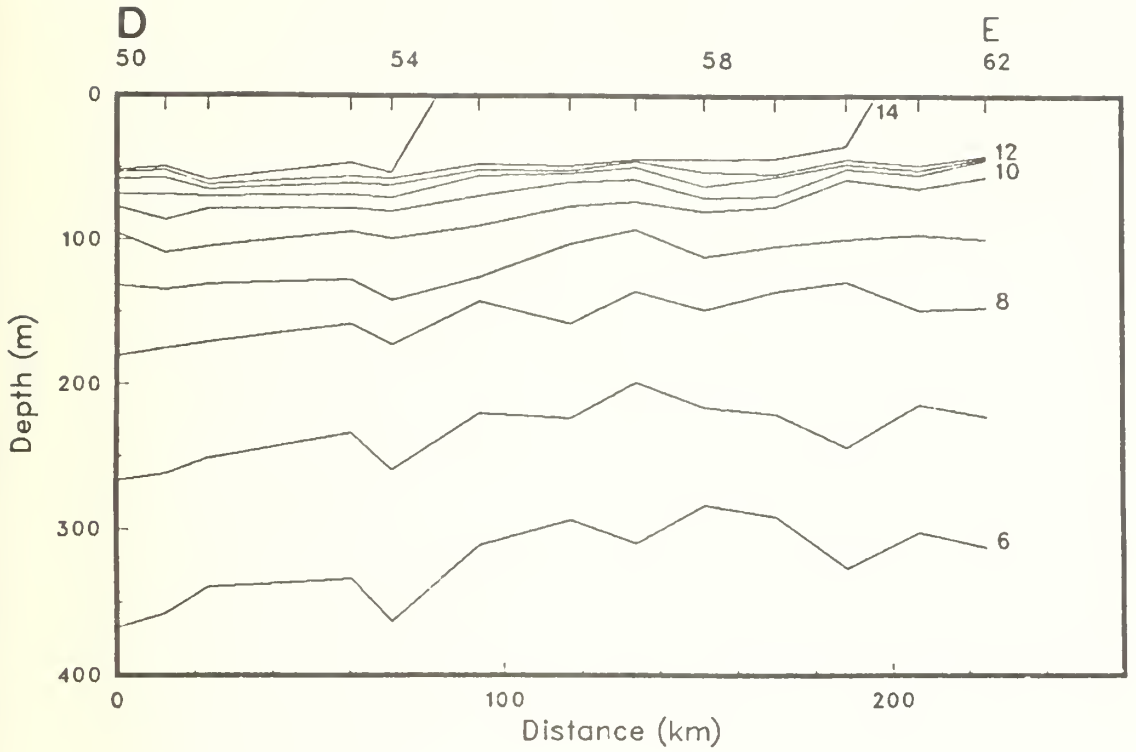


Figure 29(d)

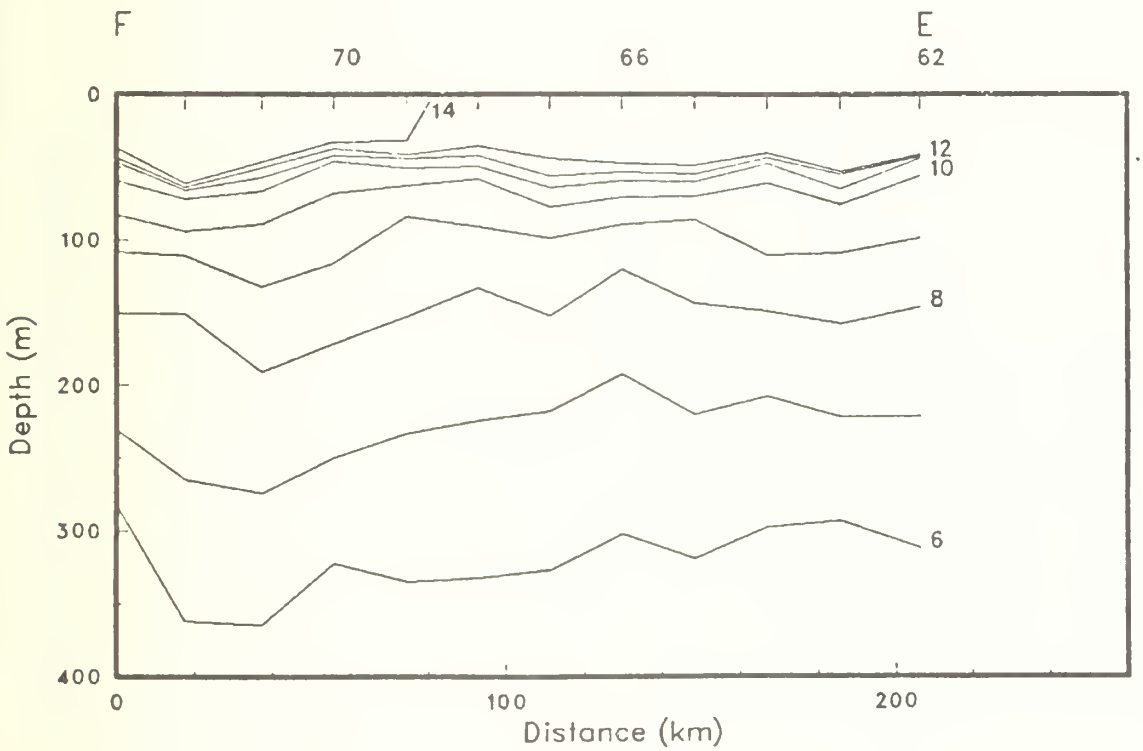


Figure 29(e)

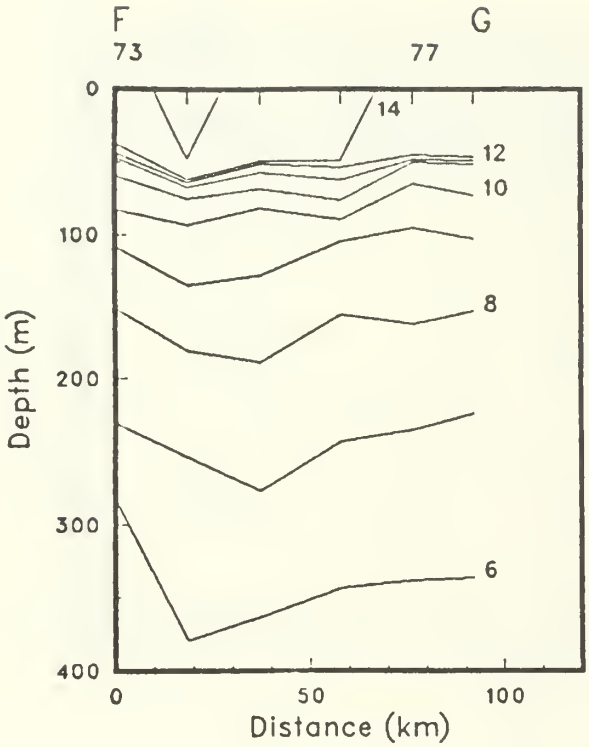


Figure 29(f)

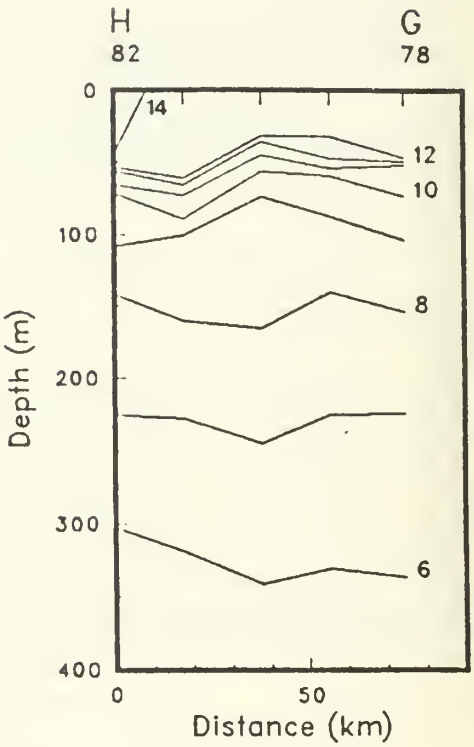


Figure 29(g)

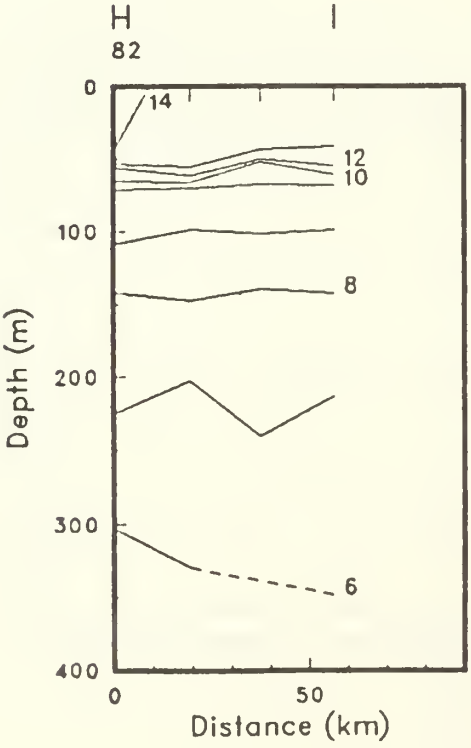


Figure 29(h)

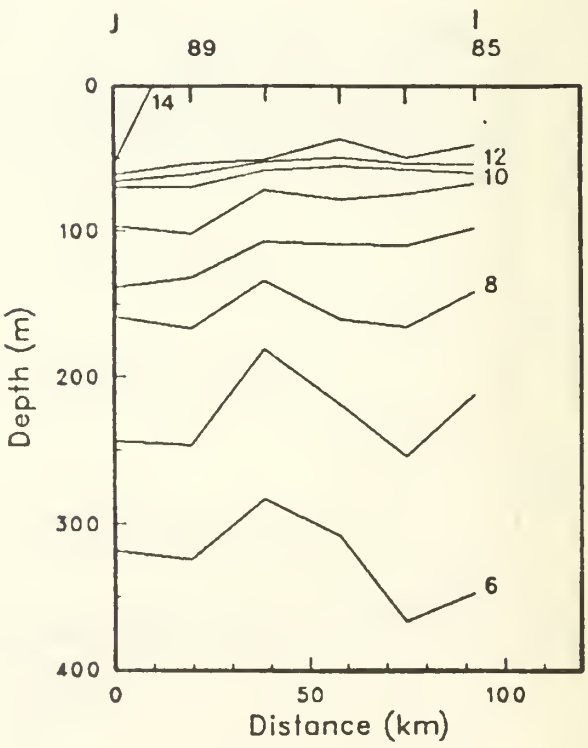


Figure 29(i)

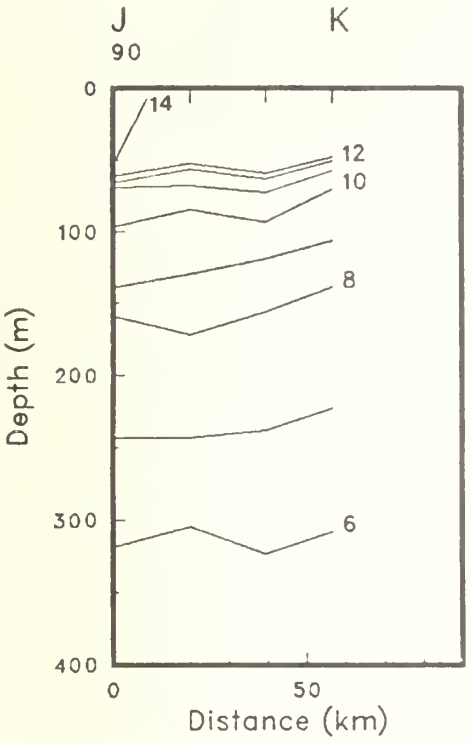


Figure 29(j)

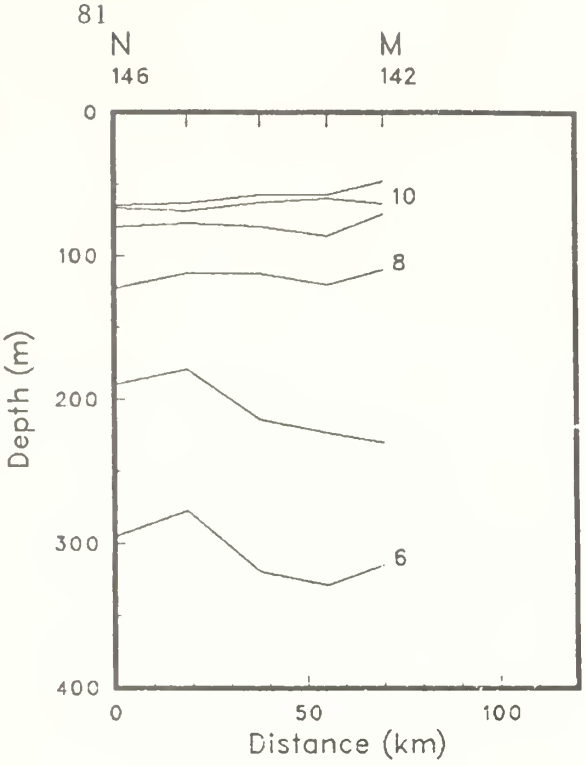


Figure 29(k)

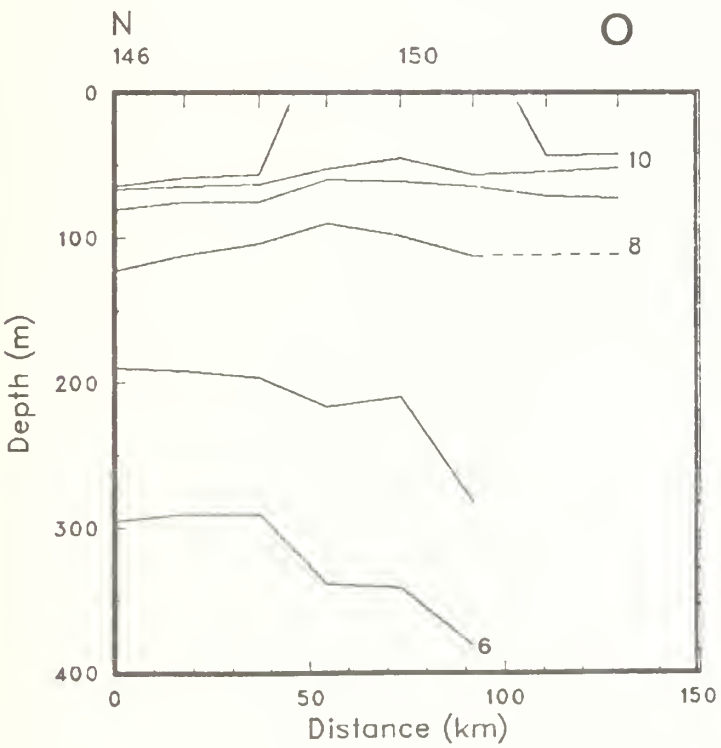


Figure 29(l)

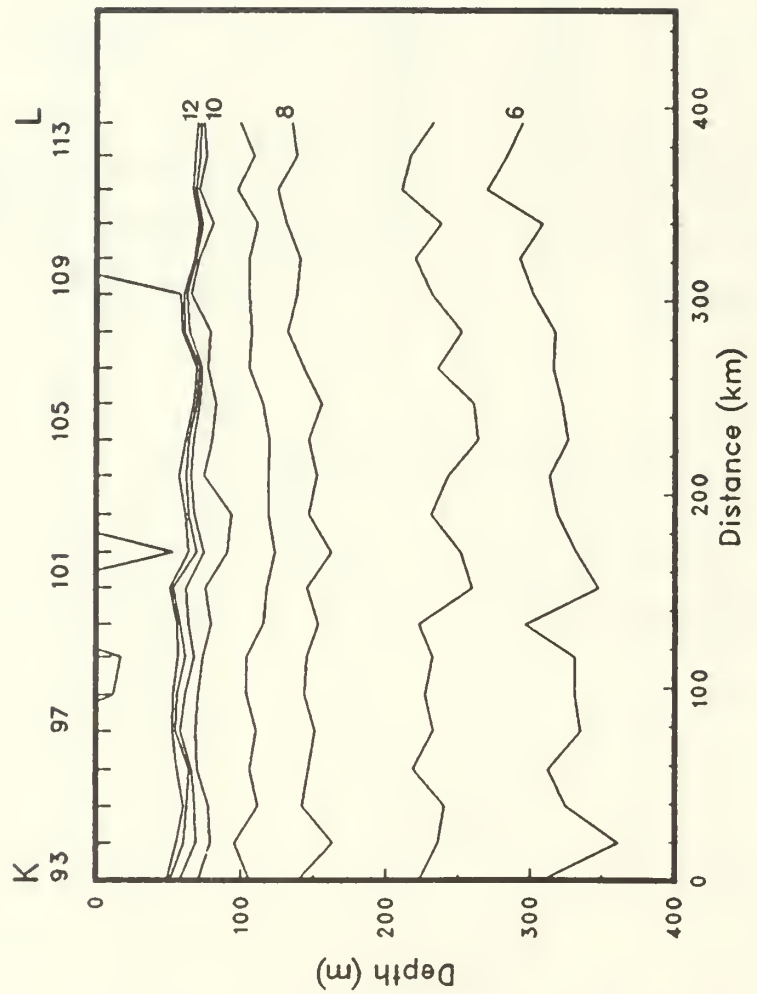

K
93
97
101
105
109
113
L
12
10
8
6
0
100
200
300
400
Depth (m)
0
100
200
300
400
Distance (km)

Figure 29(m)

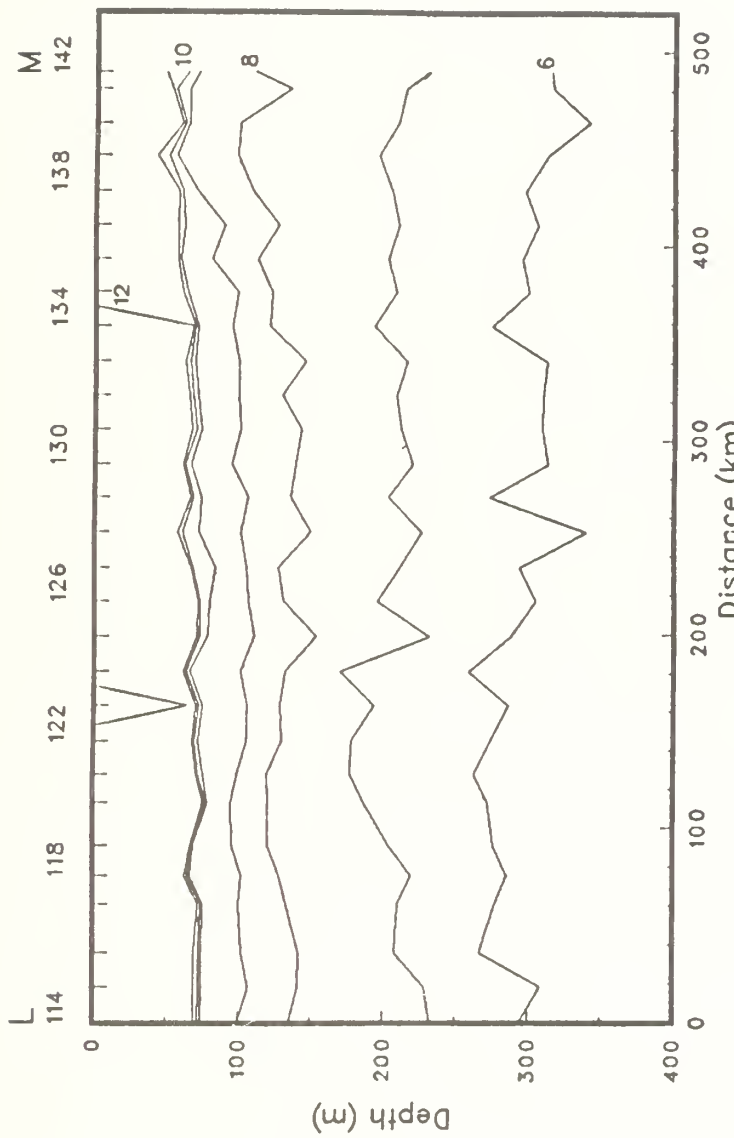

L
M
114
118
122
126
130
134
138
142
12
10
8
6
0
100
200
300
400
Depth (m)
0
100
200
300
400
500
Distance (km)

Figure 29(n)

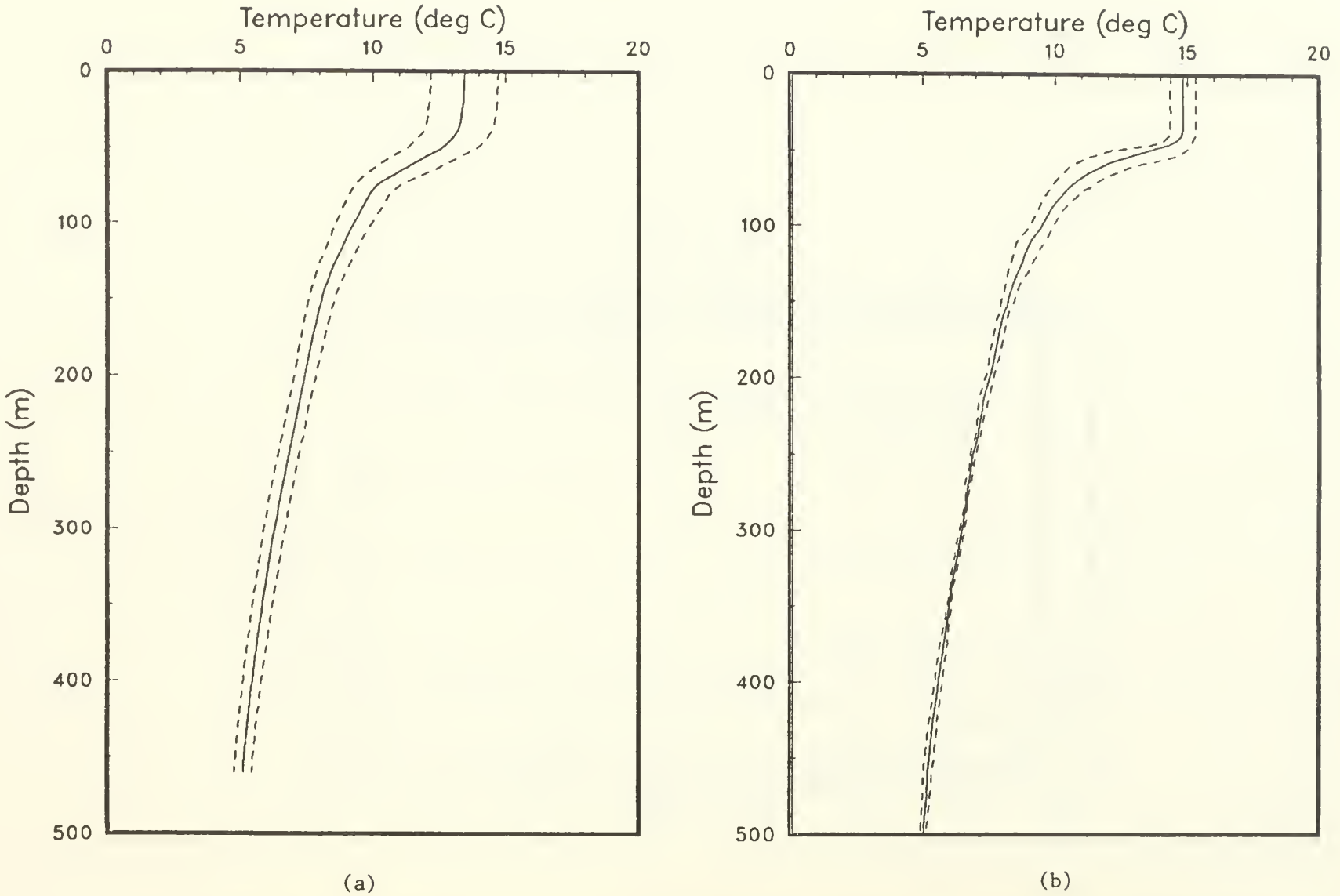


Figure 30: Mean temperature profiles from (a) XBT's and (b) CTD's, with + and - the standard deviation (OPTOMA14).

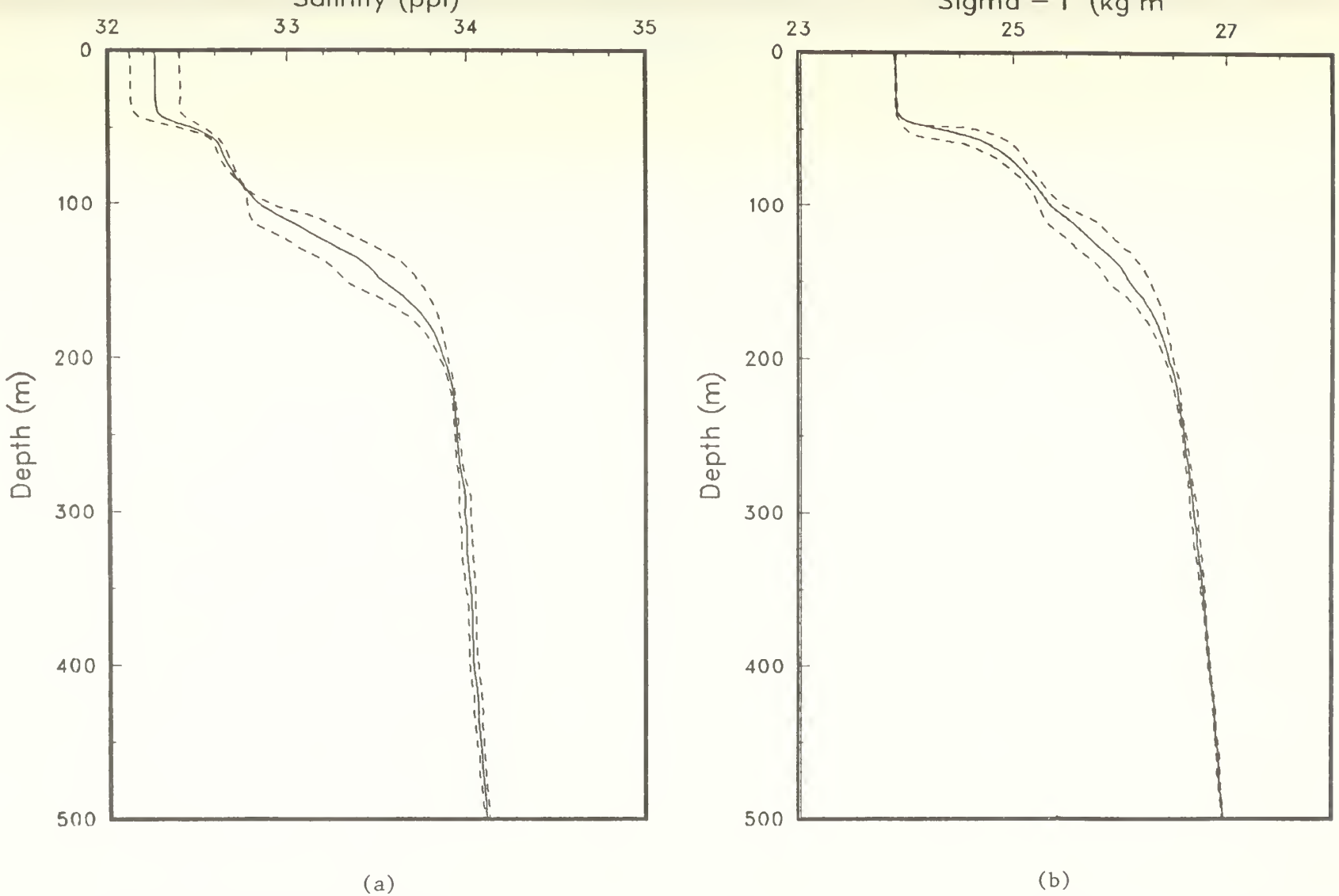


Figure 31: Mean profiles of (a) salinity and (b) sigma-t, with + and - the standard deviations, from the CTD's (OPTOMA14).

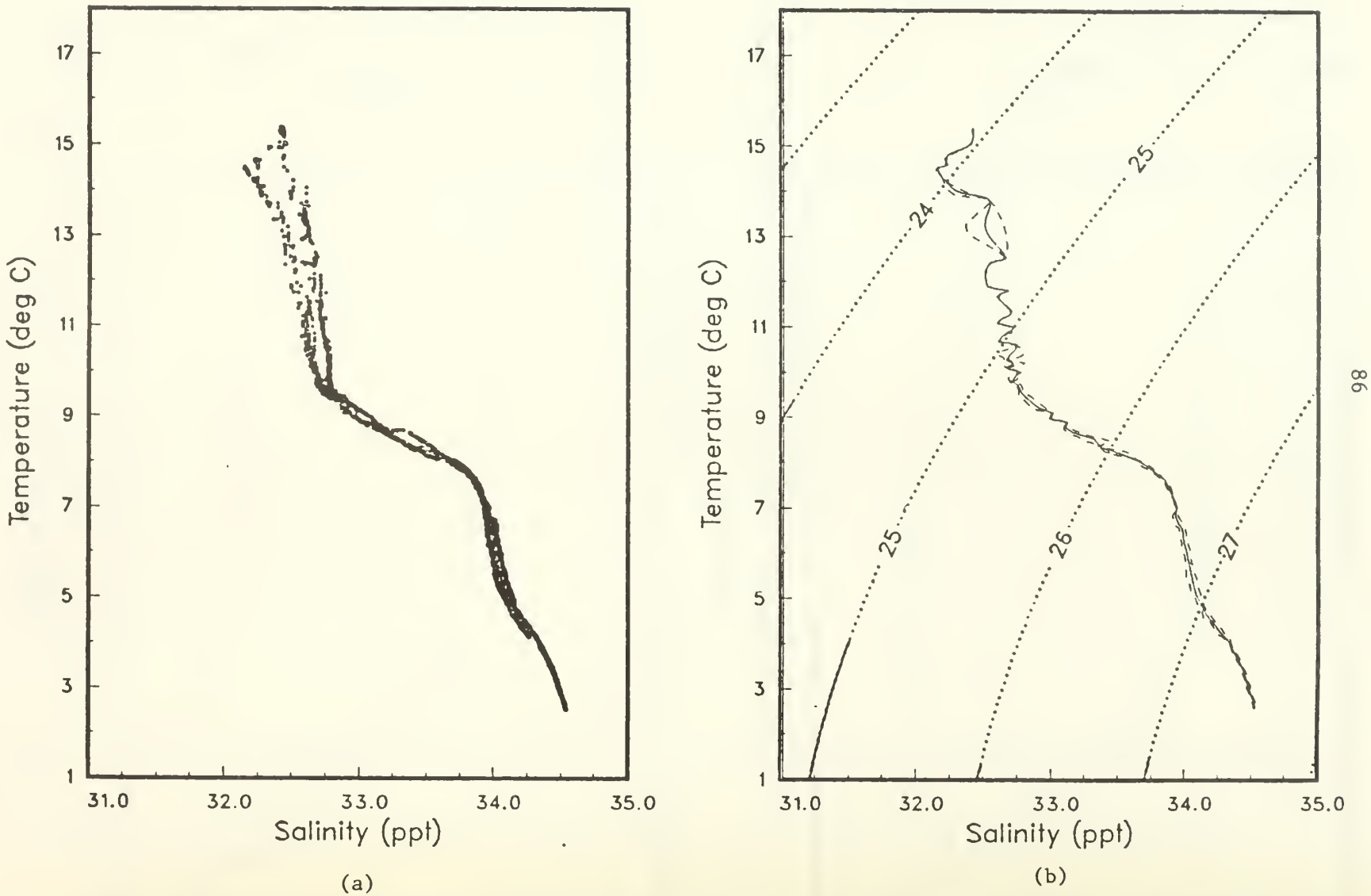


Figure 32: (a) T-S pairs and (b) mean T-S relation, with + and - the standard deviation, from the CTD's. Selected sigma-t contours are also shown (OPTOMA14).

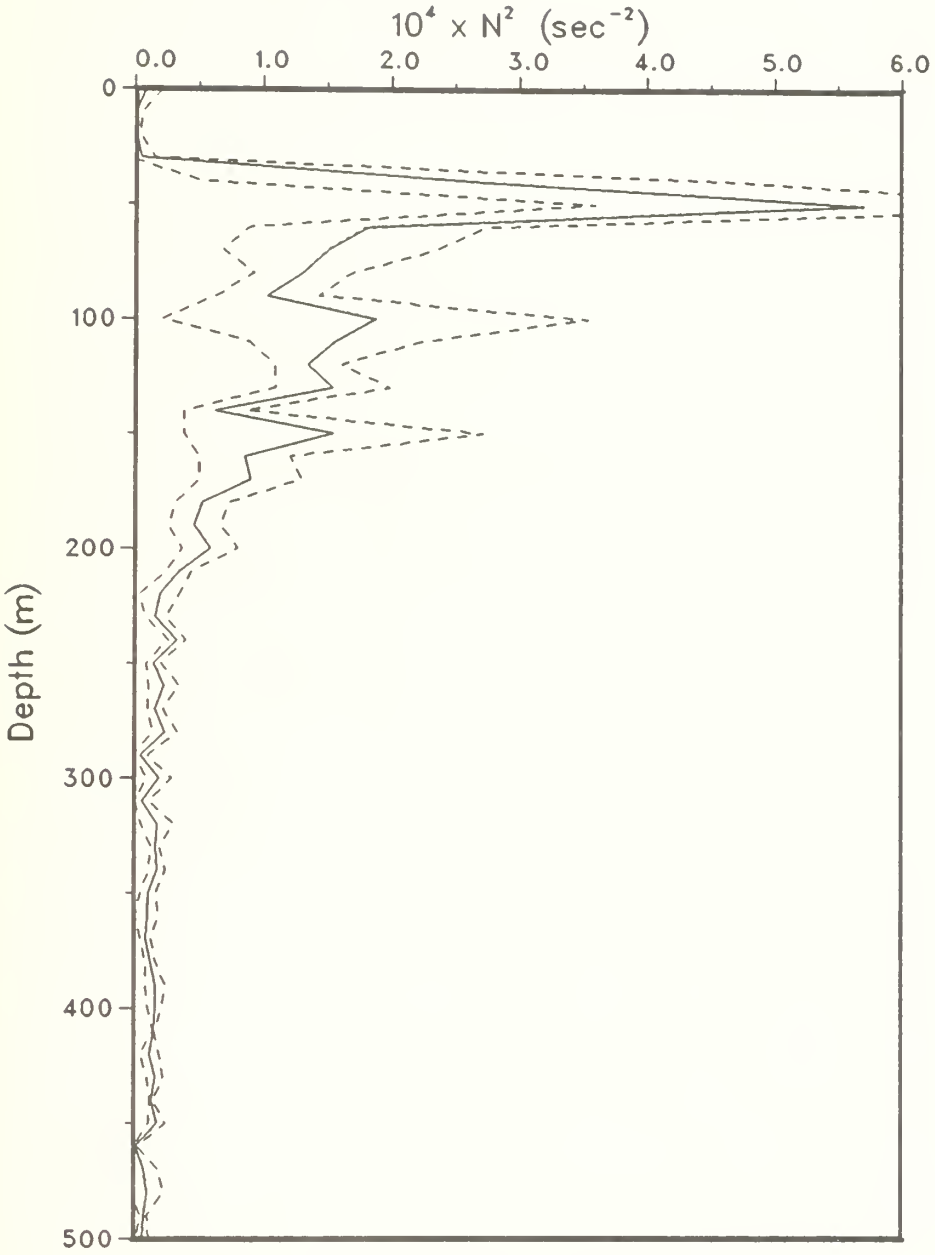


Figure 33: Mean N^2 profile(——), with + and - the standard deviation(----). The N^2 profile from $\overline{T(z)}$ and $\overline{S(z)}$ is also shown(....) (OPTOMA14).

This page left intentionally blank

Section 4

OPTOMA13P

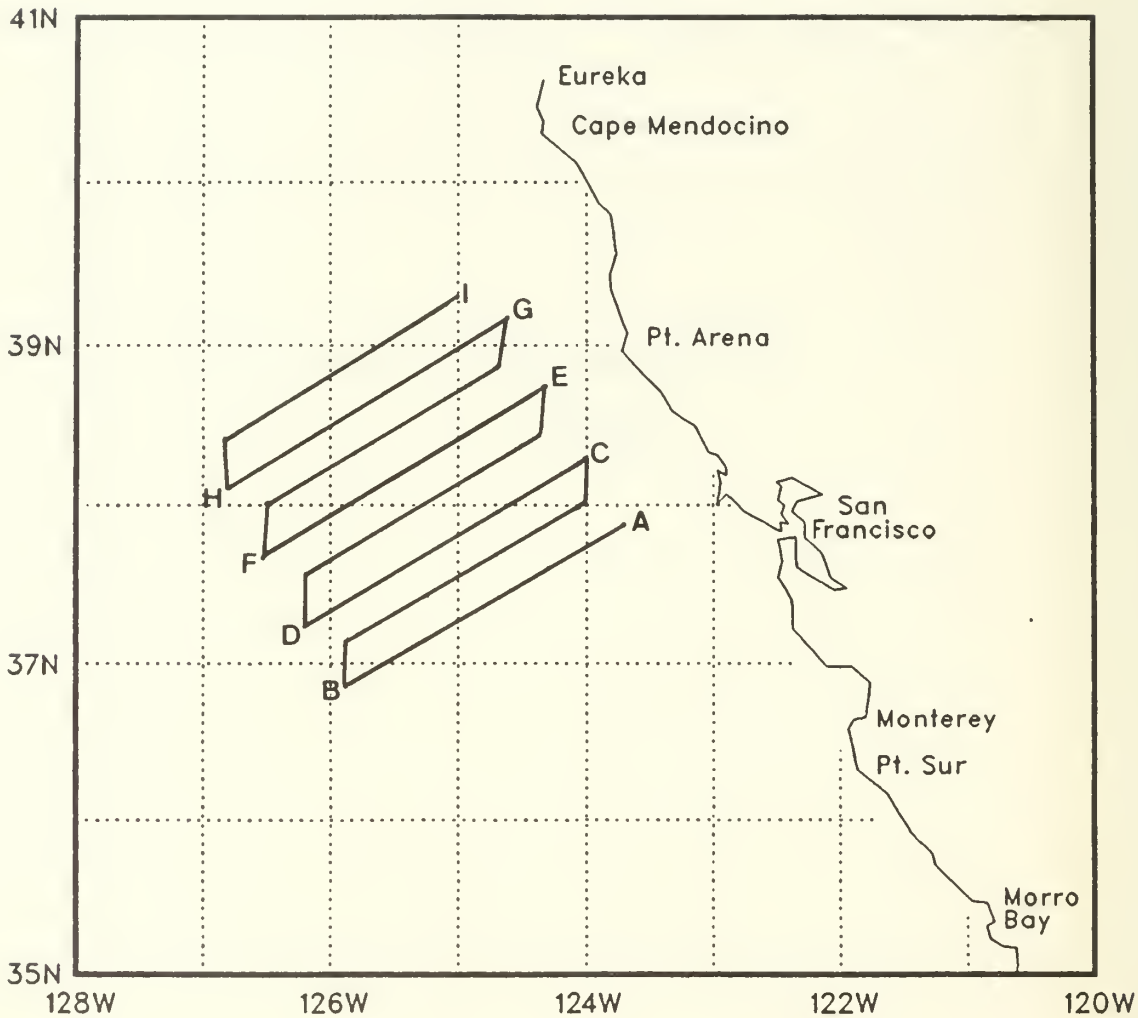


Figure 34: The flight track for OPTOMA13P.

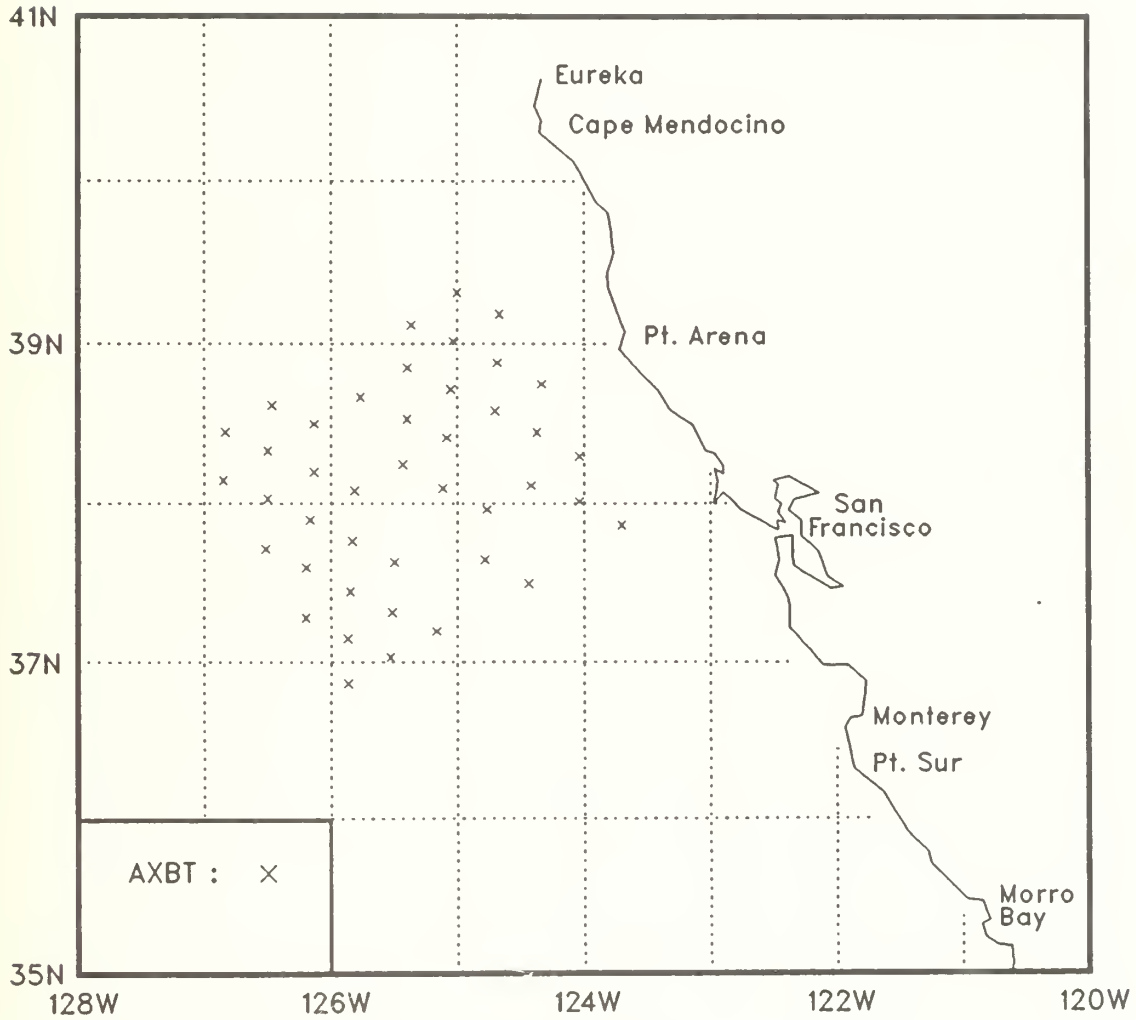


Figure 35: AXBT locations for OPTOMA13P.

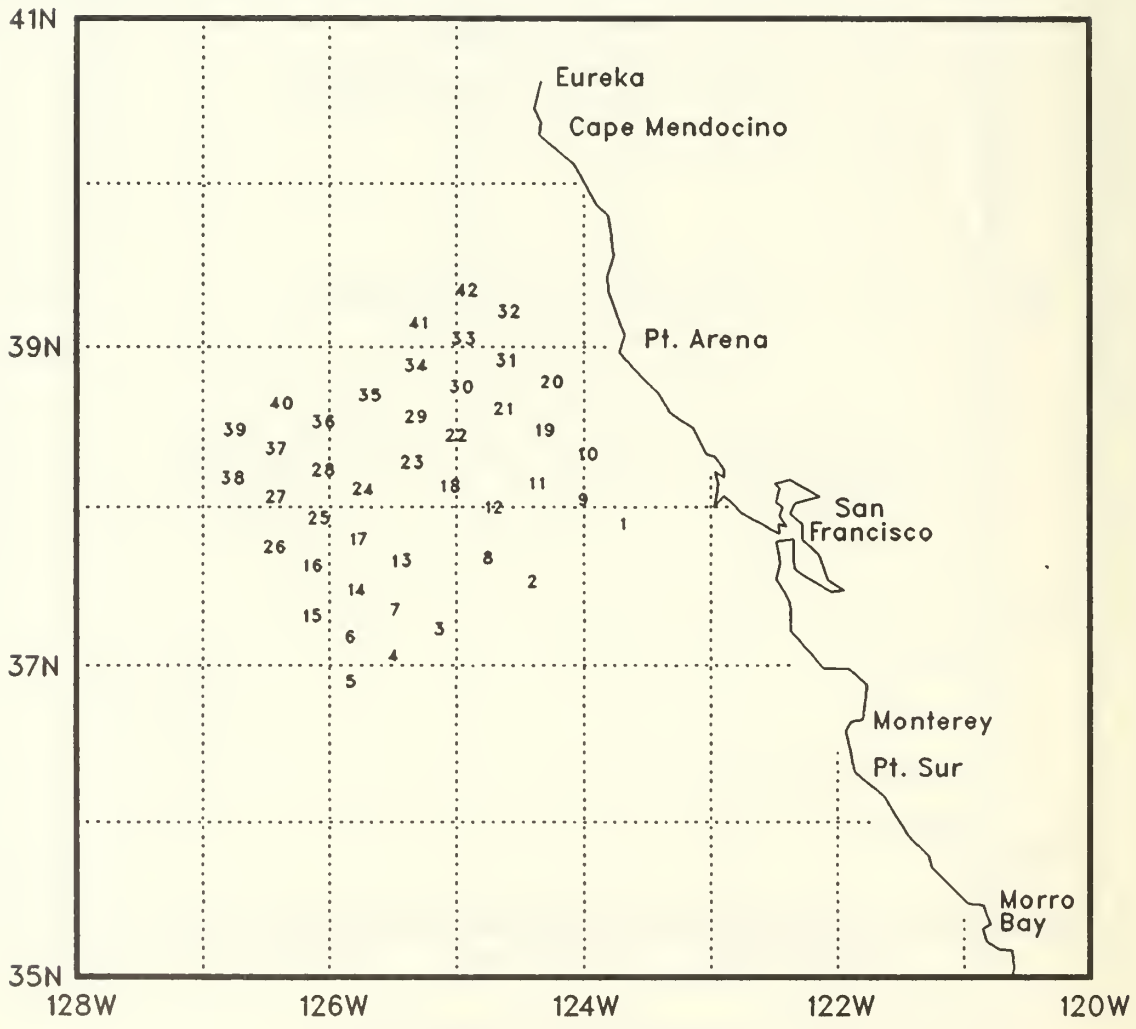


Figure 36: Station numbers for OPTOMA13P.

Table 5: OPTOMA13P Station Listing

STN	TYPE	YR/DAY	GMT	LAT (NORTH) (DD.MM	LONG (WEST) (DDD.MM)	SURFACE TEMP (DEG C)
1	AXBT	84301	1847	37.52	123.42	14.1
2	AXBT	84301	1900	37.30	124.26	14.4
3	AXBT	84301	1749	37.12	125.10	15.7
4	AXBT	84301	1755	37.02	125.32	15.4
5	AXBT	84301	1800	36.52	125.52	15.6
6	AXBT	84301	1808	37.09	125.52	15.2
7	AXBT	84301	1814	37.19	125.31	15.5
8	AXBT	84301	1824	37.39	124.47	14.2
9	AXBT	84301	1836	38.01	124.02	14.4
10	AXBT	84301	1924	38.18	124.02	13.1
11	AXBT	84301	1944	38.07	124.25	14.3
12	AXBT	84301	1955	37.58	124.46	14.2
13	AXBT	84301	2014	37.38	125.30	16.7
14	AXBT	84301	2027	37.27	125.51	15.6
15	AXBT	84301	2033	37.17	126.12	15.9
16	AXBT	84301	2050	37.36	126.12	15.4
17	AXBT	84301	2100	37.46	125.50	16.1
18	AXBT	84301	2107	38.06	125.07	14.0
19	AXBT	84301	2122	38.27	124.22	13.1
20	AXBT	84301	2132	38.45	124.20	12.1
21	AXBT	84301	2138	38.35	124.42	13.0
22	AXBT	84301	2146	38.25	125.05	15.0
23	AXBT	84301	2152	38.15	125.26	14.3
24	AXBT	84301	2200	38.05	125.49	14.4
25	AXBT	84301	2205	37.54	126.10	16.7
26	AXBT	84301	2213	37.43	126.31	16.4
27	AXBT	84301	2221	38.02	126.30	17.6
28	AXBT	84301	2230	38.12	126.08	16.4
29	AXBT	84301	2241	38.32	125.24	14.8
30	AXBT	84301	2250	38.43	125.03	14.5
31	AXBT	84301	2255	38.53	124.41	12.8
32	AXBT	84301	2302	39.11	124.40	13.1
33	AXBT	84301	2319	39.01	125.02	13.5
34	AXBT	84301	2325	38.51	125.24	14.4
35	AXBT	84301	2333	38.40	125.46	14.1
36	AXBT	84301	2341	38.30	126.08	16.9
37	AXBT	84301	2347	38.20	126.30	17.8
38	AXBT	84301	2352	38.09	126.51	17.8
39	AXBT	84301	2358	38.27	126.50	17.8
40	AXBT	84302	5	38.37	126.28	17.8
41	AXBT	84302	23	39.07	125.22	13.4
42	AXBT	84302	29	39.19	125.00	12.9

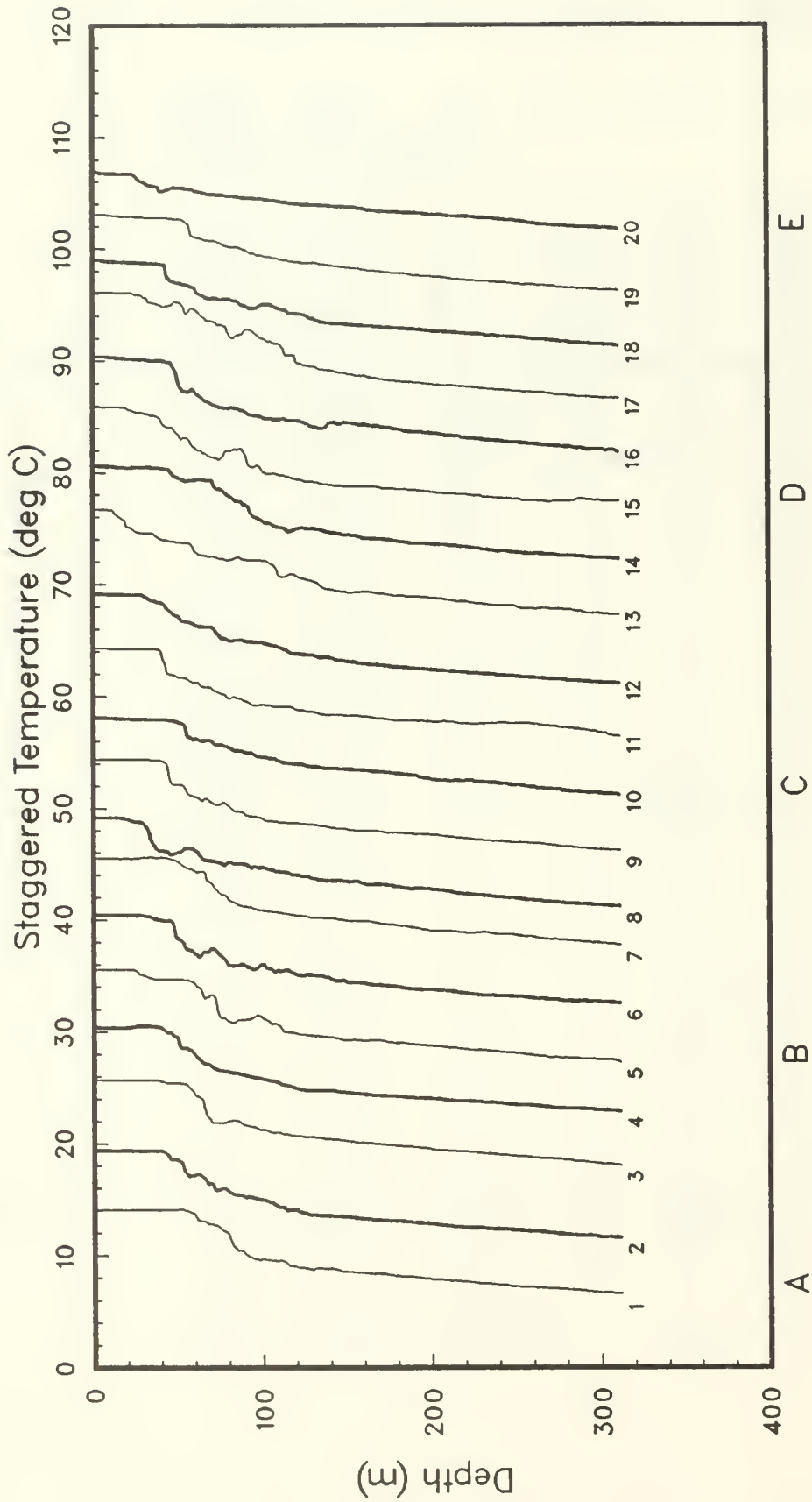


Figure 37(a): AXBT temperature profiles, staggered by multiples of 5C (OPTOMA13P).

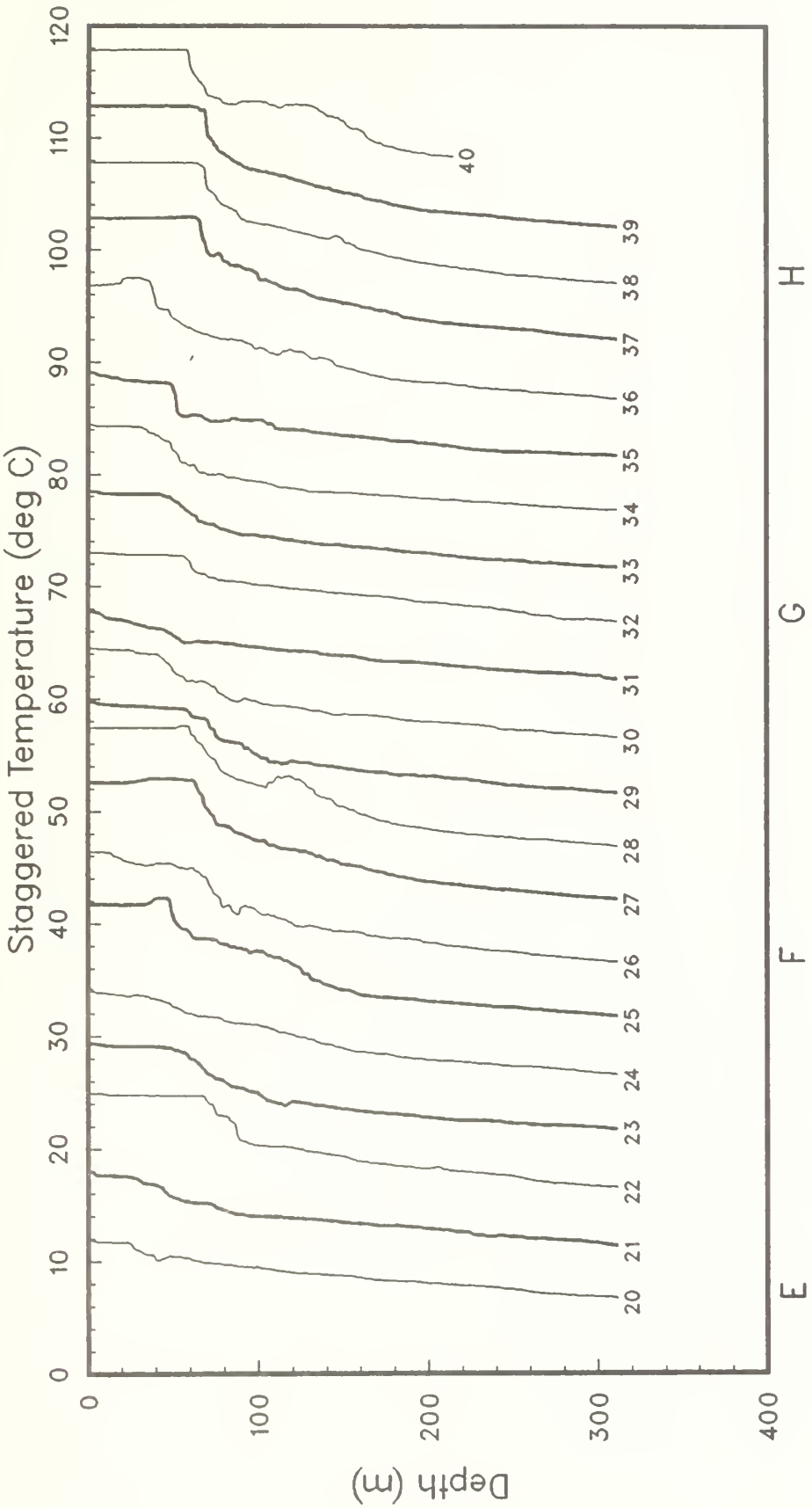

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
E
F
G
H

Figure 37(b)

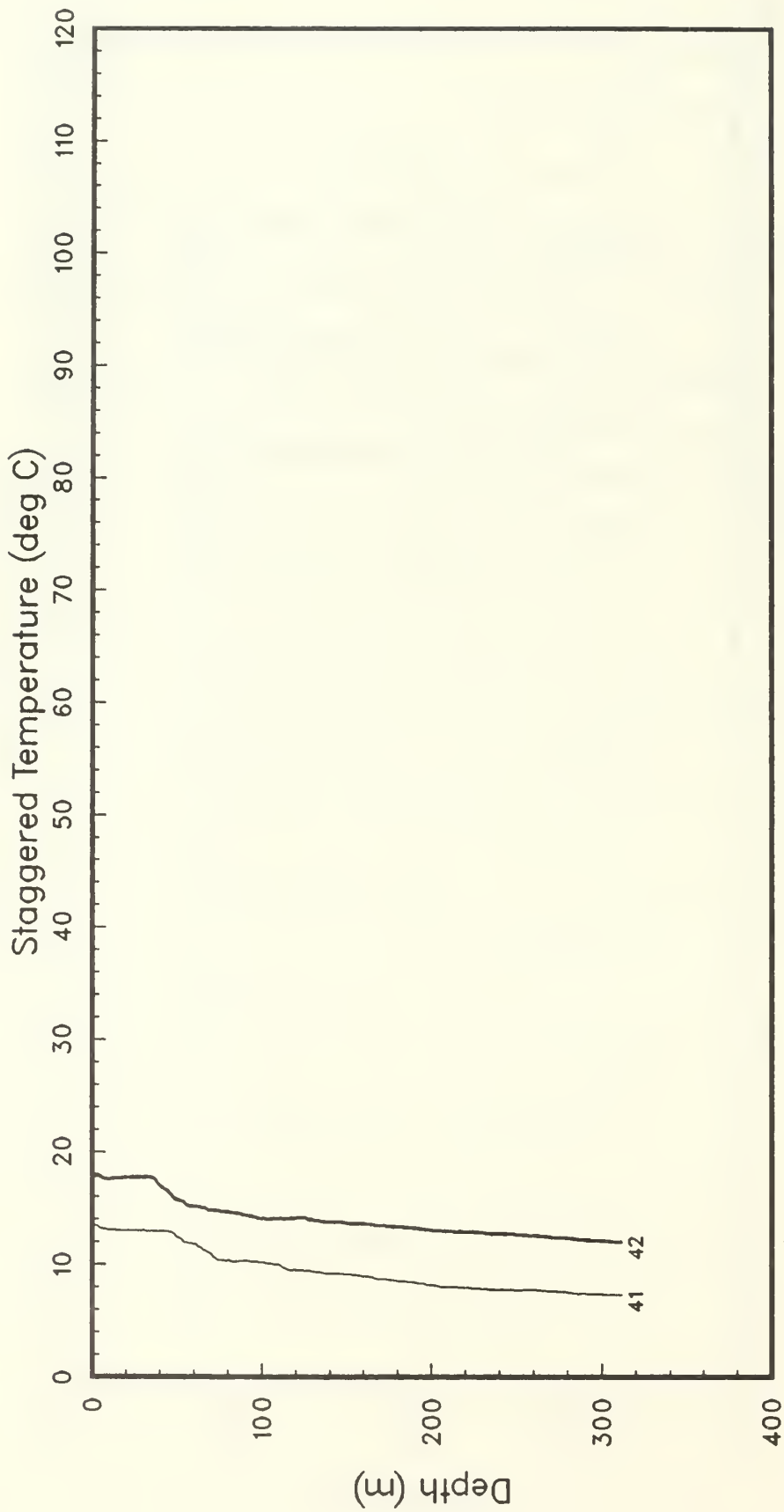

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
0
100
200
300
400
41
42

Figure 37(c)

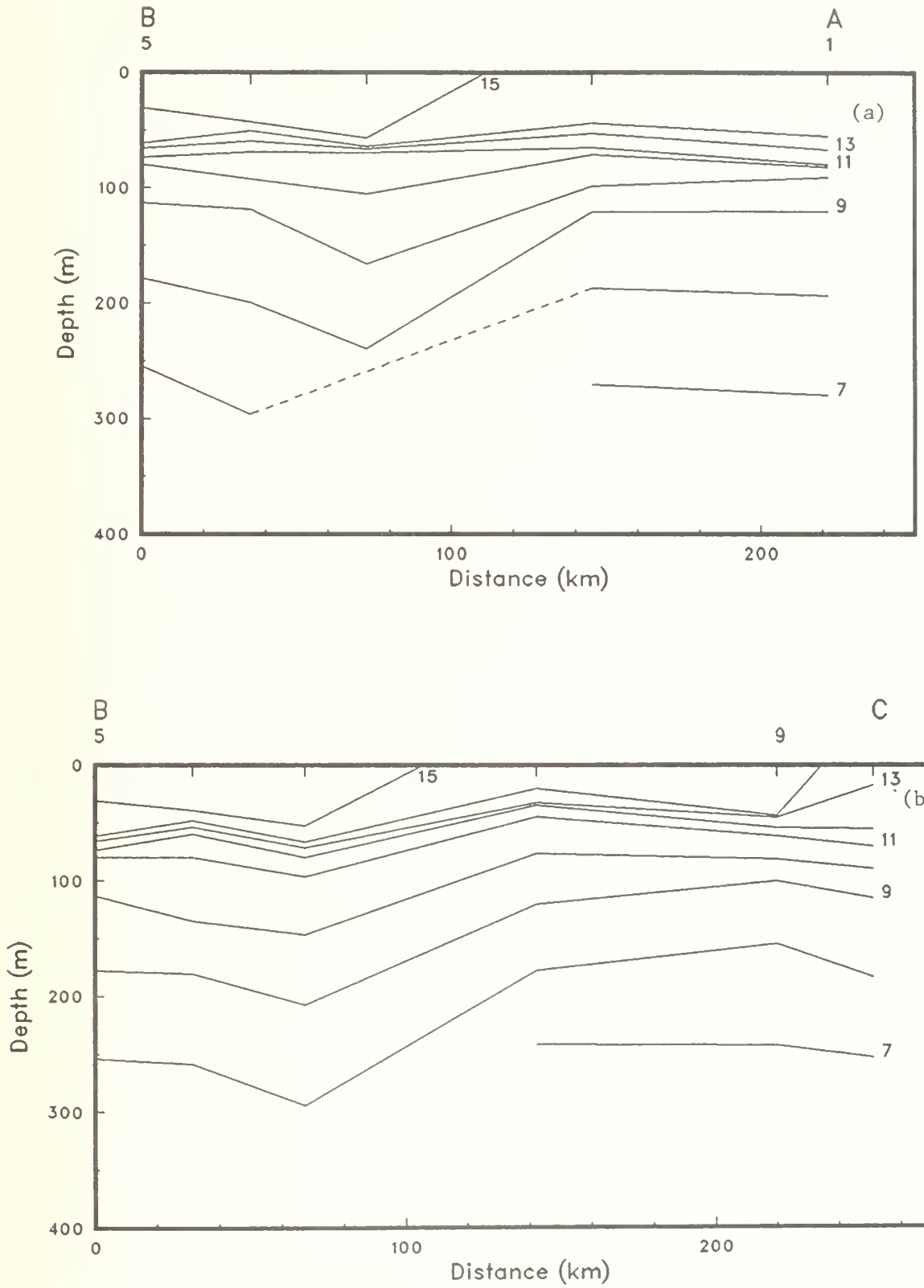


Figure 38(a)-(b): Along-track isotherms. Tick marks along the upper horizontal axis show station positions. Some station numbers are given. Dashed lines are used if the cast was too shallow (OPTOMA13P).

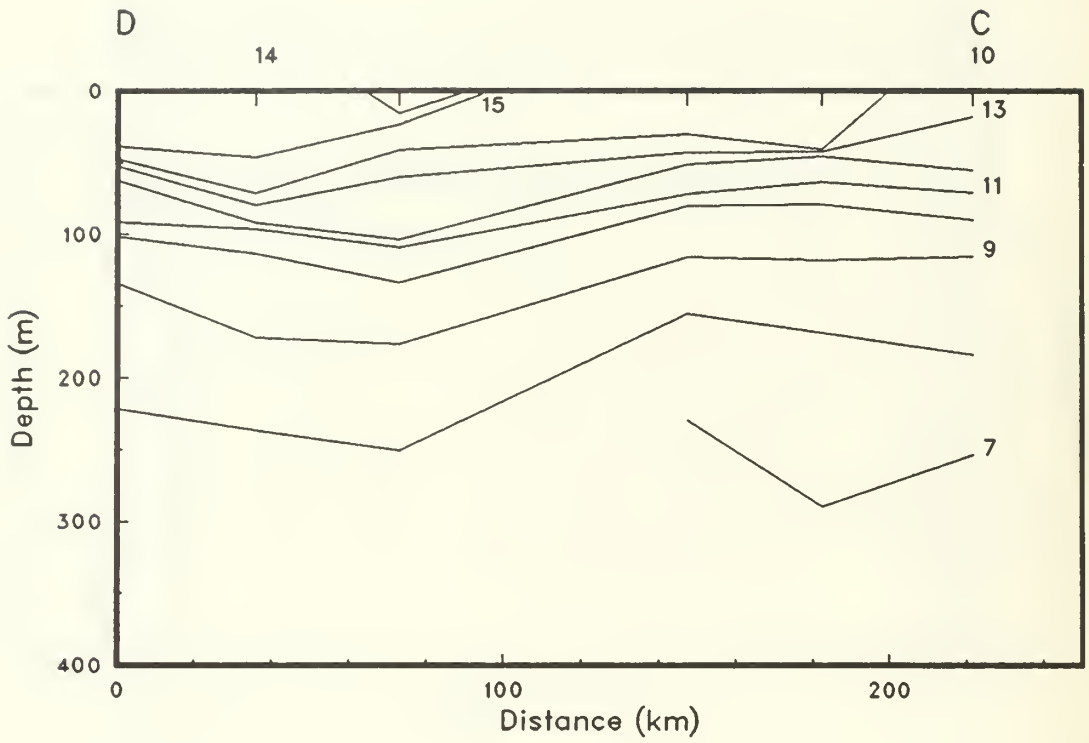


Figure 38(c)

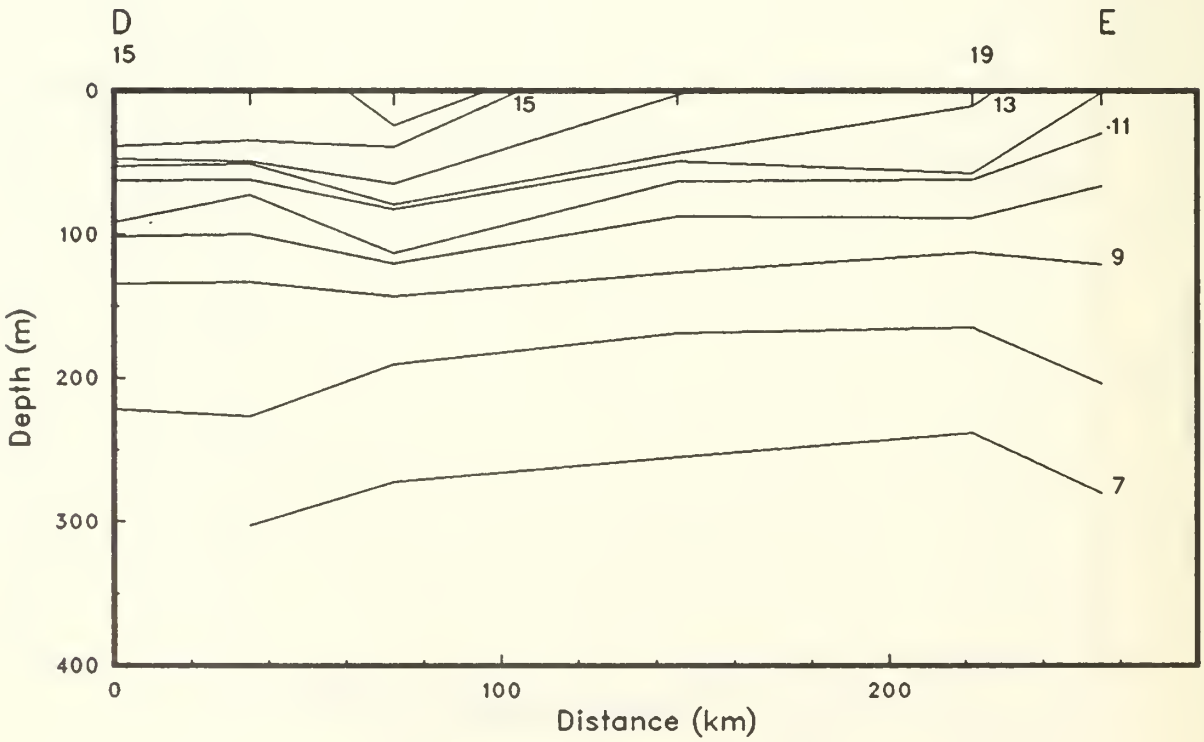


Figure 38(d)

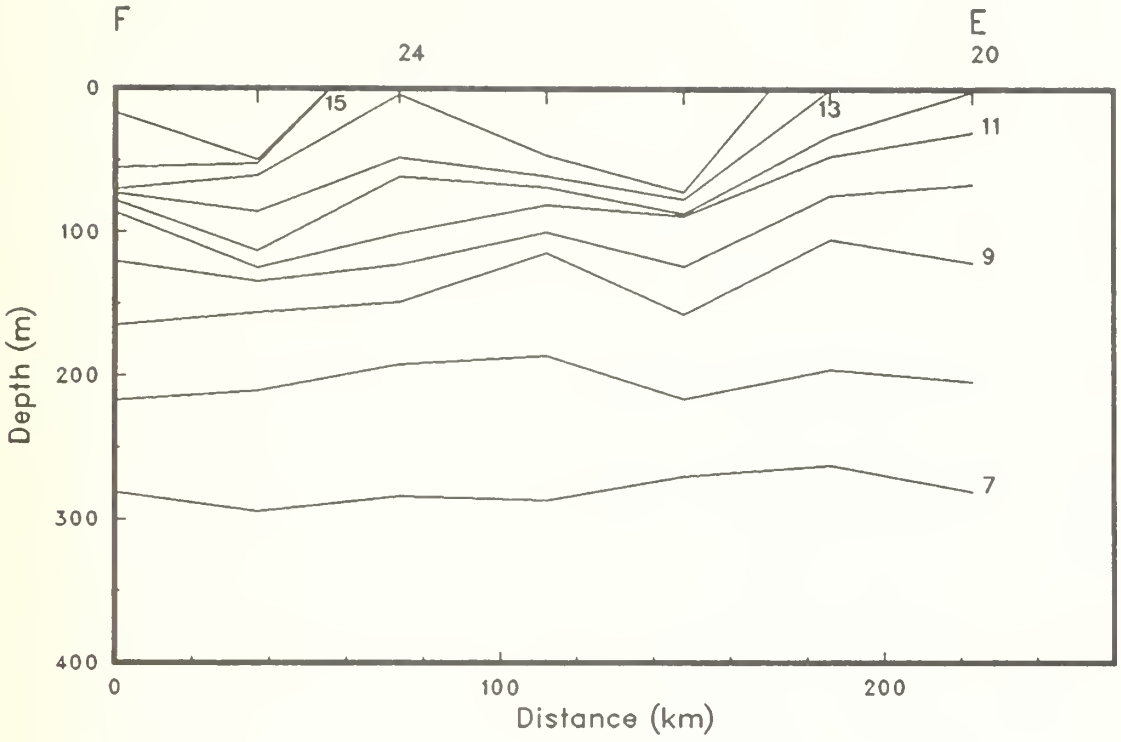


Figure 38(e)

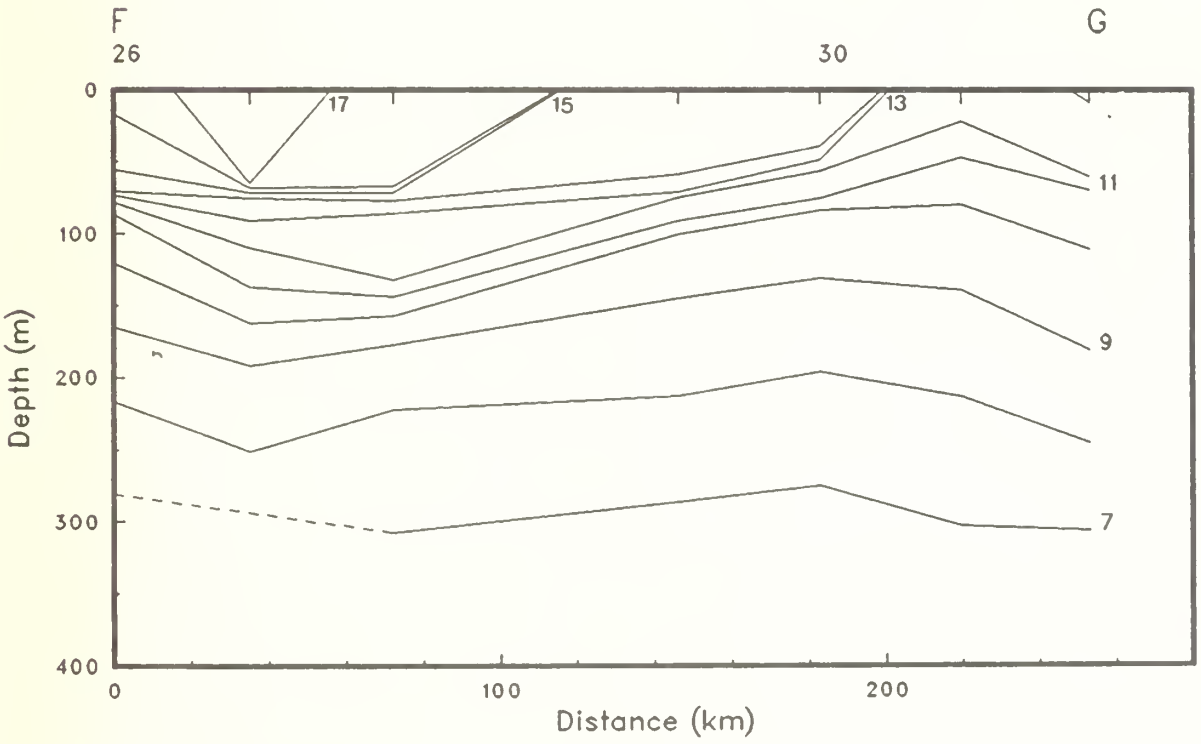


Figure 38(f)

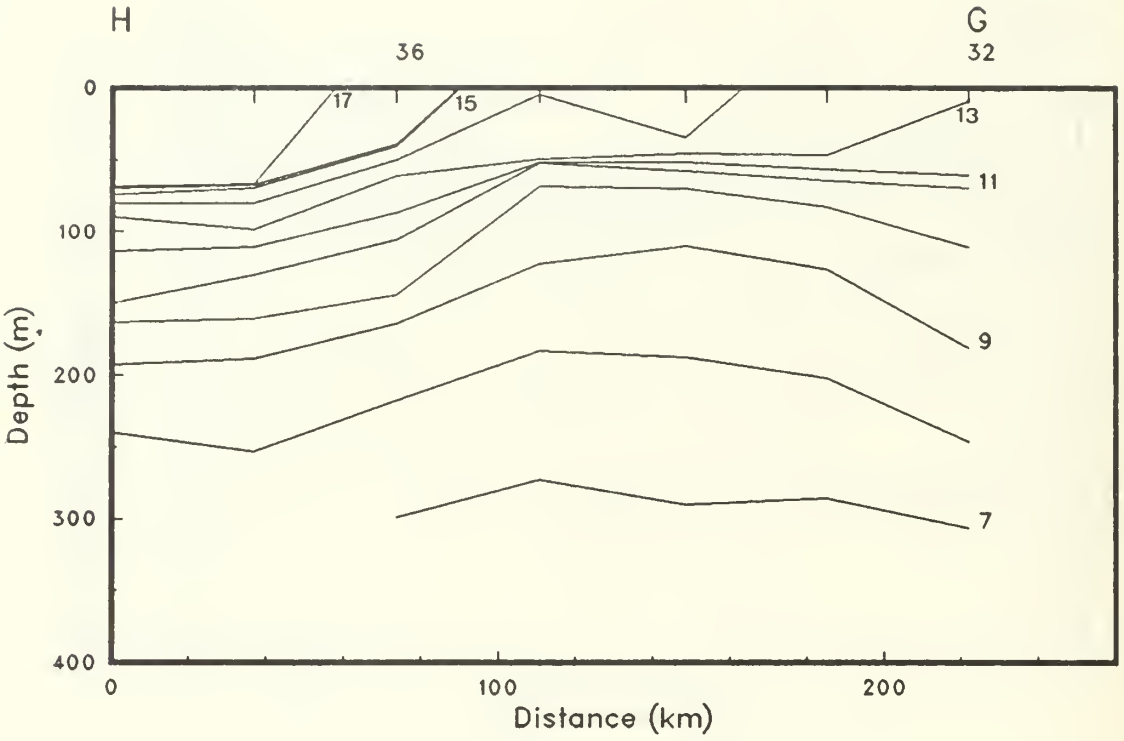


Figure 38(g)

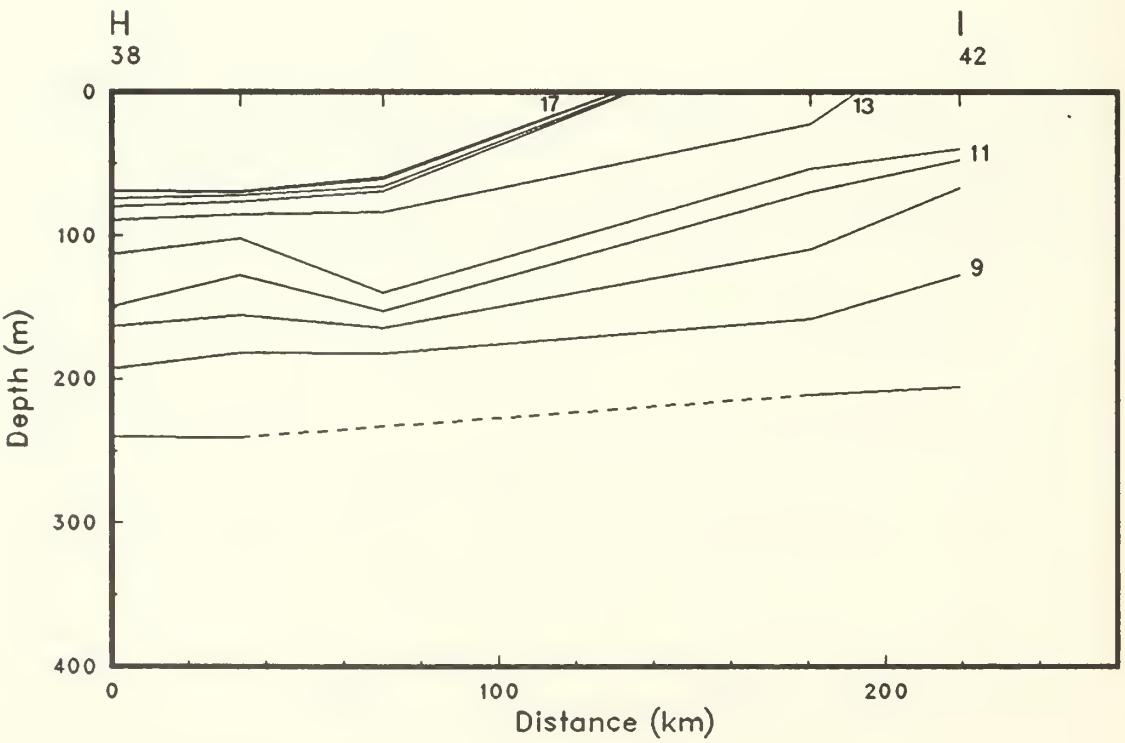


Figure 38(h)

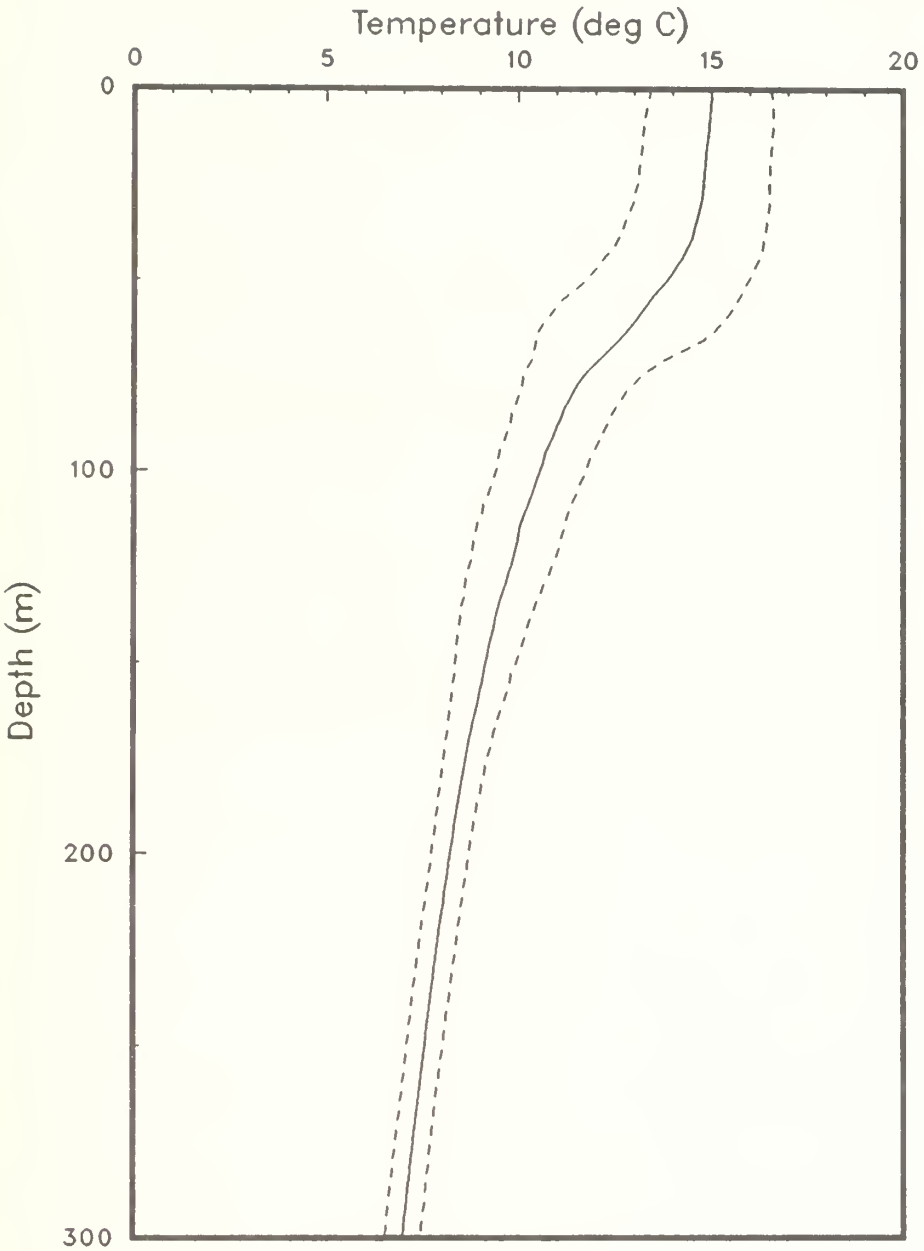


Figure 39: Mean temperature profile, with + and - the standard deviation (OPTOMA13P).

ACKNOWLEDGEMENTS

This research was sponsored by the ONR Physical Oceanography Program. The success of the fieldwork was strongly dependent on the competent, willing support of the crew of the NOAA Ship McARTHUR and the P3 Reserve Patrol Wing aircraft. The National Ocean Service, NOAA is thanked for making the NOAA ship McARTHUR available for cooperative PMEL and NPS ocean circulation and mesoscale prediction studies of the Pacific Coast EEZ. Members of the scientific cruise party were:

OPTOMA12 - Prof. C.N.K. Mooers, Chief Scientist, NPS
Mr. Paul Wittmann, Assistant Chief Scientist, NPS
Ms. Elzbet Diaz de Leon, Assistant Chief Scientist, UCSC

OPTOMA13 - Dr. Edward Kelley, Jr., Chief Scientist, NPS
Dr. Robert Loch, NPS
Mr. Eric Kunze, Applied Physics Laboratory
Mr. Arthur Bartlett, Applied Physics Laboratory

OPTOMA14 - Ms. Arlene Bird, Chief Scientist, NPS
Mr. Donald Martens, Party Chief, NPS

OPTOMA13P - Ms. Marie Colton, NPS
LT Mark Johnson, USN

REFERENCE

Lewis, E.L. and R.G. Perkin, 1981: The Practical Salinity Scale 1978: conversion of existing data. Deep Sea Res. 28A, 307-328.

INITIAL DISTRIBUTION LIST

1. Naval Postgraduate School
   Department of Oceanography
   Monterey, CA 93943

Prof. Christopher N.K. Mooers	33
Dr. Michele M. Rienecker	1
Dr. Edward A. Kelley	1
Ms. Marie C. Colton	1
Mr. Paul A. Wittmann	1
Dr. Mary L. Batteen	1
Dr. Laurence C. Breaker	1
LCDR J. Edward Johnson, USN	1

2. Harvard University
   Division of Applied Sciences
   Pierce Hall, Room 100D
   Cambridge, MA 02138

Prof. Allan R. Robinson	1
Dr. James A. Carton	1
Dr. Everett F. Carter	1
Mr. Leonard J. Walstad	1
Mr. Wayne G. Leslie	1
Ms. Nadia Pinardi	1
Prof. Myron B. Fiering	1

3. Office of Naval Research (ONR)
   800 N. Quincy St.
   Arlington, VA 22217

Dr. Thomas W. Spence	1
Dr. Thomas B. Curtin	1

4. College of Oceanography
   Oregon State University
   Corvallis, OR 97331

Prof. Robert L. Smith	1
Dr. Adrian Huyer	1

5. Jet Propulsion Laboratory (JPL)
   California Institute of Tech.
   4800 Oak Grove Road
   Pasadena, CA 91109

Dr. Denise E. Hagan (Code 183-501)	1
Dr. Mark Abbott (also at Scripps)	1

6. Commanding Officer
Fleet Numerical Oceanography Center (FNOC)
Monterey, CA 93943

CDR John F. Pfeiffer, USN	1
Mr. R. Michael Clancy	1
Mr. Ken Pollak	1
Ms. Evelyn Hesse	1
LCDR Michael R. Frost, RN	1

7. Sandia National Laboratories
Div. 6334
Albuquerque, NM 97185

Dr. Mel Marietta	1
Dr. Eugene S. Hertel	1
Dr. Stuart L. Kupferman	1

8. Marine Products Branch, W/NMC21
National Meteorological Center
National Weather Service, NOAA
Washington, D.C. 20233

LCDR Craig S. Nelson, NOAA Corps	1

9. National Center for Atmospheric Research (NCAR)
P.O. Box 3000
Boulder, CO 80307

Dr. Dale B. Haidvogel	1

10. Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093

Prof. Russ E. Davis	1
Dr. Jerome A. Smith	1
Mr. Phillip Bogden	1

11. Princeton University
Geophysical Fluid Dynamics Program
P.O. Box 308
Princeton, NJ 08540

Prof. George L. Mellor	1

12. Tulane University
Department of Mathematics
6823 St. Charles
New Orleans, LA 70118

Dr. Robert N. Miller	1

13. Woods Hole Oceanographic Institution
Department of Physical Oceanography
Woods Hole, MA 02543

Dr. Kenneth H. Brink	1
Dr. Robert C. Beardsley	1

14. Naval Ocean Research and
Development Activity (NORDA)
NSTL Station
Bay St. Louis, MS 39525

Dr. Steve A. Piacsek	1
Dr. Dana A. Thompson	1
Dr. Harley C. Hurlburt	1
Dr. Alexander Warn-Varnas	1

15. Mathematics Department
121-1984 Mathematics Road
University of British Columbia
Vancouver, British Columbia
CANADA V6T 1Y4

Prof. Lawrence A. Mysak	1

16. Department of Oceanography
University of Hawaii
2525 Correa Road
Honolulu, HI 96822

Prof. Lorenz Magaard	1

17. NAVOCEANCOMFAC Keflavik Iceland
FPO NY 09571

LTJG Diane C. Durban, USN	1

18. Ocean Circulation Division
Atlantic Oceanography Laboratory
Bedford Institute of Oceanography
Dartmouth, N.S. Box 1006
CANADA B2Y 4A2

Dr. Motoyoshi Ikeda	1

19. Precision Marine
Meteorologic Nationale
2 Ave. RAPP
75340 Paris CEDEX 07
France

Dr. Jacques Saurel	1

20. Div. of Oceanography
RSMAS
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149

Dr. Otis Brown 1

21. Applied Physics Laboratory
University of Washington
1013 NE 40th Str.
Seattle, WA 98105

Dr. Thomas B. Sanford 1

22. School of Oceanography
University of Washington
Seattle, WA 98195

Dr. Steven C. Riser 1

23. California Space Institute
MS-A021
Scripps Institution of Oceanography
La Jolla, CA 92093

Dr. Robert L. Bernstein 1

24. Marine Sciences Research Center
State University of New York
Stony Brook, NY 11794

Dr. Dong-Ping Wang 1

25. Applied Physics Laboratory
Johns Hopkins University
Laurel, MD 20707

Dr. Jack Calman 1

26. Pacific Marine Environmental Lab
NOAA
Bldg. 3
7600 Sand Point Way, NE
Seattle, WA 98115

Mr. James R. Holbrook 1

27. Defense Technical Information Center 2
Cameron Station
Alexandria, VA 22314

28. Dudley Knox Library 2
Code 0142
Naval Postgraduate School
Monterey, CA 93943