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LEVEL II

Department of Oceanography

**AN ANALYSIS OF HYDROGRAPHIC DATA
FROM KNORR CRUISE 83 IN HEBBLE
AREA, SEPTEMBER-OCTOBER, 1980**

Technical Report

AD A109623

**Georges L. Weatherly
Edward A. Kelley
and
Reinard Harkema**

October, 1981

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1. REPORT NUMBER 188		2. REPORT NUMBER AD A109623		3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) An Analysis of Hydrographic Data From KNORR Cruise 83 in HEBBLE Area, September - October, 1980				5. TYPE OF REPORT & PERIOD COVERED Technical Report	
7. AUTHOR(s) Georges L. Weatherly, Edward A. Kelley, and Reinard Harkema				6. PERFORMING ORG. REPORT NUMBER	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Oceanography; Florida State University; Tallahassee, FL 32306				8. CONTRACT OR GRANT NUMBER(s) N00014-75-C-0201	
11. CONTROLLING OFFICE NAME AND ADDRESS Office of Naval Research NORDA NSTL Station, MS 39529				10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)				12. REPORT DATE October 1981	
				13. NUMBER OF PAGES 44	
				15. SECURITY CLASS. (of this report)	
				15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
18. 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 A Florida State University Department of Oceanography Technical Report					
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)					
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) We present in figure form some of the hydrographic data collected on the Scotian Rise in September - October, 1980 as part of the HEBBLE program. Two full water column θ and S cross slope transects are presented together with two σ_t transects for comparison. Selected surface to bottom computed geostrophic velocity profiles are also presented. To focus further on conditions near the ocean bottom, two near bottom, cross slope θ and transmissivity transects are shown. Additionally, in the lowest 350 m					

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Theta

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Theta
sigma-t

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DEPARTMENT OF OCEANOGRAPHY
FLORIDA STATE UNIVERSITY
TALLAHASSEE, FLORIDA 32306

TECHNICAL REPORT

AN ANALYSIS OF HYDROGRAPHIC DATA FROM KNORR CRUISE 83 IN
HEBBLE AREA, SEPTEMBER - OCTOBER 1980

by
Georges L. Weatherly,
Edward A. Kelley Jr.
and
Reinard Harkema

PREPARED FOR THE OFFICE OF NAVAL RESEARCH UNDER
CONTRACT NUMBER N00014-75-C0201

OCTOBER 1981

ABSTRACT

We present in figure form some of the hydrographic data collected on the Scotian Rise in September - October, 1980 as part of the HEBBLE program. Two full water column θ and S cross slope transects are presented together with two σ_5 transects for comparison. Selected surface to bottom computed geostrophic velocity profiles are also presented.

To focus further on conditions near the ocean bottom, two near bottom, cross slope θ and transmissivity transects are shown. Additionally, in the lowest 350 m for each station, there is shown a plot of θ , salinity, σ_5 , and transmissivity (where available).

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INTRODUCTION

An extensive hydrographic survey was made in the HEBBLE area in September-October, 1979 (e.g. Weatherly and Kelley, 1980). The basic reason for making a similar but less extensive survey a year later in October 1980 was to see if a feature seen in the 1979 data -a distinct cold body of water above the bottom near the base of the Scotian Rise -was again present. This feature hereafter referred as the Cold Filament (CF), discussed in Weatherly *et al* (1980) and Weatherly and Kelley (1981), is about 50 m thick, 100 km wide, 20-40 m°C colder than the surrounding water (upslope, above and downslope) and is found upslope of the base of the Scotian Rise. The data presented in this report show the CF was again present and essentially the same in structure and location as in the previous year.

Another reason for making an additional survey was to obtain better salinity data to determine whether the potential temperature-salinity (θ -S) values for the CF were anomalous or not. The 1980 data show that although the CF is a distinct body of cold, fresh water, it is not anomalous in its θ -S properties.

DATA COLLECTION AND REDUCTION

The hydrographic data presented here were collected in the HEBBLE area (Figure 1) between September 21, 1980 and October 7, 1980 from the R/V KNORR (KNORR 83 cruise) by the Graduate School of Oceanography of the University of Rhode Island using a Neil Brown Instrument System CTD. A one-meter transmissometer was attached to the CTD for stations 1-7. It malfunctioned during CTD Station 7 and was replaced for the remaining stations by a 25-cm transmissometer. No data was recorded on the CTD magnetic tape

during CTD Station 1; therefore no transmissometer data is available for CTD Stations 1 and 7. These transmissometers were provided by the Optical Oceanography Group of Oregon State University. Full water column continuous profiles of temperature, conductivity, oxygen, and transmissivity were made at the 22 CTD stations indicated in Figure 1 (CTD station 2 was aborted and is not shown). Personnel from the Woods Hole Oceanographic Institution made on-board salinity measurements of water samples taken at specified depths during each cast. The authors analyzed reports of the CTD calibrations (both pre-cruise and post-cruise), on-board thermometer and salinity measurements, and the CTD measurements. As a result of this analysis, the necessary corrections for temperature and salinity to bring the CTD measurements into agreement with the so-called Worthington-Metcalf line for the Western North Atlantic were provided to the CTD Group, Woods Hole Oceanographic Institution. The CTD Group processed the magnetic tapes provided by the University of Rhode Island, applying these corrections, and provided the Department of Oceanography, Florida State University, with the following data at 2.0 decibar intervals for each station: temperature, salinity, oxygen and transmissivity. These data were processed to obtain the derived quantities shown for example in Table 1. No information was recorded on the magnetic tape from the surface to 578 m for CTD Station 8. Figures 2 and 3 contain the T-S curves for selected deep-water stations using these corrected data.

ANALYSIS AND DISCUSSION

Our basic objective for making hydrographic observations in the HEBBLE area in October 1980 during the R/V KNORR 83 cruise and for analyzing these data was to see if the CF was again present. The CF is evident in the

Weatherly and Kelley (1981) (WK) and, for comparison with WK, the figures in this report are similar in format to those in WK. Although available, no transmissivity data was shown in WK; in this report we do show transmissivity data. Transmissivity data obtained during the R/V KNORR 74 cruise are discussed in Pak and Zaneveld (1981).

The location of the CTD stations made during the R/V KNORR 83 cruise are shown in Figure 1. From these stations two cross-isobath transects were examined: Section 1 - CTD Stations 5-10 and Section 2 - CTD Stations 15-22. The total elapsed time for Section 1 was 66 hours and for Section 2, 87 hours. Full water column θ , S and σ_s transects for Sections 1 and 2 are shown in Figures 4-9.

Near-bottom θ transects along the two sections are shown in Figures 10 and 11. The CF is evident. As in WK its width is about 100 km; its thickness about 50 m; it is several tens of $m^\circ C$ colder than the surrounding water; and it is found on the continental rise near its base. The corresponding near-bottom transmission transects Figures 12 and 13 (lower transmission values indicate more opaque water) show that the CF is murkier than the surrounding water. The double maxima in the CF in Figure 13 may be an artifact of the manner in which the section was made: the northern part of this section was made first starting from the center part preceding upslope (Stations 15-19); the southern part was then sampled (Stations 20-22). The CF may have moving downslope while this section was made. In Figures 2 and 3 all θ -S values for $\theta < 1.80$ are from the Filament. The CF θ -S values from KNORR 83 fall within the Worthington-Metcalf line (indicated by "()" in these figures) and we conclude that the CF is not anomalous in its θ -S characteristics for waters in the North American basin.

Figures 14 through 35 are profiles of θ , S, transmissivity and σ_s in the lowest 350 m at each station. In each figure the latitude and longitude of the station, and the date and time the CTD reached the bottom, are listed. Comparing the latitudes and longitudes of each station (also see Figure 1) shows that some stations are repeated: Stations (12,13,15 "23"), (5,19), (6,18), (7,16), (8,11,"14",20), (9,21), and (10,22). Stations with " " denote nearby but more than 6 km away from separated stations.

The near-bottom θ transects Figures 10 and 11 indicate that CTD casts 8,9,15-18,20,21 extended down into the CF. Some features become apparent when the 0-350 meters above bottom (mab) profiles of these casts (Figures 20,21, 27-30,32,33) are compared to profiles for stations not in the CF in Figures 10 and 11, Stations 1,3-7,10,19,22 (Figures 14,15-19,22,31,34). The bottom mixed layers (BML's) in the Filament are "too cold" to be formed by mixing of a uniform temperature gradient. Thus the temperature change of 20-40 m°C in the "thermocline" capping these BML's is clearly too large to be attributed to mixing of a uniform temperature gradient; this is generally not the case for the BML's outside the CF. Generally, the "thermocline" capping BML's in the CF are about 100 m thick while those capping the BML's outside the CF are a few tens of meters thick. The thickest "thermocline" observed in this data set, as well as all other CTD profiles we have inspected from the HEBBLE area, is for Station 16; it extends to about 270 mab.

The BML's and their capping thermoclines for Stations 12-14,23 (Figures 24-26,35) have the same features noted above for CF Stations. We conclude that these casts extended into the CF.

As noted above, the BML's in the CF are "too cold" (Figures 20,21,24-30, 32,33,35). The S profiles and σ_s profiles for these stations indicate that these layers are also "too fresh" and "too dense".

Qualitatively, the transmissivity profiles are, in general, quite similar to the θ profiles. The BML in general corresponds to a homogeneous nepheloid layer. The transition region capping the homogeneous nepheloid layer, "nephelcline", in general, corresponds to the "thermocline". These are two notable exceptions: (1) Station 11 (Figure 23) shows no apparent BML or thermocline while there appears to be a quasi-homogeneous nepheloid layer capped by a "nephelcline"; (2) Station 13 (Figure 25) shows a thin "thermocline" and a thick "nephelcline". Station 13 had the murkiest BML.

Full water column geostrophic velocity profiles were calculated for selected stations. These are shown in Figure 36. The level of no motion was selected arbitrarily as 1200 m.

ACKNOWLEDGEMENTS

The work of Jan Szelag, University of Rhode Island, in deploying the CTD and Robert Millard, Jr. and Nan Galbraith, Woods Hole Oceanographic Institution, in processing the CTD data is gratefully acknowledged. J.R.V. Zaneveld and H. Pak of Oregon State University graciously provided transmissometers. M. Wimbush was most helpful in interfacing the transmissometer to the CTD. Elizabeth Howard is thanked for making salinity measurements of water samples. Finally, we thank Charles Hollister for his support during all phases of this work.

Prepared under a grant of the Office of Naval Research (contract N00014-75-C0201).

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- Weatherly, G.L., E.A. Kelley, Jr., J.R.V. Zaneveld, H. Pak, M.J. Richardson, and M. Wimbush, 1980. A deep, narrow, thin filament of the Western Boundary Undercurrent. Abstract, Trans. Amer. Geophys. U., 61 (11), p. 1017.

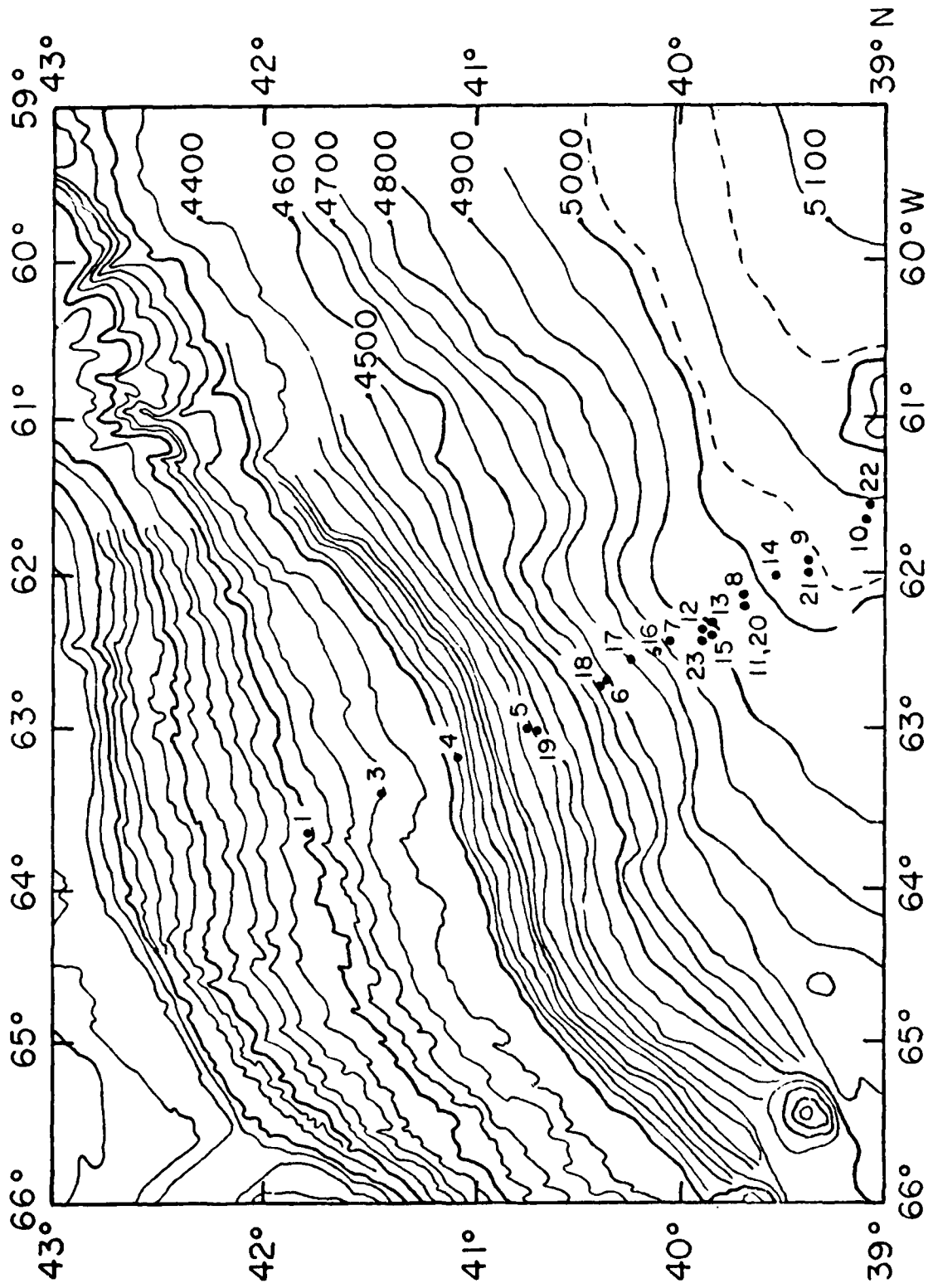


Figure 1

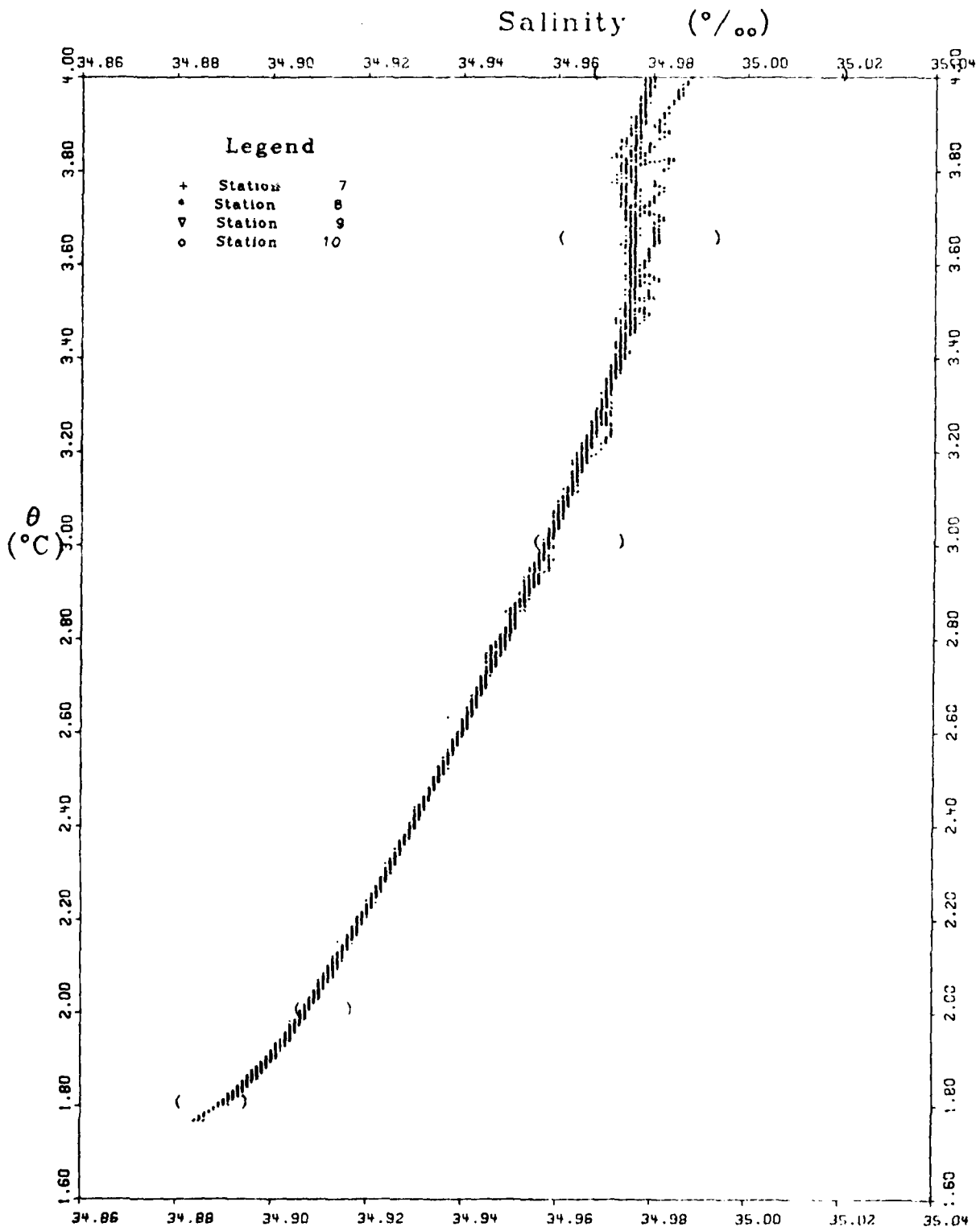


Figure 2

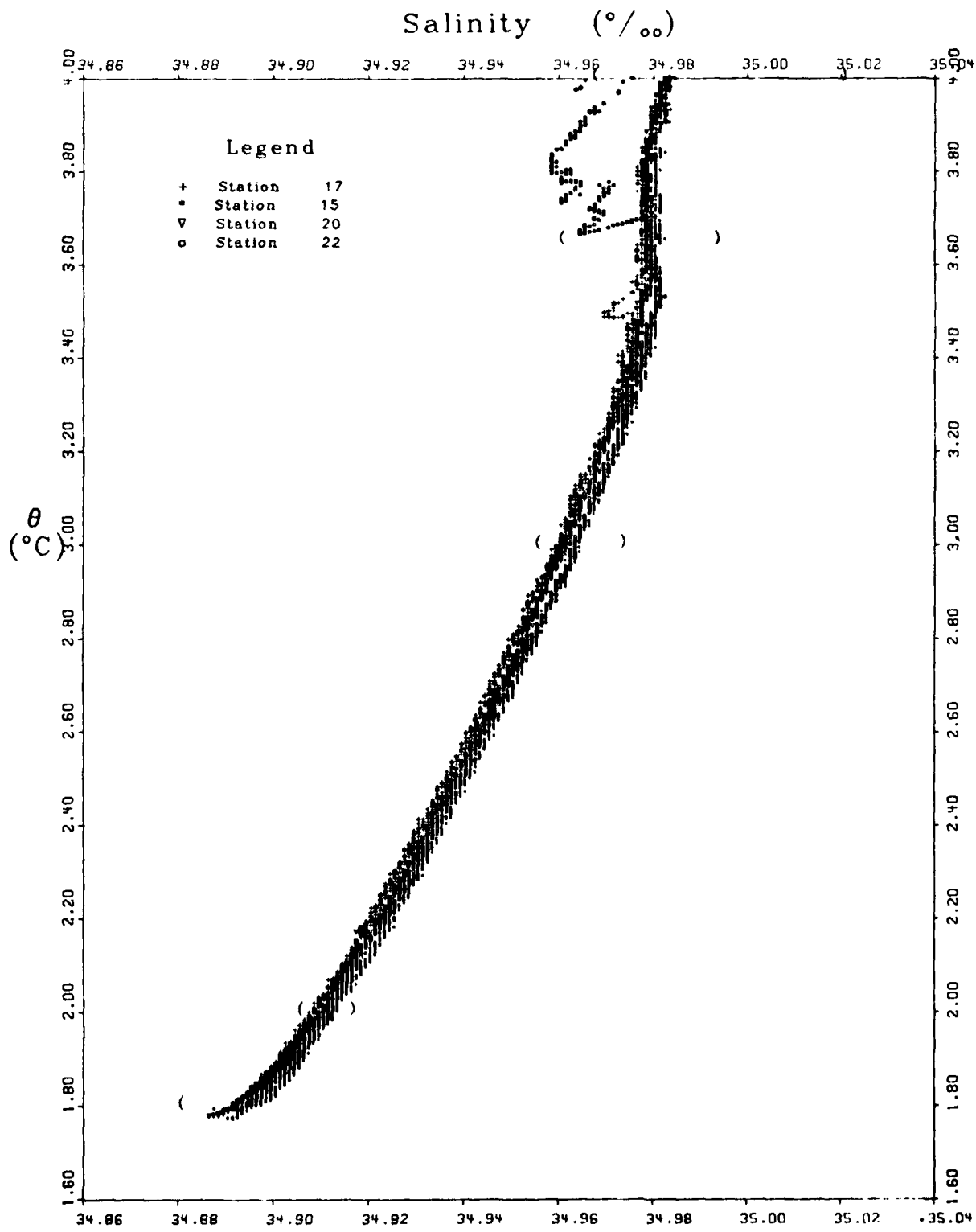


Figure 3

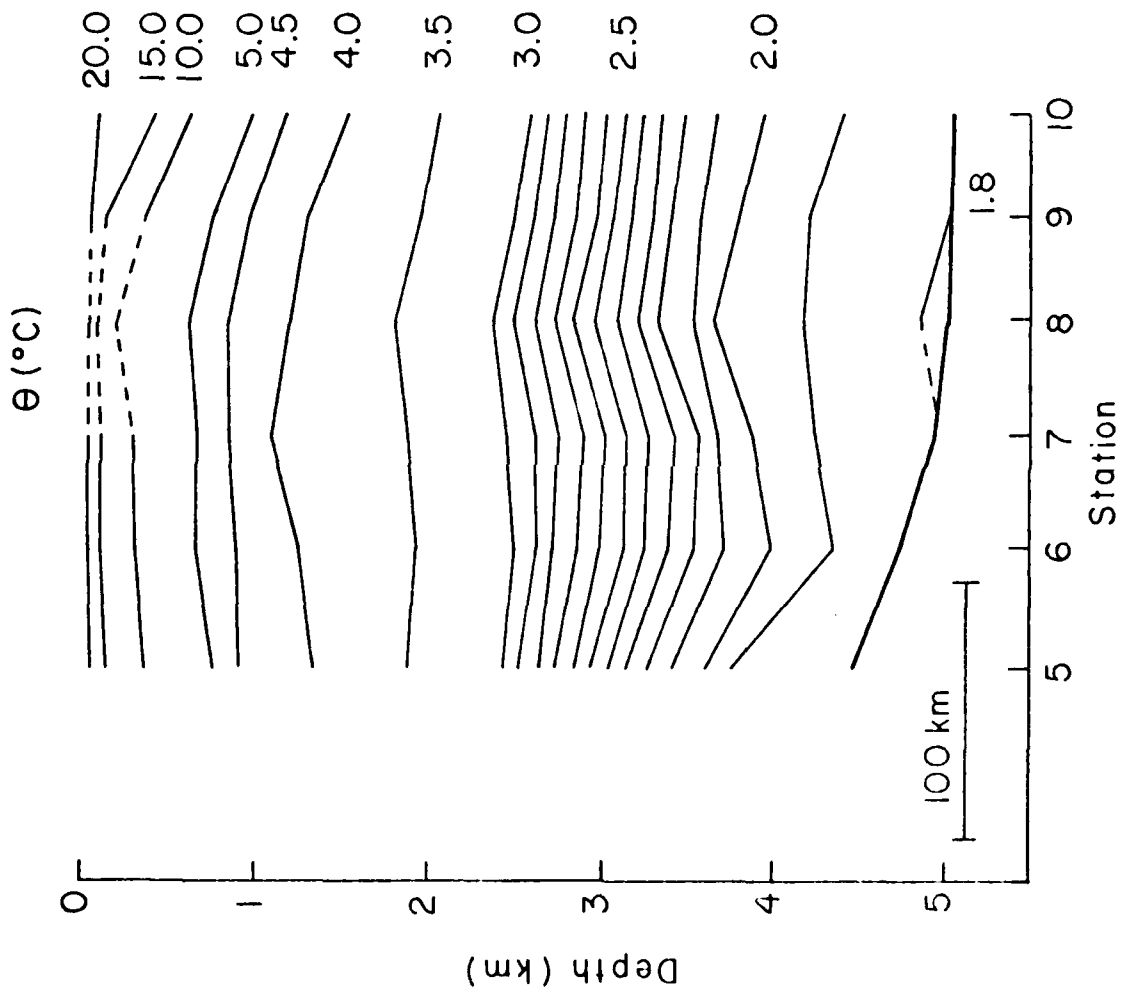


Figure 4

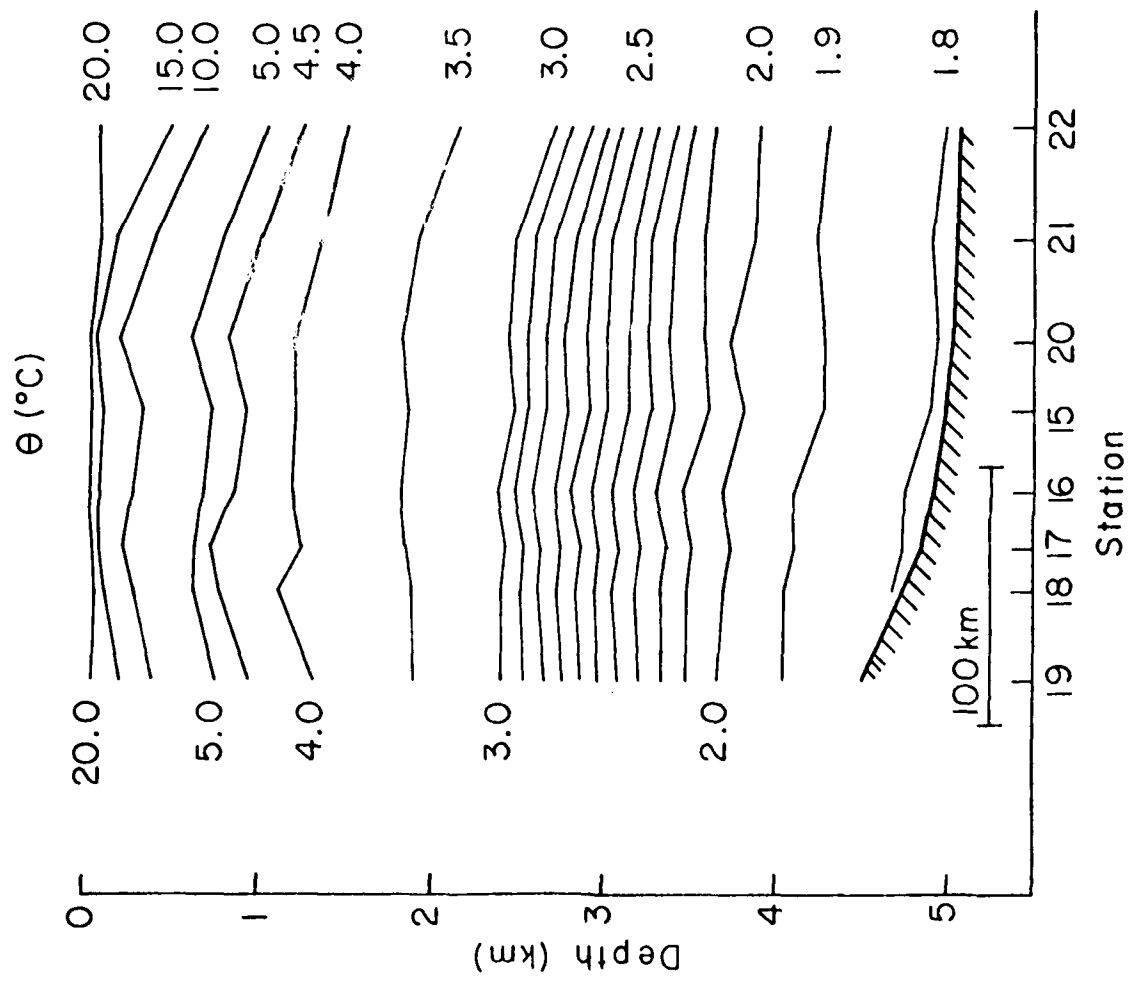


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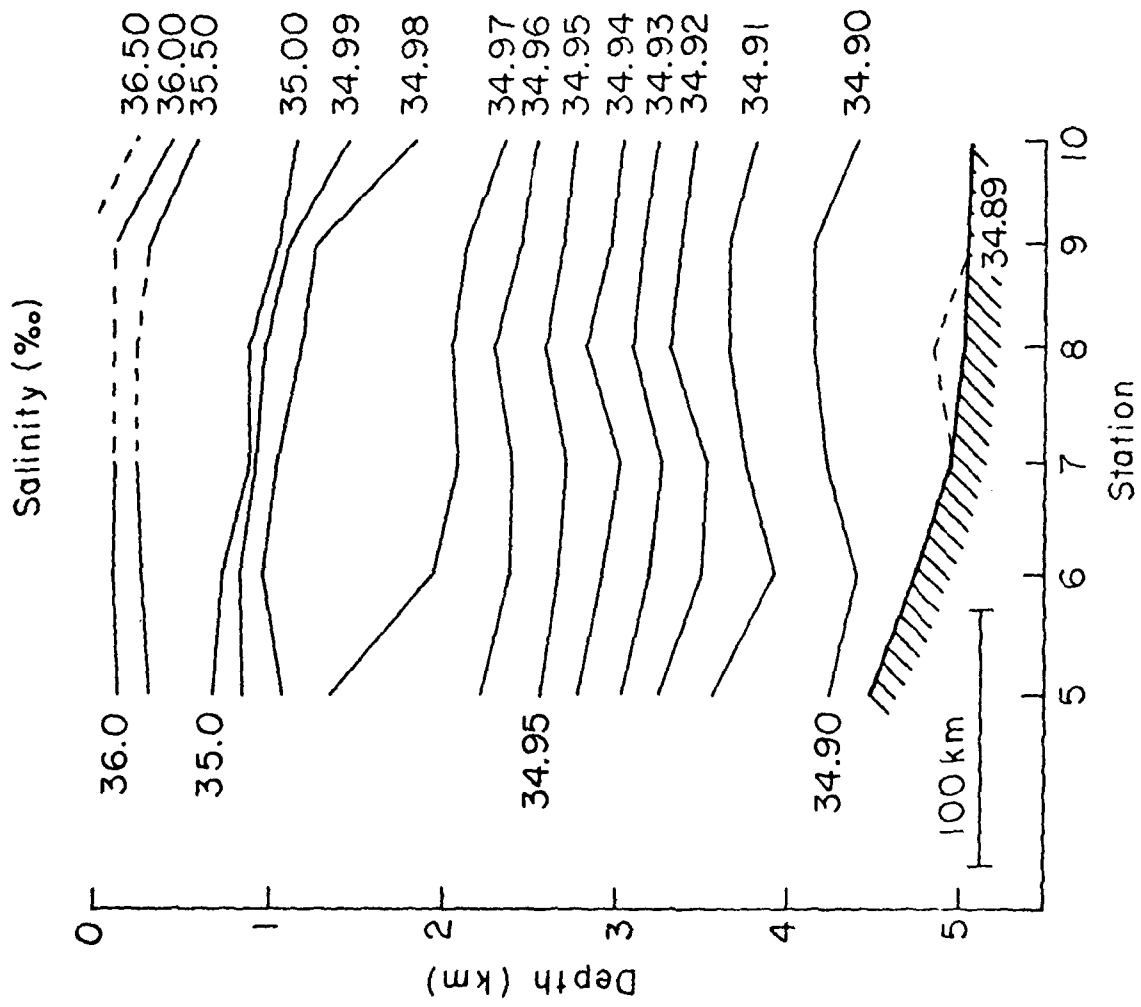


Figure 6

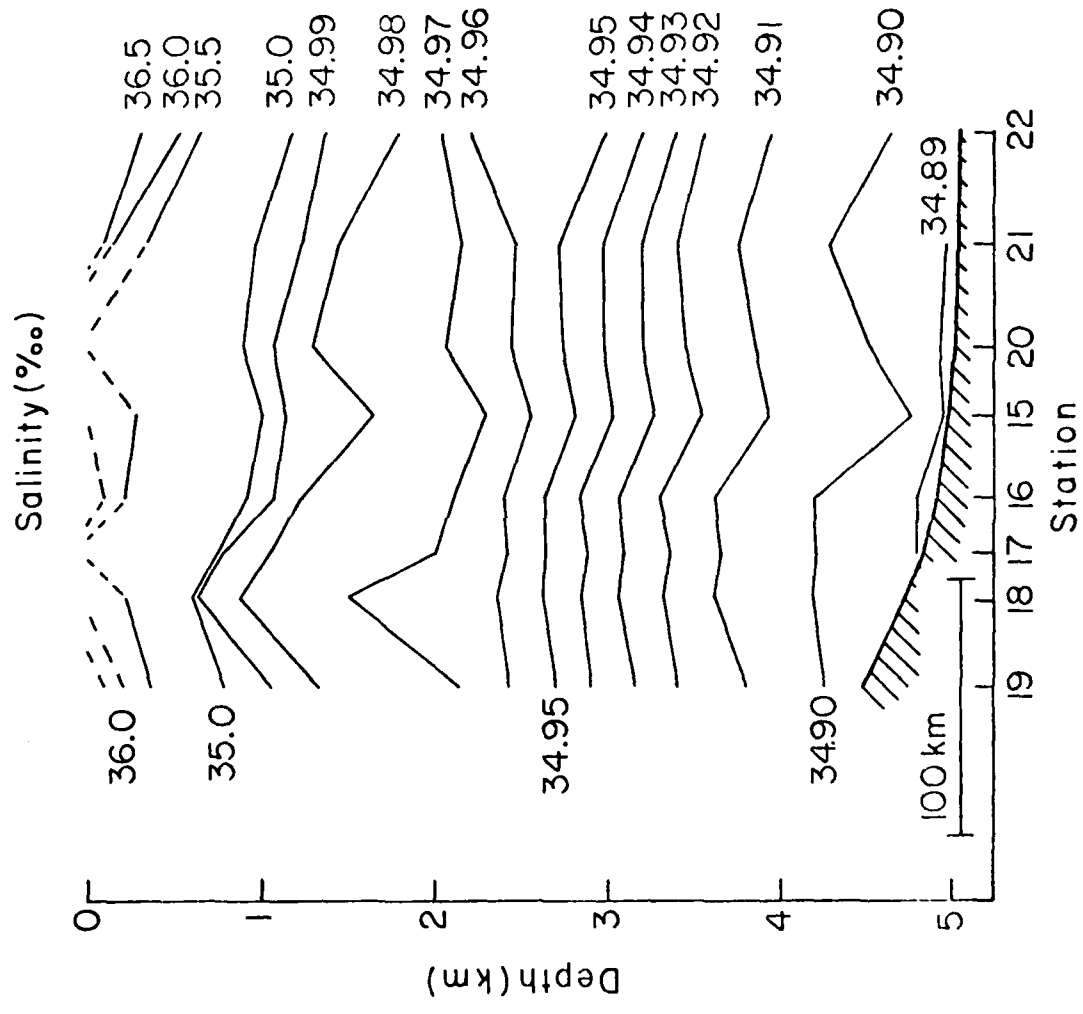


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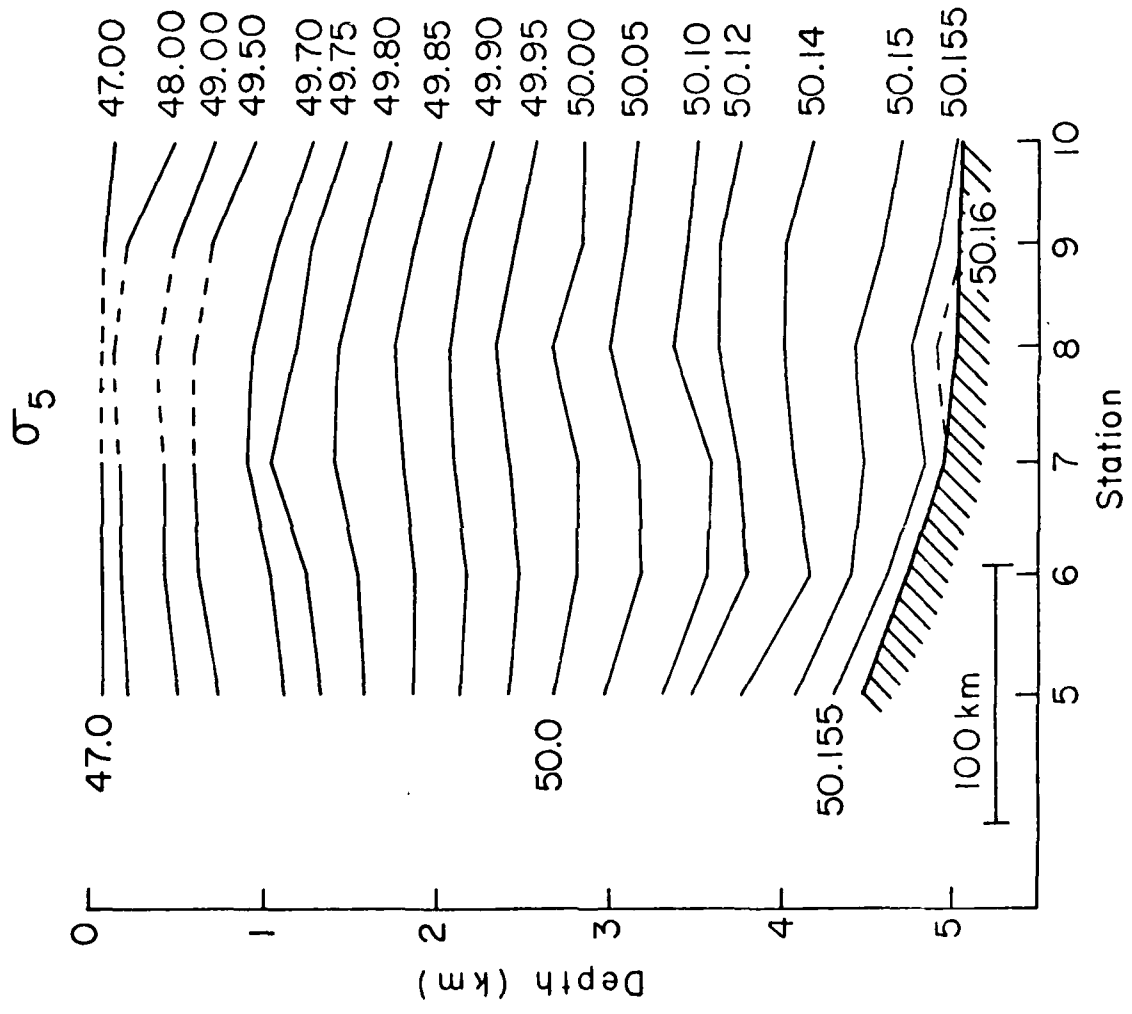


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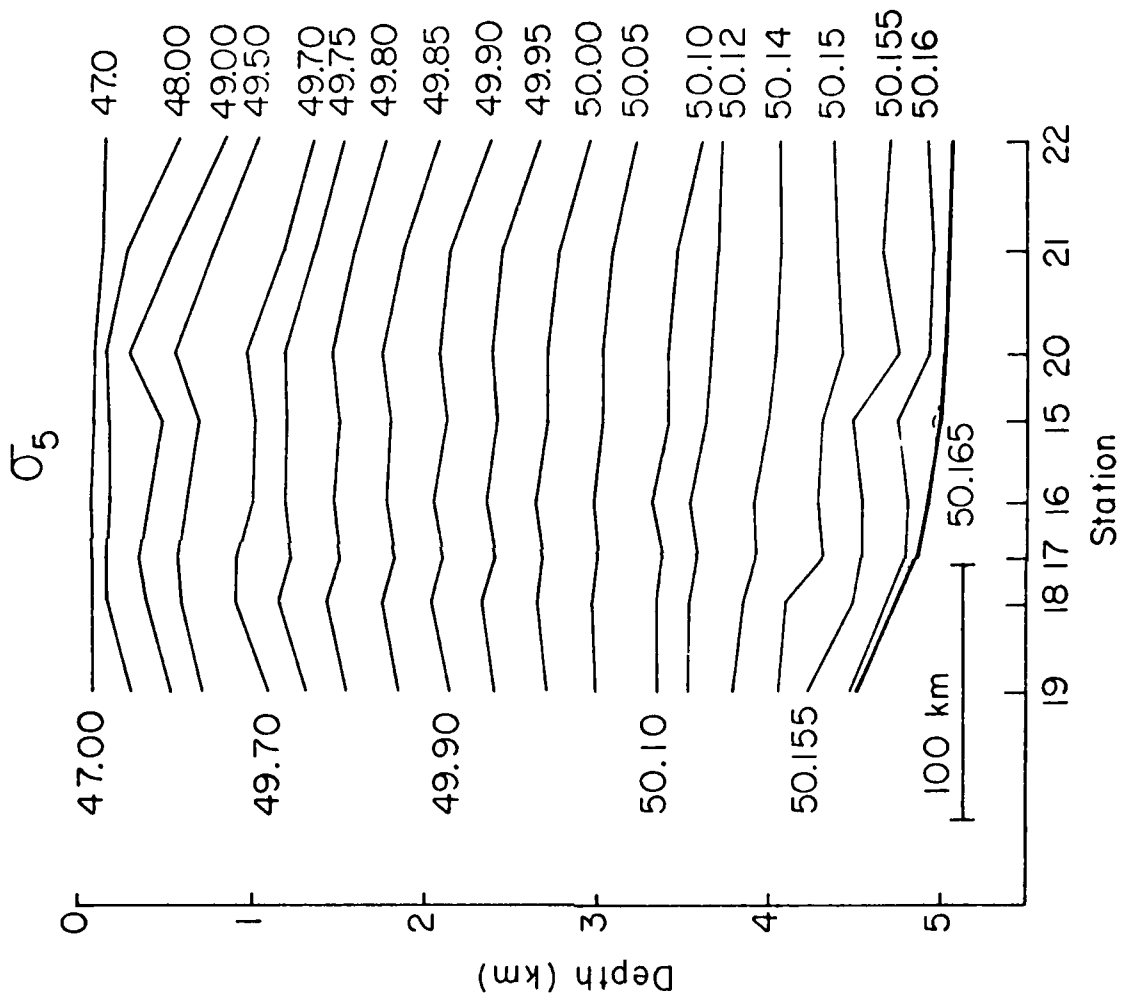


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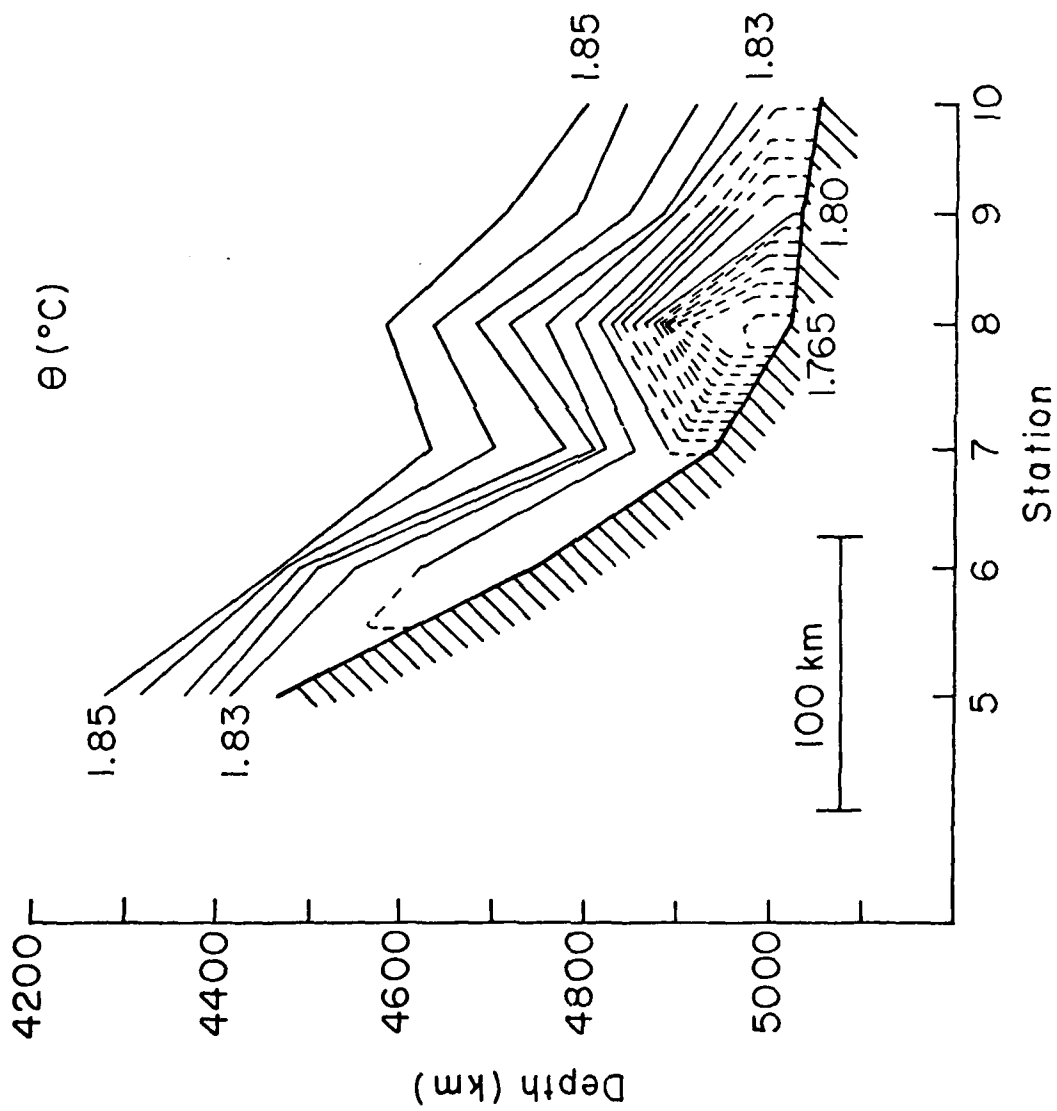


Figure 10

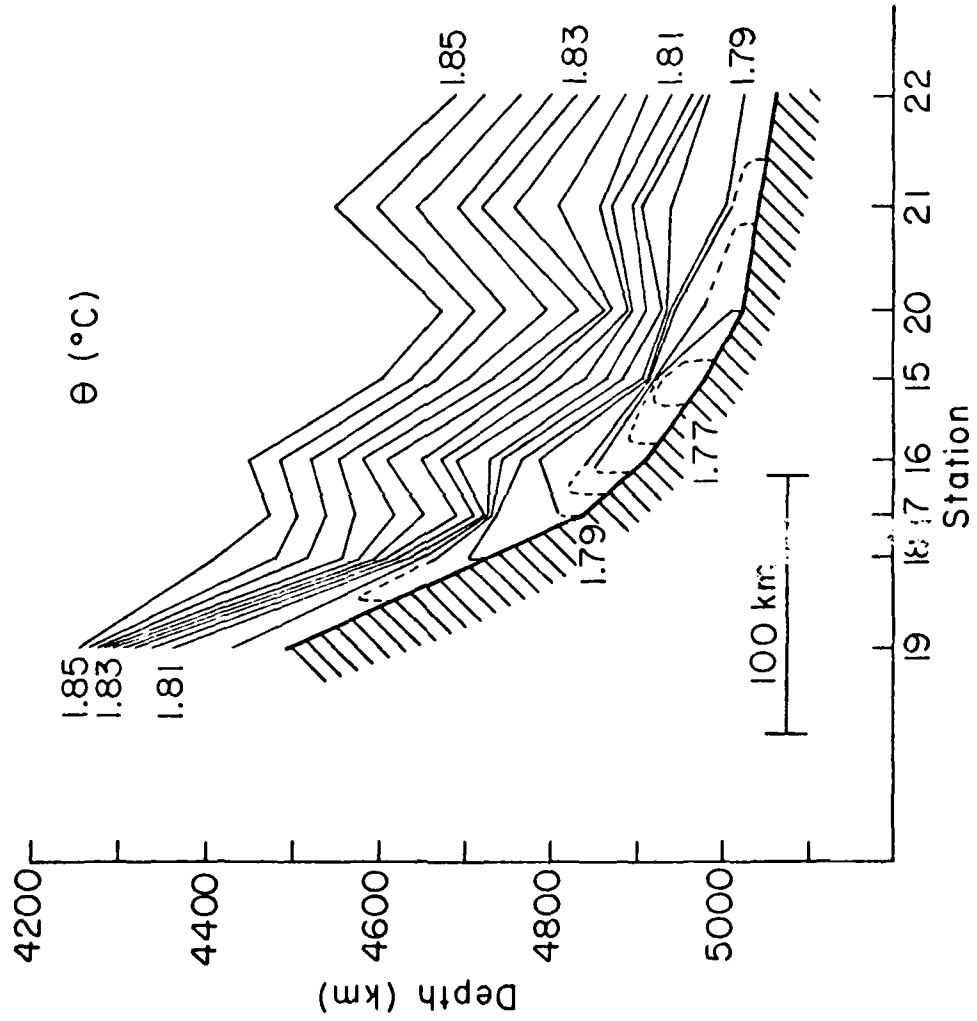


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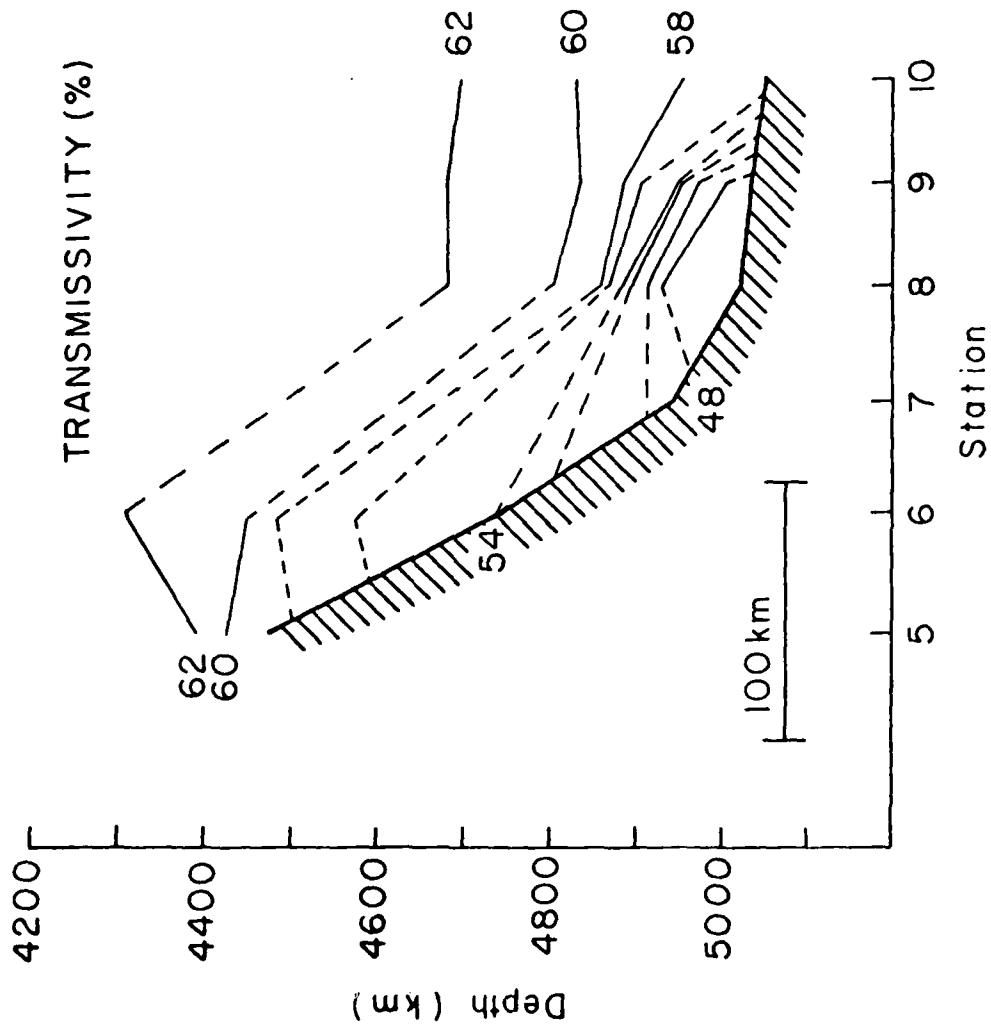


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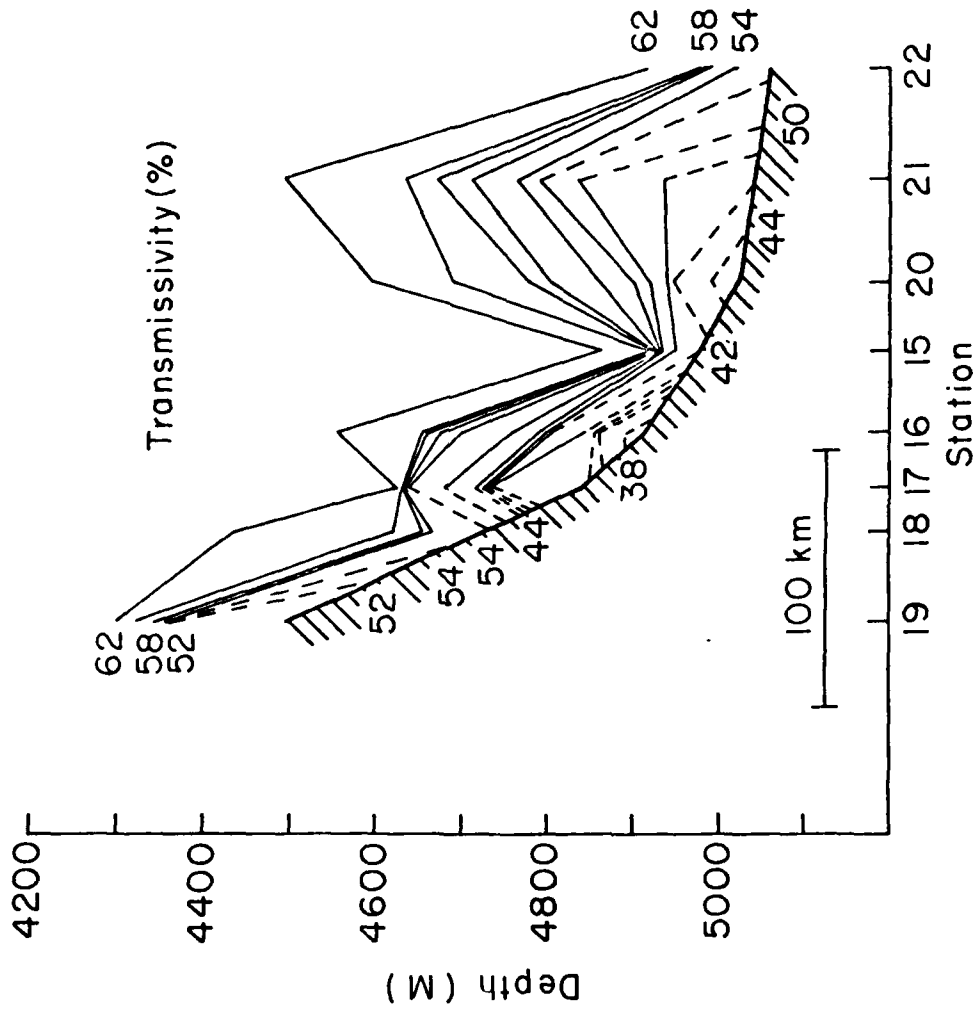


Figure 13

CTD STATION 1
Depth: 304 meters
9/22/80
0013Z
41°48'N 63°38'W

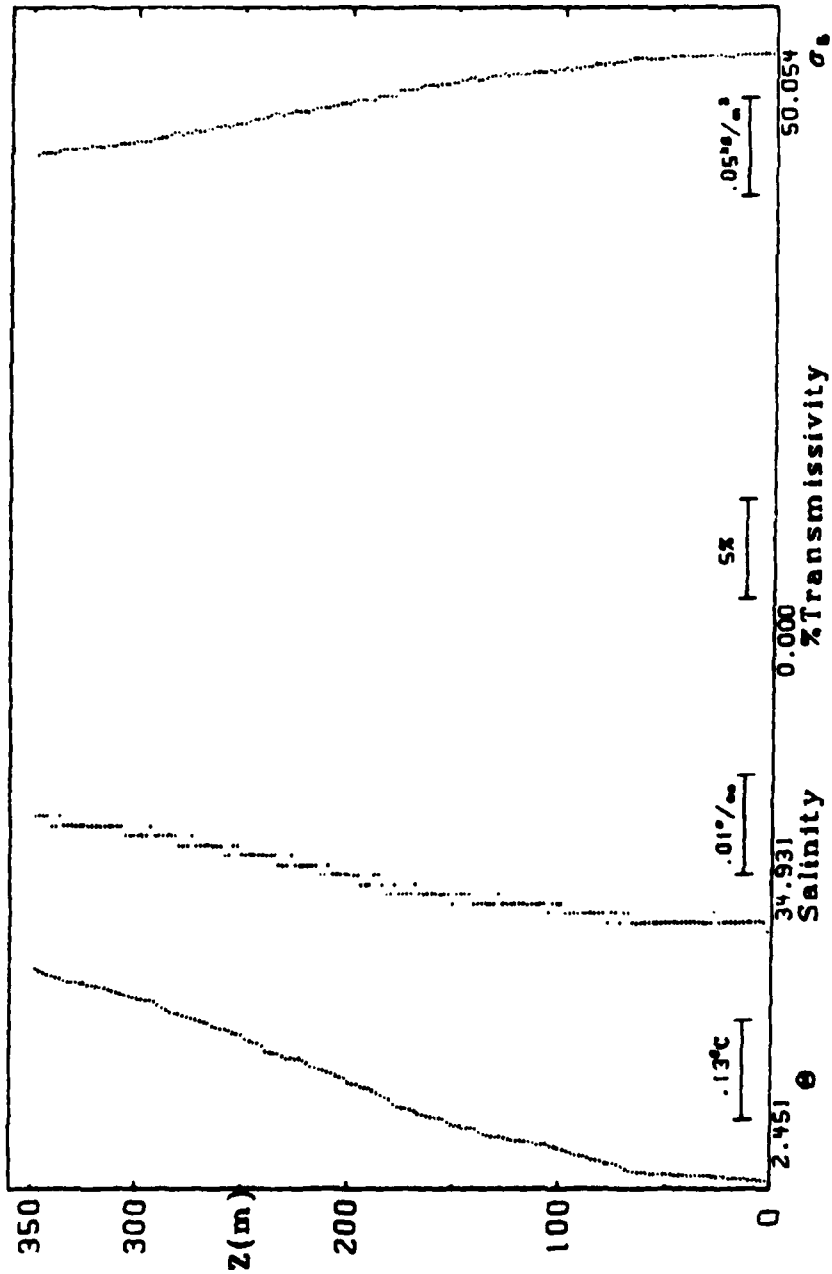


Figure 14

CTD STATION 3 3/23/80
 Depth: 3562meters 3754Z
 27°05'N 63°024'W

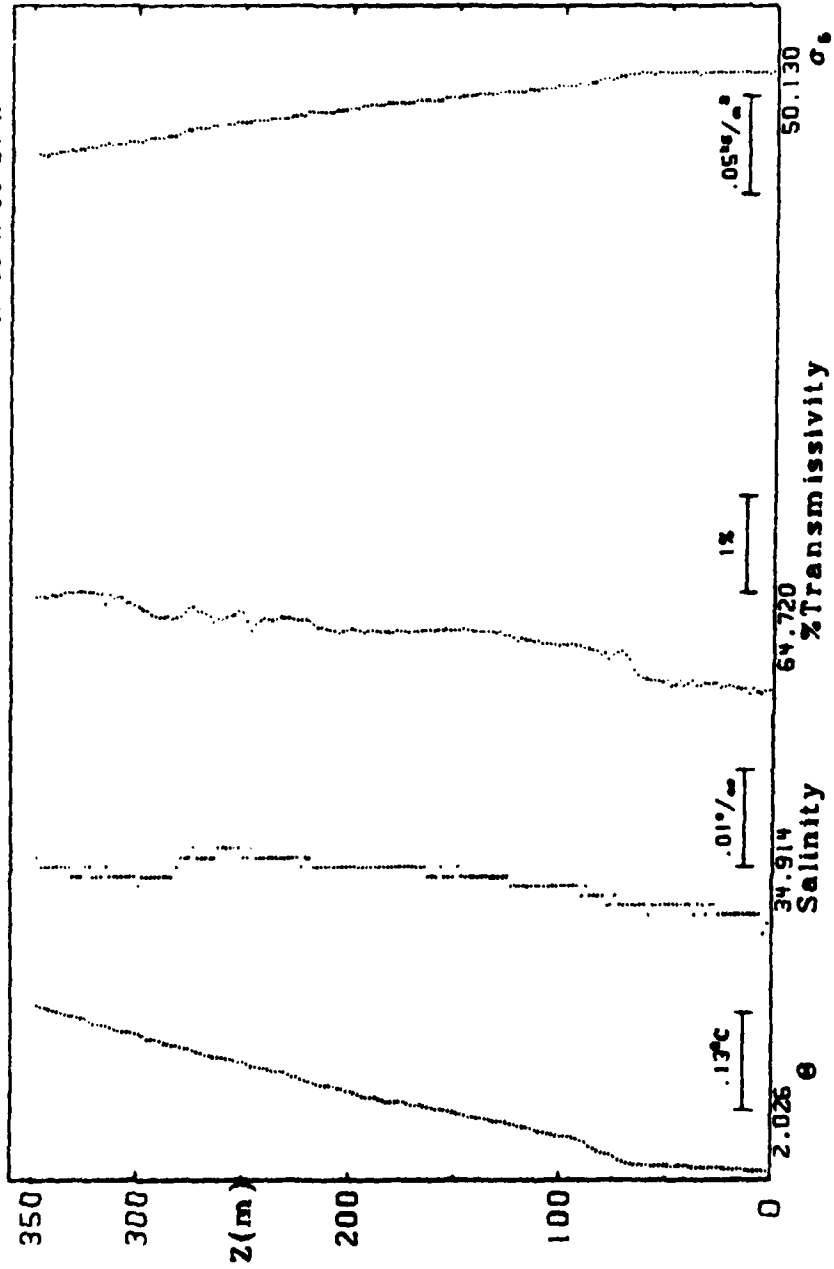


Figure 15

CTD STATION 4 9/23/80
 1347Z
 Depth: 4087meters
 41°06'N 63°11'W

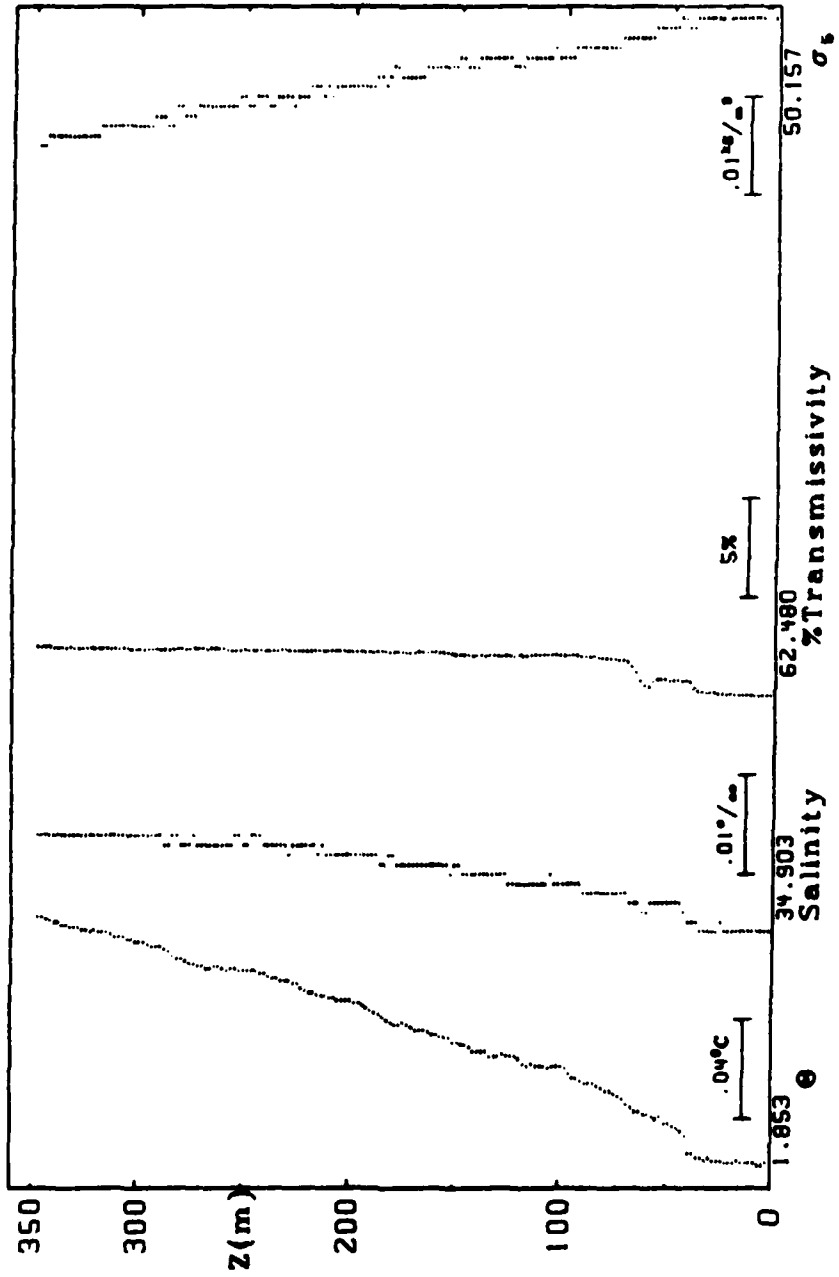


Figure 16

CTD STATION 5 9/29/81
 Depth: 4472 meters 0350Z
 40°45.4'N 62°58.7'W

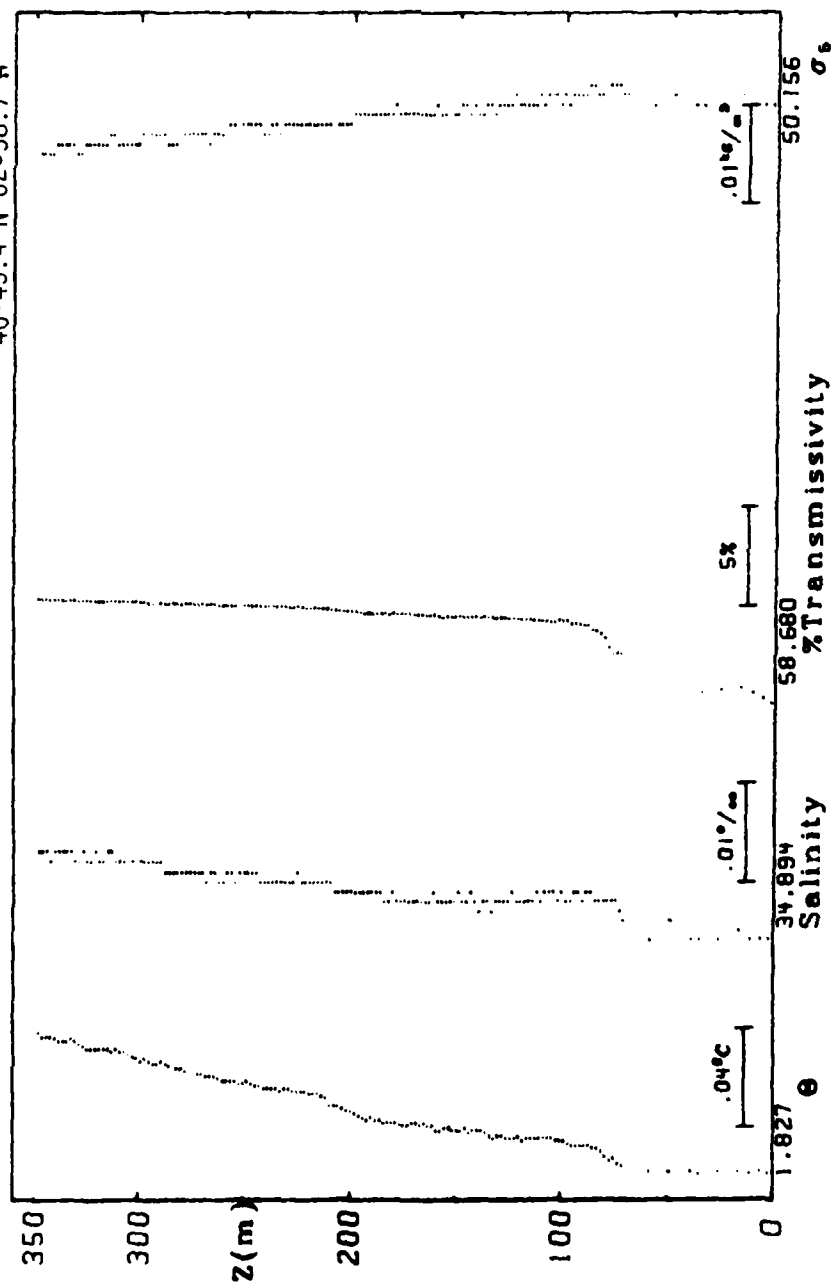


Figure 17

CTD STATION 6 9/24/80
1044Z
Depth: 4748meters 40°23'N 62°04'W

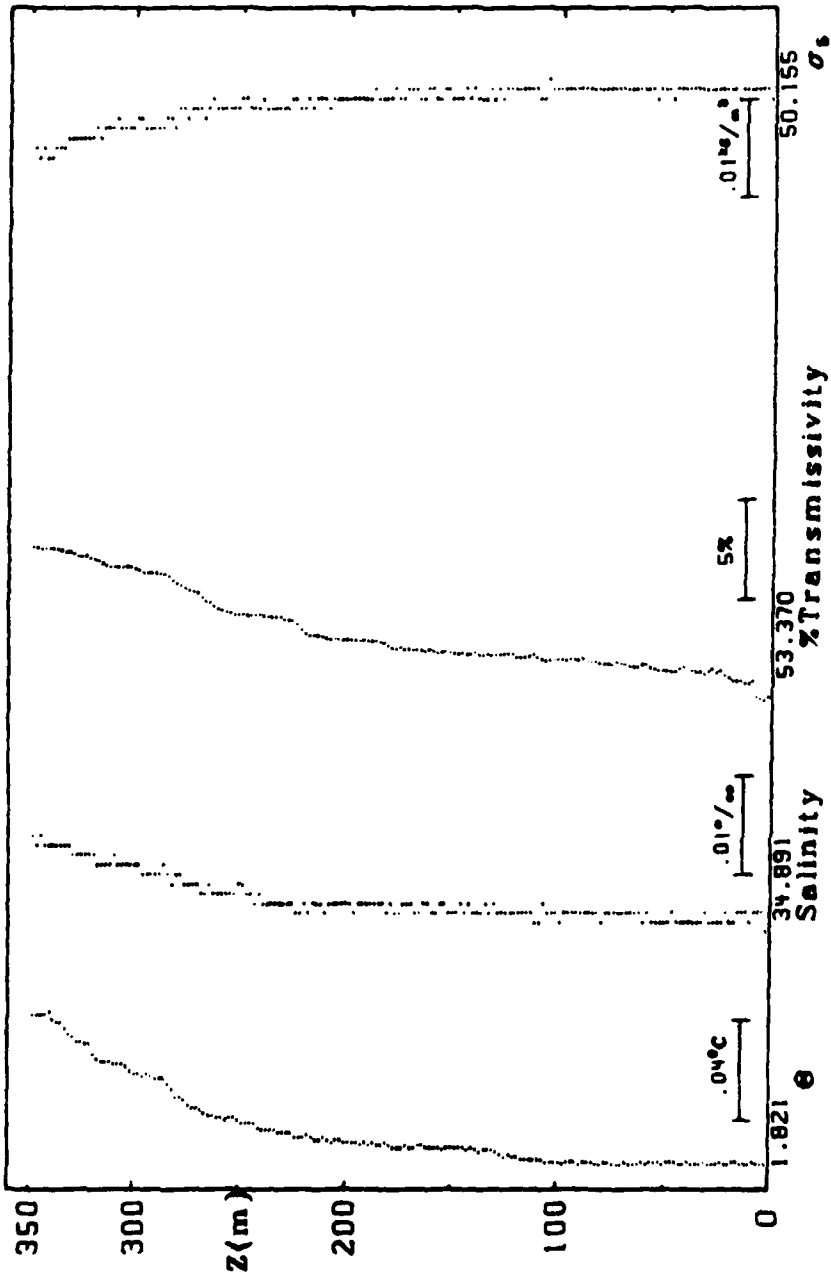


Figure 18

CTD STATION 7 9/24/80
 1647 Z
 Depth: 4946meters 40°04'N 62°027'W

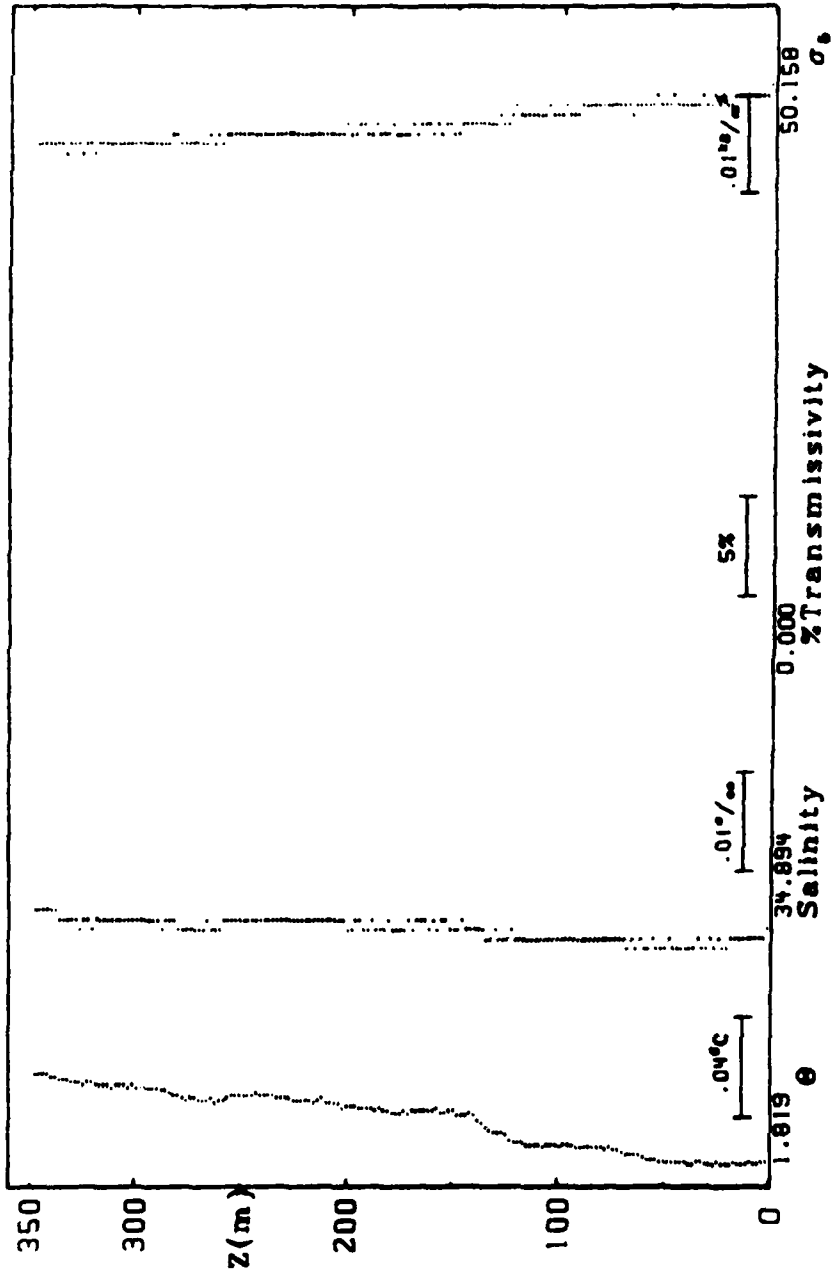


Figure 19

CTD STATION 8 9/25/80
 0837 Z
 Depth: 5025meters 39°45'N: 62°37'W

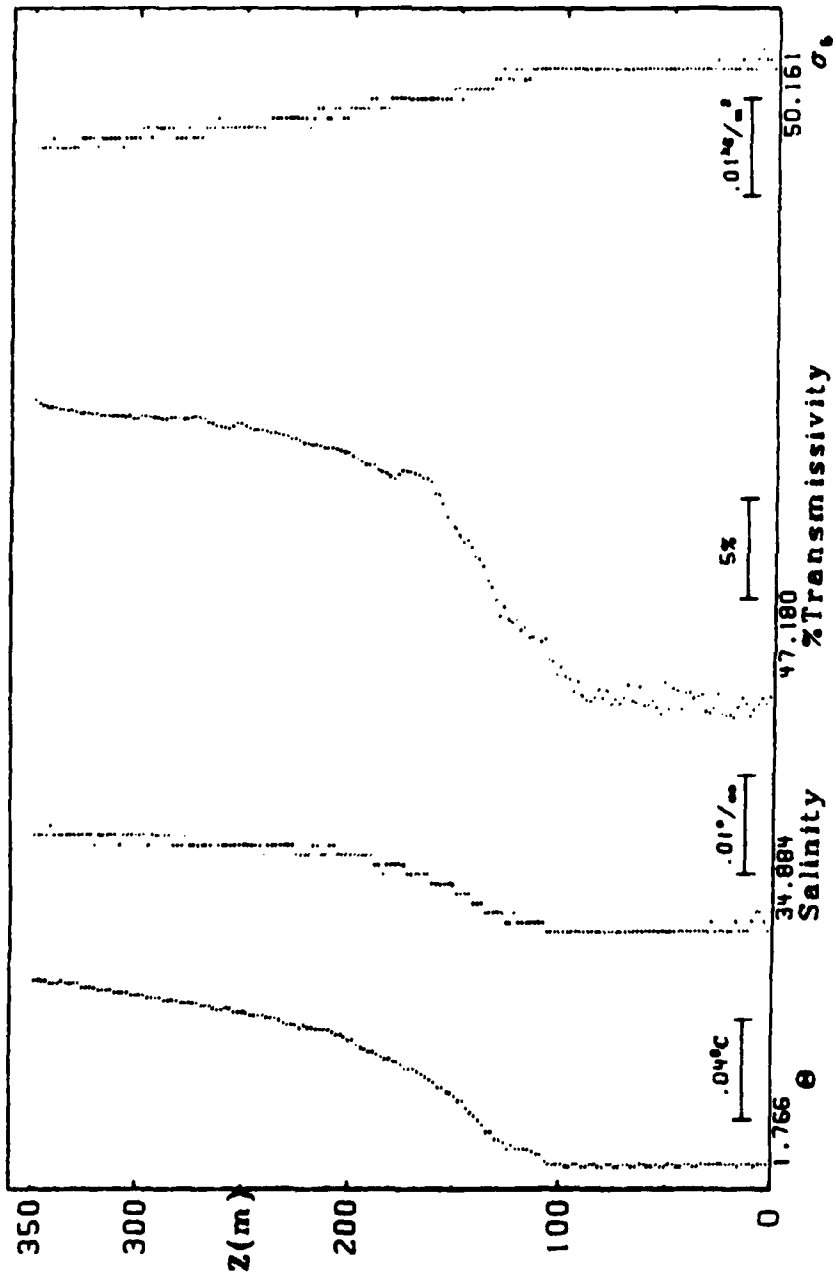


Figure 20

CTD STATION 9 9/25/80
1440 Z
Depth: 5038 meters 39°24'N 61°05'W

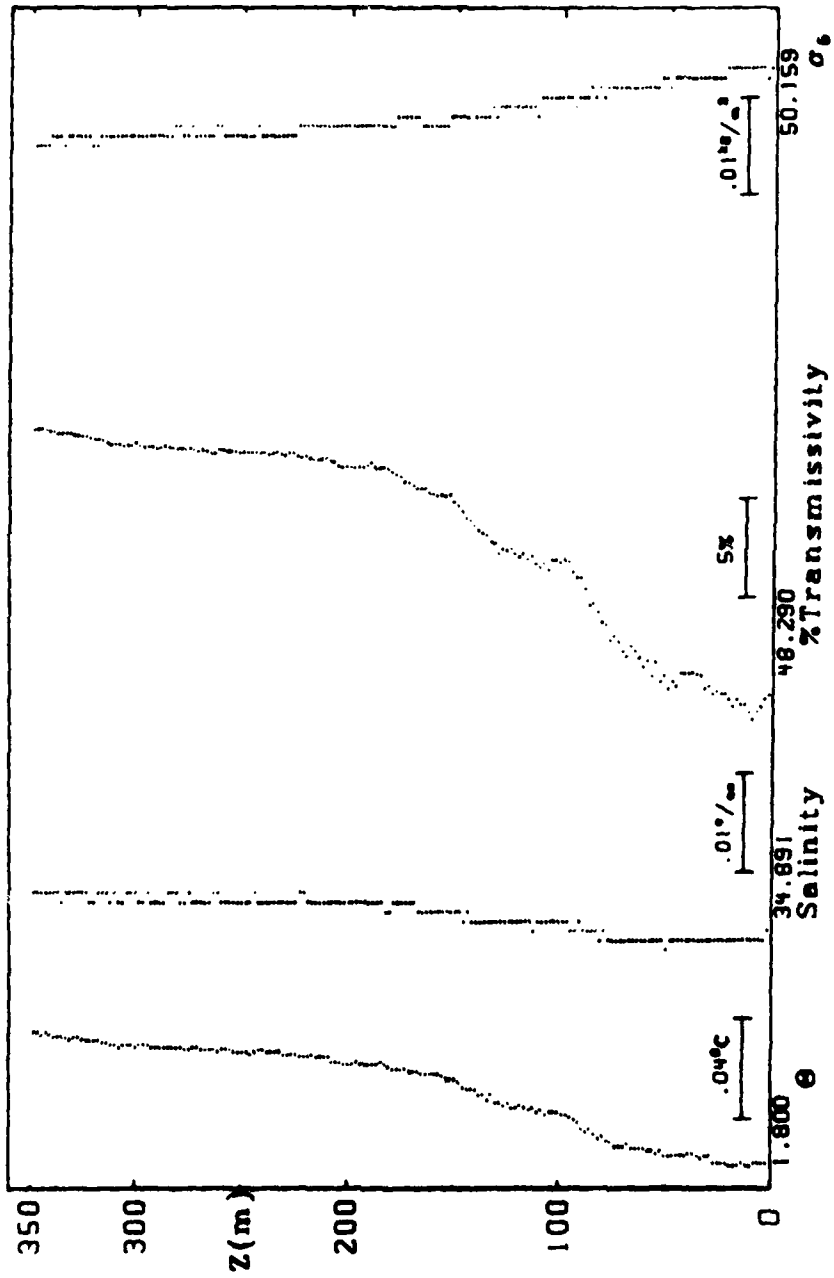


Figure 21

CTD STATION 10 9/25/80
 Depth: 5056meters 2152 Z
 39°06'N 61°40'W

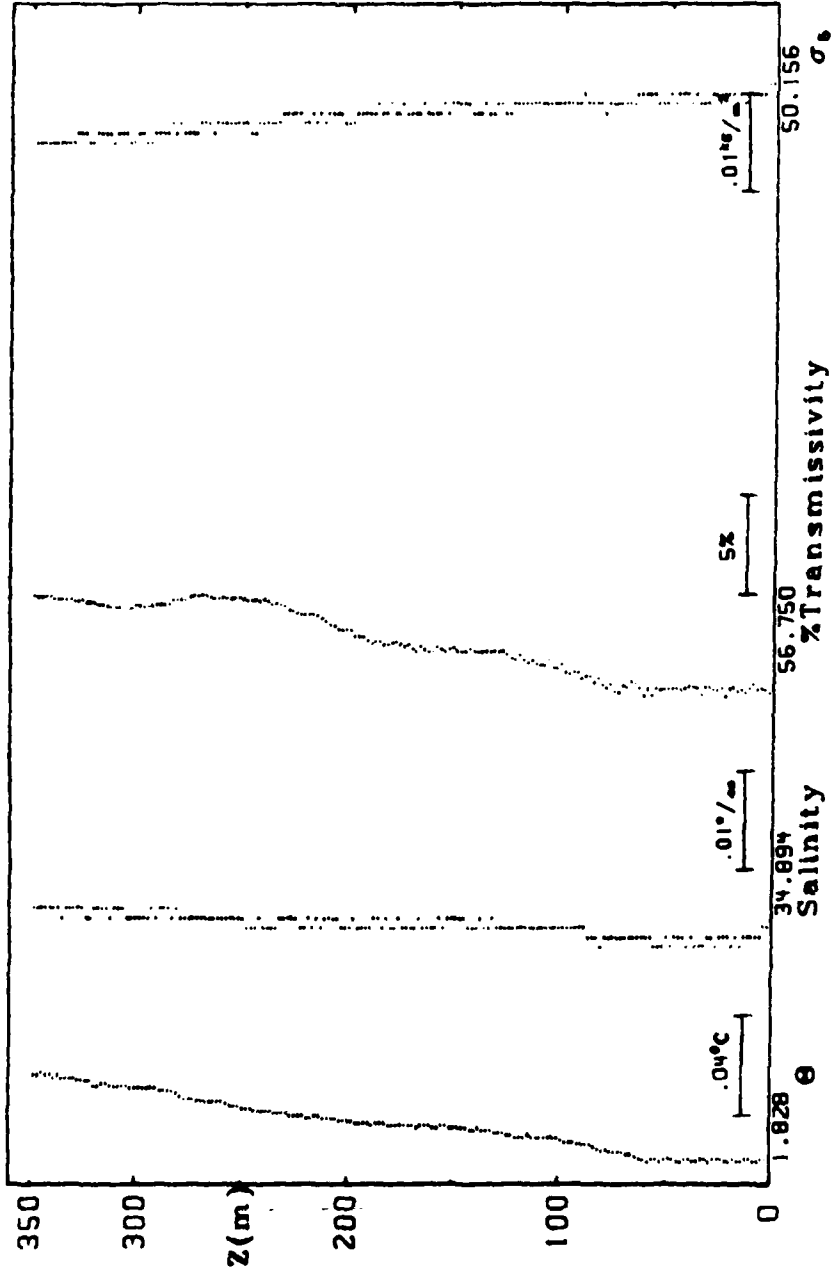


Figure 22

CTD STATION 11 9/28/80
 1910 Z
 Depth: 5020meters 39043'N 62014'W

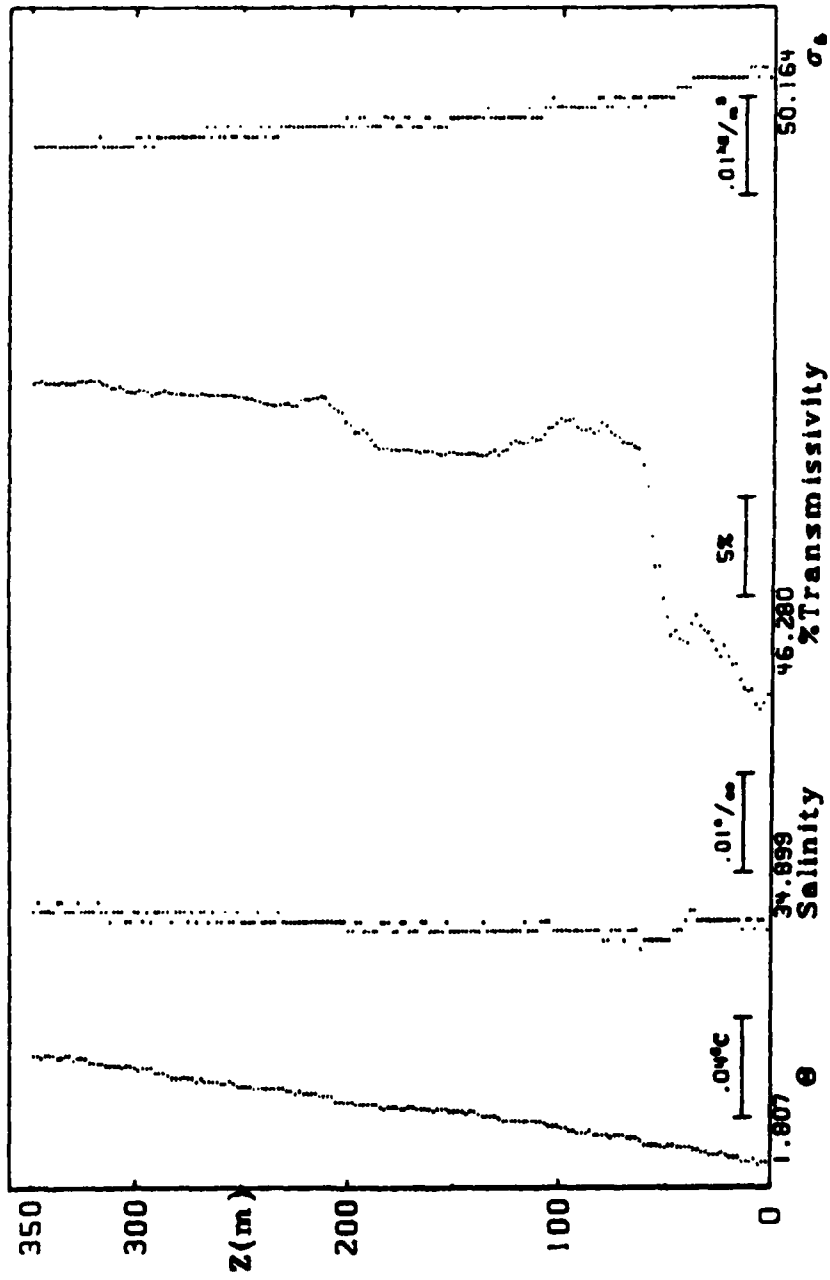


Figure 23

CTD STATION 12
Depth: 498 meters
9/29/80
0020 Z
39°53'N 62°21'W

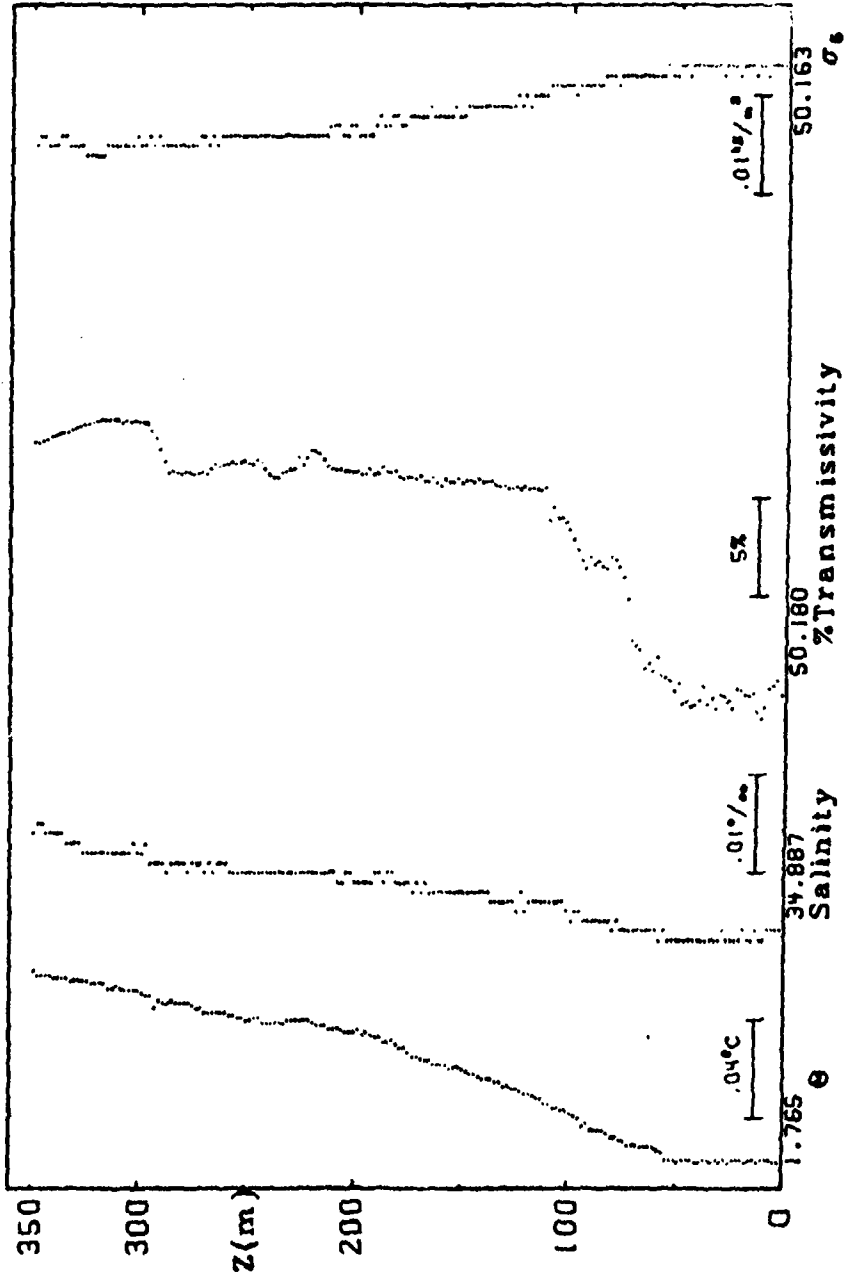


Figure 24

CTD STATION 13 10/01/80
Depth: 4985 meters 1150 Z
39053'N 62020'W

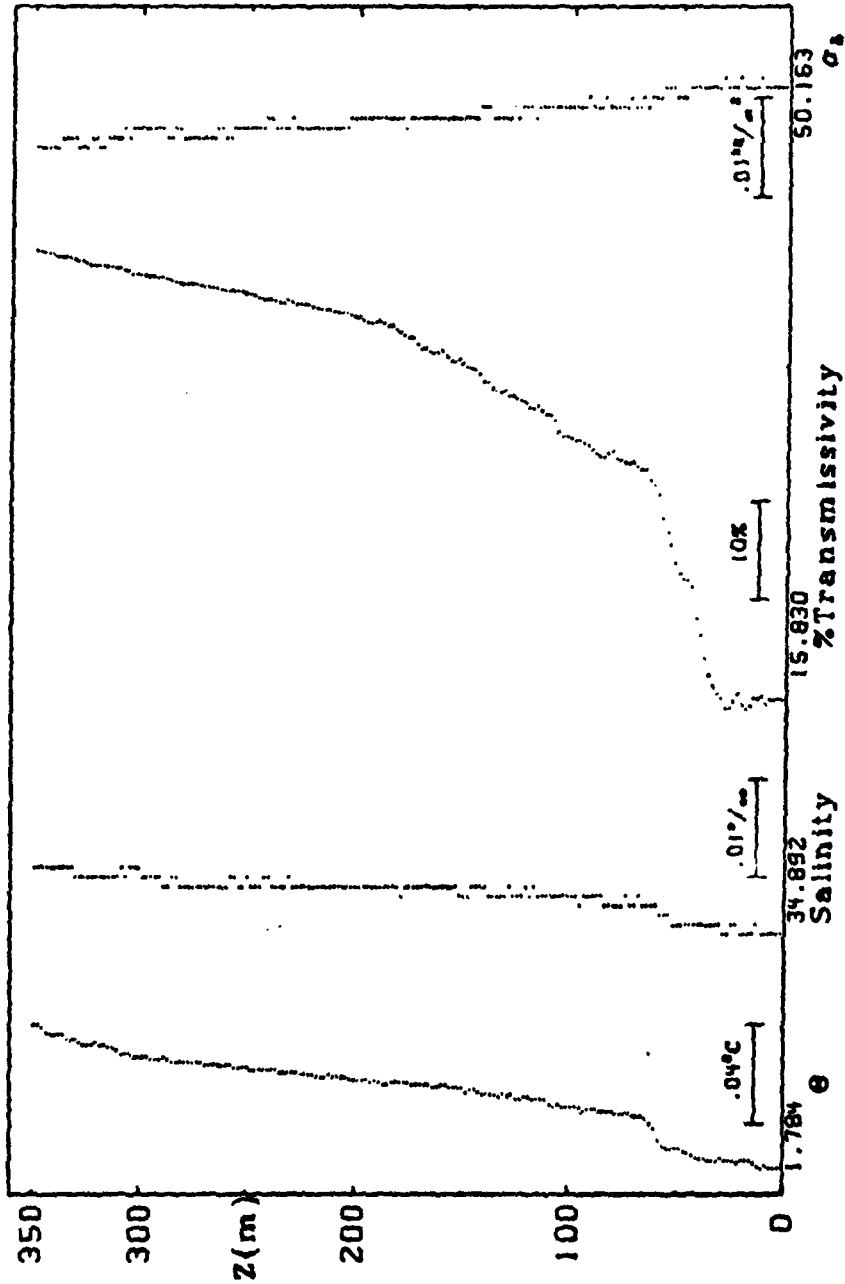


Figure 25

CTD STATION 14 10/01/81
 2237 Z
 Depth: 5030meters 39033'N 62001'W

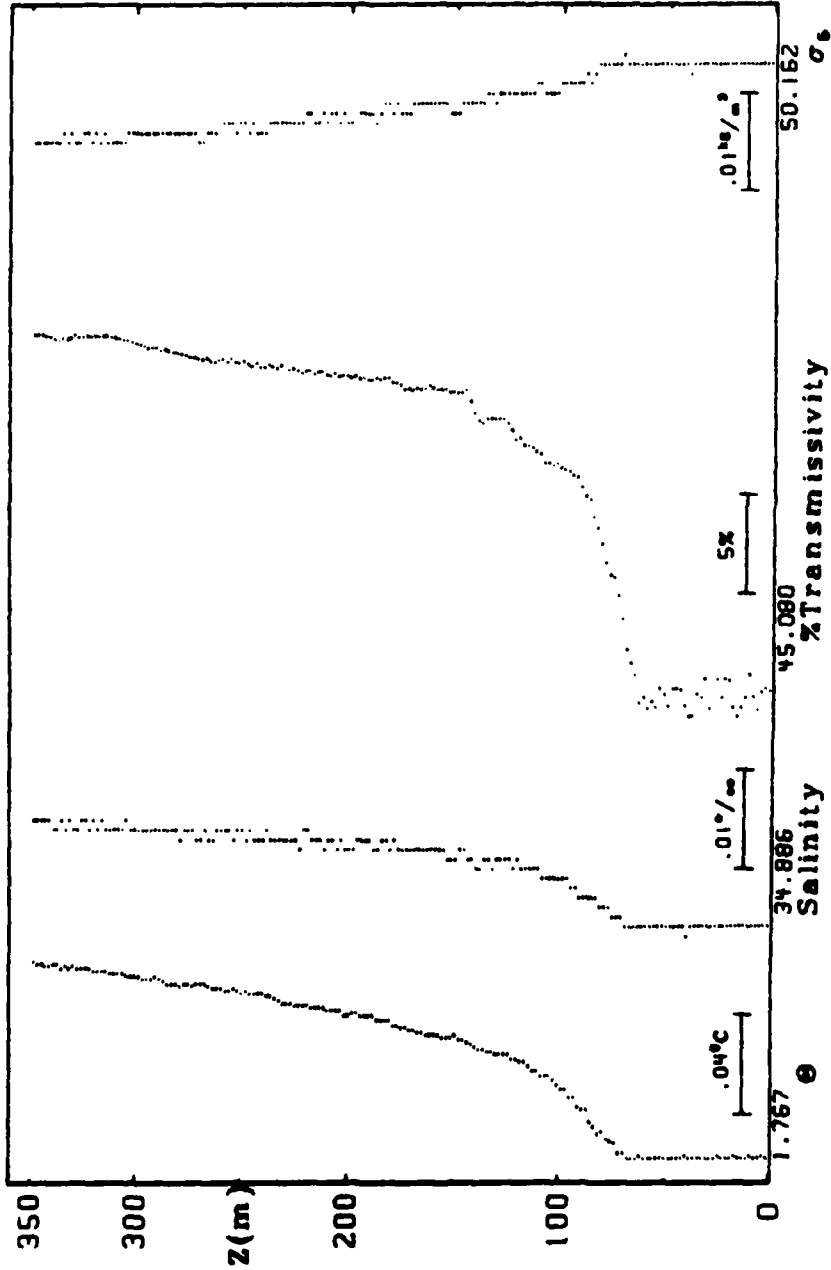


Figure 28

CTD STATION 15
 13/02/80
 1658 Z
 39°53'N 62°21'W
 Depth: 498 meters

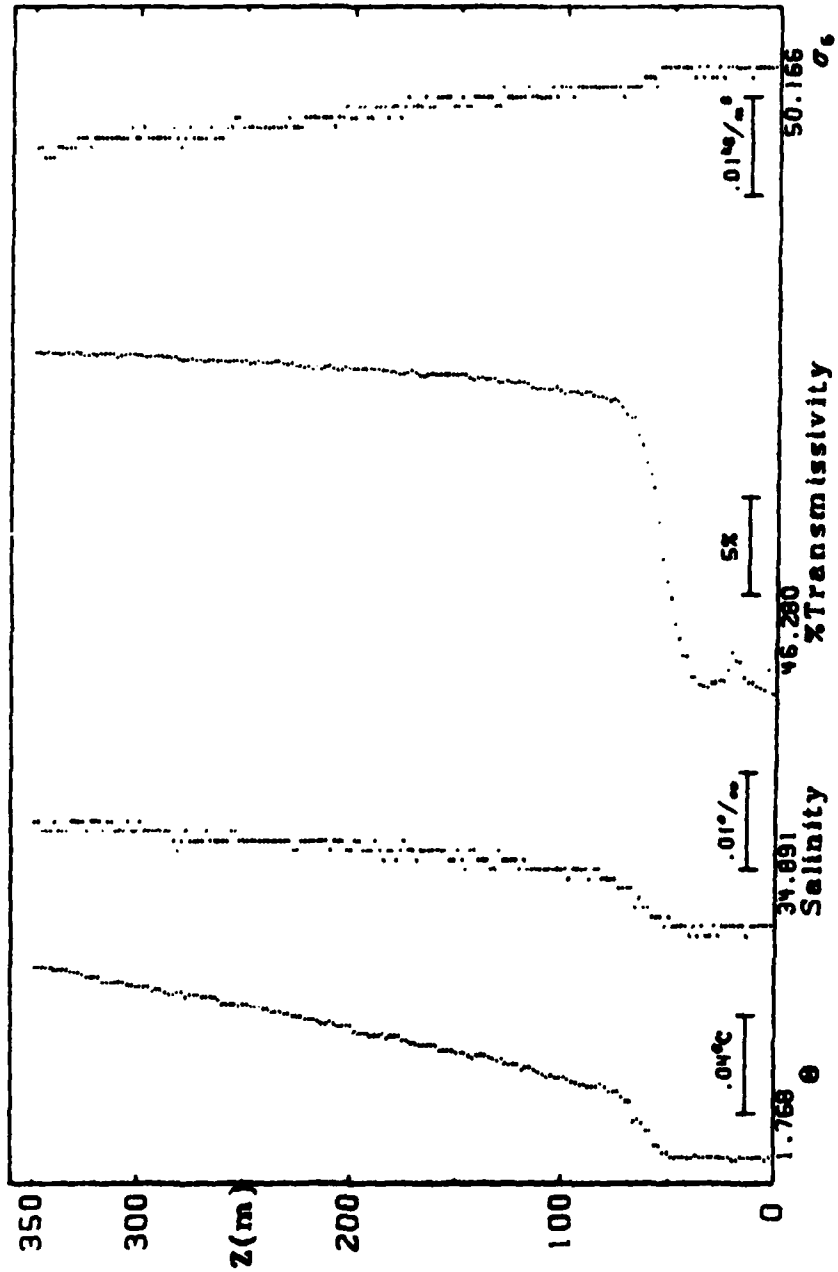


Figure 27

CTD STATION 16 10/03/80
0655 Z
Depth: 4913 meters 40°08'N 62°31'W

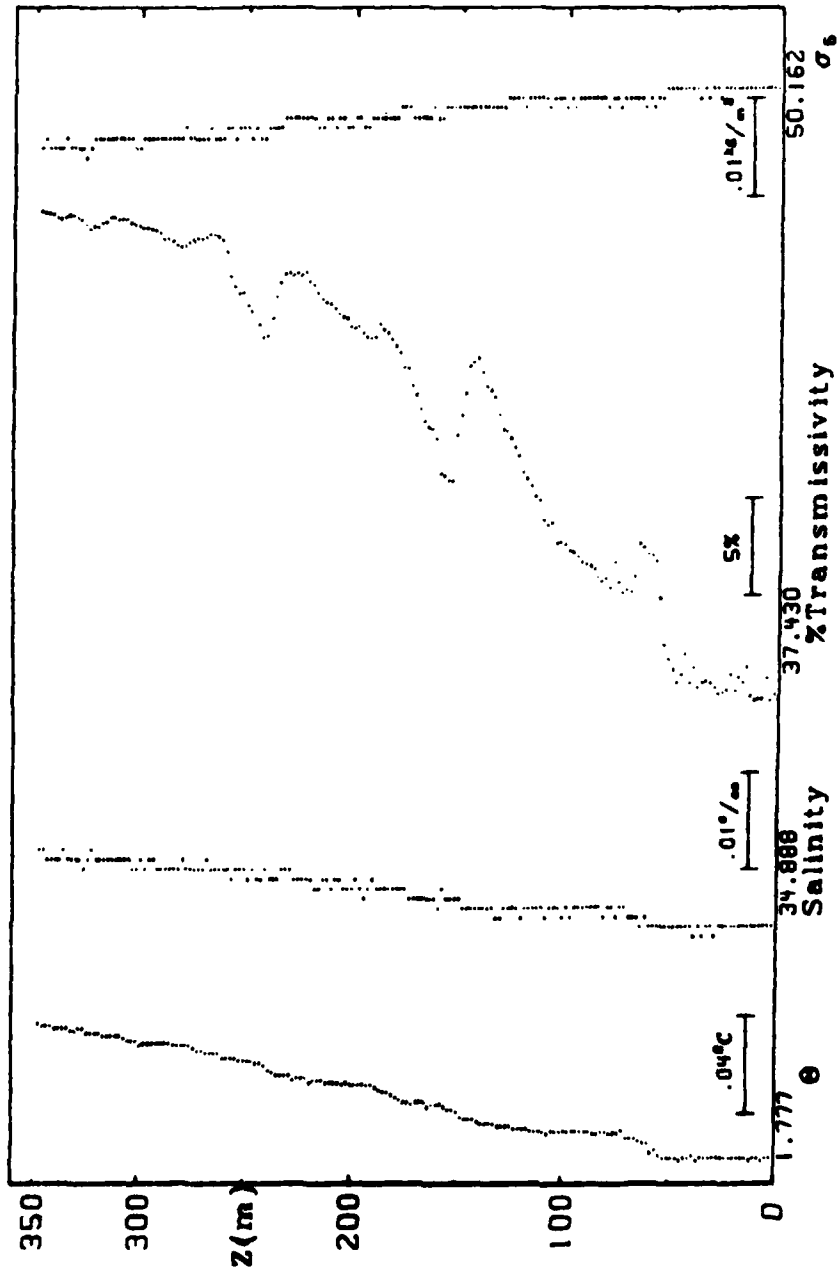


Figure 28

CTD STATION 17 10/03/80
 1504 Z
 Depth: 484 meters 40°16'N 62°33'W

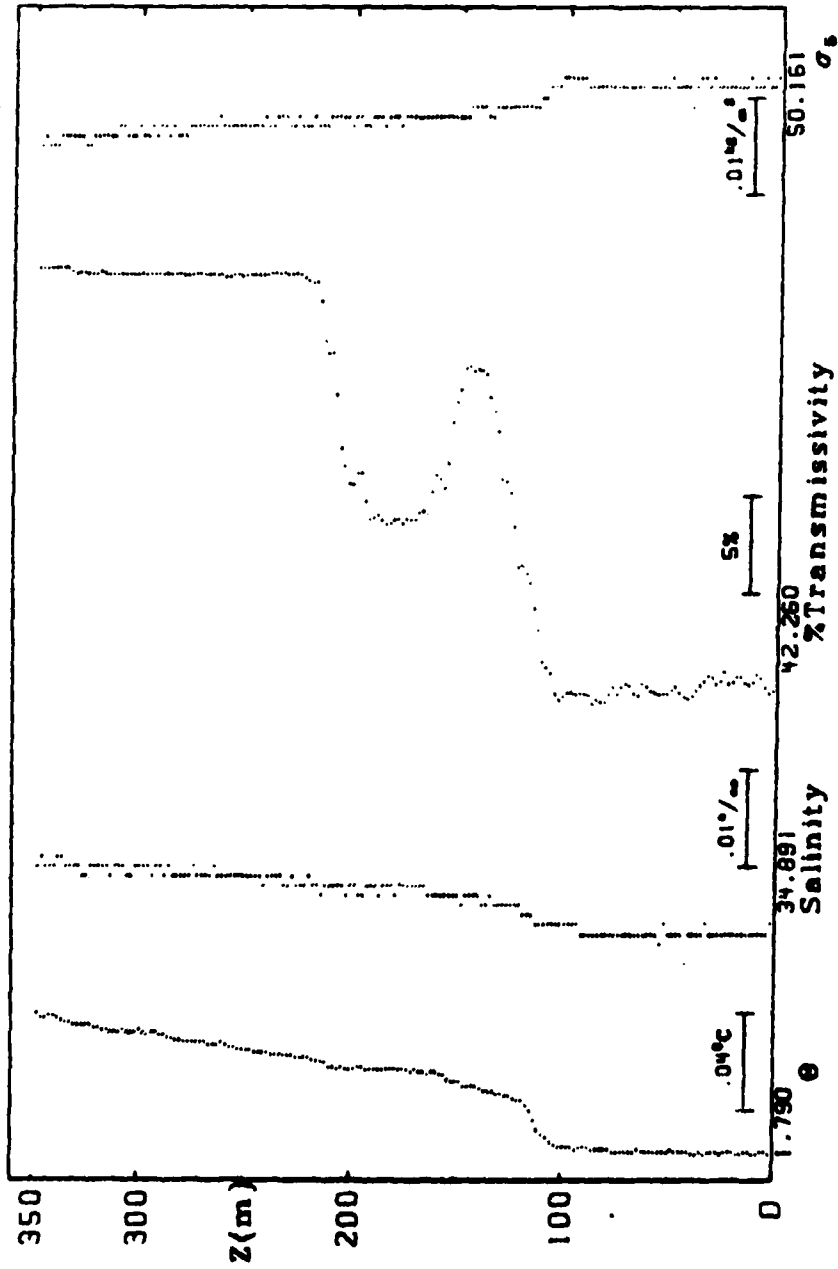


Figure 29

CTD STATION 18
Depth: 4725meters
10/03/80
2303 Z
40°24'N 62°04'W

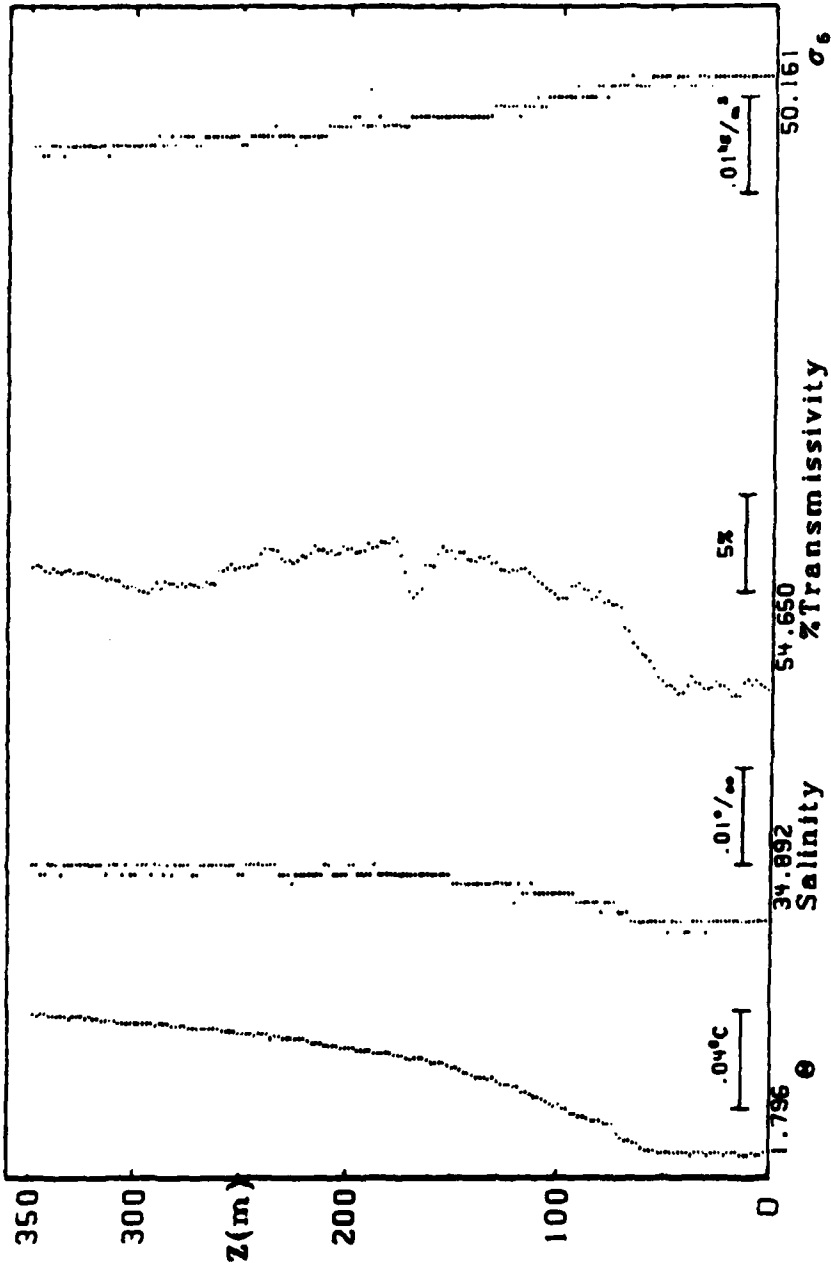


Figure 30

CTD STATION 19 10/04/80
 Depth: 4494meters 0944 Z
 40044'N 63000'W

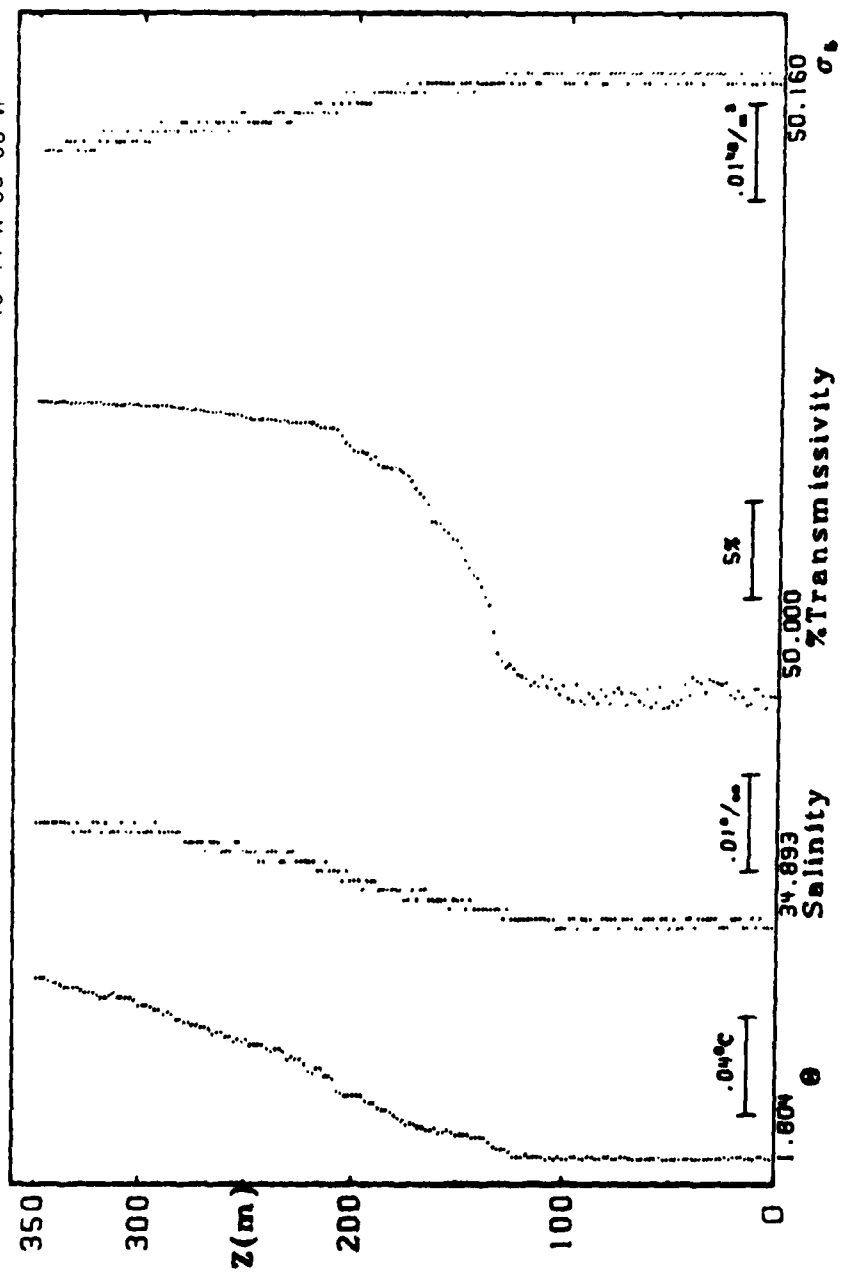


Figure 31

CTD STATION 20
 Depth: 5024 meters
 10/05/81
 1122 Z
 39044' N 62013' W

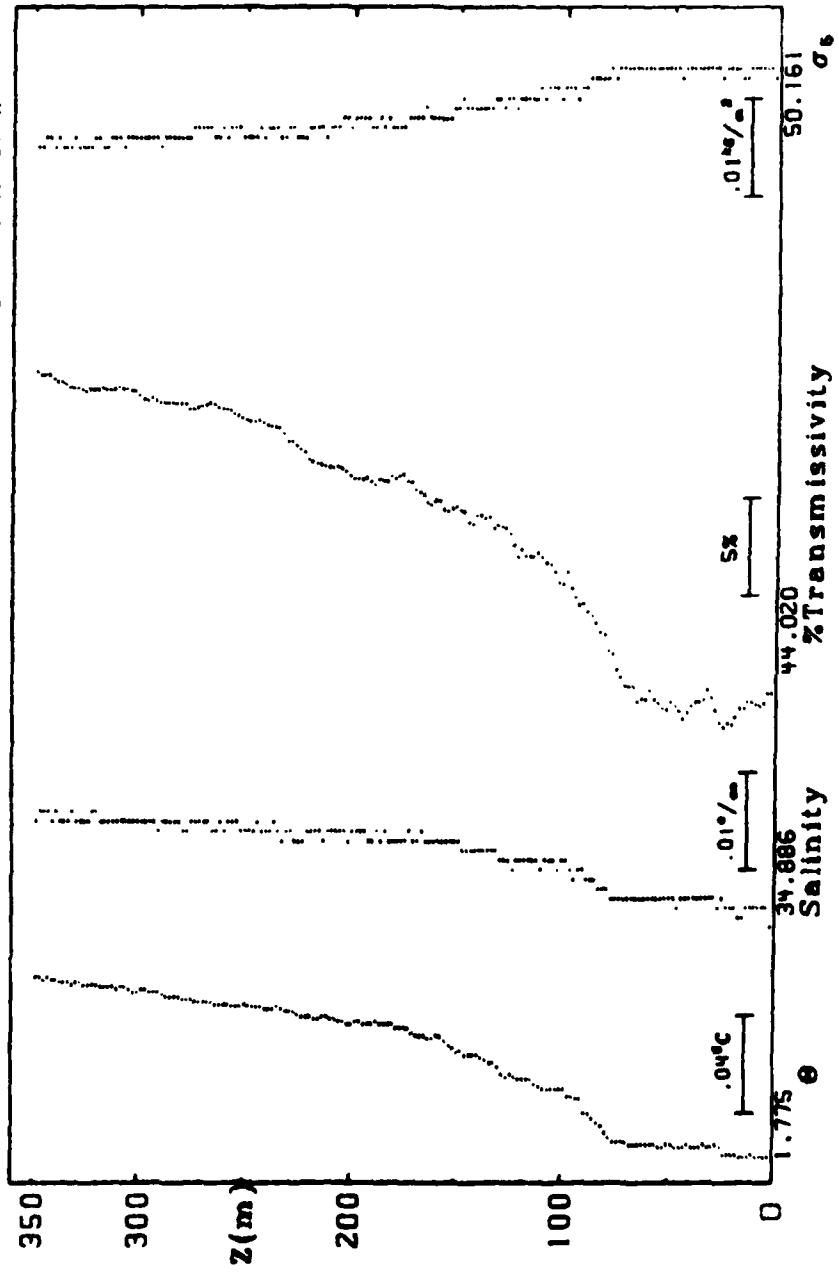


Figure 32

CTD STATION 21 10/05/80
 1804 Z
 Depth: 5042meters
 39°24'N 61°56'W

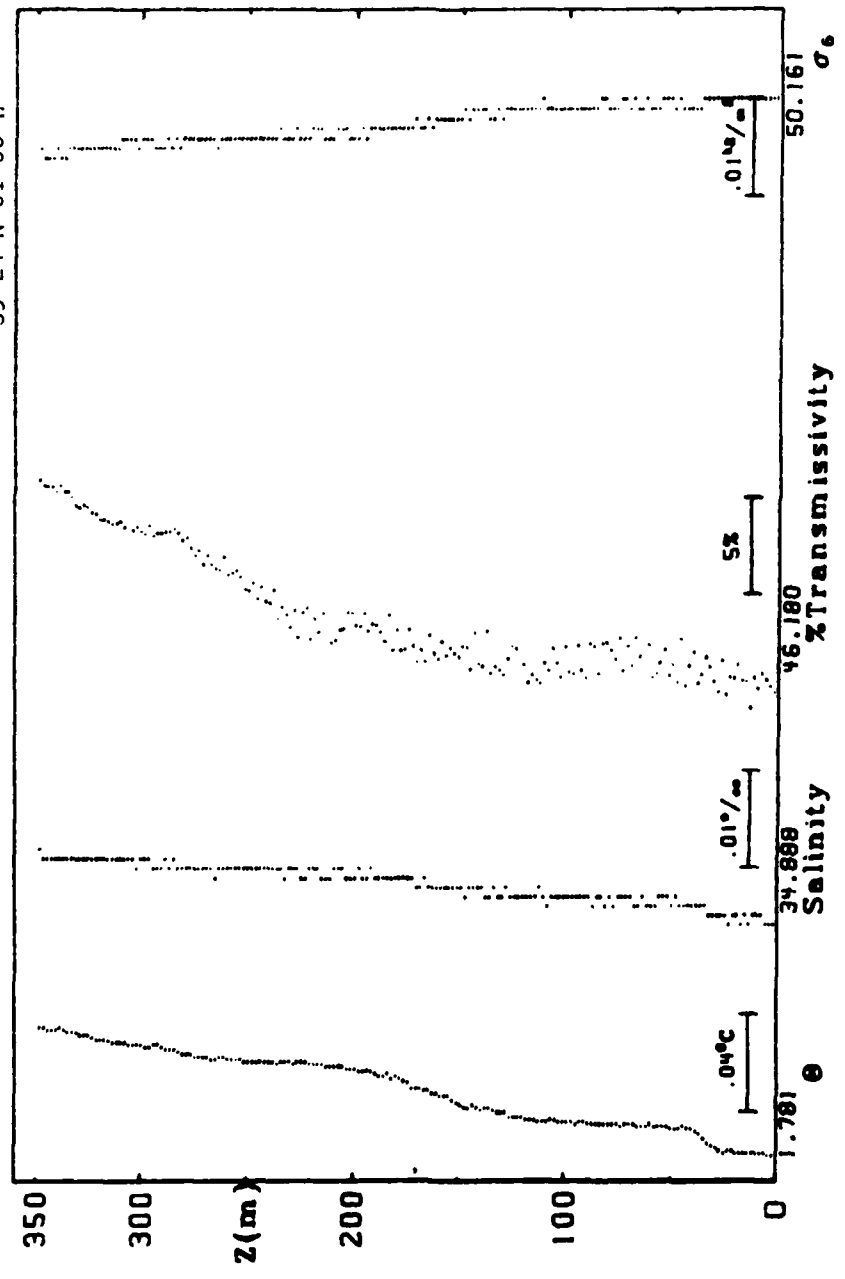


Figure 33

CTD STATION 22
Depth: 5065 meters
10/06/80
0823 Z
39°04'N 61°33.9'W

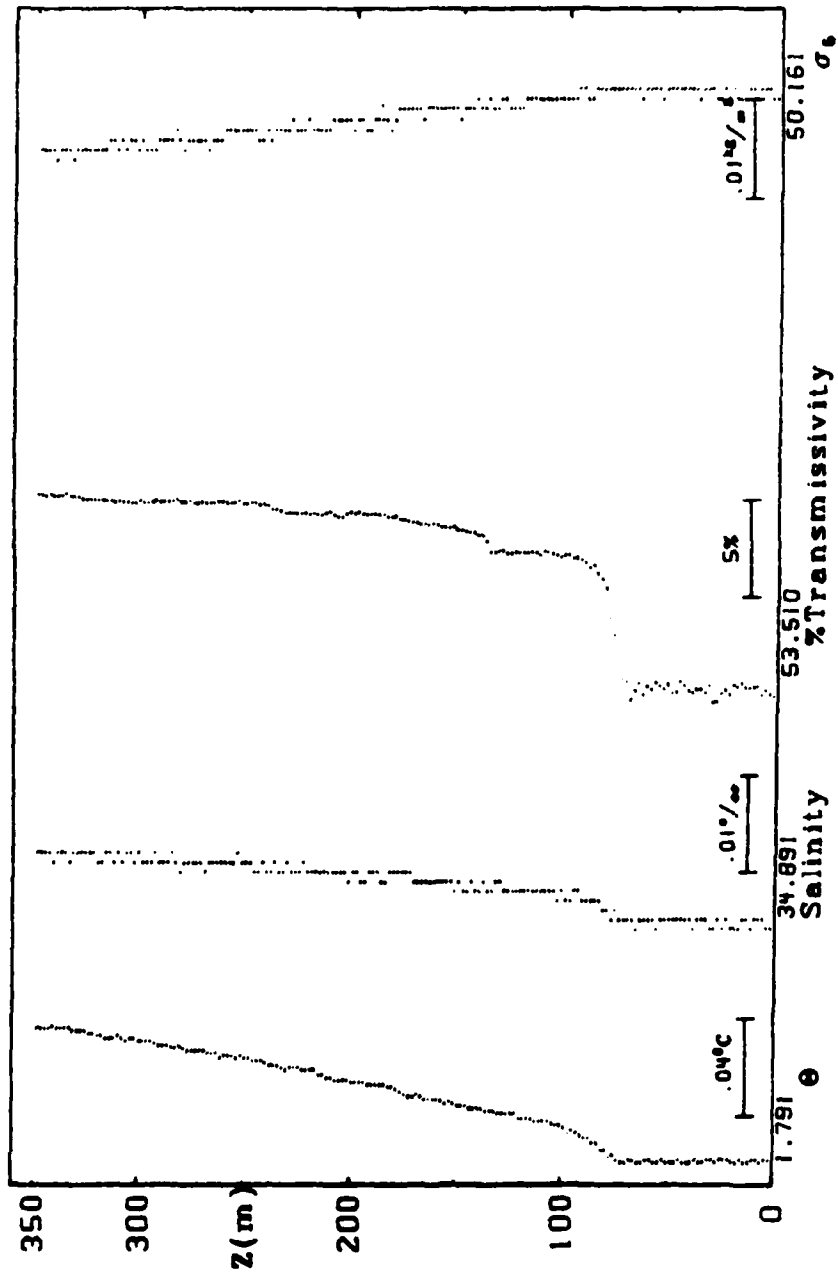


Figure 34

CTD STATION 23 10/07/80
 2430 Z
 Depth: 4973meters 3:054.6'N 62:25.0'W

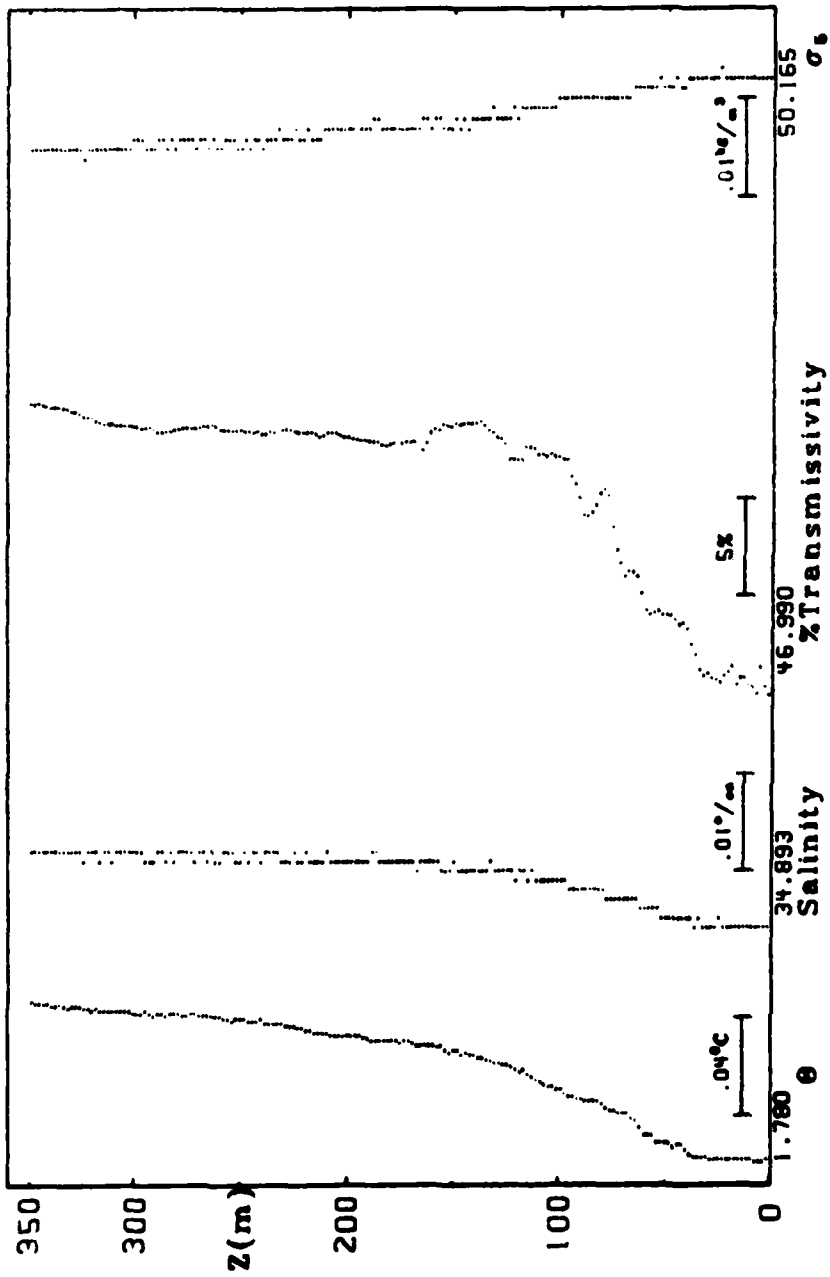


Figure 35

Geostrophic Velocity Calculated Between Indicated Ship Stations

Level of No Motion Assumed at 1200 m

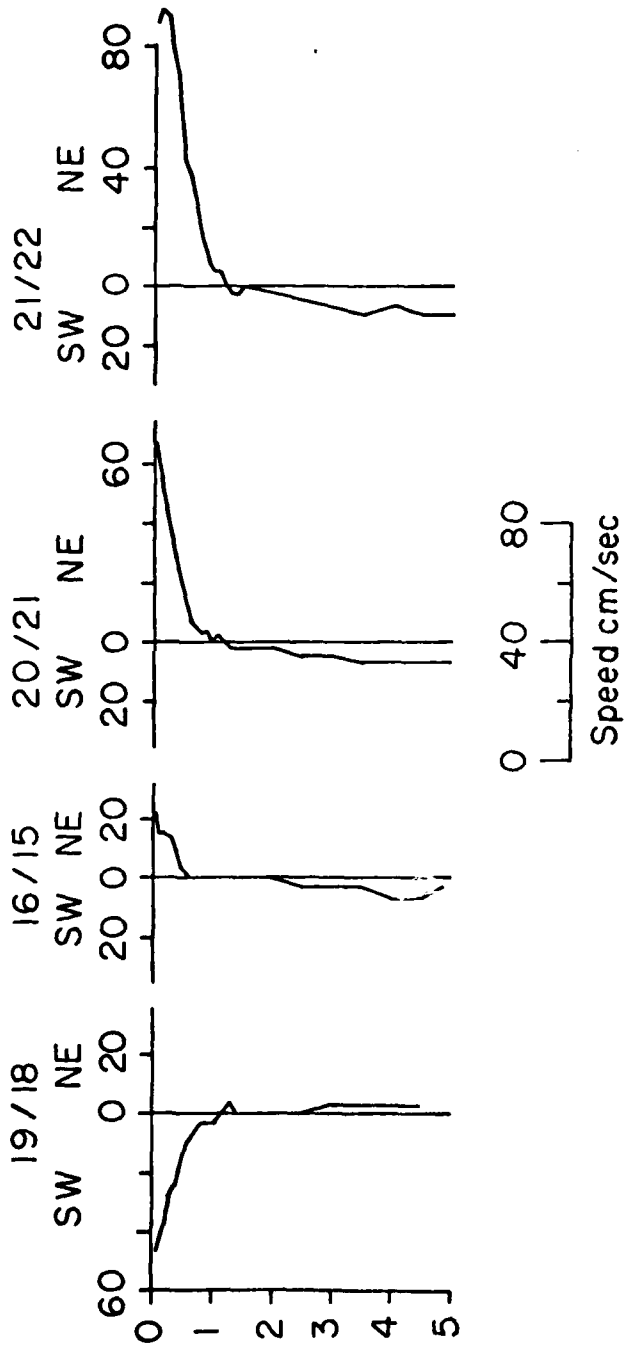


Figure 36

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