A CONTRIBUTION TO THE HYDROLOGY OF THE STRAIT OF SICILY

by

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INTRODUCTION

The Osservatorio Geofisico Sperimentale of Trieste made a series of hydrological measurements in the Mediterranean in 1968. The areas concerned were the Gulf of Taranto, the Tyrrhenean Sea and the Western Basin. At the same time, four hydrological sections were also made along the Strait of Sicily.

This area is basic for the water exchange between the two main basins of the Mediterranean Sea. Several studies have attempted to evaluate the characteristics of the Levantine water, which flows through the strait to form the middle layers of the Tyrrhenean Sea, and the characteristics of the flow of Atlantic water crossing the sill. (Lacombe and Tchernia, 1960; Le Floch and Romanovsky, 1966).

In a more recent study, Morel (1971) gave a detailed description of the Levantine Water and of the general features of these exchanges in the Strait. The purpose of our efforts is different being an attempt to improve our knowledge of the flow of Atlantic Water in the upper layer.

During the cruise which took place in the month of August 1968, (1-18 Aug) 24 hydrological stations were made along four sections (Fig. 1). We were prevented by a limit of the Tunisian territorial waters from obtaining a more detailed picture of the horizontal distribution of the Atlantic waters.

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RESULTS

The general structure of the water masses in the Strait of Sicily consists of three layers of vertically stratified water:

a) the bottom layer, of Levantine origin, crosses the Malta sill and flows along the Strait of Sicily forming a very stable "typical water", with the following characteristics:

$$14.0 \leq T \leq 14.3 \quad 38.70 \leq S \leq 38.75 \quad 29.05 \leq \sigma_T \leq 29.10$$

b) the intermediate layer, or transition layer, where the mixing between the Levantine water and the over-laying Atlantic water takes place,

c) the surface water, of Atlantic origin, which flows eastwards and has a temperature which varies considerably according to the seasons but has a rather constant mean salinity (SM=37,50%).

From these measurements, four vertical sections of salinity were made; salinity is indeed the best tracker for following the spatial evolution of Atlantic flow, (Figs 2,3,4 and 5).

The core of this water is neatly delineated in the first three sections, owing to the water with the lowest salinity being forced by the Coriolis effect to follow closely the African Plateau. This results also in a slope of the isopycnals towards the Tunisian coast.

In the most eastern section, near Malta, two low salinity cores were observed, one at station 172, the other at stations 170, 169, 168; but apparently, the main flow of Atlantic water has not been located.

This section does not extend onto the continental shelf where the Atlantic flow probably flows southeastwards. This was clearly indicated at station 172 which shows a possible branch of the main flow had divided before reaching the section and had followed a cyclonic motion; this would explain the existence of the low salinity water observed between Malta and the Sicilian coast.

These results tend to corroborate Morel's hypothesis (1971) according to which the presence of these water masses on the continental shelf off Sicily is probably due to a system of surface counter-currents forming south of Malta.

<u>T,S profile</u>

All significant points are grouped on the IS diagram shown in Fig. 6.

The profile confirms the well known thermohaline structure with: a levantine-type bottom layer, an intermediate transition layer where mixing takes place (in the profile the points relevant to this layer are in a zone delimitated by the levantine-type water and the isopycnal σ_T=28.00) and; finally, a layer with low salinity but with considerable variation in temperature caused by summer warming of the surface.

Taking into account all points defined by σ_T=28.0 an attempt was made to assess the mean value of salinity of the Atlantic water in the area.

The measured mean value, 37.48%, agrees quite well with Morel's figure of 37.50%. This isohaline was confirmed to be at a depth of about 60 m, except where it comes up to the surface which usually takes place in the northwest portion of the area. So the mean value of salinity was calculated for each station, to a depth of 60 m.

The results are shown in Fig. 1. The S_M = 37.50 isohaline divides the Strait of Sicily lengthwise into two zones: the limit of the Atlantic vein to the right of the flow and the area of lateral mixing, to the left of the flow.

One can furthermore readily recognize the outside arm and also the low mean-salinity anomaly we already mentioned.

The minimum values of mean salinity observed were about 37.25% in the south, with maximum values as high as 37.80%; this gives an idea of the process of lateral mixing in the basin, this idea can also be obtained by studying the TS profile.

The results of the present study were generally found to agree with former conclusions however a significant variation of the thickness of the transition layer was observed. Actually we never found any Levantine water at a depth less than 200 metres whether determined by salinity with values between 38.58 and 38.63 or by temperature (which was always found higher than 14.70). When compared with Morel's data these results seem to confirm the variability in the rate of water exchange.

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Section 1.

z(m)		41	40	39	38	37
0	T	24,28	23,40	23,40	23,75	23,95
	S	37,74	37,32	37,59	37,38	37,32
	σ_T	25,65	25,60	25,80	25,54	25,43
10	T	20,45	21,40	23,22	23,72	23,95
	S	37,72	37,19	37,55	37,43	37,34
	σ_T	26,73	26,06	25,82	25,58	25,45
20	T	15,51	19,38	22,38	23,25	23,90
	S	37,68	37,18	37,50	37,48	37,36
	σ_T	27,94	26,60	26,03	25,76	25,48
30	T	14,78	17,35	18,55	18,36	23,25
	S	37,86	37,03	37,42	37,26	37,37
	σ_T	28,24	27,00	27,00	26,93	25,68
50	T	14,36	15,40	16,53	16,35	18,10
	S	38,06	37,68	37,39	37,38	37,38
	σ_T	28,49	27,96	27,48	27,51	27,09
65	T	14,22				
	S	38,20				
	σ_T	28,63				
75	T			14,54	14,93	14,75
	S			37,74	37,80	37,68
	σ_T			28,20	28,16	28,11
100	T					14,72
	S					38,29
	σ_T					28,59

Section 2.

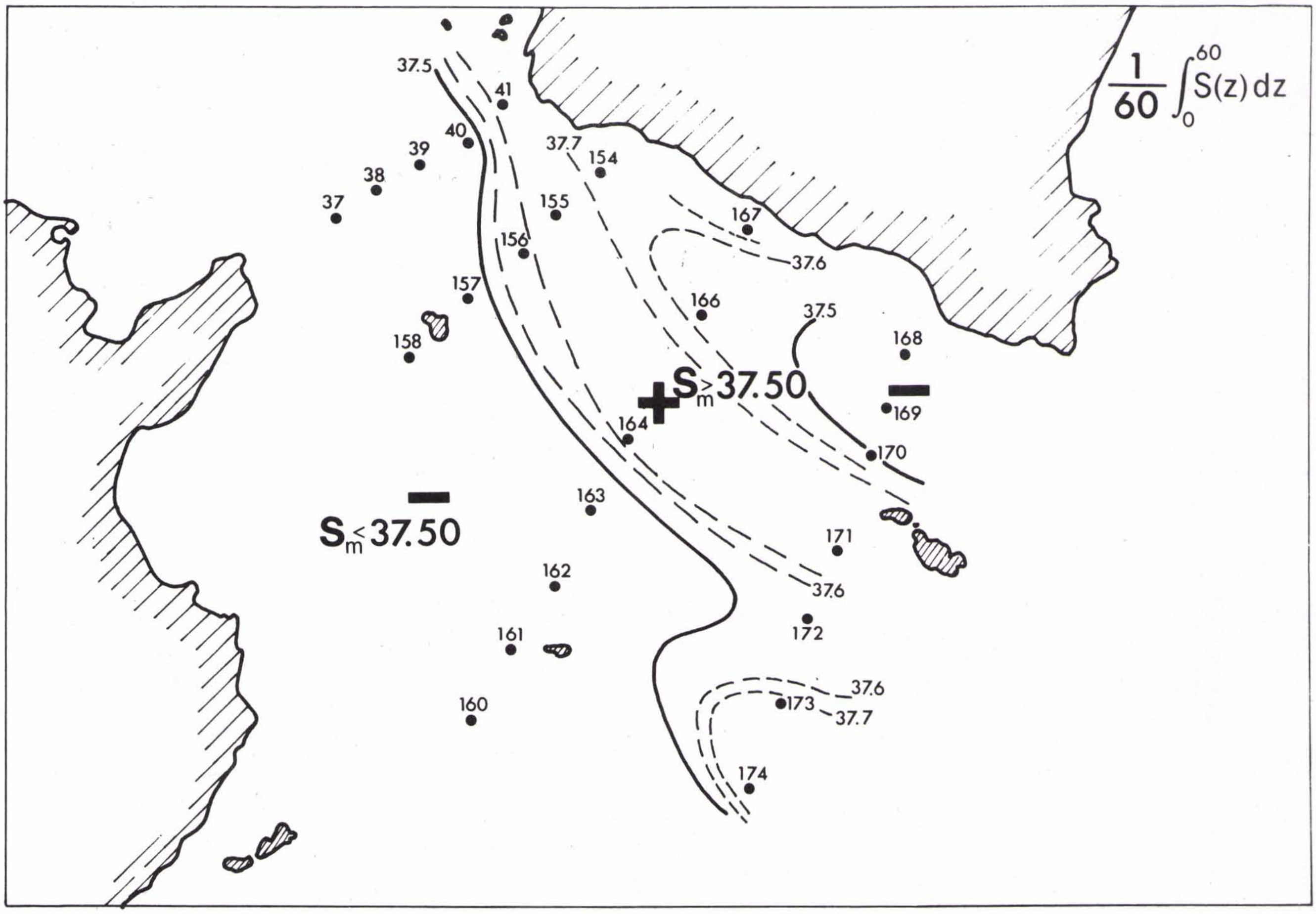
z(m)		154	155	156	157	158
0	T	23,60	23,72	23,20	23,85	23,97
	S	37,66	37,63	37,70	37,38	37,38
	σ_T	25,79	25,73	25,94	25,50	25,47
10	T	19,70	22,72	21,34	23,25	23,79
	S	37,63	37,61	37,72	37,38	37,38
	σ_T	26,86	26,01	26,48	25,68	25,52
20	T	16,80	16,32	19,22	22,78	23,22
	S	37,54	37,68	37,59	37,44	37,38
	σ_T	27,53	27,75	26,96	25,87	25,69
30	T	15,75	15,60	16,80	21,95	20,75
	S	37,56	37,80	37,56	37,47	37,41
	σ_T	27,79	28,01	27,54	26,13	26,41
50	T	14,98	14,87	15,10	18,04	16,48
	S	37,86	38,03	37,68	37,41	37,61
	σ_T	28,20	28,35	28,03	27,12	27,65
75	T	14,90	14,55	14,52	15,03	14,88
	S	38,48	38,29	38,21	37,66	37,75
	σ_T	28,70	28,63	28,57	28,03	28,14
100	T	14,69	14,70		15,16	14,80
	S	38,48	38,53		38,03	38,08
	σ_T	28,74	28,78		28,29	28,41
200	T				14,60	
	S				38,63	
	σ_T				28,88	

Section 3.

z(m)		167	166	164	163	162	161	160
0	T	24,50	25,50	26,30	26,28	25,90	25,70	25,60
	S	37,61	37,61	37,86	37,38	37,39	37,27	37,30
	σ_T	25,49	25,18	25,12	24,76	24,89	24,86	24,92
10	T	23,90	25,18	25,95	25,50	25,20	24,92	25,58
	S	37,63	37,61	37,94	37,39	37,21	37,27	37,34
	σ_T	25,68	25,28	25,29	25,01	24,97	25,10	24,95
20	T	17,10	24,96	25,89	22,48	21,75	24,28	24,20
	S	37,72	37,57	37,72	37,27	37,36	37,18	37,43
	σ_T	27,59	25,32	25,14	25,82	26,10	25,23	25,44
30	T	16,05	24,45	25,15	20,27	19,80	21,70	22,75
	S	37,81	37,57	37,66	37,29	37,36	37,17	37,42
	σ_T	27,91	25,47	25,33	26,45	26,63	25,97	25,86
40	T						20,20	
	S						37,17	
	σ_T						26,38	
50	T	14,96	17,82	18,15	18,05	17,55		
	S	37,96	37,68	37,70	37,51	37,10		
	σ_T	28,28	27,39	27,32	27,20	27,00		
75	T		16,22	16,37	16,26	15,38		
	S		38,02	38,04	37,94	37,56		
	σ_T		28,03	28,01	27,97	27,88		
100	T		16,12	15,62	15,98	15,23		
	S		38,16	38,20	38,10	37,67		
	σ_T		28,17	28,31	28,15	28.00		
150	T		15,30			15,05		
	S		38,40			38,18		
	σ_T		28,54			28,43		
200	T		14,70	14,75	14,70			
	S		38,63	38,64	38,62			
	σ_T		28,85	28,85	28,85			
300	T		14,27					
	S		38,70					
	σ_T		29,01					
400	T			14,20	13,98			
	S			38,72	38,72			
	σ_T			29,04	29,08			
500	T			13,97				
	S			38,75				
	σ_T			29,11				

Section 4.

z(m)		168	169	170	171	172	173	174
0	T	25,05	25,40	25,60	26,30	26,05	26,95	26,70
	S	37,66	37,66	37,68	37,97	37,86	37,97	37,81
	σ_T	25,36	25,25	25,20	25,20	25,20	25,00	24,95
10	T	24,47	24,60	24,95	25,85	26,03	26,16	26,58
	S	37,68	37,63	37,57	37,92	37,86	37,97	37,79
	σ_T	25,55	25,47	25,32	25,30	25,20	25,25	24,98
20	T	19,85	23,65	23,03	25,49	21,20	24,96	22,27
	S	37,20	37,52	37,47	38,06	37,66	37,68	37,57
	σ_T	26,50	25,67	25,82	25,53	26,48	25,40	26,11
30	T	17,67	22,50	21,52	24,15	17,65	23,00	20,35
	S	37,18	37,40	37,44	38,02	37,38	37,70	37,62
	σ_T	27,04	25,92	26,22	25,90	27,20	26,00	26,68
50	T	16,25	18,55	18,15	18,03	15,43	18,74	18,40
	S	37,50	37,38	37,46	37,80	37,26	37,86	37,96
	σ_T	27,63	26,97	27,14	27,43	27,63	27,29	27,45
75	T	15,54	15,87	15,97	16,40	14,60	15,88	16,70
	S	37,96	38,12	37,84	38,00	37,32	37,72	38,09
	σ_T	28,15	28,20	27,96	27,98	27,86	27,88	27,97
100	T	15,90	16,10	16,07	16,13	14,88	16,18	15,98
	S	38,22	38,26	38,16	38,09	37,62	38,05	38,12
	σ_T	28,26	28,25	28,18	28,11	28,04	28,07	28,17
150	T				15,40	15,03		
	S				38,44	38,18		
	σ_T				28,55	28,43		
200	T	14,72	14,83	14,82		14,87	14,72	
	S	38,62	38,60	38,50		38,58	38,52	
	σ_T	28,84	28,80	28,73		28,78	28,77	
250	T	14,60						
	S	38,68						
	σ_T	28,91						
300	T						14,24	
	S						38,65	
	σ_T						28,97	
400	T		14,12			14,00		
	S		38,77			38,70		
	σ_T		29,09			29,06		



$\frac{1}{60}\int_0^{60} S(z)\,dz$
$S_m > 37.50$
$S_m < 37.50$
37.5
37.7
37.6
37.6
37.5
37.6
37.6
37.7
37
38
39
40
41
154
155
156
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158
160
161
162
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174

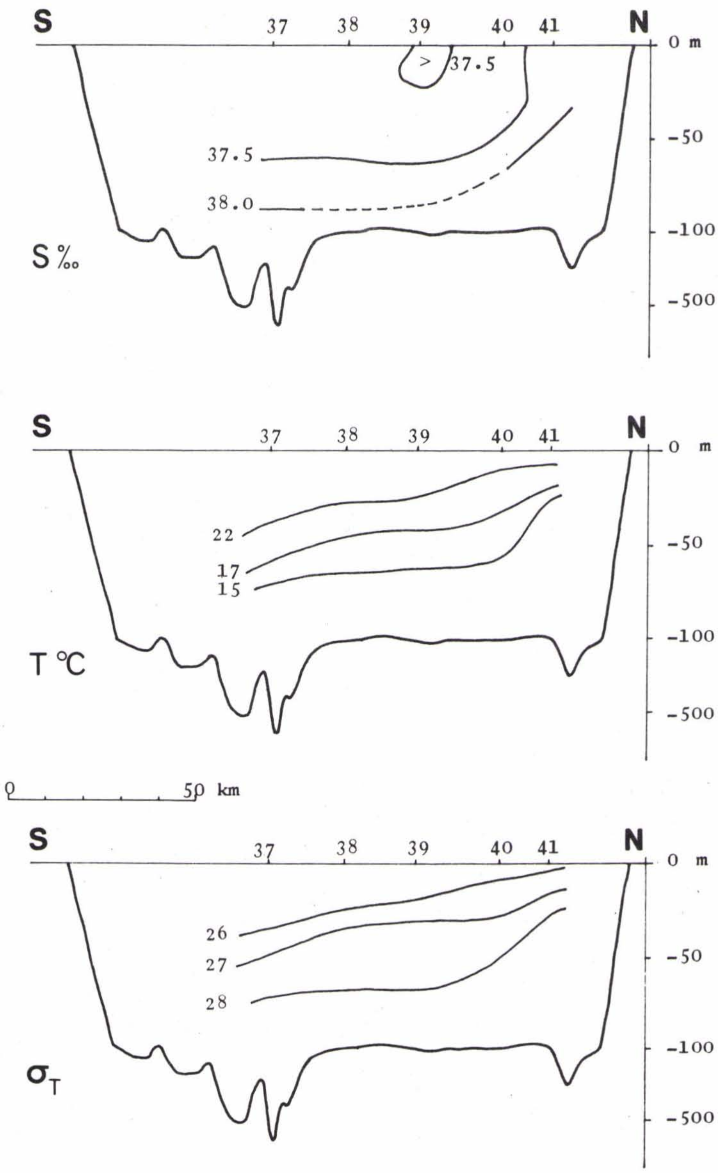

S
37
38
39
40
41
N
0 m
> 37.5
37.5
38.0
-50
-100
-500
S ‰
S
37
38
39
40
41
N
0 m
22
17
15
-50
-100
-500
T °C
0
50 km
S
37
38
39
40
41
N
0 m
26
27
28
-50
-100
-500
σT

FIG. 2

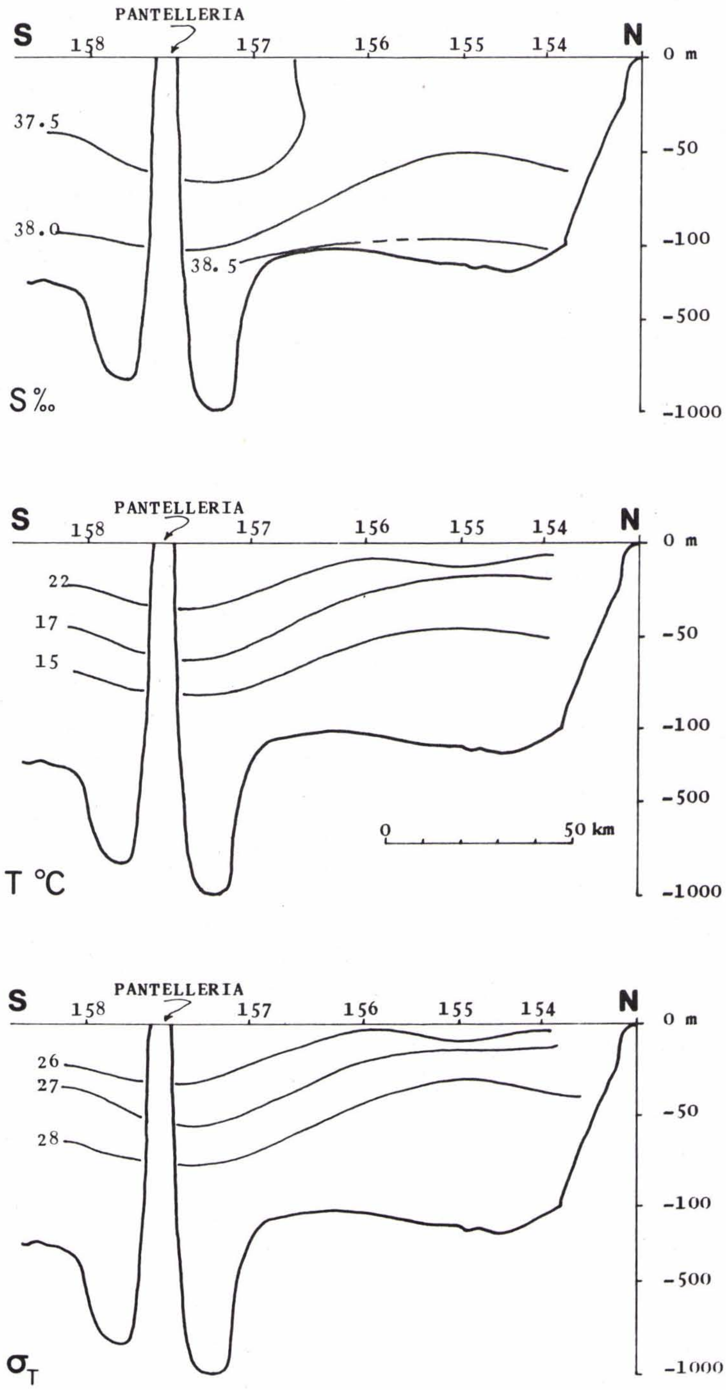

PANTELLERIA
S
158
157
156
155
154
N
0 m
-50
-100
-500
-1000
37.5
38.0
38.5
S ‰
22
17
15
0
50 km
T °C
26
27
28
σT

FIG. 3

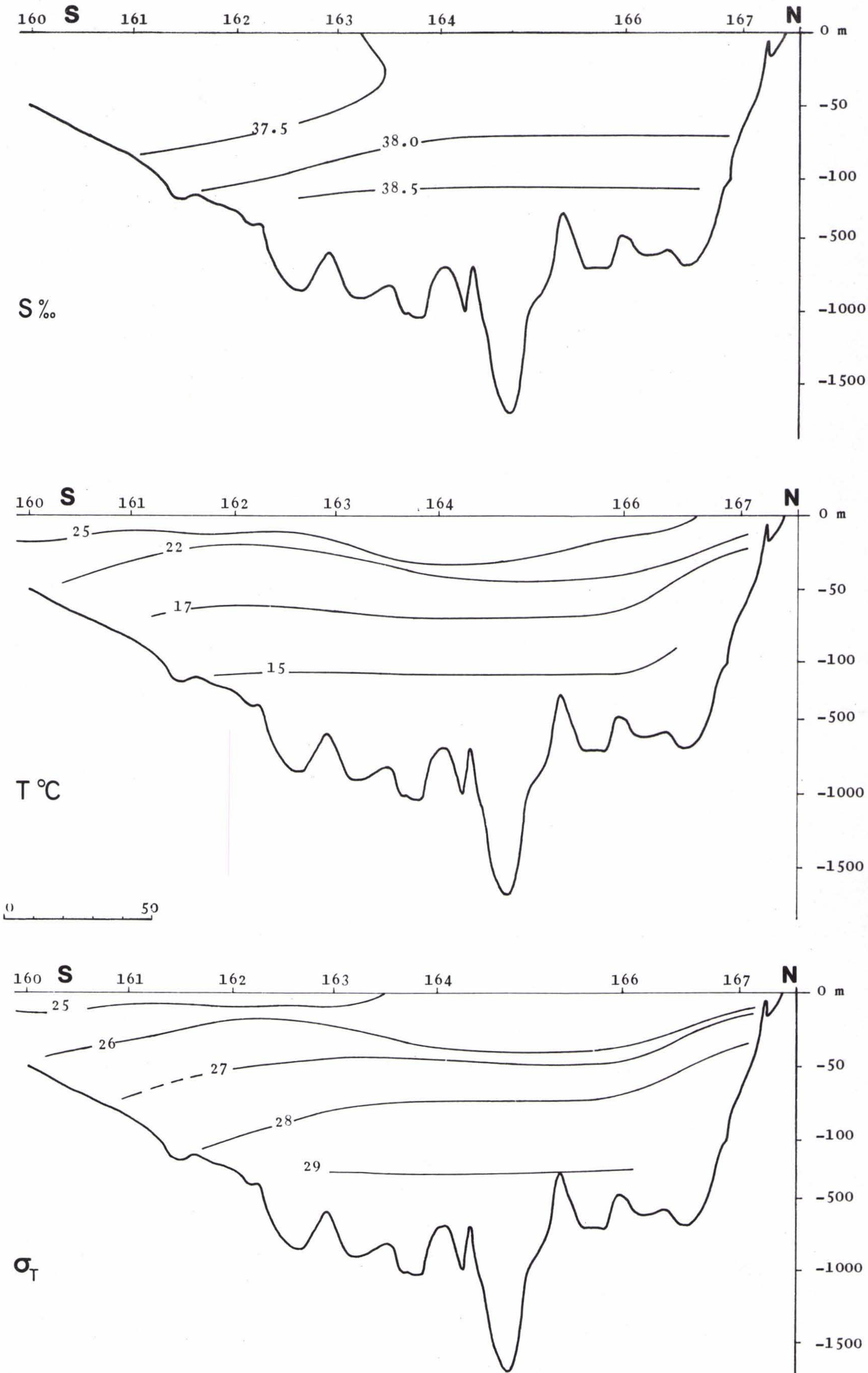
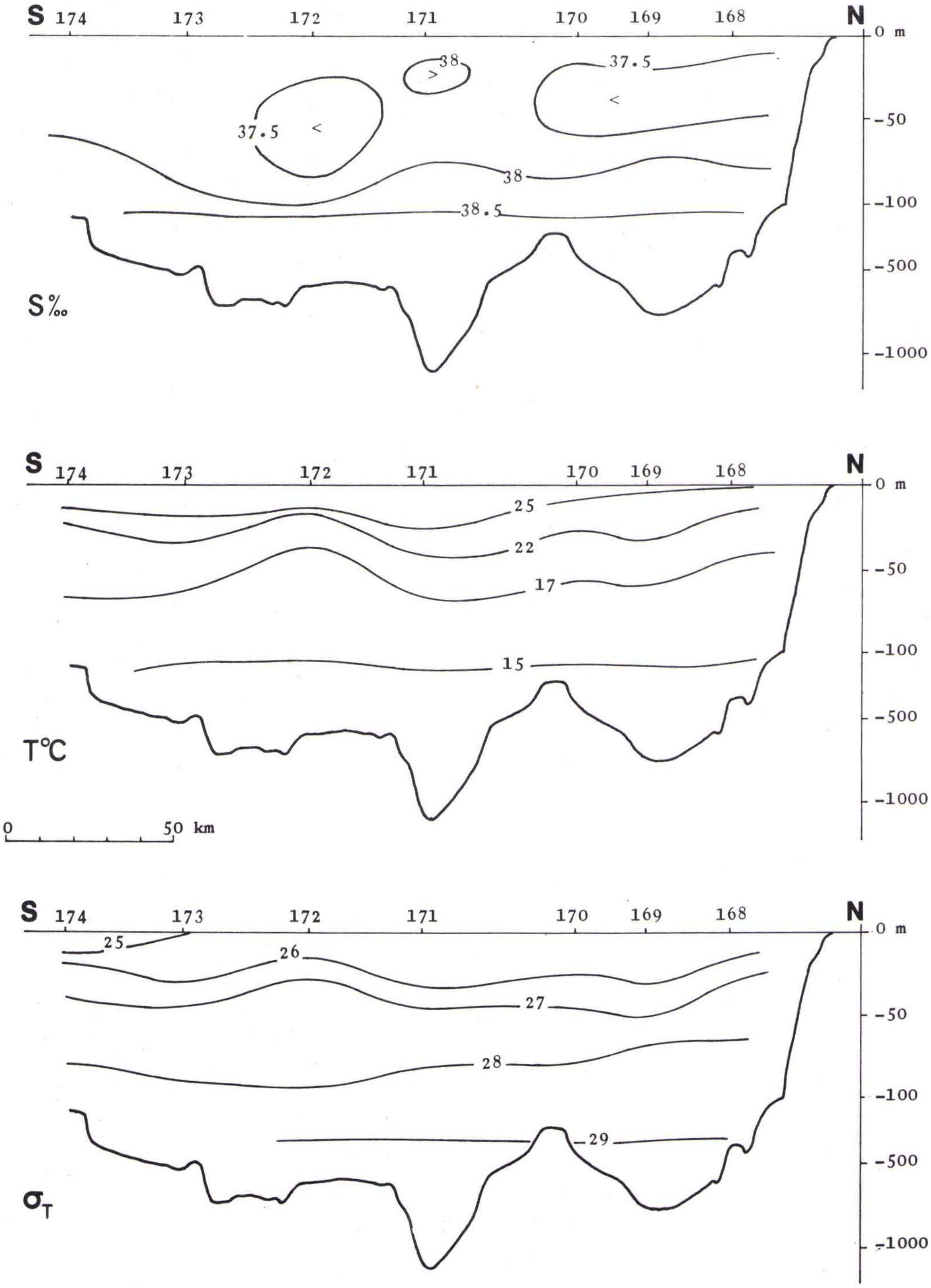
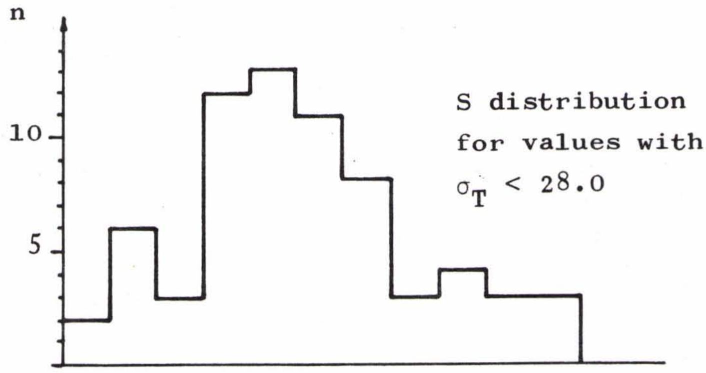

160 S 161 162 163 164 166 167 N
0 m
-50
-100
-500
-1000
-1500
37.5
38.0
38.5
S ‰
T °C
25
22
17
15
0
50
σT
26
27
28
29

FIG. 4



S 174 173 172 171 170 169 168 N
0 m
-50
-100
-500
-1000
37.5
38
38.5
S‰
T°C
25
22
17
15
σT
26
27
28
29
0 50 km

FIG. 5


n
10
5
S distribution
for values with
σ_T < 28.0

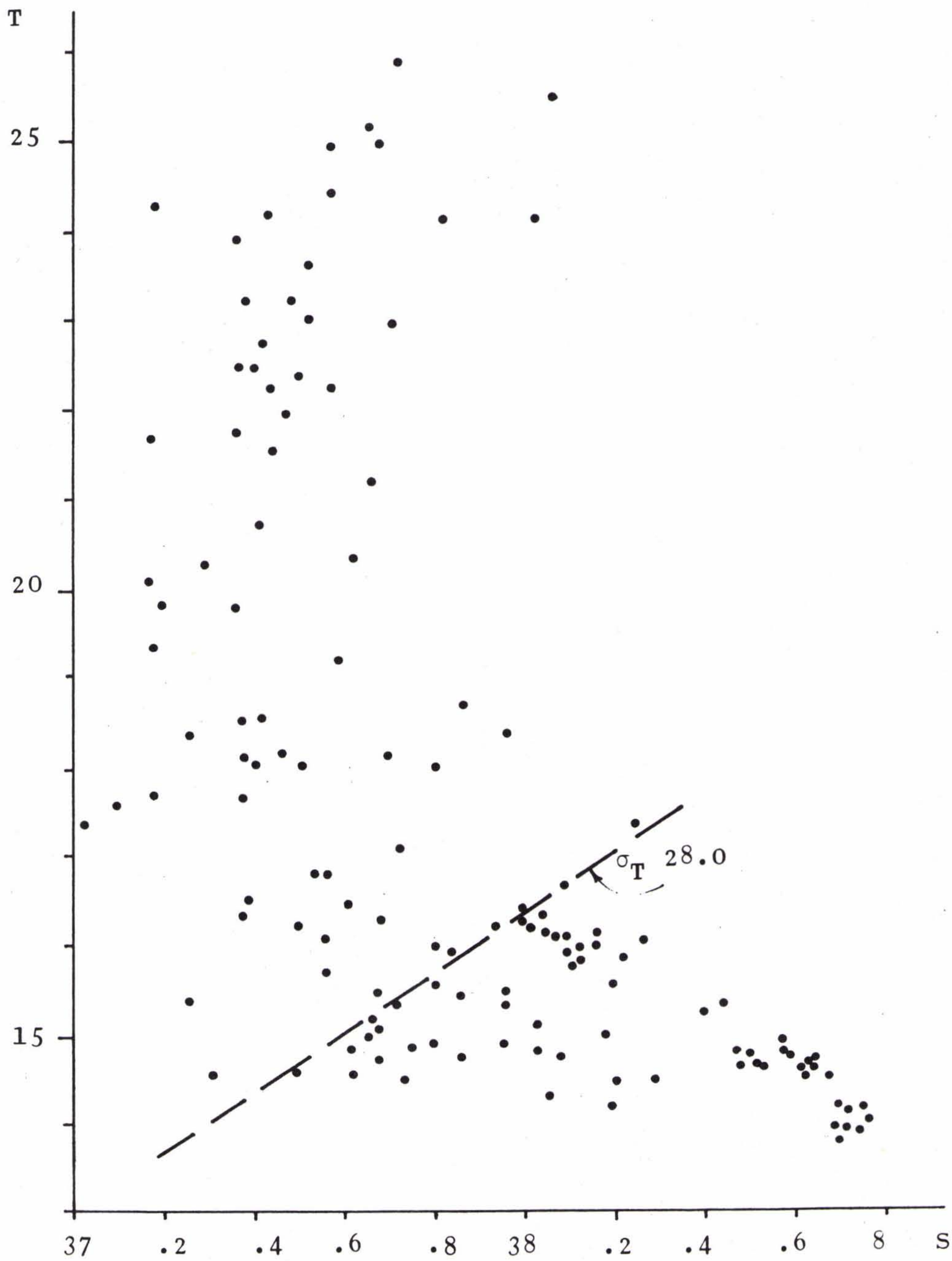

T
25
20
15
σ_T 28.0
37
.2
.4
.6
.8
38
.2
.4
.6
8
S

FIG. 6