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Stanisław RAKUSA-SUSZCZEWSKI

Department of Polar Research,
Institute of Ecology,
Polish Academy of Sciences,
Dziekanów Leśny,
05-092 Łomianki, POLAND

# Coarse-scale structure of the water column between King George and Elephant Islands (BIOMASS III, October—November 1986)

ABSTRACT: In the examined area three types of waters have been recorded: Surface Waters of winter modification, Warm Deep Waters and East Bransfield Strait Waters. Geographical location of Scotia Front is similar to that observed in previous years. The dynamics of waters within the examined area is high. It is reflected not only in physical and chemical parameters but also in the distribution of chlorophyll *a*. In the Front its total amount in a water column is greater than outside.

Key words: Antarctica, water masses dynamics, BIOMASS III.

## 1. Introduction

Scotia Front is a northern border of the Weddell-Scotia Confluence belt (Gordon, Georgi and Taylor 1977). The existence of that front over the northern shelf slope between King George and Elephant Islands has been recorded many times (Gordon 1967; Patterson and Sievers 1980; Stein 1986). Within that front, low stability and homogeneity of water have been noted (Clowes 1934; Stein and Rakusa-Suszczewski 1982; FIBEX I and II Hydrographic Data Interpretation Workshop) which is caused by convection thermohaline, vertical mixing and friction against the northern side of the shelf slope of the South Shetlands archipelago. Geographical location and the structure of waters within the front undergo seasonal and multi-year changes (Stein 1986). The objective of Polish investigations carried out in that region was a broad hydrographical and biological examination of the structure of a water column. In this paper findings supplementary to those made by Grelowski and Wojewódzki (1988) are presented.

## 2. Methods

The investigations were carried out in the period from 30th October 1986 (station 29, Fig. 1) to 3rd November 1986 (station 48) aboard r/v "Profesor Siedlecki". The temperature at the stations 37, 38, 39, 42, 43, 44, 45, 46, 47, 48 were measured by a reversible thermometer, at the remaining stations of that zone (Fig. 1) a sound STD-Bisset-Berman model 9040 was used.

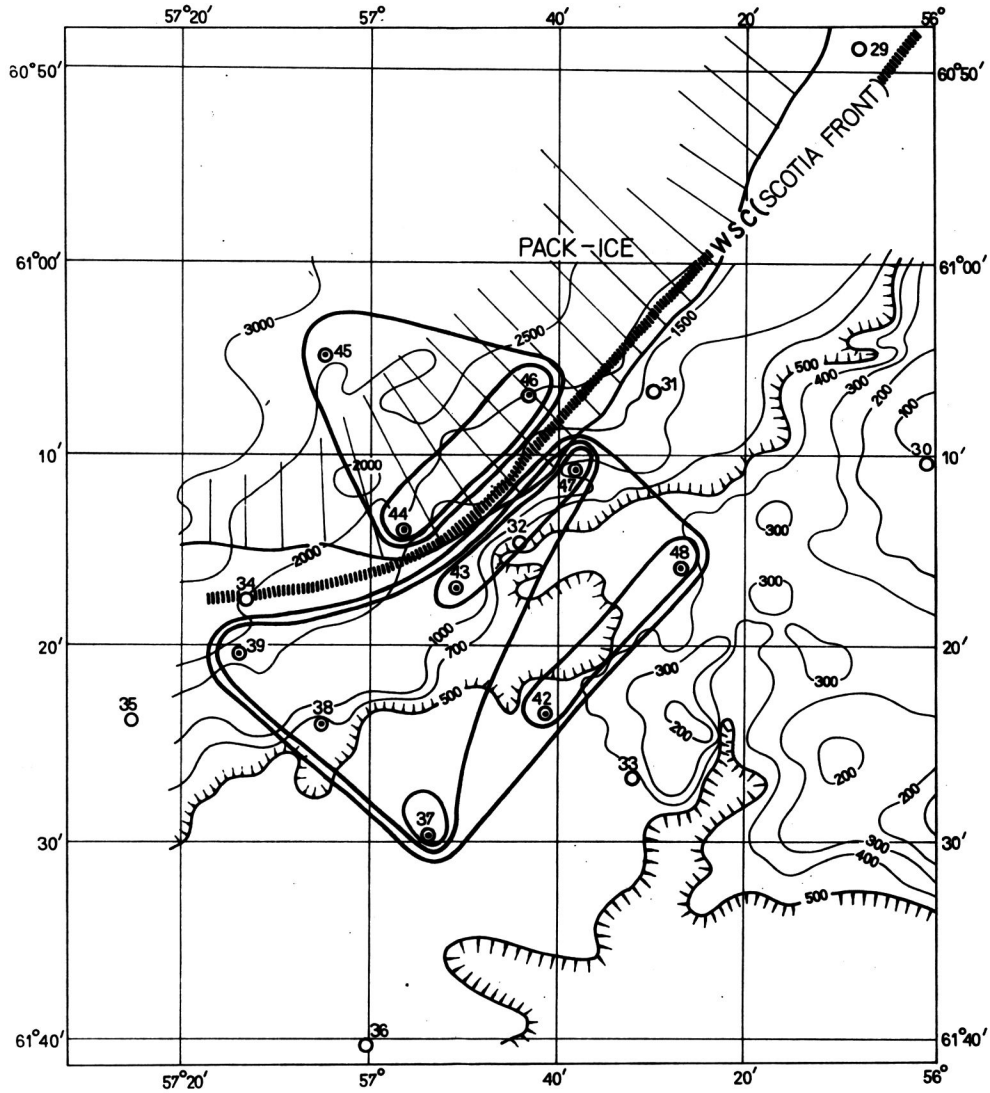


Fig. 1. Polygon 1 between King George and Elephant Islands where the structure of a water column was examined. The stations with similar T/S have been encircled with solid lines

The samples of water for the salinity and DO analysis were taken with Nansen bottles, whereas 6-litre Van Dorn bathometer was used for the analysis of chlorophyll *a*.

Measurements of T, S and DO were made by A. Grelowski and T. Wojewódzki, whereas measurements of the content of chlorophyll *a* were made by M. Lipski and K. Zieliński employing the procedure of extraction and designations identical with that used in the paper by Lipski (1985).

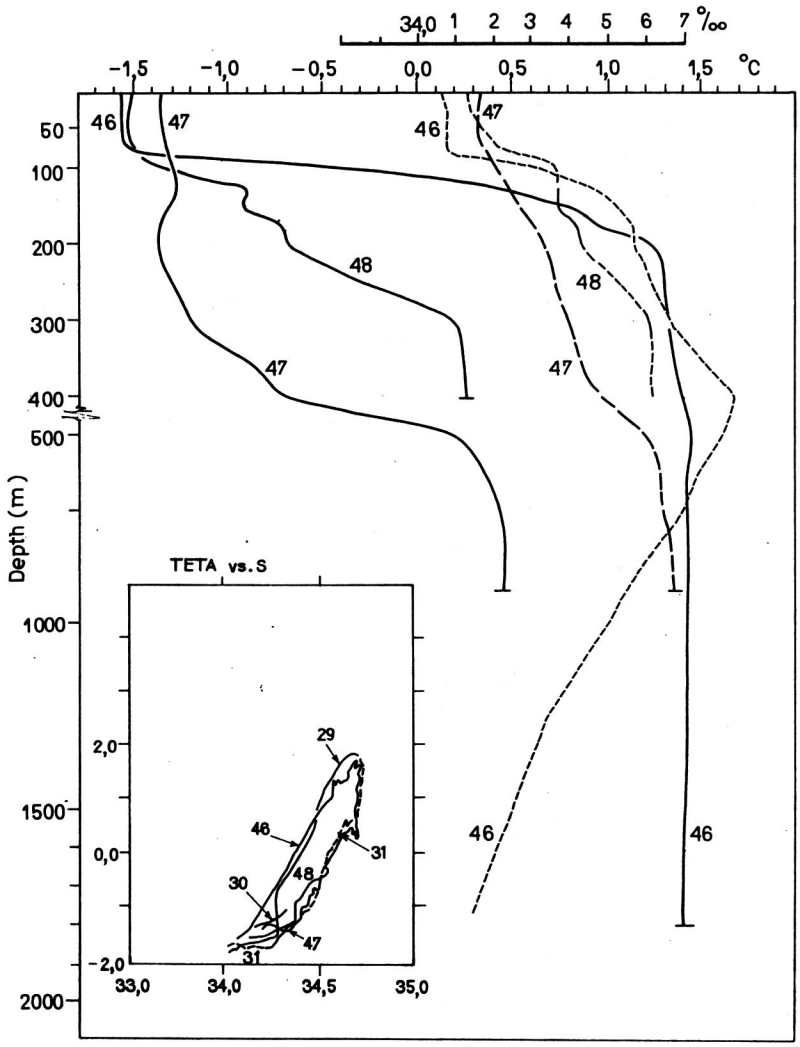


Fig. 2. Vertical stratification of temperature and salinity and T/S diagrams in transection 1 — stations 46, 47, 48

## 3. Results and discussion

The coarse scale examination of the structure of a water column within Scotia Front was based on the measurements of the area of about 20 × 40 nM (Fig. 1). To the north of that area a dense pack-ice was found. The differences of T, S and DO stratification between different stations within that fairly small region were relatively considerable (Figs. 2, 3, 4). On the basis of diagrams T/S, two hydrographically essentially distinct groups of stations

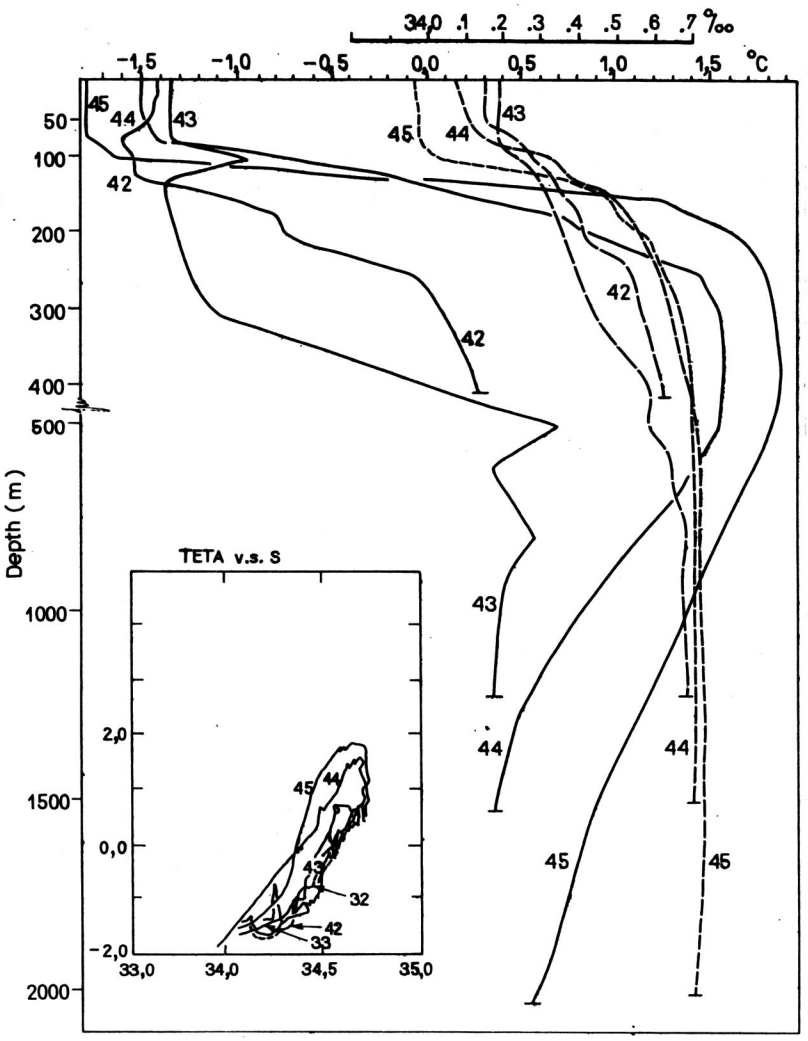


Fig. 3. Vertical stratification of temperature and salinity and T/S diagrams in transection 2 – stations 45, 44, 43, 42

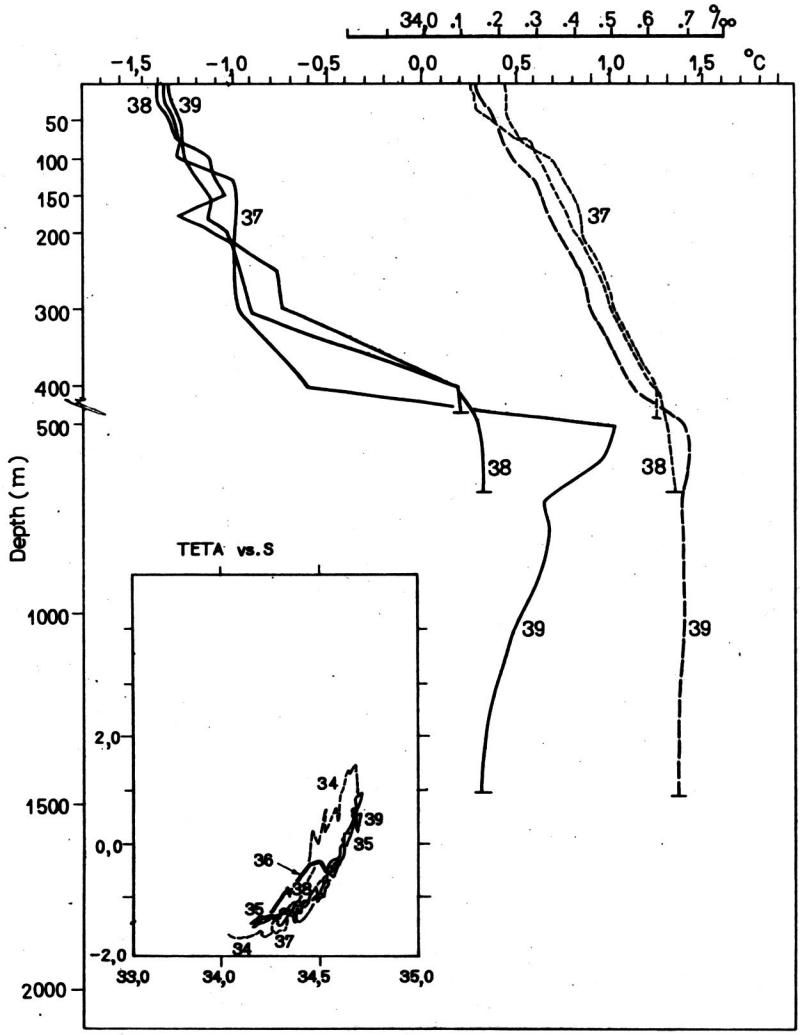


Fig. 4. Vertical stratification of temperature and salinity and T/S diagram in transection 3 — stations 39, 38, 37

separated by Scotia Front were distinguished. Within either of the groups, stations of various degree of similarity were noted (Fig. 1). The stations situated from SW to NE manifest similarities of the T/S diagrams. It is compatible with the general direction of the current in that area. A similar phenomenon was also observed in the Bransfield Strait (Stein and Rakusa-Suszczewski 1984). In the examined region, there are winter waters in the surface layer. From the north they are influenced by the presence of pack-ice lowering their temperature and salinity (Figs. 2, 3; stations 45, 46). In the zone of intensive mixing of waters (Figs. 5, 6, 7) between stations 46

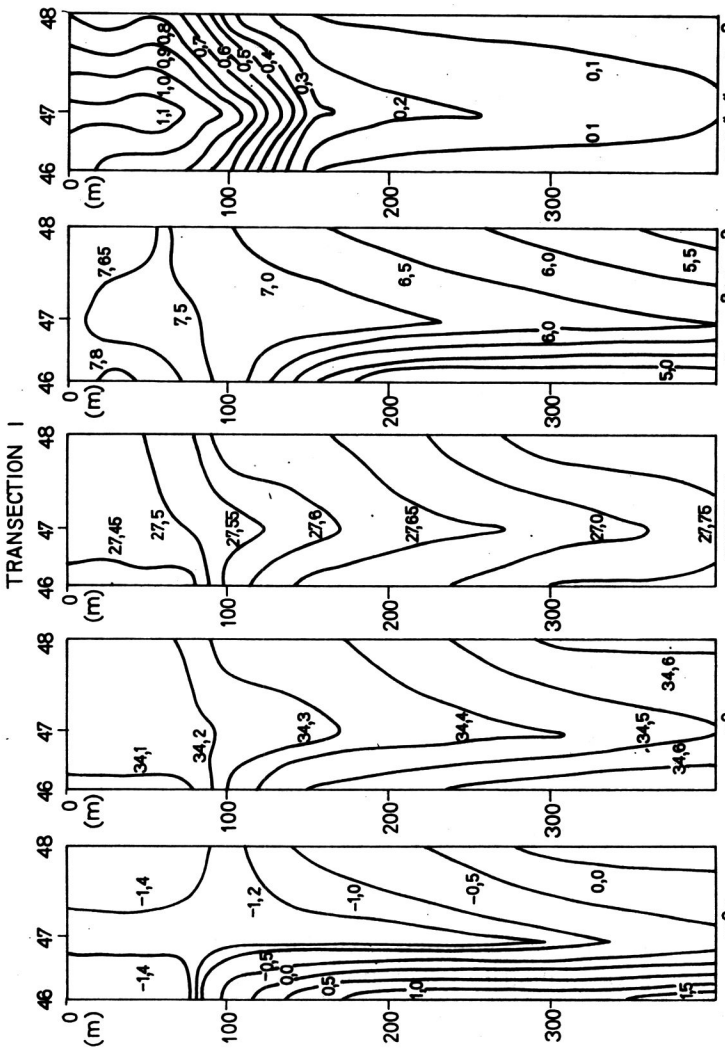


Fig. 5. Isolines of examined parameters in transection I. Characteristic curves of isolines in the Scotia Front Zoone between stations 46—47, wedging of warmer waters (0.0°C) onto the shelf and concentration and submerging of chlorophyll *a* in the Front Zone can be seen

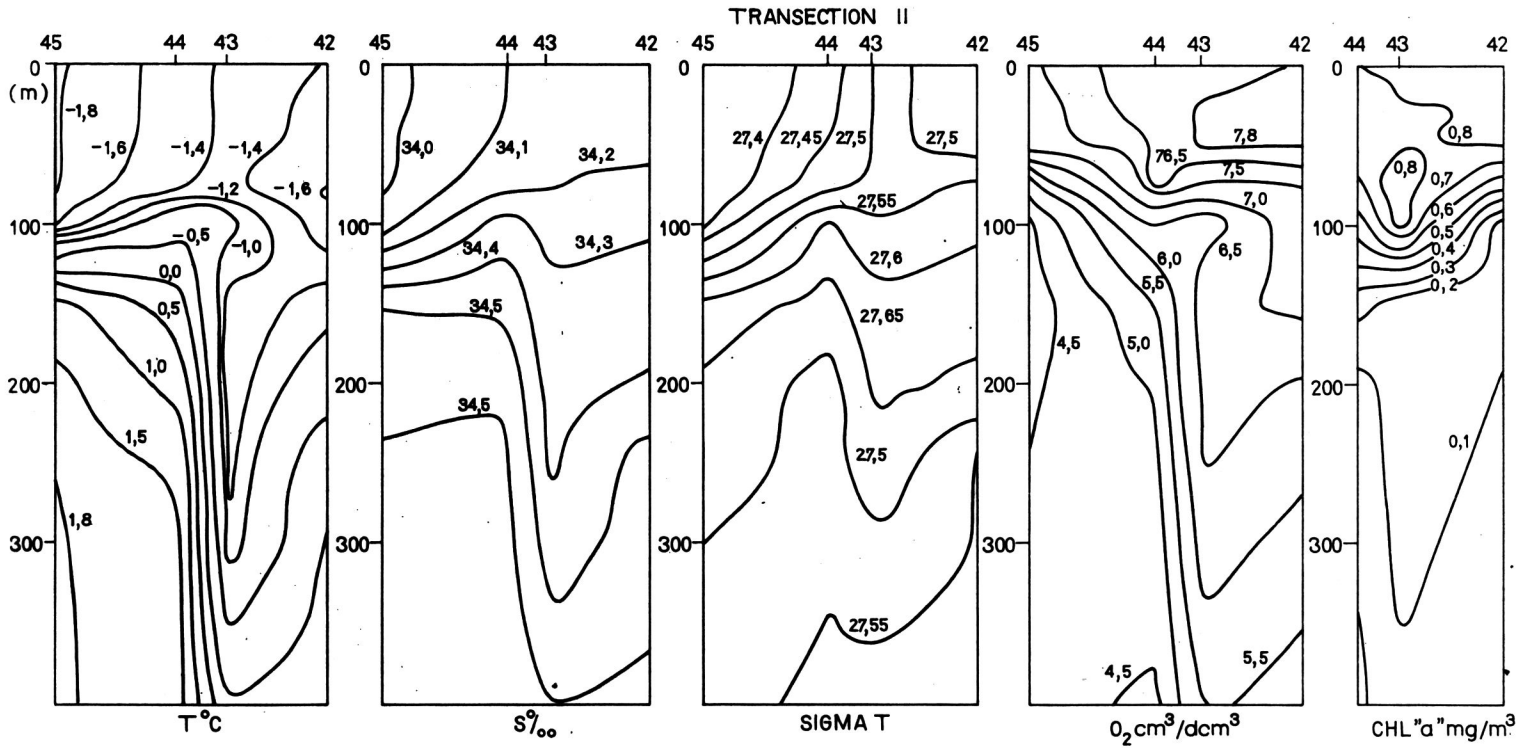


Fig. 6. Isolines of examined parameters in transection 2. The Sciota Front between stations 44—43, cutting of warmer waters onto the self and submerging of chlorophyll *a* in the Front Zone can be seen

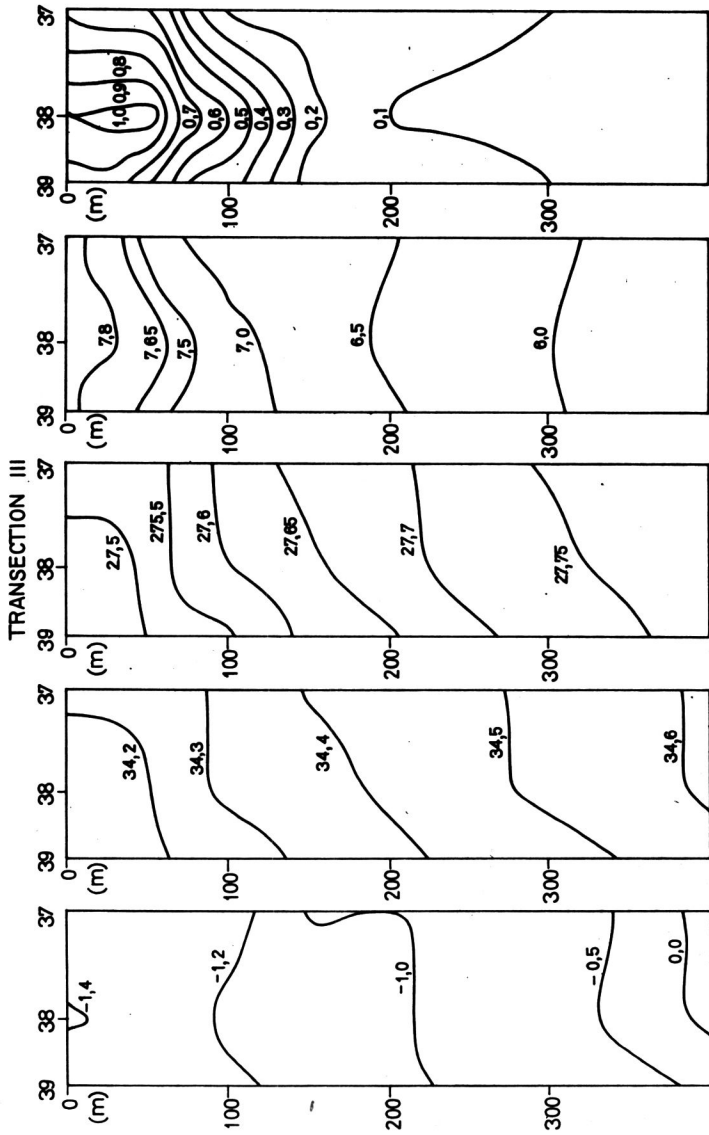


Fig. 7. Isolines of examined parameters in transection 3. The front is located further to the north of station 39 (Fig. 4). Only warmer waters (0.0°C) cutting onto the shelf can be seen

and 47, and 44 and 43, waters are under the influence of Warm Deep Water coming from below which causes a slight increase of water temperature on the surface. The processes probably help to restore regenerated nutrients to the surface waters (Foster 1984). Deeper, below 100 m, to the north of the front (stations 45, 46, 44), the presence of Warm Deep Water and upwelling can be seen. To the south of Scotia Front, over the shelf of South Shetlands waters typical for eastern part of Bransfield Strait can be found (stations 37, 42, 48). Below those waters, near the bottom, there are flowing warmer waters from the north. The Scotia Front zone and flowing of Warm Deep Water onto the shelf can be well seen on a 3-dimensional picture. It presents a water column in a rectangle covering stations 37, 39, 46, 48 (Figs. 8, 9). The depth of water layer with the temperatures of −1.0 and 0.0 °C is presented there as well. The situation of Scotia Front in the examined period was determined between stations 46—47 and 44—43, and slightly farther, north of station 39 and south of station 29. The situation of Scotia Front is in that area similar to that observed in previous years (Stein 1986). In the front zone, the process of mixing and downwelling

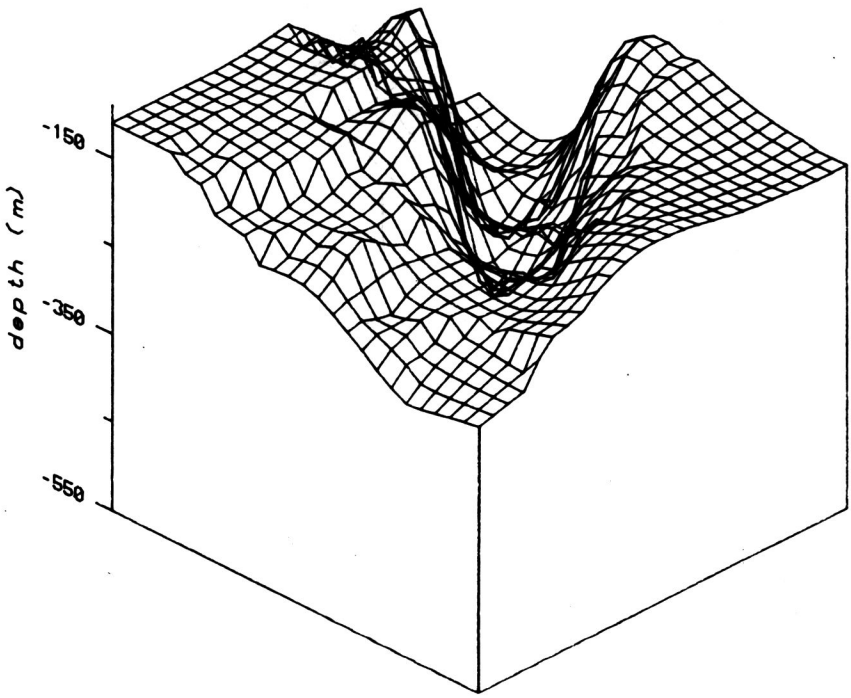


Fig. 8. Water column in a rectangle covering stations 37, 39, 46, 48 (Fig. 1). View from SE. The depth of a water layer with temperature −1 °C is presented

of waters takes place. As it can be seen (Figs. 5, 6, 7) also the distribution of chlorophyll *a* in a water column is a good indicator of that process. In the Front the total amount of chlorophyll *a* in a water column is greater than outside. A similar phenomenon was observed by Lutjeharms, Walters and Allanson (1985).

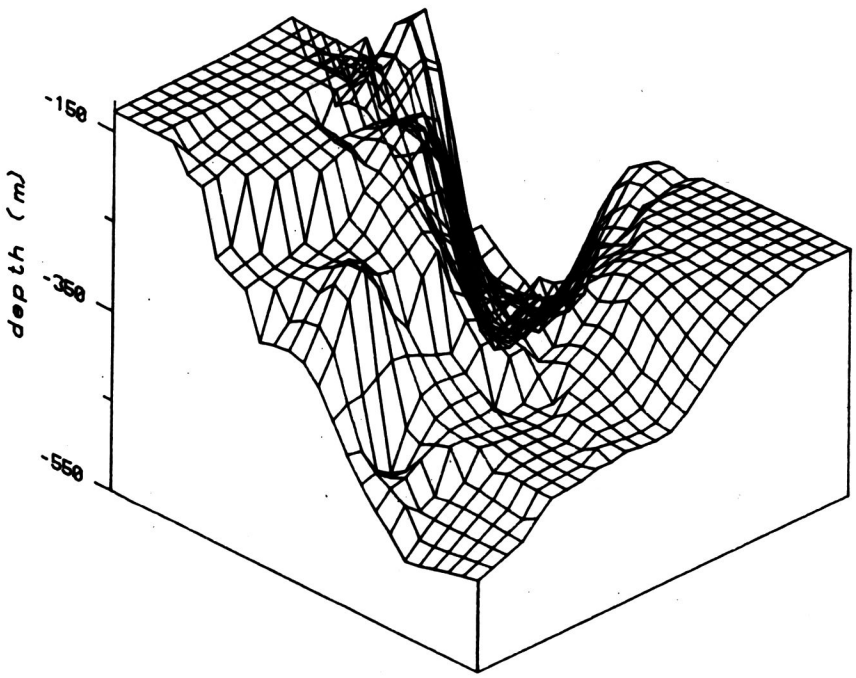


Fig. 9. Water column in a rectangle covering stations 37, 39, 46, 49 (Fig. 1). View from SE. The depth of a water layer with temperature 0 C is presented

Transection parallel to the shelf slope (Figs. 10, 11, 12) illustrate and confirm the existence of high dynamics of water masses and are an indication of horizontal eddies in the central part of the examined zone (Grelowski and Wojewódzki 1988).

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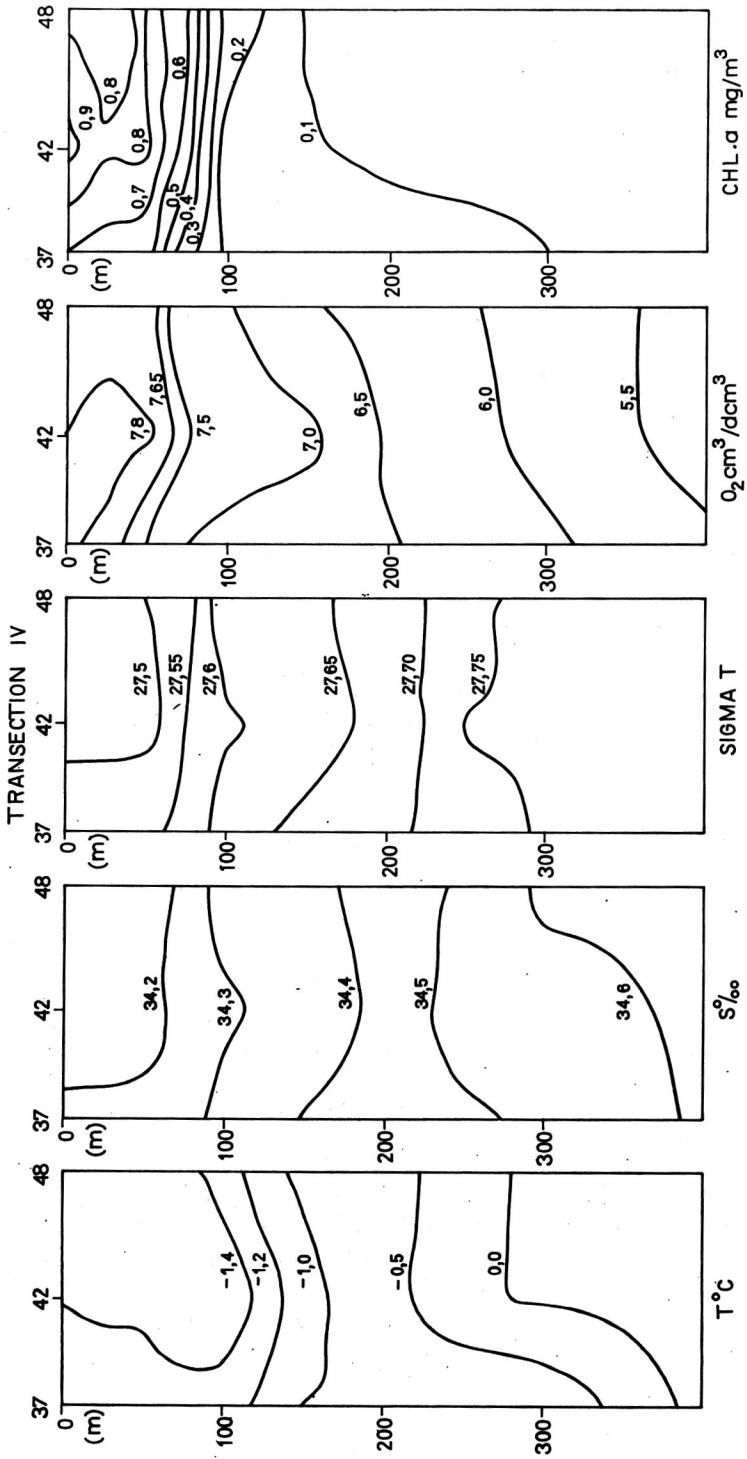


Fig. 10. Isolines of examined parameters in transection 4 (stations 37, 42, 48)

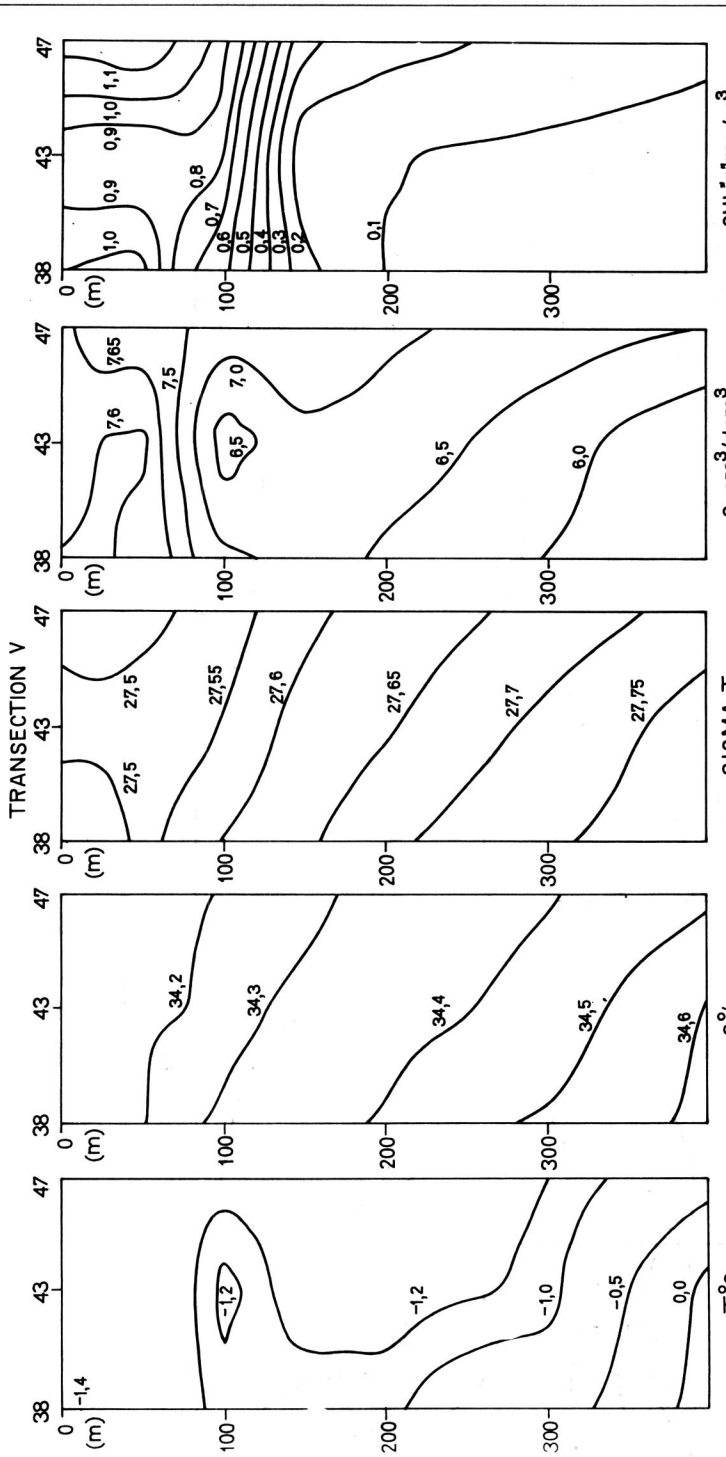


Fig. 11. Isolines of examined parameters in transection 5 (stations 38, 43, 47)

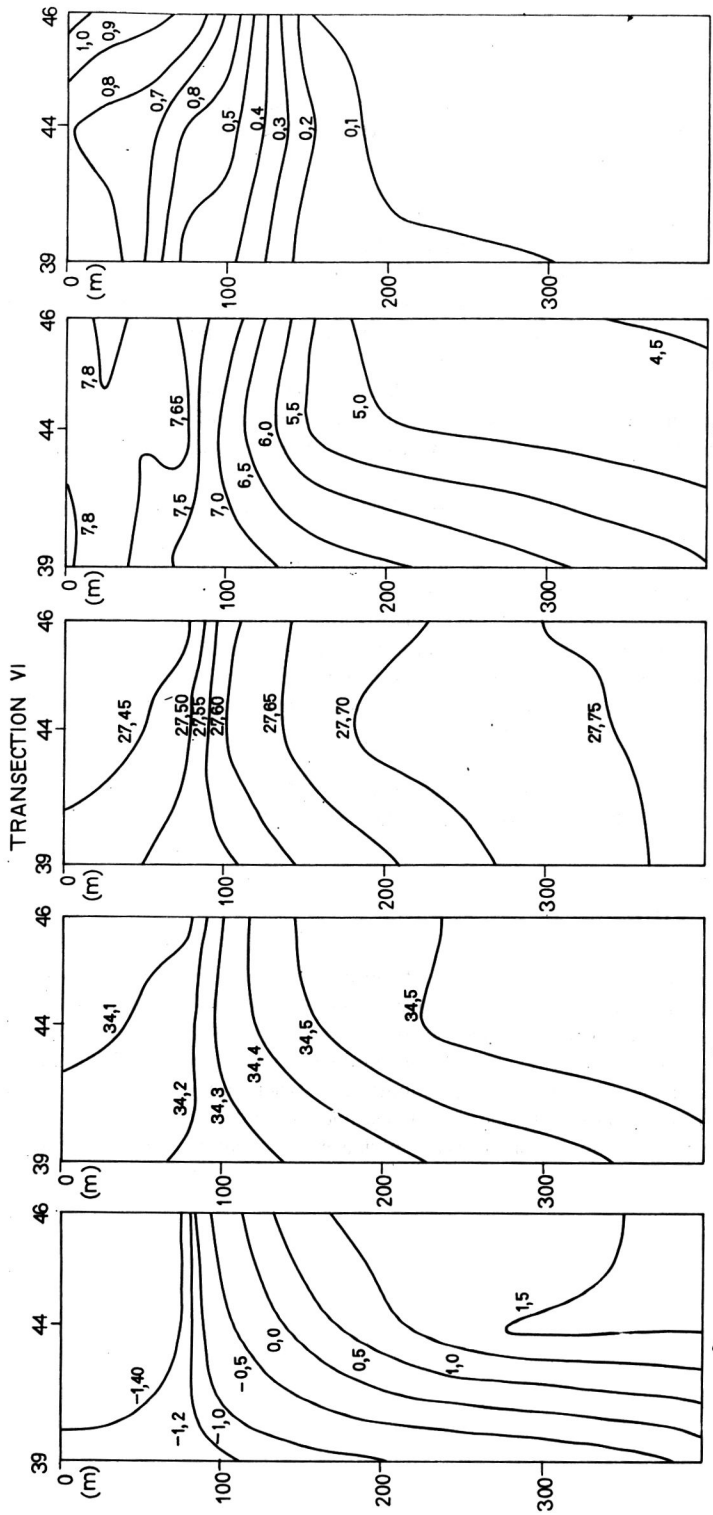


Fig. 12. Isolines of examined parameters in transection 6 (stations 39, 44, 46)

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## 5. Streszczenie

Badano strukturę kolumny wody w strefie Frontu Scotia w okresie wiosennym (Rys 1). W oparciu o pomiary T ( C), S ($^0/_{00}$), DO — rozpoznano 3 typy mas wodnych: 1) powierzchniowe wody zimowej modyfikacji do głębokości ok. 100 m; 2) ciepłe wody głębinowe poniżej 100 m na północ od strefy Frontu; 3) wody wschodniej części Cieśniny Bransfielda (Rys. 2, 3, 4). Położenie Frontu Scotia jest podobne do stwierdzonego w latach ubiegłych (Rys. 1, 5, 6). W strefie Frontu następuje silne mieszanie się wody (Rys. 7, 8, 9, 10, 11, 12). Ilość i rozmieszczenie chlorofilu *a* jest dobrym indykatorem dynamiki wód w strefie Frontu.