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PRELIMINARY DETERMINATION OF THE OCCURRENCE AND MOVEMENT OF WATER MASSES IN THE REGIONS OF SOUTH GEORGIA ISLAND, THE SCOTIA SEA AND THE ANTARCTIC PENINSULA

The hydrologic situation of waters around the Antarctic Continent is mostly affected by meteorological conditions. East winds south of 66°S give rise to circumpolar current of the East Wind Drift which is partially impeded by the Antarctic Peninsula. In the region of the Weddell Sea this current gives rise to the Weddell Current which carries waters from this sea north-easterly into the region of the Scotia Sea. The current of the East Wind Drift, poorly pronounced in Bransfield Strait, brings in cold waters from the Weddell Sea and forms the Weddell Sea gyre [3, 5] (Fig. 1).

North of 66°S, a circumpolar current of the West Wind Drift occurs due to the strong north winds predominating in this region. The water masses of this current bathe around the Antarctic Continent, over an enormous area extending to 40°S in the north, i.e. to the subtropical convergence. The masses of the West Wind Drift are separated by the Antarctic convergence zone which runs through the Atlantic sector [4] from approx. 57°S in Drake Passage to 48°S on the Cape Town meridian. In the Antarctic sector of the Atlantic Ocean, the West Wind Drift penetrates from the Bellingshausen Sea through the Drake Passage to the Scotia Sea.

Three basic types of water masses can be distinguished in the Antarctic waters. These are:

	t(°C)	S(‰)
(i) Antarctic surface water		
(a) in summer: upper layer	4.0 to —1.5	33.8 —34.0
lower layer	2.0 to —1.8	34.0 —34.4
b) in winter	—1.0 to —1.9	33.8 —34.6
(ii) Warm Deep Water	2.3 to —0.2	34.66—34.77
(iii) Antarctic Bottom Water	0.8 to —0.5	34.66—34.74

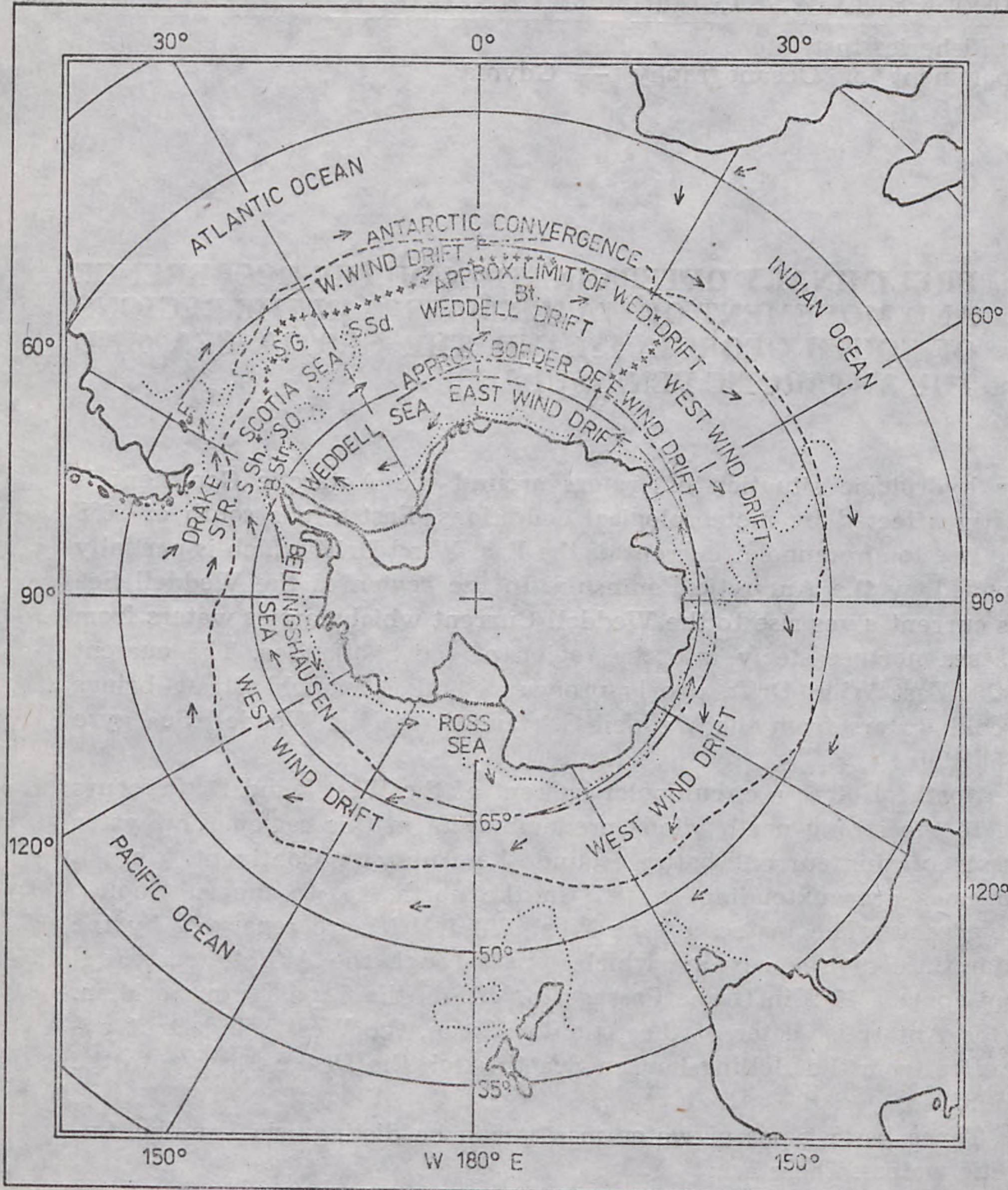

Fig. 1. Antarctic regions. Arrows indicate direction of surface currents, dotted line — the 2000-m contour. Abbr.: B. Str. — Bransfield Strait, Bt — Bouvet Island, F — Falkland Islands, K — Kerguelen Islands, S. G. — South Georgia Island, S. O. — South Orkney Island, S. Sd. — South Sandwich Island, S. Sh. — South Shetland Island [4].

Rys. 1. Rejon Antarktyki. Strzałkami zaznaczono kierunki prądów powierzchniowych, linią kropkowaną — izobatę 2000 m. Skróty: B. Str. — Cieśnina Bransfielda, Bt — Wyspa Bouveta, F — Falklandy, K — Wyspy Kerguelena, S. G. — Georgia Południowa, S. O. — Orkady Południowe, S. Sd. — Sandwich Południowy, S. Sh. — Szetlandy Południowe [4].

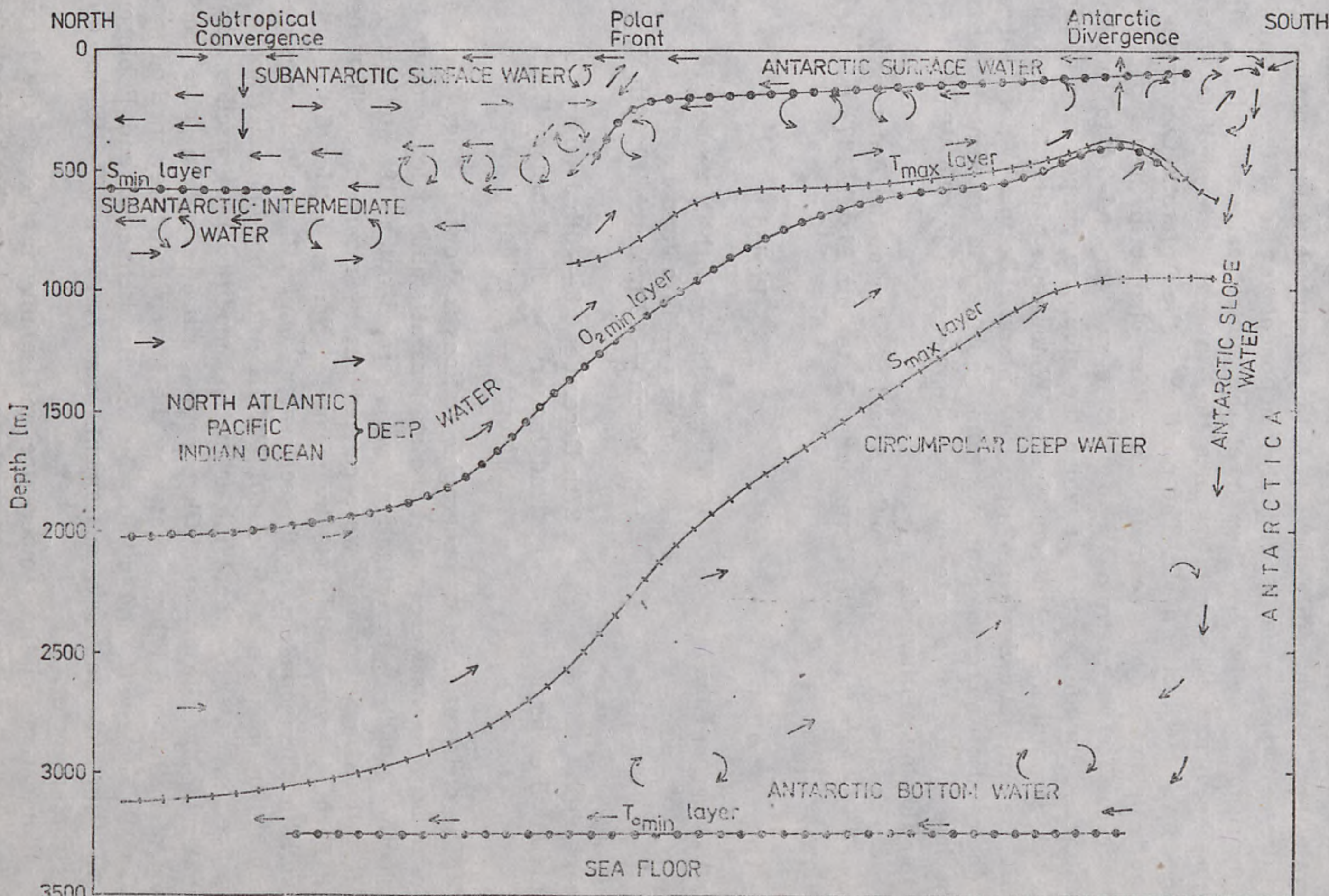

Fig 2. Schematic representation of water masses and cores of layers in the Southern Ocean (meridional cross-section).
Rys. 2. Schematyczne przedstawienie mas wodnych i rdzeni warstw w Oceanie Południowym (przekrój południkowy).

The distribution of these water masses and the currents which generate them is shown in Fig. 2 [7]. Antarctic surface waters, moving generally eastwards, have a northerly component and form the Antarctic Convergence zone where they meet the subtropical waters [2, 3, 4]. Being heavier, they sink to produce the Antarctic Intermediate Water moving further to the north. The position of the Antarctic Convergence zone is determined on the basis of a sudden change in the temperature of the surface water from 5.5 to 3.0°C in summer and 3.5 to 1.0°C in winter and by the position at which the minimum temperature within the cold stratum of the Antarctic Surface Water sinks below 200 m. Apart from the Antarctic Surface Water, the Antarctic Bottom Water formed on the coast of the continent moves from the Antarctic region northwards. The loss of these two water masses is compensated by the Warm Deep Water flowing southwards.

Oceanographic research in the Atlantic sector of the Antarctic zone was carried out from 13th December 1978 to 30th March 1979 over the following areas:

Area	Period
South Georgia Island	13th December — 26th December '78
	7th January — 14th January '79
	14th March — 19th March '79; 30th March '79
Scotia Sea	27th December '78 — 6th January '79
Antarctic Peninsula	22nd January — 25th February '79
	24th March — 26th March '79

The distribution of oceanographic stations is shown in Figs. 3 and 4. The measurements were run at the stations at standard levels down to a depth of 2000 m. Investigations were carried out at 196 stations. At 147 stations measurements were carried out by means of a STD Bissett-Berman probe and at 49 by means of Nansen bottles fitted with reversible thermometers. In the sea water samples the salinity was determined by means of a Model 601 MK III Autolab salinometer, oxygen dissolved in water by the Winkler method modified by Fonselius, phosphates by the Murphy and Riley method, silicates by the „blue" method of Mullin and Riley, nitrates by the Morris and Riley method modified by Grasshoff, and nitrites by the Bendschneider and Robinson method [6]. Colorimetric measurements were run on a UV-VIS Specord spectrophotometer.

Fluctuations in the temperature and salinity in the surface layer of the surface water in summer were estimated on the basis of the

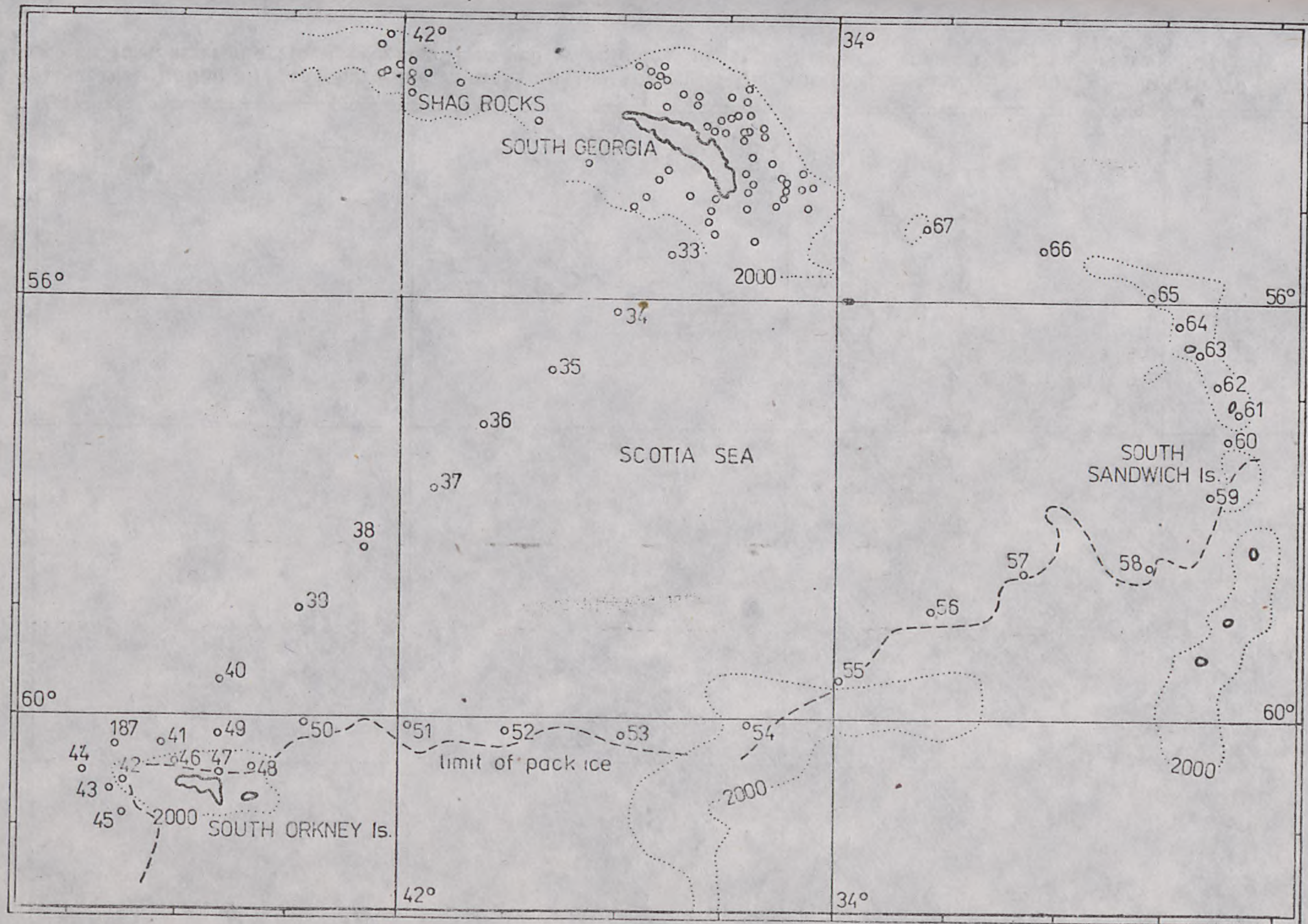

Fig. 3. Distribution of oceanographic stations in the vicinity of South Georgia Island and in the region of the Scotia Sea. December '78 — March '79.

Rys. 3. Rozmieszczenie stacji oceanograficznych w pobliżu Georgii Południowej i w rejonie Morza Scotia. Grudzień 1978 — marzec 1979.

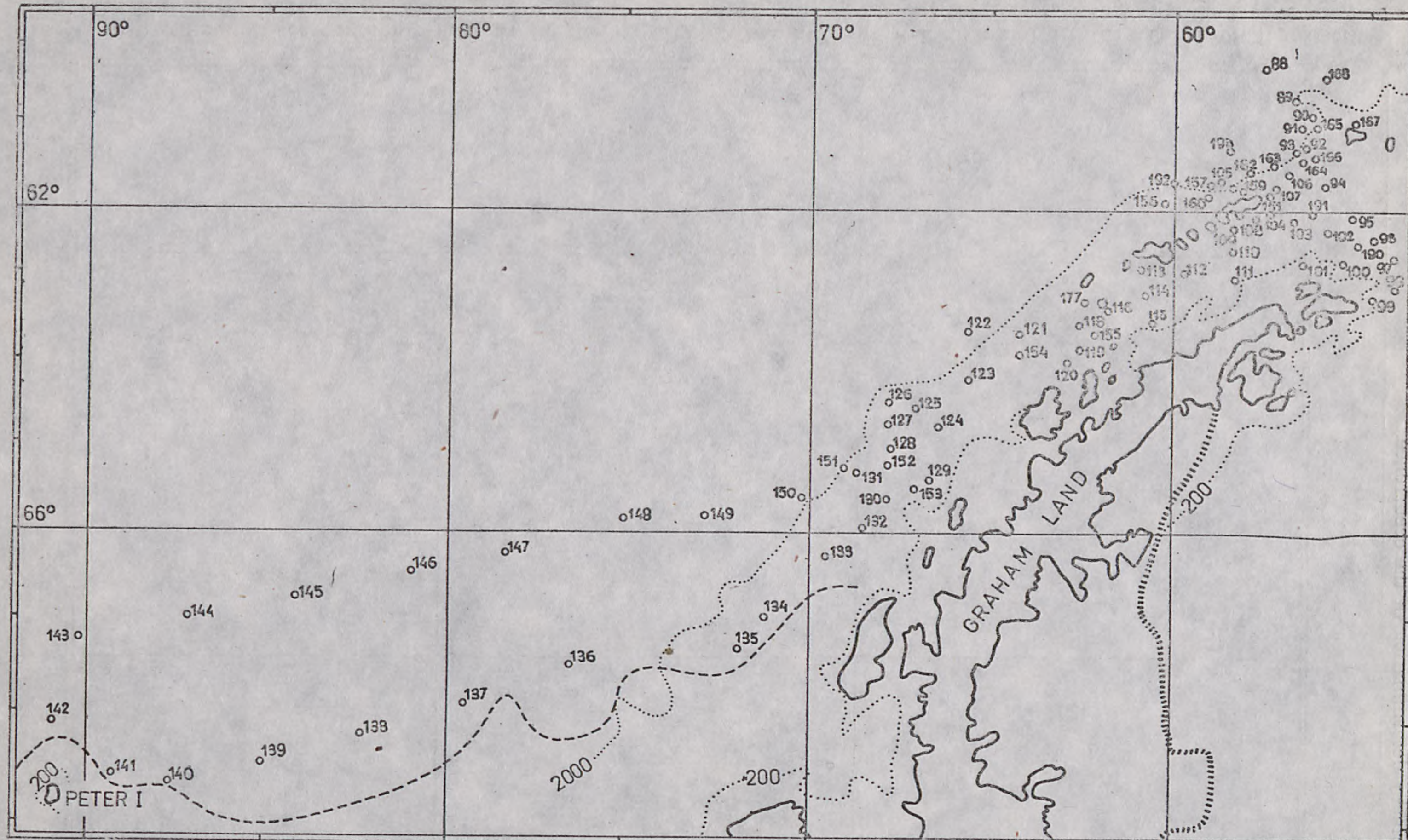

Fig. 4. Distribution of oceanographic stations in the region of the Antarctic Peninsula. January — March '79.
Rys. 4. Rozmieszczenie stacji oceanograficznych w rejonie Półwyspu Antarktycznego. Styczeń — marzec 1979.

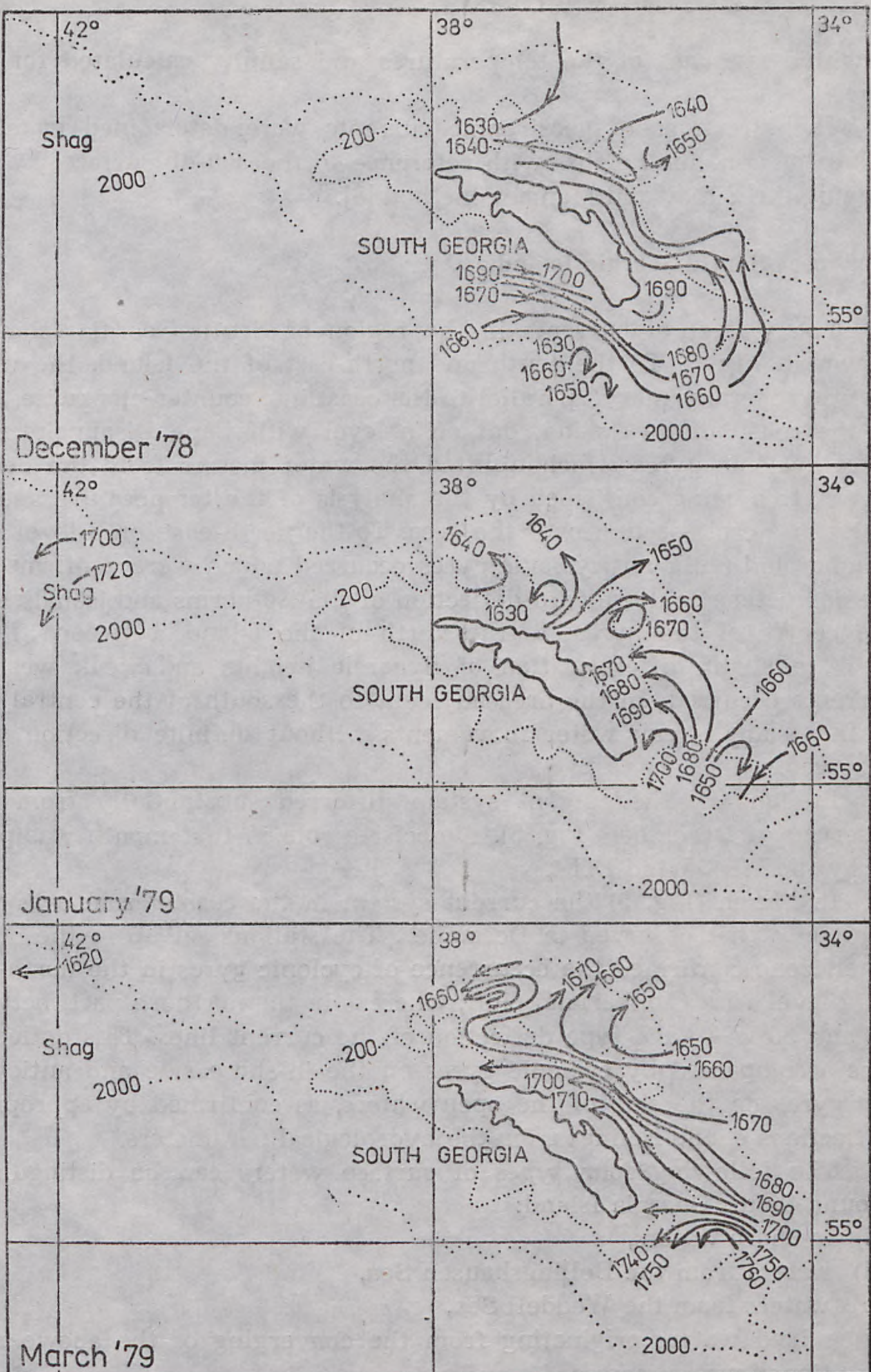

Fig. 5. Geopotential topography in the region of South Georgia Island at sea level in dynamic mm with reference to 500 db surface. December '78 — March '79.

Rys. 5. Topografia geopotencjalna w rejonie Georgii Południowej na powierzchni morza w mm dynamicznych w odniesieniu od powierzchni 500 db. Grudzień 1978 — marzec 1979.

weighted averages of the temperatures and salinity calculated for this layer.

The directions of geostrophic currents were determined from the values of dynamic heights with reference to the 500-db surface, by employing the Zubov and Mamaev method [8].

Region of South Georgia Island

The system of currents in the region of South Georgia Island is shown in Fig. 5. To the south and north-east of the Island, the water masses generally moved parallel to the coastline, counter-clockwise. Also to the south of the Island, but on a level with Cape Disappointment, were cyclonic gyres which uplifted the water masses from the deeper layers, this being confirmed by the analysis of the temperature and salinity in a cross-section over the area. To the north-east, on a level with Camberland Gulf, anticyclonic gyres occurred which were confirmed by the characteristic downward deflection of the isotherms and isohalines in the centre of the gyres; to the north of the Island, between 37 and 38°W, a slight differentiation of dynamic heights and weak westerly currents occurred. In the area adjacent to the south of the central part of the Island, weak water movements without definite direction were observed.

In January the current system differred substantially from that observed in December (Fig. 5). A decisive role in that month was played by the West Wind Drift.

In March (Fig. 5) the current system in the coastal zone was very similar to that observed in December. The stations set up in the outer-shelf zone confirmed the occurrence of cyclonic gyres in the north-east on a level with Camberland Gulf, whereas in the northern part, between 37 and 38°W — a Z-type deflection of the current lines. This deflection was accompanied by cyclonic gyres on the in-shore side and anticyclonic gyres on the side of the open waters, as confirmed by appropriate deflections of the isolines from the hydrological parameters.

The following four types of surface waters can be distinguished around South Georgia Island:

(i) in-shore waters,
(ii) waters from the Bellingshausen Sea,
(iii) waters from the Weddell Sea,
(iv) mixed waters originating from the converging of the abowe mentioned water masses.

The in-shore waters have a relatively high temperature and the lowest salinity and cover a narrow strip around the island. Waters dri-

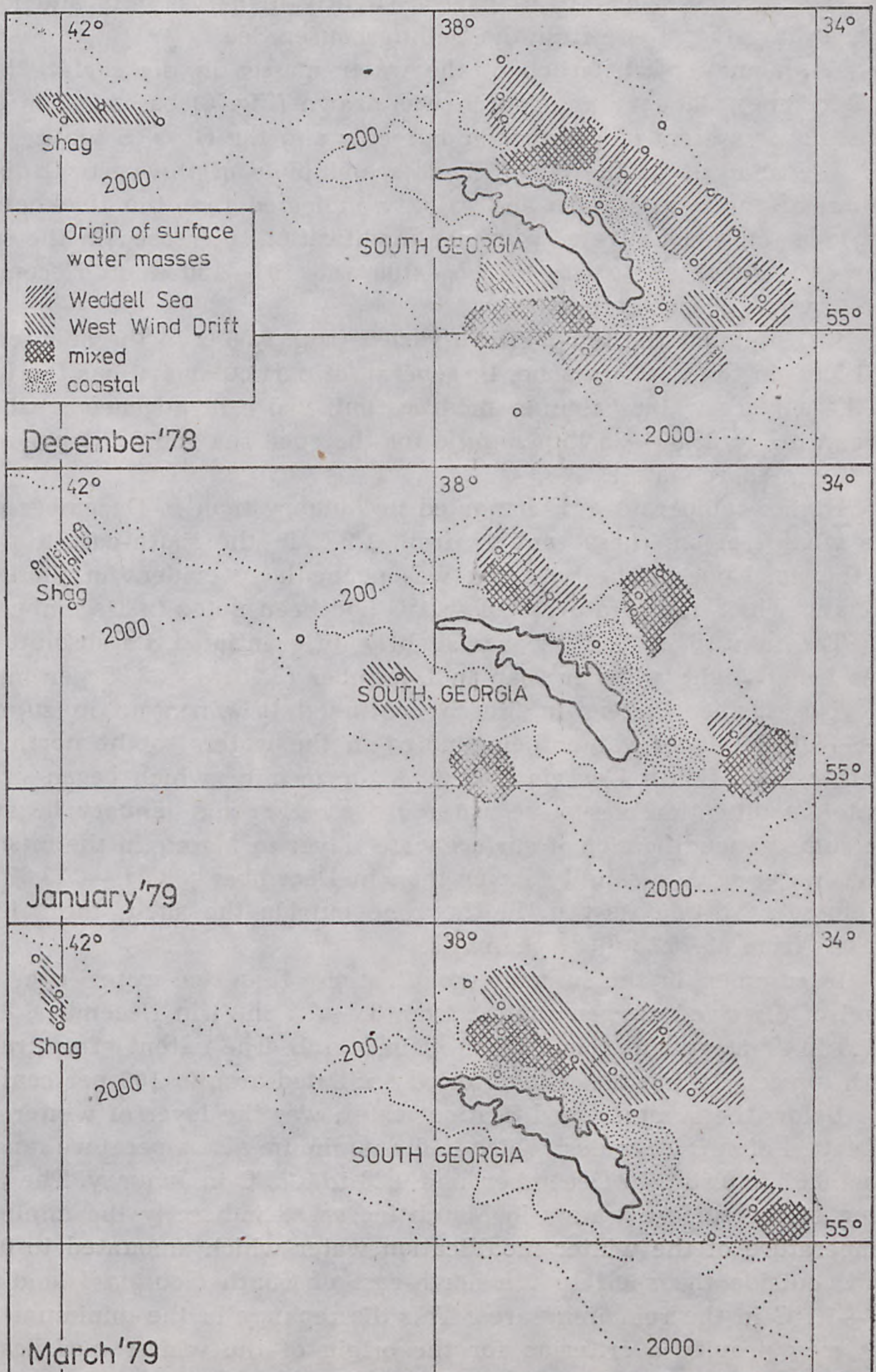

Fig. 6. Distribution of surface water masses in the region of South Georgia Island in December '78 and in January and March '79.
Rys. 6. Rozmieszczenie powierzchniowych mas wodnych w rejonie Georgii Południowej w grudniu 1978 oraz styczniu i marcu 1979.

ven in from the Weddell Sea have a slightly higher salinity and lower temperature than those from the Bellingshausen Sea.

A schematic distribution of the water masses in the surface layer in December, January and March was drawn (Fig. 6) based on an analysis of the system of geostrophic currents and the Θ vs. S plots.

The analysis of the Θ vs. S plots and plots of the vertical distribution of the temperature and salinity indicated that the thickness of the layer of surface water (summer modification) increased in the summer and amounted to 50—100, 70—100 and 100—150 m in December, January and March respectively.

In December the temperature varied from 0.56°C in the open ocean to 1.53°C in the in-shore zone. In general, at particular stations the layer of the surface water (summer modification) had a homogeneous salinity amounting to 33.80—33.95 per mille for the open sea and 33.75 per mille for the in-shore waters.

Higher temperatures were noted in January than in December over the whole region, these ranging from 1.2°C in the south-east to 2.2°C in the north-west. The warming was particularly evident in those regions in which temperatures below 1°C had been noted in December.

The salinity in January was slightly differentiated, its absolute values being slightly higher than in December (33.81 — 33.89 per mille).

The surface waters in March continued to warm up in summer (2.4—3.0°C), higher values being noted in the waters to the north and south-east of South Georgia Island. A thermocline which began in the winter modification of surface water in December and January, began in the summer modification of surface water layer in March. In the in-shore zone, water with a salinity lower than in December (33.54 — 33.67 per mille) was again observed. In the zone outside the shelf, the salinity ranged from 33.76 to 33.81 per mille.

In summer, in the summer modification of surface water layer, the level of dissolved oxygen ranged from 8.5—7.7 ml/l in December, 8.3——7.3 in January and about 7.5 ml/l in March. The extent of saturation with oxygen during the whole period oscillated around 100 per cent.

Below the summer modification water, was the layer of winter modification of surface water, which had a minimum of temperature ranging from 0.01 to 0.55°C in December, and 0.28 to 0.75°C in January. The warming of the surface waters in March increased indirectly the minimum temperature of the winter modification water which amounted to 0.3—0.5°C outside the shelf to the north-east of South Georgia Island and 0.7—1.1°C in the remaining area. This discrepancy in the minimum values may provide a criterion for the origin of the winter modification of surface water, lower values of the minima indicating its origin as the

Woddell Sea. The thickness of the winter modification of surface water decreased gradually during the summer season, amounting to 75—100 m in December and 50 m in March.

A halocline with a difference in salinity of from 34.0 to 34.4 per mille in a layer about 200 m thick appeared at the interface of the winter modification of surface water and the Warm Deep Water in December and January. The halocline was distinct at all outside the shelf stations whereas at the shelf stations no significat differences in the salinity were observed vertically. In March the halocline also occurred beyond the shelf, its beginning being at the interface of the summer and winter modification water layers, the salinity continued to increase with depth, attaining a maximum of 34.72 per mille at a depth of 1000—1600 m. An analysis of the vertical distribution of individual nutrient elements showed that the process of photosynthesis and the abundant development of phytoplankton in summer depleted mainly silicon in the photic zone. The calculated Si:P ratios for this zone were very low, ranging on average from 9 to 10. According to the literature data [1] this ratio is 32 for phytoplankton, being much higher than in our studies. Sufficient contents of phosphorus and nitrogen (N:P equal to 13—14 on average) in the whole photic zone together with the depletion of silicon suggest that during the summer of 78/79 silicon could have been the growth limiting factor for phytoplankton. This is supported by an analysis of the horizontal distribution of phytoplankton occurring around South Georgia Island. The phytoplankton was most abundant in December, and in the regions to the south-east of South Georgia Island, the Si:P ratio decreased still further and amounted to 4—6.

In the winter modification surface water, on a level with a clearly pronounced thermal minimum, the contents of nutrients did not vary during particular periods and amounted to 1.66—2.27, 18—29 and 33—53 μmol/l respectively. It might be assumed that these levels occurred in the early spring within the whole layer of the surface water after convectional mixing in winter. If this really was the case, it is evident that silicon was depleted most by the phytoplankton, while nitrogen and phosphorus only slightly. The level of nitrites in the layer down to 100 m from the surface ranged from 0.10 to 0.50 μmol/l. Below 100 m nitrites disappeared gradually, occurring occasionally in trace quantities at a level of 200 m.

In the body of the Warm Deep Water a temperature maximum (2.0± ±0.1°C) occurred in the 400—600-m layer. Below the warmest wedge of the water the temperature dropped steadily down to the bottom attaining values of 1.7—1.8°C at a depth of 1000 m and about 1°C at 2000 m.

In the layer of the Warm Deep Water an oxygen minimum (4.16—4.23 ml/l) occurred at the level of the maximum temperature. After passing this minimum the oxygen level increased downward. In the regions beyond the shelf in the Warm Deep Water, maximum levels of phosphates (2.24—2.43 μmol/l) and nitrates (approx. 35 μmol/l) occurred at the oxygen minimum level (approx. 300—500 m). The level of silicon increased downward, amounting to 103—110 μmol/l at a depth of 2000 m.

This hydrological characteristic of the Warm Deep Water did not vary during particular periods.

The Scotia Sea Region

Hydrological conditions in the eastern part of the Scotia Sea were discussed on the basis of cross-sections encircling this region (Fig. 3).

Cross-section South Georgia Island — South Orkney Island

During the survey, the temperature of the summer modification of surface water 50 nM to the south of South Georgia Island oscillated around 1°C. On going along the cross-section (Fig. 7) towards South Orkney Island out to a latitude of 59°50' S, the temperature of the surface water ranged from 0.3 to 0.6°C. Around the position 59°54' S and 45°10' W the temperature fell to 0.6—(—0.5)°C over an area of 20—30 nM, thus indicating the encountering of the Secondary Frontal Zone. This was confirmed by a substantial surface gradient of silicon level.

The salinity of the summer modification of surface water in the Scotia Sea between South Georgia and South Orkney Islands varied from 33.85 per mille in the north of the cross-section to 34.20 per mille in the waters flowing in from the Weddell Sea. The analysis of the isotherms and isohalines shows that in the layer down to 200 m, their concerted course on the cross-section may indicate the occurrence of a series of cyclonic and anticyclonic gyres between South Georgia and South Orkney Islands, causing a variability in the thickness of the summer modification water layer from 60 m at station No. 38 to 125 m at stations Nos. 35 and 40. The analysis of the flow of water, caused by geostrophic currents in this region would seem to confirm the existence of the gyres.

The winter modification of surface water layer had various minimum temperatures, depending on the latitude. The highest temperature (0.4°C) was noted in the neighbourhood of South Georgia Island, whereas the lowest one (—1.1 to — 1.3°C) near South Orkney Island. The minimum temperature between the two islands was about —0.2±0.05°C, which occurred 25—50 m below the lower boundary of the summer modification of surface water. In waters carried in by the West Wind Drift (stations Nos. 33 through 40), the lower boundary of the winter modification of surface water can be assumed to be the isotherm of 0.5°C, where the waters of the West Wind Drift meet those inflowing from the Weddell Sea (between stations Nos. 40 and 41), there is a revaluation of the occurrence of the lower boundary of the winter modification of surface

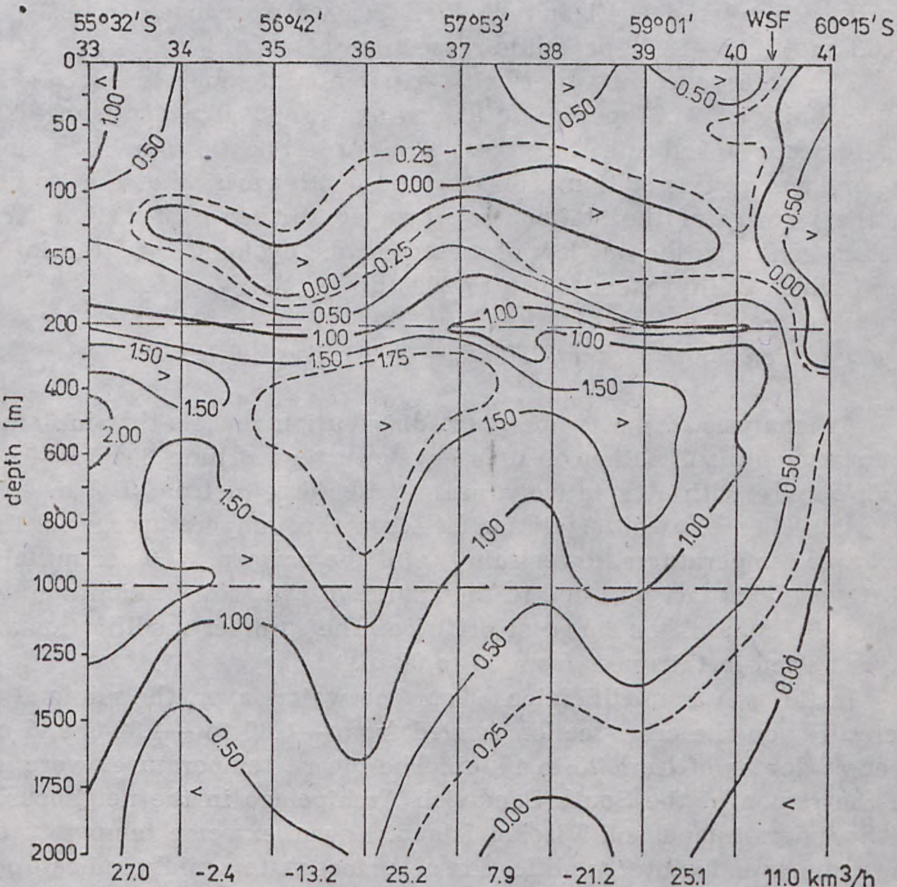

Fig. 7. Vertical temperature distribution on a profile extending from South Georgia Island to South Orkney Island. December '78 (the output of flow in km³ h⁻¹ is given at the bottom).

Rys. 7. Pionowy rozkład temperatury na profilu od Georgii Południowej do Orkadów Południowych. Grudzień 1978 (u dołu rysunku podana jest wydajność przepływów w km³ h⁻¹).

water and to the south of the frontal zone in the water from the Weddell Sea the boundary is determined by the isotherm of 0°C.

The highest temperature in the Warm Deep Water layer varied between 2.03 and 1.91°C in the region of the South Georgia Island and in central area of the cross-section between 57 and 58° S. Warm Deep Waters driven by the West Wind Drift reached the secondary frontal zone to produce equally as sharp boundary between these waters and those from the Weddell Sea as in surface waters. The maximum temperature in the Warm Deep Waters from the Weddell Sea, which did not undergo transformation, ranged between 0.3 and 0.4°C. The maximum salinity for the West Wind Drift and Weddell Sea waters ranged from 34.71 — 34.73 and 34.66—34.68 per mille respectively.

The occurrence of water with a potential temperature of —0.11°C and salinity of 34.67 per mille at station No. 38 at a depth of 2000 m would seem to indicate the presence of Antarctic Bottom Water in the upper layer at this station. This, together with uprising of the isotherms in the vicinity of the station may provide further confimation for the assumption as to the outflow of waters in the cyclonic gyre, the influence of which could extend down to 2000 m.

Cross-section South Orkney Island — South Sandwich Island

An analysis of the temperature distribution reveals that in January, the summer modification of surface water layer (latitude, 60°S) had a low temperature with a tentatively substantial range of from 0.08 to —1.0°C (Fig. 8). There was a correlation between the temperature and salinity; at lower temperatures, lower salinity (of the order of 33.0 per mille) was observed. This fact was due to the course of the cross-section mentioned along the edge of the range of drift ice. The summer modification water layer varied in thickness from 30 to 80 m.

In the winter modification of surface water layer, the minimal temperatures on the cross-section ranged from —0.60 to —1.62°C and occurred at depths of from 75 to 100 m. The lowest temperatures were noted in the region of the South Sandwich Archipelago in the neighbourhood of Saunders Island and Visokoi Island. Lower extreme temperatures of the summer and winter modification of surface waters might indicate a predomination of water from the Weddell Sea. The depth of occurrence of the lower boundary of the winter modification of surface water is best illustrated by the 0°C isotherm which occurred at depths of from 150 to 350 m. A halocline was found only where less saline surface waters occurred.

The Warm Deep Water layer, the limit of occurrence of water from

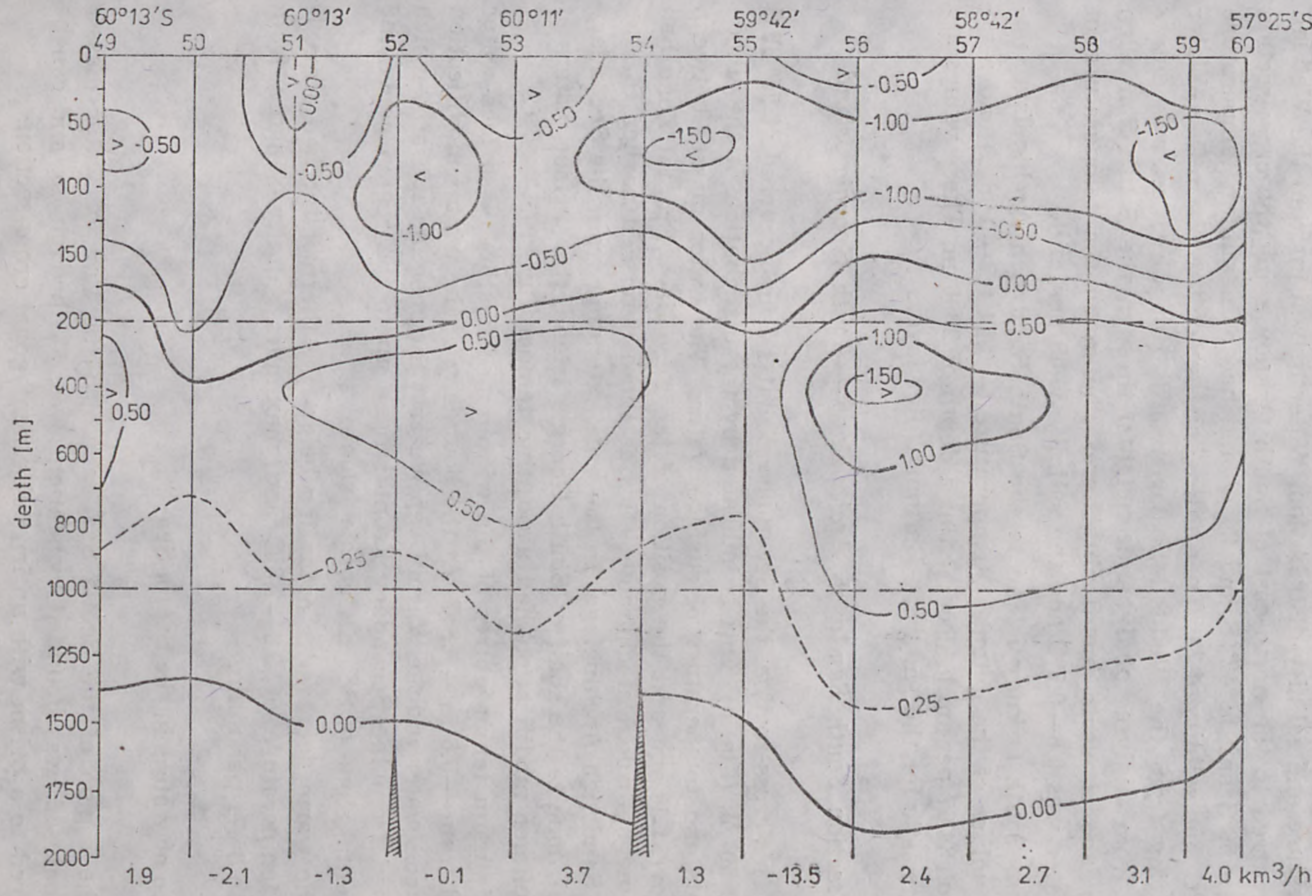

Fig. 8. Vertical temperature distribution on a profile extending from South Orkney Island to South Sandwich Island. January '79 (the output of flow in km^3 h^{-1} is given at the bottom).
Rys. 8. Pionowy rozkład temperatury na profilu od Orkadów Południowych do Sandwichu Południowego. Styczeń 1979 (u dołu rysunku podana jest wydajność przepływów w $km^3 h^{-1}$).

the Weddell Sea, that carried by the West Wind Drift and may be the degree of their mutual transformation can be followed on the basis of temperature and salinity distribution. Water driven in from the Weddell Sea occurred to the north-east of South Orkney along the cross-section between 60°S and 59°42' S and 34°W and had a maximum temperature of 1.6°C and salinity of 34.70 per mille. The flow of the Warm Deep Water originating from the Weddell Sea eastwards (the direction was determined from analyses of dynamic heights) through the South Sandwich Archipelago is worth mentioning here. The maximum temperature of this water was 0.6—0.7°C and the salinity 34.69 per mille.

From South Orkney Island to the South Sandwich Archipelago, negative values of the potential temperature (—0.24 to —0.06°C) and a salinity of 34.67 per mille occurred at a depth of 2000 m. These values are characteristic for the Antarctic Bottom Water layer.

Cross-section South Sandwich Archipelago — South Georgia Island

On this cross-section, the Secondary Frontal Zone occurred at 55°40' S and 29°50' W (Fig. 9). This is indicated by the distribution of the silicon contents and temperature of surface waters. The water masses between Zavodovski Island and the position of the Secondary Frontal Zone had the same hydrological characteristics as those described earlier for the South Sandwich Archipelago. In the area extending from the Secondary Frontal Zone to the shelf of South Georgia Island, the surface waters of the summer modification had a positive temperature (0.5—0.7°C.

Minimum temperatures of the winter modification of surface water ranged from —0.6 to —0.8°C. At the boundary of the winter modification of surface water and the Warm Deep Water, a thermocline appeared which extended from the Secondary Frontal Zone up to the region above the continental slope of South Georgia Island.

The warm deep water occurring below the thermocline had a maximum temperature of 0.9—1.3°C and maximum salinity ranging from 34.70 to 34.71 per mille.

Balance of waters in the Scotia Sea

The region of the Scotia Sea, in which the flow of water masses was analysed, was bounded by stations Nos. 33 through 65, and can be compared to a prism with an irregular pentagonal cross-section.

The balance of flow of water masses in the eastern region of the Scotia Sea is shown in table. The balance was determined on the basis

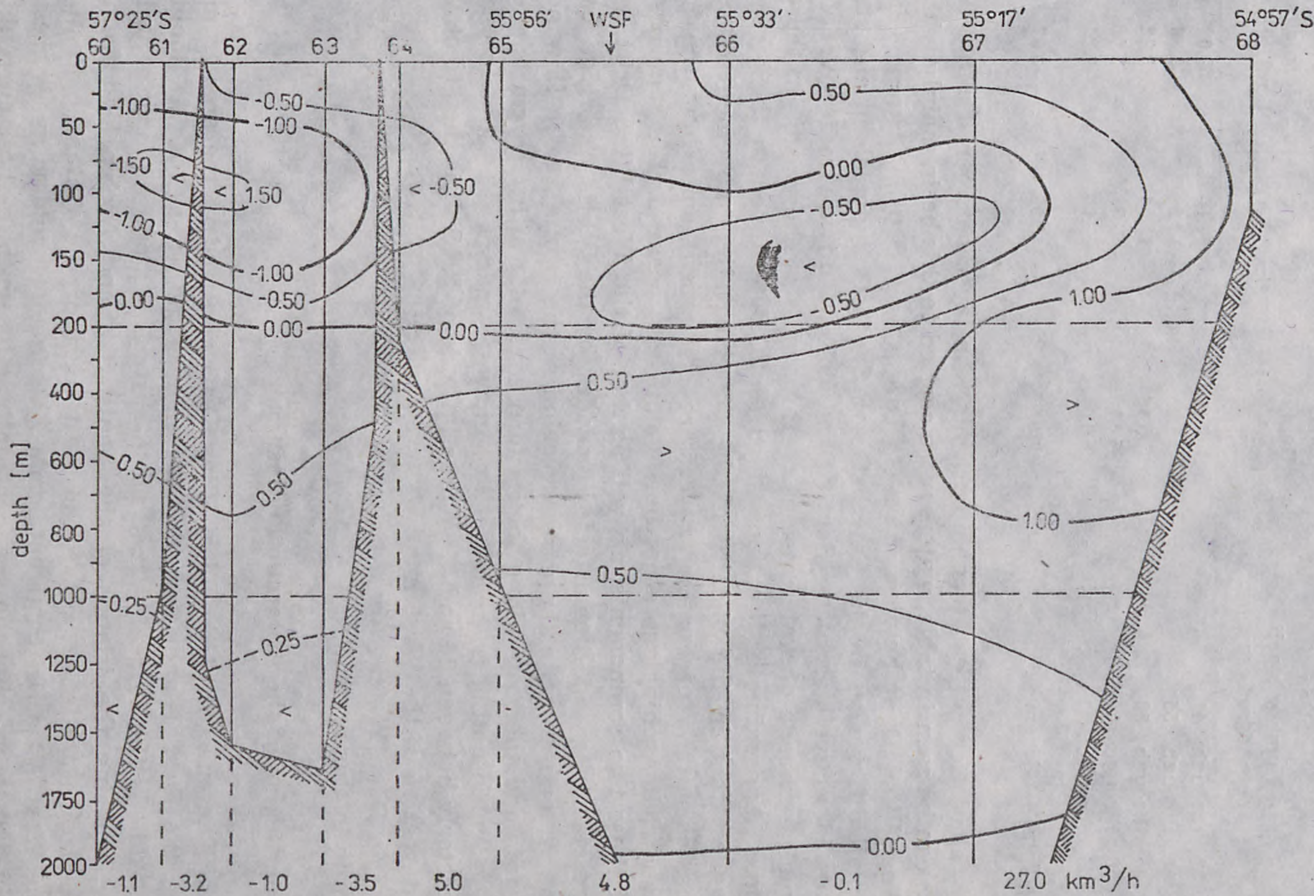

Fig. 9. Vertical distribution of temperature on a profile extending from South Sandwich Island to South Georgia Island. January '79 (the output of flow in km³ h⁻¹ is given at the bottom).

Rys. 9. Pionowy rozkład termperatury na profilu od Sand wichu Południowego do Georgii Południowej. Styczeń 1979 (u dołu rysunku podano wydajność przepływów w km³ h⁻¹).

Nos. of oceanographic stations Numery stacji oceanograficznych	Inflow Dopływ [km^3 h^{-1}]	Outflow Odpływ [km^3 h^{-1}]	Difference Różnica [km^3 h^{-1}]
33 through 41	96.18	— 37.16	59.02
41 through 55	7.26	— 11.23	— 8.38
55 through 58	5.16	— 13.54	3.23
58 through 65	12.15	— 8.92	— 47.66
65 through 33	0.0	— 47.66	2.24
Total — Razem	120.75	— 118.58	— 3.97

of calculations of geostrophic currents in a layer between 0 and 2000 m. As can be seen in table, waters were carried to this basin mainly with the West Wind Drift between South Georgia and South Orkney Islands. Small differences in the flow between South Orkney Island and station No. 55 as well as along South Sandwich Island are indicative of the small exchange of water masses on the „walls of the prism" in these regions. Approximate directions of currents, determined in these regions, suggest that in the vicinity of the 60° S parallel, movement of water masses with a predominantly eastern component and along the South Sandwich Archipelago a northern component occured. The superposition of these two components, as well as that of the West Wind Drift, in the presence of an additional factor provided by the Scotia Arc ridge, causes the water masses in the eastern region of the Scotia Sea to flow northwards and then run along the eastern coast of South Georgia Island.

Worth noting is the large flow of water masses (13.5 km^3 h^{-1}) south--easterly between 34 and 32° W at a latitude of 59° S. It is the effect of the interaction of the West Wind Drift, as indicated by the occurrence of the Warm Deep Water with a temperature of 1.6°C and salinity of 34.70 per mille in this region.

The Region of the Antarctic Peninsula

The current of the West Wind Drift occurred in the area from Peter the First Island towards Adelaide Island (Fig. 10). At longitude 78—79° W the current turned north-eastwards along the continental slope, washing the islands of the South Shetland Archipelago from the north. On the shelf, along the west coast of the Antarctic Peninsula, the West Wind Drift current formed a series of cyclonic gyres presumably due to entering the shelf and interaction with in-shore currents.

Water from the Weddell Sea flowed mostly eastwards in the vicinity of Joinville Island and partially to the Bransfield Strait along the

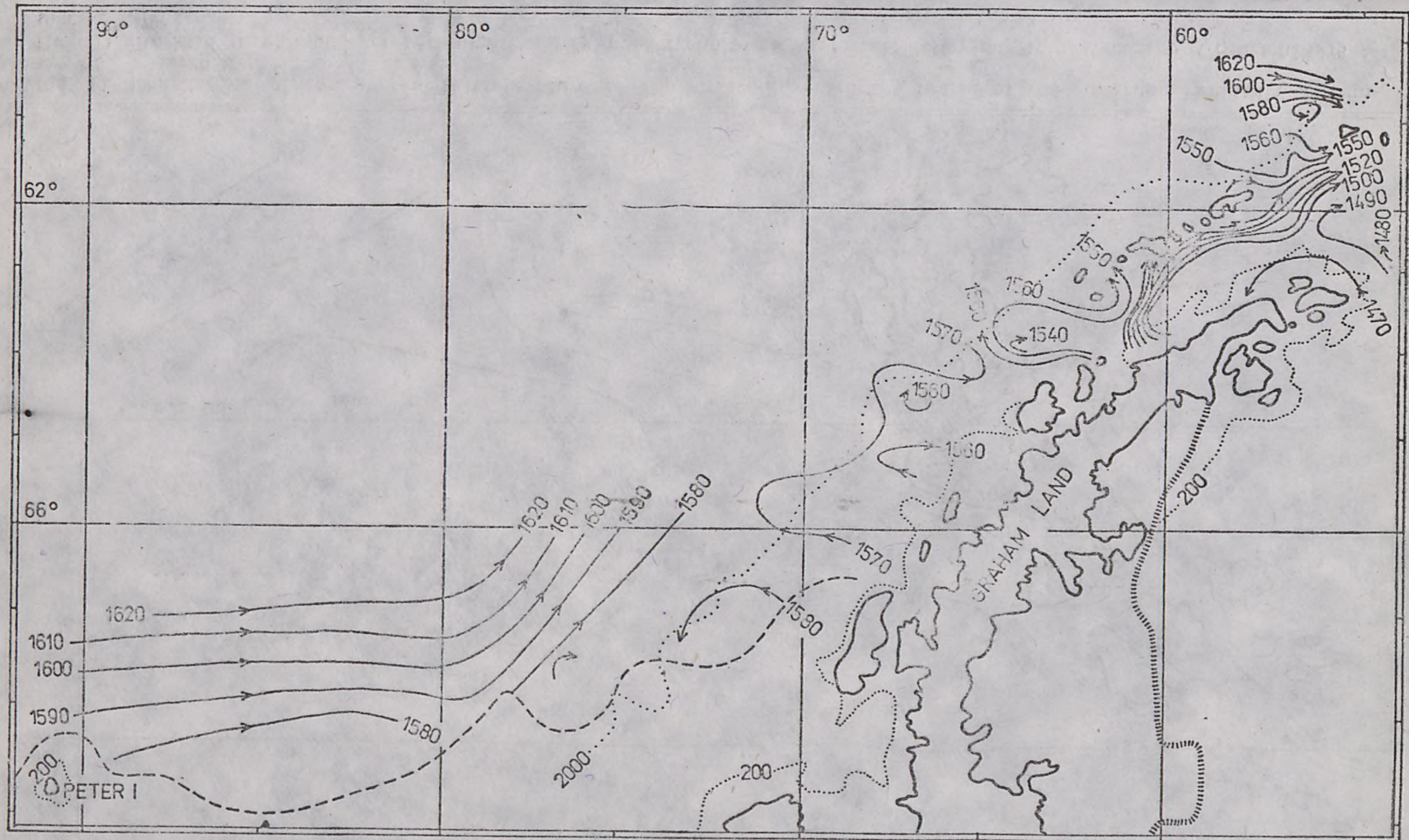

Fig. 10. Geopotential topography of surface currents in dynamic mm with reference to the 500 db surface, in the region of the Antarctic Peninsula. December '78 — March '79.
Rys. 10. Topografia geopotencjalna prądów powierzchniowych w mm dynamicznych w odniesieniu do powierzchni 500 db w rejonie Półwyspu Antarktycznego. Grudzień 1978 — marzec 1979.

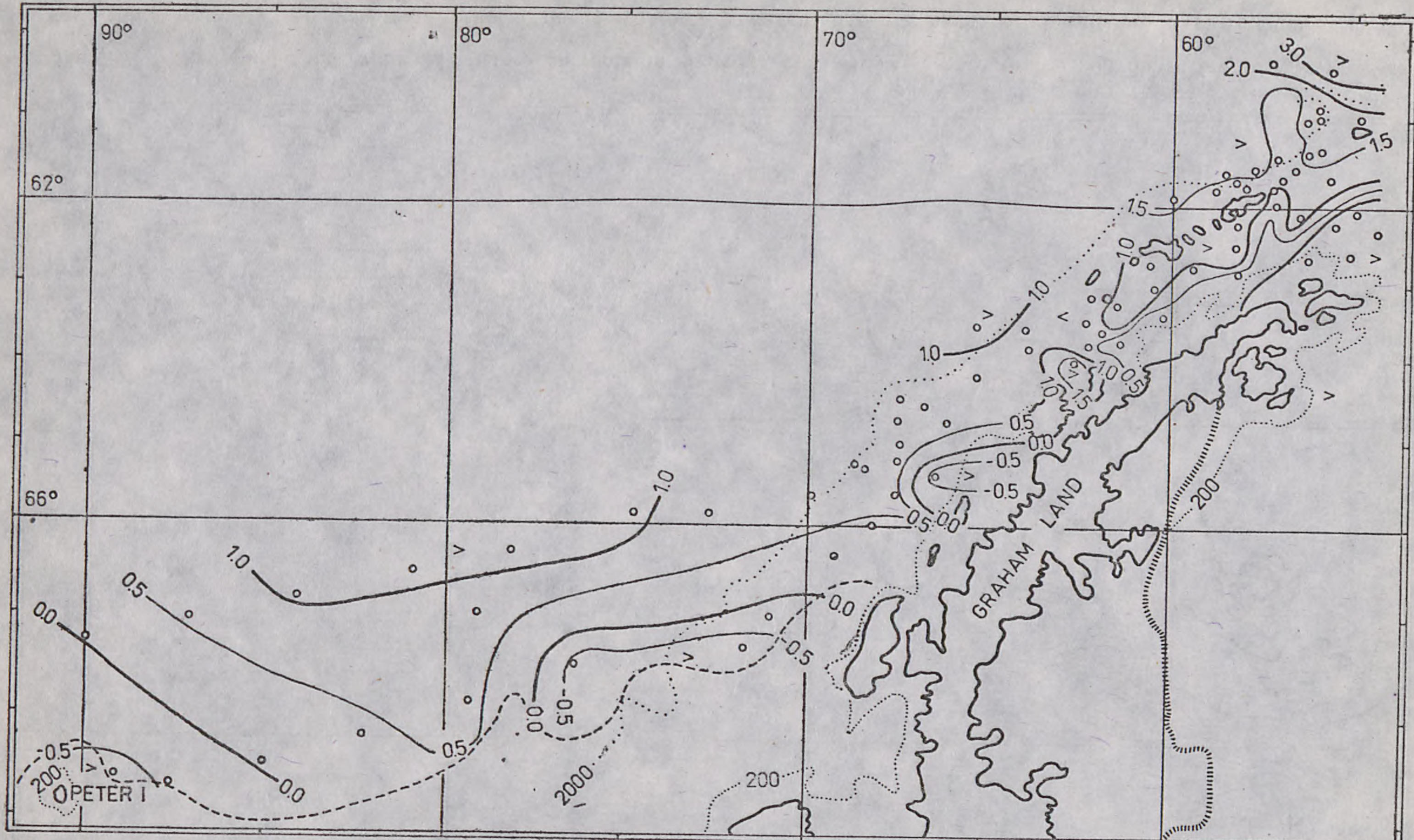

Fig. 11. Distribution of the averaged temperature of the surface layer in the region of the Antarctic Peninsula. December '78 — March '79.

Rys. 11. Rozkład uśrednionej temperatury warstwy powierzchniowej w rejonie Półwyspu Antarktycznego. Grudzień 1978 — marzec 1979.

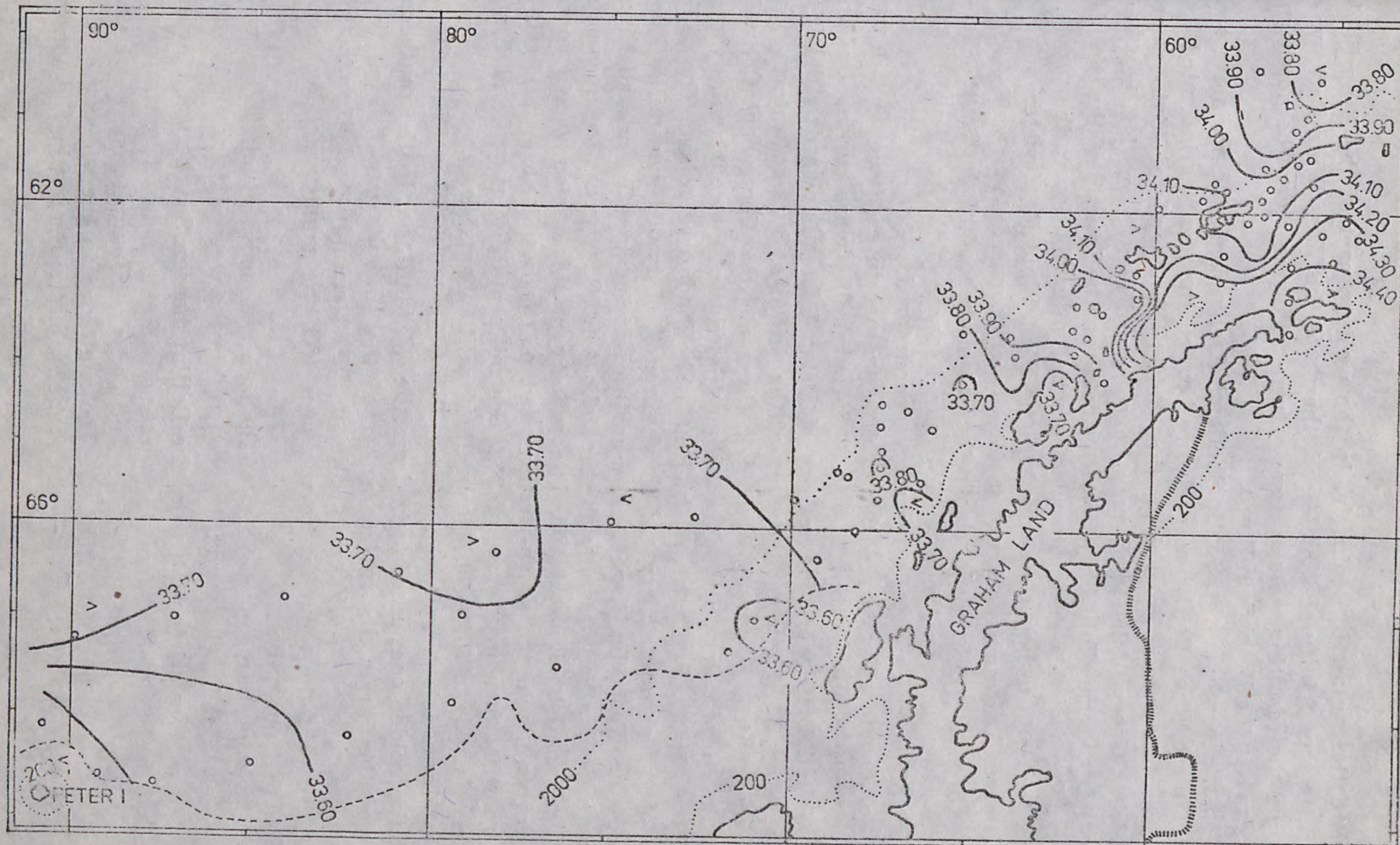

Fig. 12. Distribution of averaged salinity of the surface layer in the region of the Antarctic Peninsula. December '78 — March '79.
Rys. 12. Rozkład uśrednionego zasolenia warstwy powierzchniowej w rejonie Półwyspu Antarktycznego. Grudzień 1978 — marzec 1979.

coast of the Antarctic Peninsula. In the western part of the Bransfield Strait, in the vicinity of Low Island, they met the West Wind Drift waters and the resulting water masses returned flowing along the northern boundary of the Bransfield Strait.

To the north of the South Shetland Archipelago, the main stream of the West Wind Drift was probably beyond the shelf as indicated by comparable dynamic heights on the shelf to the north of Livingstone and King George Islands. It may have been driven from the shelf by waters from Bransfield Strait passing between the islands of the Archipelago. Proof of this assumption is the salinity distribution in the surface layer, the salinity being enhanced in the West Wind Drift waters.

The summer modification of surface water occurred down to 30—50 m around the Antarctic Peninsula. In the neighbourhood of the South Shetland Archipelago, on the side of Drake Passage, a thicker layer (75—100 m) of the same water masses was encountered.

Cold surface waters, with negative temperatures down to —0.7°C and salinity ranging from 33.5 to 33.65 per mille, were carried by the West Wind Drift from the regions of Peter I Island towards Adelaide Island (Figs. 11, 12) along the edge of the drift ice. Surface waters with a temperature of about 1°C flowed in the same direction (about 120 nM to the north of Peter I Island) and along the edge of the continental slope of the Antarctic Peninsula to the South Shetland Archipelago. The salinity of these waters increased slowly from 33.7 to 33.9 per mille. Waters of the West Wind Drift to the north of Livingstone Island and King George Islands had a temperature of about 1.5°C, whereas to the north of Elephant Island about 3°C. The salinity in this region varied from 33.9 per mille in the south-western part of the South Shetland Archipelago through a maximum of 34.1 per mille at Livingstone and King George Islands to 33.8—33.7 per mille near Elephant Island.

In Bransfield Strait, the warmer waters of the West Wind Drift met the colder ones flowing in from the Weddell Sea. In the southern part of the Strait the surface water of the summer modification had a temperature of 0—0.5°C at a salinity of 34.3 per mille, whereas in the northern part the temperature was over 1°C, the salinity ranging from 34.3 to 34.1 per mille.

The coldest and most saline of the summer modification surface waters (about —1°C; 34.4 per mille) occurred to the west of Joinville Island.

The waters originating from the Bellingshausen Sea, between Peter I Island and Adelaide Island, the winter modification of surface water was observed to a depth of 159—175 m and had a minimum temperature varying from —1.02 to —1.75°C. On the shelf and in the vicinity of the continental slope of the west coast of the Antarctic Peninsula, the winter modification of surface water went down to a depth of 200—250 m. The minimum temperature in this layer varied from —1.84°C at Adelaide Island to —0.27°C in the region of the Palmer Archipelago. In the winter modification water layer over the whole region considered, in waters of the West Wind Drift, a halocline originated at the minimum temperature, which reached down to a depth of about 300 m. The salinity in the halocline varied from 33.9—34 to 34.6 per mille.

To the east of Joinville Island, in waters originating from the Weddell Sea, the minimum temperature in the winter modification layer ranged from —1.67 to —1.32°C. Below the minimum values, a slight increase in temperature was observed over the range of negative values. In regions shallower than 300 m, a small increase in temperature was noted below the minimum, followed by a drop to approx. —1.1°C at the bottom.

The waters flowing from the Weddell Sea to the southern region of the Bransfield Strait caused a poorly marked minimum temperature occurring either over the range of low negative values or not occurring at all, the temperature decreased with depth attaining —1.1 to —1.3°C at the bottom. The salinity ranged from 34.2 to 34.6 per mille.

The Warm Deep Water occurring between the Peter I Island and the continental slope in the region of Adelaide Island had a maximum temperature of 2.05—1.71°C and 1.87—1.63°C in the layer extending between 400 and 600 m at stations Nos. 143 through 150 and 136 through 141 respectively (the positions of the stations are shown in Fig. 4). The maximum salinity in the Warm Deep Waters of the Bellingshausen Sea ranged from 34.73 to 34.74 per mille and occurred at depths of 800—1600 m.

The Warm Deep Water originating from the Weddell Sea had a maximum temperature of the order of 0.3—0.4°C at a depth of 300—400 m and maximum salinity of 34.6—34.68 per mille.

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WSTĘPNE OKREŚLENIE WYSTĘPOWANIA I RUCHÓW MAS WODNYCH W REJONACH: WYSPY GEORGIA POŁUDNIOWA, MORZA SCOTIA I PÓŁWYSPU ANTARKTYCZNEGO

Streszczenie

Badania oceanograficzne na statku „Profesor Siedlecki" przeprowadzone były od 13 grudnia 1978 do 30 marca 1979 r. Przeprowadzono pomiary temperatury, zasolenia, zawartości tlenu rozpuszczonego, zawartości: fosforanów, krzemianów, azotanów. azotynów na standardowych poziomach do głębokości 2000 m.

Generalny układ prądów geostroficznych w grudniu 1978 i marcu 1979 r. w rejonie Georgii Południowej był zbliżony. Ruch powierzchniowych mas wodnych odbywał się równolegle do linii brzegowej, w kierunku przeciwnym do ruchu wskazówek zegara. W styczniu wystąpiły słabe prądy o zmiennych kierunkach (rys. 5). Miąższość warstwy powierzchniowej wody letniej modyfikacji wzrastała w okresie letnim i wynosiła 50—100 m w grudniu, 70—100 m w styczniu, 100—150 m w marcu. Pochodzenie warstwy powierzchniowej wody letniej modyfikacji na przebadanym obszarze wokół Georgii Południowej ilustruje rys. 6.

Dla rejonu Morza Scotia wyniki przeanalizowano na podstawie trzech przekrojów (rys. 3). Obliczono bilans przepływu mas wodnych na podstawie obliczeń prądów geostroficznych.w warstwie od 0 do 2000 m (tabl.). Wyznaczone w przybliżeniu kierunki prądów pozwalają przypuszczać, że w pobliżu równoleżnika 60° S wystąpił ruch mas wodnych o przeważającej składowej wschodniej oraz wzdłuż archipelagu Sandwich Południowy — o składowej północnej. Nakładanie się na siebie tych dwóch składowych i składowej ruchu Dryftu Wiatrów Zachodnich, przy czynniku dodatkowym, jakim jest istnienie grzbietu Scotia Arc, powoduje we wschodnim rejonie Morza Scotia ukierunkowanie mas wodnych na północ i odprowadzenie ich po wschodniej stronie Georgii Południowej.

W rejonie Półwyspu Antarktycznego od Wyspy Piotra I w kierunku Wyspy Adelajdy wystąpił Prąd Dryftu Wiatrów Zachodnich (rys. 10). Na długości geograficznej 78—79° W prąd ten skręcał w kierunku północno-wschodnim wzdłuż stoku kontynentalnego. Na szelfie, wzdłuż zachodnich brzegów Półwyspu Antarktycznego, Prąd Dryftu Wiatrów Zachodnich tworzył szereg cyklonalnych zawirowań, prawdopodobnie w wyniku wychodzenia na szelf i ścierania się z prądami przybrzeżnymi.

Wody pochodzące z Morza Weddella płynęły wzdłuż południowych brzegów Cieśniny Bransfielda docierając do zachodniej jej części, gdzie w okolicy wyspy Low po napotkaniu wód Dryftu Wiatrów Zachodnich kierowały się na wschód, wąską strugą wzdłuż północnej granicy Cieśniny Bransfielda. Te wymieszane wody częściowo przepływały także pomiędzy wyspami Szetlandów Południowych powodując odchylenie poza szelf (na północ od wyspy Livingston i King George) głównego nurtu Dryftu Wiatrów Zachodnich.

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