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Water temperature distributions in N.A.F.O. Subdivision 3 Ps in autumn 1980 and late winter 1981

by

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1. Introduction.

Since 1977 two groundfish surveys are carried out each year on board the R/V Cryos in the N.A.F.O. Subdivision 3 Ps, one in late winter, another in autumn. During these cruises hydrological observations are systematically conducted and an XBT cast is done after each trawling.

In October 1980 and March 1981, 113 XBT stations were occupied during each cruise, and the aim of this paper is to provide some informations on water temperatures in Subdivision 3 Ps during these two periods.

The Gulf Stream system and the Labrador current constitue the main features of the water circulation in the Northwestern Atlantic and conditions of the environment in Subdivision 3 Ps are influenced by these water masses.

According to HACHEY et al (1954), two branchs of the Labrador current reach this area : the first one flows along the Grand Bank slopes and penetrates the Laurentian Channel ; the second one, which is an inshore branch, follows the gully past Cap Race and flows on each side of Green Bank. On the other hand, the characteristics of waters along the slopes of the Banks, South part of Subdivision 3 Ps, are directly affected by the Gulf Stream system.

As indicated by LENZ (1973) four different water masses are identified in the Laurentian Channel area as follows : surface layer, intermediate layer, warm water body (or slope water) and bottom water. Using hydrographic sections and bottom temperatures charts, the characteristics of these different layers are described for autumn 1980 and spring 1981 periods.

2. Results.

Because XBT stations are randomly distributed in the Subdivision 3 Ps, hydrographic sections were done by using stations the closest as possible to selected transects.

2.1. October 1980.

2.1.1. Hydrographic sections.

- Southwestern slope of Saint-Pierre Bank to North of Green Bank (Fig.1).

On this section, three different layers are very well identified by their temperature. The surface layer (0-35 m) is homogeneous and warm (maximum temperature : 11.6° C) and bordered by a strong seasonal thermocline near 40 meters depth. The intermediate layer appears on the slopes of Saint-Pierre Bank in depths between 50 and 155 meters. It is a cold lobe (0° C to -1° C in the core) which extends near the middle of the Laurentian Channel and represents mostly the offshore branch of the Labrador current which flows along the continental shelf of the Grand Bank, enters Laurentian Channel and then is confined to the slope of Saint-Pierre Bank around 100 meters depth. The inshore branch appears in the North of Green Bank where cold waters (below -1° C) fill Halibut Channel.

Under intermediate waters and separated from them by a strong positive gradient is the warm water body (maximum temperature of the core : 8° C). It lies from 170 to 400 meters and is produced by a mixture of Labrador current and Gulf Stream which occur on Southwest part of Grand Bank and penetrates the Laurentian Channel.

- Laurentian Channel to North of Saint-Pierre Bank (Fig.2).

This section is farther North than the previous and shows the same layers between 0 and 400 meters with some modifications however. Thus, the intermediate layer appears slightly warmer (-0.9° C in the core) as, on the opposite, slope water is colder (maximum temperature : 7° C). From 400 meters down to the bottom of the Laurentian Channel, bottom waters (below 5° C) are found, they occur in the West part of the Atlantic at similar depths.

- Burgeo Bank to Saint-Pierre Bank (Fig.3).

After flowing along the slope of Saint-Pierre Bank, the Labrador waters enter Hermitage Channel on the Saint-Pierre Bank side. Their temperature is slightly over 0° C with a smaller cold core. On the right part of the section, cold waters occur, probably originating from inshore branch of the Labrador current. From about 180 meters down to the bottom, slope waters are found again, but their temperature is slightly colder

(maximum 6.5° C). Because of its depth (less than 400 meters), bottom water cannot overflow Hermitage Channel.

2.1.2. Distribution of bottom temperature (Fig.4).

Due to the vertical stratification of water masses, temperatures on the bottom depend mostly of its depth. Thus, the shallowest parts of Saint-Pierre Bank are reached by the seasonal thermocline (temperatures about 4-6° C). Along the slopes of Saint-Pierre and Burgeo Banks, a strong gradient is found corresponding to the lower limit of the intermediate layer ; however this intermediate layer is only found on the Southwest part of Saint-Pierre Bank (temperature below 0° C), but its absence on the Northwest part is probably an artifact due to the position of the stations.

The inshore branch of the Labrador current flows in the North part of Saint-Pierre and Green Banks and overflows Pleasance Basin deeper than 90 meters.

Slope waters are found along the Saint-Pierre Bank slope, flow Northward, and enter Hermitage Channel ; bottom waters fill the Laurentian Channel deeper than 400 meters.

2.2. March 1981.

2.2.1. Hydrographic sections.

- Southwestern slope of Saint-Pierre Bank to North of Green Bank (Fig.5).

Surface waters consist of a cold layer (about 1° C) which appears at 0-70 meters and extends over the North of Green Bank to Saint-Pierre Bank. On the left part of the figure, a mass of warmer waters (maximum temperature : 4.6° C) occurs from 0 to approximately 100 meters depth.

Labrador waters (inshore branch) are found in Pleasance Basin but are not so cold than in autumn (minimum temperature : -0.5° C) probably due to their mixing with surface waters. Along the slope a cold lobe (temperature below 2° C) isolated against the bottom at 60-130 m is probably the only marks of artic waters which are less important during winter season.

The warm water body appears along the slope of Saint-Pierre Bank, with a warmer core (maximum temperature : 9° C) and larger than during autumn season.

- Laurentian Channel to North of Saint-Pierre Bank (Fig.6).

Surface waters are homogeneous in temperature (about 1.5° C), only slightly colder on the right part of the section. The intermediate layer presents a more complicated structure with mixing of warm (5° C) and colder (3° C) waters, and without cold core of Labrador origin. Slope waters are found again at 170-380 meters, but are slightly colder than in previous section. Bottom waters occur again below 380 meters depth.

- Burgeo Bank to Saint-Pierre Bank (Fig.7).

Again a cold surface layer extends over the Banks and beneath these waters the intermediate layer is reducted to a positive gradient at 120-180 meters depth. Slope waters enter Hermitage Channel and are found between 180 meters and the bottom.

2.2.2. Distribution of bottom temperature (Fig.8).

This figure indicates that tops of the Banks are reached by the lower part of the surface layer (temperature about 1° C). The Northern parts of Saint-Pierre and Green Banks are influenced by colder water (below 0° C).

Along slopes of Banks, a strong thermic gradient occurs. Slope waters are present with a core warmer than in autumn particulary in its Southern part (8° C). This warm water body flows Northward and enters Hermitage Channel. Bottom waters are found again in Laurentian Channel.

Conclusion.

Temperature distributions in Subdivision 3 Ps show large seasonal fluctuations :

- in autumn, a very well definite vertical stratification occurs : a seasonal thermocline is formed in summer and in addition a cold lobe of artic origin appears in the intermediate layer
- in late winter, from 0 to about 100 meters depth, the surface layer is homogeneous and cold, and overlays the Banks ; Labrador waters are less important particulary on the slopes of the Banks.

In addition to these seasonal variations, year to year fluctuations of temperatures water masses are observed, and 1981 late winter appears warmer than the previous four years (unpublished data), but is closed to those observed in 1970 spring (L'HERROU and MINET, 1971 ; MINET, 1974). In a same way, in autumn, large fluctuations are observed particulary on the tops of Banks from year to year mostly in relation to the depth of the seasonal thermocline.

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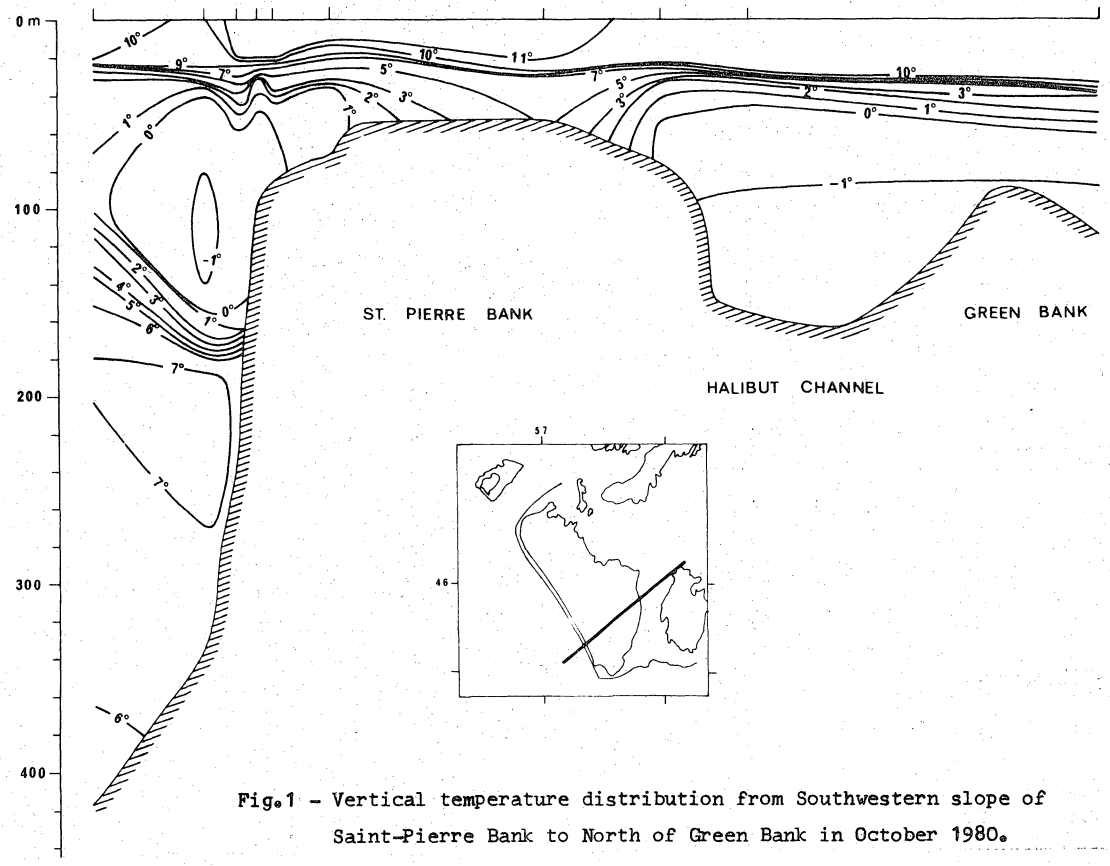

Fig.1 - Vertical temperature distribution from Southwestern slope of Saint-Pierre Bank to North of Green Bank in October 1980.

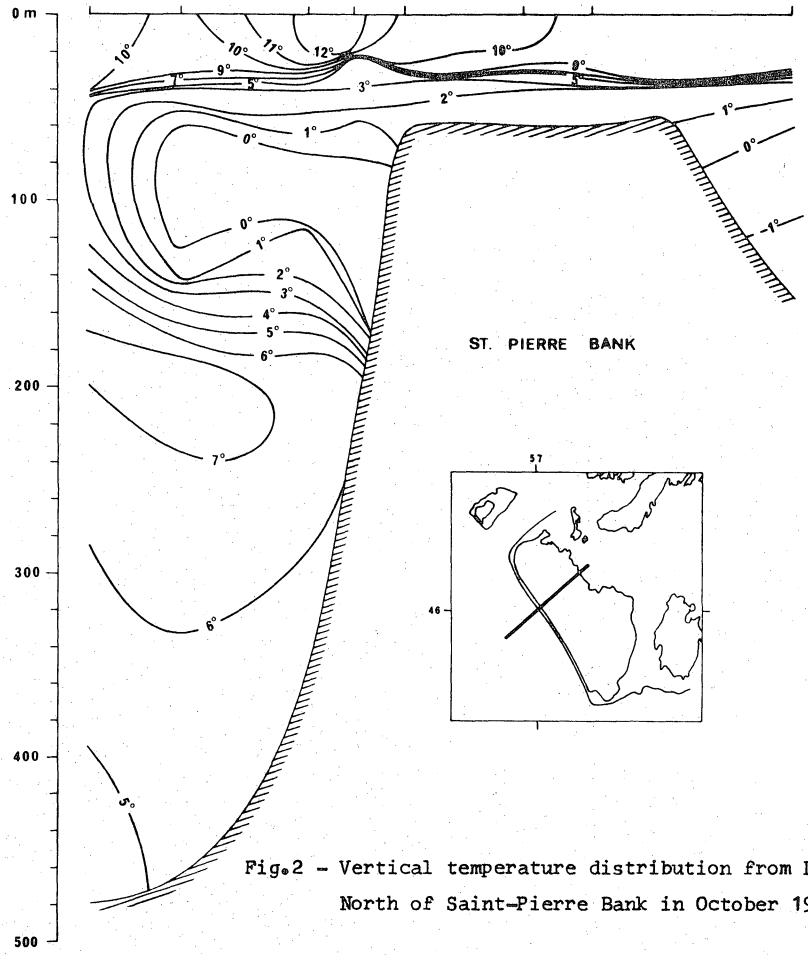

Fig.2 - Vertical temperature distribution from Laurentian Channel to North of Saint-Pierre Bank in October 1980.

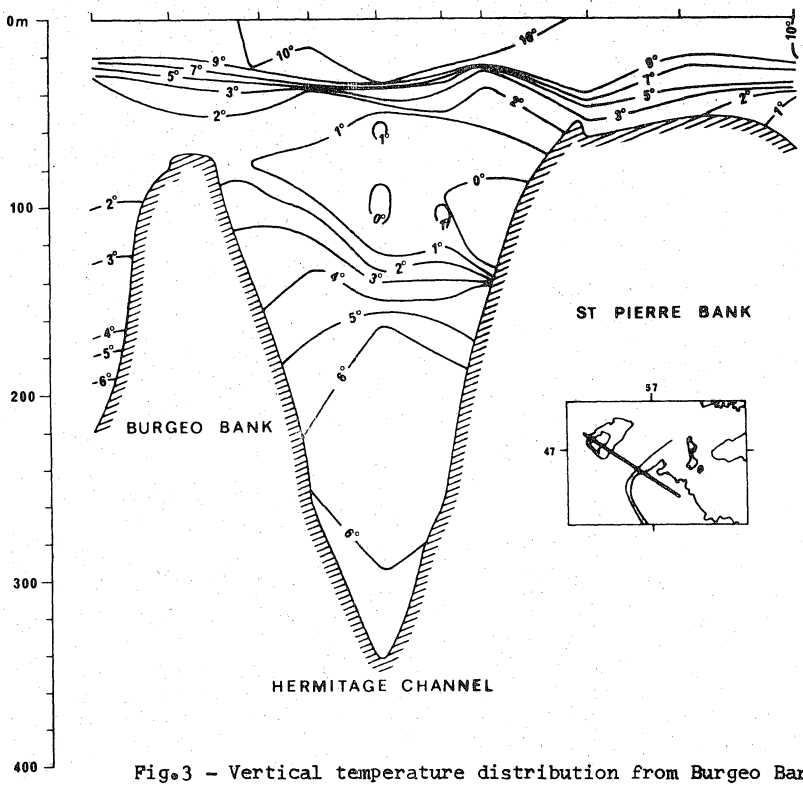

Fig.3 - Vertical temperature distribution from Burgeo Bank to Saint-Pierre Bank in October 1980.

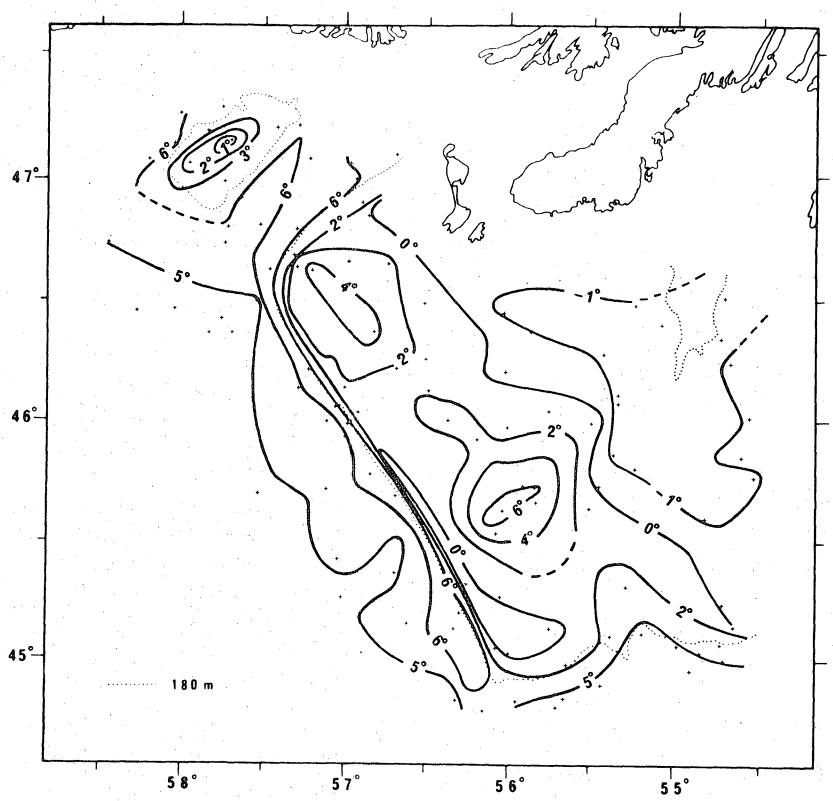

Fig.4 - Distribution of bottom temperature in October 1980 in Subdivision 3 Ps.

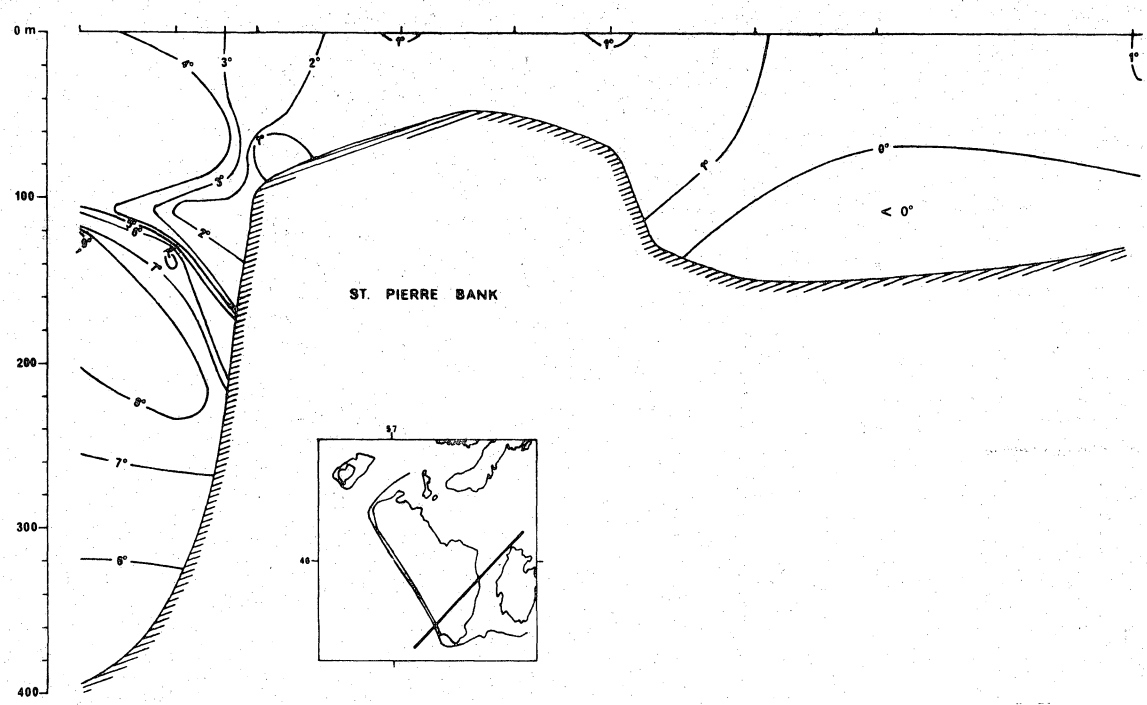

Fig.5 - Vertical temperature distribution from Southwestern slope of Saint-Pierre Bank to North of Green Bank in March 1981.

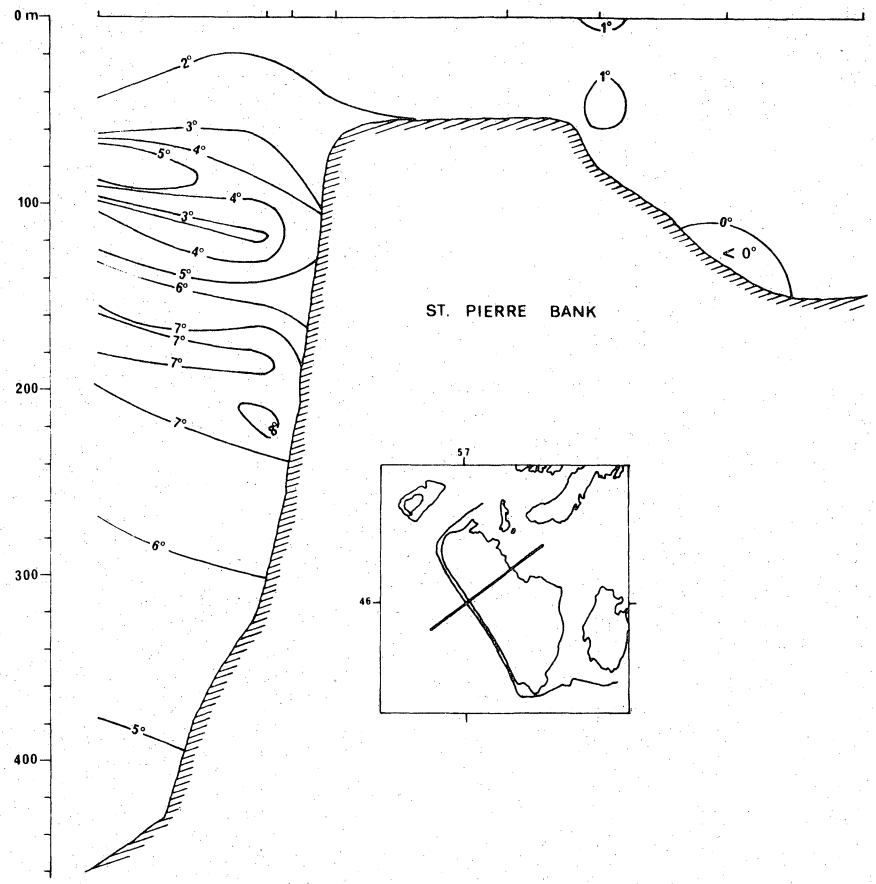

Fig.6 - Vertical temperature distribution from Laurentian Channel to North of Saint-Pierre Bank in March 1981.

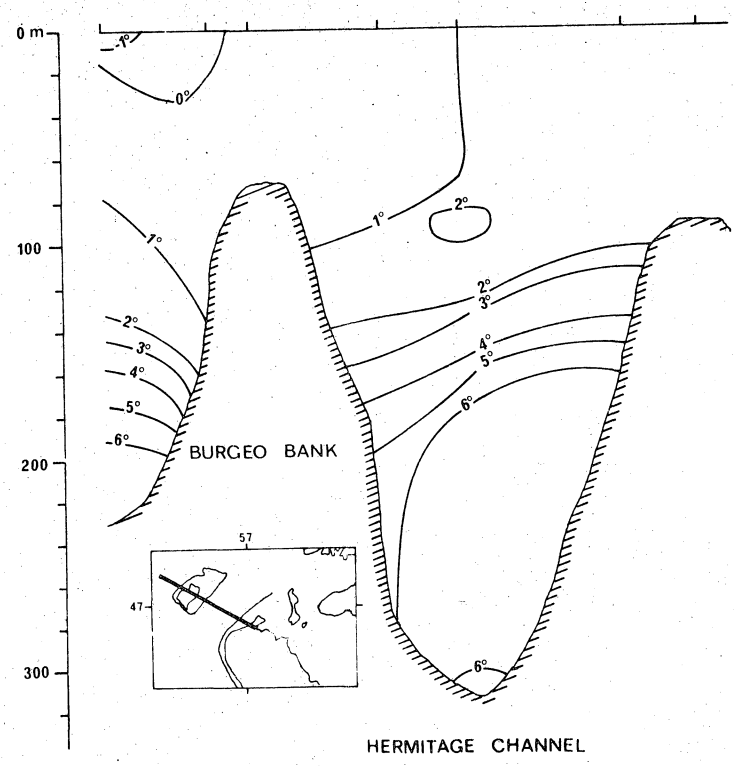

Fig.7 - Vertical temperature distribution from Burgeo Bank to Saint-Pierre Bank in March 1981.

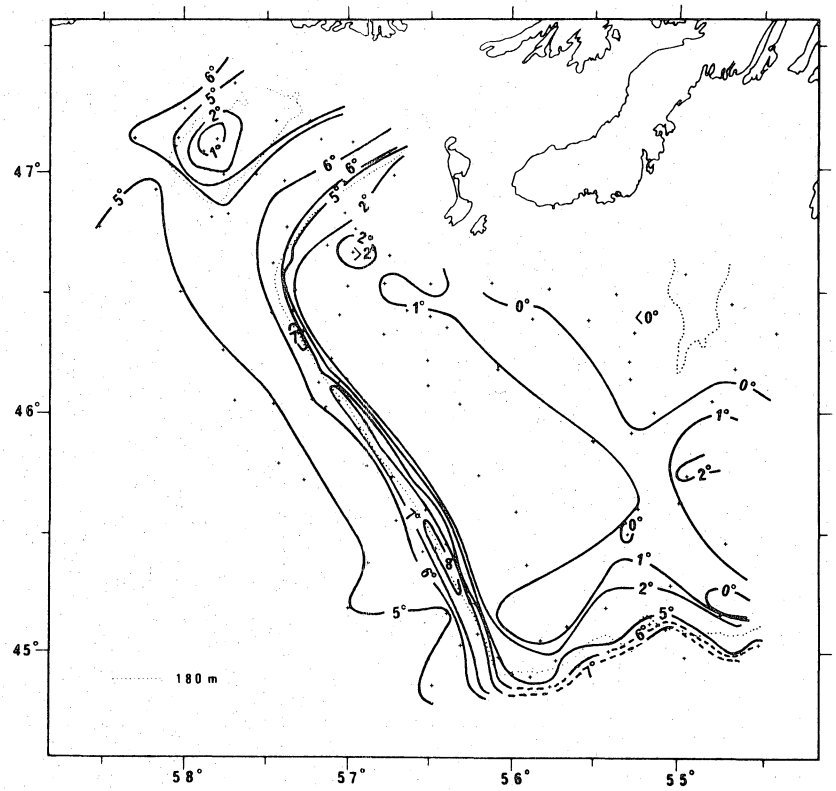

Fig.8 - Distribution of bottom temperature in March 1981 in Subdivision 3 Ps.