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CHARACTERISTICS OF OCEANIC STRUCTURE IN THE WATERS AROUND THE SOUTH SHETLAND ISLANDS OF THE ANTARCTIC OCEAN BETWEEN DECEMBER 1990 AND FEBRUARY 1991: OUTSTANDING COASTAL UPWELLING? (EXTENDED ABSTRACT)

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The sixth Antarctic survey cruise of R/V KAIYO MARU belonging to the Japan Fisheries Agency was carried out in the waters around the South Shetland Islands located in the southwest of the Scotia Sea, Antarctic (Fig. 1), during the austral summer season in 1990–1991. It is known that the distributional density of Antarctic krill (*Euphausia superba* DANA) is relatively high in waters from the insular shelf to the shelf slope located in the north of the South Shetland Islands. The observation was especially carried out by setting close-spaced grids in the waters north of the South Shetland Islands (Fig. 2). In order to investigate seasonal changes in oceanic structure, two observations were put into operation in the same area after an interval of 40 days. The first leg of the observation was from 22 to 29 December 1990, and the second leg was from 18 January to 4 February 1991. The measurement of oceanic condition was carried out by the use of the CTD system (Sea-Bird Electronics, Inc.). The depth of the measurement was selected from the sea surface to 1000 m or to near the sea bottom if shallower.

The greater part of the waters surveyed was directly affected by the Antarctic Circumpolar Current. The changes of the gradients with temperature, salinity, density and flow (Fig. 3) were larger in the north and south, whereas they indicated comparatively homogeneous zonal structure in the east and west. The pattern of geostrophic flow based on dynamic computation showed, for instance, that the faster eastward flow such as the maximum speed of 10.9 cm/s along the S line of the north-south transection was distinguished in the waters of the Antarctic Circumpolar Current, and the low westward flow such as less than 1.0 cm/s along the S line was in the waters of the insular shelf and slope of the South Shetland Islands (Fig. 4).

The more characteristic change was clearly recognized in the waters of the insular shelf from the first leg to the second leg. The Antarctic Surface Water over the insular shelf at the first leg entirely indicated the minus values of temperature (Fig. 5). Forty days later, however, the temperature in the same waters rose above the plus values (Fig. 6). The Antarctic Surface Water over the Antarctic continental shelf maintains the low temperature below 0°C and even near the freezing point of seawater under ordinary conditions even in the summer season. However, the low temperature below 0°C of

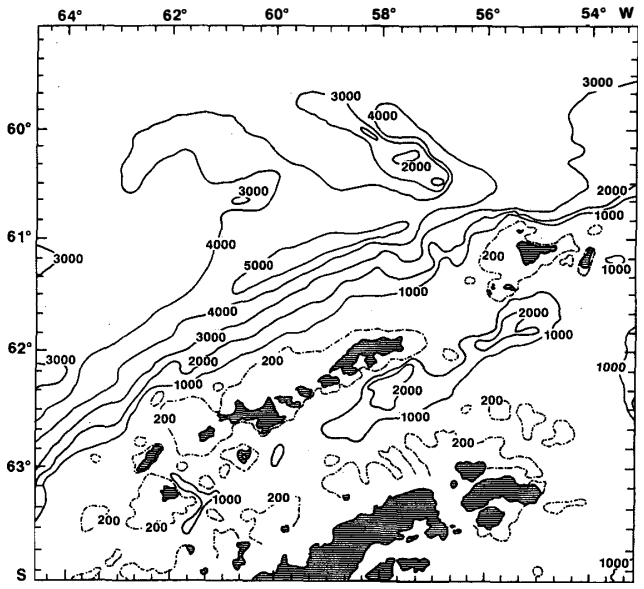

Fig. 1. Bathymetric chart around the South Shetland Islands (contours in m)

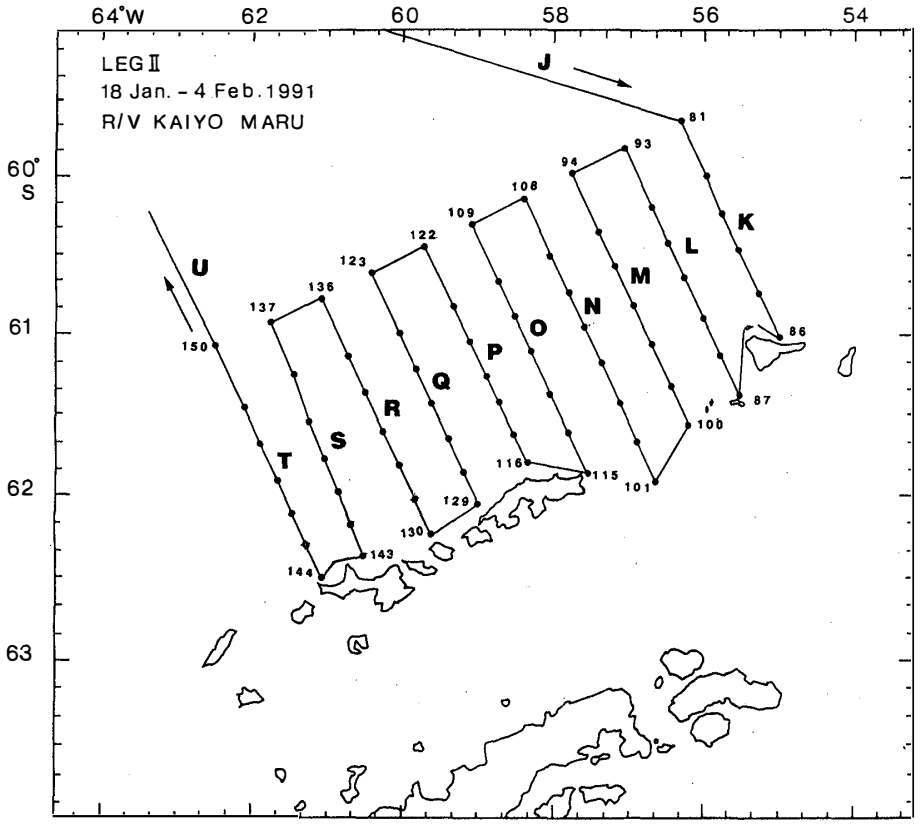

Fig. 2. Track and sampling stations in Leg II of the sixth Antarctic survey cruise of R/V KAIYO MARU from 18 January to 4 February 1991.

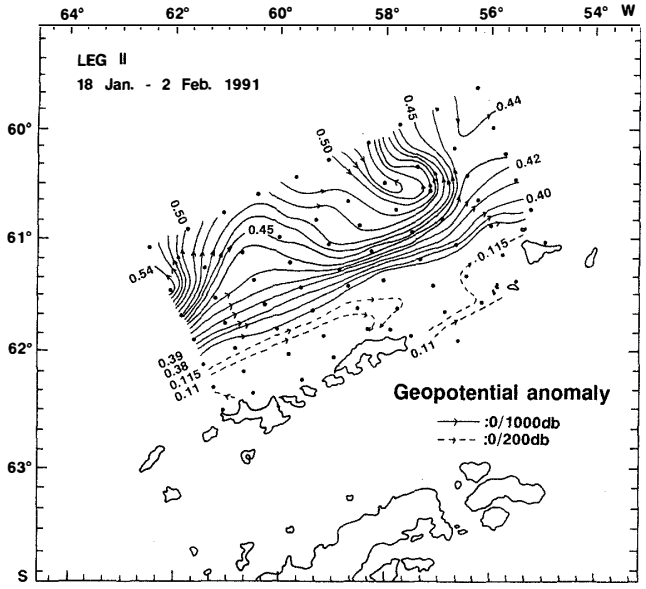

Fig. 3. Geopotential anomaly of the 0-db surface relative to the 1000-db and the 200-db surface, in dynamic m in Leg II.

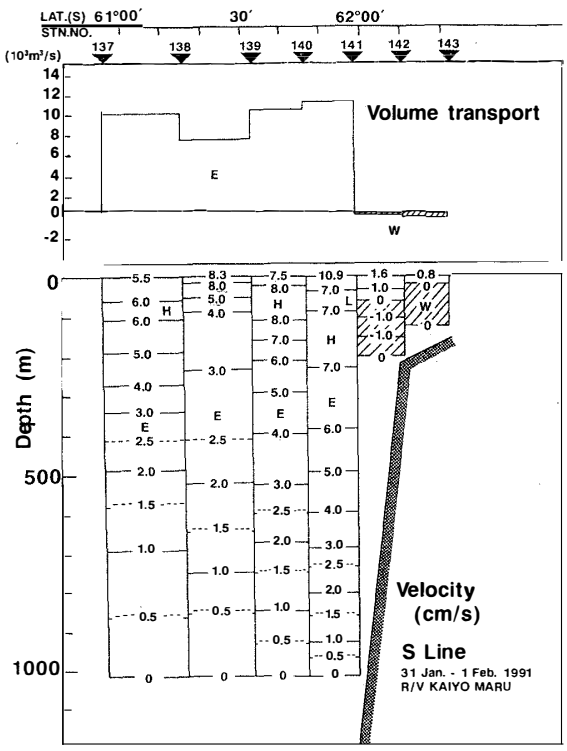

Fig. 4. Vertical distribution of velocity and volume transport along a line of S in Leg II.

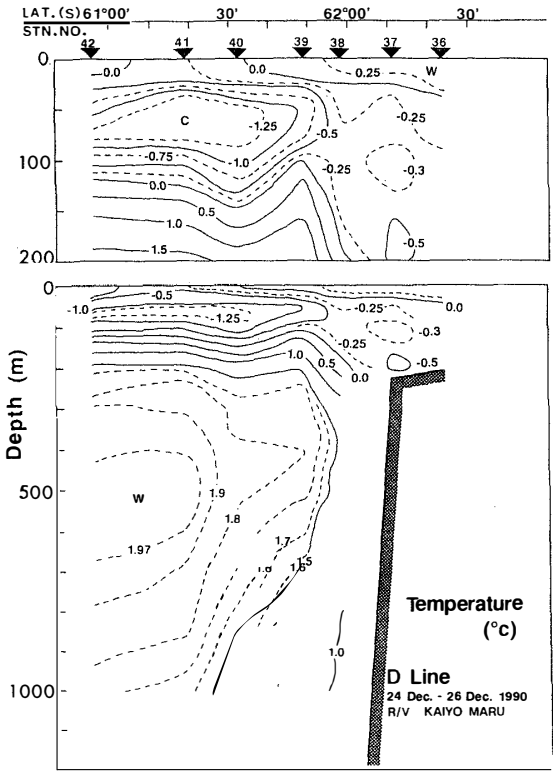

Fig. 5. Vertical distribution of temperature along a line of D in Leg I.

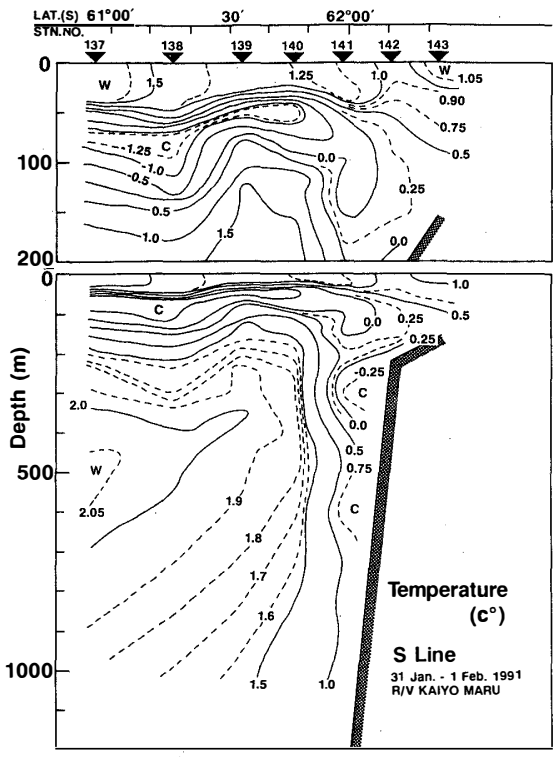

Fig. 6. Vertical distribution of temperature along a line of S in Leg II.

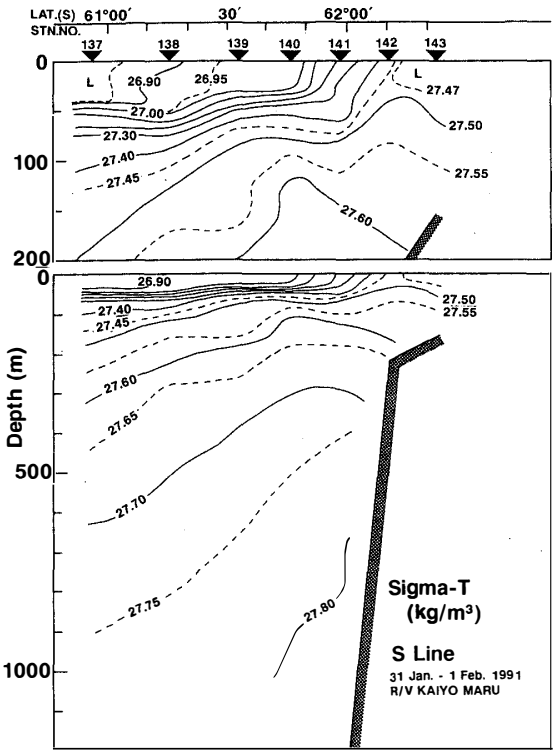

Fig. 7. Vertical distribution of density along a line of S in Leg II.

the Antarctic Surface Water was not maintained in the waters over the insular shelf of the South Shetland Islands according to the present survey.

The reason of the rise in the sea temperature of the waters over the insular shelf was considered that the Warm Deep Water intruded over the waters. The two processes are considered for the present intrusion; the first is the steady topographic upwelling of the Warm Deep Water, and the second is the wind-driven coastal upwelling. The distribution patterns of temperature, salinity, density (Fig. 7), dissolved oxygen and nutrient salts support this upwelling phenomenon.

The waters around the South Shetland Islands are normally covered with sea ice in the same way as the other parts of the Antarctic Ocean during the winter season when sea ice extended to the maximum range. However, the waters around the South Shetland Islands had relatively lower density of sea ice as compared with the surrounding area having the high density, judging from the satellite image chart of the average sea ice distribution and concentration for the Antarctic Ocean for the years 1978–1986 provided by NASA Goddard Space Flight Center (SMITH, 1990). The formation process of this lower density of sea ice distribution is considered as follows: The upwelling of the Warm Deep Water having the warmer temperature above 0°C was caused by the effect of the shallow bottom topography around the South Shetland Islands; the upwelled warmer water had a negative impact on the developing process of the freezing point due to vertical mixing during the winter season; and consequently the distribu-

tional density of sea ice became lower than the other waterswhere there were no the upwelling of the Warm Deep Water.

Furthermore, the westerly high winds above the wind force scale of 6 were distinguished during the present survey. For this reason, the offshore Ekman transport probably occurred in the waters north of the South Shetland Islands; and continuously, the Warm Deep Water upwelled to the surface layer in compensation for the offshore transport over the insular shelf—especially near the shore.

Reference

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