A STUDY OF THE TURBULENT FLOW AND CHARACTER OF THE WATER MASSES OVER THE SICILIAN RIDGE IN BOTH SUMMER AND WINTER[†]

by

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The western sill region of the Strait of Sicily lies between Sicily (Capo Lilibeo) and Tunisia (Cap Bon) and is part of the submarine ridge separating the eastern from the western Mediterranean. [Fig. 1]. It was studied during three expeditions in winter (April 1963) and summer (Sept-Oct. 1962, Sept-Oct. 1963).

The measurements, which were preceded by a bathymetric survey, consisted of hydrographic casts, bathythermograph dips, geomagnetic electrokinetograph runs, current-meter dips, the simultaneous tracking of parachute drogues at six different depths and the long-term recording of the thermal structure from a moored buoy. The results are as follows:

(1) The bathymetric survey revealed the existence of a narrow channel cutting the Adventure Bank along the meridian 11°35.6'W. This channel [Fig. 1] is about 12 mi long from north to south and, at its narrowest point, is about 1 mi wide at 400 m depth and 2.3 m wide at 200 m depth. The sill depth near this narrowest point is about 430 m. (All depths are corrected for sound velocity). The previously known sill-depth — of about 365 m — is 24 mi west-north-west of this newly-discovered sill-depth, and is separated from it by a raise, the peak of which is about 60 m deep.

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(2) The core of the "Atlantic-type" water — characterised by a salinity minimum and an O_2 maximum ($5.60 \begin{smallmatrix} +0.70 \\ -0.18 \end{smallmatrix}$ ml/l) flows south-south-west through the sill region at an average depth of 55 m [Fig. 2]. Its average depth is greater near the Tunisian coast (55 ± 12 m) than near the Sicilian coast (40 ± 5 m). GEK measurements and the tracking of parachute drogues at 20 m depth showed net transports to the south or south-east at 10-90 cm/s and 9-20 cm/s respectively. Non-periodic fluctuations, current inversions and eddies of 1-5 mi diameter were noticed at all seasons [Figs. 3 and 4]. Spurts of currents of 0.5 - 1.9 kn and 0.2 - 0.9 kn were recorded at the surface and at 20 m depth respectively.

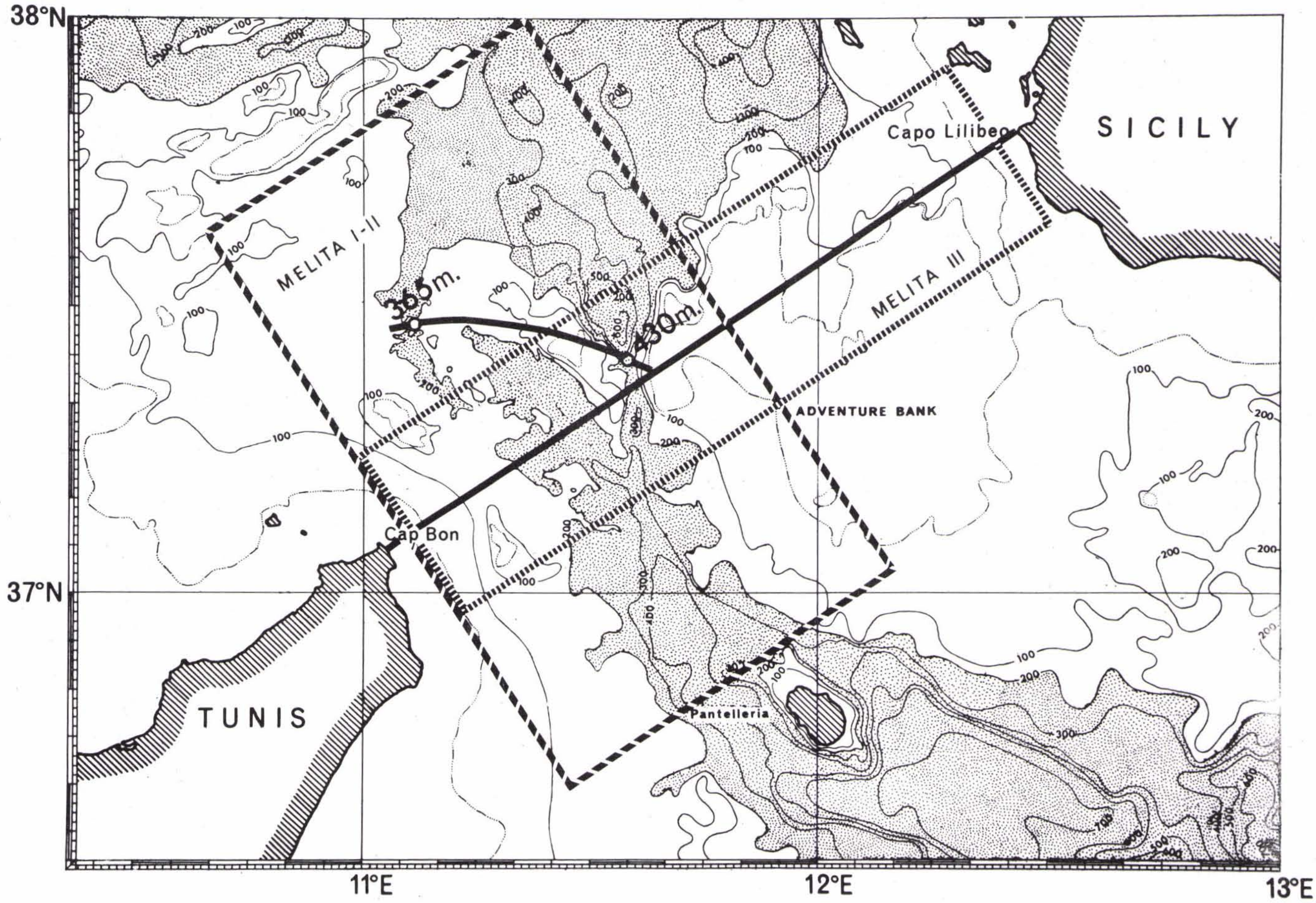
(3) The core of "Levantine-type" water — characterised by a salinity maximum — flows westward, changing depth from about 150 m at its origin (in the Rhodes-Cyprus region) to about 250 m when it reaches the eastern sill of the Sicilian Ridge (southeast of Malta) and to 300 m upstream of the western sill (between Cap Bon, Tunisia and Capo Lilibeo, Sicily). At this latter point it was recorded as having a salinity of 38.8‰ and a temperature of 14.20 ± 0.15°C in both summer and winter [Fig. 2].

Parachute drogues at 300 m and 400 m showed that there was a net north-bound transport of this water at variable speeds — between 2.5 and 12 cm/s at 300 m and between 3.2 and 5 cm/s at 400 m. Spurts of current varied from 0.15 to 0.4 knots at 300 m and from 0.03 to 0.37 knots at 400 m. Current inversions and eddies of 1 to 2 mi diameter were observed [Fig. 5].

(4) Between these two types of water — the "Atlantic-type" flowing at 40 m depth and the "Levantine-type" flowing below 300 m depth — both temperature and salinity measurements showed high amplitude fluctuations in the winter but much smaller fluctuations during the summer season [Fig. 2]. These fluctuations are probably due to turbulent mixing in the constricted, complicated bottom topography. Parachute drogues at between 60 and 200 m depth showed net transports to the north at speeds varying between 0.5 and 23 cm/s. The drogue patterns showed current inversions and eddies of 1 to 3 mi diameter; spurts in the current varied from 0.01 to 1.4 knots.

(5) All the current inversions, the changes in current speed, the isobathic temperature fluctuations over the sill recorded by an oceanographic buoy [Fig. 6] and the salinity changes in time proved to be aperiodic and to represent a type of dynamic noise. Attempts to correlate these effects with local tidal periods or with east-west changes in barometric pressure were unsuccessful. There was, however, some evidence of the effects of the wind — which is very variable in this area — on the surface currents, and of the effects of bottom topography on the deep flows.

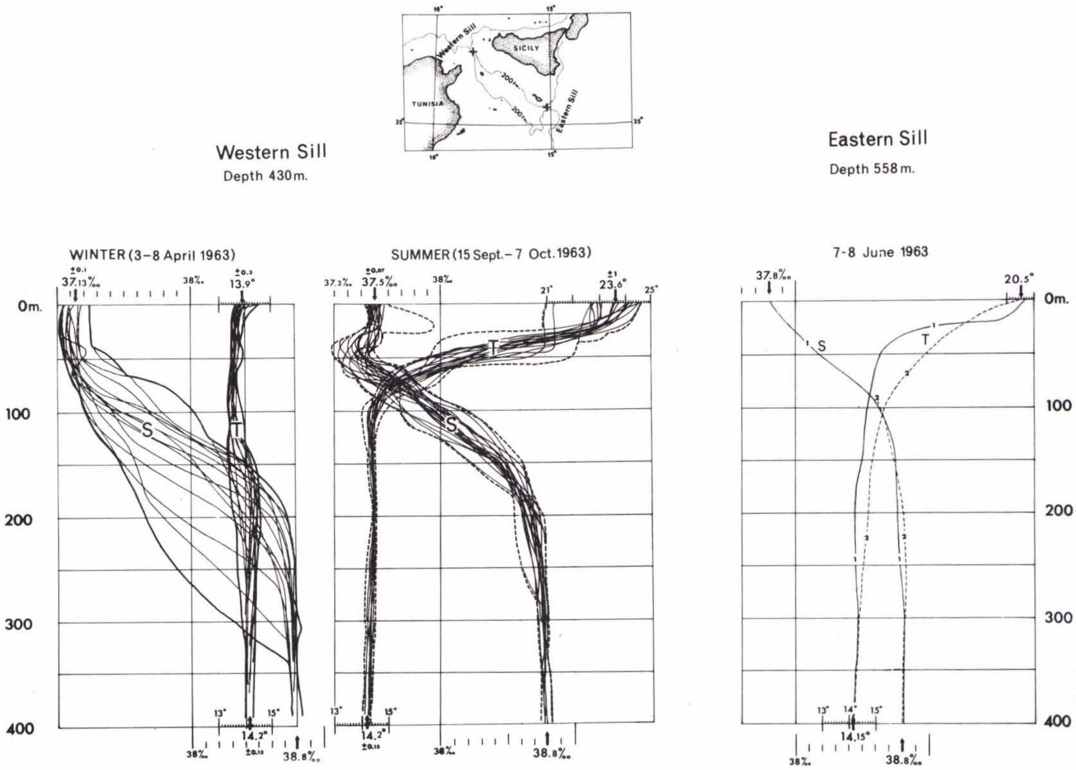
Series of BT temperature profiles over the sill on traverses from Sicily to Tunisia showed time fluctuations in the depths of the isotherms in various locations. The depth of the 23°C isotherm varied by 34 m, that of the 20°C isotherm by 14 m and that of the 15°C isotherm by 27 m. This effect may also be considered as a dynamic noise. Both the isotherms and the isohalines become deeper on the Tunisian side than they are on the Sicilian side.



Working area for cruises MELITA I (8-18 Sept. 1962) MELITA II (26 Mar - 10 Apr 63) and MELITA III (23 Sept. - 8 Oct. 63). The sill depth is 430 m in the newly-discovered narrow channel cutting the Adventure Bank. The previously known sill depth of 365 m is also shown. GEK and BT space-series were taken on the traverse from Cap Bon (Tunisia) to Capo Lilibeo (Sicily).

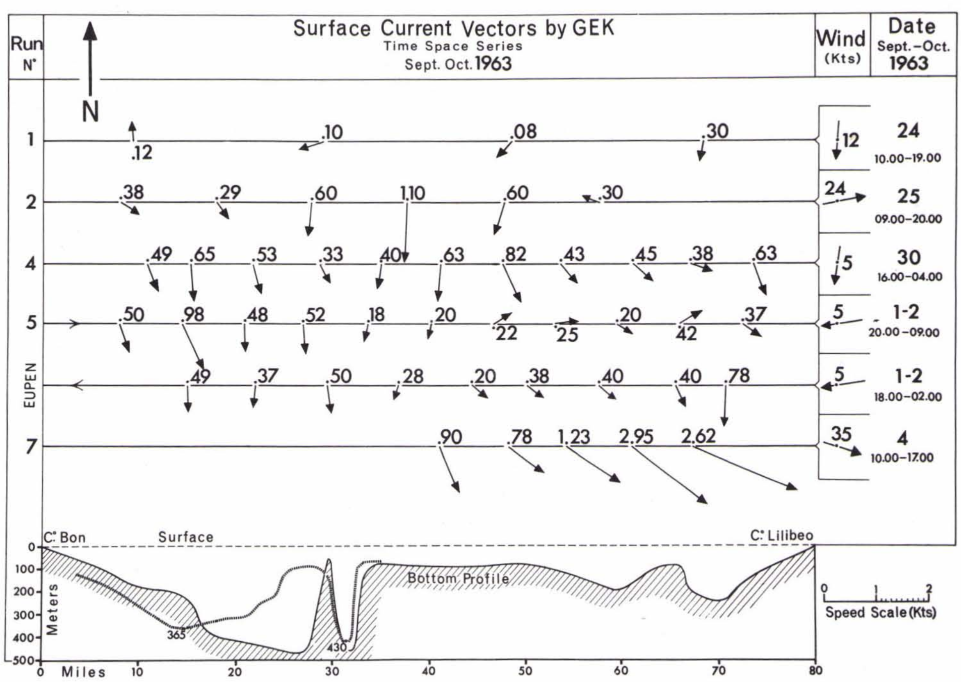
FIG. 1

Sicilian Ridge



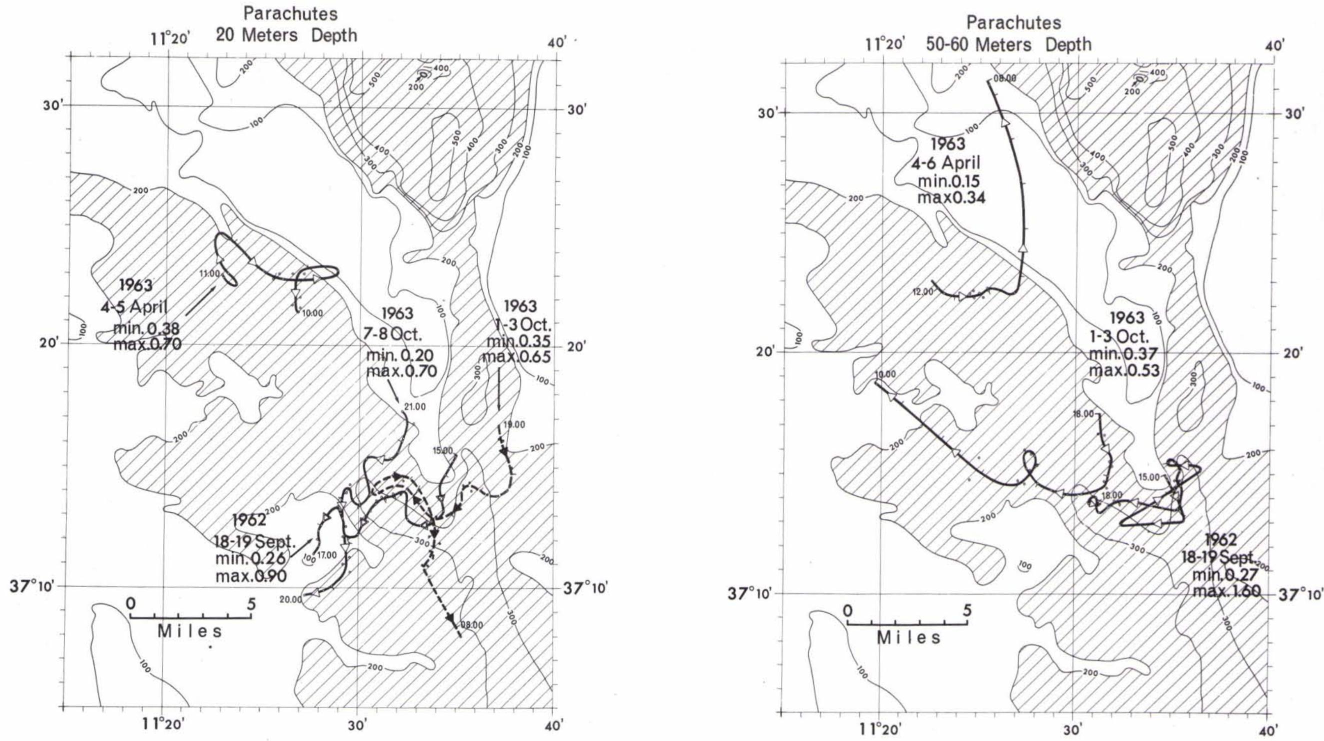
Time-series of temperature and salinity profiles in the deep section of the western sill, showing marked differences between winter and summer. The eastern sill profiles are shown on the right for comparison.

FIG. 2



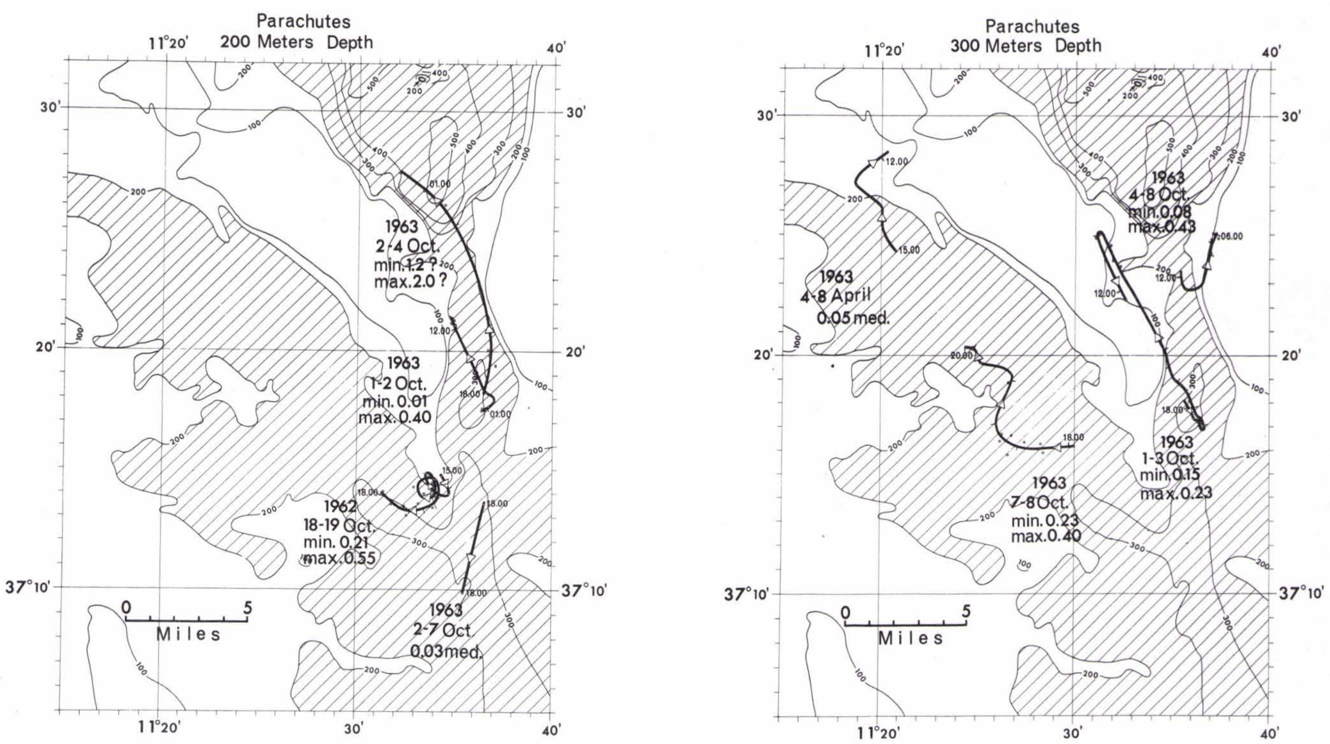
Series of GEK runs on the Sicily-Tunisia traverse, made at different times, showing the effect of the wind on the current vector. Numbers indicate current speed in knots. Rapid variations in current vectors were also found during simultaneous runs (N^{O} 5 and "EUPEN")made by two ships running on opposite courses when the wind speed was only 5 knots.

FIG. 3



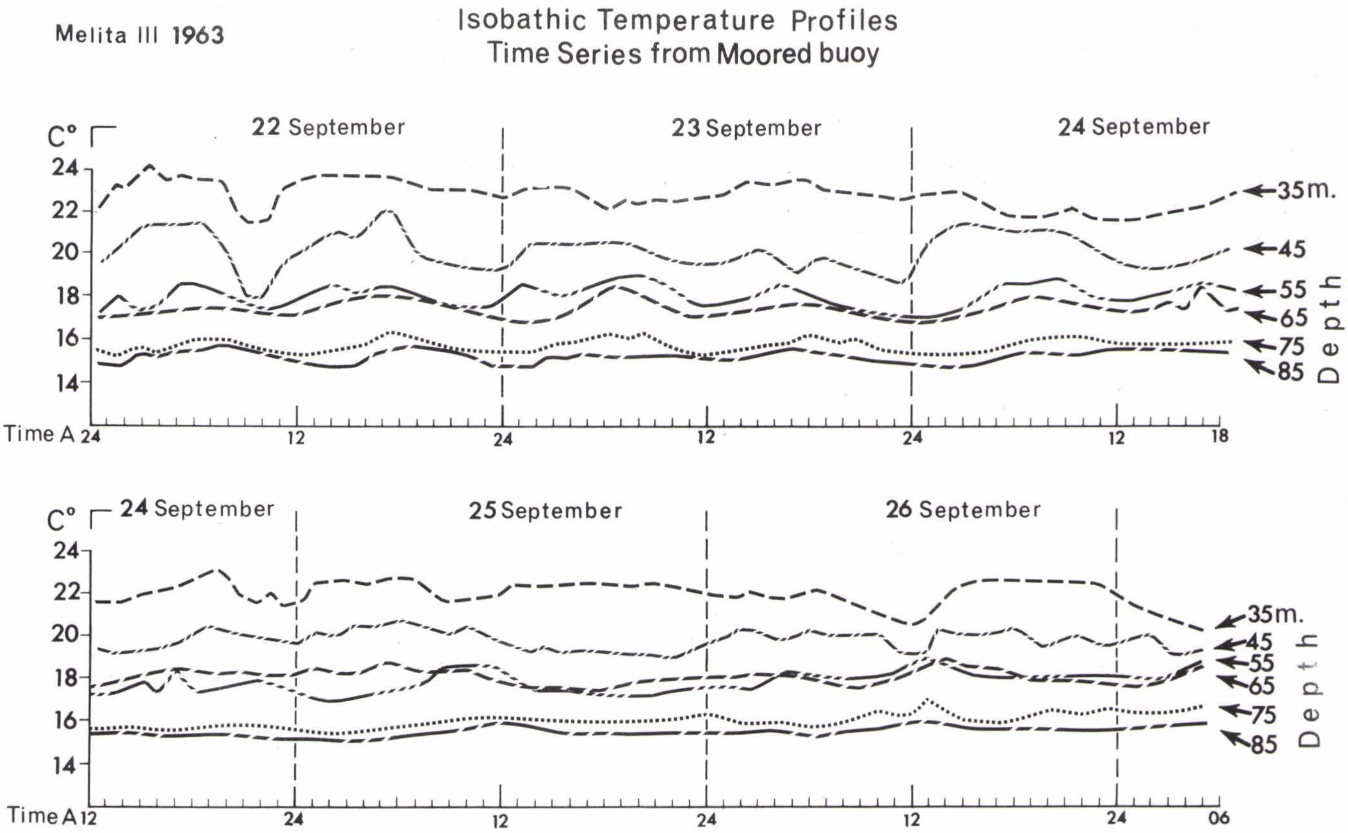
Tracks of surface floats with parachute drogues at 20 m (left) and 50-60 m (right) showing inversions and eddies of various sizes from 1 to 5 miles occurring in both winter and summer. The floats were followed by radar navigation relative to a marker buoy, the accuracy being better than 1/4 mi.

FIG. 4



Tracks of surface floats with parachute drogues at 200 m (left) and 300 m (right) showing similar conditions to those of Fig. 4. The bottom contours — which influence currents at these depths — are shown, depths below 200 m being shaded.

FIG. 5



A 5-day sample of a long-term recording of isobathic temperatures. Only the average temperatures at 10 m intervals within the thermocline (35 - 85 m) are shown. Variations of up to 3°C were recorded over a 3-4 hr period and of up to 1.5°C in 15 min. periods (not shown). The oceanographic buoy was placed over the sill depth (430 m) in the narrow channel of Adventure Bank (Fig. 1).

FIG. 6