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Technical Report No. 30 II

(PART 2 - DIAGRAMS)

SACLANT ASW
RESEARCH CENTRE

SHORT-PERIOD VERTICAL DISPLACEMENTS OF THE UPPER LAYERS IN THE STRAIT OF GIBRALTAR

by

R. FRASSETTO

1 November 1964

[redacted]

VIALE SAN BARTOLOMEO, 92
LA SPEZIA, ITALY

[redacted]

TECHNICAL REPORT 30

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R. Frassetto

PART II

DIAGRAMS

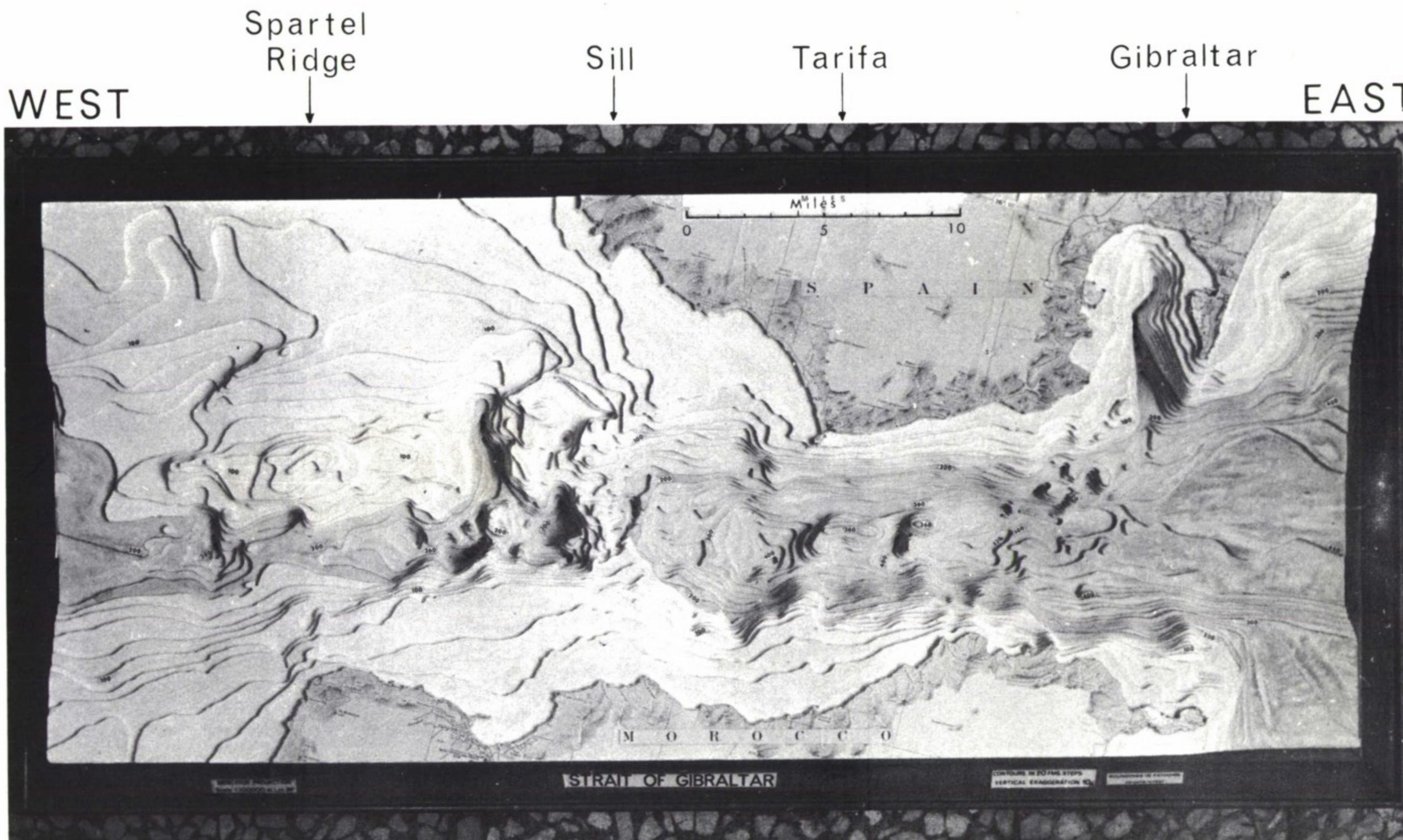


Fig. 1 Relief model of the Strait of Gibraltar. The contours are at intervals of 20 fathoms, with a vertical exaggeration of 10:1. The shaded area indicates depths of more than 200 fathoms.

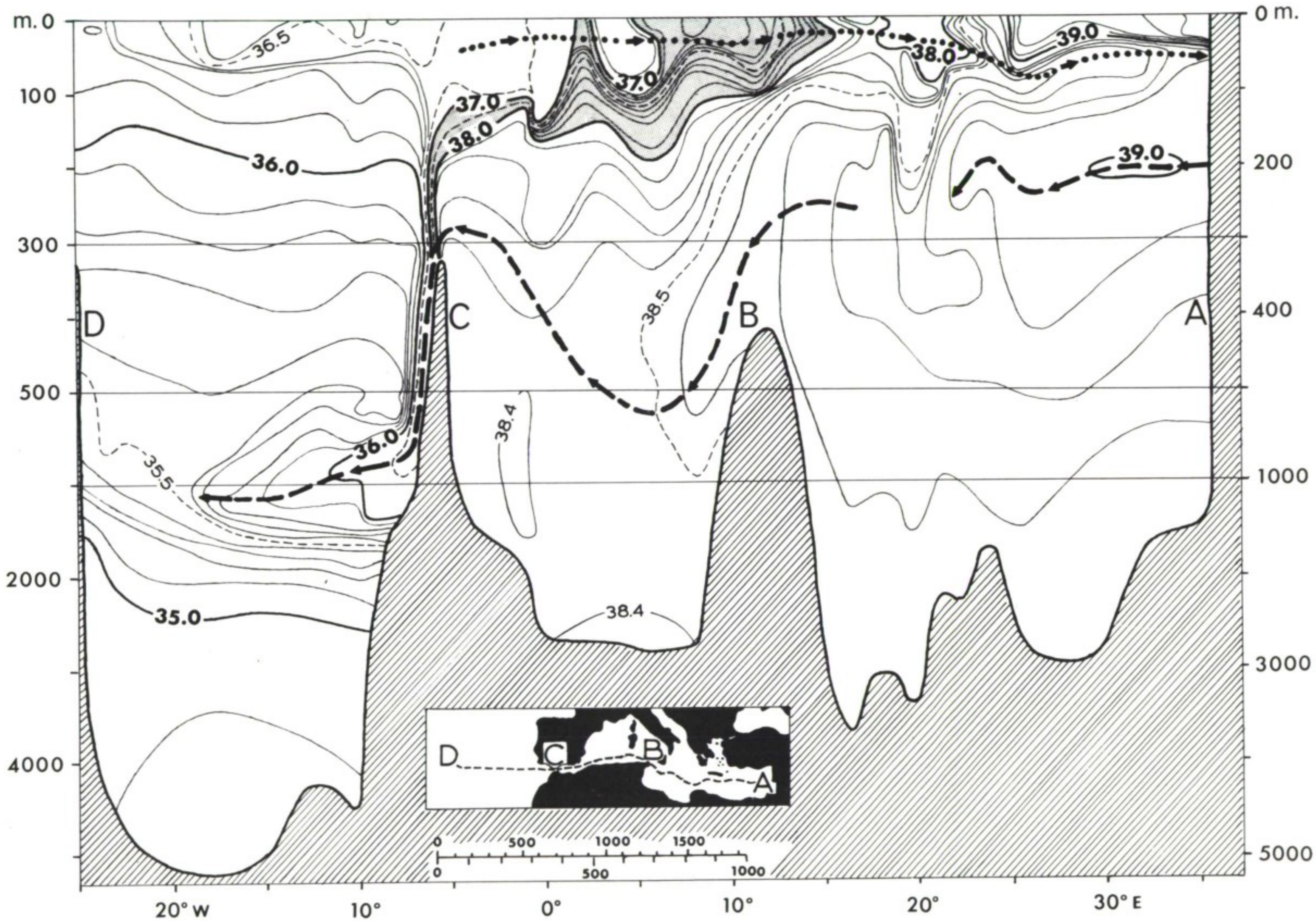


Fig. 2 Cross-section through the Mediterranean and Eastern Atlantic showing the salinity profiles in Summer and the exchange of water masses through the Strait of Gibraltar (Ref. 2). The dashed line shows the core of the outflowing Mediterranean water and the dotted line, near the surface, indicates the core of the inflowing Atlantic water.

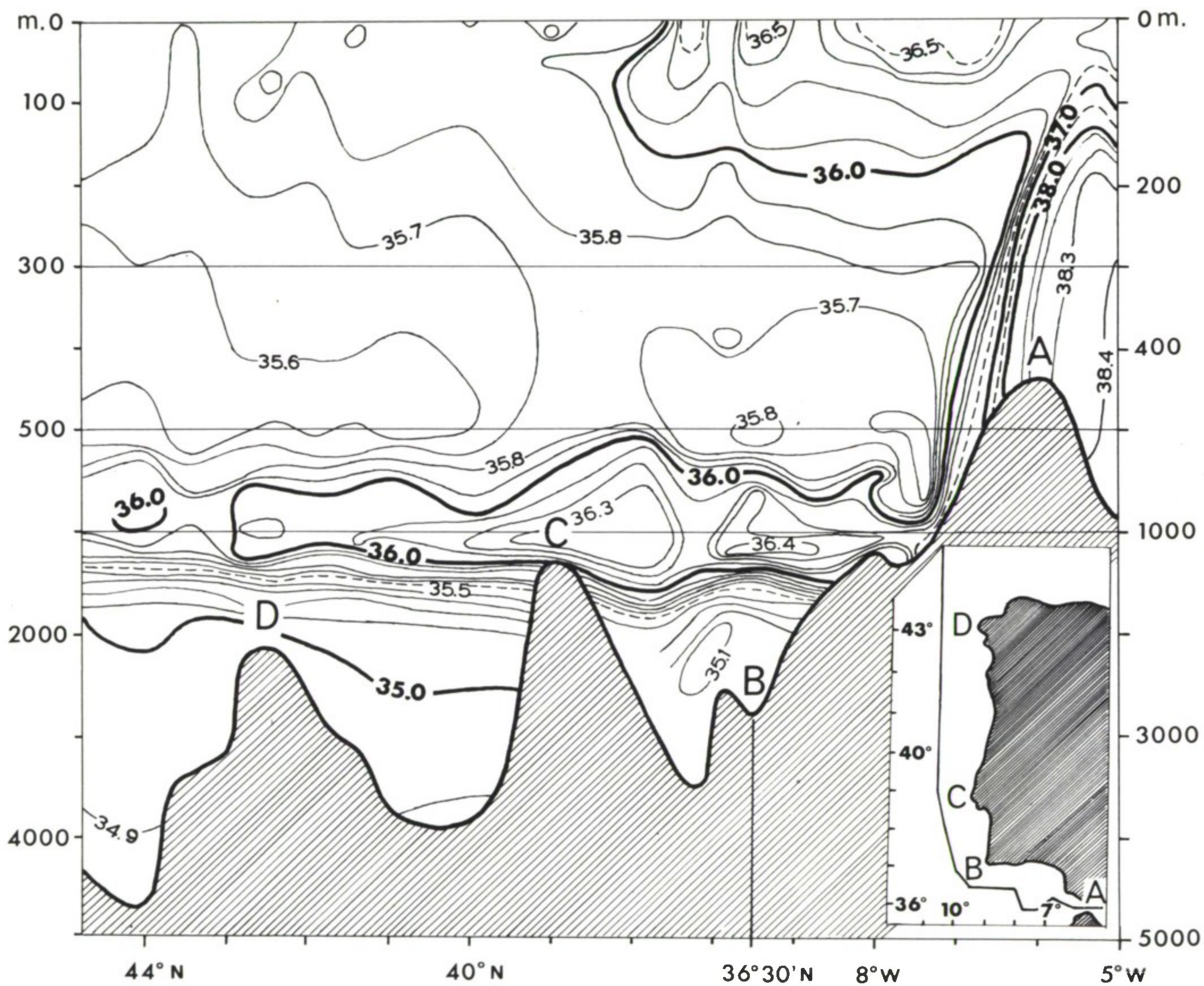


Fig. 3 Salinity profile of the deep tongue of Mediterranean water passing through the Strait of Gibraltar and, under the influence of the Coriolis force, moving northward along the Portuguese coast. (Ref. 2).

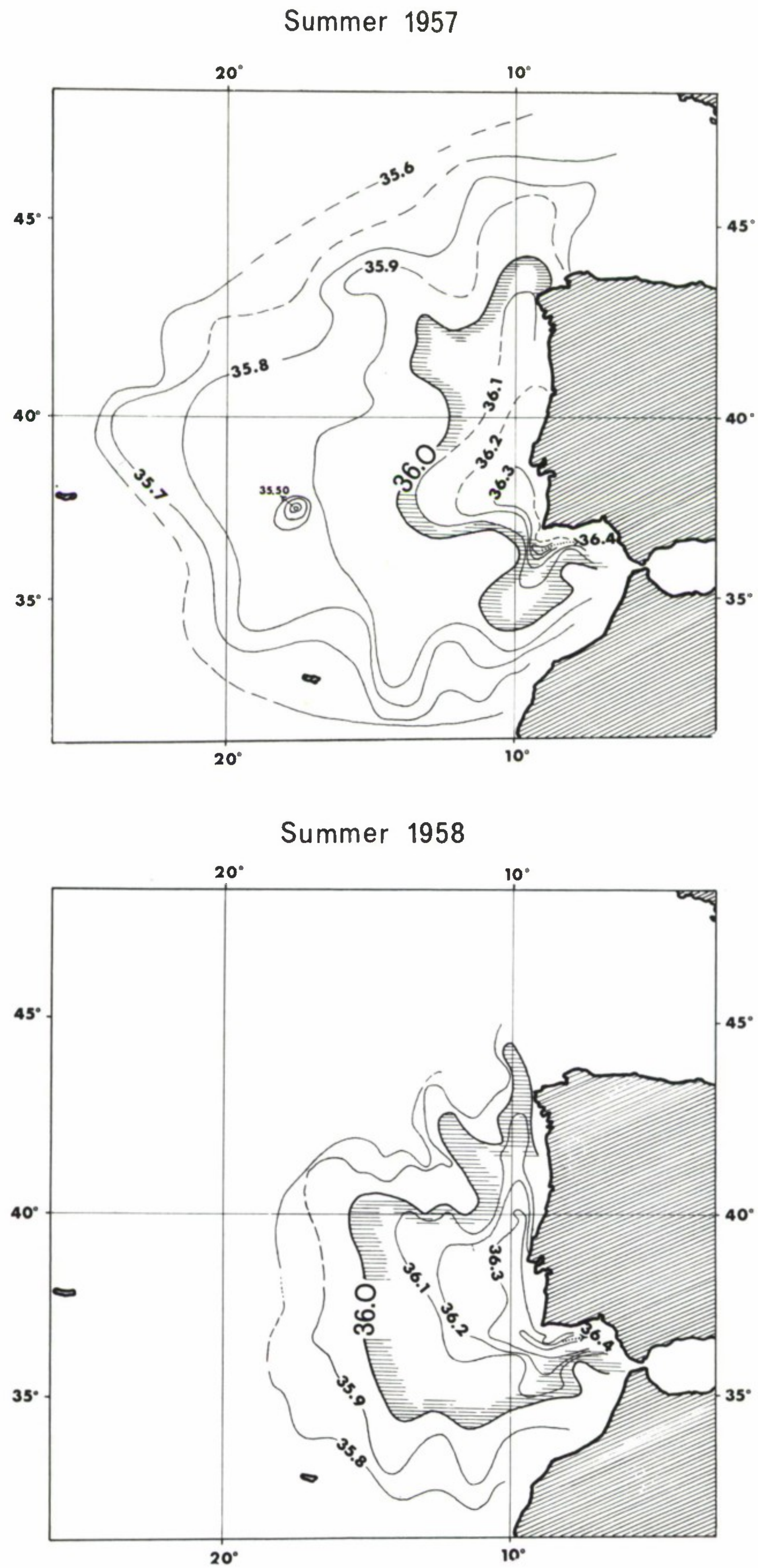


Fig. 4 Two studies of the extension of the deep tongue of Mediterranean water into the Atlantic. The isohalines are those at a depth of 1000 m. (Ref. 2).

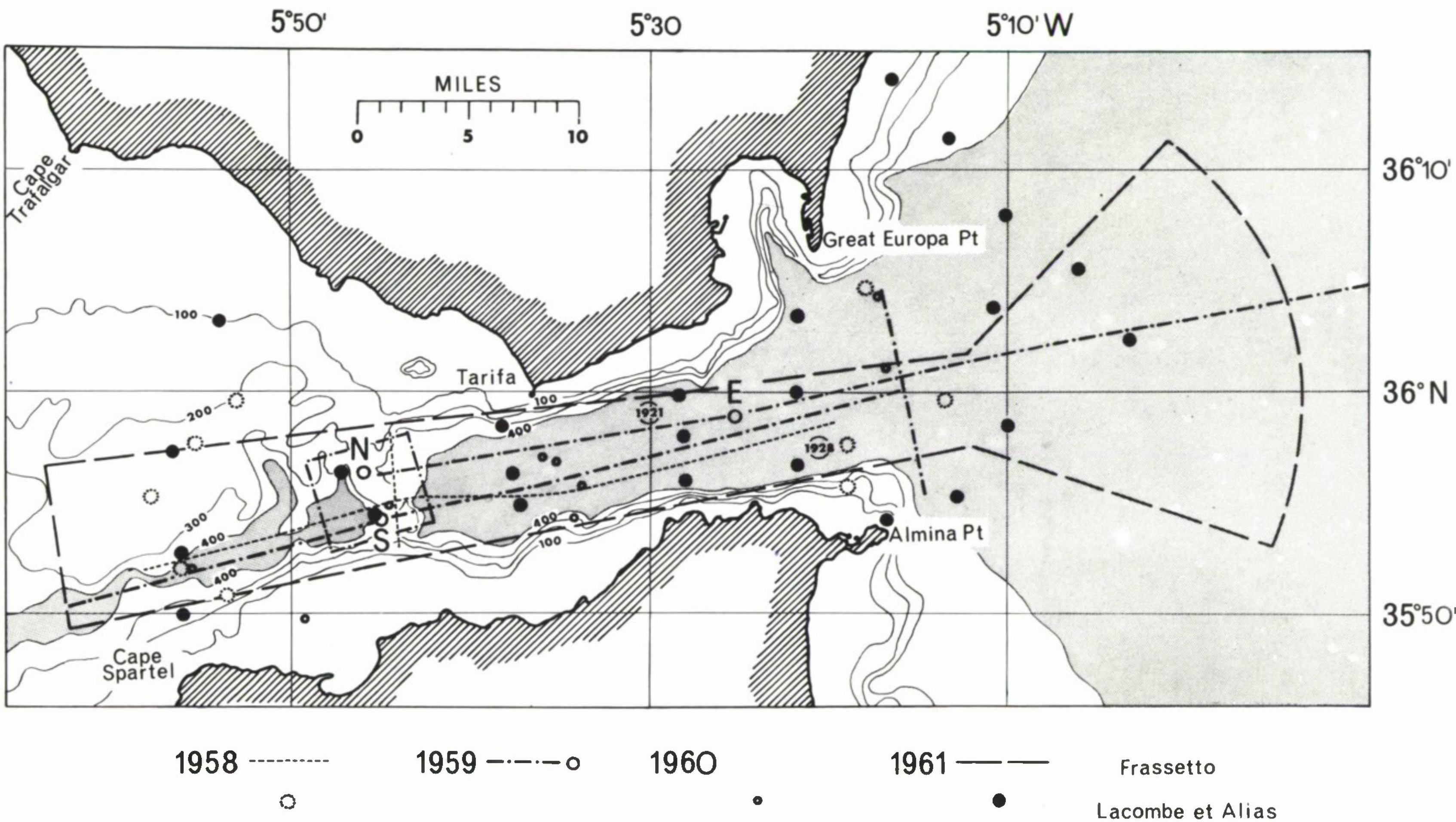
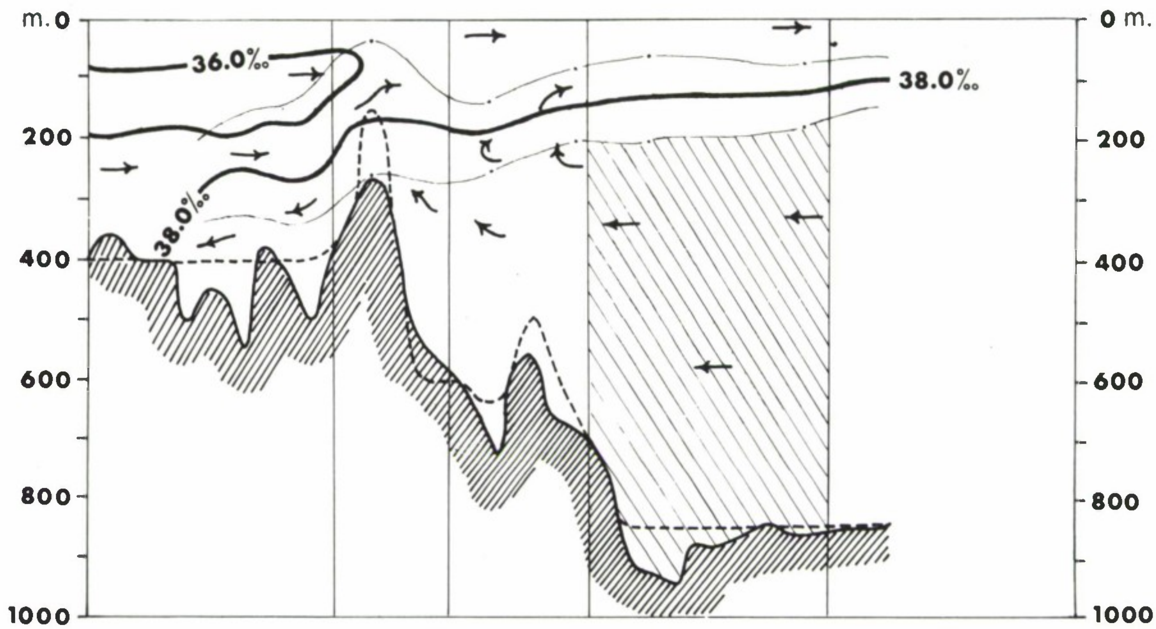


Fig. 5 Oceanographic studies in the Strait of Gibraltar used as a basis for this report. Circles indicate fixed stations held during three expeditions sponsored by the NATO Sub-Committee on Oceanography (Lacombe et al.) with the exception of positions N, S and E held by Frassetto in 1959 and the dated circles held by the DANA in 1921 and 1928. Dotted and dash-dotted lines indicate the ships' tracks in 1958 and 1959, but for 1961 the broken line encloses the area of study. All three of these studies were made by the author in cooperation with WHOI.



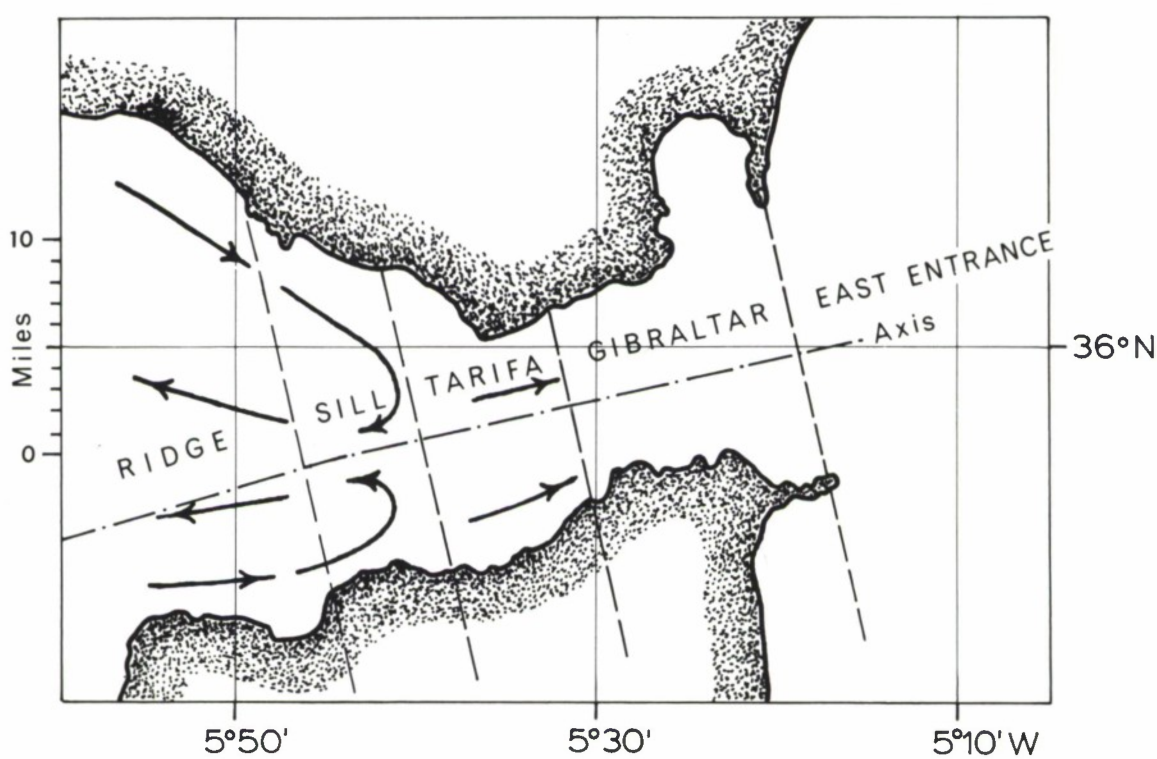


Fig. 6 Simplified model of the hydrology of the Strait, showing isohalines, generalised currents and a regional sub-division. In the upper diagram, the 38‰ isohaline represents the interface between the lower Mediterranean water and the Atlantic water; the broken lines on either side of it indicate its range of vertical displacement. The lowest section of the Gibraltar region (shaded) is the area of least variability in the Strait.

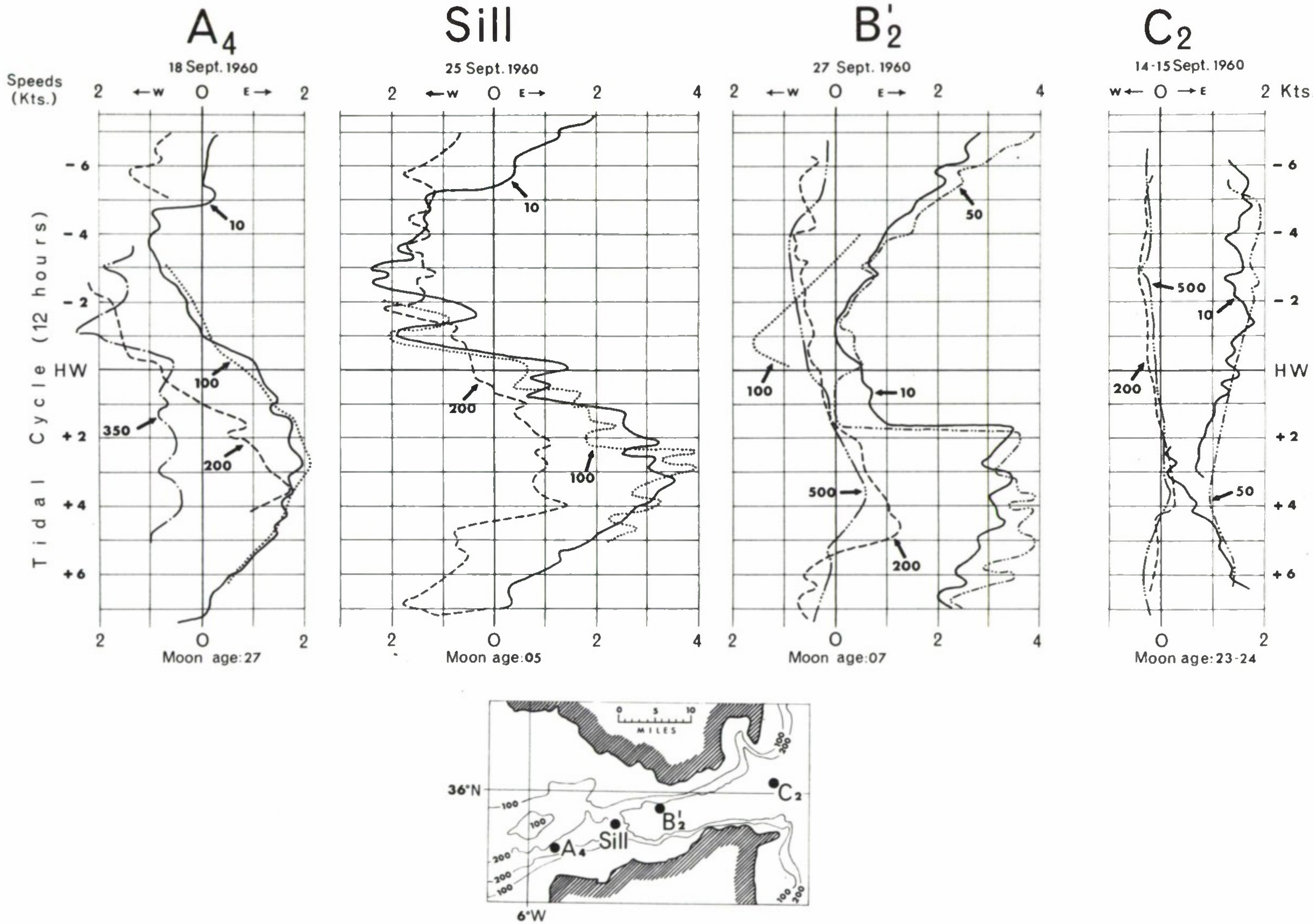


Fig. 7 Current changes at different depths during a 12 hr tidal cycle at four positions roughly along the axis of the Strait. Each curve relates to one particular depth: —— 10 m, -..-.. 50 m, ... 100 m, - - - 200 m, ——.——. 350 m, ——...——... 500 m. On the ordinate, time is represented as H.W. Gibraltar ± 6 hours, thus representing one 12 hour tidal cycle. On the abscissa, speed is represented in knots east or west of a centre line of zero speed, thereby showing current reversals. Each set of curves was collected on different dates during the 1960 expedition (Ref. 7).

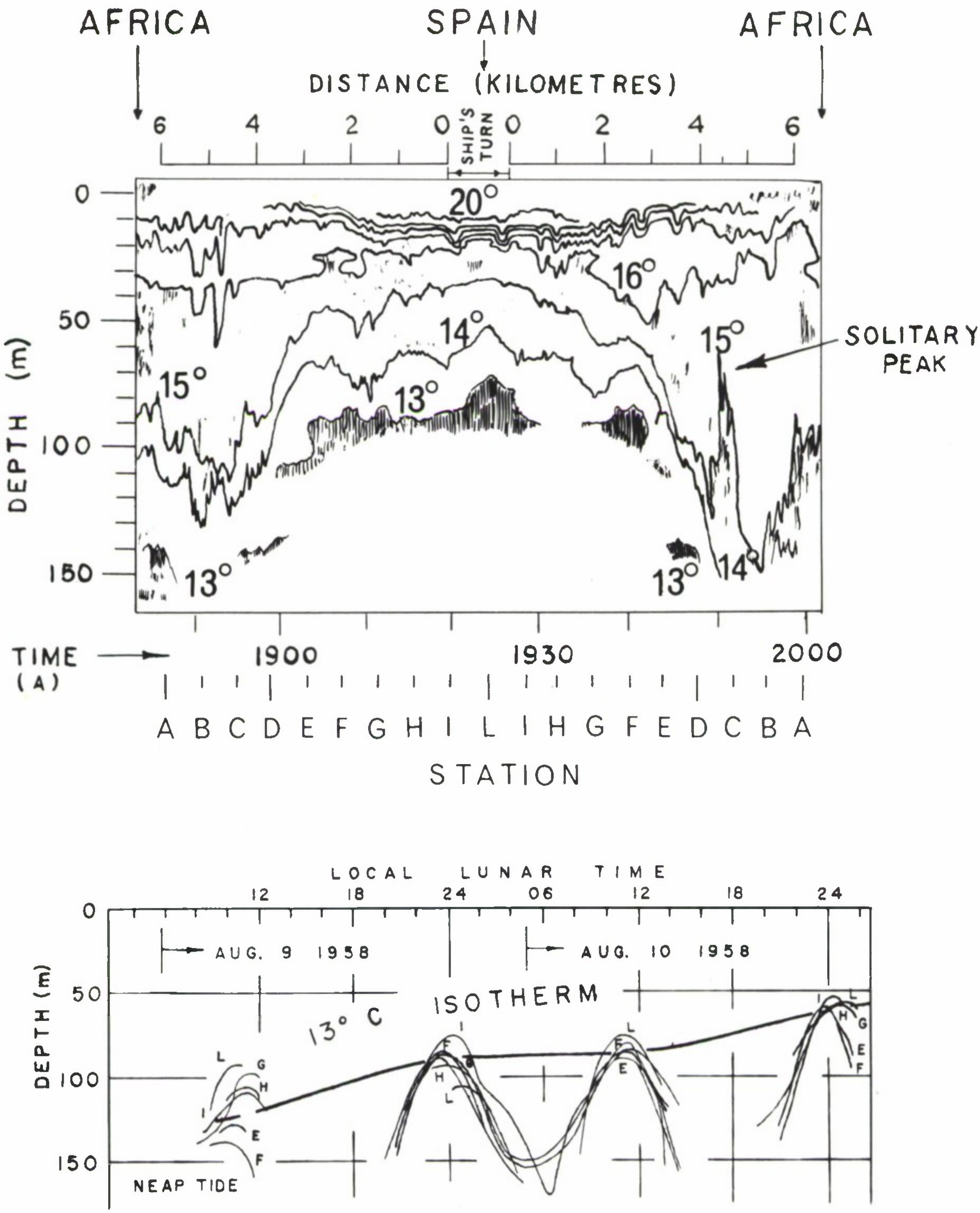


Fig. 8 A study of temperature changes over the Sill made in 1958 by means of the WHOI thermistor chain towed at 6 knots. The upper diagram shows isotherms recorded during a double traverse over the Sill. The lower diagram records long term oscillations in the depth of the 13°C isotherm at six fictitious stations (E to L) as recorded during about 35 double traverses over the Sill within a two-day period. This diagram reveals a semidiurnal period of internal tides in which the peaks coincide with the 1200 and 2400 local lunar time and the amplitudes increase from neap to spring tide at all stations.

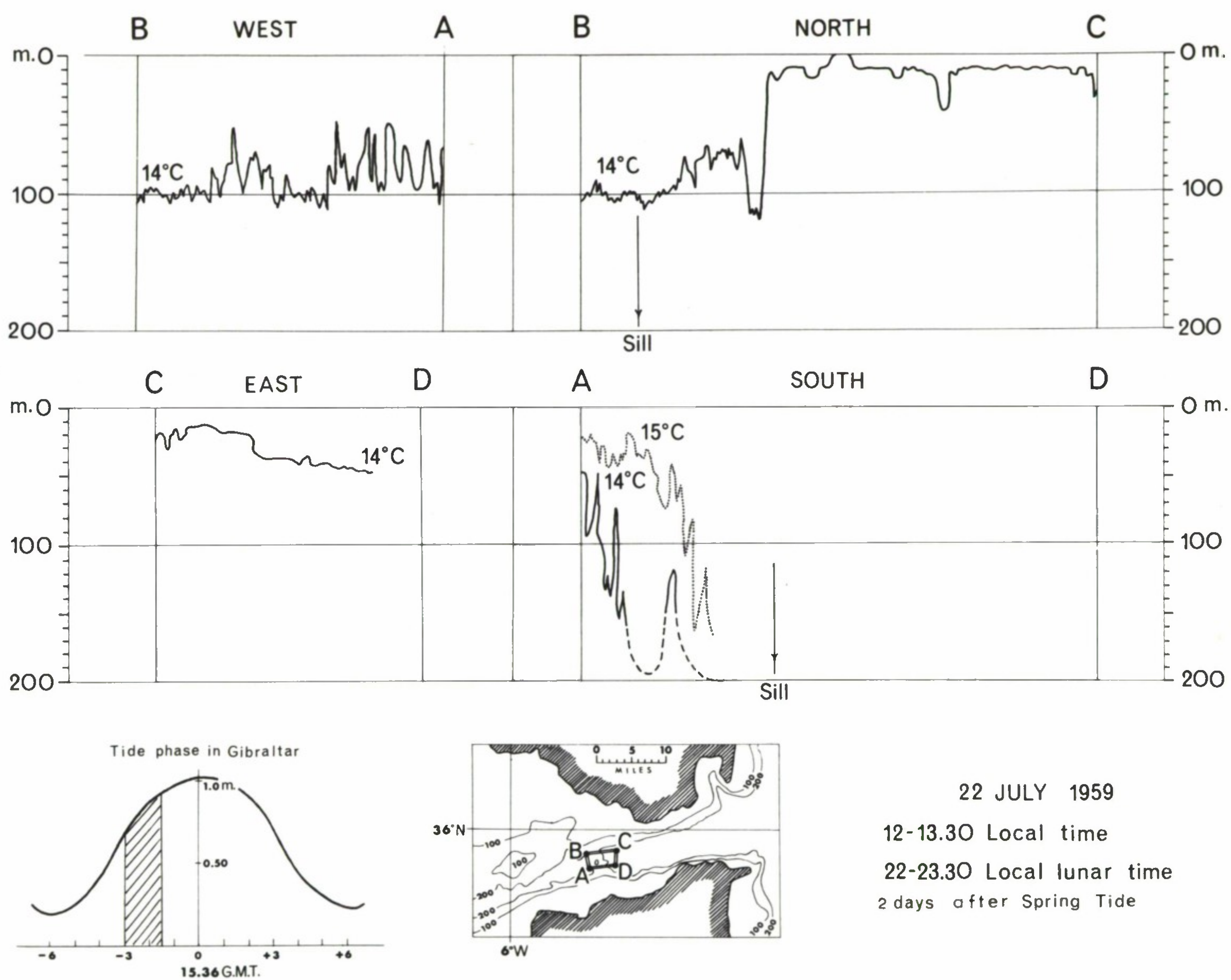


Fig. 9 Isotherm profiles around the Sill during a 1 1/2 hour run. The ship ran from a point over the Sill east of A, through A, B, and C to D. The conditions recorded occurred between H. W. - 3 hour and H. W. - 1 1/2 hours. The two diagrams on the left are as seen by an observer looking east; those on the right are as seen by an observer looking north.

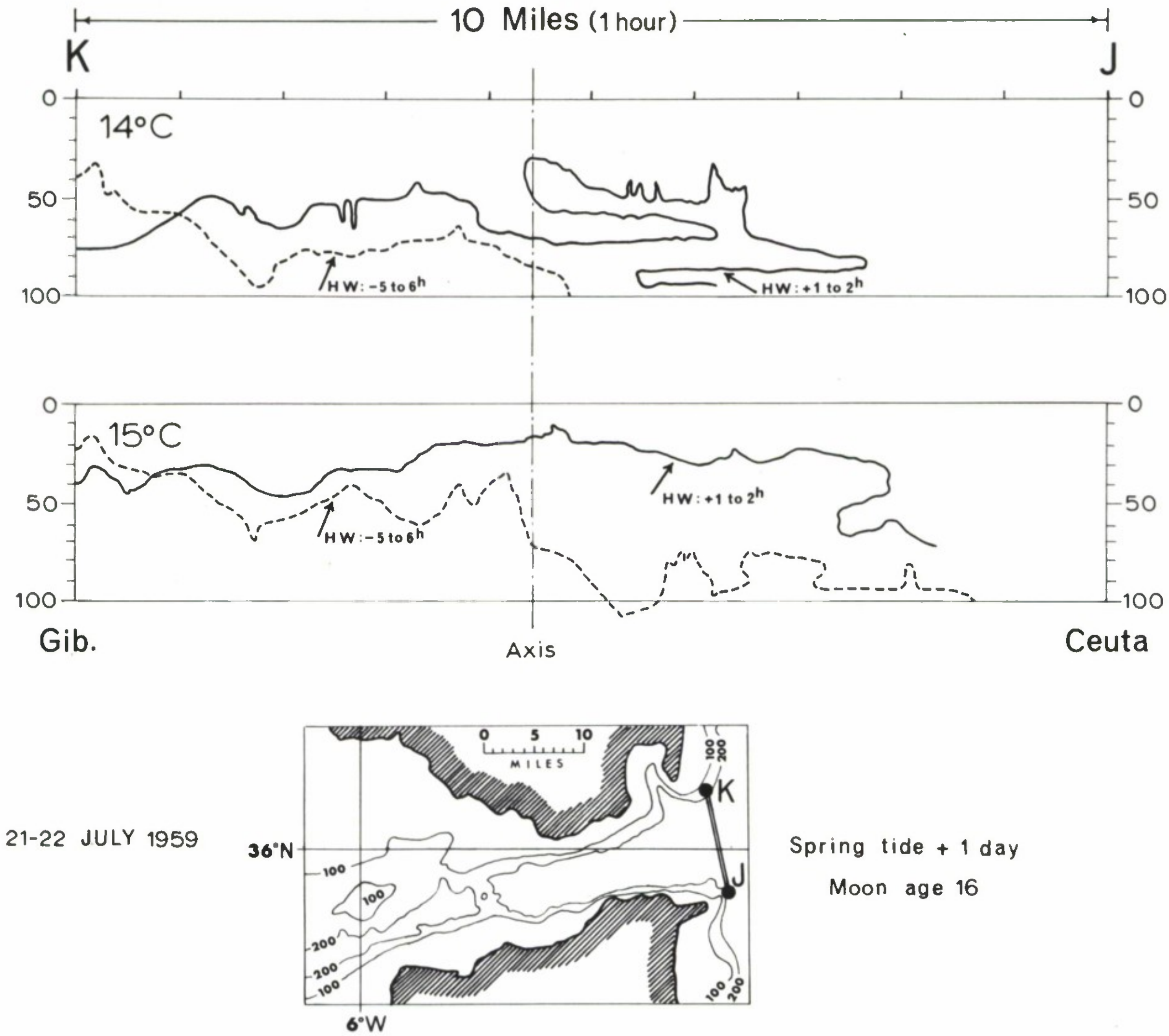


Fig. 10 Comparisons of the positions at a high internal tide (continuous lines) and a low internal tide (broken lines) of the 14°C and 15°C isotherms. Recorded across the eastern entrance to the Strait on traverses 10 miles long at ship's speed of 10 knots.

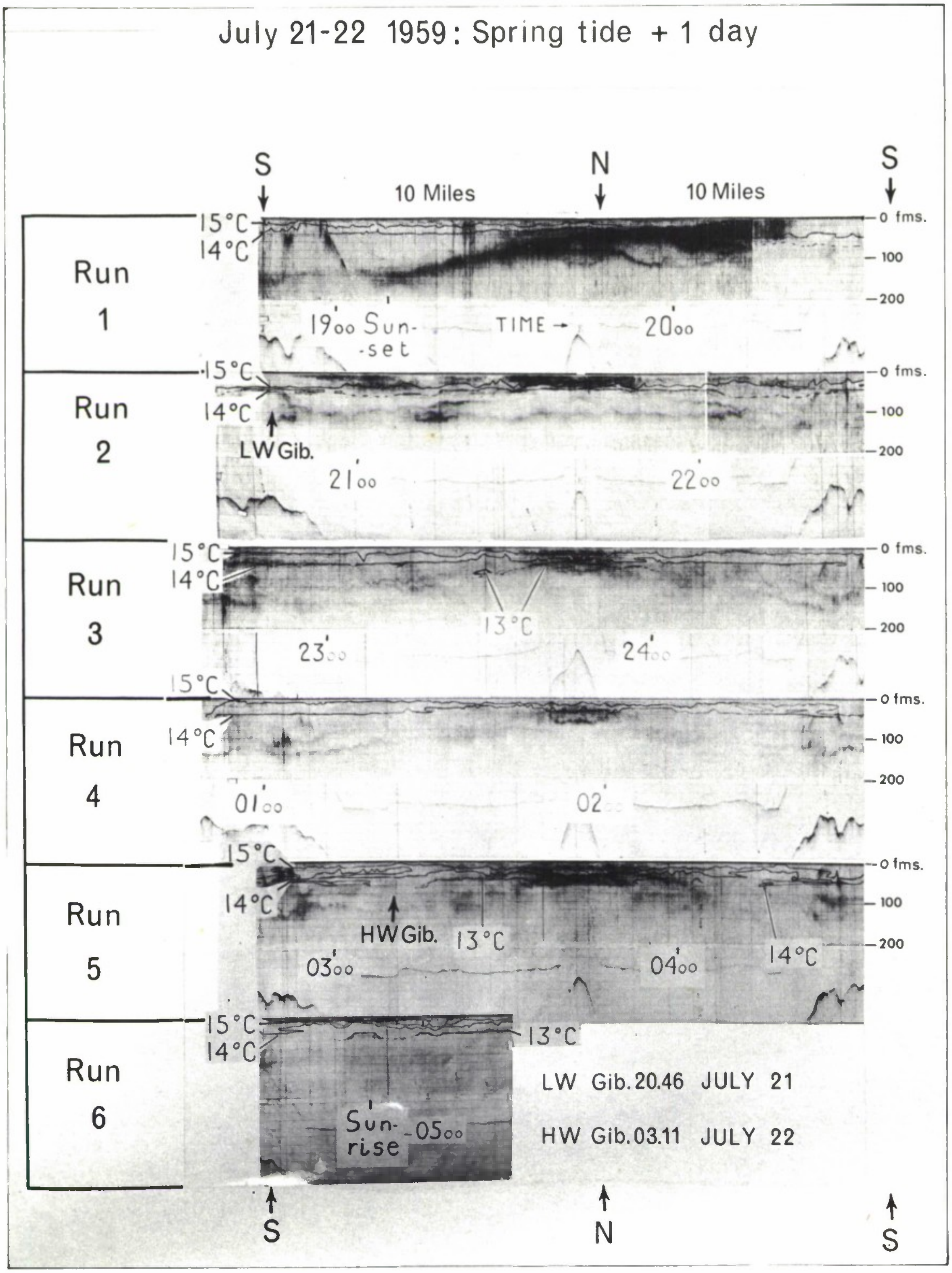


Fig. 11 Sound-scattering features recorded during 11 traverses of the eastern entrance to the Strait between sunset and sunrise.

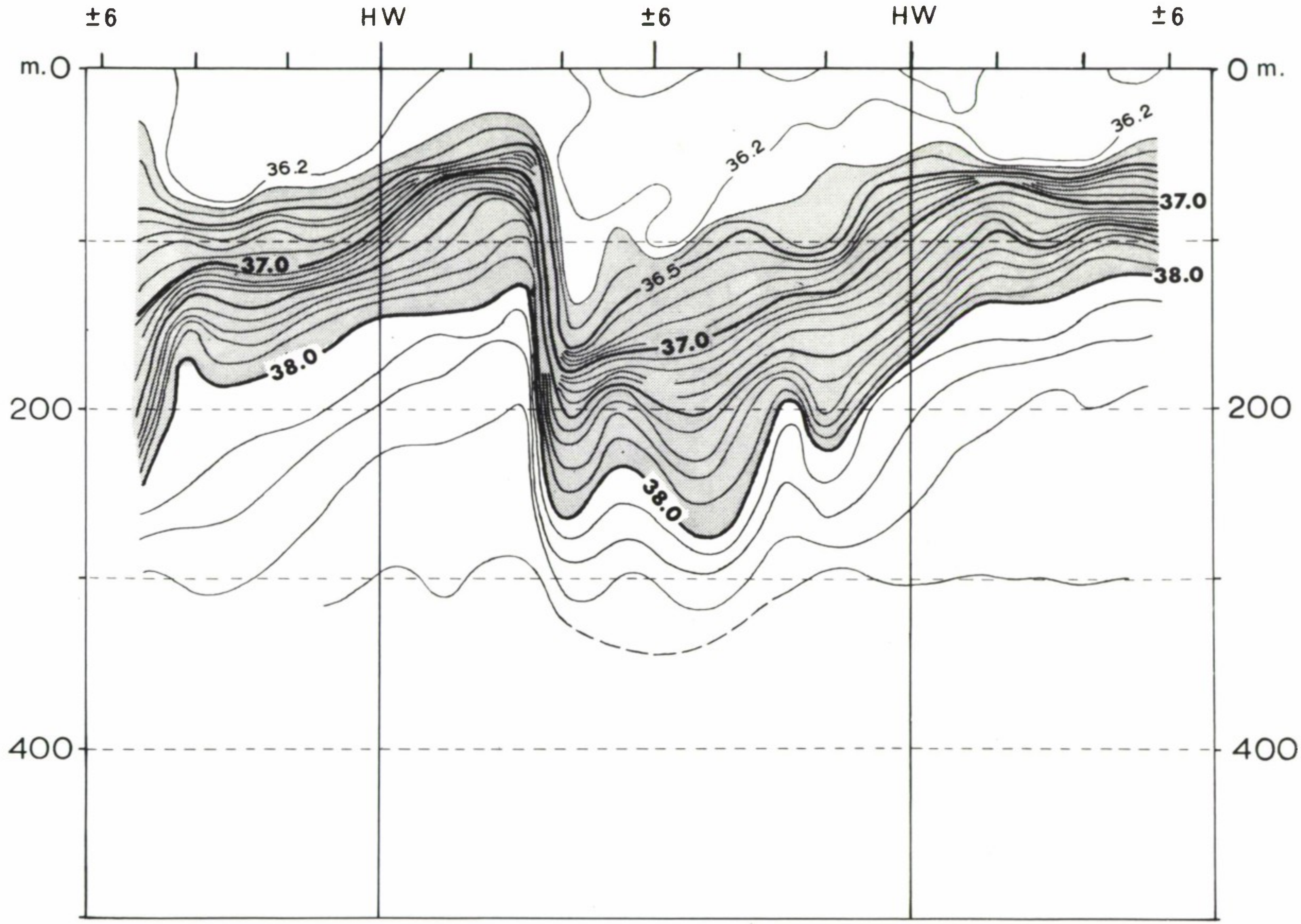


Fig. 12 Semidiurnal oscillations of the isohalines in the Gibraltar Region (at DANA's 1928 station, see Fig. 5) that suggests (at H. W. + 3 1/2 hr) conditions of dynamic instabilities and the possible generation of internal breakers. (Ref. 5).

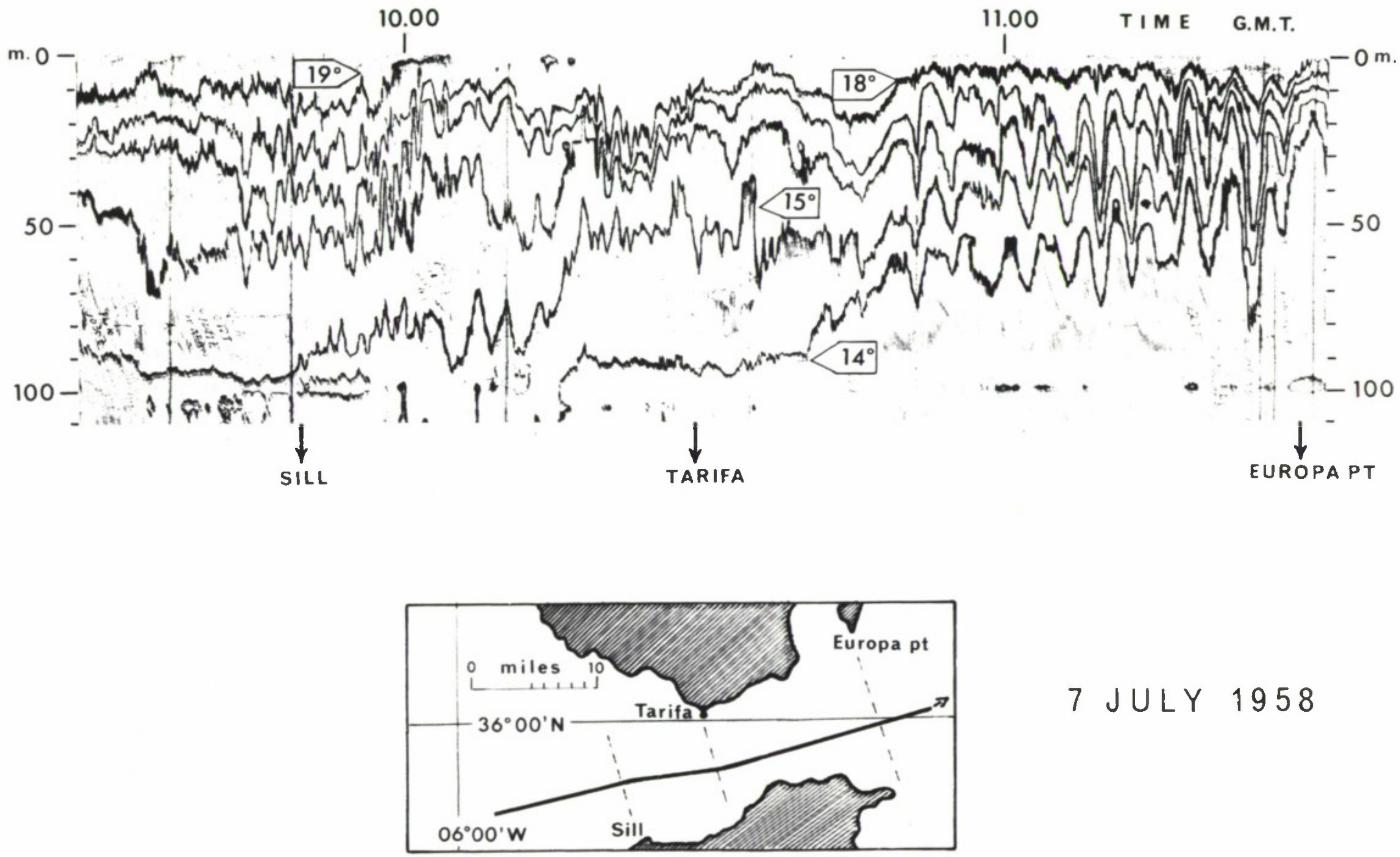


Fig. 13 Time-space sequence made with the thermistor chain along the axis of the Strait, showing a 10 mile long train of 13 waves with amplitudes of 45 m at the front and 15 m at the tail. The ship was running eastwards at 11 knots while recording.

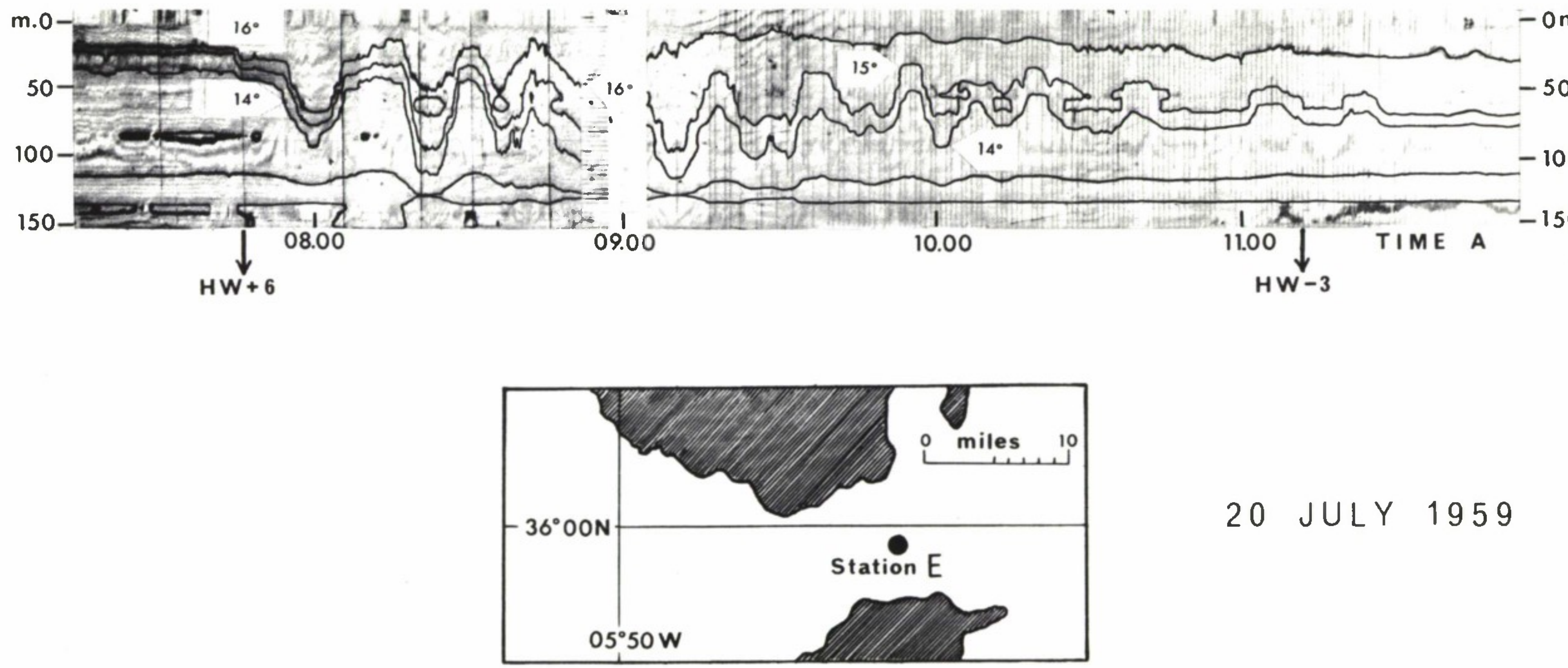
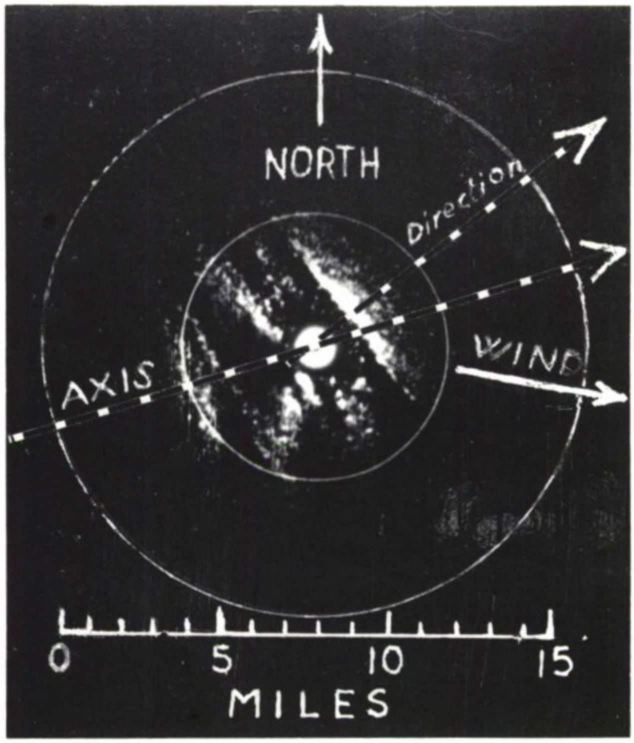


Fig. 14 Time-space sequence made with the thermistor chain at Station E, showing a wave train passing the station and decreasing in amplitude with time.



Date: JULY 21 1959

Time = HW + 3½

Wind speed 25 Kt.

Moon Age = 15

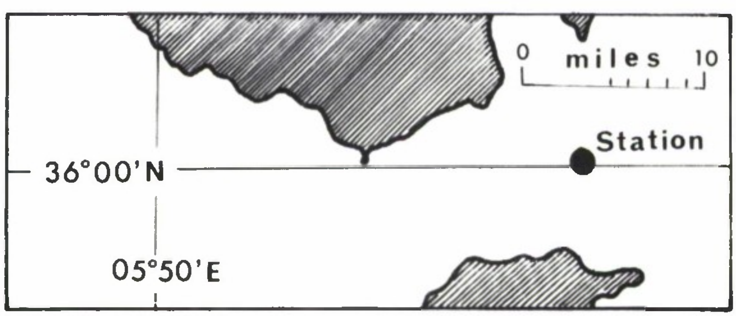
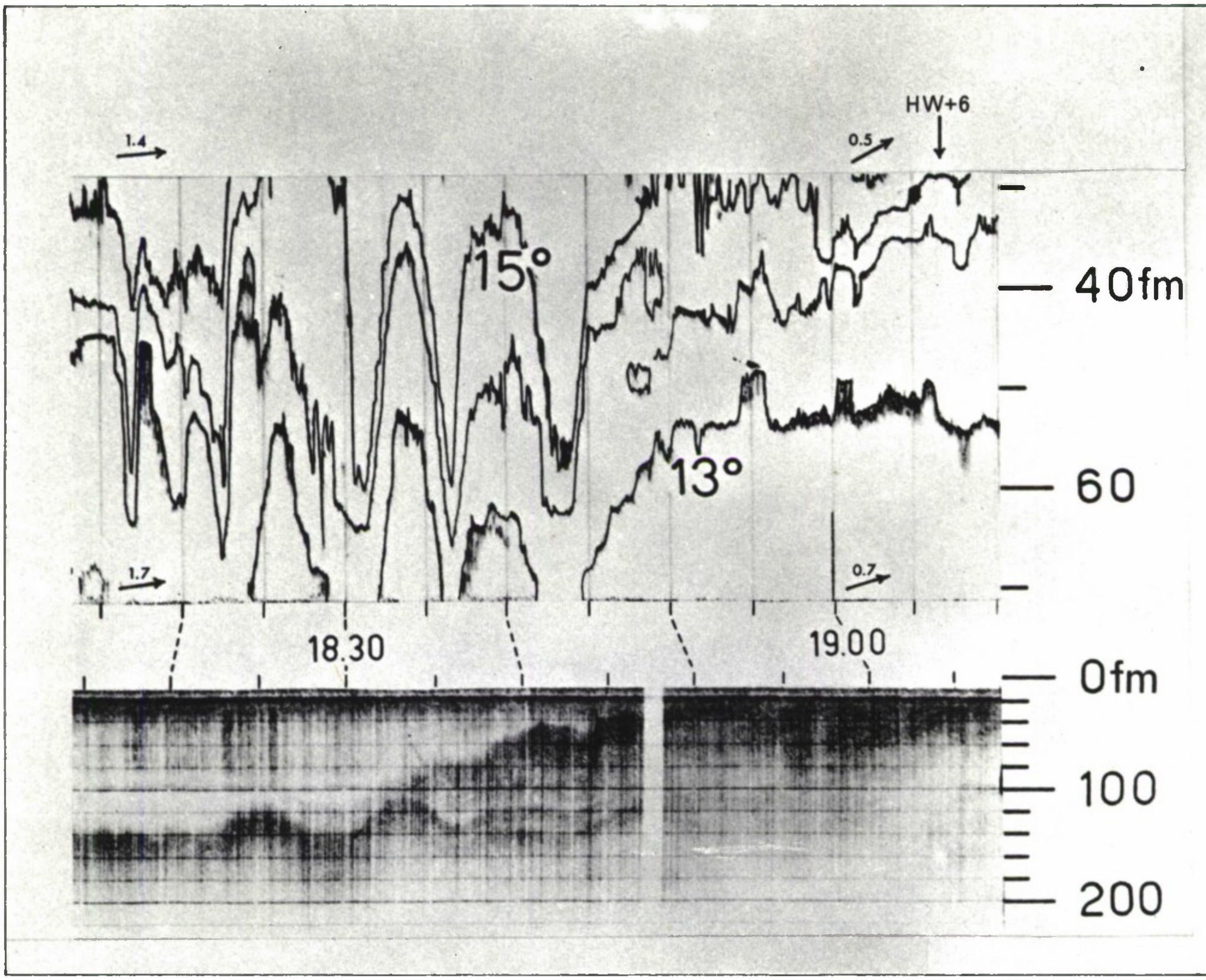


Fig. 15 Radar screen picture showing the presence of surface breakers over the front of a wave train as it passed the ship. The wind was blowing at 25 knots in the direction shown.



23 Sept. 1961

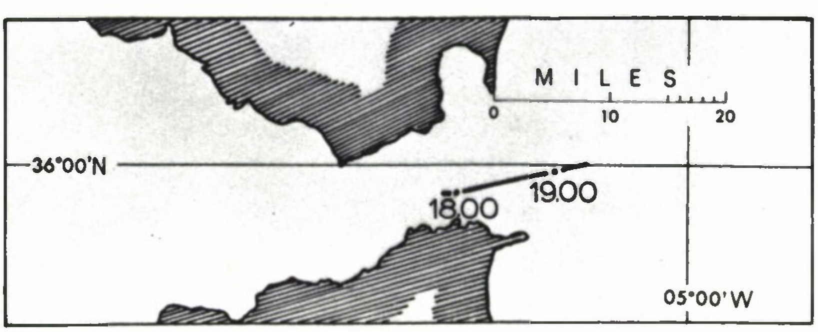


Fig. 16 Correlation between the isothermal oscillations in the first 70 fathoms and the oscillations of the Deep Scattering Layer around 130 fathoms. Small arrows in the upper diagram show the speed and direction of the current. The lower diagram also shows the vertical migration of the DSL at sunset (1835 to 1900).

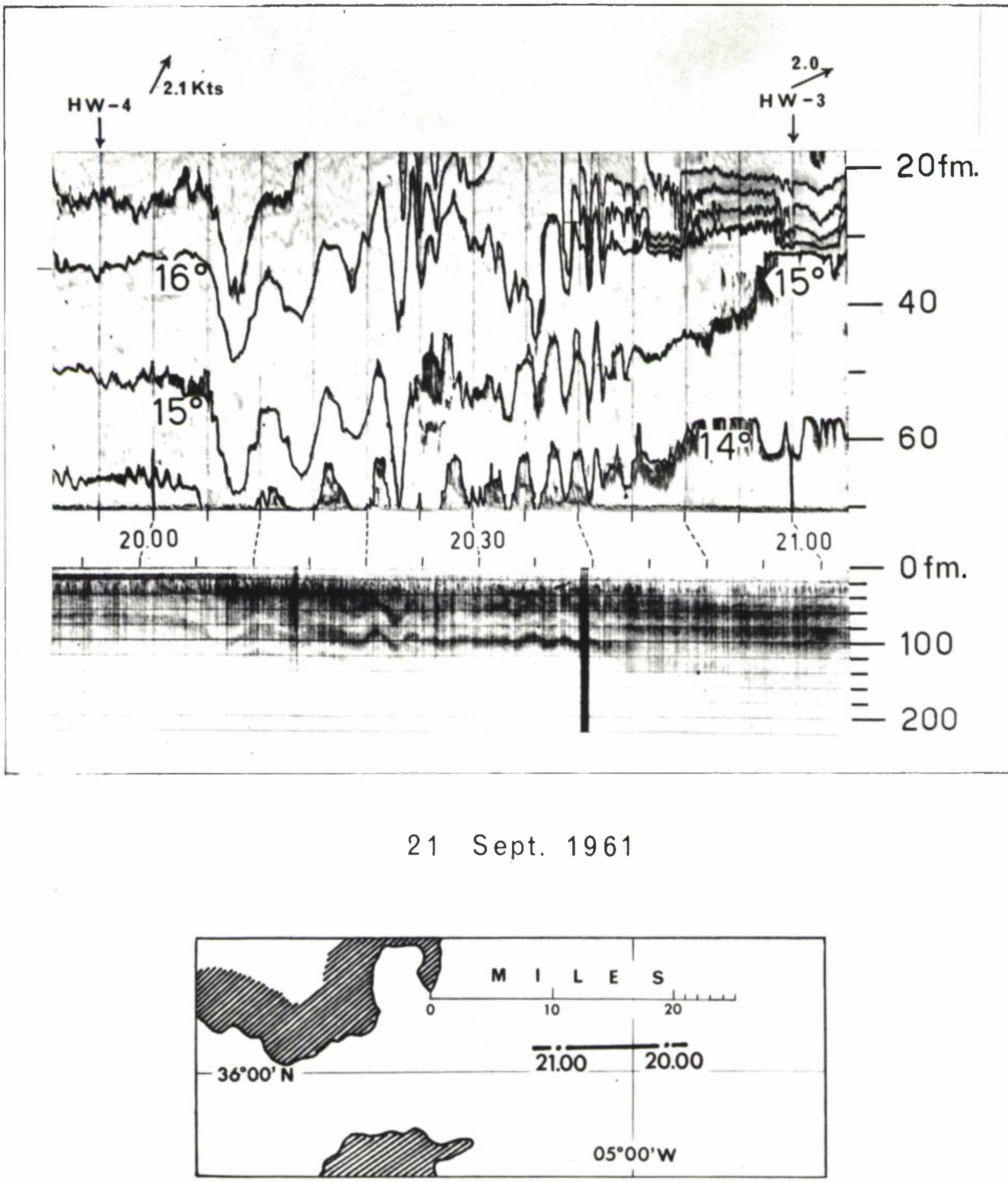


Fig. 17 A second example, of the same type as Fig. 16, made further east on passage through a train of waves. Oscillations of the DSL were recorded at 120, 100 and 60 fathoms. Past the wave train (at 2045) both the isotherms and DSL resumed a uniform distribution and profile.

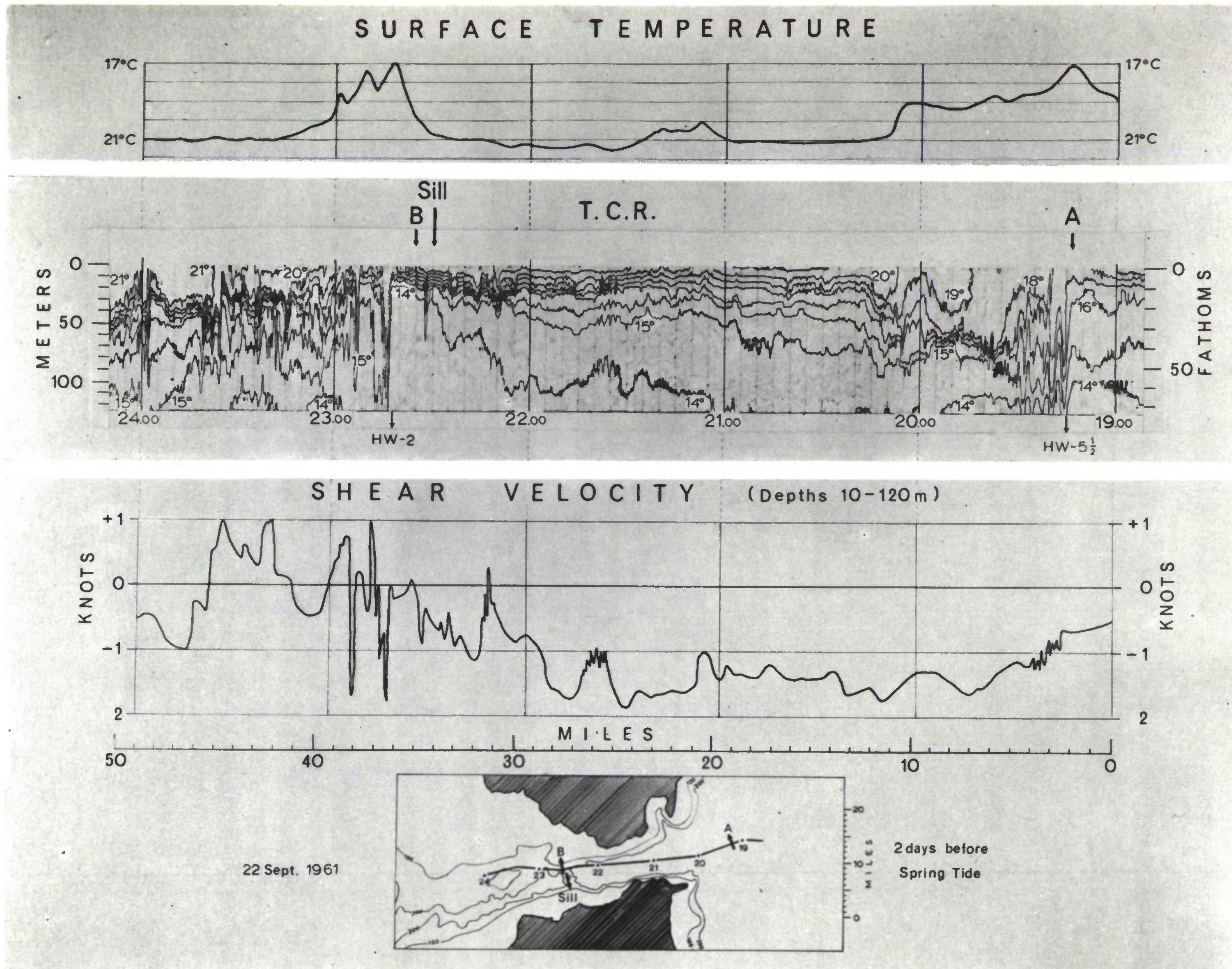


Fig. 18 Records made by a ship steaming westwards along the axis of the Strait and passing over two wave fronts: one at A, just about to dissipate into the Mediterranean, the other at B, forming over the Sill. The upper chart shows the fall in surface temperature over the wave front; the second chart shows the isothermal oscillations recorded by the thermistor chain (T. C. R.); the third chart records the relative changes in shear velocities and shows that large changes in shear velocity are associated with large amplitudes in the isothermal oscillations.

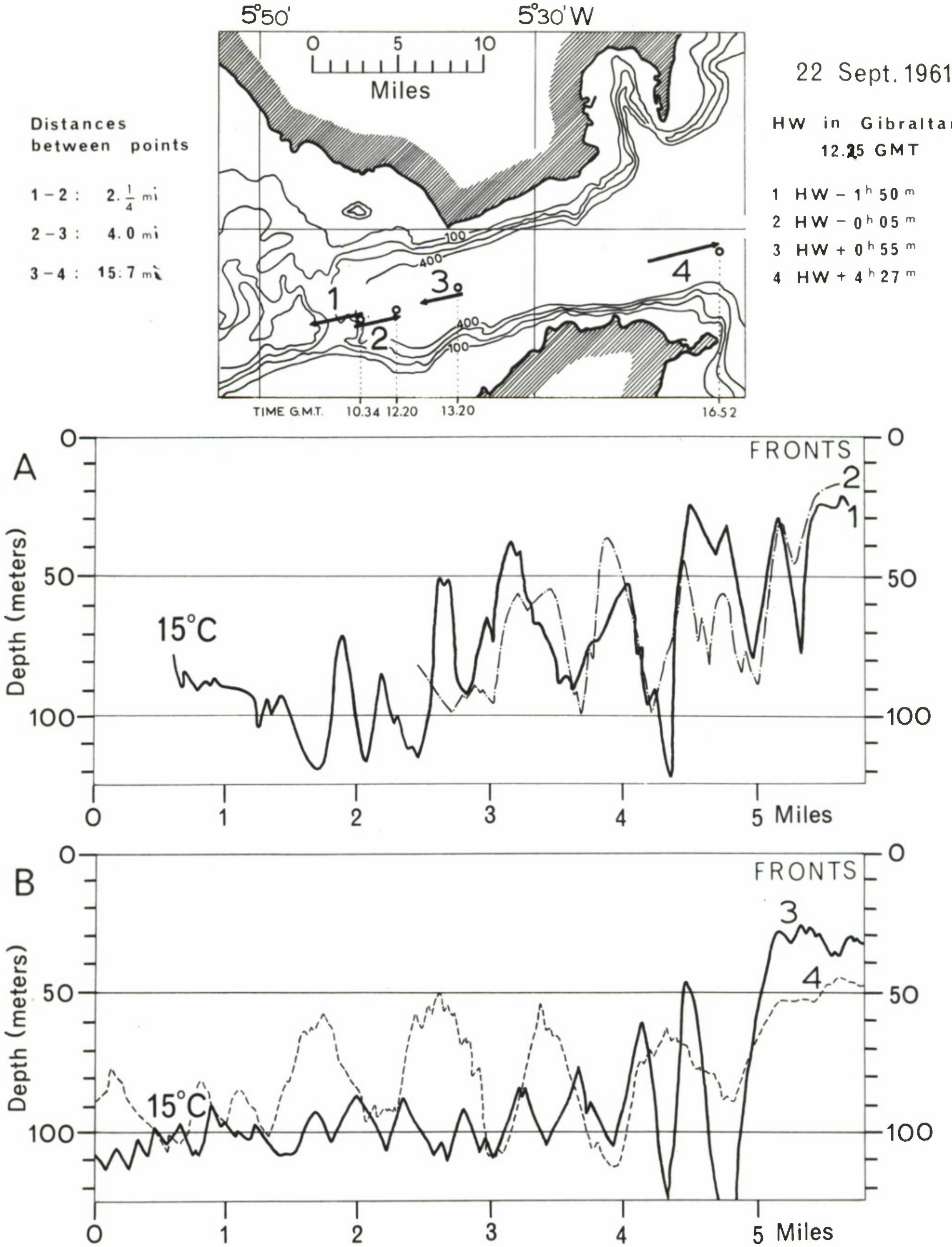


Fig. 19 A comparison of the profiles (represented by the 15°C isotherm) of a single train of waves recorded during four subsequent passages of the ship along the axis of the Strait on 22 September 1961. The four numbered circles represent the positions at which the ship crossed the front of the eastward moving wave train; the arrows indicate the directions in which the ship was moving. The speed of the front increased from 1.3 knots between positions 1 and 2 to 4.4 knots between positions 3 and 4.

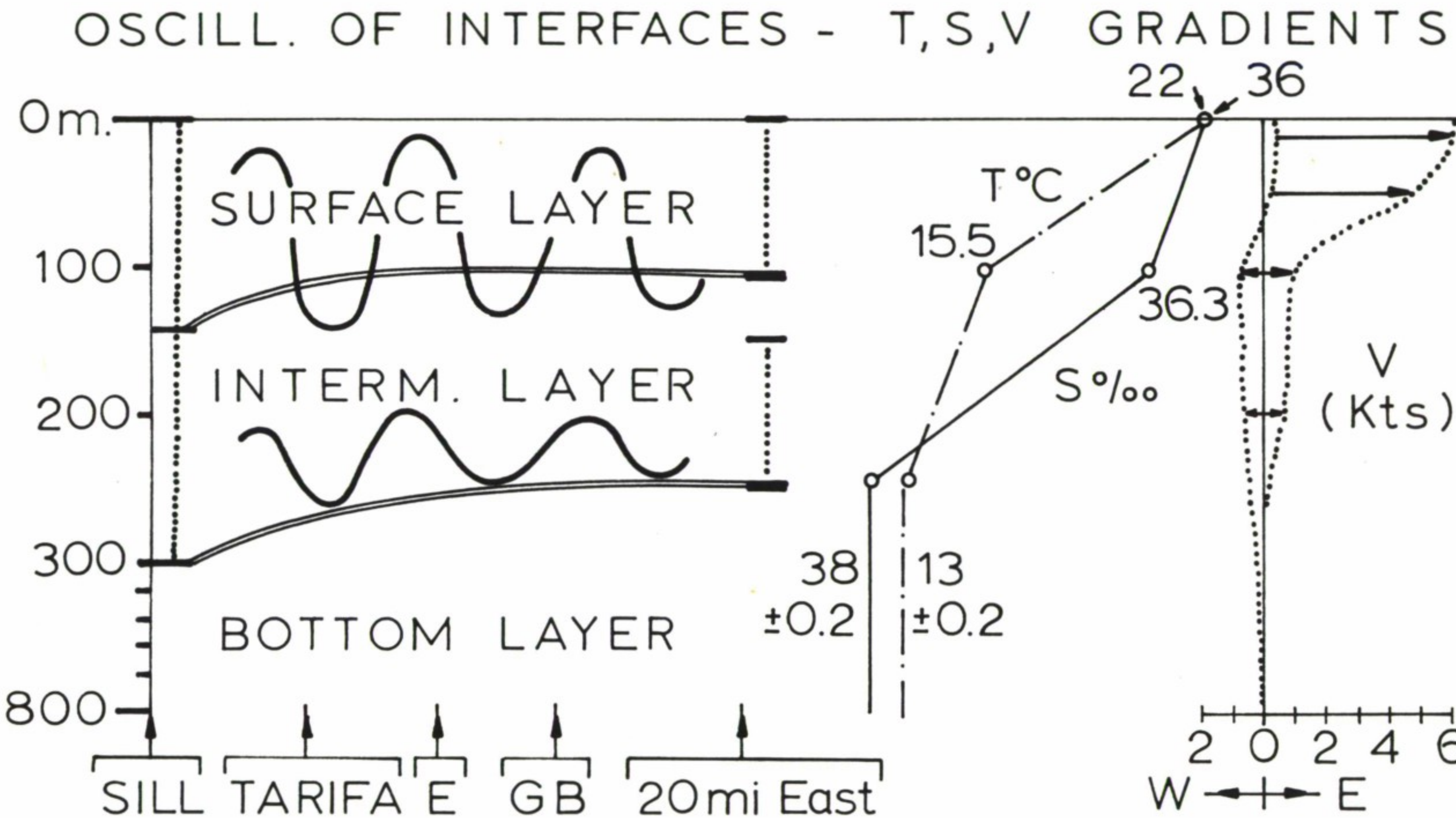


Fig. 20 Simplified model to explain the water structure in the deep, centre channel east of the Sill. The double lines on the left represent the extreme depth of the interfaces and the long arrows on the right represent the extreme values of the currents in the surface layer. Both the surface and intermediate layers, however, are layers of great perturbation.

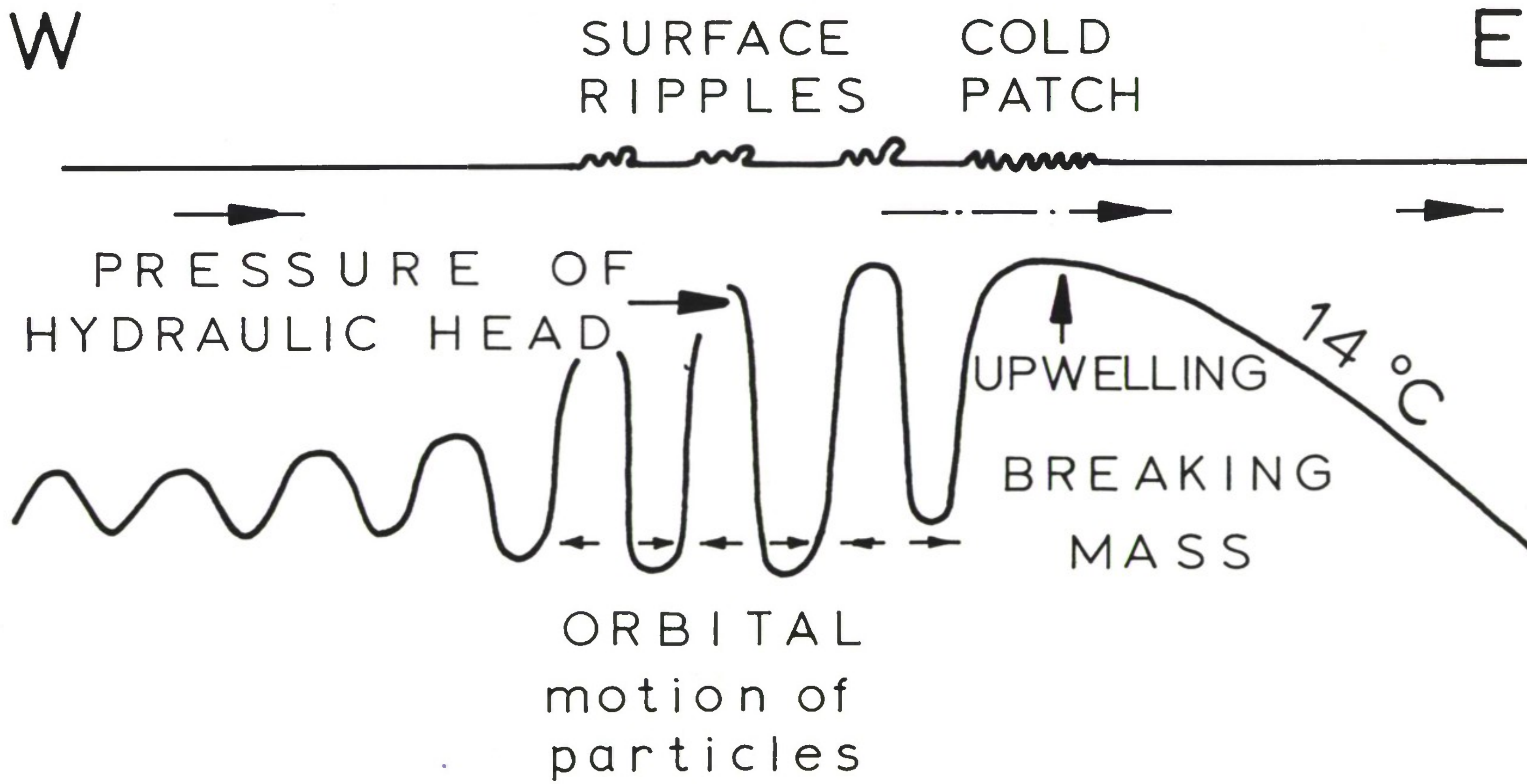


Fig. 21 Simplified model to explain the internal wave trains in the Strait.