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A LINEAR PATTERN ON THE SEA FLOOR AND ITS INTERPRETATION

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(Plate I and Text-fig. 1)

The redistribution of sediments by tidal streams has been demonstrated in a number of ways in the seas around Britain. For example, the numerous banks in the North Sea are elongated parallel to the streams, while the depth and position of certain channels are subject to such important changes in position that re-surveys have to be made each year or so (Robinson, 1956). In the same region the streams, reaching about a knot or more at the surface, have wrought a large area of sand floor into ridges normal to their path. Off the Dutch coast the grade of the sand (Jarke, 1956) decreases in their inferred direction of advance (Stride & Cartwright, 1958). Similar relief is found even at 90 fathoms near the edge of the continental shelf, at the western approaches to the English Channel (Cartwright & Stride, 1958). Pratje (1950) has shown that the occurrence and grade of loose sediment on the floor of the Channel as a whole is directly related to the velocity of the streams overhead.

Fresh evidence can now be given of the action of tidal streams on some flat floors of the English Channel and North Sea.

SURVEY

During April 1958 a survey of the floor (Fig. 1) was made by R.R.S. 'Discovery II' in the large open bay between Start and Dodman Points, near Plymouth, using echo-ranging equipment such as described by Chesterman, Clynick & Stride (1958). The present equipment had the following characteristics: frequency 37 kc/s; pulse length 1 ms; beam shape 1·8° (horizontal), 11° (vertical), with four side lobes in addition; tilt angle 5–7° below horizontal. A sample of the records obtained is shown in Pl. I, with the range abeam of 732 m (800 yards) as the horizontal scale.

During September 1958 five cores and photographs of the floor were taken by R.V. 'Sarsia' at positions shown near P in Fig. 1.

THE LINEAR PATTERN

The pattern has been recognized in a curved belt about 7 miles wide, roughly parallel to the Cornish coast from between Rame Head and Eddystone to Dodman Point. It does not extend as far east as the line run north-east from

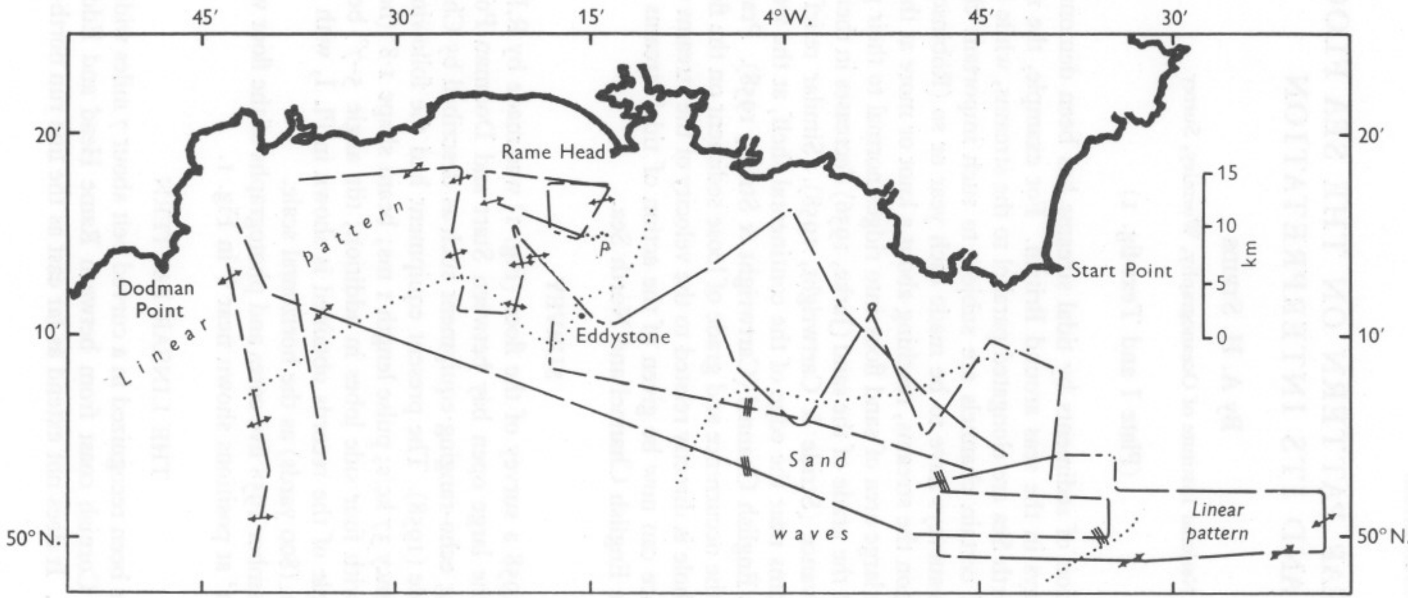

Fig. 1. Courses on which the acoustic survey was made are shown by thick lines. The patches were elongated parallel to the arrows and the crests of sand waves lay parallel to the groups of 3 lines.

Eddystone. The southern margin is gradational; the south-western limit has not yet been found. The floor is virtually devoid of relief except for the small regional depth gradient.

The acoustic pattern consists of well defined, almost parallel patches of contrasting reverberation level, such as extend across Pl. I. The low reverberation patches certainly range up to 1·8 km in length and between 50 and 200 m wide and about the same distance apart. In the middle of the region the patches are wider. Some patchiness is found farther south from here and may be present south of Start Point.

Off the East Anglian coast the patches are locally well developed, certainly reaching 1·4 km in length, yet only 90 m in width. The boundaries are generally sharp, the ends are tapered.

In each place the patches are elongated parallel to the path of the strongest tidal streams. For the Plymouth region the observed orientation of the patches is shown by the arrows in Fig. 1. The patches south of Start Point are orientated normal to the crests of sand waves occurring nearby, themselves an indicator of the direction of the streams (Chesterman *et al.*, 1958). The sand waves are up to 3 m high and mostly between 100 and 250 m apart. They are smallest and least well developed at the margins of the patch.

TABLE 1. LITHOLOGY OF CORES TAKEN NEAR EDDYSTONE

Core no.	Layer thickness (cm)	Lithology	Cumulative weight percentage of coarse fractions		
			> 12 mm	> 6 mm	> 2 mm
1	16	Fine sand with shell and rock fragments. Trace of coal	3	10	25
	10	Coarse reddish shell 'gravel' with about 30 % sand. Boundary gradational	—	—	—
2	1	Fine sand on surface	0	0	5
	13	Fine sand with shell and rock fragments. Trace of coal	—	—	—
	10	Coarse 'gravel' of shell and rock debris	—		
3	13	Fine sand with shell fragments. Trace of coal	0	2	10
	4	Coarse 'gravel' of shell and rock debris with about 20 % sand	—	—	—
4	3	Fine sand with shell and rock debris	0	4	16
	12	Same as above with trace of mud	—	—	—
	8	Coarse gravel of shell and rock debris up to 2 cm diameter, with about 20 % sand	—	—	—
5	2	Fine sand	0	0	10
	16	Sand at top grading down into gravel	—	—	—
	4	Fine gravel of shell and rock debris	—	—	—

COMPOSITION OF THE FLOOR

Between Eddystone and Plymouth grab sampling has revealed that the floor may be made of almost pure sand or sand with an appreciable fraction of coarser material, greater than 2 mm in diameter (Holme, 1953).

Five cores were taken by gravity corer in this patchy floor at the positions shown in Fig. 1 and are described in Table 1 (uppermost bed first in each case).

The cores reached from 17 to 26 cm below the surface. The base of core 1 was red in colour, rather suggesting that bed rock was nearly reached, although Holme (1953) found more than 70 cm of superficial sediments nearby.

A coarse gravel, consisting mainly of fragments of large shells with subordinate sand and rock debris, was found at the base of cores 1–4, while in core 5 there was a well-graded fine gravel.

Above the basal bed there was up to 16 cm of sand carrying as much as 25% of particles between 2 and 14 mm in diameter. In cores 2 and 5 these sediments were capped by a thin layer of sand. The abundance of the coarse fractions in the surface layers is shown in Table 1, although the figures are misleading as the particles are largely platey shell fragments.

Three samples, taken by Van Veen grab, from similar patch floor near the East Anglian coast consisted of the following components:

Sample	Sand (%)	Gravel and stones (%)
1	10	90
2	60	40
3	70	30

The first sample showed that the floor was locally made of gravel and stones carrying polyzoa and hydroids. These were absent from the second sample so that the coarse fraction was probably covered by sand. In the third case the floor proved to be made largely of sand.

DISCUSSION

The acoustically patchy floor must be an expression of differences in composition since at both localities the floor was flat. The patches of low reverberation level should correspond to the patches of sand while the high reverberation level should be caused by the presence of coarser sediments. This correlation can be made with confidence for the East Anglian example because of the considerable difference in the grade of the sediments (Chesterman *et al.*, 1958). There is good reason to believe that in the surface sediments of core 1, of the Plymouth region, there is sufficient coarse, platey material to make the sediment readily distinguishable acoustically from the surface sands of cores 2 and 5. The uppermost material of the remaining cores is probably representative of the high reverberation patches also. The larger area of acoustically patchy floor, which extends to the west of the region sampled, must be due to similar types of lithological contrast.

The acoustic pattern is interpreted as representing patches of sand lying on either pebbles or sand with up to 25% shell fragments between 2 and 12 mm wide. The patches of sand are longer than broad. The ratio is largest off the east coast where the streams reach more than 2 knots.

In both localities the streams are virtually linear, flowing to-and-fro parallel to the length of the patches. There is a difference of more than 0·1 knot between the ebb and flood streams so that the sand is probably being driven into the two localities.

The growth of a similar but smaller pattern has been seen during sand storms in a desert by Bagnold (1954, p. 176) and in a flume (Casey, 1935) under an unidirectional stream. In a desert the parallel sand strips average $\frac{1}{2}$ km in length (replacing each other *en échelon*), are 1–3 m wide, 1–2 cm thick and are separated by 40–60 m of flat, pebble-covered ground. They appear to be initiated when a strong sand-laden wind blows over a uniformly rough surface (of pebbles, say) due to lateral instability of the flow, and grow so long as the drag over the sand exceeds that over the pebbles.

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SUMMARY

An acoustic survey has been made of two regions where there is marked geographical variation in the nature of the surface sediments. It is shown that the patches are elongated parallel to the prevailing path of the tidal streams and a mechanism of origin is suggested.

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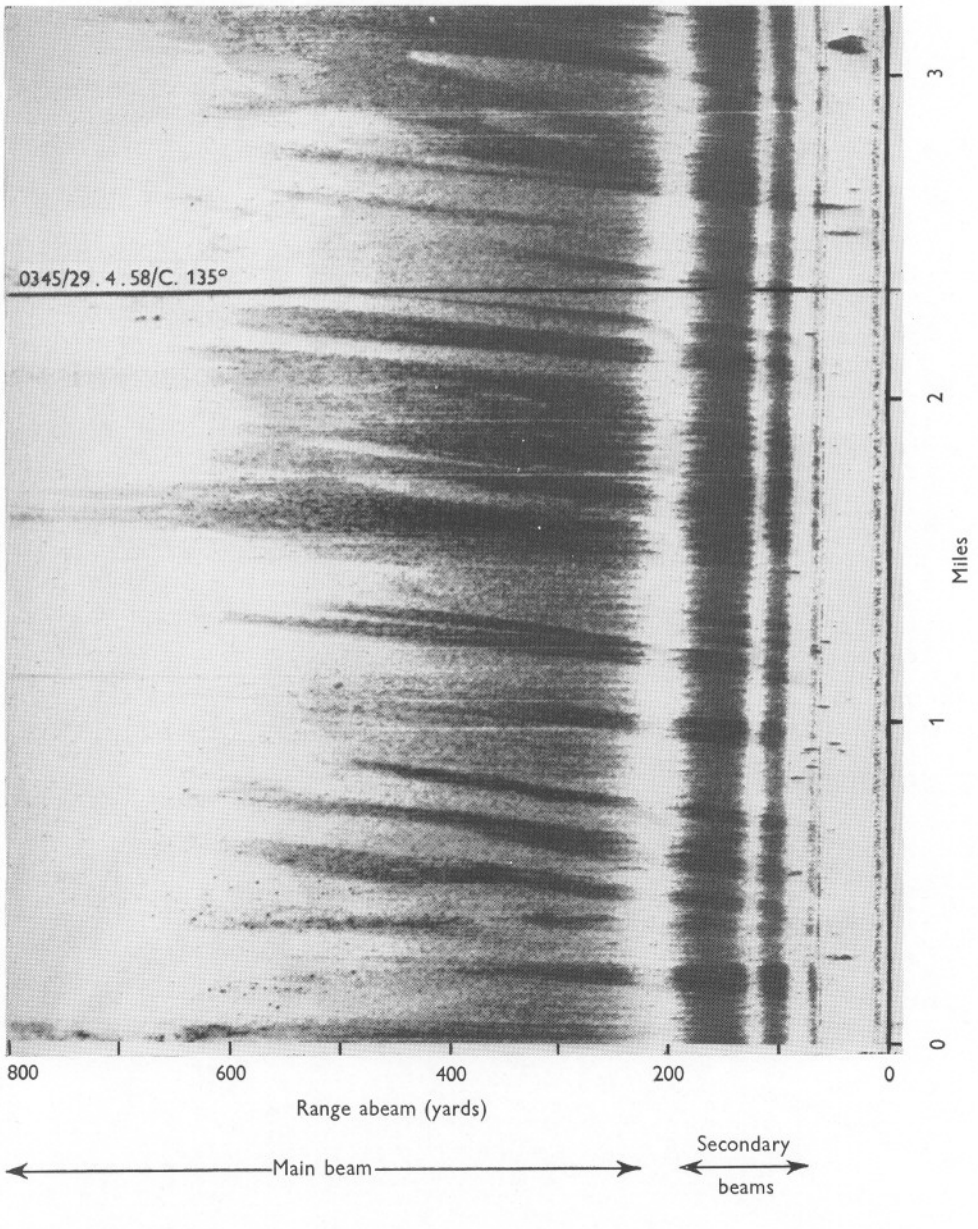
EXPLANATION OF PLATE I

Plate I. An acoustic map of patches on the floor near Eddystone. Range abeam of ship of 800 yards is exaggerated ×7 distance scale. The light toned patches extending diagonally across the record are associated with patches of sand.


0345/29.4.58/C. 135°
3
2
1
0
Miles
800
600
400
200
0
Range abeam (yards)
Main beam
Secondary
beams

(*Facing p.* 318)