GEOLOGICAL INTERPRETATION OF ASDIC RECORDS

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Navigational charts indicate the variable composition of sea floors, but only locally can boundaries between the different types of bottom be drawn with any confidence, although such information would be of interest to a wide variety of people working at sea. Engineers sometimes search for a rock floor on which to build permanent structures but prefer a flat floor on which to lay a pipeline. Tidal streams (and waves) can move a cable lying on rock enough to cause damage and make it inoperative, yet placed nearby it could be so buried by sand as to be made safe. Ecologists wish to find out what type of ground is preferred by bottom-living animals; geologists wish to know the origin of the sedimentary patterns and to study rock outcrops.

By means of echo-ranging equipment on R.R.S. *Discovery II,* the mapping necessary for such studies can be done rapidly on continental shelves. Since the accounts of detailed work are rather scattered it seems worth while to show in a single paper some geological features which have been recognized.

The equipment used has a frequency of 36 kc/s and pulse length of 1 m/s. The acoustic beam is fan shaped, 1 ½ degrees wide horizontally and 11 degrees vertically. It points out normal to the length of the ship and is tilted down at a few degrees below the horizontal, the actual value being determined by the depth of the water and the maximum slant range of 800 yards. Four side lobes reach the floor at lesser ranges, and one of these, being vertical, gives a profile of the sea floor which can be extended laterally into the plan view occupying most of the record. In each record shown below, the range abeam is 800 yards and the corresponding distance at right angles is equal to about 2 miles. This exaggeration of range can be diminished by viewing the page obliquely from top or bottom.

A rock floor can be recognised by a number of features, most characteristic of which is the presence of district beds. In figure 1 these are parallel, sharply defined, and stick up a few feet higher than the intervening clay ground with its thin cover of sand. Outcrops of beds of equal hardness would probably pass unnoticed, unless the surface had been intensively molded by solution or fauna. In figure 2 the parallel pattern typical of

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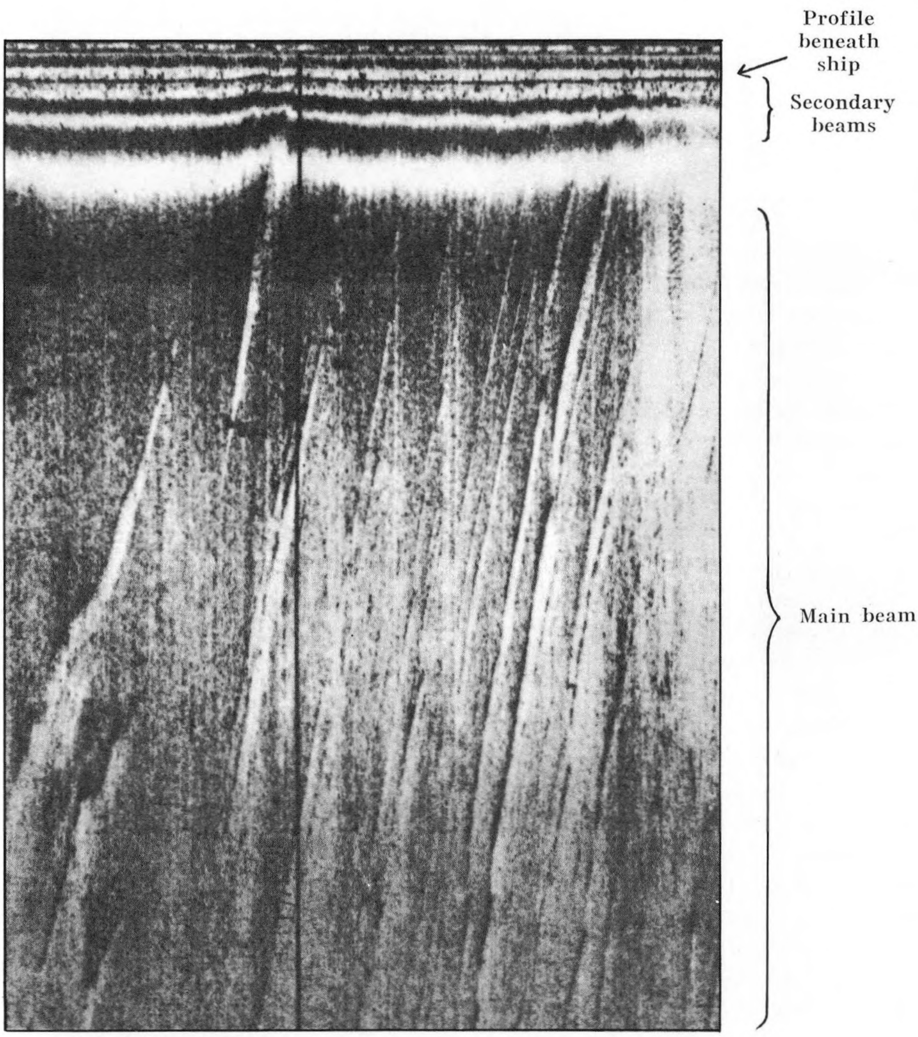

Figure 1. — Beds of hard rock forming ridges between which there are soft layers covered with sand.

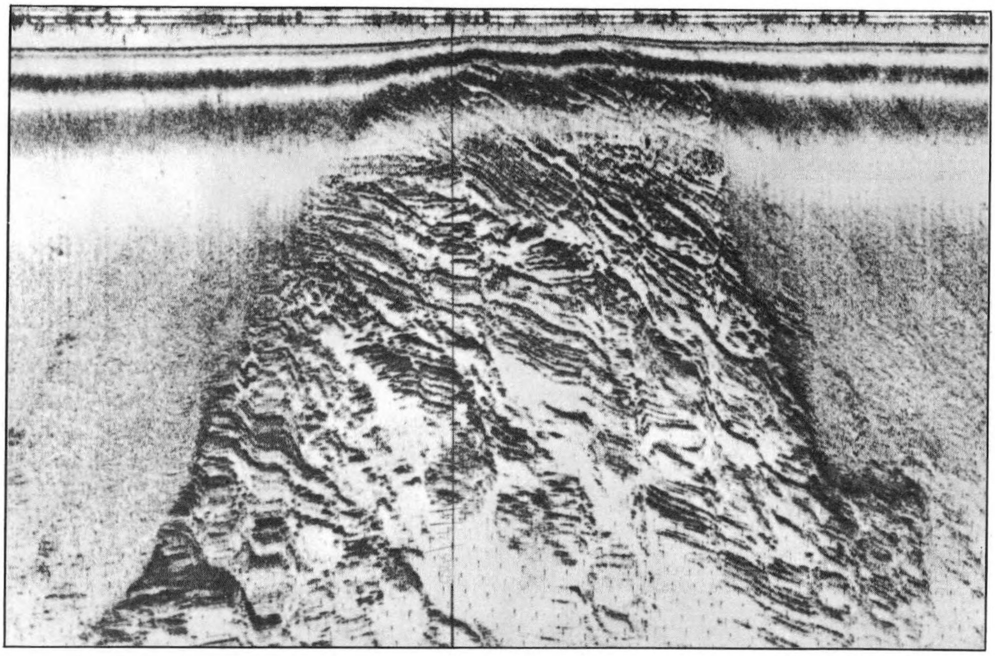

Figure 2. — Sand (even tone) surrounding a ridge of slates. The line of outcrop of individual layers of slate is interrupted by some small fractures.

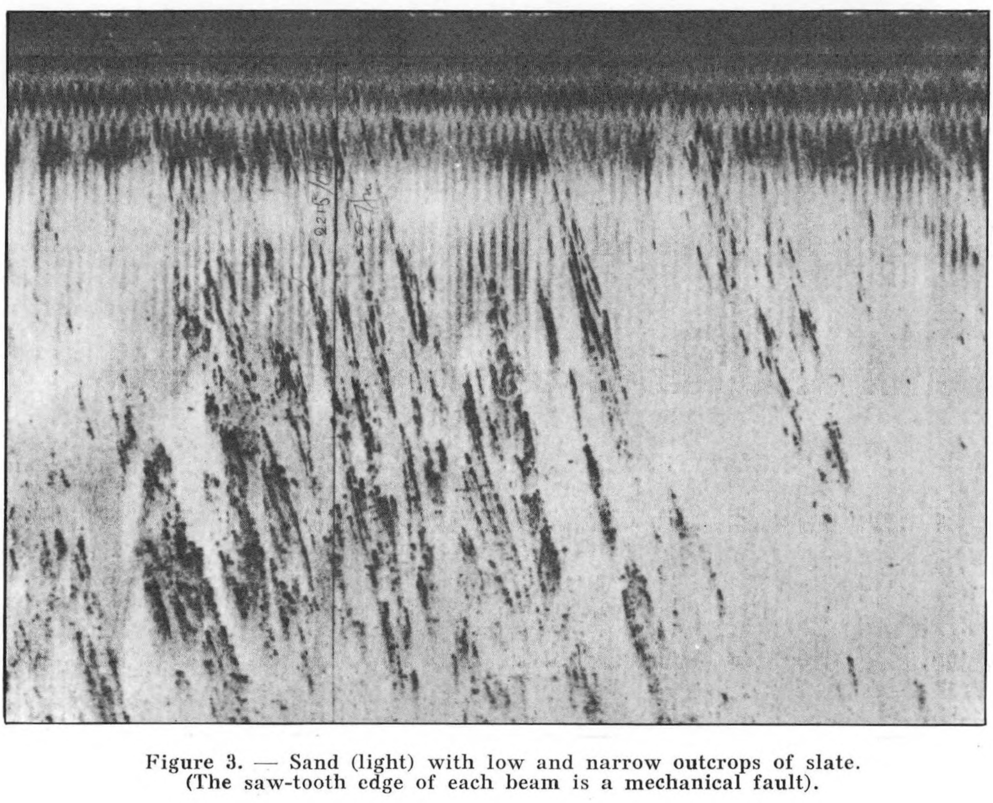

Figure 3. — Sand (light) with low and narrow outcrops of slate. (The saw-tooth edge of each beam is a mechanical fault).

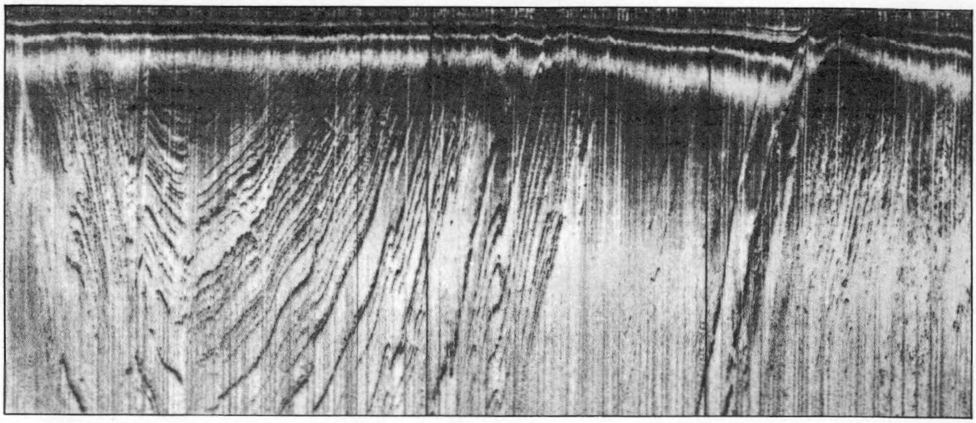

Figure 4. — Rock outcrops showing part of a gentle fold. Hard beds compose the ridge (at the right side of figure) and soft beds floor the hollow.

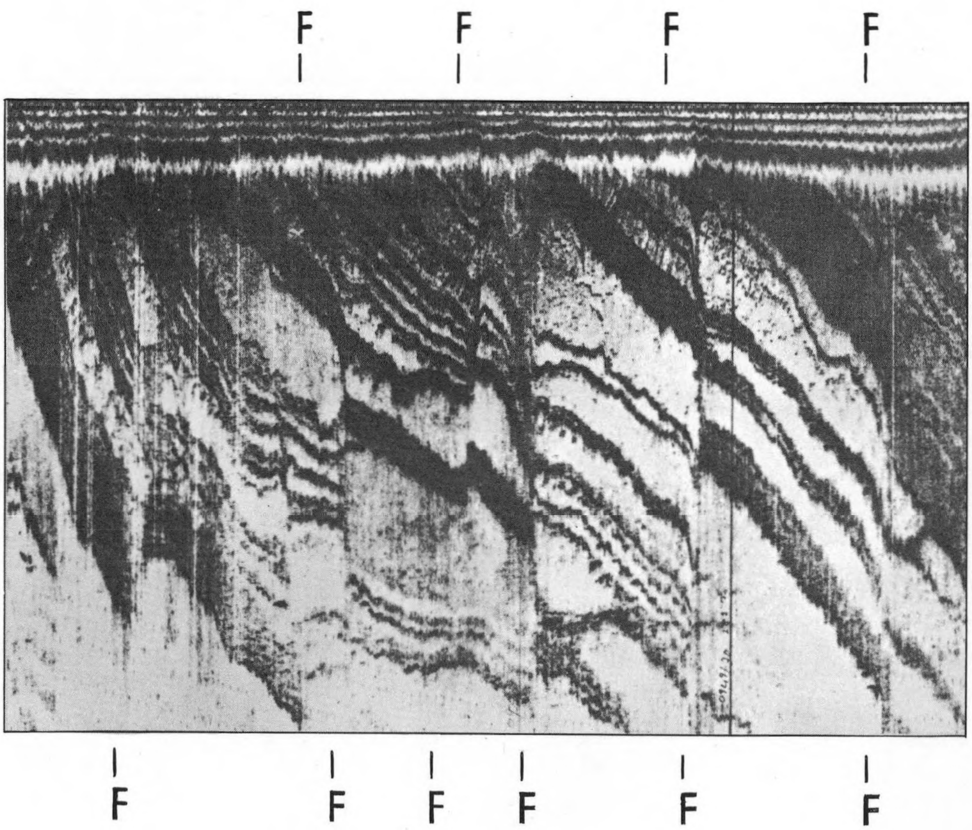

Figure 5. — A rock floor with fractures (F-F). The hard beds (dark) stand proud as ridges whose grouping allows them to be identified on either side of some fractures.

sedimentary rocks is again evident but individual beds cannot be followed very far. The boundary of this upstanding mass of slates with the surrounding sand is fairly sharp. In figure 3 only the tallest pieces of slate stand proud of the surrounding ground. Igneous rocks such as granite appear to give a rocky surface devoid of any clear pattern.

In figure 4 the outcrops bend round in a small fold. The edges of these beds (dark) face towards the top of the figure and the wide top surfaces (light) are sloping towards the lower part of the record and at right angles to the line of outcrop. The slopes are probably a few degrees below the horizontal. The ridge near the right-hand side of the figure is made of hard limestone, the almost featureless trench is cut in the softer underlying clay, while the rough ground to the left is made of clay with hard beds in it. Recognition of this sequence of rocks elsewhere has made it possible to make a detailed geological map of 150 square miles of sea floor. Other patterns of value for correlation are shown in figure 5, where groups of upstanding hard beds (dark) can be followed across the record even though the beds are displaced laterally by small fractures (F-F).

Misinterpretation of records is possible when there are hollows in a floor made of almost flat-lying beds of rock, for the trace of any bed will then tend to follow the depth contours, and the resulting pattern will simulate folded rock. In reality each eye-like structure of figure 6 must be a bump showing several layers of rock, one upon another.

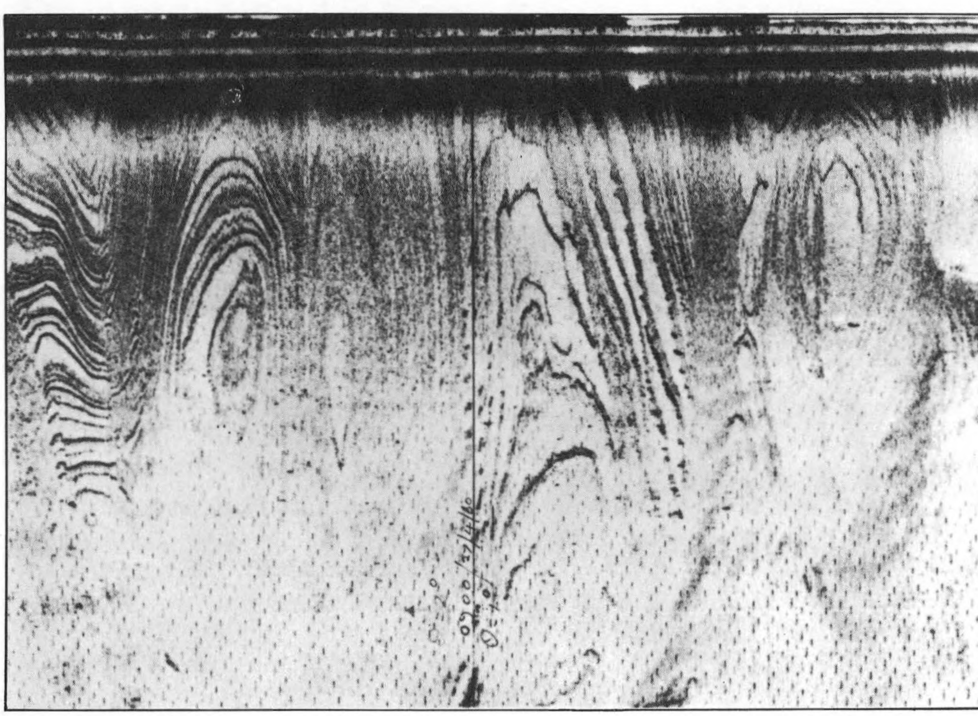

Figure 6. — A rock floor made of alternate hard and soft layers. The eye-like pattern seems to be due to the relief. (The short-line pattern on the lower half of the record is due to an electrical fault).

An even-toned record bespeaks a floor of homogeneous composition, which is also a plain surface or one of uniform roughness. No definite interpretation is attempted for the type of mottled pattern shown in figure 7, which may be due to irregular patches of several grades of sediment, accumulations of shells of molluscs, or clinker and ballast from ships. Interpretation must depend on sampling.

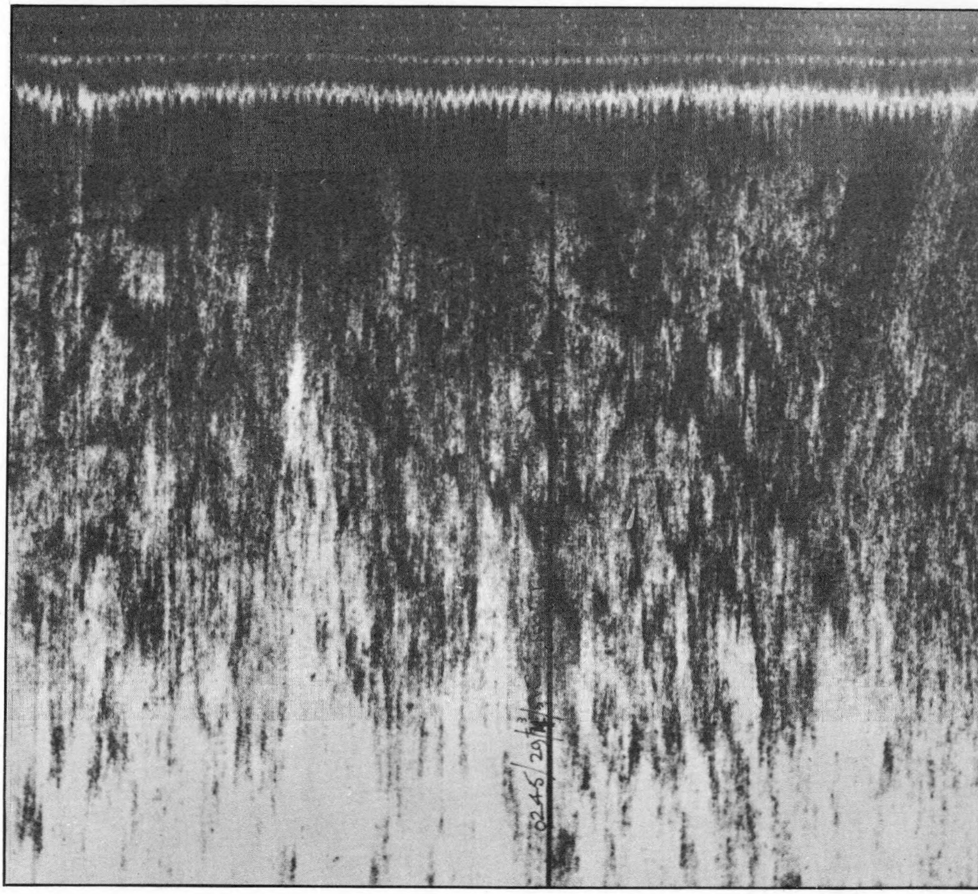

Figure 7. — A mottled pattern for which there is no interpretation at present.

Figure 8 shows part of a boundary between a rock floor (right) and a sandbank lying upon it, while on the edge of the bank are some sand waves. These occur at right angles to the prevailing path of the streams, and can be up to 50 feet high and half a mile apart, but are commonly much smaller. The crest length is generally greater than their separation (figure 9), the pattern being continued laterally by interfingering ridges. The edge of a patch of sand waves is shown in figure 10 where sand (light) gives way to a coarser material (dark). The ridges, visible in profile in the upper part of the figure, can be followed downwards as thin dark lines and then as sand tongues on the coarser basement.

Such ridges are being moved in the direction faced by the steeper of their two sides, where these are unequal. In estuaries the profile may partially reverse with each ebb or flood tide, and even in the open sea temporary alteration of the tidal regime by big storms will affect the sand waves, also.

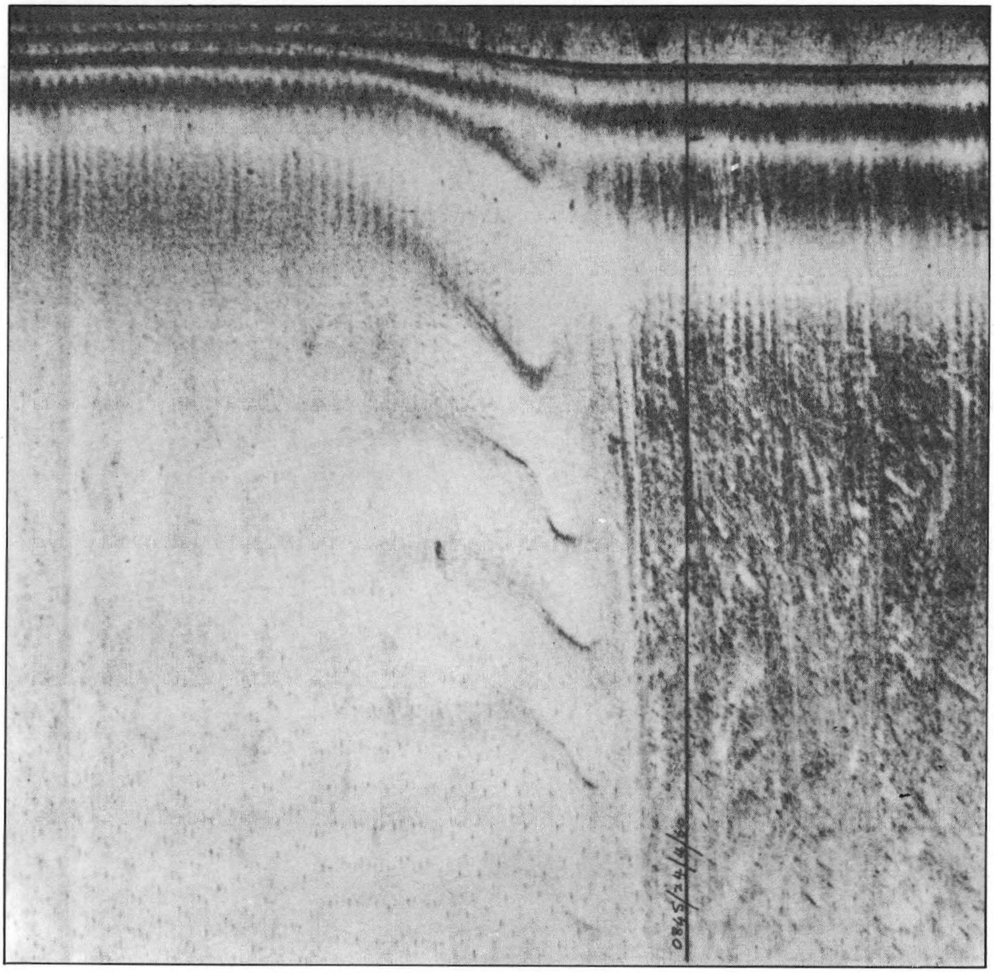

Figure 8. — The boundary between a rock floor and a sandbank lying upon it (left) with some sand waves near the edge of the bank.

Along the prevailing path of the tidal streams there is, sometimes, developed a linear pattern of sand bodies which can be more than a mile in length yet less than $\frac{1}{4}$ mile in width. The boundaries of the sand (light) are sharp but the cover of sand appears to be too thin to mask the basement (dark) completely, in this particular example (figure 11). Elsewhere there are sand ridges up to 15 feet high, also parallel to the streams, while at the upper end of the size scale there are the great sandbanks, all part of the same dynamic picture.

Figure 9. — Sand waves, apparently of two sizes. The orientation of their crests is well shown.

Acknowledgements

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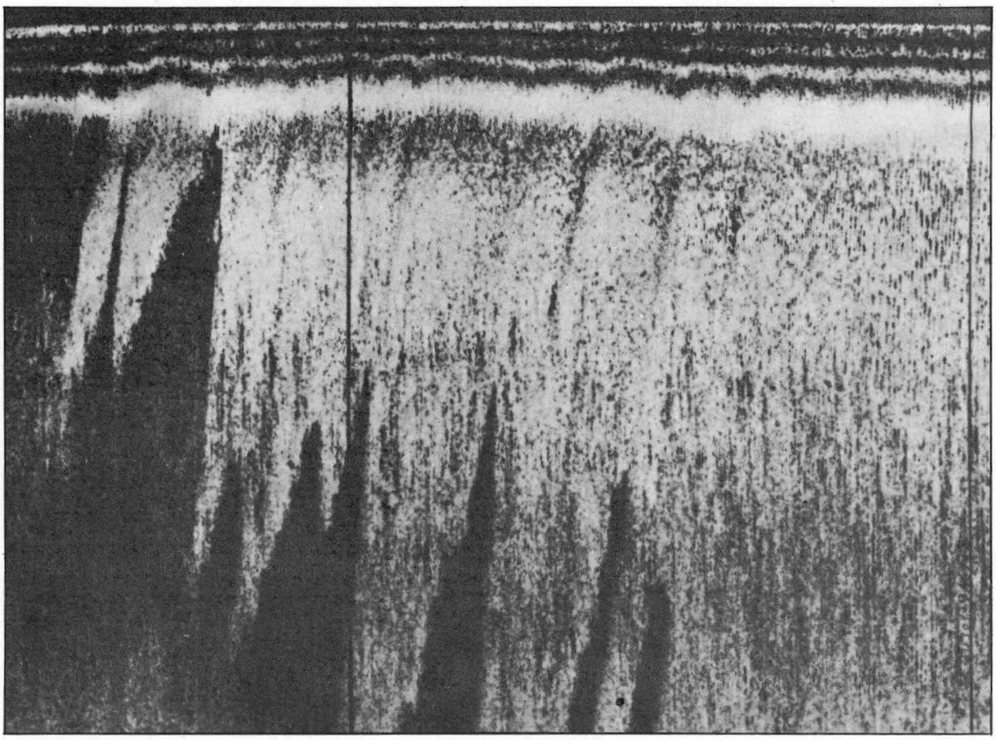

Figure 10. — The edge of a train of sand waves where sand (light) gives way to coarser material (dark). The faint trace of the ridges of the sand can be seen as thin, parallel dark lines on the upper half of the figure, extending from the profile.

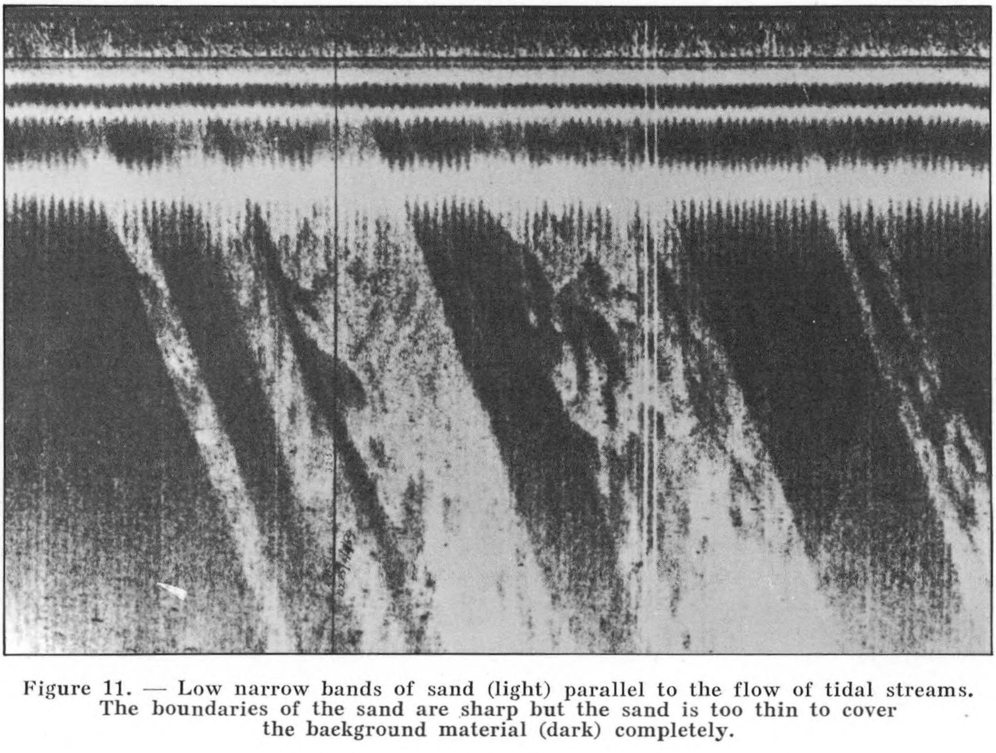

Figure 11. — Low narrow bands of sand (light) parallel to the flow of tidal streams. The boundaries of the sand are sharp but the sand is too thin to cover the background material (dark) completely.