Department of the Interior

U.S. Geological Survey

SIDESCAN SONOGRAPH PATTERNS OFFSHORE OF THE SOUTHERN DELMARVA PENINSULA

by

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INTRODUCTION

Sidescan sonographs were collected as part of a project investigating the possible locations of heavy mineral placer deposits on the mid-Atlantic inner continental shelf. The sidescan sonar data covers an area approximately 1100 km^2 offshore of the southern Delmarva Peninsula (Fig. 1).

Previous studies of the mid-Atlantic continental shelf include regional investigations dealing with the Holocene evolution of the shelf (Swift and others, 1972) and with the distribution and types of shoals along the Atlantic inner shelf (Duane and others, 1972). More specific studies included work on the inner shelf sediments off Chesapeake Bay (Nichols, 1972, and Thompson and Nichols, 1973). None of these investigations included sidescan sonographs as a tool for characterizing the seafloor. In this report, characteristics and distribution of acoustic returns depicted as sidescan sonograph records are used to describe the morphology of the seafloor with relation to surficial sediments within the study area.

Geological Setting

The seafloor topography on the inner continental shelf offshore of the Delmarva Peninsula (Figure 1) is dominanted by a ridge-and-swale pattern. The shoals in this area are generally of two types: a) linear shoals that may have connections to the shoreface; and b) arcuate shoals that are associated with bay inlets (Duane and others ,1972). Within the study area, only the isolated linear-type shoal is found. According to Duane and others, (1972), isolated shoals in this area are believed to be remnant shore-faced connected features that became detached, abandoned and reworked due to the rise in sea level and subsequent retreat of the shoreline. Smith Island Shoal, located in the southwest corner of the study area, is characteristic of isolated linear-type shoals found along the inner shelf region of the mid-Atlantic. This shoal is 10 km long and 3 kms wide (Escowitz and Grosz, 1987).

Beyond the 10 m isobath, the ridge-and-swale topography becomes masked by a hummocky morphology which is ubiquitious in the study area. Swift and others, (1972) in discussing the Holocene evolution of the central Atlantic inner continental shelf, described the seafloor as being a palimpsest surface with a variety of geomorphological elements. Smith Island Shoal is characteristic of this palimpsest surface.

METHODS

During June 1985, sidescan sonographs along 89 km of tracklines were collected on a portion of the inner continental shelf offshore of the southern Delmarva Peninsula. The sidescan system operated at a frequency of 100 kHz and scanned 100 m on each side of the ship's track. Transit satellite was used as navigational control during the survey. The sidescan sonar records were hand-corrected for both across-track (slant range) and along-track distortion. Interpretations of textural changes were based on the differences in light and dark tones on the records due to changes in reflectivity of the bottom sediments. Sidescan sonograph patterns described by Knebel (1989) were used as a general guide for the interpretation of the sidescan data.

Patterns on the Sidescan Sonographs

Four categories of sidescan sonograph patterns were recognized and mapped in the study area. Figure 2 shows the distribution of each pattern along the survey tracklines.

Pattern 1: High Acoustic Energy Return

Patterns of strong, uniform reflection were found along parts of each trackline (Figure 2). Sidescan records with a high acoustic return were characteristically darker than those from the surrounding areas (Figure 3). Areas of high acoustic energy return typically have sharp borders. These high return areas were predominant on Lines A-B and E-F, located in the northern corner of the study area.

Pattern 2: Low Acoustic Energy Return

Sidescan sonographs with low acoustic return and uniform light shadingwere found across the majority of the area (Figures 2 and 4). Lines B-C and C-D (out to the 20 meter isobath) are almost exclusively featureless. These portions of lines are in areas with a generally low relief, hummocky-type topography as seen on the bathymetric map of the study area (Figure 2).

Pattern 3: Ripple Marks

Ripple marks were found along the central portion of Line D-E (Figure 2). The ripple marks (Figure 5) are oriented in a N-S direction and have wavelengths of 0.5 to 1.5 meters. These bedforms are also located in a distinct ridge-and-swale area at the northwestern end of Smith Island Shoal.

Pattern 4: Tonal Patches

Distinct small, acoustically reflective tonal patches were found along the first third of Line E-F. This line obliquely transverses the ridge-and-swale system in a northwesterly to northeasterly direction and that is predominant in areas shallower than 20 meters. Figure 6 shows typical examples of the tonal patches, with patch size ranging from 5 to 20 meters in diameter.

DISCUSSION

The high acoustic energy return patterns (darker areas as in Figure 3) seen on the sidescan sonograph records are due to a more reflective bottom. Differentiation of bottom reflectivity is indicative of surficial textural changes. The areas along the tracklines that exhibit high acoustic energy reflectivity are associated with bathymetric highs. This is evident when the locations of the high acoustic energy returns are compared with the trackline bathymetric profile of the trackline. High reflectivity is associated with both the crest and the seaward face of the bathymetric high. The high reflectivity is likely associated with coaser material concentrated by the winnowing of the fine particles leaving a "rougher" textured bottom surface.

Patterns produced by low acoustic reflectivity (light featureless areas, Figure 4) correlate with the more gentle hummocky parts of the study area. This pattern indicates a more homogeneous, smoother surficial sediment texture.

The ripple mark pattern observed on the sidescan sonar records was found at the northeastern end of Smith Island Shoal. This linear isolated shoal, trending in a southwest to northeast direction, is delineated by the 12 meter isobath. Due to the shallow water depth over the shoal (minimum depth to the top of the shoal is 9 meters) the presence of ripple marks may be indicative of hydrodynamic processes and sediment transport influenced by bathymetric changes.

The tonal patches, seen on the oblique transverse line across the ridge and swales (line E-F) are characteristic of the variability of the surficial sediment texture on this part of the inner continental shelf. The more reflective (dark) patches are probably "rougher" texturally and are likely due to the winnowing of the finer sediments. The patches commonly occur along the ridges, or bathymetric highs and would be more susceptible to storm and current hydrodynamic forces.

REFERENCES

Duane, D. B., Field, M.E., Meisburger, E.P., Swift, D.J.P., and Williams, S.J., 1972, Linear shoals on the Atlantic inner continental shelf, Florida to Long Island, in, Shelf Sediment Transport: Process and Pattern, D.J.P. Swift, D.B. Duane, and O.H. Pilkey, (eds). Dowden, Hutchinson and Ross, Stroudsburg, PA, p.447 - 498.

Escowitz, E.C. and Grosz, A.E., 1987, Heavy minerals of the mid-Atlantic Inner Continental Shelf. U.S. Geological Circular 995. p.19.

Knebel, H.J., 1989, Modern sedimentary environments in a large tidal estuary, Delaware Bay. Marine Geology v. 86 pp. 119-136.

Swift, D.J.P., Kofoed, J.W., Saulsbury, F.P., and Sears, P., 1972, Holocene evolution of the shelf surface, central and southern Atlantic shelf of North America, in, Shelf Sediment transport: Process and Pattern, Swift, D.J.P., Duane, D.B., and Pilkey, O.H. (eds). Dowden, Hutchinson and Ross, Stroudsburg, PA. p. 499-574.

Figure 1. Location map of study area on the mid-Atlantic inner continental shelf.

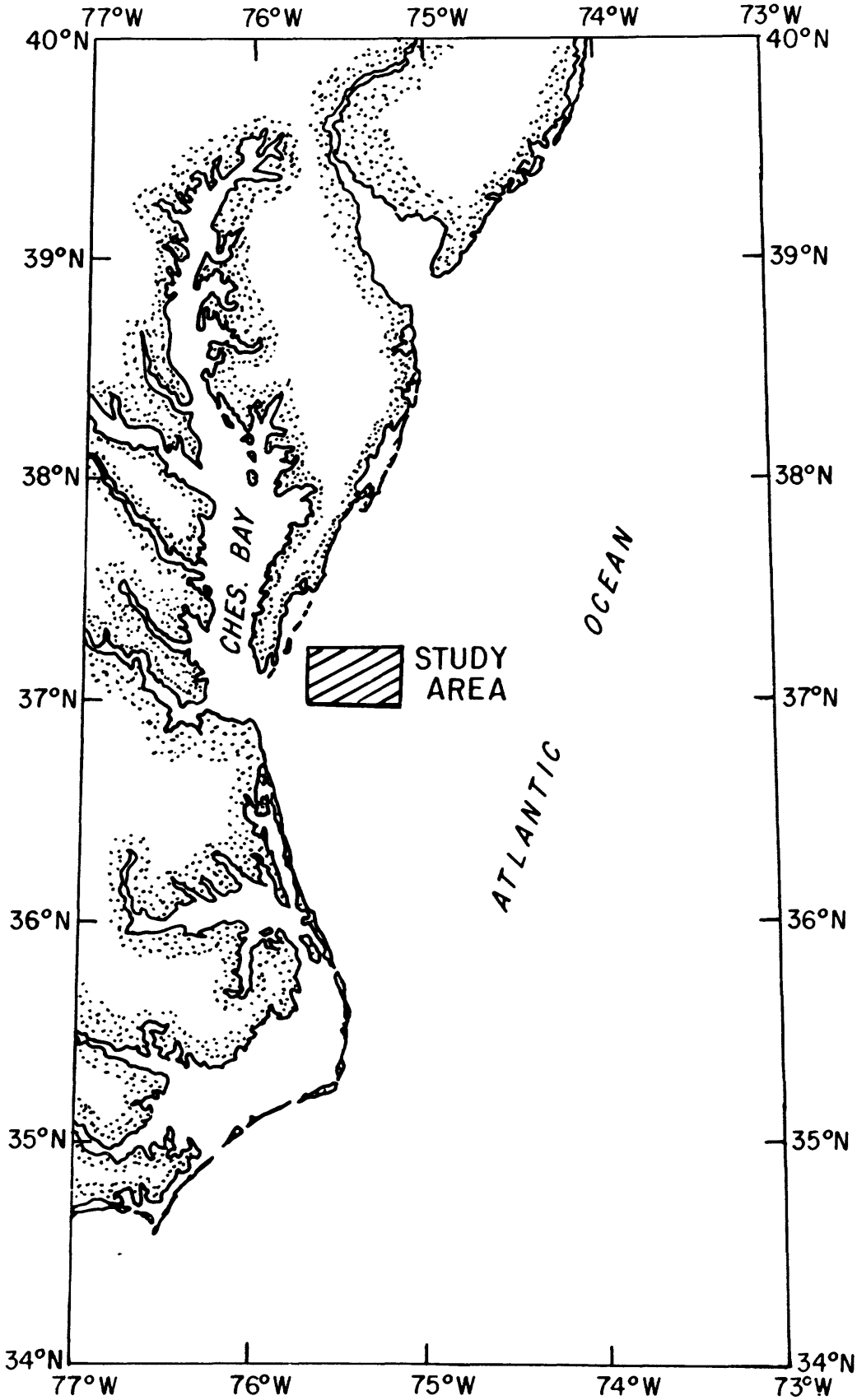

77°W
76°W
75°W
74°W
73°W
40°N
39°N
38°N
37°N
36°N
35°N
34°N
CHES. BAY
STUDY AREA
ATLANTIC OCEAN

Figure 2. Bathymetry and tracklines, showing the distribution of sidescan sonographs patterns along the tracklines.

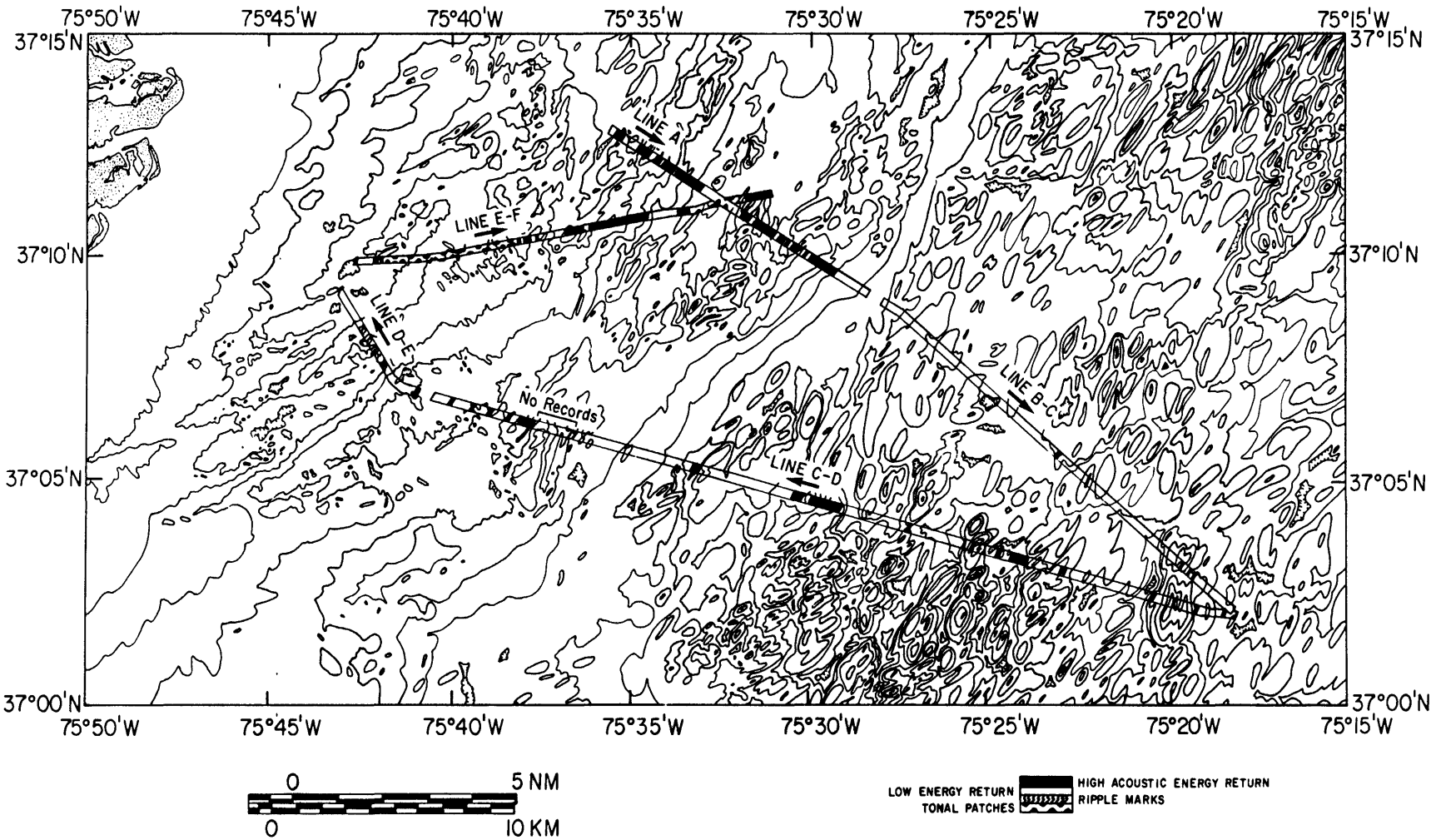

75°50'W
75°45'W
75°40'W
75°35'W
75°30'W
75°25'W
75°20'W
75°15'W
37°15'N
37°10'N
37°05'N
37°00'N
LINE A-B
LINE E-F
LINE D-E
No Records
LINE C-D
LINE B-C
0
5 NM
0
10 KM
LOW ENERGY RETURN
TONAL PATCHES
HIGH ACOUSTIC ENERGY RETURN
RIPPLE MARKS

Figure 3. Sidescan sonograph pattern showing high acoustic energy return.

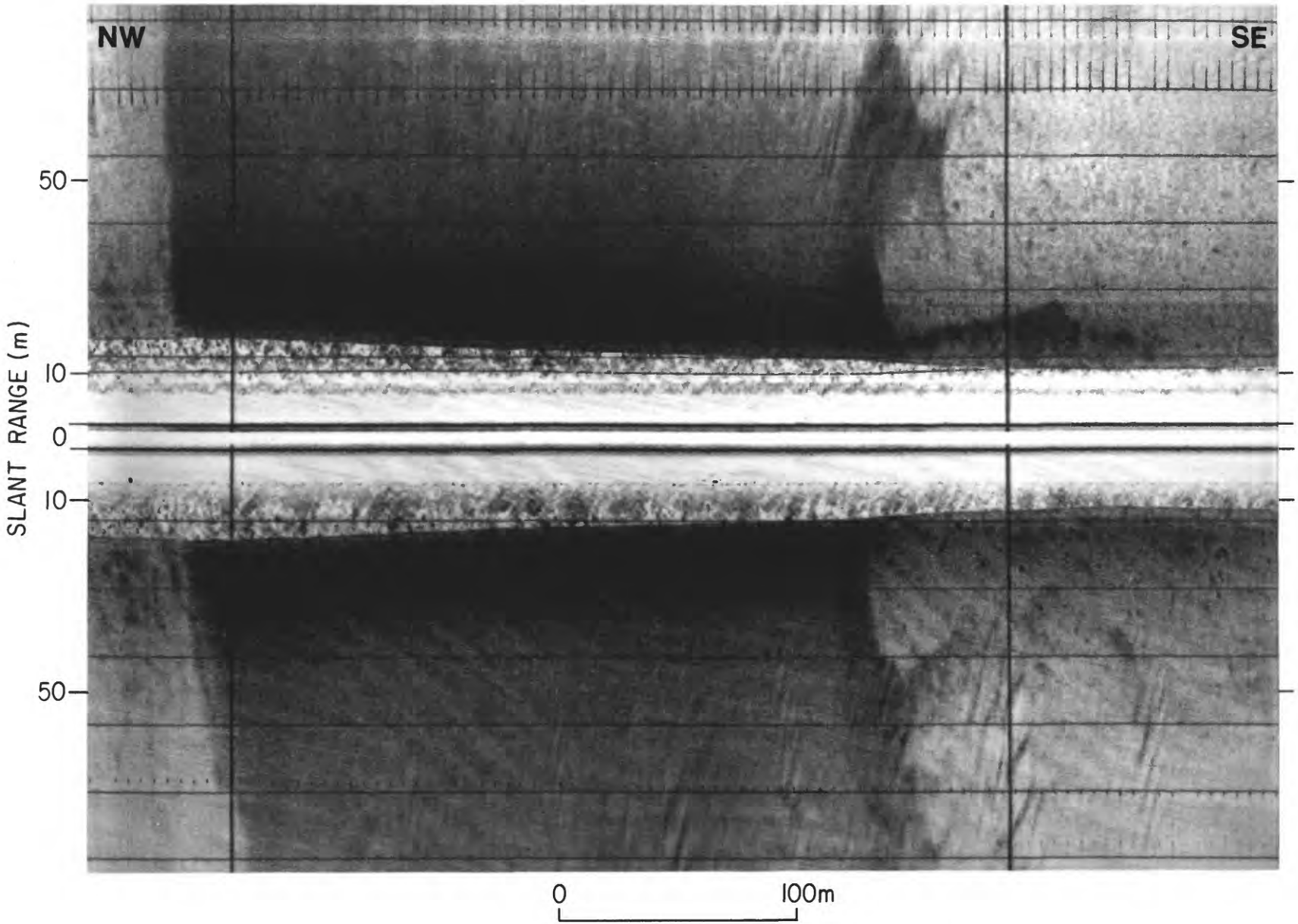

NW
SE
50
10
0
10
50
SLANT RANGE (m)
0
100m

Figure 4. Sidescan sonograph pattern showing low acoustic energy return.

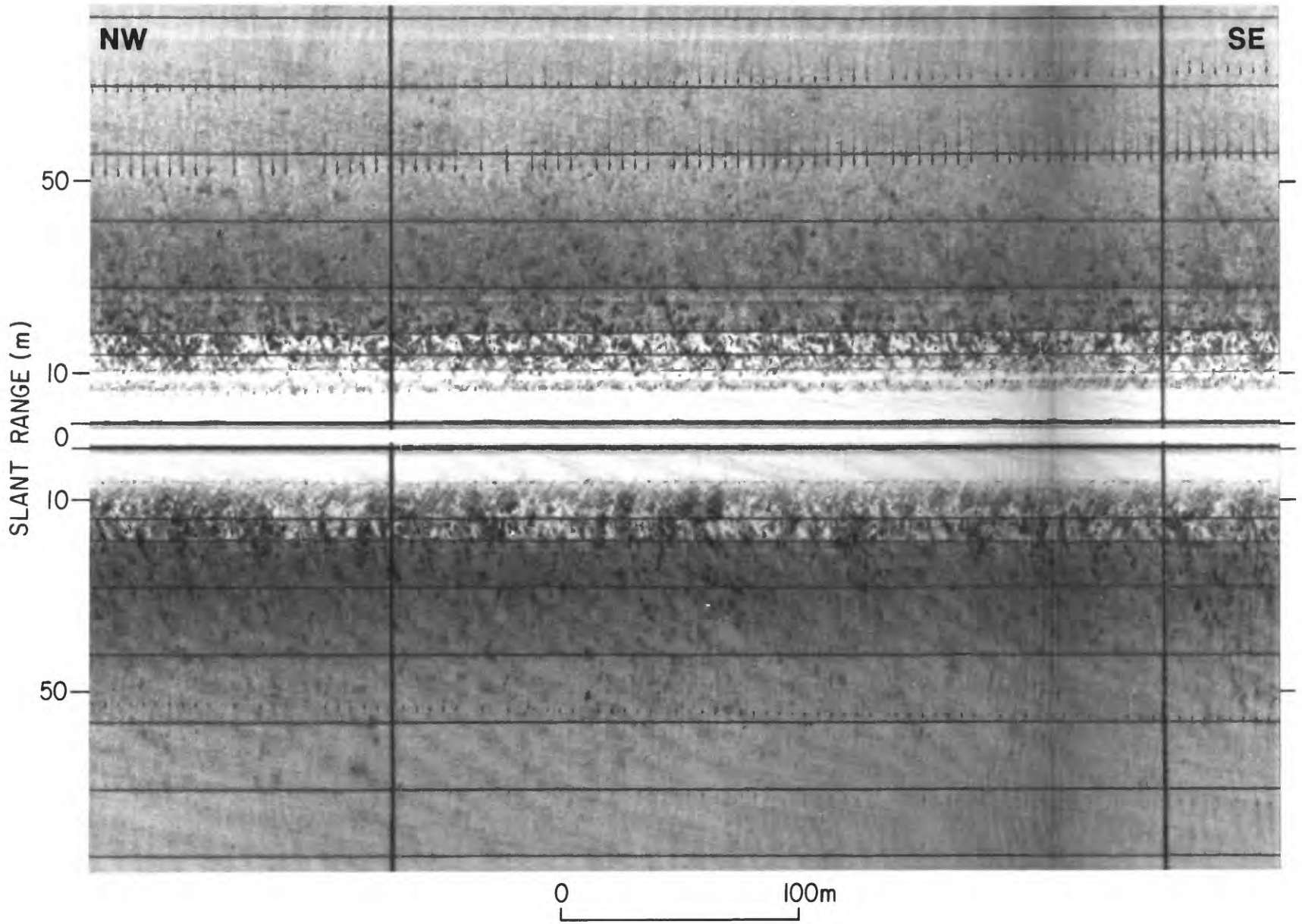

NW
SE
50
10
0
10
50
SLANT RANGE (m)
0
100m

Figure 5. Sidescan sonograph pattern showing ripple marks.

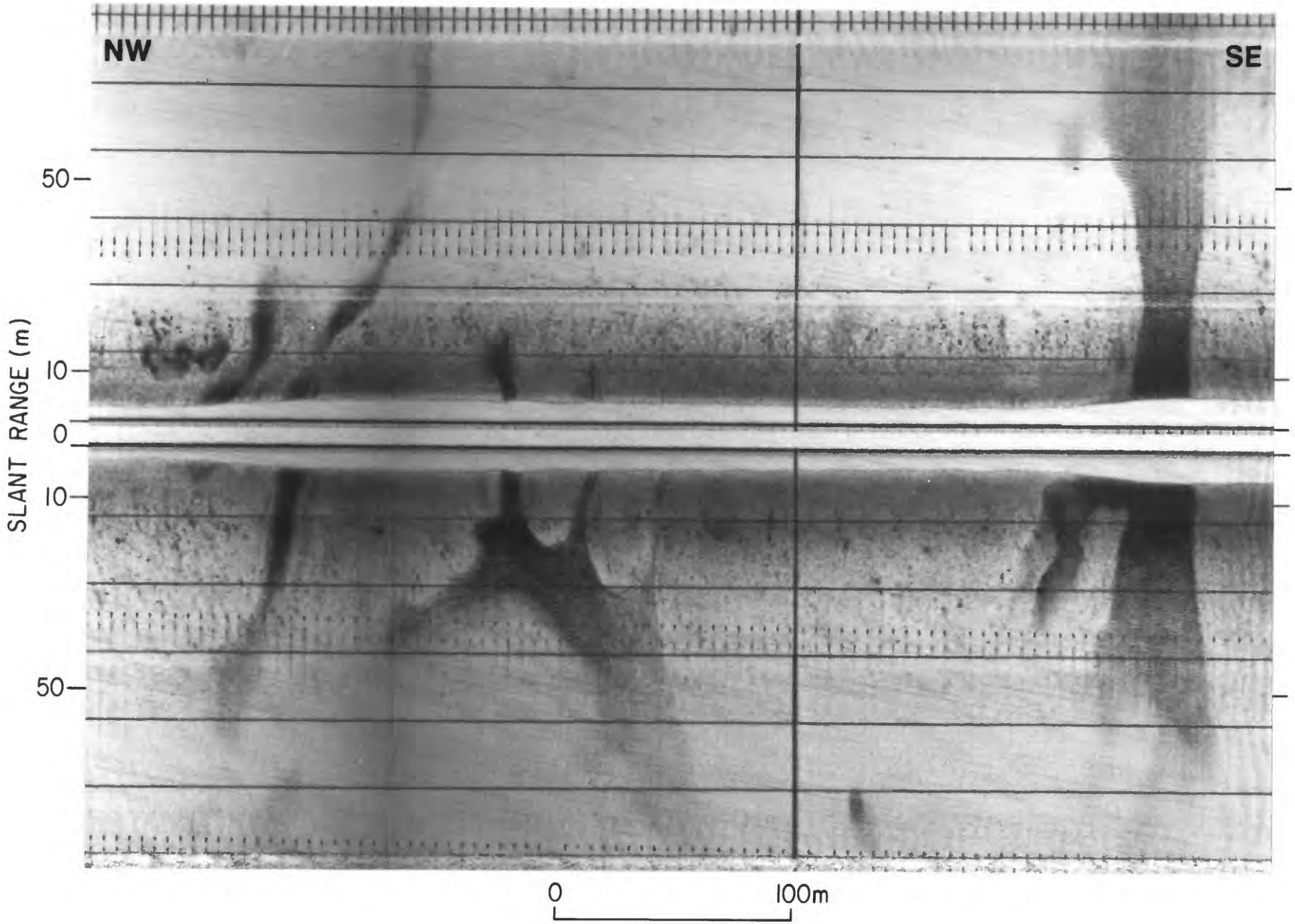
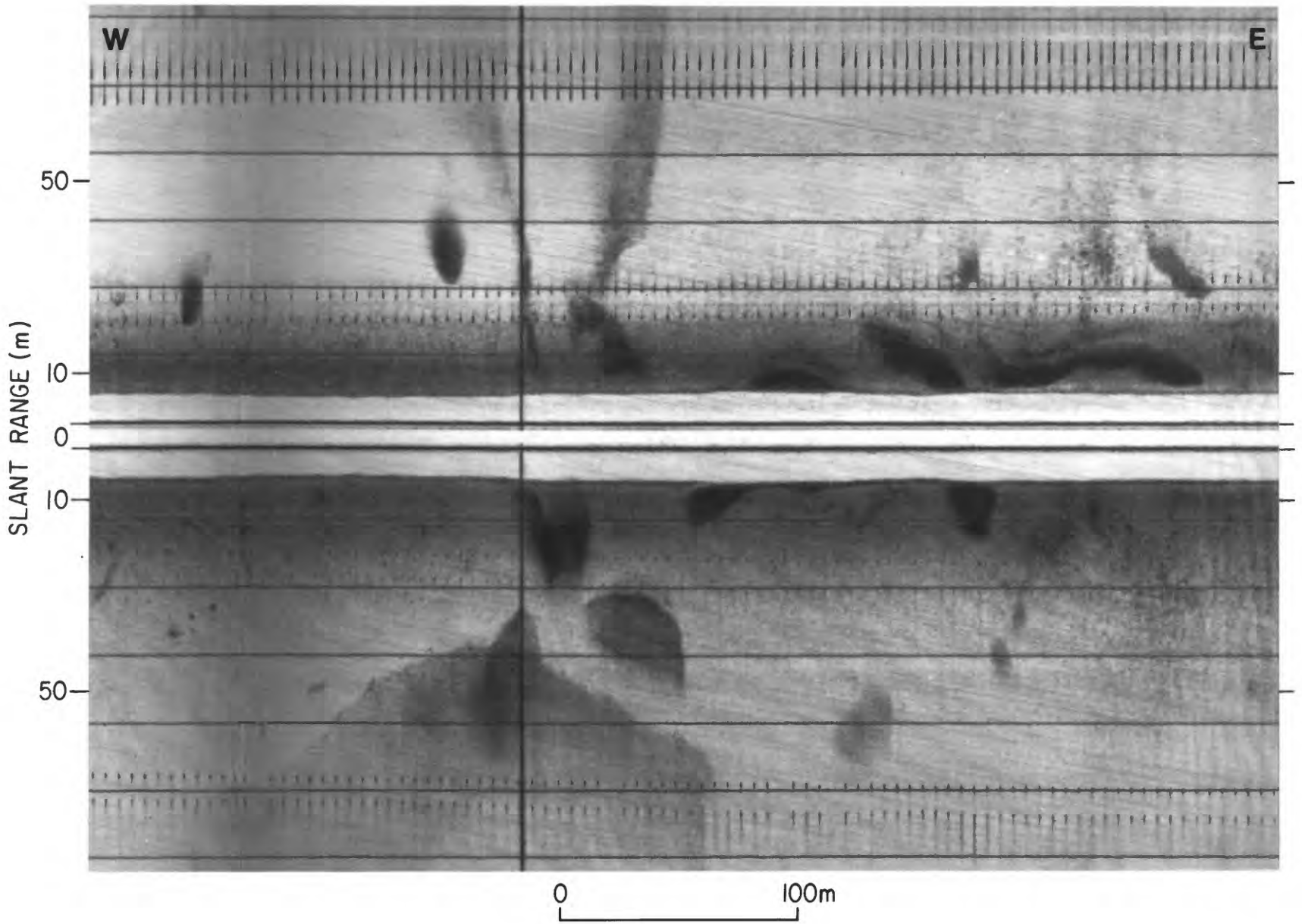

NW
SE
50
10
0
10
50
SLANT RANGE (m)
0
100m

Figure 6. Sidescan sonograph pattern showing high acoustic energy returns from tonal patches.


W
E
50
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10
50
SLANT RANGE (m)
0
100m