

## ANALYSIS OF SEISMIC PROFILES AND SIDE-SCAN SONAR RECORDS FROM LOWER NEW YORK HARBOR, A PROGRESS REPORT

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### INTRODUCTION

Analysis of side-scan sonar records and closely-spaced seismic profiles can provide important information about the sedimentary processes active in marine environments and the evolution of those environments. Such information is particularly important in coastal settings because of the interplay between natural and anthropogenic processes. Important new side-scan sonar and seismic profile data has been collected in Lower New York Harbor, including Raritan Bay, collected by the Waterways Experimental Station (WES) as part of a joint U.S. Geological Survey (USGS) - U.S. Army Corps of Engineers (USACE) mapping program (Fig. 1). These data are being processed and analyzed at MSRC. Our analysis of these data is only partially completed, but initial results are providing insights into the structure of the Lower New York Harbor including the distribution of gassy sediments, the nature of the erosional surface created during the post-glacial sea-level rise, and the structure of glacial and pre-glacial sediments. In this extended abstract we present information on the distribution of the data and some example records. The poster presentation will include additional data about the distribution of seismic facies in Lower New York Harbor as well as preliminary analysis of side-scan sonar data.

### METHODS

Bathymetry, seismic reflection and side-scan sonar was collected in 1996 along about 550 km of ship tracks trending northeast-southwest and spaced 200 m to 600 m apart (Figs. 2 and 3). Seismic reflection data were collected with a boomer (frequency range 1 kHz to 5 kHz) and a 3.5 kHz pinger. Data were digitized during acquisition and stored on disk. Seismic data was provided to MSRC on CD-ROM, and was processed to create a set of seismic profiles which could be studied for reflection patterns and acoustic facies. Existing cores and borings in Lower New York Harbor provide insight into the nature of the acoustic facies. Side-scan sonar data are being processed by the USGS in Woods Hole. Reflectivity patterns in the side-scan sonar data will be compared with sediment grain size distribution patterns.

### PRELIMINARY RESULTS

The southern part of New York Harbor, including Raritan Bay, is characterized by a reflection pattern in the seismic records that indicates the presence of gas in the sediments (Figs. 4 and 5). Gas bubbles in sediments cause the sound energy to be scattered resulting in a strong but diffuse reflection in the sediments and the lack of any deeper layering (Figs. 4 and 5). The gas, primarily biogenic methane, is a late-stage product of organic diagenesis and occurs primarily in areas where there has been relatively rapid fine-grained sediment deposition for the last appx. 10,000 years, following the post-glacial sea-level rise. The gassy sediments occur primarily in western and eastern Raritan Bay. In eastern Raritan Bay the gassy sediments follow a sinuous pattern consistent with sediment filling an earlier river valley (Fig. 6). Possible gassy sediments are also found in Chappel Hill South Channel and in several of the borrow pits

(sites of earlier sand mining) which appear to be sites of fine-grained sediment accumulation. In some areas, especially in northern and eastern parts of Lower New York Harbor, the highly reflective layering may be due to the presence of coarse sediments rather than gas.

As noted above, boomer and pinger profiles show the existence of several channels filled with fine-grained sediments, especially in Raritan Bay (Figs. 4 and 5). For example, on Profile F (Fig. 5) the edges of a filled channel are observed on both the southwest and northeast of a zone of gassy sediment, and the Raritan Bay East Reach channel has been dredged into the gassy fine-grained sediments. Several smaller channels are also observed, and they also are often filled with gassy sediments (e.g., Profile E, Fig. 5). Pinger profiles A-C (Fig. 4) suggest that the largest river valley is cut into sediments with apparently deformed layering. Some smaller valleys (e.g., Profile C, Fig. 4) are observed cut into these sediments. The deeper sediments may have been deformed by the movement of the ice sheet in this region. The unconformity between the deeper, contorted and channelized sediments and the overlying fine-grained post-glacial sediments (Fig. 4) probably formed when sea level rose following the last glacial period. This unconformity can be followed throughout much of southern Lower New York Harbor, except where sediments are gassy.

A number of shoals exist in Lower New York Harbor. Pinger profiles across some of these shoals suggest that they are composed of contorted or deformed sediments (Profiles G (Round Shoal) and H, Fig. 7). The deformation was probably related to ice-sheet activity. A buried deposit similar to a surficial sand shoal is observed on Profile I (Fig. 7) from central Lower New York Harbor suggesting that it was also formed by ice-sheet activity. A portion of the sediments overlying this deposit have been removed by sand mining. The depth of that sand mining was regulated by permit.

Deeper layering is observed on boomer profiles in a number of areas (Figs. 5 and 8). Some of these deeper layers appear to correlate with Cretaceous sediments recovered in nearby boreholes (e.g., Profile D, Fig. 5) while the ages of other deeper layers are presently unknown. These deeper layers are not flat in some areas, but show structure that may result from folding (Profile J; Fig. 8), older buried sand-filled channels (Profiles K and L; Fig. 8), or faulting (Profile M; Fig. 8). The apparent folding and faulting may have occurred when sediments near the edge of the ice sheet were deformed.

Side-scan sonar data collected along these survey lines (Figs. 2 and 3) have only been partially processed. These data demonstrate some regional patterns in backscatter that may be related to sediment type and/or the presence of gassy sediments. More complete analysis will await final data processing.

## CONCLUSIONS

A new set of seismic (boomer and pinger) profiles and side-scan sonar data has been collected from Lower New York Harbor, including Raritan Bay. Preliminary analysis of the seismic profiles shows that fine-grained sediments filling older valleys in Raritan Bay are generating methane gas. A regional unconformity can be identified on seismic profiles that marks the erosional surface formed by post-glacial sea-level rise. This unconformity is especially prominent in Raritan Bay. The glacial-aged sediments and pre-glacial sediments show evidence for folding and faulting in several areas, suggesting importance of deformation near the termination of the ice sheet. Regional patterns in side-scan sonar reflectivity exist, but more of the sonar data needs to be processed.

## ACKNOWLEDGMENTS

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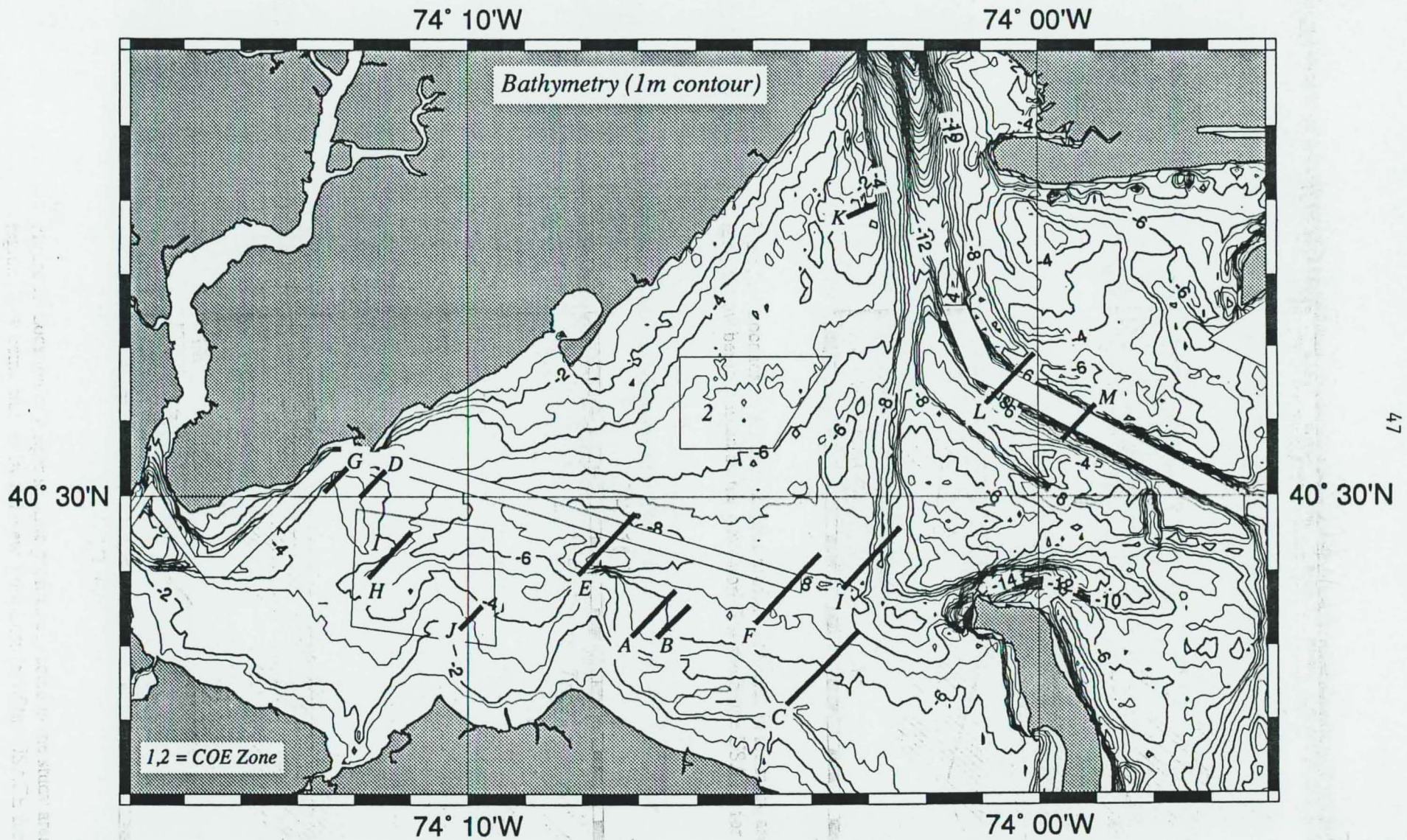


Figure 1. Bathymetry of Lower New York Harbor, including Raritan Bay. Thick black lines show the locations of seismic profiles illustrated on Figs. 4, 5, 7, and 8. Smaller boxes labeled 1 and 2 are the regions now being studied by the New York District of the USACE for potential dredge spoil enclosures. Contour map based on NOS surveys in the 1930s; areas blanked out are regions of no data in this survey.

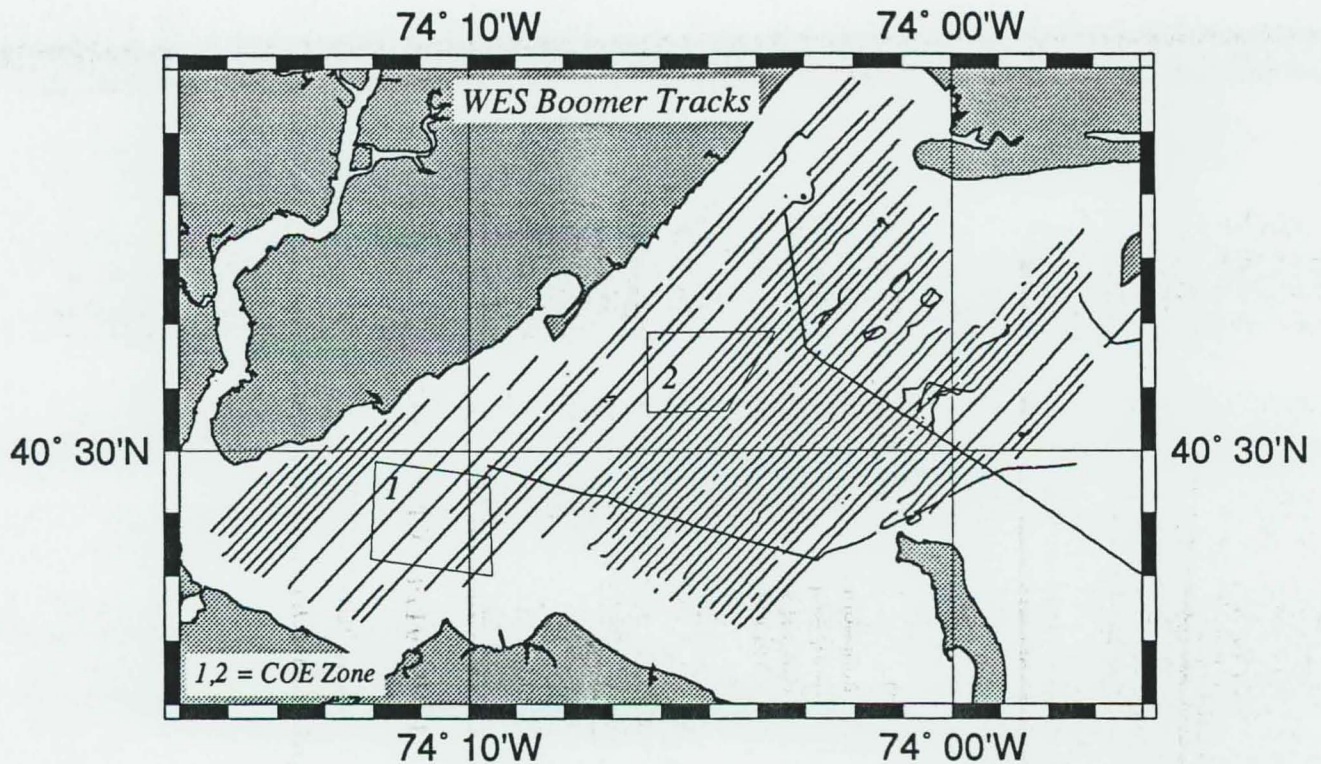


Figure 2. Location of boomer seismic profiles collected in the study area. Boxes labeled 1 and 2 are the regions now being studied by the New York District of the USACE for potential dredge spoil enclosures.

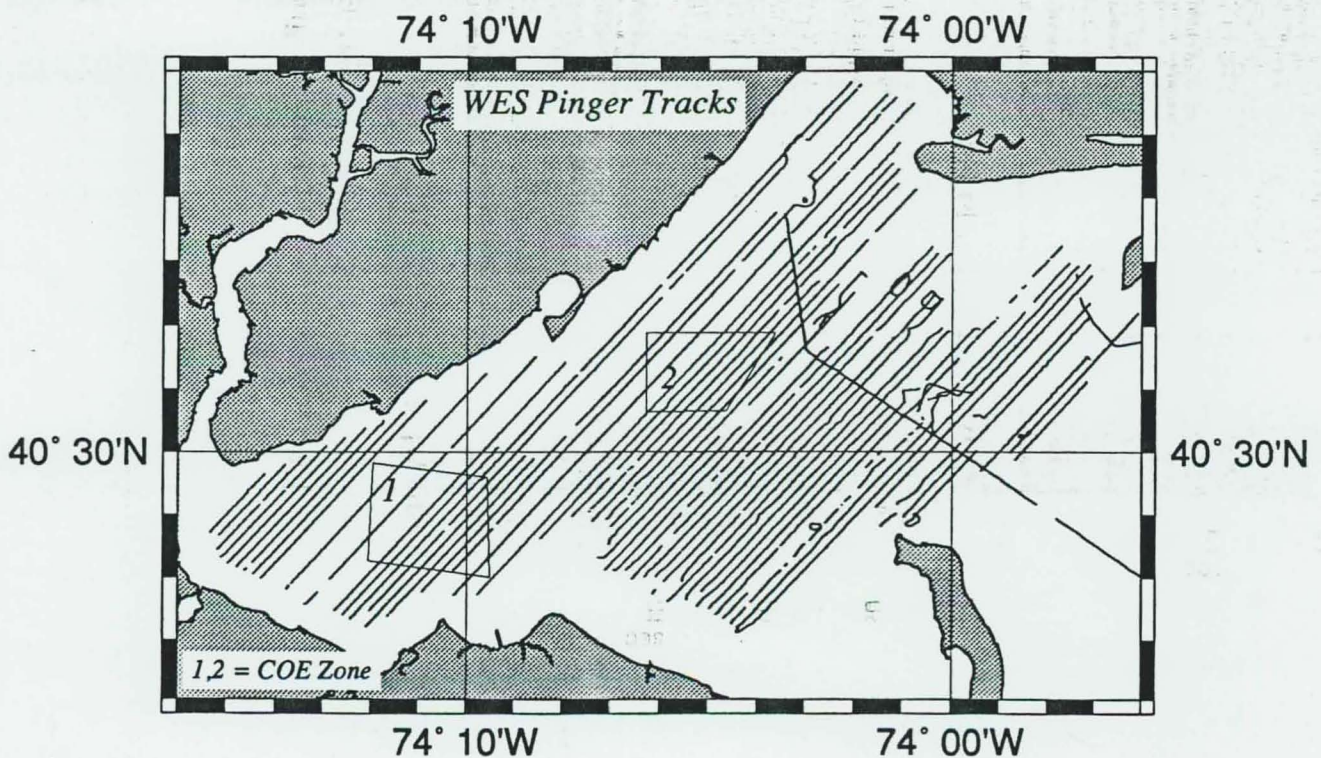


Figure 3. Location of pinger seismic profiles collected in the study area. Boxes labeled 1 and 2 are the regions now being studied by the New York District of the USACE for potential dredge spoil enclosures.

Laminated post-glacial sediments overlying contorted sediments  
(obscured by gassy sediment to northeast)

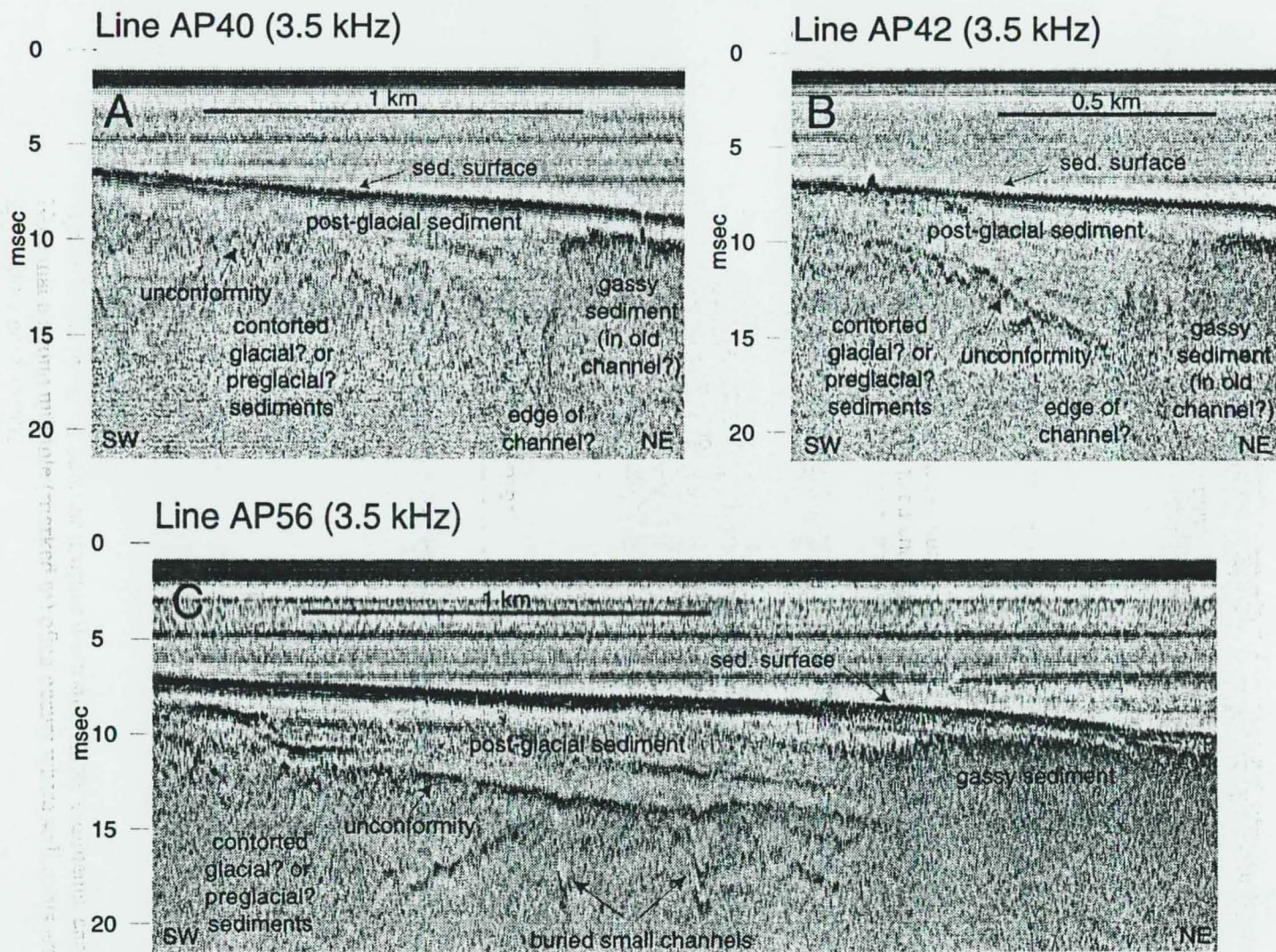


Figure 4. Examples of pinger profiles illustrating gassy, fine-grained post-glacial sediments overlying glacial or pre-glacial sediments. Vertical scale is in milliseconds (msec). 10 msec vertically is approximately 8 meters.

## Filled channels, gassy sediments and deep layering

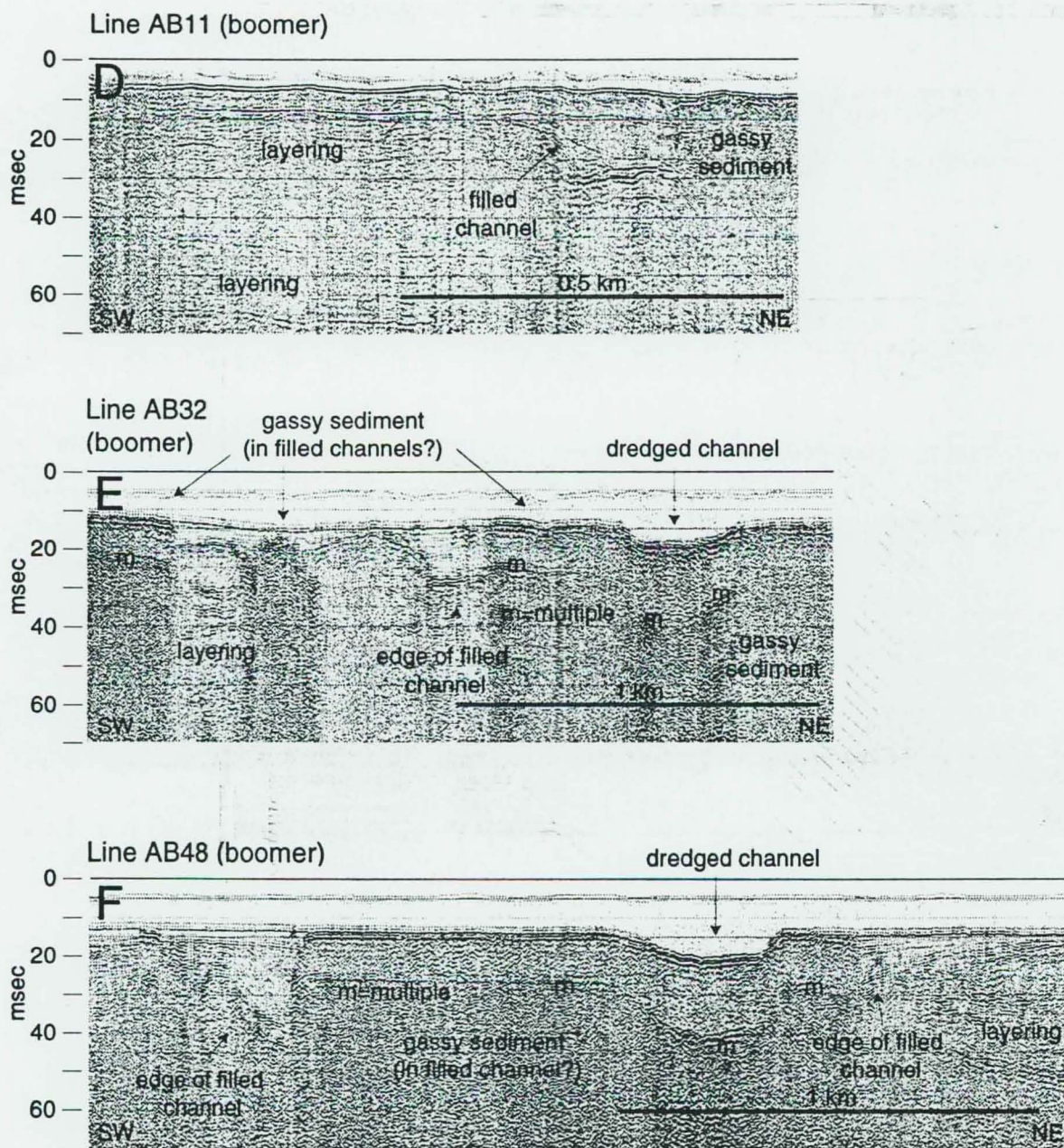


Figure 5. Examples of boomer profiles illustrating gassy sediments, channel fill and deeper layering. Note that a strong multiple (marked m) often occurs where sediments are gassy. (10 msec vertically is approximately 8 meters.)

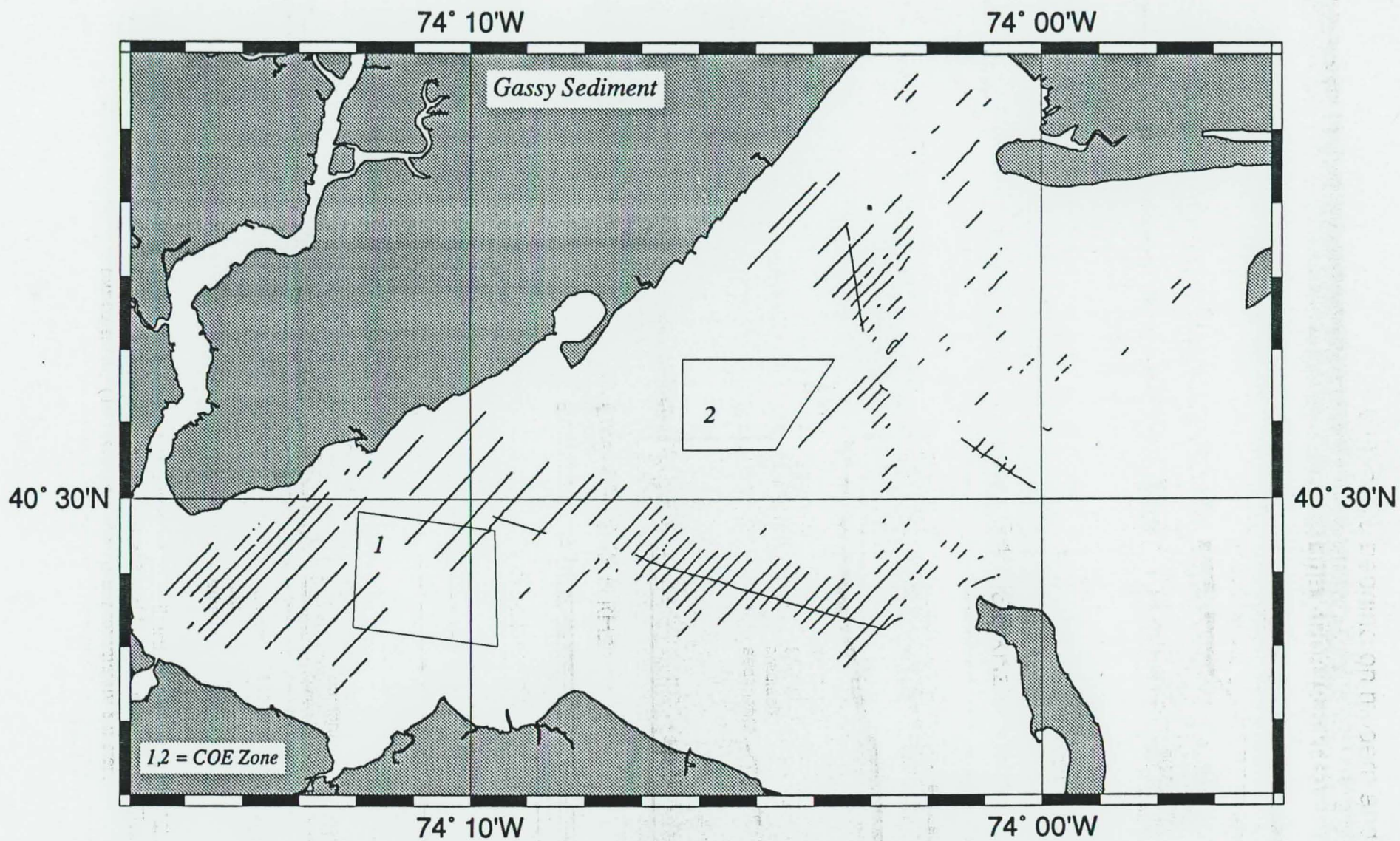


Figure 6. Lines indicate where boomer records show highly reflective surface or near-surface sediments. High reflectivity is generally due to the presence of methane gas bubbles in fine-grained sediments, although the high reflectivity could also be due to the presence of coarse sediment at the surface in some areas. Boxes labeled 1 and 2 are the regions now being studied by the New York District of the USACE for potential dredge spoil enclosures.

## Contorted bedding on modern and buried shoals

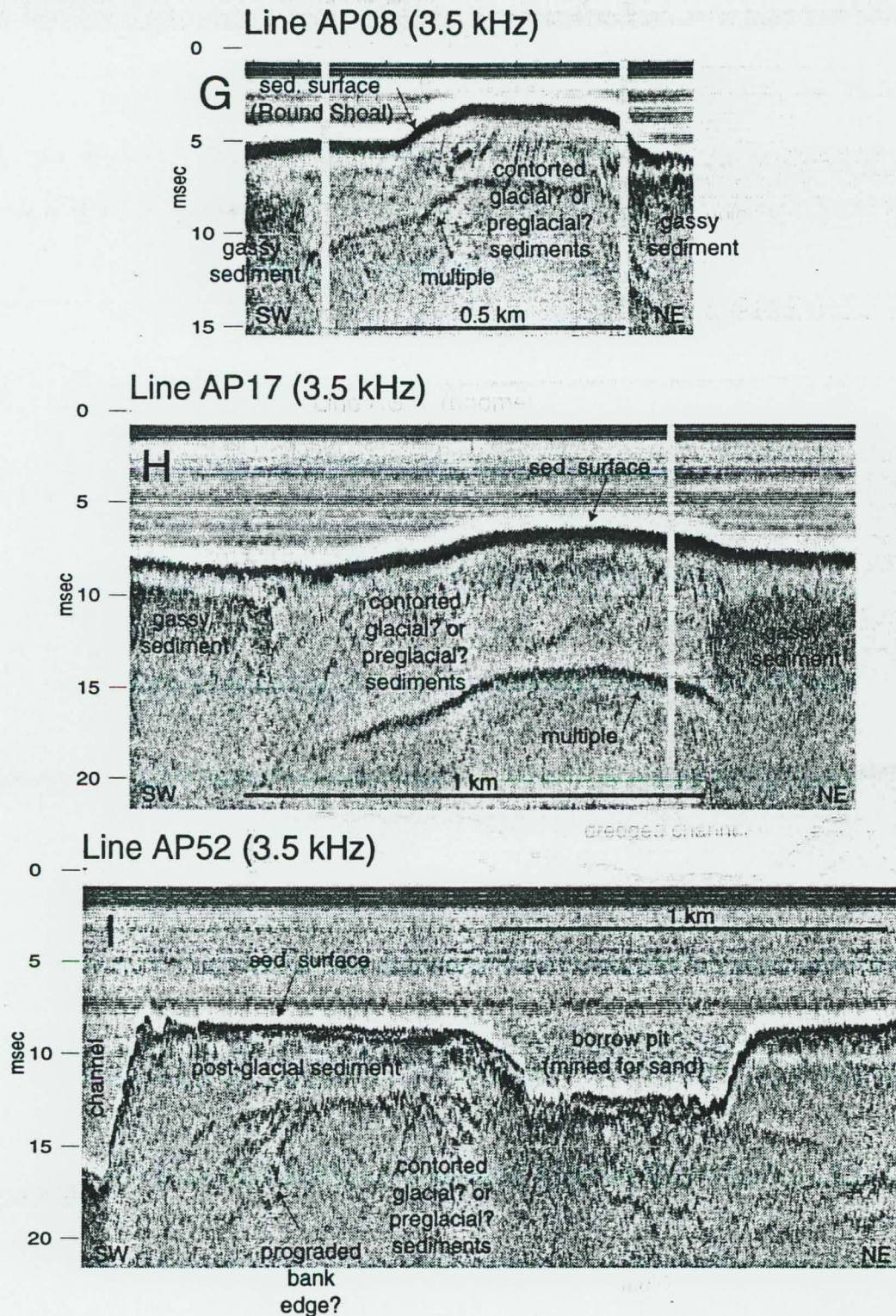


Figure 7. Examples of pinger profiles illustrating contorted bedding in near-surface and buried shoals. Gassy sediments are present on either side of the shoals in Profiles G and H. Profile I shows a possible buried shoal. (10 msec vertically is approximately 8 meters.)



## Deep layering (folding?, channels?, faulting?)

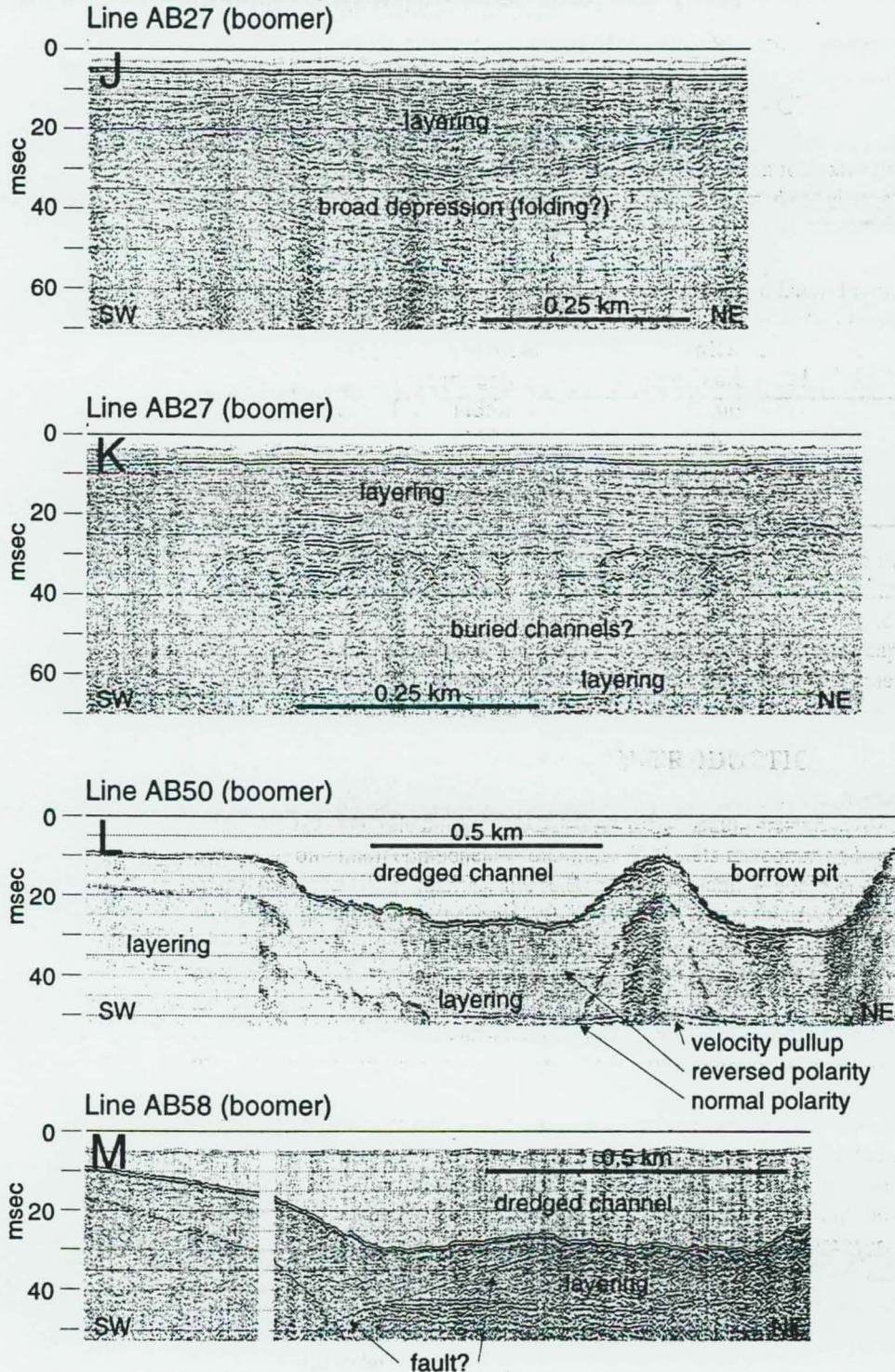


Figure 8. Examples of boomer profiles illustrating deeper layering patterns, including possible folding, sand-filled channels, a broad depression beneath the present-day dredged channel, and a possible fault truncating layering. At least some of these patterns may be representative of deformation near the edge of the ice sheet. (10 msec vertically is approximately 8 meters.)