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Importance of Bottom Coring to Investigate Former Shores

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Abstract

Shore-based geological observations, nearshore-offshore borehole drillings, bottom sampling and high-resolution shallow-seismic reflection profilings were reviewed from several coastal regions around Turkey. The main purpose was to show that high-resolution seismic surveys, which are commonly, carried out for submarine geotechnical investigations can not solely be reflect true bottom-subbottom conditions without further sampling and coring. Examples from Mersin Bay, Gulf of Iskenderun, Sea of Marmara and Black Sea showed that different materials such as paleosoils, consolidated beachrocks, unconsolidated sand and gravel as well as volcanic rocks produce similar seismic reflection configurations ("unconformities") beneath the unconsolidated siliciclastic mud of recent ages.

Introduction

A great deal of studies have shown that the lowering of sea levels during the last glacial maxima in late Quaternary (Milliman, 1989), approximately 18,000 years ago, led to subaerially exposure (weathering and erosion) of many continental shelves, worldwide. As a result, former continental shelves were eroded by wave and current activities leaving coarser-grained bottom deposits (Emery, 1968) and dissected valleys and channels behind, now buried under the postglacial, Holocene marine transgressive deposits which are relatively finer-grained. Here, in particular for submarine geotechnical surveys, high-resolution shallow-seismic reflection profiling techniques have been widely used. In most of the cases, the presence of irregular and chaotic seismic reflections (unconformities) underlying parallel and continuous reflections which are observed on seismic records is commonly interpreted to correspond to the products of low stands of sea level (Payton, 1977;Sangree and Widmier, 1979;Suter et al., 1987). Additionally, subbottom coring and dating techniques has further contributed to investigate the former shores or beaches.

However, as shown from some examples in coastal zones around Turkey, the erosional unconformities obtained from seismic records may not always reflect and/or locate the coarse-grained deposits and erosional surfaces from the Holocene/Pleistocene boundary. Therefore, this study points out the importance of bottom coring to investigate the geotechnical properties of the sea floor.

Material and Methods

In this study, a variety of methods and materials, which are collected from Mersin Bay, Gulf of Iskenderun, Sea of Marmara and the Black Sea were reviewed. These include: high-resolution shallow-seismic reflection profiles, sidescan sonographs, bottom sampling, field observations on exposure and submarine extension of coastal geology, beachrocks, paleosoils etc.

Results and Discussions

The results obtained from different coastal regions are discussed below.

Case Study: Mersin Bay

The sea floor of Mersin Bay is largely composed of fine-grained, siliciclastic mud of Holocene age (Shaw and Bush, 1978; Bodur and Ergin, 1992). It is characterized on seismic records by the presence of continuous parallel reflections above (Fig.1). Its thickness is approximately 10-15 m but it ranges to more than 35 m off the major river deltas (Ergin et al., 1992a). However, below this seismic configuration, the Holocene/Pleistocene boundary is characterized by an unconformity with irregular and chaotic reflections. This unconformity displays locally changing subbottom characteristics within the bay. For example, off the Town of Mersin, seabed excavations and nearshore borehole drillings showed the occurrences of brownish-stiff soils (Ergin, 1996; Fig.2)

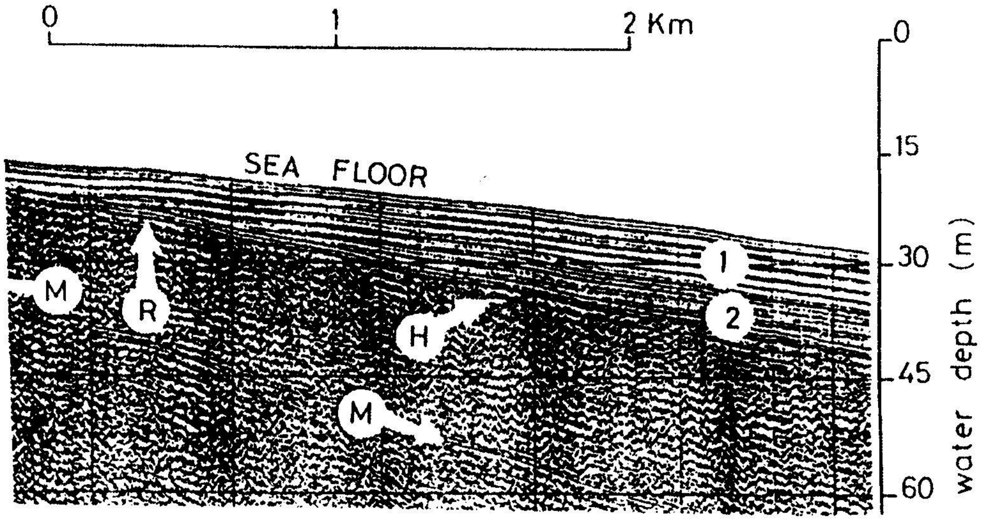

Fig. 1: Seismic record obtained from the Mersin Bay. Note the erosional unconformity (R) overlain by parallel reflections of unconsolidated mud (Ergin ET al., 1992a).

Fig. 2: Paleosoils from inner continental shelf off Mersin (Ergin, 1996).

and conglomeratic sandy-gravely beachrocks (Bodur and Ergin, 1992;Fig.3) both must be formed at low stands of sea level during the Holocene/Pleistocene boundary. These features are similar to erosional unconformities on seismic records although both are made of different materials. The beachrocks extend from the shoreline down to –15 m depths below the sea floor (Fig.4).

Case Study: Gulf of Iskenderun

In most parts of the Gulf of Iskenderun, Holocene siliciclastic mud is the dominant sediment type but in some locations, shelly sand and gravel (derived from

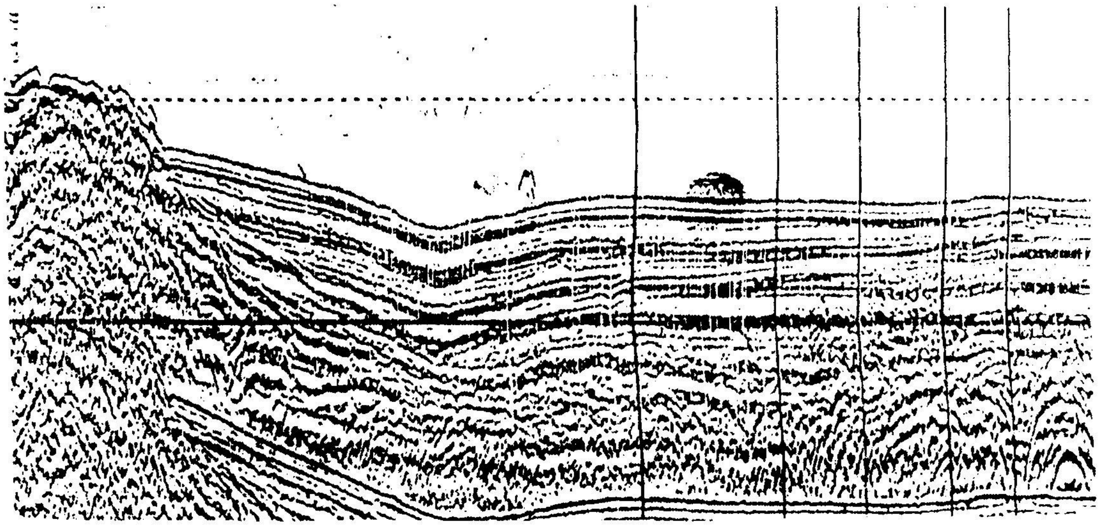

Fig. 3: Seismic records showing beachrocks from Mersin Bay (Bodur and Ergin, 1992).

Fig. 4: Beachrocks from the shorelines of Mersin Bay.

benthic organism remains) are exposed on the sea floor (Ergin et al., 1998; Fig.5). On seismic records, continuation of these coarse grained materials down to 5-15 m subbottom depth reaches the typical erosional unconformity in this gulf (Fig.5).

Case Study: Sea of Marmara

The floor of the Sea of Marmara, especially on the southern continental shelf, is mostly covered by siliciclastic mud although some coarse-grained belts occur (Fig.6) to show the effects of low stands of sea level during the Early Holocene (Ergin et al., 1997).

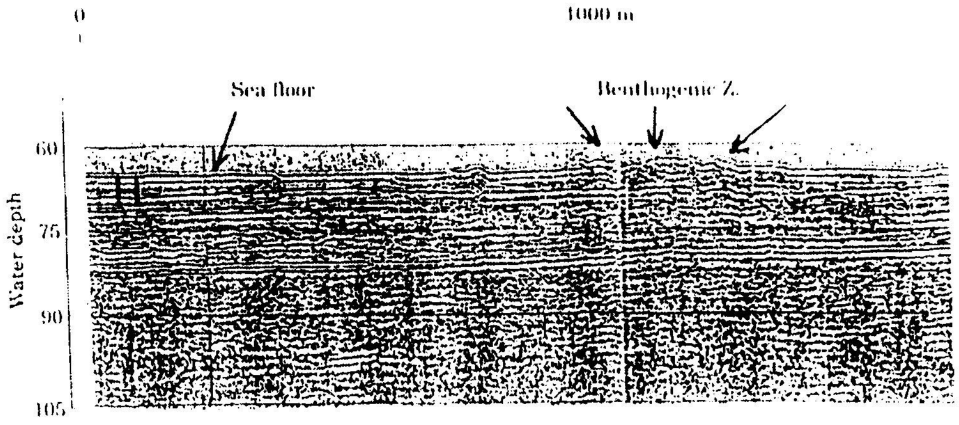

Fig. 5: Seismic record from Gulf of Iskenderun showing shelly sand and gravel derived from benthic organism remains. Note the erosional unconformity partly exposed to sea floor (Ergin et al., 1998).

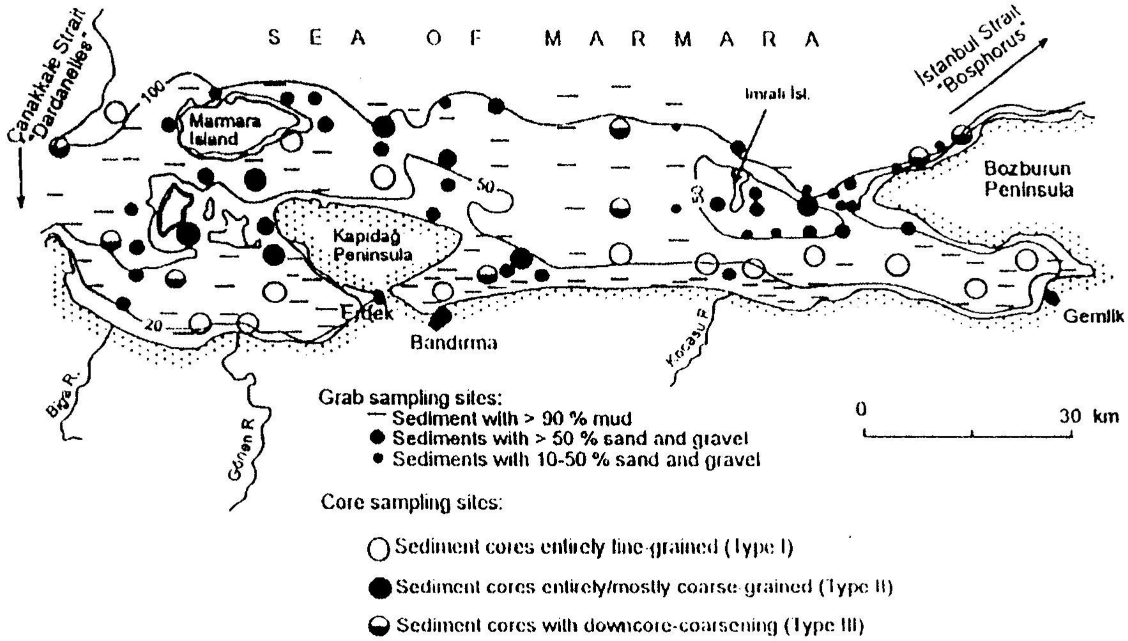

Fig. 6: Bottom conditions in the southern Sea of Marmara. Note the changing bottom characteristics (Ergin et al., 1999).

Microscopic examination of the coarse-grained sand and gravel fractions of sediments indicates a relict nature for these deposits (i.e., former shores or beaches; Ergin et al., 1997). The available seismic records especially those taken from coastal inlets suggest 10-15 m thick Holocene mud and the sediment cores obtained are too short to penetrate the Holocene/Pleistocene boundary (Ergin et al., 1999). Obviously, the erosional unconformities on the seismic records correspond to the coarse grained sand and gravel deposits on irregular surfaces of these belts. On the other hand, the great variations in Holocene thickness and the surface exposures of sand and gravel (Fig.6) of early Holocene could be related, at least in part, to neotectonic movements.

Case Study: Black Sea

The sea floor of the two studied regions, off Trabzon and off Samsun is characterized by the overwhelming presence of siliciclastic mud with some sandy components (Ergin et al., 1992b). Although Cretaceous to Eocene volcanic rocks are dominant along the coastal hinterlands in both regions, the Kızılırmak and Yeşilırmak Rivers have produced large submarine delta fans off Samsun.

On seismic records obtained in both marine regions, continuous parallel reflections are based at some depth by chaotic and irregular unconformities (Figs.7a and 7b). It is expected that parallel reflections above reflect siliciclastic mud of Holocene age and below the chaotic reflections with erosional surface suggest sand and gravel of Holocene/Pleistocene boundary. However, field observations made at the coast and boreholes drilled nearshore showed subbottom materials off Trabzon and off Samsun are greatly different despite similar seismic configurations (Okyar et al., 1994). For example, off Trabzon volcanic rocks (Fig.7a) and off Samsun (Fig.7b) deltaic sand both represent chaotic reflections with erosional unconformities.

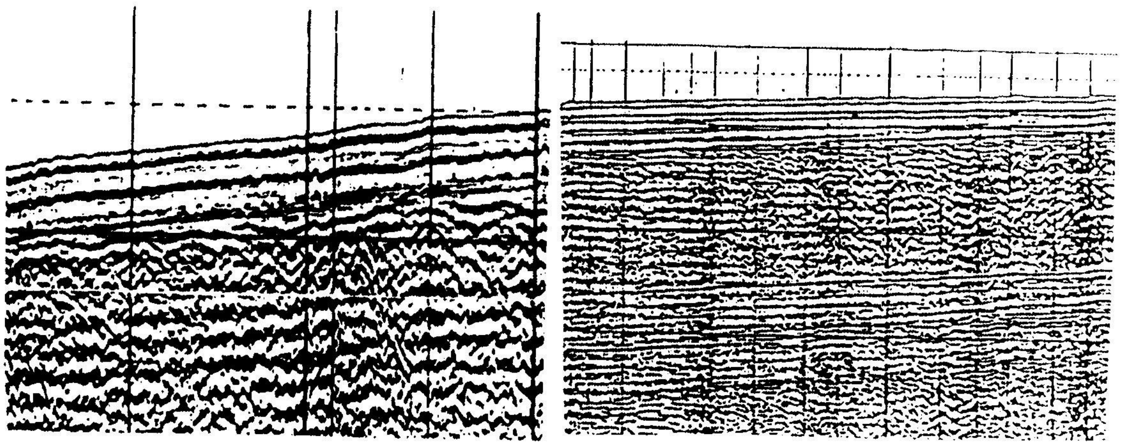

Fig. 7: Seismic records from the Black Sea (Okyar et al., 1994). Unconformities (left) represent volcanic rocks off Trabzon and (right) unconsolidated sand and gravel off Samsun.

Conclusions

Results obtained here and also data from many other studies on coastal geology and in particular, on submarine geotechnics showed that seismic profiling techniques alone may not reflect true bottom conditions in the seas. The so-called unconformities which separate the finer-grained mud above from coarser-grained sand and gravel below along an erosional surface can be derived from different materials and of ages; sand and gravel, beachrock, paleosoil, volcanic or other rocks etc. To achieve better information on the bottom nature of sea floor, coring techniques and petrographic analysis thereof are suggested which could save considerable amounts of costs during the nearshore-offshore constructions.

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