

LATE QUATERNARY DEPOSITIONAL ENVIRONMENTS ON THE
SOUTHERN MARMARA SHELF

GEÇ KUVATERNER'DE GÜNEY MARMARA ŞELFİNDEKİ ÇÖKELME
ORTAMLARI

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Abstract

In this study, 182 surficial sediment samples have been used to investigate the characteristics of sedimentary depositional environments on the southern Marmara shelf. Grain size analyses revealed the presence of, at least, three distinct depositional zones where sediments contained relatively high sand and gravel components partly derived from the remains of benthic organisms. Zone 1 extends from the Bozburun Peninsula in the east to the west off İmralı Island in the west. Zone 2 extends from the east off Marmara Island to the east off Kapıdağ Peninsula. Zone 3 extends from west of Marmara Island towards southwest. The sediments of these three zones grade into fine-grained mud both in nearshore and offshore directions. The presence of ridge-like and high bottom reliefs, based on bathymetric profiles, further suggest that these zones could be relict features such as former shorelines resulted from the last sea-level changes. Due to lack of data, possible influences of neotectonics remain questionable. Zone 3 seems to be controlled by a complex of mechanisms. Further investigations are underway.

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Introduction

The Sea of Marmara forms a transitional link between the Black Sea in the northeast and Aegean Sea in the southwest whereby the two narrow straits of Çanakkale ("Dardanelles") and İstanbul ("Bosphorus") provide connections between these two adjacent seas. Thus, physical, chemical, and biological properties of the Sea of Marmara are greatly influenced by the inflows from water masses of the adjacent Aegean and Black Sea's.

Because of this, characteristics of sedimentary depositional environments of the Sea of Marmara has increasingly received attention (Bodur and Ergin,1994;Ergin et al.,1991,1993,1994;Ergin,1994; Kazancı et al.,1996). However, the southern Marmara shelves which receive significant amount of detrital input from the southerly major rivers, seem to be poorly studied in terms of their sedimentary depositional aspects (Algan and Akbulut,1985;Ergin et al.,1993;Kazancı et al.,1996). The primary objective of this study is,therefore,to determine the types and modes of distribution of the major sedimentary depositional environments and to investigate the controlling marine conditions which have prevailed during the late Quaternary on the southern Marmara shelves.

Materials and Methods

A total of 182 surface sediment samples (upper 15cm of seafloor) was collected from the southern shelves (18-273 m water depths) of the Sea of Marmara during the 1995 cruise of R/V MTA-Sismik 1 using a grab sampler (Fig.1). The sediment samples obtained have been subjected to grain size, carbonate and microscopic analyses. The analyses of the sand (0.063-2mm) and gravel (>2mm) fractions were carried out using dry-wet sieving techniques and remaining mud fraction (<0.063mm) was calculated. The percentage of total carbonate was determined on the basis of weight difference after the relase of CO₂ by acidification of the dry sample with diluted HCl acid. The preliminary results achieved are discussed here.

Results and Discussion

The total carbonate contents (expressed as % CaCO₃) of bulk sediments ranged between 1-80% whereby the majority of the values falls in the range of 10-30% (Fig.2). A carbonate belt, characterized by relatively high values (30-50%), occurs between the Bozburun Peninsula in the east and Kapıdağ Peninsula in the west with a tendency to extend farther offshore towards the deep Marmara Trough (Fig.2). Highest carbonate contents (>50%) are found around the İmralı Island, at the Bandırma Bay entrance and in some patches west off the Kapıdağ Peninsula (Fig.2). Based on microscopic examinations, most of the carbonate contents are likely derived from biogenic material, remains of calcareous benthic organisms.

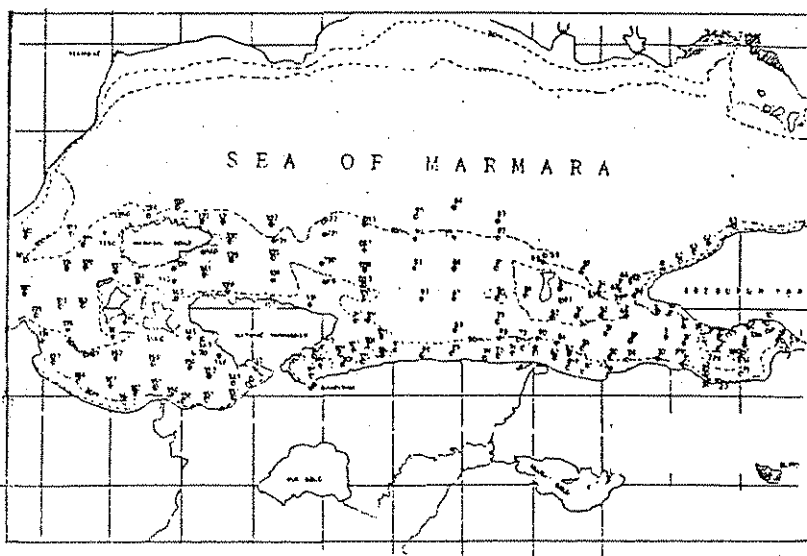


Figure 1. Map of the study area showing the sampling stations of the surface sediments.

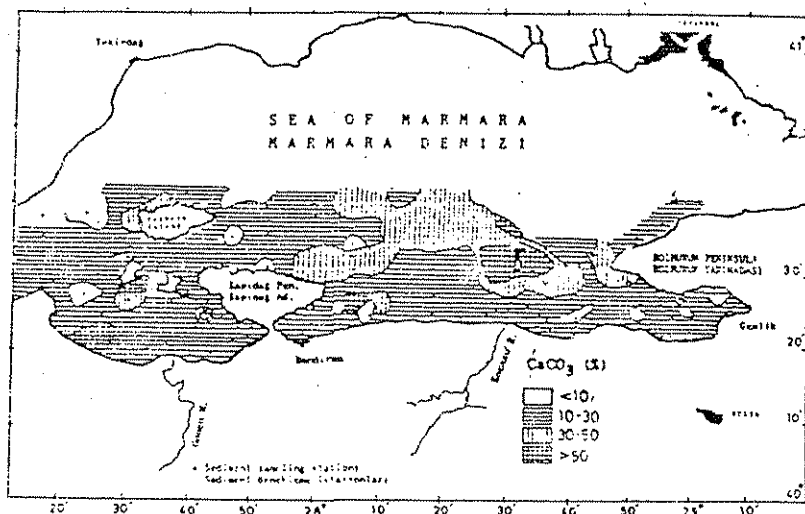


Figure 2. Total carbonate (as %CaCO₃) distribution in surface sediments of the southern Marmara shelf.

Grain size analyses showed that sediments contain 1-33% gravel whereby high gravel percentages (>5%) are found in sediments collected between Kapıdağ and Bozburun peninsulas as well as in the eastern part of Kapıdağ Peninsula (Fig.3). Otherwise, the most of the sediments contained less than 5% gravel. Sand contents varied between 1 and 88%; whereby high values occur in sediments from eastern and northeastern offshore waters of Kapıdağ Peninsula and Marmara Island as well as, west off the Bozburun Peninsula (>10%;Fig.4). Microscopic examinations revealed the dominance of benthic organism remains in the both gravel and sand fractions of sediments. Mud percentages of sediments ranged from 5 to 99%. In general, areas rich in coarse-grained sediments (Fig.5) display small mud portions (<50%;Fig.6). It means that the prevailing marine conditions have not allowed fine sediments to accumulate on the sea floor or erosion and transportation of fine material occurred as a result of presently-unknown hydrodynamic conditions since the presence of latter mechanism has not yet been reported.

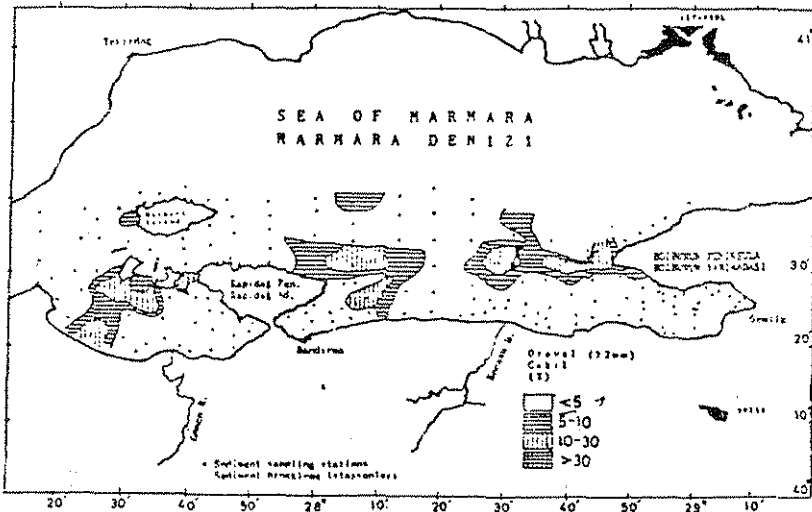


Figure 3. Gravel distribution in surface sediments of the southern Marmara shelf.

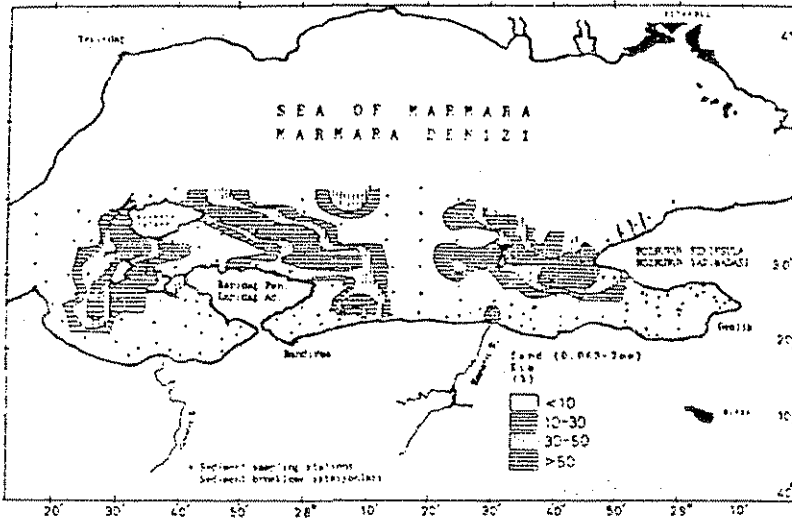


Figure 4. Sand distribution in surface sediments of the southern Marmara shelf.

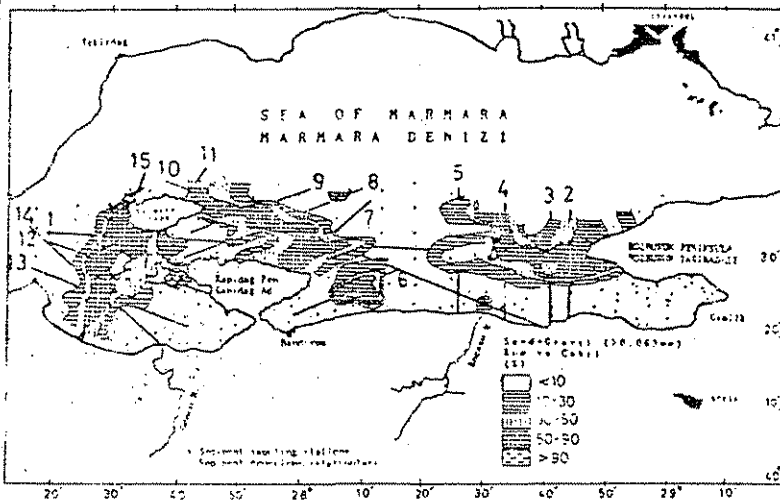


Figure 5. Sand and gravel distribution in surface sediments of the southern Marmara shelf.

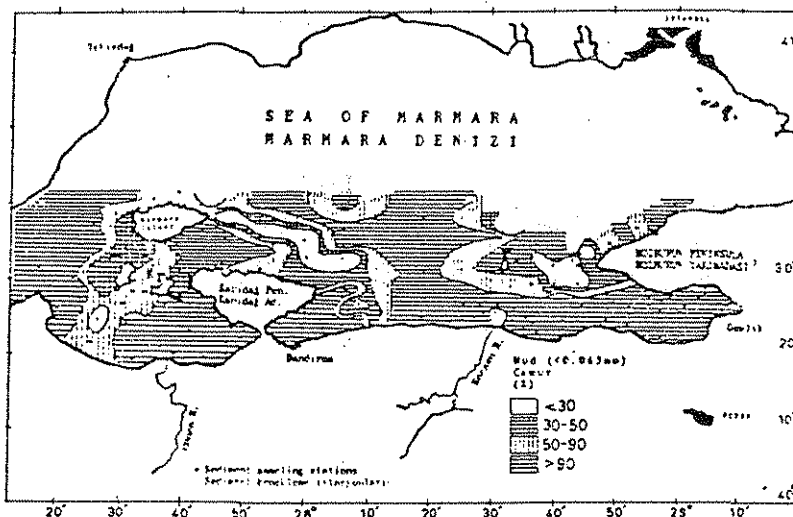


Figure 6. Mud distribution in surface sediments of the southern Marmara shelf.

The sand and gravel fractions combined together, display three zones of enrichment (Fig.5); Zone 1 is located between İmralı Island and Bozcaada Peninsula and is about 25km long and 10km wide with an east-west trending tendency. Zone 2 extends from the east off Marmara Island to the east off Kapıdağ Peninsula; it is about 15-25km wide and more than 50km long (Fig.5). The third zone (Zone 3) is located in the southwest off Marmara Island; it is about 25km wide and 30km long. It is interesting to note that all the three zones which are characterized by their overwhelming coarse-grained sediments are surrounded by fine-grained, mud-rich sediments.

An attempt was made to determine the biogenic and terrigenous ratios in sediments based on comparison between the carbonate-bearing ("biogenic") and carbonate-free ("terrigenous" or "lithogenic") grain size distribution. For example, terrigenous sand and gravel portions (carbonate-free; Fig.7) showed, even to a smaller extent, distribution patterns similar to that of bulk sand and gravel (Fig.5). However the overall pattern of distribution of both carbonate-bearing (Fig.5) and carbonate-free (Fig.7) coarse fractions remains same. To test the relationship between the occurrences of coarse-grained depositional sites and the sea-bottom topographies, some selected physiographic cross-sections are presented in Fig.8. As shown, two of the depositional zones of coarse-grained sediments are characterized by high bottom reliefs and are close to the shelf break. Since there is no data available to show unusually high hydrodynamic conditions in these areas which could favour coarse-grained sedimentation, it is more likely that these areas are, at least in part,

relict in origin. The thicknesses of sediments in these coarse-grained areas are not known exactly but difficulties in penetration during core sampling at the same sites suggest that this is not a present-day phenomenon. It is therefore difficult to establish age relationships between the growth of these terrigenous and biogenic belts on the southern Marmara shelf. Further research is underway. However, the distribution pattern of these zones rich in coarse-grained sediments and the presence of significant amount of remains of benthic marine organisms indicate, at least in part, their origin may be resulted from the last sea level changes, sometimes during the late Quaternary. Due to lack of high-resolution seismic data, it is difficult to establish any relationship between the presence of such coarse-grained zones and tectonic movements (raised shorelines).

On the other hand, the general decrease in carbonate-free mud contents (Fig.9) in sediments from these three zones well coincide with the presence of high amounts of carbonate-free coarse sediments. High mud percentages also occur in sediments with high carbonate contents (Figs.2 and 9) suggesting the importance of biogenic components in the fine-grained, mud fractions. Microscopic studies shall be carried out to identify the origin of carbonates in these fine sediment fractions.

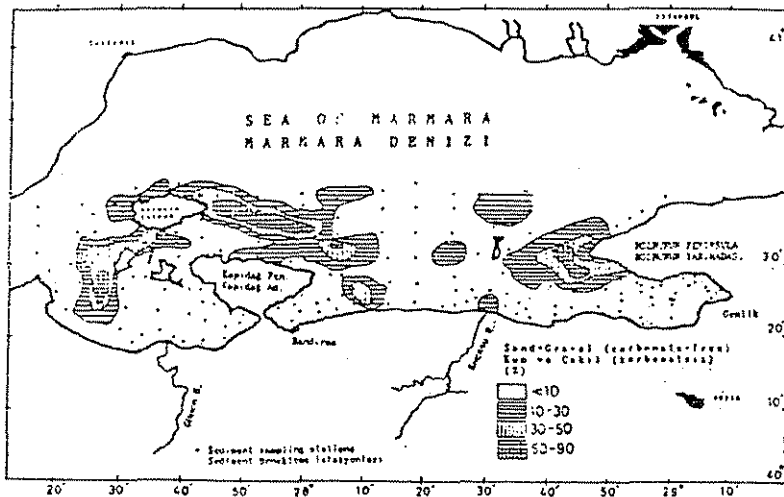


Figure 7. Carbonate-free sand and gravel distribution in surface sediments of the southern Marmara shelf.

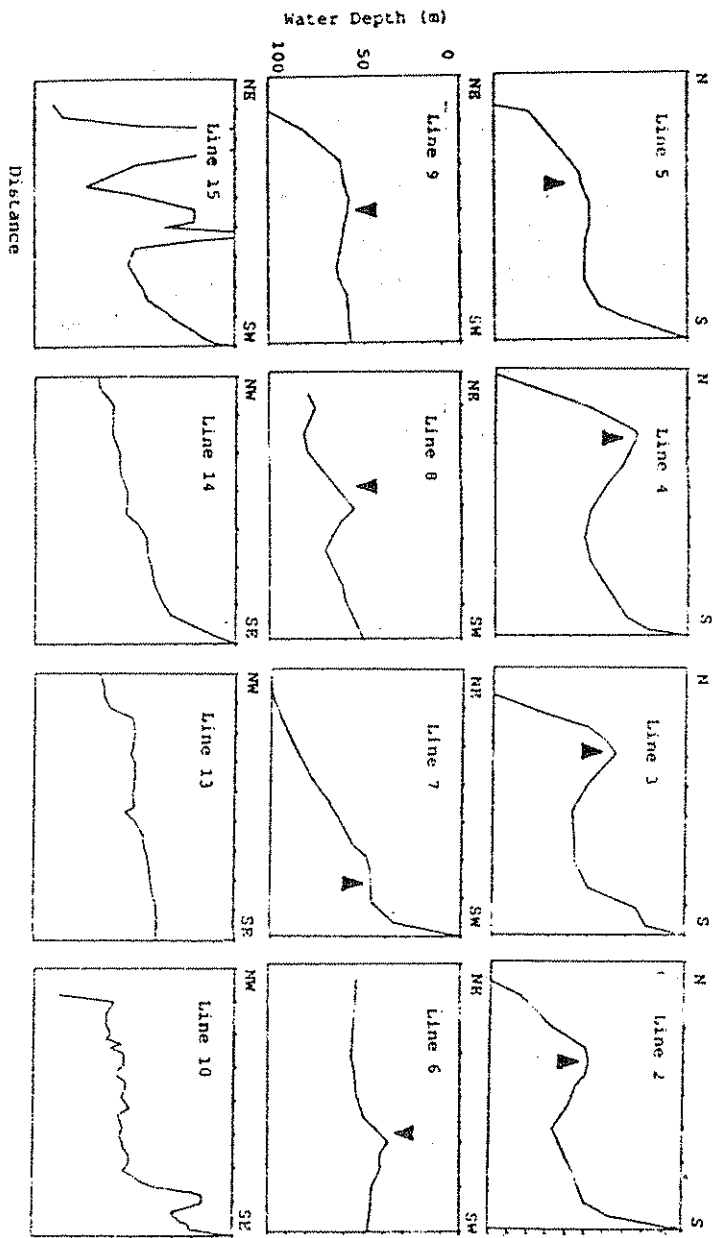


Figure 8. Simplified bathymetric cross-sections of the coarse-grained terrigenous and benthenic zones on the southern Marmara shelf. Arrows indicate high bottom reliefs characteristic of coarse-grained accumulations. See Fig.5 for locations.

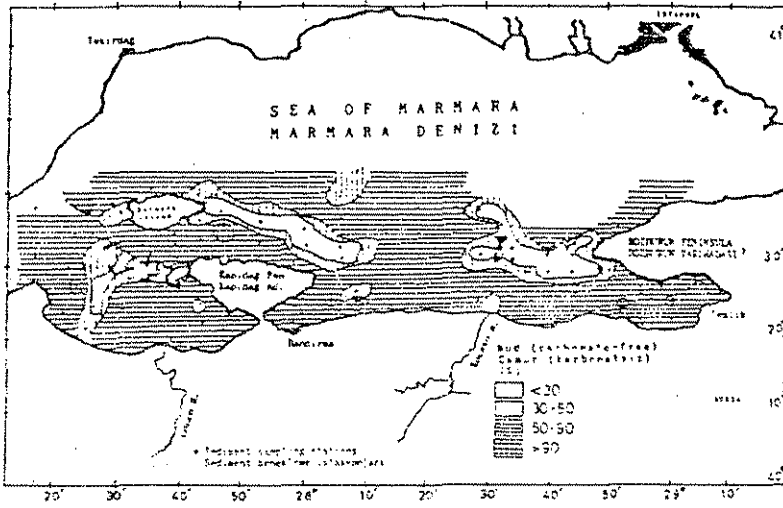


Figure 9. Carbonate-free mud distribution in surface sediments of the southern Marmara shelf.

Conclusions

On the basis of present data obtained in this study, following conclusions can be drawn:

On the southern Marmara shelf there exists, at least three, zones which are characterized by the dominance of coarse-grained sediments rich in both biogenic and terrigenous components. Of these, two zones display elevated (ridge-like) bottom reliefs which separate nearshore and offshore depositional sites for fine-grained, mud sediments. This suggests a relict nature ("former shorelines") for these zones which possibly formed under the influences of last sea level changes (i.e., depositional high-energy environments and benthic production in relatively shallower waters). This and tectonic influences shall be further investigated.

Özet

Bu çalışmada, güney Marmara kıta sahanlığındaki sediment çökeltme ortamlarının özelliklerini araştırmak için 182 yüzeysel sediment örnekleri kullanılmıştır. Tane boyu analizleri en az üç farklı çökeltme bölgesinin varlığını göstermiştir. Bu bölgeler kısmen bentik organizma kabuklarından oluşan ve nisbeten bol miktarda kum ve çakıl malzemelerinden meydana gelen sedimentlerden oluşmaktadır. Birinci bölge doğuda Bozburun Yarımadası'ndan batıda İmralı Yarımadası'nın batı açıklarına kadar

uzanmaktadır. İkinci bölge Marmara Adası'nın doğu açıklarından Kapıdağ Yarımadası'nın doğu açıklarına kadar uzanmaktadır. Üçüncü bölge Marmara Adası'ndan güneybatıya doğru uzanmaktadır. Bu üç bölgenin iri taneli sedimentleri yakın kıyı ve açık denizde ince taneli sediment türlerine geçmektedir. Batimetrik profiller, bu bölgelerdeki sırta benzer yüksek taban rölyeflerinin son deniz seviyesi değişimlerinden kaynaklanan eski kıyı şeridi gibi yapıların olabileceğine işaret etmektedir. Mevcut bulguların eksikliği neotektonizmanın etkilerini şüpheli kılmaktadır. Üçüncü bölgenin oluşumu karmaşık mekanizmaların kontrolünde gelişmiş olabilir. Çalışmalar devam etmektedir.

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