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Lithostratigraphic response of the last sea level cycle in the Saronikos shelf

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Introduction

Quaternary sea level cycles are well imprinted in the marine sediments of continental margins worldwide. The Aegean hosts several locations where excellent preservation of these cycles is manifested on seismic reflection records (Lykousis, 2009; Anastasakis and Piper, 2013). Seismic records of medium and high resolution are not capable to fully resolve and describe the complete association of sedimentary lithofacies that normally develop around 4th and 5th order sea level fluctuations. This is only possible by direct sampling and studying of the sedimentary sequences formed in response to sea level fluctuations. Reworking of the sediments can locally distort the lithostratigraphic continuity, but such processes can readily be identified on the basis of textural and compositional parameters.

Objectives

The objective of this study is to establish a core transect across the outer shelf and shelf break of the Saronikos Gulf in order to establish and evaluate the sedimentary sequences developed during the last sea level cycles. Compositional and textural parameters are established in relation to the sea level curve.

Methodology

Four gravity cores (SAR3, 4, 5 and 6) presented in this study were retrieved by the Department of Historic Geology-Paleontology, during the 2011 Saronic research expedition utilizing a trawler boat. The cores were scanned for their magnetic susceptibility, split and photographed. Cores were sampled at a few cm resolution based on macroscopic and susceptibility differentiations. Samples were oven dried at 45ºC. Carbonate content (%) was measured on all samples following the Muller and Gastner (1971) method. Organic carbon content was measured on selected samples using a combustion technique. Selected samples were also picked for grain size analysis. Core SAR5, recovered at 160m water depth, which displays the well-established Eastern Mediterranean lithostratigraphy, was chosen for detailed X-ray bulk mineralogy. Carbonate minerals were estimated by measuring peak areas of main peaks on diffractograms and utilizing published calibration curves. Other well crystallized minerals were measured using peak heights and mineral correction factors (Muller and Mann, 1979).

Results

SAR-3 was recovered at 110 m depth and is entirely composed of bioclastic sands dominated by coarse calcareous algae fragments, bivalves and gastropods. Carbonate contents range in-between 60-80%. At the base of the core an unconformity is observed. The basal section of this core displays a significant percentage of well rounded, sub-spherical terrigenous grains, plus many iron-coated mostly foraminifera tests. Coarse biogenic grains are broken and rounded. All the above suggest exposure to a sub-aerial wave dominated coastal environment.

SAR-4, retrieved at 138 m depth, consists of medium to fine carbonate sands with frequent large sized shells. Generally carbonate contents are decreasing upwards ranging from 50-70%.

SAR-5 obtained at 160 m depth, on the slope, displays well developed cyclothematic lithoface associations starting from the bottom with coarse grained carbonate sands, enriched on biogenic fragments and their carbonate content to range from 90% at the base to 55% on the top of the core. A well-developed sapropelic layer is developed on the upper section of the core. Grain size mean diameters are around-1φat the lower half of the core, due to coarse biogenic tests and rapidly decrease upwards from below the sapropelic sequence to the top of the core. There is also a concomitant to the grain size decrease in carbonate contents.

Detailed bulk mineralogy of this core also displays well expressed trends. Terrigenous minerals score highest percentages at the upper section of this core. Illite is the most dominant mineral varying from 3 to 17 %, quartz is the second in abundance scoring 2-16% respectively. There are two levels with enhanced feldspar contents, around 7%, most likely associated with cryptotephras. Carbonate minerals consist mostly from Mg-rich calcite, calcite and aragonite while dolomite is present in trace amounts. From top of the core until below the sapropelic layer Mg-calcite varies from 20-38%, calcite scores 16-21% and aragonite varies from 6-15%. At a well expressed stratigraphic interval below the sapropelic lithoface, there is a coarse calcareous algae sand lithoface that presents aragonite contents up to 32%. Below this layer, there is a step-wise increase of Mg-rich calcite paralleled by a concomitant decrease of calcite and aragonite. Mg-rich calcite scores up to 74%.

SAR-6 is located at 212 m depth within the basin of South Saronikos. It is generally composed of a fine sandy marl with carbonate contents generally decreasing upwards from 65-45%. A thin 6 cm sapropelic horizon is developed on the uppermost section, from 26-32 cm. Carbonate contents score the highest percentages of 68% around 10-20 cm below the sapropelic layer and then steadily decrease to the bottom of the core varying in-between 40-50%. Grain size shows little variability along this core with the finest sediments attaining median diameters of around 3,7φ at the top 10 cm.

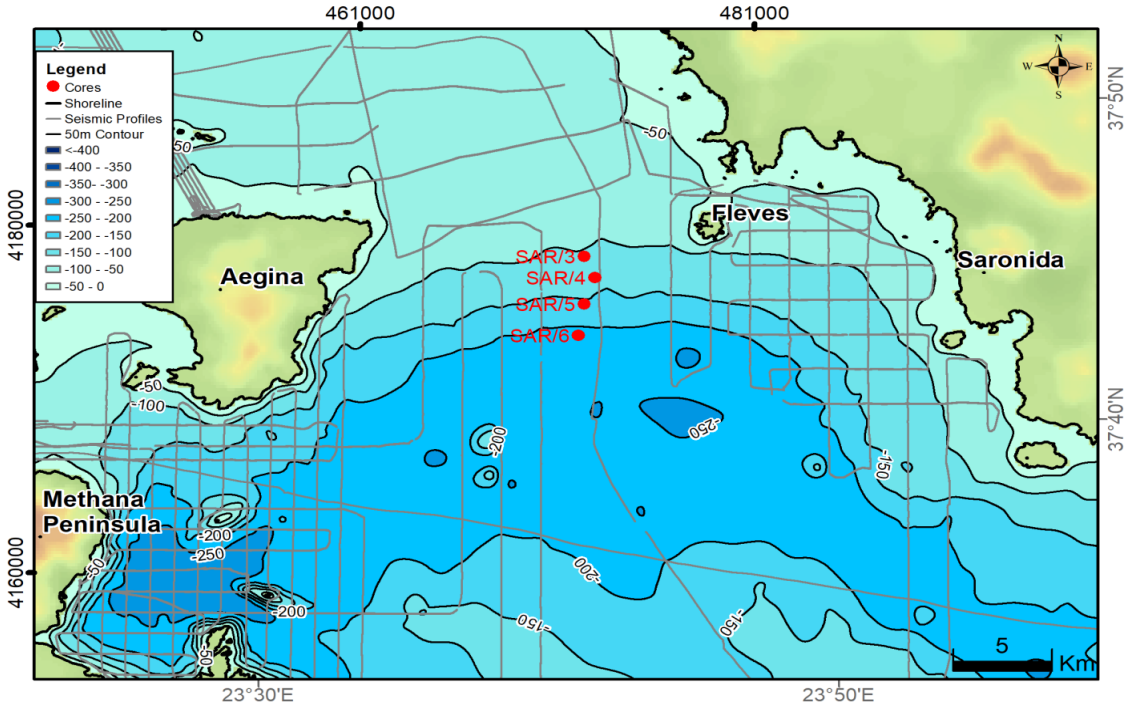

Fig.1 - Bathymetric map of the study area with core locations presented in this study.

An indicative high resolution chirp profile along the bathymetric transect established along the coring stations presented in this study shows:

a. A 8-20 m thick horizon developed in water depths greater than 190m.
b. A less than 1m thick surface horizon developed in-between 190-120m.
c. A clinoform package developed at 115-120 m attributed to the last glacial sea level strandline. This clinoform package is bounded to the north by a ca 5-m high sandy barrier.

Conclusions

A bathymetric transect in-between water depths of 110-212 m, obtained by coring stations along the South Saronikos shelf revealed the following:

1. There is direct evidence of subaerial exposure in core SAR-3 recovered in water depth of 110 m. Terrigenous grains at the time of this exposure suggest littoral transport along this paleo-coast presumably developed during the last glacial sea level drop as mapped on seismics by the identification of a clinoform wedge at 115-120 m.
2. Cores recovered down to water depths of around 140m display a coarse sandy carbonate facies.
3. Deeper cores display cyclothematic lithofacies associations with a thin sapropelic layer developed in the upper 30 cm. Texture of sediments becomes coarser below the uppermost sapropelic horizon, as a result mostly of coarser biogenic grains precipitated in shallower water depths during reduced sea levels of MIS 2 and 3. There appears to be terrigenous sediment trapping landwards to the north, behind a sediment barrier developed in Saronikos shelf during the lowest and lower sea levels.
4. Mg-calcite contents at a core recovered at 160 m water depth display slightly reduced percentages at the colder stratigraphic interval of MIS 2 and further show a drastic increase throughout MIS 3 as compared to MIS 1. This paradox can be attributed to the enhanced contribution to the biogenic carbonate factory of Mg-calcite secreting organisms, such as coralline red algae, bryozoans and echinoids. This is due to the fact thatMIS 3 sea level consisted of an initial rise to a level of approximately 60 m for the first half of MIS 3 and subsequent drop to 80 m for the remainder.

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