OCEANOGRAPHIC AND SEDIMENTOLOGICAL PROCESSES IN AN SEMI-ENCLOSED GULF. AMVRAKIKOS GULF, WESTERN GREECE.

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Abstract

Amvrakikos Gulf is a tectonically produced estuary, located in central Western Greece. It is a semi- enclosed embayment separated from the Ionian Sea by a beach barrow complex of Holocene age. On 2008, 2009 and 2011, three (3) research cruises were carried out in order to obtain oceanographic data. During this period, a total of 21 observation stations were positioned through the gulf and measurements were carried out throughout the water column. In the same period, another survey took place in the area, in which a 30 m core was obtained from Logarou Lagoon, in order to be analyzed and give results, concerning the environments that are found in the area. After elaborating with the data, it was found that a well-stratified two layer structure in the water column develops in the Gulf, whilst during winter period the pycnocline is disappeared with lower rates of salinity and higher provisioning inflow of brackish water from the rivers. In the course of summer, anoxic conditions occur at depths exceeding 25 meters. Also, based on the organic matter and magnetic susceptibility, there were identified 3 lithostratigraphic units which subscribe the environment and at the same time express the conditions that are charactering every zone.

Keywords: amvrakikos gulf, lagoon, oceanography, sedimentology.

Introduction

Amvrakikos Gulf is a tectonically produced estuary, located in central Western Greece. It is a semi- enclosed embayment of approximately 400 km^2, separated from the Ionian Sea by a beach barrow complex of Holocene age. In the north it is bounded by the deltaic plain of rivers Louros and Arachthos and surrounded by twenty lagoons of total area of 63.500 acres (Piper et al., 1982; Kapsimalis et al., 2005; Anastasakis et al., 2007). The area of the gulf and the basins of the rivers are developed in the western edge of the Hellinides Mountain Ranges and its main system and regional basins are predominantly situated in the isotopic zone of Ionian Sea, whilst its eastern part is developed in the isotopic zones of Gavrovos and Pindos (Kapsimalis et al., 2005; Anastasakis et al., 2007), (Fig. 1).

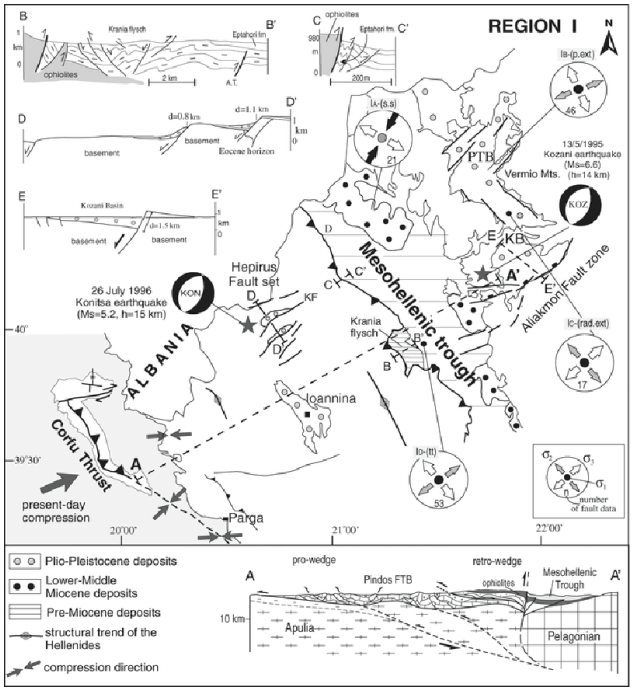

Figure 1: Tectonic map of Amvrakikos Gulf. (Kokalas et al., 2005)

Most of the gulf is floored with rather uniform silty clays. However, sand is abundant in Preveza Strait where stronger currents prevail. It is also characterized by tidal ranges < 30cm and a calm wave climate. The Gulf has been subjected to major morphological changes during Upper Quaternary, as a result of sea level fluctuations and neo-tectonic activity. Moreover, it is most likely that during the last post- glacial transgression (earlier than 10 ka BP), seawater from the open Ionian Sea had already entered into the Gulf (Poulos et al., 1995; Anastasakis et al., 2007).

Materials and Methods

In the present study some primary data are presented, along with data previously published, setting up a review article. On 2008, 2009 and 2011, three oceanographic cruises were carried out in the framework of an EU funded project (HYPOX project).

During this period, a total of 21 observation stations were positioned through the gulf (Fig. 2), where physicochemical parameters such as temperature, salinity, redox potential, pH and dissolved oxygen were simultaneously measured. Measurements were carried out throughout the water column using multi-parameter seawater sensors such as YSI 600XL, Insitu troll 9500 and Methane Sensor Capsum METS. More specifically, YSI 600XL is able to measure conductivity, temperature, D.O., pH, ORP with 80 meter cable for real time, whereas Insitu troll 9500 can also measure pressure, (optical) D.O., turbidity with 100 meter cable for real time. In the end, Methane Sensor Capsum METS is tha appropriate instrument for measuring the fluctuation of the amount of CH_4 After data acquisition, vertical profiles throughout the water column were constructed using Golden.Software.Surfer.v9.9.785 and Microsoft Excel. These columns were expressing the parameters T, S, v, DO, ORP, pH, Turbidity, CH_4 which were collected from the Preveza Straits, within the Gulf and the open Ionian Sea.

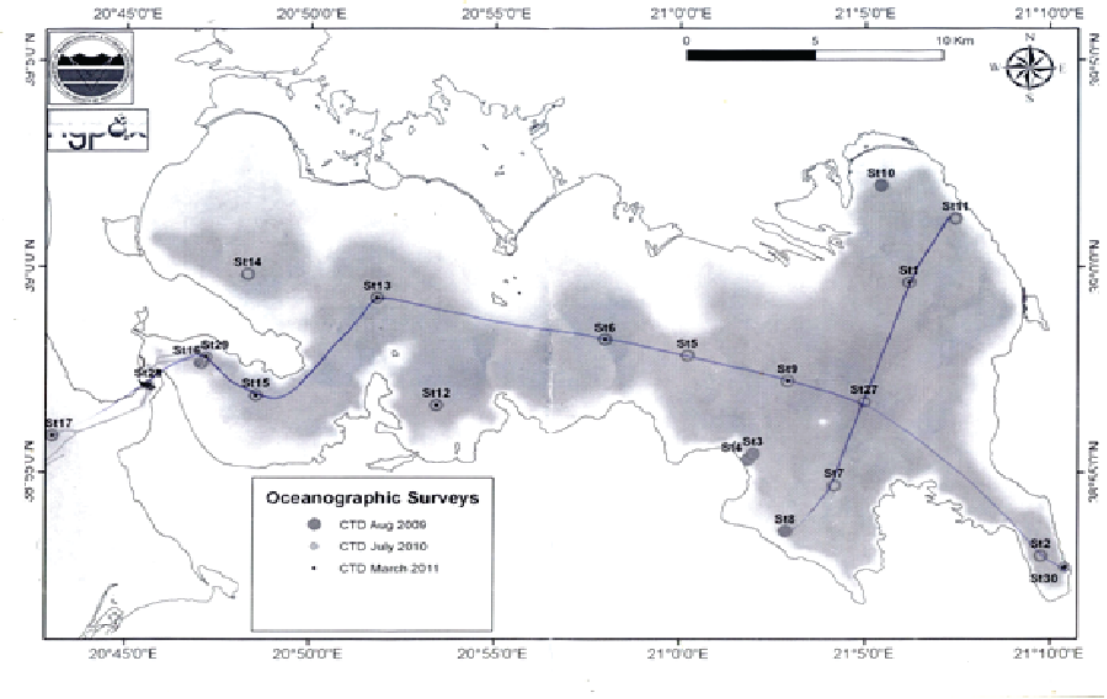

Figure 2: Measurement spots and vertical profiles throughout the water column.

In the same period, another survey took place in the area, in which a 30 m core was obtained from Logarou Lagoon in order to be analyzed and provide information concerning the palaeoenvironment. Firstly, the granulometric size was measured with the use of Malvern Mastersizer 2000 Hydro. The method applied, is based on laser diffraction and is used in samples of the same origin for the distribution of granulometric sized sediments between 0.02 to 2000μm (Pieri, 2006).

Measurements of magnetic susceptibility took also place so as to identify the minerals (macro) and distinguish them from other kind of magnetic minerals. The instrument used was MS2 System of Magnetic Susceptibility full equipped with a variety of sensors. Organic carbon was determinate by the wet oxidation method of Gaudette et al. (1974). The organic matter was oxidized with $K_2Cr_20_7$ in an acid medium of concentrated H_2SO_4, and the excess $K_2Cr_20_7$ was measured with ferrous sulfate; in order to eliminate compounds that react with the $K_2Cr_20_7$. Even though the organic material is rarely the main component in the bottom sediments of coastal environments or estuarine areas, it is often considered as a good indicator of the depositional environment of sediments.

Results and Discussion

Oceanographic data analysis has shown that during summer period a well-stratified two layer structure in the water column develops in the Gulf, whilst during winter period the pycnocline is disappeared; lower rates of salinity occur in the surface because of higher provisioning inflow of brackish water from the rivers (Fig. 3).

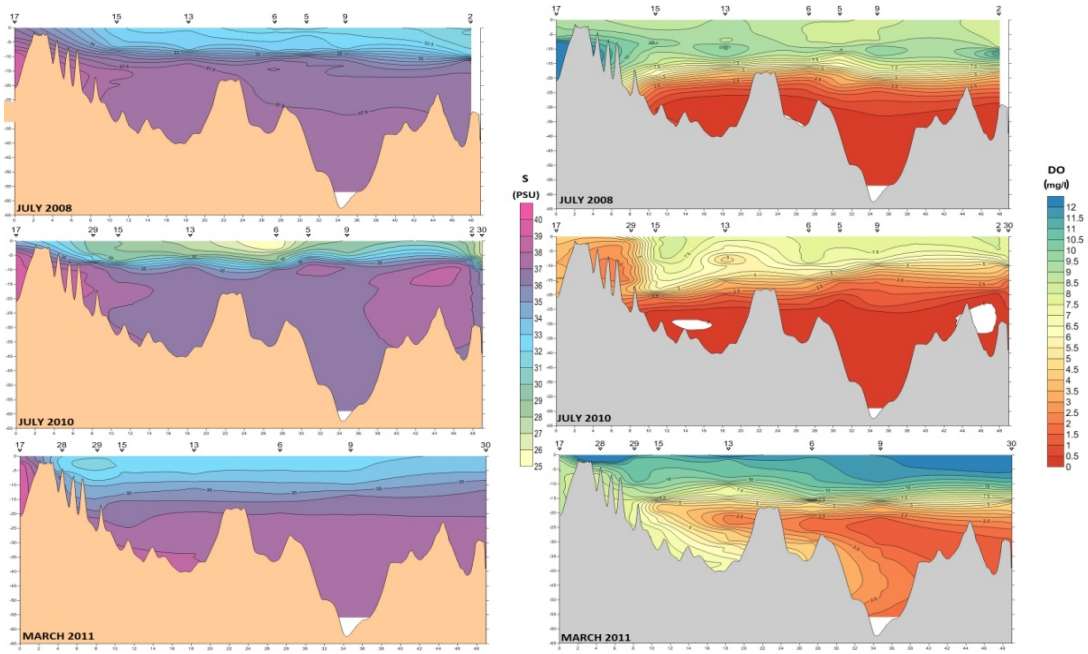

Figure 3 Surfer vertical profiles of the water column: salinity (on the left) and dissolved oxygen (on the right)

Concerning dissolved oxygen, during summer period anoxic conditions occur at depths exceeding 25 meters (Fig. 3). In the course of winter, strongly oxidized conditions prevail, whereas hypoxia occurs only in the deeper eastern-isolated from the Ionian Sea part of the gulf.

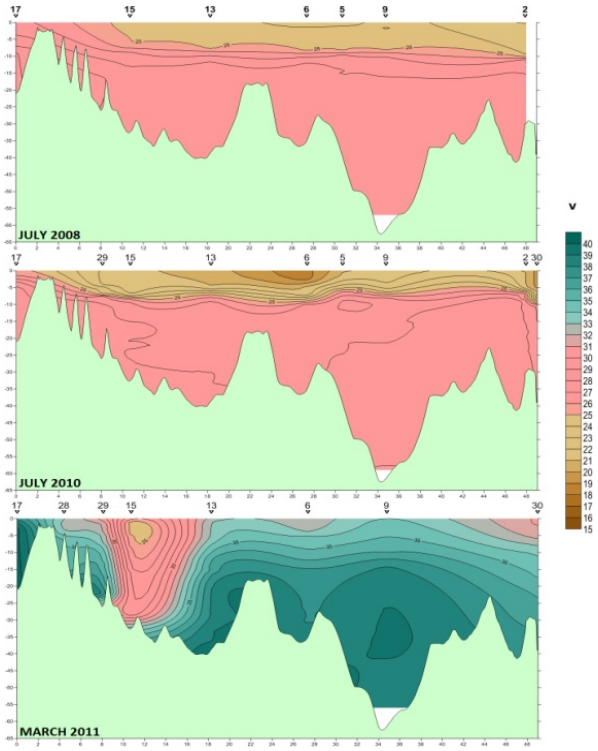

Figure 4: Surfer vertical profile of the water column: potential density.

As it is noticeable on Figure 4, potential density is high during winter period, except from the straits NW of the gulf, in contrast to summer periods where mediate to low values prevail.

The organic matter is rarely found on bottom sediments, but it is important for the characterization of the environment that the sediments are deposited. On the analyzed core 3 lithostratigraphic units (upper, middle, lower) were identified, according to the percentage of organic matter and magnetic susceptibility (Fig. 6). The first unit (5.3 – 11.5 m) is showing a mechanism which varies from uniform suspension up to pelagic suspension. The second (11.6 – 21.6 m) is mainly characterized by uniform suspension, whereas the third lithostratigraphic unit (21 – 30.07 m) appears to have a pelagic suspension with a completely calm environment of sedimentation (Fig. 5).

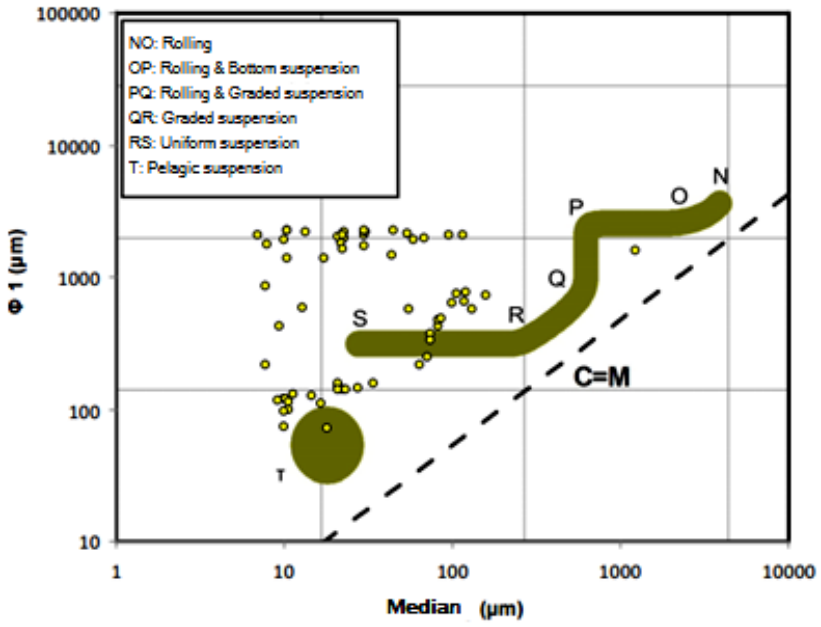

Figure 5: C-M diagram of the examined samples. The green curve represent turbidite fields that are proposed by Passega (1957). Turbidite fields were confirmed by Passega who studied turbidite deposits in Apennina (Italy).

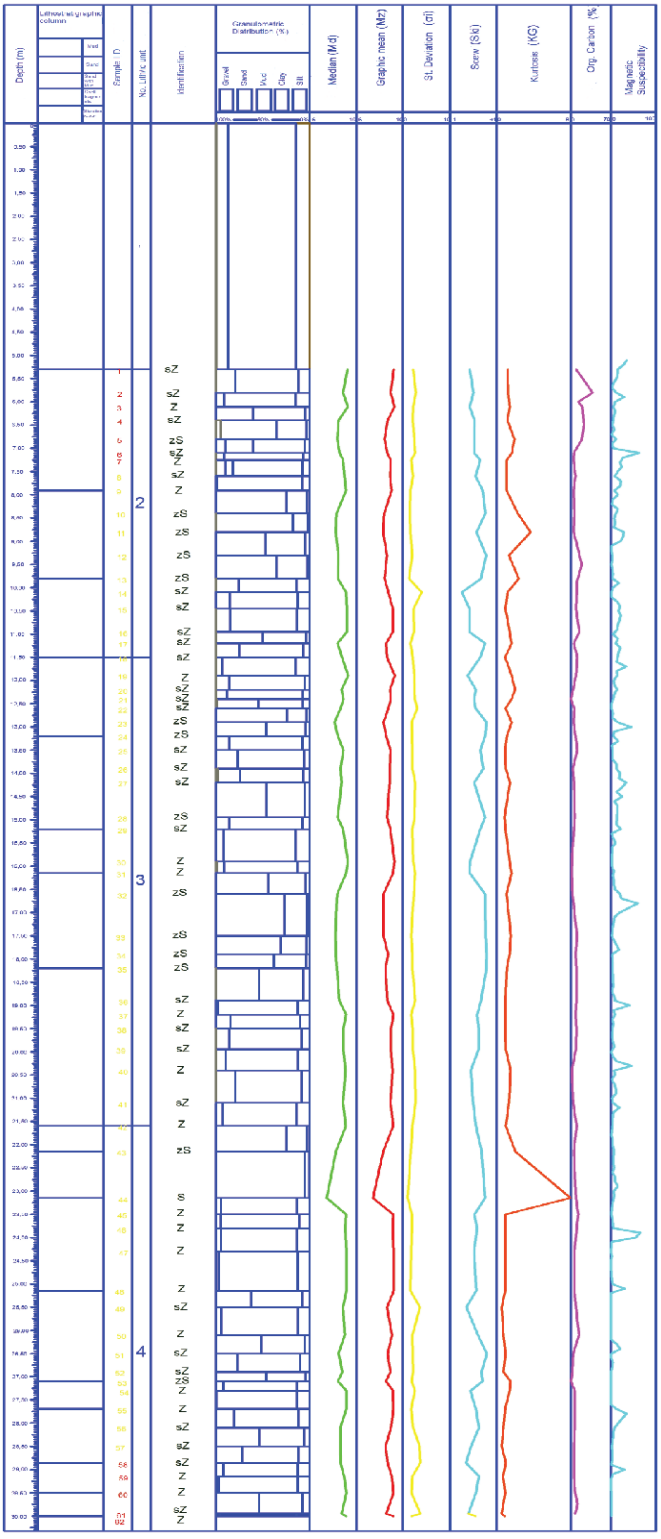

Figure 6: Lithostratigraphic sequence of a 30m core in Logarou lagoon.

Conclusions

Oceanographic conditions during the summer in combination with the morphology of the Gulf, suggest that it is characterized by a fjord-like water circulation. In the water column develops a well-stratified two layer structure, whereas along the Straits and over the sill there is a predominant two-layer model flow, with brackish out-flowing water at the surface and saline inflowing water near seabed.

The distribution of salinity and density alongside the Straits suggests that the deep water is trapped by the sill. The brackish surface layer is well mixed and separated from the bottom layer by a well developed thermocline / halocline. The strong thermocline / halocline impedes the downward diffusion and advection of the DO, resulting in low DO concentrations in water deeper than 25 m and of approximately zero in water depths of more than 33 m. In conjunction with the sharp redox cline, dysoxic and anoxic boundaries suggest that oxidizing and reducing biochemical processes, respectively, prevail.

Based on the quantity of the organic carbon and of magnetic susceptibility, 3 lithostratigraphic units were identified (lower, middle, upper). The upper and the middle unit showed a dry climate whereas the lower a thermal one. As far as it considers the environments, the upper suggests a lagoon environment, the middle probably appears to have oligotrophic characteristics and the lower appears to have a more tranquil environment of sedimentation.

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