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SEDIMENT CHARACTERISTICS OF CORES OF BOREHOLES EUXRO01-1 AND EUXRO03-3 OF NORTHWEST BLACK SEA

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Abstract: *During the period 2010-2013, under the program for cross-border cooperation, the project „MARINEGEOHAZARD" was implemented with the participation of scientists from the Institute of Oceanology - BAS Varna. The main goal was to build an early-warning system for marine and geohazards along the Bulgarian-Romanian coast. In the process of implementation, lithostratigraphic analysis is made of core samples of boreholes EUXRo01-1 and EUXRo03-3, located south and southeast of the Danube Delta, depth of 228 m 615 m. The specific density of boreholes" cores, according to BDS 646-81, and the carbonate content of the sediments were defined, granulometric analysis is made. The study analyzed the geological conditions of the locations of boreholes EUXRo01-1 and EUXRo03-3. Turbidity currents in the sedimentary deposits in Unit 3 of borehole EUXRo01-1, and layers of rice-like aragonite in borehole EUXRo03-3 have been found. The latter are typical for the Early Holocene low standing of the Black Sea level. The results justify the necessity of additional studies of the physical and mechanical properties of the sediments of the continental slope of the Northwestern part of the Black Sea.*

Keywords: *Black Sea, early warning system, lithological analysis, specific* ***density****, granulometric analysis, carbonate content.*

Introduction

The Black Sea as an almost isolated marginal sea is particularly sensitive to paleoenvironmental changes. Black Sea sediments therefore provide an excellent opportunity for high-resolution studies of past climatic and hydrological changes in the catchment (Bahr et al., 2006).

The project MARINEGEOHAZARD is the first major initiative addressing in an integrated and coordinated manner the much needed geohazard early-warning system for the Black Sea.

Operational joint early-warning system to marine geological hazards, requires Euxinus network, a complex system consisting of five early warning marine platforms, in key points of the Black Sea area (Fig.1).

Fig. 1. Location of five early warning marine platforms (including gravity core EUXRo01-1 and EUXRo03-3)

Material and methods

Three gravity cores were collected by a GeoEcomar team during a scientific cruise on board R/V Mare Nigrum from the Romanian locations of the MARINE GEOHAZARD observatories. According to the working plan of the project the cores were delivered to IO-BAS Varna and so far two of them - EUXRo01-1 and EUXRo03-3 were lithologically described (Fig.1., Table 1).

Sedimentological description and sampling of the core EUXRo01-1 and EUXRo03-3 for carbonate, grain size and mineral density analyses were performed in the Institute of Oceanology, Bulgarian Academy of Sciences. The samples were analyzed in the Geological Institute, Bulgarian Academy of Sciences.

For determination of carbonate contents of the sampling intervals of the core a classic approach of decarbonatization was used. Dry sample with an exact weight (10 g) is treated with 5% HCl. After finishing of the reaction the solid remainder was desiccated and measured. Based on its weight the carbonate contents were calculated. The particle size distribution is one of the most important physical characteristics of sediments. The percentage of sand, silt and clay in the inorganic fraction of sediments was measured using the Stoke's method based on the rate of sedimentation of particles suspended in water. In this article, the particle size analyses were done according to the following Bulgarian standard: BDS 2762-83 for particle-size distribution of soils by hydrometer analysis. The mineral density analyses were done according to the following Bulgarian standards: BDS 646-81 for mineral density (ρ_s), using 100 ml volumetric flask. A stratigraphic approach to the study of core EUXRo01-1 sediments includes the application of the stratigraphy on the basis of investigations of Ross and Degens (1974).

Table 1. The investigated cores EUXRo01-1 and EUXRo03-3 of Euxinus network in Black Sea, Romanian zone

Core	Length (cm)	Water depth (m)
EUXRo01-1	400	228
EUXRo03-3	500	615

Results and interpretation

Lithological description of the sediment cores

In the lithological description of both cores are ascertained the following features. Both sediment cores from the continental slope show the subdivision in three units typical for sediments from the Black Sea basin [2]: the marine units – Unit I - finely laminated coccolith ooze and Unit II – sapropelic sediments at the top and the lowermost Unit III - clay deposited under lacustrine conditions. In the core EUXRo01-1 are ascertained shells and shell fragments of bivalves and gastropods in Unit I, Unit II and Unit III. In the core EUXRo01-1 are ascertained as well as deposits of turbiditic flux in Section III, within interval 225-252 cm more than 7000 yrs BP.

Degens, Ross (1974), [2] point to 3090 ± 130 years – a date close to the number obtained by the author with regard to the lower part of unit Ia - finely laminated coccolith ooze. The thickness of the sediments on the continental slope and in the deep sea depression is from 10–15 cm to 30–45 cm. There are only rare cases of coccolith oozes with thickness up to 80–90 cm. Very often the coccolith oozes are interleaved by thin (1–2 mm) strips of diatom algae. It is clearly visible in Fig.2.

Fig.2. Photographic illustration of Core EuxRO-1, Section I (100-0 cm).

According to [2] the boundary between units III/II is 7090±150 ^{14}C yr BP. The onset of sapropel deposition in the core EuxRo03-3 is described at 100 cm with sharp contact between Unit III and Unit II (Fig.3).

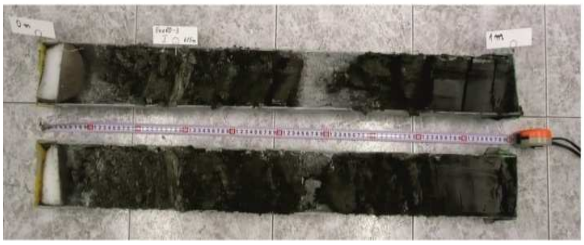

Fig.3. Photographic illustration of Core EuxRO-3, Section I (100-0 cm).

The lowermost Unit III is described in both cores as clay deposited under lacustrine conditions (Fig.4).

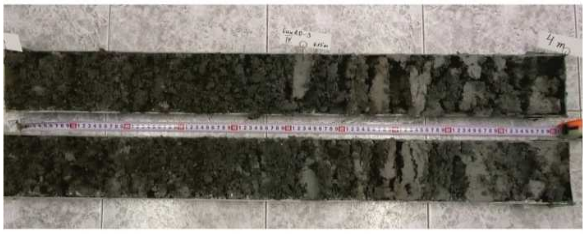

Fig.4. Photographic illustration of Core EuxRO-3, Section IV (300-400 cm).

Mineral densities analyzes

The average mineral density of core samples for ***Core EUXRo03-3*** in the interval from 0 to 100 cm is 2.51 g/cm^3 (excepting the sample from 90 cm, which has low mineral density – 2.10 g/cm^3). The density gradually increases in depth. In the interval from 100 to 300 cm, the average mineral density is 2.72 g/cm^3 and from 300 to 400 cm – 2.75 g/cm^3. At the end of the interval (500 cm) the density reaches 2.79 g/cm^3.

The average mineral density of core samples for ***Core EUXRo01-1*** in the interval from 0 to 147 cm is 2.55 g/cm^3. In the interval from 147 – 252 cm the average mineral density is 2.64 g/cm^3 (except the sample from 220 cm, which has low mineral density – 2.37 g/cm^3) and from 252 to 400 cm – 2.75 g/cm^3.

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Regarding the particle size, slow increase of mineral density is shown at samples with higher silt content (0.063-0.004 mm). It should be noted that in both cores, the mineral density begins increasing at 100-110 cm.

Carbonate contents and the particle size distribution of core EUXRo03-3

The lithological description with stratigraphic subdivisions and the graphic drawing of results from the grain size and carbonate analyses of core EUXRo03-3 for interval 150-20 cm are shown on the Fig.5.

An interval from 150 to 110 cm is described as a trend of a carbonate values increase in the core EuxRo03-3 (Fig. 5), much higher than these of the glacial time, and stagnation in the change of the coarsest fraction, a slight increase of the medial coarse fraction and slight decrease of fine particle size fraction. The carbonate values in this interval are representative of the warm climate, because of the insignificant increase of the medial coarse ingredient values. Particle size data, show a susceptibility to conditions only from the medial coarse component to the finest component. Taking into account the location of the core EuxRo03-3 (615 mbsl), the presented data is interpreted as result of regressive Black sea level state.

The abrupt increase of medial coarse component values in the interval 110-100 cm and the abrupt decrease of fine component in the same interval and the decrease of the carbonate values are the indication for regression in its last stage, i.e. the most active phase. The medial coarse fractions in this interval are indicative of the Black sea level state, due to the significant remoteness of the core EuxRo03-3 location from the shore area. On the other hand the decrease of the carbonate values is a result of the increase of the terrigenous component.

The onset of sapropel deposition in the core EuxRo03-3 is described at 100 cm with sharp contact between Unit III and Unit II, (Fig.5).

In maintenance of assertion for the sediment redeposition in the core EuxRo03-3 is the increase of the coarse fraction values in the interval 100-90 cm, probably related to the disturbance of the equilibrium of the deposits when the sea level had been increasing permanently, as a result of the inundation of the Mediterranean sea salt waters in the Black sea or the turbidite formation, considering the values of all fractions in the following interval from 90 to 60 cm of the core.

Carbonate values are low in the interval 90-60 cm, in comparison with the lower intervals, which is a sapropel typicalness and is in consistence with the investigations of different authors.

The interval 60-30 cm in the core EuxRo03-3 from a lithological point of view is referred to the marine stage of the basin evolution. The coarsest fraction in the interval varies little, the medial coarse fraction decrease significantly getting to its minimal values, the fine and the finest fractions increase significantly getting to their maximum values, (Fig.5). These results are indicative of the Black sea level raising and the distancing shoreline from the core location.

At 30 cm in the core is described the boundary between Unit 2 and Unit 1 as well as the stable appearance of *E.huxley*. At 24 and 25 cm in the core are described two diatomic ooze intercalations, which are about 1 mm in thickness, (Fig.2). Carbonate values, which are very low in marine Unit II (sapropel), increase significantly in Unit I, (Fig.5). This increase is related to the occurrence of coccolith-rich layers. The trend of the increase of the carbonate content moderates at 25 cm, because of silicate seams of diatomic ooze, as probably they are the reason for the values variations of all fraction at 25 cm.

At 25 cm and upwards getting to the top of the core, the carbonate values increase getting to their maximal values, explicable with the deposition of coccolith-rich layers, brought about by the warm climate. In the top of the core the values of coarse fractions decrease in comparison with their values at 30 cm, and fine fractions increase compared to their values at 30 cm. It is unambiguous information for the deepening of the basin and calm hydrological conditions for the core location.

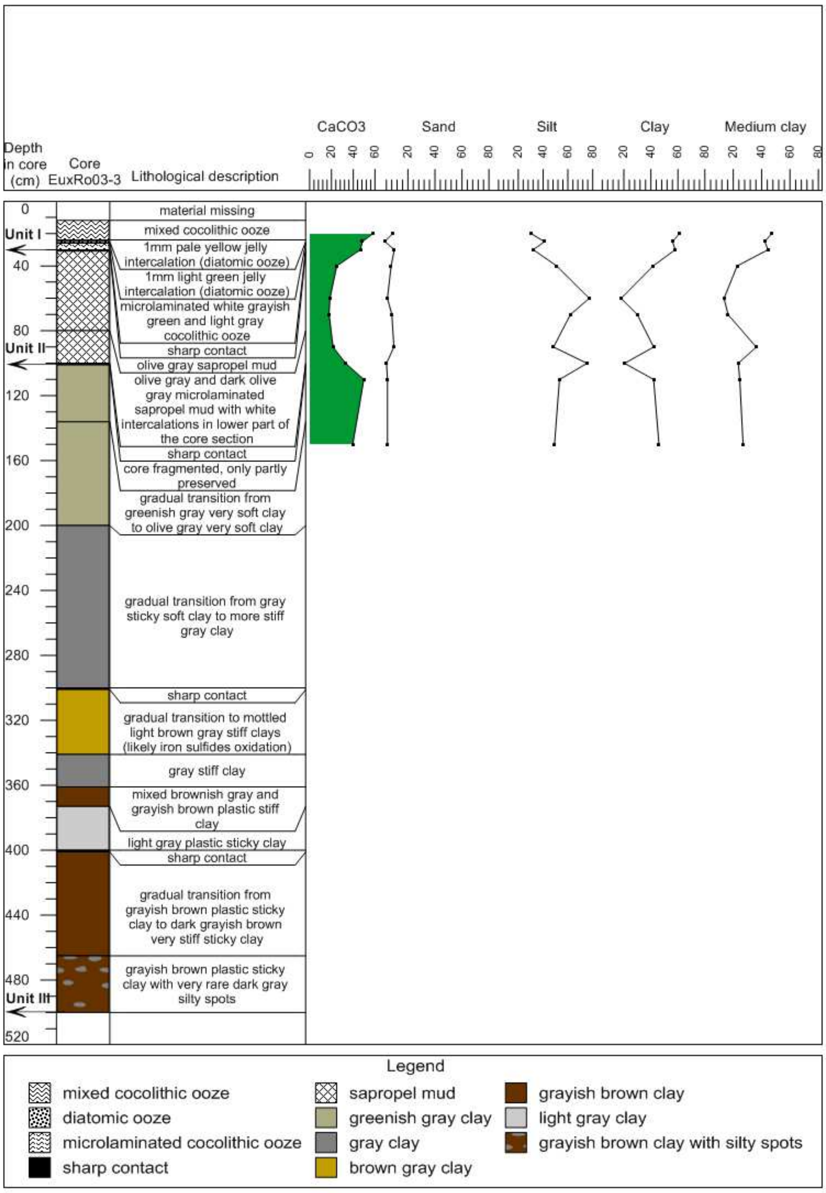

Fig.5. Lithological description with stratigraphic subdivisions of core EUXRo03-3 and graphic drawing of results from particle size and carbonate analyses for the core interval 150-20 cm.

Conclusions:

The onset of sapropel formation in the core EuxRo03-3 and the core EuxRo01-1 is related to the end of the regressive lake-brackish stage of the basin evolution and the incursion of the salt Mediterranean Sea waters in the Black Sea. Timing of this event with the geochronological scale is referred to ~7300 ^{14}C a BP.

Taking into account the location of the core EuxRo03-3 (615 mbsl), the presented data for the interval from 150 to 110 cm in the core EuxRo03-3 is interpreted as result of regressive Black sea level state.

The data for the interval 110-100 cm, show a regressive stage in the Black Sea basin evolution, just before the onset of the sapropel deposition and contradict the assertions of the some authors.

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