A REFINED MODEL OF SEDIMENTATION ON THE NORTHWESTERN BLACK SEA SHELF IN LATE NEOEUXINE AND HOLOCENE

Konikov E. G.

Scientific and Educational Center of Geoarchaeology, Marine and Environmental Geology (SECGMEG), Odessa I.I. Mechnikov National University, 2, Shampansky Per., Odessa 65058, Ukraine, konikov@mail.ru

Keywords: sedimentation, spectral analysis, periodicity, transgressions, regressions **Introduction**

The primary goal of the research presented in this paper is to understand the periodicity of sedimentation processes on the northwest shelf and to construct a mathematical model, as well as a detailed reconstruction of sea-level changes in the Black Sea in Late Neoeuxine and Holocene. In our publications devoted to this problem (Konikov 2007; Konikov *et al.* 2007), it has been proven that to resolve this problem with success, the measurements of physical and mechanical properties of bottom sediments, as well as chemical composition and salinity of pore waters, can be used.

Database and Methodology

The database for addressing the problem consists of 16 vibracores collected from the northwestern shelf of the Black Sea. The entire sediment columns (min. length -1.2 m; max. - up to 4.5 m) have been studied with X-ray analysis of sedimentary texture and structure. Grain-size statistics, $CaC0_3$ content, organic content, and key physical measurements (water content, density, plasticity, consistency, and porosity) were determined using 2.0-2.5 cm continuous sub-samples. In some cores, mechanical properties (penetration, shear strength) have been tested.

Statistical Methods

Based on a spectral analysis of textural statistics and physical properties (water content, density, liquid limit, void ratio), a periodic character of variability of these parameters in sediment cores has been established. Statistically significant periods of various frequencies are revealed. It should be noted that in different cores and for various parameters of sediment structure and composition, identical or statistically similar periodicities were obtained.

Results and Discussion

The following modeling step consisted in construction of "smoothed" curves of changes in sediment structure and composition corresponding to statistically significant values. The procedure of smoothing was carried out using Bartlett function in the «Time-series analysis» module, using the "Statistics" package. Subsequently, the combined analysis and recalculation of period values from a linear to a time scale was performed on the basis of available ^{14}C dates. The results of the smoothing procedure are presented in Figs 1, 2.

For example, the age-structure in core # 37A-82 is based on five samples of mollusks (conventional radiocarbon dating, Institute of Geophysics, NAS of Ukraine; 1984) and two dated by AMS method (University of Wollongong, Australia, 2005). In this core, based on two AMS dates, peak age values have been calculated (curves 2 and 3, Fig. 1). The calculated ages correspond well to the bulk dates from the Institute of Geophysics. A similar calibration has been performed for core # 37-82 (Fig. 2).

In the opinion of many Black Sea researchers (e.g., Balabanov *et al.,* 1981; Degens, Ross 1972; Fedorov 1982.) the border between Novochernomorian and Drevnechernomorian strata falls on 7.1-7.5 ka BP. This date is linked with the inception of salinization of the basin. Based on this, the 7.15 ka BP date has been accepted as the beginning of Novochernomorian stage of development of the Black-Azov Sea Basin. During construction of sedimentation models based on other cores which lack age control by radiocarbon dating, the contact between strata based on core descriptions has been assigned the age of 7.15 ka BP. According to the procedure described above, in each core the peaks of the smoothed curves have been digitized.

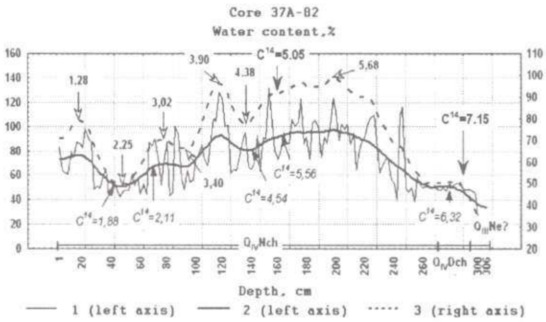

Fig. 1. Spectral analysis of water content series (core # 37A-82): 1 – curve of water content change by testing. Smoothing curves: 2 – period of 42 cm; 3 - period of 34 cm. Age of sediments is based on molluscs: Q_{IV}Nch - Novochernomorian; Q_{IV}Dch - Drevnechernomorian; Q_{III}Ne - Upper Neoeuxinian. Age of sediments by isotopic analysis: C^{14}= 7.15 ka – AMS method; C^{14}= 4.54 ka – conventional method; 3.90 – estimation quantities.

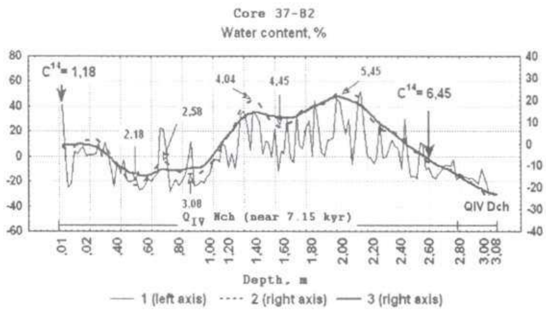

Fig. 2. Spectral analysis of water content series (core # 37-82): 1 – curve of water content change by testing. Smoothing curves: 2 – period of 31.54 cm; 3 - period of 56.8 cm. For other symbols, see Fig. 1.

Conclusions

Among the most repetitive, statistically significant periods the following periodicities have been established (in thousands of years): 4.09-4.04; 2.05-1.92; 1.64-1.54; 1.15-0.96; 0.66- 0.61-0.58; 0.30-0.26; 0.14-0.11; and 0.09-0.07. The second and third of the above periods correspond to known cycles of climate humidity in the Northern Hemisphere (Shnitnikov Cycle), and the first - to the doubled cycle of humidity. The fourth and fifth periods are approximately equal to half of Shnitnikov Cycle and, as is well known, they respond on average to the duration of transgressive or regressive phases of the Holocene. The mid- frequency cycle is equal on average to the duration of 660-640 years and corresponds as a whole to a cycle of the function of barycentric movements of the Sun (649.5-760 years), equal to it in duration. Other mid-frequency and high-frequency periods are likely connected with periodicity of solar activity and other astrophysical parameters (Konikov 2007; Shmuratko 2001, 2007).

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