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GEOLOGICAL PALEOOCENOGRAPHY OF EARLY EOCENE SEDIMENTARY COMPLEX OF TETHYS BLACK SEA SEGMENT

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ГЕОЛОГІЧНА ПАЛЕООКЕАНОГРАФІЯ РАННЬОЕОЦЕНОВОГО ОСАДОВОГО КОМПЛЕКСУ ЧОРНОМОРСЬКОГО СЕГМЕНТУ ТЕТІСА

The main features of Early Eocene deposition within north-western Black sea shelf have been determined. In the basin axial zone the carbonate-clayey mud of the external shelf was deposited. On its periphery the biogenic bank-reef buildups and alongshore bars were developed. The main part of the territory was occupied by the inner shelf with carbonate-clayey mud domination in eastern part and terrigenous-clay mud in central and western parts.

Keywords: sedimentation, Tethys ocean, biogenic buildups, alongshore bars, Early Eocene.

Встановлено основні риси осадоагромадження на території північно-західного шельфу Чорного моря і суміжних суходолів у ранньоеоценовий час. В осьовій частині басейну відбувалося осадоагромадження карбонатно-глинистих мулів зовнішнього шельфу. По його периферії були розвинені біогенні банко-рифові споруди та вздовжберегові бари. Більшу частину території займала область внутрішнього шельфу з домінуванням карбонатно-глинистих мулів у східній та теригенно-глинистих – у центральній та західній частинах басейну.

Ключові слова: седиментація, океан Тетіс, біогенні споруди, вздовжберегові бари, ранній еоцен.

INTRODUCTION

The area of research covers the northwestern shelf of the Black Sea and the adjacent uplands, where certain oil- and gas prospects are related to the Eocene sediments. However, today, this sedimentary complex is covered by lithological studies only fragmentary. Investigation of lithological characteristics of this sequence and creation of sedimentologic models will be the basis for a more accurate prediction of spatial-temporal occurrence of oil-gas prospects within the Black Sea shelf.

METHODOLOGY

Eocene sedimentary complex of the Black Sea segment was formed in basin, that was located on the northern periphery of the Tethys Ocean (Fig. 1). This basin stretched in sublatitudinal direction for more than 1000 km. Both along and across its stretch the sedimentary environments varied, besides that they evolved in time, and it caused a specific variety of sedimentary environments.

Lack within the sedimentation basin of large-area denudation zones characterized by low hypsometric level (lake-alluvial or lake-marsh coastal lowland), led to the minor solid flow of clastic material, that was presented mostly by products of older destruction rocks, mainly of carbonaceous composition. The latter were redistributed in the basin under the influence of waves, bottom and contour currents.

Sedimentary reconstructions were based on the study of spatial-temporal distribution features of the various lithofacies, mineralogical and petrographic specialization of deposits and lithogenetic interpretation of the results of well-log studies using the known methods (Muromtsev, 1983; Porebski, 1999).

During the constructing of sedimentary schemes the fundamental model of carbonate shelf was taken into account (Selley, 1989; Hallam, 1983). Thus, the intervals of section where the limestones dominated (50% of limestones, mudstones less than 10%) were interpreted as barrier (bank-reef) biofacies, limestones and marls (25-50% limestone, 10-30% mudstone) – a frontal slope and inner shelf, with the predominance of mudstones (limestone less than 25%; 30% mudstone) – outer shelf. It is well correlated with the data (Fortunatova, 2007), according to which the formation of organic structures are characterized by clay content less than 10% and clinofornic body of carbonate alluvial fans (frontal slope) – 10-30%.

For selection of the facial zones of terrigenous shelf the method of facial diagnostics based on the results of well-log data was used (gamma-ray log, self-potential polarization). The principle of the facial balance was taken into account (Selley, 1989): stability of the alluvial delta system structure: channel – a mouth bar – barrier island – fan. For the localization of alongshore bars the configuration of lithofacial zones and morphostructural features of sedimentation basin were taken into consideration.

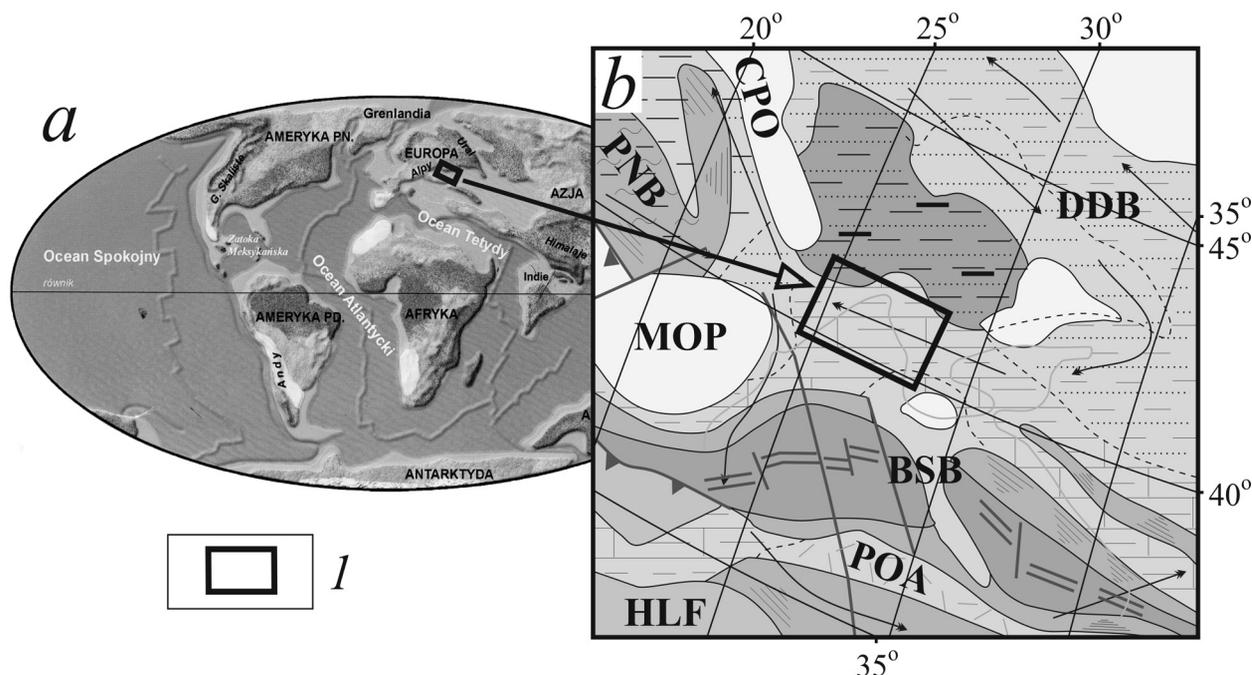


Fig. 1. General paleoceanographic situation (a) (Scotese, 2001). Early Eocene. Fragments of scheme (b) (Kazmin, Natapov, 2000):

1 – territory of investigations: DDB – Dnipro-Donets Basin; PNB – Pennine Basin; BSB – Black Sea Basin; HLF – Hellenides (Fold belt); CPO – Central Poland High; MOP – Moesian Platform; POA – Pontus Volcanic Arc.

RESULTS AND DISCUSSION

In the first phase of research the construction of sedimentary models for some sections was carried out, its location is shown at Fig. 2.

Sedimentary sections showed regular replacement from the central areas of sedimentary basin to its periphery of outer shelf to the internal shelf environments (Fig. 3).

Two alongshore bars were localized (thickness of the bodies reaches 35 m): the first – in the section of borehole Tavriyska-6, 11 and Khersonska-19 (in the North of the Black Sea), the second – in borehole Odeska-2 (Fig. 3). Sediments are composed of psammitic formations (thickness of the layers 2-25 m) with the individual layers of silt (1-12 m).

Such pattern of distribution of the Early Eocene terrigenous formations shows that the clastic material was brought into the sedimentary basin by ocean currents from western and northwestern parts of the sedimentary basin.

While the terrigenous and pelitic sedimentation dominated in western and central parts of the Eocene basin, the carbonate one dominated in eastern and southern parts of it.

Thus, practically because of the carbonate formations of barrier biofacial zone that was traced in sections of Eocene strata wells Desantna-1, Chap-

lynska-2, Skadovska-1, Flangova-2, Holitsyna-2, Shmidta-6, Karkinitska-1, Hamboortseva-2 and Tsentralna-1 were bored. At the corresponding sections (I-I, II, II, V-V, VI-VI) (Fig. 3) the biogenic build-ups usually have a discrete spatial-temporal occurrence. Carbonate deposits are represented as units or sequences (26 m), which are delimited by horizons (1-20 m) of clay-carbonate, more seldom clay formations. Bank-reef carbonate formations are bordered by carbonate clastic slopes, sections of which are characterised by a reduced role of just carbonate species and thinner interlaying with clay and carbonate-clay silts (thickness of sequences is up to 10 m).

After the interpolation of constructions on 6 profiles, individual research wells, and taking into account the lithologofacial data, for the first time a regional model for Early Eocene was made, that covers the territory of the northwest shelf of the Black Sea and adjacent territory (Fig. 4). In that time sedimentation took place in an isolated basin, which, due to the changes in sea level could periodically be separated from Tethys by Dobrudzka, Crimean and Kalamitska paleolands. The carbonate-clay silts of outer shelf were formed in the central part of the basin. On its periphery the terrigenous and carbonate accumulation bodies

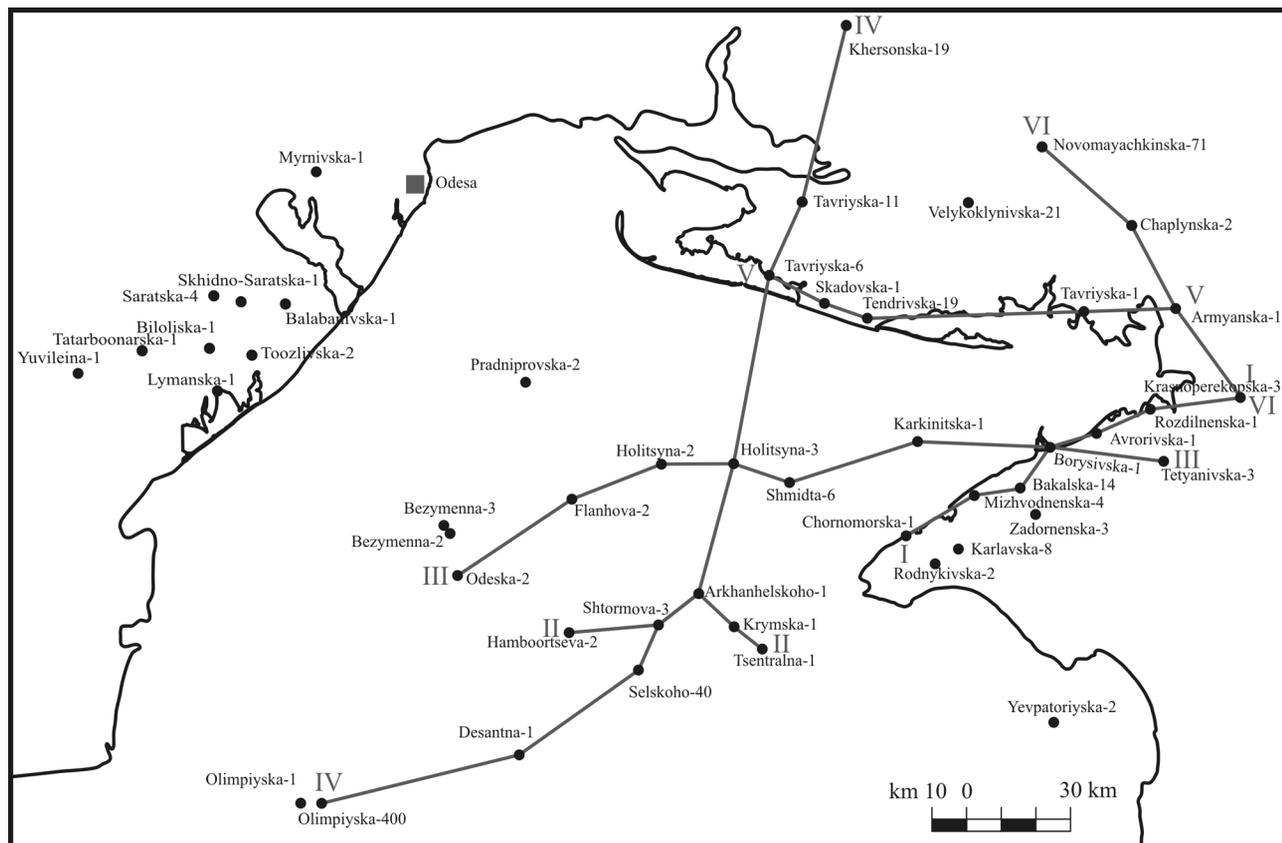


Fig. 2. Scheme of sedimentary sections disposition.

occurred: the bank-biogenic reef structures and alongshore bars. The area of the inner shelf covered the main part of the territory with predominance of carbonate-clay silt in the eastern and terrigenous clay – in the central and western parts of the basin.

The depocentre of basin the outer shelf zone (water depth of over 100 m) – is localized in the central region and covers the axial zone of the Karkinitsko-North Crimean depression (Mykhailivska depression). Clay-calcareous and clay silts with a small admixture of clastic material were formed predominantly there.

Terrigenous input into the western part of the basin was provided by regional currents that formed the alongshore bars. Three sand-silt bodies of the northwestern stretch (thickness of sediments 25-50 m), which tend to slope of consedimentational highs are localized within the western area. Their formation took place at depths of 10-50 m, and aleurite-psammitic and psammite-aleuritic silts have been mainly accumulated in them.

Sediments of bars were disclosed by the boreholes Odeska-2, Tavriyska-6, -11 and Khersonska-19, where they are grey and dark grey oligomictic sandstones and siltstones with clay-carbonate

cement and lense- or horizontally-layered texture.

Carbonate shelf of the southern and eastern parts of the Early Eocene basin was characterized by the development of standard biofacial zones: inner shelf – barrier zone – frontal slope (clastic aprons) – outer shelf.

The inner shelf occupied the largest part of the territory, covering the Northern and Western Black Sea, Plane Crimea, the southern and northern regions of the Black Sea shelf. Minimum water depths dominated in this area, which didn't exceed 20 m. Calcareous, calcareous-clay and clay silts with sand and silt interbeddings were formed here.

Within the inner shelf the small by size and thickness areas of alongshore bank-barrier reef buildups development is observed. Their formation took place in the shallow-marine environments with calm hydrodynamics and low input of terrigenous material. Such formations were disclosed by the boreholes Desantna-1, Skadovska-1, Tendrivska-19, Armianska-1 and are represented by interlaying of limestones and marls.

Barrier formations are represented by two organogenic buildups: Holitsyna and Shmidtivska, tending to the northern edge of Karkinitska-South Crimean depression. Sedimentation in these areas

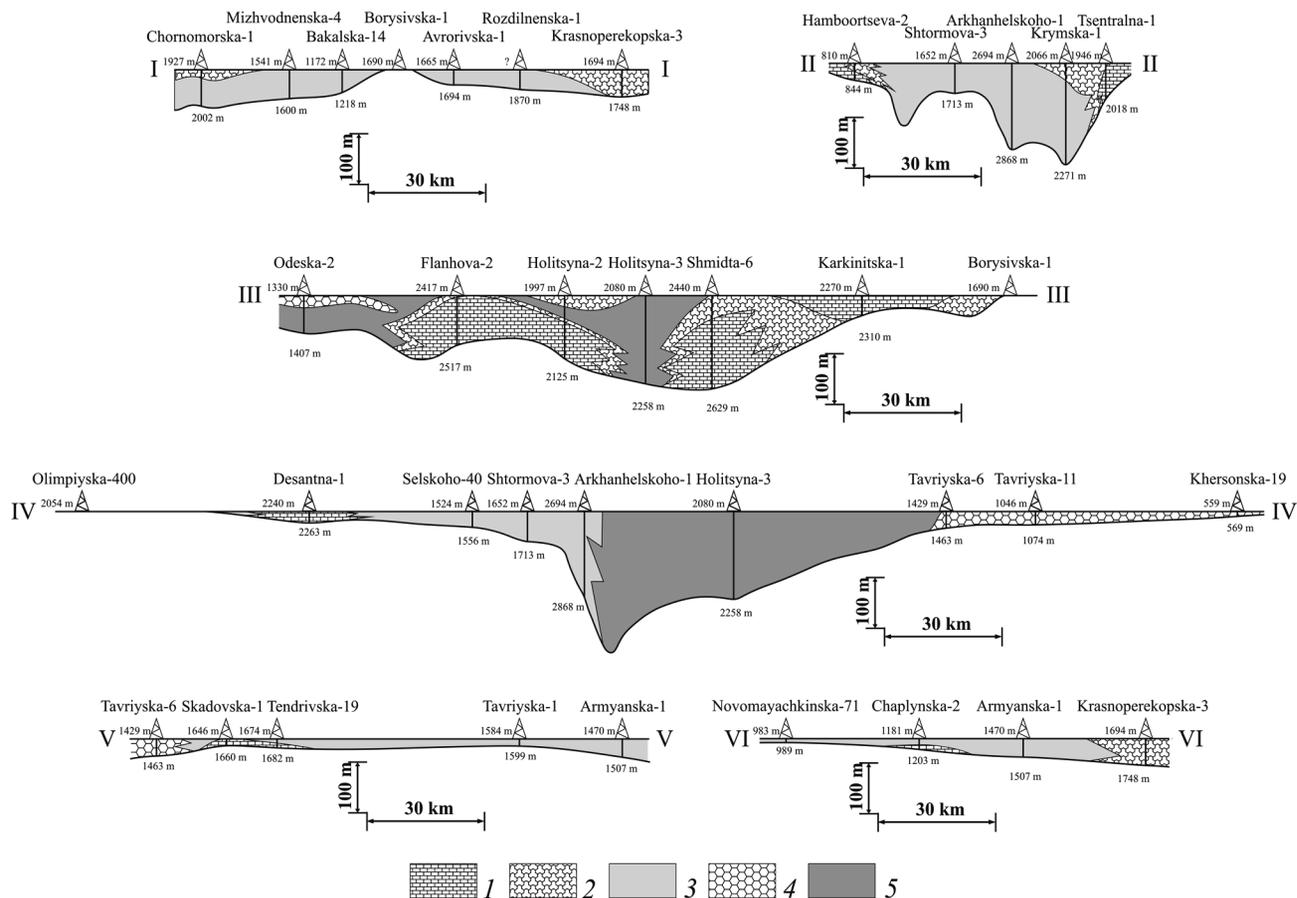


Fig. 3. Sedimentary models by sections I-I – VI-VI:

1 – bank-reef buildups; 2 – deposits of carbonate clastic aprons; 3 – formations of inner shelf; 4 – alongshore bars; 5 – formations of outer shelf.

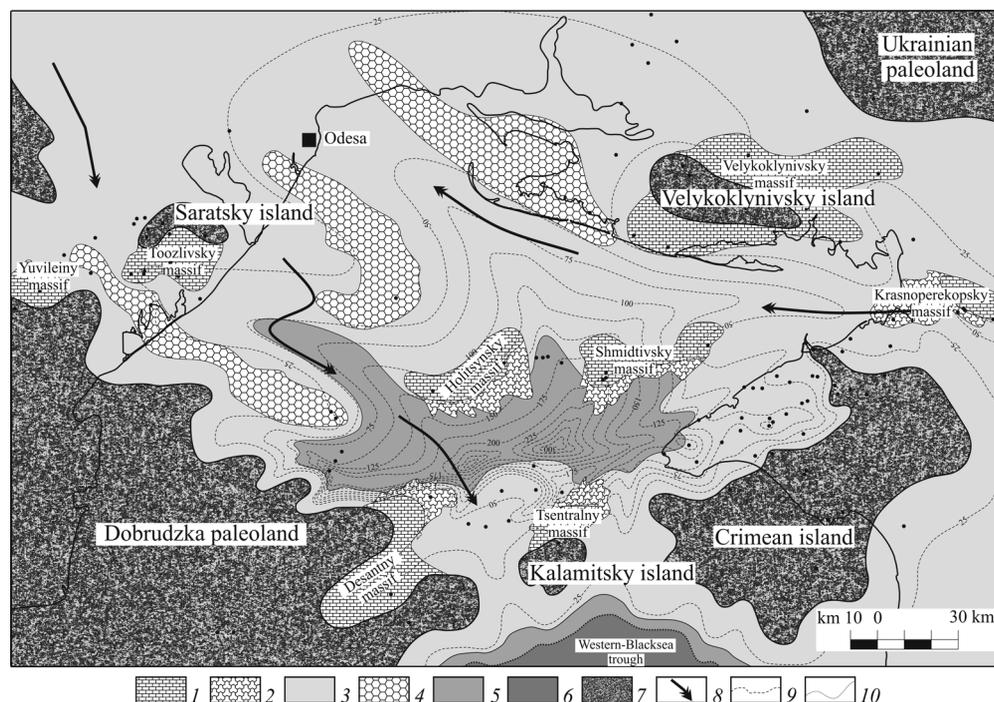


Fig. 4. Paleooceanographic model of Black Sea-Crimean basin. Early Eocene:

1 – bank-reef buildups; 2 – deposits of carbonate clastic aprons; 3 – formations of inner shelf; 4 – alongshore bars; 5 – formations of outer shelf; 6 – trough; 7 – land; 8 – currents (Kazmin, Natapov, 2000); 9 – isopachs; 10 – present-day shelf break.

took place in the shallow water conditions (20-50 m), and biogenic formation of carbonate has dominated there. The main characteristics for such deposits is a significant biota content (35-40 %) and a broad range of species (benthic foraminifera, crinoids, spicules and other forms).

The formation of organogenic-clastic aprons (frontal slope zone) developed in front of the southern parts of biogenic buildups. Sedimentary environments were characterized here by moderate depths (50-100 m) and mainly the calcareous clay, calcareous silts and clasts of organogenic buildups were formed.

Sediments of the frontal slope zone were disclosed by the boreholes Hamboortseva-2, Rozdilnenska-1 fragmentary Chornomorska-5; Bakalska-17; Borysivska-2; Kashtanivska-1. The deposits of this biofacial area are represented by marls, organogenic limestones

and argillites. The latter can be observed mainly as thin layers and lenses in sequences of marl.

CONCLUSIONS

Sedimentologic-paleoceanographic reconstructions allowed establishing the main features of sedimentation. In Early Eocene the sedimentation took place in an isolated basin, which could be periodically separated from ocean by Dobrudzka, Crimean and Kalamitska paleolands. In the axial part of the basin the carbonate-clay silts of outer shelf were formed.

Terrigenous and carbonate accumulations – biogenic bank-reef buildups and alongshore bars were developed along its periphery. Most of the territory was occupied by the inner shelf with dominating carbonate-clay silts in the eastern and terrigenous clay – in the central and western parts of the basin.

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