The morphostructural analysis of the Northern Black Sea shelf

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Introduction

The Northern Black Sea shelf is a subaerial plain and regional zone of the continental platform. It is a classic example of a transgression-regression shelf. During the Late Pleistocene and Holocene, the shelf was flooded and drained repeatedly as the coastline migrated across its surface (Shcherbakov et al., 1976; Ivanov et al., 1982). According to Morgunov et al. (1981), the modern relief of the coastal part of the shelf is a zone of flooded valleys of late generation.

Analysis of the literature and our own data provide the basis for this summary of the paleogeomorphology of the Northern Black Sea shelf and a reconstruction of the changes it underwent during the Late Neogene and Holocene.

Material and methods

The structural-geomorphologic schematic map of the northern part of the Black Sea and adjacent territory with its paleogeographic elements results from the interpretation of geological material and is derived from complex analysis of all the peculiarities of the above- and underwater relief.

Drillings on the shelf conducted by State Geological Enterprise "Prichernomorgeologiya," State Enterprise "Odessmorgeo," and the Odessa National University have also been used.

Methods of investigation included morphometric analysis, study of ~300 boreholes (80–100 m) and ~2000 vibrocores (up to 4.5 m), analysis of Holocene and modern sediment thickness and their lithological composition, use of data relating to the observation of modern tectonic movements, and interpretation of the flooded coastlines, etc.

Lithological-facies complexes and their hypsometric position were fixed on the basis of lithologic and faunistic attributes. Their spatial correlation allowed us to define the position of the coastline for various transgressive-regressive phases of sea level.

Eustatic sea-level curves of the Black Sea constructed by different authors have been used to reconstruct a control sequence of sediemntological units.

Results

The connection between tectonic structures of the region (Shmuratko, 2001) and both geological structure and geomorphology of the shelf is confirmed. The sublatitude hollow is a basic element of the shelf's structural plan. The Holocene relative rises are on the north and south. The flexure formed along the coast, coinciding with the coastline. The coastal section from Dniestrovsky liman to the Dnieper River is an exception. Here, the landward part is included within the zone of lowering.

Paleogeographic map-cuts for geomorphological stratoisochronous surfaces have been constructed using GIS-based modeling. They reflect the lithological-facies picture and position of the coastline during the Neoeuxinian, Bugazian, Kalamitian, Dzhemetinian, and modern stages of development of Karkinitsky Bay.

The main structural elements of the adjoining land continue onto the shelf (Fig. 1).

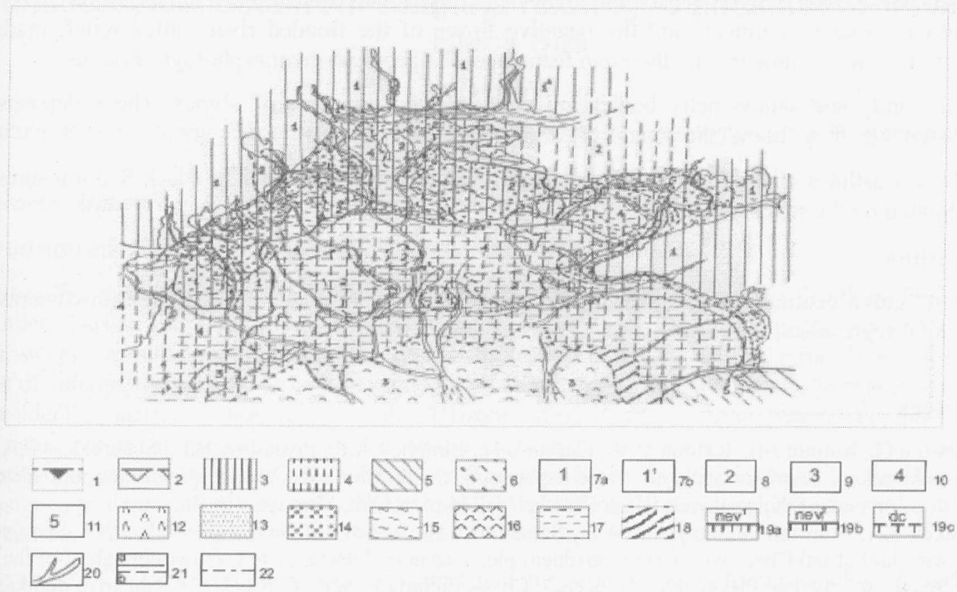

Figure 1. Structural-geomorphologic schematic map of the northern part of the Black Sea and adjacent land with paleogeographic elements: Pre-Holocene structures of continental suburb of subaerial and sea genesis, affected to a different extent by wave processes and processes of non-wave accumulation:

I) first order morphostructures: 1 = borders of the continental shallow (the modern shelf); 2 = borders of the ancient (Paleogene-Neogene) slope (the buried slope of the Black Sea hollow); 3 = erosive-accumulative low-lying plains; 4 = alluvial-accumulative low-lying plains and lowland; 5 = low fold-block mountains; 6 = the same, submerged beneath sea level.

II) second order morphostructures: 7a = the watershed leveled surfaces composed of complexes of carbonate-terrigenous neogene rocks of red color and a loess subformation; 7b = the same formed on upper Pliocene river terraces; 8 = the same represented by ancient Pleistocene river terraces composed of sand-argillaceous and loess rocks; 9 = buried cones of river evacuation on the shelf and on the continental slope; 10 = river valleys composed of sand-argillaceous sediment of alluvial facies; 11 = the surfaces of mountain-fold structures submerged under the sea surface as a result of neotectonic movements.

Modern and Holocene surfaces and relief forms of wave and non-wave accumulation:

I) sea-bottom morphostructures: 12 = abrasion sea terraces (bench); 13 = surfaces of active wave processing and accumulation of coarse material; 14 = surfaces of moderate wave processing and accumulation of various granular material and coquina; 15 = surfaces of non-wave accumulation within the shelf zone (liman-lagoon genesis); 16 = surfaces of non-wave accumulation within the top part of the continental slope in the presence of conditions for the development of suspension flows, destructive underwater landslides, and erosion; 17 = the same on the open external shelf; 18 = denudation-erosion surfaces on the top part of the continental slope characterized by the absence of modern sea deposits.

II) paleogeographic elements: ancient coastlines: 19a = beginning of Neoeuxinian transgression; 19b = final stage of the Neoeuxinian transgression; 19c = ancient Black Sea transgression; 20 = the river paleovalleys in the pre-Neoeuxinian stage (Late Neogene-Quaternary time).

Planimetric lines: borders of morphostructures: 21a = of the first order; 21b = of the second order; 22 = morphostructure borders (plain of submarine denudation) of the Holocene and Modern ages.

The presence of two large geomorphologic areas—the raised flat relief of the watershed spaces, formed by eolian-talus loamy sediment, and the negative forms of the flooded river valley relief, made by alluvial sandy-pelite sediment—are the main features of the geologic-geomorphologic structure.

The small sandy and sandy-shelly bodies are connected by "watershed" slopes. These deposits are typical beach, i.e., they "mark" the position of ancient coastlines.

The ancient coastlines of the early Neoeuxinian, late Neoeuxinian, and ancient Black Sea transgression are highlighted on the schematic map.

Conclusions

Today's structural-geomorphologic plan of the Black Sea shelf resulted from tectonic movements and transgression-regression fluctuations of the Black Sea level.

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