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MORPHOSTRUCTURAL ANALYSIS OF COASTAL ZONE OF KHERSON REGION, UKRAINE

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ABSTRACT

The connection between tectonic conditions of development and geomorphological features of the coast of Kherson region was analyzed in the relevant article. Geomorphological features of coastal zone were considered from the position of block structure of Karkinit-Sivash system of troughs. For the first time the attention was referred to the tectonic dependence of morphological and morphostructural features of coastal zone of research region. It was established that the mosaic of natural environment is typical feature for coasts of the Black Sea and the Azov Sea, which is caused by a variety of land structures and features of physiographical development. Analysis of tectonic conditions and geomorphological features of coastal zone of the region of our study allowed us to determine that the system of Karkinitsky-Syvash deflections is divided by the faults into separate block structures that develop in different speed mode of tectonic movements. That's why the character of morphosculptural systems, which are widely spread within the relevant morphostructures are directly related to the tectonic conditions.

Keywords: shore, basin, fault, tectonic movements, morphology

INTRODUCTION

A certain mosaic of natural conditions is typical for the shores of the Black Sea and the Azov Sea, which is caused by a variety of land structures and features of physico-geographical development [1, 2, 3]. Within the shores of these basins relatively weakly revealed such a factor of relief formation as the impact of post-glacial transgression, unlike other seas of the World Ocean. It should also be noted that the question of the influence of the tectonic structure and modern tectonic movements on the shores of the corresponding seas [4, 5] is very controversial. The prevailing opinion is that the modern evolution of shores is carried out exclusively under the domination of hydrometeorological factors, and especially the stir and non-periodical oscillatory movements of the sea level [6, 7].

The diversity of natural features led to the allocation along the coast of Ukraine of the eight coastal areas (Figure 1) [7]. Directly the region of our research occupies a significant part of Dnipro-Karkinit lobed and Sivash lagoon areas and territorially belongs to the Kherson region.

The shores of the region are characterized with specific features, among which the low absolute altitude of the land surface, the shallow coastal water areas as well as the extremely flat and extremely sloping nature of the surface. In our opinion, the corresponding specificity of natural conditions is primarily due to the tectonic structure and the character of modern tectonic movements, which constitute the most important factors of relief formation in the region of research.

That is why we decided to analyze at the regional level the connection between the endogenous factors of relief formation and the geomorphological nature of the coastal zone.

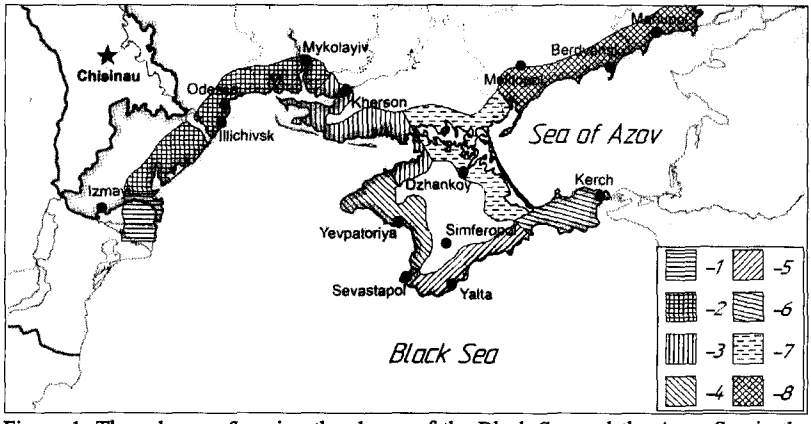

Figure 1. The scheme of zoning the shores of the Black Sea and the Azov Sea in the borders of Ukraine. Coastal areas [7]:

1 – Danube delta; 2 – Northwest estuary; 3 – Dnieper-Karkinit lobed; 4 – Tarkhankut-Kalamite serotica aligned; 5 – South-Crimean mountain small-bay; 6 – Kerch small-bay; 7 – Sivash lagoon of the secondary alignment; 8 – North-Azov of the secondary partition.

General structural-tectonic conditions of the research area. The shores of the research area are widespread within the northern edge of the Karkinit-Sivash system of troughs. The corresponding structure was formed at the junction of the ancient Precambrian East-European platform and young Hercynian-Cimmerian Scythian platform and it is territorially revealed within the boundaries of both structures [8, 9]. The natural boundaries of this system of deflections are disjunctive disturbances in the form of interregional deep faults: Odessa-Sinop in the west and Novocaricin-Melitopol (Orekhovo-Pavlograd) in the east [10, 11].

Within the Karkinit-Sivash system of troughs, the disjunctive violations of the regional level, which include Mykolaiv, Skadovsko-Yevpatoria, Salgir and Bilozerka [10, 11, 12], are also important in relief forming. Existence of those faults allows to reveal the block structure of the trough and the adjacent territory; they also determine the location, shape, size and nature of the movement of regional geostructures (Figure 2).

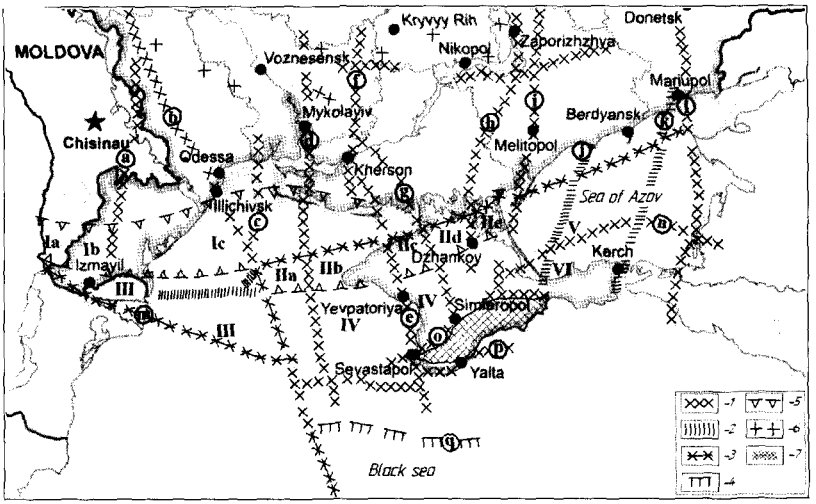

Figure 2. The scheme of location of deep faults zones and geostructures in the south and south-east of Ukraine:

1 – deep faults zones; 2 – regional faults zones; 3 – suture deep fault zone between ancient East-European platform and young Scythian and Moesian platforms; 4 – faults zones of the Paleozoic age, which limit the Black Sea depression; 5 – granite layer pinching out zone; 6 – the contour of the uplifted part of the Ukrainian shield; 7 – Crimean megaanticlinorium.

On the diagram the Roman numerals depict: I – Moldovan-Krylov Mesozoic trough; Ia – Birladsky block; Ib – Moldovan block; Ic – Krylov block; II – Karkinit-Sivash trough; IIa – Odessa block; IIb – Karkinit block; IIc – Pervomaisk block; IId – Dzhankoy block; IIe – Genichesk block; III – Bolgrad-Kiliya protrusion; IV – Yevpatoria-Simferopol uplift; V – Azov swell; VI – Indolo-Kuban forefront trough.

Deep and regional faults: a – Frunze-Artsyz; b – Odessa; c – Ryasnopilsk; d – Mykolaiv; e – Yevpatoria-Skadovsk; f – Kryvyi Rih-Kremenchuk; g – Salgir; h – Bilozerka; i – Melitopol; j – Feodosia-Korsak; k – Kerch-Mariupol; l – Dzhiginsk-Kalmius; m – Danube; n – Azov; o – Simferopol; p – Yalta; q – Northern Black Sea.

The region of the Karkinit-Sivash system of troughs is characterized by the predominance of negative vertical tectonic movements, but with certain regional differences. The regions of the Isthmus of Perekop and the Utljuk Plateau are exceptions because of domination of the alternating movements [5].

Within studied system of troughs, five regional tectonic blocks are pointed out due to the presence of disjunctive violations: Odessa, Karkinit, Perekop (Pervomaisk), Dzhankoy (Western Sivash) and Genichesk [10].

The corresponding blocks are characterized by certain structural, neotectonic and geomorphological differences that affect the features of the coastal zone. That is why we

will analyze the geomorphological features of the coastal zone of the research region in terms of regional tectonic structure.

Geomorphological analysis of the shores of the study region. ***The Odessa block*** occupies the most western part of the Karkinit-Sivash system of troughs; it is limited with the Odessa-Sinop interregional deep fault in the west and the Mykolaiv regional deep fault in the east [10].

In morphographic terms, mainly accumulative forms of marine and alluvial genesis occur on the surface of this block. The corresponding forms include the Kinburn Spit, the Tendra Spit, the Dolgiy Island and the Odessa Bank. The indigenous Egorlyk Kut Peninsula is located between these spits. This peninsula, as well as accumulative forms, conduces to allocate the Egorlyk and Tendra Bays within the northwestern part of the Black Sea.

In neotectonic terms, the corresponding block is characterized by negative tectonic movements, but the speed of these movements is not homogeneous within the surface of the block and occurs with certain regional differences. Within the northern part of the block, the speed of plunge ranges from 2.25 to 3.7 mm/year, while within the southern part, the speed increases to 4.5 mm/year. Therefore, the corresponding block is the most immersed part of the trough where the crystalline foundation is located at a depth of more than 10 km [4, 5].

Those tectonic conditions redound to the formation on the surface of the block an extremely low-lying areas, the absolute heights of which do not exceed 1.2 m within the coastal zone (cliffs of the Egorlyk Kut Peninsula), while the dominant is the height from 0 to 0.2 m. Simultaneously, the areas of the coastal land and the underwater slope are characterized by very slight slopes that have prevailing values from 0.0003 to 0.0006. But the slopes increase to 0.0093 [13] along the coastal zone of the western part of the Egorlyk Kut Peninsula.

In morphogenetic terms, the land surface of this block is located within the western part of the Nizhnedneprovska delta flat and wavy lowland, which is an accumulative alluvial-marine morphostructure [14]. Geological history and tectonic conditions determine the allocation of three morphostructures of the fifth order within the relevant part of the investigation region.

The *Kinburn Spit* and adjacent areas of the bottom of Egorlyk Bay represent the accumulative fluvial-delta and marine flat plain.

The *Egorlyk Peninsula* and adjacent areas of the bottom of the Egorlyk and Tendra bays belong to the accumulative fluvial-delta subhorizontal slightly wavy low-lying morphostructure.

The *Tendra Spit* and adjacent areas of the bottom of Tendra Bay and the northwestern part of the Black Sea represent an accumulative marine above-water lowland morphostructure.

The Karkinit block is located in the central part of the Black Sea sector of the Karkinit-Sivash system of troughs. The existence of the Mykolaiv regional deep fault in the west and the Evpatoria-Skadovsk regional deep fault in the east [10] led to the allocation of this block.

Morphographically, on the block's surface, the indigenous continental coast of the western part of the Karkinit and Dzharylgach bays, as well as the body of the accumulative spit-island Dzharylgach, are singled out [13]. The corresponding form allows allocating the Dzharylgach Bay water area into an independent reservoir.

The neotectonic regime of this block is characterized by the dominance of negative tectonic movements at speeds from 1.8 to 2.5 mm/year, herewith the depth of the crystalline basement reaches 7 – 8 km [4, 5].

The disclosure of slower negative neotectonic movements caused a slight increase in the absolute height of the coastal zone. Therefore, the absolute altitudes of the cliffs do not exceed 1.0 m within the limits of the mainland between the Tendra and the Dzharylgach spits, while the corresponding height slowly increases from 0.8 m to 2.1 m (the area of the Karzhinsky Rozhok Cape) within the limits of the Dzharylgach Bay coast.

The gradients from 0.0006 to 0.0009, at a maximum of 0.0035 within the city of Skadovsk are typical for the coastal land and the underwater slope of the Dzharylgach Bay. The slopes range from 0.008 to 0.0125 [13] along the indigenous coast of the Karkinit Bay and the frontal part of the spit-island Dzharylgach.

In morphogenetic terms, the land surface of this block is located within the eastern part of the *Nizhnedneprovska delta flat and wavy lowland*, which is an accumulative fluvial-delta subhorizontal undulated plain morphostructure [14]. An accumulative marine above-water lowland morphostructure, which includes the spit-island Dzharylgach, adjoins the corresponding structure.

The Perekop (Pervomaisk) block is located in the central part of this system of troughs and represents a natural boundary between the Black Sea and the Azov basins. The Skadovsko-Yevpatoria regional deep fault is the western boundary of the block, and the similar Salgir fault is the eastern border [10].

Morphographically, the Isthmus of Perekop and three indigenous peninsulas, in particular, Karabay (Dangelti), Girkiy Kut (Khorly) and Domuzgla, are singled out on the surface of this block. Due to the presence of the corresponding peninsulas, within the Karkinit Bay the secondary bays are allocated, among which are Girka, Shiroka, Perekop, Chatyrlitsk and Samarchitsk. There are no thick surface accumulative forms within the block, but only the Kalanchak and the Lebediny Islands and Kandjaly Spit, and the Kalanchak and Churum banks are also here. It should also be noted that the Bakal Spit and the Bakal bank are located on the boundary of the blocks in the Skadovsko-Yevpatoria regional deep fault zone.

Within this block the neotectonic movements are mainly interchangeable and range from -1 to +1 mm/year. The crystalline foundation of this block lies at a depth of less than 4-5 km, so this part of the Karkinit-Sivash deflection is the most lifted [4].

The corresponding neotectonic conditions contribute to the appearance of cliffs with the height from 1.2 m to 12.0 m on the surface of the block, and the height increases in the direction of the Isthmus of Perekop. The morphological features of the underwater slope are characterized by slight deviations from 0.0002 to 0.0006, but within the western coast of the Domuzgla Peninsula the slopes increase and equal 0.0025.

In morphogenetic terms, two morphostructures of the fourth order are partially located on the surface of this block: *the Askania-Melitopol alluvial (terraced) flat lowland and the*

Prisivash lake-liman lowland [14]. Within the limits of the indigenous coast of the Karkinit Bay the Askania-Melitopol plain morphostructure is presented by a system of peninsulas and bays, from the Kalanchak Estuary to the peak of the Perekop Bay. The Prisivash lowland morphostructure is revealed within the Isthmus of Perekop and the western part of the Sivash Bay.

The Dzhankoy (Western Sivash) block occupies the western part of the Sivash deflection; it is limited with the Salgir regional deep fault in the west and the Bilozersky in the east [10].

Morphographically, on the surface of this block, the western part of the Sivash Bay is almost completely located, which is characterized by a large number of branched forms of islands and peninsulas separated by shallow sections of the Sivash Lagoon.

The neotectonic regime of the corresponding territory develops under conditions of negative movements domination, the speed of which ranges from -1.2 to -1.8 mm/year, with the most intense immersion in the southern part of the block. The long-term development of the territory in the corresponding neotectonic regime led to a certain immersion of the crystalline basement and its location at a depth of 5-5.5 km [4, 5].

The neotectonic and structural conditions of the development of this block determine the wide spreading of cliffs with a height of 5.0 to 15.0 m, but cliffs of lesser height are also widely found. The morphology of the coastal land and the underwater slope causes the spreading of extremely flat areas with the deviations from 0.0002 to 0.0004 [3].

In morphogenetic terms, the surface of the corresponding block occupies most of *the Prisivash lake-liman lowland morphostructure*; it belongs to the bedded-accumulative and bedded-denudation formations [14]. That is why the abrasive areas alternate with accumulative and dynamically stable ones along the coastal zone.

The Genichesk block occupies the most eastern position within the Karkinit-Sivash system of troughs; it is limited with the Caricin-Melitopol (Orekhovo-Pavlograd) interregional deep fault in the east and the Bilozersky regional deep fault in the west [10]. The corresponding block is characterized by the most specific location, which is due to its displacement in a horizontal direction from south-west to southeast.

Morphographically, on the surface of this block, various forms of relief are developed, including the Chongar Peninsula, the northern part of the Arabat Arrow, the indigenous coast of the Genichesk Plateau, and the body of the accumulative form of the Fedotova Spit – Biryuchy Island.

The corresponding block is characterized by complicated neotectonic regime; within its northern part the negative movements occur with a speed of – 0.6 to – 0.8 mm/year, in the central part – 1.2 – 2.0 mm/year, and in the southern part – 2.5 – 2.8 mm/year. Under the conditions of the corresponding neotectonic regime, the depth of the crystalline basement within the block is 6-7 km [3].

The corresponding structural features and the nature of non-tectonic movements resulted the development of cliffs with the height of 7-8 m within the limits of abrasive areas of the coastal zone, with an increase to 11-12 m in the area from the village Azovske (Frunze) to the city of Genichesk. The deviations of the underwater slope of the Utljuk Liman and the eastern part of the Sivash Bay range from 0.004 to 0.006, and increase

from the north to the south from 0.003 to 0.015 within the maritime part of the Arabat Arrow.

In morphogenetic terms, two morphostructures are located on the surface of this block: *the Prisivash lake-liman lowland and the Askania-Melitopol alluvial (terraced) flat lowland* [14]. Corresponding morphostructures belong to belong to the bedded-accumulative formations. That is why the abrasive areas alternate with accumulative and dynamically stable ones along the coastal zone.

CONCLUSION

Analysis of tectonic conditions and the nature of the geomorphological features of the coastal zone of the study region allowed us to reach the following conclusions:

1. The Karkinit-Sivash system of troughs is divided into separate block structures by deep faults. Those block structures develop at different speeds modes of tectonic movements.
2. Each tectonic block is characterized by certain geomorphological features, which essentially distinguish it from others. To the relevant features we refer morphographical and morphological features.
3. Each tectonic block differs from another with morphogenetic type of morphostructure, which is characteristic for the coastal areas of the land. The corresponding differences are due to geological history and the nature of tectonic movements.
4. That is why the morphosculpture complexes within the respective morphostructures are in direct dependence on tectonic conditions.

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