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Relief-forming processes in the southeastern periphery of the Bulgarian continental microplate

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Abstract: *This study presents a comprehensive review of the orogenic processes contributing to the development of the contemporary relief and its characteristic morphostructural features in the southeastern periphery of the Bulgarian continental microplate. The analysis is grounded in current plate tectonic theories concerning the geodynamic evolution of the Balkan Peninsula as part of the Neoeuropean continental margin of Eurasia. Special attention is given to the present-day morphostructural configuration of the terrain and the significant role of listric tectonics in its formation. The examined relief-forming processes are interpreted as a complex interaction between endogenous (tectonic and orogenic) forces and exogenous (denudational and depositional) processes, reflecting the dynamic nature of landscape evolution in the region.*

Keywords: plate tectonics, orogenesis, listric tectonics, block-mosaic structure

Introduction

The paper presents the results of a study on the origin and evolution of the relief in the Strandzha morphostructural zone. This is the first regional investigation of the problem, which as a whole is based on the factually substantiated mobilist theory of plate tectonics that became established in the late 20th century. This scientific approach has now replaced the previously dominant, factually unsupported fixist concept of the pre-Triassic existence of this part of the continental landmass of the Balkan Peninsula as an element of the European continent [1].

Material and Methods

The main method used to clarify the origin and evolution of the relief in the studied area is morphostructural analysis [2]. Within this framework, the exceptional role of listric tectonics is highlighted as the principal agent shaping the block structure in the uppermost parts of the Earth's crust.

Relief-forming processes in the southeastern part of the Balkan Peninsula

The analysis of the increasing scientific data shows that by the end of the Paleozoic era, the part of the present-day continental land west of the Rhine River and south of the Bohemian Massif, the Tatra Mountains, and the Eastern Carpathians up to the mouth of the Danube River was part of the floor of the Tethys Ocean. Therefore, the Strandzha morphostructural zone, as an element of continental Neo-Europe, can be considered to have existed since the late Mesozoic era.

The subduction of the western part of the Tethys Ocean that began during the Paleozoic was accompanied by intense destructive processes in the corresponding sector of the northern passive continental margin of Gondwana. This led to the separation of a significant number of continental blocks of varying sizes from the continental massif at the end of the Triassic period (between 250 and 200 million years ago). Alongside the particularly large continental fragments of the Pyrenean and Arabian plates (located respectively at the western and eastern ends of the western Tethys), the much smaller Gondwanan fragments situated between them formed the Mediterranean archipelago (Fig. 1). One of these was the predecessor of the future Strandzha morphostructural zone. These island continental landmasses exhibited largely different paleogeographic and paleomorphotectonic evolution during the Jurassic, Early Cretaceous, and partly Late Cretaceous periods (between 200 and 85 million years ago). Due to their small size, they moved faster northward during the subduction process than the front of the Gondwanan continent. Upon reaching proximity to the subduction zone, these light (with relatively low weight) crustal fragments did not subduct together with the much heavier oceanic crust. Instead, they accumulated in front of the European continent's margin, gradually compacted, and sutured together, forming the Neo-European continental margin of Eurasia during the Late Cretaceous and Paleocene (between approximately 83 and 56 million years ago) [1]. One of these fragments is precisely the island continental landmass on which the Strandzha morphostructural zone originated.

At that time, the lands of the Strandzha fragment featured a lowland plain relief, heavily waterlogged and abundant with bays, lagoons, and swamps (Fig. 1). This surface character dominated until about 83 million years ago. In this initial phase, the relief of the new continental land exhibited features of a protoplain. By the end of the Late Cretaceous (Campanian and Maastrichtian stages, between 83 and 65 million years ago) and the Paleocene (between 65 and 56 million years ago), the relief of the lands in this part of the Neo-European continental land gradually acquired the character of a lowland plain, dotted with residual elevations and crossed

by intertwined rivers. These and other physiogeographic features (vegetation, biodiversity, climate, etc.) indicate that this natural environment was similar to the modern savanna [3, 4]. This phase of the relief-forming process in the lands of the Strandzha morphostructural zone carries the characteristics of an ortho-plain.

During the Pliocene (between 5 and 2 million years ago), when subduction in the western part of the Tethys Ocean came to an end (except in the Black Sea region) [5], the grand transcontinental collision began between Neo-Europe and the northern front of Gondwana, which was subducting beneath it. The thickness of the Earth's crust in the collision zone reached exceptionally high values. This led to intense regional brittle tectonic deformations that destroyed a significant part of the ortho-plain. During the planation process, these deformations affected the primary fault zones in the basement of the ortho-plain. As a result, the relief of the Balkan Peninsula acquired a block-mosaic morphostructure, consisting of blocks with mountainous and mountainous-hilly relief (oroplains) and relics of the ortho-plain (post-ortho-plain). In this case, the lands of the Strandzha morphostructural zone have the character of an oroplain. This morphotectonic and morphographic setting has been preserved up to the present day.

Morphotectonic features of the Strandzha morphostructural zone

On a regional scale, the oroplain of the Strandzha morphostructural zone is clearly divided into three morphostructural areas – from west to east: Sakar, Derwent, and Strandzha. Each of these areas is distinguished by specific orographic features that indicate different morphotectonic evolutions (Fig. 2).

The most significant fragment – the Strandzha morphostructural area – is characterized by a large number of centers of maximum present-day uplift. This fact attests to particularly intense morphotectonic processes during the last several million years. In this respect, two areas can be distinguished within the region: a northern one, with linearly arranged centers of maximum present-day uplift, and a southern one, where these centers are centrally clustered around the present-day massif of Mt. Golyama Mahiada (the highest peak of the Strandzha Mountain).

The northern part of the area is characterized by a weakly expressed hilly-low-mountain relief, within which two longitudinal belts can be distinguished. The relief shows a gradual decrease in elevation toward the north-northeast, with small hypsometric differences between its northern periphery and the adjacent Burgas post-ortho-plain. In contrast, the southern part is significantly more uplifted compared to the East Thracian post-ortho-plain located to the south. Within the internal structure of this area, a pronounced zone of maximum present-day uplift is outlined around Mt. Golyama Mahiada, accompanied by a general monoclinal, stepwise lowering along listric faults toward the south-southwest.

The Sakar morphostructural area is characterized by a much smaller number of centers of present-day maximum uplift, located in its central part. The overall morphostructure of the area has a domal character.

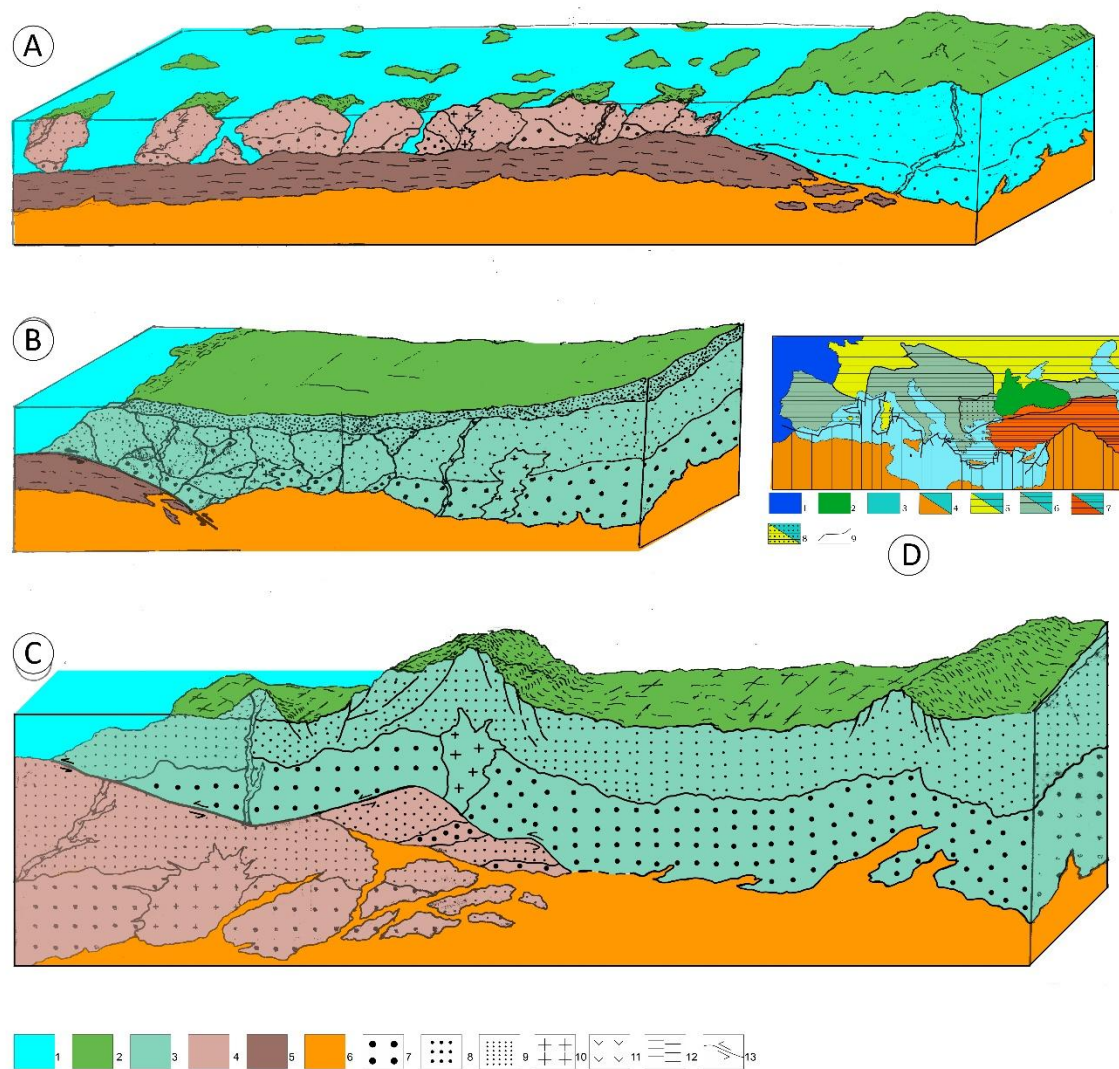


Figure 1. Stages in the formation of Neo-Europe

A – protoplain, B – orthoplain, C – oroplain and post-orthoplain

1 – marine basin, 2 – land surface, 3 – Paleo-Europe and Neo-Europe, 4 – Gondwana, 5 – oceanic crust, 6 – true upper mantle, 7 – metamorphic continental complexes, 8 – sedimentary continental complexes, 9 – sedimentary cover of Neo-Europe, 10 – intrusive rocks, 11 – volcanic rocks, 12 – oceanic crust, 13 – faults

The Dervent morphostructural area is orographically the lowest part of the zone, with very few asymmetrically distributed centers of present-day maximum uplift, situated in its eastern part, along the boundary with the Strandzha morphostructural area.

In the Sakar and Derwent morphostructural areas, the relief denivelation toward the north, in the direction of the Upper Thracian post-ortho-plain, is smaller than that toward the south, facing the East Thracian post-ortho-plain.

The analysis of the local morphostructural setting reveals a differing expression of listric tectonics among the individual areas. It is most pronounced in the Strandzha morphostructural area and correspondingly weakest in the Derwent morphostructural area.

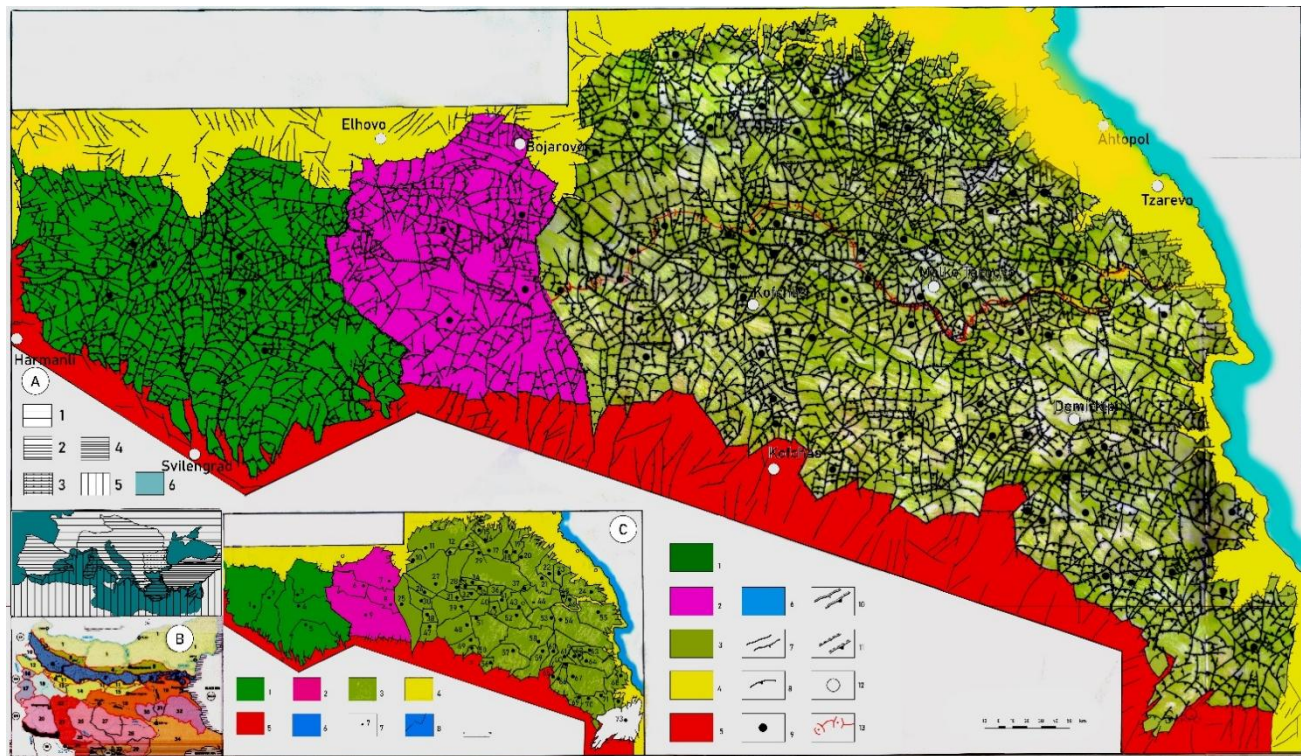


Figure 2. Morphostructural map of the Sakar-Strandzha morphostructural zone

1 – Sakar morphostructural area; 2 – Derwent area; 3 – Strandzha area; 4 – Upper Thracian morphostructural zone; 5 – East Thracian morphostructural zone; 6 – Black Sea basin; 7 – fault disturbances; 8 – listric faults; 9 – centers of maximum present-day uplift; 10 – boundaries of morphostructures; 11 – boundaries of morphostructural districts; 12 – settlements; 3 – state border

A – Overview morphotectonic map of the Mediterranean region

1 – Paleo-Europe; 2 – Neo-Europe; 3 – Bulgarian continental microplate; 4 – Anatolian continental microplate; 5 – Gondwana; 6 – water basins

B – Overview map of the block-mosaic structure of the Bulgarian continental microplate

C – Overview map of the morphostructural units in the Sakar-Strandzha morphostructural zone

Conclusion

In conclusion, the Strandzha morphostructural zone represents a typical example of an oroplain within the block-mosaic structure of the eastern part of the Balkan Peninsula. The eastern periphery of the zone coincides with the continental segment of the direct contact between the Balkan Peninsula and the present-day, sole remnant of the Tethys Ocean – the Black Sea.

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