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*ASN, Vol. 12, No 1, Pages 49–58,* 2025

**Acta Scientifica Naturalis**

Former Annual of Konstantin Preslavsky University of Shumen: Chemistry, Physics, Biology, Geography

Journal homepage: https://content.sciendo.com/view/journals/asn/asn-overview.xml

# Characteristic features of the Razgrad block morphostructure

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**Abstract:** *The presented research examines the structural-geomorphological features of the Razgrad block morphostructure. The boundaries and main parameters of the visible part of the morphostructure are determined: area of the hypsometric belts, slope of the slope surfaces, configuration of the hydrographic network, as well as the values of the horizontal and vertical dissection of the relief. An analysis of the geological-tectonic features (rock complexes, tectonic disturbances, etc.) and geophysical characteristics (geophysical fields, transitions, gravity anomalies, etc.) of the Razgrad block morphostructure was performed. During the field research, characteristic elements of the landforms were mapped: erosional slopes, leveled surfaces and river terraces. The Razgrad morphostructure is defined as a relatively independent block in the parietal region of the North Bulgarian arch swelling. It was established that it was placed on an old Permian-Triassic block bounded and uplifted by two sub-parallel faults in the Upper Jurassic-Valangian carbonate complex. Lower Cretaceous, Pleistocene and Holocene rock complexes are described in the Razgrad morphostructure. In the final part of the study, a scientifically based conclusion was made that the morphostructural development of the Razgrad block morphostructure went through the following stages: Doneogene, Neogene, Pliopleistocene and Holocene.*

**Keywords:** morphostructure, rock, tectonic, slopes, leveled surfaces, river terraces, stages of development

## Introduction

The Razgrad morphostructure is located in the central part of the North Bulgarian arch uplift and represents an independent block, eroded by exogenous processes into several smaller components. In geomorphological classifications of Bulgaria, this morphostructure is considered an integral part of the larger Danubian Plain morphostructure, referred to by various names: Danubian morphostructural zone [5], Moesian block step [1], or Danubian epi-platform plain [2].



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DOI: 10.2478/asn-2025-0006

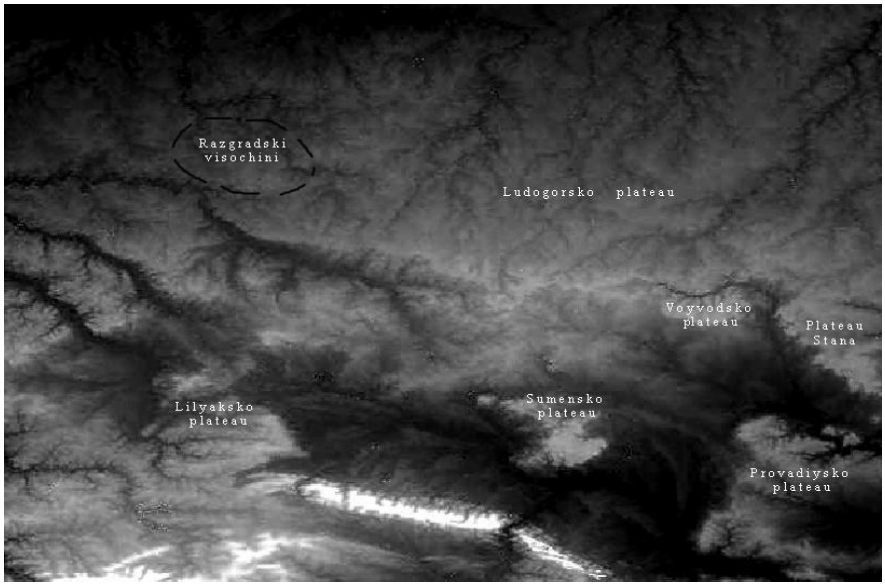


**Fig. 1.** Space photo of the region of Northeastern Bulgaria /Saliut-4/

Satellite and aerial images analysis identifies the Razgrad block morphostructure as a circular structure (Fig. 1 and Fig. 2) in the eastern part of the core Moesian photogeological subcomplex [12].

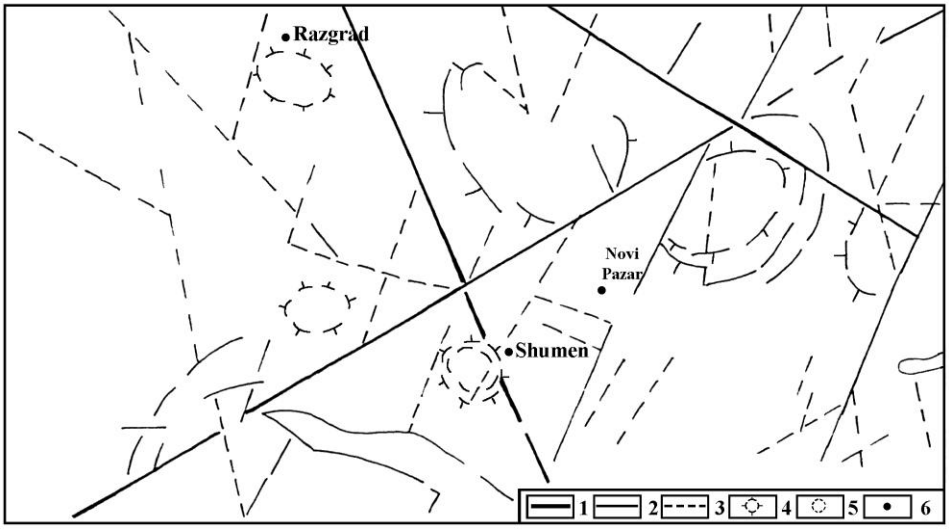


**Fig. 2.** Decodedscheme of the Razgrad block morphostructure /CPH-Saliut-4/:
1 - Transregional briahline; 2 - Regional briahline; 3 - Local briahline;
4 - Positive structures; 5 - Circle structures; 6 - Sity



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**Morphology**

From a morphological perspective, the Razgrad block morphostructure represents a clearly expressed arc-shaped depression in the relief, stretching from northwest to southeast-northeast, with dimensions of 30-32 km from west to east, and from 4-5 to 8-9 km from north to south. The boundaries of the Razgrad morphostructure are defined as follows: to the northwest – by the valley of the Malki Lom River, along the line connecting the villages of Lomtsi-Sadina-Zahari Stoyanovo; to the north-northeast – by the northern slope of the Moeisian block step and parts of the Ludogorie Plateau; to the east – by the valley of the Beli Lom River, separating the Samuilov Heights and the Khitrinska morphostructure to the east; to the south – by the Loznishki block and the Trapishko structural depression; to the southeast – by the spring areas of the Malki Lom River and the Lilyaks Plateau (Fig. 3).

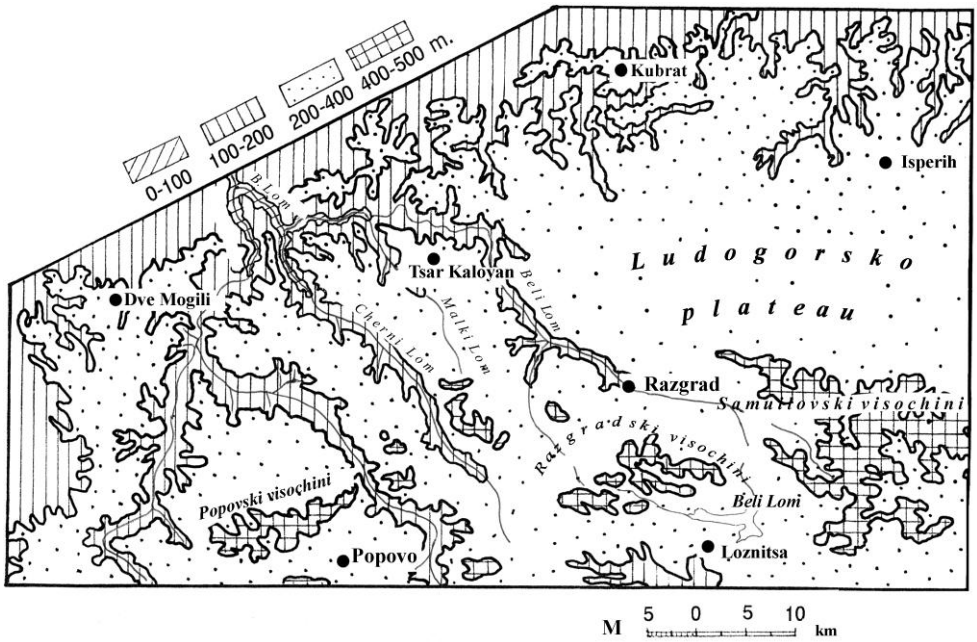


**Fig. 3.** Hypsometric map of the region of the Razgrad Heights

Within the specified boundaries, the area of the Razgrad block morphostructure covers 201.5 km². Several elevated constituent blocks within the structure are characterized by altitudes ranging from 250-300 to around 400-450 meters. The visible surface area of the morphostructure includes several main hypsometric belts: from 250 to 300 m – 41.5 km²; from 300 to 400 m – 112 km²; and from 400 to 479.3 m (Mount Kanarata) – 44 km². The average altitude for the entire visible area of the Razgrad block morphostructure is 346.8 m.



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The Razgrad Heights are drained by the Beli Lom River, the Malki Lom River, and their tributaries, with a total drainage basin of 1140 km². The Rusenski Lom River has a drainage basin of 2947 km², with 378 km² of this basin lying up to the town of Razgrad. Several smaller rivers flow south toward the Trapish depression.

The river network within the study area has a centrifugal character. The river order increases gradually as one moves away from the highest parts of the Razgrad block, with the most rapid increase occurring in the lower part of the slope and on the gently sloping foothills—reaching the 2nd–3rd order. The main river valley of the Beli Lom River is of 3rd order, and after the town of Razgrad, the order increases to the 4th order.

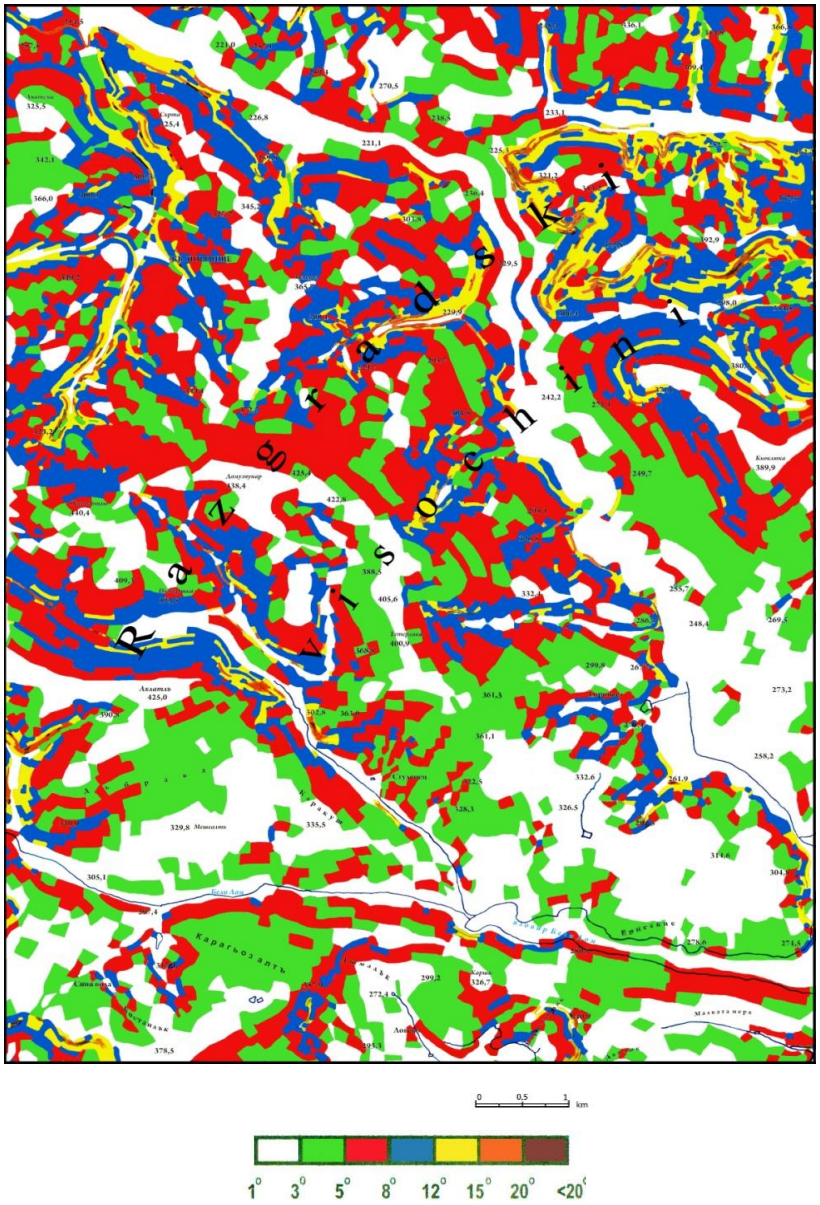


**Fig. 4.** Map of the slope gradient in the Razgrad Heights region



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In the peripheral parts of the Razgrad Heights, the main drainage artery follows the area from the Beli Lom Reservoir to the north-northwest, until it flows into the Beli Lom River (at Momin Rid Peak – 321.2 m) via its tributary, which has its source near the village of Studenitsa. The catchment area of this section of the river is 28.7 km², with a length of 9 km (the length of the first left tributary is 0.95 km, the length of the second left tributary is 2.17 km), and a slope of 22 m. The elevation bands across the area are distributed as follows: from 250 m to 300 m – 2.65 km²; from 300 m to 350 m – 0.101 km²; from 350 m to 400 m – 5.102 km²; and from 400 m to 440 m – 21.056 km². The calculated average elevation of the studied basin is 405.8 m.

The horizontal dissection of the terrain in the area of the Razgrad positive morphostructure varies from 0.5 to 1.5 km/km². The vertical dissection also shows relatively small values: between 50 and 100 m/km². Higher values are noted on the peripheral, steeply descending slopes.

Actual slopes increase from the flat ridged sections towards the slopes of the Razgrad Heights. The prevailing average slopes range from 3-7° to 10°. In the cut river valleys, and on the western and southern slopes of the studied morphostructure, the actual slopes in some places exceed 15-20° (Fig. 4).

**Geological and Geophysical data**

The Razgrad morphostructure, part of the Northern Bulgarian arch uplift, was formed by the elevation of the Upper Jurassic-Valanginian carbonate complex. In depth, it is based on a block uplifted during the Permian-Triassic period, delineated by two subparallel fossilized faults: one to the north, passing near the town of Razgrad, and the second south of the upper valley of the Beli Lom River to the village of Blagoevo, continuing westward between the villages of Sadina and Zaraevo. Several younger faults have been identified: a fault with a northwest-southeast orientation, coinciding with parts of the valleys of the Studenitsa and Kamenitsa rivers; a second fault northwest of the village of Sadina, directed northeast along the Sadina River; a third fault, with the northern part subsiding by up to 100 meters, directed from the village of Lomtsi towards the Kavetska River valley, then diverging northeastward, with subsidence ranging from 90 to 120 meters [7].

Cheshitev et al. [10] identified a structure between the villages of Ostrovche, Gradina, Poroyshte, and the town of Razgrad, which they named the "Ostrovchenska" structure. It has an axis stretching in a southeast-northwest direction, a length of 10 km, a width of 6–7 km, and an uplift amplitude of approximately 60 meters.

Within the boundaries of the Razgrad morphostructure, sedimentary rocks from the Lower Cretaceous, Pleistocene, and Holocene periods are revealed (Fig. 5).

Primarily in the lower parts of the slopes of the river valleys, clayey limestones and marls are observed in many places. These belong to the Razgrad Formation, with a thickness of 80–320 meters and are of Hauterivian-Barremian age. In the northwestern part of the Razgrad Heights, in the area of the village of Ushintsi



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and to the east and southwest of it, Upper Hauterivian limestones are exposed. These were separated [9] and defined [6] as the Bashbunar Member of the Razgrad Formation, with a thickness ranging from 20 to 63 meters.

On the higher parts of the Razgrad Heights, as well as in many areas on the bay-like descending slopes, clayey loess is observed. This loess is of eolian origin and has a thickness ranging from 5 to 20 meters. The age of the loess formation is Middle to Upper Pleistocene, and it has buried much of the Lower Cretaceous rock materials. In the western part of the Razgrad Heights, along the upper slopes above the village of Sadina, as well as along the Sadinska River, porcelanous, organic, and grainy limestones (Hauterivian-Barre-mian–Ruse Formation) are exposed. The thickness of these rock materials ranges from 50 to 150 meters [9, 11].

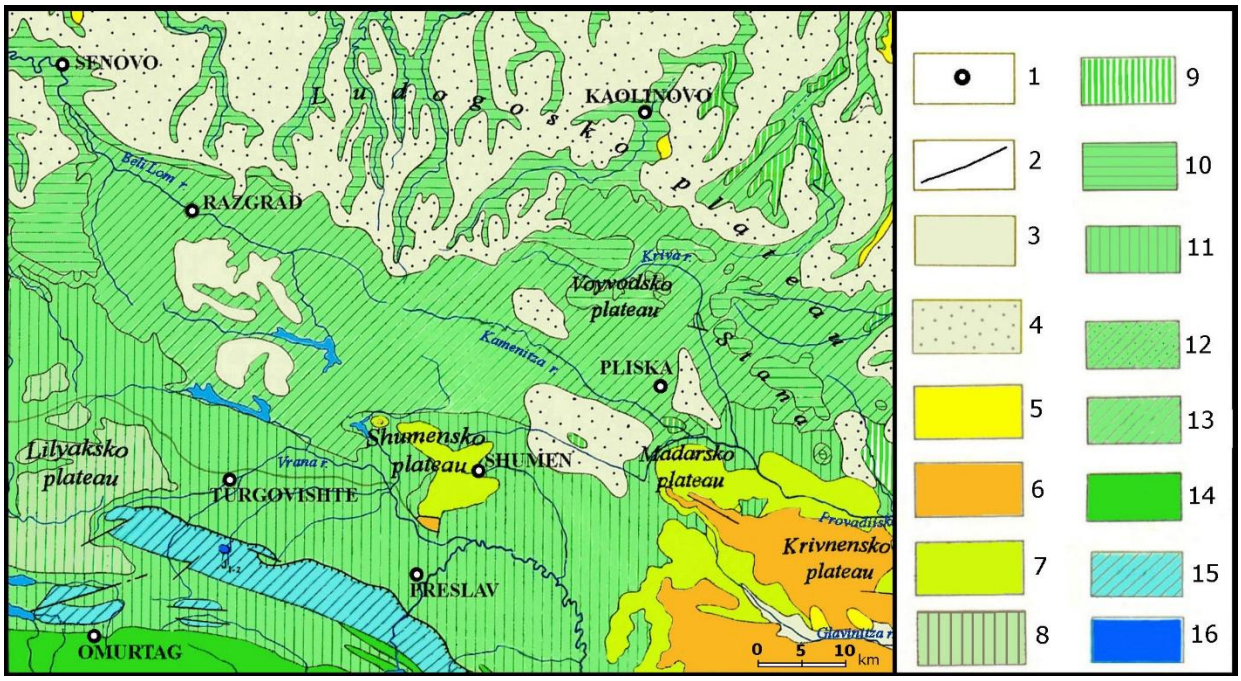


**Fig. 5.** Stratigraphic-petrographic map of the area of the Razgrad morphostructure:

**1**-Sity; **2**-Fault; **3**-Alluvial sediments /boulders, sands, clays/; **4**-Eolian sediments /loess/; **5**-Miocene /limestone, sand, clays/; **6**-Paleogene /marls, sandstones, sands, limestones/; **7**-Upper Cretaceous /limestones, carbonate rocks/; **8**-Upper Cretaceous, Aptian-Albian/sandstones and marls/; **9**-Barremian-Aptian/limestones, conglomerates, sandstones, clays/; **10**-Hauterivian-Aptien /limestones, clayey limestone/; **11**-Hauterivian-Aptien /marls and clayey, marls with sandstone interbeds/; **12**-Clayey limestone formation with sandstone and siltstone; **13**-Lower Cretaceous /clayey limestones and marls/; **14**-Valanginian-Hauterivian /thick packets of sandstones and marls/; **15**-Jurassic-Cretaceous, Tithonian-Valanginian /marls and clayey limestones/; **16**-Middle-Jurassic /Shales, flysch/



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On the lower and higher floodplain terraces of the rivers, gravel, sands, and clays of Holocene age are almost universally revealed.

The values for the contemporary vertical movements of the Earth's crust for the Razgrad morphostructure are positive, approximately +1 mm/year. For Razgrad itself, an uplift rate of +0.9 mm/year has been calculated [4].

Along the western boundary of the Razgrad morphostructure, through geophysical methods on the Paleozoic basement, an uplift has been discovered towards the village of Sadina. When comparing the uplifts described by geologists on the Valanginian - one with an amplitude of 100 m and the other towards the town of Razgrad - with the local gravitational anomalies, it is concluded that there are three such uplifts, with the Valanginian gradually sinking towards the town of Razgrad. A difference is also found in the direction of the fault, which, according to gravimetric data, is located 10 km further to the north, with the subsided side being to the south, not the north. The extensive syncline area near the town of Razgrad shows that the Valanginian participates in a nearly parallel subsidence with the Paleozoic basement. Within the studied morphostructure, the Ostrovchenska structure is found, which is part of a larger negative gravitational anomaly, marked as the Razgrad gravitational minimum. An intense gravitational maximum is formed 10 km northwest of it, with a concentric shape extending southeastward and southward [3].

**Geomorphological reppers**

By the end of the Upper Cretaceous, the territory of the studied morphostructure was completely drained and active denudation began. During the Paleogene, the Razgrad morphostructure was a lowland. The formed denudation surface was later destroyed and reworked.

During the Old Neogene, the territory of the Razgrad block continued to slowly rise. Denudation processes took place throughout the entire Miocene, as a result of which a Miocene denudation surface was formed at an altitude of about 400-450 meters above sea level. Later, in many places, it was denuded and fossilized.

At the end of the Pliocene and the beginning of the Pleistocene, with increased temperature and humidity and the continuing uplift of the Razgrad block, the modern river network began to form in the studied region. On the slopes towards the river valleys, denudation-accumulation Pliopleistocene surfaces and river terraces above the floodplain formed.

During the Holocene, floodplain terraces of the rivers were formed, and various genetic types of materials were deposited — alluvial, deluvial, and proluvial deposits (Fig.6).



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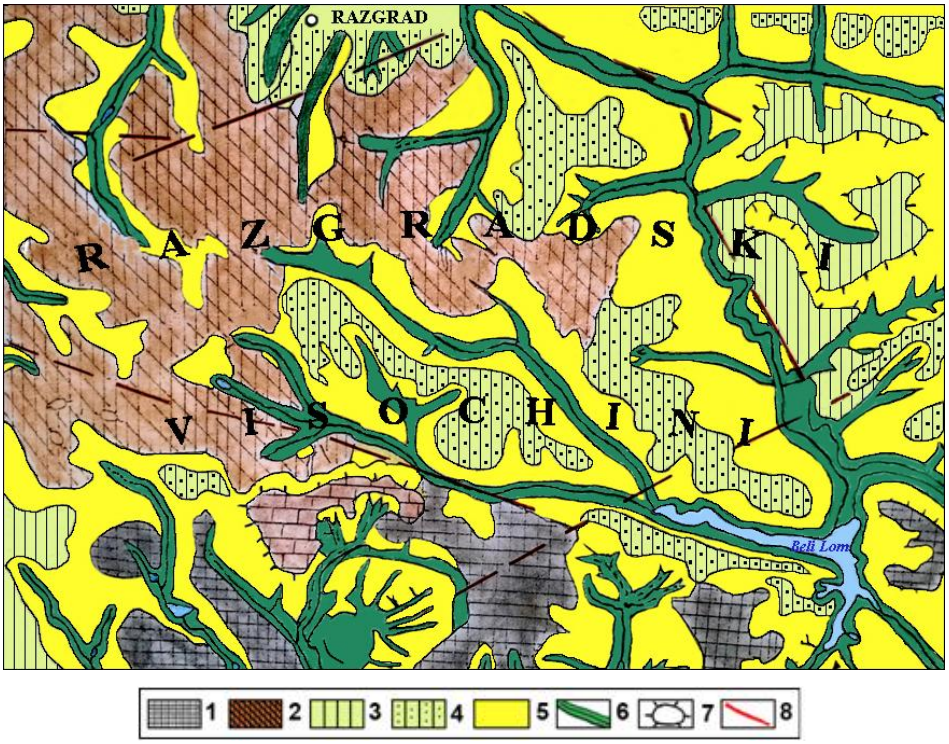


**Fig. 6.** A map scheme of the geomorphological reppers in the Razgrad morphostructure: **1**-Miocene denudation surface; **2**-Denuded and fossilized Miocene surface; **3**-Low Plio-Pleistocene (villafranc) level; **4**-High Plio-Pleistocene (villafranc) level; **5**-erosive slopes; **6**-river valleyswith alluvial deposits; **7**-plateau with rocjwreaths and cuts; **8**-faults

## Conclusion

As a component of the North Bulgarian dome uplift, the Razgrad block is rooted in carbonate Paleozoic rocks and shaped in Jurassic-Lower Cretaceous rock formations. Several stages can be identified in the development of the Razgrad morphostructure: pre-Neogene, Neogene, Pliopleistocene, and Holocene.

**Pre-Neogene Development.** During the Upper Paleozoic, the territory was part of an extensive epicontinental basin, included in a general uplift that formed the North Bulgarian dome. The subsequent transgression continued until the end of the Triassic. During the Jurassic-Lower Cretaceous, the basin gradually shallowed. By the end of the Upper Cretaceous, the area was completely drained and formed into a low weakly dissected land.

**Neogene Stage.** During this period, the main watershed between the Pontic and Precarpathian basins passed through the higher parts of the Razgrad block. The Razgrad block rose quite intensively by about 400-500 m, and the morphostructure acquired roughly its present outlines. In the high areas (from 400 to 450 m), a



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Miocene denudational surface was formed. Later, this surface was complicated by a younger weathering crust and overlain with loess deposits.

**Pliopleistocene Stage.** This stage is characterized by the denudation of the old surface. The river network of the Beli Lom River and the smaller rivers in the region is established. With the uplift and differential elevation of the Razgrad block, sloping foothill levels are formed, which are erosional-accumulative in origin. In several places, red clays are superimposed on these levels (with a thickness ranging from 1 m to 10 m. [8]. The highest river terraces are formed on the slopes of the valleys.

**Holocene Stage.** The slow epeirogenic uplift of the Razgrad block continues, accompanied by the gradual reduction of the river network of the draining rivers that shape the morphostructure, such as the Beli Lom, Malki Lom, and their tributaries. In the lower parts of the river valleys, the modern low and high floodplain terraces are formed. Significant manifestations of contemporary morphogenetic processes occur.

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