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Geomorphological characteristic of the plateaus in Northeastern Bulgaria

Abstract: The work deals with the geomorphological characteristics of the plateaus in Northeastern Bulgaria. It gives information about the geography, relief and rocks of the plateaus. Special attention has been paid to the borders, morphology, hydrography, the surface rocks, geomorphological characteristics (flat surfaces and river terraces) and the manifestation of the exogenic processes. The geomorphological analysis was carried out in connection with the use of the plateaus as a geomorphological resource. The analysis deals with the unique combination of specific relief forms, various hydrological sites, a unique landscape, natural and historical landmarks. Special attention has been paid to the nature parks, reserves, protected natural landmarks and hunting grounds in the area of the plateaus in Northeastern Bulgaria. The text is visually enriched with original map material and author's photos of characteristic sites in the area of the plateaus. In the final part of the text there are recommendations to competent local and government institutions to direct their efforts in utilizing the still unappreciated unique relief forms and natural landmarks. To do that, competent specialists should be employed, who will draw up a marketing strategy for the utilization and popularization of the natural landmarks and the cultural-historic heritage of the plateaus in Northeastern Bulgaria.

Keywords: relief forms, plateaus, paleogeomorphological development, geological formations, current geomorphological processes, geotouristic potential.

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Геоморфоложка характеристика на платата в Североизточна България

Анотация: Представеният труд е посветен на геоморфоложките характеристики на платата в Североизточна България. Предложена е информация за географията, релефа и скалите на платата. Специално внимание е отделено на границите, морфологията, хидрографията, повърхностните скали, геоморфоложките характеристики (равнини и речни тераси) и проявата на екзогенните процеси. Геоморфоложкият анализ е извършен във връзка с използването на платата като геоморфоложки ресурс. Анализът разглежда уникалното съчетание на специфични форми на релефа, различни хидроложки обекти, уникален ландшафт, природни и исторически забележителности. Специално внимание е отделено на природните паркове, резерватите,

защитените природни забележителности и ловните полета в района на платата в Североизточна България. Текстът е визуално обогатен с оригинален картен материал и авторски снимки на характерни обекти в района на платата. В заключителната част на текста има препоръки към компетентните местни и държавни институции да насочат усилията си към оползотворяване на все още неоценените уникални релефни форми и природни забележителности. За целта трябва да бъдат привлечени компетентни специалисти, които да изготвят маркетингова стратегия за оползотворяване и популяризиране на природните забележителности и културно-историческото наследство на платата в Североизточна България.

Ключови думи: форми на релефа, плата, палеогеоморфоложко развитие, геоложки образувания, съвременни геоморфоложки процеси, геотуристически потенциал.

Introduction

Plateaus in Northeastern Bulgaria are distinguished by a number of specific features, mainly due to their intermediate position in relation to the orogenic structures of the Balkanides from the south and the plain placid structures from the north.

The purpose of the study is to carry out a geomorphological characterization of the plateaus in Northeastern Bulgaria, paying special attention to the natural features that can be used as an important geotourist resource.

To achieve the purpose, the following main tasks are set:

- analysis of the scientific publications affecting to one extent or another the geomorphology of the plateaus in Northeastern Bulgaria;
- determination of plateaus' boundaries and detailed morpho-hydrographic relief characteristics, leveled surfaces and river terraces;
- study of the lithologic-stratigraphic features of plateaus;
- determination of the main stages in relief development in Northeastern Bulgaria;
- analysis of the anthropogenically assimilated natural objects in the studied plateaus, which are used as a geotourist resource.

Geomorphological analysis is the theoretical-methodological basis for studying the landforms in platues of Northeastern Bulgaria, which considers the relief as a single system of tectonic structure, form and lithological content.

Various classic research methods were used during the study:

- information methods are applied both before and during the entire study;
- expeditionary field methods include reconnaissance, work and control routes, during which observations, measurements, taking rock samples, photography, primary mapping, etc. are carried out;
- cameral methods are based on a summary and synthesis of the acquired information;
- cartographic methods are related to the preparation of various maps and other graphic applications.

Having regard to its natural geographic features, Northeastern Bulgaria is well detached region of Bulgaria covering an area of 20,300 sq. km. The region includes the eastern part of the Danube Plain and the northern part of the Black Sea coastline.

The northern boundary of the area is traced along the river Danube from Batin isand, crosses the towns of Russe and Tutrakan, and reaches the town of Silistra to the east is 150 km. The western boundary is defined by the watershed line between the river Russenski Lom and the river Yantra and crosses to the south the valley of the river Golyama. From that point the boundary follows southeastward the Fore-Balkan. The eastern boundary is clearly determined by the Black Sea (*Figure 1*).

Northeastern Bulgaria is characterized by plain and hilly relief. The hilly lands occupy 54% of the territory and the rest 46% of the area is covered by lowland and plain belt.

Geological settings and paleogeomorphological development

The plateaus in Northeastern Bulgaria were formed on the periphery of the old Mysian platform (the so-called South Mysian periplatform region). In this part of Bulgaria there were risings in the fundament of Dobrudja horst step and the North Bulgarian vault swelling and sinkings in Popovo and Varna depressions. The structure of the upper part shows the development of the periplatform from the Paleozoic to the Neozoic period (*Atanasov et al.,1 1976*).

The oldest surface rocks are of the Early Cretaceous period. They can be seen in the western part, while in the east there are mainly rocks from the Paleogenic and Miocenic period.

The Quarternary deposits are: loess, clay loess, loess-like clays, surface gravels, sands and clays of the unfloodable and floodable terraces as well as materials of current morphogenetic processes (*Figure 2*).

The paleogeomorphological development of the plateaus in Northeastern Bulgaria can arbitrarily be divided into several stages (*Vladev, 2005*):

Late Cretaceous-pre-Eocenic Stage. The Black Sea depression, whose sinking influences a significant part of Northeastern Bulgaria, dates back to the late Cretaceous period.

During the transgressions the southernmost low parts of the North Bulgarian and Dobrdja swelling become part of an epicontinental sea basin. Decreased zones with active sedimentation are the presentday territories of Shumensko, Royaksko, Madarsko, Krivnensko and Dobrinsko plateaus (thickness of Late Cretaceous – 200-300 m).

Eocenic -Oligocenic Stage. From the time of Mid Eocene to the end of Oligocene the sinking went on in the territories of present day Royaksko and the western parts of Frangensko and Avrensko plateaus (Eocene-Oligocene – 400 m). Present day Shumensko, Madarsko, Krivnensko and Dobrinsko plateaus are higher.

Neocenic Stage. There is a decrease in the endogenic activity while at the same time the role of the exogenic processes increases. The pediplens gradually changed and by Mud Miocene there was a clear initial surface (peneplains). Along the upper parts of Dobrinsko, Krivnensko and Madarsko plateaus it is of a karst character, cut in Late Cretaceous and Early Paleogenic rocks. In the eastern part of Avrensko plateau the Miocene sediments are represented in a continual cut from the Chocrace to the Sarmatian. After that Avrenski block gradually rose, thus forming Late Sarmatian (layered in the south) surface. The northern part of Avrensko plateau became the highest, marking the hinge of the rise. There are still positive Tectonic movements, which started at the beginning of the Oligocene. They form the raised plateau-like arc in the south – Royaksko plateau. By the end of the Sarmatian period the tectonic movements die down and a

flat Paleo relief was formed in the north. During the Pontian period Varna decline was formed north of Avrensko plateau. At the same time there was a slow epeirogenic rise of the neighbouring plateaus and a forming of denuding surfaces on them. At the end of this stage builds the oldest generation river valleys.

Plio-Pleistocenic Stage. The relief developed under the influence of the Rhone and Wallachian Tectonic phases and fluctuations of the erosive basis of the Black Sea. The exogenic geodynamics is predetermined by the warm and wet climate, the main factor for the increase of the river flow. As a result of the stage by stage of the cutting-in of the river valley network, along the plateau slopes (mainly on the southern slopes and the secondary watersheds) several slanting (often overlapping) levels (steps) were formed. During this stage the second generation of valley systems is formed in the basin of Provadiiska and Golyama Kamchiya. In a north-northwest direction the denuding-erosive levels can be found still lower, and in some places, they are fossilized by loess deposits.

Pleisocenic Stage. The development of the relief of the plateaus is defined by the mutual influence of their Tectonic rising, the climate, the Eustatic fluctuations of the Black Sea basin and the cutting-in of the river valleys. The Pleistocenic evolution is marked by transgressions and regressions, reflecting the Glacial and Interglacial periods. Varna and Kamchiya firths developed as a result of a sinking, and sea and alluvial deposits (40-50 m thick) piled on the peripheral part of Frangensko and Avrensko plateaus. It was during the Pleistocene period that the third, the youngest generation of river valley networks – short, not deeply cut in the plateaus' river valleys by the springs and the mouths – were formed.

The deposits on the first unfloodable river terrace refer to the *Holocene period*, while the delluvial-prolluvial shleifs, the elluvial weathering covers, screes, landslides, landslips, beaches, as well as the low and high floodable river terraces date back to the Late Holocene period.

Geomorphological features and specific landforms

A number of mid-high (400-500 m) and low (300-400 m) plateaus can be found in Northeastern Bulgaria (*Figure 1*).

The *Ludogorsko plateau* (300 m) is a vast, undulating, deep chopped plateau area, with slopes mostly in the north. It is situated east of Beli Lom and north of the Popovsko-Razgradski and the Samuilovski Heights.

Within these borders Ludogosko Plateau is 80-85 km long west-east and 35-40 km wide north-south. Its latitude increases from 200 m in the north to 300 m in the south.

The bigger rivers running through the Ludogorie spring near the main watershed for Northeastern Bulgaria, forming a fan, make their way northward to the river Danube. In their upper and middle courses they indent significantly in the loess, Quaternary and Tertiary limestone forming deep dry valleys (*Figure 3*). Within the area of Ludogorsko Plateau, mainly in the chalk rock formation, are traces of *the Early Micene denuding surface*. The denuding flat is highly karstic, covered with loess and loess-like clays. Right under it at an altitude of 200-250 m can be seen fragments of a *Plio-Pleistocene denuding-accumulative surface*. Because of the absence of a clear rock section the surface is difficult to detect in some places. During the Plistocene epoch the slow rise of Ludogorsko Plateau continued, accompanied by the cutting-in of the river network

and the formation of unfloodable river terraces. During the Holocene period were formed the *floodable river terraces*, formed mainly from sands, gravel and clay link.

Dobrudja Plateau (368.2 m) is 200-210 km long south to north, 60-70 km wide east to west and has an area of about 13 325 sq. km. There are two distinguishable parts of it – northern (in the Southeastern Romania) and southern (in the Northeastern Bulgaria), divided by a low section between them.

Its boeders are marked as follows: to the west-southwest by Ludogorsko Plateau; to the south by Frengensko Plateau and Devnya valley structural decline; to the east by Seasde Dobrudja; to the northwest and north by North Dobrudja Plateau (within the borders of Romania).

In the morphography of the Dobrudja Plateau (length is 50-60 km, width is 40-60 km, area is 2750 sq. km; altitude is 325 m) a major watershed line, developed from the village Stozher (350 m) northward to the of village Rositsa (220 m), is clear notable. The mean altitude of the plateau is 300-330 m. The plateaus are deeply cut by dry valleys and in numerous places a range of ravines are developed transversely the valleys.

More significant river networks form the Suha Reka, the Batova River, the Kazalak, the Krapinets, the Karasu and the Toshevska River. As they flow through a karstic region the rivers are shallow and often dry up in summer.

In the direction of Seaside Dobrudja, west of the line of the villages of Rositsa-Kraishte-Pisarevo-Snyagovo-Momchil at an altitude – 100-250 m *the crust is flat Pliocene*. East, north and northwest of Dobrudja Plateau at an altitude of 130-170 m can be found a flat – an old *abrasive-accumulative level*. *The Pleistocene-Holocene development* could be followed through the river terraces.

The borders of *Lilyaksko Plateau* (516.9 m) are defined as follows: to the north by the southern periphery of Razgrad Heights; to the northeast by Trapishte structural decline; to the east by Targovishte substructural decline; to the south by Omurtag block; to the southwest by Antonovo Heights and to the west by the decline with a center in the vicinity of the village Svetlen. Within these boundaries Lilyakovsko Plateau has approximately the following measures: 7.5 km long west-east-north, south – 15 km; 10 km wide north-south to the west, 7.5 km to the east. The area of Lilyaksko Plateau is 96.32 sq. км.

The slightly inclined to the west slopes of the plateau are strongly segmented in a subparallel direction by the Chetni Lom River tributaries and the valley of the Dermendere is strongly cut in. The southern and eastern slopes of Lilyaksko Plateau are steep and the northern are slanting with a slight incline.

The initial surface appearing on the ridge of has an old origin. Polyfacial, defossilized and replaned it is formed in subhorizontal Early Cractaceous rocks. Its mean altitude is 450-500 m. In the western part the structural surface appears in the highest part of the slope in the shape of an almost vertical cornice. In a western direction can be seen, slanting towards the river valleys, *Plestocene surfaces*. The higher ones are erosive and the ones in the lower part of the slope have a mixed erosive-accumilative character. They are situated one below the other at a height of 300-340 m and 250-300 m.

Shumen plateau (501.9 m) is situated in the south-western part of north-east Bulgaria. The plateau is a separate block of the Misia table, segmented along its periphery by bay-like river valleys (*Figure 4*).

The plateau is bordered by: to the north – the valleys of the rivers Strazhka, Pakosha and Chairdere; to the north-east – the upper part of the Matnishka river; and to the southwest – part of the Kamenitza river watershed; to the east-southeast – Shumen-Smyadovo lowlands with part of the Golyama Kamtchia river valley; to the south and west Targovishte substructural lowlands with part of the Vrana river valley. Shumen plateau is about 12 km long in west-east direction; its length changes in south-north direction – from 7-8 км in its southernmost part, to 9-10 км in the central part, to 11-12 a bit more to the north and to about 20 km in the northernmost part. In north-south direction in its width varies between 15 and 17 km. The total area of the plateau is 73.13 sq. km.

From a geomorphological point of view the relief of Shumen plateau can be divided into three parts – ridge, slopes, and foot. The ridge is undulating with a karsts' relief with predominating slanting slopes and segmentation. The slopes of the plateau are quite segmented differentiating in steepness and manifestation of current morphogenetic processes. The foot of the plateau is in the altitude range of 180-200 m (from the south) and 250-330 m (from the east and the north) and most of the land is arable.

The current manifestation of the morphogenetic processes in the plateau is defined both by the weather conditions and the armouring effect of the sub-horizontal Maastricht limestone. The latter form perpendicular slopes, rock wreaths, landslides, landslips and taluses.

There is a big active landslide along the eastern slope of the plateau with a four-lane highway passing along it. Two landslide zones, going to old gullies now covered by the road, are discernable within it.

A landslide complex of several big ones and a large number of smaller detrusive landslides can be found along the western slope of Shumen plateau, west and northwest of Tarnovtabiya peak (501,9 m). This section is about 5 km long (*Figure 5*).

Karsts processes are well defined in Shumen plateau as they form: more than 200 eddies, more than 160 hollows, as well as gorges, dead-end karsts dales, karsts springs, fields and karsts rock wreaths, karsts niches and caves.

The geomorphological evolution of the Shumen plateau can be traced by the size and the characteristics of the denuding surfaces and river terraces (*Figure 6*).

The borders of *Voivodsko Plateau* (475.8 m) are defined as follows: to the west by Samuil Heights; to the north, northeast and east by the valley of the Kriva Reka (48 km long, with water catchment area of 220 sq. км); to the south border lies along the line between the villages of Iglika-Zhivkovo-Praventsi-Izbul. Voivodsko Plateau is 11-12 km long, 5-7 km wide, with an area of almost 57 sq. km.

Voivodsko Plateau is drained by the the right-hand side tributaries of the Kriva Reka –short and shallow often drying up in summer (*Figure 7*).

Between Haidara locality and Mogilata peak there is a valley enlargement and the rivers draining the central part of Voivodsko Plateau flow towards it in a fan-like form.

Piles of broken rocks can be found at the foot of the plateaus (*Figure 8*).

There are two or three denuding surfaces on Voivodsko Plateau. The highest *Sarmatian-Pontian surface* encompasses the flat ridge of the plateau. From 450 m in the central part it drops down in the north to 350-320 m. Then follow several superimposed *Pleistocene steps* hanging over the river valleys (*Figure 9*).

Stana Plateau (440.9 m) has an oval shape elongated in the direction of northwest-southeast with symmetrical sides.

The borders of the plateau are defined as follows: to the west and northwest by the valley of the Kriva Reka, which separates it from Kaspichansko structural decline and Voivodsko Plateau; to the south by the valley of the Provadiiska River and the short Chatakdere River, which serve as a border with Krivnensko Plateau; to the east and northeast by the valley of the Zlatina River and Zlatinsko-Vetrinsko structural-denuding decline and to the north by the valleys of the rivers Kavakdere and Tolumdere, which separate the plateau from the southern periphery of Ludogorsko Plateau. The total area of Stana Plateau is 183 sq. км.

On the surface of Stana Plateau we can find some flat areas: *layered* – at an altitude of 380 to 440 m, *Sarmatian-Pontian* – developed along the ridge of the platea in a southeast-northwest direction at an altitude from 240-260 m to 320-340 m and several *Pleistocene slope steps* fixed at an altitude of 140 to 220 m (*Figure 9*).

The Quarternary period is marked by several terrace levels, developed along the valleys of the rivers going down the slopes. Delluvial and delluvial-prolluvial shleifs, 10-12 thick, can be found north of the village of Nevsha. A significant part of the deforested slopes of the plateau is taken up by gullies. They are from 5-6 to 10-12 m deep (*Marinov, 1991*).

Provadiisko Plateau is bow-shaped with a length of 70 km, width of 2-3 to 15 km and an area of 371 sq. км (*Figure 10*). The borders of Provadiisko Plateau can be defined as follows: to the north by Shumensko-Smyadovsko decline; to the northwest by Kaspichansko substructural decline; to the north by Stana Plateau and Zlatinsko-Vetrinsko decline; to the northeast and east by Devnensko and Varnensko declines; and to the south and southeast by Provadiisko structural-denuding decline. The plateau is drained by some tributaries of the Provadiiska River, the longest of which is the Glavinitsa River (40.8 km long).

Several relatively independent blocks can be distinguished in Provadiisko Plateau – *Madarski* (length of 12 km from east to west, width of 2-3 km from north to south and an area of 28 sq. км), *Krivnenski* (length of 65-70 km, width of 2-3 up to 10 km and an area of 285 sq. km) and *Dobrinski* (an area of 58 sq. км), which are separate plateaus. There are two or three denuding surfaces on Provadiisko Plateau.

The northern, northwestern and western slopes of the *Madara plateau* (429.8 m) are vey steep, in some places almost vertical, in a small section in the western part even overhanging.

There are a number of cracks in the vicinity of the *Madara Horseman* which enable the separation of the peripheral parts of the plateau. Some of them cut the whole thickness of the armoured limestones reaching the bottom of the vertical slopes (*Figure 11*).

The geomorphological evolution of this part of Northeastern Bulgaria can be traced by the size and the characteristics of the denuding surfaces (*Figure 12*), river terraces and the manifestation of current morphogenetic processes.

Under the influence of tectonics, the specific rock composition, the gradient of the slope and the climate in the region of the Madara Plateau have been observed increased landslip-landslide processes, which in some places could be hazardous for the visitors.

The foot is of 1-2 km wide landslip-landslide terraces, delluvial and delluvial-prolluvial shleifs.

Krivnensko Plateau (476 m) is bow-shaped, stretching from southwest to northeast with a length of 65-70 km, width of 2-3 up to 10 km and an area of 285 sq. km. There are two prevailing hypsometric belts in the region of the plateau – from 200 to 300 m and from 300 to 400 m.

The ridge flat is covered by a *layered subhorizontal surface* situated at a height of 240 to 400 m. On the eastern and southern slopes of Krevnensko Plateau at the height of 120 to 200 m can be found one or two *villafranca flat foot levels*. In most places they have the characterstics of a slope step (*Figure 12*).

The valleys of the rivers starting from Krivnensko Plateau – the Haramiyata, Kosovska, Kalaidjideresi, Veredere, etc, are deeply cut into the rock complexes.

In the lower break on the slope of the plateau one can find a wide band of rock materials that have slid down and form delluvial and delluvial-prolluvial shleifs. The results of karst processes are also well defined on the slopes of the plateau. On the steep northern slopes of Krivnensko Plateau one can find cut-in short and deep gullies, called by the local population *boazi* (*Figure 13*).

The linear erosion is represented by a number of erosive furrows and gorges. Between the village of Zlatina and Vasil Kolarov station the Provadiiska River flows through a deep gorge with a length of about 10-12 km, which separates Krivnensko plateau fron Dobrinsko Plateau.

Dobrinsko Plateau (360 m) is oval-shaped with slanting southern and steep northern slopes. The southetn slopes are segmented into two symmetrical parts by the valley of the Manastirska River (*Figure 14*).

The borders of the plateau are defined as follows: to the west by the gorge of the Provadiiska River from the village of Zlatina to Vasil Kolarov station; to the south by the southeastern parts of Provadiisko structural-denuding decline; to the east by Devnensko decline with the valley of the Devnenska River; to the northwest by Vetrinsko decline. Within these boundaries Dobrinsko Plateau has an area of 58 sq. км.

The upper part of Dobrinsko Plateau has a layered surface at the height of 210 to 250 m, composed of organogenic and sandy limestones armoured in sandstones. The surface is slightly inclined from north to south. Immediately beneath the surface flat one can find delevelled *villafranca slope steps*. The widest of them are on the southern slope, which is not that steep (*Figure 12*).

The northeastern slope of Dobrinsko Plateau is interspersed with a number of gullies (from 50-100 to 200-750 m long, from 3-5 to 12-14 m deep), with a lot of steep and vertical slopes, developed in delluvial deposits. (*Marinov, 1991*). The slope has undergone such a significant change because of erosion that it looks like a typical badland.

Royaksko Plateau (410 m) is eliptic in shape, extended from west to east with a length of 38 km, width from 250 m to 7-8 km and an area of almost 163 sq. km (*Figure 15*).

The borders of the plateau are defined as follows: to the north, northeast and east by Provadiisko decline; to the south by the valley of Kremen Dere; to the west by Shumensko-Smayadovsko and to the southeast by Dolnokamchiisko decline; to the northwest by Provadiisko Plateau substructural decline.

Layered surface at a height of 300 to 360 m is formed on the ridge of Royaksko Plateau. It is deformed in some places by local swellings and depressions. Northeast of the villages of Sladka

Voda and Boryana one can find slope *Plio-Pleistocene* (villafranca) steps at a height of 140 to 180 m (*Figure 12*). Some of them are erosive-denuding while others are mainly accumulative.

The river valley network is short because of the configuration of the plateau. There are flat platforms of high river terraces at a height of 70-90, 50-60, and 35-40 m on the western and southern slopes of the plateau.

Frangensko Plateau. The borders of Frangensko Plateau (with an area of 360 км; 377.8 m) are defined as follows: to the north by the valley of the Batova River; to the east by the Black Sea; to the south by Varnensko decline; to the west by the watershed between the springs of the rivers Batova and Suha Reka.

The oldest forms of the plateau relief are the denuding surfaces (*Figure 12*). The highest of them at an altitude of 300 to 320 m developed during the Late Miocene, formed on horizontal and subhorizontal armoured Sarmatiah sediment rocks. An *old abrasion-accumulative (Pontian) level* can be seen on the southern, northern and eastern slopes of the plateau. It is 320 m. north of the valley of the Kranevska River.

The southern slope of the plateau that runs north of the city of Varna through Vladislavovo quarter, the villages of Axakovo, Dobrogled and Kalimantzi is well defined morphographically.

The most common forms defined by the current morphogenetic processes are the *landslides*.

To the south the slope gradually or by steps in a narrow band, interspersed with a landslide system, goes down to the floodable terrace of Varna and Beloslav Lakes. The lower border of the landslide swathes is marked by small hills.

Along the whole eastern slope of Frangensko Plateau (16 км long and 700 m to 4,5 км wide) is one of the widest landslide complexes along the Bulgarian Black Sea coast. Active (63.24%) and potential (19.12%) landslides are dominant. The stabilized landslides comprise only 13.24 % and 4.41% have not been investigated yet (*Geozashtita Newsletter, 2018*).

Avrensko (Momino) Plateau. Avrensko Platau (328.8 m) has a rectangular shape, elongated in west-east direction with a maximum length of 28 km, width of 18 km an area of 410 sq. км.

There is a *layered surface* (at a height of 250 to 300 m) and up to two villafranca underfoot levels (at a height of 90 to 140 m) easily seoparated on Avrensko Plateau (*Figure 12*).

The rivers draining Avrensko Plateau are short and shallow. There is a clear asymmetry of the river valleys – short northern valleys and two or three times longer southern ones.

Significant ravine formations can be seen along the steep slopes of the plateaus. Alluvial cones have been formed near the mouth of the rivers where there are sudden changes in the incline, mainly at the northern foot of the plateaus. The entire eastern part of Avren Plateau is covered with landslides and landslips.

The geotouristic potential of the plateaus in Northeastern Bulgaria

The touristic potential of the plateaus in Northeastern Bulgaria is determined by the unique combination of temperate climate, specific relief forms, a variety of the hydrological sites, a unique landscape, natural, and historical landmarks.

The most developed forms of tourism in the region of the plateaus are: recreational tourism, ecotourism, sports tourism, hunting tourism, educational and cultural-historical tourism.

The most often visited places are the Black Sea resorts in the eastern periphery of Avren, Frangensko and Dobrudja Plateaus. This is where the big resort complexes – *Rusalka*, *Albena,*

Golden Sands, St. St. Konstantin and Elena, Riviera, etc. are situated. Recreational tourism is favoured by the presence of sea water combined with a large number of beaches, a cliff shore with various rock forms, beautiful bays, a lot of mineral springs, healing mud, etc.

A somewhat negative effect on the development of the sea tourism is caused by the current landslide processes along the entire seaside zone of Avren and Frangensko Plateaus.

The rich network of *nature parks*, *reserves*, *protected natural landmarks* and hunting grounds in the area of the plateaus in North-Eastern Bulgaria is a potential for the development educational, ecotourism, hunting tourism and other forms of alternative tourism.

Approximately 3,896 hectares of the upper part of the Shumensko Plateau have been turned into a *nature park* and 90.1% of the whole territory of the park is forested. The Bukaka Reserve is situated here. The prevailing type of tree is the Misia beech. On the eastern slopes of Shumensko Plateau the most popular region is Kyoshkovete forest park.

Due to its more or less flat relief Shumensko Plateau is particularly suitable for bicycle tourism and some of its steep slopes for rock climbing. One of the most preferred places for paragliding in Bulgaria is situated on its eastern slope. Quite popula are also localities like Khan Krum's Gates, Hisarlaka with Stariya Grad historic-arcaelogical reservation, Visoka polyana locality, monument "1300 years of Bulgaria", Biserna Cave, rock phenomenon "Snail", Rock monasteries (*Figure 16*), etc.

The Biserna Cave is the longest and most beautiful cave on Shumensko Plateau. It got its name because of the beautiful cave formations and the constantly falling drops of karst water. It was formed about 3.5 mil years ago. It was urbanized in 2016 and about 800 m are accessible for tourists. An underground river, fed by more than 40 eddies, runs along its lower floor. It is the habitat of 14 different kinds of bats.

In the area of the Madara Plateau is the *National Historical-Archaeological Reserve "Madara"* (1958). Its territory encompasses the *protected territory of Madara rock wreaths*. An area of 3,691,336 decares covers a protected territory of habitats of petrophile and protected animal species and finds of rare plant species.

The beautiful nature, the inaccessible cliffs with their caves and niches, as well as the abundant water are favourable prerequisites for the settlement of the region as early as antiquity. The Madara Plateau has been inhabited for more than 5000 years. Record from six historical epochs have been found in the area of the Madara Plateau, that is why the first explorers of the region called Madara the *Bulgarian Troya.*

The most remarkable monument of VII century is the life-size horseman with a spear in his hand hewn into the cliff-face 23 m above ground level (*Figure 17*).

One of the biggest medieval rock monasteries in Bulgaria was built in the vertical western slope of the Madara Plateau in the 14th century. It included more than 200 natural caves and niches situated at different levels along the cliff wreath, used as monk cells, chapels, churches and tombs. One of the big caves was used as a church. It is the still used *St Panteleimon* rock chapel (*Figure 18*).

In 1979, at the World Congress in Luxor (Egypt), The Madara Horseman was included as a UNESCO Heritage Site and on June 29, 2008, after a long public dispute it was declared Bulgaria's global symbol. In 2008, it was decided that The Madara Horseman would be depicted on the first Bulgarian *Euro coin.*

The region of Krivnensko and Dobrinsko plateaus offers perfect conditions for ecotourism. Particularly picturesque is the Provadyiska River Canyon between the village of Mogila and the town of Provadyia. It cuts through the northern edge of Krivnensko Plateau, thus separating a number of smaller plateaus, hillocks and picturesque rock wreaths. The maximum depth of the canyon is about 250 m. There is an eco path from the bottom of the *Kaleto* locality to the *Tabiite* locality.

There are 32 archeological sites in the Municipality of Provadiya, the most often visited being *Ovech Fortress, the Thracian Sanctuary and St. Georgi and Kara Peshtera rock monasteries*.

Eco tourism can also be organized in the *Provadiysko-Royaksko Plateau protected area* and its protected territories Snezhinska Kuriya, Slaveykovska Gora, Golyamata Kanara, Pobitiya Kamak and Petrovdolsko Gnezdovo Nahodishte. Provadiysko Plateau offers also the possibility of a specific kind of eco tourism – ornithological one, as the plateau is the habitat of 118 different birds, 18 of which are in Bulgaria's Red Book, and 63 are of European environmental significance.

Of particular interest is the *Pobitite Kamani (Standing Stones)* natural phenomenon – columns of 3 to 10 m high at 5 levels (30 m) in 5 groups and 18 areas in the western part of Frangensko and Avrensko (Momino) Plateau (*Figure 19*).

Pobitite Kamani are unique geological formations, which in their degree of preservation and imposing appearance have no analogue in the world. The columns are concentric and contain microbial carbonate. Their inner part is built up of sands, so that some of them are hollow (*Nachev & Nachev, 2001*).

They were declared as a protected territory in 1995, and from 2002, they are a protected area of 253.3 ha. Different archeological finds have been discovered in the area such as stone and flit knives, hammers and axes, arrow points and so on. There are unique representatives of flora and fauna, mainly species that do not need wet conditions. Pobitite Kamani is one of the most often visited nature site due to its closeness to the big touristic complexes along the Black Sea coast.

The *Yatata* protected area (Strashimirovsko Marsh) is situated at the northern foot of Avren Plateau, close to the canal between Beloslav and Varna lakes. It is a region where aquatic birds spend the winter season. More than 20,000 aquatic birds live here annually, 79 species of which are included in Bulgaria's *Red Book*.

The medieval fortress *Petrich Kale* (*Figure 20*), situated in the north-eastern part of Avren Plateau also attracts a lot of tourists. The fortress is naturally protected – to the west and north by vertical 35-metre-high cliffs; to the east and partially to the south by deep steep ravines. It was accessible only from the south by a narrow rock path, connecting it with the main part of Avren Plateau.

The smallest nature park in Bulgaria, *Zlatni Pyasatsi*, or *Golden Sands*, (13.2 sq. km) is situated in the eastern part of Frangensko Plateau. It was created in order to preserve the natural coastal ecosystem in which different types of trees and bushes occupy about 90% of its area. One of the most often visited touristic sites *Aladja Monastery* is situated here.

Northeast of the Goden Sands NP is situated the *Baltata Reserve*. It occupies the lower part of the Batova River. This is the northernmost part of the European floodplain forest. More than 260 higher plants (28 of them protected), more than 180 different birds, 36 kinds of mammals,

15 kinds of amphibians and 16 kinds of fish can be found here. The reserve is guarded but tourists are allowed to visit if they keep to the strict rules.

Southeast of Dobudja Plateau is situated the famous Balchik Touzla and the Cape Kaliakra natural phenomenon. *Balchik Touzla* is a balneological resort that uses healing mud obtained from two lakes located at the foot of a steep sea shore amid a large landslide. *Cape Kaliakra* is the longest cape on the Black Sea coast, the final part of a narrow peninsula. The shore is comprised of vertical reddish cliffs about 70 metres high. The only cave archeological museum in Bulgaria is situated in its southwestern part. Kaliakra is a nature reserve with karst landscape and unique wild life. More than 450 kinds of steppe vegetation can be found here, 45 of which are rare, endangered, or endemic species. There are also dolphins, seals, cormorants, starlings and rock black birds.

North of Cape Kaliakra is the *Bolata Marsh* (a marshy firth) and the *Taukliman (*bird firth*) lake-lagoon,* the habitat of many aquatic birds.

A number of hunting grounds in Northeastern Bulgaria are also attractive for specialized tourism (*Figure 21*).

The main centre of the hunting grounds in northeastern Bulgaria is the *Palamara* state hunting ground, where red deer are bred and sent to other hunting grounds. The fallow deer is less popular and can be found in the open areas of Ludogorsko Plateau.

Discussion

The relevance of the presented topic is based on the fact that plateaus in Northeastern Bulgaria are not yet sufficiently well studied from a natural-geographical point of view. This gives reason to carry out complex and local natural-geographical studies in the area of the plateau in the future in the field of geology, geomorphology, soils, hydrology, climate, vegetation, and animal life.

This gives reason to carry out future complex and local natural-geographic studies in of plateaus area in the field of geology, geomorphology, soils, hydrology, climate, flora and fauna.

An important problem related to the practical application of geomorphological studies is the large-scale mapping of the researched territories. Such maps can be used in various spheres of public life – agriculture, land melioration, urban, industrial, and road construction, development of urban territorial plans, etc.

In the plateau region there are many important archaeological sites, some of which are well studied, but a number of mounds, caves, cave niches, impressive rock complexes, etc. remains unexplored. There are well-established methods of geomorphological research of such objects that can be successfully applied. Modern technical means, such as ground-penetrating radars, that allow research to be carried out without causing serious damage to the natural environment.

It is imperative to first identify unexplored impressive rock and landforms that may be of tourist interest. Such are, for example, a number of megalithic rock niches and caves on the periphery of the plateaus - Shumensko, Madarsko, Krivnensko, Avrensko, Frangensko, etc., as well as deposits of ordered and unordered poorly worked stone blocks (menhira) in the areas of the town of Pliska, Zlatna niva village, etc. After selection of the objects, it is necessary to prepare projects for their detailed local interdisciplinary study, in which geodesists, historians, geologists,

geomorphologists, physicists, etc. can be involved. In final stage of this research, the most impressive of the studied sites can be included in new tourist routes.

Conclusion

The plateaus in Northeastern Bulgaria have a great touristic-resource potential, which unfortunately is not utilized rationally enough.

Despite the presence of a number of impressive relief forms and unique natural and archeological landmarks only few of them have a touristic infrastructure and consequently only some of them are used as touristic resources.

It should note that it is extremely important to find a balance between the rational use of the natural touristic resources of the plateaus in Northeastern Bulgaria and their environmental protection. Undoubtedly such a balance will guarantee the stable development of the regions from touristic and environmental viewpoint, by managing and integrating ecological, landscape and cultural values of the plateau regions and the development of the municipalities. The protection of the natural recreational-touristic resources is a very important part of the entire environmental policy.

In conclusion we can recommend to competent local and government institutions to direct their efforts in utilizing the still unappreciated unique relief forms and natural landmarks. To do that, competent specialists should be employed, who will draw up a marketing strategy for the utilization and popularization of the natural landmarks and the cultural-historic heritage of the plateaus in Northeastern Bulgaria.

Information

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Appendix

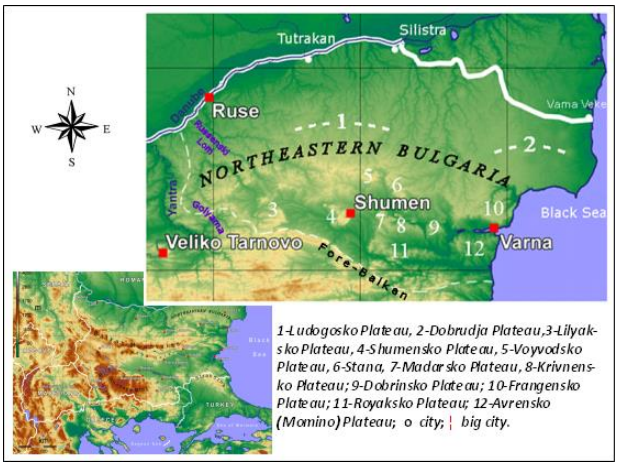

Figure 1. Location of the Northeastern Bulgaria

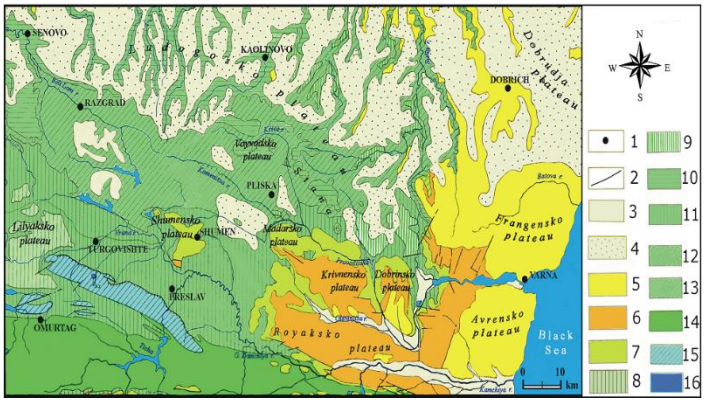

Figure 2. Geologic map of Northeastern Bulgaria

1 – Big sity; 2 – Fault; 3 – Alluvial sediments (pebbles and sands of flood-plain and higher terraces; beach terraces and beachsands; swamp deposits); 4 – Eolian sediments (loess, sandy loess, clayey loess); 5 – Miocene (limestones, glays sands with clay interbeds, kaolin-sand, conglomerates sands and glays); 6 – Paleogene (marls, locally with interbeds of detrital sandstones, glayey sands, sandstones and sands, nummulites limestones); 7 – Upper Cretaceous (limestones, carbonate rocks); 8 – Lower Cretaceous, Aptian-Albian (sandstones and marls); 9 – Barremian-Aptian (Urgonian tupe limestones, conglomerates, sandstones, clays); 10 – Hauterivian-Aptien (limestones, clayey limestone); 11 – Hauterivian-Aptien (marls and clayey, marls with sandstone interbeds); 12 – Clayey limestone formation and in upwards succession of sandstone, siltstone and clayey limestone formation on and para; 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 (alternation of shales and sandstones, with olistolites of Lower Jurassic and Triassic rocks)

Figure 3. View from the Ludogorsko plateau

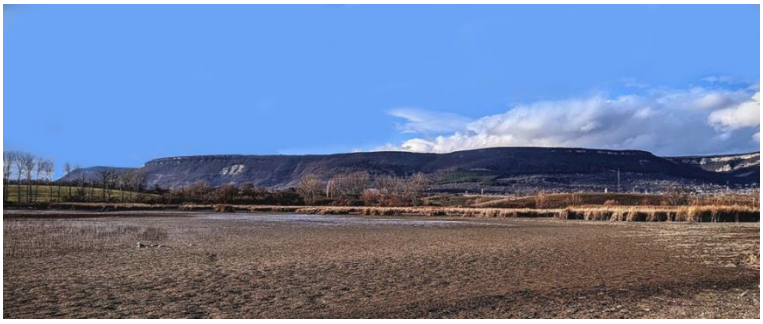

Figure 4. The eastern part of the Shumen plateau

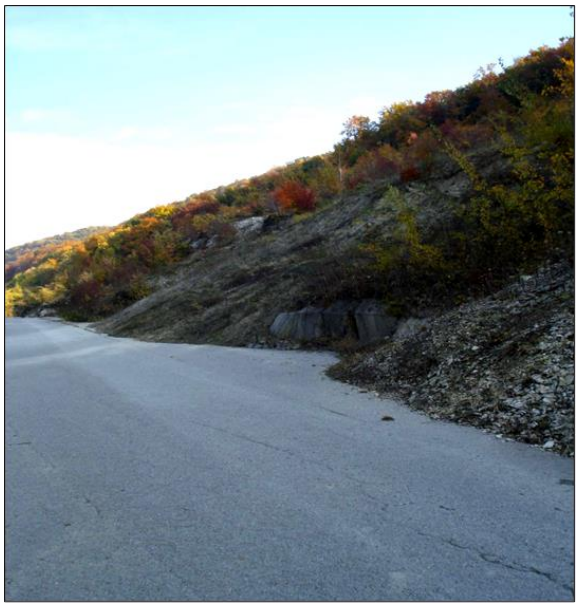

Figure 5. Landslide activity along the western slope of Shumen plateau, above the road from the village of Kochovo to the villages of Novosel and Lozevo

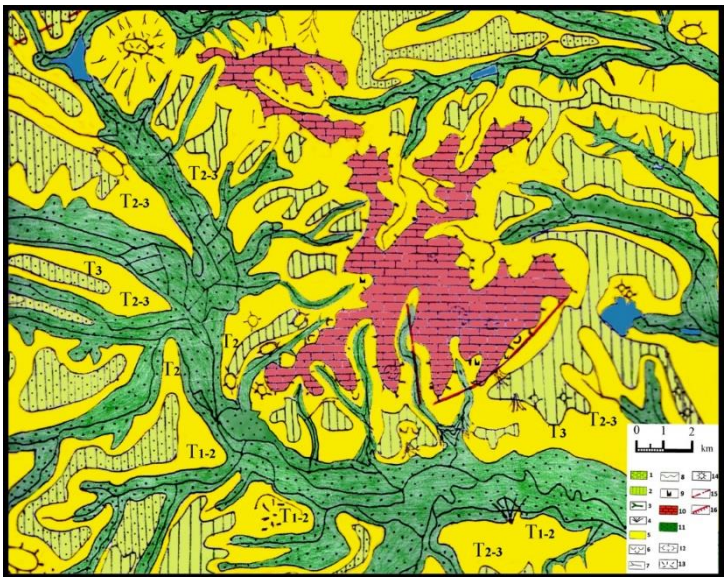

Figure 6. Geomorphological map of the Shumen plateau

1 – low Plio-Pleistocene (villafranca) level; 2 – high Plio-Pleistocene (villafranca) level; 3 – river valleys with alluvial deposits; 4 – cone with overlays; 5 – erosive slopes; 6 – landslides; 7 – ravines; 8 – border line; 9 - self-protruding rocks; 10 – subhorizontal layered surface; 11 – river accumulation surface; 12 – plateau with rocj wreaths and cuts; 13 – karst slope; 14 – a small structural erosive knoll; 15 – fossilized faults; 16 – leap.

Figure 7. The valley of the River Kriva with the northern slope of the Voivodsko Plateau

Figure 8. Landslide in the villafrank limestone rocks above the village of Stanovets

Figure 9. Geomorphological map of the Voivodsko and Stana Plateau

1 – low Plio-Pleistocene (villafranca) level; 2 – high Plio-Pleistocene (villafranca) level; 3 – river valleys with alluvial deposits; 4 – erosion-accumulation surface and river terraces covered with clay loess; 5 – erosive slopes; 6 – landslides; 7 – ravines; 8 – border line; 9 - self-protruding rocks; 10 – subhorizontal layered surface; 11 – river valleys with alluvial deposits; 12 – plateau with rocj wreaths and cuts; 13 – Sarmatian-Pontian surface; 14 – a small structural erosive knoll; 15 – fossilized faults; 16 – faults.

Figure 10. View from Provadia Plateau

Figure 11. Landslip in front of the entrance to the Nimfite cave

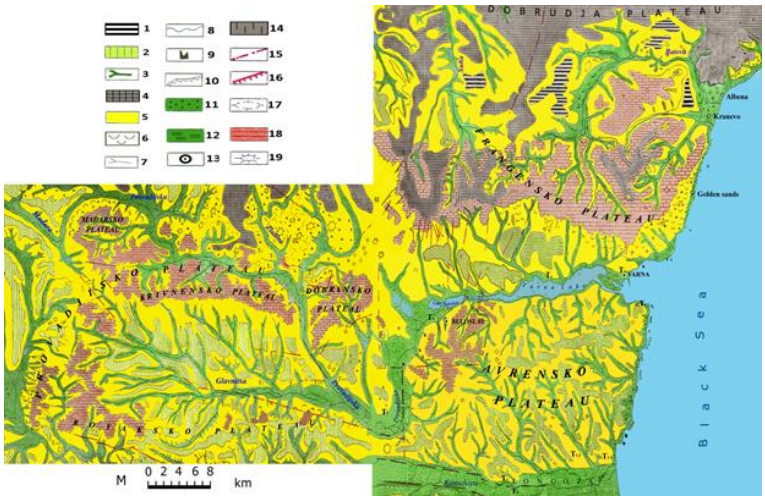

Figure 12. Geomorphological map of the Provadijsko (Madarsko, Krivnensko, Dobrinsko), Royaksko, Dobrudzhansko, Frangensko and Avrensko Plateau

1 – Pliocene level; 2 – Plio-Pleistocene (villafranca) level; 3 – river valleys with alluvial deposits; 4 – erozionno-accumulative and river terraces, covered with loam; 5 – erosive slopes; 6 – landslides; 7 – ravines; 8 – current beah line; 9 – underwater rocks and separate jutting land rocks;10 – cliff shorer; 11 – river, sea and river-sea accumulative surface; 12 – new Black Sea terrace (1.5-2 m and 3-5 m); 13 – settlement; 14 – old abrasion-accumulative level; 15 – fossilized faults; 16 – fault structures with mounts; 17 – plateau with rocj wreaths and cuts; 18 – subhorizontal layered surface; 19 – a small structural erosive knoll.

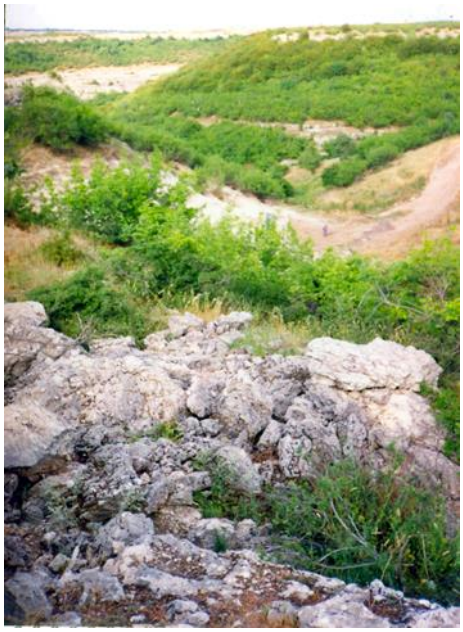

Figure 13. Karst valley on the river Sersem Dere

Figure 14. Panoramic photo of Dobrynsko plateau

Figure 15. Panoramic photo of the northern slope of the Royaksko plateau

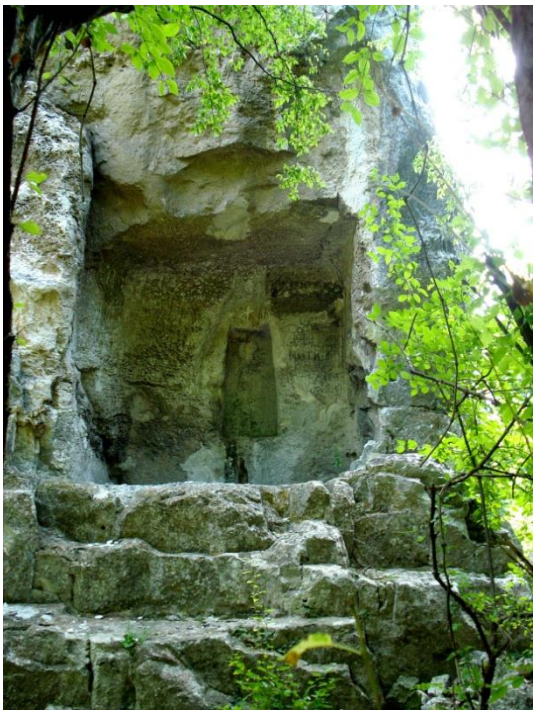

Figure 16. Chapel in the area of the Rock Monasteries

Figure 17. The Madara Horseman

Figure 18. St. Panteleimon Chapel

Figure 19. Disclosure of quartz sands in the Pobitite Kamani

Figure 20. Petrich kale

Figure 21. Map of the hunting grounds in Northeastern Bulgaria

Notes:

Figure 3. Retrieved September 10, 2022, from https://forum24.bg/кои-са-всъщност-истинските-граници-на/