

## GEOMORPHOLOGY AND MORPHOGENESIS OF WATER CATCHMENT BASIN SUHA REKA RIVER

**Abstract:** In this report are examined results of regional geomorphological researches in water catchment basin of Suha reka river. It represents one of the ten dry valleys in North East Bulgaria spread alongside the border with Romania. The dry valleys in North East Bulgaria are distinguished with their monotonous at glance relief. From other side this river valley net which a part is Suha reka river with its genesis, morphogenesis and stages of development represents enigmatic morphological phenomena.

The main aim of this report is to reveal the lithology substrata and tectonic movements during Neogen – Quaternary stage applied for morphological face an spatial behavior of each elements in water catchment basin of Suha reka river.

**Keywords:** dry valleys, Paleo karst , relict erosion relief, Neo karst, apt, alb.

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**G**eographical location, borders and area of the region. Suha reka river before 1942 was known as Ishikli river. It is one of nine first class river –valley systems (dry valleys) in North- East Bulgaria. The valley is developed between Ludogorie plateau and Dobrudga plateau. This river valley marks the geomorphological border between Black Sea coastal area and the interior of South Misian morphostructure zone. The determine series features in the basis and development of the whole water catchment basin.

Westward the border of the region is marked by the flat water shed between water basins of Suha reka river and Hursovskka river and Eastward the border is marked bi water shed hills which divide it from water catchment basins of Toshevaska river and its feeders. The maximal water catchment width of Suha reka river is about 53 km in its south (spring) parts.

The river starts at Western foot of Frangen plateau from spring fountain 1,5 km Southern from Izgrev village, Varna region. In its main part it flows through Dobrudga plateau in deep valley to meridian direction with several canyon shaped parts. In some places its water flows through the whole length of the valley and cross Romanian border and after Oltina lake they flows in to Danube River. In these borders the whole researched region is about 2258 km<sup>2</sup>.

**Lithological determination of the relief.** The relief in North East Bulgaria in the main its part is modeled onto early aged limestone which influence the karst processes.

The oldest rocks which build water catchment basin of Suha reka river and are revealed on the surface are from Down Cretaceous age. In its Northern parts river valleys and gorges are revealed Neogen limestone, sands and clays. Southward in the deep incised dry valleys are revealed Down Cretaceous porcelain and organogenic limestone. Down Cretaceous and Neogen sediments are covered by Plio- Pleistocene deposits (red – brown clays thickness 4-6 m) and loess complex with thickness 25- 28 m Pleistocene age [1].

Quaternary deposits and mainly the loess complex veil the contemporary relief where dominate forms of valley geomorphological complex (mainly dry valleys) and the karst geomorphological complex (contemporary, active karst forms combined with buried and focalized karst forms).

Because the big drainage of loess cover in midstream and downstream of the rivers in researched region have flow formed by rainfalls or melting snow.

Widely spread the loess cover make unclear the transition between denudation surfaces also and the transitions between the slope and valley bottom, between surface and karst declinations.

Widely spread of karst high- carbonated limestone are main precondition for leak of surface water e. g. presence of dry valleys drain forms of Epi – and Mesozoic karst.

**Tectonic and relief.** In tectonic relation the Suha reka valley have to refer to Misian platform and its cover North - East wing of North Bulgarian vault arch. As whole this part of Bulgaria has low tectonic stile and features with mostly horizontal incline of layers with low slope with 6- 4°, seldom with 5-7° Northward North- West ward.

The tectonic structure of the basis in this part of the country has mosaic character which is featured by series of fault breaks different as volume and displacement blocks. According [1] the analysis of geomorphological information shows coincidence between the old (pre Mesozoic) plan with the rude features of contemporary relief.

The meridian placement of the Suha reka valley is predetermined by Venelin – Pruts fault zone. This sub- meridian fault zone is formed on land in its East ward part, Black sea coastal part of Balkan peninsula. In different grade of authenticity it follows form Prut river valley in Romania Northward to early folded Alps structures in East Stara planina mountains Southward. Central place in this fault sheaf takes Venelin – Pruts fault which is marked by tectonic breaks wide 2 – 5 km. Main part of this fault cuts the structures of Misian platform. On the surface this fault zone is presented as sheaf of sub meridian faults wide 3 – 5 km in its Southern periphery increased to 15 – 20 km Northward.

**Geomorphologic characteristics of the relief.** *Denudation surfaces* are one of the oldest forms of the relief genesis. They give opportunity interprets geomorphologic development of Suha reka river valley. They fix given geo- historical stage in relief evolution. Their location, genesis and age mark the main stages of interconnection between endogenic and exogenic processes in development of relief. The origin of denudation surfaces is narrow connected to Neo- tectonic activities of several geological structures during Neogen – Quaternary.

In result of terrain researches in within water catchment basin of Suha reka river are determined two denudation surfaces (Fig. 1). According present conceptions [2], [3] etc. these level up surfaces are with Sarmatian – Pont and Pliocene (Levant) ages.

According [4] and [5] these two surfaces are remnant of a denudation surface (Orthoplain) – Post Early Pleistocene surface which is the last one in our land. The origin, its nature and the age of these denudation level up surfaces is connected with the processes of Listric tectonic in forming the positive morphostructures.

In researched area the starting denudation surface is covered by loess and loess clays. The surface is highly karsted in places the paleo- karst micro and meso forms are filled with quartz – kaolin sands.

The oldest and the highest levels are preserved in Stana and Frangen plateaus where enclose the spring parts of Suha reka river. Northward it follows till line Breastak, General Kiselovo, Vedrina and Draganovo villages (Fig. 1). It is developed in hypsometric interval 400- 350 m altitude and it is clear displaced Southward and reach 300 m altitude Northward. The big slope incline (14 – 16°) an V shape cross profile in this part of the valley represents active contemporary ascending movements.

The second denudation surface in researched area is developed in hypsometric interval 250 – 200 m altitude. The trend here is lowering Northward in 150 – 100 m altitude.

This level is clearly represented in line Bdintzi, Vladimirovo, Orlova mogila, Odrintzi and Paskalevo villages till Danube river valley Northward.

Both denudation surfaces were under active river erosion and the result is they are incised. They are in tongue shaped alongside feeder valleys of Suha reka river (Fig. 1).

**Fluvial relief.** Erosion forms developed in water catchment basin of Suha reka river are the main dominating morphostructure element. The contemporary river valleys and gorges and their forms are result as from the erosion of flow water as and from the intensity of the young tectonic movements in combination with more humid climate conditions during Pliocene and Quaternary.

The features in morphology, structure and development of river valleys are genetic related with Neogen- Quaternary evolution in researched area. River valley net has formed as result of the main erosion basis fluctuations – Danube river and Black Sea from one side and North Bulgarian ascent during Neogen- Quaternary from other side.

The overall in development of river valley net in the are the river valleys are weak incised in their upstream with scour shaped cross profile. They are incised in the hypsometric range 150 – 200 m where have canyon shaped form. One of the reasons for forming canyon cross profile is in the lithologic basis represented by strong Apt limestone in Ruse suite.

The particularity of cross section profile of Suha reka river bed is the slight incline and it meander in its alluvial deposits filled the wide (200 – 300 m) valley bed. Clearly are represented Suha reka river meanders in Zvanetz, Karapelit, Dryanovetz, Balik, Ognyanovo, Godesh and Karanovo villages.

The cross section of the valley changes from scour shaped Southward to canyon shaped in the middle parts where the meanders are incised (Fig. 1).

In water catchment basin of Suha reka river have several diffractions in directions to its feeders which are due to tectonic fractures in fundament have reflections not only on the young sediments but and on contemporary relief. The maximal depth of erosion incise of Suha reka river is 150 m between Balik and Onugur villages.

The orientation of the midstream net to the main directions to the main directions North – South West- East and North–West – South-East is due tectonic predestination- the presence of cracks systems some of them probably connected with shallow faults.

Morphographic features of valleys and gorges in researched area are formed by structure – lithological conditions where they were developed. The slopes are mostly slight incline the transition to plain gorge ridges and to valley bed is slight and inconspicuous. In its main part the cross section profile of valleys is wide, scour shaped on places chest shaped with valley bed width 70 – 90 m. This is in main grade due from loess – clay cover which veils the bumps of the Pre Quaternary relief.

In some parts the shape of Suha reka river is determined of distribution of Down Cretaceous limestone. The slopes are steep on places vertical which gives a canyon shape of the valleys. There are formed rocky wreaths (Fig. 1).

In upstream springs of Suha reka river and its biggest feeders- Karamandere and Botevska the cross profile of the valleys is V- shaped and asymmetric on some places. The erosion incise is fairly deep – about 50 – 60 m and on some places 100 – 120 m (Vodnyanci, Pchelnik, Hitovo, Fnogur villages).

It is due the active incising of the rivers after intensive ascent of North Bulgarian arc elevation. The slopes are inclined on 14 – 16° covered with grass and bushes and on some places with farmlands.

Due the fact Suha reka river midstream is close to the West watershed there is asymmetry in water catchment basin. It has preponderance of the right feeders over the left ones where on some places they are reduced. The left feeders are shorter and deeper and the right ones longer and with less incline.

In result of terrain researches in Suha reka river water catchment basin were discovered the next features in valley morphology. The main valley is distinguished with line reptilian sectors on some distances till 4 km Northern from Botevo village. After Novo Botevo village and between Karapelit and Dryanovetz villages as their element are represented many incised meanders. There the valley is modeled by hard oolite, semi – porcelain and porcelain limestone in Apt age. Due them is the deep incised on places canyon character of the valley.

The valley slopes in the meander range have different incline. In its concave part are slight and in terraces and its convex part – steep mostly vertical where are formed rocky wreaths and many karst cave holes (Fig. 1).

In the main part of the researched area miss surface outflow. Only in rainfalls Suha reka river forms episodic surface outflow with big capacity which not reach Danube river due the well developed karst. Deep karsted limestone drain atmospheric rainfalls. The module of the outflow in the dry valleys region is the smallest in country – 0,5 l/s/km<sup>2</sup>. There are weak water capacity and the average annual outflow is under 15 mm. It has episodic character and it forms only after strong rainfalls.

Fluvial relief in Suhareks river valley has formed in different times for different parts of its stream. Upstream and midstream of the river where has constant flow it is comparatively young and its development is dictated by the contemporary erosion processes and for their appearance role have the contemporary rising in the range of North Bulgarian arc ascent which temp is 0,5 – 1 mm per year [6]. In the rest part of the valley where is developed dry valleys the fluvial relief has relict character. It is veiled by Pre deposited loess and also veiled by contemporary morphogenesis processes.

**Karst relief.** Morphographic conditions in researched area favor the development of karst. The plain relief, the wide slight valley slopes (the slight incline of limestone rocks) facilitate the infiltration of surface outflow. From other side the weak vertical dismemberment and the small annual quantity rainfalls (500 – 600 mm) obstacle the development of the deep karst. Only in the high parts (Stana, Frangen and Dobrudga plateaus) the karst penetrates in a big depth.

The rising movements spread over North Bulgarian arc ascent catalyze the development of the karst process in big depth and karst water penetrate to 200 m. In this part of the valley the karst process are not appear on the surface as the karsted rocks are covered by clay loess and loess clays. From other side the weak development of karst processes in South part of the area is due the rocks from Razgrad suite which are featured with low content of CaCO<sub>3</sub>- marl, limestone marl and clay limestone. They cover strong karsted malm-valanjian limestone and dolomites of Kaspichan suite and their role is „armor“ layer and protect from development of karst processes in depth.

Downstream Suhe reka river with the change of lithologic substrata represented in more pure limestone in Ruse suite increase the karst forms on the surface. The thick sediment cover buried on some places the limestone from Ruse suite doesn't allow the development of karst processes on the surface.

The karsted limestone is one of the main reasons for absence of constant outflow in dry valleys in North East Bulgaria.

The presence of karst in researched area determine the features of the relief and the specifics of acting morpho- sculpture processes. In Suha reka river water catchment basin are developed two age generation layers karst- Paleo karst (old) and Neo Karst (young, plio- Pleistocene).

The old (buried) karst is difficulty for observation as it is buried under clay – sands and loess- clays deposits with big thickness lays depp and can be prove with well. According [7] it is dead fossil karst, developed during Down Cretaceous (Apt- Alb). The data for Paleo Geographical evolution in North East Bulgaria proves the processes of karstification have begun after the early Apt and continuous till now [1].

Despite the buried strata isn't revealed on the surface it influence on geomorphological and hydrological processes. There are discovered the biggest reserves of underwater which are use for water supply in settlements in region.

The young karst has developed during Neogen and Quaternary and its evolution is represented now days in contemporary morphological situation and hydro- climate conditions. It develops in contemporary stage of relief forming and it is represented in contemporary valleys or it is slightly veiled on the ridges between the gorges by thin loess- clay materials. Despite the fossilization done by the loess strata, the main shape s of whirlpools and uvals are „reflected“ in the contemporary relief.

From the karst forms belonged to the young karst (surface and underground) in the researched are presented well the forms of the underground (mesokarst) – caves and niches.

They are connected to the valley slopes mainly in deep incised valleys of Dobrichka river before it flows in Suha reka river to Balik (Fig. 1).

From underground karst forms developed in valley slopes of Suha reka river are the caves. They are developed as separate also into the bottom of hollows, uvals and blind dry karst valleys. There are widely spread the whirlpools Northern Paskalevo and Rosenovo villages, around Lomnica and Ovcharovo villages, in the territory of Cherna village, between Krushari, Severci and Telerig villages, between Dobrin and Poruchik Kardjievo villages (Fig. 1).

**Uvals.** They are represented mainly in territory between Paskalevo and Svoboda villages around Krushai village.

**Main stages in development of the valley.** On the base of analysis of the past geological and geo – physics researches as and from terrain researches in the region we can conclude main role in forming of contemporary relief of Suha reka river have played karst and erosion – denudation processes acted favor lithologic substrata – ductile to karstification thick porcelain limestone as and ductile to erosion clay limestone and marl in sub role of Neo tectonic – raising of North Bulgarian arc ascent and several times lowering of the erosion basis – Danube river and Black Sea.

In Bulgarian geomorphological studies is state the perception the main stage in forming river valleys in our country is Quaternary. According some authors [1], [3], [8], [9], [10] the overlay and the development of river- valley net in North East Bulgaria goes out the borders of Quaternary i.e. it has relict character.

In confirmation of this it can be point some of the features of rivers (dry valleys) in North East Bulgaria partially this of Suha reka river couldn't explain only with the vitality of the water but only with the factor – time. For instance Suha reka river valley is deep incised in resistant to erosion porcelain and porcelain shape thick limestone and the maximal cutting in is 150; in midstream and downstream the valley has canyon character ; the average incline is small- 1,7 % and the cross profile is close the ideal curve; in some places midstream and downstream miss constant river outflow. From other side the presence of incised meanders proves statement for its epigenetic origin of whole river – valley net including Suha reka river.

**Conclusion:** The researched studies, analysis of geology- geomorphology data as and the terrain researches give us reason to conclude several main statements about the evolution of Suha reka river valley and particularities in its morphology:

1. Till the present moment is valid the statement of [1] the beginning of evolution in researched area have to relate to the beginning of Apt century. In the conditions of warm and humid climate typical for the tropics have formed huge surface Paleokarst forms. After they have fossilized by deposits with sub aqua (marine) origin of Alb basin.

2. The growth of Suha reka river could be related to the end of Down Cretaceous when onto the wide Alb sediment surface was born river net prototypes of the contemporary ones.

3. Quaternary geomorphological evolution is connected with forming of two denudation plain levels preserved mainly on 300 –400 m and 200 – 250 m, Northern to 100 – 500 m.

4. At the end of Pleistocene begins intensive loess blowing and fossilization of water sheds. Widely spread of loess cover makes unclear and slight the transition between denudation surfaces, as and transitions between the slope and the bed.

5. The wide spread of high carbonated limestone are the main precondition of miss surface flow water, i.e. for presence of dry valleys drain the forms of epi karst and meso karst.

6. The features in morphology of Suha reks river valley are due the lithologic substrata.

7. Morphological face and spatial behavior of the every elements in Suha reka river valley are summarized by of karst and erosion processes from one side and the influence of tectonic movements during Neogene – Quaternary from other side (the lowered erosion balance of Black sea kettle and the rising movements in the area of North Bulgarian arc ascent.)

8. The executed morphostructure researches in the Eastern part of South Misian platform area show the fault zone marked by sub- meridian basin of Suha reka river marks the border between the coastal and continental part of the zone.

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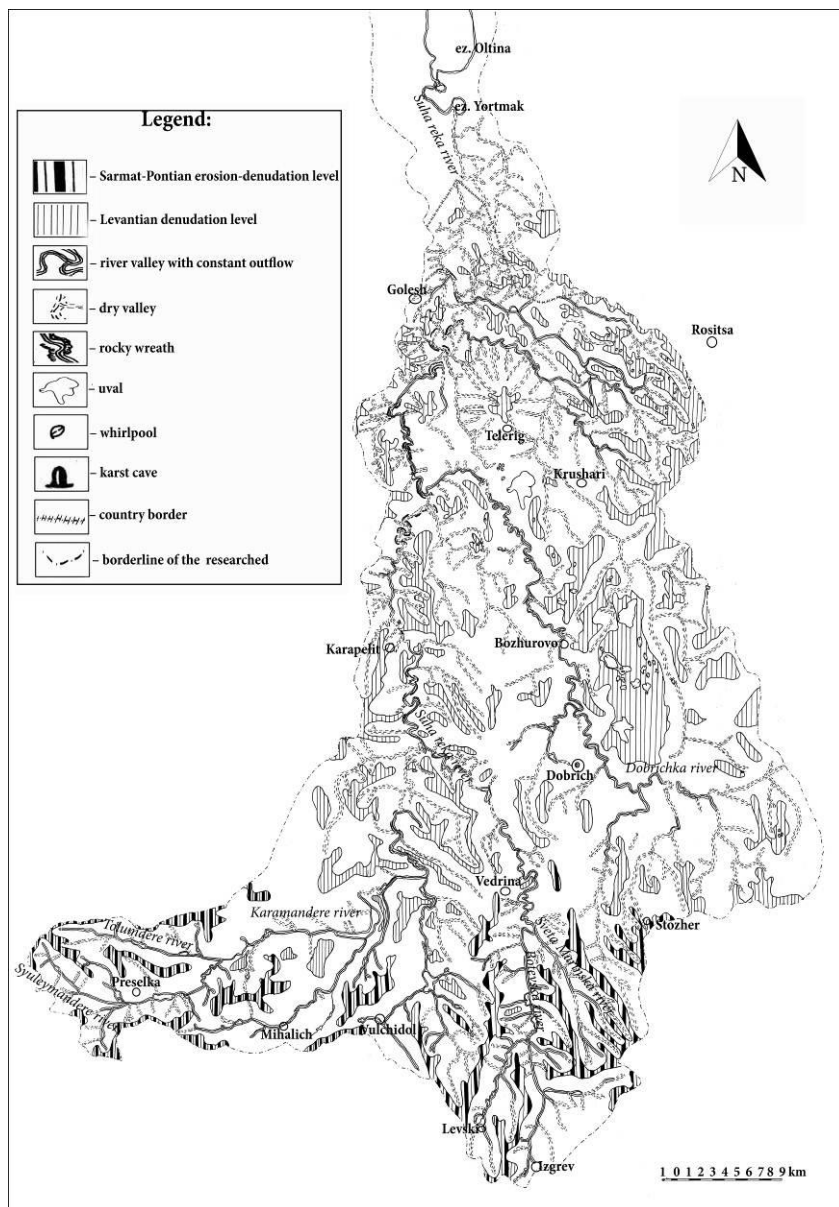


Fig. 1 Geomorphologic map of water catchment basin Suha reka river