

FLUVIO-DENUDATIONAL STRUCTURES IN THE VALLEY OF THE TOPLICA IN THE AREA OF THE SETTLEMENT OF PLOČNIK

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Abstract: The studied area comprises the settlement of Pločnik situated in the western part of Southern Serbia on the easternmost slopes of Kopaonik. It is situated on the left valley side of the Toplica river, in the scope of Topličko-Kosanička basin of the midmost Toplica, from the village of Vlajnje to Gubetin. Only few geomorphologists dealt with these issues. This study represents continuation of the studies of Jovan Cvijić and Sima Milojević. On the basis of their studies, as well as on the high diversity of the studied ground, we explored geotectonic structure and morphologic characteristics of the relief with special attention to fluvial and denudational structures. The methodology applied principally implied analysis and synthesis of the results. On the basis of that we carried out field study which implied comparing fluvio-denudational structures singled out by S. Milojević, with the facts on the field. It enabled quality geomorphologic mapping. Modeling method, through GIS (Geographic Information System) usage joined the methods of remote detection, geomorphologic mapping and visualization. Topographic and geologic map were then geo-referenced in QGIS (quantum GIS), the area of the settlement of Pločnik was defined, digitalization of content was done, while geologic foundation was divided according to the age and type. Detailed analysis of the studied area enabled the review of abrasive elements to be updated. We defined the existence of the inter-abrasive level (567-598 m) between the first two abrasive floors (520-560 m and 610-640 m) according to S. Milojević. As for the valley morphology, that is, fluvial erosion, two more fluvial terraces were spatially defined (I - Šanac at about 440 m and II - Barutana 400 m and Bandera at about 380 m sea level).

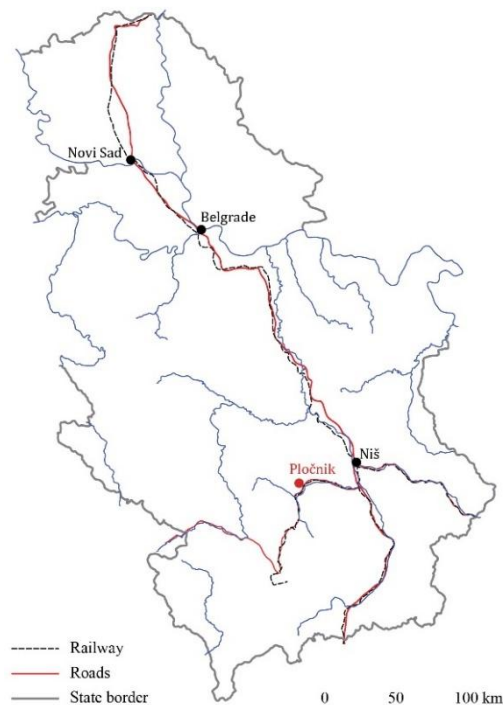
Key words: Fluvial terraces, denudation, the valley of the Toplica, the settlement of Pločnik

1. Introduction

The studied area comprises the settlement of Pločnik which is situated in Southern Serbia according to macro-geographical position. On the basis of regional geographical distribution, it belongs to the micro region of Toplica, which is situated in the western part of the mesoregion of Southern Serbia, comprising the basin of the river of the same name (Marković, J. 1995). It is situated on the territory of municipality of Prokuplje and it belongs to Toplički district.

In physical-geographic sense Pločnik is situated on the easternmost slopes of Kopaonik on the left valley side of the Toplica. Average sea level of the settlement is 420 m. It also includes the following tops: Bojovo hill (567 m), Ovsišće (564 m), Paramida (561 m), Prisoje (533 m), Vesova čukara (469 m), Ravan (412 m) and Bandera (384 m), as well as the area up to the river of Toplica on sea level of about 300 m.

Pločnik has a very favorable traffic position, because main road M-25, Niš – Prokuplje – Kosovska Mitrovica runs through the very settlement, as well as the railway route Prokuplje – Kuršumlija - Priština.



Picture 1 – Geographic and traffic position of Pločnik in the Republic of Serbia

On the basis of the previous studies and the high diversity of the studied area, a part of Toplica valley in the area of the settlement of Pločnik, we explored geotectonic structure and morphologic characteristics of the relief, with special attention to fluvial and denudational structures. Very few geo-morphologists explored the valley of the Toplica. One of them was Jovan Cvijić, but he only superficially dealt with the area. Somewhat higher contribution came from Sima Milojević who analyzed main morphological characteristics of the relief in the valley of the Toplica. This study represents continuation of their analysis in the part of the Toplica valley to which the settlement of Pločnik belongs, firstly in the sense of a more detailed analysis of fluvio-denudational structures.

2. Material and method

To adequately examine fluvio-denudational structures in the studied area we applied many scientific methods. Analytical method primarily implied studying of both our and foreign literature which deals with these issues, in the sense of finding and systematization. The second phase of the application of this method implied critical review on the hitherto studies in this field. The final phase of the analytic work implied the application of synthetic method. By a synthesis of all relevant factors and agents fluvio-denudational processes in the settlement of Pločnik were completely defined and the connection among certain isolated parameters which influence this process was found. By a comparative method the obtained results were compared to the results from hitherto studies in this area.

In the analytical part of the work, by cartographic methods, we obtained numerical, that is, morpho-metric data which are relevant to the studied phenomenon. A topographic map was used, 1:25000, sheet Kuršumlja 4-1. In the synthesis part of the work, by the procedures of thematic cartography, as specialized maps, geomorphologic and geologic, we provided insight to the spatial distribution of the studied parameters.

A very important method in studying fluvio-denudational structures is field study. Field study implied defining facts in the field on several occasions, where this method was frequently combined with the method of geomorphologic mapping. Detailed geomorphologic mapping contributed to collecting qualitative new data from the studied field. This field study is superimposed with teledetection methods on the basis of satellite records.

Topographic map which shows the area of the settlement of Pločnik is from 1972, so that the differences related to factual condition in field are defined. Apart from field study, we also used program Google Earth.

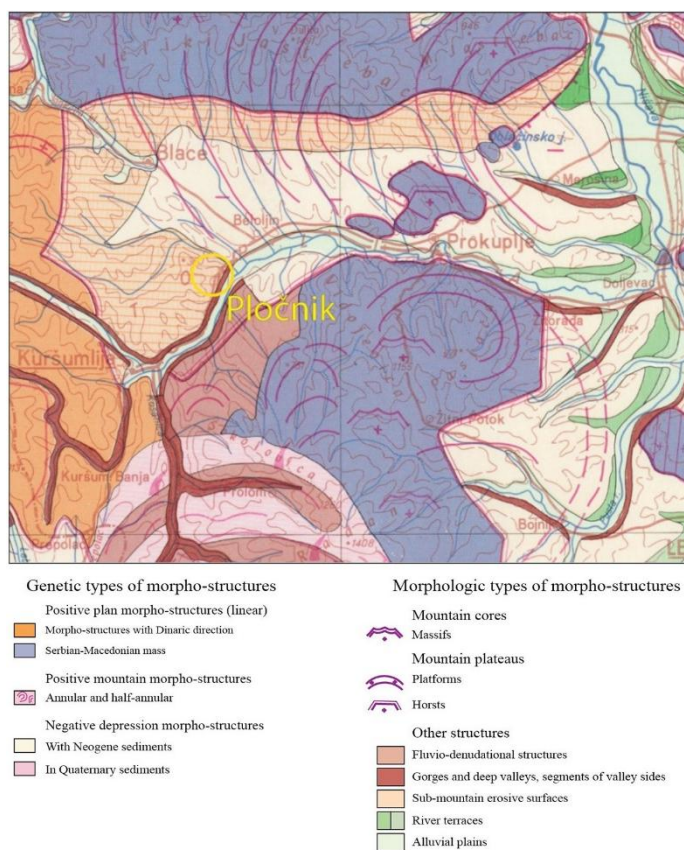
Finally, modeling method joined methods of remote detection, geomorphologic mapping and visualization through GIS usage. Topographic and geologic map were geo-referenced in QGIS, the area of the settlement of Pločnik was defined, and content digitalization was done, while geologic foundation was divided according to the age and the type.

3. Results and discussion

The relief of Toplica belongs to the oldest part of the mainland of the Balkan Peninsula – Serbian-Macedonian mass and Dinaric zone of folded mountains. It was formed during Alpine orogenesis. In the middle of Oligo-Miocene there was a segmenting of old Rodopi mountain mass, and the consequence of these processes was the formation of block mountains and basins which are separated by faults. Topličko-kosanička basin with its rims was also formed in this geologic period. It is situated among Mali Jastrebac and Veliki Jastrebac in the north, Kopaonik and Požar in the west, Prolomske mountains, Sokolovica, Arbanaške mountains, Vidojevica and Pasjača in the southwest and south (Rudić, B. V. 1978). During Neogene a bay of Panonian lake permeated Topličko-kosanička basin and filled it with water the level of which reached 760 m sea level. After the recession of the lake in the bottom of the central lake plain, the Toplica incised in time and constantly changed shape, forming shallow and broad valley with the network of its tributaries (Cvijić, J. 1911). The basin stretches in the direction east-west, with longer axis of about 30 km, while the shorter is 10 km. The relief is mildly hilly and gradually declines from the north to the south (Group of authors, 1977).

Geologic foundation of Toplica consists of metamorphic schists (especially gneiss and micashist) through which eruptive masses of granite and gabbro sporadically break through (Milojević, S. 1929). Above the metamorphic basis sedimentary rocks were deposited. On the western rim of Toplica basin, Kopaonik and Sokolovica cretaceous sediments are present: quartzite and clay sandstone, as well as marls and basal conglomerates (Rakičević, T. 1969). Younger lake sediments are present in middle and lower course of the Toplica. They are made of sand, clay and marls.

Toplica valley is composite; it consists of many broadenings and gorges. It is composed of four morphological units: 1. Gorge valley of the upper Toplica from the spring to the village of Vlajnje; 2. Topličko-kosanička basin (the basin of middle Toplica) from Vlajnje to Gubetin; 3. A short breakthrough between Gubetin and Prokuplje; 4. The valley of the lower Toplica incised in the lake floor of Dobrič (Milojević, S. 1929). According to this morphological division of the valley of the Toplica introduced by S. Milojević, Pločnik is situated in the scope of Topličko-kosanička basin of the middle Toplica, from the village of Vlajnje to Gubetin.



Picture 2 – Geo-morphologic map of the territory of Pločnik and Toplica basin according to geomorphologic (morpho-structural) map 1:500 000 (Zeremski, M. 1990)

Mountain area of Pločnik is represented by the tops of Bojovo brdo (567 m), Ovshte (564 m), Paramida (561 m) and Vesova čukara (469 m) which represent the slopes of mountains under Kopaonik. Lower parts are hilly with smoother elevation than it is on the right valley side in the village

of Točane. The field is decomposed by weak and intermittent courses among which elongated inclined planes stretched. It is represented by spacious and flattened fluvial terraces.

On the basis of geomorphologic (morpho-structural) map 1:500 000 (Zeremski, M. 1990) (Picture 2) bigger part of the settlement of Pločnik is represented by sub-mountain erosive surfaces, while gorges and deep valleys, that is, segments of valley sides are southernmost of the settlement, on Barlovski Vis. From the very spring of the Toplica to Pločnik the valley is gorge-like, while it downstream broadens into a shallow and spacious valley. In the low belt northernmost of the settlement, towards the village of Bace, negative depression morpho-structural configurations are present. They are represented by poorly preserved sediments or without Neogene sediments. Alluvial planes stretch immediately along the whole course of the Toplica in Pločnik.



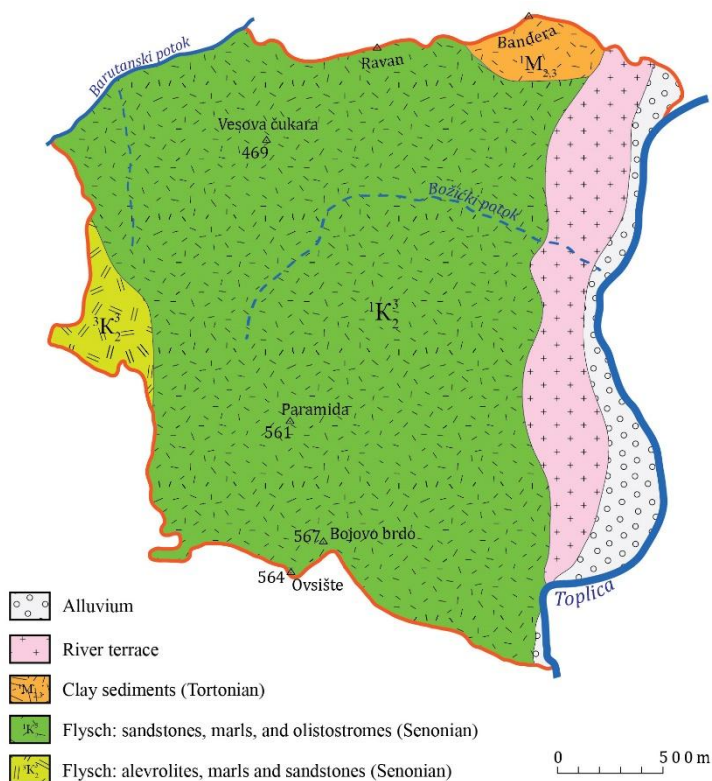
Picture 3 – Late Cretaceous flysch on Barlovski Vis

According to the latest geological research and according to BGM (Basic Geological Map) of Serbia (K 34-19, sheet Kuršumljija, 1:100 000, 1980) on the territory of Pločnik there are (Picture 4):

- Flysch: alevrolites, marls and sandstone (Cretaceous / Senonian)
- Flysch: sandstones, marls and olistostromes (Cretaceous / Senonian)
- Clay sediments (Miocene/ Tortonian)
- River terrace
- Alluvium

Flysch rocks are represented in the most part of the territory of Pločnik, comprising higher parts of the terrain and all the tops, except Bandera. Clay sediments are situated in a small northern part of Pločnik, that

is, southern slopes of the mountain top Bandera. River terrace is situated between flysch rocks and alluvium which is present in the narrow zone near the river of Toplica.

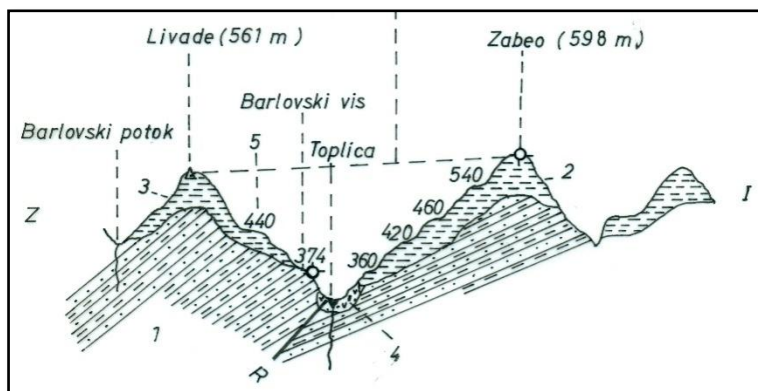


Picture 4 – Geologic map of the settlement of Pločnik according to BGM of Serbia 1:100,000, Military-geographic Institute (1980)

Serbian–Macedonian mass represents a separate tectonic unit which comprises the area of Central and Southern Serbia. There are different opinions on tectonic structure of Serbian–Macedonian mass, its position and borders. Anđelković M. singled out Šumadija zone as a distinct tectonic unit of the first rank within Serbian-Macedonian mass (Anđelković, M. 1963, 1967, 1970). It is situated between Morava zone in the east and the zone of Western Serbia in the west, while it is bounded by the sank part of the Panonian massif in the north-west. This very labile area is characterized by structural directions NNW – SSE. There are numerous radial configurations of meridional direction which are intersected by transversal and diagonal

faults. Plicative tectonic configurations represented by folds of different shape and size appear often, too (Group of authors, 1976).

Senonian flysch on the territory of Pločnik belongs to Serbian–Macedonian mass, that is, Šumadija zone. It is stratified and it extends in the direction NNW-SSE, while its layers fall to WSW at different angles. Flysch rocks in the very river-bed of the Toplica on the left valley side are at the angle of 30-40°, while at Barlovo height they are at somewhat bigger angle of 40-50°. Field research showed that there are no flysch rocks on the right valley side of the Toplica, that is, in Točane, which leads to the conclusion that the right bank declined, while the left in Pločnik emerged. This leads to another conclusion, which is that the course of the Toplica follows faults, which is shown in the profile (Picture 5). The fault has a reverse plain; some mineral waters and springs which are profuse in this area point to the fault.



Picture 5 – Morpho-tectonic profile of Toplica valley at Pločnik (Legend: 1 Senonian flysch, 2. Lake sediments of Miocene, 3. Mio-Pliocene, 4. Alluvium, 5. 374 and 440 m fluvial terraces, R fault)

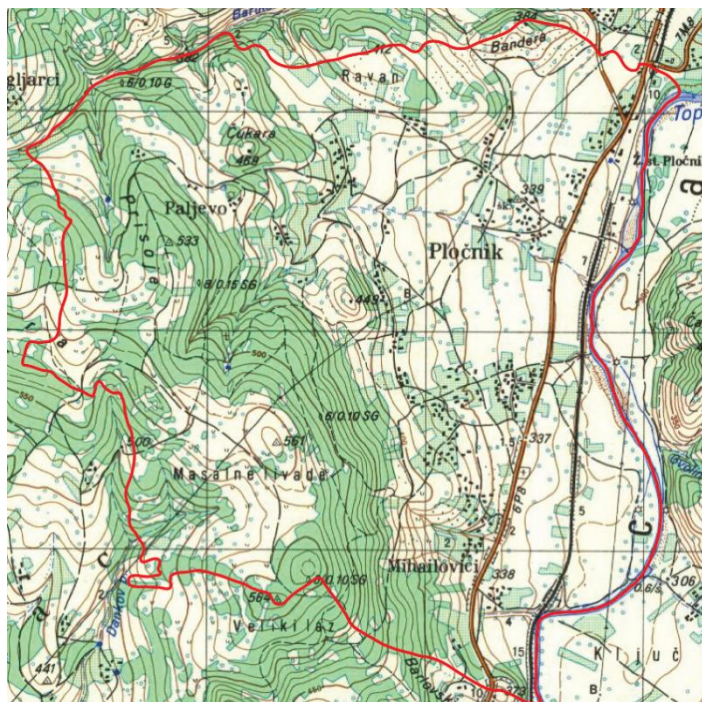
According to Cvijić, Toplica valley was a lake in Pliocene, which is confirmed by the sediments on the bottom of the valley (Cvijić, J. 1911). Toplica valley was studied in somewhat more detail by Milojević S., by singling out four abrasive levels: 520-560, 610-640, about 740 and 800-850 m. Only the lowest floor 520-560 m was studied in detail. Inclination of the floor is morphologically interesting, because it is not regularly inclined towards central plain and the valley of the Toplica, but vice versa, it is inverse. Higher lake floors in this area are not disrupted, but normally inclined (Milojević, S. 1929). Central lake plain resulted from the activities of denudational and fluvial processes. Denudation originates from Latin word

denudatio, which means stripping, derivation and divestment (Martinović, Ž. 2004). It is manifested in several ways, but mechanical action of affluence of surface waters which cause rock destruction is often dominant.

The remains of the bottom of the central lake plain on the territory of Pločnik, which is at the same time the last abrasive terrace (the oldest terrace) are the highest mountain tops: Bojovo hill (567 m), Ovsišće (564 m) and Paramida (561 m). These mountain tops are flattened broad surfaces with a section and a terrace which is unformed and extends in the direction SE-NW. Clay sediments, which are processed, are present there. All the other terraces are the result of fluvial erosion and they are situated on lower on the sea level. It can be concluded that there is another abrasive floor in this area which is situated between the first two floors which are specified by Milojević. Namely, the highest tops in Pločnik, Bojovo hill (567 m), Ovsišće (564m) and Paramida (561m) are somewhat higher than the above mentioned first floor according to S. Milojević, as well as the top Zabeo (598 m) on the right valley side of the Toplica in the village of Točane, so it can be concluded that the remains of central lake plain in this part represent mid-level (567-598 m), between the first two abrasive floors (520-560 m and 610-640 m).

Fluvial erosion has two basic components: vertical – manifested by incising river courses into topographic surface and lateral – inclined to broadening of the river-bed and river valley. Which of these two components will be dominant depends on the existing decline in the river-bed. Two basic structures of fluvial relief are erosive and accumulative structures (Petrović, D. 2003). By the incision of the river course into topographic surface the river forms erosive and accumulative fluvial structures.

On the territory of Pločnik valley morphology, that is, fluvial erosion is known, but not sufficiently studied in detail. Milojević S. distinguishes five fluvial terraces in this area: I - (1-3 m), II - (8-12 m), III- (23-31 m), IV- (65-70 m), V- (94-102 m). The lowest terrace 1-3 m is incised into river drift, sporadically into hard rock, too. It is present continuously either on one or the other valley side. Terrace 8-12 m is sporadically incised on the left valley side into eluvial clay. The remaining terraces are rocky, of narrower angular point and often appear together, two or more. The highest terrace 94-102 m was observed only between settlements Barlovo and Pločnik (Milojević, S. 1929).



Picture 6 – Topographic map with the border of the settlement of Pločnik, sheet Kuršumljia 4-1, ratio 1:25000, Military-geographic Institute, 1972, Belgrade.

By detailed field study the existence of these terraces according to S. Milojević was confirmed. The terraces extend to the following areas on the territory of Pločnik:

- The flat one represents the highest fluvial terrace (94-102 m of absolute height, that is, 397-405 m sea level). It has two flattened levels overgrown with pastures and bushes, the lower of which is in decline because of denudation. Fluvial terrace Ravan at about 410 m sea level belongs to this fluvial level. It is situated in the northernmost border of the village area.
- Lower fluvial terrace 365-370 m sea level extends to the area south from the top Ravan (412 m sea level), as well as Barlovski Vis southernmost of the village area.
- Fluvial terrace at 320-335 m sea level is of elongated shape. Main road is traced in one part of it.
- The terrace at 308-312 m sea level is situated in the continuation of the lowest fluvial terrace where the railway is traced.
- Lug is the lowest fluvial terrace at 304-306 m sea level of broad angular point with mild decline. It extends from the Toplica to the railway station.



Picture 7 – Fluvial terraces in the settlement of Pločnik

Apart from these five fluvial terraces in the area of Pločnik settlement, detailed field study showed that there are two more which are not in the terrace system according to S. Milojević:

- Šanac at about 440 m sea level, situated above fluvial terrace (365-370 m) according to Milojević. Its angular point is narrow and it is situated in the central part of the village area. It represents the highest fluvial terrace in Pločnik.
- Barutana at 400 m sea level, which is very spacious and of broad angular point, as well as Bandera at about 380 m sea level, of somewhat narrower angular point. They are situated in the northern rim of the village area. This fluvial terrace represents mid-level between the highest terrace (397-405 m) and lower fluvial terrace (365-370 m) according to S. Milojević.



Picture 8 - Fluvial terraces in the settlement of Pločnik

The river of Toplica on the territory of Pločnik incised into flysch rocks, forming several constrictions and broadenings by the processes of fluvial erosion. There are rapids on shorter sectors, and sporadically there are cavities in the river-bed – “giant pots”. Gullies are noticed in several places.

Sedimentation of alluvial drift resulted in small river islands which are flooded during high water-levels.

The valley of the Toplica in the area of Pločnik and Točane is asymmetric; the left valley side where Pločnik is situated is lower, with milder decline and many forest complexes, which prevents rinsing and higher erosion. On the right valley side in Točane erosion is more prominent because of the steeper slope and denuded sites. The flysch present in Pločnik is subject to denudation and decomposition, which causes accumulation of debris material.

4. Conclusion

Detailed study of the examined field, a part of the Toplica valley in the area of the settlement of Pločnik, which is little known in geomorphologic literature, an attempt has been made to obtain a better notion of the basic relief characteristics, with special attention to fluvial and denudational structures. From what has been done, the following conclusions can be made:

Geological structure is simple, without any significant details (flysch rocks, clay sediments and alluvium).

Tectonic configuration of the studied field is not very well-known. This study attempts to define certain elements: decline and direction of rock layers were determined, as well as their structure and the existence of the fault, which has a reverse plain and to which the course of the Toplica in this sector sticks.

Morphology of the studied area is known, but not in detail. This study complements the review on abrasive elements. A mid-level of the central lake plain (567-598 m), was determined, between the first two abrasive floors (520-560 m and 610-640 m) according to S. Milojević.

As for the valley morphology, that is, fluvial erosion, some complements relating to fluvial terraces were also spatially determined. In the terrace system according to S. Milojević five terraces were singled out. This study defined them. Apart from that, the existence of two more fluvial terraces was confirmed: Šanac at about 440 m sea level, which represents , the highest fluvial terrace in Pločnik; and Barutana 400 m, as well as Bandera at about 380 m sea level, which represent mid-level between the highest terrace (397-405 m) and lower fluvial terrace (365-370 m) according to S. Milojević.

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