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# GEOLOGICAL-TECTONICAL STRUCTURE AND HIDROGEOLOGICAL CHARACTERISTICS OF THE STUPČANICA RIVER CATCHMENT AREA

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*ABSTRACT*
***Geological-tectonical structure and hidrogeological characteristics of the Stupčanica river catchment area***

*The Stupčanica River catchment area belongs to the Bosnia River Basin. It is situated in the central part of the Bosnian Mountains. The catchment area covers 283 km$^2$ .The Stupčanica River originates when two waterflows Bijesnica and Pištica meet each other upstream from the Pjenovac settlement. In its further flow, from the right side this river receives several larger and smaller streams, of which excelled are Varošnica, Bjelava and Grabovica, and from the left side Dobrovački potok, Čađavica, Studenac, Duboki potok and Jablanica. Numerous sources and springs (permanent and temporary) with significantly less abundance are situated on both valley sides of the Stupčanica, all until the source zone. Beside permanent surface flows, there are temporary ones as well, which existence is conditioned by water plunging into the ground or springs' drying. It has been performed in this paper the analysis of geological-tectonical structure as well as hydrogeological characteristics of the Stupčanica catchment area, from its source and down to Olovo, where together with Bioštica River it makes the River Krivaja Basin. The border of the basin-watershed with its significant part is underground-hydrogeological, very often with zonal character. The watershed has been determined on the base of analyse on geological structure and geomorphological relations as well as examinations on underground relations.*

*KEY WORDS*
*Stupčanica River, catchment area, geological-tectonical structure, hydrogeological, characteristics, watershed*

## 1. Introduction

The Stupčanica River Basin belongs to the Bosnia River Basin. The Stupčanica River meets Bioštica River at the town of Olovo, where it makes the Krivaja River's flow. This basin is surrounded by the Middle Bosnian Mountains. With orographic and underground watershed it is divided from the Drinjača Basin in the north, Studeni Jadar in the northeast and Bioštica in the southwest. Northeast and southwest part of the basin, concerning its geological structure has been separated as underground zonal watershed, and from the north and the southwest as surface watershed. The total catchment area covers 283 $km^2$. The Stupčanica River originates by connection of the two water flows Bijesnica and Pištica upstream from the Pjenovac settlement. In its further flow, from the right side this river receives several larger and smaller streams, of which excelled are Varošnica, Bjelava and Grabovica, and from the left side Dobrovački potok, Čađavica, Studenac, Duboki potok and Jablanica.

Numerous sources and springs (permanent and temporary) with significantly less abundance are situated on both valley sides of the Stupčanica, all until the source zone. Concerning hydrographical net, beside permanent surface flows, there are temporary ones as well, which existence is conditioned by water plunging into the ground or springs' drying. The catchment area has been made of sediments from the older Palaeozoic, Mesozoic, magmatic and Quaternary sediments. Tectonically relations of the terrain are very complex and complicated. The catchment area has been made of rock masses that are different according to hydrogeological characteristics and functions within the terrain. The border of the basin-watershed with its significant part is underground-hydrogeological, very often with zonal character. The watershed has been determined on the base of analyse on geological structure and geomorphologic relations as well as examinations on underground relations. According to engineering-geological characteristics, researched parts of the terrain have been made of complex of various lythological kinds of rocks.

## 2. Geomorphologic characteristics of the terrain

In geomorphologic sense, this mountain area are made of plains inside which were developed karst shapes like basins, valleys, caves and zones with depressions. Geomorphologically, the Stupčanica River valley is different concerning geological conditions of areas the river cut through. Generally, it has the shape of canyon with extremely sharp and steep sides in the middle and lower part of the terrain. In the source part, the terrain is made of sleeked karst plateau with all karst characteristics such are numerous depressions and valleys. This river basin is surrounded by the Middle Bosnian mountains with stretching direction northwest-southeast. The Stupčanica River basin is

surrounded by the Middle Bosnian mountains with stretching direction NW-SE. The Stupčanica River generally has the flow direction east-west. In orographic view here dominates massif Sljemenska planina in the southeast and Javor in the northeast.

Several relief types are presented in the researched area, and they are:
- karst type of relief
- erosive type of relief which conditioned the origin of eluvial-deluvial covering, and
- river (fluvial) erosion; relief formed by work of rivers and their tributaries.

Karst type of relief is presented in the area of Petrović in lower part of the Stupčanica River. It is surrounded by ranges: Slivanjsko brdo, Plasci and Tisovina on the right side, and Krševi and Srihinj on the left side. They are made of Jurassic products ($^{2}J_{3}^{3}$) of shoal limestones which are massive and banked. These limestones make the largest part of these massifs with sharp and steem sides of canyon type, with ranges and sleeked tops in which have been formed numerous depressions, valleys and caves. On the fact that this terrain is karstificated, points also that in this area almost there is no surface flows. Almost all surface flows are temporary and short and usually they finish into abysses where they sink.

The middle and upper stream of the Stupčanica River is also characterized by karst type of relief. It is surrounded by Sljemenska planina on the left coastal, and Javornik, Kusača and Visočnik in the southeast. They are made of sediments of the Middle and Upper Triassic ($T_{2,3}$) shoal limestones and megalodonic limestones of the Upper Triassic ($T_3$). The middle and the source part of the terrain is with a mild plateaus in which structure come products of the Upper Jurassic ($^{1}J_{3}^{3}$) conglomerates, marls, sandstones, and breccias and sandstones, feldspars and cherts of the Middle and Upper Jurassic ($J_{2,3}$?) and the Lower Cretaceous ($K_{1}^{3-5}$) with marl-sand limestones and marls with requiendis and orbitolinas.

These products mainly build mild slope sides overgrown with rich vegetation and they are covered by eluvial-deluvial coverings. Geological and tectonical structure conditioned also production of river (fluvial) erosion. With fluvial erosion, the river has changed its flow during crossing from mountain into wide valley. As in its upper and lower stream this river has torrent type, and thus it enabled forming of overflown deposits and in very valleys (the Čude village) and on these deposits river terraces have been formed. River deposits of fluvial type are situated in the riverbed.

## 3. Geological characteristics of the terrain

The Stupčanica River catchment area mostly has been made of sediments of older Palaeozoic and Mesozoic as well as of Quaternary sediments. Concerning lythological sediments' composition, carbonate Mesozoic deposits have the greatest presence, after which klastic Mesozoic sediments come. Relatively large presence of carbonate sediments in the structure, has conditioned karst characteristics of this region. If analyse the presence of rocks according to geological formations, one can say that in this area the most spacious areTriass sediments developed in all three horizons and they have continuity in sedimentation and they take up more than 50% of the catchment area. The second place takes klastic sediments of Upper Jurassic and Cretaceous which spread in central and northwest part of the catchment area. According to the same criteria, the third place goes to klastic and klastic-carbonate sediments of Jura, Cretaceous and flows of magmatite. Geological map of the catchment area has been done on topographic base scale 1:100 000 using reconnaissance of terrain and printed paper of the basic geological map of Vlasenica with legend (Fig.1).

In geological structure of the catchment area the following lythostratigraphic units take part: Products in older Palaeozoic are presented by quartz-sericite shales, amphibole shales and amphibolites, serpentinites and peridotites. Generally, they spread very little, and are situated in the middle and lower part of the river basin. Products of Mesozoic age are spread in the whole catchment area, and are presented by quartz sandstones, conglomerates and feldspars, infrequent limestones and dolomites ($T_1$), grey and reddish limestones ($T_2^1$), limestones ($T_2$), limestones, cherts and marls ($T_2^2$), diabases, bank limestones with corals, bryozoas and algae ($T_{2,3}$), megalodonic limestones ($T_3$), red limestones with amonites and brachiopodes ($J_{1,2}$), gabbrodolerites, spilites, gabbropegmatitic veins, sandstones, feldspars and cherts ($J_{2,3}$?), conglomerates, sandstones, and marls ($^1J_3^3$), bank limestones ($^2J_3^3$), marl-sandy limestones and marls ($K_1^{3-5}$) and marl limestones and marls ($K_2^{1,2}$)-Fig.2-6.

Quartar has been presented with alluvial and terrace deposits, clayish crushed stone lake and marsh sediments. Inside the catchment area they have low spreadiness. Quarternary products have been developed mainly in a river valley area, in a riverbed, slope parts and depressions. They have various genetic types, and according to them, we have eluvial, diluvia and alluvial products. Eluvial products appear like covering made of various basical rock masses' decay. They cover slopes and flat parts of the terrain. Generally, they have clayish-sandy-debris composition which thickness goes from 1 to 3 m. Diluvial products have composition identical to the eluvia ones, so it is hard to divide them. Mainly they are concentrated on slight slopes, depressions, valley and valley sides. They have various thicknesses which go 1-5m.

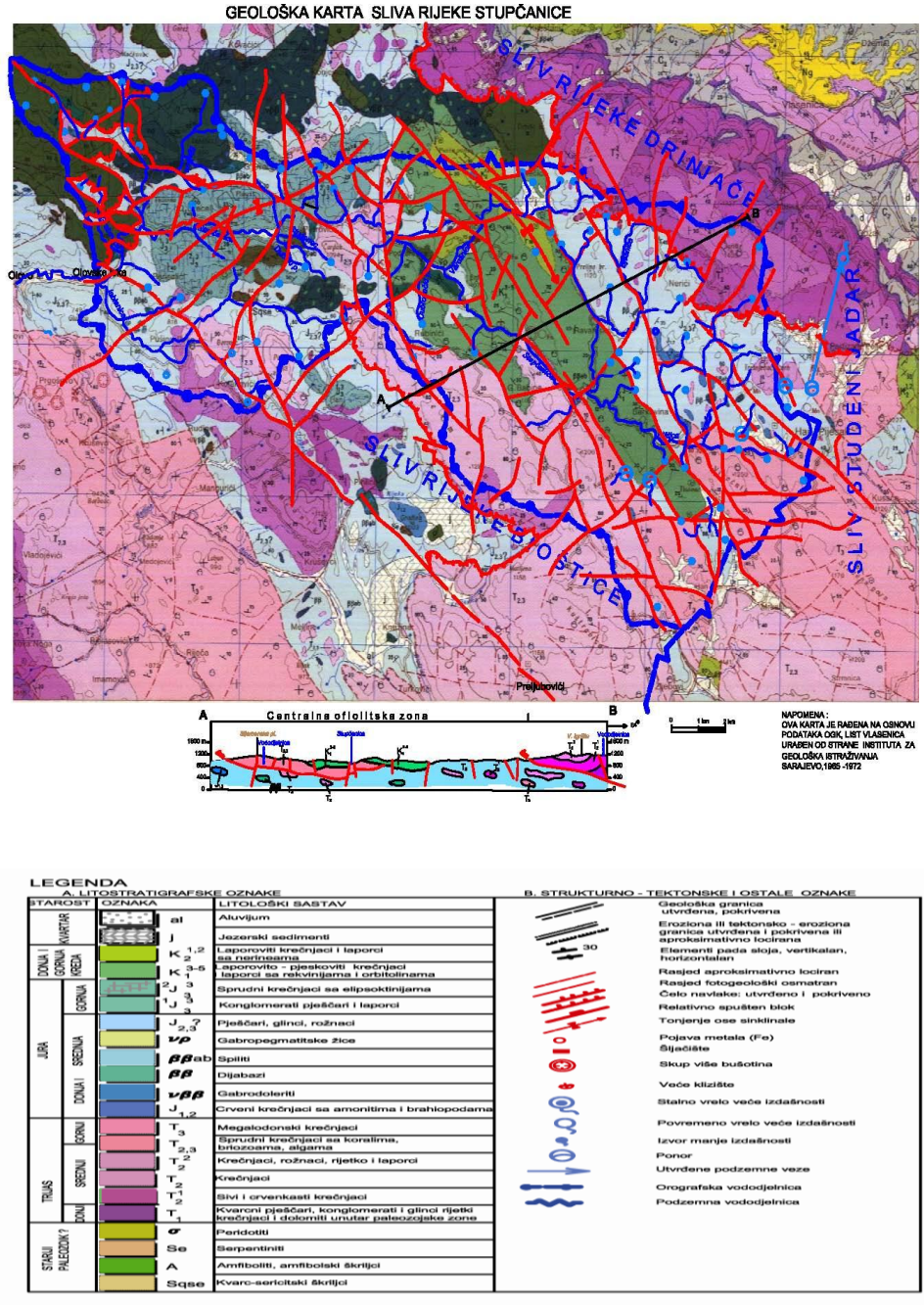


*Fig 1: Geological map of the Stupčanica River catchment area*

Fig 2: Bank limestones with ellipsactinias (titon) $^{2}J_{3}^{3}$

Fig 3: Limestones in ravines of the road with cracks $^{2}J_{3}^{3}$ Locality D. Drecelj , in the Stupčanica canyon, downstream

Fig 4: Bank limestones $^{2}J_{3}^{3}$ - underflow.

Fig 5: Bank limestones contact $^{2}J_{3}^{3}$ with conglomerates, sandstones and marls $^{1}J_{3}^{3}$.

Fig 6: Bank limestones with corals, bryozoas and algaes $T_{2,3}$.

Fig 7: The Stupčanica bed in deposit of gravel, sand and limestone fractions-upstream

Locality Klis - the Stupčanica middleflow

Alluvial deposits are presented by deposits such are gravel, sand, and in terraces there are mainly sediments with small fractions of sandy-dust and clayish deposits.

## 4. Tectonical structure of the terrain

Tectonics of the terrain is very complex. According to facial and structural characteristics, the following structural-facial units are selected:

- Central ophiolite zone
- Drinsko-Ivanjički palaeozoic and
- Olovske Luke-Pjenovac-Drinjača unit

Central ophiolite zone is the most presented in this part of the basin. In this zone's framework, rocks have various composition and are selected into two tectonical units where excelled the complex of volcanogenic-sediment products. In this complex composition come the rocks originated during formation of volcanogenic-sediment formation, and sediments originated in the side, and put in the formation in a shape of olistolith. Ultrabasic magmatic rocks have been tectonically brought to this complex, and followed by intrusions and effusions of basical magma. The whole ophiolite complex during which formation olistostrome mechanism was strongly expressed, have been caught several times by tectonical phases inside the Alpic magmatic-tectonic cyclus. Plicative shapes are impossible to reconstruct, while faults are more perceived. The most significant fault here is Kladanj-Petrovići which spreads north-south.

Drinsko-Ivanjički Palaeozoic is made of middle Carbon and Triassic products. Inside this structural-facial unit, here is sorted out the Han Pijesak-Devetak-Knežina unit. It has been made of Triassic limestones which lie tectonically over the central ophiolite zone. Some blocks of this unit, are divided by faults and longer transported. Triassic limestones, which mainly build this unit, on all spaces are more or less tectonically damaged. The borders towards the central ophiolite zone products are always tectonical. The Olovske Luke-Pjenovac-Drinjača unit are made of sediments of Titon and Cretaceous, which were less taken and broken. Limestones and klastites of this unit lie discordant over the Central ophiolite zone as well as over various Triassic' members. In structural view those are mild synclinals jammed in canals. Inside this unit, Olovske Luke i Pjenovac units are sorted out. The Olovske Luke unit has been made of limestones of Titone near the villages of Petrovići and Drecelj. It makes mild synclinals. In the northwest wing is emphasized stronger fault with stretching direction east-west, with which titonic sediments are in tectonically contact with volcanogenic-sediment formation.

The Pjenovac unit is sorted out in the middle part. It is presented with Cretaceous clastites and limestones. It lays transgressively over various Triassic members and Jurassic volcanogenic-sediment formation. In a structural point of view, it is a chain of mild-waved synclinals which, by faults direction northeast-southwest, have been broken into smaller blocks.

## 5. Hydrogeological characteristics of the terrain and the basin's borders

The Stupčanica catchment area has been made of rock masses which differ among themselves according to hydrogeological characteristics and functions. Northeast and southwest part of this basin, concerning geological structure, has been sorted out as underground zonal watershed, and from the north and southwest as surface watershed which suits to orographic watershed. This catchment area amounts 243 $km^2$. According to hydrogeological characteristics and functions, these rock masses can be sorted into:

- Rocks with crack-cavernous porosity very permeable – hydrogeological collector
- Rocks with crack-split porosity poor permeable to impermeable – hydrogeological isolators
- Impermeable rock masses – hydrogeological isolators. Rocks with crack-cavernous porosity are made of karstificated limestones of Triassic and Jurassic age. They are characterized by large permeability and cavernousity with all characteristics of karst such are abysses, karst sources, caves, and karst sinkholes in which underground waters flow through concentrated underground channels. On a surface, terrain built from these rocks is practically without water, with local appearances of periodical surface flows. At the same time, those are main masses in the terrain inside which underground waters are accumulated. From these aquifers also underground zonal watershed has been sorted out.

Rocks with crack- split porosity poor permeable to impermeable are made of lower Triassic and klastic sediments ($T_1$), sandstones, feldspars and cherts ($J_{2,3}$ ?), conglomerates, sandstones and marls ($^1J_3^3$), Cretaceous complex of marls, marl and sandy limestones ($K_1^{3-5}$, $K_2^{1,2}$). Mostly they are situated in tectonically damaged structure, cut with faults and covers. They represent ground hydrogeological isolator which hydrogeological function is very important in the terrain. On these sediments' position, structure and relation towards hydrogeological collectors, as well as hypsometric relations of these masses, other factors depend such are regime and moving direction of underground waters, and other collector's characteristics, appearances of outlet zone and so. Practically, roof zone of these sediments at the same time makes basis until that can be reached by the process of karstification inside Triassic carbonate complex which lies above.

Impermeable rock masses are made of: gabbros-pegmatite veins, spilits, diabases, gabbrodolerites, peridotites, serpentinites, amphibolites and amphibole shales and quartz-sericite shales (Sqse). According to this composition, these rock masses make hydrogeological isolators which most often, are small thickness and in given relations in the terrain, usually they are represent by roof hydrogeological isolators. Concerning very low spreadiness in the basin, most often they form shallow aquifers and have no greater hydrogeological importance. Quaternary products, intergranular type of porosity present distinct hydrogeological category of rock masses. They are characterized by changeable permeability and prevailed intergranular porosity. In them and through them are done infiltration and distillation of surface and flow waters. To this group here belong: lake and marsh sediments, terrace and sediments of riverbed as well as eluvial, diluvial and proluvial coverings.

## 6. Conclusion

The Stupčanica River catchment area belongs to the Bosnia River Basin. It is situated in the central part of the Bosnian Mountains. The Stupčanica River originates when two waterflows Bijesnica and Pištica meet each other upstream from the Pjenovac settlement. The catchment area covers 283 $km^2$ .

The catchment area has been made of sediments from the older Palaeozoic, Mesozoic, magmatic and Quaternary sediments. Concerning lithological composition, carbonate deposits have the greatest presence, after which come clastic sediments and much less other rocks. Geological map of the catchment area has been done on the base of Vlasenica paper, scale 1:100 000.

Tectonical relations of the terrain are very complex and complicated. We can sort out three structural-facial units: Central ophiolite zone, Drinsko-Ivanjisčki Palaeozoic and Olovske Luke-Pjenovac-Drinjača unit. The catchment area has been made of rock masses that are different according to hydrogeological characteristics and functions within the terrain. The border of the basin-watershed with its significant part is underground-hydrogeological, very often with zonal character. The watershed has been determined on the base of analyse on geological structure and geomorphologic relations as well as examinations on underground relations.

According to seismologic map of SFRJ, 1987, in researched area maximum expected earthquake intensities are from 7 º MSK-64 scales with occurrence possibility of 63% for reversible period of 500 years. In engineering-geological regard, parts of the terrain have been built of connected well-stoned rocks. They are generally solid and they make favourable working environment.

Parts of the terrain built of complexes of various lythological rock types, generally characterize the terrain as unfavourable natural construction and working environment, but on the other side excelled favourable attributes in regard to water sustainability – hydrogeological isolators.

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