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GEOMORPHOLOGICAL FEATURES OF THE BAŠKE OŠTARIJE KARST POLJE

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The Baške Oštarije karst polje is stretching out in the direction E-W at length of 3.75 km, while the width is varying from 0.25 to 2.0 km. It divides the central from the south part of Velebit mountain (Croatia) and it is formed at the contact of two orographic wholes. Besides karst and fluvio-karst processes, the derasion and periglacial processes have been most expressed at the relief formation. The water which flows down from edge parts of polje has great importance in relief formation because of its corrosional aggressivity.
Key words: Baške Oštarije karst polje, Velebit mountain, karst, fluvio-karst, derasion and periglacial processes and relief forms, Croatia

Zavala Oštarijskog polja u kršu proteže se u smjeru I-Z u dužini od 3,75 km, dok širina varira od 0,25 do 2,0 km. Ovo polje dijeli središnji od južnog dijela Velebita i oblikovano je na kontaktu dvije orografske cjeline. U oblikovanju reljefa najizraženiji su, uz krški i fluviokrški, i derazijski i periglacijalni procesi. Voda koja dotječe s rubnih dijelova polja zbog svoje korozijske agresivnosti ima veliku važnost u oblikovanju reljefa.
Ključne riječi: Oštarijsko polje u kršu, Velebit, krš, fluvio-krš, derazijski i periglacijalni procesi i reljefni oblici, Hrvatska

Introduction

Oštarijsko polje divides the middle and southern part of Velebit Mt. representing at the same time one of the important ridges. It extends east-west for 3.75 km and its width varies from 0.25 to 2.0 km (Fig. 1). It was developed on the contact of two orographic units which in morphostructural context represent conformal denudational-tectonical units. The influence of exogenic processes on the relief formation becomes distinct primarily by selective denudation. On steeper parts of the flanks of Oštarijsko polje, where clastics and dolomites predominate, the most prominent relief forming processes are slope (derasional) destructive and accumulation processes.

Regarding that this polje was formed on the contact of more permeable and less permeable rocks, it can be considered as a marginal field in the karst according to Gams (1974, 1978). The main role in shaping of Oštarijsko polje is attributed to the water which comes down from the marginal noncarbonate areas and periglacial processes during glacials. Namely, the parts that were formed in Permian and Triassic clastics formed faster because those rocks were an easier subject to mechanical erosion

Fig. 1 The view from the west toward eastern part of polje
Sl. 1. Pogled sa zapada prema istočnom dijelu polja

Previous investigations

The Baške Oštarije ridge became an important startup location for investigations of Velebit Mt. due to its central position. This is especially visible in the late 19th century. Namely, F. Hauer (1867-1871) had already made a geological map including this area, too. After him Dragutin Franić (1894) gave the first data on length, height and volume of Velebit Mt. in his paper "Orometrics of Lika-Gacka highlands". During the 20th century R. Shubert and L. Wagen (1912, 1913), and F. Koch (1929 a, b) continued geological investigations. Exceptional contribution to knowledge about Carbon and Permian rocks of Baške Oštarije and neighbouring areas, was given by M. Salopek (1942), B. Sokač (1973) and B. Sokač et al (1970 - 1976). Neotectonics was studied by E. Prelogović (1995). Hydrogeological characteristics of the area were studied by M. Herak and S. Bahun (1974), A. Pavičić (1974, 1995) and B. Biondić (1981). Among geographers (geomorphologists) distinguished authors of regional-geographical and geomorphological papers are V. Rogić (1958), D. Perica (1998), D. Perica and N. Buzjak (2001) and B. Fürst-Bjeliš et al. (2000-2001). Valuable are also the results of speleological investigations of M. Garašić (1981, 1986) and O. Lukić (1992).

Methods of research

Field investigation was the basic method. Only direct observations in the field could enable identification of particular geomorphological processes and relief types. The field work also yielded data on mutual relationship of petrographic composition of rocks, hydrological characteristics and climatic conditions within the processes of relief formation of Oštarijsko polje.

Discussion and results

General morphological characteristics

Oštarijsko polje, in fact, represents a ridge that divides Middle from Southern Velebit Mt. It was formed on the contact of two orographic units which are conform morphostructures of denudational-tectonical type (BOGNAR, 1994, 1999-2001). Oštarijsko polje extends east-west for 3.75 km and its width varies from 250 m on the east side (till the Linići village) to 2 km on the west side. Polje is located 900 m a.s.l. at the west end, while it raises up to 980 m on the north in the area of Stupačinovo (Fig. 2, 3, 4 and 5).

Fig. 2 The view of the western part of the Oštarije Polje from the Dabarski Kukovi
Sl. 2. Pogled na zapadni dio Oštarijskog polja s Dabarskih kukova

The origin of polje was preconditioned by tectonics, namely Brušane fault striking WNW-ESE along the marginal northern part of the polje, and Oštarije fault of E-W strike along the southern margin. Regarding the fact that Brušane fault cuts a fundamental monoclinal structure of Velebit Mt., exactly in the area of Oštarijsko polje, the zonal arrangement of lithostratigraphic units or members is therefore disturbed by horizontal movement and distorsion of Brušane-Oštarije anticline (SOKAČ ET AL, 1970, 1976). It can be supposed that the crest of the anticline was fractured by horizontal strike-slip movement, which enhanced the effect of selective denudation (mechanical erosion, derasion, corrosion and fluvial erosion). In eastern part of the polje, along the Brušane fault, impermeable and low permeable sediments of Carbon, Permian and Lower Triassic crop out (PAVIČIĆ, 1995). Water that springs there (Ljubica Creek) runs towards the lower west part of the polje where approaching the fractured zone of partly impermeable rocks (Anisian limestone and dolomite) gradually sinks.

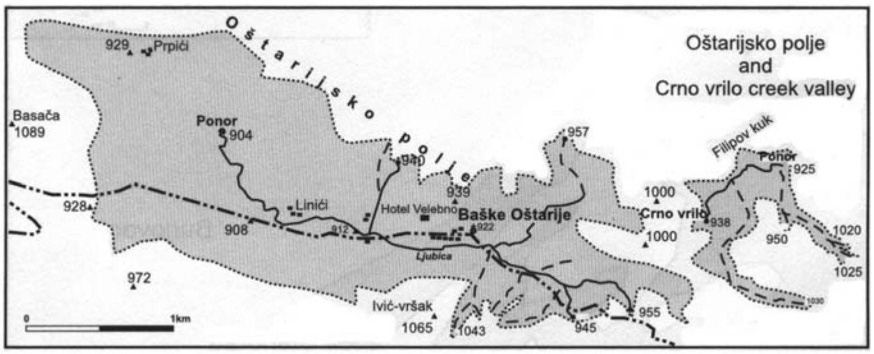

Fig. 3 The concise map of the polje of Oštarije
Sl.3. Pregledna karta Oštarijskog polja

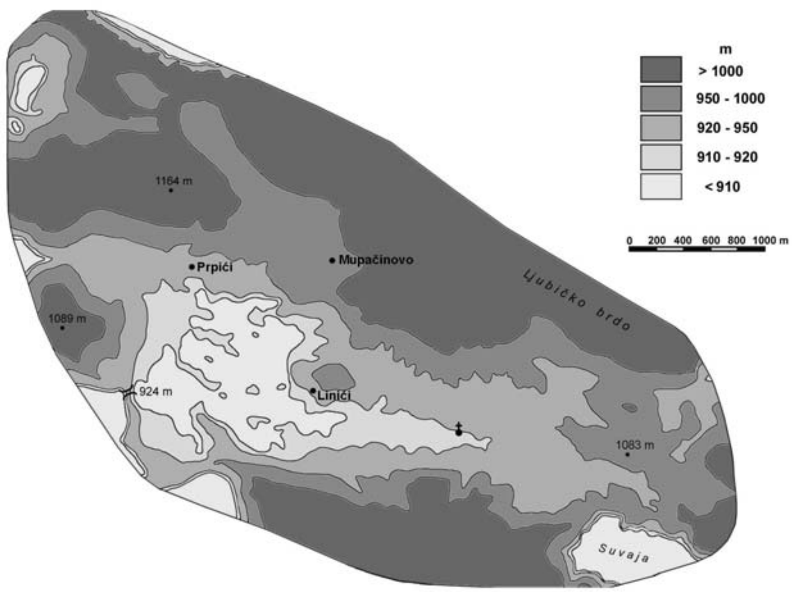

Fig. 4 The hypsometric map of the polje of Oštarije
Sl. 4. Hipsometrijska karta Oštarijskog polja

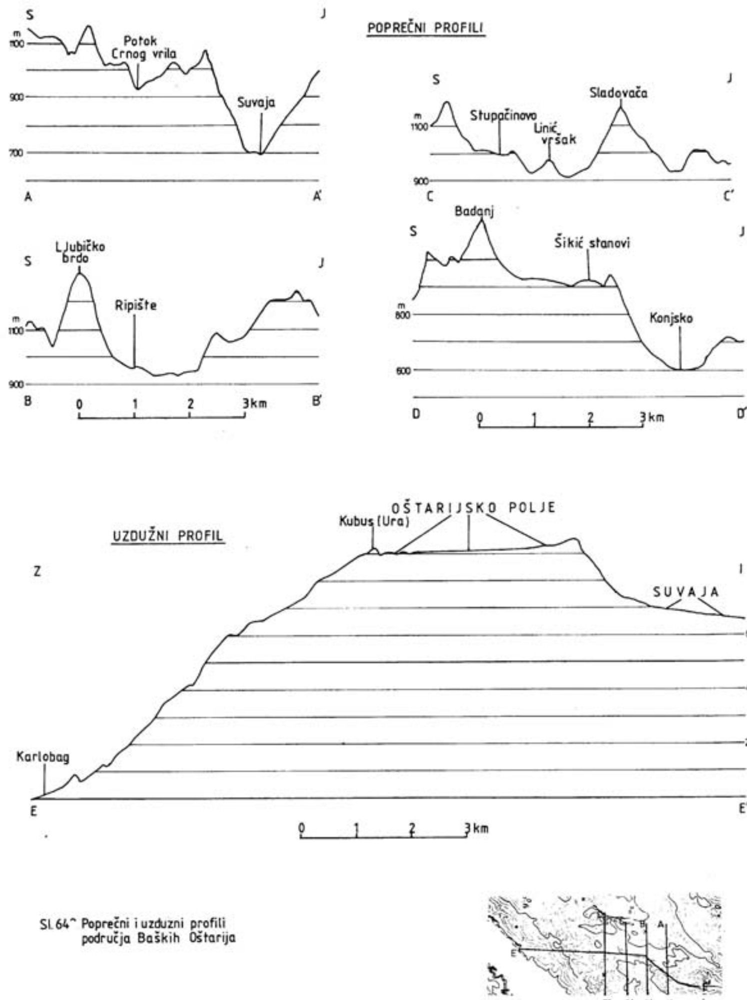

Fig. 5 The transversal and longitudinal profiles of the polje of Oštarije
Sl. 5. Poprečni i uzdužni profili Oštarijskog polja

Interpretation of the origin of the highest, northern part of the polje represents a special problem. It is most probable that the bend visible from Prpići village (on the west side) eastwards, was conditioned by a reverse fault. At that place the most intensive bending of Oštarije-Brušane anticlinal structure, which is, at that place, also fractured along the transverse fault striking N-S. Sink holes of the Ljubica Creek are connected to this fault (Fig. 6).

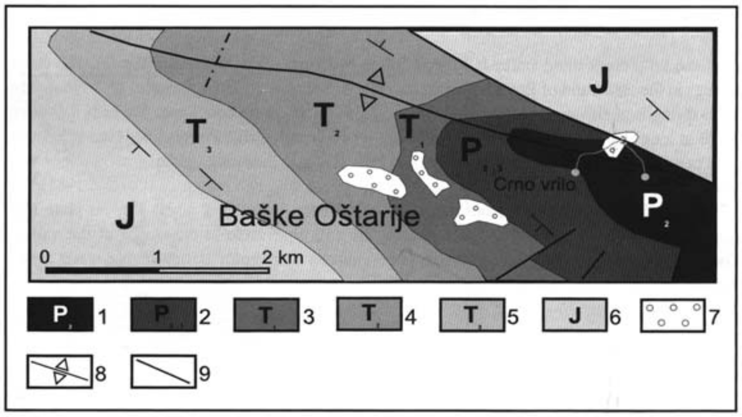

Fig. 6 The geological map of the polje of Oštarije. Legend: 1 – Middle Permian sandstones and quartz conglomerates, 2 – Middle and Upper Permian dolomites, 3 – Lower Triassic dolomite, sandstone and slate, 4 – Middle Triassic dolomites, 5 – Upper Triassic dolomites, 6 – Lower Jurassic beds, 7 – alluvium (Quaternary), 8 – anticline, 9 – major fault

Sl. 6. Geološka karta Oštarijskog polja. Legenda: 1 – pješčenjaci i kvarcni konglomerati srednjeg perma, 2 – dolomiti srednjeg i gornjeg perma, 3 – dolomiti, pješčenjaci i slejt donjeg trijasa, 4 – dolomiti srednjeg trijasa, 5 – dolomiti gornjeg trijasa, 6 – naslage donje jure, 7 – aluvij (kvartar), 8 – antiklinala, 9 – glavni rasjed

Exogenic relief

The influence of exogenic processes on relief formation stands out primarily by selective denudation. Triassic and Permian dolomites show strong physical erosion, and even corrosion during wet periods of spring and fall. In the areas with Paleozoic and Lower Triassic clastics processes of flushing and trenching predominate, as well as fluvial erosion and accumulation. As a consequence of lower permeability of Middle and Upper Triassic dolomites, these deposits are shaped by fluvial erosion. In the most north-westward and south-eastward parts of the studied area, where Jurassic limestones predominate, the corrosion processes predominate in relief formation while mechanical disintegration and flushing become distinct only there where dolomites occur, or they alternate with limstones. In general, besides lithology, tectonics had a great impact on intensity and trend of exogenic processes.

Slope processes and forms. On the steeper slopes of Oštarijsko polje, where clastics and dolomites predominate, the most prominent are slope destruction and accumulation processes (derasion). Especially noticeable are the processes of rock-fall, collapsing, washout, trenching and creeping.

The processes of rock-fall and collapsing are mainly preconditioned by temperature oscillations between day and night. They are connected to tectonic escarpments of Dabarski Kukovi and Filipov Kuk. On the steep slopes of Dabarski

Kukovi smaller gullies formed with talus beneath, composed of fairly sorted angular debris.

Processes of gullying are most intensive on the slopes of Badanj and Basača uplands, northwest from the polje bottom (near Prpići village) where Triassic dolomite prevails. Intensive gullying processes are also visible on hillsides of the eastern and middle part of the polje where Permian and Lower Triassic clastics and dolomites occur. The length of gullies varies from few tens to few hundreds of meters. They commonly end with smaller proluvial (torrent) fan and occasionally form derasion valleys.

They were formed by widening of older gullies (probably of Pleistocene age) with rainfall waters. In the foothills of Badanj and Basač uplands the gullies are partly incised in colluvial cones. Intensive flushing by rainfall waters produced gullies and colluvial cones. Colluvial cones are also visible in the foothills of Dabarski Kukovi, Ljubačko brdo, and on southern slopes of Debela Kosa, Jelar, Ivić Vršak and Glavičica uplands. Their composition is not easy to observe because they are covered with grass. An exception is the area of Ljubica Creek, next to the ski lift, where in open profiles coarse sand/gravel predominates.

Fluvio-denudational and fluviokarst relief. Predominance of impermeable rocks in the most eastern part of the polje, and partly permeable rocks in the middle of it, favoured the occurrence of intermittent or permanent springs of low capacity as a result of unfavourable pluviometric regime. Springs are productive in fall and winter, namely more humid part of the year due to heavier rainfalls, snow melt and lower evaporation. The springs feed smaller creeks from 250 to 500 m long. An exception is the Ljubica Creek running from eastern to central part of the polje. Other brooks are tributaries of Ljubica. In the central area of the polje Ljubica Creek flows into the area of microtectonically fractured carbonates, and sinks in a line of sieve-type. Open swallow-holes lie down beneath Linić vršak upland. The main characteristic of the Ljubica Creek, as well as that of its tributaries, is the oscillation of discharge. Therefore, Ljubica Creek commonly floods the central polje during cold periods (near Linići village) and dries out during summer.

Fig. 7 The Ripište with spring part of the Ljubica stream
Sl. 7. Ripište s izvorišnim dijelom potoka Ljubice

Differential tectonical movements conditioned a complex morphostructural development of the Ljubica Creek valley. Intensive microtectonical crushing resulted in formation of wider part of the polje in Ripište area (Fig. 7). The central section of the valley became narrower, only 250 m wide, due to compression during the uplift of Linić Vršak and Sladovača blocks (Fig. 8).

Fig. 8 The narrowest part of the polje with the doline of the Ljubica stream
Sl. 8. Najuži dio polja s dolinom potoka Ljubice

Waterflow is tectonically preconditioned and turns from the E-W direction to N-NW direction and sinks beneath the west hillside of Linić vršak (Fig. 9.). Higher, eastern and northern section of polje bottom (up to 915 m a.s.l.) is mainly covered with residuum, slope material and alluvial deposits. Thickness of those deposits in the valley of the Ljubica Creek is up to a few meters. The most intensive sedimentation was during Pleistocene, as it was also in Rujansko Polje.

Fig. 9 The swallow-holes of the Ljubica stream
Sl. 9. Ponori potoka Ljubice

Karst relief. Northern, southern and western rims of the polje is characterized by the occurrence of carbonate rocks and Jelar breccias. Their microtectonical fractures enabled intensive corrosion processes and formation of karst features. The area of the north rim, precisely the escarpments and top parts of Dabarski Kukovi, is characterized by the occurrence of extreme karst with various karren types, while slope parts of lower gradient and west rim of the polje are characterized by the occurrence of rocky karst. Other parts of polje, like central and west part of the polje bottom, are characterized by occurrence of covered and semi-covered karst. Some parts above 1200 m that are exposed to strong winds, are characterized by crionival karst occurrence. Namely, lack of snow (the wind bora blows it away) as thermal isolator enables cryogenic processes and rock fracturation by freezing.

On the west and lowest side of the polje (the area of Šikić stanovi) where Lower Jurassic limestones predominate, many funnel-shaped sink-holes (ponikvas) occur. In the neighbouring, more eastwards part, where Upper Triassic dolomites predominate there are many pan-shaped sink-holes (ponikvas). In fact, due to a very low dip angle (2-5 °) a mechanical erosion of dolomites is distinct. In some parts, mechanical erosion goes even 5 m deep (Fig. 10).

Fig. 10 The surface mechanical weathering of the dolomites
Sl. 10. Površinsko mehaničko trošenje dolomita

One of the polje characteristics is the lack of speleo-features, except the swallow-holes of the Ljubica Creek. The Ljubica swallow-holes are very narrow probably due to dolomite rock characteristics where they were formed. Meanwhile, it must be pointed out that speleo-features could have been buried with earth, rock debris and gravel during colder periods of Pleistocene when periglacial processes were dominant in relief shaping. Today, speleo-objects occur in higher areas, especially in the area of Brušane fault (GARAŠIĆ, 1981, LUKIĆ, 1992).

Conclusion

Oštarijsko Polje is a part of the main ridge and at the same time it orographically divides central from southern Velebit. It extends in the E-W direction and it is 3,75 km long and 0,25-2,0 km wide.

The origin of the polje is tectonically preconditioned by Brušane fault (north section) and Oštarije fault (south section). The most eastern section of the polje is built of impermeable rocks of Permian age which enabled occurrence of water on the surface. Further westwards partly permeable Triassic rocks occur, while the most westwards part comprises mainly highly permeable Jurassic deposits (PAVIČIĆ, 1995). Higher, eastern part of polje is filled with residuum, slope clays and alluvial deposits even several meters thick in the valley of Ljubica Creek. In the most west section where Jurassic limestones predominate, there are mainly semi-covered karst with numerous funnel-shaped sink-holes (ponikvas).

Regarding that this polje developed on the contact of more permeable and less permeable rocks, it can be considered as a marginal karst polje. Waters coming from marginal noncarbonate areas were very important for shaping the Oštarijsko polje because of corrosion. Flushed slope clays, residuum and other fine-grained accumulated material that fills the polje, also have great importance in increasing the corrosive activities. Water and higher CO_2 content (humic acids) increase the lateral widening of polje. Periglacial processes during glacials had also great influence. Namely, noncarbonate areas, because of stronger exposure to mechanical erosion, developed more quickly.

LITERATURE

BIONDIĆ, B. (1981): *Hidrogeologija južnog dijela Hrvatskog primorja i Like*. Doktorska disertacija. PMF, Zagreb, pp. 214.

BOGNAR, A. (1994): *Temeljna skica geoekoloških osobina Velebita*. Senjski zbornik 21, Senj 1-8.

BOGNAR, A. (1999): Geomorfološka regionalizacija Hrvatske. Acta Geographica Croatica, 34, Zagreb, 7-29.

FORD, D., WILLIAMS, P. (1994): *Karst Geomorphology and Hydrology*, Chapman and Hall, London pp. 601.

FRANIĆ, D. (1894): *Orometrija Ličko-gackoga ili gornjo-hrvatskoga visočja i njegovih orografskih sastavina*. Nastavni vjesnik 2, Zagreb, 14-34, 109-123.

FÜRST-BJELIŠ, B., LOZIĆ, S., PERICA, D., (2000): *Man and the Environment in the Central Velebit area – Baške Oštarije and Suroundings*, Acta Geographica Croatica 35, Zagreb, 111-130.

GAMS, I. (1974): *Kras*, Slovenska matica, Ljubljana.

GAMS, I. (1978): *The polje: the problem of its definition*, Z. Geomorph. 22, 170 -181.

GARAŠIĆ, M. (1981): *Ponor Crnog vrela na Velebitu*. Naše planine 11-12, Zagreb, 277-278.

GARAŠIĆ, M. (1986): *Hidrogeologija i morfogeneza speleoloških objekata u kršu SR Hrvatske*. Doktorska disertacija, zajednički studij iz područja geologije RGN i PMF-a, Zagreb, pp. 159.

HAUER, F. (1867-1871.): *Geologische Ubersichtskarte Osterereichisch-Ungarischen Monarchie nach den Aufnahmen der k. k. Geologishen Reichsanstalt bearbeitet von F. Ritter von Hauer*, Geol. Reichsanst. Verlag Beck schen Univ. Buchhandl. Alfred Holder, Wien.

HERAK, M., BAHUN, S., redaktori (1974): *The basis of the Hydrogeological Map of the Dinaric Karst,* 1:500 000 (osnova hidrogeološke karte Dinarskog krša). PMF, Zagreb.

KOCH, F. (1929a): *Geološka karta Hrvatske, Slavonije i Dalmacije, list Karlobag-Jablanac (Zone 27. Col. XII.)*, Zagreb-Beograd.

KOCH, F. (1929b): *Tumač Geološkoj karti Karlobag-Jablanac, Prilog geologiji Velebita i Like*, Zagreb, pp. 42.

LUKIĆ, O. (1992): *Speleološka istraživanja na području Baških Oštarija (srednji Velebit)*, Speleolog 38-39, Zagreb, 21-24.

PAVIČIĆ, A. (1974): *Geološka osnova velebitske razvodnice*, Magistarski rad, Geološki odjel PMF-a, Zagreb.

PAVIČIĆ, A. (1995): *Hidrogeološki uvjeti za ostvarenje akumulacija u kršu zaleđa Velebita*. Doktorska disertacija, Geološki odsjek PMF-a, Zagreb, pp. 124.

PRELOGOVIĆ, E. (1995): *Geološka struktura Velebita*. Paklenički zbornik 1, Simpozij povodom 45. godišnjice NP "Paklenica", Starigrad-Paklenica, 49-54.

PERICA, D.(1998): *Geomorfologija krša Velebita*, Doktorska disertacija, Geografski odsjek PMF–a, Sveučilište u Zagrebu, Zagreb, pp. 251.

PERICA, D., BUZJAK, N. (2001): *Contact Karst of Southern Velebit (Croatia),* Acta Carsologica 30/2, Ljubljana, 103-113.

ROGIĆ, V. (1958): *Velebitska primorska padina*, Radovi Geografskog instituta u Zagrebu 2, Zagreb, 1-114.

SALOPEK, M. (1942): *O gornjem paleozoiku Velebita u okolini Brušana i Baških Oštarija,* Rad Hrv. akad. znan. i umjetn. 274, Zagreb, 218-272.

SCHUBERT, R., WAAGEN, L. (1912): *Geologische Specialkarte der im Reichsrate vertretenen Konigreiche und Lander der Osterreisch-Ungarischen Monarchie neu aufgenommen und herausgegeben durch die k. k. Geologische Reichsanstalt*, Pago 1:75000 (Zone 28 Col. XII. SW-Gruppe Nr. 115).-Geol. Reichsanst., Wien.

SCHUBERT, R., WAAGEN, L. (1913): *Erlauterungen zur Geologischen Karte der im Reichsrate vertretenen Konigreiche und Lander der Osterreichisch-Ungarischen Monarchie. SW Gruppe Nr. 115,* Pago (zone 28, Col. XII der Spezialkarte der Osterr.-Ungar. Monarchie im Masstabe 1:75000).-Geol. Reichsanst., Wien, 1-32.

SOKAČ, B. (1973): *Geologija Velebita*, Doktorska disertacija, Geološki odjel PMF-a, Zagreb.

SOKAČ, B., NIKLER, L., VELIĆ, I., MAMUŽIĆ, P. (1967, 1974): *Osnovna geološka karta SFRJ 1:100000. List Gospić L33-127,* IGI Zagreb, SGZ Beograd.

SOKAČ, B., ŠĆAVNIČAR, B., VELIĆ, I. (1967, 1976): *Tumač za list Gospić L 33-127*, IGI Zagreb, SGZ Beograd, pp. 64.

SAŽETAK

Dražen Perica, Andrija Bognar, Sanja Lozić: Geomorfološke značajke zavale Oštarijskog polja u kršu

Zavala Oštarijskog polja zbog svog središnjeg položaja na Velebitu postala je već veoma rano (19. st.) važna točka istraživačima Velebita. Predstavlja, de facto, prijevoj koji odjeljuje srednji od južnog Velebita. Zavala je oblikovana na kontaktu dviju orografskih cjelina koje u strukturno geomorfološkom smislu predstavljaju komformne morfostrukture denudacijsko-tektonskog tipa. Zavala je izdužena pravcem I-Z 3,75 km, dok mu širina varira od 250 m, na istočnom dijelu (sve do zaseoka Linići), pa do 2 km na zapadnom dijelu. Polje se nalazi na nadmorskoj visini od 900 m (Z dio) do 980 m (S dio).

Najveće značenje u egzogenom oblikovanju reljefa imala je selektivna denudacija. Kod dolomita trijaske i permske starosti dolazi do izražaja jako fizičko trošenje, a tijekom vlažnog proljetnog i jesenskog razdoblja i korozija. U okviru klastičnih naslaga paleozojske i donjo trijaske starosti izraženi su procesi spiranja i jaruženja, te fluvijalna erozija i akumulacija, a manje vodopropusni dolomiti srednje i gornje trijaske starosti utjecali su i na razvoj fluvijalnog oblikovanja reljefa.

Na strmijim dijelovima padina zavale Oštarijskog polja, u čijem sastavu prevladavaju klastiti, dolomiti i karbonatne breče (Jelar naslage) pri oblikovanju reljefa najizraženiji su padinski (derazijski) procesi. Posebno se ističu procesi osipanja, urušavanja, spiranja, jaruženja i puženja.

Izrazita prevlast vodonepropusnih naslaga na krajnjem istočnom dijelu, te djelomično vodopropusnih naslaga u centralnom dijelu zavale polja, pogodovale su nastanku cijelog niza povremenih ili stalnih izvora. Njihova mala izdašnost posljedica je nepovoljnog pluviometričkog režima. Najizdašniji su tijekom hladnog dijela godine uslijed veće količine padalina, kopnjenja snijega i smanjenog isparavanja.

Sjeverni, južni i zapadni rub polja karakterizira prevlast karbonatnih stijena i breča (Jelar naslage). Njihova mikrotektonska razlomljenost omogućila je izuzetno jaku aktivnost korozijskog procesa i oblikovanje različitih krških reljefnih oblika. Područje sjevernog ruba polja odnosno Dabarskih kukova karakterizira pojava ljutog krša s raznim tipovima grižina, dok njegove niže dijelove i zapadni rub obilježava pojava stjenovitog krša. Za ostale dijelove strana zavale, kao i za središnje i zapadne dijelove polja, karakteristična je pojava pokrivenog i polupokrivenog krša. Mjestimično, na dijelovima uzvišenja iznad 1100 m koji su izloženi jakim vjetrovima, uočljiva je i pojava krionivalnog krša. Naime, zbog nedostatka snijega (bura!) kao termoizolatora, zimi su ti dijelovi izloženi kriofrakcijskim procesima.

S obzirom da je zavala Oštarijskog polja nastala na kontaktu stijenskih naslaga jače vodopropusnosti s onima slabije vodopropusnosti, može se ubrojiti u rubna polja u kršu. Pri njenom modificiranju veliku važnost, zbog svoje agresivnosti, ima i voda koja dotječe s rubnih, nekarbonatnih dijelova. Spiranjem i akumuliranjem obronačne ilovače, rezidijuma i ostalih finozrnatih sedimenata koji sudjeluju u sastavu polja. Veće količine CO_2 organskog porijekla (humusna kiselina) još i više pospješuju korozijski i biokorozijski proces. Osim toga treba dodati i periglacijalne procese i njihov velik utjecaj na razvoj reljefa tijekom pleistocena.