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**DEVELOPMENT OF THE SCYTHIAN SERIES IN THE
ORLICA ANTICLINE AREA (SAVA FOLDS)**

**RAZVOJ SKITSKE SERIJE NA OBMOČJU ORLIŠKE
ANTIKLINALE (POSAVSKE GUBE)**

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Bogoljub Aničić & Stevo Dozet & Anton Ramovš: Razvoj skitske serije na območju orliške antiklinale (Posavske gube)

Članek obravnava razvoj skitske serije na območju orliške antiklinale. Skitske plasti orliške antiklinale leže diskordantno na karbonskih in permskih kamninah. Sestavljene so iz petih litostratigrafskih členov. Starejša dva člena pripadata spodnjemu skitu ali seiskim plastem, mlajši trije pa zgornjemu skitu ali campilskim plastem v širšem pomenu besede. V peščenih plasteh seiskega zaporedja se pojavljata školjki *Eumorphotis venetiana* in *Anodontophora*, v campilskih plasteh pa polža *Natiria costata* in *Natica*, školjka *Myophoria costata* in foraminifera *Meandrospira pusilla*.

Ključne besede: stratigrafija, litološka razčlenitev, okolje nastanka, skit, orliška antiklinala, vzhodne Posavske gube, Slovenija.

Abstract

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Bogoljub Aničić & Stevo Dozet & Anton Ramovš: Development of the Scythian series in the Orlica anticline area (Sava folds)

This paper deals with the development of the Scythian series in the Orlica anticline area. The Scythian beds of the Orlica anticline area lie discordantly upon various Carboniferous and Permian rocks. They are composed of five lithostratigraphic members: The older two members belong to the Lower Scythian, Seis beds respectively, and the younger three to the Upper Scythian, Campilian beds in the wider sense respectively. In the sandy beds of the Seis succession the pelecypods *Eumorphotis venetiana* and *Anodontophora* occur. On the other hand, in the Campilian beds the gastropods *Natiria costata* and *Natica*, as well as the pelecypod *Myophoria costata* and the foraminifera *Meandrospira pusilla* occur.

Key words: stratigraphy, lithologic dismembering, environment, Scythian, Orlica anticline, eastern Sava folds, Slovenia.

INTRODUCTION

The Orlica area with wider surroundings, treated in this article, belongs to the southeastern part of the Litija anticlinorium, the eastern Sava folds respectively, passing to the south into the Dolenjsko Karst. The Alps/Dinarides border between the Sava folds and Karst Dinarides can not be defined in this part of Slovenia as a tectonic line but as a transitional belt of minor meaning (Germovšek, 1955). However, the Orlica area is strongly folded showing here and there a complicated thrust structure. The whole area treated is cut by numerous faults that caused a block structure of the area. The borehole at Veliki Kamen, where the Triassic and Cretaceous beds are overthrust upon the Tertiary rocks, confirms this statement. Due to the complicated structure there is no everywhere the complete cross-section of the Scythian beds in the Orlica anticline area. In spite of that it is quite possible to put together the complete cross-section, which is lithologically and paleontologically very similar to the classic Werfen development. The Paleozoic-Mesozoic core of the Orlica anticline is enclosed by the Tertiary sediments.

The considered area was explored by many investigators. The first who explored and described the geology of the area was Lipold (1858). Zollikofer (1861-1862) elaborated the Geological map of Orlica, Bohor and Rudnica area dividing the Triassic rock succession into the Werfen and Gutenstein limestones as well as Hallstatt limestones and dolomites. The Dreger's geological map Rogatec-Kozje on the scale of 75 000 was printed in 1907. In the Orlica region among other the Werfen beds are separated as well. The explanatory text of the map was published in 1920. The Werfen beds are separated in the Vettors Geological map of the Republick Österreich S 1:500 000. Grad (1967) writes about the geology of the Kozjansko area. He found out that the Scythian stratigraphic sequence in the eastern Sava folds is composed of grey and yellow stratified dolomite, marly limestone and sandy shale. Buser (1979) separated and described among other the Scythian beds of Bohor. Recently, the Scythian beds of the considered area were worked out by Aničić and Juriša (1984, 1985), Aničić (1991) as well as Aničić and Dozet (2000).

GEOGRAPHIC SETTING

The considered area comprises Orlica Mts. with wider surroundings, which represent the eastern prolongation of the Sava folds that sink towards the east under the Tertiary beds of the Pannonian basin. The Orlica mountains extend in the northeast-southwest direction. This mountain chain has a very expressively developed relief. The high relief of the area consists of Orlica (626 m), Veliki vrh (701 m), V. Trbojnik (653 m), Velika gora (684 m), Intermedija (662 m), Denžičev breg (588 m) Rošce (619 m), V. Špiček (693 m), V. Vagla (667 m), Kunšperk (597 m) and Marjeta (507 m). The Orlica mountain chain is cut by numerous valleys in the north-east and northwest-southeast direction. The valleys are the deepest on the northern side. The hydrographic net is well-developed. In the northern part of the area treated there is the a small river Bistrica leading the water off from the northern part of Orlica into the river Sotla. Other water streams flow into the river Sotla or directly into the river Sava. Larger currents of the considered area are Orlica and Sušica rivulets as well as Močnik, Dramlja, Trebčica, Glog and Čehovec smaller water streams.

METHODS

The aim of this paper is to describe the Orlica sedimentary succession and to gather paleontological data for detailed lithological and biostratigraphic dismembering of the Scythian stratigraphic sequence as well as to find out its relations with surrounded rocks and formations. Stratimetrically measured and sedimentologically examined in detail are sedimentary successions in the cross-sections Pečice-Goli vrh, Kunej-Orliški potok and Orliški potok-Podsreški grad. The carbonate and clastic rocks are arranged by Folk's (1959) and Pettijohn's (1975) classifications.

STRATIGRAPHY

LOWER TRIASSIC-SCYTHIAN

DISTRIBUTION

Orlica anticline and its surroundings are built of the Younger Paleozoic, Scythian, Anisian, Ladinian, Norian, Rhaetian, Cretaceous as well as Oligocene, Miocene and Pliocene rocks.

In the considered area the Scythian beds are pretty wide-spread. They can be followed in tectonically several times interrupted belt passing from the village Pečice, across the Pusti vrh, Javor, Tisovec and Kunšperk towards the east as far as the Sotla river. In the study area the Scythian rocks are the most extended in the Osredek region.

LITHOLOGY

In the Orlica anticline area and its surroundings the Scythian sedimentary succession is composed of siltstone, sandstone, claystone, bedded sandy dolomite, oolitic, sparitic and micritic limestone, as well as marly limestone and marl. In the upper part of the succession nodular limestone and calcareous intraformational breccia occur here and there. The above-enumerated rocks form five lithostratigraphic members lying from bottom to top as follows: the Seis beds, the oolitic calcareous sandy member with gastropods, the Campilian beds, the limestone member with *Natiria costata* and *Meandrospira pusilla* (Fig. 1), as well as the marly and nodular limestone member.

The lower and upper boundary

The erosional-tectonic contact between the lowermost Scythian beds, we added to the Seis member, and the underlying Younger Paleozoic rocks is exposed in the core of the Orlica anticline. The topmost Scythian limestones pass normally into the dark grey dolomite, which is according to its stratigraphic position, superposition and fossil contents ranged into the Anisian stage. Namely, in the lowermost part of the dolomite succession the foraminifers *Glomospirella* sp. and *Glomospira* sp. have been found.

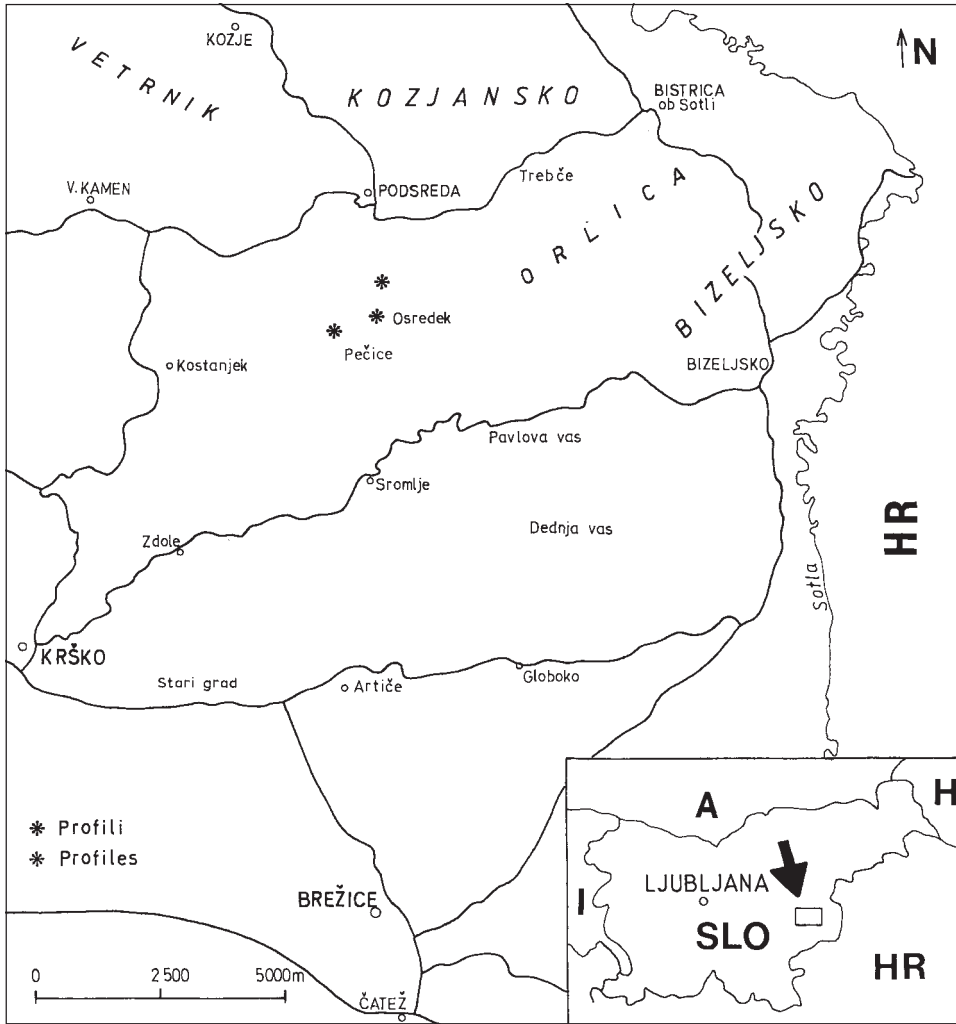


Fig. 1: Location sketch map of the investigated area.

Sl. 1: Lega raziskanega ozemlja.

The Seis beds

The lowermost part of the Scythian sedimentary succession in the Orlica anticline area is added to the Seis beds in narrower sense of the word. It is characterized by a rather typical and variegated sedimentation.

In the Seis stratigraphic sequence a sandstone, siltstone, marl, dolomite and limestone alternate. The sandstone is thin-bedded and fine-grained. The siltstone is very fine-stratified passing

frequently into a thin-bedded, fine-grained, siltstone and marl. All three sediments contain a pretty considerable quantity of mica. The dolomite is stratified and more or less micaceous. The limestone is micritic, stratified and platy.

The colour of the described rocks is very different. In the Seis clastic rocks the blackish red (violet) colour is predominant. The dolomites are mostly yellowish grey to yellowish brown. The limestone is dark grey.

Within the greenish grey and violet sandy shale poorly preserved pelecypods belonging to the genus *Anodontophora* and the species *Eumorphotis venetiana* Hauer occur. In the shales numerous dendrites can be seen. The thickness of the Seis beds amounts to 80 metres.

Oolitic calcareous sandy development with gastropods

Over the Seis sedimentary succession lies concordantly 65 metres thick succession, where bioclastic limestone with gastropods and pelecypods, further on, micritic and oolitic limestone as well as a limestone with iron ooids and a sandstone occur. The limestones are medium and thin-bedded (15-35 cm, 10-15 cm), brownish to dark grey or even blackish grey. Marly and clayey microsparitic limestones with frequent interlayers of oolitic and bioclastic limestones with *Holopella gracilior* (Schauroth) and *Natica* sp., as well as rare interbeds of brownish to dark grey stratified (15-45 cm) limestone with red iron ooids are predominant. The clayey microsparitic limestone is platy and thin-bedded. The strata are 10 cm to 25 cm thick. The rock is medium to olive grey. Here and there the limestone contains burrows with a diameter ranging from 1 mm to 4 mm. The burrows are darker than the rock passing in all directions. The clayey admixture is distributed in subparallel spots. Between the spots there are microsparitic areas. Such structure is a result of bioturbation. The burrows are filled in a part with pelmicrosparite and partly with echinoderm fragments and dolomite rhombhedrons.

The sandstone is fine- to medium-grained, yellow, orange yellow and rarely greenish, platy or even very fine stratified. Beside different colours this sediment is characterized by a larger or smaller contents of mica.

Campilian beds

In the whole Scythian stratigraphic succession the Campilian member is the best developed. Fine clastic sediments such as sandstone, siltstone, claystone and shale are prevalent in its composition. Within the clastic succession are dolomite as well as marly and oolitic limestone. Prevalently clastic development of the Campilian member passes occasionally laterally into a preva-

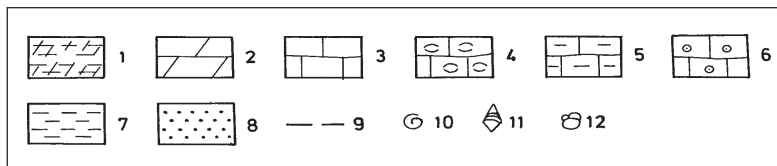
Legend: 1- massive dolomite, 2- bedded dolomite, 3- limestone, 4- nodular limestone, 5- marly limestone, 6- oolitic limestone, 7- marl, 8- sandstone, siltstone, shale, 9- fault, 10- molluscs, 11- gastropods, 12- foraminifers (on the page 91).

Legenda: 1- masivni dolomit, 2- plastnati dolomit, 3- apnenec, 4- gomoljasti apnenec, 5- lapornati apnenec, 6- oolitni apnenec, 7- lapor, 8- peščenjak, meljevec, skrilavec, 9- prelom, 10- moluski, 11- polži, 12- foraminifere (na strani 91).

STOPNJA-STAGE		Geološki stolpec Geological column	Debelina Thicknesses (m)	SESTAVA COMPOSITION	FOSILI FOSSILS	TEKSTURA STRUCTURE
Člen Member	ANIZIJ ANISIAN					
				masivni dolomit massive dolomite plastnati dolomit bedded dolomite	Glomosipa sp. Glomospirella sp.	stromatoliti stromatolites
			10	lapor. in gomoljast ap. mari a. nodular limest.	Holopella gracilior Meandrospira pusilla Natria costata	dendriti dendrites
			30	različni apnenci z mikro in makrofavno Various limestones with micro a. macrofauna	Myophora costata Meandrospira pusilla Natria costata Natica sp.	vodoravna laminacija parallel lamination
			40 - 100	a. Pretežno dolom. razvoj a. Prevalently dolomitic development b. Pretežno peščen razvoj b. Prevalently sand development		
			65	Oolitni apnenčevo peščeni razvoj s polžki Oolitic limestone sandy development with gastropods	Holopella gracilior Holopella gracilior	navzkrižna laminacija cross- lamination
			80	peščenjaki apnenci lapor, dolomit sandstones limestones marl, dolomite	Anodontophora Eumorphotis venetiana	dendriti dendrites

Fig. 2: Geological column of the Scythian beds in the Orlica anticline area.

Sl. 2: Geološki stolpec skitskih plasti na območju orliške antiklinale.



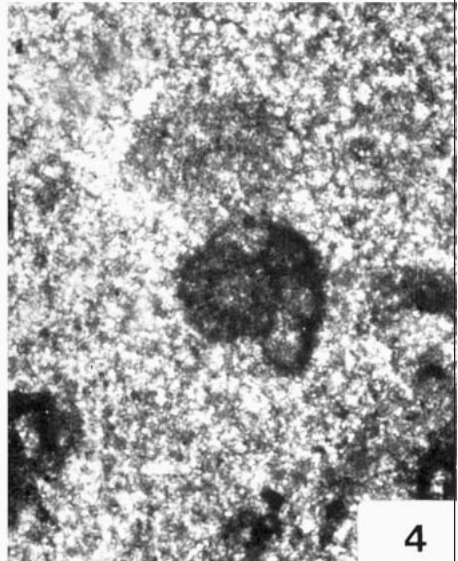
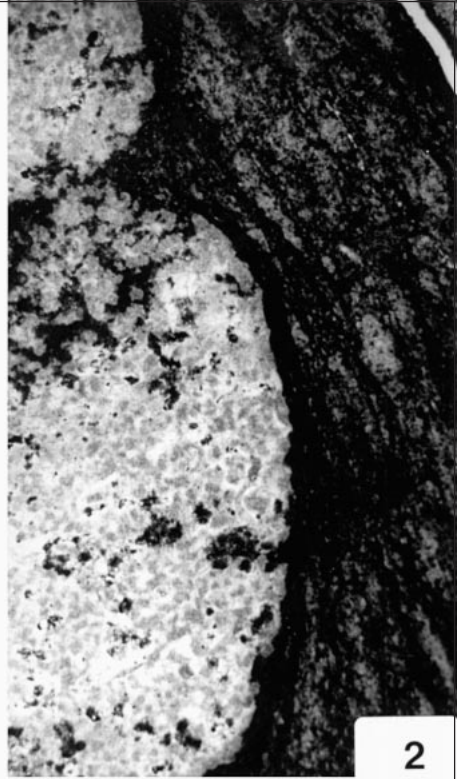
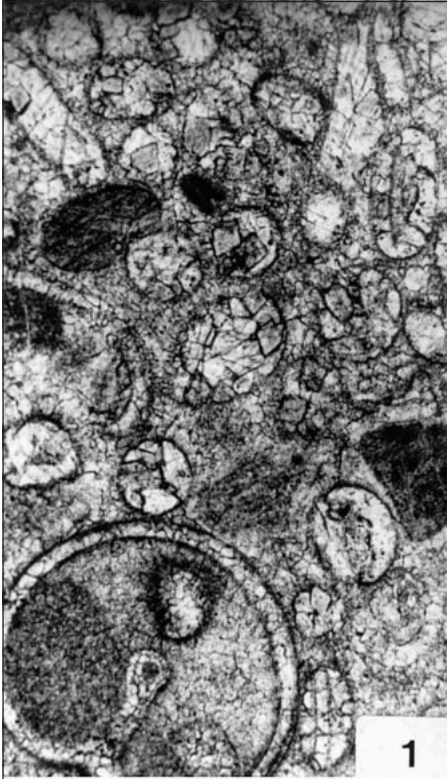


Fig. 3/1: Strongly dolomitized bioosparitic limestone with numerous fragments and sections of molluscs. Orlica, Lower Scythian, (47×).

Sl. 3/1: Močno dolomitiziran bioosparitni apnenec s številnimi odlomki in preseki moluskov. Orlica, spodnji skit, (47×).

Fig. 3/2: Clayey microsparitic limestone with burrows. A detail of a larger burrow filled with pelmicrosparitic mud. North of Pečice, Lower Scythian, (19×).

Sl. 3/2: Glinasti mikrosparitni apnenec z rovi (burrows). Detajl večjega rova zapolnjenega s pelmikrosparitom. Severno od Pečic, spodnji skit, (19×).

Fig. 3/3: *Myophoria costata* Zenker in grained limestone. At the road Goli vrh-Pečice, Upper Scythian, (2×).

Sl. 3/3: *Myophoria costata* Zenker v zrnatem apencu. Ob cesti Goli vrh-Pečice, zgornji skit, (2×).

Fig. 3/4: *Meandrosira pusilla* (Ho) in a strongly recrystallized limestone. Orlica, (250×).

Sl. 3/4: *Meandrosira pusilla* (Ho) v močno rekristaliziranem apencu. Orlica, (250×).

lently dolomitic development with intercalations of clastic sediments. In the study area the Campilian member is characterized beside the variegated lithological composition also by variety of colours and large contents of mica. The most colourful are clastic sediments appearing in various shades of red colour and sometimes in bluish, yellowish and greenish grey colour. The dolomite is yellowish grey to orange yellow and in spots pinky.

The limestone is moderate dark grey and brownish yellow (if it is weathered). The dolomite is stratified (15-35 cm). Within the dolomite beds accumulations of mica can be observed. The mica is recognizable still with the naked eye in the dolomite as well. In spots the dolomite shows an oolitic structure, but it mostly occurs in the form of dolomicrite or dolosparite. The limestone is micritic or fine-oolitic. Sometimes it can be bioclastic containing numerous mollusc fragments.

The limestones with pelecypods, gastropods and foraminifers

Concordantly and without interruption over the Campilian member lies dark grey, greyish black and black, platy and stratified (10-60 cm) micritic and grained limestone containing frequently white calcite veinlets. In the basal bed of that interval of the Scythian lithological column occur very well-shaped gastropods of the species *Natiria costata* (Münster). In the stack of micritic limestone rare interbeds of oolitic limestone as well as rare beds of bioclastic-limestone with rare pelecypods and gastropods of the genus *Natica* can be observed. In the fossil material the pelecypod *Myophoria costata* Zenker (Fig. 3/3) is found out. In the thin-sections of the sparitic limestone the foraminifer *Mandrosira pusilla* (Ho) is determined (Fig. 3/4).

The thickness of the described sedimentary succession amounts to 30 metres.

Marly and nodular limestone

In the topmost part of the Scythian lithological column there is about 8 to 10 metres thick stack of platy and thin-bedded (1-15 cm) dark grey marly limestone with schistose structure and yellowish to orange oxide cover containing rare thin interlayers of oolitic limestone. In the fine-grained limestone the foraminifer *Meandrospira pusilla* (Ho) has been found. On the other hand, in the bioclastic limestone at the top of the Scythian sedimentary stack, the gastropod *Natiria costata* (Münster) and the pelecypod *Myophoria costata* (Zenker) have been found.

The considered lithologic member is terminated by a 60 centimetre thick bed of greyish red oolitic limestone with the gastropod *Holopella gracilior* (Schauroth).

SEDIMENTARY ENVIRONMENT

In the Orlica anticline area and its surroundings a shallow restricted sea predominates in the Scythian period, where sand and ooids have been episodically and periodically brought by currents and waves. The groundmass between ooids was formerly micritic and later recrystallized into a microsparite and very fine-grained sparite. The micritic groundmass indicates a calm water. Microsparitic clayey limestone proves a calm sedimentary environment as well. Partly early diagenetic dolomitization of limestone and an occurrence of fine-grained sparitic dolomite speaks for a shallow water and episodic desiccation in the supralittoral belt.

CONCLUSIONS

The variegated sedimentary succession in the Orlica anticline area, which is ranged into the Scythian series, lies discordantly upon the Permo-Carboniferous dark grey to black shales, quartz sandstones and conglomerates passing upwards normally on to the concordantly overlying moderate grey stratified Anisian dolomite with foraminifers *Glomospira* sp. and *Glomospirella* sp.

In the considered area the Scythian series is subdivided into 5 lithostratigraphic members; namely: 1) - Seis beds, 2) - oolitic limestone-sand member with gastropods, 3) - Campilian beds, 4) - limestone member with *Natiria costata* and *Meandrospira pusilla* and 5) - marly and nodular limestone. In the lithologic composition of the Seis beds stratified and massive, red and violet red, rarely greenish grey quartz sandstones with interbeds of claystones as well as clayey shales, dolomites and limestones occur. In the sandy shales the pelecypods *Anodontophora* sp. and *Eumorphotis venetiana* have been found.

In the oolitic limestone-sand member bioclastic limestones with *Holopella gracilior*, micritic and oolitic limestone, limestone with iron ooids and quartz sandstone alternate. In the southern Sava folds in the Orlica anticline area the Campilian beds are most colourfully developed. In its composition fine-grained sediments such as sandstones, siltstones, claystones and clayey shales prevail. Within the described succession interbeds of dolomite as well as marly and oolitic limestones occur. In the Campilian member no fossils have been found yet.

Concordantly upon the Campilian sediments lies the succession of the dark grey to black, prevalently bedded micritic and grained limestone with white calcite veinlets, well-preserved

gastropod *Natiria costata* shells and *Natica*, as well as the pelecypod *Myophoria costata* and foraminifer *Meandrospira pusilla*. The Scythian series is terminated by a 60 cm thick bed of greyish red oolitic limestone with the gastropod *Holopella gracilor*.

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RAZVOJ SKITSKE SERIJE NA OBMOČJU ORLIŠKE ANTIKLINALE (POSAVSKE GUBE)

Povzetek

Pestro zaporedje sedimentov na območju orliške antiklinale, ki smo ga uvrstili v skitsko serijo, leži diskordantno na karbonskih in permskih temno sivih do črnih glinenih skrilavcih, kremenovih peščenjakih in konglomeratih, navzgor pa prehajajo brez prekinitve v konkordantno ležeči srednje sivi, plastnati anizijski dolomit s foraminiferama *Glomospira* sp. in *Glomospirella* sp.

Skitska serija je na obravnavanem ozemlju razčlenjena na 5 litostratigrafskih členov (od spodaj navzgor): 1) - seiske plasti, 2) - oolitni apnenčevo peščeni člen s polži, 3) - campilske plasti, 4) - apnenčev člen s školjkami, polži in foraminiferami in 5) - lapornati in gomoljasti apnenec.

V sestavi seiskih plasti prevladuje plastnati in masivni, rdeči in vijoličasto rdeči, redkeje zelenkasto sivi kremenov peščenjak z vložki glinovca, glinenega skrilavca, dolomita in apnenca. V peščenem skrilavcu se pojavljajo školjke *Anodontophora* sp. in *Eumorphotis venetiana*.

V oolitnem apnenčevo peščenem členu se menjavajo bioklastični apnenec s polži *Holopella gracilior*, mikritni in oolitni apnenec, apnenec z železovimi ooidi ter kremenov peščenjak.

V južnih Posavskih gubah je na območju orliške antiklinale najbolj pestro razvit campilski člen. V njegovi sestavi prevladujejo drobnoklastični sedimenti peščenjak, meljevec, glinovec in glineni skrilavec. Vmes se pojavljajo vložki laporja, dolomita ter lapornega ali oolitnega apnenca. V campilskem členu niso najdeni fosili. Konkordantno na campilskih sedimentih leži skladovnica temno sivega do črnega pretežno plastnatega mikritnega in zrnatega apnenca z belimi kalcitnimi žilicami in lepo ohranjenimi hišicami polžev *Natiria costata* in *Natica* sp. ter s školjko *Myophoria costata* in foraminifero *Meandrospira pusilla*.

Skitsko serijo zaključuje skladovnica temno sivega tankoplastnatega, ploščastega in skrilavega lapornega apnenca, ki navzgor prehaja v drobnogomoljasti apnenec s foraminifero *Meandrospira pusilla* in polžema *Natiria costata* in *Natica* sp. Skitsko serijo zaključuje 60 cm debela plast sivkasto rdečega oolitnega apnenca s polžem *Holopella gracilior*.

ZAHVALA

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