Геолошки анали Балканског полуострва Annales Géologiques de la Péninsule Balkanique	77	13–21	Београд, децембар 2016 Belgrade, December 2016

DOI: 10.2298/GABP1677013G

Chert blocks in the ophiolitic mélange of Zlatibor Mt. (SW Serbia) – age and geodynamic implications

Nataša Gerzina[1] & Nevenka Djerić[2]

Abstract. Cherts are quite frequently occurring rocks in the Internal Dinarides, an extremely complex area composed of several tectonostratigraphic units in which oceanic sediments, ophiolites and partly metamorphosed parts of the distal continental margin of Adria are preserved. Therefore, these cherts differ in age and the original depositional environment in which they were formed.

Results of investigations carried out in the chert blocks found in the mélange in the vicinity of Jasenovo village on SE slopes of Zlatibor Mt. are presented here. Radiolarian cherts from the studied localities represent blocks in mélange of the East-Bosnian–Durmitor Unit, exposed in a large tectonic window below the Triassic carbonates of Drina–Ivanjica Unit. Biostratigraphic data revealed Callovian–early Kimmeridgian ages of the studied chert blocks, thus implying a Kimmeridgian or younger age of obduction of the West Vardar ophiolites.

Key words: Cherts, radiolarians, ophiolitic mélange, Jurassic, Internal Dinarides, SW Serbia.

Апстракт. Рожнаци се често срећу у Унутрашњим Динаридима, изузетно комлексној области изграђеној од неколико тектоностратиграфских јединица у којима су сачувани океански седименти, офиолити и делимично метаморфисани делови дисталне маргине Адрије. Тако се на овом простору појављују рожнаци различите старости формирани у различитим депозиционим срединама.

У овом раду приказани су резултати истраживања рожначких блокова у меланжу у близини села Јасеново на ЈИ падинама Златибора. Радиоларијски рожнаци са истраживаних локалитета представљају блокове у меланжу Источнобосанско-дурмиторске јединице, откривеном у тектонском прозору испод тријаских карбоната Дринско-ивањичке јединице. Биостратиграфском анализом добијена је келовејско-доњокимеријска старост истраживаних блокова рожнаца, што указује да је обдукција Западно-вардарских офиолита била током кимерица или касније.

Кључне речи: Рожнаци, радиоларије, офиолитски меланж, јура, Унутрашњи Динариди, ЈЗ Србија.

Introduction

Precise dating of wide variety of oceanic sediments is necessary for reconstructions of palaeogeography and geodynamic evolution of oceanic basins and their continental margins. In that sense, radiolarian biostratigraphy is extensively used today in dating pelagic marine sediments. Investigations of radiolarian associations carried out so-far in the Internal Dinarides of Serbia reveal the following age clusters: Middle to Late Triassic, Middle Jurassic and Late Cretaceous. Early Jurassic ages have not been proven in the Internal Dinarides in Serbia, while Upper Jurassic ages have been questioned recently.

Both Triassic and Jurassic radiolarians occur in chert blocks embedded in mélange of Late Jurassic age in the Internal Dinarides (e.g. Obradović *et al*. 1987/88; Goričan *et al*. 1999; Vishnevskaya *et al*. 2009; Ozsvárt & Kovács 2012; Gawlick *et al*. 2009; Djerić *et al*. 2010).

Triassic ages are obtained for oceanic sediments associated with MORB-like and within-plate basalts

[1] University of Belgrade - Faculty of Mining and Geology, Department of Geology, Kamenička 6, P.O. Box 227, 11000 Belgrade, Serbia. E-mail: natasa.gerzina@rgf.bg.ac.rs

[2] University of Belgrade - Faculty of Mining and Geology, Department of Palaeontology, Kamenička 6, P.O. Box 227, 11000 Belgrade, Serbia. E-mail: nevenka.djeric@rgf.bg.ac.rs

(OBRADOVIĆ *et al*. 1987/88; VISHNEVSKAYA *et al*. 2009), while Middle Jurassic ages are established for pelagic sediments that stratigraphically overlie platform carbonates of the passive margin of Adria (e.g. DJERIĆ *et al*. 2007, 2012), as well as from ophiolite-bearing detrital sediments formed during the obduction of the ophiolites onto the adjacent continental margin (OBRADOVIĆ & GORIČAN 1988; VISHNEVSKAYA *et al*. 2009; DJERIĆ *et al*. 2010). Late Cretaceous radiolarians are found in sedimentary cover of ophiolitic mélange of the Western Vardar Zone (e.g. DJERIĆ *et al*. 2009; BRAGINA *et al*. 2014; DJERIĆ & GERZINA 2014).

The aim of this paper is to present results of investigations carried out in the chert blocks found in the mélange in the vicinity of Jasenovo village on SE flanks of Zlatibor Mt.

Geological setting

The study area is situated in SW Serbia. In a geotectonic sense, it is a part of the Internal Dinarides, DIMITRIJEVIĆ, M.D. 2001; DIMITRIJEVIĆ *et al*. 2001, 2003; KARAMATA 2006).

According to other opinions (e.g. BERNOULLI & LAUBSCHER 1972; BAUMGARTNER 1985; PAMIĆ 1998; PAMIĆ *et al*. 2002; CSONTOS *et al*. 2003, 2004; BORTOLOTTI *et al*. 2004, 2013; BORTOLOTTI & PRINCIPI 2005; SCHMID *et al*. 2008) all these ophiolites derived from a single ocean and were thrusted onto the continental margin of Adria. According to these interpretations, continental (Drina–Ivanjica, Jadar, and East-Bosnian–Durmitor) blocks which separate two ophiolite belts are tectonic windows below the obducted ophiolites, in which the most distal parts of Adria are exposed (Fig. 1). This implies that ophiolites formed single, continuous sheet referred to as the Western Vardar Ophiolitic Unit that was obducted during the Late Jurassic (CSONTOS *et al*. 2003, 2004; SCHMID *et al*. 2008) and includes all ophiolites of the Dinarides west of the Sava Zone. Subsequent out-of-sequence thrusting resulted in formation of composite units made up of the continental margin of Adria, ophiolitic mélange and obducted ophiolites.

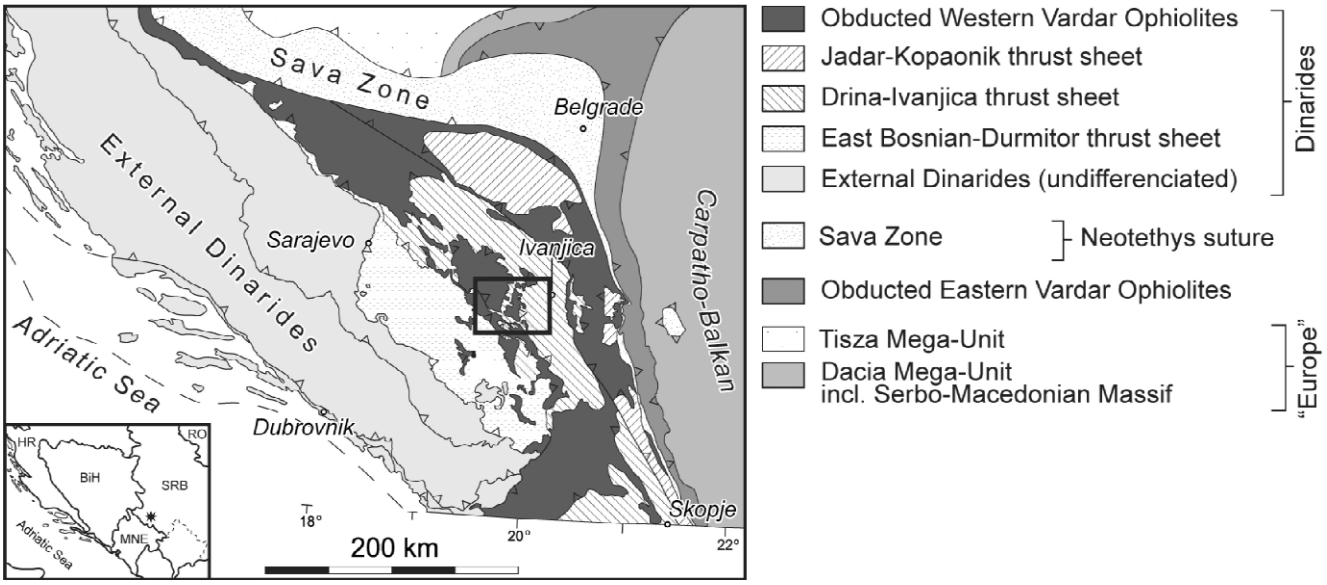

Fig. 1. Tectonic sketch of the Dinarides (modified after SCHMID *et al*. 2008; SCHEFER *et al*. 2010), with indicated position of the studied localities.

geologically extremely complex area composed of several tectonostratigraphic units in which oceanic sediments, ophiolites and partly metamorphosed parts of the distal continental margin of Adria are preserved.

Dinaridic ophiolites have been considered as remnants of two different oceanic basins by majority of Serbian authors working in the Dinarides (e.g., MAKSIMOVIĆ 1975; DIMITRIJEVIĆ & DIMITRIJEVIĆ 1973, 1974, 1975, 1976, 1979; PAMIĆ & MAJER 1977; KARAMATA *et al*. 1980; PAMIĆ 1983; LUGOVIĆ 1986; ROBERTSON & KARAMATA 1994; KARAMATA *et al*. 1999;

Methods

Two samples were collected from chert blocks found in the mélange in the vicinity of Jasenovo village on SE flanks of Zlatibor Mt. All the productive samples are radiolarian cherts and were treated with diluted 7% hydrofluoric acid, following the method of PESSAGNO & NEWPORT (1972). The radiolarians are generally poorly preserved. The assemblages were dated with the zonation of BAUMGARTNER *et al*. (1995). The data obtained during the last 15 years show that some

species have longer ranges than previously established by BAUMGARTNER *et al*. (1995). The age assignments are discussed below. Generic names have been updated according to O'DOGHERTY *et al*. (2009).

The SEM microscope ISI-160 in GIN RAN (Moscow) (sample NĐ 132) and JEOL JSM - 6460LV SEM at the Department for Biology and Ecology, University of Novi Sad (sample NĐ 108) were utilized for the precise identification and illustration of the radiolarians. All the material examined is deposited at the Faculty of Mining and Geology, University of Belgrade.

Description of outcrops and biostratigraphy

The studied samples were collected from two chert outcrops on SE slopes of Zlatibor Mt. (Fig. 2).

The locality Rauke is situated 3 km east of village Jasenovo (x = 7412597, y = 4824315). It is about 1.5 m thick succession of greenish, dark gray and black stratified chert with thin interlayers of siliceous shale (Fig. 3). Average thickness of chert layers is 3–6 cm, but it exceeds 15 cm in places.

Sample NĐ 132, taken at this locality, is characterized by a relatively poorly preserved radiolarian association. Presence of species *Praewilliriedellum robusta* (MATSUOKA) indicates a latest Bajocian to early Callovian age of the sediment (UAZs 5-7). The association can not be younger than the Callovian, which is confirmed by the presence of species *Belleza decora* (RUST) whose last occurrence is in UAZ 7, (BAUMGARTNER *et al*. 1995). Besides these characteristic species, the radiolarian association in the sample NĐ 132 comprises also *Transhsuum maxwelli* gr. (PESSAGNO), *Transhsuum* sp. aff. *T. maxwelli, Transhsuum*

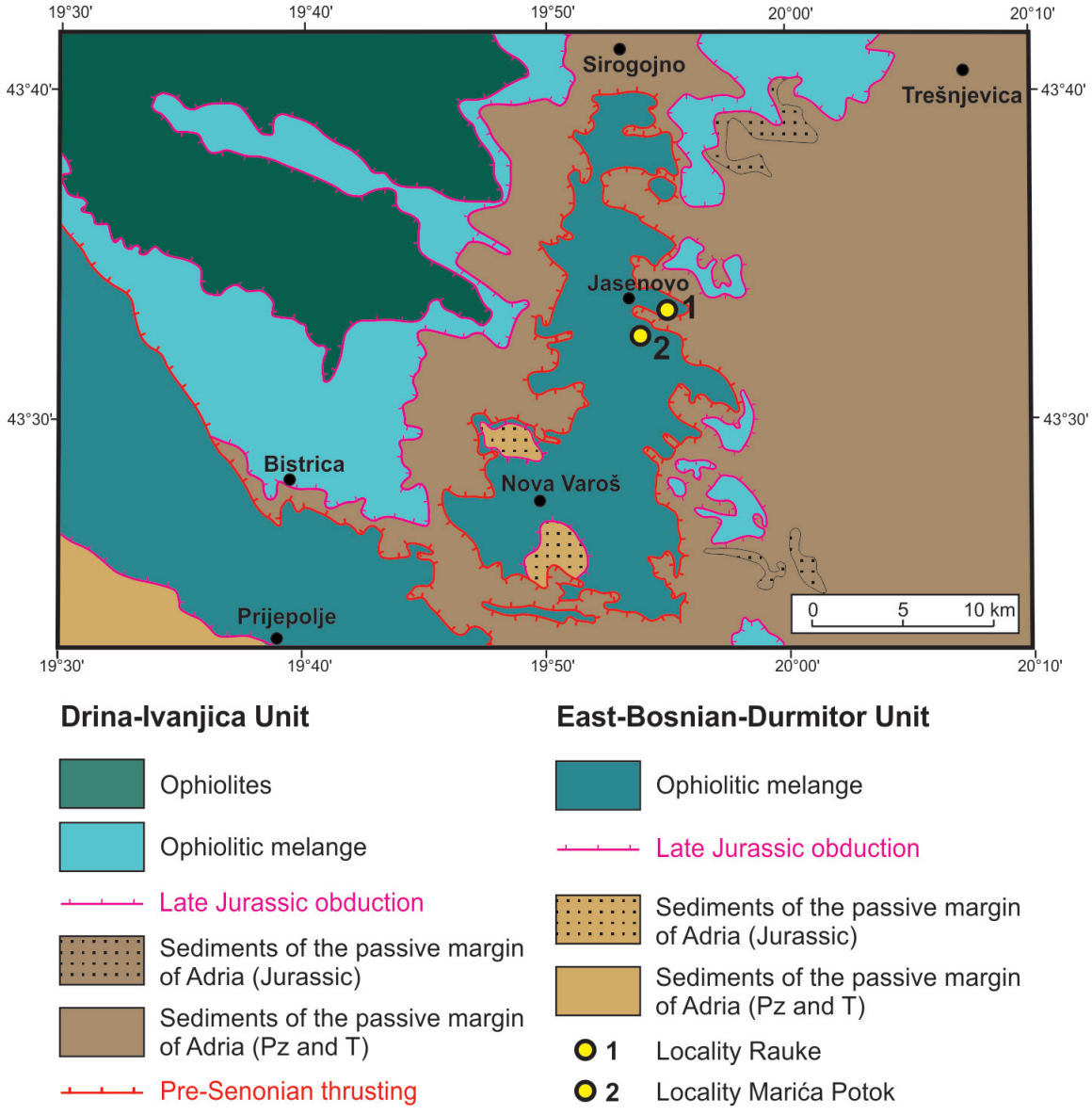

Fig. 2. Simplified geologic map of the wider investigation area (modified after DJERIĆ *et al*. 2012).

Fig. 3. Chert block at the locality Rauke.

brevicostatum gr. (OZVOLDOVA), *Tethysetta baloghi* (KOZUR), *Transhsuum* sp., *Napora* sp., *Stichomitra* sp. and *Praewilliriedellum* sp. (Fig. 4).

Transhsuum sp. cf. *T. maxwelli* gr., *Eucyrtidiellum ptyctum* (RIEDEL & SAN FILIPPO), *Zhamoidellum ventricosum* DUMITRICA, *Zhamoidellum ovum* DUMITRICA, *Zhamoidellum* sp. cf. *Z. ovum*, *Zhamoidellum* sp. cf. *Z. kozuri* (HULL), *Williriedellum frequens* (TAN SIN HOK) and *Cryptamphorella* sp. (Fig. 6).

According to BAUMGARTNER *et al*. (1995), the last occurrence of *Transhsuum maxwelli* gr. is reported in UAZ 10. Acording to the same authors, *Zhamoidellum ventricosum* is known from the UAZ 8-11, but it has recently been reported also from assemblages of UAZ 6-7 (e.g. ŠMUC & GORIČAN 2005; O'DOGHERTY *et al*. 2006; CHIARI *et al*. 2013) and is no more considered to have its first occurrence in UAZ 8. *Zhamoidellum ovum* is, according to BAUMGARTNER *et al*. (1995) known from the interval Middle–Late Oxfordian to Late Kimmeridgian–Early Tithonian (UAZ 9-11). However, according to SUZUKI & GAWLICK (2003), this species has its first occurrence in Callovian. Also *Cinguloturris carpatica* has its first occurrence in UAZ 7 (BAUMGARTNER *et al*. 1995). Originally, this zone comprised the late Bathonian and early Callovian (BAUMGARTNER

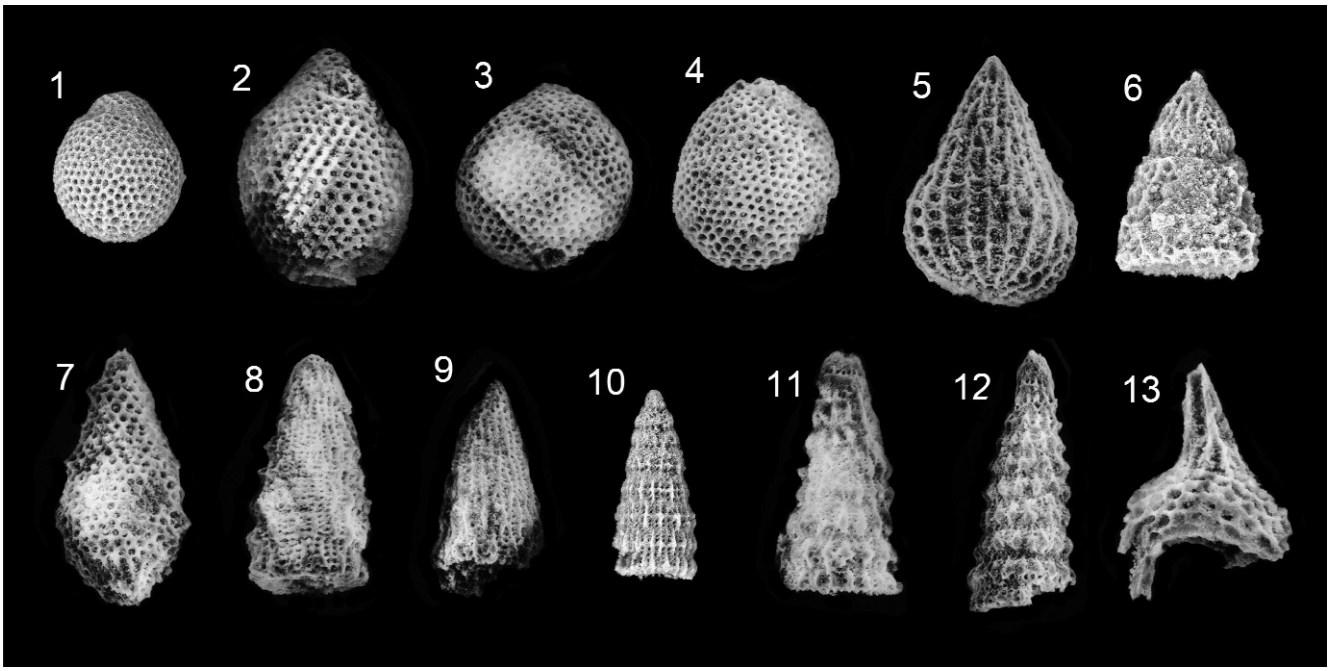

Fig. 4.. Middle Jurassic radiolarians from the Rauke locality. **1, 2,** *Praewilliriedellum* sp. cf. *P. robusta* (MATSUOKA), ×300; **3, 4**. *Praewilliriedellum* sp., ×200; **5.** *Belleza decora* (RUST), ×300; **6.** *Stichomitra* sp., ×200; **7.** *Tethysetta baloghi* (KOZUR), ×200; **8, 9.** *Transhsuum maxwelli* gr. (PESSAGNO), ×200; **10.** *Transhsuum* sp. aff. *T. maxwelli* (PESSAGNO), ×200; **11.** *Transhsuum* sp., ×200; 12. *Transhsuum brevicostatum* gr. (OZVOLDOVA), ×200; **13**. *Napora* sp., ×200

At the locality Marića Potok, in a creek near village Jasenovo (x = 7411278, y = 4822274), there is an outcrop of 8 m thick red thin-layered chert with thin interlayers of siliceous shale (Fig. 5).

Sample NĐ 108, taken at this locality, contains the following radiolarian association: *Cinguloturris carpatica* DUMITRICA, *Transhsuum maxwelli* gr. (PESSAGNO), *et al*. 1995). A diverse radiolarian assemblage of UAZ 7 was subsequently described from a sample above the early Callovian ammonites, which led to the conclusion that UAZ 7 is mainly Callovian in age (BECCARO 2006).

According to these data, this sample is not older than the Callovian and not younger than late Oxfordian–early Kimmeridgian.

Fig. 5. Chert block at the locality Marića Potok (Photo courtesy of Milan Sudar and Divna Jovanović).

been proven yet in the territory of Serbia. Radiolarian cherts of Jurassic age, which represent the uppermost part of the obducted oceanic crust, appear to be preserved in Albania only (e.g. CHIARI *et al*. 1994; PRELA *et al*. 2000).

Jurassic-age radiolarian cherts are also found as an integral part of the "*in situ*" preserved passive margin sedimentary sequence in the footwall of the ophiolitic mélange (East-Bosnian–Durmitor and Drina–Ivanjica units) (DJERIĆ *et al.* 2007, DJERIĆ *et al*. 2012, RADOIČIĆ *et al*. 2009). Such radiolarites were originally deposited onto Triassic and Lower Jurassic carbonaceous platform sediments of the distal Adriatic margin. Parts of the sedimentary sequence of the passive margin were subsequently torn-off and incorporated in the mélange at the front of the obducting nappe.

Although there are outcrops of basalt pillow-lavas in the immediate vicinity of the studied localities, no

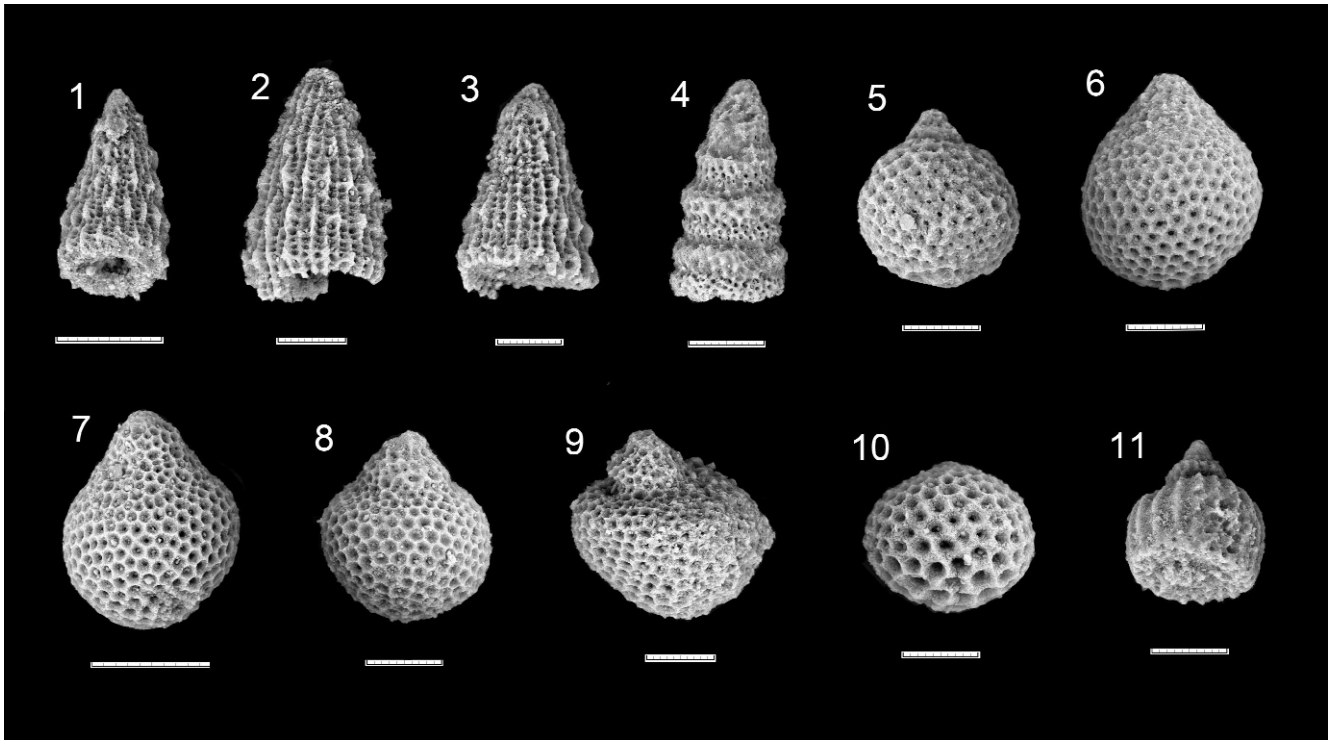

Fig. 6. Middle to Late Jurassic radiolarians from the Marića potok locality. Scale bar 50 μm (2–11); 100 μm (1). **1.** *Transhsuum maxwelli* gr. (PESSAGNO); **2, 3.** *Transhsuum* sp. cf. *T. maxwelli* gr. (PESSAGNO); **4.** *Cinguloturris carpathica* DUMITRICA; **5.** *Williriedellum frequens* (TAN SIN HOK); **6, 7.** *Zhamoidellum ovum* DUMITRICA; **8.** *Zhamoidellum* sp. cf. *Z. kozuri* (HULL); **9.** *Zhamoidellum ventricosum* DUMITRICA; **10.** *Cryptamphorella* sp.; **11.** *Eucyrtidiellum ptyctum* (RIEDEL & SANFILIPPO)

Discussion and conclusions

Middle Jurassic radiolarian cherts are abundant in the region. A widely accepted opinion among Serbian geologists (e.g. RADOVANOVIĆ 1987; KARAMATA 2006) is that these rocks represent a sedimentary cover of the Neotethyan oceanic crust. However, a clear association of Jurassic cherts with MOR basalts has not stratigraphic contact with cherts has been observed. This confirms previous observations that there are no radiolarites associated with mid-ocean-ridge related basalts which would represent the uppermost part of the Jurassic oceanic crust in the Dinarides. Therefore, the studied cherts probably did not derive from the sedimentary cover of the ocean floor, but from the distal parts of the passive margin of Adria. Besides, field

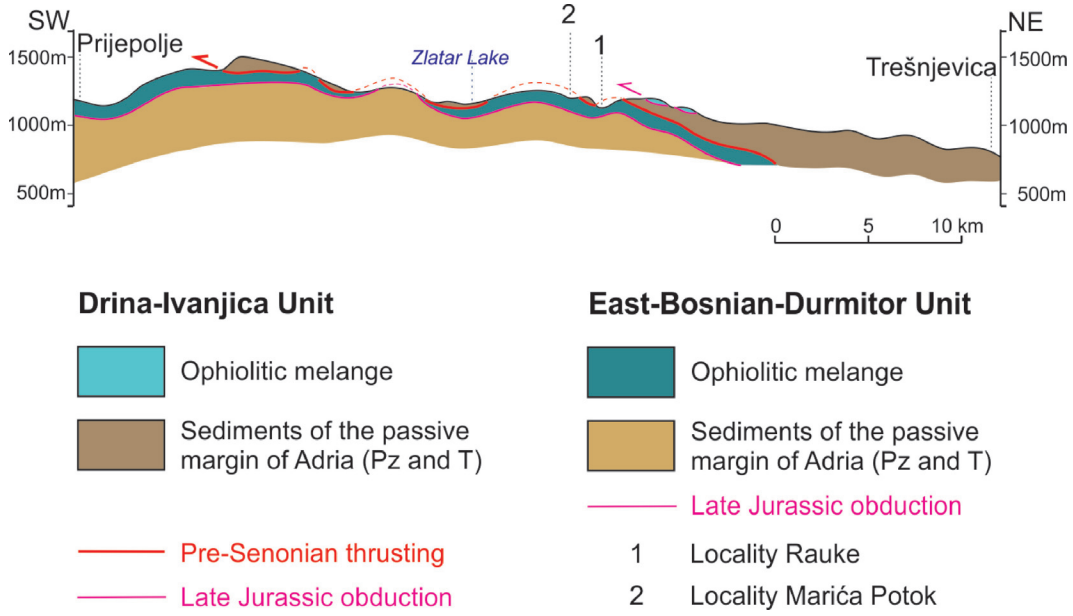

Fig. 7. Geological cross-section through the SE flanks of Zlatibor Mt. with indicated positions of the studied localities.

observations show that all these rocks are in a large tectonic window below the Triassic carbonates of Drina–Ivanjica Unit. Accordingly, radiolarian cherts from the studied localities at the SE flanks of Zlatibor Mt. represent blocks in mélange of the East-Bosnian–Durmitor Unit (Figs. 2, 7).

The age of mélange formation, and hence of the final stages of obduction of the West Vardar ophiolites is equal to, or younger, than the youngest dated blocks in the mélange. Radiolarian age obtained for the chert block at the locality Rauke is rather similar to that of the previously dated radiolarite blocks in the Serbian Dinarides (GAWLICK *et al*. 2009; VISHNEVSKAYA *et al*. 2009; DJERIĆ *et al*. 2010). The radiolarian association identified from the chert sample from the locality Marića Potok certainly represents the youngest so-far determined age (Callovian – early Kimmeridgian) of chert blocks in the mélanges in this part of the Dinarides. This implies a Kimmeridgian or younger age of obduction of the West Vardar ophiolites. This age, however, should be taken with extreme caution because such a wide age interval could be a result of low diversity and poor-to-moderate level of preservation of the analyzed radiolarian association. Nevertheless, the obtained data perfectly comply with timing of obduction of the Jurassic Neotethyan oceanic crust based on radiometric ages (179–150 Ma) obtained from metamorphic soles in the Dinarides and Hellenides (e.g. SPRAY *et al*. 1984).

Acknowledgements

The study was supported by Ministry of Education Science and Technological Development of the Republic of Serbia, Project No. 176015. Many thanks go to HAZIM HRVATOVIĆ (Federal Institute for Geology, Sarajevo, Bosnia & Herzegovina) and NIKITA BRAGIN (Russian Academy of Sciences, Moscow, Russia) for their helpful revisions.

References

BAUMGARTNER, P.O. 1985. Jurassic sedimentary evolution and nappe emplacement in the Argolis Peninsula (Peloponnesus, Greece). *Mémoires de la Société Helvétique des Sciences Naturelles*, 99: 1–111.

BAUMGARTNER, P. O., BARTOLINI, A., CARTER, E. S., CONTI, M., CORTESE, G., DANELIAN, T., DE WEVER, P., DUMITRICA, P., DUMITRICA-JUD, R., GORIČAN, Š., GUEX, J., HULL, D., KITO, N., MARCUCCI, M., MATSUOKA, A., MURCHEY, B., O'DOGHERTY, L., SAVARY, J., VISHNEVSKAYA, V., WIDZ, D.& YAO, A. 1995. Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys based on Unitary Associations. *In*: BAUMGARTNER, P.O., O'DOGHERTY, L., GORIČAN, Š., URQUHART, E., PILLEVUIT, A. & DE WEVER, P. (Eds.), Middle Jurassic to lower Cretaceous radiolaria of Tethys: Occurrences, Systematics, Biochronology. *Mémories de Géologie*, 23: 1013–1048.

BECCARO, P. 2006. Radiolarian biostratigraphy of Middle-Upper Jurassic pelagic siliceous successions of western Sicily and the Southern Alps (Italy). *Mémoires de Géologie (Lausanne)*, 45: 1–87.

BERNOULLI, D. & LAUBSCHER, H. 1972.The palinspastic problem of the Hellenides. *Eclogae geologicae Helvetiae*, 65 (1): 107–118.

BORTOLOTTI, V. & PRINCIPI, G. 2005. Tethyan ophiolites and Pangea break-up. *Island Arc*, 14: 442–470.

BORTOLOTTI, V., CHIARI, M., MARCUCCI, M., MARRONI, M., PANDOLFI, L., PRINCIPI, G.F. & SACCANI, E. 2004. Comparison among the Albanian and Greek Ophiolites: in

search of constraints for the evolution of the Mesozoic Tethys Ocean. *Ofioliti*, 29: 19–35.

Bortolotti, V., Chiari, M., Marroni, M., Pandolfi, L., Principi, G. & Saccani, E. 2013. Geodynamic evolution of ophiolites from Albania and Greece (Dinaric-Hellenic belt): one, two, or more oceanic basins? *International Journal of Earth Sciences (Geologische Rundschau)*, 102: 783–811.

Bragina, L.G., Bragin, N.Yu., Djerić, N. & Gajić, V. 2014. Late Cretaceous Radiolarians and Age of flyschoid Sediments in the Struganik Section (Western Serbia). *Stratigraphy and Geological Correlation*, 22 (2): 90–107.

Chiari, M., Marcucci, M. & Prela, M. 1994. Mirdita ophiolites Project: 2. Radiolarian assemblages in the cherts at Fushe Arrez and Shebaj (Mirdita Area, Albania). *Ofioliti,* 19(2a): 313–318.

Chiari, M., Baumgartner, P., Bernoulli, D., Bortolotti, V., Marcucci, M., Photiades, A. & Principi, G. 2013. Late Triassic, Early and Middle Jurassic Radiolaria from ferromanganese-chert "nodules" (Angelokastron, Argolis, Greece): evidence for prolonged radiolarite sedimentation in the Maliac Vardar Ocean. *Facies*, 59: 391–424.

Csontos, L., Gerzina, N., Hrvatović, H., Schmid, S.M. & Tomljenović, B. 2003. Structure of the Dinarides: a working model. *Annales Universitatis Scientarium Budapestinensis de Rolando Eötvös Nominata*, *Sectio Geologica*, 35: 143–144.

Csontos, L., Gerzina, N., Hrvatović, H., Schmid, S.M. & Tomljenovic, B. 2004. Structural evolution of the Internal Dinarides: a preliminary study based on selected regions. *5th International Symposium on Eastern Mediterranean Geology*, Thessaloniki, Greece, 14. –20. April 2004.

Dimitrijević*, M. D.*, 2001: Dinarides and the Vardar Zone: a short review of the geology. *Acta Vulcanologica* 13, 1–8.

Dimitrijević, M. D. & Dimitrijević, M. N. 1973. Olistostrome Mélange in the Yugoslavian Dinarides and Late Mesozoic Plate Tectonics. *Journal of Geology*, 81: 328–340.

Dimitrijević, M. D. & Dimitrijević, M. N. 1974. On genesis of the "Diabase-chert Formation". Geological Survey of Montenegro. *Geološki glasnik*, 7: 333–349 (in Serbian).

Dimitrijević, M. D. & Dimitrijević, M. N. 1975. "Diabase-chert Formation" of the Ophiolitic Belt and the Vardar Zone: genetic comparison. *Acta Geologia*, VIII-18, 41: 347–358 (in Serbian).

Dimitrijević, M. D. & Dimitrijević, M. N. 1976. The polyphase mélange of the Vardar zone. *Bulletin de la Société Géologique de France*, 18 (2): 205–208.

Dimitrijević, M. D. & Dimitrijević, M. N. 1979. Olistostrome, polyphase and recycled mélange. *Radovi Znanstvenog savjeta za naftu. Sekcija za primjenu geologije, geofizike i geokemije*, JAZU, A, 7: 101–117 (in Serbian).

Dimitrijević, M. N., Dimitrijević, M. D., Karamata, S., Sudar, M., Gerzina, N., †Kovács, S., Dosztály, L., Gulácsi, Z., Less, G. & Pelikán, P. 2001. Comparison of the Mesozoic olistostromes/mélanges in Yugoslavia and NE Hungary. *Pancardi 2001 Meeting (Sopron, Hungary 19. – 23. 9. 2001)*, Abstracts, DO-8, Geodetic and Geophysical Research Institute of the Hungarian Academy of Science..

Dimitrijević, M. N., Dimitrijević, M. D., Karamata, S., Sudar, M., Gerzina, N., †Kovács, S., Dosztály, L., Gulácsi, Z., Less, G. & Pelikán, P. 2003: Olistostrome/mélanges - an overview of the problems and preliminary comparison of such formations in Yugoslavia and NE Hungary. *Slovak Geological Magazine*, 9 (1): 24–40.

Djerić, N. & Gerzina, N. 2014. New data on the age of an Upper Cretaceous clastic-carbonate succession in Brežđe (Western Serbia). *Geologia Croatica*, 67 (3): 163–170.

Djerić, N., Gerzina, N. & Schmid, M.S. 2007. Age of the Jurassic radiolarian chert formation from the Zlatar Mountain (SW Serbia). *Ofioliti*, 32 (2): 101–108.

Djerić, N., Gerzina, N., Gajić, V. & Vasić, N. 2009. Early Senonian radiolarian microfauna and biostratigraphy from the Western Vardar Zone (Western Serbia). *Geologica Carpathica,* 60 (1), 35–41.

Djerić, N., Gerzina, N. & Simić, D. 2010. Middle Jurassic radiolarian assemblages from Zlatar Mt. (SW Serbia). *Geološki anali Balkanskoga poluostrva*, 71: 119–125.

Djerić, N., Gerzina, N. & Schmid, M.S. 2012. Middle Jurassic radiolarian assemblages from the sedimentary cover of the Adriatic margin (Zlatibor Mountain, SW Serbia). *Bulletin de la Société Géologique de France*, 183 (4): 359–368.

Gawlick, H. J., Sudar, M., Suzuki, H., Djerić, N., Missoni, S., Lein, R. & Jovanović, D. 2009. Upper Triassic and Middle Jurassic radiolarians from the ophiolitic melange of the Dinaridic Ophiolite Belt, SW Serbia. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen*, 53 (2–3): 293–311.

Goričan, Š., Karamata, S. & Batočanin-Srećković, D. 1999. Upper Triassic (Carnian-Norian) radiolarians in cherts of Sjenica (SW Serbia) and the time span of the Oceanic Realm Ancestor of the Dinaridic Ophiolite Belt. *Bulletin Academie Serbe des Sciences et des Arts*, *CXIX*, *Sciences naturales*, 39: 141-150.

Karamata, S. 2006. The geological development of the Balkan Peninsula related to the approach, collision and compression of Gondwana and Eurasian units. *In*: Robertson, A.H.F. & Mountrakis, D. (eds.), *Tectonic Development of the Eastern Mediterranean Region*. Geological Society London Special Publications, 260: 155–178.

Karamata, S., Majer, V. & Pamić, J. 1980. Ophiolites of Yugoslavia. *In*: Rocci, G. (Ed.): Tethyan ophiolites. *Ofioliti*, Special Issue, 1: 105–125.

Karamata, S., Dimitrijević, M. N. & Dimitrijević, M. D. 1999. Oceanic realms in the central part of the Balkan Peninsula during the Mesizoic. *Slovak Geological Magazine*, 5 (3): 173–177.

Lugović, B. 1986. Gabbro-peridotite rock association at the northwestern rim of Maljen ophiolite complex (with general comparison with similar occurrences in the

Dinaridic Ophiolite Belt). *Doctoral dissertation. Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb*, 207 pp. (in Croatian).

MAKSIMOVIĆ, Z. 1975. The geochemical study of Alpine-type ultramafic rocks of Yugoslavia. *Geološki anali Balkanskoga poluostrva,* 39: 231–302. (in Serbian, English summary).

OBRADOVIĆ J. & GORIČAN Š. 1988. Siliceous deposits in Yugoslavia: Occurences, types, and ages. In: J. HEIN and J. OBRADOVIĆ (Eds.), *Siliceous deposits of the Tethys and Pacific regions*. Springer-Verlag, New York, 51–64.

OBRADOVIĆ, J., MILOVANOVIĆ, D. & VASIĆ, N. 1987/88. Siliceous rocks in the Mesozoic from Serbia in association with the Diabase-chert and Porphyrite-chert Formation. *Bulletin of Nature History Museum,* 42/43 (A): 23–49 (in Serbian, English summary).

O'DOGHERTY, L., BILL, M., GORIČAN, Š., DUMITRICA, P. & MASSON, H. 2006. Bathonian radiolarians from an ophiolitic mélange of the Alpine Tethys (Gets Nappe, Swiss-French Alps). *Micropaleontology*, 51: 425–485.

O'DOGHERTY, L., CARTER, E. S., DUMITRICA, P., GORIČAN, Š., DE WEVER, P., BANDINI, A. N., BAUMGARTNER, P. O. & MATSUOKA A. 2009. Catalogue of Mesozoic radiolarian genera. Part 2: Jurassic-Cretaceous. *Geodiversitas*, 31 (2): 271–356.

OZSVÁRT, P. & KOVÁCS, S. 2012. Revised Middle and Late Triassic radiolarian ages for ophiolite mélanges: implications for the geodynamic evolution of the northern part of the early Mesozoic Neotethyan subbasins. *Bulletin de la Société Géologique de France*, 183: 273–286.

PAMIĆ, J. 1983. Considerations on the boundary between lherzolite and harzburgite subprovinces in the Dinarides and northern Hellenides. *Ofioliti*, 8 (1): 153–164.

PAMIĆ, J. 1998. North Dinaridic Late cretaceous-Paleogene subduction-related tectonostratigraphic units of southern Tisia, Croatia. *Geologica Carpathica*, 49 (5): 341–350.

PAMIĆ, J. & MAJER, V. 1977. Ultramafic rocks of the Dinaride Central zone in Yugoslavia. *Journal of Geology*, 85: 553–569.

PAMIĆ, J., TOMLJENOVIĆ, B. & BALEN, D. 2002. Geodynamic and petrogenetic evolution of Alpine ophiolites from the central and NW Dinarides: an overview. *Lithos*, 65: 113–142.

PESSAGNO, E.A. & NEWPORT, R.L. 1972. A technique for extracting radiolaria from radiolarian cherts. *Micropaleontology*, 18 (2): 231–234.

PRELA, M., CHIARI, M. & MARCCUCI, M. 2000. Jurassic radiolarian biostratigraphy of the sedimentary cover of ophiolites in the Mirdita area, Albania: new data. *Ofioliti*, 25: 55-62.

RADOIČIĆ, R., SUDAR, M & JOVANOVIĆ, D. 2009. Stratigraphy of the Krš Gradac section (SW Serbia). *Geološki anali Balkanskoga poluostrva*, 70: 23–41.

RADOVANOVIĆ, Z. 1987. Report on investigations of the Diabase-Chert Formation in SW Serbia (Thematic Geologic Map – Project D2). *Geological documentation of the Geological Institute*, 1–76, Beograd (unpublished).

ROBERTSON, A. & KARAMATA, S. 1994. The role of subduction-accretion processes in the tectonic evolution of the Mesozoic Tethys in Serbia. *Tectonophysics*, 234: 73–94.

SCHEFER S., EGLI D., MISSONI S., BERNOULLI D., FÜGENSCHUH B., GAWLICK H.J., JOVANOVIĆ D., KRYSTYN L., LEIN R., SCHMID S.M. & SUDAR M. 2010. Triassic metasediments in the internal Dinarides (Kopaonik area, southern Serbia): stratigraphy, paleogeographic and tectonic significance. *Geologica Carpathica*, 61: 89–109.

SCHMID, M.S., BERNOULLI, D., FÜGENSCHUH, B., MATENCO, L., SCHEFER, S., SCHUSTER, R., TISCHLER, M. & USTASZEWSKI, K. 2008. The Alpine-Carpathian-Dinaridic orogenic system: correlation and evolution of tectonic units. *Swiss Journal of Geosciences*, 101 (1): 139–183.

SPRAY J.G., BÉBIEN J., REX D.C. & RODDICK J.C. 1984. Age constraints on the igneous and metamorphic evolution of the Hellenic-Dinaric ophiolites. *In*: J. E. DIXON *et al*. (Eds.), The geological evolution of the eastern Mediterranean. *Geological Society, London - Special Publications*, 17: 619–627.

SUZUKI, H. & GAWLICK, H.J. 2003. Biostratigraphie und Taxonomie derRadiolarien aus den Kieselsedimenten der Blaa Alm und nördlichdes Loser (Nördliche Kalkalpen, Callovium-Oxfordium). *Mitteilungen der Gesellschaft der Geologie- und Bergbaustudenten in Österreich*, 46: 137–228.

ŠMUC, A. & GORIČAN, Š. 2005. Jurassic sedimentary evolution of a carbonate platform into a deep-water basin, Mt. Mangart (Slovenian-Italian border). *Rivista Italiana di Paleontologia e Stratigrafia*, 11 (1): 45–70.

VISHNEVSKAYA, V.S., DJERIĆ, N. & ZAKARIADZE, G.S. 2009. New data on Mesozoic Radiolaria of Serbia and Bosnia, and implications for the age and evolution of oceanic volcanic rocks in the Central and Northern Balkans. *Lithos*, 108: 72–105.

Резиме

Блокови рожнаца у офиолитском меланжу Златибора (ЈЗ Србија) – старост и геодинамичке импликације

Прецизно одређивање старости различитих океанских седимената је неопходно за реконструкције палеогеографских прилика и геодинамичке еволуције океанских басена и њихових континенталних маргина. У том смислу се биостратиграфска анализа радиоларијских асоцијација данас често користи за одређивање старости пелашких маринских седимената.

Досадашња истраживања радиоларијских асоцијација у Унутрашњим Динаридима показују да се у меланжу ЈЗ Србије налазе блокови рожнаца тријаске и јурске старости. Тријаски рожнаци углавном представљају делове океанске коре Неотетиса, док јурски представљају стратиграфску повлату платформних кречњака таложених на па-

сивној маргини Адрије (нпр. Djerić *et al*. 2007, 2012) или блокове у офиолитском меланжу формираном током обдукције офиолита на оближњу континенталну маргину (Obradović & Goričan 1988; Vishnevskaya *et al*. 2009; Djerić *et al*. 2010).

Биостратиграфски подаци добијени из блокова у меланжу су значајни јер је старост меланжа, а тиме и време финалних стадијума обдукције западно-вардарских офиолита дефинисана старошћу најмлађих блокова у меланжу. У овом раду презентовани су резултати истраживања блокова рожнаца на два локалитета у близини села Јасеново на ЈИ падинама Златибора.

Старост блока рожнаца на локалитету Рауке (келовеј) одговара претходно добијеним старостима блокова јурских радиоларита у српском делу Динарида (Gawlick *et al*. 2009; Vishnevskaya *et al*. 2009; Djerić *et al*. 2010). Радиоларијска асоцијација из блока рожнаца на локалитету Марића поток, међутим, представља најмлађу до сада одређену старост (келовеј – доњи кимериџ) рожначких блокова у меланжу у овом делу Динарида.

Ово упућује на кимериџску или пост-кимериџску обдукцију западно-вардарских офиолита. Ову старост, међутим, треба узети са извесном резервом, јер овако широк временски интервал може бити добијен услед слабог диверзитета и лошије очуваности радиоларијске асоцијације. У сваком случају, добијени подаци одговарају времену обдукције неотетиских офиолита добијеном радиометријским методама (179–150 Ma) из метаморфних ђонова у Динаридима и Хеленидима (нпр. Spray *et al*. 1984).

Средњојурски рожнаци се често срећу на простору Унутрашњих Динарида. Широко распрострањено мишљење међу српским геолозима је да ове стене представљају седиментни покров океанске коре Неотетиса. Међутим, јасна асоцијација јурских рожнаца са базалтима средњоокеанских гребена није пронађена на простору Србије. Јурски радиоларити се такође појављују као део "*in situ*" сачуваних седимената пасивне маргине у подини офиолитског меланжа (Источнобосанско-дурмиторска и Дринско-ивањичка јединица). Радиоларити су таложени преко тријаских и доњојурских седимената карбонатне платформе да дисталној маргини Адрије. Део ових седимената је откинут са пасивне маргине и инкорпориран у меланж на фронту обдукционе навлаке.

Иако постоје изданци базалтних пилоу лава у непосредној близини истраживаних изданака, нормалан стратиграфски контакт са рожнацима није запажен. Ово је у складу са претходним закључцима о непостојању асоцијације јурских радиоларита са базалтима средњоокеанског гребена, односно горњих делова јурске океанске коре у Динаридима, те истраживани блокови рожнаца вероватно потичу са дисталних делова пасивне маргине Адрије. Осим тога, теренска истраживања показују да се ове стене налазе у великом тектонском прозору испод тријаских карбоната Дринско-ивањичке јединице. Имајући све наведено у виду, радиоларијски рожнаци истраживаних локалитета на СИ падинама Златибора представљају блокове у меланжу Источнобосанско-дурмиторске јединице.