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BIOSTRATIGRAPHICAL STUDY OF LOWER CRETACEOUS KAŠAJINA RIVER BEDS AND ITS IMPORTANCE FOR GEOLOGY OF NE SERBIA

by

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This article presents results of detailed palynological study in the Lower Cretaceous Kašajina River Beds (Klokočevac, NE Serbia) and its importance for the geology of NE Serbia. On the basis of the biostratigraphic analysis of fossil spores, pollen grains and dinoflagellates, investigated beds are most probably of Lower Cretaceous age (mainly Valanginian–Hauterivian). The paleoecological results suggest humid and subtropical conditions in the hinterland.

Key words: palynomorphs, biostratigraphy, flysch, Kašajina River Beds, Lower Cretaceous (Valanginian–Hauterivian), NE Serbia.

У раду се приказују резултати детаљних палинолошких испитивања из доњокредних "слојева Кашајине реке" (Клокочевац, североисточна Србија) и њихов значај за геологију североисточне Србије. На основу биостратиграфске анализе фосилних спора, полена и динофлагелата испитивани седименти највероватније припадају доњој креди (валендин–отрив). Палеоеколошка испитивања указују на влажне и суптропске услове на копну.

Кључне речи: палиноморфе, биостратиграфија, флиш, "слојеви Кашајине реке", доња креди (валендин–отрив), североисточна Србија.

INTRODUCTION

A set of particular rock beds lie by the Sinaia Beds of the South Carpathians and northeastern Serbia, known as the Azuga Beds in Romania (Codarcea et al., 1961) and as the Kašajina River Beds in Serbia (Grubić, 1962; Fig. 1). In lower part of geological column are dark tabular to thin-bedded siltstones with numerous manganese concretions, and topped by red and green shales, usually rich in silica. These shales locally contain the diabase lenses and their tuffs; in Romania, the schistose serpentinite tectonic lenses

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occur. This part of the column contains also cross-laminated silicified limestones, greenish and grayish marls and silicified limestones, laminated grayish marls and fine-grained micaceous sandstones. These rocks in alternations, however, do not have the features of sequences characteristic for the flysch.

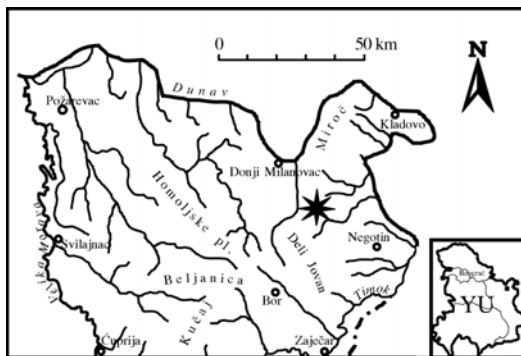


Fig. 1. Geographic position of investigated samples.
Сл. 1. Географски положај испитиваних узорака.

The Kašajina River Beds of northeastern Serbia are always found beneath the earliest Sinaia Flysch (Grubić et al., 1997); this position is not quite evident in the Romanian South Carpathians where, deformed by folding and imbrication, these beds apparently occur in lower and middle parts of the Sinaia Beds (Codarcea et al., 1961).

Using aptychus remains, the Azuga Beds of Romania are dated Tithonian (Staniou, 1978). All efforts to find the characteristic fossils in these beds, since 1957, in NE Serbia, have failed and only some undeterminable radiolarians were found so far.

However, a rich paleopalynological association has been found recently in Serbia, a preliminary study of which is reported by the authors of this contribution (Grubić et al., 1998).

The Kašajina River Beds of NE Serbia form thin, partly discontinuous zones in the Kosovica subzone, and in eastern and western Miroč Zones. Incidentally, fossil material has been found only in from which samples for micropaleontological study were collected, is located in a Klokočevac–Negotin road cutting at the foot of Kolje hill (Figs. 2, 3).

On the basis of the biostratigraphic analysis of fossil spores, pollen grains and dinoflagellates, investigated beds are most probably of Lower Cretaceous age (mainly Valanginian–Hauterivian). The paleoecological results suggest humid and subtropical conditions in the hinterland.

EXPERIMENTAL

Samples

The palynological studies were performed on 14 samples from outcrop in Kašajina River Beds in the valley of the Klokočevac river (Klokočevac, NE Serbia; Fig. 1). The

palynomorphs assemblage (spores, pollen and dinoflagellates) have been derived from the geological column of Kašajina River Beds. Samples from that location contain relatively good fossil material.

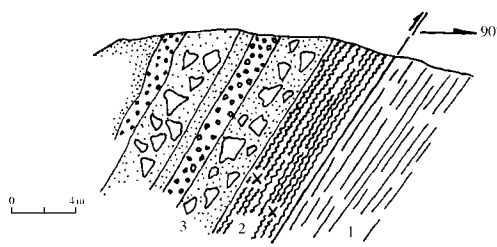


Fig. 2. Detail of the Veliki Greben section, the Klokočevac river valley. 1. Highly schistose Quasi-Sinaia Beds; 2. The Kašajina River Beds (X – palynological sampling place); 3. Olistostrome in the Sinaia Beds.

Сл. 2. Детаљ са тачке на профилу Великог гребена у Клокочевачкој реци. 1. интензивно ушкриљени квазисинајски слојеви; 2. "слојеви Кашајине реке" (X – ознака за место са кога су узети примерци за палинолошку анализу); 3. олистостроме у синајским слојевима.

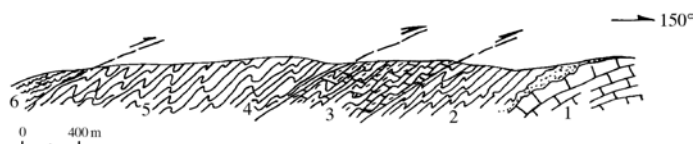


Fig. 3. Veliki Greben section in the Klokočevac River valley. 1. Light-grey Jurassic and Lower Cretaceous micrites; 2. Grey and dark grey marly Jabukovac Beds (Albian-Cenomanian-Turonian); 3. Quasi-Sinaia platy micrites with black chert and tintinnids, interbedded by marl and micaceous fine-grained sandstone (Valanginian-Hauterivian); 4. The Kašajina River Beds of red or green siliceous shale and brown sandstone with manganese concretions (Valanginian); 5. Sinaia Flysch (Valanginian-Hauterivian); 6. Leptynolite, gneiss, micaschist, and siltstone of Golubinje Zone; 1. and 2. Miroč parathon; 3. Subkosovica nappe; 4. and 5. Kosovica nappe; 6. Gethic nappe.

Сл. 3. Профил Великог гребена у Клокочевачкој реци. 1. светлосиви јуреки и доњокредни микрити; 2. сиви и тамносиви лапоровити јабуковачки слојеви (алб-ценоман-турон); 3. квазисинајски плочасти микрити са црним рожнацима и тинтинидама и прослојцима лапорца и лискуновитих ситнозрних пешчара (валендин-отрив); 4. "слојеви Кашајине реке" црвени и зелени силициозни глинци и мрки пешчари са манганским конкрецијама (валендин-отрив); 5. синајски флиш (валендин-отрив); 6. лептинолити, гнајсеви, микашисти и алевролити голубињске зоне. 1. и 2. мирочки паратон; 3. субкосовичка навлака; 4. и 5. косовичка навлака; 6. гетска навлака.

Methods and aims

The palynomorphs was observed on isolated kerogen concentrate from different rock samples with the classical 30% HCl, (removal of carbonate) and 38% HF (removal of silicate) treatments. Therefore HCl was used in order to dissolve the silica gel forming during the HF silicate reaction. The total residue was submitted by separation ($ZnCl_2$; $d=1.9-2.0 \text{ g/cm}^3$). Occasionally separated kerogen concentrate was also submitted to conditional acetolysis and oxidation ($NaCl+HNO_3$; $KClO_3+HNO_3$; staining effect on exines; Ercegovac, 1990).

Some of the most significant and good preserved palynomorph are illustrated on the Plates I–IV.

BIOSTRATIGRAPHIC CHARACTER OF PALYNOMORPH ASSOCIATIONS

Spores, gymnosperm pollen and dinoflagellate types identified in Lower Cretaceous Kašajina River Beds (Figs. 1, 2) are the following:

- Antetruma SPORITES H. Potonić, 1893
 Turma TRILETES (Reinsch) Dettmann, 1963
 Subturma AZONOTRILETES (Luber) Dettmann, 1963
 Infraturma LAEVIGATI (Bennie & Kidston) R. Potonić, 1956
 Cyathidites Couper, 1958
 Cyathidites australis Couper, 1953
 Cyathidites minor Couper, 1953
 Cyathidites sp.
 Calamospora Schopf, Wilson & Bentall, 1944
 Calamospora cf. *mesozoica* Couper, 1958
 Biretisporites (Delcourt & Sprumont) Delcourt, Dettmann & Hughes, 1963
 Biretisporites potoniaei Delcourt & Sprumont, 1955
 Concavisporites (Pflug) Delcourt & Sprumont, 1955
 Concavisporites variverrucatus Couper, 1958
 Concavisporites cf. *obtusangulus* (R. Potonić) Krutzsch, 1964
 Concavisporites sp.
 Gleicheniidites (Ross) Delcourt & Sprumont, 1955
 Gleicheniidites senonicus Ross, 1949
 Gleicheniidites sp.
 Deltoidospora (Miner) Potonić, 1956
 Deltoidospora cf. *toralis* (Leschick) Lund, 1977
Deltoidospora sp.
 Trilitisporites Laveine & Danze – Corsin, 1963
 Trilitisporites microverrucosus Hagemann, 1965
 Infraturma APICULATI (Bennie & Kidston) R. Potonić, 1956
 Subinfraturma VERRUCATI Dybova & Jachowicz, 1957
 Converrucosisporites Potonić & Kremp, 1954
 Converrucosisporites cf. *venitus* Batten, 1973
 Converrucosisporites sp.
 Subinfraturma NODATI Dybova & Jachowicz, 1957
 Osmundacidites Couper, 1953
 Osmundacidites cf. *wellmanii* Couper, 1958
 Infraturma MURORNATI Potonić & Kremp, 1954
 Foveosporites Balme, 1957
 Foveosporites sp. (aff. *multifoveolatus* Döring, 1963)

- Klukisporites* Couper, 1958
Klukisporites sp.
- Lycopodiumsporites* (Thiergart) Delcourt & Sprumont, 1955
Lycopodiumsporites cf. *clavatoides* Couper, 1958
- Uvaesporites* Döring, 1965
Uvaesporites sp.
- Cicatricosisporites* (Potonié & Gelletich) Potonié, 1966
Cicatricosisporites subrotundus Brenner
Cicatricosisporites angustus Singh, 1971
Cicatricosisporites australis Couper, 1958
Cicatricosisporites brevilaesuratus Couper, 1958
Cicatricosisporites cf. *dorogensis* R. Potonié & Gelletich, 1933
Cicatricosisporites cf. *claricanalis* Philips & Felix
Cicatricosisporites cf. *venustus* Deák, 1963
- Plicatella* Maljavkina, 1949
Plicatella sp.
- Lycopodiacidites* (Couper) R. Potonié, 1956
Lycopodiacidites cf. *cerniidites* (Ross) Brenner, 1963
Lycopodiacidites sp.
- Nevesisporites* Jersey & Paten, 1964
Nevesisporites sp.
- Cooksonites* (Pocock) Dettmann, 1963
Cooksonites sp.
- Turma ZONALES (Bennie & Kidston) R. Potonié, 1956
Subturma AURITOTRILETES Potonié & Krutzch, 1954
Infraturma AURICULATI (Schopf) Dettmann, 1963
Appendicisporites Weyland & Krieger, 1953
Appendicisporites tricornitatus Weyland & Greifeld, 1953
Appendicisporites tricuspидatus Weyland & Greifeld, 1953
Appendicisporites cf. *problematicus* (Burger) Singh, 1971
Appendicisporites potomaceous Brenner, 1963
Appendicisporites sp.
- Matonisporites* Couper, 1958
Matonisporites sp.
- Trilobosporites* (Pant) R. Potonié, 1956
Trilobosporites cf. *apiverrucatus* Couper, 1958
Trilobosporites sp.
- Trilites* (Erdtman ex Couper) Dettmann, 1963
Trilites sp.
- Subturma ZONOTRILETES Waltz, 1935
Infraturma CINGULATI (R. Potonié & Klaus) Dettmann, 1963
Cingutritetes Pierce, 1961
Cingutritetes cf. *clavus* Dettmann, 1963
Cingutritetes sp.

- Contignisporites* Dettmann, 1963
Contignisporites cf. *cooksoni* (Balme) Dettmann, 1963
Contignisporites sp.
Distaltriangulatisporites cf. *irregularis* Singh, 1971
Distaltriangulatisporites sp.
- Anteturma POLLENITES R. Potonić, 1931
- Turma SACCITES Erdtman, 1947
- Subturma DISACCITES Cookson, 1947
Alisporites Daugherty, 1941
Alisporites cf. *bilateralis* Rouse, 1959
Alisporites sp.
Podocarpidites (Cookson) Potonić, 1958
Podocarpidites ellipticus (Cookson) Couper, 1953
Podocarpidites sp.
- Subturma POLYSACCITES Cookson, 1947
Callialasporites (Sukh Dev.) Potonić, 1966
Callialasporites dampieri (Balme) Sukh Dev, 1961
- Subturma MONOPORINES Naumova, 1939
Classopollis (Pflug) Pocock & Jansonius, 1961
Classopollis classoides (Pflug) Pocock & Jansonius 1961
Classopollis torosus (Reissinger) Couper, 1958
Classopollis sp.
- Turma ALETES Ibrahim, 1933
- Subturma AZONOLETES (Luber) R. Potonić & Kremp, 1954
- Infraturma GRANULONAPITI Cookson, 1947
Araucariacites (Cookson) Couper, 1953
Araucariacites sp.
Sphaeripollenites (Couper) Jansonius, 1962
Sphaeripollenites sp.
- Subturma POLYPLICATES Erdtman, 1952
Ephedripites Bolchowitina, 1953
Ephedripites sp.
Welwitschiapites Bolchowitina, 1953
Welwitschiapites simplex Deák, 1963
Welwitschiapites alekhinii Bolchowitina, 1953
- Subturma MONOCOLPATES Iversen & Troals – Smith, 1950
Ginkgocycadophytus (Samoilovitch) De Jersey, 1962
Ginkgocycadophytus cf. *scabratus* (Stanley)
Cycadopites (Wodehouse) Wilson & Webster, 1964
Cycadopites sp.
Monosulcites (Cookson) Couper, 1953
Monosulcites subgranulosus Couper, 1958
Monosulcites minimus Cookson, 1947

DINOFLAGELLATAE

- Dingodinium* cf. *cerviculum* Cookson & Eisenack, 1958
Solisphaeridium sp.
Pareodinia sp. (type *asperata* Riley, 1980)
Pareodinia sp.
Pareodinia cf. *arctica* Wiggins, 1975
Cleistosphaeridium ancoriferum Cookson & Eisenack, 1969
Cleistosphaeridium cf. *polytrichum* (Valensi) Davey et al., 1969
Cleistosphaeridium cf. *polyacanthum* Gitmez, 1970
Scriniodinium oxfordianum Sarjeant, 1962
Ctenidodinium sp.
Ctenidodinium cf. *fenellum* Deflandre, 1938
Ctenidodinium cf. *elegantulum* Millioud, 1967
Systematophora sp.
Tenua hystrix Eisenack, 1958
Cyclonephelium sp.
Fromea cf. *amphora* Cookson & Eisenack, 1958
Fromea sp.
 Peridineae gen. et sp. indet.
Cymatiosphaera sp.
 ? *Haplocysta* sp.
Periodinium sp.
 ? *Deflandrea* sp.
Hystrichosphaeridium sp.

MICROFORAMINIFERA

- Lagenamina* sp.

General characters of presented palynomorph association can be described as follows:

Trilete levigate spores as *Cyathidites* and *Deltoidosporites* (fam. Cyatheaceae and Dicksoniaceae) in the investigated samples are sporadic. The same refers to species of the genera *Todisporites*, *Matonisporites* and *Osmundacidites*, indicating a notable reduction in Jurassic floral elements (pteridophyte spores). A particularity of the association is the presence of *Cingutriletes* and *Converrucosisporites*-type spores, and of concave spores (*Concavisporites variverrucatus*) that are common in Upper Jurassic of England and Scotland (Couper, 1958). Spores of *Contignisporites*-type – common elements of the Upper Jurassic microflora – are found sporadically.

Few *Trilites* spores are found in samples from the Kašajina River Beds. Döring (1966) mentions their relatively common presence in Lower Cretaceous rocks of Germany (Wealden).

Palynomorph associations changed much in composition during the Valanginian: *Classopollis*-like pollen was much reduced; representatives of *Platysacus* and spores of *Rogalskaisporites* disappeared. The species *Appendicisporites jansonii*, *A. tricornitatus* and others are found at the base of Valanginian unit. The appearance of *Pilosisporites verus*

and *P. trichopapillosus* spores (*Lygodium*) is also associated with the Valanginian. Note that these spores are not found in the Kašajina River Beds sediments.

The palynological assemblage from Kašajina River Beds contains very rare presence of spores from fam. Gleicheniaceae, which are more abundant in Aptian sediments of Europe (Couper, 1958; Baltes, 1967; Pantić & Šećerov, 1975).

Relatively frequent in the association are the canaliculate species *Cicatricosisporites subrotundus*, *C. angustus*, *C. australiensis*, *C. brevilaesuratus*, *C. cf. dorogensis*, *C. cf. claricanalis*, *C. cf. venustus* and *Appendicisporites tricornitatus*, *A. tricuspoidatus*, *A. cf. problematicus*, *A. potomaceus*, whose incidence is significant in Lower Cretaceous of Europe and Russia. Vakhrameev & Doludenko (1976) believe that the Berriasian was characterized by the occurrence of striate (canaliculate) spores of the type *Cicatricosisporites*, whereas in the Indo-European paleofloral province the genus *Appendicisporites* occurs in the Lower Cretaceous (Valanginian). Pocock (1967, 1980) studies sedimentary rocks at the Jurassic–Cretaceous boundary and interprets the appearance of *Cicatricosisporites* and *Arcellites* as an indication of the Lower Cretaceous.

Monosulcate pollen grains of *Ginkgoales*, *Cycadales* and *Bennettitales* are quite infrequent in the presented association. The lack of bisaccate pollen of Pinaceae and Podocarpaceae families can be explained by genetic conditions of these sediments; developed hill vegetation probably did not exist within the reach of the depositional area. The above stated also refers to the genera *Araucariacites*, *Callialapollenites*, and *Classopollis*. The scarcity of the *Classopollis*-type pollen may be explained by the conditions of sedimentation (where xeromorphic vegetation such as *Brachyphyllum* and *Pagiophyllum* might have existed at some distance from the coast).

A relatively frequent presence was noted in the examined samples of the Dinoflagellatae algal group. Most of the dinoflagellates remains are poorly preserved.

Dinoflagellate remains in palynomorph associations from the Kašajina River Beds have certain biostratigraphical value. *Gonyaulacysta*, *Lanterna* and other genera characteristic of Oxfordian and Kimmeridgian, and partly Tithonian, have not been identified. There are few *Pareodinia cf. arctica*, *Ctenidodinium cf. tenellum*, *Solisphaeridium* sp., *Cleistosphaeridium cf. polyacanthum*, *Scrinodinium oxfordianum* and *Systematophora* sp., common in Tithonian rocks. Some of these, however, continue throughout the Berriasian to the Lower Valanginian. The prevalingly Lower Cretaceous age (Berriasian, Valanginian and ? Hauterivian) is indicated by *Dingodinium cf. cerviculum*, *Cleistosphaeridium ancoriferum*, *C. cf. polytrichum*, *Ctenidodinium cf. elegantulum*, *Tenua hystrix* and *Fromea cf. amphora*, and quite abundant microforaminifera.

A marine depositional environment is characterized by the relatively common presence of the so-called palynoforaminifera and microforaminifera with chitinous linings (*Scytinascia*; Deák 1964). These remains are often found in sedimentary units of the Jurassic and the Lower Cretaceous, but their biostratigraphical importance is not great.

The Jurassic–Cretaceous sedimentation break is not found in several regions of Europe (England, France, etc.; Hughes, 1973), where many palynomorphs characterizing sedimentary rocks of the latest Jurassic are also contained in Lower Cretaceous formations. They are *Cicatricosisporites dorogensis*, *Pilosisporites trichopapillosus*, *Cingulatisporites valdensis* and others.

Transitional systems between the Tithonian and the Berriasian in many regions of Russia are characterised by spores of *Cicatricosisporites*-type. Tithonian, Berriasian, and Valanginian rock units also contain leiotrilete spores (*Cyathidites minor*, *C. junctus*, *Lygodiumsporites subsimplex*, *Klukisporites pseudoreticulatus*, *Gleicheniidites* sp. and others concave spores). Still predominant in the Valanginian is pollen of *Classopollis*, and there are many occurrences of *Cicatricosisporites* and *Appendicisporites* species, and species of *Gleicheniidites senonicus*, *Trilobosporites bernissartensis* and *Cyathidites minor* (Vakhrameev & Doludenko, 1976). The genus *Appendicisporites* is found in Valanginian rocks of the Indo-European paleofloral region.

The Jurassic–Cretaceous boundary on the continental shelf of the Netherlands, defined on palynomorphs (Burger, 1966; Hengreen et al., 1980), is marked by first occurrences of *Plicatella*-like spores (*Appendicisporites tricornitatus*), *Cicatricosisporites*, *Trilobosporites*, *Maculatisporites* and *Tuberositriletes*. Pilate spores are notable (*Pilosisorites trichopapillosus*). Cicatricose spores in uppermost Tithonian and Berriasian formations are fairly abundant. This boundary is actually marked by a *Classopollis* Zone (Upper Malm). Additionally to this dominant pollen, sporadically occur *Callialasporites turbatus* (*Applanopsipollenites triangularis*) and dinoflagellate of *Ctenidodinium ornatum*, *Gonyaulacysta jurassica* and *Pareodinia ceratophora* – type (at Middle–Upper Malm). The species *Gonyaulacysta cladophora*, *G. granulatus* and *G. longicornis* disappear in the late Malm. The *Cicatricosisporites*–*Plicatella* (*Appendicisporites*) Zone corresponds to the Lower Cretaceous (Berriasian, in: Hengreen et al., 1980). Its microfloral composition is represented by *Plicatella tricornitata*, *Trilobosporites apiverrucatus*, *Concavissimisporites* and *Pilosisorites trichopapillosus*. Valanginian marine sedimentary formations (upper parts) contain some new dinoflagellate genera (*Broomea*, *Muderongia* and others). Palynomorphs from the Jurassic–Cretaceous system of the Netherlands are correlative with similar associations of Germany (Mecklenburg; Döring, 1965) and England (Dorset; Norris, 1969).

An abundant association of palynomorphs in Lower Cretaceous sedimentary rocks of northwestern Dnieper–Donets region, Russia, is reported by Voronova (1984). The Valanginian complex is much diverse, characterized dominantly by spores of the family Schizaceae (*Anemia*, *Lygodium*, etc. by about 70%) and Gleicheniaceae (20–30%), and scarce families Dicksoniaceae, Matoniaceae (less than 4%). Pollen grains of conifers (Protoconiferae, Pinaceae, Bennettitaceae, and Ginkgoaceae) are comparatively common, and those of *Classopollis*-type are much scarcer, like in the palynomorph association of the Kašajina river sediments. Voronova (1984) suggests that the Hauterivian–Barremian system of the mentioned sedimentary rocks is very similar to the Valanginian system. Climatic changes reduced Bennettite- and Ginkgo-phytes, and consequently affected the character of the palynomorph association. However, the described system is characterized by the predominance of Gleicheniaceae spores (60%) and the sporadic presence of *Anemia*, *Lygodium*, *Cibotium*, *Pelletiera* and *Dicksonia*. These terrestrial ferns, highly prolific in spores, populated largely tropical and subtropical regions. Also sparse are typical representatives of Jurassic flora (Bennettitaceae, Cycadaceae, Ginkgoaceae and Araucariaceae). The increased density of Taxodiceae and Cupressaceae pollen and the few occurrences of angiosperm are characteristic of Aptian rock complexes. This floral composition

of the vegetation suggests warm and wet climate of the Dnieper and Donets regions in the Lower Cretaceous; the climate was more moderate in the end of the epoch, as evinced by Albian palynologic systems.

A palynomorph association, dated Valanginian–Hauterivian, from Lower Cretaceous rocks of Stara Planina (Rsovc; Ercegovac & Anđelković, 1972) indicates mesophilic character of the flora that existed in the region. The spore and pollen association still includes some elements of Upper Jurassic flora (spores of the fern *Coniopteris* and pollen of primitive conifers of Palaeoconiferae group), and floral elements of the early Lower Cretaceous (Schizaceae, Gleicheniaceae and others). This palynological material from Rsovc section ("Visočica Region" of Lower Cretaceous bathyal formation on Stara Planina) is well correlated with microflora from the Kašajina River Beds.

Palynomorph associations from Kašajina River Beds of NE Serbia are partly correlative with rich spore and pollen associations from Lower Cretaceous units of Vojvodina (Site Uzdin–1 and Šibovo–1; Pantić & Šećerov, 1975). Numerous fern typical of Lower Cretaceous sediments (*Cicatricosisporites*, *Plicatella*, *Trilobosporites* and others), cycadophyte (*Cycas*), particular forms from the group *Classopollis*, and many conifer remains (*Alisporites*, *Podocarpidites*) suggest the likely sediment deposition in the Hauterivian and the Barremian.

Published information on changes in the composition of palynomorph associations at the Jurassic–Cretaceous boundary is the following:

The same refers to species of the genera *Todisporites*, *Matonisporites*, and *Osmundacidites*, indicating a notable reduction in Jurassic floral elements (pteridophyte spores). A particularity of the association is the presence of *Cingutritetes* and *Converrucosisporites*-type spores, and of concave spores (*Concavisporites variverrucatus*) which are common in Upper Jurassic of England and Scotland (Couper, 1958). Spores of *Contignisporites*-type – common elements of the Upper Jurassic microflora – are found sporadically.

Sedimentary systems of the Upper Jurassic (mostly Tithonian) in most of the localities over the world contain dinoflagellates, dominantly *Scriniodinium luridum*, *Gonyaulacysta jurassica*, *Pareodinium ceratophora* and others (England; Batten, 1973). However, the species *G. jurassica* and *P. ceratophora* are scarce in lowermost parts of the Lower Cretaceous unit. Late in the Tithonian, phytoplankton content is much lower than in the Kimmeridgian, while spores and pollen of terrestrial plants are higher. Valanginian sedimentary rocks often contain marine phytoplankton of *Gardodinium* and *Cyclonephelium* genera.

CONCLUSION

On the basis of geological and palynological investigations of the Kašajina River Beds (Klokočevac; NE Serbia), the conclusions are following:

The microfloral character of the obtained palynoassociation in Kašajina River Beds allows some new consideration in relation to Jurassic–Cretaceous boundary in NE Serbia. By the available biostratigraphical data Lower Cretaceous of this sediments was more precise determined.

From these sediments, relatively abundant but rather uniform association of spores, pollen and marine phytoplanktonic remains are obtained. Palynospectres are dominated by *Cicatricosisporites*, *Appendicisporites*, *Trilites*, *Foveosporites* and *Cornutisporites* (*Wel-witchiapites*). Rarely, there are also spores of *Cyathidites*, *Matonisporites*, *Deltoidospora*, *Biretisporites*, *Converrucosisporites*, *Trilobosporites* and *Cooksonites*. Concave spores with pilose appendices, usually very characteristic for the Lower Cretaceous sediments of Europe and Canada, were not identified in the palynofacies of the Kašajina River Beds. Especially important characteristic of palynospectres is rare presence of primitive Coniferae pollen grains of *Classopollis*, *Caytonipollenites*, *Alisporites*, *Callialasporites* and *Sphaeripollenites*-type. The forms of *Monosulcites*, *Ginkgocycadophytus*, *Alisporites* and *Podocarpidites* are more often present. The remains of dinoflagellates (*Cleistosphaeridium*, *Peridinium*, *Gonyaulacysta*, *Pareodinia*, *Fromea*, *Ctenidodinium*, *Tenua*, *Systematophora*, *Scriniodinium*, and others) are present in significant amounts, with a dominance of Lower Cretaceous forms over Upper Jurassic (Kimmeridgian) ones.

Microscopic examination of organic facies and palynofacies suggests that the preservation state of deposited organic matter in this samples is significantly methamorphosed.

The lithofacial and metamorphic appearances of the Kašajina River Beds and the contents of manganese concretions, diabase, and serpentinite, and particularly the complete lack of carbonate-shelled fossils are unequivocal indications that these beds are typical "schistes lustres" formed on the deep oceanic floor, below CCD level.

The Valanginian-Hauterivian age of the Kašajina River Beds has an important geological implication. It definitely corroborates the presence of Lower Cretaceous Sinaia Flysch type and Azuga Beds type their tectonic recurrence and the abnormal position – thrust over the Miroč paratchton, as seen in the Veliki Greben regional section in the Klokočevac river (Figs. 2, 3)

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РЕЗИМЕ

БИОСТРАТИГРАФСКА ИСПИТИВАЊА ДОЊОКРЕДНИХ "СЛОЈЕВА КАШАЈИНЕ РЕКЕ" И ЊИХОВ ЗНАЧАЈ ЗА ГЕОЛОГИЈУ СЕВЕРОИСТОЧНЕ СРБИЈЕ

Проблем старости флишних седимената на простору Карпато–балканида, који су у литератури познати под називом Синајски слојеви и данас је веома актуелан. Доњим секвенцама ових флишних творевина Источних Карпата на територији Румуније припадају "слојеви Азуга" у подручју Мехадинти (у долини Прахове), који су изграђени од смеђих алевролита, црвених и зеленкастих силициозних глинаца са туфовима, спилитима и манганским конкрецијама. Најнижи делови садрже и ушкриљена сочиваста тела дијабаза и серпентинита. По свим главним особинама представљају типичне сјајне шкриљце настале на дубоком океанском дну. У румунским Карпатима убрани "слојеви Азуга" налазе се у доњим и средњим деловима Синајских слојева (Codarcea et al., 1961). У долини Cosustea садрже титонску асоцијацију калпионела (*Calpioneles*; Staniou, 1978). Ти седименти у Источној Србији налазе се у зони Косовице, а означени су као "слојеви Кашајине реке" (Grubić, 1962). Према Grubiću (1962) "слојеви Кашајине реке" су идентични са "слојевима Азуга" из подручја Мехадинти у Румунији (Codarcea et al., 1961).

У стратиграфском погледу седименти Кашајине реке до сада нису ближе дефинисани. Добијени подаци о старости ових слојева су од посебног значаја за тумачење геологије ширег простора североисточне Србије (Grubić et al., 1998). У раду се приказују биостратиграфске и палеоеколошке карактеристике фосилних спора, полена и динофлагелата из "слојева Кашајине реке".

У источној Србији у долини Кашајине реке налазе се најбоље откривени профили доњих делова Синајских слојева. У њима до сада није пронађен никакав фосилни материјал. На западним падинама Мироча ови слојеви су откривени такође али само местимично. Најбоље откривен изданак се налази на путу Мајданпек–Неготин источно од Клокочевца. На слици 1 приказан је положај испитиване локалности. У више наврата (у распону од 2 деценије) другопотписани аутор је проучавао "слојеве Кашајине реке" са те и других локалности и сакупио обиман материјал за микропалеонтолошка испитивања из пешчарских, лапоровитих и глиновитих секвенци. Испоставило се да фосилни материјал ти слојеви садрже само у профилу Клокочевачке реке о коме је овде реч.

Због специфичних литолошких особина ових "сјајних шкриљаца" може се констатовати да је у основи коришћен уобичајен, али мало прилагођен поступак мацерације па је добијен и релативно богат микрофлористички материјал (Egsegovac, 1990). С обзиром да је органски материјал (палиноморфе и остаци ткива) значајније метаморфисан (карбонизирани опне палиноморфа) примењен је поступак оксидације ($\text{NaCl} + \text{HNO}_3$, $\text{KClO}_3 + \text{HNO}_3$ или пушљива HNO_3), што је омогућило палеонтолошку детерминацију највећег броја палиноморфа.

Из најнижих делова геолошког стуба Синајских слојева у долини Клокочевачке реке (источно од Клокочевца, на путу Мајданпек–Неготин) добијена је релативно богата, али и доста једнолична асоцијација спора, полена и морских фитопланктонских остатака. У палиноспектрима доминирају микрофлористички остаци копнених биљака (споре птеридофита и полена четинара). У палиноспектрима својом учесталошћу истичу се родови *Cicatricosisporites*, *Appendicisporites*, *Trilites*, *Foveosporites* и *Cornutisporites* (*Welwitschiapites*). Ређе се јављају споре типа *Cyathidites*, *Matonisporites*, *Deltoidospora*, *Biretisporites*, *Converrucosisporites*, *Trilobosporites* и *Cooksonites*, као и споре типа *Gleicheniidites* и *Contignisporites*. Конкавне споре са пилосним израштајима (*Pilosporites*), иначе веома карактеристичне за седименте доње креде Европе и Канаде, у палинофацији "Кашајиних слојева" нису констатоване. Посебно значајно обележје палиноспектара је ретко појављивање полена примитивних четинара типа *Classopollis*, *Caytonipollenites*, *Alisporites*, *Callialasporites* и *Sphaeripollenites*. Родови *Monosulcites*, *Ginkgocycadophytus* и *Podocarpidites* чешће су заступљени у односу на поменуте облике. Значајно учешће имају остаци динофлагелата (*Cleistosphaeridium*, *Peridinium*, *Pareodinia*, *Fromea*, *Ctenidodinium*, *Tenua*, *Systematophora*, *Scrinioidinium* и др.), међу којима су типичне врсте из горње јуре (титон) знатно ређе заступљене у односу на доњокредне облике.

Микрофлористички материјал припада топлој и влажној тропској биљногеографској провинцији, која је егзистовала у доњој креди на простору Источне Србије.

На основу проучавања микрофлористичких остатака из доње креде Старе Планине (Рсовци; Egsegovac & Andjelković, 1972) утврђено је да палинолошки спектар, чија је старост одређена као валендинско–отривска, показује мезофилни карактер флоре која је постојала на овом простору. Он се огледа у томе што су у

комплексу спора и полена присутни још увек неки елементи горњојурске флоре (споре папрати *Coniopteris* и полен примитивних четинара из групе *Palaeosconiferaceae*), као и елементи флоре старије доње креде (*Schizaeaceae*, *Gleicheniaceae* и др.). Овај палинолошки материјал са профила Рсовци ("височка област" батијалног развића доње креде на Старој Планини) може се такође добро корелисати са микрофлором из слојева "Кашајина реке".

Добијени палинолошки спектри из "Кашајина слојева" североисточне Србије могу се делимично корелисати са богатим асоцијацијама спора и полена из доње креде Војводине (буш. Уздин–1 и Шибово–1; Pantić & Šećerov, 1975). На основу бројних остатака папратњака типичних за доњу креду (*Cicatricosisporites*, *Plicatella*, *Trilobosporites* и др.), присуство цикадофита (*Cycas*), као и специфичних облика из групе *Classopollis* и честих остатака конифера (*Alisporites*, *Podocarpidites*) може се закључити да су ови седименти највероватније стварани у отриву и барему.

На основу биостратиграфске анализе фосилних спора, полена и динофлагелата старост "Кашајиних слојева" је одређена као највероватније доњокредна (претежно валендин–отрив). Добијена асоцијација палиноморфи из "Кашајина слојева" источне Србије може се добро корелисати са палиноморфама из седимената старије доње креде Европе (Енглеска, Немачка, Румунија); (Norris, 1969, Hengreen et al., 1980, Döring, 1965, 1966, Baltes, 1967), који су створени у континенталној фазији (валендин), као и са седиментима који означавају границу јура–креда на простору Северне Канаде (Roscoff, 1980).

Резултатима овог рада утврђене су поуздано и неке важне регионално–геолошке чињенице. Дефинитивно је потврђено постојање доњокредних седимената типа Синајског флиша и "Азуга слојева" и на западном крилу велике мирочке антиформе (сл. 2) и њихово тектонско понављање и ненормалан, односно навучени положај преко мирочког парахтона (сл. 3).

PLATE I ТАБЛА

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| Fig. (Сл.) 1. | <i>Cyathidites australis</i> Couper |
| Fig. (Сл.) 2. | <i>Calamospora</i> cf. <i>mesozoica</i> Couper |
| Fig. (Сл.) 3. | <i>Biretisporites potoniaei</i> Delcourt & Sprumont |
| Figs (Сл.) 4, 5. | <i>Matonisporites</i> sp. |
| Fig. (Сл.) 6. | <i>Gleicheniidites</i> cf. <i>stellatus</i> Bolkovitina |
| Fig. (Сл.) 7. | <i>Gleicheniidites</i> cf. <i>senonicus</i> Ross |
| Fig. (Сл.) 8. | <i>Trilitisporites microverrucosus</i> Hagemann |
| Fig. (Сл.) 9. | <i>Converrucosisporites</i> cf. <i>venitus</i> Batten |
| Fig. (Сл.) 10. | <i>Converrucosisporites</i> sp. |
| Fig. (Сл.) 11. | <i>Osmundacidites wellmanii</i> Couper |
| Fig. (Сл.) 12. | <i>Foveosporites</i> cf. <i>multifoveolatus</i> Döring |
| Fig. (Сл.) 13. | <i>Klukisporites</i> sp. |
| Fig. (Сл.) 14. | <i>Lycopodiumsporites</i> cf. <i>clavatoides</i> Couper |

PLATE II ТАБЛJA

- Fig. (Cл.) 1. *Uvaesporites* sp.
 Fig. (Cл.) 2. *Cicatricosisporites* cf. *claricanalis* Philips & Felix
 Fig. (Cл.) 3. *Cicatricosisporites* *subrotundus* Brenner
 Fig. (Cл.) 4. *Cicatricosisporites* sp.
 Fig. (Cл.) 5. *Cicatricosisporites* *australis* Couper
 Fig. (Cл.) 6. *Cicatricosisporites* cf. *venustus* Deák
 Fig. (Cл.) 7. *Appendicisporites* cf. *problematicus* (Burger) Singh
 Fig. (Cл.) 8. *Appendicisporites* *tricuspidatus* Weyland & Greifeld
 Fig. (Cл.) 9. *Appendicisporites* *tricornitatus* Weyland & Greifeld
 Fig. (Cл.) 10. *Plicatella* sp.
 Fig. (Cл.) 11. *Nevesisporites* sp.
 Fig. (Cл.) 12. *Trilobosporites* cf. *apiverrucatus* Couper
 Fig. (Cл.) 13. *Trilobosporites* sp.
 Fig. (Cл.) 14. *Contignisporites* cf. *cooksoni* (Balme) Dettmann
 Fig. (Cл.) 15. *Cingutriteles* cf. *clavus* Dettmann

PLATE III ТАБЛJA

- Fig. (Cл.) 1. *Cooksonites* sp.
 Figs (Cл.) 2, 3. *Alisporites* sp.
 Fig. (Cл.) 4. *Araucariacites* sp. (type *austalis* Cookson)
 Fig. (Cл.) 5. *Callialasporites* *dampieri* (Balme) Sukh Dev
 Fig. (Cл.) 6. *Ephedripites* sp.
 Fig. (Cл.) 7. *Classopollis* *torosus* (Reissinger) Couper
 Fig. (Cл.) 8. *Classopollis* sp. *classoides* (Pflug) Pocock & Jansonius
 Fig. (Cл.) 9. *Sphaeripollenites* sp.
 Fig. (Cл.) 10. *Corniculatisporites* (*Welwitschiapites*) cf. *virgatus* Deák
 Fig. (Cл.) 11. *Corniculatisporites* (*Welwitschiapites*) *simplex* Deák
 Fig. (Cл.) 12. *Ginkgocycadophytus* sp.
 Fig. (Cл.) 13. *Monosulcites* sp.
 Fig. (Cл.) 14. *Pareodinia* cf. *asperata* Riley
 Fig. (Cл.) 15. *Pareodinia* cf. *arctica* Wiggins
 Fig. (Cл.) 16. *Periodinium* sp.

PLATE IV ТАБЛJA

- Fig. (Cл.) 1. *Dingodinium* cf. *cerviculum* Cookson & Eisenack
 Fig. (Cл.) 2. *Tenua* cf. *hystrix* Eisenack
 Fig. (Cл.) 3. *Fromea* sp. (cf. *amphora* Cookson & Eisenack)
 Fig. (Cл.) 4. *Ctenidodinium* sp. (cf. *elegantulum* Millioud)
 Fig. (Cл.) 5. *Cyclonephelium* sp.
 Fig. (Cл.) 6. *Scriniodinium* *oxfordianum* Sarjeant
 Fig. (Cл.) 7. *Cleistosphaeridium* cf. *polyacanthum* Gitmez
 Figs (Cл.) 8, 9. Microforaminifers (*Lagenamina* sp.)
 Fig. (Cл.) 10. Microforaminifera

TABLA 1

TABLA 2

TABLA 3

TABLA 4