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Review paper
Прегледни рад

Orogenic structure of the Serbian Carpathians: a synthesis from the Danube River Gorge transect

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Key words:
Ceahlău–Severin ocean, Dacia mega-unit, Danubian unit, deformational evolution, lithostratigraphy.

Abstract. The Serbian Carpathians, a segment of the Carpatho–Balkanides orogen, preserve a tectonic record of Jurassic to Miocene evolution related to the opening and closure of the Ceahlău–Severin ocean. The Danube River Gorge provides an exceptional field transect through this orogenic system, exposing the main tectonic units, their lithostratigraphic architecture, and the superposed deformation phases that define the present-day structure of the orogen. This contribution synthesizes field observations from ten key localities distributed along the Danube River Gorge between Golubac and Donji Milanovac. The transect directly documents the relationships among the Supragetic–Getic unit, the Ceahlău–Severin unit, and the Danubian unit, as well as their associated sedimentary successions, contractional structures, and post-orogenic fault systems. The field profile includes deep-water Jurassic–Lower Cretaceous sedimentary successions deposited along the passive continental margin of the Ceahlău–Severin ocean, tectonic contacts within the Dacia mega-unit, east-vergent folds and thrusts related to the emplacement of the Danubian nappes, and younger strike-slip and extensional structures linked to Cenozoic strain partitioning. The transect demonstrates that the first-order architecture of the Serbian Carpathians is primarily controlled by latest Cretaceous east-vergent nappe emplacement, during which Dacia-derived units were thrust over the Danubian domain. Earlier Jurassic–Early Cretaceous extension established the paleogeographic and structural template of the system, whereas late Early Cretaceous deformation records internal nappe stacking within the Dacia mega-unit. Oligocene–Miocene strike-slip and extensional deformation subsequently segmented the nappe stack without fundamentally modifying its overall geometry. The Danube River Gorge, therefore, provides a unique field-based framework for understanding the tectonic evolution and orogenic architecture of the Serbian Carpathians.

Апстракт. Српски Карпати представљају сегмент Карпато–балканског орогена у коме је очуван тектонски запис јурско–миоценске еволуције повезане са отварањем и затварањем океанског домена Чехлау–Северин. Ђердапска клисура пружа изузетан теренски профил кроз овај ороген, дуж којег су директно изложене главне тектонске јединице, њихова литостратиграфска грађа и суперпониране деформационе фазе које дефинишу савремену структуру орогена. У раду је приказана синтеза теренских запажања са десет кључних локалитета распоређених дуж

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Ђердапске клисуре између Голупца и Доњег Милановца. Профил директно приказује односе између Супрагетско–гетске јединице, Чехлау–Северин јединице и Данубијске јединице, као и њихових седиментних секвенци, контракционих структура и посторогених раседних система. Дуж профила изложени су јурско–доњокредни дубоководни седименти настали дуж пасивне континенталне маргине океана Чехлау–Северин, тектонски контакти у оквиру Дакијске мега–јединице, источно вергентне наборно-навлачне структуре настале током формирања данубијских навлака, као и млађе транскурентне и екстензионе структуре повезане са кенозојским деформацијама. Профил показује да је архитектура Српских Карпата првенствено контролисана најмлађокредним источно-вергентним навлачењем, током којег су јединице дакијског афинитета навучене преко данубијског домена. Старија јурско–доњокредна екстензија успоставила је палеогеографски и структурни шаблон система, док деформације на прелазу између ране и касне креде бележе интерно навлачење у оквиру Дакијске мегајединице. Потоње олигоценско–миоценске транскурентне и екстензионе деформације сегментирале су кредни навлачни пакет без значајније измене његове основне геометрије. Ђердапска клисура стога представља јединствен теренски оквир за разумевање тектонске еволуције и орогене структуре Српских Карпата.

Кључне речи:
Чехлау–Северин океан, Дакијска мега-јединица, Данубијска јединица, деформациона еволуција, литостратиграфија.

Introduction

The Serbian Carpathians represent a segment of the Carpatho–Balkanides orogen in SE Europe (Fig. 1a). Their orogenic structure, lithostratigraphic record, and deformation patterns reflect Jurassic to Miocene tectonic evolution related to the development and closure of the Ceahlău–Severin ocean (Djerić et al., 2026 and references therein). The Danube River Gorge (Figs. 1b, 2) provides a unique natural transect through this orogen, exposing key relationships among the major tectonic units and allowing their structural and stratigraphic evolution to be examined directly in the field.

Recent regional studies have emphasized that the Serbian Carpathians evolved within a complex geodynamic framework involving the interaction of subduction systems and indentation-related deformation, resulting in pronounced strain partitioning and overprinting of deformation phases (Krstekanić et al., 2017, 2020, 2022; Randjelovic et al., 2025; Djerić et al., 2026; Stojadinovic et al., 2026). In this context, their orogenic architecture can only be adequately understood through the integration of structural, stratigraphic, and geodynamic perspectives.

This contribution aims to synthesize the orogenic structure of the Serbian Carpathians along a transect through the Danube River Gorge and to demonstrate how field-scale structural and lithostratigraphic relationships reflect the evolution of the Ceahlău–Severin oceanic domain.

Geological setting

Regional tectonic framework

The Serbian Carpathians form part of the Carpatho–Balkanides segment of the Alpine–Carpathian–Dinaridic orogenic system (Schmid et al., 2008, 2020). Structurally, they occupy a back-arc-convex position within the Carpathian orocline, between the Moesian Platform to the east and the Dinarides to the west (Fig. 1b, c).

The east-vergent orogenic nappe stack of the Serbian Carpathians is composed of three principal tectonic units (Fig. 1b). From west to east, these are: (i) the Supragetic–Getic unit, forming part of the Dacia mega-unit, (ii) the Ceahlău–Severin unit, representing ophiolite-bearing oceanic remnants, and (iii) the Danubian unit, corresponding to the Moesian foreland domain.

The Ceahlău–Severin ocean is widely interpreted as the easternmost branch of the Alpine Atlantic (Alpine Tethys), separating the Getic and Danubian

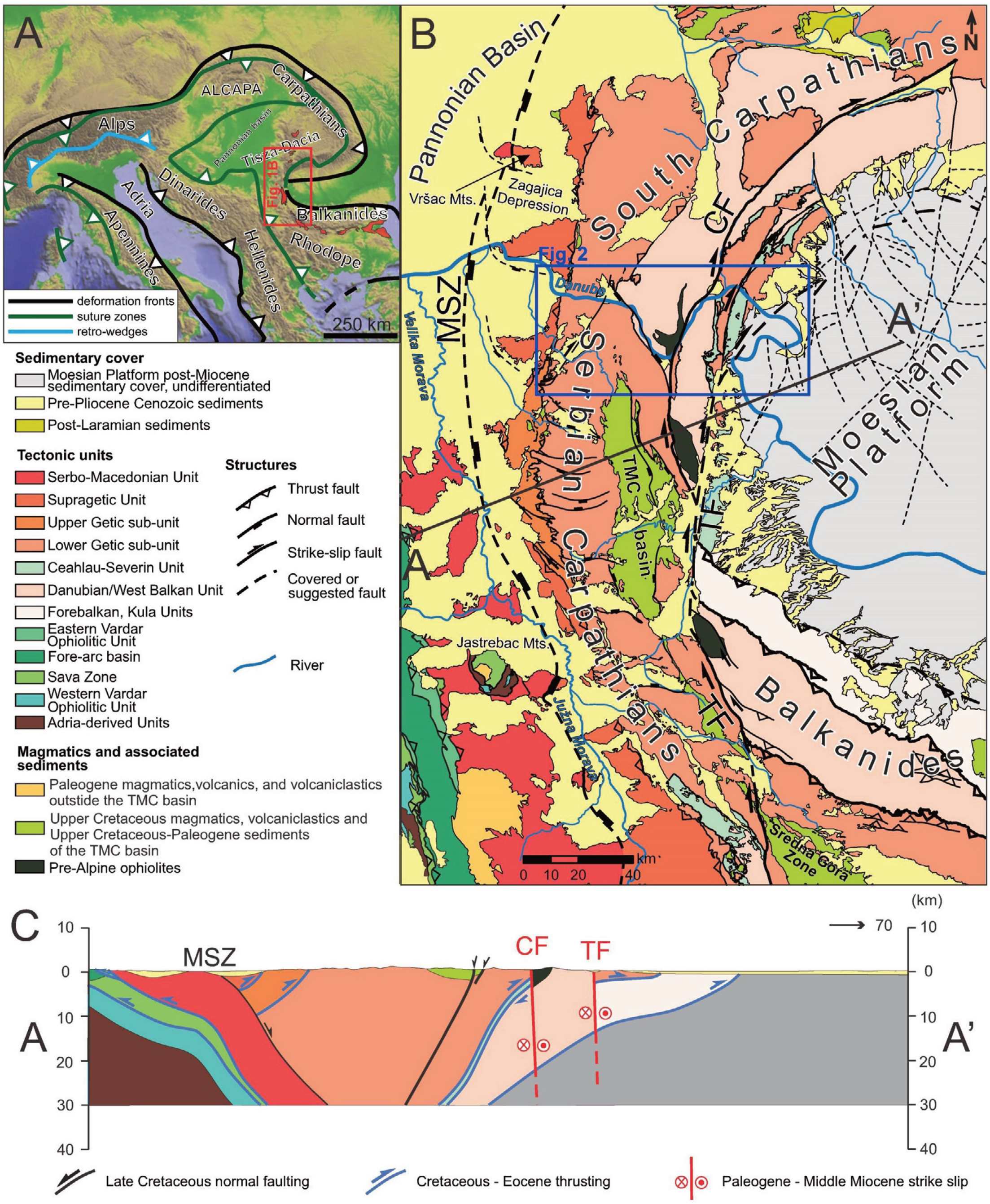

***Fig. 1. A)** Physical map of the Central Mediterranean orogens, displaying suture zones, orogenic fronts, and retro-wedges (modified after* Krstekanić *et al., 2020). The red rectangle indicates the location of the tectonic map shown in Figure 1B.* ***B)** Regional tectonic map of the area connecting the Dinarides and Carpathians showing the main tectonic units of the Serbian Carpathians (modified after* Schmid *et al., 2008, 2020). The black line indicates the position of the A–A' cross-section shown in Figure 1C, whereas the blue rectangle indicates the location of the map in Figure 2.* ***C)** Regional cross-section across the Serbian Carpathians and their transition to the Dinarides, twice vertically exaggerated (modified after* Randjelovic *et al., 2025). The ages of the main faults are shown in the legend, while the colours of the tectonic units correspond to those from Figure 1B. Abbreviations:* ***CF** – Cerna Fault;* ***TF** – Timok Fault;* ***MSZ** – Morava Shear Zone.*

continental domains during Jurassic rifting and controlling their subsequent convergence (Djerić et al., 2026 and references therein). Its evolution, from rifting to subduction and closure, exerted a first-order control on the structural architecture of the Serbian Carpathians.

Mesozoic–Cenozoic tectonic evolution

The Alpine tectonic evolution of the Serbian Carpathians is expressed through four deformation phases (D1–D4), which define the present-day structure observed along the Danube River Gorge transect and record the evolution of the Ceahlău–Severin ocean.

The oldest deformation phase (D1) corresponds to the Jurassic to Early Cretaceous opening of the Ceahlău–Severin ocean and the development of a rifted continental margin. Extension resulted in lithospheric thinning, horst-and-graben segmentation, and syn-rift sedimentation, particularly within the Danubian unit domain. Stratigraphic records indicate a transition from siliciclastic deposition to hemipelagic and pelagic sedimentation during progressive subsidence (Djerić et al., 2026).

During late Early Cretaceous onset of ocean closure, deformation phase (D2) was dominated by internal nappe stacking within the Dacia mega-unit, during which the Supragetic unit was thrust over the Getic unit. This phase is recorded by ductile to semi-ductile structures and defines the structural architecture of the upper tectonic levels (Krstekanić et al., 2017).

Latest Cretaceous continental collision (D3) corresponds to the main contractional event in the study area. The previously assembled Supragetic–Getic nappe system was emplaced over the Danubian unit, forming the Danubian nappes (Mațenco, 2017). This process involved large-scale east-vergent thrusting, resulting in tectonic burial followed by Late Eocene to Early Oligocene exhumation of the Danubian basement (Fügenschuh & Schmid, 2005). These relationships are well expressed along the Danube River Gorge transect and define the primary structural architecture of the orogen.

The Oligocene–Miocene post-collisional evolution (D4) is characterized by indentation of the Moesian Platform margin and the development of the Circum-Moesian Fault System (Krstekanić et al., 2022). Deformation is strongly partitioned into strike-slip, extensional, and subordinate contractional structures, leading to segmentation of the orogen and the formation of intra-montane basins (Fig. 1b).

Structural architecture of the study area

The Danube River Gorge exposes a well-expressed nappe stack in which the Supragetic–Getic units occupy structurally higher positions and are thrust over the Danubian unit along major east-vergent thrusts. Remnants of the Ceahlău–Severin domain occur as discontinuous ophiolitic and sedimentary assemblages marking the suture zone (Fig. 1b). The large-scale structure of the study area is defined by the D3 nappe architecture, which controls the stacking of the main tectonic units. Subsequent D4 deformation locally reactivated and segmented these structures through strike-slip and normal faulting, representing an overprint on the nappe system. Despite this reactivation, the primary nappe geometry has been largely preserved.

Methods and approach

This study is based on field observations collected along the Danube River Gorge transect and integrated with regional geological data and interpretations. Field analysis focuses on: (i) the identification of lithostratigraphic units and their contacts; (ii) the characterization of deformation structures, including faults, folds, and foliations; and (iii) the analysis of kinematic indicators used to infer the sense of movement. The relative timing of deformation was established through overprinting relationships, allowing discrimination among successive deformation phases (D1–D4). Emphasis was placed on distinguishing structures related to nappe emplacement from those associated with later strike-slip and extensional deformation. Field observations provide the primary constraints, which are interpreted within the broader geodynamic framework of the Ceahlău–Severin ocean and the Carpatho–Balkanides orogen.

Field excursion – Danube River Gorge transect

Itinerary and general overview

The field transect across the Danube River Gorge between Golubac and Donji Milanovac provides a condensed along-strike overview of the Serbian Carpathians, including their sedimentary evolution, nappe emplacement, and subsequent strain partitioning. It comprises ten key observation points distributed across the principal tectonic units of the Serbian Carpathians (Fig. 2).

The excursion is organized as a one-day field traverse beginning from Donji Milanovac, from where the route proceeds eastward through the central sectors of the gorge and subsequently westward toward Golubac. The itinerary is designed to provide a progressive overview of the lithostratigraphic architecture, tectonic contacts, and deformation styles that define the orogenic structure of the Serbian Carpathians. The transect begins within the Danubian unit, where Jurassic and Lower Cretaceous deep-water sedimentary successions record the evolution of the passive continental margin of the Ceahlău–Severin ocean. These localities expose hemipelagic limestones, radiolarites, turbidites, and gravity-flow deposits that document basin segmentation and synsedimentary tectonic instability during Jurassic–Early Cretaceous rifting and passive-margin development. The central part of the profile focuses on contractional structures related to latest Cretaceous nappe emplacement, including east-vergent folds, thrust-related deformation, and tectonic contacts between the major tectonic units. The western segment of the transect illustrates the internal architecture of the Dacia mega-unit through exposures of the Supragetic–Getic tectonic contact and associated late Early Cretaceous deformation structures. The excursion additionally documents the younger post-orogenic overprint expressed by strike-slip faulting and extensional basin formation associated with the Circum-Moesian Fault System. These structures are particularly well exposed along the Cerna Fault zone and within the Donji Milanovac Basin, where Miocene sediments unconformably overlie the older nappe architecture.

Description of key stops

Stop 1 – Sinaia and Comarnic Beds of the Ceahlău–Severin unit
[44°40’34.92”N 22°30’35.88”E]

This locality exposes the Lower Cretaceous deep-marine sedimentary succession of the Ceahlău–Severin unit, interpreted as remnants of the easternmost branch of the Alpine Atlantic (Ceahlău–Severin ocean). The lower part of the section is represented by the Tithonian–Hauterivian Sinaia beds, composed predominantly of distal shales and marlstones deposited in a basinal environment above oceanic crust (Seghedi & Oaie, 1997). These deposits are over-

Fig. 2. *Satellite map of the Danube River Gorge transect showing the location of the ten observation points (Imagery © Google Earth Pro, accessed 2026).*

lain by the Barremian–Aptian Comarnic beds, consisting of proximal siliciclastic turbidites derived from the advancing accretionary wedge during progressive basin closure. The entire succession was incorporated into the Late Cretaceous nappe stack during the D3 deformation phase and today records sedimentation within a deep-water convergent-margin setting.

Stop 2 – Upper Jurassic Deep-Water Carbonates of the Danubian unit at Mali Kazan
[44°38’19.21”N 22°18’29.67”E]

Mali Kazan represents the narrowest and one of the most spectacular sectors of the Danube River Gorge within the Iron Gates area, characterized by steep limestone cliffs rising directly above the river channel. The gorge marks a deeply incised segment of the Serbian Carpathians and provides exceptional exposures of the Jurassic sedimentary cover of the Danubian unit (Fig. 3).

The exposed succession consists of Upper Jurassic deep-water limestones with chert intercalations deposited along the passive continental margin of the Ceahlău–Severin ocean (Djerić et al., 2026). The facies association reflects hemipelagic sedimentation within a structurally differentiated marine basin dominated by pelagic carbonate accumulation and episodic silica-rich sedimentation (Fig. 4). These deposits represent the same deep-water carbonate system described in greater detail at stops 6–8.

Stop 3 – Metamorphic Basement of the Danubian Unit and the Cerna Fault Zone
[44°28'21.24"N 22°11'6.38"E]

This locality exposes the metamorphic basement of the Danubian unit affected by brittle deformation along the Cerna Fault system, one of the principal strike-slip structures of the Serbian Carpathians. This fault accommodates approximately 35 km of dextral offset, as constrained by the displacement of the Tisovița-Iuți–Deli Jovan Devonian ophiolites (Fig. 1b; Krstekanić et al., 2022). The outcrop is characterized by a metre-scale fault plane displaying prominent subhorizontal striations associated with dextral strike-slip movements formed during the Oligocene–Miocene D4 deformation phase. The Cerna Fault accommodated large-scale tectonic transport related to post-orogenic strain partitioning and clockwise rotation of the Carpatho-Balkanides during Cenozoic tectonic reorganization.

Stop 4 – Badenian Deposits of the Donji Milanovac Intra-Montane Basin
[44°27’53.42”N 22° 9’18.03”E]

The Donji Milanovac Basin represents a Middle Miocene intra-montane basin formed during post-orogenic extension associated with the development of the Circum-Moesian Fault System. Basin subsidence was controlled by normal faulting along its

Fig. 3. *Panoramic view of the Mali Kazan sector of the Danube River Gorge.*

southwestern margin during the D4 deformation phase (Fig. 1b). The sedimentary infill is dominated by Badenian marine conglomerates and sandstones overlain by *Lithothamnium* limestones, reflecting progressive marine transgression into the newly formed extensional basin (Fig. 5, Knežević, 1997). The Badenian deposits unconformably overlie both the metamorphic basement and the Mesozoic sedimentary cover of the Danubian unit, documenting Miocene tectonic and paleogeographic reorganization of the region.

Fig. 4. *Upper Jurassic hemipelagic limestones with chert intercalations exposed in the Mali Kazan sector of the Danube River Gorge.*

Stop 5 – Lower Cretaceous Maiolica-Type Pelagic Carbonates of the Danubian Unit

[44°31’24.38”N 22° 2’31.87”E]

This section exposes the Lower Cretaceous pelagic carbonate succession of the Danubian Unit, composed predominantly of Berriasian–Valanginian Maiolica-type deposits developed in a basinal setting (Fig. 6). The succession consists mainly of white micritic limestones with marly interbeds, recording sedimentation dominated by continuous settling of calcareous plankton and episodic contributions of biogenic silica. Up-section, calpionellid-bearing limestones gradually transition into biomicritic limestones enriched in radiolarians and sponge spicules. A slumped interval within the succession is interpreted as the product of submarine gravity sliding related to slope instability during the early Valanginian (Djerić et al., 2026). By the Berriasian–Valanginian, the entire region became draped by Maiolica-type pelagic carbonates, reflecting the establishment of relatively stable outer-shelf to basinal depositional conditions across the former paleorelief of the Danubian domain (Djerić et al., 2026).

Fig. 5. *Badenian sediments of the Donji Milanovac Basin unconformably overlying the Danubian basement.*

Stop 6 – Jurassic Pelagic Plateau Deposits of the Danubian Unit in the Boljetinska River Canyon

[44°32'25.26"N 22°1'46.78"E]

The Boljetinska River Canyon forms a narrow gorge incised into the Jurassic sedimentary succession of the Danubian unit and represents one of the most accessible exposures of deep-water Mesozoic deposits in the Serbian Carpathians. The canyon morphology reflects intense fluvial incision controlled

Fig. 6. *Berriasian–Valanginian Maiolica-type pelagic carbonates of the Danubian Unit.*

by inherited tectonic structures and differential erosion of carbonate and siliciclastic lithologies (Tchoumatchenco et al., 2006).

The exposed succession records Middle–Upper Jurassic deep-water sedimentation dominated by marly limestones, nodular limestones, and calcarenitic gravity-flow sediments deposited on a pelagic plateau (Fig. 7). The facies assemblage reflects hemipelagic carbonate sedimentation periodically interrupted by redeposition events related to slope instability and gravity-driven sediment transport.

Fig. 7. *Middle–Upper Jurassic pelagic plateau deposits exposed in the Boljetinska River Canyon.*

Stop 7 – Jurassic Rosso Ammonitico and Pelagic Plateau Deposits of the Danubian Unit near Lepenski Vir
[44°36'1.70"N 22° 0'0.66"E]

This section is situated immediately north of Lepenski Vir, one of the most important Mesolithic and Early Neolithic archaeological sites in southeastern Europe, renowned for its trapezoidal dwellings and monumental sandstone sculptures dated to approximately 9500–6000 BC (Borić et al., 2018). The site occupies a strategic position along the Danube River Gorge and reflects long-term human occupation linked to the riverine environment of the Iron Gates region.

This outcrop exposes a condensed Jurassic succession of the Danubian Unit deposited on a pelagic plateau (Fig. 8). The succession does not exceed 20 m in total thickness and ranges in age from Lower Jurassic transgressive siliciclastics to Lower Cretaceous pelagic spotted limestones (Djerić et al., 2026). The predominant facies is represented by Callovian–Oxfordian Rosso Ammonitico-type red nodular limestones, recording strongly condensed pelagic sedimentation. Up-section, the succession passes into Latest Oxfordian–Late Kimmeridgian red, laminated, thin-bedded limestones with intercalated cherts, reflecting deposition dominated by pelagic carbonate mud and biogenic silica under less condensed conditions and reduced bottom-current activity. The uppermost part of the section consists of Late Kimmeridgian–Tithonian red and grey nodular limestones. Rare chert nodules and layers occur only within the middle part of the succession (Djerić et al., 2026).

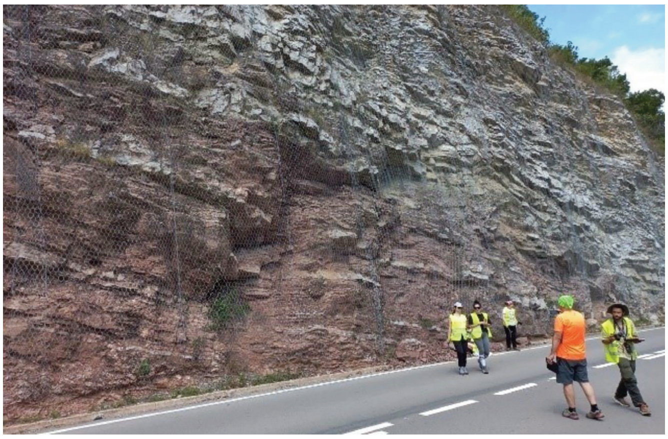

Fig. 8. *Condensed Jurassic pelagic plateau deposits of the Danubian Unit exposed near Lepenski Vir.*

Stop 8 – Deformed Upper Jurassic–Lower Cretaceous Pelagic Plateau Succession of the Danubian Unit.
[44°37'1.96"N 21°59'51.10"E]

Together with the section at Stop 7, this locality represents a structurally deformed segment of the Upper Jurassic–Lower Cretaceous pelagic plateau succession developed along the southern passive margin of the Ceahlău–Severin Ocean. The succession consists predominantly of red and grey nodular limestones, marly limestones, and thin-bedded pelagic carbonates with subordinate chert intercalations, corresponding to Rosso Ammonitico-type and related pelagic facies (Djerić et al., 2026). The deposits record condensed pelagic sedimentation dominated by carbonate mud settling, with episodic contributions of biogenic silica and locally developed calcarenitic interbeds. Microfacies are characterized by pelagic biota including *Saccocoma*, *Glo-*

bochaete, radiolarians, calcareous dinocysts, sponge spicules, and thin-shelled bivalves, whereas some carbonate beds contain redeposited shallow-water material derived from adjacent structural highs (Djerić et al., 2026). The succession is strongly deformed by asymmetric overturned folds with eastward vergence, axial-planar cleavage, and associated thrust faults formed during the D3 contractional deformation phase (Fig. 9).

Fig. 9. *Deformed Upper Jurassic–Lower Cretaceous pelagic plateau succession of the Danubian Unit showing asymmetric overturned folds and axial-planar cleavage formed during D3 contractional deformation.*

Stop 9 – Deformed Tithonian limestones of the Upper Getic Sub-unit near the Golubac Fortress
[44°39'31.71"N 21°40'31.17"E]

The locality is situated near the Golubac Fortress, a major medieval fortification strategically positioned at the entrance to the Iron Gates Gorge along the Danube River. The fortress occupies a narrow sector where the river enters the gorge system and historically controlled navigation and communication between Central Europe and the Balkans.

The outcrop exposes decametre-scale asymmetric folds developed within Tithonian limestones of the Upper Getic sub-unit in the footwall of the Supragetic thrust (Fig. 10). The folds display pronounced southeastward vergence and formed during late Early Cretaceous contraction associated with top-to-SE thrusting during nappe stacking (D2 deformation phase). The deformation geometry records progressive shortening accommodated away from the principal thrust zone, where penetrative shearing transitions into large-scale flexural folding within the carbonate succession.

Fig. 10. *Decametre-scale asymmetric folds within Tithonian limestones of the Upper Getic sub-unit near the Golubac Fortress.*

Stop 10 – Supragetic–Getic Tectonic Contact near Tumane Monastery
[44°35'28.38"N 21°38'38.02"E]

This section is located near the Tumane Monastery, within the structurally complex contact zone between the Supragetic and Getic units of the Serbian Carpathians. The outcrop exposes overturned and faulted Upper Jurassic limestones of the Getic unit, tectonically overlain by low-grade metamorphic rocks of the Supragetic unit (Fig. 11). Deformation is characterized by asymmetric folds with eastward vergence, formed during late Early Cretaceous thrusting of the Supragetic unit over the Getic unit during the D2 deformation phase. Later tectonic overprinting is expressed by dextral strike-slip movements along subvertical, NE–SW-oriented fault planes related to the D4 deformation phase and the post-orogenic tectonic reorganization of the region.

Fig. 11*. Overturned folds and later dextral strike-slip overprint in the Jurassic limestones of the Getic unit.*

Along-transect synthesis

The Danube River Gorge transect provides a continuous field-based overview of the tectonic architecture of the Serbian Carpathians and directly illustrates the relationships among the Danubian, Ceahlău–Severin, Getic, and Supragetic domains. The observed lithostratigraphic and structural relationships indicate that the present-day architecture of the orogen results from the superposition of Jurassic–Miocene deformation phases, with the dominant structural framework established during latest Cretaceous nappe emplacement. The eastern and central sectors of the transect are dominated by the Danubian unit, where Jurassic–Lower Cretaceous sedimentary successions record the evolution of the passive continental margin bordering the Ceahlău–Severin ocean. Lateral facies variations between radiolarites, hemipelagic limestones, calcarenitic gravity-flow deposits, and flysch-type successions reflect strong paleogeographic segmentation of the basin system during D1 extension. The spatial distribution of these facies indicates deposition within structurally differentiated deep-marine environments controlled by synsedimentary fault activity and progressive continental margin subsidence. The Ceahlău–Severin domain is represented by deep-water Lower Cretaceous successions exposed near the eastern entrance of the gorge. These deposits document sedimentation within an oceanward basinal setting and preserve the transition from passive-margin sedimentation to convergent-margin flysch deposition during progressive closure of the oceanic domain. Their incorporation into the nappe stack reflects large-scale contractional deformation related to D3 collision. Contractional structures become progressively more pronounced toward the structurally higher Getic and Supragetic domains exposed in the western part of the transect. East- to southeast-vergent asymmetric folds, thrust contacts, overturned limbs, and axial planar cleavage record progressive shortening during D2 and D3 deformation. The Supragetic–Getic contact near Tumane documents internal nappe stacking within the Dacia mega-unit during late Early Cretaceous deformation, whereas the large-scale east-vergent structures affecting the Danubian domain reflect the latest Cretaceous emplacement of Dacia-derived nappes over the Moesian foreland. The transect additionally demonstrates significant lateral variations in deformation style associated with post-orogenic strain partitioning during D4. Earlier contractional structures are segmented by dextral strike-slip faulting along major NE–SW-oriented fault systems, while extensional deformation controlled the formation of Miocene intra-montane basins such as the Donji Milanovac Basin. Despite this overprint, the primary nappe geometry remains largely preserved, indicating that post-orogenic deformation segmented rather than fundamentally reorganized the orogenic stack. Taken together, the Danube River Gorge transect demonstrates that the Serbian Carpathians preserve a well-exposed record of passive-margin development, ocean closure, nappe emplacement, and post-orogenic tectonic reorganization. The along-strike distribution of lithostratigraphic units and deformation structures provides a robust field framework for reconstructing the tectonic evolution of the Serbian Carpathians.

Summary

The Serbian Carpathians form part of the Carpatho–Balkanides within the Alpine–Carpathian–Dinaridic orogenic system, situated between the Moesian Platform to the east and the Dinarides to the west. Their structure reflects the Jurassic to Miocene evolution of the Ceahlău–Severin oceanic domain, from rifting to final closure. The orogen is defined by an east-vergent nappe stack composed of three main tectonic units: (i) the Supragetic–Getic unit, a segment of the Dacia mega-unit, (ii) the Ceahlău–Severin unit, preserved as ophiolitic and sedimentary remnants of the former oceanic domain, and (iii) the Danubian unit, representing the Moesian foreland. The Danube River Gorge provides an exceptional natural transect through this system, where key relationships between these units are well exposed and suitable for field-based structural analysis. Field observations indicate that the present-day architecture results from four deformation phases (D1–D4). D1 extension established the initial

structural template during Jurassic rifting. D2 deformation, during the late Early Cretaceous times, produced internal nappe stacking within the Dacia mega-unit. The dominant architecture formed during the latest Cretaceous D3 contractional phase, when east-vergent thrusting emplaced Dacia-derived units over the Danubian unit, forming the Danubian nappes. D4 deformation represents a post-orogenic overprint, characterized by strike-slip faulting and extension, which segmented but did not significantly modify the nappe geometry. Overall, the structure of the Serbian Carpathians is primarily controlled by D3 nappe emplacement, while earlier and later phases define its initial development and subsequent modification. The Danube River Gorge transect thus provides a robust field-based framework for understanding the tectonic evolution of the Serbian Carpathians.

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