

Structural types of terrains in the ophiolite belt of the Dinarides, Central Bosnia

Bojana Grujić^a, Aleksandar Golijanin^b, Žarko Grujić^c, Nikola Banjac^d

^a University of Banja Luka, Faculty of Architecture, Civil Engineering and Geodesy, Department of Civil Engineering, Banja Luka, Bosnia and Herzegovina
e-mail: bojana.grujic@aggf.unibl.org, **corresponding author**,
ORCID iD: <https://orcid.org/0009-0004-6926-6920>

^b University of Banja Luka, Faculty of Mining, Prijedor, Bosnia and Herzegovina
e-mail: aleksandar.golijanin@rf.unibl.org,
ORCID iD: <https://orcid.org/0009-0005-9404-6898>

^c University of Banja Luka, Faculty of Architecture, Civil Engineering and Geodesy, Department of Civil Engineering, Banja Luka, Bosnia and Herzegovina
e-mail: zarko.grujic@aggf.unibl.org,
ORCID iD: <https://orcid.org/0009-0009-4291-8032>

^d University of Novi sad, Faculty of Technical Science, Department of Civil Engineering, Novi Sad, Republic of Serbia
e-mail: banjacn@uns.ac.rs,
ORCID iD: <https://orcid.org/0009-0007-3665-4259>

 <https://doi.org/10.5937/vojtehg74-60644>

FIELD: geology

ARTICLE TYPE: original scientific paper

Abstract:

Introduction: The ophiolite belt of the Dinarides in the Central Bosnia region represents a specific formation, both in lithological and engineering-geological terms. From an engineering-geological perspective, this formation is characterized by anisotropic and heterogeneous geotechnical properties, with all the specific features typical of an ophiolitic mélange. It consists of a series of intrusions and extrusions of basic and ultrabasic magmas, partially of intermediate composition. A distinctive feature of this formation is the presence of a volcanogenic-sedimentary sequence that locally separates magmatic rocks from Paleogene, Neogene, and Quaternary clastic sediments. Additionally, magmatic activity during later stages led to the metamorphosis of basic and ultrabasic rocks, resulting in the formation of serpentinites.

Methods: Terrain instability phenomena, primarily represented by landslides, are predominantly associated with areas where direct contact exists between sedimentary formations and magmatic rocks. Rockfalls, as geodynamic processes, are linked to steep rocky slopes or road cuts and,

occasionally, riverbeds. By applying geological and geotechnical investigation methods, six terrain types within the ophiolite belt of the Dinarides in Central Bosnia were identified and analyzed. This classification is of critical importance for the design, construction, and maintenance of artificial structures, particularly in view of the the alignment of the Vc motorway through this region of Bosnia and Herzegovina.

Results: The paper presents research findings related to the age of individual lithological units and their stratigraphic positions. Furthermore, the study provides significant insights into the physical and mechanical properties of specific lithological members, their hydrogeological characteristics, and their broader functional role within the terrain system of Central Bosnia.

Conclusion: Based on the conducted investigations, terrain types within the ophiolite belt of the Dinarides have been defined and analyzed. The study concludes that the causes of terrain instability during construction, particularly the activation of landslide processes, can be classified into four main categories: geological, geomorphological, physical (climatic), and anthropogenic factors, all of which are clearly defined and addressed in this paper.

Key words: ophiolite belt of the Dinarides, sediment, magmatites, landslides.

Introduction

The area of Central Bosnia, located within the triangle formed by Žepče, Zavidovići, and Tešanj, is part of the central sections of the ophiolitic belt of the Dinarides. It is primarily composed of clastic rocks from the Jurassic and Cretaceous periods. Within the Jurassic period, the volcanogenic-sedimentary formation stands out in particular. In this formation, clastic rocks dominate, mainly represented by various types of sandstones, which often show signs of epigenetic changes. They most commonly contain interlayers of siltstone and, more rarely, breccias formed from fragments of volcanic rocks. Hornfels are present in thicker sequences south of Zavidovići. The sedimentary rocks are distinguished as separate lithological units, including sandstones, breccias, hornfels, siltstones, and clays (Golijanin & Malbašić, 2019; Grujić et al., 2025; Ahmed Bilal Benjahia et al., 2025).

Within the volcanogenic-sedimentary formation, two groups of magmatic rocks can be identified. The first group includes spilites, diabases, dolerites, gabbros, and granites, while the second group consists of ultrabasic rocks, represented by peridotites, which most likely formed during the final phase of magmatic activity. As such, these rocks

were intruded and cooled, along with amphiboles, within pre-existing formations.

Spilites are mainly products of submarine eruptions, while diabases appear in the form of layers within the sediments of the volcanogenic-sedimentary formation. Dolerites are more widespread than diabases and spilites. They most often occur at contact zones between ultramafic rocks and the sediments of the volcanogenic-sedimentary formation. Gabbroid rocks are also widely distributed within the volcanogenic-sedimentary formation. Granites appear as smaller masses along fault zones in ultramafic rocks or in their marginal areas. Amphibolitic schists and amphibolites generally occur as narrow or broader zones along the contact between ultramafic rocks and the volcanogenic-sedimentary formation.

Peridotites form a large ultramafic massif in the Ozren region and the northern part of the Krivaja massif. Peridotites are typically serpentinized to varying degrees, typically between 30% and 50%. Serpentinites, which are subordinate to peridotites, appear in several forms: as small masses within the sediments of the Jurassic volcanogenic-sedimentary formation, along the edges of large ultramafic massifs, and within them along fault zones. Serpentinites are typically highly tectonized.

The ophiolitic massif of the Dinarides in Central Bosnia is divided into several structural or tectonic units. These include:

1. The Krivaja-Mračaj syncline, predominantly composed of rocks from the Jurassic volcanogenic-sedimentary formation;
2. The Klečka anticline, which is located north of and adjacent to the Krivaja-Mračaj syncline;
3. The Maglaj-Zavidovići syncline, composed of rocks from the volcanogenic-sedimentary formation and representing the most prominent structural unit in this area;
4. The Paklenica syncline, a smaller structural unit located in the extreme northwestern part.

These tectonic units are outlined on the Geological Map of the Former Yugoslavia, Zavidovići sheet (Sunarić et al., 1973; 1974), Figure 1.



Figure 1 - A detail of the basic geological map of Zavidovići, R 1:100,000

Methodology of terrain research

For the construction of the highway section on Corridor Vc through Bosnia and Herzegovina, the most advanced research methods were

applied, both in the field and in laboratory conditions. Based on the results of field and laboratory geological investigations, a synthesis was made, and characteristic types of terrain in the ophiolite belt of the Dinarides in Central Bosnia were identified.

The research included detailed engineering-geological mapping of the terrain, based on which numerous exploration works were located, both during the design phase and additional works during the construction phase of the highway section. The research also involved a series of shallow boreholes, exploration trenches, and test pits. Geophysical investigations were applied, along with a significant number of laboratory geomechanical, mineralogical, and petrological tests, as well as several engineering-geological and hydrogeological maps for specific areas of the terrain. All of this was done depending on the construction challenges of certain structures along the highway section, such as bridges, tunnels, and retaining structures, with the goal of defining the conditions for the construction of specific objects or resolving the stability conditions of certain slopes whose natural stability was disrupted by the construction of the roadway in question.

During the 1970s and 1980s, extensive regional geological surveys were conducted, resulting in the Zavidovići and Teslić sheets of the Basic Geological Map of the former Yugoslavia (Sunarić et al., 1973; 1974), Figure 1.

This paper presents scientific solutions regarding the age of specific lithological formations and their position in the geological column. It also defines the physical-mechanical characteristics of individual lithological members as well as their hydrogeological properties.

Research results

Chronological overview of the geological composition of the Central Bosnia terrain

The Middle and Upper Triassic formations ($T_{2,3}$) have a very limited distribution and are represented exclusively by carbonate rocks, including limestones and dolomites. These formations are not fully differentiated on the geological column and are considered a single lithological unit. The older Jurassic ($J_{1,2}$) includes a series of rocks composed of claystones, marl limestones, limestones, and hornfels. These formations appear in narrow and wide zones along the tectonic contact between peridotites and the volcanogenic-sedimentary formation (Cvetkovic et al., 2016).

The younger Jurassic ($J_{2,3}$), or the Jurassic volcanogenic-sedimentary formation, also known as the "diabase-hornfels formation," has the largest

extent in the ophiolitic zone of Central Bosnia. It is most widespread in the southern parts of this zone, where it forms the Krivaja-Mračaj syncline. This volcanogenic-sedimentary formation also extends into the large Maglaj-Zavidovići syncline and the Bočinja anticline. A narrow zone of the volcanogenic-sedimentary formation is also present in the southern part of the Paklenica syncline. The Jurassic volcanogenic-sedimentary formation is a very thick complex of rocks with a highly varied composition. In addition to numerous sedimentary rocks, it contains large masses of ultrabasic rocks, amphibolites, and both effusive and intrusive basic and acidic magmatic rocks (Cvetkovic et al., 2016).

The Late to Early Cretaceous (J,K₁) includes a thick series of coarse clastic sediments that form the large Maglaj-Zavidovići syncline. Consequently, the sediments of the Late Jurassic and Early Cretaceous, along with the Jurassic volcanogenic-sedimentary formation, have the greatest distribution.

Upper Cretaceous sediments (K₂₂), predominantly carbonates, are much less widespread than the Jurassic and Late to Early Cretaceous formations. Their greatest distribution is in the Paklenica syncline, located in the extreme northwestern part of the ophiolitic zone. These sediments are represented by layered limestones and limestone conglomerates.

The Paleogene (Pc, E) is developed exclusively in the extreme northwestern parts of the ophiolitic zone, where it forms the central parts of the Paklenica syncline. It is represented solely by limestones, which are typically massive and rarely layered.

Neogene sediments (Ng) have a wide distribution in the ophiolitic zone, particularly in the northern parts of the terrain. They are represented by lacustrine-lagoonal (Oligo-Miocene, Lower and partly Middle Miocene) and marine (Tortonian, Sarmatian, and Pliocene) facies. This also includes the so-called "red series," which represents the oldest sediments in the superposed Neogene sequence. It consists of alternating conglomerates and sandstones, with subordinated claystones and mudstones. The conglomerates are poorly to moderately sorted and very heterogeneous (containing clasts of hornfels, diabase, grauwacke sandstones, clays, limestones, and serpentinites). The cement is primarily carbonate, sometimes mixed with limonite. In this zone, sandstones are poorly sorted and poorly cemented.

Lithological composition

In the area of Central Bosnia, within the so-called Ophiolitic Zone of the Dinarides, specifically in the "diabase-hornfels" formation, we can identify all types of rock masses, differentiated by their origin. These

include: igneous (both intrusive and effusive), sedimentary, and metamorphic rocks (Božović et al., 2013).

Sedimentary rocks dominate the volcanogenic-sedimentary formation and are represented as follows:

- Sandstones, which are the most prevalent rocks in this formation.
- Siltstone clays, which are somewhat less common than sandstones.
- Breccias, with a variable granulometric composition; their fragments vary in size.
- Hornfels, which occur rarely, usually in the form of chalcedony and opal.
- Limestones, which are also a rare component of this complex, and are generally marly.

Volcanic rocks in the volcanogenic-sedimentary formation are significantly represented and form a large part of the terrain in the area under consideration in this study. These are predominantly effusive rocks of medium acidity, including spilites, diabases, and dolerites.

Intrusive rocks are of basic and ultrabasic character and are represented by gabbros of various types, as well as peridotites.

- Spilites ($\beta\beta_{ab}$, $J_{2,3}$) are a very important and common eruptive member of the volcanogenic-sedimentary formation. The size of spilitic masses varies considerably. Sometimes, they form small bodies that are not clearly distinguished within the sediments, while at other times, they cover areas of several tens of square kilometers.
- Diabases ($\beta\beta$, $J_{2,3}$) are also an important member of the volcanogenic-sedimentary formation. It is often difficult to distinguish diabases from spilites in the field. They differ from dolerites in their granulometric composition. The grains of diabases are not visible to the naked eye, unlike in dolerites.
- Dolerite rocks ($u\beta\beta$, $J_{2,3}$) are widely distributed, much more so than the described diabases and spilites. They typically appear in the contact zones between ultramafic masses and the sediments of the volcanogenic-sedimentary formation, in larger or smaller bodies.
- Gabbros (u , $J_{2,3}$) are intrusive, basic igneous rocks that are noticeable on the surface. Depending on their composition and occurrence, they can be divided into: amphibolic gabbros, gabbros, troctolites, microgabbros, and gabbro-peridotites.
- Peridotites ($J_{2,3}$) are by far the most widespread igneous rocks in the Jurassic volcanogenic-sedimentary formation. These are ultrabasic igneous rocks. Peridotitic massifs are in clear tectonic

contact with the sediments of the volcanogenic-sedimentary formation. As a result, the peripheral parts of this formation are subject to intense metamorphic processes, specifically serpentinization.

Metamorphic rocks in this area are represented by serpentinites and amphibolitic schists (Božović et al., 2013).

- Serpentinites (Se, J_{2,3}) are commonly found within larger ultramafic massifs, occurring as narrow zones along faults. Large masses of serpentinites are also frequent and typically form parts of larger peridotitic massifs that border younger, usually Tertiary sediments. Serpentinites are often intensely tectonized.
- Amphibolitic schists (A, J_{2,3}) frequently appear as narrower zones along the contact between ultramafic rocks and the Jurassic volcanogenic-sedimentary formation. They are much rarer within the lithological formations themselves.

Marine development is represented by Tortonian sediments of the Upper Miocene (M₂₂). This formation is subdivided into two horizons:

- Limestone conglomerates (¹M₂₂), which lie transgressively over the "red series". These are composed exclusively of limestone clasts, poorly sorted, and well cemented by carbonate and marl binders.
- Sandstones, conglomerates, and clays (²M₂₂), which lie normally over the conglomerates.

Tectonic properties of the terrain

The central ophiolitic zone of the Dinarides is characterized by the presence of large ultramafic bodies. There is considerable debate in the literature regarding the age of the peridotite masses, but it is generally accepted that they date back to the Jurassic period (J_{2,3}). Based on the analysis of the sheets from the Basic Geological Map of the former Yugoslavia that cover this area, six structural units can be identified (J. Sunarić et al., 1973; 1974).

- Krivajsko-Mracaj Syncline
- Klecka Anticline
- Maglaj-Zavidovici Syncline
- Paklenica Syncline
- Freshwater Neogene Basins
- Marine Neogene Basins

Hydrogeological properties of the terrain

In hydrogeological terms, the Quaternary eluvial-deluvial deposits, degraded siltstone, clays, sandstones, and thin-bedded marls, during

periods of heavy precipitation, represent a water-saturated environment in the ophiolitic area of Central Bosnia. Under such conditions, physically bound water reduces shear strength parameters, adds additional load to slopes, and consequently contributes to the activation of sliding processes. Free groundwater in fractured rock aggregates, with its pressure and circulation, contributes to the physical-chemical weathering and degradation of the primary rock mass.

Magmatic and metamorphic rocks in the ophiolitic zone of Central Bosnia are characterized by highly developed fracture porosity. Based on porosity type, hydrogeological function, and position within the terrain, as well as the hydrogeological conditions of formation, the following categories of rock masses can be distinguished by their hydrogeological function:

- Hydrogeological aquifers: These are rocks with prominent fracture porosity and are predominantly of magmatic origin. They are represented by diabases ($\beta\beta$), spilites ($\beta\beta ab$), dolerites ($u\beta\beta$), gabbros (u), peridotites, and metamorphic rocks represented by serpentinites (Se).
- Relative hydrogeological modifiers: These are siltstones, aleuritic sandstones, breccias, sandstones, and limestones, which are the dominant rocks in the volcanogenic-sedimentary formation of Neogene age (Ng).

Types of terrain construction

From a mechanical perspective, rock masses, as real bodies, exhibit very complex behavior. This is due not only to their specific structure but also to the different stress conditions they have experienced throughout geological history. As a result, all rock masses- even the youngest ones- are fractured, both with primary and secondary fractures, which are the result of various stresses that exceed the strength of the rock masses.

The terrain formed by the ophiolite formation, specifically the diabase – chert formation, is of heterogeneous composition, consisting of Neogene sediments, volcanogenic-sedimentary formations, and various types of magmatic rocks, including both eruptive and plutonic, as well as metamorphic rocks. These magmatic rocks collide with each other but also intrude into one another. These lithological components have different physical and mechanical properties. As a result, the terrain is formed by complex geological structures with the following characteristics (Sunarić, 2017; Golijanin et al., 2024):

1. Plastic environments – Deluvial clayey
2. Plastic to quasi-plastic environments – Neogene sediments
3. Quasi-plastic environments – Volcanogenic-sedimentary

4. Brittle environments – Magmatics (Eruptives and Plutonics) and Serpentinities

In the ophiolite belt of the Dinarides in Central Bosnia, the diabase-chert formation consists of six distinct types of terrain construction, which the authors illustrate in the following images, from Figure 2 to Figure 7.

Based on the types of terrain construction in the ophiolite zone, specifically the diabase-corneal formation of the Dinarides in Central Bosnia, as well as the overall complex tectonic relationships throughout the region, it can be concluded that the forms of deformation are highly intricate. Depending on the spatial arrangement of the geotechnical environments (lithological units) that interact in this area—sometimes colliding, sometimes intruding through one another, and at other times overlying each other—each with distinct physical and mechanical properties, their behavior in nature varies under the influence of specific forces and stresses.

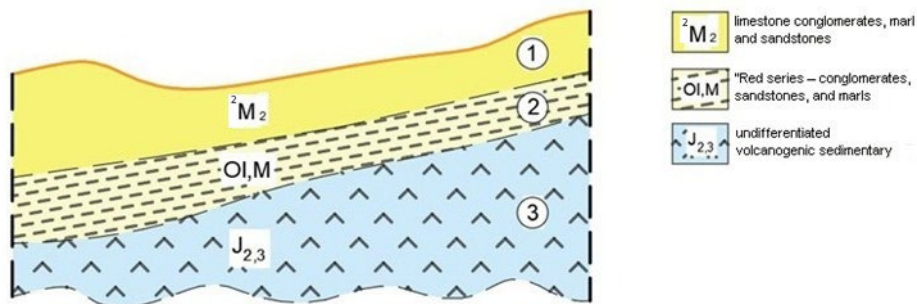


Figure 2 - Terrain construction type 1

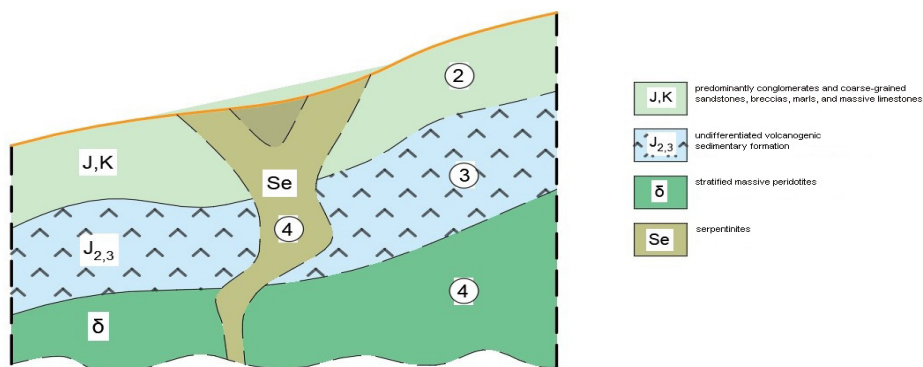


Figure 3 - Terrain construction type 2

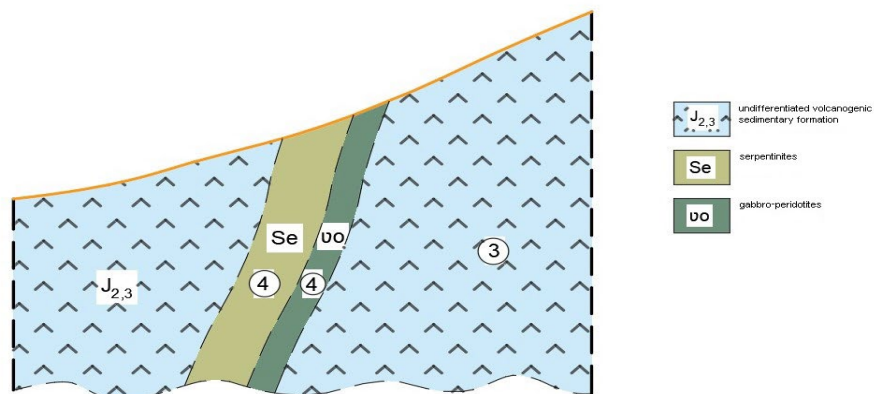


Figure 4 - Terrain construction type 3

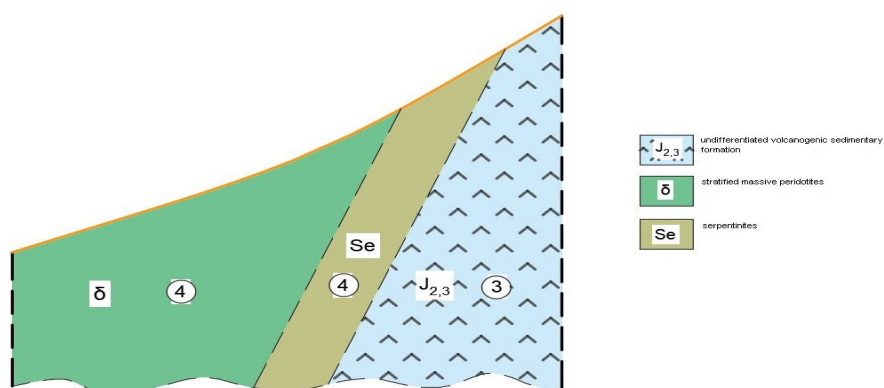


Figure 5 - Terrain construction type 4

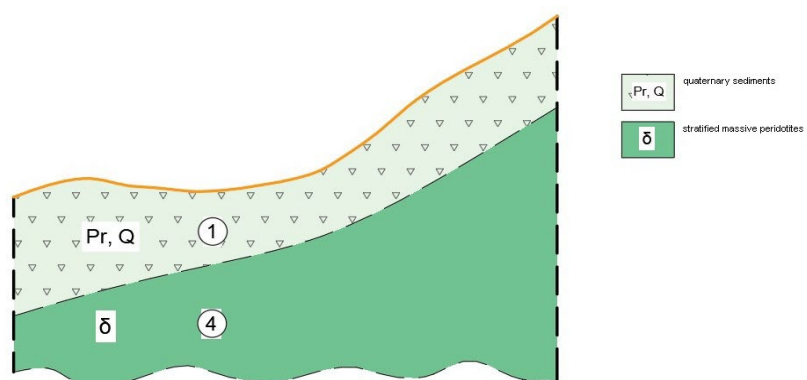


Figure 6 - Terrain construction type 5

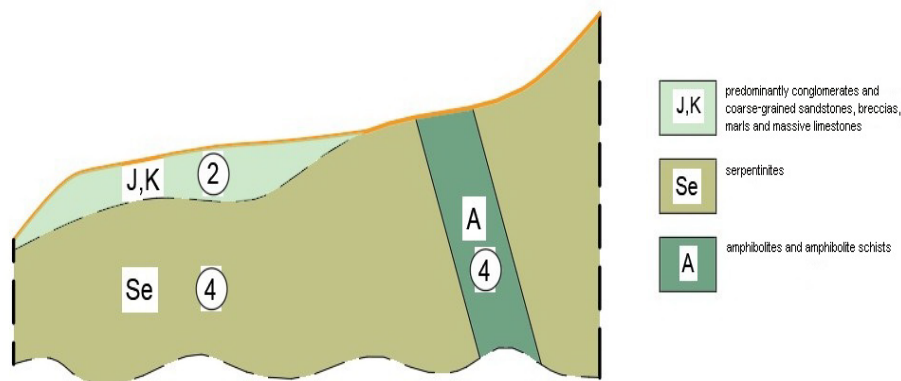


Figure 7 - Terrain construction type 6

Modern processes in the ophiolite zone of the Dinarides in Central Bosnia

A generalized classification of contemporary exodynamic processes in our region has been in use since 1960 (Janjić, 1982). According to this classification, contemporary exodynamic processes are categorized as follows:

- Rockfalls
- Landslides
- Soil creep
- Earth flows

Rockfalls within the ophiolite belt of the Dinarides in Central Bosnia are not characterized by significant areal distribution or large volumes. They are predominantly associated with steep man-made road cuts and steep valley flanks incised by river channels. The formation of rockfalls is primarily attributed to significant annual temperature fluctuations and substantial precipitation. Large rock blocks are rarely observed, occurring mainly along transportation corridors in excavated or cut sections. Rockfalls may also be triggered by seismic activity (Sunarić et al., 2008). Landslides, as a form of contemporary geodynamic activity, involve the downslope movement of soil and rock masses along a well-defined shear surface, without detachment from the basal material. Within terrains underlain by these geological formations, landslides of various scales are commonly observed. In areas where sedimentary deposits directly overlie magmatic rocks and where favorable morphological conditions exist, such zones may be considered naturally predisposed to slope instability.

The causative factors of landslide formation are diverse and often interdependent. The primary factor is the lithological contact between the underlying magmatic rocks and the overlying sedimentary sequences, along which displacement typically occurs. Additional contributing factors include slope gradient, saturation of sedimentary masses with water, and proximity to hydrological features, including major and minor fluvial systems - most notably the Bosna and Krivaja Rivers, among others.



Figure 8 - "Strupina" landslide near Maglaj city

In the explored area, the landslides predominantly fall within the category of consequent landslides, specifically those exhibiting a block-structured morphology with preconditioned slip surfaces (Zolotarev, 1990). The slip surface typically develops at the interface between the bedrock—comprising magmatic rocks—and the overlying Neogene and Quaternary sediments. In addition to this inherent lithological relationship, several other factors critically influence the initiation and development of landslides, including terrain saturation, thermal fluctuations, topographic configuration, and the spatial disposition of the bedrock within the landscape.

In portions of the terrain where a distinct geological unit—designated on the Basic Geological Map as volcanogenic-sedimentary—intervenes between the magmatic bedrock and the sedimentary cover, it may be inferred that this formation contributes significantly to slope stability. Notably, landslides have not been observed in these zones, nor have any displacements been recorded in excavated sections. By way of illustration, the authors refer to the excavated slopes adjacent to the approach portals of the "Crni Vrh" tunnel along Corridor Vc. Remarkably, the near-vertical

cuts within this geological context remained stable over six months, exhibiting no visible deformation despite substantial exposure to both rainfall and snow accumulation between December 2023 and April 2024 (Divel d.o.o., 2024).



Figure 9 - Terrain cut near the southern portal of the "Crni Vrh" tunnel on Vc Corridor, Bosnia and Herzegovina

Discussion of research results

This paper presents six characteristic types of terrain structure within the specific lithological formation under study, with clearly defined conditions of their formation. The identified types of terrain configuration are of significant importance for analyzing the stability of specific terrain sections during the construction of artificial engineering structures, such as motorways, as well as during slope excavation in tunnel portal zones on steep slopes or when constructing bridge foundations.

The causes of instability during construction, i.e., the triggering of landslide processes, can generally be categorized as geological, geomorphological, physical (climatic), and anthropogenic.

Geological conditions contributing to instability are inherent in the rock masses themselves — their origin, formation conditions, and physico-mechanical properties, which reflect their capacity to respond more or less rapidly to external weathering agents. The contact between the magmatic bedrock and overlying sedimentary formations, when combined with favorable contact morphology, can lead to the activation of landslide processes under anthropogenic influence (Jevremović & Golijanin, 2025). Interestingly, the presence of re-deposited volcanogenic-sedimentary formations — representing a combination of terrigenous and volcanogenic materials located between the bedrock and sedimentary units — acts as a

stabilizing factor regardless of terrain morphology or the geometry of the lithological contact (Figure 8).

Geomorphological conditions relate to the morphogenetic development of slopes and the shaping of the terrain under the influence of contemporary exogenous processes.

Physical or climatic conditions refer to the amount of precipitation and the rapid freezing and thawing of snow.

Anthropogenic activity, or human-induced impact, is the most common cause of instability. These instabilities — such as landslides and rockfalls — are not only frequent but also characterized by rapid and uncontrolled development, often resulting in severe consequences for residential and infrastructure facilities (Figure 7).

Conclusion

The ophiolitic or diabase-hornblende formation in Central Bosnia represents a complex lithological unit formed during the Middle and Upper Jurassic periods — Dogger and Malm (J2,3). Following the emplacement of magma during the Dogger and Malm, the area was initially subjected to intense disintegration processes, resulting in the degradation of magmatic and volcanic rocks. In the final stages of the Jurassic and into the Lower Cretaceous, the terrain experienced partial lacustrine sedimentation and the redeposition of disintegrated surface material. This led to the formation of a volcanogenic-sedimentary unit, which acts as a kind of "buffer" or damping layer between the magmatic rocks and subsequently deposited sediments. This interaction enables terrain stability even under conditions of vertically excavated slopes.

The extruded magma was of neutral, basic, and ultrabasic composition. In certain parts of the terrain, additional magmatic activity occurred during the Neogene period, resulting in dacitic magma intrusions and the deposition of tuff layers. Partial metamorphism of the surrounding ultrabasic magmatic rocks—specifically peridotites - also took place during this process, leading to the formation of serpentinites.

In areas where sedimentary deposits of Paleogene (Pg), Neogene (Ng), and Quaternary (Q) age directly overlie the magmatic basement in a discordant contact, and where the volcanogenic-sedimentary unit is absent, such zones are considered unstable from a slope stability perspective - particularly when morphological conditions are favorable for instability. In these cases, the likelihood of landslide occurrence is significantly increased. Landslides are especially likely to be triggered if the primary geostatic conditions are disturbed, such as through terrain

water saturation, anthropogenic activities, or the occurrence of seismic movements.

References

- Božović, M., Prelević, D., Romer, R. L., Barth, M., Van Den Bogaard, P., & Boev, B. 2013. The Demir Kapija Ophiolite, Macedonia (FYROM): A Snapshot of Subduction Initiation within a Back-arc. *Journal of Petrology*, 54(7), 1427–1453. Available at: <https://doi.org/10.1093/petrology/egt017>
- Cvetkovic, V., Prelević, D., & Schmid, S. 2016. Geology of South-Eastern Europe. In P. Papic (Ed.), *Mineral and Thermal Waters of Southeastern Europe* (pp. 1–29). Springer International Publishing. Available at: https://doi.org/10.1007/978-3-319-25379-4_1
- Divel d.o.o. 2024. *Autocesta koridor Vc, dionica Medakovo – Ozimica, Knjiga: C1011 – Elaborat o inženjersko-geološkim i geotehničkim karakteristikama tla sa podacima o geomehaničkim, geotehničkim i geoseizmičkim svojstvima tla i stijena za trasu, potporne konstrukcije*. Divel d.o.o. (in Serbian)
- Golijanin, A., & Malbašić, V. 2019. Geotechnical Terrain Models and Types of Instabilities in the Durmitor Flysch Complex. *Materials and Geoenvironment*, 66(1), 1–11. Available at: <https://doi.org/10.2478/rmzmag-2018-0021>
- Janjić, M. 1982. *Inženjersko-geološke odlike terena NR Srbije*. Beograd, Srbija: Zavod za geološka i geofizička istraživanja, (in Serbian)
- Jevremović, D., & Golijanin, A. 2025. *Inženjerska geologija*. Banja Luka, BiH: Rudarski fakultet Prijedor, Univerzitet u Banjoj Luci (in Serbian)
- Grujić, B, Golijanin, A, Torbica D, Grujić Ž, 2025. Characteristic Types of Landslides in The Durmitor Flysch Complex Area, AGG+, Faculty of Architecture, Civil Engineering and Geodesy, University of Banja Luka. Available at: <https://doi.org/10.61892/AGG202501009G>
- Benyahia, B. A., Irki, I., Djafar, H. A., Eziane M. & Laidani, Z. el A.. 2025, Effect of crushed limestone sand and dust on the mechanical behaviour of river sand mixtures: An experimental study, *Vojnotehnički glasnik/Military Technical Courier*, 73(2), pp. 605-632. Available at: <https://doi.org/10.5937/vojtehg73-56170>
- Sunarić, D. 2017. *Inženjerska geodinamika—Teorija i praksa*. Beograd, Srbija: Akademija inženjerskih nauka Srbije i Institut za vodoprivredu „Jaroslav Černi”. (in Serbian)
- Golijanin A, Grujić B, Grujić Ž, 2024, Geomorphological, geological, and hydrogeological features of the immediate surroundings of sarajevo, Bosnia and Herzegovina, *Arhiv za tehničke nauke*. Available at: <https://doi.org/10.59456/afts.2024.1630.015G>
- Sunarić, D., Stojinić, N., & Nedeljković, S. 2008. *Seizmičnost terena i egzogene geodinamičke pojave (klizišta i odroni) u zapadnoj Srbiji*. Beograd, Srbija: Institut za vodoprivredu „Jaroslav Černi”, (in Serbian)

Sunarić, J., Pamić, O., & Olujić, J. 1973. *Osnovne Geološke Karte SFRJ list Zavidovići, Tumač*. Institut za geološka istraživanja (in Serbian)

Sunarić, J., Pamić, O., & Olujić, J. 1974. *Osnovne Geološke Karte SFRJ list Teslić, Tumač*. Institut za geološka istraživanja (in Serbian)

Zolotarev, G. S. 1990. *Metodika inženerno-geologičeskikh issledovanij*, Moskva: Moskovskij gosudarstvennyj universitet, ISBN: 5-211-01063-9 (in Russian) (In the original: Золотарев, Г. С. 1990. *Методика инженерно-геологических исследований*, Московский государственный университет)

Vrste terena u ofiolitskoj zoni Dinarida na području srednje Bosne

Bojana Grujić^a, Aleksandar Golijanin^b, Žarko Grujić^a, Nikola Banjac^c

^a Univerzitet u Banjoj Luci, Arhitektonsko–građevinsko-geodetski fakultet, građevinski odsek, Banja Luka, Republika Srpska, BiH

^b Univerzitet u Banjoj Luci, Rudarski fakultet, Prijedor, Republika Srpska, BiH

^c Univerzitet u Novom Sadu, Fakultet tehničkih nauka, Deapartman za građevinarstvo, Novi Sad, Republika Srbija

OBLAST: geologija

KATEGORIJA (TIP) ČLANKA: originalni naučni rad

Sažetak:

Uvod/cilj: Ofiolitski pojas Dinarida na području centralne Bosne predstavlja specifičnu formaciju, kako u litološkom, tako i u inženjergeološkom pogledu. U inženjergeološkom pogledu, ova formacija se odlikuje anizotropnim i heterogenim geotehničkim svojstvima, sa svim specifičnostima koje karakterišu dijabazno-rožnačku formaciju. Ova formacija se sastoji od niza proboja i izliva bazne i ultrabazne magme, delimično intermedijarnog karaktera. Posebnost ove formacije je prisustvo vulkanogeno-sedimentnog paketa koji mestimično odvaj magmatite od klasičnih sedimenata paleogena, neogena i kvartara. Takođe, pod uticajem magmatskih procesa u kasnijoj fazi, došlo je do metamorfizma baznih i ultrabaznih stena i njihove transformacije u serpentinite.

Metode: Fenomeni nestabilnosti terena, uglavnom predstavljeni klizištima, povezani su sa područjima gde postoji direktan kontakt između sedimenata i magmatita. Klizišta, kao geodinamički fenomeni, povezana su sa strmim usecima ili urezima stena i, mestimično, sa rečnim koritima. Primenom geoloških i geotehničkih metoda, u radu je predstavljeno šest tipova terena u ofiolitskom pojasu Dinarida centralne Bosne, što je od izuzetnog značaja za izgradnju i održavanje veštačkih objekata, s obzirom na to da trasa autoputa Vc kroz Bosnu i Hercegovinu prolazi kroz ovo područje.

Rezultati: U ovom radu predstavljena su istraživanja o starosti pojedinačnih litoloških formacija, njihov položaj u geološkom stubu i u značajnoj meri definisana su fizičko-mehanička svojstva pojedinačnih litoloških članova,

njihova hidrogeološka svojstva i njihova funkcija u širem smislu, sve na području centralne Bosne.

Zaključak: Na osnovu sprovedenih istraživanja dobijeni su i analizirani tipovi terena u ofiolitskom pojasu Dinarida, gde je zaključeno da se uzroci nestabilnosti tokom izgradnje veštačkih objekata, odnosno aktiviranja procesa klizanja, mogu svesti na geološke, geomorfološke, fizičke i tehnoгене uzroke koji su jasno definisani u ovom radu.

Ključne reči: ofiolitski pojas Dinarida, sedimenti, magmatiti, klizišta.

Paper received on: 5 August 2025.

Manuscript corrections submitted on: 13 November 2025.

Paper accepted for publishing on: 12 January 2026.

© 2026 The Authors. Published by Vojnotehnički glasnik / Military Technical Courier (www.vtg.mod.gov.rs). This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/rs/>)

