

## Additional Considerations on the Epiadriaticum, Outer Dinarides

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**Key words:** Pelagic beds, subduction, Outer Dinarides

**Ključne riječi:** Pelagičke naslage, subdukcija, Vanjski Dinaridi

### Abstract

Reinterpretation of some earlier published data on pelagic beds in Lika, Dalmatia, western Bosnia, eastern Hercegovina and Montenegro confirms the existence of a pelagic, labile Interplatform Belt (Epiadriaticum) in the frame of the Outer Dinarides.

### Sažetak

Reinterpretacija nekih ranije objavljenih podataka o pelagičkim naslagama u Lici, Dalmaciji, zapadnoj Bosni, istočnoj Hercegovini i Crnoj Gori potvrđuje postojanje labilnog, pelagičkog Meduplatformnog pojasa (Epiadrijatika) u okviru Vanjskih Dinarida.

### 1. INTRODUCTION

The Dinarides are a permanent inspiration for the geologist. In the phase of attempts to construct a model of their structural pattern, attention was mainly given to recognizing the features which determine their tectogenetic history and megatectonic frame. In that procedure the features which speak in favour of a chosen concept were selected. They may only be certain, probable or possible. Their full positive evaluation is acceptable only if there are no tectonic phenomena which can not be explained within the chosen concept.

As for the Dinarides, I hope that their subductional tectonic pattern has been definitely proven. The tectogenetic dynamics depended upon asthenospheric movements which influenced displacements of four main megatectonic belts in various ways (see Fig. 1): (1) The Adriatic Carbonate Platform (Adriaticum), (2) The Interplatform Labile Belt connecting the Pindus, Krasta, Budva, Tolmin and Belluno zones (Epiadriaticum), (3) The Dinaric Carbonate Platform (Dinaricum), and (4) The Inner, Oceanic Labile Belt (Supradinaricum). The last one was bordered, on the northern and north-eastern side by median masses such as the Tisia and the Serbo-Macedonian Mass. The reasons for such an interpretation have been elaborated in my previous papers (HERAK, 1986, 1989, 1991, etc.) in which the main competent references are reviewed. Therefore, the history of previous opinions may be omitted. The major difference between the currently proposed concept and the former ones are the introduction of an epi-continental (A-subductional) tectogenetic belt (the Interplatform Belt = Epiadriaticum), the negation of the primary tectogenetic meaning of the so-called Central Ophiolitic Belt (Serbian, Merdita, Subpelagonian) which is explained as a nappe, and finally, the explanation of the

so-called Pelagonian Belt, not as an autonomous unit, but as a result of interaction between the oceanic part of the Inner Dinaric Belt (Supradinaricum) and the Dinaric Carbonate Platform (Dinaricum).

Until the Upper Triassic, the post-Variscan platforms were influenced mostly by epirogenetic oscillations and limited rifting. Both of the labile belts, the epi-continental as well as the oceanic, originated due to shallow or deep rifting within a common post-Variscan platform. The epi-continental belt originated after the Middle Triassic, while the oceanic belt was formed during the Jurassic (after the Lias).

The origin of tangential structures is explained by subduction, first in both labile belts, and after the collision within the platforms as well, causing systems of nappes and overthrusts.

The final tectonic pattern was accomplished by differentiated vertical and sub-vertical movements accompanied by tilting and gravitational displacements of masses.

The proposed concept is elaborated on the basis of the comparison of various opinions giving preference to those ideas which make a consistent model. Nevertheless, there remain some gaps in interpretation which may be eliminated with the help of reinterpretation of some published data, which is the subject of this paper.

### 2. THE SPACE BETWEEN THE BUDVA AND TOLMIN AREAS

In the area of the so-called Outer Dinarides, the pelagic outcrops from the Upper Triassic until the Paleogene are known in the Budva Zone (Montenegro) as well as in the Tolmin Zone, or the "Slovenian Trench" (Slovenia), with a continuation into the Belluno Zone (Italy). Some problems have been elaborated in numerous papers, which are reviewed in my

previous publications (HERAK, 1986, 1989, 1991).

This paper is based on the reinterpretation of some basic papers which make possible a common conclusion concerning the source area and tectonic attitude of pelagic beds deposited upon platform margins (FURLANI, 1910; SALOPEK, 1910; ZIEGLER, 1963; CHOROWICZ & GEYSSANT, 1972; PAPEŠ, 1985; GAKOVIĆ, 1986; RADOIČIĆ, 1989; BUSER, 1989; GUŠIĆ & JELASKA, 1990).

Pelagic outcrops are widespread on the Dinaric and Adriatic platforms which are at many places directly superimposed, which means that their primary contacts with the Interplatform Belt are not exposed. The platforms mentioned above strongly differ in respect to preserved pelagic beds whose origin is related to the main interplatform open sea region. The deposition places may be within this region or adjacent to it. In many cases the above-mentioned open sea was only a source area for pelagic components which have been added to primary platform deposits.

The Adriatic Platform is relatively uniform with respect to pelagic elements. According to GUŠIĆ & JELASKA (1990) the first pelagic episode occurred during the Cenomanian-Turonian age. The second one followed during the Late Senonian-Campanian age. Transgressive flysch deposits containing pelagic components belong to the Eocene. They are all widespread and therefore it is not necessary to mark single localities. It is evident that the above-mentioned pelagic deposits are only offsprings of a covered open sea region from which they were alimented.

The Dinaric Platform is rather different. Pelagic elements in its frame start in the Upper Triassic. Jurassic and Cretaceous outcrops are frequent, as well as the flysch deposits belonging to the Senonian-Paleogene age. Some outcrops derive directly from the pelagic Interplatform Belt. Others were deposited in adjacent basins, while many components ingressed the platform itself. The outcrops are scattered due to tectonic disturbances including overthrusts and inverse faults. Therefore, some pelagic complexes appear in tectonic windows, while the others interfinger with platform elements.

Upper Triassic pelagic beds have been registered only in the area of Glamoč (Fig. 1). They consist of dark grey platy limestones with ammonites. For more details see PAPEŠ (1985).

Jurassic localities are scattered in different areas. They are represented by platy limestones, marls and cherts belonging to the Lias, Dogger, and Malm: Liasic outcrops are preserved in the units of Mt. Cincar and Mt. Malovan in western Bosnia. Liassic and Doggerian beds are registered in Mt. Rumija, and Mt. Lovćen. Liassic, Doggerian and partially Malmian sediments are to be found in the area of Zalomka-Gacko in Hercegovina. Lemeš Beds have been found in various tectonic areas, as follows: Lemeš, Straža and Mt. Poštak in Dalmatia, the surroundings of Udbina and Donji Lapac in Lika, Mt. Velika Kapela in Gorski Kotar, and in Zavalje near Bihać (Fig. 1).

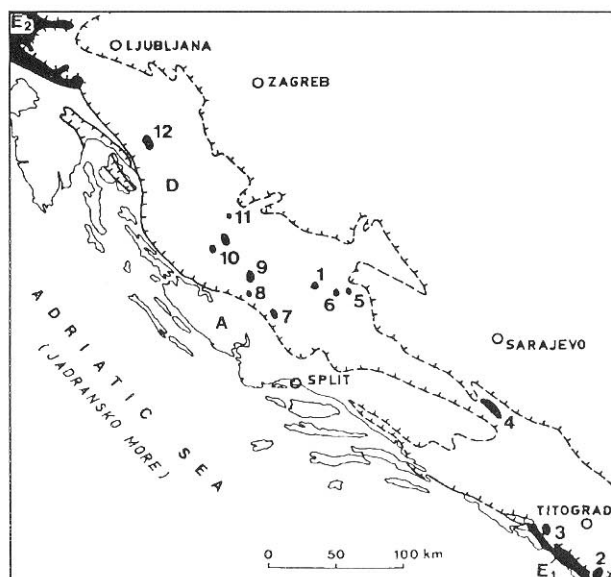


Fig. 1: Distribution of Triassic and Jurassic pelagic outcrops (surfaces not to scale): A - Adriatic Carbonate Platform (Adriaticum); E - Interplatform Pelagic Belt (Epiadriaticum): 1 Budva, 2 Slovenian Trench or Tolmin; D - Dinaric Carbonate Platform (Dinaricum): 1 Upper Triassic pelagic outcrops (Glamoč), 2-12 Jurassic pelagic outcrops: 2 Rumija, 3 Lovćen, 4 Zalomka-Gacko, 5 Malovan, 6 Cincar, 7 Lemeš, 8 Straža, 9 Poštak, 10 Udbina-Donji Lapac, 11 Zavalje near Bihać, 12 Velika Kapela.

Slika 1: Raspored trijaskih i jurskih pelagičkih izdanaka (ne u mjerilu): A - Jadranska karbonatna platforma (Adriatik); E - Meduplatformni pelagički pojas (Epiadriatik): 1 Budva, 2 Slovenski jarek ili Tolmin; D - Dinarska karbonatna platforma (Dinarik): 1 gomjotrijaski pelagički izdanci (Glamoč), 2-12 jurski pelagički izdanci: 2 Rumija, 3 Lovćen, 4 Zalomka-Gacko, 5 Malovan, 6 Cincar, 7 Lemeš, 8 Straža, 9 Poštak, 10 Udbina - Donji Lapac, 11 Zavalje kod Bihaća, 12 Velika Kapela.

Cretaceous and Paleogene pelagic elements are present at several localities in the frame of the whole Dinaric platform. Here, only the general succession will be given, confirmed by some localities which are geographically well-known.

Albian - Cenomanian carbonate complexes in Mt. Dinara contain partially thin-bedded limestones with dolomitic intercalations and chert nodules. The latter indicate slight pelagic influences. Cenomanian-Turonian pelagic white microcrystalline limestones with globotruncanids and oligosteginids are present in the unit of Mt. Dinara.

The well-known Senonian-Paleogene flysch deposits are present also in western Bosnia. In the area of Mt. Malovan they non-conformably overlie Cenomanian and Cenomanian-Turonian beds, while in the unit of Mt. Cincar they overlie Turonian beds (PAPEŠ, 1985).

At the margin towards the Inner Dinarides (Supradinaricum), for example in Mt. Ljubuša and Mt. Plazenica, Upper Cretaceous breccias, calcarenites, thin-bedded limestones with globotruncanids and marls have been found. They overlie Malmian, Lower Cretaceous and Cenomanian limestones. For more details see PAPEŠ (1985). Elsewhere, they grade upwards into the Senonian-Paleogene flysch of the

Inner Dinaric provenance. Therefore, the breccias and the flysch in question may be omitted in the discussion of the Interplatform Pelagic Belt (Epiadriaticum).

### 3. DISCUSSION

The majority of the above-mentioned pelagic complexes are either intercalated into the carbonate sequences or overlie them. In such a tectonic frame their outcrops are not mutually connected due to tectonic disturbances. In some places even nappe relations between pelagic outcrops and platform carbonate complexes are registered, as it has been indicated by CHOROWICZ & GEYSSANT (1972) in Lika (Visuč), and by HERAK (1991) and TOMIĆ (1993) in Mt. Velika Kapela (Gorski Kotar). Probably the same may be valid for the localities Straža and Lemeš.

In some places the basis of Lemeš Beds is concealed (e.g. Lemeš in Mt. Svilaja, the area of Mt. Velika Kapela, etc.). TOMIĆ (1993) has proven that the pelagic sequences which were supposed to be Kimmeridgian-Lower Tithonian in age reach deeper, perhaps down to the Dogger. This suggests the possibility that some concealed Jurassic beds were deposited from the Lias onward. In that sense Jurassic ingressions over the margins of carbonate platforms are easily explained. In addition, the opinion expressed by RADOIČIĆ (1989) that direct influences existed between the Budva Basin on one hand, and the Rumija, Lovćen and Zalomka-Gacko areas on the other, argues in favour of such a conclusion. The possible influences of the "Slovenian Trench" upon carbonate platforms in Slovenia may be explained in the same way, as the relations summarized by BUSER (1989) suggest.

However, due to the great distances, the space between Lemeš and Mt. Velika Kapela could not be influenced in the same way. CHOROWICZ & GEYSSANT (1972) already distinguished separate deposition areas (High Karst Zone and two lateral ridges) instead of the earlier concept of separate lagoons. The question of the provenance of pelagic components was not discussed. However, the mobilistic concept suggests the conclusion that the Budva Zone and the "Slovenian Trench" were convergently prolonged, forming a common pelagic labile Interplatform Belt (Epiadriaticum) with two margins displaying possible temporal environmental changes (HERAK, 1986). Its main body has been consumed due to A-subduction or at least covered (overthrust) by structural elements of the Dinaric Carbonate Platform (Dinaricum) after the collision between the Adriatic and Dinaric platforms.

All the existing pelagic outcrops are distributed among different overthrust units. Consequently, for estimation of the grade of overthrusting it is necessary to determine the particular tectonic unit to which each outcrop belongs.

Only Upper Triassic pelagic outcrops (Glamoč) and Lemeš Beds (Lemeš, Straža, Poštak, Lika, Velika

Kapela, etc.) do not indicate their proper basis, due to overthrusting and additional inverse faulting with the equally allochthonous Dinaricum. They might be deposited in axial parts of the labile pelagic Interplatform Belt (Epiadriaticum), or at least in the vicinity. All the other pelagic outcrops were deposited within platform environments, being supplied by pelagic components which derived from the labile belt, and were mixed with some platform products.

All of the Adriatic and peri-Adriatic pelagic outcrops have been deposited on the northern (northeastern) margin of the Adriatic Carbonate Platform (Adriaticum). The same may be possible for Cretaceous pelagic outcrops in Mt. Dinara (Troglav, Kamešnica). The localities in Mt. Rumija, Mt. Lovćen, in the Zalomka-Gacko area and further in the Mt. Cincar and Mt. Malovan units belong to the southern (southwestern) margin of the Dinaric Carbonate Platform (Dinaricum). Transgressive pelagic components of Mt. Ljubuša and Mt. Plazenica derived from the Inner Dinarides (Supradinaricum) and belong to the marginal flysch overlying the northern (northeastern) margin of the Dinaric Carbonate Platform (Dinaricum). All this indicates that the grade of subductions increased going from the southeast to the northwest, i.e. from the Budva Zone towards the "Slovenian Trench".

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## Dodatna razmatranja o epiadrijatiku u Vanjskim Dinaridima

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U radovima koji su navedeni među referencama spominju se brojna nalazišta pelagičkih naslaga gornjeg trijasa (Glamoč), Iijasa (Cincar, Malovan), Iijasa i dogera (Rumija, Lovćen), Iijasa, dogera i dijelom malma (Zalomka, Gacko), malmske lemeške naslage (Lemeš, Straža, Poštak, okolica Udbine i Donjeg Lapca, Velika Kapela i Zavalje kod Bihaća) (sl. 1). Osim toga postoje razasuta nalazišta krednih i paleogenskih izdanaka, najčešće vezanih uz platformne elemente, koje pokrivaju ili su s njima naljuskane. Za neke je od malmskih izdanaka ustanovljeno da se nalaze u jasnim navlačnim odnosima (Poštak, Visuč kod Udbine, Velika Kapela). Općenito se može reći da je primarna podloga na koju su taložene lemeške naslage pokrivena, pa je moguće da je u subduciranim i konzumiranim dijelovima pelagičkih naslaga postojao kontinuitet od gornjega trijasa do paleogena, s određenim variranjem okoliša zbog povremenog i mjestimičnog oplićavanja i jačeg neritskog utjecaja. Na to nas izravno upućuje nalaz (TOMIĆ, 1993) prema kojem raspon lemeških naslaga u Velikoj Kapeli nije ograničen na kimeridž i donji titon (kao što se obično mislilo), nego se u okviru postojećih izdanaka spušta u donji malm (vjerojatno i doger). Sve to govori u prilog zaključku (HERAK, 1986 i dr.) da je između Budva zone i Tolminske zone ("Slovenski jarek") postojao Meduplatformni pojas koji ih je povezivao i istovremeno utjecao na rubove Jadranske i Dinarske karbonatne platforme, kao što pokazuju osobito pelagički izdanci krede i paleogena, a dijelom i jure za koju CHOROWICZ & GEYSSANT (1972) smatraju da je taložena u tri pojasa, u

visokokrškom i na dva postrana praga. U našoj interpretaciji radi se o Meduplatformnom pojasu i o dva ruba platformi na koje je donošen pelagički materijal iz središnjeg pojasa. O takvim utjecajima izravno iz Budvanskog bazena na područje Rumije, Lovćena, Zalomke i Gacka piše RADOIČIĆ (1989).

Daljnji će zadatak biti da se preciznije odredi kojoj platformi i kojem njezinom rubu pripadaju pojedina nalazišta pelagičkih naslaga koja su često vezana za poremećena tektonska okna. Za sada možemo pretpostaviti da gornjotrijaske naslage (Glamoč) i lemeške naslage (Lemeš, Straža, Poštak, Lika, Velika Kapela) odgovaraju prostoru koji je blizu samog središta pelagičkog pojasa ili u njemu. Kredna i paleogenska nalazišta pripadaju taložinama platformnih rubova na koje su donošene pelagičke komponente iz međuplatformnog prostora.

Jadranska i perijadranska nalazišta odgovarala bi sjevernom (sjeveroistočnom) rubu Jadranske karbonatne platforme. Rumija, Lovćen, Zalomka - Gacko, Cincar i Malovan mogli bi odgovarati južnom (jugozapadnom) rubu Dinarske karbonatne platforme. Transgresivni gornjokredni slojevi Ljubuše i Plazenice potječu iz prostora Unutrašnjih Dinarida i pokrivaju sjeverni (sjeveroistočni) rub Dinarske karbonatne platforme. Ove navode valja uzeti samo kao naznaku kako treba pojedine lokalitete geotektonski razvrstati da bi se dobili pouzdani podaci za precizniju strukturnu analizu, kako pojedinih područja tako i Vanjskih Dinarida kao cjeline.

Manuscript received December 10, 1992.

Revised manuscript accepted March 5, 1993.