

## Upper Triassic - Lower Jurassic sediments of the Lučatín Unit in the Northern Veporicum: facial diversity and tectonic stacking

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**Abstract.** The Lučatín unit is a transitional tectonic element between the Križna nappe and the Veporic superunit, analogous to the Veľký Bok unit. It consists of three partial nappe subunits differing in structural positions and lithofacial characteristics of especially the Lower Jurassic syn-rift sediments. The lowermost subunit crops out only in small tectonic windows and it facially closely approaches the Zliechov basinal succession of the Križna nappe, the structurally highest subunit is confined to the North Veporic basement. The paper concentrates on the middle, Farbište subunit, with peculiar Upper Triassic - Lower Jurassic strata. Middle to Upper Liassic variegated limestones point to the deposition in an elevated and dissected domain rapidly subsiding during the Middle and Late Jurassic. Several facies uncommon in the Western Carpathians (Rhaetian reefal Jakub Limestones, lowermost Dogger Neptunian dykes filled up with Bositra Limestones) indicate "southern" affinities of the Lučatín shelf.

**Key words:** Central Western Carpathians, Lučatín unit, Upper Triassic, Lower Jurassic, facial diversity, partial nappes

### Introduction

The Lučatín Unit has been defined by MAHEL' (in MAHEL' et al., 1967) as a marginal rear element of the Križna nappe, analogous to the Veľký Bok Unit of the Nízke Tatry Mts. Similarly as the Veľký Bok Unit in the Liptovská Teplička district (PLAŠIENKA, 1995), the Lučatín Unit is composed of several superimposed, flat-lying partial nappes or recumbent folds, the higher ones clearly confined to the pre-Alpine crystalline basement of the Northern Veporicum.

Three subunits form the structure of the Lučatín Unit between Poniky, Slovenská Ľupča and Ľubietová villages (PLAŠIENKA, 1981, 1983). The lowermost Driekyňa subunit (or the basal structure sensu MAHEL', 1977), has a deep-water development of Jurassic formations and it is characterised by slight metamorphic imprint. The higher, Farbište subunit, has a complete stratigraphic

succession from the Lower Triassic to the Lower Cretaceous, with the most remarkable Upper Liassic and Lower Dogger variegated limestone formation (for a detailed lithofacial characterisation and description of Ammonite fauna see MIŠÍK, 1962, 1964; MIŠÍK & RAKÚS, 1964; RAKÚS, 1964). The uppermost Hutná subunit is formed of Middle and Upper Triassic dolomite complexes, strongly reduced Jurassic members and a thick Neocomian marly limestone formation. Some complementary data on stratigraphy and lithofacial content of the Lučatín Unit have been provided by the study of new boreholes realised in the area of the Driekyňa Valley and Farbište Hill. Continuous borehole profiles (up to 100 m) have been obtained especially from the Upper Triassic-Jurassic formations of the Farbište subunit. The knowledge achieved indicates substantial facial variety and contrasts of the Lower Jurassic sedimentation, both within the Farbište subunit itself, and especially between individual partial nappes of the Lučatín Unit.

### Lithostratigraphy of the Upper Triassic - Lower Jurassic formations of the Farbište subunit

#### *Carpathian Keuper Formation*

The Carpathian Keuper Formation consists of grey massive or brecciated dolomites, with intercalations of brick-red, violet and greenish marlstones (Fig. 1). In some boreholes, the variegated marlstones ("bunte Keuper-Mergel") are predominant. The transition of Keuper into the overlying Rhaetian beds is usually sharp, locally however with repeated appearance of dolomite beds in sediments of the Fatra Formation. The thickness of the Keuper Formation reaches 50-100 m in boreholes.

#### *Fatra Formation*

Rhaetian sediments are in the Farbište subunit represented mostly by the Fatra Formation displaying a cyclic character. The base of each cycle is formed of co-



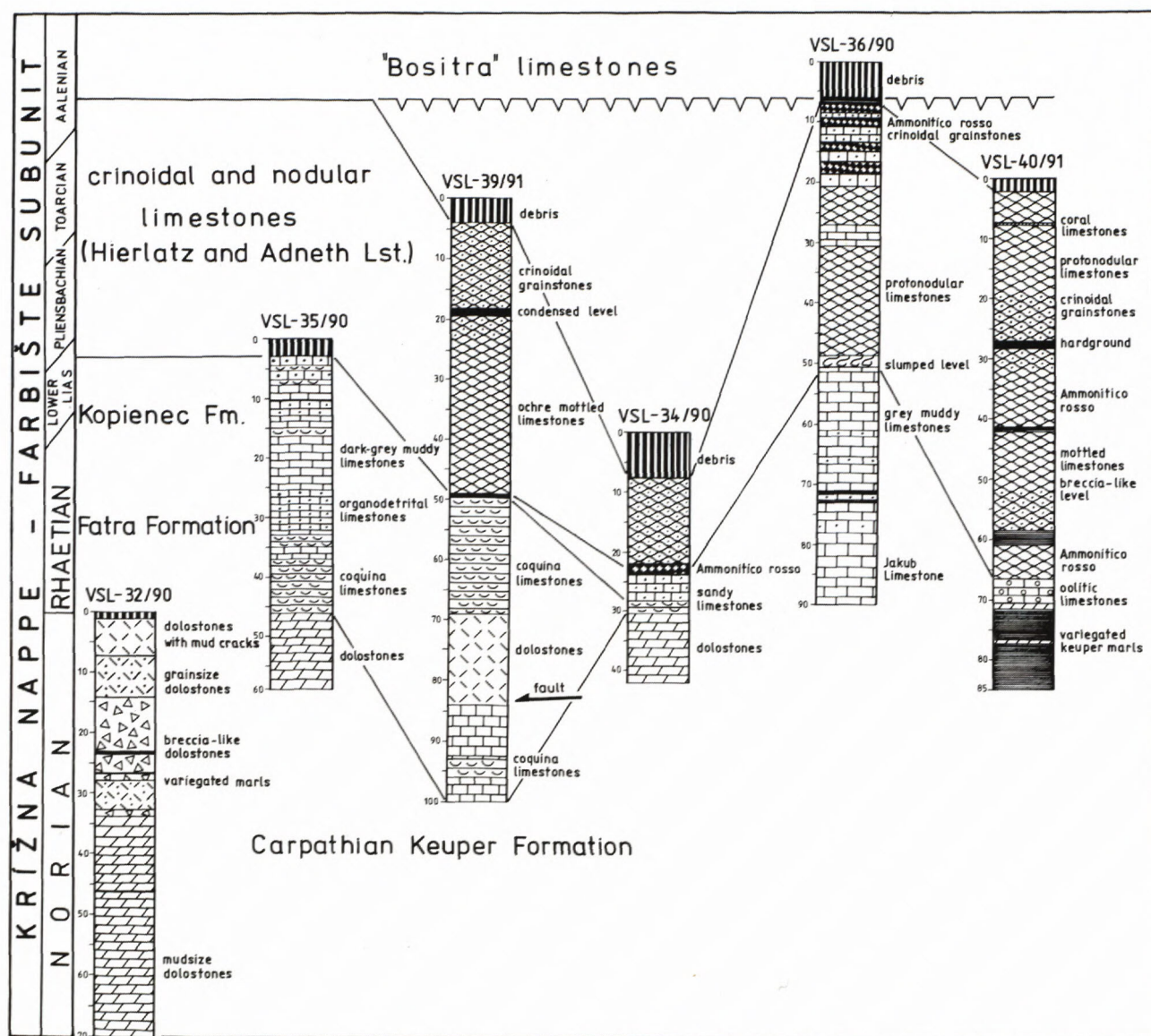


Fig. 1. Lithostratigraphic sequence and spatial diversity of the Upper Triassic - Lower Jurassic sediments of the Farbište subunit, constructed from the field and borehole profiles.

quina limestones with *Rhaeticavicula contorta* and the grain size decreases upwards. The interphases of cycles consist of biotrititic and oolitic limestones and the muddy cycles end with ooze or marly limestones (Fig. 1). Limestones of the Fatra Formation contain abundant bivalvians, brachiopods, crinoids and corals (also in the form of patch reefs). Microfauna is represented by forams *Agathammina inconstans* (MICHALÍK, JENDREJÁKOVÁ & BORZA), zoospores *Globochaete tatrica* RADWANSKI, fragments of thallophytic algae etc.

#### Jakub Limestone

The Jakub Limestones appear in the uppermost parts of the Fatra Formation below sandy limestones of the

Kopienec Formation (Fig. 1). They occur only locally, probably in places of paleotopographic elevations with reef buildups. They are grey massive limestones with cavities filled with layered-fibrous calcite. Microstructurally, the biomicritic matrix contains numerous sparitised foraminifer tests of *Aulotortus sinuosus* WEYNSCHENK, *Angulodiscus communis* KRISTAN *Gandinella falsofriedli* ZANINETTI, dating the Jakub Limestones as Rhaetian.

#### Kopienec Formation

The basal part of the Liassic sequence of the Farbište subunit is represented by the Kopienec Formation de-



tritic sediments, Hettangian to Sinemurian in age. Lithologically they are very similar to the Fatra Formation, however they contain a greater proportion of sandy and marly material and less coquina layers. In the borehole profiles, we recorded also intervals of "Gresten-type" black shales. Coeval shallow-water carbonate sedimentation in the Driekyňa Valley is represented by so-called cyanophyte limestones (Mišík, 1964).

### *Crinoidal and nodular limestone formation*

The detrital-carbonate sediments of the Kopienec Formation are followed by varied sedimentation of crinoid and nodular limestones in the Farbište Unit. They are characterised by considerable lateral changes of thickness, from thin, strongly condensed layers to thick intervals with manifestation of slope accumulation (up to 60 m - Fig. 1). Their lithofacies vary from red nodular limestones with residual clay of the "Ammonitico rosso" type, indistinctly nodular and mottled limestones of ochre, beige and pink colour with abundant stylolites, as well as pseudobreccia limestones. The nodular facies alternates in the borehole profiles with layers of violet-red and grey crinoidal limestones (Fig. 1). Lithological variability is documented also by the presence of coral-bearing layers, ferrolitic crusts (hardgrounds), limestones with Fe-ooids and allochems of "black pebbles" type etc. Microfacies of nodular limestones is characterised especially by echinoderm segments, filaments, zoospores of *Globochaete*, segments of ophiurians and thick-walled forams of the genus *Involutina* (*I. liassica* JONES and *I. farinacciae* BRONNIMANN & KOEHN-ZANNETTI). In layers of stronger condensation, tests of nodosarian foraminifers concentrate in a great quantity (representatives of *Dentalina*, *Nodosaria*, *Marginulina*, *Falsopal-mula* etc.). In variegated limestones, there are often cavities with isopachous and pseudospar calcite fillings. The texture and isotopic composition ( $\delta^{18}\text{O}$ : 1.9 - 3.1 ‰,  $\delta^{13}\text{C}$ : -2.3 to 3.3 ‰) documents the marine character of the cavity cement. Varied nodular and crinoidal limestones contain also rich ammonite fauna, represented mostly by the Domerian species *Partschiceras* cf. *monestieri*, *Calliphyloceras nilsoni*, *Juraphyllites limatus* and others (RAKÚS, 1964, 1989; MIŠÍK & RAKÚS, 1964).

### *Bositra Limestones*

The varied Liassic limestones are immediately overlain by the light Bositra Limestones in the Driekyňa Valley (Fait's quarry). Their position in the succession is not quite clear, however. They may be a normal sequence member, but they may also represent fillings of Neptunian dykes penetrating the Liassic substratum. Limestones are actually coquinas of the bivalvian shells *Bositra buchi* (ROEMER). The limestones are very pure, washed and recrystallised. Observed in thin-sections,

their biotrititic texture is overprinted by strong sparitisation - only outer periostracum layers have been mostly preserved from the shells.

Bositra coquinas from the Driekyňa Valley remind of bivalvian necrocenoses concentrating dead shells washed down into open fissures in the sea bottom ("Efekt postmortaler Verfrachtung", "trap for fossils"). Therefore, it is possible to accept the dyke character of these limestones, at least partly. The described Bositra Limestones represent Lower Dogger member of the Farbište subunit (Aalenian - Bajocian), overlain by basinal violet-red laminated siliceous and marly limestones.

### *Upper Jurassic formations of the Farbište Unit*

During the Late Jurassic, grey platy cherty limestones, siliceous and marly limestones and red radiolarites were deposited. Uppermost Jurassic and Lower Cretaceous are represented by red, grey and green marly slates and thick complex of grey calcareous phyllites.

### *Structural pattern of the Lučatin Unit*

The Driekyňa subunit, as the lowermost one within the Lučatin stack, crops out only in one larger and one small tectonic window in the upper part of the Mokrá Driekyňa valley (Fig. 2). It is built up of a deep-water Jurassic to Lower Cretaceous succession, slightly metamorphosed and intensively folded. Dark grey marly slates with scarce turbiditic beds of sandy crinoidal limestones represent probably the Lower to Middle Jurassic Allgäu formation, overlain by the Upper Jurassic black-brown siliceous limestones and silicites and Lower Cretaceous grey-green marly slates. We parallelize the Driekyňa succession with the Fatric (Křížna) Zliechov-type units. The Neocomian marlstones of the Driekyňa subunit are overridden by the Scythian quartzose clastics and middle Triassic Ramsau dolostones of the higher Farbište subunit (Fig. 2). Thin lenses of clastic Lunz beds intercalate the upper part of the dolomite complex, being overlain by a considerably thick sequence of varicoloured dolomites, shales and sandstones of the Carpathian Keuper Formation. Fossiliferous Rhaetian Fatra Formation and the lowermost Liassic clastic Kopienec Formation underlie the Middle to Upper Liassic massive limestone body containing various lithologies close to the Hierlatz and Adnet facies, the main subject of the present study. Middle to Upper Jurassic variegated marly and cherty limestones and red radiolarites are overlain by Neocomian grey marly shales. The Farbište subunit is strongly folded in a macroscopic scale (Fig. 2), recognizable from the spatial distribution of the competent layer of Liassic limestones embedded amidst incompetent shally and marly sequences. The first macrofold set is formed by two northward-facing recumbent anticlines (Fig. 2) with cores filled with soft Keuper rocks detached



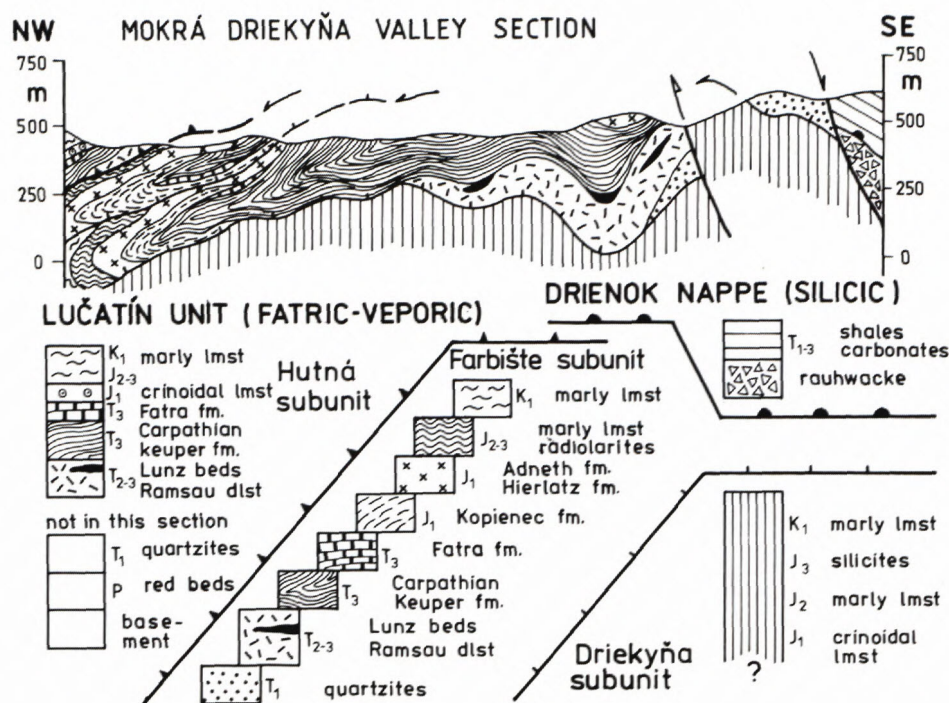


Fig. 2. Geological profile of the Lučatín Unit along the Mokrá Driečyňa valley, east of Poniky village.

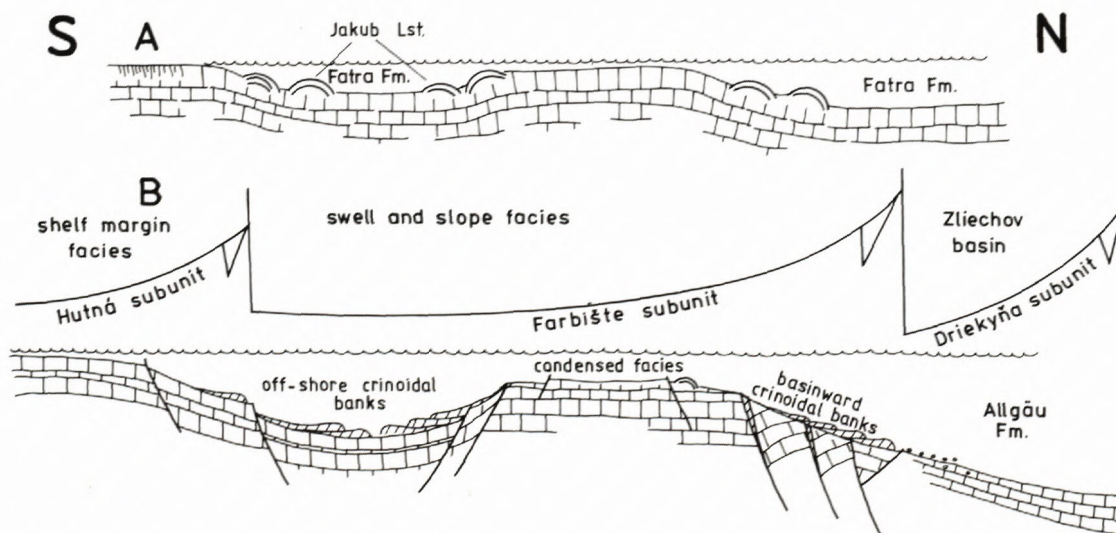


Fig. 3. Late Triassic - Early Jurassic paleogeography of different sedimentary areas of the Lučatín unit. A - Upper Triassic carbonate platform, B - post-collapse configuration of the North Veporic slope facing the Zliechov basin with suggested original positions of the Lučatín subunits.

from their Ramsau dolomite substratum. Recumbent folds are refolded by two perpendicular sets (SW-NE and NW-SE trending) of symmetrical open upright macrofolds, giving rise to a very complex structure of the Farbište subunit in the map view. The highermost Hutná subunit is rimming the Farbište half-window, composed

of complete Permian to Lower Cretaceous succession confined to the pre-Alpine basement of the north Veporic Ľubietová Zone. Unlike the Farbište subunit, the Hutná succession includes only a very thin, mostly marly Jurassic sequence and considerably thick Neocomian marlstones.



*Paleogeography and tectonic stacking of the Lučatin Unit*

The Lučatin Unit of the Northern Veporicum is characterised especially by a varied development of Liassic sedimentation, starting after the collapse of the Triassic carbonate platform. This variety documents the substantial topographic differentiation of a shelf domain at the transition from the Veporic margin into the Zliechov Basin. The considerable contrast in Liassic formations is thus manifested among the partial nappes of the Lučatin Unit, ranging from the shelf margin (Hutná subunit), foot of the shelf slope (Farbište subunit) and the basinal plain (Driekyňa subunit - Fig. 3). The Lučatin Unit, as a vertically differentiated system of nappe subunits, formed in the rear part of the Křížna thrust stack before its final emplacement as a cover nappe overriding the Tatricum (PLAŠIENKA, 1983). The subunits originated by inversion of original marginal extensional halfgrabens formed due to the Lower Jurassic rifting event (Fig. 3). Their transformation into recumbent macrofold structures included domino-type rotation of halfgraben blocks and progressive contraction, macroscopic folding and flattening of their partly detached sedimentary successions (PLAŠIENKA & PROKEŠOVÁ, 1996).

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**References**

- MAHEL, M., 1977: Niektoré závažnejšie otázky stavby kryštalínika a mezozoika tatrid a veporid. *Miner. Slov.*, 9, 1, 1 - 9.
- MAHEL, M., BUDAY, T. et al., 1967: Regional geology of Czechoslovakia. Part II - The West Carpathians. Academia, Praha, 723 p.
- MIŠÍK, M., 1962: Litofaciálny výskum liasu Veľkej Fatry v západnej časti Nízkych Tatier. *Geol. Práce, Zoš.* 62, Bratislava, 229 - 232. (In Slovak).
- MIŠÍK, M., 1964: Lithofazielle Studien im Lias der Grossen Fatra und im westlichen Teil der Niederen Tatra. *Západné Karpaty* 1, *Geol. Úst. D. Štúra, Bratislava*, 8 - 88.
- MIŠÍK, M. & RAKÚS, M., 1964: Bemerkungen zu räumlichen Beziehungen des Lias und zur Paläogeographie des Mesozoikum in der Grossen Fatra. *Západné Karpaty* 1, *Geol. Úst. D. Štúra, Bratislava*, 159 - 185.
- PLAŠIENKA, D., 1981: Tectonic position of some metamorphosed Mesozoic series of the Veporicum. Thesis, *Geol. Inst. Slov. Acad. Sci., Bratislava*, 153 p.
- PLAŠIENKA, D., 1983: Kinematic assessment of some structures of the Northern Veporic in relation to the generation of the Křížna nappe (in Slovak, English summary). *Mineralia Slov.*, 15, 217 - 231.
- PLAŠIENKA, D., 1995: Cleavage and folds in changing tectonic regimes: The Veľký Bok Mesozoic cover unit of the Veporicum (Nízke Tatry Mts., Central Western Carpathians). *Slov. Geol. Mag.*, 2/95, 97 - 113.
- PLAŠIENKA, D. & PROKEŠOVÁ, R., 1996: Towards an evolutionary tectonic model of the Křížna cover nappe (Central Western Carpathians). *Slov. Geol. Mag.*, this volume.
- RAKÚS, M., 1964: Paleontologische Studien im Lias der Grossen Fatra und Westteil der Niederen Tatra. *Západné Karpaty* 1, *Geol. Úst. D. Štúra, Bratislava*, 95 - 154.
- RAKÚS, M., 1989: Paleobiografia amonitov plienbachu Západných Karpát. In: MICHALÍK, M. & SAMUEL, O. (eds.): *Zborník z paleontologickej konferencie - Súčasný problémy a trendy v československej paleontológii*. *Geol. Úst. D. Štúra, Bratislava*, 111-116. (In Slovak, Engl. res.).