

Paleogeographic significance of the Upper Karpatian and Lower Badenian deposits along the eastern margin of the Carpathian Foredeep (South Moravia)

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Abstract. The paper deal with definition of the Central Paratethys regional stages Karpatian and the Early Badenian (Burdigalian/Early Lauglian) in the Carpathian Foredeep (South Moravia). Beside precise foraminiferal stratigraphy also paleogeographic model of the studied area development is given.

Keywords: Paleogeography, Outer Western Carpathians, Early/Middle Miocene, South Moravia

Introduction

Deposits of the Karpatian and Early Badenian stages (in terms of the local stratigraphy), found both in front and on the top of the outer Carpathian flysch nappes, play a significant role in understanding the tectonic and paleogeographic evolution of the Carpathian foreland basin. The relationship between some Karpatian and Badenian sediments, however, is not quite clear, especially with respect of the stratigraphic position of the Grund Formation in Lower Austria.

The Grund Formation is referred to both as the Early Badenian (Rögl et al., 1998) or as a transitional formation between Karpatian and Badenian stages thus reaching into both of them (Cicha, 1995, inter alii). The last opinion comes from mapping of the type locality of the Grund Formation in the Lower Austria. Cicha & Rudolský (1998) and Pálenský (1998) spoke about the transition between the Grund and underlying Laa Formation while Čtyroký (1997) suggested that the Grund Formation rests transgressively on the Laa Formation. Švábenická & Čtyroká (1999) based on studies of successive nannoplanktic and foraminiferal assemblages both in the Lower Austria and south Moravia established 4 successive intervals (Fig. 1). In this paper we approach this problem by studying this strata on several localities situated on the flysch nappe as well as in their foreland on SE Moravia (Fig. 2).

Miocene sediments on the Pouzdřany Flysch Unit related to this problem

The "Kolby" hillock north of Pouzdřany village (Fig. 2, Nr. 14 / 1 – in circlet). In the western top hillock part there were exposures of the greenish-grey slightly sandy calcareous claystones alternating with pale yellow and grey calcareous sands and medium- to coarse grained gravels, which were preserved in the form of denudational relics

spread on the Pouzdřany Unit. Both gravels and sands rest transgressively with an angular discordance on the uneven erosive basement of the Uherčice Member (upper part of the Oligocene). The contact surface is lopsided showing the angle of 15–30° towards EEW up to W, while claystones in the Uherčice Member decline towards SE in general. Lower part of the claystones contains rich microfauna assemblages of the Laa Formation's type (see Fig. 1). There are *Globorotalia* aff. *mayeri*, *G. siakensis* and *Globigerinoides* cf. *bisphericus* findings in upper part of the claystones, thus indicating commencement of the Grund Formation elements here. In the middle-top part of the hillock, north of the disappeared clay pit location, there calcareous unstratified clays provided the full-grown foraminiferal benthos consisting of *Lenticulina* div. sp., *Cibicidoides* div. sp., *Praeglobobulimina* div. sp., *Melonis pompilioides*, *Bolivina antiqua*, *Amphistegina mammilla*, *Elphidium fichtelianum*, *E. crispum*, *Uvigerina acuminata*, *U. gracilis* and *U. semiornata* specimens in the overlies of gravels mentioned. Planktic assemblage is rather poor displaying rare specimens of *Globigerinoides trilobus* and *G. cf. bisphericus*. Nannoplanktic assemblage contains *Helicosphaera* ex gr. *waltrani* findings (B. Hamršíd). This assemblage indicates the possibility of correlation with faunas in the lower part of Grund Formation in sense of Cicha (1995, 1998) or prospectively with the 2nd interval by Švábenická & Čtyroká (1999).

There is very similar lithological and fauna succession lying on the Pouzdřany Unit W of Křepice village at the Barchanka spot height.

Carpathian Foredeep in the south and central Moravian flysch-nappe foreland

There are grey stratified and fractioned calcareous claystones to clays with intercalations of fine-grained gravels showing predominance of the Bohemian Massif

Fig. 1. Comparison of stratigraphic division of the Early (Karpatian)/ Middle (Badenian) Miocene in Lower Austria and South Moravia (Molasse, Waschberg Zone, Foredeep).

chrono-stratigraphy	RÖGL et al. (1998)		CICHA (1998)	ŠVÁBENICKÁ, ČTYROKÁ (1999)
	Lower Austria	Waschberg Z.	Lower Austria, South Moravia	Lower Austria, South Moravia
Lower BADENIAN			Lithothamn. Lmst. Tegel Conglomerates	4. Interval with <i>Vaginulina legumen</i> (<i>Uvigerina aculeata</i> , <i>Lenticulina echinata</i> , <i>Planularia</i> div. sp., <i>Sphenolithus heteromorphus</i>)
	Grund Formation	Lower Lageniden-zone	Grund Formation	3. Interval with <i>Praeorbulina</i> ex gr. <i>glomerosa</i> (<i>Orbulina aequalis</i> , <i>Globorotalia</i>) Last occurrences: <i>Globigerinoides bisphericus</i> , <i>Pappina</i> , <i>U. graciliformis</i> , <i>Helicosphaera waltrants</i>
KARPATIAN	Laa Formation	Laa Formation	Laa Formation	2. Interval with <i>Globorotalia</i> et <i>Globigerinoides</i> div. sp. 1. Interval with <i>Globigerina</i> div. sp. (<i>Globigerina ottnangensis</i> , <i>Pappina primiformis</i> , <i>P. breviformis</i> , <i>Uvigerina graciliformis</i>)

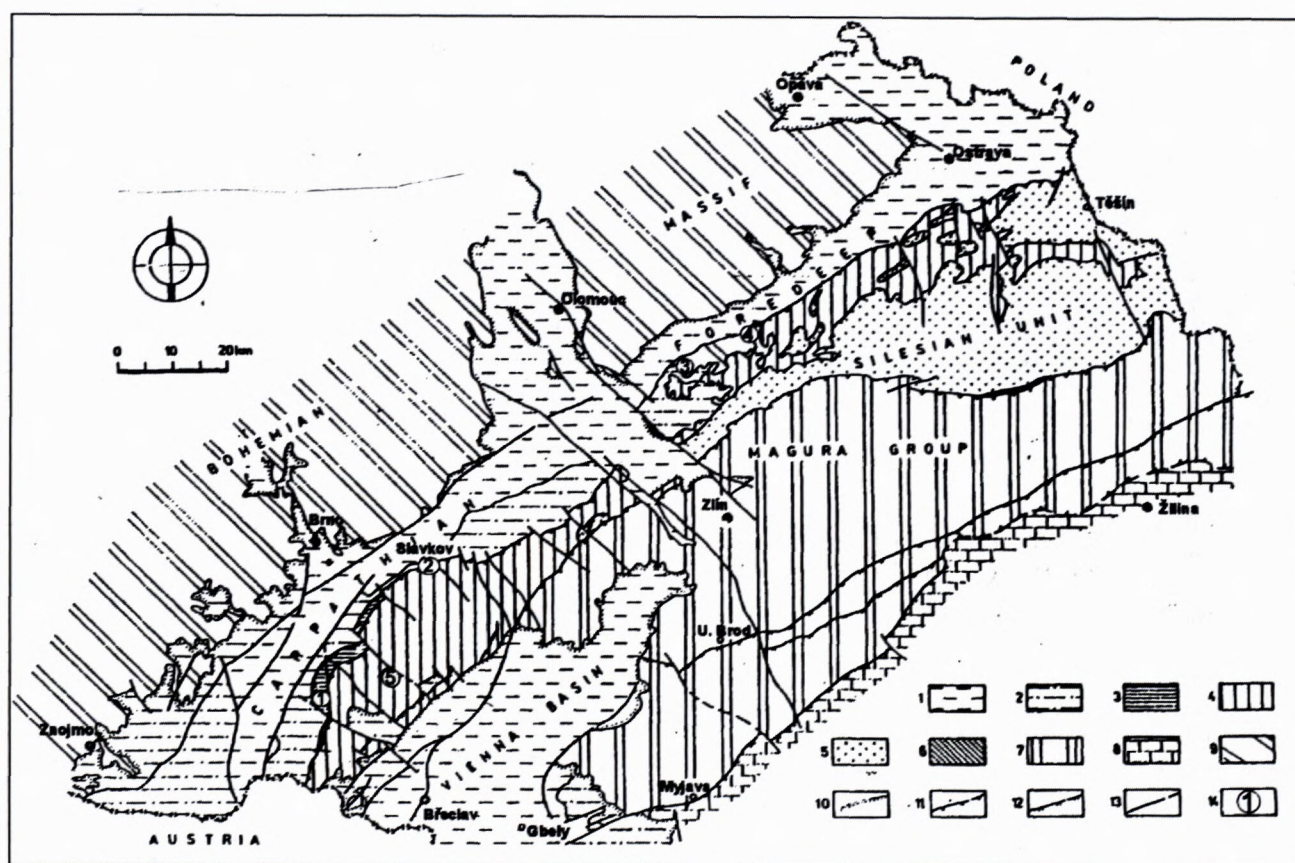


Fig. 2. Map of the tectonic elements of the Western Carpathians in Moravia. Explanation: 1 - Post-orogenic sediments (Badenian - Pliocene), 2 - Lower Miocene (Eggenburgian - Karpatian), 3 - Pouzdřany Unit, 4 - Ždánice - Subsilesian Unit, 5 - Silesian and Zdounky Units, 6 - Pre-Magura Unit, 7 - Magura Group, 8 - Klippen Belt, 9 - Bohemian Massif, 10 - Erosional Boundary, 11 - Overthrusts, 12 - Thrust-slices, 13 - Faults, 14 - Localities (1 - Kolby Hill near Pouzdřany, 2 - Slavkov, 3 - Helfštýn, 4 - Hranice na Moravě, 5 - Klobouky)

material in the lower part of the trench named Slavkov-1 cropping out north of Slavkov town (Fig. 2, Nr. 14 / 2 - in circlet). In its lower part clays contain conclusive microfauna specimens corresponding with the Laa Formation. Microfauna assemblage found in the upper part indicates anoxic environment during deposition (prevalence of euryoxibiotic genera, sponge spiculae, teleostei skeleton fragments). In the roof there is

alternation of fine-grained gravels to sandy gravels with greenish-grey and brownish stratified calcareous clays. Clays are accompanied with the rich benthic assemblage of *Uvigerina graciliformis* with the rare sponge spiculae but the specimens of *Globorotalia* div. sp. and *Globigerinoides bisphericus* join further on (2nd Interval by Švábenická & Čtyrská, 1999), in the upper part *Praeorbulina glomerosa circularis* specimens occur

without the notable lagenid representatives, while "Karpatian" *Uvigerina* findings recede and disappear. Above this alternation in the uppermost part of the trench mentioned there were greenish-grey unbedded calcareous clays (e. g. "Tegel" facies) disclosed. Along with the change in lithology the change in microfauna assemblage appears corresponding with 3rd Interval in its nature (Švábenická & Čtyroká, l. c.).

In central Moravia the base of the Miocene deposits has been newly documented in SW and NE parts of the Maleník Block.

Speaking of the first occurrence near Helfštýn (SE of Lipník n. B.) there are greenish-grey calcareous clays to claystones lying in the roof of basal clastics bearing specimens of *Uvigerina macrocarinata* (Čtyroká & Pálenský, 1997). They represent an equivalent to the uppermost part of 3rd Interval (Fig. 2, Nr. 14 / 3 – in circlet).

The second occurrence is formed by unstratified calcareous clays („Tegel“ facies) filling up erosive depressions in the Paleozoic limestones situated along the uppermost level of the cement works quarry at Hranice na Moravě town (Fig. 2, Nr. 14 / 4 – in circlet). Clays contain rich microfauna assemblage with the typical planktic forams (*Praeorbulina glomerata circularis*, *Orbulina suturalis*, *Globorotalia* div. sp., *Globigerina* div. sp.). Benthos is represented by lagenid facies with the specimens of *Lenticulina echinata* and frequent relics of molluscs and solitaire corals. This assemblage indicates the 4th Interval according to the authors mentioned above. Speaking of benthic elements these beds represent the development corresponding with the typical basin facies in the Vienna Basin region (facies of the lower part of Early Badenian, i. e. the lower Lagenidae Zone).

Conclusions

When accepting the stratigraphic succession of faunal assemblages in sense of Cicha (1998) and Švábenická & Čtyroká (1999) we may suggest that there is progressive transgression of deposits in the upper part of Karpatian up to Early Badenian from SW towards NE in the area studied, i. e. on the Pouzdřany Unit and in the inner part of the Carpathian Foredeep. This observation provides us with the possibility to define following paleogeographic and geotectonic patterns in the SW part of the Carpathian Foredeep in Moravia concerning the uppermost part of Karpatian and Early Badenian time period.

During the deposition of the Laa Formation the sedimentary fill of the Pouzdřany realm was folded up and integrated into accretionary wedge of the flysch belt. The imbricate structure of this wedge and foreland propagated development of thrusts originated by mechanism of piggy-back thrusting. Within the time of this orogeny, representing the important events from the West Carpathians tectogenetic structure point of view, thrusting of the flysch nappes over the older members of the Laa Formation took place. The well data document the distance of burial of these deposits below the edges

of thrust belt increases from SW towards NE starting with zero in Mikulov region up to 10 km in the Zlín surroundings. On the Ždánice Unit there are only older members of this facies. They gradually developed from the underlying Lower Miocene deposits of the piggy-back type Šakvice syncline superimposed on the Ždánice nappe. They were folded during the orogeny together with the underlying deposits in the Late Karpatian (Stráňík, 1999). The Lower Badenian strata (equivalent of the Lanžhot Formation, Fig. 2, Nr. 14 / 5 – in circlet) overlapped on the folded Ždánice nappe (Cicha & Pícha, 1964) with gravels, oyster chutes sands and with the Middle Badenian calcareous clays (N of Přítluky village) and variegated Middle Badenian Žižkov Member (Stráňík et al., 1982). The upper members of the Laa Formation and possibly also the lower part of the Grund Formation overlapped on the outer margins of the accretion wedge in south Moravia during the Late Karpatian. They are characteristic with sandy marlstone facies with layers of gravels, sands and unstratified calcareous clays above the clastics. In the Carpathian Foredeep in front of the Flysch Belt intensive subsidence took place in response to the folding in orogenic belt. It was associated with deformation of strata of the Lower Miocene deposits and increased coarse-grained clastic input connected with regression and the local depositional interruption. The Karpatian deposits reach thickness up to 1.200 m close to the overthrust in the Mikulov region. Deposition continued with alternating gravels and pelites in the uppermost part of the Karpatian sandy marlstone facies („Schlier“) of the Laa Formation in central Moravia along the front of the Ždánice nappe at Slavkov near Brno. It was followed by deposition of equivalents of the Grund Formation. Regression and depositional interruption took place from Dražovice towards the „Moravská Brána“ Valley. This area and more distant foreland (Dražovice, Helfštýn) were later covered by transgressive Lower Badenian deposits with *Uvigerina macrocarinata* (Čtyroká & Pálenský, 1997). Near Hranice na Moravě the highstand sediments of the Early Badenian corresponding to the 4th Interval fauna assemblages (Švábenická & Čtyroká, 1999) overlapped. In the uppermost Karpatian to lowermost Badenian, the area between Slavkov and „Moravská Brána“ Valley was still a depression. It gradually deepened towards NE and shallowed to the SW where algae limestones were deposited. The uplifting from SW culminated after the Early Badenian and the southern part of the Slavkov – Těšín Ridge formed from the Nesvačilka canyon as far as the „Moravská Brána“ Valley.

The model introduced here does not assume existence of the forebulge in front of the Ždánice nappe during deposition of the Laa and Grund Formations in the Early Badenian as it is suggested in the Ostrava region by Eliáš & Pálenský (1998). It is evidenced by the mentioned deposition on the Pouzdřany nappe and in front of the Carpathian overthrust, in the foreland nappes as well as the less striking erosion of Lower Miocene (Karpatian) strata. The Carpathian Foredeep did not represent a narrow

subsiding depression south of the „Moravská Brána“ Valley but a substantially broader basin. The subsidence culminated in the uppermost Early Badenian and the transgression reached far onto the Bohemian Massif flooding the present-day Drahaný Highlands. The SW part of the Carpathian Foredeep was interconnected with the Vienna Basin not only in the Karpatian (see Karpatian sequence of strata overlying the Pouzdřany and Ždánice Units) but evidently also in the lowermost Badenian. This is documented by the deep-water facies overlying the Pouzdřany and Ždánice nappes (Cicha & Pícha, 1964) and the Lanžhot Formation at the western margin of the Vienna Basin which lacks the shallow-water marginal facies (Špička, 1966).

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