

DEVONIAN AND LOWER CARBONIFEROUS LIMESTONES IN THE SOUTHERNMOST PART OF THE MORAVIAN KARST

DEVONSKÉ A SPODNOKARBONSKÉ VÁPENCE V NEJJIŽNĚJŠÍ ČÁSTI MORAVSKÉHO KRASU

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Abstract

Devonian and Lower Carboniferous limestones in the southernmost part of the Moravian Karst. *Acta Mus. Moraviae, Sci. geol.*, 84:89–96.

Two limestone outcrops in the southernmost part of Moravian Karst area in the surroundings of Bedřichovice have been studied from the viewpoint of biostratigraphy, sedimentology, structural geology and microfacies analysis. The foraminiferal and conodont fauna from Bedřichovice abandoned quarry suggests a Late Frasnian age while in the Líšeň – Zetor quarry, the limestones are of a Late Tournaisian – Middle Viséan age.

The sedimentological and microfacies investigations indicate that limy material was carried by low density turbidity currents from the carbonate platform. The sedimentation of distal calciturbidites correspond to the facies D (Bedřichovice) and facies C (Líšeň – Zetor quarry) of the outer carbonate apron (MULLINS and COOK 1986). The sequence of rocks in Bedřichovice is strongly tectonically affected by folds and dislocational deformations.

Key words: Moravian karst, limestones, microfacies analysis, calciturbidites, Devonian, Carboniferous. Jiří Synek, Dept. of Geology and Paleontology, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic.

Introduction

In the southernmost part of the Moravian Karst, the occurrences of Upper Devonian and Lower Carboniferous limestones have been reported from the vicinity of Bedřichovice near Brno, between Líšeň and the Zetor factory and between Slatina and Bedřichovice (BRZOBHATÝ et al. 1987). In this report, the limestones are described from both, the sedimentological and biostratigraphical points of view as well as from the viewpoint of structural geology.

Bedřichovice

Description of the outcrop

The studied locality is located in the fields on the right side of the highway Brno–Vyškov, between the villages of Bedřichovice and Slatina (fig. 1). There is an abandoned scrubby shelf quarry with quarry-wall dimensions of 40x5 meters. Another outcrop located nearby, a small abandoned quarry between Slatina and Bedřichovice (BRZOBHATÝ et al. 1987), was destroyed during the construction of the highway Brno–Vyškov. According to BRZOBHATÝ et al. (1987), a ten meters thick light grey micritic Vilémovice Limestone crops out in the lower part of this exposure. At top of the Vilémovice Limestone, grey, yellow, green and brown nodular Křtiny Limestone, two meters thick, have exposed. Conodont fauna of the Middle and Late Frasnian age (cono-

dont zones *Ancyrognathus triangularis* and *Palmatolepis gigas*) was described from their lower part. The uppermost part of this exposure is represented by dark grey, platy limestones with intercalations of grey, laminated limestones and limy shales (Hády-Říčka Limestone). Their thickness is approximately ten meters. The coalificated fossil remains of crustacean of the genus *Montecaris* (CHLUPÁČ 1960) were described from the bed surfaces.

The wall of the quarry in question is oriented approximately in a SE–NW direction, it may be divided into eastern, central and western parts. The average value of the bedding plane orientation is 73/47.

In the Bedřichovice quarry, the layers of biotrital and biomicritic limestones alternate with thin intercalations of shales. The biomicritic limestones are grey, brown-grey, locally black, often cut with thin calcareous veinlets. They form either medium beds (10–30 cm thick), or thin beds (2–10 cm thick). These beds are often repeated, being intercalated by thin beds of the shales. Some beds of biomicritic limestones show nodular fabric and parallel lamination. Locally, a graded bedding in the limestones can be distinguished, with biomicritic limestone passing upward into the micritic limestone.

Biotrital limestones are grey to dark grey. Limestones form mostly well bedded layers, 15–18 cm thick, locally they show nodular fabric. Rarely, the limestones form 4–15 cm thick beds, which alternate with laminae of shales creating sets with a total

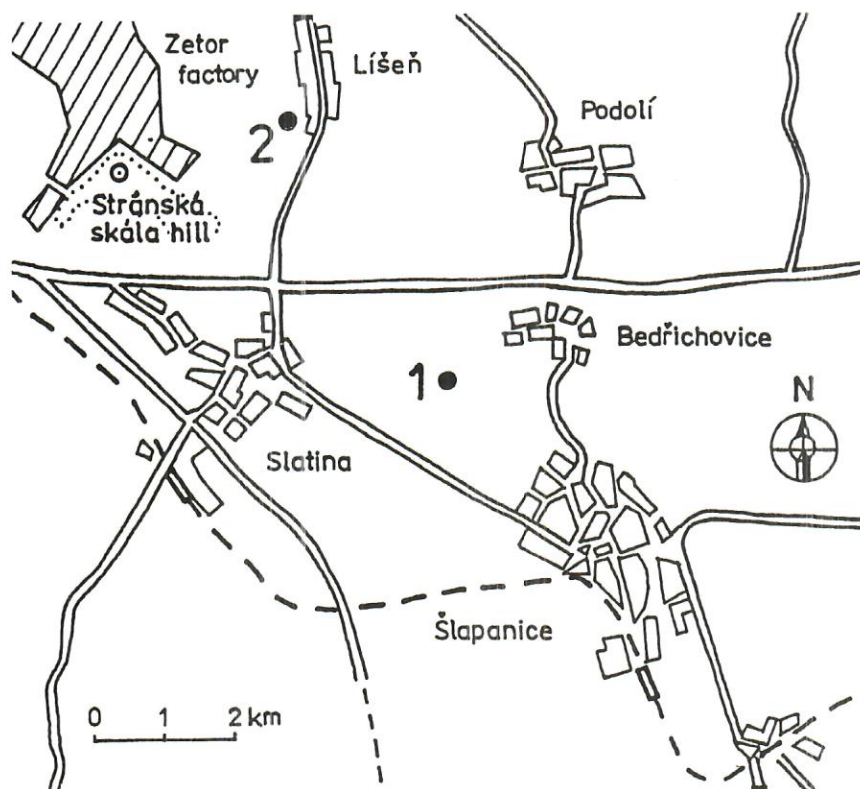


Fig. 1. Sketch map showing the position of the exposures in surroundings of Bedřichovice. 1 – Bedřichovice quarry, 2 – Líšeň – Zetor quarry.

Obr. 1. Situační pláněk odkryvů v okolí Bedřichovic. 1 – lom u Bedřichovic, 2 – Líšeň – lom u Zetoru.

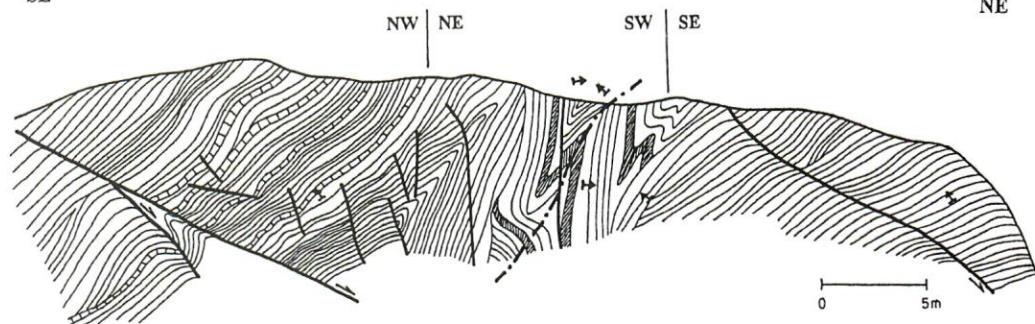


Fig. 2. Structural sketch of the Bedřichovice quarry.
Obr. 2. Strukturní náčrt lokality Bedřichovice.

thickness of 20–80 cm or as much as two meters in the eastern part of the exposure. In the biotrital limestones, distinct graded bedding can be locally macroscopically distinguished, which is manifested not only by a change of the grain size but also by colour alteration, with a dark, coarse-grained lower part of the bed passing upward into a light coloured, fine grained upper part of the bed.

Shales are brown to grey brown. They form 1–7 cm thick beds between the limestones. Their content increases in the western part of the exposure.

Tectonic pattern of the exposure

The limestone beds of the Bedřichovice quarry were affected by several deformation phases. Relics of small duplexes in the western and eastern parts of the exposure can be distinguished. An older generation of folds (F_1) is represented by pinch folds (their axes dipping towards SE – 134/7, with a interlimb angle of approximately 45°). Folds of this type are associated with formation of cleavage. The average value of the cleavage orientation is 75/24. Folds F_1 were subsequently refolded by a second generation of folds (F_2), which are best visible on corrugated axial planes of F_1 folds. The folded complex was later affected by vertical faulting and finally by two moderately dipping normal faults. They are evident in the eastern and western part of the Bedřichovice quarry, where they are accompanied by crushing of surrounding rocks and with drags.

Biostratigraphy and microfacies

Eighteen conodont samples of limestone were treated with acetic acid. Conodonts were very rare and only in two samples were representatives of the species *Ancyrodella curvata* Branson et Mehl found. Their stratigraphical range is from the *Palmatolepis rhenana* to *Palmatolepis linguiformis* Zone of the Late Frasnian age.

Thin sections, prepared from 30 samples, were described in terms of the extended Dunham's classification and were subjected to point-counting analysis (approximately 300 points per each thin section). In the Bedřichovice quarry, two types of limestones predominate: biomicritic limestones are represented by wackestones, biotrital limestones by packstones.

Well-sorted skeletal wackestones, contain mostly radiolarians, calcispheres and short sponge spicules and less often, also thin walled ostracodes. Foraminifers, remains of bivalves and tentaculites are rare and in one case a fragment of a trilobite was discovered. Quartz grains were also discovered in some cases. Locally normal grading of carbonate material is visible.

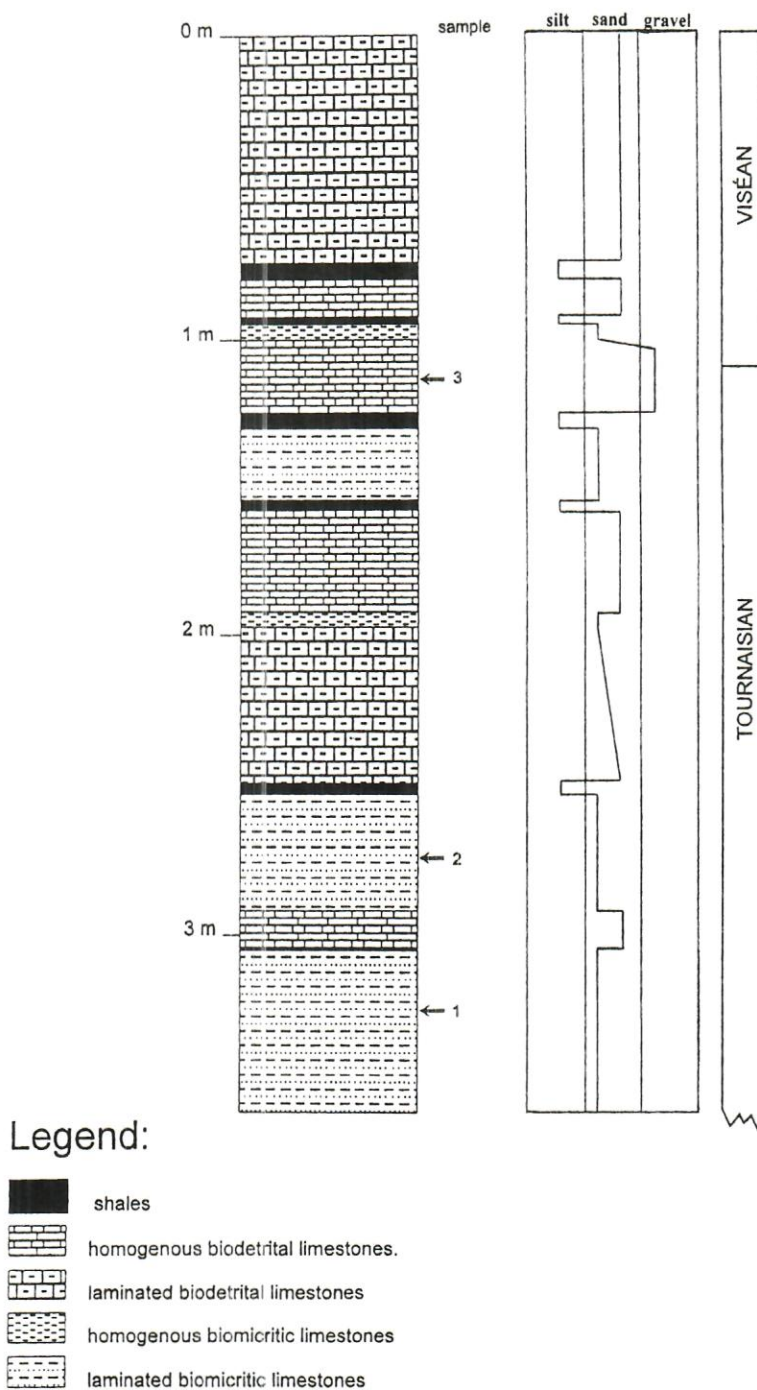


Fig. 3. Graphic log of the Liščin – Zetor quarry
Obr. 3. Profil lokalitou Liščin – lom u Zetoru.

The packstones contain abundant peloids and skeletal grains, with rare detrital quartz grains. The skeletal grains primarily include multi-chambered foraminifers, thin-walled ostracods, sponge spicules; less abundant are small radiolarians, calcispheres, fragments of corals, bivalves, tentaculites and crinoids and the remains of single-chambered foraminifers. In one case, a fragment of a conodont was discovered. In thin sections, both graded packstones and graded packstone to wackestone transitions were observed. Packstones are often penetrated by the calcareous veinlets.

The foraminifers were relatively abundant in only twelve, mostly packstone samples. The occurrences of foraminifers in particular samples were described by SYNEK (1997). Foraminifers are represented by the following species:

Eonodosaria evlanensis Lipina
Eonodosaria stalinogorski Lipina
Tikhinella fringa Bykova
Frondilina sorrosis Bykova
Nanicella evoluta Reitlinger

The foraminiferal assemblage contains taxa typical of the Multiseptida corallina – *Eonodosaria evlanensis* Zone (KALVODA 1989). Stratigraphical range of this zone is Middle Frasnian to Late Frasnian. The presence of the species *Eonodosaria evlanensis* Lipina and *Frondilina sorrosis* Bykova is typical for the upper part of this zone, which corresponds to the uppermost Frasnian (*Palmatolepis rhenana* to *Palmatolepis linguiformis* Zone).

Líšeň-Zetor quarry

Description of the outcrop

The locality, operationally named as Líšeň – Zetor quarry, is situated between the Zetor factory and the district of Líšeň called „Pod oříšky“ (fig. 1). There is a small quarry, which expose beds of Hádý-Říčka Limestone. The quarry wall is oriented approximately in a E–W direction, its dimensions are 4×1.5 meters.

The whole exposure may be divided in three litological types – dominant biotrital limestones, biomicritic limestones and shales, which are exposed mainly in the western part of the exposure.

Biotrital limestones are mainly dark grey and form homogenous medium beds 15–40 cm thick or sets (50–80 cm thick), which contain thin bedded limestones. Medium beds locally show graded bedding and contain rare black cherts.

Biomicritic limestones occur in particular in the eastern part of the exposure. They are massive, grey to dark grey with thin layers (about 5 cm) predominating. Locally, limestones form beds 20–50 cm thick.

In the western part of the exposure, the beds of biotrital limestone contain intercalations of dark grey to dark green shales, their thickness is 3–6 cm. Shales are laminated and strongly weathered on the surface.

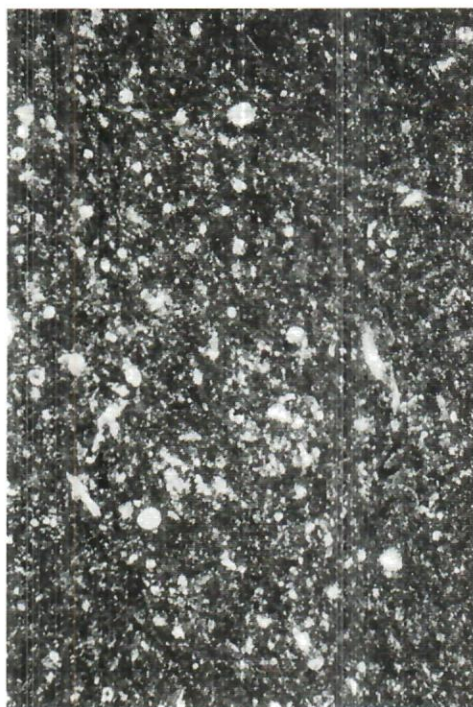
Biostratigraphy and microfacies

Three samples were treated for conodonts in the locality, however, only indeterminate fragments were obtained. Earlier investigations (FRIÁKOVÁ in BRZOBHATÝ et al. 1987) revealed conodont fauna of the *Scaliognathus anchoralis* Zone. Thin sections were made from another three samples, their position being indicated in the lithological section (fig. 4).

Sample 1: peloidal packstone with abundant radiolarians, sponge spicules and quartz grains.



1 2
3 4



Sample 2: partly silicified packstone with sponge spicules and quartz grains. Radiolarians and multi-chambered foraminifers (*Spinoendothyra* sp.) are less frequent. The foraminiferal fauna indicates a Late Tournaisian age.

Sample 3: rudstone overfilled with foraminifers and their fragments, crinoids, peloids, quartz grains and less abundant fragments of bivalves. The foraminiferal assemblage with *Spinoendothyra* sp., *Dainella* sp., *Glomodiscus* sp. indicates the *Viseidiscus eospirillinoides* – *Glomodiscus oblongus* Zone (KALVODA 1989). Stratigraphical range of this zone corresponds to the late Lower Viséan to early Middle Viséan (V1b–V2a).

Biomicritic limestones are represented by wackestones, while biotrital limestones by packstones and rudstones.

Conclusions

Grading, parallel lamination, a common occurrence of benthic and pelagic groups of organisms and regular alternation of biomicritic and biotrital limestones with thin laminated shales show, that the limestones from the Bedřichovice quarry can be regarded as calciturbidites. More over, distal facies representing the upper parts of the Bouma sequence T_{de} and F9 class according to MUTTI (1992) are present. Limestone beds often display normal grading from biotrital to biomicritic limestones and parallel lamination. Laminae of dark shales probably correspond to hemipelagic sediments deposited in the period between the sedimentation of individual turbidites.

Shallow water grains are represented mainly by remains of calcareous benthic foraminifers and rare fragments of bivalves. They were transported from carbonate platform margins together with terrigenous quartz. Locally, sponge spicules derived from slopes are abundant.

We assume that the limestones in Bedřichovice quarry originated in a slope base environment and that calcareous material was transported from the edge of carbonate platform by low density turbidity currents. Sediments correspond to the facies D of the outer part of the carbonate apron (MULLINS and COOK 1986).

Analogous calciturbidite facies were described from the Middle and Upper Devonian of the basinal and transitional developments by BÁBEK (1995) and from Rheinisches Schiefergebirge by EDER et al. (1983). The occurrence of trilobites and tentaculites in the Bedřichovice section, together with lithological and sedimentary structures show, that

EXPLANATION OF PLATE

Longer edge of all photographs is 3 mm long.

Photomicrograph 1. Rudstone with tests of foraminifers and fragments of crinoids, Líšeň – Zetor quarry, *Viseidiscus eospirillinoides* – *Glomodiscus oblongus* Zone (V1b–V2a).

Mikrofotografie 1. Rudstone se schránkami foraminifer a úlomky krinoidů, Líšeň – lom u Zetoru, zóna *Viseidiscus eospirillinoides* – *Glomodiscus oblongus* (V1b–V2a).

Photomicrograph 2. Rudstone with remains of crinoids, tests of foraminifers and quartz grains, Líšeň – Zetor quarry, *Viseidiscus eospirillinoides* – *Glomodiscus oblongus* Zone (V1b–V2a).

Mikrofotografie 2. Rudstone se zbytky krinoidů, schránkami foraminifer a křemennými klasty, Líšeň – lom u Zetoru, zóna *Viseidiscus eospirillinoides* – *Glomodiscus oblongus* (V1b–V2a).

Photomicrograph 3. Packstone with abundant peloids, small radiolarians, sponge spicules, quartz grains and thin walled ostracodes, Bedřichovice, *Multiseptida corallina* – *Eonodosaria evlanensis* Zone, Upper Frasnian.

Mikrofotografie 3. Packstone s hojnými peloidy, malými radiolariemi, jehlicemi hub, křemennými klasty a tenkostěnnými ostrakody, Bedřichovice, zóna *Multiseptida corallina* – *Eonodosaria evlanensis* (svrch. frasn).

Photomicrograph 4. Wackestone with small radiolarians, sponge spicules and quartz grains, Bedřichovice, *Multiseptida corallina* – *Eonodosaria evlanensis* Zone, Upper Frasnian.

Mikrofotografie 4. Wackestone s radiolariemi, jehlicemi hub a křemennými klasty, Bedřichovice, zóna *Multiseptida corallina* – *Eonodosaria evlanensis* (svrch. frasn).

they represent the deepest Frasnian facies in the southern part of the Moravian Karst area. They markedly differ from the time-equivalent Vilémovice Limestone of the Platform Development.

The sedimentation in the Líšeň – Zetor quarry largely resembles the sedimentation in Bedřichovice. Biotrital limestones, which predominate in the exposure, however, are more coarse grained, alternating with layers of biomicritic limestones and (in the western part of the exposure) also with thin laminated shales. Limestones also contain more frequent terrigenous quartz grains. Benthic organisms are represented mainly by foraminifers and crinoids. The foraminiferal assemblages indicate a Late Tournaisian to Middle Viséan age.

Similar to Bedřichovice, the Hády-Říčka limestones in the Líšeň – Zetor quarry also originated as a result of sedimentation from calcareous turbidity currents. Sediments can be compared with the facies C of the outer carbonate apron (MULLINS and COOK 1986). Analogous calciturbidites were described by KALVODA (1996) from the Tournaisian sections in Mokrý near Brno.

SOUHRN

V okolí Bedřichovic, v jejíž jižní části Moravského krasu, byly dvě lokality studovány z hlediska biostratigrafie a sedimentologie. Foraminiferní společenstvo a konodontová fauna z opuštěného lomu u Bedřichovic ukazují na svrchnofrasnské stáří, na lokalitě Líšeň – lom u Zetoru se podařilo prokázat stáří vápenců v rozpětí svrchní tournai až střední visé. Ze sedimentologických a mikrofaciálních výzkumů vyplývá, že se jedná o uložení z řídkých turbiditních proudů, které vynášely vápnitý materiál z okrajů karbonátové platformy. Sedimenty v Bedřichovicích odpovídají faciálnímu typu D a na lokalitě Líšeň – lom u Zetoru faciálnímu typu C podle MULLINSE a COOKA (1986). V obou případech se jedná o sedimentaci vnější části karbonátového závojevitěho tělesa (carbonate apron). Stručný přehled strukturně geologických výzkumů na lokalitě Bedřichovice tvoří další část článku.

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