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BIOSTRATIGRAPHY OF LOWER CRETACEOUS OF THE MANÍN UNIT (BUTKOV QUARRY, STRÁŽOVSKÉ VRCHY MTS., WESTERN CARPATHIANS)

BIOSTRATIGRAFIE SPODNÍ KŘÍDY MANÍNSKÉ JEDNOTKY
(LOM BUTKOV, STRÁŽOVSKÉ VRCHY, ZÁPADNÍ KARPATY)

Abstract

This paper is a continuation of systematic stratigraphical research of Lower Cretaceous sequence of the Manín Unit excavated in the Butkov quarry. Calcareous deposits are significant especially by richness of ammonites. Attention is focused on the parts enabling the definition of ammonite zones. The following ammonite zones were determined: the Campylotoxus Zone (Early Valanginian), the Furcillata Zone (Late Valanginian), the Balearis Zone (Late Hauterivian) and boundary between the Pulchella Zone and the Compresissima Zone (Early Barremian). Non-calcareous and calcareous dinoflagellates, calpionellids and calcareous nannoplankton were analysed in the same places to provide a correlation of their ranges with ammonite zones.

Abstrakt

Tato práce je pokračováním systematických stratigrafických výzkumů spodnokřídových uloženin manínské jednotky těžených v lomu Butkov. Tamější karbonátové uloženiny se vyznačují bohatým výskytem amonitů. Pozornost je věnována úsekům umožňujícím definování amonitových zón. Zjištěny byly následující amonitové zóny: zóna Campylotoxus (spodní valangin), zóna Furcillata (svrchní valangin), zóna Balearis (svrchní hauteriv) a hraniční uloženiny mezi zónou Pulchella a zónou Compressissima (spodní barrem). Ve stejných úsecích byly studovány vzorky na nevápnitá a vápnitá dinoflageláta, kalpionely a vápnitý nanoplankton za účelem jejich korelace s příslušnými amonitovými zónami.

Key words: biostratigraphy, Lower Cretaceous, Manín Unit, Central Western Carpathians.

Introduction

Calcareous Lower Cretaceous sediments exposed in the active quarry Butkov in vicinity of the village of Ladce (Fig. 1), which pertain to the Manín Unit of the Central Western Carpathians, represent one of the most complete sections of the Lower Cretaceous deposits in the Western Carpathian System. Calcareous deposits are famous for the abundance of ammonites, or also of other cephalophods, such as belemnites and aptychi. Altogether, it is one of the richest localities of Lower Cretaceous (pre-Aptian) cephalopods in the whole of Western Carpathians.

In the last century, the section was processed in detail, e. g. Borza et al. (1987), Maheľ (1978), Michalík and Vašíček (1987), Rakús (1977), Vašíček and Michalík (1986). A new lithostratigraphic division of the Lower Cretaceous deposits of that place was proposed in Borza et al. (1987). Later, Vašíček et al. (1994), or Vašíček (1995) provided summarised data on the association and the distribution of Lower Cretaceous cephalopods in the locality Butkov.

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Last years, when documenting the sections and taking samples for non-calcareous dinoflagellates, calcareous nannoplankton and thin-sections, in several places on higher levels of the quarry we succeeded in finding some very significant occurrences of ammonites known only little, or unknown in the Western Carpathians.

Here, results in a summary form following from new macrofaunistic and micropaleontological studies of parts enabling the definition of ammonite zones are presented. Those are arranged according to the stratigraphic sequence of strata from bottom to top, i.e. the Ladce Formation, the Mráznica Formation, part of the Lúčkov Formation and the Butkov Formation.

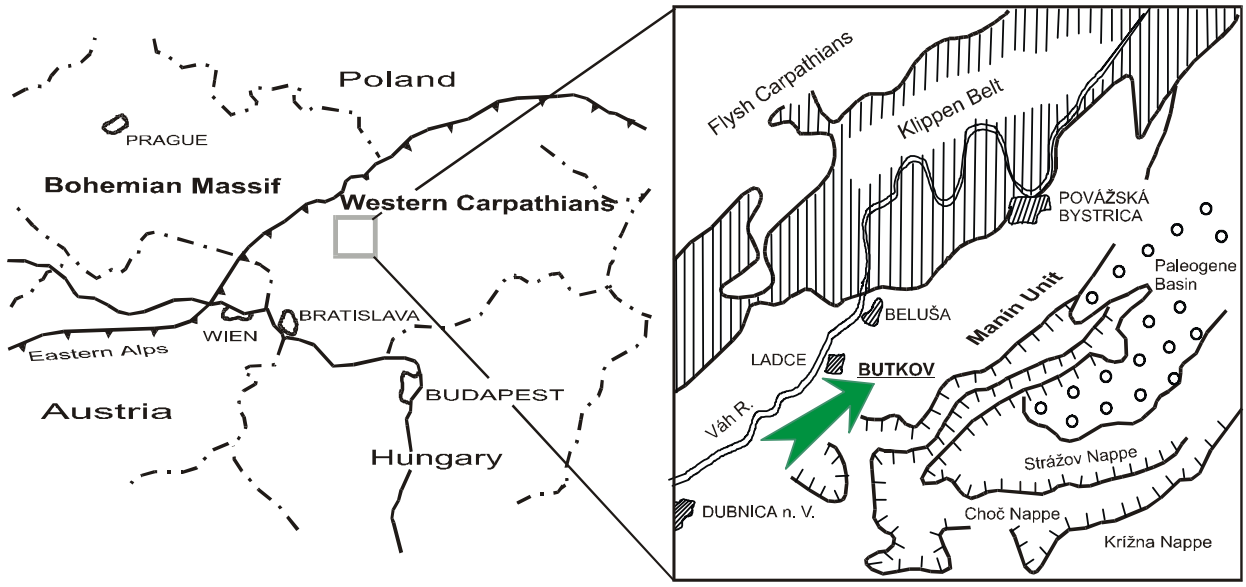


Fig. 1. Location map of the studied area and the Butkov quarry (according to Vašíček et al. 1994)

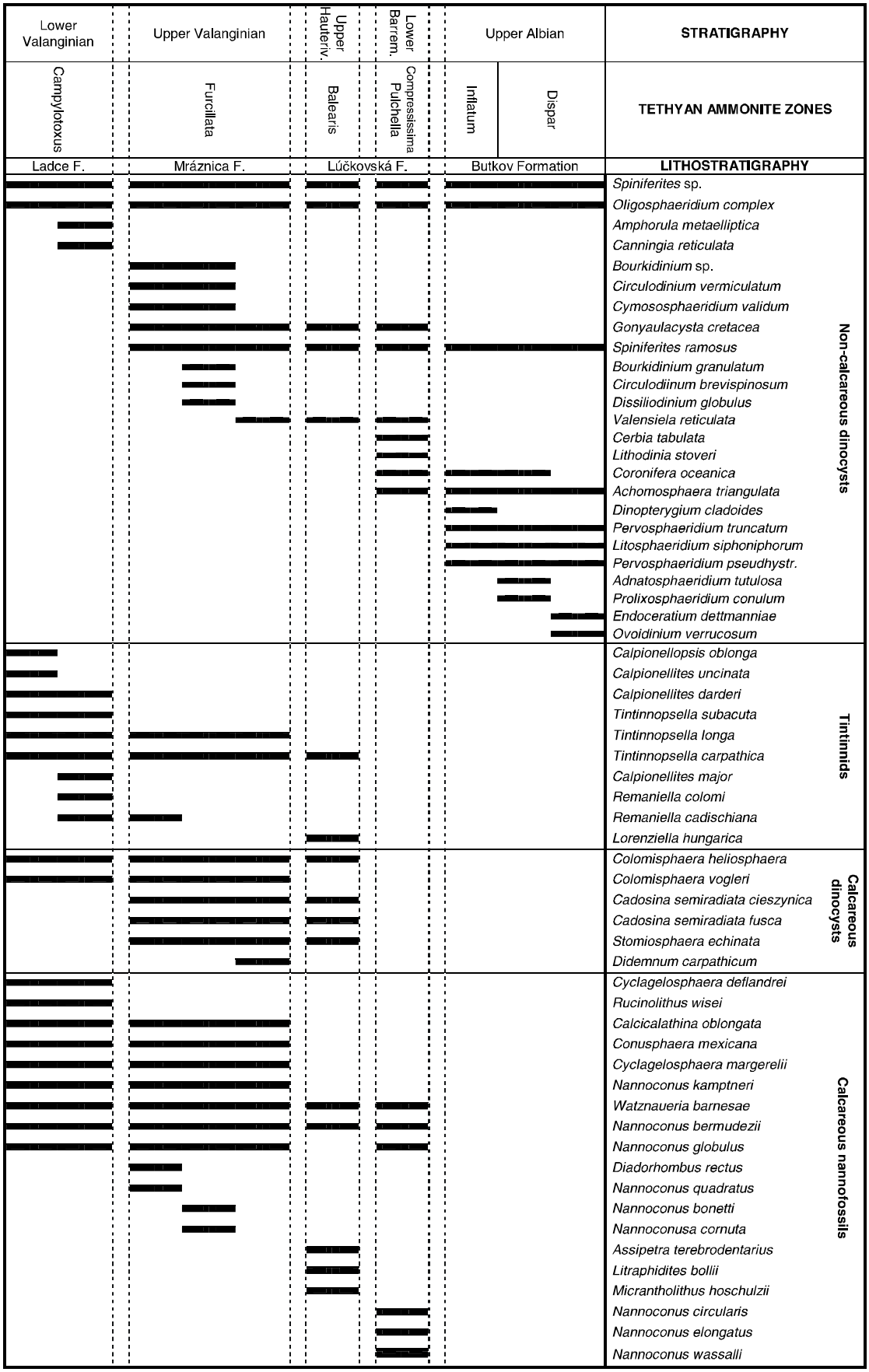
Stratigraphy

Ladce Formation (Borza et al. 1987)

The oldest findings of Lower Cretaceous ammonites come from the Ladce Formation, from the immediate overlying layers of Jurassic/Cretaceous breccia (in a meander of the exit from the 10th to the 11th level). To most significant of them *Busnardoites campylotoxus* (Uhlig) belongs. Moreover, the occurrence of *Vergoliceras salinarium* (Uhlig) published already earlier (Michalík et al. 1995, as *Neolissoceras salinarium*) should be noted as well. The above mentioned ammonites prove that the pelagic sedimentation of the Ladce Formation began in the Lower Valanginian ammonite Campylotoxus Zone. In the higher part of the Ladce Formation (12th lewel) we succeeded, among other matters, in finding two incomplete macroconches with tubercles on ribs. Primarily it is a fragment of the living chamber of a specimen close to *Busnardoites campylotoxus* (Uhlig) and also *Neocomites platycostatus* (Sayn). *Neocomites platycostatus* is the index species for upper part of the ammonite Campylotoxus Zone.

The calpionellid association belongig to Darderi and Major Subzones of the standard Calpionellites Zone (Reháková & Michalík 1997) confirms this result. Marly limestones of biomicritic structure of the Ladce Formation contain tintinids *Calpionellites darderi* (Colom), *C. major* (Colom), *Tintinopsella carpathica* (Murgeanu et Filipescu), and others (Tab. 1), and calcareous dinoflagellates, *Colomisphaera heliosphaera* (Vogler), *C. vogleri* (Borza), and others. In addition, globochaets, ostracods and sponge spicules supplement this association of microfossils.

Of palynomorphs, spores and bisaccate pollen grains occur sporadically in the samples. They evidence a low supply of terrestrial material. Non-calcareous dinoflagellate cysts are present sporadically. Among stratigraphically significant ones, *Oligosphaeridium complex* (White) Davey & Williams and *Spiniferites* sp. belong, according to which the part under study is not older than the middle part of Lower Valanginian (i.e. ammonite Pertransiens Zone).



Tab. 1. The occurrence of selected calpionellids, calcareous and non-calcareous dinoflagellates in the Butkov quarry. The ammonite zones are defined according to ammonites found in outcrops; merely in the Late Albian the ammonite zones presented were deduced in virtue of non-calcareous dinoflagellates.

As far as calcareous nannoplankton is concerned, *Calcicalathina oblongata* (Worsley) Thierstein (FO in ammonite Otopeta Zone 136.66 Ma - Hardenboll et al. 1998) and *Rucinolithus wisei* Thierstein (with last occurrence in the ammonite Verucosum Zone - Bergen 1994) are stratigraphically significant. *Rucinolithus wisei* was found only in the sample BK 10-11**.** Other stratigraphical important species are: *Eiffelithus windii* Applegate & Bergen (FO Petrasiensis ammonite Zone 136.11Ma. - Hardenbol et al. 1998 - in very bad stage of preservation) and nannoconids - *Nannoconus bermudezi* Brönnimann and *N. kamptneri* Brönnimann with the first occurrence on the base of the Valanginian. Calcareous nannofossil assemblage has been assigned to the Lower Valanginian calcareous nannoplankton Zone Calcicalathina oblongata NK3, subzone NK-3A Rucinolithus wisei (Bralower et al. 1989).

Mráznica Formation (Borza et al. 1987)

The most complete ammonite-bearing section was found on the 11th level in the quarry face. Deposits documented pertain to the Mráznica Formation. The studied part of the Mráznica Formation is much more richer in the occurrence of ammonites, of which the following were determined: *Neolissoceras grasianum* (d'Orbigny), *Teschenites subflucticulus* Reboulet*, T. subpachydicranus* Reboulet, *Olcostephanus nicklesi* Wiedmann & Dieni, *O. balestrai* (Rodighiero), *Criosarasinella furcillata* Thieuloy*, C. heterocostata* (Mandov)*, C. mandovi* Thieuloy, *Himantoceras trinodosum* Thieuloy, and others. From the stratigraphical point of view, *H. trinodosum* and *C. furcillata* are the most significant; the former being a zone species of the middle part of Upper Valanginian (Trinodosum Zone) and the latter being an equivalent of the subzone species *C. furcillata,* that is the index for the upper part of the zone mentioned above. The occurrence of *O. nicklesi* is also of importance. This is a subzone species of the lower part of the Trinodosum Zone. With regard to the fact that *O. nicklesi* occurs together with *C. furcillata*, it is necessary to assume that merely the higher part of the Trinodosum Zone (uppermost part of Peregrinus Zone by Hoedemaeker, Reboulet et al. in print) is represented here.

In the uppermost part of the Mráznica Formation, assemblages being rich in ammonites, e.g. *Neolissoceras grasianum* (d'Orbigny), *Teschenites subpachydicranus* Reboulet*, Olcostephanus nicklesi* Wiedmann & Dieni, *Oosterella cultrataeformis* (Uhlig), *Criosarasinella subheterocostata* Reboulet, *Crioceratites primitivus* Reboulet*, Himantoceras trinodosum* Thieuloy were found. According to the occurrence of *C. subheterocostata*, the representation of the ammonite Subheterocostata horizon, which is defined in the uppermost part of Trinodosum Zone by Atrops and Reboulet (1995), can be confirmed. According to Hoedemaeker, Reboulet (in print) it is an uppermost part of the Furcillata Subzone.

It is again the case of prevailingly marly limestones, in which calcareous dinoflagellates *Cadosina semiradiata cieszynica* (Nowak), *C. s. fusca* (Wanner), *Stomiosphaera echinata* Nowak and tintinids *Remaniella cadischiana* (Colom)*, Tintinopsella carpathica* (Murgeanu et Filipescu) appear most frequently. Benthic foraminifers, globochaets, ostracods and crinoids are present as well.

As for palynomorphs, dinoflagellate cysts are prevailing; acritarchs, microforaminifers, prasinophytes, pollen grains and spores occur too. Calm sea sedimentation can be considered with a negligible supply of terrestrial material. The composition of assemblages of dinoflagellates reflects their original sea environment of the depth of only a few hundred meters (littoral to varying salinity types predominate, e.g. *Circulodinium* sp.*, Muderongia* sp., together with oceanic types, e. g. *Pterodinium* sp.). For instance, *Cymososphaeridium validum* Davey*, Gonyaulacysta cretacea* (Neale & Sarjeant) Sarjeant belong to the most stratigraphically significant dinoflagellates; representatives of the genus *Bourkidinium* Morgan appear very often. The assemblage corresponds to the Cymososphaeridium validum dinocyst zone defined by Leereveld (1995) for the Upper Valanginian – the lowermost Hauterivian.

The association of nannofossils is similar to that of the Ladce Formation, but without *Rucinolithus wisei*. Newly, sporadic *Tubodiscus verenae* Thierstein emend. Grün appears, rare nanoconids are present (e.g. *Nannoconus boneti* Trejo, *N. cornuta* Deres & Achéritequy*)* with first occurrence in the Lower Valanginian and the last occurrence is related to the Upper Valanginian (*N. quadratus* (Noël)). *Calcicalathina oblongata, Cruciellipsis cuvillieri* (Manivit) Thierstein remain part of nannoassociation. In the uppermost part, an increased number of *Calcicalathina oblongata, Nannoconus globulus* Brönnimann, *Watznaueria barnesae* (Black) Perch-Nielsen could be observed. Specimens of this interval can be assigned to the Upper Valanginian calcareous nannoplankton Zone Calcicalathina oblongata NK3, subzone NK 3B Tubodiscus verenae (Bralower et al. 1989).

Lúčkovská Formation (Borza et al. 1987)

In the deposits of the Lúčkovská Formation (on the 7th level), we found ammonites preserved imperfectly and remains of belemnites. Among them the most complete finding belongs to *Duvalia dilatata majoriana* Stoyanova-Vergilova. As for the ammonites, it is the case of *Lytoceras subfimbriatum* (d'Orbigny), *Partschiceras infundibulum* (d'Orbigny), and ?*Pseudothurmannia "binelli"* Thomel (non Astier). According to Hoedemaeker (1995), the latter mentioned species occurs in the lower part of the ammonite Balearis Zone (Upper Hauterivian).

It is a case of biodetritic and marly limestones, in which calcareous dinoflagellates *Cadosina semiradiata cieszynica* (Nowak), *C. s. fusca* (Wanner), *Colomisphaera heliosphaera* (Vogler), *Stomiosphaera echinata* Nowak and tintinid *Tintinopsella carpathica* (Murgeanu et Filipescu) are present. Foraminifers, sponge spicules, globochaets, radiolarians, fragments of bivalves, crinoids and bryozoa are abundant.

As for nannoplankton, the species *Litraphidites bollii* (Thierstein) Thierstein (appeared at the level of 131.14 Ma in the ammonite Loryi Zone - Hardenbol et al. 1998 for the first time) not perfectly preserved was found very rarely. The abundance of micrantholiths (e.g. *Micrantholithus hoschulzii* (Reinhardt) Thierstein) and nannoconids (e.g. *Nannoconus bermudezi*) is characteristic; *Assipetra terebrodentarius* (Applegate et al.) Rutledge & Bergen appears here, *Cruciellipsis cuvillieri* is not observed any longer. The nannofossil assemblages can be assigned to the nannoplankton Zone Litraphidites bollii Thierstein (1971, 1973), subzone NC5b (Bralower 1987).

In the higher part of the Lúčkovská Formation (on the 7th level-east, BK7-V), an ammonite-bearing layer was found containing abundant barremites and some interesting, or stratigraphically very significant species, such as *Nicklesia pulchella* (d'Orbigny), *Moutoniceras nodosum* (d'Orbigny), *Dissimilites dissimilis* (d'Orbigny), *Spitidiscus gastaldianus* (d'Orbigny), holcodiscids, *Paraspiticeras* sp., *Karsteniceras* sp., *Patruliusiceras lateumbilicatum* Avram, *Metahoplites diversecostatus* (Coquand) and others. According to *N. pulchella* and *D. dissimilis,* and also according to holcodiscids found, it can be assumed, that the ammonite-bearing horizon belongs to the Lower Barremian, to deposits on the boundary between the ammonite Pulchella and Compressissima Zones.

In the ammonite-bearing horizon of the Lúčkovská Formation, pollen grains and spores appear in palynological samples in a negligible amount; otherwise cysts of dinoflagellates prevail. The assemblage of dinoflagellates consists especially of littoral (*Cerbia* sp., *Tenua* sp.) and neritic (*Oligosphaeridium* sp., *Spiniferites* sp.) representatives. Among those of stratigraphic importance, *Achomosphaera triangulata* (Gerlach) Davey & Williams, *Coronifera oceanica* Cookson & Eisenack and *Lithodinia stoveri* (Millioud) Gocht belong. It is the presence of the species *Cerbia tabulata* (Davey & Verdier) Below that is interesting. The species is generally known only from the higher part of the Lower Barremian ammonite Caillaudianus Zone (now upper part of the Compressissima Zone and Darsi Zone).

In the sample taken from the ammonite-bearing layer, the first abundant taxon is *Watznaueria barnesae*, an increased number and higher diversity of nannoconids (e.g. *Nannoconus steinmanni steimanni* Kamptner, *N. bermudezi, N. globulus*) were observed and *Micrantholithus hoschulzii* was common. Representatives of nannoconids, the first occurrences of which are connected with the base of the Barremian (e.g. *N. elongatus* Brönnimann, *N.wassalli* Brönnimann, *N. circularis* Deres & Achéritéquy), appeared here. The absence of *Calcicalathina oblongata*, whose last occurrence is indicated in the ammonite Caillaudianus Zone in France and Huggii in Italy(Hardenbol et al.1998), makes it possible to determine the subzone NC5d (Bralower 1987).

Butkov Formation (Kysela et al. 1982)

In the assemblages of palynomorphs of samples taken from the Butkov Formation (2nd level), dinoflagellate cysts dominate; acritarchs (e.g. *Wallodinium* sp., *Veryhachium* sp.), bisaccate pollen grains and microforaminifers occur sporadically. The dinoflagellates are represented primarily by a deep-sea species typical of both the open neritic sea (*Achomosphaera* sp., *Litosphaeridium* sp.) and the ocean (*Pterodinium* sp.). From the above mentioned, a basinal sedimentary environment can be deduced.

The samples contain stratigraphically significant species of dinoflagellates, such as *Endoceratium dettmanniae* (Cookson & Hughes) Stover & Evitt, *Litosphaeridium siphoniphorum* (Cookson & Eisenack) Davey & Williams, *Ovoidinium verrucosum* (Cookson & Hughes) Davey, *Prolixosphaeridium conulum* Davey. The first occurrence of *L. siphoniphorum* was confined to the upper part of the Upper Albian ammonite Inflatum Zone and the first occurrence of *P. conulum* delimits the ammonite Dispar Zone, which is supported by the presence of species *E. dettmaniae* and *O. verrucosum* (Davey and Verdier 1973). With respect to the fact that no species characteristic of the Cenomanian have been found it is possible to connect investigated part of the Butkov Formation with the ammonite Inflatum and Dispar Zones .

Conclusion

New studies of Lower Cretaceous deposits of the Manín Unit made it possible to correlate ammonites, tintinids, calcareous nannofossils, non-calcareous and calcareous dinocysts with the following ammonite zones: the Lower Valanginian (Campylotoxus Zone), the Upper Valanginian (Furcillata Zone), the Upper Hauterivian (Balearis Zone) and the Lower Barremian (along the boundary between the Pulchella Zone and the Compresissima Zone). According to the non-calcareous dinocysts, deposits corresponding to Upper Albian ammonite zones (Inflatum and Dispar) have been successfully distinguished.

The quantitative composition of the dinoflagellate cysts assemblages reflects both the inner neritic environment in the Valanginian and Lower Barremian, and the basinal environment in the Albian.

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Resumé

V souboru nových výzkumných prací realizovaných v rámci grantového úkolu GAČR č. 205/00/D030 jsme nově dokumentovali spodnokřídové uloženiny odkryté na těžebních etážích lomu Butkov poblíže obce Ladce v manínské jednotce Centrálních Západních Karpat.

Tamější karbonátové uloženiny z hlediska úplnosti vrstevního sledu a podle množství nalézaných amonitů představují jednu z nejbohatších lokalit spodnokřídových amonitů v celé soustavě Západních Karpat. Amoniti zařazují až na úroveň amonitových zón převážnou část těžených cementářských surovin do časového rozpětí spodní valangin (amonitová zóna Campylotoxus) až bazální část svrchního barremu (zóna Vandenheckii). Nashromážděná bohatá amonitová kolekce obsahuje množství mediteranních vůdčích a zónových druhů. Podle poslední verze amonitového zónování pro mediteranní oblast (přijaté v Lyonu 2002) zónovými amonity zatím byly doloženy zóna Campylotoxus (spodní valangin), nejvyšší část zóny Peregrinus a spodní část zóny Furcillata (svrchní valangin), zóna Balearis (svrchní hauteriv) a zóna Compressissima (spodní barrem). Ze slínů butkovského souvrství byla získána společenstva dinoflagelát známá ze svrchního albu, podle Daveye a Verdiera (1973) z amonitových zón Inflatum a Dispar. Z toho je možno tyto amonitové zóny předpokládat v lomu Butkov.

Vedle litologické dokumentace a sběru makrofauny byly v lomu současně odebírány též vzorky na studium nevápnitých a vápnitých dinoflagelát, kalpionel a vápenitého nanoplanktonu, což ve vrstevním sledu umožňuje vzájemnou korelaci výskytu uvedených skupin fosilií. Výsledky korelace stratigraficky významných druhů výše uvedených skupin mikroorganismů s amonitovými zónami zobrazuje tabulka 1.

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