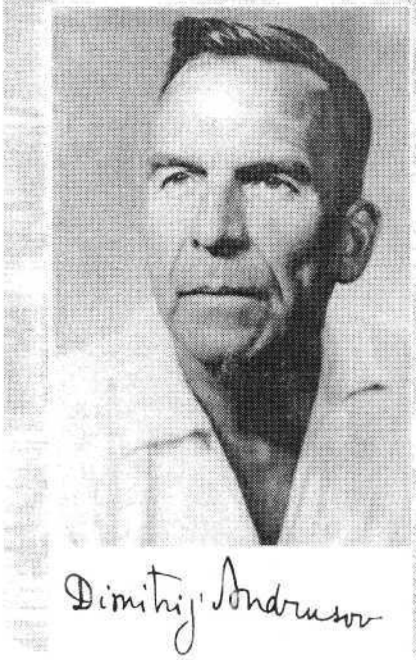
4-5/29/1997
ISSN 0369-2086

Mineralia Slovaca

NOVÁ MONOGRAFIA

(september 1997)

IŠIEL SOM TOUTOU CESTOU



GALINA ANDRUSOVOVÁ-VLČEKOVÁ

DIMITRIJ ANDRUSOV (1897-1976)

ŽIVOTOPISNÁ ČRTA

Mineralia Slovaca (ISSN 0369-2086) vychádza šesťkrát ročne. Vydavateľ: Geocomplex, a. s., Bratislava. Sadzba v redakcii Mineralia Slovaca systémom DTP Apple Macintosh. Tlač: Grafotlač, Prešov.
Predplatné v roku 1997: Členovia Slovenskej geologickej spoločnosti 80 Sk, študenti 40 Sk, organizácie 228,- Sk (+ 6 % DPH). Cena jednotlivého čísla je 38,- Sk. Cena dvojčísla 76,- Sk. Časopis možno objednať v redakcii.
Inzeráty: Požiadavky zasielať redakcii. Adresa redakcie: Mineralia Slovaca, Werferova 1, 040 11 Košice. Telefón: 095/437 846.

Mineralia Slovaca (ISSN 0369-2086) is published bimonthly by the Geocomplex, a. s., Bratislava. Text was written, edited and composed on a DTP system using Apple Macintosh computers in the editorial office Mineralia Slovaca.
Subscription for 1997 calendar year: 92 USD including postage. Claims for nonreceipt of any issue will be filled gratis. Subscription can be sent Mineralia Slovaca, Werferova 1, 040 11 Košice, Slovakia and SLOVART - G.T.G., Krupinská 4, P. O. Box 152, 852 99 Bratislava.
Advertising: Contact managing editor. Address of the Editorial office: Mineralia Slovaca, Werferova 1, 040 11 Košice, Slovakia; Phone: 421/95/437 846.

OBÁLKA: Lokalita Brodno, lom v úžine „Kysuckej brány“ v okolí Žiliny odkrývajúci (v prevrátenej pozícii) prechodné vrchnojurské a spodnokriedové formácie, menovite červené čajakovské rádiolarity (oxford), červené čorstýnske hľuznaté vápence (kimeridž až vrchný titón, ľavá časť obrázka) a svetlé až biele vápence typu „majolika“ pieninskej vápencovej formácie (najvrchnejší titón až hoteriv). Lokalita je navrhnutá na stratotyp titonsko-barémskej hranice. Výsledky detailného biostratigrafického a magnetostratigrafického štúdia sú podané v tomto čísle. Foto: J. Michalík.

COVER: The Brodno locality in a quarry in the „Kysuca Gate“ narrows near Žilina exposed (in overturned position) transitional Upper Jurassic and Lower Cretaceous formations, namely red Czajakowa radiolarites (Oxfordian), red Czorsztyn nodular limestones (Kimmeridgian to Late Tithonian age, left part of the figure and pale to white „majolica“ limestones of the Pienieny Limestone Formation (latest Tithonian to Hauterivian). The locality is suggested as the local stratotype of the Tithonian/Berriasian boundary. Results of detailed biostratigraphical and magnetostratigraphical study are given in this volume. Photo: J. Michalík.

UNESCO
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FINAL MEETING OF THE PROJECT N° 362 „TETHYAN/BOREAL CRETACEOUS CORRELATION“

ABSTRACT BOOK

J. MICHALÍK & D. REHÁHOVÁ (editors)

SEPTEMBER 30TH - OCTOBER 5TH, 1997
STARÁ LESNÁ, SLOVAKIA

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Mineralia Slovaca

Časopis Slovenskej geologickej spoločnosti a slovenských geologických organizácií
Journal of the Slovak geological society and Slovak geological organizations

Vydáva Združenie Mineralia Slovaca
Published by Mineralia slovaca corporation

Mineralia Slovaca 29 (1997) • 4-5

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Something like an introduction

This year is the fifths year of activity of our Project No 362. The time is running very rapidly not only in a human life. Now is the time to look back and re-evaluate our way.

Three main goals have been selected by establishing of the Tethyan/Boreal Correlation (TBC) Project in 1993: Development of a stratigraphic tool by identifying the events nature and amplitude - documentation of the global system processes - paleoclimate and paleoenvironmental models. These tasks were more evolved during Annual Meeting of the Project in Coimbra, Portugal (1993), Smolenice, Slovakia (1994), Maastricht, Netherlands (1995) and Freiberg, Germany (1996).

Nine work groups specialized on main biostratigraphic tools have been established in Coimbra (1993). Their activity has been documented in all four annual meetings and in numerous workshops round the Europe, as well. Two groups dealing with alternative stratigraphic methods (magnetostratigraphy, sequence stratigraphy) presented their results both in the Smolenice and Maastricht meetings. Regional aspects in approach to the Tethyan/Boreal correlation have been introduced in both the Maastricht and the Freiberg meetings. Twenty two national coordinators have been installated: the majority of them actively organizes the research of spatial interrelationships of the Cretaceous sedimentary basins. New ideas and data were generated concerning the interaction of the paleoceanographic and paleoatmospheric processes and the role of biota in paleoclimate fluctuations. Thirteen international meetings were organized during 1996 reflecteing a high activity in the realm of the spread of knowledge and exchange of ideas.

The results of individual meetings have been published in several international scientific journals: Cretaceous Research (16/3-4), Geologica Carpathica (Volumes 46/5 and 48/3). The project 362 cooperates with several closely oriented projects. A joint meeting has been organized during 30th IGC in Beijing in August 1996 with the IGCP Project 352 lead by Prof. Hakyu Okada. We are starting cooperation with the IGCP Project 386 (Response of the atmosphere/ocean system to the past global change). Good cooperation exists between our project and the International Cretaceous Symposia organized by German universities. Our last Annual Meeting joined with the 5th IGC has been organized by the Mining University of Freiberg. A part of our results will be published together with another achievements of this Conference in the Zentralblatt für Geologie und Paläontologie.

The Scientific Board of the UNESCO International Geological Correlation Programs on its 25th session appreciated the wide range of activities, geographical extension and the general scientific achievement of the 362 Project. Our project has been evaluated as excellent and its results as exquisite in the frame of the IGCP projects.

Our Final Meeting will be devoted to finalizing of our work. We will concentrate on three main goals, as indicated in this Abstract Volume. The first group of themes will be connected with the basic problems like Cretaceous paleoceanography, paleoclimatology, interrelations between both the Tethyan and Boreal Realms, investigations of key sections. The second group will be concentrated on the methods in stratigraphic research like integrated stratigraphy, sequence stratigraphy, magnetostratigraphy, or cyclostratigraphy. The last circle consists of sedimentological, paleontological, paleoenvironmental and paleogeodynamical contributions. We hope that these presentations and, chiefly, fruitfull discussion will contribute to the formulation of the final results and to the success of our Final Meeting.

Let us to welcome you in Stará Lesná, in a wonderfull corner of Slovakia. We wish you nice stay and interesting new knowledge concerning not only with the Tethyan/Boreal interplay, but also with the reconnaising of new peoples and with intensifying of our common cooperation. Let this "Final" meeting should be the start of our new collaboration!

The Organizing Committee

Mineralia Slovaca, 29 (1997), 243 - 244

The effect of changes of the mean salinity on ocean circulation

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Key words: Cretaceous, palaeoceanology, salinity

The density of seawater is related to temperature, salinity, and pressure through a complex function termed the equation of state. Because of the non-linearity of the equation of state of seawater, the densities of waters having the same salinity differences will have varying responses to a change in temperature as the mean salinity of the ocean varies. Although this strange property of seawater is evident in a plot of the equation of state (Fig. 1), its implications have never been seriously considered in attempts to simulate ancient ocean circulation. The differences in the ocean density field may have caused it to respond differently to atmospheric forcing in the past and may be key to understanding "ocean anoxic events", large scale burial of C_{org}, and the origin of petroleum source rocks.

Holser et al. (1980) made a first attempt to track salinity back through time, taking salt extractions into account. They came to the unexpected conclusion that the Cambrian ocean probably had a salinity of about 48 and that the ocean has been getting less saline throughout the Phanerozoic. Using principles of sedimentary mass-balance and recycling, Hay and Wold (in press) have made estimates of the mean salinities of the ocean since the end of the Paleozoic.

Fig. 1 is a plot of temperature (T), salinity (S), and density (curved lines) for some modern and simulated Late Cretaceous ocean surface waters. The dotted curve (A) shows 5° zonal averages of T, S, and from the Arctic through the North Atlantic to the equatorial Atlantic. The dashed curve (D) shows 5° zonal averages of T, S, and for the South Pacific. Solid curve C shows zonal averages of T, S, and for the Cretaceous "South Pacific" from the simulation (DeConto et al., in press; Hay et al., in press), which assumed an average ocean salinity of 34.8. Solid curve E is identical to C but is displaced to the right, to reflect an average ocean salinity of 43.6, our current estimate of the highest salinity during the Early Cretaceous, prior to deposition of the South Atlantic salt. Solid curve B is identical to C but is displaced to the left, to reflect an average ocean salinity of 32.6, our current estimate of the lowest salinity the ocean has seen (Late Neogene). Although the solid curves are identical, the density contrasts along them are different. This is because the slopes of the density curves change with the assumed average salinity, a result of the non-linearity of the equation of state of seawater. The total density contrast in curve E is about 7.7 kg/m^3 whereas in B it is about 7.0 kg/m^3. The total density contrast on the modern South Pacific curve (D) is only 5.4 kg/m^3. These are very large changes in view of the fact that slight density differences separate major water masses in the interior of the modern ocean (Hay, 1995). Today the density difference between the Intermediate Water, which contains the oxygen minimum and the Deep Water is about 0.3 kg/m^3, and the difference between warmer, more saline North Atlantic Deep Water and colder, less saline Antarctic Bottom Water is less than 0.1 kg/m^3.

At salinities near 27.4, the salinity at which the maximum density and freezing point of seawater coincide, cooling of the water has very little effect on its density. Density changes are much more easily induced by changing the salinity of the seawater. This occurs through sea-ice formation. Freshly formed sea ice has a salinity of about 7; the remainder of the salt is expelled into the surrounding water, increasing its salinity and density. At salinities near 40 and above, the cooling of seawater has a significant effect on density, and sea-ice formation becomes more difficult because the density of the water increases as it nears the freezing point, causing it to sink below the surface. With mean ocean salinities in the high 30's or 40's sea ice formation depends on significant freshening of the surface layer by precipitation or runoff. Thus the higher salinities preceding the Messinian salt extraction may well have played a role in delaying the onset of northern hemisphere glaciation by inhibiting the formation of sea ice.

A peculiar feature of the Cretaceous ocean is evident in Fig. 1. For the modern ocean, density increases steadily from the warm equatorial region to the poles. As a result, the density surfaces in a pole-to-pole meridional section would look like a syncline, depressed at the equator where the lowest density water is found, and rising to the surface at higher latitudes. In the Cretaceous the maximum

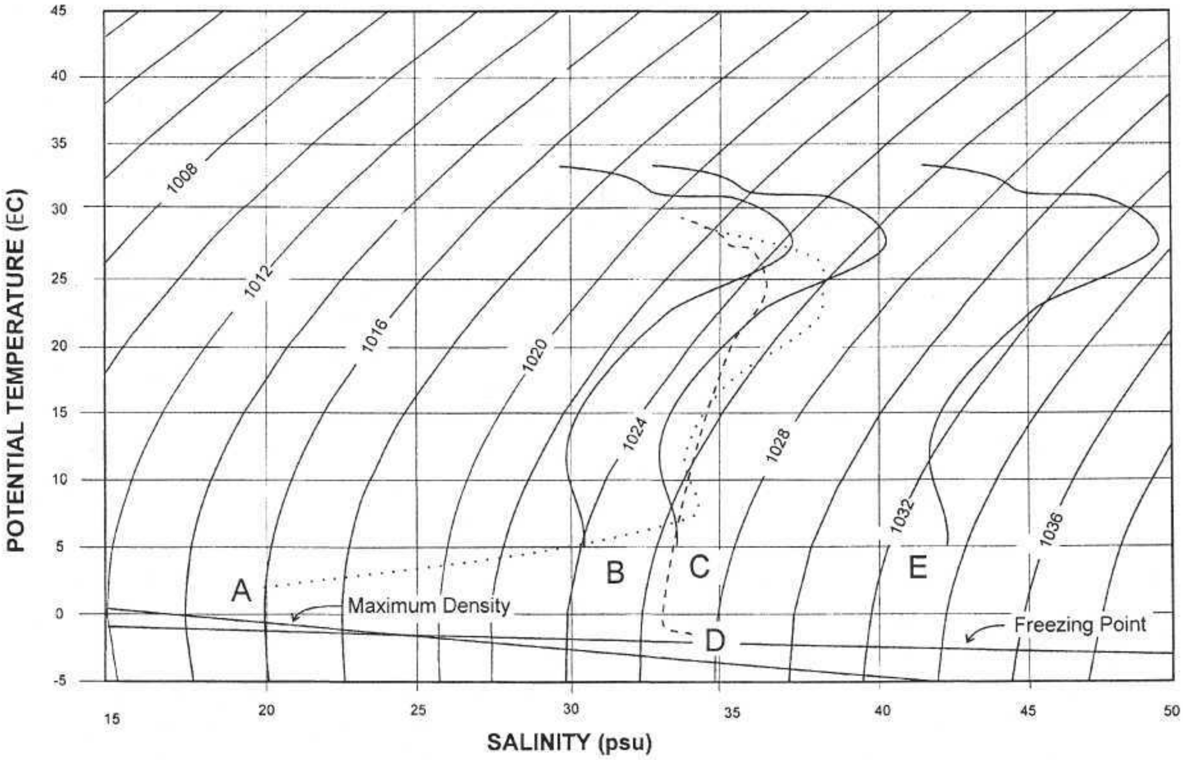

Fig. 1. The differences between modern surface ocean temperatures, salinities, and densities, and those simulated for the Late Cretaceous. The curved lines are densities ($kg.m^{-3}$). Dotted curve A is the average for the surface of the present North Atlantic and Arctic Oceans, and dashed curve D is the average for the surface of the South Pacific. Except for the Arctic Ocean, the densest waters are in the polar regions, with density declining steadily to the equatorial region. Solid curve C represents temperatures and salinities for the South Pacific from the Campanian simulation assuming the average ocean salinity to be 34.8. In the Campanian simulations the densest waters are the high salinity warm waters of the low latitudes and densities decrease toward both the equator and poles. Solid curve E is for the Campanian South Pacific assuming a mean ocean salinity of 43.6. Solid curve B assumes a mean ocean salinity of 32.9. The temperature range in the Campanian simulations is 5 to 34 °C; the present range is -1 to 28 °C. Campanian surface ocean salinity contrasts are significantly greater than present. Fig. 4A shows that outside the South Pacific there are large areas of the simulated Campanian ocean where the maximum density of seawater would be above the freezing point.

densities are in the tropics and in the polar regions. In a pole-to-pole meridional section the density surfaces look like three synclines, with zones of lower density water in the mid-latitudes and along the equator. Any region where surface waters have high density is a potential site of intermediate or deep water formation.

During the Late Jurassic and Early Cretaceous Corg-rich sediments were deposited in many areas of the world. These are now the source rocks of most of the major producing oil fields. The fact that the Corg-rich sediments of the Late Jurassic and Early Cretaceous accumulated when mean ocean salinity was high (>43), before the South Atlantic salt extraction, and that Corg-rich deposits are rare in the Late Cretaceous, when the salinity of ocean waters was much lower leads us to suspect that the behavior of the thermohaline circulation in the Late Jurassic and Early Cretaceous was fundamentally different from that of today. The higher salinities would promote more active thermohaline circulation, and particularly more intensive intermediate water formation. Intermediate water is the has the highest concentrations of nutrients and is the major source of nutrient-rich upwelled water, promoting both the surface high-productivity and subsurface oxygen depletion required for the formation of petroleum source rocks.

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Climatic and oceanographic changes reflected in the palynological record of orbitally induced Late Albian black shale rhythms from Central Italy

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Key words: Albian, paleoceanography, paleoclimatology, orbital cycles, Appenines, central Italy.

Introduction

In general, resistant organic walled dinoflagellate cysts are produced by planktonic representatives at a stage in their life cycle. The distribution of these cysts in the sediment is dependent on environmental factors such as temperature, salinity, nutrient supply and shelfal transport.

The present study aims to recognize climatic and oceanographic patterns reflected in the palynological content of the Late Albian "Amadeus segment" of the Fiume Bosso section in Central Italy (Fig. 1). This pelagic sediment consists of a two meter thick alternation of limestones, marls and black shale layers. Several authors have reported a response to orbital parameters (especially precession and eccentricity) of the carbonate content (Herbert and Fisher, 1986), trace fossil distribution (Erba and Premoli Silva, 1994) and planktic (Premoli Silva et al., 1989) and benthic (Coccioni and Galeotti, 1993) foraminifera. The presence of black shale/marl bundles seems to follow the eccentricity cycle, while the individual black shale layers occur at precession lows (Herbert and Fisher, 1986).

Materials and methods

Thirty-eight samples were collected on a bed to bed scale and processed according to standard palynological procedures. Samples not mentioned in the figures did not contain enough palynomorphs (dinoflagellates, pollen and spores).

Results

The ratio between peridinioid and gonyaulacoid dinoflagellate cysts, a proxy for productivity, is presented in Figure 2. The eccentricity cycles in carbonate content (Herbert and Fisher, 1986) are plotted next to the P(eridinoid)/G(onyaulacoid) curve. The organic productivity responds to larger scale trends rather than the precession cycle. Figure 2 also shows the ratio between continental (pollen and spores) and marine (dinoflagellates) palyno-

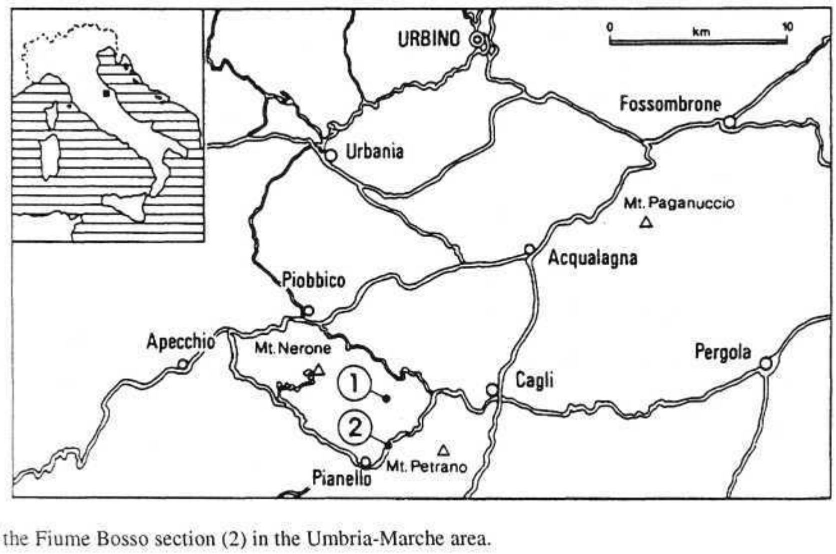

Fig. 1. Location map of the Fiume Bosso section (2) in the Umbria-Marche area.

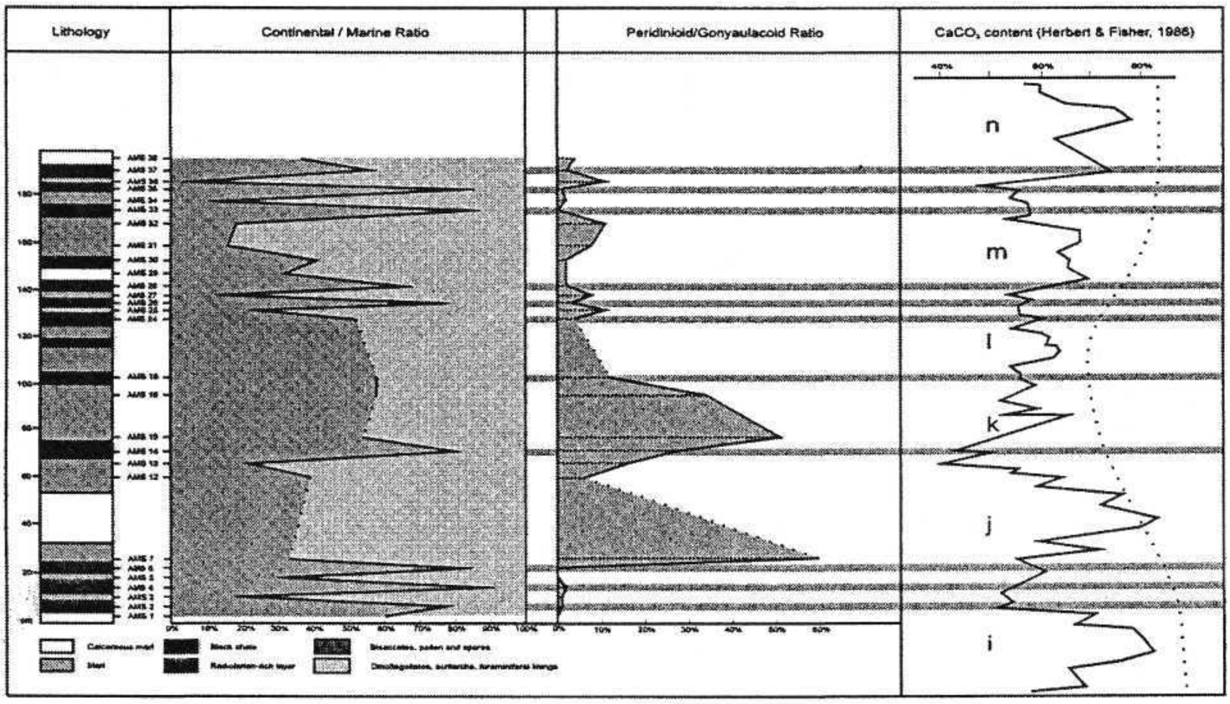

Fig. 2. Relative abundances of continental and marine content, Peridinioid and Gonyaulacoid dinoflagellates (nPeridinioids/nPeridinioids +nGonyaulacoids) in the Amadeus segment of the Fiume Bosso section and the $CaCO_3$ content of the Amadeus segment equivalent in the Piobbico core (Herbert and Fisher, 1986). Dotted outlines indicate barren intervals.

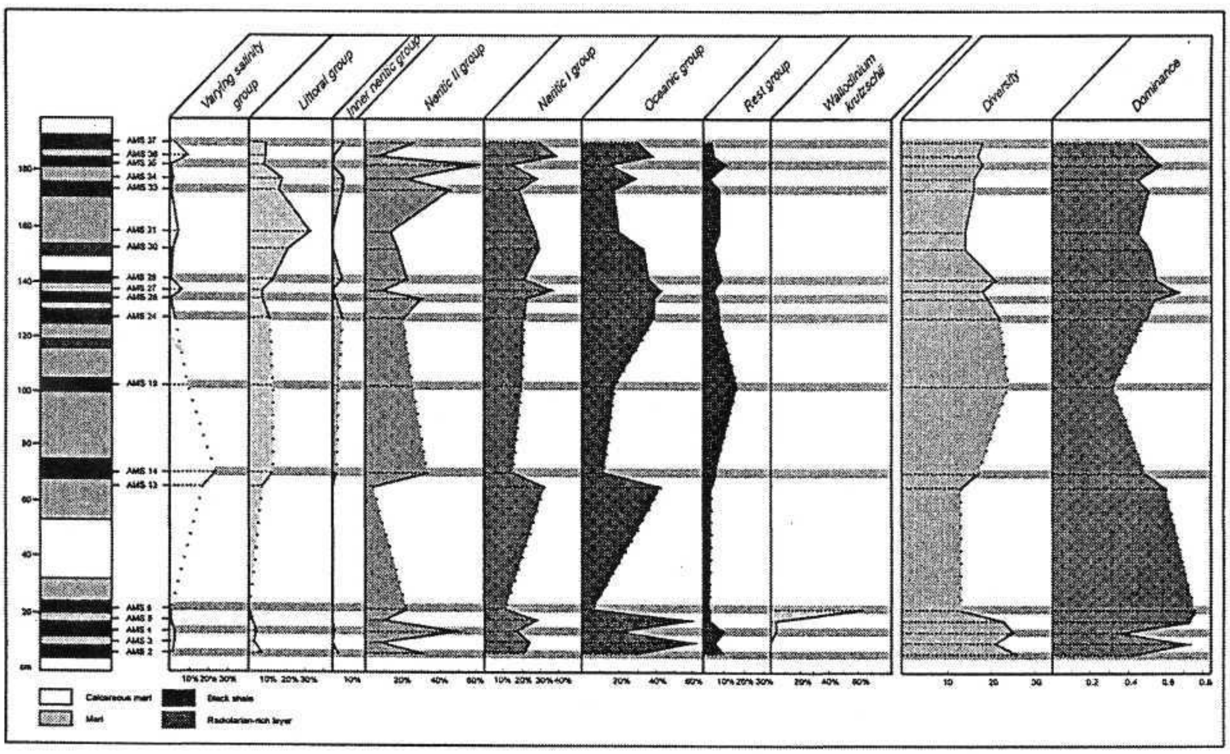

Fig. 3. Relative abundances of paleo-environmental groups of dinoflagellate cysts in the Amadeus segment of the Fiume Bosso section. Dotted outlines indicate barren intervals.

morphs. Fluctuations of this curve on an individual bedding scale, related to the precession cycle, are clearly visible.

The majority of dinoflagellate species live on various places on the shelf. These species were grouped in paleoenvironmental groups (Fig. 3); the Varying Salinity group represents the shallowest marine conditions, the Neritic I group the most basinward paleo-environment. The oceanic group is the only autochtonous group (not transported from the shelf, but living in the oligotrophic pelagic waters). In individual black shale layers higher relative amounts of shelf derived dinocysts occur.

Discussion

Lower productivity in black shale bundles is interpreted as a sign of decreased nutrient supply due to lower circulation and vertical mixing intensity. In these conditions stratification is enhanced by an influx of fresh water (as is indicated by the high continental input in black shale layers) during precession minima. The nutrients flushed in by this increased run-off will expand shelf conditions more basinward, and higher amounts of shelf dwelling dinoflagellates are available to be transported to pelagic areas. In the more open ocean on the other hand, productivity will not increase, since the stratification of the water column prevents an efficient nutrient recycling. Due to this lack of mixing, dysoxic conditions are created in deeper waters, facilitating the storage of organic matter.

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A transect through the Aptian western Tethys Ocean: Palaeoceanography and Palaeoclimate

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Key words: Aptian, palaeoceanography, palaeoclimate, greenhouse model, Mediterranean Tethys

The Aptian is known as a time of volcanogenically induced perturbations of the atmosphere and of climate. Changes in hydrological cycling, in weathering erosion and runoff and changes in paleoceanography are among the expected consequences of changes in atmospheric CO_2 levels. Sediments deposited along the narrow west-east trending alpine Tethys seaway provide us with documents of the climatic and oceanographic changes during the Aptian.

Sediments from a six different Tethyan paleoenvironments are used for the reconstruction of the Aptian climate perturbation and of the reactions of the marine carbon system to climate change: 1. The northern Tethyan mixed siliciclastic-carbonate platform and shelf, 2. the northwestern Tethyan Valais Trough with a hemipelagic sandstone-black shale sequence, 3. the northern Brianconnais region with a pelagic record preserving an equivalent of the globally recognized "Livello Selli", 4. the deep Piemont Ocean with carbonate-free black siliceous shales, 5. the deep pelagic environment of the southern continental margin with the "Livello Selli" and 6. the Adriatic carbonate platform which was not affected by river activity. Stratigraphic correlation between the different paleoceanographic environments was done with biostratigraphic and chemostratigraphic methods.

The Tethyan record indicates how changes in paleoclimate and linked changes in paleoceanography choked carbonate production along river influenced coasts but stimulated phytoplankton blooms in the pelagic environment. Severe growth crises of mixed siliciclastic-carbonate shelves occurred at times of sealevel rise. These crises or platform drowning events coincided with episodes of widespread black shale formation during the Early Aptian. The pronounced Aptian C-isotope excursion records this coupled but contrasting response of the marine organic and carbonate carbon systems to Aptian climate change. Changes in organic carbon burial and changes in the carbonate carbon system both had an influence on the atmospheric CO_2 concentration. Fixation of excessive CO_2 in organic matter and in calciumcarbonate contributed to climate stabilisation up to millions of years after the onset of the perturbation.

Lower/Middle Campanian paleoceanographic event - its record in the Magura Unit (Polish Flysch Carpathians)

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Key words: Late Cretaceous, paleoceanography, flysch sedimentology, anoxy, Western Carpathians, Poland

Black shales and a chert bed, alternating with thin-bedded dark-grey mudstones and sandstones have been found in the Bystrica subunit (Magura unit). Their stratigraphic position (between *Uvigerinammina jankoi* and *Caudammina gigantea* zones) suggests that they can correspond to the lower/middle Campanian palaeoceanographic crisis (LMCE), known from many sections in the Tethyan and Atlantic regions.

The microfauna from these deposits is characterized by exceptionally scarce foraminifers, dominated by pyritized "tubes". Kuhnt et al. (1992) documented LMCE deposits in the North Atlantic which are devoid of benthonic foraminifers, with directly overlying beds are chracterized by low-diversity agglutinated tubular forms and ammodiscidae. In the Tethyan pelagic realm, the LMCE is characterized by occurrence of biosiliceous facies (e.g., Neagu, 1968; Butt, 1981). It coincides with a taxonomic change in agglutinated foraminifers, where *U. jankoi* assemblage is replaced by a *C. gigantea* assemblage in flysch series (Kuhnt et al., 1992).

Although the changes in agglutinated assemblages were well documented from the Upper Cretaceous and Paleogene West Carpathian flysch facies (Jurkiewicz, 1961; Geroch and Nowak, 1984; Geroch and Koszarski, 1988), the LMCE deposits in this facies complex have not been recorded yet.

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The Tethyan/Boreal Problem as the result of paleobiogeographical changes: Early Cretaceous examples from the Russian Platform

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Key words: Early Cretaceous, paleobiogeography, interregional correlation, East European, Platform, Russia

The Russian Platform (RP) is relatively hard block of the Earth crust. It responded on the outer stress conditions by changes in its relief and therefore in the shape of sea basin existed on the RP and its paleogeography. The investigation of that phenomenon includes 4 main aspects: (1) the working out of the fine biostratigraphical scale; (2) paleogeographic modelling of the RP history; (3) Boreal/Tethyan fauna distribution analysis (mainly ammonites) and (4) paleotectonic reconstructions.

The basement of the RP is heterogenous. It determined the position and the development of the different troughs, depressions and syneclines during the Cretaceous (Milanovsky, 1987). The main outer stress affected on the development and paleogeograohical changes in the RP was the collision between the Arabia and the Scythian Platform (Nikishin et al., in press).

Stratigraphy

The most important works on the Lower Cretaceous of RP were published by S. N. Nikitin, A. P. Pavlow, N. A. Bogoslowsky, I. G. Sasonova, A. E. Glasunova, M. S. Mesezhnikov and many, many others. Some new data on the Aptian and Albian were published by the author (Baraboshkin, 1996; Baraboshkin in press; etc.). Due to reinvestigation of ammonite collections and outcrops from Moscow Syneclise, Simbirsk - Saratov Syneclise, Rjasan-Saratov Trough and Peri-Caspian Syneclise, comparison with ammonite data from other region, the following biostratigraphical scheme (for central parts of RP) is offered.

In general, the scheme includes many international (Hoedemaeker et al., 1993) zones from both Boreal and Tethyan scale, because of great mixing of Boreal (prevailed) and Tethyan faunas in this region. Some subdivisions based on the fauna were distinguished mainly for Peri-Caspian area.

Paleogeography and paleobiogeography

The most complete data one can find in the monography of Sasonova and Sasonov (1967). However, those data are very old and have to be corrected in many cases. There were several stages in Early Cretaceous RP development according to the new data, published partially (see the figure):

1. Early Berriasian. Depend of the point of view in determination Jurassic/ Cretaceous (Volgian/Berriasian) boundary, there are several different ways to reconstruct paleogeography of RP:

a) Absence of Lower Berriasian sediments or presence of their continental analogues,

b) Shallow water coarse-grained sedimentation with phosphogenesis and small hiatuses or partially continental and fresh - water sedimentation.

According to the recent publications of Sei and Kalacheva (1997), the Upper Volgian should be correlated with the Lower Berriasian. The interval does not considered in the present paper because of the absence of the new reliable data in those long-time discussion.

2. Late Berriasian is characterized by the shallow sea to continental conditions and strong influence of Tethyan faunas in the beginning, when representatives of family *Berriasellidae* (Riasanites, *Transcaspiites*) penetrated from Caucasus and Transcaspia through RP to the Poland and probably, even to the Spitsbergen (Ershova and Korchinskaya, 1980). Boreal fauna was less distributed in the beginning of the Substage (*Hectoroceras, Surites,* etc.). It occupied the RP area completely during latest Berriasian.

3. Early Valanginian. Shallow sea to continental conditions environments existed over the RP. The Basin had a submeridional configuration, but the fauna was only Boreal (*Temnoptychites,* etc.) and crossed the RP up to Mangyshlak region.

4. Late Valanginian is characterizied by the appearance

of the latitudinal sea-connection and the Dichotomites fauna distribution. Only in Peri-Caspian findings of Tethyan *Neohoploceras* (?) are known (Gordeev, 1971).

5. Early Hauterivian. Continental environments and non-deposition took place. The existence of marine sediments and the presence of Lower Hauterivian fauna is supported only for the northern part of the RP, where *Homolsomites* were found.

6. Late Hauterivian. Shallow sea conditions, which were locally accompanied by anoxic events (Ulianovsk-Saratov and Peri-Caspian Syneclise).The ammonite assemblage is the same that in England (Rawson, 1971), Germany, Spitsbergen (Ershova, 1983). Boreal ammonites penetrated from Poland and Spitsbergen through the RP to the south, up to the Northern Caucasus and Crimea, where mixed (*Speetoniceras, Milanowskia* and *Craspedodiscus* together with *Pseudothurmannia*) assemblages are known (Baraboshkin, 1997, in press).

7. Barremian. Shallow water and continental condition with poor bivalve assemblages and belemnites *Oxyteuthis* (Baraboshkin, in press). Probably, the fauna was killed by water freshening. All of the mentioned Tethyan ammonites mentioned in the literature have not supported by the recent data. All the other fauna (bivalves, belemnites) supports Boreal assemblages.

8. Early Aptian ammonite assemblages (*Tropaeum, Deshayesites, Sanmartinoceras,* etc.) shows equal conditions in the RP, to the North (Spitsbergen, Ershova, 1983) and to the South (N. Caucasus, Crimea, Middle Asia, Mediterranean, etc.) with the fauna of European type. The expanded shallow sea conditions with areal anoxia (the North-East of RP) existed in the meridional Basin (Baraboshkin in press).

9. The Basin was considerably restricted to the North in the Middle Aptian. The presence of *Epicheloniceras* and

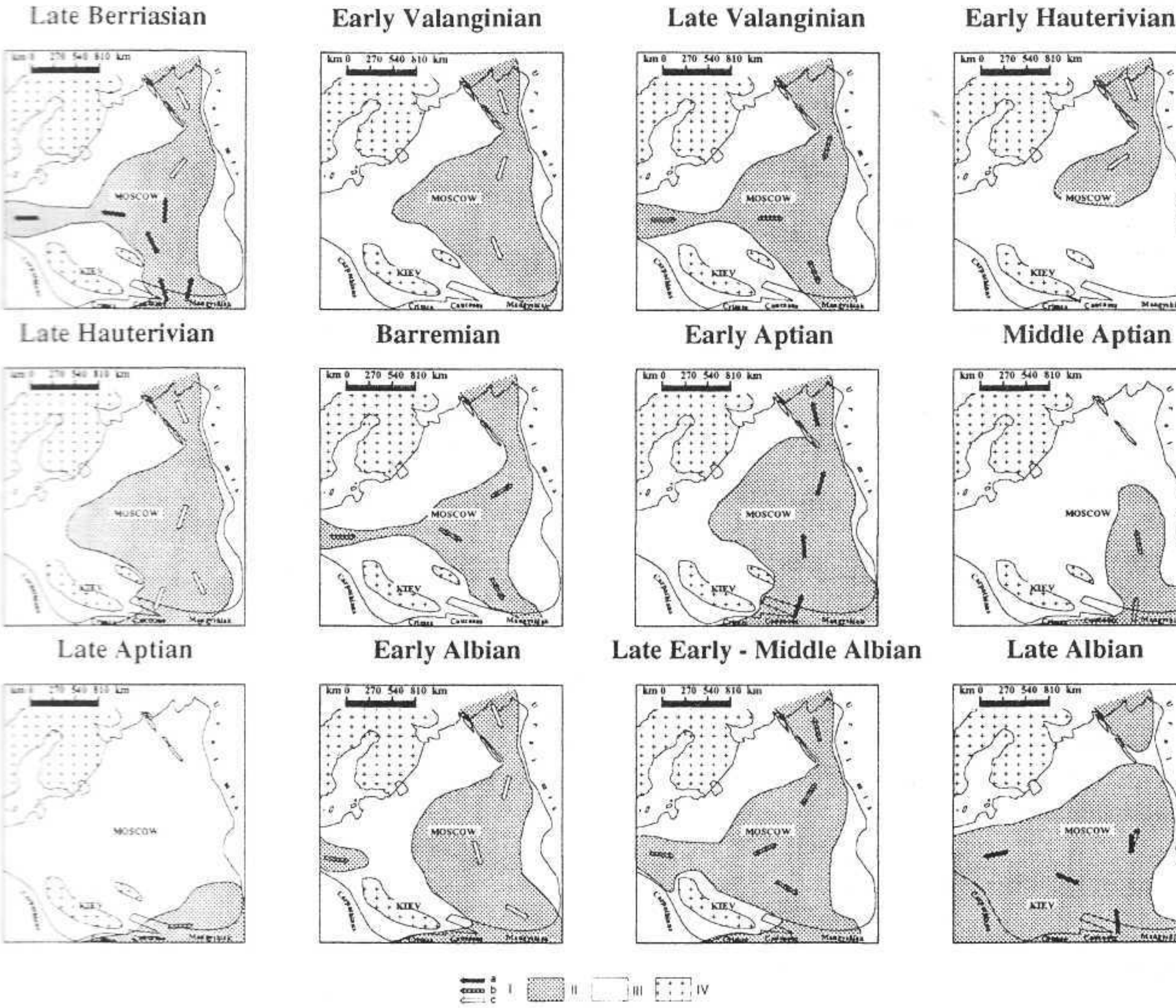

Fig. 1. Early Cretaceous development of the Russian Platform and faunal migration routes. Legend: I - direction of fauna migration (arrows), a - from Tethyan Realm; b - from European Basin; c - from Boreal Realm; II - sea; III - land; IV - shields in the recent structure.

Parahoplites indicates the water conditions similar to the European ones.

10. Nearshore and continental environments prevailed in the RP during the Late Aptian. That is why ammonites *Acanthohoplites* and *Hypacanthoplites* are known only from Peri-Caspian area.

11. Early Albian was characterized by near-shore, deltaic and shallow marine conditions. There were Boreal faunas with *Arcthoplites, Cymahoplites* and *Anadesmoceras* existed here. They migrated southward (Baraboshkin, 1996) from the Spitsbergen area (Nagy, 1970). The boundary between Tethyan/Boreal assemblages run through the Peri - Caspian area.

12. Shallow water expanded. The environments of intensive phosphatogenesis with numerous hiatuses took place during the late Early Albian to Middle Albian. The ways of ammonite migration passed from west and from the south and to the north of RP (Baraboshkin, 1996) and similar assemblages existed in Spitsbergen (Nagy, 1970; Ershova, 1983), Mangyshlak (Mikhailova and Saveliev, 1989), Poland (Marcinowski and Wiedmann, 1990). The fauna was of the European type (*Hoplites, Anahoplites,* etc.: Baraboshkin, 1996).

13. Upper Albian. Shallow water sea spread almost the whole RP, anoxic conditions prevailed in this time. In the late Albian RP basin isolated from Boreal basin and typically European (*Callihoplites*) and Tethyan (*Mortoniceras*) fauna spread over RP (Baraboshkin, 1996).

Acknowledgements: I wish to acknowledge IGCP 362, the Peri-Tethys Programme, INTAS (Grant No.94-1805) and RBSF Foundation (Grant No.95-07-1915, 97-05-65-567) for financial support of investigations.

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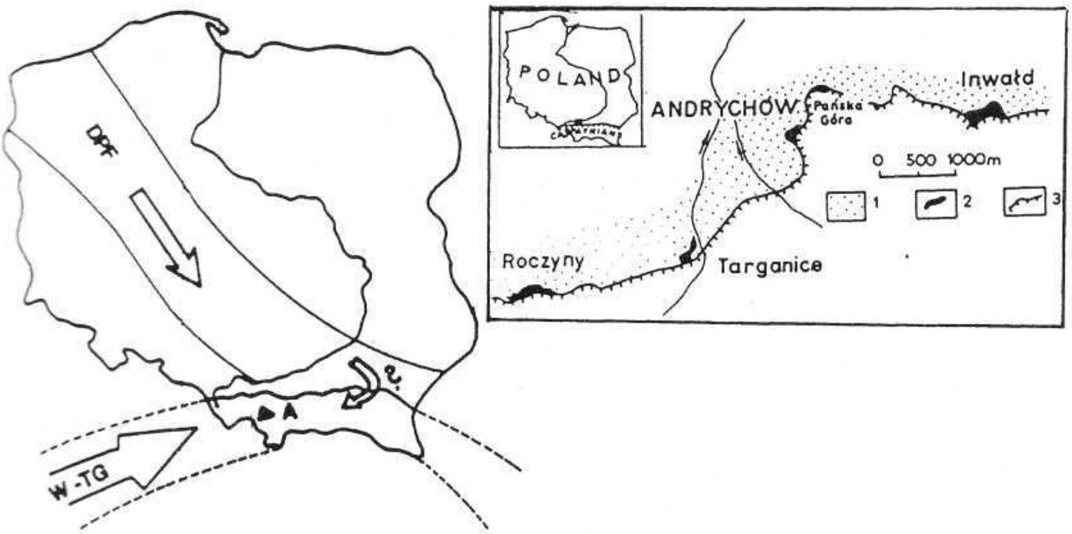

Fig. 1

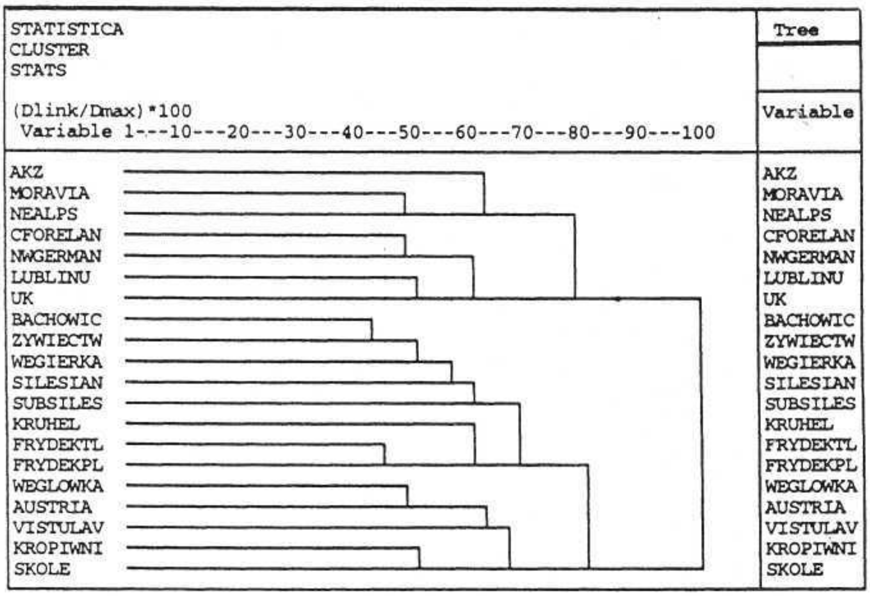

Fig. 2

early Neogene clockwise rotation of the Inner Carpathians, respective to the Outer Carpathians, caused the long distance transportation of the AKZ complex from the West.

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Mineralia Slovaca, 29 (1997), 256 - 258

Possible Boreal faunal immigration of the Lower Cretaceous ammonites into Outer Western Carpathians related to the global sea level changes

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Key words: Lower Cretaceous, palaeobiogeography, ammonites, Western Carpathians, Czech Republic, Slovak Republic

Lower Cretaceous ammonites occur in two structural units of the western Outer Carpathians in more substantial quantity: in the Silesian Unit and in the Pieniny Klippen Belt (PKB) only. The occurrences of imperfectly preserved specimens in the Silesian Unit are restricted on to dark coloured lime - claey pelites with pelosiderite concretions. The findings derived from the PKB area come from pale marly calcareous deposits. Due to small resistence against the weathering, or, respectively, due to strong tectonic reworking, continuous sections necessary for any detailed study are practically missing in these areas. Therefore, the ammonite successions must have been reconstrued according to composition of the faunas in individual localities, knowledge of geologic structure of the territory, and correlated with the data from literature (see Vašíček et al., 1994).

We summarized the distribution of ammonite species collected in the area studied into scheme of Early Cretaceous ammonite zones (Hoedemaeker, Company et al., 1993; Bulot and Thieuloy, 1995; Atrops and Reboulet, 1995; Hoedemaeker, 1995; Reboulet, 1995, etc.) combined with eustatic level curve (Vail et al., 1991; Hoedemaeker, 1995).

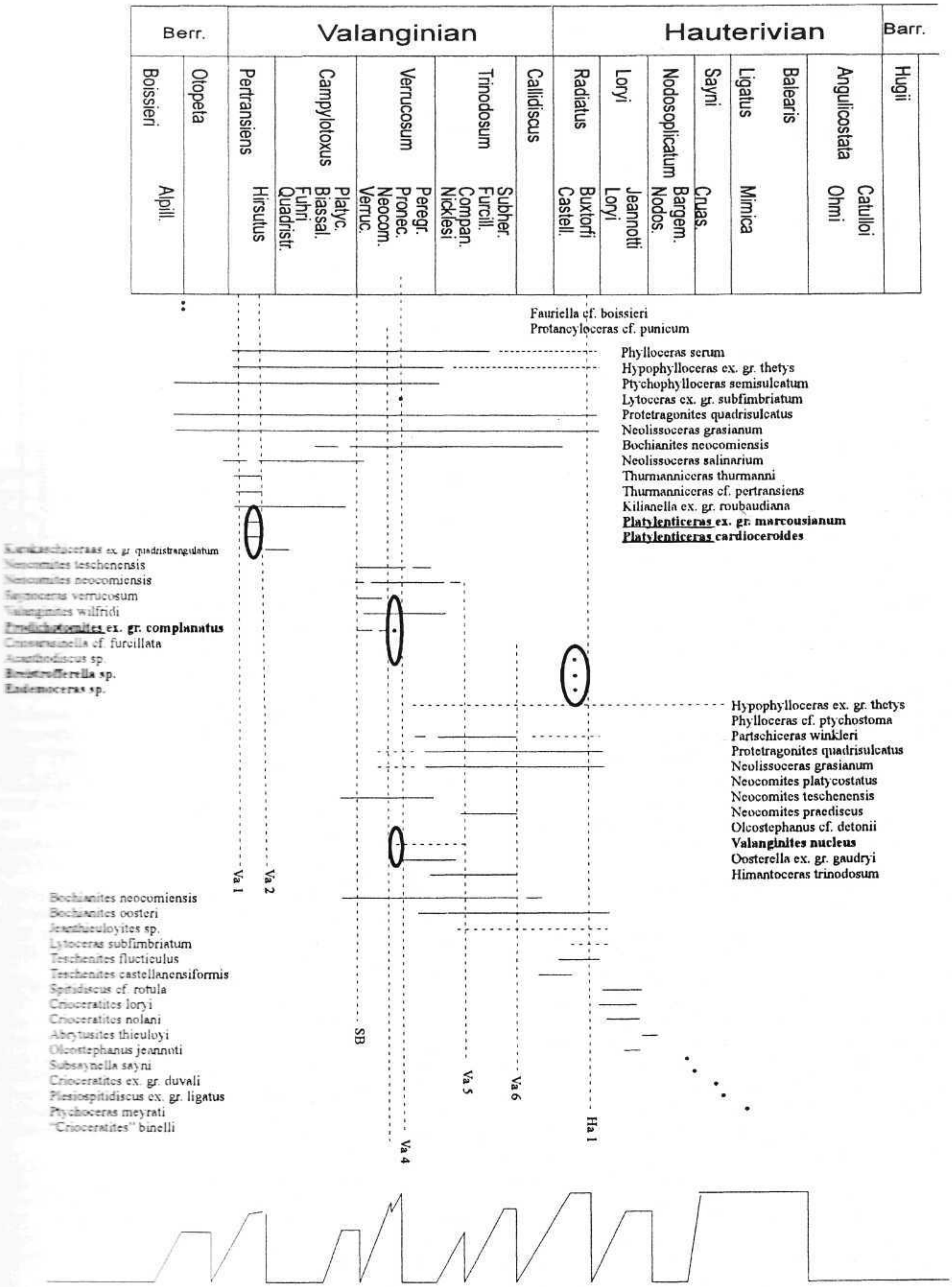
The species indicated in the left side of the figure came from the uppermost Berriasian to the lowermost Hauterivian slope (resp. rise) Baška facies. The right side comprises the upper Valanginian to the lower Hauterivian PKB biofacies. Despite of considerable diversity of the Barremian - lower Aptian ammonite fauna of the Godula Basin, the scarcity of index species in it hampers the creation of any species distribution chart of this time interval.

Although certain inpreciseness can be supposed in the presented ammonite occurrence span diagram, there is evident that several apparent high diversity sections alternate with the small diversity intervals. The first high diversity interval is equivalent to the basal Valanginian *Pertransiens* ammonite biozone. This interval, roughly synchroneous with the Va- 1 highstand of the sequence stratigraphic scale, yielded (with the exception of the Mediterranean faunal elements) also *Platylenticeras,* which occurs both in the Boreal and Mediterranean Realm. The genus is represented both in rise (Baška) and basinal (Godula) developments of the Silesian Unit (no Early Valanginian ammonites have been found in the PKB until now, yet).

The second high diversity interval is indentical to the basal Late Valanginian *Verrucosum* Zone, equivalent to the Va - 3 highstand preceeding the extensive Va - 4 shallowing. Rich Mediterranean ammonite association is accompanied here by Boreal *Prodichotomites* ex gr. *complanatus* and cosmopolitic representatives of *Valanginites*. Interestingly, the Boreal species mentioned has been found in the rise Baška development (only one specimen has been reported in the PKB Ridge), but never in the basinal Godula development of the Silesian Unit. The high diversity ammonite fauna appears also in the successive *Trinodosum* Zone (Va - 4 highstand) in the PKB area. Late Valanginian *Campylotoxus* and *Callidiscus* Zones are evidenced by poor ammonite faunal associations only.

Early Hauterivian *Radiatus* and *Loryi* Zones are evidenced in the PKB by pure Mediterranean fauna (the lower zone also in the Baška development of the Silesian Unit). Despite of this, the diversity of ammonites (with the occurrence of possible Boreal *Endemoceras*) peaked during highstand preceeding the Ha-1 sequence boundary. The highest Early Hauterivian Nodosoplicatum Zone has not been proved in continuous sections neither in the Godula development of the Silesian Unit, nor in the PKB area. Although the Late Hauterivian ammonite fauna is poorly diversifed, it contains several index species (*Subsaynella sayni, Plesiospitidiscus* ex gr. *ligatus, "Crioceratites" binelli,* etc.), indicating *Sayni-, Ligatus-* and *Balearis* Zones. The topmost Hauterivian (the *Angulicostata* Zone) has not been proved yet.

Purely Mediterranean Barremian and Early Aptian ammonite fauna is very abundant in the basinal Godula development of the Silesian Unit. However, continuous sections are not at disposal, and, moreover, index species absent here. Siliciclastic Upper Aptian sequence does not contains any ammonites more.


Berr.
Valanginian
Hauterivian
Barr.
Boissieri
Alpill.
Otopeta
Pertransiens
Hirsutus
Campylotoxus
Platyc.
Biassal.
Fuhri
Quadristr.
Verrucosum
Peregr.
Pronec.
Neocom.
Verruc.
Trinodosum
Subher.
Furcill.
Compan.
Nicklesi
Callidiscus
Radiatus
Buxtorfi
Castell.
Loryi
Jeannotti
Loryi
Nodosoplicatum
Bargem.
Nodos.
Sayni
Cruas.
Ligatus
Mimica
Balearis
Angulicostata
Catulloi
Ohmi
Hugii
Fauriella cf. boissieri
Protancyloceras cf. punicum
Phylloceras serum
Hypophylloceras ex. gr. thetys
Ptychophylloceras semisulcatum
Lytoceras ex. gr. subfimbriatum
Protetragonites quadrisulcatus
Neolissoceras grasianum
Bochianites neocomiensis
Neolissoceras salinarium
Thurmanniceras thurmanni
Thurmanniceras cf. pertransiens
Kilianella ex. gr. roubaudiana
Platylenticeras ex. gr. marcousianum
Platylenticeras cardioceroides
ex. gr. quadristrangulatum
teschenensis
neocomiensis
verrucosum
wilfridi
ex. gr. complanatus
cf. furcillata
sp.
sp.
sp.
Hypophylloceras ex. gr. thetys
Phylloceras cf. ptychostoma
Partschiceras winkleri
Protetragonites quadrisulcatus
Neolissoceras grasianum
Neocomites platycostatus
Neocomites teschenensis
Neocomites praediscus
Olcostephanus cf. detonii
Valanginites nucleus
Oosterella ex. gr. gaudryi
Himantoceras trinodosum
Va 1
Va 2
Bochianites neocomiensis
Bochianites oosteri
Jeanthieuloyites sp.
Lytoceras subfimbriatum
Teschenites flucticulus
Teschenites castellanensiformis
Spitidiscus cf. rotula
Crioceratites loryi
Crioceratites nolani
Abrytusites thieuloyi
Olcostephanus jeannoti
Subsaynella sayni
Crioceratites ex. gr. duvali
Plesiospitidiscus ex. gr. ligatus
Ptychoceras meyrati
"Crioceratites" binelli
SB
Va 5
Va 6
Ha 1
Va 4

S. discofalcatus	Ps. catulloi Ps. ohmi				ANGULICOSTATUS	U. Hauterivian
S. gottschei					BALEARIS	
S. staffi	Su. mimica	LIGATUS			LIGATUS	
	Cu. cruasense	SAYNI			SAYNI	
S. inversum	Ol. variegatus	NODOSOPLICATUM	L. bargemensis L. nodosoplicatum		NODOSOPLICATUM	L. Hauteriv.
En. regale En. noricum	Ol. jeannoti C. loryi	LORYI	Ol. jeannoti C. loryi		LORYI	
En. amblygonium El. paucinodum	L. buxtorfi B. castellanensis	RADIATUS			RADIATUS	
D. tuberculata	T. callidiscus	CALLIDISCUS			CALLIDISCUS	Upper Valanginian
Di. bidichotomoides Di. triptychoides Di. crassus	Cr. furcillata Ol. nicklesi	TRINODOSUM	Cr. subheterocostata Cr. furcillata Ka. companyi Ol. nicklesi		TRINODOSUM	
Pr. polytomus Pr. holwedensis	V. peregrinus Ka. pronecostatum Sa. verrucosum	VERRUCOSUM	V. peregrinus Ka. pronecostatum N. neocomiensis Sa. verrucosum		VERRUCOSUM	
		INOSTRANZEWI	N. platycostatus		CAMPYLOTOXUS	Low. Valanginian
Po. hapkei Po. clarkei Po. multicostatus Po. pavlovi	Bu. campylotoxus Bu. subcampylotoxus Ba. hirsutus	STEPHANOPHORUS	Ka. biassalensis Sa. fuhri Ka. quadristrangulatum Ba. hirsutus			
Pl. involutum Pl. heteropleurum Pl. robustum		PERTRANSIENS		E	PERTRANSIENS	
	K. thieuloyi Ti. otopeta	OTOPETA	Ti. otopeta		OTOPETA	
		ALPILLENSIS	Ti. alpillensis Pi. picteti	D_3	BOISSIERI	Berrias.p.p.
Mutterlose 1996 Rawson 1995	Bulot & Thieuloy 1995		Atrops & Reboulet 1995	D_2	Hoedemaeker, Company et al. 1993	

High ammonite diversity intervals well correspond with sea level fluctuations and with data from the Danian - Polish Trough (Witkowski, 1969; Kutek et al., 1989; Marek, 1989, 1997), which represented the seaway connecting the Boreal with the Tethys marginal seas (represented by the Silesian Unit of the Outer Carpathians today). Co-occurrences of both Boreal and Mediterranean ammonites in the *Pertransiens* and *Verrucosum* (probably also in the *Radiatus*) Zones in the Silesian Unit answer to high sea level stands and to the normal sea regime intervals in the Danian - Polish Trough. Shallowings correspond to the low species diversity in the Silesian unit. Long termed Late Hauterivian - Early Albian shallowing interrupted any connection with the Boreal. Pure Mediterranean ammonite fauna with endemic elements characterizes the Silesian Unit, the important index groups like pulchelliids, colchiditids, *Spitidiscus, Holcodiscus, Hemihoplites, Deshayesites*, etc. being underrepresented or missing at all. On the other hand, the rarity of Barremian and Early Aptian ammonite occurrences in the PKB prevent more detailed paleogeographic conclusions.

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Mineralia Slovaca, 29 (1997), 259 - 261

The Boreal equivalents of teh Berriasian and Valanginian stages

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Key words: Berriasian, Valanginian, ammonite zonation, stratigraphy, interregional correlation, Boreal, Siberia

Introduction

Boreal Berriasian (BB) and Boreal Valanginian (BV) are generally considered to be the time analogue of the Mediterranean Berriasian and Valanginian. The Boreal fauna is known to cover the vast territories north of the 50th latitude, occasionally invading as far as the 40th latitude along the coast of the Pacific. Thus the BB and BV are known in the northern hemisphere in Europe, Asia, Northern America and Arctic islands. The biostratigraphic range of BB is determined by the presence of the following ammonite genera: *Praetollia, Pachypraetollia, Hectoroceras, Borealites, Praesurites, Surites, Bojarkia, Tollia, Pronjaites, (?)Lynnia, Peregrinoceras.* Additionally, for the Lower Berriasian, there are other typical genera: *Chetaites, Externiceras, Schulginites, Garniericeras. Craspedites, Subcraspedites.* The BV is defined as a whole by the presence of genera *Neotollia, Temnoptychites, Selandites, Propolyptychites, Euryptychites, Siberites, Polyptychites* (with subgenera: *Polyptychites, Paleodichotomites, Dichotomites*). However, there is no direct zonal correlation established between Berriasian and Valanginian sediments of the Boreal and Mediterranian realms, a problem which stems from the profound differences in the faunas. This problem is mainly caused by faunal disparity between areas as a result of climatic differences and geographic isolation. As a result, the stratigraphical ranges of BB and BV have been redetermined several times during the last century.

Choice of the standard sections of the BB and BV

In order to conduct the stratigraphic work more effectively throughout the entire Boreal territory we should select a standard section of the BB and BV. No sections of the BB have been found in continental Europe that satisfy the requirements for stratotype status. It has already been shown the Ryazanian Stage is not an appropriate time equivalent of the BB, and additionally, this stage is stratigraphically incomplete. Erosional surface and significant stratigraphic hiatuses characterize the lower and upper contacts of the Ryazanian interval everywhere on the Russian Platform, including the Oka River sections, and a further hiatus is postulated within this Stage (in sense of Bodylevsky, 1956; Saks and Shulgina, 1973). Thus, we conclude that the Ryazanian Stage of the Russian Platform can not be selected as a standard for BB. Instead, we propose to select as a standard the North Siberian section, which is stratigraphically complete and is thus not prone to the flaws we described for the Ryazanian interval on the Russian Platform. This section is located in northern Siberia on the Laptev Sea coast, Nordvik Peninsula. The section is excellently exposed in the sea cliffs and consists of black shales of deep water facies belonging to the central part of the north Siberian marine basin. These facies constrain the entire sequence from the Upper Volgian to the Lower Valanginian Substage. The section has a continuous succession of ammonites, Buchias, foram and dinocist zones from the top of Middle Volgian Substage to that of the Lower Valanginian. In summary, this section is the best choice for a BB stratotype because: 1) has being deposited in deep marine conditions it is stratigraphically complete, 2) the abundant fauna provides very detailed and reliable age determinations.

References to the sections of Lower Saxonia (Germany) as boreal equivalents of Valanginian are very common in west-European literature. Perhaps unsurprisingly so, since the zonation of part of the Lower Valanginian, and most of the Upper Valanginian in these sections is based on ammonites of the family Polyptychitidae. However, the whole Saxonian sequence of ammonite zones cannot be accepted as the Valanginian Boreal Standard (BV), because: 1) At the top and base of the sections, the zones are defined by the Tethyan genera *Platylenticeras* and *Dicostella;* 2) It is difficult to correlate this section with other sections of the vast Arctic area, because ammonites of the family *Craspeditidae* are absent in Saxonia; 3) The base of the Saxonian sections is non-marine. Almost all equivalents of the Siberian zones may be found in northern Canada, but in the latter, there are no continuous sections. Additionally, there is no continuity between most of the zones, including those chosen to mark the boundaries with the Boreal Hauterivian and the BB. In East Greenland the sections of the BV show a full stratigraphic thickness, but there are no continuous sections or clear zonal subdivision. The Russian Platform comprises both Upper and Lower substages with their zonal subdivision, but again there are no continuous sections, and the zones are contracted in extent and somewhat lens-shaped. Moreover, the section shows many sedimentary gaps. The section of the BV in the Subpolar Urals (Yatria River) is very important: a rather complete sequence of ammonite zones is described from here, and BV is present in continuous section with both boundaries being complete. Unfortunately, the section is relatively unfossiliferous (for ammonites and Buchias), especially in comparison with the Siberian sections. In contrast, the BV section in northern Siberia (Boyarka River) is more suitable for the standard, because the sequence of ammonite and buchia zones is more complete than anywhere else, and the section is well exposed with optimum thickness (about 130 m). This section must be proposed to the International Subcomission on the Cretaceous System as the Boreal Standard.

Description of the proposed standards

The BB section is exposed along the Laptev Sea coast. The total thickness of the succession is 31 m. The sediments are characterized by alternation of dark brown mudstones and bluish-grey condensed clays. There is no evidence of significant post-depositional diagenesis, weathering, tectonic overthrusting, or nearby volcanic heating, although the sediments are slightly fractured. An iridium anomaly is detected in the five-centimeter thick layer of phosphatic limestone at the Jurassic/Cretaceous boundary. Clay mineralogy and geochemistry have been well studied. The following ammonite zones comprise the Upper Volgian Substage: *Craspedites okensis* (4.7 m thick), *C. taimyrensis* (4.2 m), *Chetaites chetae* (1.2 m); the BB includes the zones: *Praetollia maincy* (0.5 m), *Chetaites sibiricus* (3.5 m), *Hectoroceras kochi* (8.7 m), *Surites analogus* (4.7 m), *Bojarka mesezhnikowi* (18.5 m); BV: *Neotollia klimovskiensis* (14.1 m), *Propolyptychites* quadrifidus (37.8 m). The *Hectoroceras kochi* and *Surites analogus* Zones in Kheta River section (onshore, shallow water facies) have been subdivided into 3 and 2 subzones respectively. Most of these ammonite zones are widespread in north Eurasia from the Anabar River Basin in north Siberia to Greenland in the western hemisphere. The section also contains a complete *Buchia* succession: Buchia unschensis (Jurassic/Cretaceous boundary beds), *B. okensis, B. jasikovi, B. tolmatsschowi, B. inflata* (BB/Boreal Valanginian transition beds). A similar succession of *Buchia* zones is determined elsewhere in Boreal realm and in some Pery-Tethyan regions (e. g. in Northern California, USA). Thus, Buchias are one of the most important group of fauna for correlation of Boreal and Tethyan sections.

The proposed BV standard crops out along the banks of the Boyarka River, Kheta River Basin, north Eastern Siberia. The section's lower boundary with the BB is unexposed (basal part of the Neotollia klimovskiensis Zone only), whilst the upper boundary with the Boreal Hauterivian is well exposed and apparently complete: in between, a full sequence of ammonite and *Buchia* zones is displayed. The section consists of alternate layers of fine-grained sands, silts and clays with a total thickness of approximately 130 m. Sands prevail in the lower part of the section, whilst silts and clays are dominant in the upper part. 70 beds united in 7 cycles (3rd and 4th order depositional cycles = sequences and parasequences) have been recognized in the section. The following ammonite zones been established here: Lower BV - Klimovskiensis Zone (54.8 m), Quadrifidus and Astieriptychus Zones (12.3 m), Ramulicosta Zone (34 m), Ramulicosta Subzone (26.3 m), Beani Subzone (7.7 m); Upper BV - Bidichotomus Zone (25.3 m), Triplodiptychus Subzone (2.5 m), Bidichotomoides Subzone (16.1 m), Kotschetkovi Subzone (6.7 m).

The BB and BV boundaries and the pan-Boreal correlation

At the present time, the BB lower boundary is tentatively established by the first appearance of the genus *Praetollia* (cf. Zakharov, 1995). Different species of this genus are reported to be found along both sides of the northern Atlantic: in Greenland, England, Svalbard Island, Franz Joseph Land, Arctic Canada; and in northern Russia, in the Pechora River Basin, the sub-Arctic Urals, and in western and eastern Siberia. The *Praetollia maincy* Zone base is placed in the middle of the *Buchia unschensis* Zone at the Hypostatotype section of the BB in north Siberia. The position of the upper boundary of the BB is also uncertain. Currently, the last layers containing ammonites of the family *Suritidae* are assigned to the uppermost Berriasian, whilst the base of the boreal Valanginian is recognized by the first appearance of the genus *Temnoptychites*. On the Russian Platform, Greenland, and England the lowermost Berriasian is assigned to the *Peregrinoceras* spp. Zone. Layers containing *Tollia tolli* and other species of this genus are found in northern Siberia and Northern America, and they are included into BB because layers containing *Temnoptychites* overlay *Tollia* beds, although previously layers containing *Tollia* were assigned to the lowermost Valanginian. Because *Tollia* layers are traceable throughout the entire Boreal realm, they are useful reference horizons. The BB is terminated with *Bojarkia* spp. Zones in north Siberia, the Subpolar Ural, and in Canada, and with the Zones of *Peregrinoceras* spp. in England, east Greenland, and on the Russian Plain.

The BV lower boundary is drawn at the base of the *Neotollia klimovskiensis* Zone, at the appearance of the nominative species and the genus *Temnoptychites*. The upper boundary is drawn at the level of appearance of the boreal species *Homolsomites bojarkensis*, and coincides with the disappearance of ammonites belonging to the family Polyptychitidae. The lower boundary of upper substage is drawn at the base of *Polyptychites (Paleodichotomites)* and *Polyptychites (Dichotomites)* beds. Pan-Boreal zonal correlation is not generally recognized, but nevertheless workable at the substage level, and to some extent at zonal level in the Lower Valanginian. Reliable sections in North Siberia can be correlated with those of the Valanginian of West Siberia, the Subpolar Urals, the northern and central Russian Platform, north-eastern Greenland, Arctic Canada and the Arctic islands. There are also some marker-levels that allow correlation of Siberian sections with those of the Peritethyan region, in Northern California (USA), and Lower Saxony (Germany).

The problem of the Boreal - Tethyan correlation

The most complicated problem is the infrazonal correlation of the Tethyan Berriasian Stage and the BB. It is well known that there is no direct correlation between the Boreal realm and Mediterranean area for the interval of time spanning the Upper Volgian Substage to the lowermost Valanginian. Both the Volgian-Tithonian and BB-Berriasian intervals typically contain different taxa in the two realms, making it impossible to conduct any direct correlation (*Riasanites* and *Euthymiceras* are not effective for infrazonal correlation). Neither is there a generally accepted point of view about the Boreal-Tethyan correlation of the Jurassic-Cretaceous boundary. However, there are two dominating approaches: most paleontologists assume that the base of the Boreal *Praetollia* genozone coincides with that of the Mediterranian *Berriasella grandis* Subzone. However, it is also possible that the base of the BB should coincide with the base of the *Fauriella boissieri* Zone. Similarly, it is possible that the top of the Upper Tithonian is isochronous with that of the Middle Volgian Substage. Nevertheless, it does not mean that the base of the Berriasian and Upper Volgian Substage is also isochronous. If we accept correlation of Upper Tithonian with Middle Volgian, the lower boundary of the BB *Praetollia* Zone would correspond to the lower boundary of the Mediterranean *Tirnovella occitanica* Zone.

The Boreal-Tethyan correlation of the BV is somewhat less problematic than that of the BB. A reliable Boreal-Tethyan correlative level occurs at the base of the Boreal Valanginian, owing to joint finds of *Platylenticeras* and *Propolyptychites* genera in the lowermost Lower Valanginian of north-west Germany (Lower Saxonian Basin) and northern Siberia. We consider the first appearance of the *Polyptychitinae* in these two areas to be isochronous. Therefore, we can correlate the North Siberian *Propolyptychites quadrifidus* Zone with the standard *Thurmanniceras pertransiensis* Zone. Additionally, the basal Boreal Valanginian *Neotollia klimovskiensis* Zone has been correlated with the *Thurmanniceras otopeta* standard zone due to its stratigraphical position. Moreover, from the sections in northern Germany (Lower Saxonia) it is possible to recognize three ammonite marker-levels; one in the middle Lower Valanginian, and two levels in the Upper Valanginian, all of which allow correlation with the stratotype. Application of both ammonite and *Buchia*- based zones allows reliable correlation of the Boreal sections of northern Russia with Peritethyan sections of western USA.

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Mineralia Slovaca, 29 (1997), 262 - 263

Ophiolitic detritus in the Lower Cretaceous sandstone of Gerecse Mountains, Hungary: petrography, detrital modes, provenance

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Key words: Lower Cretaceous, volcanics, petrography, spinel geochemistry, paleogeography, Hungary

Introduction

In the last couple of years numerous papers have discussed (Fogarasi, 1995; Császár and Árgyelán, 1994; Császár and Haas, 1984; Sztanó, 1990) the stratigraphical and sedimentological features, as well as the palaeotectonic position of the Lower Berriasian to Lower Albian(?) siliciclastic sediments of Gerecse Mountains, which is located within the Transdanubian Range unit (TR). Close facial similarities between the Gerecse flysch se-quence and the Rossfeld Formation of the Northern Calcareous Alps (NCA) have been known for a long time (Fülöp, 1958) based on the lithology and ammonite assemblage.

This paper is dedicated to the detrital framework grain analysis, to the geochemistry of detrital spinel grains from the Gerecse Mountains and to their palaeogeographic implications.

Sandstone petrography

Standard framework grain analysis was done by Dickinson's method (Dickinson and Suczek, 1979), using the ribbon-counting technique on monomineralic and unstable lithic grains, 0.063 - 2 mm in size.

Studied sandstone samples are calcite cemented, immature-mature, fine- to coarsegrained lithic arenite and sublitharenite.

Five kinds of unstable lithic fragments can be distinguished: 1. neutral and acidic plutonic rock fragments, 2. acidic volcanic lithic fragments, 3. fragments of ophiolite complex, 4. sedimentary and 5. metasedimentary lithic fragments.

Rhyolite-dacite rock fragment with pilotaxitic-hyalopilitic texture appearing in the Upper Jurassic calpionellid limestone and in the basal part of the flysch sequence suggest contemporaneous andesitic-rhyolitic volcanic activity in the source area. Holocrystalline diorite, tonalite rock fragment, porphyritic granite-granodiorite, granite with micropegmatitic texture may have connected to the plutonic roof of an arc or eroded from the continental crust.

In the heavy mineral assemblage of the Aalenian-Bajocian red, nodular "ammonitico rosso" type limestone of the Gerecse Mountains unusual amount of biotite have been distinguished. This new findings may support the idea of the above-mentioned volcanic activity.

Serpentinite detritus with various texture types, bastite, gabbro, intergranular-ophitic-variolitic basic rock fragments 0.4 - 1.5 - 2.0 mm in size are common, and may reflect the ophiolite complex.

Large amount of detrical spinel grains in the heavy mineral assemblage also support the ophiolitic source area.

Fragments of ophiolite complex decrease in quantity countinouosly during the deposition with increasing of quartz grains, sedimentary and metasedimentary detritus.

Based on the detrital framework grain analysis the detritus of the Cretaceous clastic sequences of Gerecse Mountains combine the terrigenous materials from an oceanic island arc, collision suture zone, fold-thrust belt containing continental basement and deep-water sheets.

Spinel geochemistry

In detrital spinel grains of the studied succession the Cr# [Cr# = Cr/(Cr+Al)] ranges from 0.3 to 0.85 and the Mg# [Mg# = Mg/(Mg+Fe2+)] from 0.4 to 0.75. Fe_2O_3 and TiO_2 contents are consequently very low. The Fe3+# [Fe3+/(Cr+Al+Fe3+)] ratios of the analysed samples are always lower than 0.05, which is a characteristic feature of spinels from mantle-derived rocks. The TiO_2 wt% ranges from 0.00 to 0.65, in many instances the TiO_2 wt% are zero. Zonal spinel grain was not found (Árgyelán, 1996).

Compositional populations of spinels from the Gerecse Mountains fall into the harzburgite field of Pober and Faupl (1988), consequently showing close similarities to those of Rossfeld Formation of the Eastern Alps.

The majority of data sets can be described as Type II and Type III alpine-type peridotites and ophiolites, reflecting a complex multistage melting history of the source area, and the formation of an island arc on oceanic crust (Dick and Bullen, 1984).

Palaeogeography

As a result of the Jurassic-Early Cretaceous tectonic movements the Tethys-Vardar basin was closed, and its detritus (chrome spinels and volcanic rock fragments) could have been eroded and transported to the sedimentary basins (e. g. Rossfeld Formation of the NCA and Ostrc Formation of the Dinarids) surrounded the obduction zone from the earliest Cretaceous. During the collision the oceanic crust was incorporated partially by the intraoceanic subduction that generated an oceanic island arc. The acidic volcanic rock fragments (andesite-dacite-rhyolite) and granite, diorite, tonalite detritus in the basal beds probably reflect the CA volcanism of the oceanic island arc, which later was obducted into the Dinaridic realm. Based on sandstone petrography, the detritus of the Gerecse sedimentary basin may have been eroded from a volcanic arc, an ocenic suture zone, and from a continental crust reflecting mixed orgenic source area.

Geochemistry of spinel grains suggest that the source rocks for the detrital sequence of the Gerecse Mountains may have been the harzburgite subprovince of the Tethys-Vardar suture zone, similar to that of the Rossfeld Formation. The main difference between the formations is: the Rossfeld Formation does not contain acidic and ophiolitic rock fragments.

Based on the newest palaeogeographic reconstruction and the sandstone petrography and petrology, the Gerecse sedimentary basin was situated in the frontal part of the obducted volcanic island arc.

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Deep-water Upper Cretaceous variegated facies in the Czorsztyn Succession, Pieniny Klippen Belt, Western Carpathians

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Key words: Late Cretaceous, couches rouges facies, Foraminifera, Western Carpathians, Poland

Variegated deposits consisting of cherry-red and green, argillaceous and marly shales, intercalated with fine-grained, thin- and medium-bedded, calcareous, hieroglyphic sandstones and mudstones have been studied in relation to biostratigraphy and palaeoecology.

These deposits, occurring in the Trawne stream near Rogoźnik quarry belong to the Czorsztyn Succession of the Pieniny Klippen Belt. Their lithological features suggest that they may be attributed to the Malinowa Shale Formation *sensu* Birkenmajer (1977).

This Formation is a characteristic Upper Cretaceous element of the Grajcarek Unit (incorporated to the Pieniny Klippen Belt during Late Cretaceous-Early Tertiary; Birkenmajer, 1986) and only scarce evidence confirms their presence in the Czorsztyn Succession (Birkenmajer and Geroch 1961; Birkenmajer, 1963, 1965).

Microfauna is characterised by the presence of agglutinated foraminifers with dominating *Recurvoides* spp., *Karrerulina conversa, Uvigerinammina jankoi, Trochammina* spp. and tubular forms. No taxa diagnostic for lower Senonian - belonging to *Bulbobaculites problematicus, Haplophragmoides* cf. *bulloides* and no taxa characteristic for lower/middle Campanian-Maastrichtian (*Caudammina gigantea*) have been found in these deposits. It suggests that the Malinowa Shale Formation represents the Santonian-lower Campanian sediments in the studied section of the Czorsztyn Succession. Occurrence of many intercalations of thin- to medium-bedded sandstones confirms such a high stratigraphic position of this formation (Birkenmajer, 1977).

Features of foraminiferal assemblages (morphogroup analysis, diversity index of benthos, content of $CaCO_3$) show that sedimentation of these deposits took place under deep-water conditions (lower bathyal), similarly as in equivalent deposits (red facies of the Macelowa Marl Formation) in the Branisko and Pieniny successions.

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Mineralia Slovaca, 29 (1997), 265 - 266

Sedimentary environments of the Urgonian formations of Hungary

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Key words: Cretaceous, sedimentology, environments, Urgonian facies, Hungary

The term Urgon is used different way in the literature even now. The most widely accepted definition has been formulated by Rat (1965) who has considered it as a biosedimentary system and not as a chronostratigraphic or a lithostratigraphic term. The term Urgon is used in Hungary since the 70th of the 19th century (Böckh, 1875-1878) first in stratigraphic sense then since the beginning of this century in facies sense (Staff, 1906-1907) as well.

The Urgon facies is widely distributed in the Tethyan Realm (Moullade et al., 1985). It was a common facies within the Alpine-Carpathian system (Fig. 1) due to a frequent alternations of lands and seas in space and time. Its recognition is retarded considerably due to the subsequent erosion during the Late Cretaceous - Early Tertiary tectonic activity (Hagn, 1982; Schlagintweit, 1987; Michalík, 1994; Császár and Turnšek, 1996).

Urgon facies has been developed in both Pelso and Tisza basic tectonic units of Hungary. There are 4 formations differing from each other in time, in time span and in sedimentary environment.

The Nagyharsány Limestone is situated in the Villány-Bihar Zone within the Tisza Unit. It is deposited on the karstified ramp surface of Upper Jurassic limestones with bauxite lenses in its traps. The total thickness of the formation exceeds one thousand metres. Some areas at the beginning of the sedimentation have been separated from the sea by low ridges and freshwater limestone of a few tens of metres in thickness has been deposited behind them. These areas have been flooded during storms an high tides and black pebble horizons and/or brackish or even marine water intercalation were deposited. This part of the formation is characterised by common subaerial exposures and paleosol occurrences. After total flooding of the ridge, various marine communities were alternating that were ruled by the following groups of biota: dasycladacean algae, orbitolina, miliolids, rudists and *Bacinella* - *Codiaceae* colonies. Branching coral colonies are restricted to one horizon only. The water agitation was increased with the retrogradation. The probable age of the cessation of the carbonate platform is Middle Albian. The phenomenon was in connection with the break of the platform when the fissures originated, later filled by planktonic foraminiferal and crinoidal limestones and marls. The Nagyharsány Limestone is capped by hardground and covered by the Bisse Marl Formation.

The special rudistid bioconstruction which developed around giant basalt volcanoes in the Mecsek Mts does not belong to the Urgon facies s. str. Their vestiges are preserved within the Magyaregregy Conglomerate of slope facies and the Hidasivölgy Marl of basin facies as gravitationally redeposited material after the erosion of volcanic build-up. The fossil community is represented by a taphocoenosis formed by gravitational movement and consisting of great variety of corals, rudists, ostreids and other shallow water bivalves, gastropods and various deeper water or pelagic elements such as brachiopods, ammonites, cadosinas. The first group of fossils must lived around volcanoes forming atoll-like rings. The existence of this atoll-like rings repeatedly built until the Late Albian when it was replaced by hemipelagic limestones and marls that was followed by the red Vékény Marl Fm. of Turonian age. The cessation of the atoll-like rings seems to coincide in time with the drowning of the atolls in the North-Western Pacific (Grötsch and Flügel, 1992) that indicate a world-wide sea level rise.

The Környe Limestone is found in a narrow belt in the Transdanubian Range of the Pelso unit bordering a semi-restricted basin of the former Vardar ocean, and consists of two member rank units that are different from sedimentary environment point of view. The lower member is developed more or less continuously from the hemipelagic Tata Limestone Fm. without remarkable changes. The definitive difference between the two mentioned units is the bioclast composition. The Tata Limestone prevailingly consists of crinoidal and echinoid fragments as far as its successor of rudist detritus. The other common elements are as follows: red algae, agglutinated benthonic and planktonic forams, sponge spicules, a few radiolarians and a great quantity of glauconites. The lower member of the Környe Formation is an allodapic slope sediment of a prograding carbonate platform as far as the upper member is a real Urgon facies, that is a product of an aggrading platform consisting of *Agriopleura* and *Chondrodonta* biostromes and at the margin of the platform some coral and chaetetopsis colonies. This carbonate platform was drowned not in deep water but it was destroyed

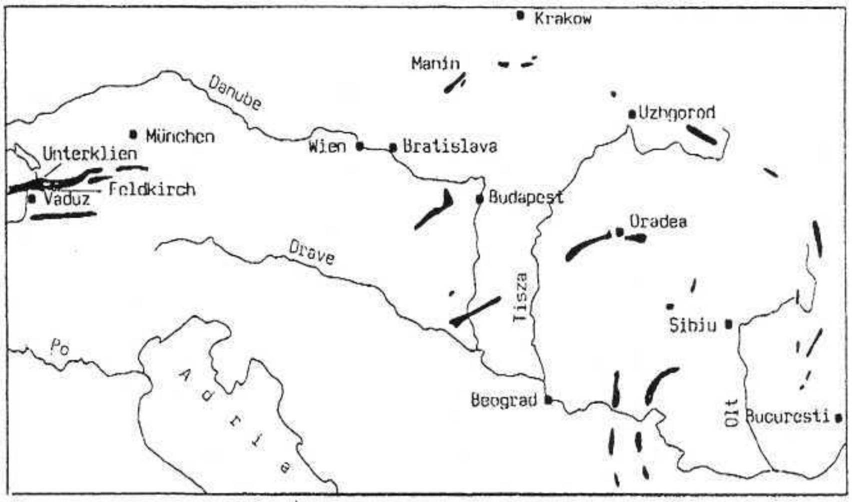

Fig. 1. Urgonian occurences in the East-Alpine - Carpathian system

by an increased siliciclastic influx. The result of the sea level changes is evidenced by the alternation of the variegated non-marine Tés Clay and the rudistid limestones.

The olistolites within the Köszörűkőbánya Conglomerate of the Lábatlan Sandstone Formation deposited in a foreland basin of the island arc system of the Vardar ocean is considered to be a part of the Környe Limestone. The siliciclastic host rock and the limestone cobbles and slabs also contain chrome spinels evidencing a nearby obducted ultramafic source rock (Császár and Árgyelán, 1994). The situation was similar to the margin of the Penninic ocean (Michalík, 1994) except that the Gerecse was situated at the southern margin of the Vardar ocean. The accretionary prism probably eroded in both zones.

The Zirc Limestone located in the axis of the Transdanubian Range was deposited on an extended carbonate platform in-between the Northern Calcareous Alps and the Southern Alps and represented by successions differing in thickness, lithology and fossil composition. Two types of Urgonian successions are known to occur here. In the larger part of its extent the total thickness is 50 m and it is subdivided into three member rank units that are different in fossil content and to a certain extent in lithology as well. The lower member is a rudistid limestone, the middle one is a foraminiferal (including orbitolines) limestone and the upper one is a biodetrital, sandy limestone of open shelf origin with a few planktonic foraminifera. The sedimentation of the last member has been preceded by a short time sea level drop that was followed by a rapid sea level rise. The new cycle of the sea level changes started with an other sea level drop and karstification. The base of the Pénzeskút Marl Fm. is a condensed horizon represented by glauconitic and phosphatic bed and infillings of karstic cavities. This level is considered as a maximum flooding without sedimentation of the transgressive systems tract. The thickness of the Zirc Limestone in the South Bakony exceeds 200 m with no member rank subdivisions and subsequent marl above it. It is characterised by alternation of gastropod rich beds with rudistid beds, and with some intercalations of tempestites, brackish water limestones, paleosols and even bauxitic layers. The Zirc Limestone must have been closely related to the Urgon of the Northern Calcareous Alps the vestiges of which has been discovered as pebbles only in the Upper Cretaceous and Eocene sediments.

The paper will be focused on presenting evidences for the similarities and differences between the Urgon successions in Hungary and the neighbouring countries.

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Tethyan Mid-Cretaceous (Cenomanian-Turonian) Roveacrinids (Roveacrinida, Crinoidea) as stratigraphical and paleobiogeographical tools

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Key words: Cenomanian, Turonian, Roveacrinida, Roveacrinidae, Stratigraphy, Palaeogeography, Tethys

Microfacies study of three Tethyan sections evidenced several remarkable echinoderm-rich layers. These sections are located on distant peri-Tethyan platforms: the Sabunsuyu ravine (Taurus, Turkey: Cros et al., 1991), the Piedra Parada section (Tuxtla Guttierez area, Chiapas, Mexico: Cros et al., in prep.) and the Chiquimula section (Rio Lajas, Guatemala: Debrabant et al., 1996). All were dated by means of microfacies and of larger foraminiferids. The stratigraphical resolution was unfortunately hampered by the paucity of foraminifers. Scarce micropaleontological data established that they were all straddling the Cenomanian-Turonian boundary but within a large range of sample spacing (more than 10 m). The first aim of this paper was to study thoroughly these roveacrinidal microfacies but rapidly turned into a detailed investigation of their stratigraphical potential to locate more precisely the C/T boundary.

The biostratigraphical data compiled from the stratotypic Cenomanian-Turonian areas (Ferré, 1995) and the inferred microfacies methodology (Ferré and Berthou 1994; Ferré and Granier, 1997) lead us to propose a preliminary dating. The former C/T interval was restrained thanks to the presence of *Orthogonocrinus* cf. *apertus* Peck, 1943 and of Roveacrinus cf. *geinitzi* Schneider, 1989. These datations are consistent with previous ones based upon larger foraminiferal sections. Moreover they do confirm the existence of roveacrinidal events (qualitatively -as datum planes- as well as quantitatively -as abundance zone-). Such "blooms" were first documented in the *Plenus* Marls from the Anglo-Paris Basin (Jefferies, 1962). Consequently one must now admint the concept of roveacrinidal event introduced by Kristan-Tollmann (1970) from Tethyan Triassic somphocrinidal microfacies. Compiled bibliographical data and unpublished materials confirmed during the latest Cenomanian the existence of an outstanding roveacrinidal horizon all over the peritethyan platforms: from New Zealand (Chanier et al., 1990), Turkey, Syria (Al-Maleh, 1976), SW- and SE-France, Tunisia (Razgallah et al., 1994), Morocco, Spain, NE-Brazil (Bengtson and Berthou, 1982; Berthou and Bengtson, 1988; Ferré and Berthou, 1994; Ferré et al., 1996), Guatemala, Mexico, to the Texas Gulf (Peck, 1943, 1955). Moreover this event extends also deeply north into the Boreal Realm (see among others: Rasmussen, 1961; Pisera, 1983; Griffiths, 1985).

The roveacrinidal microfacies display great potentials for event stratigraphy and palaeoecology regarding to their ecological opportunism and polymorphism. Beyond the qualitative vs quantitative debate, they are of primary importance to record marine connections at a high-resolution level since their widespread occurences can be used as a marker-bed to trace back the palaeogeography of the Tethyan seaways with a great stratigraphical confidence. Ongoing studies based upon peri-tethyan materials are about to confirm the changes in peritethyan seaways from Albian to Turonian times (Dias-Brito and Ferré, 1997).

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Mineralia Slovaca, 29 (1997), 269 - 271

The origin of rhythmical bedding in Middle Cenomanian carbonate rocks in the Bakhchisarai Region (SW Crimea)

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Key words: Cenomanian, sedimentology, orbital cycles, Crimean Peninsula

The most important biostratigraphical investigations in the studied region were made by D. P. Naidin and A. S. Alekseev (Naidin et al., 1975, 1980; Alekseev, 1989). The contacts of Cenomanian deposits with both the Upper Albian and Lower Turonian strata are of erosional nature. The same boundary type was found on the Lower/Middle Cenomanian boundary. The thickness of the whole Cenomanian sequence varies from 20 to 70 meters. Middle Cenomanian rhythmically bedded marls and limestones contain ammonites *Mesogaudryceras leptonema* (Sharpe), *M. rarecostatum* Balan, *Galycoceras (?) sp.*, the bivalves *Inoceramus virgatus Schlut.* and belong to *Rotalipora cushmani* zone (Alekseev, 1989). The rhythmicity in the Middle Cenomanian carbonate rocks were studied by V. T. Frolov (Frolov, 1996). The early Cenomanian was a time when a rapid transgression took place. The depth of the basin constantly increased during the Cenomanian up to the first hundred meters (according to foram data). It is slightly differs according to ichnofossils and fish data made by A. S. Alekseev and was estimated as first hundred meters - shelf to the shelf wedge.

The development of the basin took place under stable tectonic conditions. Anoxic events are typical for Cenomanian - Turonian boundary of this region (Alekseev, 1989). The present study focused on the conditions of rhythmicity formation in Middle Cenomanian carbonate rocks.

The outcrop is located in the mountainous part of the Crimea Peninsula in the Bakhchisarai region on southern slope of the Selbuhra Mountain. The Middle Cenomanian sequence consists from 22 rhythms, 45 beds, its visible thickness is 12.4 m. The rhythms are mostly presented by alteration of marls and marlstones or limestones. The colour of marls is usually grey, sometimes pale, while the limestone is always white. The thickness of limestones is first decimetres to meters. Marls are of several or sometimes of several hundreds centimetres thick (Fig. 1).

The succession was divided into rhythms on the basis of colour, bioturbation and thickness variations in the field. Elements of the rhythm shows the difference in content of carbonate, clay, terrigenous minerals, bioclasts (Tab. 1, Fig. 1). The planktonic/benthic foraminifera ratio is different in the rhythm elements. Rocks were investigated by thin section analyses (30 samples), acid dissolution (43 samples) and Total Organic Content analyses (2 samples) and X-ray diffraction techniques (2 samples). Boundaries are heterogeneous: erosional; transitional, diffuse; usually contrast. The quantity of pyrite concretions and carbonate content increase, bioturbation decreases to the top of the section. Ichnofossils (*Planolites, Zoophycos, Teichichnus, Chondrites, Thallassinoides, Phycosiphon*) are usually presented in both rhythm elements, but the bioturbation in limestones is always higher than in marly limestones and marls (Fig. 1).

Several models are suggested to explain the origin of the rhythmically bedded pelagic/hemipelagic carbonate rocks. They are briefly described below.

Dilution cycles. Model 1 (Pratt, 1984; Ricken, 1994). Cyclic changes of moisture, terrestrial run off due to climatic variations form rhythmicity in the carbonate sediments. During dry season mostly limestones are deposited. Wet season is a time of marls, when the dilution of the constant carbonate sedimentation by terrigenious material (clay), transported by rivers, take place.

Dilution cycles. Model 2 (Shacklton, 1982; Ruffel, Spaeth & Mutterlose, 1996). This model is close to the first one. The difference is that in the first case cyclic climatic changes result in the cyclic changes in volume of run off, but here climatic fluctuations cause variations in the nature of weathering and in the composition of the constantly transported by rivers terrigenious material. Wet, (or) warm season is a time of marl sedimentation. Limestones occur during dry, (or) cold conditions.

Dilution cycles. Model 3 (Morozov, 1952). Sea level change (Sea Level Up) causes transgression (ingression) with relatively high terrigenious input. Sea Level Down is a time of regression and relatively low terrestrial input.

Solution cycles. Model 4. This model is proposed by

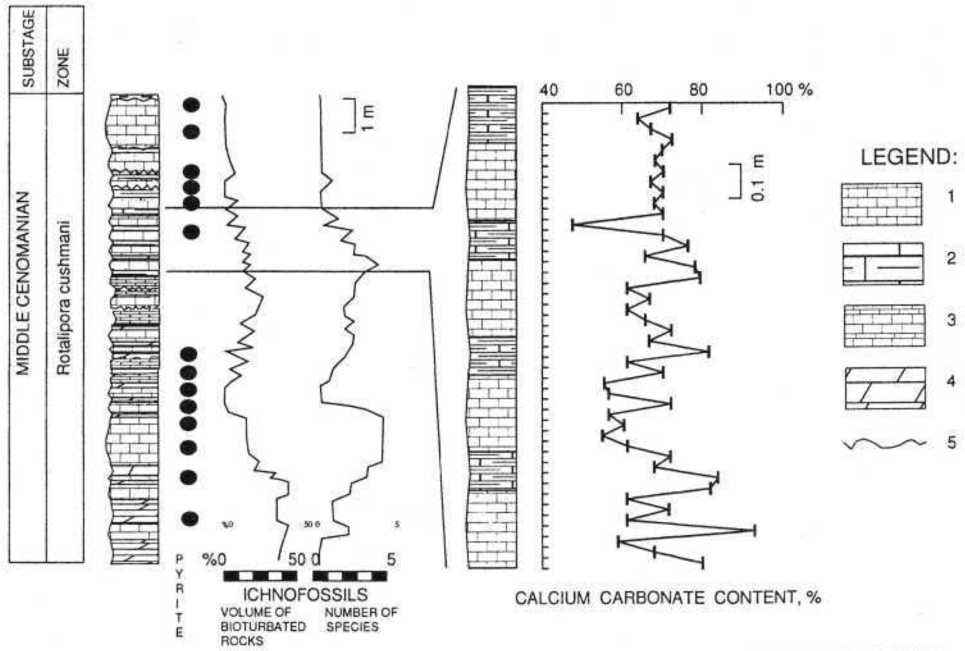

Fig. 1. The variation of ichnofossils and calcium carbonate content in rhythmically - bedded limestone/marl succession (Middle cenomanian, *Rotalipora cushmani* zone), Selbukhra mountain, SW Crimea.

the author together with E. J. Baraboshkin. Cyclic repeating of condensation and sedimentation result in appearance of rhythmic limestone-carbonate clay section. Limestones always have erosional boundary with clays. Limestones represent sedimentation regime, condensation causes the appearance of carbonate clay (result of limestone dissolution). Erosional surfaces occur due to non-depositional regime and include soft- and hard-grounds. Condensation and sedimentation are proposed to be cyclic processes.

Solution cycles. Model 5 (Savdra and Bottjer, 1994). Climatic variations result in fluctuations of winds and water current direction, which cause changes in the content of oxygen dissolved in bottom waters. Cyclic changes aerobic - dysaerobic - anaerobic conditions result in periodic solution of constantly deposited carbonates. Because of new current direction and some specific bottom relief forms stagnate, stratified water masses can occur.

Solution cycles. Model 6 (Ricken, 1994). Sea level change causes cyclic depth variation of the basin, which results in periodic occurrence of stratified waters with anoxic or nearly anoxic conditions and solution of the constantly deposited carbonates. Sea level up - marl, sea level down - limestone.

Solution cycles. Model 7 (Einsele, 1985). SLC causes variation of the critical carbonate solution depth. Periodically the solution volume of the constantly deposited carbonate changes.

Solution cycles. Model 8 (Berger, 1982). Global carbon cycles are responsible for changing carbon/oxygen relation in the athmo- and hydrospheres.

Cycles of bioproductivity, dilution, solution. Model 9 (Fischer and Arthur, 1983). The whole history of the or-

Tab. 1
The comparison of Middle Cenomanian rhythm elements (composition, texture, etc.)

	Limestone	Marly limestone, marl
Carbonate, %	95 - 70	85 - 47
TOC, %	0.08	0.44
Colour	white	grey
Thickness, m	0.08 - 1.3	0.1 - 0.6
Foraminifera P/B, %	5.5	5
Carbon isotope 13, %*	20 - 30	20 - 30
Oxygen isotope 18, %*	-20	-5
Sea water temperature, degrees centigrade*	23 - 25	14 - 15
Ichnofossils & bioclasts	>	<

(*Frolov, 1996)

Tab. 2
The mineral composition of rhythm elements according to X-ray diffraction data

	Limestone	Marl
Calcite, %	88.8	69.7
Illite, %	4.5	12.6
Mixedlay, %	0.7	
Quartz, %	5.3	8.4
Rutile, %	0.8	
Chlorite, %		0.4
Microcline, %		1.4
Montmorillonite, %		7.5

ganic world can be devided into polytaxa and oligotaxa intervals, which occur due to climatic variations, SLC.

Different P/B relation in rhythm elements and the increasing of the thickness of limestones demonstrates cyclic changes in the carbonate sedimentation (due to solution or bioproduction). Dilution cycles are proved by relatively high content of bioclasts (Tab. 1) and terrestrial material (Tab. 2) in marls and marly limestones. The solution was caused by anoxic conditions in the sedimentary basin according to cyclic variations in distribution of ichnofossils, pyrite concretions, etc. (Fig. 1). The author proposes models 1, 2, 5 for this type of rhythmicity. The rhythmicity in the Middle Cenomanian carbonates of Crimea Basin is thought to be connected with the Milankovitch cycles and is probably similar to carbonate rhythms of other Cretaceous Tethyan Basins.

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The sedimentary environment and genetic types of the Lower Cretaceous deposits in the Ukrainian Carpathians

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Recently, the problem of the sedimentation of the Lower Cretaceous deposits from the Ukrainian Carpathians is discussed, but sedimentary genetic types of these deposits are not recognized. The sedimentary environment of forming Barremian-Albian Spas and Shypot black shale formations are considered in the article.

Spas formation (thickness 300 m) is located in the Skyba tectonic unit (Vialov et al., 1981). It consists mainly of hemipelagites – black and dark-grey claystones, rarely marls and cherts. The macroscopic texture of the claystones in uniform. Hemipelagites (background deposits) comprise thin turbidite layers of bedded sandstones. The sandstones are usually cross- and horizontal- laminated (Bouma's textures CDE, rarely BCDE, ABCDE).

The Spas formation locally contain thick lenses (30 - 60 m) of massive sandstones (Tershiv member) without lamination. These psammites are interpreted as grain flow deposits.

Thus, the Spas formation consists of the following sedimentary genetic types: hemipelagites, thin bedded turbidites and grain flow deposits. The Spas sedimentary sequence is compared with the continental slope foot complex (Kennet 1982; Reading et al., 1986).

The Shypot formation (thickness 300 - 350 m) is developed in Chornogora, Svydovets, Krasnoshora, Duklya, Krosno tectonic units (Vialov et al., 1981). The lower part of the formation consists of hemipelagites (black and dark-grey claystones, somewhere marls, limestones) with thin intercalations of turbidites (bedded sandstones with Bouma's texture CDE). These deposits are comparing with the sediments of the continental floor.

The upper part of the Shypot formation is represented by sandy turbidites (Bouma's textures BCDE, ABCDE, CDE). Background deposits – black claystones, firestones, - sporadically occur as thin intercalations within thick bedded sandstones. The thick bedded turbidites of the upper part of the formation are interpreted as lobe-like accumulative bodies (Reading et al., 1986) of the continental floor.

The sedimentary features of the Spas and Shypot formations indicate that they represent deposits of a continuous particle by particle fallout from the water column (background sediments) and grained deposits, recognized as redeposited by various gravity flows. The Spas – Shypot sedimentary basins were situated on the continental slope foot of a passive continental margin (Figure).

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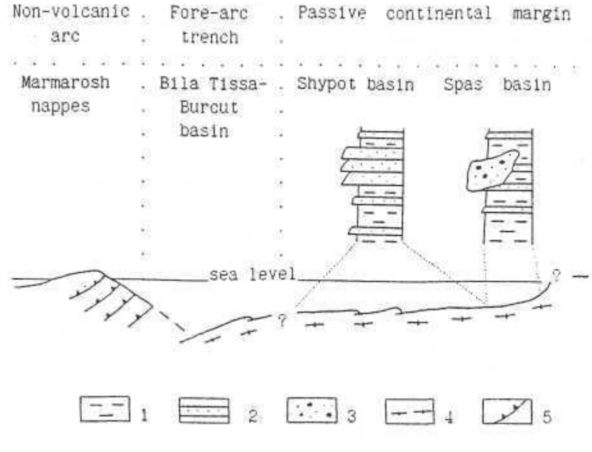

Fig. 1. Scheme of the paleotectonic location of the Spas and Shypot basins. Albian. 1 - hemipelagites, 2 - turbidites, 3 - deposits of the grain flow, 4 - thinned continental crust, 5 - nappe.

Mineralia Slovaca, 29 (1997), 273 - 274

Pyritization of Radiolaria in anoxic water column, anoxic deposits of the Cenomanian/Turonian Boundary in the Pieniny Klippen Belt, Poland

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Information about pyritized radiolarian skeletons are relatively common (e. g. Pessagno, 1976; Thurow, 1988; Bąk, 1996) but process of pyritization of radiolaria skeletons has not been described yet.

The pyritized radiolarian skeletons have been found in the deposits of Czorsztyn, Niedzica, Branisko and Pieniny successions of the Pieniny Klippen Belt around the Cenomanian/Turonian boundary. The excellent preserved pyritized skeletons have been found within the marly and silty blue-grey shales of Snežnica Siltstone Member in the Branisko Succession. The pyritized specimens belong mostly to the cryptothoracic Nassellariina as *Holocryptocanium barbui* Dumitrica, *Hemicryptocapsa tuberosa* Dumitrica and *Hemicryptocapsa prepolyhedra* Dumitrica. Less abundant are *Xitus maclughlini* (Pessagno) and *Thanarla pulchra* (Squinabol). Typically pyrite very faithfully replaces all originally siliceous skeleton elements of studied specimens, with the finest details of ornamentation, even in cryptothoracic forms with thick abdomen wall (e. g.: *H. barbui, H. tuberculatum*). At lower magnifications (below 1000x) SEM images reveal very even surfaces of pyritized skeleton elements. However, higher magnifications (5000 - 10000x) show that these skeletons are built of masses of small irregular grains of pyrite (size about 0.5 µm), intergrown or closely packed, sometimes with pores. Pyrite framboids are common in pyritized radiolarian skeletons. They typically occur in two different positions: 1. in channels (pores); 2. inside of abdomen of cryptothoracic forms, attached to internal surface, often at channel exit.

Pyrite formation can be formed either direct or indirect (via iron monosulfides, mainly mackinawite and greigite) although the latter pathway is more typical for sediments (Rickard, 1975; Howarth, 1979; Berner, 1980; Rickard et al., 1995). It is rarely formed in a water column (euxinic) whereas its formation during diagenesis and replacement of fossils are common processes. we suggest that pyritization of radiolaria skeletons took place in anoxic water column because so perfect and "clean" replacement of silica by pyrite as observed could not happened in a sediment during and/or after burial. The following facts known from literature may support this idea: possibility of formation of sulfides and pyrite framboids in anoxic waters column (Skei, 1988; Canfield et al.,1996), rate of pyrite formation which can be very fast, in specific cases even in terms of days (Howarth, 1979), and sulfur isotope data from the Black Sea which suggest a rapid water-column formation of Fe-S (Lyons in Canfield et al., 1996).

The pyritization process started in the upper part of anoxic water column where settling radiolarian skeletons rich in organic matter were the sites of organic matter decomposition and enhanced bacterial sulfate reduction producing sulfide. Higher contents of dissolved iron in this zone diffused to radiolarians and precipitated as iron sulfides replacing opaline skeletons. Main controls of this process were: 1. rate of opal skeleton dussolution, 2. rate of bacterial sulfate reduction (BSR), 3. availability of dissolved iron.

Dissolution of silica radiolaria skeletons took place during sinking in an anoxic water column. Hydrogen sulfide is produced via BSR in radiolaria using organic material from soft bodies and sulfates from the seawater. Iron is supplied in dissolved from the seawater. Detail replacement occurs when precipitation of iron sulfide is matched by dissolution of silica. Based on similarity between size of grains building silica and pyrite skeletons we suggest that replacement of silica by iron sulfides could be grain for grain. If oxic/anoxic zone was too high in the water column, when dissolution of siliceous skeletons was not advanced enough, we could expect only incrustations on skeleton which during further dissolution could be lost. If oxic/anoxic zone was too low, when siliceous radiolaria skeletons were already partly dissolved, pyritization could not well preserve all morfological details.

Pyritization of only specific radiolaria species may be explained by different dissolution rates. In the studied sample the pyritization proceses comprised only selected species among the Nassellariina. This fact might sugested that the pyritization took place into the water column where the opaline skeletons of these selected species of Nassellariina were "ready" to be replaced by pyrite. We found some difficulties in calculations of the water depth on which the pyritization proces might started, because there are not calculations concerning the habitat of live these selected Cretaceous radiolarians taxa.

Pyrite framboids present in radiolaria were probably formed after pyritization of framboids. They occur in free space of skeleton and could form during diagenesis (even late diagenesis if only BSR is still active) of the sediment, similarly as pyrite concretions.
The latter could replace siliceous radiolarian skeletons or recrystallized former pyritized radiolaria during diagenesis.

Specific distribution of microfossils and pyritization in the studied vertical section across Cenomanian/Turonian in the Pieniny Klippen Belt seems to reflect changes in water column chemistry during that period.

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Sedimentary paleoenvironment of Coniacian phosphatic beds in the Ionian Basin (Mediterranean Tethys)

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Key words: Coniacian, sedimentology, stratigraphy, Ionian Basin, Albania, Greece

Coniacian phosphatic horizon represents a typical sedimentary facies widespread all over the Ionian zone in Albania and Greece. This wide distribution and characteristic microfaunistic association make from this carbonatic, phosphatic, cherty, globotruncana - rich lithology a well recognizable marker horizon.

The sequence consists of limestones, phosphorites and cherts. They form individual mutually intercalated strata. Its thickness varies between 8 - 10 - 15 m, sometimes up to 40 - 50 m. The sequence is more phosphatic in the central parts of the Ionian zone. At both flanks, in west and east, the phosphatic facies was replaced by the carbonaceous ones.

The lower boundary of the sequence is stressed by the presence of thin green clay layers, while the upper one is gradual, with transition to the limestones with rare phosphatic bands and to the pure limestones above.

Several detailed sections selected in various structures of the Ionian Zone have been studied stratigraphically. The composition of microfaunistic associations is almost identical in all section; with rare exceptions only. A bloom of the rich microfaunistic association dominated by planktonic foraminifers (mainly by globotruncanids): *Marginotruncana renzi, M. schneegansi, M. coronata, Globotruncana lapparenti, Marginotruncana sigali, Dicarinella concavata, Rosita fornicata,* over globigerinids, radiolarians, pithonellids etc, was observed just above the clay layer.

Coniacian age of this complex was determined on the base of presence of index forms belonging to the *Marginotruncana concavata* Zone. The basemental rocks belong to the Turonian *Helvetoglobotruncana helvetica* Zone.

The carbonates of the phosphatic - cherty strata biomicritic mudstones composed of small grains (15 - 30 microns). They were deposited in deep basin out of the clastic, terrigenous input. The argilaceous component is also missing in high phosphatic strata. The presence of phosphatic laminae, disseminated pyrite, organic matter and traces of elements such as Pb, Zn, etc, testify the origin in a pelagic, reduced environment, at levels of minimum oxygen depth. We suppose that laminated fabric of phosphatic beds was formed by pristine phosphatized particles when the accumulation rate was higher than the erosional one. During Coniacian, the Ionian Basin was a pelagic basin prolonged from southeast to northwest. The increase of thickness of phosphatic beds from central part of the Ionian zone towards the east is result of the sea bottom differentiation and of basin deepening in this direction.

Thus, the phosphatic sequence was formed under deep sea conditions, in a relatively calm tectonic regime of the Ionian Basin.

Lower Albian limestones from frontal parts of the Krížna Nappe in the Strážovské vrchy Mts. (Western Carpathians, Slovakia)

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Key words: Albian, channel fillings, lithology, biostratigraphy, microfacies, Krížna nappe, Western Carpathians

The presence of limestone strata in Lower Albian sequence of the Krížna Nappe was documented by Maheľ and Kullmanová (1961), Borza (1980) and Maheľ (1985). Nevertheless, their importance for regional geology was not appraised sufficiently for a long time. In spite of reduced thickness (about 10 m) in a wide area reaching from Homôlka to Súľov (up to 10 km), the limestone sequence can serve as an important geological marker which divides the monotonous Párnica Formation into two members.

The Lower Albian sequence consists of grey, dark - grey, thick bedded, limestones with sporadic dark - grey cherts bearing marks of extensive bioturbation. Mud - supported biodetrital wackestones to packstones contain less abundant lithic pellets and intraclasts. Among macrofaunal remnants, the belemnite *Neohibolites* (Maheľ and Kullmanová, 1961) dominates over echinoderms (Szörenyi, 1957) and ammonites represented by *Douvilleiceras* (Rakús, 1977).

Microfossil association consists of echinoderm fragments, thick - wall bivalves, "filaments", ostracods, sponge spicules, radiolarians *(Spumelaria),* benthic foraminifers (*Dorothia* sp.), planktonic foraminifers (*Hedbergella* sp., *Frondicularia* sp.), calpionellids (*Colomiella* sp.,) and *Globochaete alpina* Lombard. Organic remnants are sporadicaly concentrated in lamina or accumulated in nests.

Planktonic foraminifers (*Ticinella* sp.,) and ammonites (*Neohibolites* gr. *minimus* Miller, *Douvilleiceras* ex. gr. *mamillatum* (Schlotheim)) indicate Early Albian age of the limestone sequence.

One of the most completed sections is exposed on northern slope of the Svinorné elevation point (southwards of the Butkov Mt) where the Albian limestone sequence is in overturned position(Michalík and Vašíek, 1980). Underlying sequence is built by grey - brown thick - bedded, fine to coarse grained organodetrital, extensive recrystallised limestones. Biodetrite accumulations are often visible on a weathered surface. Both the size- and abundance variations of biodetritus were evaluated in the frame of limestone strata.

Intrabiopelsparite grainstones, rarely intrabiopelmicrosparite to intrabiopelmicrite wackestones to packstones contain bioclasts scarcely attaining the rudite fraction (biointrapelsparrudit grainstones to rudstones). The matrix is recrystalized, the cement being scarce. Besides thick - wall bivalves (some of them belong to rudists), orbitolinid foraminiferas (*Orbitolina (Mesorbitolina) parva* Douglass dominated over *?Dictyoconus* (determined by Dr. E. Köhler) planktonic foraminifers *Ticinella* sp. were identified. Faunal association indicates Gargasian (Late Aptian) age of the material in redeposited layers.

Due to sedimentological features described and to the preservation state of organic fragments we conclude, that the light coarse detrital limestones form fragments in fluxoturbidite bodies infilling channels in dark gray Lower Albian limestones.

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New stratigraphic refinements of the Cretaceous stratigraphy of the Eastern Albania (Mirdita and Krasta Zone) through the calcareous nannofossils

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Key words: Jurassic, Cretaceous, biostratigraphy, nannoplankton, Dinarides, Albania

The calcareous nannofossils of four stratigraphic sections belonging to the Tithonian-Berriasian (Ulza-Bushkazi section), Aptian-Albian (Derja section), Upper Aptian-Albian (Trebishti section) and Turonian-Maastrichtian deposits (Ura e Milotit section), are investigated. The Ulza-Bushkazi section is located at the Western margin of the Mirdita Ophiolite Zone, while the Trebishti section at its Eastern margin. The Derja and Ura e Milotit sections belong to the Krasta tectonic zone. The Tithonian-Beriasian formations (Mirdita zone) consist of two sequences: (1) the ophiolite conglobreccias and (2) the marly flysch. These formations are unconformable with subjacent ophiolites and Triassic-Jurassic limestones on both Eastern and Western ophiolite margins (Gjeologjia e Shqiperise, 1990; Harta Gjeologjike e Shqiperise, 1983). Within the ophiolite conglobreccias of Ulza-Bushkazi section, an argillaceous bed occurs. The found nanofossils, *Parhabdolithus embergeri, Conusphaera mexicana minor, Conusphaera mexicana mexicana,* document the Tithonian. A marly bed rich in nannoconus is evidenced within the marly flysch.

The main calcareous nannofossils are the following ones: *Nannoconus kamptneri minor, Nannoconus kamptneri kamptneri, Cruciellipsis cuvillieri, Cretarhabdus crenulatus, Micrantholithus obtusus.* This association dates Berriasian. The Upper Aptian-Albian formations (Trebishti section) consist of grey marly flysch. So far, this flysch is considered to be of Tithonian-Neocomian, being analogous to the marly flysch (Gjeologjia e Shqiperise, 1990; Harta Gjeologjike e Shqiperise, 1983). In fact, the Rucinolithus irregularis, Eprolithus floralis, Braarudosphaera africana et al., found in these sediments suggest the Upper Aptian-Albian. In the Krasta zone, that Westward thrusts the Kruja adjacent zone, the oldest known formations belong to the Aptian-Albian. These deposits consist of grey marly flysch similar to this one of Trebishti. This flysch underlies the Senonian limestones with Globotruncana. According to several authors, the occurred foraminifera in the lowermost part of flysch indicate the Albian, but the evidenced (Lula et al., 1981; Gjeologjia e Shqiperise, 1990), but the *Micrantholitus obtusus, Conusphaera mexicana mexicana, Rucinolithus irregularis* et al. suggest the Aptian. Upwards, *Cribrosphaerella ehrenbergii, Eiffellithus turriseiffelii* et al. are observed. This assemblage corresponds to the Albian. The terrigenous section continues up to Turonian. Ura e Milotit section consists of Turonian-Maastrichtian formations. The found nannofossils are related to Turonian - Santonian, Campanian and Maastrichtian. The Turonian-Santonian formation are distinguisshed on the base of *Quadrum gartneri, Eprolithus floralis* et al. Among the others, *Aspidolithus parcus* and *Eiffellithus eximius* are recognized within the Campanian deposits. *Micula murus, Micula prinsii* et al. are found in Maastrichtian. Upper Maastrichtian-Eocene sediments of Krasta zone consists of flysch. Summing up the obtained data,the Krasta zone consists of two flyschs corresponding to above and below the Senonian. This important feature distinguish the Krasta zone from the Cukali one which contains only the upper flysch (Kici, 1988).

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Mineralia Slovaca, 29 (1997), 278 -280

Cretaceous correlations between Tethyan and Boreal Realms from Romania, based on Nannoflora

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Key words: Cretaceous, nannoplankton, palaeobiogeography, Romania

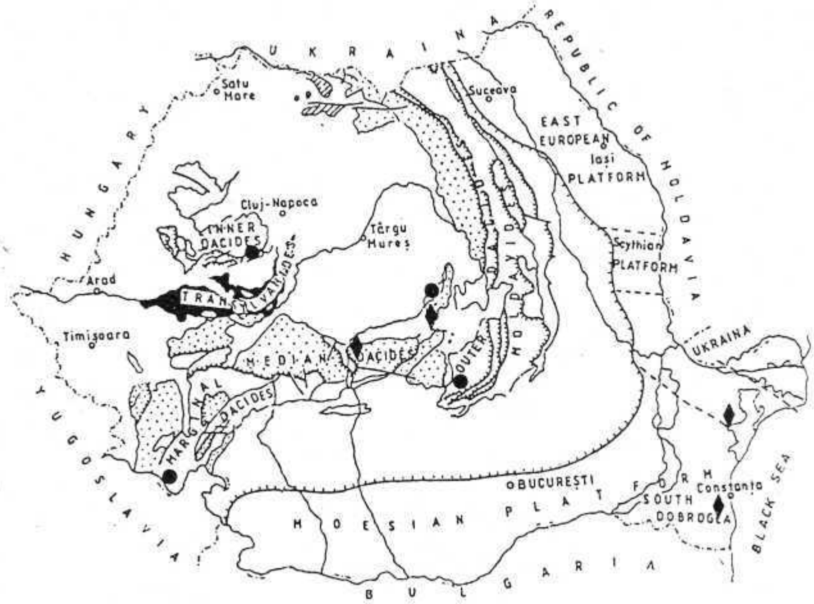
The marine deposits of the Cretaceous are widespread in different areas of Romania (Eastern and Southern Carpathians, Moesian Platform, including its eastern part - South Dobrogea, as well as the North Dobrogea, nearby the Black Sea), both in pelagic and flysch facies.

Several sections from Romania, from different areas, covering almost all the Cretaceous, have been studied from the calcareous nannoplankton distribution point of view. Besides the Tethyan and cosmopolitan taxa identified in the nannofloral assemblages, some short intervals offered also associations which contain Boreal species.

Typical Boreal nannoflora and macrofauna were identified in the lower part of Late Valanginian ammonite *Verrucosum* Zone. The Uppermost Barremian sediments, which corresponds in Romania to the ammonite *Meridionale* Zone contain also Boreal macrofaunal and nannofloristic elements.

Concerning the Upper Cretaceous, a small group of Boreal species was identified from the Lower Coniacian (which correspond to the macrofaunistic level of *Dydimotis*), as well as from the Upper Campanian (lower part) and from the Upper Maastrichtian.

The presence of Boreal nannoflora within the Tethyan calcareous nannoplankton assemblages from Romania indicates intermittent marine connections between the Tethys and the Boreal - Artic Ocean, via the Polish Trough. This fact allows to extend the areal distribution of the transitionary area between Tethyan and Boreal Realms up to the East and South Carpathians, as well as to the Moesian Platform.



Boreal nannoflora in the Tethys Cretaceous from Romania

• Early Cretaceous

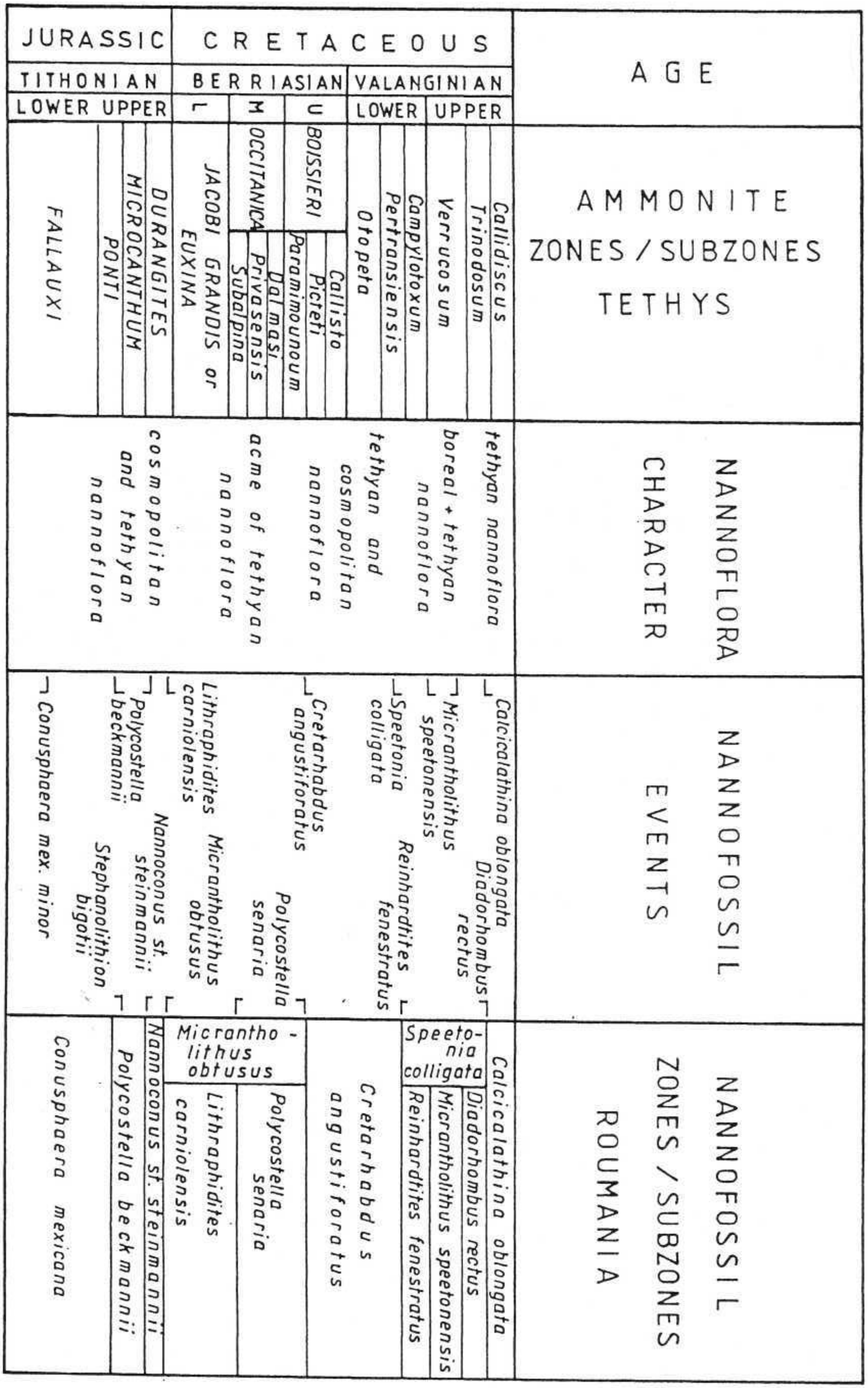
♦ Late Cretaceous

Correlation between the Early Cretaceous calcareous nannofossils from Tethys and Boreal Realms

Stages		Ammonite zones recognized in Romania (Avram 1993, 1994, 1996)	Nannofossil zones in Tethys (Applegate & Bergen 1988, Bralower et al. 1989)	Nannofossil zones in Romania (Melinte 1992, 1996, this work)	Nannofossil zones in Boreal Realm (Mutterlose 1988, 1991; Crux 1989)
Aptian	Lower	Tuarkyricus	Rucinolithus irregularis	Rucinolithus irregularis	Chiastozygus litterarius
Barremian	Upper	Meridionale ●	Micrantholithus hoschulzii	Vagalapilla matalosa ●	Vagalapilla sp.
		Giraudi		unstudied	Zeugrhabdotus sisyphus
		Feraudianus			
		Vandenheckii			Nannoconus abundans
	Lower	Caillaudianus	Lithraphidites bollii		
		Nicklesi			Tegumentum octiformis ■
		Hugii		Lithraphidites bollii	
Hauterivian	Upper	Angulicostata	Cretarhabdus loriei / Speetonia colligata		Tegulalithus septentrionalis
		Balearis			Cyclagelosphaera margerelii
		Ligatus		Calcicalathina oblongata	Eprolithus antiquus
		Sayni			
	Lower	Nodosoplicatum	Cretarhabdus loriei / Eiffelithus striatus		
		Loryi			Conusphaera rothii ■
		Radiatus			
Valanginian	Upper	Callidiscus	Calcicalathina oblongata / Eiffelithus windii	Speetonia colligata / Diadorhombdus rectus	Tegumentum striatum ■
		Trinodosum			
		Verrucosum ●		Speetonia colligata / Micrantholithus speetonensis ●	
	Lower	Campylotoxum	Calcicalathina oblongata / Tubodiscus verenae	Speetonia colligata / Reinhardtites fenestratus	unnamed
		Pertransiensis			Micrantholithus speetonensis
		Otopeta		Cretarhabdus angustiforatus	unnamed; Sollasites arcuatus
Berriasian	Upper	Boissieri	Cretarhabdus angustiforatus		Perissocyclus fletcheri; Nannoconus sp. ■
	Middle	Occitanica	Nannoconus steinmannii	Micrantholithus spp. / Polycostella senaria; Lithraphidites carniolensis	
	Lower	Euxina		Nannoconus steinmannii	

● Boreal faunas and nannofloras in Tethys

■ Tethyan nannofloras in the Boreal Realm



Correlation between the ammonite and the nannofossil zones from Tethys (Roumania) around the Jurassic/Cretaceous boundary

Cretaceous evolution of the Northeastern margin of the Friuli Platform (NE Italy)

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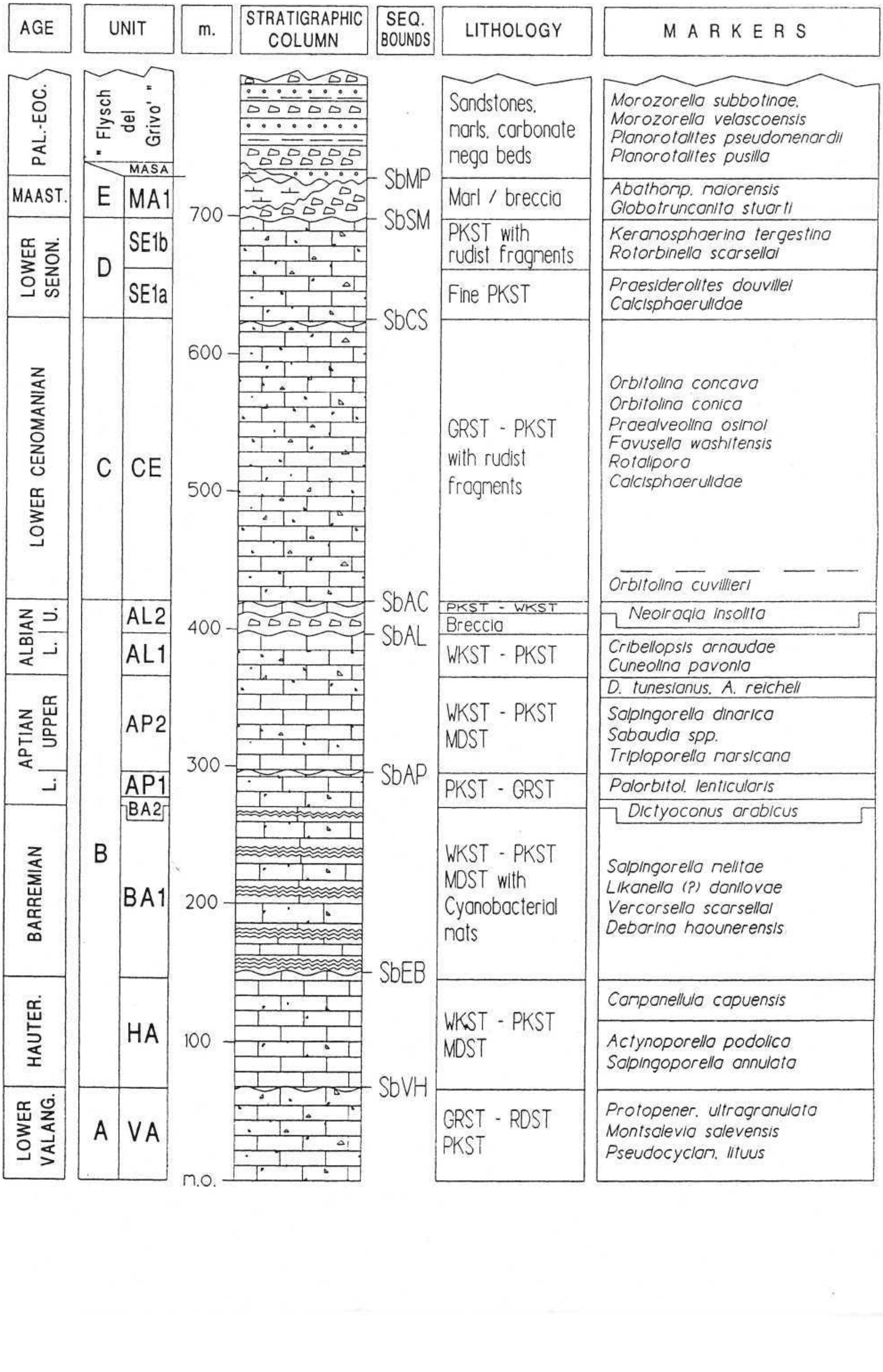
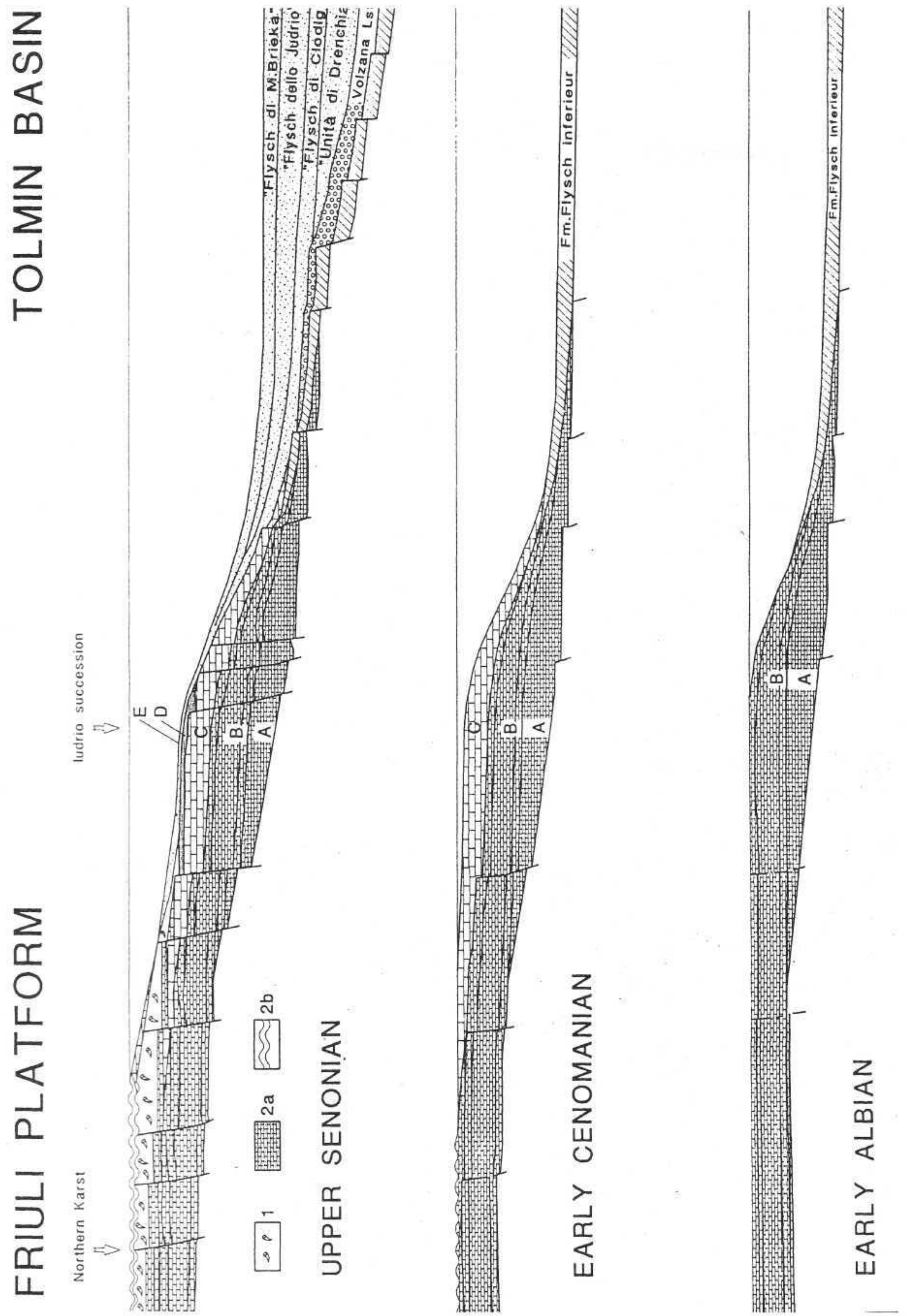
Key vords: Cretaceous, sedimentology, biostratigraphy, Friuli platform, Julian Prealps, Italy

Some successions of platform margin carbonates have been recently analyzed in the Julian Prealps region (Eastern Friuli) with the aim to examine the events and factors which caused the depositional evolution of the northeastern sector the Friuli Platform. The succession of the Iudrio Valley (Fig. 1) is palaeogeographically and palaeotectonically very important because it perpendicularly cuts the northeastern margin of the Friuli Platform which is connected to the Tolmin Basin. In this section five main units have been recognized. The oldest unit (Valanginian) identifies an outer platform sequence. Unit B (Hauterivian-Barremian-Aptian-Albian) represents restricted facies with interbedded some more open facies. Unit C (Lower Cenomanian) is referred to open facies. Unit D (Lower Senonian) is made up of ramp carbonate facies. After a long growth phase, platform collapsed during the Upper Senonian. Unit E (Maastrichtian) and two clastic Paleogene units are respectively ascribed to preflysch and flysch stages. Some sequence boundaries have been recognized in the Iudrio section. On the base of these and of the development of the different stratigraphic units examined in the wide area between Trieste karst and Tolmin (Slovenia) a model is proposed (Fig. 2). It summarizes the most important data about the evolution of the margin during the Early Albian-Upper Senonian. Here the ideal stratigraphic relationships are synthetically traced: i. e. relationships between the karst inner platform limestones, the platform margin carbonates (Iudrio succession), the limestones of the slope in the zone of Mt. Mataiur (Natisone Valley, Eastern Friuli) and the deep water basinal deposits of Kolovrat-Tolmin region (W. Slovenia).

Early Aptian is a relevant period which is connected to the middle Cretaceous orogenic phase. This phase produced remarkable gravity flow deposits at the lower slope and in the Tolmin Basin and has had important consequences on the Friuli Platform. The lower Cenomanian carbonates make a typical ramp succession in Iudrio zone, meanwhile a significant rearrangement of inner platform facies occured, conversely, in the slope and basin areas the coeval deposits are condensed or lacking. A new important tectonic phase during the upper Senonian modified the framework of the northeastern margin of the Friuli Platform which underwent a gradual collapse towards SW. In the Tolmin Basin the carbonate turbiditic sedimentation began (Volzana Lst) followed by preflysch and flysch deposits of late Campanian-Maastrichtian age.


AGE
UNIT
m.
STRATIGRAPHIC COLUMN
SEQ. BOUNDS
LITHOLOGY
MARKERS
PAL.-EOC.
" Flysch del Grivo' "
MASA
MAAST.
E
MA1
LOWER SENON.
D
SE1b
SE1a
LOWER CENOMANIAN
C
CE
ALBIAN L. U.
AL2
AL1
APTIAN UPPER L.
AP2
AP1
BA2
BARREMIAN
B
BA1
HAUTER.
HA
LOWER VALANG.
A
VA
700
600
500
400
300
200
100
n.o.
SbMP
SbSM
SbCS
SbAC
SbAL
SbAP
SbEB
SbVH
Sandstones, marls, carbonate mega beds
Marl / breccia
PKST with rudist fragments
Fine PKST
GRST - PKST with rudist fragments
PKST - WKST
Breccia
WKST - PKST
WKST - PKST MDST
PKST - GRST
WKST - PKST MDST with Cyanobacterial mats
WKST - PKST MDST
GRST - RDST PKST
Morozorella subbotinae, Morozorella velascoensis Planorotalites pseudomenardii Planorotalites pusilla
Abathomp. maiorensis Globotruncanita stuarti
Keramosphaerina tergestina Rotorbinella scarsellai
Praesiderolites douvillei Calcisphaerulidae
Orbitolina concava Orbitolina conica Praealveolina osimoi Favusella washitensis Rotalipora Calcisphaerulidae
Orbitolina cuvillieri
Neoiraqia insolita
Cribellopsis arnaudae Cuneolina pavonia
D. tunesianus, A. reicheli
Salpingorella dinarica Sabaudia spp. Triploporella marsicana
Palorbitol. lenticularis
Dictyoconus arabicus
Salpingorella melitae Likanella (?) danilovae Vercorsella scarsellai Debarina haounerensis
Campanellula capuensis
Actynoporella podolica Salpingoporella annulata
Protopener. ultragranulata Montsalevia salevensis Pseudocyclam. lituus


FRIULI PLATFORM
TOLMIN BASIN
Northern Karst
Iudrio succession
E
D
C
B
A
1
2a
2b
UPPER SENONIAN
"Flysch di M.Brieka"
"Flysch dello Judrio"
"Flysch di Clodig"
"Unità di Drenchia"
Volzana Ls
EARLY CENOMANIAN
Fm.Flysch Inferieur
EARLY ALBIAN
Fm.Flysch Inferieur

Mineralia Slovaca, 29 (1997), 284

Early Cretaceous deposits of the Great Caucasus (Azerbaijan): An overview

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Azerbaijan can be subdivided in 3 structural geological units: the Alpine mountain ranges of the Minor Caucasus in the south and the Great Caucasus in the north are separated by the Kura Depression The present study will give an update of a joint international effort carried out under the umbrella of IGCP-Project No. 362 to interpret the Azerbaijan section of the Great Caucasus in a geodynamic model using modern concepts. It is stressed that further research is necessary to validate the (preliminary) conclusions made in this study.

An important feature of the Great Caucasus is the fact that sediments from the southern and northern slope are different. The separation in a characteristic Southern Sedimentary Domain (SSD) and Northern Sedimentary Domain (NSD) already existed during the Early Jurassic. Volcanogenic sediments of Early to Middle Jurassic age were deposited in the SSD and are interpreted to be related to ocean floor spreading while the NSD was the site of normal marine sedimentation.

Cretaceous sediments from the SSD are generally deposited in a deeper marine environment when compared with sediments from the NSD. The hemi-pelagic nature of the lowermost Cretaceous sediments from the SSD and NSD are similar. Only the sediments of the SSD have a silicified character suggesting sedimentation beneath "carbonate compensation depth" level. During the "Mid" Cretaceous the SSD received mass-transported flysch-like sedimentation. These flysch-like sediments contain a great percentage of volcanogenic components. Hemi-pelagic circumstances prevailed at the NSD during the "Mid" Cretaceous, turbidites and other mass transported sedimentary features are found here but do not dominate the sedimentation.

From the above it is concluded, that the separation of the Great Caucasus in a SSD and NSD is caused by seafloor spreading during the Early Jurassic. Sediments of the SSD were deposited in an oceanic or peri-oceanic domain while sediments of the NSD were deposited on continental crust. The ocean/continent boundary separates the SSD from the NSD. The onset of compression during the Cretaceous resulted in further development in a characteristic SSD and NSD. The ocean/continent boundary has probably been used as a zone of weakness to accommodate compressional stress built up. It is here preliminary concluded that during the Cretaceous the Great Caucasus became the site of a foreland basin. The SSD became a foreland basin during the Cretaceous whereby flysch-like sediments were deposited in a deep oceanic environment. The NSD probably became a piggy-back basin during the Cretaceous whereby hemi-pelagic sediments were deposited in a less deep marine environment.

Mineralia Slovaca, 29 (1997), 285 - 286

Correlation of Cretaceous radiolarian, planktonic and agglutinated Foraminifera zonations in the Pieniny Klippen Belt, Western Carpathians, Poland

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Key words: Late Cretaceous, integrated biostratigraphy, Radiolaria, Foraminifera, Western Carpathian, Poland

Albian to Turonian deposits in the Polish part of the Pieniny Klippen Belt comprise pelagic and shaly turbidite facies. They represent products of rather shallow (shelf) to deep-water environments, being relatively rich in radiolarian fauna as well as in planktonic and agglutinated foraminifers.

The Unitary Association approach has been combined with the method based on first and the last appearance of taxa for establishing the Radiolaria biozonation. Radiolarian zones (*Holocryptocanium barbui, Hemicryptocapsa prepolyhedra* and *Hemicryptocapsa polyhedra*) (Tab. 1) have been correlated with sligthtly modified Robaszynski and Caron's (1995) planktonic Foraminifera biozonation (from *Ticinella bejaouaensis* to *Dicarinella primitiva* Zones). Some modification have been made by Bąk (1997) who took into account the pecularities of middle Cretaceous planktonic foraminifers distribution in the Pieniny Klippen Belt if compared with the successions studied by Robaszyński and Caron (l. c.).

The benthic Foraminifera biozonation (from *Haplophragmoides nonioninoides* to *Uvigerinamina* ex gr. *jankoi* zones) follows the scheme proposed by Geroch and Nowak (1984), which has been applied by Bąk et al. (1995) to the Pieniny Klippen Belt successions.

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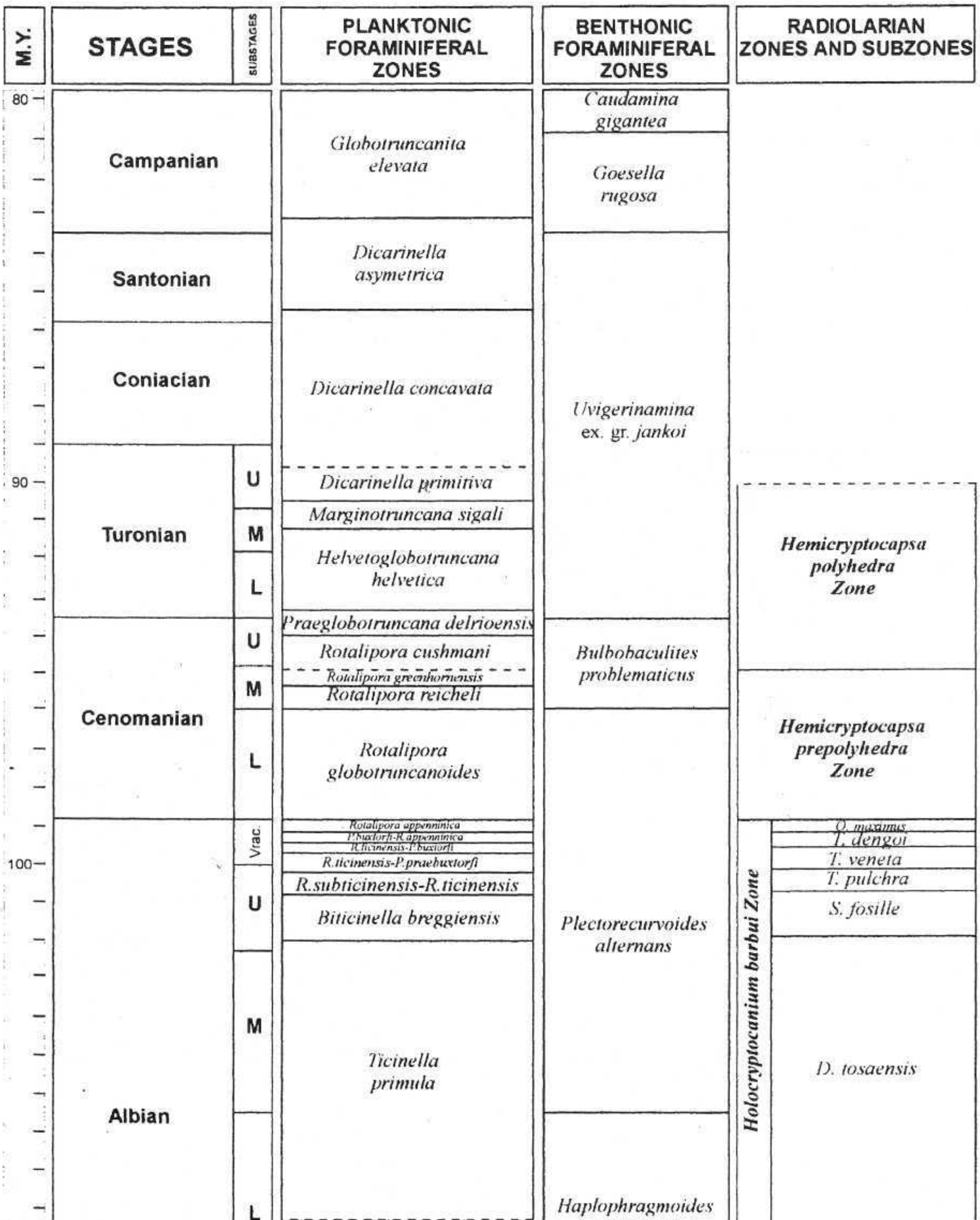

Tab. 1. Chart showing the tentative correlation of the planktonic (after Bąk, 1997) and benthonic (after Geroch and Nowak, 1984) foraminiferal zonations with the radiolarian zonal scheme proposed for the Cretaceous deposits in the Polish part of PKB.

Mineralia Slovaca, 29 (1997), 287 - 289

Integrated microbiostratigraphy in the Maastrichtian to Paleocene distal-flysch sediments of the Uzgruň section (Rača unit, Carpathian flysch, Czech Republic)

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Key words: Maastrichtian, Paleocene, integrated microbiostratigraphy, sedimentology, Outer Western Carpathians, Czech Republic

Introduction

The biostratigraphy in the Magura group of nappes of the Carpathian Outer Flysch Belt is limited by usually missing or poorly preserved calcareous micro- and nannofossils especially in the Cretaceous to Lower Eocene sediments. From this point of view, the Uzgruň section is very important. Pesl and Švábenická (1988) reported from this section the nannofossils of CC25 and CC26 nannozones evidenced the Late Maastrichtian age of the sediments considered up to that time Paleocene. Rich fossil content (foraminifers, radiolarians, calcareous nannofossils) in the section has enable to apply the integrated microbiostratigraphy approach.

Studied section

The Uzgruň section consists of several isolated outcrops along the unnamed brook on the NNE of Uzgruň settlement close to Czech-Slovak border. Faults and folds disturb the section from place to place.

The Soláň Formation is represented by predominantly thin-bedded flysch with high claystone/sandstone ratio. Green-grey and grey hemipelagic non-calcareous and turbidite calcareous claystones prevail over fine-grain sandstones, siltstones and marlstones in the Maastrichtian part. Thicker and more frequent sandstone beds occur in the completely non-calcareous Paleocene part.

The Beloveža Formation is poorly outcropped. In its lower part, the red-brown claystones probably predominat containing several meters thick bodies of coarse sandstones. The upper part is thin bedded with predominance of green-grey claystones over red-brown.

Autochthonous agglutinated assemblages and distal turbidites indicate the sedimentation in lower turbidite fan (margin of continental rise) below the CCD.

The turbidite calcareous claystones contained abundant and well-preserved calcareous nannofossils and sporadically planktonic foraminifers. Non-calcareous hemipelagic claystones contained abundant autochthonous agglutinated foraminifers. In addition, we found well preserved (pyritized) radiolarians in several layers of claystones (both turbidite and hemipelagic).

Foraminifers

Planktonic foraminifers are extremely rare in the Soláň Formation. Nevertheless the find of one test of *Abathomphalus mayaroensis* is stratigraphically important, evidencing the Uppermost Maastrichtian A. mayaroensis Zone.

Whole higher Lower Campanian - Maastrichtian interval is time equivalent of the Hormosina gigantea Zone sensu Geroch and Nowak (1984). Unfortunately, *Hormosina (=Caudammina) gigantea* is completely missing in the Uzgruň section. More detail subdivision of the Campanian-Maastrichtian interval world-wide based on the agglutinated foraminifers is still problematic.

The first occurrence of *Rzehakina fissistomata* defines the base of the Rzehakina fissistomata Zone sensu Geroch and Nowak (1984) and Bubík (1995) which is correlated approximately by the K/T Boundary. At the outcrop (point19) in the Uzgruň section, we observed the first occurrence of this species approximately 5.6 m above the last intercalation of calcareous claystone with Upper Maastrichtian nannofossils and *Abathomphalus mayaroensis*. The K/T boundary is expected within this interval.

Other stratigraphically important species are *Spiroplectammina* sp. 1 and *"Trochammina"* sp. 4 sensu Bubík (1995), and *Bulbobaculites fontinensis* sensu Geroch (1960). Last two mentioned species are promising for a subdivision of the Paleocene R. fissistomata Zone. *"Trochammina"* sp. 4 is known till now from the Lower Paleocene (Bubík, 1995). *Bulbobaculites fontinensis* occur in the youngest studied Paleocene strata of the Uzgruň section. This form is known till now from the Eocene. The ranges of both taxa have anyhow to be defined with more precision.

Uzgruň section	Age	Litho-stratigraphy	Calcareous nannofossils		Agglutinated foraminifers Bubík (1995)	Planktonic foraminifers Caron (1995)	Radiolarians Hollis (1992)
			Sissingh (1977)	local zones (this paper)			
29, 28	Paleocene	Beloveža Formation			Rzehakina fissistomata		
32, 23, 27, 19	Paleocene	Soláň Formation					
20	Maastrichtian		CC26	Micula prinsii		A. mayaroensis	Lithomelissa? hoplites
21, 25, 24	Maastrichtian		CC26	Nephrolithus frequens			
26	Maastrichtian		CC25c	Micula murus			

Stratigraphic correlation chart of the Maastrichtian to Paleocene sediments in the Uzgruň section.

Radiolarians

The recognised low latitude radiolarian association from the Soláň Formation is dominated by *Nassellariinae* belonging to the genera *Cryptocapsa, Gongylothorax, Cryptamphorella, Theocapsomma, Siphocampe, Rhopalosyringium, Myllocercion, Eostichomitra, Stichomitra, Dictyomitra* and *Amphipyndax*. *Spumellariinae* are less common in association investigated. They are represented by the genera as *Pseudoaulophacus, Patellula, Praeconocaryomma* and *Orbiculiforma*.

The assemblage investigated can be correlated with the late Campanian to Maastrichtian Amphipyndax tylotus Zone of Foreman (1977), Theocapsomma comys Zone of Riedel and Sanfilippo (1974) of approximately Maastrichtian age, and Maastrichtian Orbiculiforma renillaeformis interval Zone proposed by Pessagno (1976).

The assemblage from Uzgruň can be also correlated with the Late Campanian to the latest Maastrichtian Lithomelissa ? hoplites Zone of Hollis (1992) based on presence of *O. anillaeformis, A. stocki, M. acineton, E. asymbatos* and *D. multicostata*. Hollis (1992) defined the top of this zone as the first appearance of *Amphisphaera aotea* Hollis and dated it as the K/T boundary. Moreover, radiolarian composition changes from *Nassellarinae* to *Spumellarinae* dominance at the K/T boundary.

The radiolarian fauna composition in our assemblage is dominant by *Nassellarinae* and also lacking *A. aotea* what may prove its Cretaceous age.

Calcareous nannofossils

The nannofossil associations of the Soláň Formation contained Maastrichtian species as *Arkhangelskiella cymbiformis, Prediscosphaera grandis, Cribrosphaerella danae, Lithraphidites quadratus* and *Ceratolithoides kamptneri*.

The Late Maastrichtian age is documented by presence of *Micula murus* (CC25c Zone) and by *Nephrolithus frequens* (CC26 Zone sensu Sissingh, 1977 and Perch-Nielsen, 1985). Presence of *Micula prinsii* allowed the correlation with the uppermost part of the Late Maastrichtian (Perch-Nielsen, 1985).

In addition, the stratigraphically "youngest" nannofossil assemblages contained the so called "survivor species", such as *Markalius apertus, M. inversus* and *Placozygus sigmoideus*.

No Paleogene species were occur in the above mentioned nannofossil associations. Unfortunately, the overlying non-calcareous sequence that provided foraminifers of the Paleocene age did not contain calcareous nannofossils.

In these Late Maastrichtian sediments, we observed common occurrences of high- and low-latitude nannofossils. *Micula murus, M. prinsii* and *Lithraphidites quadratus* represent the Mediterranean elements. On the other hand, *Nephrolithus frequens* that prefers cold-temperate waters was also present. Moreover, the presence of *Prediscosphaera stoveri, Biscutum coronum, B. boletum* and *Monomarginatus quaternarius* may be also considered as the feature of the Boreal bioprovince.

Conclusions

Continuous section across the K/T boundary was observed in the distal flysch sediments of the Soláň Formation. In the Maastrichtian, the high-resolution biostratigraphy is based on calcareous nannofossils. In the complete non-calcareous Paleocene part of the formation, agglutinated foraminifers are only tool for biostratigraphy.

The nannofossils evidenced the influence of both Boreal and Tethyan bioprovince on the Magura sedimentary area.

The Uzgruň section provided also interesting data on the radiolarian biostratigraphy, considering the fact, that the well-documented sections containing Upper Cretaceous to Paleocene deposits with biostratigraphic control are generally lacking.

There is no disproportion between the results from single fossil groups at the studied section.

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Mineralia Slovaca, 29 (1997), 290 - 294

Upper Cretaceous integrated biostratigraphy from Romania

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Key words: Late Cretaceous, integrated stratigraphy, ammonites, inoceramids, foraminifers, palynomorphs, nannoplankton, Carpathians, Dobrogea, Romania

The contribution compiles recent biostratigraphic knowledge of Late Cretaceous sequences in both Eastern and Southern Carpathians, northern and southern Dobrogea, based on several groups of fossil organisms. Ammonite and inoceramid zonation has been studied by Szasz, planktonic foraminifers by Ion and Szasz, calcareous nannoplankton by Melinte, dinoflagellates and palynomorphs by Antonescu. The authors correlated their results with standard ammonite zonation (Kennedy, 1984a, b; 1985), inoceramid zonation from the german Basin (Tröger, 1989) and planktonic Foraminifera zonation (Robaszynski and Caron, 1983, 1984).

Fig 1- 4 captions: 1 - not investigated biostratigraphically; 2 - sedimentary gap; boundary marker bioevents for the zones/subzones; 3 - first occurreance; 4 - last occurreance; 5 - bloom; auxiliary; bioevents; 6 - first occurrence, 7 - last occurrence.

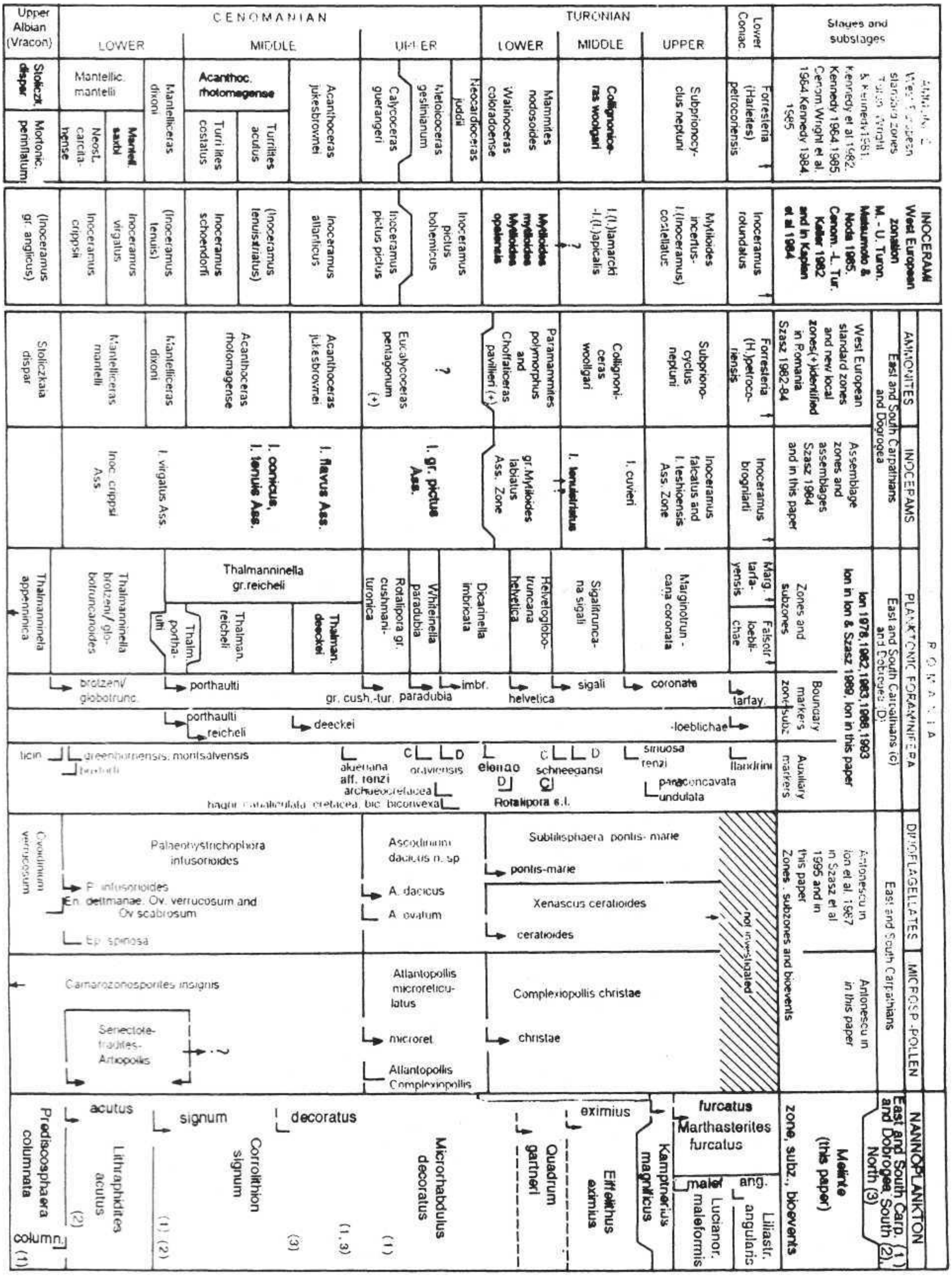
Key to fossils for figures 1 - 4: Macrofossils: B - *Belemnitella;* Bo - *Bostricoceras;* Co - *Conulus;* Di - *Diplacmoceras;* Ga - *Gautiericeras;* H - *Hoplitoplacenticeras;* Ho - *Hoploscaphites;* E - *Echinocorys;* I - *Inoceramus;* M(D) - *Menabites* (*Delawarella*); Mi - *Micraster;* P - *Pachydiscus;* Pa - *Parapuzosia;* Pl - *Pacenticeras;* Pr - *Paratexanites;* Px - *Pseudoxybeloceras;* Tx - *Texanites.*

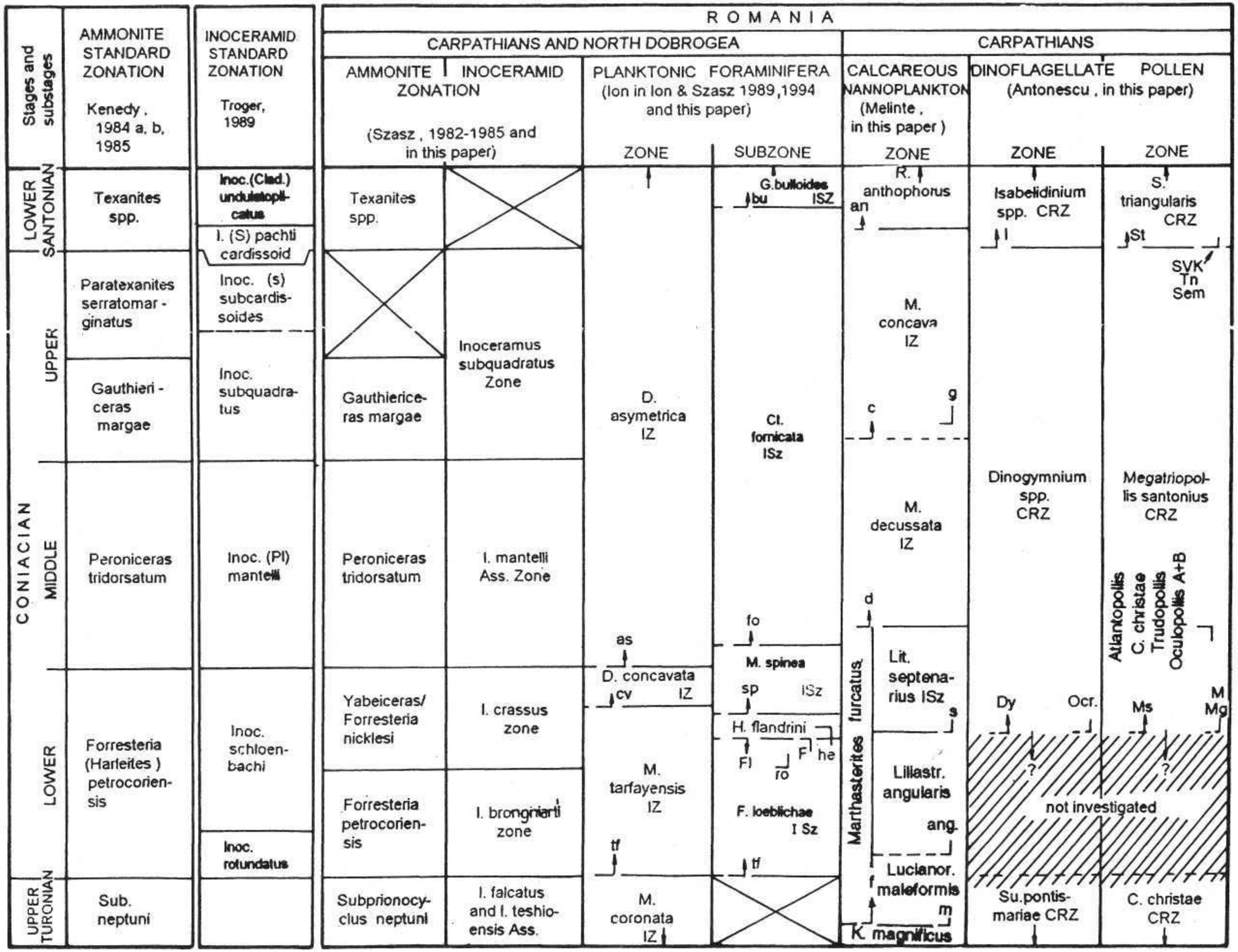
Planktonic foraminifera: Ab - *Abathomphalus;* my - *Ab. mayaroensis;* it - *Ab. intermedius;* Ct - *Contusotruncana;* ct - *Ct. contusa;* fo - *Ct. fornicata;* m - *Ct. manaurensis;* D - *Dicarinella;* as. - *D. asymetrica;* bb - *D. biconvexa biconvexa;* bg - *D. biconvexa gigantea;* cv - *D. concavata;* F - *Falsotruncana;* Fl - *F. loeblichae;* G - *Globotruncana;* a - *G. arca;* ag - *G. aegyptiaca;* bu - *G. bulloides;* es - *G. esnehensis;* fs - *G. falsostuarti;* gn - *G. gagnebini;* l - *G. linneiana;* ro - *G. rosetta;* rg - *G. rugosa;* v - *G. ventricosa;* Gg - *Globigerina;* eu - *G. eugubina;* Gl - *Globotruncanella;* gn - *Globoconusa;* Gs - *Gansserina;* gs - *Gs. gansseri;* Gt - *Globotruncanita;* cl - *Gt. calcarata;* cn - *Gt. conica;* el - *Gt. elevata;* fc - *Gt. falsocalcarata;* sf - *Gt. stuartiformis;* st - *Gt. stuarti;* H - *Hedbergella;* fl - *H. flandrini;* he - *Helvetoglobotruncana helvetica;* M - *Marginotruncana;* p - *M. paraconcavata;* sp - *M. spinea;* tf - *M. tarfayensis;* Pl - *Plummerita;* Ra - *Racemiguembelina;* va - *R. varians;* Rt - *Rugotruncana;* k - *Rt. kefiana.*

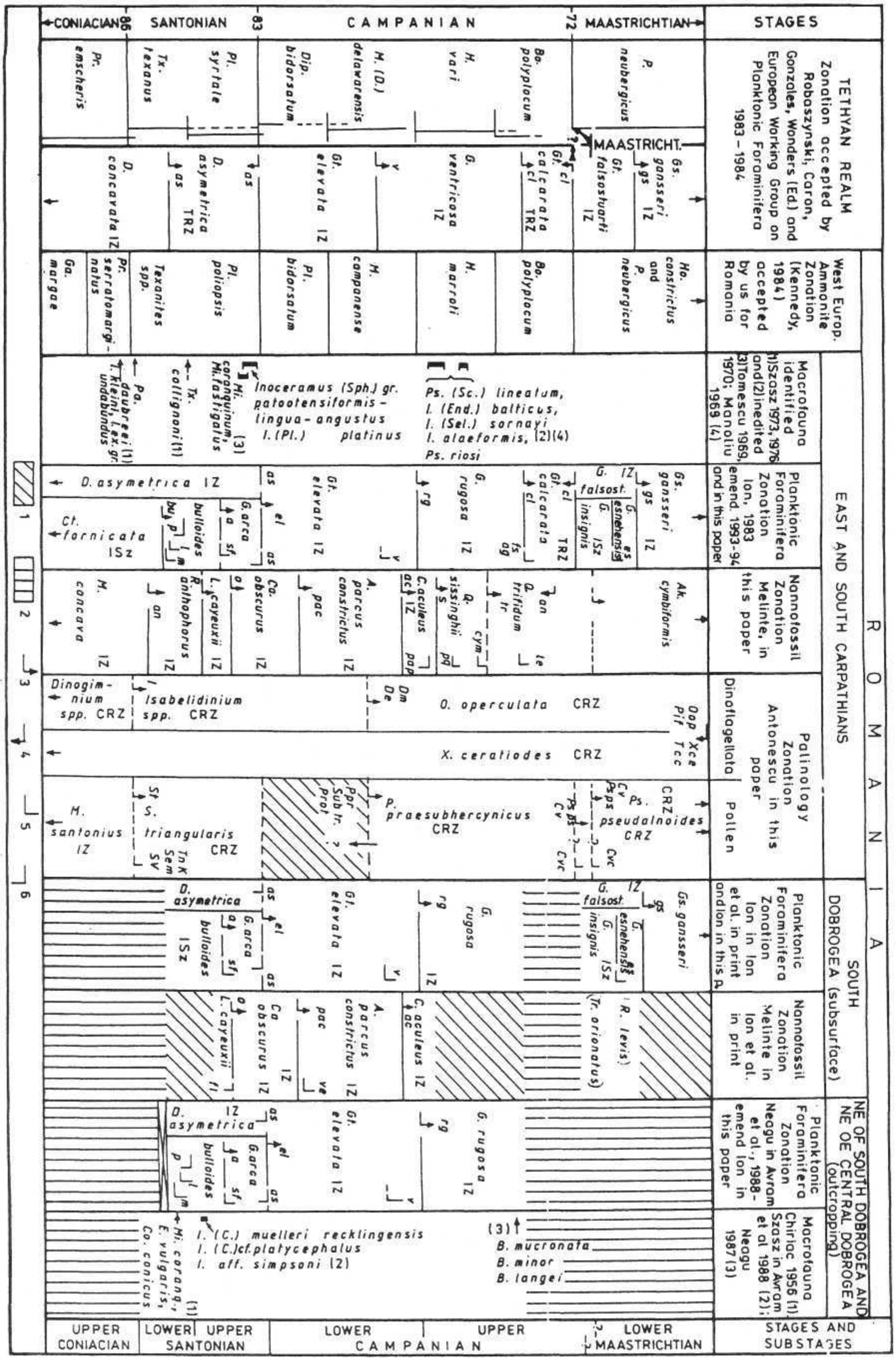
Dinoflagellates: Dy - *Dinogymnium;* De - *D. euclaense;* Dm - *D. majus;* I - *Isabelidinium;* O - *Odontochitina;* Ocr - *O. cribropoda;* Oop - *O. operculata;* Pif - *Palaeohystrichophora* infusorioides; Su - *Subtilisphaera;* Si - *Senoniasphaera inornata;* T - *Talassiphora;* Tp - *T. pelagica;* Tc - *Trichodinium castaneum;* Tt - *Trithirodinium;* Tev - *T. evittii;* Tru - *Triblastula utinensis;* X - *Xenascus;* Xce - *X. ceratoides.*

Pollen: C - *Complexiopollis;* Cv - *Convexipollis;* Cvc - *Cv. convexigerminallis;* K - *Krutzschipollis;* M - *Megatriopollis;* Ms - *M. santonius;* Mg - *M. glabrum;* Oo - *Oculopollis orbicularis;* P - *Pseudopapilopollis;* Ppr - *P. praesubhercynicus;* Po - *Pompeckjoidaepollenites;* Prot - *Proteacidites;* Ps - *Pseudotrudopollis;* Psps - *Ps. pseudalnoides;* S - *Suemeghipollis*; St - *S. triangularis*; Sem - *Semioculopollis medius;* Sub - *Subtriporopollenites;* Tn - *Trudopollis* cf. *nonperfectus;* Tr - *Triporopollenites.*

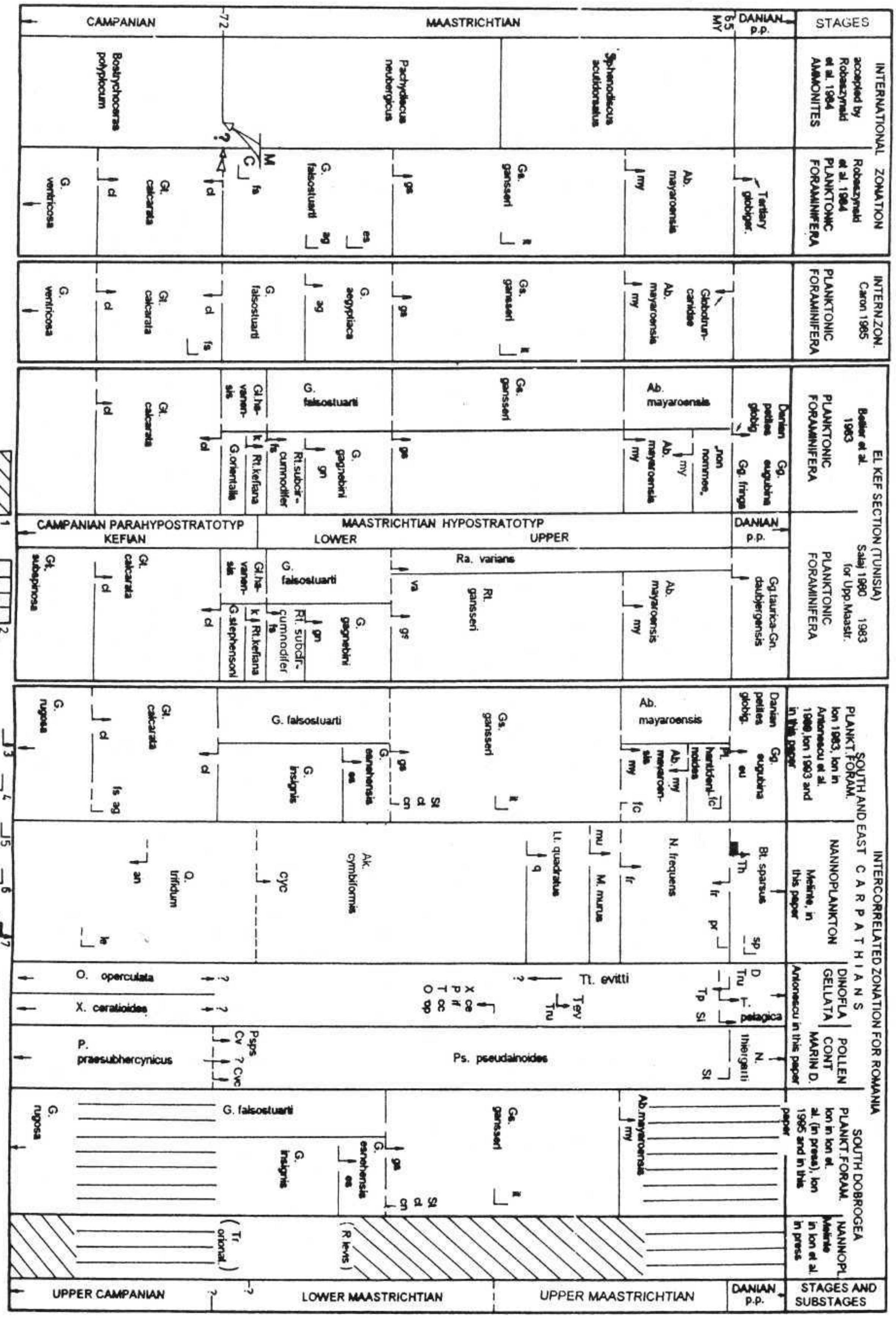
Calcareous nannoplankton: a - *Aspidolithus;* pac - *A. parcus constrictus;* pap - *A. parcus parcus;* Ak - *Arkhangelskiella;* cyc - *Ak. cymbiformis cymbiformis;* cym - *Ak. cymbiformis minor;* Bt - *Biantholithus;* K - *Kamptnerius;* Lil - *Liliasterites;* ag - *Lil. angularis;* Lit - *Lithastrinus;* g - *Lit. grillii;* s - *Lit. septenarius;* L - *Lucianorhabdus;* cy - *L. cayeuxii;* m - *L. maleformis;* Lt - *Lithraphidites;* pq - *Lt. praequadratus;* q - *Lt. quadratus;* M - *Micula;* d - *M. decussata;* mu - *M. murus;* pr - *M. prinsii;* Ma - *Marthasterites;* f - *Ma. furcatus;* N - *Nephrolithus;* fr - *N. frequens;* Q - *Quadrum;* si - *Q. sissinghii;* tr - *Q. trifidum;* R - *Reinhardtites;* an - *R. antophorus;* le - *R. levis*; Tr - *Tranalithus*; Th - *Thoracosphaera*; ve - *Ceratholithoides verbeekii.*


Upper Albian (Vracon)
CENOMANIAN
LOWER
MIDDLE
UPPER
TURONIAN
LOWER
MIDDLE
UPPER
Lower Coniac.
Stages and substages
INOCERAMI
AMMONITES
INOCERAMS
PLANKTONIC FORAMINIFERA
DINOFLAGELLATES
MICROSP.-POLLEN
NANNOPLANKTON
ROMANIA
East and South Carpathians and Dobrogea
Thalmanninella gr.reicheli
Palaeohystrichophora infusorioides
Subtilisphaera pontis-mariae
Xenascus ceratioides
Camarozonosporites insignis
Complexiopollis christae
not investigated
acutus
signum
decoratus
eximius
furcatus
Marthasterites furcatus
Rotalipora s.l.


Stages and substages
UPPER TURONIAN
CONIACIAN
LOWER
MIDDLE
UPPER
LOWER SANTONIAN
AMMONITE STANDARD ZONATION
Kenedy, 1984 a, b, 1985
Sub. neptuni
Forresteria (Harleites) petrocoriensis
Peroniceras tridorsatum
Gauthieri-ceras margae
Paratexanites serratomarginatus
Texanites spp.
INOCERAMID STANDARD ZONATION
Troger, 1989
Inoc. rotundatus
Inoc. schloenbachi
Inoc. (Pl) mantelli
Inoc. subquadratus
Inoc. (s) subcardissoides
I. (S) pachti cardissoid
Inoc. (Clad.) undulatoplicatus
ROMANIA
CARPATHIANS AND NORTH DOBROGEA
AMMONITE | INOCERAMID ZONATION
(Szasz, 1982-1985 and in this paper)
Subprionocyclus neptuni
Forresteria petrocoriensis
Yabeiceras/ Forresteria nicklesi
Peroniceras tridorsatum
Gauthiericeras margae
Texanites spp.
I. falcatus and I. teshioensis Ass.
I. brongniarti zone
I. crassus zone
I. mantelli Ass. Zone
Inoceramus subquadratus Zone
PLANKTONIC FORAMINIFERA
(Ion in Ion & Szasz 1989,1994 and this paper)
ZONE
SUBZONE
M. coronata IZ
tf
M. tarfayensis IZ
cv
D. concavata IZ
as
D. asymetrica IZ
tf
F. loeblichae I Sz
Fl
ro
F
he
H. flandrini
sp
M. spinea ISz
fo
Ct. fornicata ISz
bu
G. bulloides ISZ
CARPATHIANS
CALCAREOUS NANNOPLANKTON
(Melinte, in this paper)
ZONE
K. magnificus
Marthasterites furcatus
f
m
Lucianor. maleformis
ang.
Liliastr. angularis
s
Lit. septenarius ISz
d
M. decussata IZ
c
g
M. concava IZ
an
R. anthophorus
DINOFLAGELLATE POLLEN
(Antonescu, in this paper)
ZONE
Su. pontismariae CRZ
not investigated
?
Dy
Ocr.
Dinogymnium spp. CRZ
I
Isabelidinium spp. CRZ
ZONE
C. christae CRZ
Ms
M
Mg
Atlantopollis
C. christae
Trudopollis
Oculopollis A+B
Megatriopollis santonius CRZ
SVK
Tn
Sem
St
S. triangularis CRZ



CONIACIAN 86 SANTONIAN 83 CAMPANIAN 72 MAASTRICHTIAN
STAGES
TETHYAN REALM Zonation accepted by Robaszynski, Caron, Gonzales, Wonders (Ed.) and European Working Group on Planktonic Foraminifera 1983 – 1984
West Europ. Ammonite Zonation (Kennedy, 1984) accepted by us for Romania
Macrofauna identified (1)Szasz 1973, 1976 and (2) inedited (3) Ionescu 1969, 1970; Manoliu 1969 (4)
Planktonic Foraminifera Zonation Ion, 1983 emend. 1993-94 and in this paper
Nannofossil Zonation Melinte, in this paper
Palinology Zonation Antonescu in this paper
Dinoflagellata
Pollen
EAST AND SOUTH CARPATHIANS
Planktonic Foraminifera Zonation Ion in Ion et al. in print and Ion in this p.
Nannofossil Zonation Melinte in Ion et al. in print
SOUTH DOBROGEA (subsurface)
Planktonic Foraminifera Zonation Neagu in Avram et al., 1988 - emend Ion in this paper
Macrofauna Chiriac 1956 (1), Szasz in Avram et al 1988 (2); Neagu 1987 (3)
NE OF SOUTH DOBROGEA AND NE OF CENTRAL DOBROGEA (outcropping)
ROMANIA
UPPER CONIACIAN
LOWER UPPER SANTONIAN
LOWER UPPER CAMPANIAN
LOWER MAASTRICHTIAN
STAGES AND SUBSTAGES
1 2 3 4 5 6


CAMPANIAN
MAASTRICHTIAN
DANIAN p.p.
STAGES
CAMPANIAN PARAHYPOSTRATOTYP KEFIAN
MAASTRICHTIAN HYPOSTRATOTYP
LOWER
UPPER
DANIAN p.p.
G. falsostuarti
Ra. varians
O. operculata
X. ceratioides
Tt. evitti
P. praesubhercynicus
Ps. pseudalnoides
G. falsostuarti
UPPER CAMPANIAN
LOWER MAASTRICHTIAN
UPPER MAASTRICHTIAN
DANIAN p.p.
STAGES AND SUBSTAGES

The Albian ammonites, nannofossils and sequence stratigraphy in Bulgaria

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Key words: Albian, integrated, stratigraphy, ammonites, nannoplankton, sequence stratigraphy, Bulgaria

The Albian sequences are well exposed on the territory of North Bulgaria. They consist of sediments deposited in differrent basinal zones. There are a number of condensed sections (glauconite-phosphoritic sediments), as well as typical thick deep-water successions (predominantly marls).

The Albian Stage and its ammonite fauna have been a subject of intensive research in the last decade (Ivanov and Stoykova, 1990; Ivanov, 1991). In the present study, the first attempt for direct calibration of ammonite, nannofossil and eustatic events is made (Fig. 1). The base of the Albian sequence is drawn by the first appearance of the ammonite genus *Leymeriella,* at the base of *L. tardefurcata* Zone. The first occurrence (FO) of the nannofossil species *Prediscosphaera* aff. *columnata* is recorded within the uppermost Aptian *H. jacobi* ammonite Zone.

In the lower part of the *L.(L.) tenuicostata* Subzone, a distinct sequence boundary (SB 1) is recognised. The latter is washed-out on the slope margin, resulting in condensations. The following two sequence units spanning the Lower Albian are represented by submarine wedges. The FO of the calcareous nannofossil *Cribrosphaera ehrenbergii* is restricted within the Early Albian *L.(N.). regularis* Zone. In the upper part of the Lower Albian (*D. mammillatum* Zone, below the base of *P.(I.) eodentatus* Subzone), the next sequence boundary is registered (SB 3). The nannofossil event FO of *Tranolithus phacelosus* falls within the *P.(I.) eodentatus* Subzone.

The base of the Middle Albian is drawn at the base of *L. lyelli* Subzone. It is marked by the appearance of the index-species as well as the FO of the typical *Hoplites.* Strong condensation in the basinal and marginal sections are documented within the *A. intermedius* ammonite subzone. The base of this subzone coincides with the next sequence boundary, SB 4.

The base of the Upper Albian is drawn at the appearance of the ammonite species *Dipoloceras cristatum.* This substage boundary is equated to the base of *E. turriseiffelii* nannofossil zone (CC 9), marked by the FO of the index-species at the base of *M. inflatum* ammonite zone (Fig. 1). It is a sharp limit, coinciding with the base of the sequence unit 5 (SB 5). At least four 3-rd order sequences can be identified within the Upper Albian (SB 6 - 9).

The upper boundary of the Albian sequence is drawn at the disappearance of the ammonites *Stoliczkaia dispar, Ostlingoceras puzosianum,* etc. No apparently reliable nannofossil event occurs over the Albian/Cenomanian boundary. The first simultaneous occurrence of the nannofossils *Corollithion kennedyi* and *Lithraphidites acutum* is recorded some 10 m above the Albian/Cenomanian boundary in ammonite terms.

The results obtained are based on direct combined ammonite and nannofossil logging of 15 sections of the Albian Stage, located in North-West and Central North Bulgaria. This study was undertaken in the framework of the Project No 505/95, financed by the Bulgarian Scientific Foundation.

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Magnetostratigraphic and calpionellid biostratigraphic scales correlation in the Jurassic/Cretaceous boundary strata

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Key words: Tithonian, Berriasian, magnetostratigraphy, microbiostratigraphy, Western Carpathians, Slovakia

The magnetostratigraphic scale of the Jurassic/Cretaceous boundary strata in the locality of Brodno (W. Slovakia) is known in full details (Krs, Krsová, Pruner in Houša et al., 1996a, 1996b). Detailed study of calpionellids in this strata makes possible to situate exactly the position of the stratigraphically important events of calpionellid associations in the magnetostratigraphic scale.

First specimens of Chitinoidella (*Ch. slovenica, Ch. colomi, Ch. dobeni*) appear in the late reverse magnetozone M20r. They dissapear in a short time already at the boundary between M20r and M20n magnetozones, immediately before the appearence of *Ch. boneti.*

The M20n magnetozone is divided into two normal magnetosubzones by short reverse magnetosubzone (M20n - 1 in Ogg et al., 1991). We designate this reverse magnetosubzone by the name "Kysuca". In the younger part of the early normal magnetosubzone ("Praekysuca") of the M20n magnetozone, acme of *Ch. boneti* occurs. Together with it *Praetintinnopsella andrusovi* appears. *Ch. boneti* disappears by the end of Praekysuca magnetosubzone, the latest specimens of *P. andrusovi* were detected in the basal part of the Kysuca reversed magnetosubzone, immediately before the appearence of first calpionellids with full hyaline lorica.

First specimens of *Calpionella grandalpina* (base of the Intermedia Subzone) appear on the base of the reverse magnetozone M19r. In the identical position, we found this event on other sections studied too, e. g. Bosso (Italy) and Rio Argos (Spain).

Base of Calpionella alpina Standard Zone (J/C boundary) in Brodno is situated slightly above the center of the normal M19n magnetozone. In the upper part of this magnetozone, a short reverse magnetosubzone occurs. We designate it by the name "Brodno" reverse magnetosubzone. A short acme of *Crassicollaria parvula* in the Brodno section is situated slightly below the middle between J/C boundary and the Brodno reversed magnetosubzone. In the identical position, we detected it in the Bosso section (Italy) too.

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Late Jurassic/Early Cretaceous revised calpionellid zonal and subzonal division and correlation with ammonite and absolute time scales

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Key words: Jurassic, Cretaceous, Biochronology, Calpionellid Zones, Calpionellid Subzones

Introduction

Calpionellids are distributed worldwide in (hemi)pelagic rocks of the Tethyan belt (see Remane, 1985; Pop, 1994b) and are the only fossils allowing a biochronologic zonation as precise as ammonite zonation. Although a standard calpionellid zonation was established during the second conference on planktonic organisms at Rome 1970 (Allemann et al., 1971), until now no commonly accepted biochronologic framework exists in terms of subzonal division. Allemann et al. (1971: tab. 1) and Remane et al. (1986, Sümeg meeting) gave comparative charts of the subzonal divisions proposed until 1986. Because obviously these subdivisions were not satisfying, several new proposals for the subdivision of the standard calpionellid zones were published since then [Altiner and Özkan (1991), Oloriz et al. (1995), Pop (1994-1996), Blanc (1995), Reháková (1995), Grün and Blau (1997), Reháková and Michalík (1997)]. The calpionellid zonations published since the Sümeg meeting with the addition of Trejo's (1975-1980) zonation are compiled in Fig. 1.

Revised calpionellid zonal and subzonal division

Based on field data (Grün and Blau, 1996, 1997) and on literature work, a revised zonal and subzonal biochronologic framework for the Calpionellidea is proposed. From the Middle Tithonian to the (?) Late Hauterivian this framework comprises six calpionellid zones which are subdivided into 19 subzones. For accompanying annotations see Grün and Blau (1997). Remarks are provided here only if subjects became changed since the latter work.

***Chitinoidella* Zone**
Base: corresponds to the base of Dobeni Subzone.
Dobeni Subzone
Base: First occurrence (FO) Chitinoidellidae Grün and Blau, 1997.
Index: *Chitinoidella dobeni* Borza.
Boneti Subzone
Base: FO of *Chitinoidella boneti* Doben.
Index: *Chitinoidella boneti* Doben.
Bermudezi Subzone
Base: FO *Chitinoidella bermudezi* Furrazola-Bermudez.
Index: *Chitinoidella bermudezi* Furrazola-Bermudez.
Andrusovi Subzone
Base: FO *Praetintinnopsella andrusovi* Borza.
Index: *Praetintinnopsella andrusovi* Borza.

***Crassicollaria* Zone**
Base: corresponds to the base of the Remanei Subzone.
Remanei Subzone
Base: FO Calpionellidae Bonet.
Index: *«Tintinnopsella» remanei* Borza.
Intermedia Subzone
Base: FO *Calpionella alpina* (Lorenz) (large variety).
Index: *Crassicollaria intermedia* (Durand-Delga).
Catalanoi Subzone
Base: FO genus *Remaniella.*
Index: *Remaniella catalanoi* POP.

***Calpionella* Zone**
Base: corresponds to the base of the Alpina Subzone.
Alpina Subzone
Base: FO *Remaniella duranddelgai* Pop.
Index: *Calpionella alpina* Lorenz.
Elliptica Subzone
Base: FO *Calpionella elliptica* Cadisch.
Index: *Calpionella elliptica* Cadisch.
Cadischiana Subzone
Base: FO *Remaniella cadischiana* (Colom).
Index: *Remaniella cadischiana* (Colom).
Remark: *Remaniella cadischiana* (Colom) was revised by Grün and Blau (1996) and a lectotype choosen. Due to the revision *Remaniella cadischiana* (Colom) now represents a clearly determinable species.

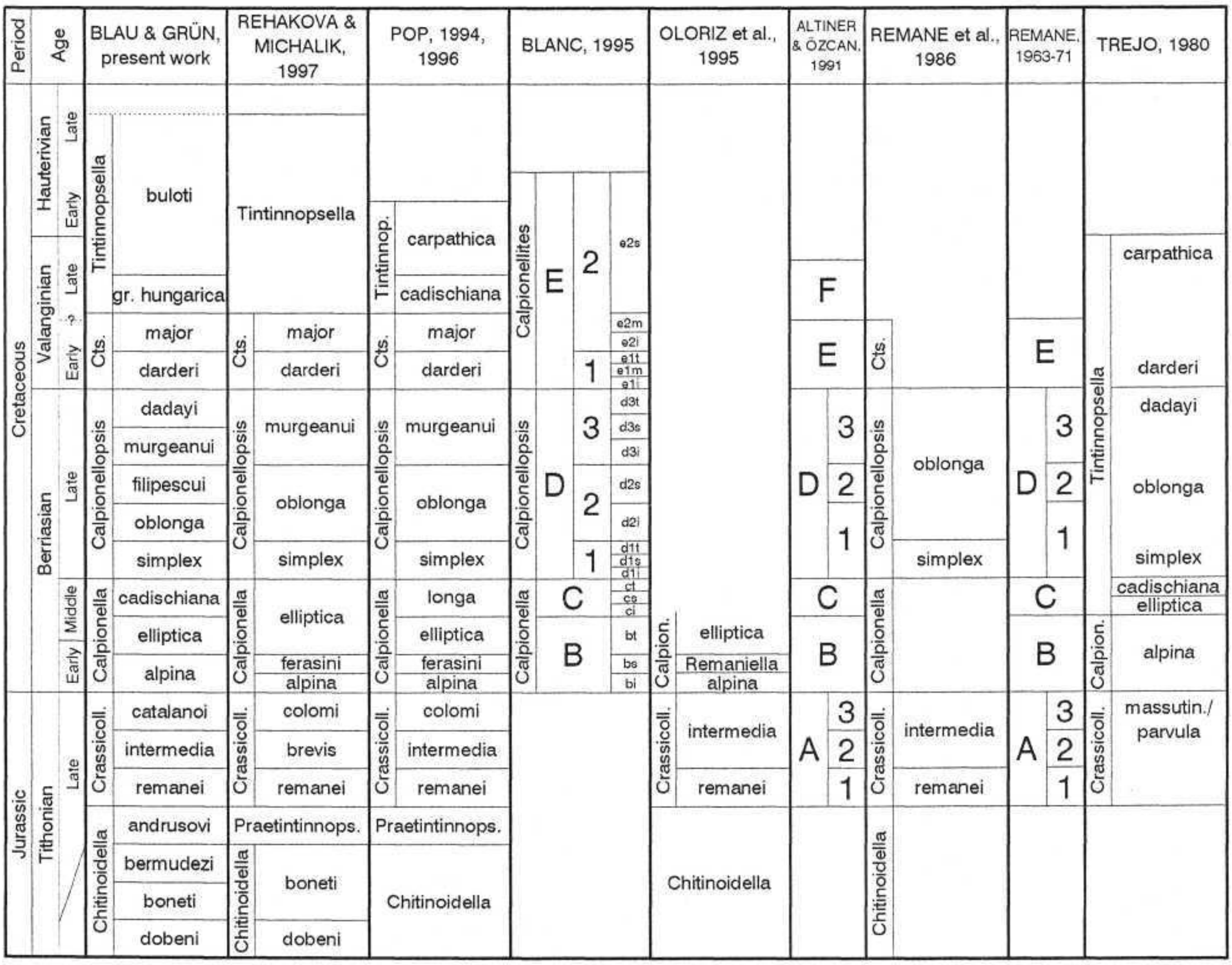

Fig. 1. Comparative chart of the revised biochronological calpionellid zonation and zonations published since the Sümeg meeting.

Calpionellopsis Zone
Base: corresponds to the base of the Simplex Subzone.
Simplex Subzone
Base: FO *Calpionellopsis simplex* (Colom).
Index: *Calpionellopsis simplex* (COLOM).
Oblonga Subzone
Base: FO *Calpionellopsis oblonga* (Cadisch).
Index: *Calpionellopsis oblonga* (Cadisch).
Filipescui Subzone
Base: FO *Praecalpionellites filipescui* Pop.
Index: *Praecalpionellites filipescui* Pop.
Murgeanui Subzone:
Base: FO *Praecalpionellites murgeanui* (Pop).
Index: *Praecalpionellites murgeanui* (Pop).
Dadayi Subzone:
Base: FO *Praecalpionellites dadayi* (Knauer).
Index: *Praecalpionellites dadayi* (Knauer).
Remark: The taxonomic validity of *Praecalpionellites dadayi* (Knauer) was demon-strated by Grün and Blau (1996). According to their revision, *Praecalpionellites dadayi* (Knauer) and *Remaniella cadischiana* (Colom) can be clearly distinguished by means of metric data, lorica shape, and collar construction.

Calpionellites Zone
Base: corresponds to the base of the Darderi Subzone.
Darderi Subzone
Base: FO *Calpionellites darderi* (Colom).
Index: *Calpionellites darderi* (Colom).
Major Subzone
Base: FO *Calpionellites major* (Colom).
Index: *Calpionellites major* (Colom).

Tintinnopsella Zone
Base: corresponds to the base of the gr. Hungarica Subzone.
gr. Hungarica Subzone:
Base: Last occurrence (LO) of the genus *Calpionellites*
Index: *Lorenziella* gr. *hungarica* Knauer and Nagy.
Buloti Subzone
Base: LO *Praecalpionellites dadayi* (Knauer).
Index: *Tintinnopsella buloti* Blanc.

Remarks: The gr. Carpathica Subzone of Grün and Blau (1997) is renamed herein to Buloti Subzone.

Calpionellid, ammonite, and absolute time scales

Fig. 2 shows a correlation chart of calpionellid chronostratigraphic, ammonite chronostratigraphic, and absolute time scales. Data for the absolute time scale are taken from Gradstein and Ogg (1996). All modern correlations between ammonite and calpionellid zones and subzones (Tithonian: Geyssant and Enay, 1991; Berriasian: Zakharov et al., 1996; Valanginian: Bulot, 1996) still use the calpionellid zonal scheme developed by Remane (1963, 1964, 1971) and Le Hégarat and Remane (1968). The correlations themselves are a graphical handfittet interpolation with all its problems (Grün and Blau, 1997).

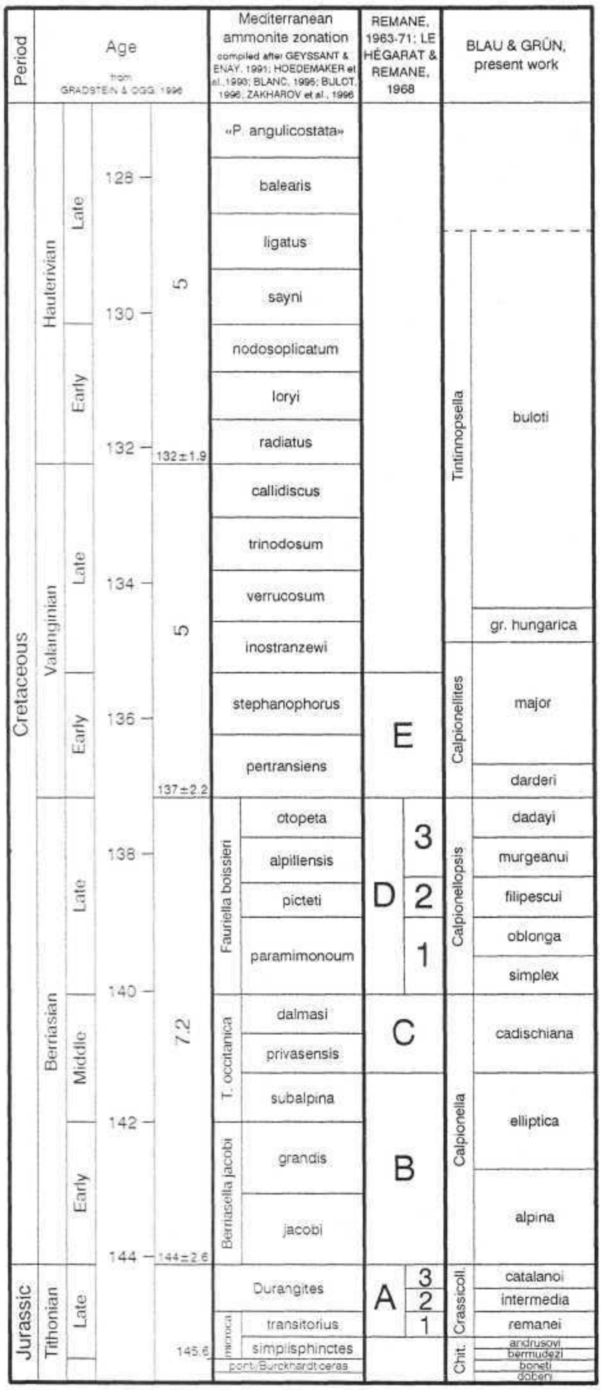

Fig. 2. Correlation chart of calpionellid, ammonite, and absolute time scales.

The Tithonian/Berriasian boundary is marked by the base of the Alpina Subzone (the base of Remane calpionellid B Zone). This is accepted by Geyssant and Enay (1991) and more recently by Zakharov et al. (1996).

The latter authors alsoprovide the data for the Berriasian ammonite and calpionellid zonation which was modified by us including the southeastern French Otopeta ammonite zone and using the Alpillensis Ammonite Zone in the sense of Bulot (1996) and the data on Early Valanginian calpionellid biochronology. In fact, the definition of the Valanginian base is a matter of controverse discussion (see Bulot, 1996) and not yet solved. According to new data (e.g., Blanc, 1995; Reháková, 1995) calpionellids extend until Late Hauterivian (see also Pop, 1994b).

Discussion

We present a revised zonal and subzonal biochronologic scheme based on calpionellids. The lower boundaries of the units of our scheme are well fitting with those of the subdivisions of the Vocontian Trough (for detailed discussion see Grün and Blau, 1997) worked out by Remane (1963, 1964, 1971) and Le Hégarat and Remane (1968) which, despite its limitations, acts as a «quasi-standard» until now. The resolution of the revised (sub)zonation is comparable to the one of ammonite (sub)zones. We want not to «cement» any stage, zonal or subzonal correlations with our zonation, which, at first, stands alone for the calpionellids. In our point of view there are still a lot of limitations in the exact correlation between ammonites and calpionellids, which should be solved by an interdisciplinary working group.

Additionally no commonly accepted zonation for the Tethyan Early Cretaceous my means of ammonites is published. Nearly each author uses his own scheme, although Hoedemaker Company et al. (1993) proposed an Early Cretaceous Mediterranean standard ammonite zonation. Therefore, in our correlation we use a compiled scheme, which surely cannot serve as a standard. The data used herein are provided by Geyssant and Enay (1991); Hoedemaker, Company et al. (1993); Blanc (1995); Bulot et al. (1996), and Zakharov et al. (1996).

Our scheme can become much more refined by the introduction of units in terms of faunal horizons (for basical information see Callomon, 1984, 1995). Such a refinement has to be tested in different profiles, sections with a high sedimentation rate and therefore a good biochronologic resolution are to be preferred. A first attempt has been made by Blanc (1995, see Fig. 1). The latter one raises some questions. Blanc (1995) observes the first occurrence

(FO) of *Lorenziella hungarica* Knauer and Nagy before *Praecalpionellites murgeanui* (Pop), which is in contradiction to our observations from Ra Stua section (see Grün and Blau, 1997). This can be explained by the difficulties in separating morphologically the first *Lorenziella hungarica* Knauer and Nagy from *Lorenziella plicata* Le Hégarat and Remane, a problem discussed also by other authors. For the present authors therefore the FO of *Lorenziella hungarica* Knauer and Nagy is not a sufficient biostratigraphical marker. A second problem is Blanc's observation of the late FO of *Remaniella cadischiana* (Colom), which is not shared by other authors. And at least, the LO of *Calpionellopsis* is in zone D3 (Calpionellopsis Zone) *sensu* Blanc (1995). It has been shown by Grün and Blau (1997) and several other authors, that this genus extends into Calpionellites Zone (Major Subzone).

Another problem is the early occurrence of *Remaniella* in the Ra Stua section (Grün and Blau, 1996, 1997). This event is the base for our introduction of Catalonoi Subzone but has not been detected by other authors until now. It stresses the question, whether this is a local phenomenon or can be recognized by reinvestigating known profiles. An alternative - but indeed non satisfying - explanation is, that the «explosive» radiation of *Calpionella alpina* reached the area of Ra Stua later than other regions.

For the base of Oblonga Subzone two different definitions exist in literature. For the Vocontian Trough Le Hégarat and Remane (1968) based the D2 Subzone on the predominance of *Calpionellopsis oblonga* (Cadisch) over *Calpionellopsis simplex* (Colom). In Remane et al. (1986) the base of the Oblonga Subzone is defined with the FO of *Calpionellopsis oblonga* but there it is described as comprising the D2/D3 Subzone of the Vocontian Trough. Therefore we supposed that authors who worked with the Vocontian Zonation (A-E) used the D2 Subzone as defined in Le Hégarat and Remane (1968) (e. g. Altiner and Özkan, 1991) and the others were working with the Oblonga Subzone established by the FO of *Calpionellopsis oblonga* (Cadisch).

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Mineralia Slovaca, 29 (1997), 301 - 303

Tithonian to Valanginian bioevents and integrated zonation on calpionellids, calcareous nannofossils and calcareous dinocysts from the Western Balcanides, Bulgaria

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Key words: Tithonian, Berriasian, Valanginian, integrated stratigraphy, calcareous microplankton, Balcanides, Bulgaria

The results of a joint biostratigraphic investigation on three planktonic microfossil groups (calpionellids, calcareous nannofossils and calcareous dinocysts) from continuous successions of pelagic carbonates in the Western Balkanides have enabled a fine zonal and subzonal subdivision of the Tithonian, Berriasian and Valanginian Stages. Three formations have been studied: Gintsi Formation (pink and gray nodular limestones), Glozhene Formation (gray micritic limestones) and Salash Formation (micritic limestones, clayey limestones and marls) (Fig. 1).

The purposes of this study are: to obtain authentic, detailed and integrated data on the vertical distribution of calpionellid, nannofossil and calcareous dinocyst species by co-sampling of same levels at same sections; to select characteristic bioevents, mainly first occurrence data, within the parallel successions of the three microfossil groups; to evaluate the biostratigraphic potential of the selected bioevents for refining and enhancing the resolution of Tithonian to Valanginian zonal schemes.

A total of 117 microfossil species are identified (40 calpionellids, 48 calcareous nannofossils and 29 calcareous dinocysts) in the Tithonian, Berriasian and Valanginian successions. Range-chart of selected species from Barlya section is shown in Fig. 1. Starting from the Middle Tithonian, the sections are divided into 7 calpionellid zones and 12 subzones on the basis of 15 successive bioevents widely recognized in the Tethyan Realm. Three additional calpionellid events are potential candidates for lower boundaries of subzones. The evolution of the calcareous nannoplankton during the Late Kimmeridgian to Valanginian shows 22 successive events which are not uniformly distributed across the sections but form 5 groups of bioevents. The nannofossil zonation consists of 5 Tethyan and regional zones. As for the calcareous dinocysts, 14 events are selected thus enabling a subdivision into 9 total-range and interval zones. Among them, 2 zones in the Valanginian are introduced here as regional zones for the first time in the Tethyan Lower Cretaceous. The microfossil zonations of the Tithonian, Berriasian and Valanginian in the Western Balkanides are comparable to earlier zonal schemes proposed by Pop (1994), Bralower et al. (1989) and Řehánek (1992).

As a rule, the bioevents recorded in the evolution of the calpionellids, calcareous nannofossils and calcareous dinocysts do not coincide (Fig. 2). The accumulated number of successive, non-coinciding bioevents in the three groups is 42 which enhances the potential for a high-resolution microbiostratigraphy of the Tithonian, Berriasian and Valanginian. The common study of the three microfossil groups ensures also a shared control between the registered events by direct calibrations. In cases of coincidence of bioevents in two or in all the three groups, it further increases the argumentation of the zonal subdivisions. Calpionellid, nannofossil and calcareous dinocyst events across the Tithonian/Berriasian and Berriasian/Valanginian boundary intervals are of special interest.

The results obtained by common study of different fossil groups clearly reveal the advantages of this approach for establishment of accurate, fine and reliable biostratigraphic standards of the Tethyan Upper Jurassic and Lower Cretaceous stages.

This work was undertaken in the framework of Project 72/95-96 "Mesozoic correlations of the Moesian Platform" funded by the Peri-Tethyan Programme and Project 515/95 of the Bulgarian Scientific Fund.

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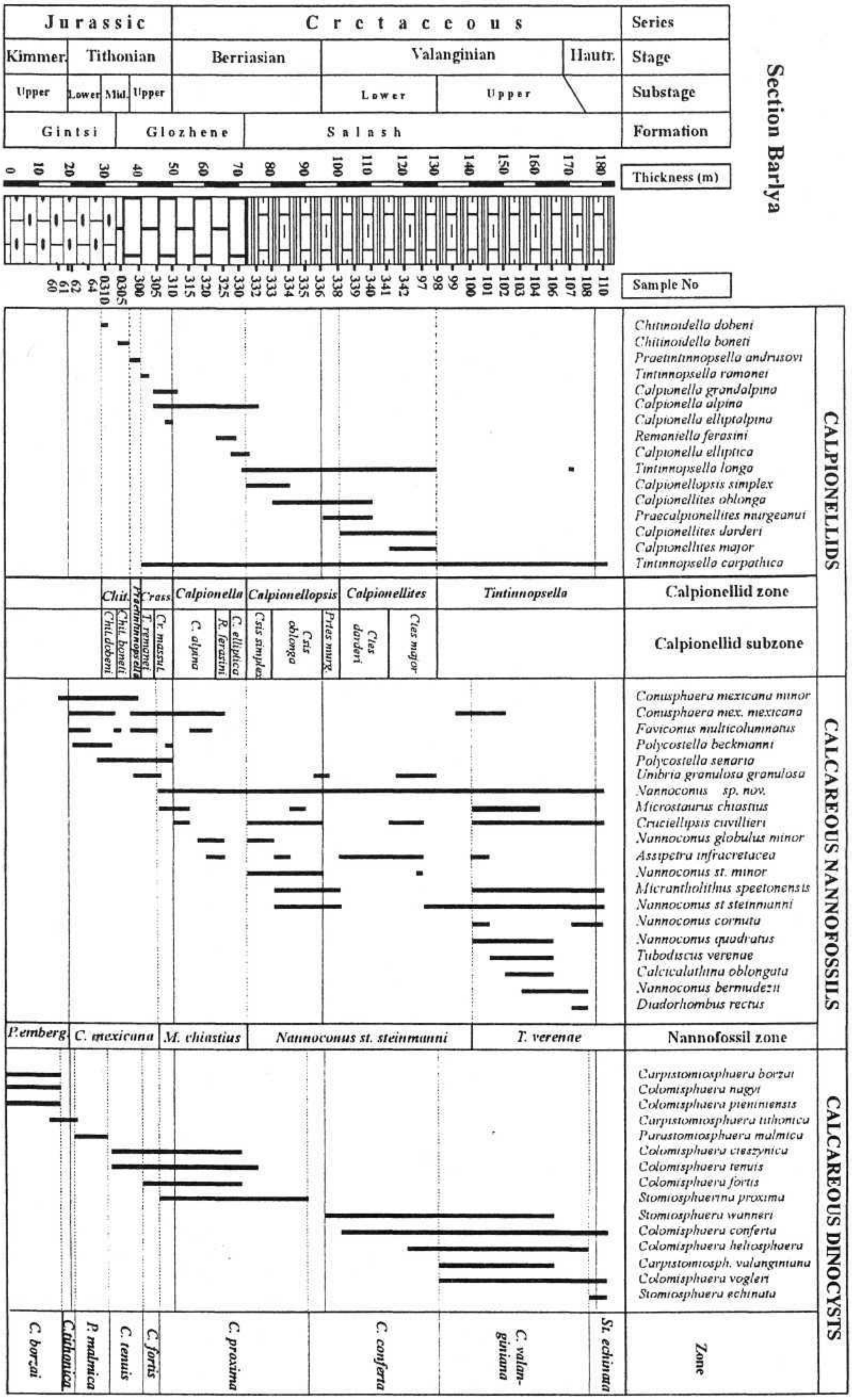

Fig. 1. Range-charts of selected species and zonations on calpionellids, calcareous nannofossils and calcareous dinocysts in Barlya section, West Balkan Mts.

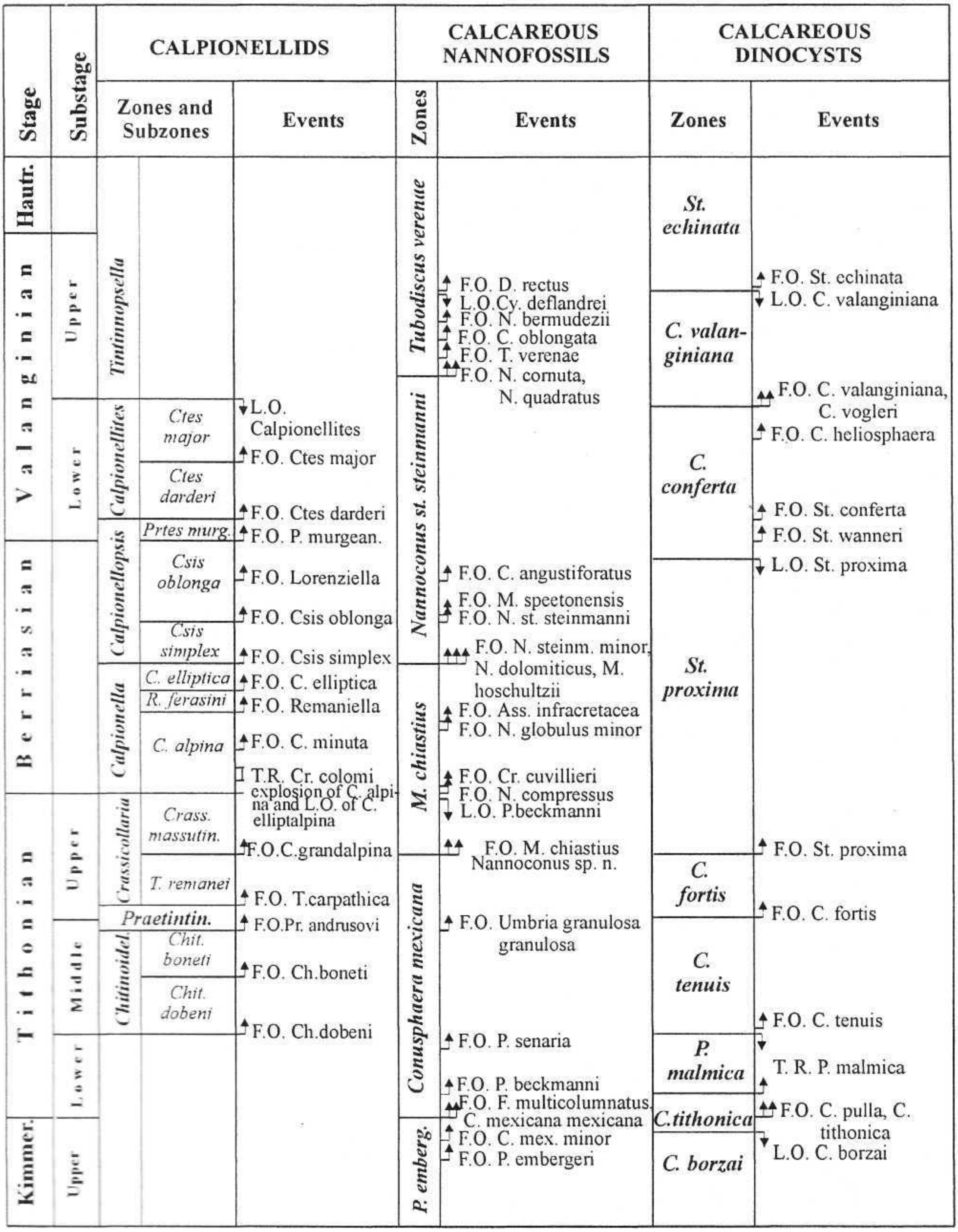

Fig. 2. Bioevents and zonations of the Tithonian, Berriasian and Valanginian in the Western Balkanides.

Mineralia Slovaca, 29 (1997), 304 - 305

Tithonian to Hauterivian praecalpionellids and calpionellids: bioevents and biozones

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Key words: Tithonian, Berriasian, Valanginian, Hauterivian, calpionellids, taxonomy, biozonation, bioevents, Mediterranean Tethys

It is known that the phylitic evolution of Tithonian to Hauterivian praecalpionellids and calpionellids was marked by many events, particularly the first (FO) and the last (LO) occurrences, in a relatively short span of time (about 22 Ma) Some of these events were observed over a large Tethyan area and used as biozonal boundaries in a great number of related studies (see: Rename, 1969, 1985, 1986; Alemann et al., 1971; Grandesso, 1977; Trejo, 1978; Borza, 1984; Remane et al., 1986; Pop, 1994; and many others). These contributions have inevitably led to a high-resolution biochronologic model, which is an important tool in the detailed geological correlations. There are also several other bioevents, especially concerning the new taxa recently identified, which suggest that the biochronologic potential of these microorganisms may be improved using additional data (Fig. 1).

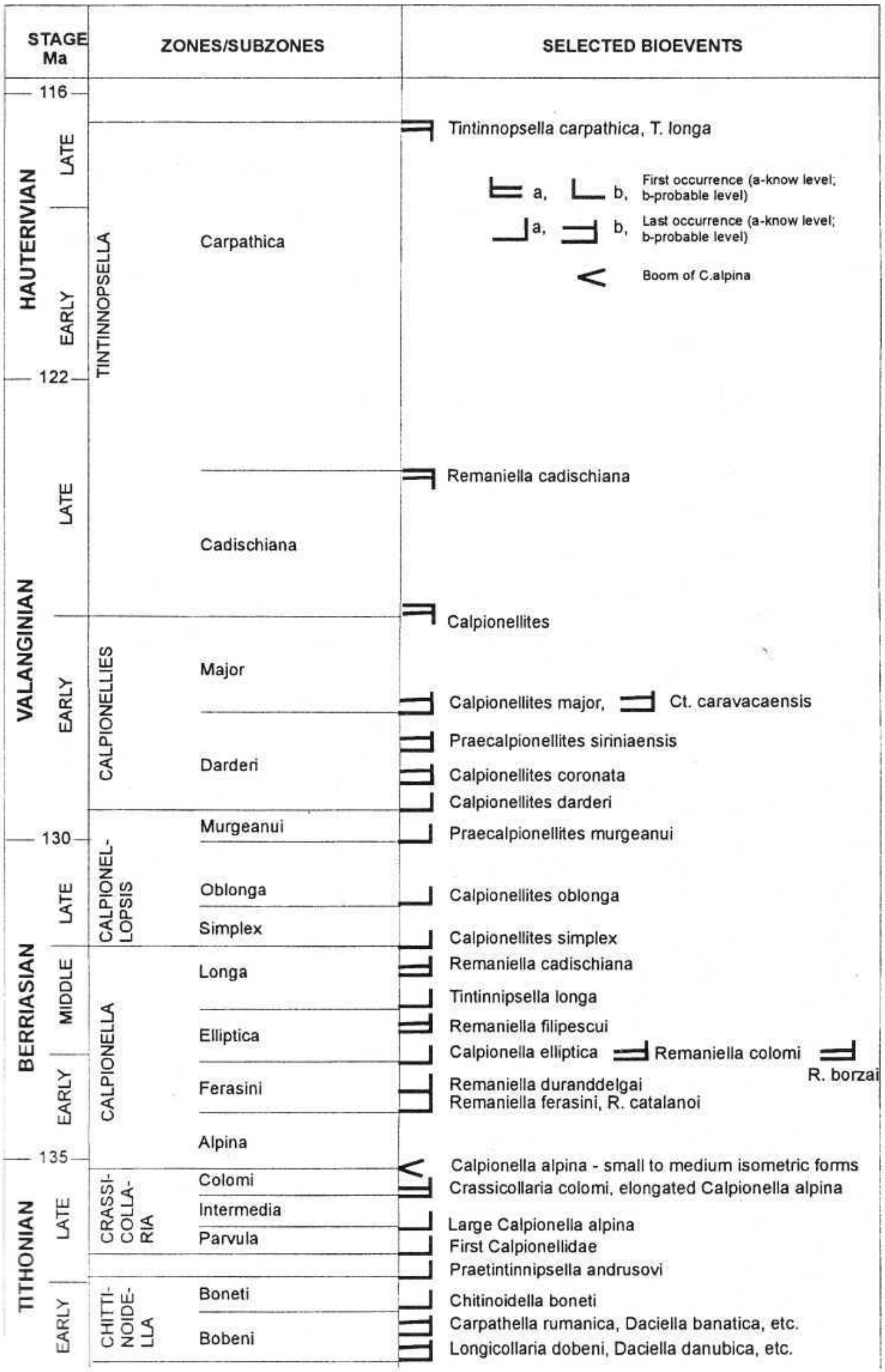
Consequently, the adopted model includes successive biozones of which six are divided into some subzones. All the biochronologic units are here defined by their lower boundaries. Chitinoidella Zone (late Early to earliest Late Tithonian) is divided into Dobeni Subzone and Boneti Subzone, which are defined by the FO of *Chitinoidellidae* (= zonal boundary) represented by that of *Longicollaria dobeni,* and of *Chitinoidella boneti* respectively. Within Dobeni Subzone, several other chitinoidellid species occur: *Daciella danubica, D. svinitensis, D. banatica, D. almajica, Carpathella rumanica, Dobeniella tithonica, D. bermudezi, D. cubensis, Borziella slovenica,* and *Cylindrella insueta. Chitinoidella elongata* occurs within Boneti Subzone.

Praetintinnopsella Zone (early Late Tithonian p. p.) is distinguished by the FO of *P. andrusovi*. Crassicollaria Zone (Late Tithonian p. p.) includes three subzones named Parvula (nom. Nov.), Intermedia (sensu Pop, 1994) and Colomi; they are delimited by the FO of Calpionellidae (= zonal boundary), of large *Calpionella alpina* and of elongated *C. alpina* and/or of *Crassicollaria colomi* respectively. According to the last data, the FO of calpionellid species from the Parvula Zone should be independent events, given by the polyphyletic evolution (parallel lineages) from chitinoidellids to calpionellids, and placed very close to the lower zonal boundary. The new name of this first subzone was claimed because *Tintinnopsella remanei* was considered a synonym of *Lorenziella hungarica*.

Calpionella Zone (Early to Middle Berriasian) comprises four subzones: Alpina, Ferasini (Early Berriasian), Elliptica and Longa (Middle Berriasian), which are defined by the following bioevents: sudden increase in abundance of small- to medium-sized *Calpionella alpina* (= zonal and Jurassic-Cretaceous boundaries), and the FO of *Remaniella ferasini,* of *Calpionella elliptica* and of *Tintinnopsella longa*. Within these subzones other species of the genus *Remaniella* occur (*R. catalanoi, R. duranddelgai, R. colomi, R. filipescui, R. cadischiana*).

Calpionellopsis Zone (Late Berriasian to earliest Early Valanginian) is divided into *Simplex, Oblonga* and *Murgeanui* subzones on the basis of FO levels of *Calpionellopsis simplex* (= zonal boundary), *Cs. oblonga* and *Praecalpionellites murgeanui*. Other bioevents within these subzones are also pointed out: FO of *Sturiella dolomitica* and *S. oblonga,* and LO of *Calpionella elliptica, Calpionellopsis simplex* and *Calpionella alpina.* Calpionellites Zone (Early p. p. to earliest Late Valanginian) includes Darderi and Major subzones with their lower boundaries marked by the FO of *Calpionellites darderi* (= zonal boundary) and of *Ct. major.* Some other species occur within the two subzones, such as: *Calpionellites uncinata, Ct. coronata, Ct. caravacaensis* and *Praecalpionellites siriniaensis.* The extinction of several calpionellid species is also noted.

Tintinnopsella Zone (Late Valanginian p. p. - Hauterivian) in tentatively divided into Cadischiana and Carpathica subzones using the LO of *Calpionellites* (= zonal boundary) and of *Remaniella cadischiana.* The upper boundary of this last zone is given by the LO of *Tintinnopsella carpathica.* Practically, the above biozones may be recognized by their relatively unitary assemblages.



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Calpionellid associations versus Late Jurassic and Early Cretaceous sea - level fluctuations

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Key words: Tithonian, Early Cretaceous, microbiostratigraphy, sequence stratigraphy, Western Carpathians, Slovakia

Calpionellids represent a small planktonic protozoan group with calcitic loricas. They are largely widespread in the Middle Tithonian to Hauterivian basinal carbonate formations. Calpionellids were distributed over a large geographic area from Mexico and western North Atlantic to Tibet, possibly to New Guinea, where they exibit generally the same morphological aspects and assemblages. The phyletic evolution of these microorganisms includes a number of events very favourable for detailed interregional and intercontinental correlation of the carbonate deposits of pelagic origin, mainly in regions such as Western Carpathians are, where cephalopod remains (ammonites, belemnite rostra, aptychi) are very rare (Vašíček et al., 1994). Late Tithonian to Early Albian interval is represented by regularly bedded white to grey cherty pelagic limestone sequence in contact with the underlying Ammonitico Rosso (or with more basinal marly limestone and marlstones). The biostratigraphic framework was based on calpionellid distribution supplemented by calcareous nannofossil, calcareous dinoflagellate, planktonic foraminifer, radiolarian as well as ammonite and aptychi zonations (Hoedemaeker et al., 1993; Pop, 1994; Reháková, 1995; Vašíček, 1994).

The correlation of Upper Jurassic - Early Cretaceous calpionellid events to the sea - level fluctuations (Fig. 1) has been established in several Carpathian, Alpine and Spanish sections. At this time, N European shelf margin was the site of pelagic carbonate sedimentation with local threshold and reefal developments.

Calpionellids with microgranular loricas appeared during Middle Tithonian, starting with the *Dobeni* Subzone of the *Chitinoidella* Zone. According to quantitative evaluation, the chitinoidellids reached their diversity maximum during the *Boneti* subzone. It coincides with the regressive (lowstand) interval Ti-3.

Sudden change of the lorica ultrastructure (from microgranular to hyaline tests) in the *Praetintinnopsella* Zone reflects a period of calcium carbonate hypersaturation of the sea - water, which triggered mass evolution of calcitic tests producing microorganisms (Reháková and Michalík 1997).

An expressive change at Ti-4 (end of Early Tithonian) was accompanied by a decrease of terrigeneous clastic input, by a decrease of calcareous dinoflagellate plankton abundance, and by rapid evolution of both calpionellids and calcareous nannoplankton. These facts indicate possible aridization of climate. Hyaline calpionellids reached their maximum diversity during the regressive (lowstand) Ti-5 period in the *Brevis* Subzone of the *Crassicollaria* Zone.

Another, shorter significant event in the plankton evolution possibly connected with an abrupt climatic change happened during topmost Tithonian (Ti-7) *Colomi* Subzone. Relatively diversified crassicollarian and nannoconid associations were retreated by poorly diversified (opportunistic ?) *Alpina* Subzone microplankton. Transgressive Be-1 interval is characterized by a low calpionellid diversity. Small sphaerical *Calpionella alpina* became dominant in the rock record of this time interval.

New calpionellid diversity maximum with high radiation appeared during the *Elliptica* Subzone of the *Calpionella* Zone. It coincides with the Be-4 regressive period. On elevated zones, high diversity and radiation persisted since the *Oblonga* Subzone of the *Calpionellopsis* Zone. Weathering, erosion and runoff recorded during the expressive Be-7 sea level drop event was accompanied by an increase of the dinoflagellate abundance.

Terrigeneous influx renewed during the Late Valanginian Va-4 lowstand. It coincides with the positive excursion of δ^{13} C connected with greenhouse climatic conditions. This excursion coincides with an increased accumulation of terrigenous clastics (the Oravice event). Supply of terrestrial organic matter has been related to increased river discharge. It is also the indicator of an intensified hydrological cycling. At the same time, abrupt decrease in calpionellid abundance and diversity was recorded. Similar event was observed in nannoconid evolution. The increasing temperature accompaning an extensive climatic change could caused the failure of calpionellids (with the exception of *Tintinnopsella*) to produce calcitic loricas.

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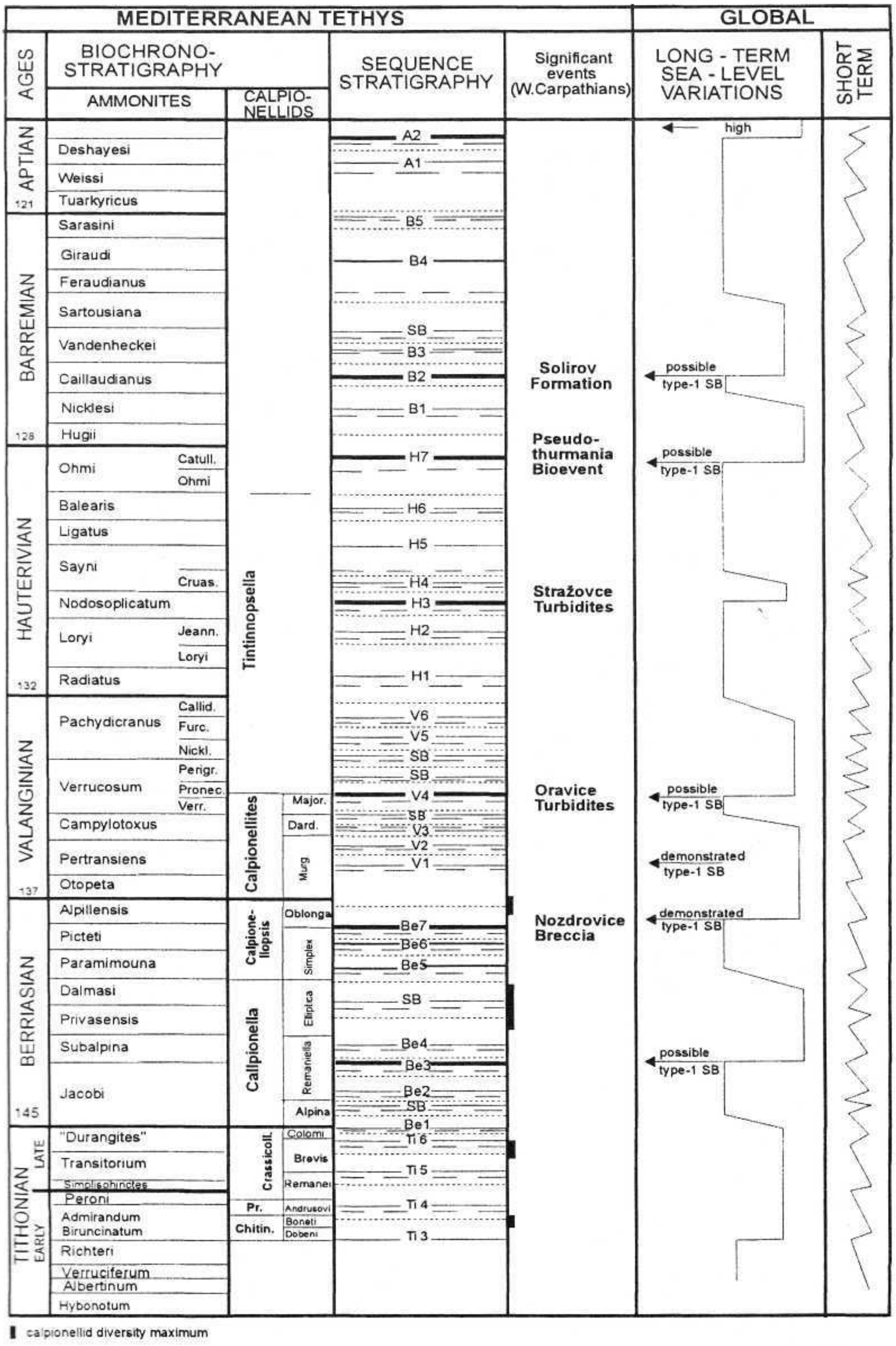

▌ calpionellid diversity maximum

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Mineralia Slovaca, 29 (1997), 308 - 310

Magnetostratigraphic and petromagnetic studies of the Jurassic/Cretaceous limestones from the Río Argos (Caravaca, SE Spain), Carcabuey (S Spain) and the Bosso Valley (Umbria, central Italy)

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Key words: Tithonian, Early Cretaceous, magnetostratigraphy, integrated stratigraphy, Spain, Italy.

Magnetostratigraphic studies across the Jurassic/Cretaceous (J/C) boundary strata at the locality of Brodno near Žilina (Western Carpathians) resulted into detection of magnetozones M17 to M21, including two narrow reverse subzones in the normal zones M19 and M20, cf. Houša et al., 1996a, b. These high-resolution magnetostratigraphic data offer a reliable alternative method of identifying chronologically identical sections in distant regions and can potentially be used to correlate globally biostratigraphic zonations in the Tethyan realm near the J/C boundary. Consequently, the magnetostratigraphic studies, in addition to those from the Brodno near Žilina and other localities in the Western Carpathians, were extended to next localities in the Tethyan realm, namely to the Río Argos (Caravaca, SE. Spain), Carcabuey (S. Spain) and the Bosso Valley (Umbria, central Italy).

The section of the Río Argos covering the Early Cretaceous limestone strata was chosen due to its importance, detailed geological and palaeontological documentation and good exposure of individual strata (Hoedemaeker and Leereveld, 1995). Altogether 361 oriented hand samples were collected covering the uppermost Tithonian, Berriasian, Valanginian, Hauterivian, Barremian and the Early Aptian beds. All the collected samples were subjected to systematic thermal or combined demagnetization. Thermal demagnetization was carried out by means of the MAVACS apparatus (Příhoda et al., 1989) at relatively dense steps up to 590 °C, in many cases up to 690 °C. Multi-component analysis was applied to separation of respective remanent magnetization components, Fisher's (1953) statistics were used for the calculation of the mean directions of separated components in combination with fold tests. The majority of samples shows three components of remanence, A-, B- and C-components. The studied limestones could be divided into two groups of rocks, the first group with syn-folding magnetization, and the latter group of limestones totally remagnetized in the Neogene. Figs. 1 and 2 show stereographic projection of B-components (mostly inferred in temperature intervals of 100 to 400 °C) of remanence of samples with syn-folding magnetization corrected and not corrected for dip of rocks. Table 1 summarizes the mean values of declination (Decl.), inclination (Incl.) of separated B-components, α_{95} and k for samples not corrected for the dip of strata (correction 0 %), and for samples fully corrected for the dip of strata (correction 100 %) as well as for transitional dip corrections at 10 to 90 %. These data indicate syn-folding origin of the B-components of remanence. The B-components are with the exception of three samples only normally polarized, what also excludes the syn-sedimentary origin of the B-components of remanence. The B-components of totally remagnetized samples (with post-folding magnetization) are shown on Fig. 3 clearly indicating the Neogene age of total overprint. The C-components of weakly magnetic samples derived in temperature intervals above 400 °C showed too big scatter and were not applicable to fold tests.

The study of anisotropy of magnetic susceptibility resulted into the conclusion that the fabric of limestones of both the groups of samples either partially or totally remagnetized showed the same features. The axes of minimum anisotropy are vertical (normal to bedding) and the axes of maximum and intermediate anisotropy are contained within the bedding plane. Foliation dominates over lineation, what is common for the sedimentary-type fabrics. However, the limestones under study display no signs of thermal, hydrothermal, chemical, dynamometamorphic or other alterations. Apart from few samples totally weathered (with unblocking temperatures below 100 °C indicating presence of goethite), magnetite with well defined unblocking temperature around 540 °C was found as the principal carrier of remanent magnetization. The limestones from the Río Argos were either syntectonically or post-tectonically totally remagnetized, and thus they were found not suitable for derivation of magnetostratigraphic scales (Krs et al., 1996; Hoedemaeker et al., submitted for press).

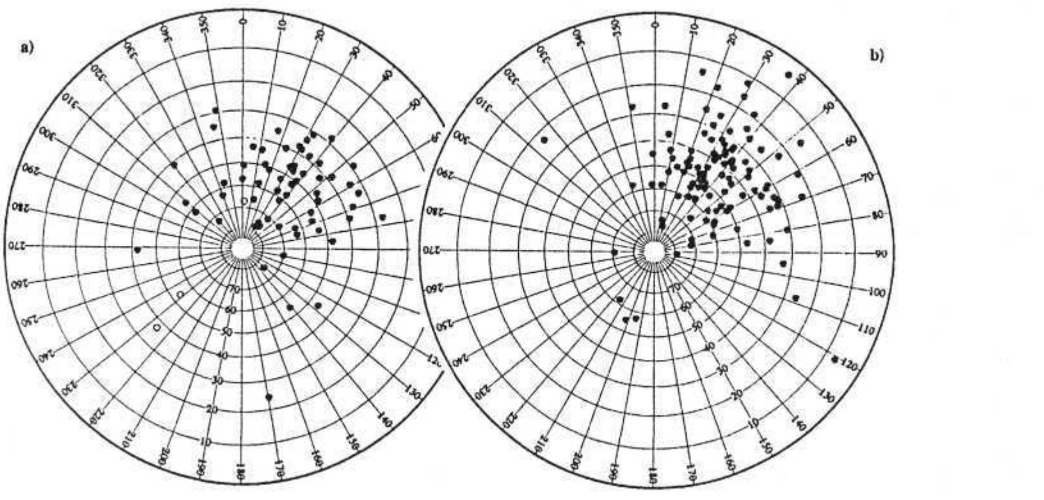

Fig. 1. Río Argos. Directions of B-components of remanence of limestone samples with syn-tectonic magnetization, corrected for dip of rocks.

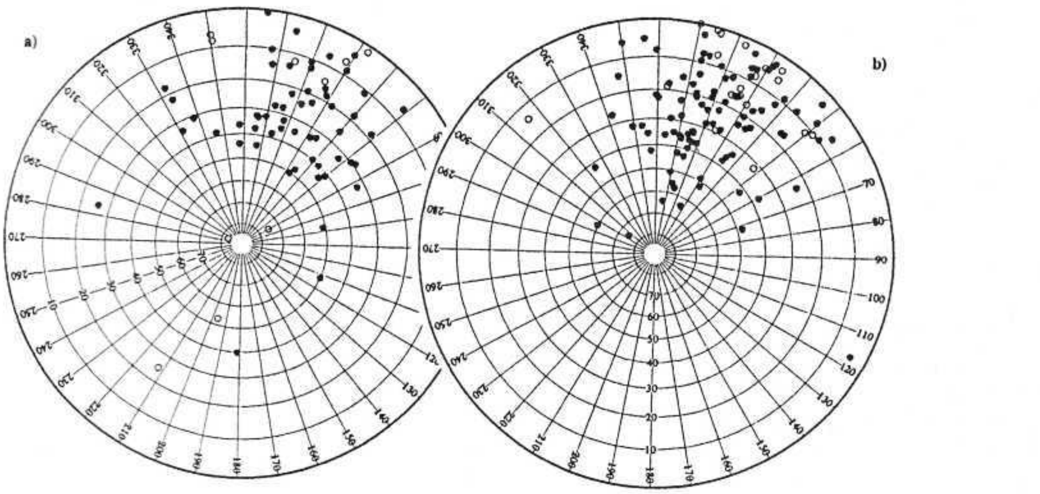

Fig. 2. Río Argos. Directions of B-components of remanence of limestone samples with syn-tectonic magnetization, not corrected for dip of rocks.

The main objective for high-resolution magnetostratigraphy was to select a new locality in Spain with continuous sedimentation and good palaeontological record along the J/C boundary strata. Two sections of red to white ammonite-rich pelagic limestones spanning the complete Kimmeridgian and most of the Tithonian were studied at Sierra Gorda and Carcabuey some years ago (Ogg et al., 1984). However, a new locality distanced about 2 kms from the previous one and representing a broader section of J/C boundary strata was recently published by Tavera et al. (1994). Detailed studies enabled correlation of ammonites, calpionellids and calcareous nannofossils recorded in this section. Five palaeomagnetic pilot samples were collected to test their applicability to magnetostratigraphic investigations. The results of thermal demagnetization using the MAVACS apparatus are outstanding: the normalized values of M_t/M_n in dependence on temperature t as well as Zijderveld diagrams are extremely reliable and precise. The remanence is composed of three components A, B and C. The C-component was reliably derived within the temperature interval of 400 to 560 °C, in combination with fold and other tests it was proved to be the carrier of palaeomagnetic directions. Consequently, the locality at Carcabuey studied recently by Tavera et al. (1994) is proposed for high-resolution magnetostratigraphic studies in the next programme, in relation to similar studies in Brodno (W. Carpathians, Slovakia) and the Bosso Valley (Umbria, central Italy).

A section of the Early Cretaceous Maiolica pelagic limestone, of thickness of 110 m, in the Bosso Valley (Umbria, central Italy) was studied by Lowrie and Channell (1983). Clearly defined magnetozones were outlined which were correlated with palaeomagnetic polarity records derived from the M-sequence of marine magnetic anomalies. The dominant magnetic mineral carrying the fossil record of the palaeomagnetic field is magnetite, its content is low, consequently, the moduli of remanent magnetization are generally low. In order to prepare the Bosso profile for high resolution magnetostratigraphy, the broader section of th J/C boundary strata was resampled by V. Houša, M. Kr and P. Pruner in 1996. Results so far obtained are summa rized in Fig. 4. The critical section at the Bosso Valle shall be resampled at a higher density with the aim to dete

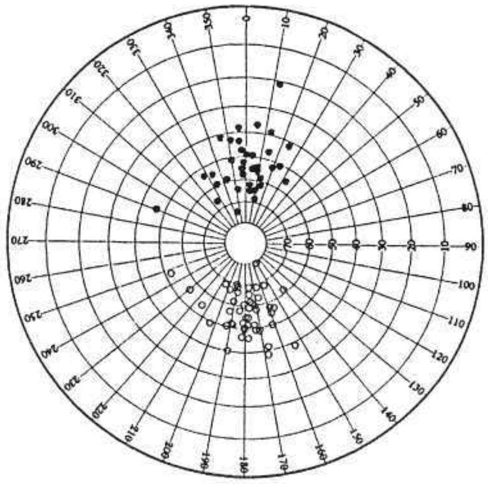

Fig. 3. Río Argos. Direction of B-components of remanence of limestone samples totally remagnetized during the Neogene, not corrected for dip of rocks.

Tab. 1
Río Argos. Mean directions of B-components of remanence of samples with syn-folding magnetization

Corr. for dip (%)	Mean directions Decl.	Incl.	α_{95}	k	n
100	38.9°	49.2°	4.46°	6.67	176
90	36.5°	46.7°	4.45°	6.69	176
80	34.3°	44.2°	4.45°	6.70	176
70	32.2°	41.5°	4.45°	6.69	176
60	30.3°	38.7°	4.46°	6.67	176
50	28.5°	35.8°	4.48°	6.62	176
40	26.9°	32.9°	4.50°	6.56	176
30	25.3°	30.0°	4.56°	6.48	176
20	23.9°	27.1°	4.57°	6.39	176
10	22.6°	24.3°	4.61°	6.29	176
0	21.4°	21.5°	4.66°	6.19	176

precisely the narrow reverse subzones in magnetozones M19n and M20n. Palaeontological zonation based on calpionellids will be established in relation to magnetozones and reverse subzones in a similar way as was done for the locality of Brodno, W. Carpathians (Houša et al., 1996a, b).

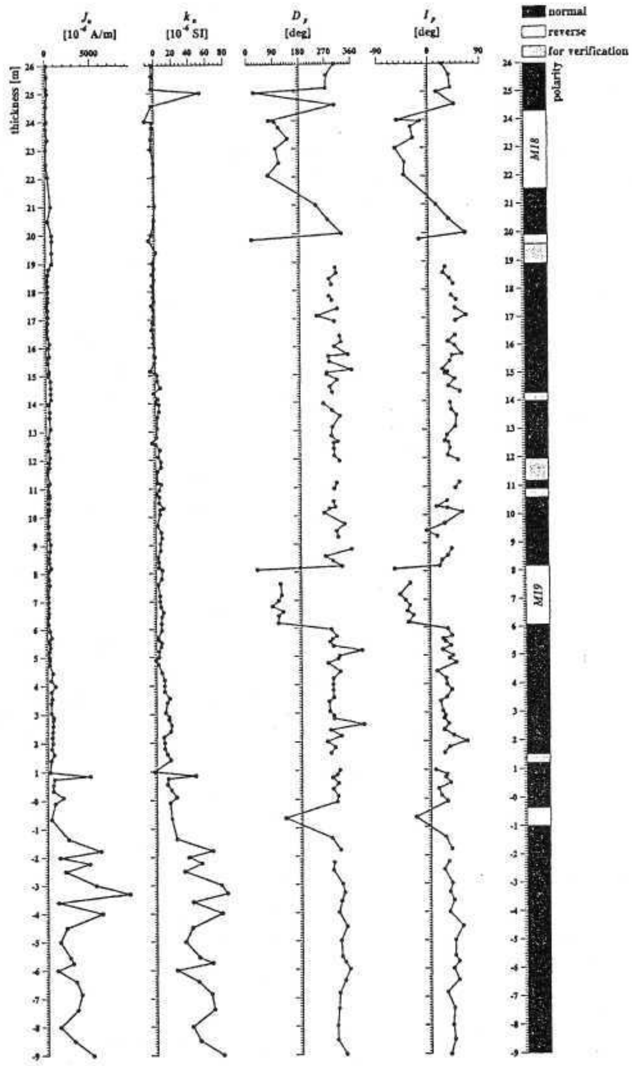

Fig. 4. Bosso Valley. Basic magnetostratigraphic data along a section proposed for next detailed investigation.

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The Coniacian-Santonian boundary in Northern Spain: the Olazagutia section

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Key words: Coniacian, Santonian, stage boundary, biostratigraphy, Spain.

Coniacian and Santonian sediments and their fossil content have been extensively described from different sections of the Navarro-Cantabrian Basin (NCB) and the North Castilian Platform (NCP). The presence of *Platyceramus undulatoplicatus* (Roemer), whose lowest occurrence was proposed (Second International Symposium on Cretaceous Stage Boundaries, Brussels 1995) as the primary marker for the Coniacian-Santonian boundary, has been reported in several of them, e. g. Boveda, Fresneda, Lastras de la Torre, Mambliga, Ormijana, Oteo, and Villacian sections in the Valle de Losa (NCB, Burgos province); La Mesa, Nidaguila, Torme, Turzo, and Villamartin sections in the Alto Ebro region (NCP, Burgos province); Cabo Menor section in Santander (NCB); and Olazagutia section in La Barranca (NCB, Navarra province). The last one, the Olazagutia section, was selected during the same Symposium as a candidate for Boundary Stratotype Section and M. Lamolda was asked to collate data and report to the Chairman.

We visited the section last June for general geological observations and to sample for biostratigraphy (macro and microfossils), taphonomy and isotope stratigraphy purposes, to fulfil the requirements of a formal proposal. Although before completing the study of the samples, some of which have been sent to other scientists, we can communicate some preliminary observations.

The Olazagutia section is located in the Eguibil marl Quarry, exploited by Cementos Portland. Outcropping materials range from the Coniacian to the Campanian. The upper Coniacian-lower Santonian interval is a highly expanded sequence of marls with some intercalation of marly limestone, although in the upper part some limestone levels appear, and yields inoceramid bivalves, ammonites, echinoids, foraminifera and nannofossils; geochemical markers are being investigated. The boundary interval crops out at the main ramp for access to the quarry front, constituting a durable and periodically maintained outcrop (the society responsible of the exploitation took this compromise), and at the quarry front, giving a continuous source of new material for collecting.

Six *Platyceramus undulatoplicatus* levels occur in an interval of approximately six metres; these levels have been recognised in the main outcrop and in different parts of the quarry. The specimens could come to reach a great size, complete specimens of even 35.0 cm high, as well as fragments of ribs that would correspond to specimens estimated as reaching 50.0 cm of high, have been collected. The inoceramid concentrations are concordant to the sediment and are laterally continuous, showing a "pavement" geometry. They are matrix-supported and mainly polytypic in the western part of the quarry, there inoceramids co-occur with other bivalves, echinoids and sponges. While in the eastern part they are bioclastic- supported, mainly monotypic and the number of individuals is greater, showing a stacking fabric in cross section. *Platyceramus rhomboides* (Seitz), that presents some growth stages very similar to those of *P. undulatoplicatus,* is the only other inoceramid species occurring in this interval.

Below the first occurrence of *P. undulatoplicatus,* inoceramid fauna is represented by the *Magadiceramus subquadratus* (Schlueter) association, being more abundant the species index, *Magadiceramus subquadratus subquadratus* (Schlueter). Above the last occurrence, some species of the *Cordiceramus* and *Platyceramus* genera have also been recognised, like it is the case of *Cordiceramus bueltenensis* (Seitz), *Platyceramus cycloides cycloides* (Wegner) and *P. cycloides ahsenensis* (Seitz). The first *P. cycloides cycloides* occur from 1 metre above the last occurrence of *P. undulatoplicatus* until 200 metres above; it is especially abundant and the specimens reach a great size, of even 27.0 cm high, at levels located at 50 and 150 m respectively.

Ammonite fauna is not particularly abundant, and it is to remark that the first texanitid occurrence reported until now is 120 m above the first occurrence of *P. undulatoplicatus.*

Echinoids are the most abundant macrofossils. Genus *Micraster* first appears 45 m below the first *P. undulatoplicatus* and it continues appearing as far as the top levels of the quarry (Campanian). *Hemiaster* also appears in the same levels but it is not so continuous, being found again some 20 m below and then, some 7 to 10 m over the first *P. undulatoplicatus* level. *Cardiaster integer* (Agassiz) appears 2 m below the first *P. undulatoplicatus* level and goes over it across levels more or less 100 m thick. *Echinocorys* first occurrence is only 4 m over the last *P. undulatoplicatus* and lasts as long as *C. integer. Offaster* seems to be limited to a single event, 14 m over the last *P. undulatoplicatus.*

High-resolution magnetostratigraphy across the Jurassic- Cretaceous boundary strata at Brodno near Žilina, Western Carpathians, Western Slovakia

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Key words: Tithonian, Berriasian, magnetostratigraphy, microbiostratigraphy, Western Carpathians, Slovakia

The Palaeontological and Palaeomagnetic Departments of the Geological Institute of the Czech Academy of Sciences started in 1992 a joint project of magnetostratigraphic investigations of the Tithonian-Berriasian boundary strata at two localities in the Western Carpathians, Brodno near Žilina, W. Slovakia, and Štramberk, N. Moravia. The above studies were preceded by petromagnetic and palaeomagnetic investigations of the pilot samples collected from five localities in the Western Carpathians. All the five localities were found suitable for magnetostratigraphic investigations, but the Brodno locality was given preference due to its suitable geological and palaeontological conditions (Houša et al., 1996a, b). The aim was to determine the principal biostratigraphic boundaries in reference to magnetostratigraphic scales and to prepare data for the next correlations between biostratigraphic zonations in the Tethyan and Boreal realms.

Magnetostratigraphic and biostratigraphic investigations carried out at the Brodno locality confirmed fully the geological assumption that a sedimentation in a quiet basin is fundamental for preservation of a continuous fossil record of accurately defined geomagnetic polarity zones. Samples for micropalaeontological and magnetostratigraphic analyses were collected independently, but in reference to the same strata labelled with numbers. Boundary positions of biozones and magnetozones were interpreted more accurately during additional and repeated collection of samples. Ammonites are missing at the Brodno locality, consequently, only associations of calpionellids were used for correlation.

Selected pilot samples were subjected to magnetic mineralogy studies. The unblocking temperatures of between 540° to 560 °C suggest the presence of magnetite. The magnetite as the principal carrier of magnetization was confirmed by magnetic measurement (unblocking temperatures determined on natural samples and pilot samples subjected to saturation magnetization) as well as by X-ray diffraction studies. Few samples exhibited also a small fraction of a mineral with an unblocking temperature below 680 °C, evidently due to a small admixture of haematite.

The measured remanence data were subjected to the multi-component analysis (Kirschvink, 1980). All samples exhibit high proportions of secondary magnetization (viscous magnetization and chemo- remanent magnetization conditioned by weathering). The laboratory measurements indicated that the palaeomagnetization carrier is magnetite, evidently fine-grained magnetite which is in accordance with results from other localities in the Tethyan realm and generally with results obtained in samples of marine shallow-water carbonates. The interpreted magnetozones were published in the papers by Houša et al. (1996a, b). The pattern of normal and reverse polarity magnetozones from M17 to M21 correlates well with magnetozones derived in the regions of Foza (north Italy), Bosso Valley (Umbria, central Italy) and with marine M (Mesozoic) anomalies. It is of significance, that a very narrow subzone was detected in the younger part of the magnetozone M19n well correlating with a similar subzone in the marine magnetic M anomalies. The base of the standard Calpionella Zone, i. e. the Jurassic/Cretaceous boundary, was placed in the younger part of the older half of the magnetozone M19n.

The next narrow reverse sub-zone of marine origin was reported from the younger part of the M20n, cf. Butler (1992, page 225). Consequently, additional very detailed (condensed) sampling was carried out in the Brodno locality in the beds potential for occurence of this sub-zone. The subzone was safely delineated in the magnetozone M20n. For the critical section of the Brodno profile, Fig. 1 presents some petromagnetic data (J_n - moduli of natural remanent magnetic polarization, k_n - values of volume magnetic susceptibility of rocks in natural state), palaeomagnetic directions derived from the C-components of remanence (D_p - palaeomagnetic declination. I_p - palaeomagnetic inclination), the derived polarity magnetozones and two narrow subzones with reverse polarity. The sample of No. 7550A located at the transition zone between

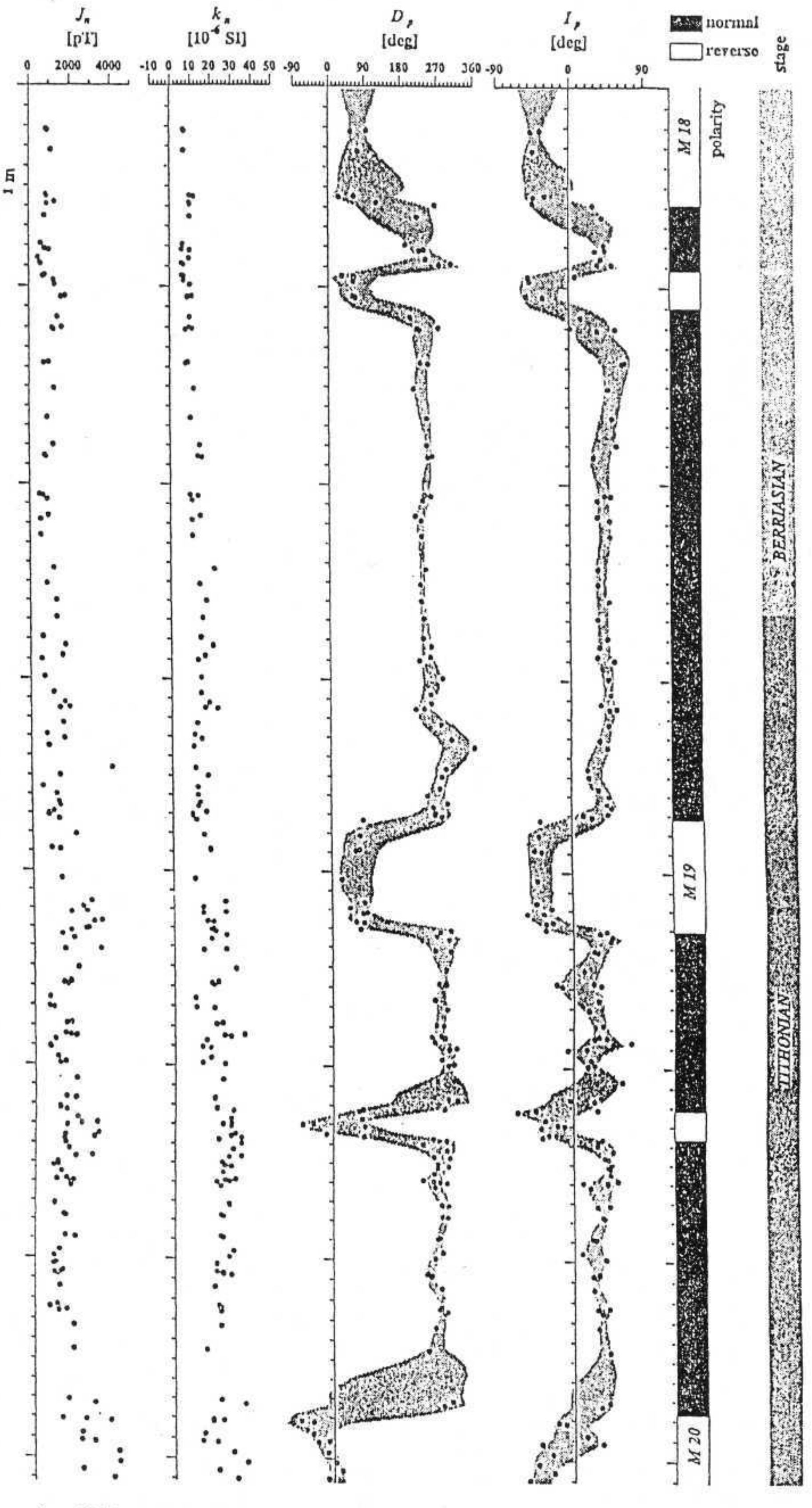

Fig. 1. Basic petromagnetic and high-resolution magnetostratigraphic data across the critical section J/C boundary strata, Brodno near Žilina.

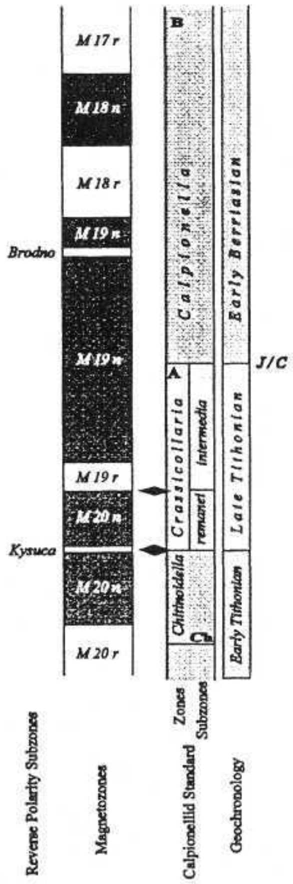

Fig. 2. Summary results of magnetostratigraphic and micropalaeontological investigations across the Tithonian/Berriasian strata, Brodno near Žilina.

the normal polarity magnetozone M20 and the upper part of the reverse polarity subzone is carrier of two fossil components of remanence with normal and reverse polarities. This documents that the transition of the palaeomagnetic field was fossilized in a layer whose thickness is less than 2 cm.

Fig. 2. summarizes results of magnetostratigraphic and micropalaeontological investigations. For next easy references, we propose to name the narrow reverse polarity subzone located in the normal polarity magnetozone M19 as the "Brodno" subzone and that in the normal polarity magnetozone M20 as the "Kysuca" subzone. Detection of two narrow subzones "Brodno" and "Kysuca" as well as precise detection of magnetozones M17 to M21 range the Tithonian-Berriasian magnetostratigraphic profile at Brodno near Žilina to high-resolution magnetostratigraphic profiles suitable for accurate correlation with biostratigraphic zones.

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Mineralia Slovaca, 29 (1997), 315 - 316

Sedimentary and isotopic record of the Aptian anoxic "Selli" event in the Pieniny Klippen Belt, Slovakia

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Key words: Aptian, lithology, anoxy, C isotopes, bioevents, stratigraphy, Western Carpathians, Slovakia

Pelagic and calciturbiditic Brodno Limestone sequence overlying huge white to grey pelagic cherty Pieniny Limestone Formation complex in the Rochovica section (Kysuca Gate by Žilina, NW Slovakia, Pieniny Klippen Belt) is interrupted by the Koňhora Member. An abrupt environmental change is indicated by the substitution of pelagic carbonate sedimentation with dark shaly complex intercalated by several organodetritic limestone beds. Almost eight meters thick Koňhora Beds consist of calcareous clays to marlstones with sporadic mica leaflets, coalified plant fragments and pyritized macrofossils.

Limestone strata closely underlying the Koňhora Beds contain microfossils of the *Globigerinelloides blowi* Zone. Somewhat higher, nannoplankton association of the *Chiastozygus literarius* Zone has been identified in marlstones. Within this zone, an abrupt diminishing in nannoconid abundance was observed, resembling the "nannoconid crisis" (Erba et al., 1996). These micro- and nannofossil associations indicates top Barremian to earliest Aptian age (Caron, 1985; Erba, l. c.). Two limestone intercalations within Koňhora Beds, referrable to the Ap-1 and Ap-3 lowstands respectively, contain diverse radiolarian associations.

The C isotope record in the Rochovica Lower Cretaceous sequence indicates three distinct global events (Fig. 1). The first (Late Valanginian, cf. Lini et al., 1992) greenhouse event was observed here by Michalík et al. (1995). Increased values of $\delta^{13}C$ (+ 2,1 to 2,8 ‰) in beds No 384 to 413 indicate the second, Barremian event. The most distinct C isotope excursion (+ 3,3 to 4,9 ‰) was observed in the Aptian part of the sequence studied. This C excursion clearly indicates anoxic marine conditions recorded in deposition of the shaly Koňhora Beds. Noticeably decreased values of $\delta^{18}O$ in this part of rock column (Fig. 1) could be connected with temperature increase and/or with high terrigeneous input. The supply of terrestrial organic matter has been related with intensified hydrologic regime under high sea level conditions (Fig. 1).

The Koňhora Formation could serve as an important marker of global warm and humid conditions with accelerated sediment cycling and with global sea level rise, equivalent to the "Selli" interval (Erba, 1994).

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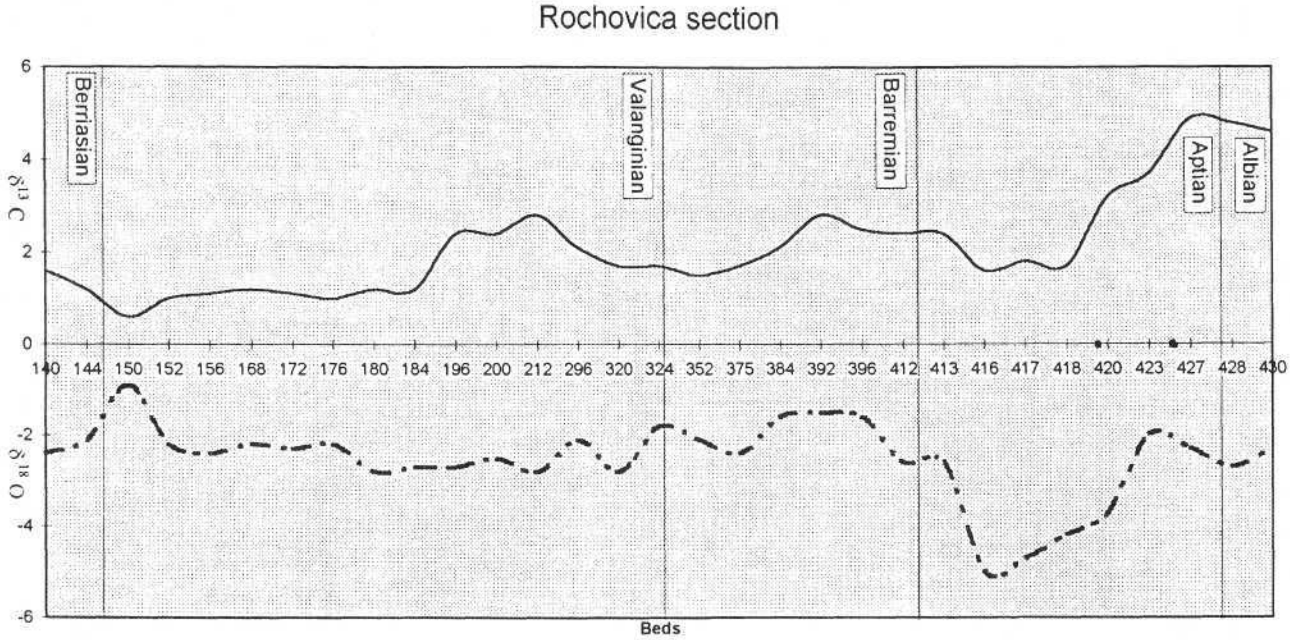
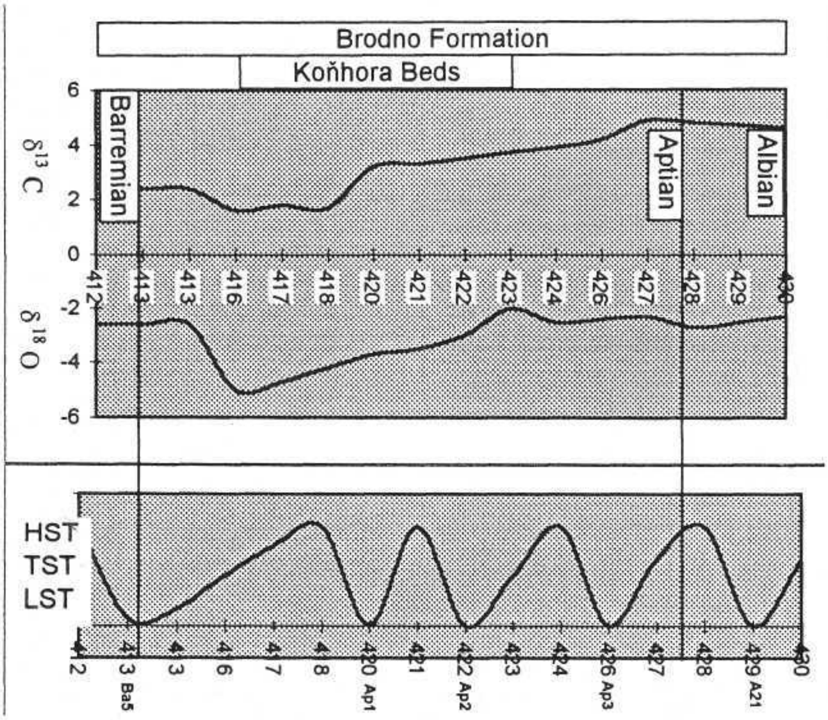

Rochovica section
Berriasian
Valanginian
Barremian
Aptian
Albian
δ13 C
δ18 O
Beds


Brodno Formation
Koňhora Beds
Barremian
Aptian
Albian
δ13 C
δ18 O
HST
TST
LST

Long-period variations of palaeomagnetic declination in the Barremian beds from the Northern Caucasus and their importance for detailed correlations

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Key words: Barremian, magnetostratigraphy, Northern Caucasus, Daghestan

Detailed bio- and magnetostratigraphic studies of the North Caucasus Barremian strata supported by field observations, have allowed to reveal sinusoidal changes in paleomagnetic directions with declination amplitudes of about 40 degrees. The duration of fluctuations was estimated as one milion years.

The Barremian beds were studied on the Urukh River, in the vicinity of Gergebil and Akusha villages (Dagestan) (Fig. 1). Paleomagnetic sampling in the Gergebil section was duplicated in the northern wing of the Gergebil anticline and the southern wing of the Kuli-Meirskaya anticline (Fig. 2).

Paleomagnetic sampling was carrried out in co-operation with biostratigraphers, which allowed fine geologic-paleontological verification of the paleomagnetic arrangements. Sampling intervals varied from 0.75 to 1.5 m.

Paleomagnetic studies were accompanied by the standard complex of laboratory work. Magnetic susceptibilities and natural remanent magnetizations were measured; magnetic cleaning was carried out with temperatures and alternating magnetic fields; normal magnetization curves were drawn. Thermomagnetic and differential thermomagnetic analyses (TMA and DTMA) were widely used to diagnose the magnetic phàses. A number of samples from each section were studied by means of optical mineralogy.

The analyses of normal magnetization parameters (Hs, H'cs) and the TMA and DTMA data make it possible to conclude that magnetization of the rocks studied was caused mainly by magnetite. Zijderveld diagrams were constructed for component analyses of remanent magnetization vectors. Magnetization of the rocks considered is characterized by two components: the primary one, revealing its trend after mild thermal cleaning and preserving it up to 500 degrees, and the secondary one, of probable viscous nature.

To substantiate the Jn priority fold test, Fisher distribution and numerous geological-geophysic criteria and tests were applied:

1. One of the important indications of a Jn sign depends in orientation independence of magnetization vectors upon lithologic-mineralogic characteristics, being related with the polarity of an ancient field.

2. Another evidence of primary magnetization lies in the lack of interrelations between polarity signs and scalar magnetic characteristics.

3. The immersional analyses data show allothigenic magnetite to be present in the rocks. The coarsest magnetite varieties have angular grains with obvious signs of water transport (scratches and grooves on faces and edges), which confirms their terrigenous origin. To a certain extent, this indicates the detrital nature of magnetization. Firm grounding of this statement is identical to NRM priority proof.

4. Low values of Kenigsberger ratios ($Q = Jn/Ji = 0.05 - 0.5$) and low inter-sample clustering of the trends of stable NRM components ($k = 5 - 30$), characteristic of DRM (or PDRM), are regarded as the indirect paleomagnetic evidences in favour of orientational (or postorientational) genesis of magnetization.

5. Correlability of the paleomagnetic structures of the similar-aged beds from distant heterofacies sections, may certainly serve as a strong argument for substantiating the geophysical nature of magnetozones.

Each of the above criteria indirectly confirms, but does not prove priority of Jn. An important evidence in favour of this hypothesis, however, lies in the sum of independent observations conforming to the suggestion of the ancient nature of NRM.

The composite magnetostratigraphic section of the Barremian from the North Caucasus consists of three major subzones: those of reverse (R), normal (N) and alternating (RN) polarities (Fig. 3).

The reverse polarity Rbr subzone, corresponding to the lowermost Barremian layers, is recognized only in Gergebil.

The overlying normal polarity Nbr subzone is traced everywhere. On the Urukh, it encompasses the whole of

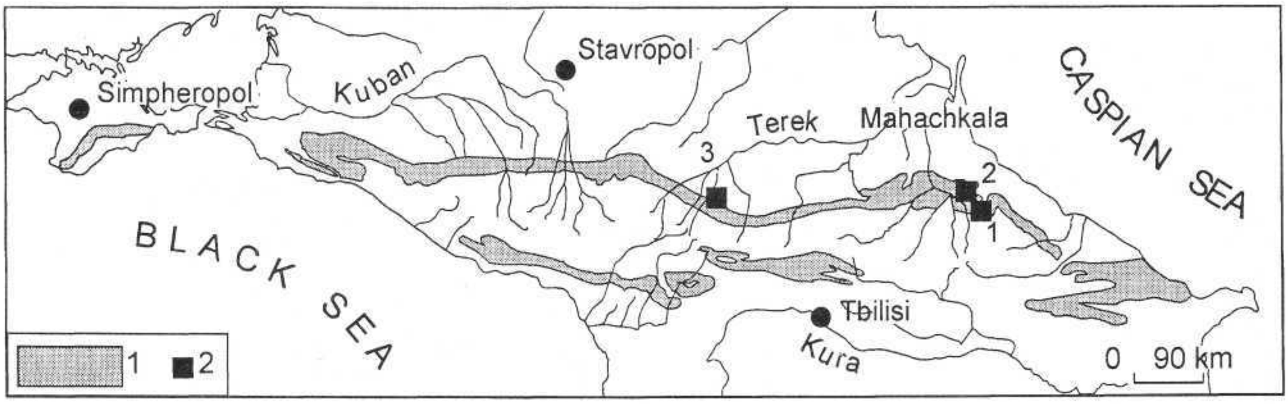

Fig. 1. Location map. Sections: 1 - Urukh city, 2 - Gergebil village, 3 - Akusha village.

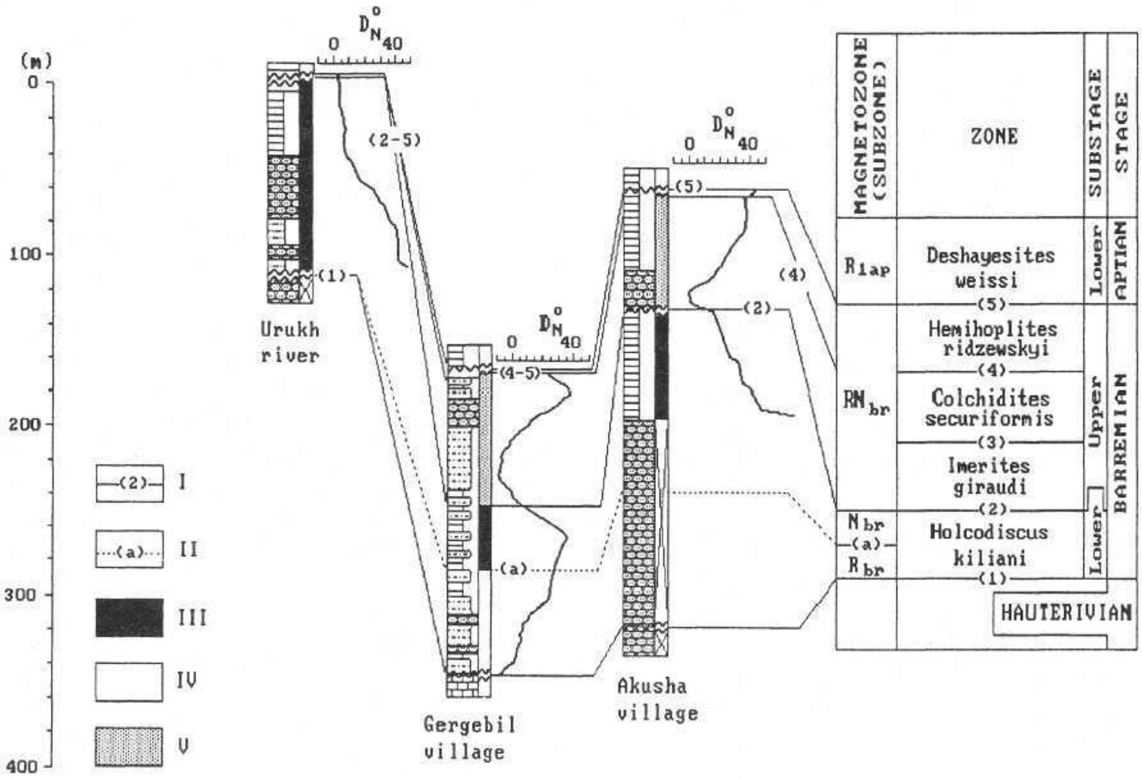

Fig. 2. Paleomagnetic characteristics of the Barremian deposits from Gergebil section. D, I - the paleomagnetic directions were revealed after the resulting vectors Jn had been normalized to the positive polarity, i. e. those corresponding to the R-intervals were turned 180 degrees. "φ", "λ" - latitude and longitude paleomagnetic pole.

the Lower Barremian sequence. In Gergebil and Akusha, the Nbr zone is peculiar of the middle part of the Lower Barremian substage.

The upper alternating polarity subzone, RNbr, is stratigraphically equivalent to the uppermost of the Lower and the whole of the Upper Barremian.

Variations of the paleomagnetic directions were revealed after the resulting vectors Jn had been normalized to the positive polarity, i. e. those corresponding to the R-intervals were turned 180 degrees.

The oscillations thus revealed do not depend upon geomagnetic reversals. Due to their periodicity, they can not be related to lithospheric block movements. Thus, they are interpreted as migration of the Early Cretaceous geomagnetic pole. Besides standard paleomagnetic tests, oscillation identity within the synchronous intervals of distant sections served as a principal criterion of the result reliability. The geochronologic dating of the Barremian, geologic and paleontologic information on stratigraphic section completeness sedimentation rates, faunal evolution and other factors were taken into consideration in time estimation of individual variations.

Complex correlations of the sections according to magnetozones and Dn curves, have allowed most detailed cor-

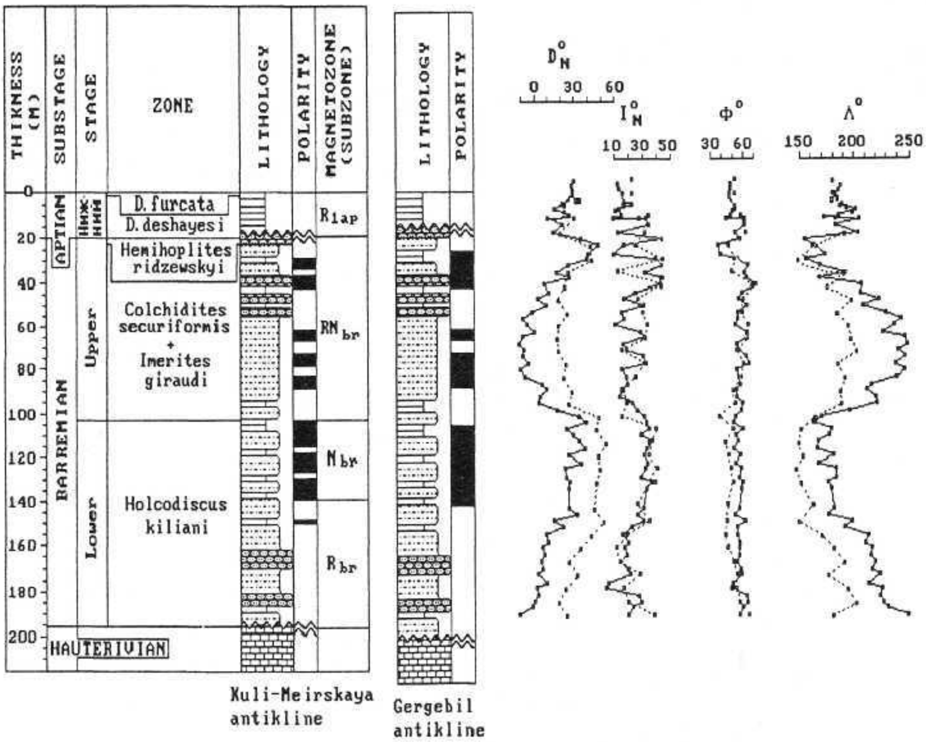

Fig. 3. Paleomagnetic correlations of the Barremian deposits from the North Caucasus. I - Lines of biostratigraphic correlations, II - Lines paleomagnetic correlations, III - normal polarity (N), IV - reverse polarity, V - alternating polarity.

relations of the Barremian strata from the Northern Caucasus (Fig. 3). The effect discovered is most important both for stratigraphic correlations and palinspastic reconstructions. In case if it will be confirmed, the changes in virtual paleomagnetic pole coordinates may be, in some cases, related to the travels of the Barremian magnetic pole proper, and not to plate drift.

The work was financially supported by the Russian Foundation For Fundamental Research (Project 96-05-65442).

Mineralia Slovaca, 29 (1997), 320 - 322

Some features of the Early Cretaceous sedimentation in the Cis-Caucasia reflected in the rock magnetic properties

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Key words: Early Cretaceous, lithology, magnetic susceptibility, North Caucasus

The results of petromagnetic research of the Lower Cretaceous deposits from the Central and Eastern parts of the North Caucasus are presented along with the geologic interpretations. Six reference sections from Dagestan, Chechnya, Kabarda and the Mineral Water district were examined (see the Figure). Those contain carbonate and terrigenous facies of the marine Lower Cretaceous, from the Berriasian through the Albian.

As regards our constructions, it is important to note, that irrespective of paleotectonic interpretations, two geomorphologically distinct sources, the Northern and the Southern ones, existed there in the Early Cretaceous, with an intermediate zone of intensive submergence, the latter one acting as an area of active marine sedimentation in the Early Cretaceous. The Mesozoic paleogeography of the North Caucasus is generally analysed at the level of major sedimentation tectonic cycles, frequently uniting several geologic periods and epochs (Dale et al., 1992; Khain, 1968). Konyukhov (1961) and Konyukov and Olenin (1955) recognized an independent Early Cretaceous stage in the geologic development of the Eastern Cis-Caucasia; this is peculiar for a prolonged transgression, that has started in Berriasian and continued until Late Albian. Carbonate-terrigenous sedimentation prevailed during the early stage of the Lower Cretaceous transgession (Berriasian-Valanginian). Terrigenous deposition characterized the Barremian, Aptian and Albian sedimentation.

Determination of the sources of terrigenous inflow to the Cis-Caucasian basin presents one of the debatable problems for the Mesozoic paleogeography of the North Caucasus. This problem is discussed in detail in a number of important papers on the lithology of the Mesozoic sedimentary complexes from the region, but the authors arrive at different conclusions. Konyukhov (1961) considered the Northern land as the principal source province during whole Early Cretaceous, while Grossheim (1961) regarded the elevations of the Great Caucasus as the main distributive province. Expanding the Grossheim's scheme (l. c.), Sholpo (1978) supposed that the Caucasus has undergone active Callovian erosion, that has practically stopped during Early Cretaceous, renewed during Late Barremian and reached its maximum during Aptian and Albian.

The authors obtained additional paleogeographic information while analysing the data on scalar magnetic characteristics of the Lower Cretaceous beds from the North Caucasus. The petromagnetic data enabled to carry out detailed analyses of Early Cretaceous sedimentation, to specify the importance of the Northern and Southern distributive provinces in the Early Cretaceous sedimentogenesis, and to evaluate the geochemical changes during the transgression.

Rock magnetic properties are primarily determined by the compositions and concentrations of allothigenic or/and authigenic ferromagnetic minerals; these, in their turn, vary depending on sedimentation settings. From this follow the previously formulated postulates for the geologic interpretation of petromagnetic data (Guzhikov and Molostovsky, 1995).

The following theses are relevant to the present theme:

- The magnetization susceptibility of sedimentary rocks, containing allothigenic ferromagnetics, is determined by the paleogeographic and tectonic factors, controlling denudation, drifting and precipitation of terrigenous materials. Petromagnetic differentiation of the layers within a stratigraphic section reflects deposition rhythms and changing sedimentation settings, resulting from geodynamic reconstructions in denudation areas, and, mostly, from the sourceland changes.
- Variations in the dk parameter adequately reflect changing geochemical settings and hydrogen sulfide contamination of the bottom silts or its absence. (dk=kt-k - magnetic susceptibility measured upon heating the rocks up to 500° in air medium. The variations in the dk=kt-k parameter reflect the concentration changes of initially non-magnetic iron sulfides. Pyrite and marcasite change into magnetite upon heating, which results in increasing magnetic susceptibility. Thus, increasing dk's reflect the con-

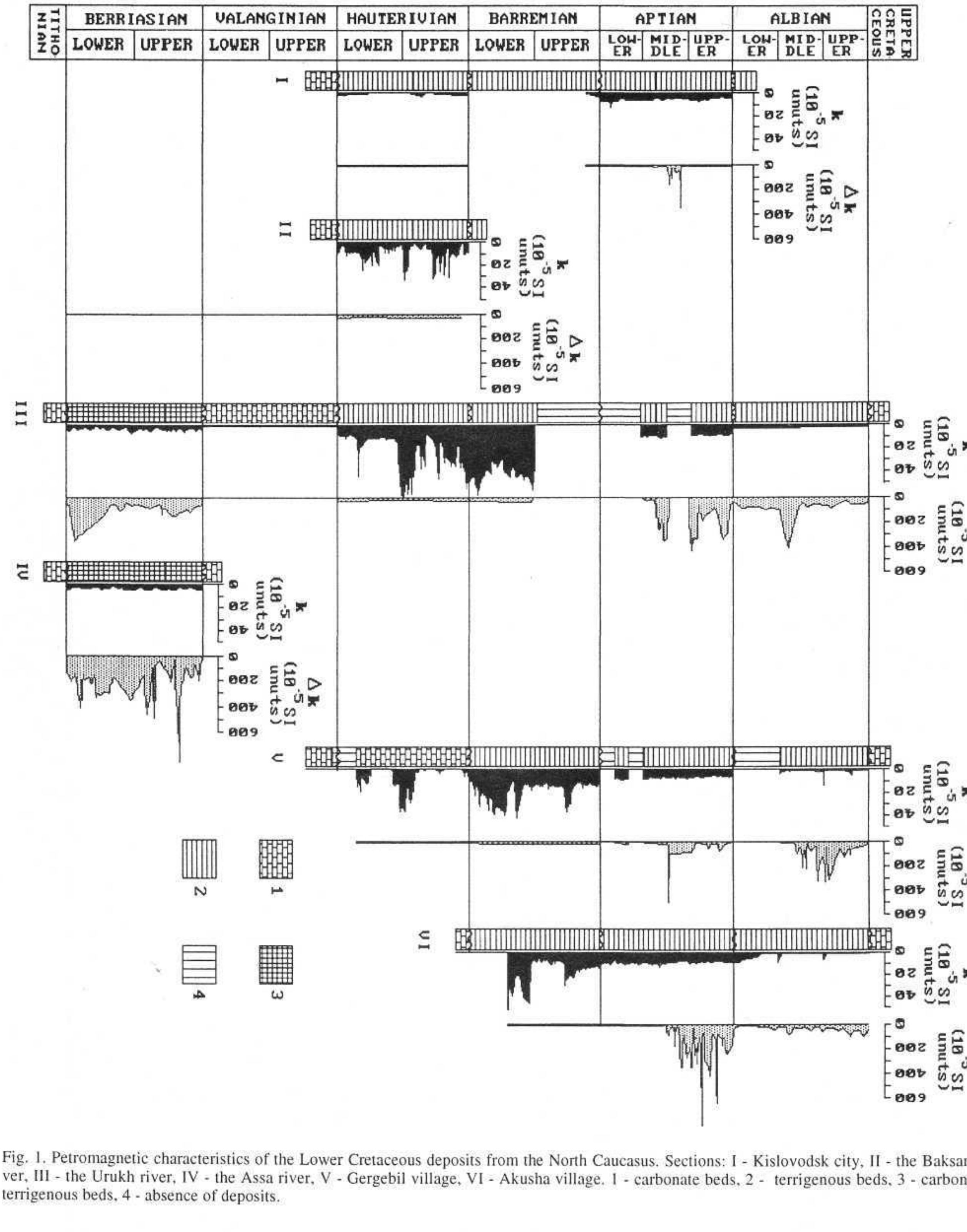

Fig. 1. Petromagnetic characteristics of the Lower Cretaceous deposits from the North Caucasus. Sections: I - Kislovodsk city, II - the Baksan river, III - the Urukh river, IV - the Assa river, V - Gergebil village, VI - Akusha village. 1 - carbonate beds, 2 - terrigenous beds, 3 - carbonate-terrigenous beds, 4 - absence of deposits.

tents of newly generated magnetite, and consequently, the concentrations of original FeS_2).

The set of geologic and petromagnetic data provides the grounds for subdividing the Lower Cretaceous stage in the development of the North Caucasian region into three steps, reflecting peculiar geodynamic and geochemical settings in various intervals of geologic time.

The first one, the Berriasian-Valanginian step, is peculiar for mainly carbonate deposition. The insignificant amount of detritus in the Berriasian deposits, and its almost complete absence from the Valanginian sequences, are indicative of quiet paleotectonic settings and low erosion bases both, in the Southern, and the Northern lands.

The second, the Hauterivian-Barremian step, was characterized by intensive terrigenous drift against the background of general tectonic activization. The Central part of the Great Caucasus becomes then one of the principal sourcelands, with fairly commonly developed granite and basite bodies - the chief suppliers of magnetic materials to the region of marine accumulation. The Hauterivian-Barremian tectonic activation of the Great Caucasus might be a regional reflection of the final stage of the Late Cimmerian tectogenesis phase (Kunin and Sardonnikov, 1976).

The third one, the Aptian-Albian step, coincides with tectonic stabilization of the region associated with further northward transgression development. The Great Caucasus then has probably lost its importance as a supplier of terrigenous material, and the marginal regions of the Scythian Plate have once more become the principal distributive provinces. During that stage, the deposition was taking place in reducing hydrogen-sulfide settings. A correspondence can't be ruled out between the noted peculiarity of the Lower Cretaceous basin paleogeochemistry, and the global anoxic events at the Early/Late Cretaceous boundary (Dale et al., 1992).

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Comparison of the Maastrichtian biostratigraphic scales from Daghestan and Kopet-Dagh sections with the paleomagnetic data

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Key words: Maastrichtian, magnetostratigraphy, integrated biostratigraphy, Northern Causasus, Kopet- -Dagh

The author's data on magnetozonal structures of the Dagestan (the Bass River, Aimaki village) and Turkmenian sections (Kara-Kala settlement, Isak Mts, the Kamyshly and Kanavchai streams) were used for detailed correlation of regional biostratigraphic schemes.

The palaeomagnetic column of the Maastrichtian succession from Kopet-Dagh consists of a major reverse polarity zone, comprising four subordinate normal polarity intervals, with their positions indicated by biostratigraphic methods. Two of them are associated with the middle part and the sole of the *I. tegulatus* Zone, and another two - to the bases of *D. cylindraceum* and *H. sulcatum* ammonite biozones, respectively.

Similar structure is characteristic of the Late Maastrichtian palaeomagnetic column from the Dagestan composite section, comprising the inoceramid (*I. tegulatus*) and echinoid (*P. renngarteni*) biozones. The difference lies in the position of the n-interval, recognized on the base of the *D. cylindraceum* Zone (Kopet-Dagh) and in the top of lower substage (the Caucasus), or in the level occupied by the upper n-subzone, associated with the biozone boundary.

The palaeomagnetic biostratigraphic regional columns correlate as follows:

1) by analogy with the Kopet-Dagh section, the base of the *I. tegulatus* Zone in the Caucasian section should be lowered to lie at the top of the *P. renngarteni* Zone.

2) abrupt reduction of the r-zone part overlying the upper n-interval in the Kopet-Dagh section testifies a significant gap between the Cretaceous and Paleogene, and to a washout of the top part of the *I. tegulatus* Biozone, deeper than in the Caucasian section. On the basis of correlations with the Kopet-Dagh section, the Maastrichtian substage boundary in the Caucasian composite section should be placed below the n-subzone.

In the Kopet-Dagh section, the Early Maastrichtian *H. sulcatum* Zone and the latest Campanian (the top of the *B. polyplocum* Zone) correspond to a major r-zone, extending until the Late Maastrichtian. This comprises one narrow n-interval within the sole of the *H. sulcatum* Zone.

In the Caucasian section, the analogous r-magnetozone encloses both the Early Maastrichtian *Inoceramus buguntaensis*- and *I. alaeformis* biozones, and the bulk of the Late Campanian mute layers. The only narrow n-interval is associated there with the middle of the *I. alaeformis* Biozone.

The work was supported by the Russian Foundation For Fundamental Research (Project 96-05-65442).

Mineralia Slovaca, 29 (1997), 324 - 325

Petromagnetic and palaeomagnetic investigations of Jurassic-Cretaceous limestones aimed at magnetostratigraphy in the Mediterranean area

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Key words: Tithonian, Early Cretaceous, magnetostratigraphy, magnetic susceptibility, Spain, Italy, Bohemia, Slovakia

In the year of 1992, the Palaeontological and Palaeomagnetic Departments of the Geological Institute of the Czech Republic in Prague started a joint project aimed at Jurassic/Cretaceous (J/C) magnetostratigraphy in the Te-thyan realm. Elaboration of geomagnetic polarity time scales (GPTS) required investigations of petromagnetic, magnetomineralogical and palaeomagnetic properties of pilot limestone samples collected from several localities in the Tethyan realm.

Prior to systematic magnetostratigraphic investigations, pilot samples were collected from five localities in the Western Carpathians, namely from 1 - Štramberk, N. Moravia, quarry "Kotouč", the 6th level within the operating quarry; 2 - Štramberk, N. Moravia, quarry "Skalka"; 3 - Brodno near Žilina, W. Slovakia; 4 - Strážovce, between the settlements of Čičmany and Zliechov; W. Slovakia; 5 - Hlboč Valley near Smolenice, W. Slovakia, cross-section in a forest; 6 - In the next step of works, the Early Cretaceous limestone strata at the Río Argos, Province Murcia, SE Spain, were selected for systematic magnetostratigraphic investigations, in collaboration with Dr. Ph. J. Hoedemaeker; 7 - From the locality of Carcabuey, only pilot samples were collected to test their principal palaeomagnetic properties, in collaboration with Dr. F. Oloriz. 8 - Recently, systematic and detailed magnetostratigraphic investigations have been commenced at the locality of the Bosso Valley, Umbria, central Italy, in collaboration with Prof. G. Nardi and Dr. F. Cecca.

Attention was paid to detailed petromagnetic and magnetomineralogical analyses applied to all collected samples. The remanent magnetization and volume magnetic susceptibility were measured with the use of the JR-4 and JR-5 spinner magnetometers and KLY-2 kappa-bridge (Jelínek, 1966, 1973). Selected samples were subjected to alternating-field (AF) demagnetization by means of the Schonstedt GSD-1 apparatus. Higher efficiency was obtained during demagnetization by means of the MAVACS apparatus, Magnetic Vacuum Control System (Příhoda et al., 1989). Consequently, all samples investigated for magnetostratigraphy were subjected to thermal demagnetization by means of the MAVACS apparatus. For the locality of Brodno near Žilina, the magnetic measurements were combined with X-ray diffraction studies to identify the magnetization carriers of weakly magnetic limestones. In the Figs. 1 to 3, M_t denotes the remanent magnetic moment of a sample demagnetized at temperature t; M_n is the sample moment in natural state. M_t/M_n and k_t/k_n are normalized values of remanent magnetic moment and of volume magnetic susceptibility, respectively. The Zijderveld diagrams and stereographic projection of remanence directions of samples in natural state (NS) as well as during thermal demagnetization were constructed for all the samples; examples are presented in Figs. 1 to 3. Results were obtained from large sets of samples, which were all subjected to multi-component analysis of remanence (Kir-schvink, 1980).

All samples, without exception, exhibit high portion of secondary magnetization - viscous magnetization or chemo-remanent magnetization conditioned by weathering. The unblocking temperatures vary within the prevalent limit of 540° to 560 °C. The palaeomagnetization carrier is fine-grained magnetite which is in accordance with results from other localities in the Tethyan realm. The only exception was found for the locality of the Río Argos, where the magnetite shows syn- or post-folding magnetization (thermo-viscous effect?). Directions of totally remagnetized samples from the Río Argos indicate the Neogene age of remagnetization (see Tab. 1). A substitute locality for the J/C magnetostratigraphy was found at Carcabuey, a locality about 2 km distanced from that originally investigated by Ogg et al. (1984). This new locality representing a broader section of J/C boundary strata was recently described by Tavera et al., 1994. Fig. 1 shows typical results of thermal demagnetization of a Tithonian limestone from Carcabuey.

Limestone samples from the Western Carpathians show suitable palaeomagnetic properties (cf. Houša et al., 1996). In the locality of Brodno near Žilina, the sedimentation in a quiet basin was one of the basic pre-requisites for reliable derivation of high-resolution magnetostratigraphic data. The derived palaeomagnetic pole position rotated palaeotectonically corresponds well to J/C pole positions, see Tab. 1. The pattern of normal and reverse magnetozones correlates well with data derived in the regions of Foza (north Italy), Bosso Valley (Umbria, central Italy) and with marine M (Mesozoic) anomalies. Detailed measurements and precise detection of two narrow reverse subzones (proposed to be named "Brodno" and "Kysuca" by Dr. V. Houša) in the normal magnetozones

Tab. 1.
Río Argos, Brodno near Žilina. Palaeomagnetic directions and pole positions

Region locality	Location		Mean direction		α_{95}	k	n	Pole position		Confidence ovals	
	Lat.	Long.	Decl.	Incl.				Lat.	Long.	δm	δp
Río Argos*	38.1°N	358.1°E	359.3°	56.2°	2.8°	31.8	84	88.6°N	200.8°E	4.0°	2.9°
Brodno near Žilina	49.26°N	18.75°E	236.3°	45.4°	5.6°	9.8	104	1.1°N	29.2°W	7.1°	4.5°

*Limestones totally remagnetized in the Neogene

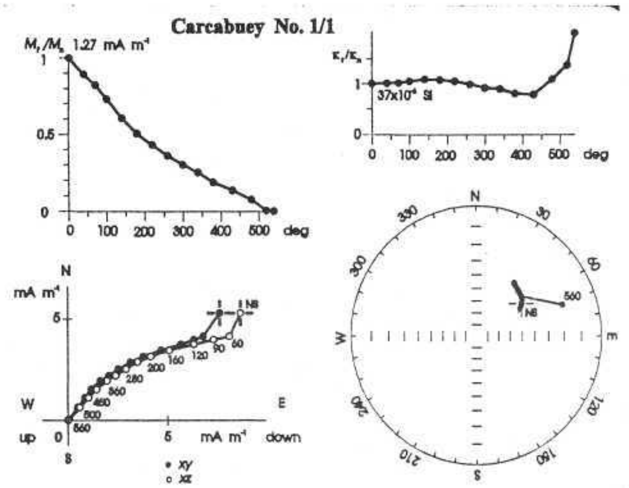

Fig. 1. Carcabuey, southern Spain, typical results of thermal demagnetization.

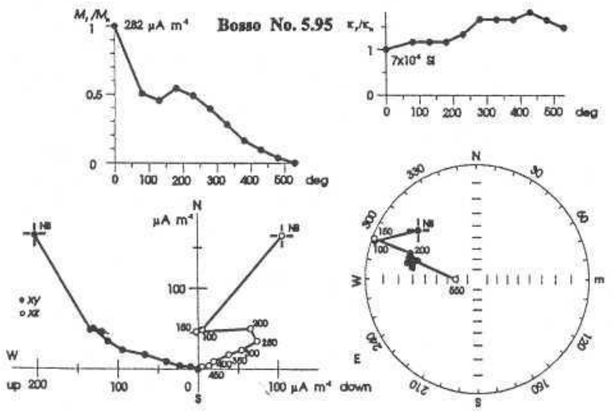

Fig. 2. Boss Valley, Umbria, central Italy, typical properties of normally polarized samples.

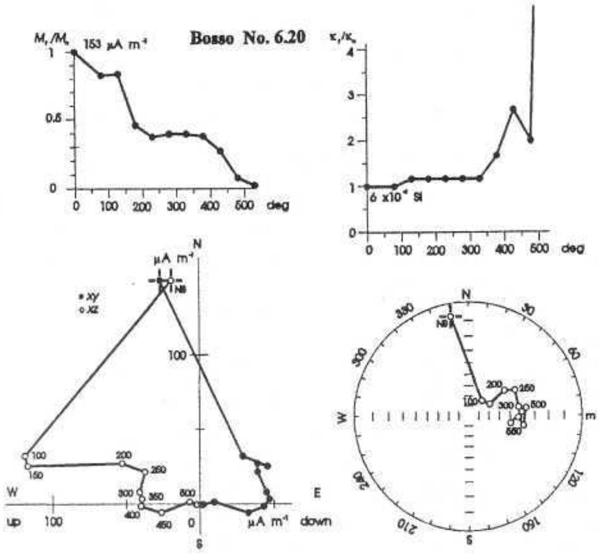

Fig. 3. Bosso Valley, Umbria, central Italy, typical properties of reversely polarized samples.

M19 and M20 range this profile into the high-resolution magnetostratigraphic profiles. A section of the Early Cretaceous Maiolica pelagic limestone in the Bosso Valley, Umbria, central Italy, was originally studied by Lowrie and Channell (1983). Clearly defined magnetozones were outlined which were correlated with palaeomagnetic polarity records derived from the M-sequence of marine magnetic anomalies M19 to M14, and possibly M13. In order to prepare the Bosso profile for the high-resolution magnetostratigraphy, the J/C section was resampled in 1996, typical results of normally and reversely polarized samples are shown on Figs. 2 and 3. In 1997, this profile is scheduled for detailed sampling with the aim to detect and outline precisely two narrow reverse subzones for correlation with the Brodno profile and eventually with next profiles in the Tethyan realm.

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Mineralia Slovaca, 29 (1997), 326 - 327

Mid - Cretaceous radiolarian zonation in the Polish part of the Pieniny Klippen Belt (Outer Western Carpathians)

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Key words: Middle Cretaceous, Radiolaria, biozonation, biostratigraphy, Western Carpathians, Poland

The Albian to Turonian deposits in the Polish part of the Pieniny Klippen Belt comprise pelagic and shaly turbidite facies. They represent shallow (shelf) to deep-water environments, and they are relatively rich in radiolarian fauna.

Over 70 radiolarian species of the Carpathian Tethyan low latitude realm were identified in over 200 samples from 18 sections in the deposits of the Pieniny, Branisko, Niedzica and Czorsztyn successions of the Pieniny Klippen Belt. 17 horizons containing abundant and well-preserved radiolarian fauna have been chosen to analysis.

This data were processed with the BioGraph 2.02 computer program (Savary and Guex, 1991) based on the Unitary Associations Method. The program produced a sequence of 11 U. A. which were used for constructing radiolarian zonal scheme (Tab. 1).

Three radiolarian zones and six subzones (*Holocryptocanium barbui* Zone with *Stichomitra tosaensis, Squinabollum fossile, Thanarla pulchra, Thanarla veneta, Torculum dengoi* and *Obeliscoites maximus* subzones, *Hemicryptocapsa prepolyhedra* Zone and *Hemicryptocapsa polyhedra* Zone) have been proposed for the interval investigated.

Holocryptocanium barbui zone

The base of this zone is defined as first appearance of *Holocryptocanium barbui*. The upper limit of the zone is defined as the first appearance of *Hemicryptocapsa prepolyhedra*. In this zone *H. barbui* has its maximum of abundance within the Pieniny Klippen Belt deposits. The radiolarian fauna is the most diverse in this unit, over 40 species make their first appearance in this zone. It represents an important period of faunal renewal.

Stichomitra tosaensis Subzone

The lower part of this subzone is restricted by the first appearance of index taxon. This zone is characterised by co-occurrence of *Holocryptocanium barbui, Pseudodictyomitra pentacolaensis, Pseudodictyomitra carpatica, Stichomitra mediocris, Thanarla brouweri* and *Stichomitra communis*. *Cryptamphorella macropora* makes its first appearance in the upper part of the subzone.

Squinabollum fossile Subzone

The bottom of this subzone is defined by the first occurrence of *Squinabollum fossile*. *Dictyomitra formosa* and *Torculum coronatum* make their first occurrence within this subzone. Simultaneously, the last occurrence of *Pseudodictyomitra carpatica* takes place.

Thanarla pulchra Subzone

The first appearance of *Thanarla pulchra* defined the bottom of this subzone. This unit is characterised by the co-occurrence of many characteristic pairs of species (U.A.3). The first appearance of *Holocryptocanium geysersensis, Dictyomitra montisserei, Xitus mclaughlini, Pseudoaulophacus sculptus* and *Pseudodictyomitra pseudomacrocephala* take place within the unit. The last occurrence of *Crucella aster* is also observed.

Thanarla veneta Subzone

The lower boundary of this subzone is defined by the first appearance of index species. This unit is characterised by the co-occurrence of numerous characteristic pairs of species (U.A.4 - U.A.6). The first appearance of *Dictyomitra gracilis, Trisiringium echitonicum, Godia unica, Dactyliosphaera silviae, Crolanium pulchrum* and *Pseudodictyomitra paronai* is observed within this unit as well as the last occurrence of *Thanarla spoletoensis, Thanarla brouweri* and *Dactyliodiscus cayeuxi*.

Tab. 1.
Reproductability table. Ther grey rectangles represent the Unitary Associations, strictly identifiable in the sections studied.

U.A.	Mag	Lor	Sz	Ki	St	Kp	Buk	Kos	Fl	Cz
11							■			
10							■			
9	■		■							
8		■		■						
7						■		■	■	
6					■					
5									■	
4										■
3									■	
2							■			
1					■					

Torculum dengoi Subzone

The lower boundary of this subzone is marked by the first occurrences of *Torculum dengoi*, the total range of which is included within this unit. The events characterised this unit are the final appearance of many species as *Stichomitra mediocris, Praeconocaryomma globosa, Hexapyramis pantanelli, Pseudoaulophacus sculptus, Thanarla veneta, Dictyomitra gracilis, Crolanium pulchrum, Torculum coronatum, Godia unica* and *Pseudodictyomitra paronai*. Only three radiolarian specimens as *Obeloscoites giganteus, Dactyliosphaera acutispina* and *Dictyomitra pulchra* making their first appearance within this unit.

Obeliscoites maximus Subzone

The lower boundary of this subzone is defined as the first appearance of *Obeliscoites maximus*. The co-occurrence of *Holocryptocanium barbui, Squinabollum fossile, Stichomitra communis, Thanarla pulchra* and *Xitus mclaughlini* are observed within this unit.

Hemicryptocapsa prepolyhedra zone

The lower boundary of this zone is marked by the first appearance of the index species. The last occurrence of *Xitus mclaughlini* and *Thanarla pulchra* is observed in the upper part of this zone. This unit is characterised by the co-occurrence of characteristic pairs of species (U.A.8) *H. prepolyhedra* zone is characterised by a relative decrease in the number of species illustrates the transition of radiolarians from the Cenomanian to Turonian.

Hemicryptocapsa polyhedra zone

The lower boundary of this zone is defined as the first appearance of *Hemicryptocapsa polyhedra*. This unit is characterised by the co-occurrence of characteristic pairs of species (U.A.9 - U.A.11).

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Late Santonian - Maastrichtian benthic foraminiferal zonation in the European palaeobiogeographical area (EPA)

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Key words: Late Cretaceous, biostratigraphy, paleobiogeography, benthic Foraminifera, Europe

The proposed Late Santonian-Maastrichtian benthic foraminiferal zonal scheme for the EPA was constructed on the basis of analysis of zonal schemes and zonal assemblages of different regions of the eastern and western EPA, particularly of the Mangyshlak-Precaspian Basin (Akimetz et al., 1991) and the NW German Basin (Koch, 1977; Schönfeld, 1990).This scheme comprises 18 biostratigraphical units, 13 zones and 5 subzones (Figs. 1 - 3). Most of the zones are widely applicable. They can be followed throughout the EPA, and some of them are also recognised throughout the adjacent areas. The benthic zonal scheme is 2 - 3 times more detailed then the planktic. The duration of the zones ranges from ~0.4 up to ~3.3 Ma, and that of the subzones fluctuates from ~0.1 to ~ 1.9 Ma. The shortest zones comprises the Late Santonian - earliest Campanian interval, and the terminal Campanian. These stratigraphical intervals correspond to the regressive phases (Late Santonian and terminal Campanian), and to the beginning transgression (earliest Campanian, cf. Naidin et al., 1984a, b).

The scheme is based on the phylogenetic lineages of *Heterostomella, Neoflabellina, Stensioeina, Globorotalites, Gavelinella, Brotzenella, Cibicidoides, Bolivina, Bolivinoides,* and other genera. Some phylogenetic evolutionary events of *Stensioina, Bolivinoides, Bolivina* and other genera are widely distributed, being determinable in Europe as well as in Asia, Africa, North America, Australia and in the oceans.

On the basis of peculiarities of the geographical distribution of the Late Santonian - Maastrichtian benthic foraminifers, the EPA can be subdivided into two palaeobiogeographical provinces: West European- and East European one. The first one was linked with the North Sea and North Atlantic, and, to a lesser degree, with the Tethys. The connection of the second subprovince with the Arcto-Boreal West Siberian Sea through the Turgai Strait was restricted, but this with the Tethys was never interrupted.

The appearance of several stratigraphically important benthic species and all of the planktic species reflect different abiotic palaeogeographic events: eustatic transgression and connection between the EPA Basin and Tethys, North Atlantic, and the Boreal-Arctic West Siberian Sea through the Turgai Strait, which was formed during the later Late Campanian. Open connection between the East European Province, and the Arcto-Boreal West-Siberian Sea through the Turgai Strait was established during Late Maastrichtian.

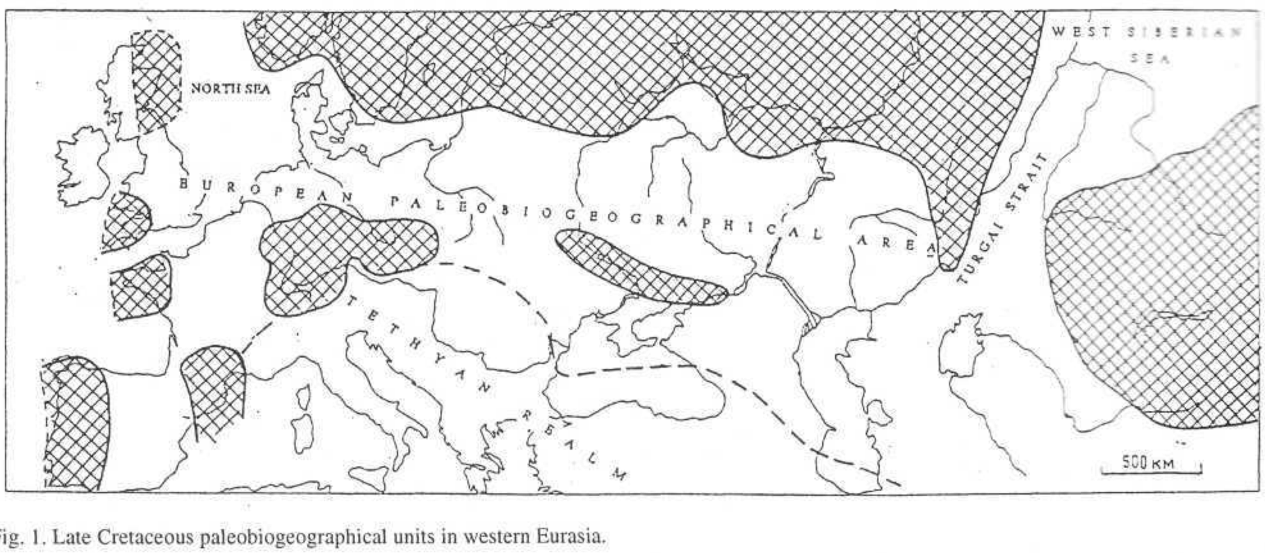

Fig. 1. Late Cretaceous paleobiogeographical units in western Eurasia.

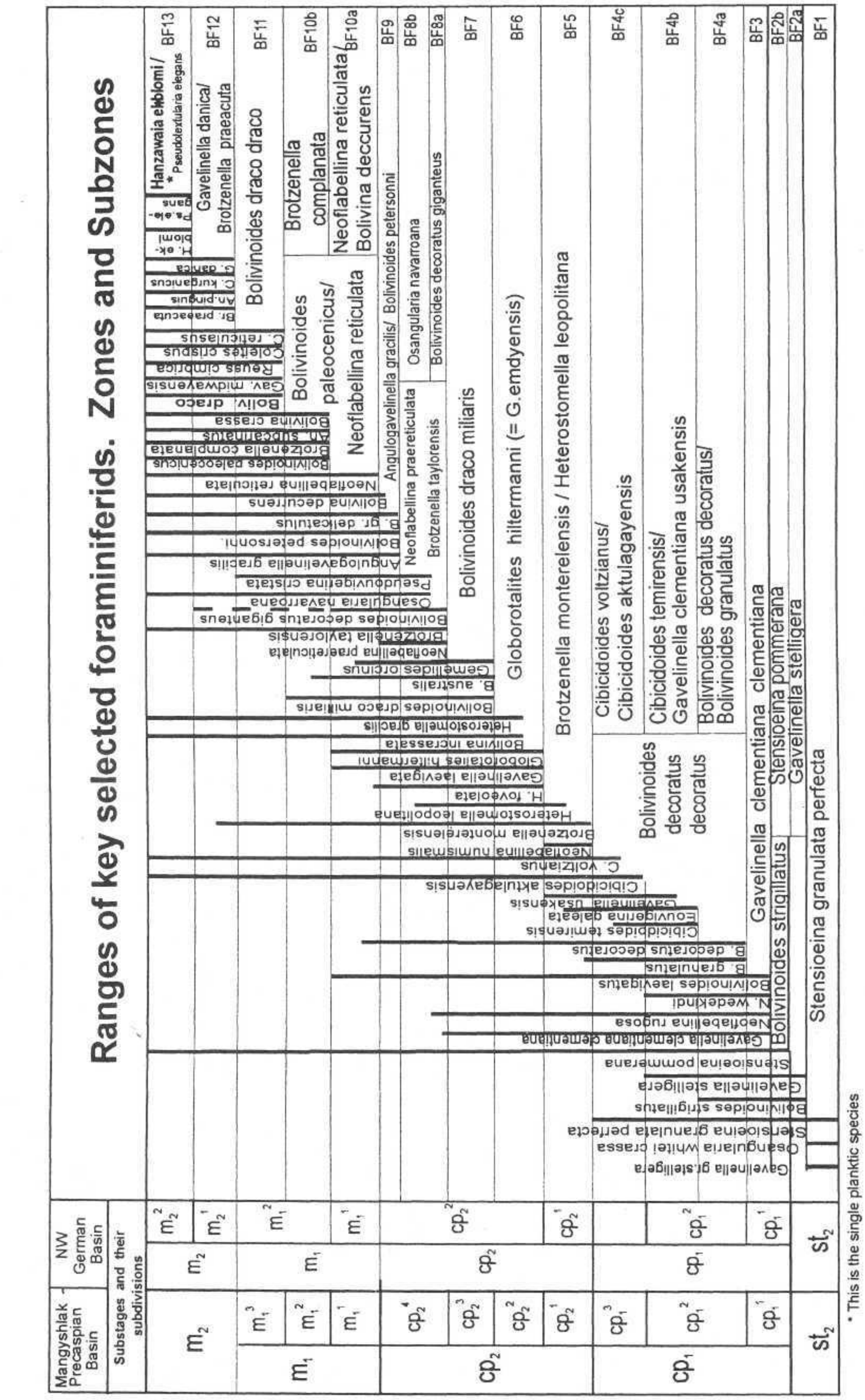

Fig. 2. Late Santonian-Maastrichtian detailed benthic foraminiferal scheme of the EPA.

Mangyshlak/ Precaspian Basin		NW German Basin		Benthic Foraminiferal Zonation for EPA		Eastern EPA (Naidin et al., 1984 a,b; Akimetz, Beniamovskii, Kopaevich, 1991)		Western EPA: Koch, 1977	Western EPA: Schonfeld, 1990
substages and their subdivisions									
m_2		m_2	m_2^2	Hanzawaia ekblomi	BF13	Hanzawaia ekblomi	XXVI	Pseudotextularia elegans	
			m_2^1	Gavelinella danica / Brotzenella praeacuta	BF12	Brotzenella praeacuta	XXV	Gavelinella danica	
m_1	m_1^3	m_1	m_1^2	Bolivinoides draco draco	BF11	Bolivinoides draco draco	XXIV	Bolivinoides draco draco	paleocenicus/ reticulata - P.R.Zone
	m_1^2			Bolivinoides paleocenicus/ Neoflabellina reticulata; Brotzenella complanata	BF10b	Brotzenella complanata	XXIII	Neoflabellina reticulata	
	m_1^1		m_1^1	Neoflabellina reticulata / Bolivina decurrens	BF10a	Angulogavelinella gracilis	XXII		decurrens - I.Zone
cp_2	cp_2^4	cp_2	cp_2^2	Angulogavelinella gracilis/ Bolivinoides peterssonni	BF9			Bolivinoides draco miliaris	peterssoni/hiltermanni - C.R. Zone
				Neoflabellina praereticulata/ Brotzenella taylorensis; Osangularia navarroana	BF8b	Brotzenella taylorensis	XXI		navarroana/cristata - P.R.Zone
				Bolivinoides decoratus giganteus	BF8a				miliaris/incrassata - P.R.Zone
	cp_2^3			Bolivinoides draco miliaris	BF7	Bolivinoides draco miliaris	XX		gracilis - P.R Zone
	cp_2^2			Globorotalites hiltermanni (= G.emdyensis)	BF6	Brotzenella monterelensis	XIX	Neoflabellina numismalis	leopolitana - P.R.zone
	cp_2^1		cp_2^1	Brotzenella monterelensis/ Heterostomella leopolitana	BF5	Cibicidoides voltzianus	XVIII		laevigatus - P.R Zone
cp_1	cp_1^3	cp_1	cp_1^2	Bolivinoides decoratus decoratus: Cibicidoides voltzianus / Cibicidoides aktulagayensis	BF4c	Cibicidoides aktulagayensis	XVII	Bolivinoides decoratus decoratus	voltzianus -P.R Zone
	cp_1^2			Cibicidoides temirensis/ Gavelinella clementiana usakensis	BF4b	Cibicidoides temirensis	XVI		granulatus - P.R zone
				Bolivinoides decoratus decoratus/ Bolivinoides granulatus	BF4a	Bolivinoides decoratus decoratus	XV		wedekindi - P.R Zone
	cp_1^1		cp_1^1	Gavelinella clementiana clementiana	BF3	Gavelinella clementiana clementiana	XIV	Bolivinoides strigillatus	clementiana - P.R. Zone; concinna - I.Zone
				Bolivinoides strigillatus; Stensioeina pommerana	BF2b	Bolivinoides strigillatus	XIII		pommerana / frankei P.R. zone
				Gavelinella stelligera	BF2a				strigillatus - P.R Zone
st_2		st_2		Stensioeina granulata perfecta	BF1	Stensioeina granulata perfecta	XII	Stensioeina granulata perfecta	perfecta - P.R Zone

Fig. 3. Relationship between the zonal scheme newly proposed and the zonal schemes of two regions of the EPA: Mangyshlak-Precaspian and NW Germany.

Revision of Upper Cretaceous ammonite fauna from the Bakony Mts (Hungary)

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Key words: Upper Cretaceous, biostratigraphy, ammonite zonation, Bakony Mts, Hungary

In the framework of National Science Found T-015783 („Bakony/Gubbio Late Cretaceous correlation and Re-evaluation"), we re-evaluated Late Cretaceous ammonite fauna of the area of Sümeg - Csabrendek (Bodrogi et al., 1995; Bodrogi and Yazykova, 1996). The data gained in 1995 - 1996 are presented in the tab le b elow.

All the ammonites were derived from the **Rendek Member** of the **Polány Marl Formation** with the exception of *P. polyopsis* that was found in theCsingerwolgy member of the **Jákó Marl Formation.**

Since the former determination of all the ammonites was incorrect (with the exception of *P. polyopsis,* again), the age of ammonite - bearing layers was estimated as one stage younger.

Original description	Originally described age	Valid taxon	Reevaluator	Valid age
Pachydiscus neubergicus Hauer 1858; Papp, Városi Quarry, PMF-RM, Lóczy 1913, K-2728	Early Maastrichtian	*Pachydiscus precolligatus* Collignon 1955	Yazykova 1996	Early Campanian
Pachydiscus neubergicus Hauer 1858; Noszky, Városi Quarry, PMF-RM, Haas et al. 1984, K-8645	Early Maastrichtian	*Eupachydiscus levyi* Grossouvre 1894	Yazykova 1996	Early Campanian
Pachydiscus neubergicus Hauer 1858 2 exemplar; Kocsis, Városi Quarry, PMF-RM	Early Maastrichtian	*Pachydiscus precolligatus* Collignon 1955	Yazykova 1996	Early Campanian
Pachydiscus neubergicus Hauer 1858; Kocsis, Városi Quarry, PMF-RM	Early Maastrichtian	*Eupachydiscus levyi* Grossouvre 1894	Yazykova 1996	Early Campanian
Mortoniceras sp.; Budai & Vincze 1981, Haraszt Quarry, PMF-RM, Budai 1981	Late Campanian	*Texanites* sp.	Summesberger 1995; Yazykova 1996	Santonian
Placenticeras polyopsis (Dujardin 1837) syn: *Placenticeras syrtale* Morton 1963; in Partényi 1986, Summesberger 1986, Csabrendek Cr-2 borehole, JMF-CSM, Partényi 1986, K-14583	Late Santonian	*Placenticeras polyopsis* (Dujardin 1837) not Placenticeras syrtale Morton 1963:	Yazykova 1996	Late Santonian

PMF=Polány Marl Formation; RM=rendek Member; JMF=Jákó Marl Formation; CSM=Csingervölgy Member. Original description: species; collector, location, stratum typicum, reference, museum number (in collection of the Hung. Geol. Inst.)

Correlating the uncorrelatables

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Key words: Lower Cretaceous, integrated stratigraphy, interregional correlation, Western Europe

The here presented correlation of the Pre-Aptian Cretaceous successions of the Boreal and Tethyan realms has an accuracy which is unprecedented. This is due to the combination of three correlation tools: biostratigraphy, magnetostratigraphy and sequence stratigraphy.

The most recent correlations of Tethyan with Boreal Pre-Aptian Cretaceous successions by means of fossils have been done:

For the Berriasian: by Hoedemaeker, 1987, 1990;

for the Valanginian: by Kemper et al., 1982; Hoedemaeker, 1987;

for the Hauterivian: by Kemper et al., 1982;

for the Barremian: by Kakabadze, 1983, this paper.

From these correlations can be gathered that there are only a very few reliable biostratigraphic tie-points between the Tethyan and Boreal realms due to the high provinciality of the marine biota during Pre-Aptian Cretaceous times. Fossils common to both realms are very scarce. We may conclude that we cannot hope for a better correlation with biostratigraphic means only. If we want a more precise correlation, magnetostratigraphy and sequence stratigraphy have to be used as additional correlation tools = 20.

It appears that all depositional sequences determined in the Pre-Aptian Tethyan Cretaceous succession along the Río Argos (Caravaca, SE Spain) can be found in SE France (sections of Berrias, La Charce and Angles), but also in the Boreal successions in north Germany and in England. The magnetostratigraphic analyses in the stratotype of the Berriasian Stage in SE France and in the Purbeck beds of the Durlston succession in S. England (Ogg et al., 1991) permit a good correlation of these successions, which could be made more precise by means of sequence stratigraphy. Neither magnetostratigraphy, nor sequence stratigraphy or biostratigraphy should contradict each other, when correlating.

As a sequence stratigraphic analysis of most boreal sections is still lacking, a Tethyan - Boreal correlation could not be done before an interpretation was made of the precise stratigraphic positions of the various Pre-Aptian depositional systems tracts in the boreal sections of England and north Germany. Such an interpretation can only be done in sections which have been accurately measured and lithologically described in detail, and of which also the fossil content is well studied. Such sections furnish all the data necessary to form a well-founded interpretation of the sequence-stratigraphic boundaries. Fortunately, such Boreal sections are known. For our analyses were used:

The section of the German Wealden in the Isterberg 1001 borehole;

the section of the Valanginian in Sachsenhagen;

the section of the Hauterivian from the Moorberg claypit near Sarstedt;

the section of the Barremian from the Gott claypit near Sarstedt;

the section along the Mittellandkanal near Pollhagen;

the Speeton Clay section near Speeton (Valanginian - Barremian);

the Purbeck sections in Dorset and in the Weald; (Hallam et al., 1991)

the Wealden section of the Warlingham borehole;

the Purbeck sections in the Neuch(tel region (Switzerland).

The data gathered from these sections and some additional sections, furnish a sound interpretation of the various depositional systems tracts and the correlation of the Boreal and Tethyan sequences is shown in this correlation scheme.

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Foraminifera and sedimentary paleoenvironment of the Lower Cretaceous black shales (Ukrainian Carpathians)

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Key words: Lower Cretaceous, Foraminifera, lithology, sedimentary environment, Ukrainian Carpathian

Lower Cretaceous black shale formation is developed in the Dukla-, Krosno- and Skyba tectonic units and Chornogora zones. These Upper Barremian-Albian strata are subdivided into Shypot and Spass Formations. Lower part of them is represented by black and dark-grey claystones, while the sandstones dominate in their upper part. The problems of the origin and sedimentary environment of these well known and in the Carpathians widely spread sediments this problem are discussed, still.

Several depository environment have been reconstructed on the basis of the foraminifer paleoecology and sedimentology. Following foraminiferal biofacies can be distinguished in the Upper Barremian-Albian interval:

1. Mixed slope biofacies (*"Marssonella"* assemblage sensu Haig, 1979) were determined in the lowest (Barremian) part of the Spass Formation. They are characterized by calcareous *Spirillina, Patellina, Gavelinella, Discorbis, Valvulineria,* agglutinated *Falsogaudryinella, Gaudryinella, Verneuilinoides, Tritaxia* and rare planctonic *Hedbergella*. Olszewska (1984) previously described *"Marssonella"* assemblage of the Polish Outer Carpathians as indicator of the open continental shelf and bathyal environment above the CCD.

2. The slope flysch-type biofacies (lower slope paleobathymetric assemblage sensu Kunt and Kaminski et Moullage, 1989) were estimated in the lowest part of the Shypot formation. The poorly diversified agglutinated foraminifers are represented by numerous *Verneuilinoides* and *Gaudryina* while astrorhizids, ammodiscids, lituolids and calcareous elements occur less frequently. These biofacies can indicate the depth of about 1.5 -2.5 km.

3. Abyssal *"Krasheninnikov"* biofazies (sensu Krasheninnikov, 1973; = "Type-B" assemblage sensu Gradstein et Bergren, 1981). This assemblage of agglutinated foraminifers characterized by small forms with a smooth-walled finely grained test, represented by *Hippocreppina, Rhizammina, Kalamopsis, Saccammina, Reophax, Ammodiscus, Haplophragmoides, Trochammina genera.* These biofacies were found in the lower part (Aptian) of Spas and Stypot formations. Gradstein and Bergren (1981) noted a "Type-B" assemblage of agglutinated foraminifers with smooth-walled varieties at the deep > 4 km.

The low diversified agglutinated foraminifer association occurr in the noncalcareous organic rich claystones indicating unfavourable paleoenvironment until the Aptian time in the some parts of the basin. It may indicate restricted bottom water circulation, low oxygen and temperature and another factors.

4. Abyssal flysh-type biofacies (*"Recurvoides"* assemblage sensu Haig, 1979; = "Type-A" assemblage sensu Gradstein et Bergren, 1981) are recognized in the Albian part of the Shypot and Spass formations. They are characterized by dominant of agglutinated foraminifers with a coarse grained tests of the genera: *Glomospirella, Reophax, Thalmannammina, Recurvoides, Plectorecurvoides, Haplophragmoides, Trochammina.* It is considered to indicate bathyal and abyssal environment bellow the CCD (2.5 - 3.5 km). The *"Recurvoides"* assemblage was previously identified in the Verovice and Spass formations of the Polish Outer Carpathians (Olszewska, 1984).

The sedimentological data confirm the paleoecological conclusions based on foraminifers indicating deep-water depositional environment of black shale formation. So the lower part of the Spas and Shypot formation (black claystones) is characterized as a hemipelagite sequence. The bedded sandstones in their upper part are defined as lobe-like turbidites. These deposits are compared with the slope foot basinal sediments.

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Mineralia Slovaca, 29 (1997), 334 - 335

Turonian planktonic Foraminifera biozonation - the problems of taxonomy and synonymy of index species

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Key words: Turonian, Foraminifera, taxonomy, biozonation, Meditterranean Tethys

The authors establishing the microbiostratigraphic standard zonal division of the Turonian Stage (Caron, 1985; Salaj, 1986; Robaszynski and Caron, 1995) used different index taxa in characteristics of individual planktonic biozones due to different interpretation of the International Zoological Nomenclature Code (Stoll et al., 1961). We stress some of the most important contradictions below:

1. The definition of the *Whiteinella archaeocretacea* Biozone (large globigerinid zone of Sigal, 1995) used for the topmost Cenomanian - basal Turonian, is incorrect. The *Whiteinella archaeocretacea* (Pessagno) appears at the top of middle Turonian *Helvetoglobotruncana helvetica* Zone (Pessagno, 1967), being morphologically identical with the *Whiteinella inornata* (Bolli), occurring in the same association. Salaj (1997) regarded them as synonymic, at least the former taxon could represent a subspecies (= *Whiteinella inornata archaeocretacea*).

Lehmann (1962) described new index ? *Praeglobotruncana gigantea,* in this time interval on the Cenomanian/Turonian boundary (Zone "á Grandes Globigerines" seulles). This species was used by Bolli (1966) for his new Praeglobotruncana gigantea Zone. However, Porthault (1969) considered it conditionally as homonyme (but not synonyme), of formerly described new species *Praeglobotruncana biconvexa gigantea* Samuel et Salaj (1962). This was because he introduced a new taxon *Whiteinella lehmanni,* 1969, synonymous with *Whiteinella gigantea* (Lehmann). Regarding it, van Hinte (1976) established the *Whiteinella lehmanni* Zone (1974).

Taking into consideration that *Preeglobotruncana biconvexa gigantea* (Salaj et Samuel) belongs to the genus *Dicarinella* Porthault (Donze et al., 1970), we cannot regard both *Whiteinella gigantea* (Lehmann) and *Dicarinella biconvexa gigantea* (Samuel et Salaj) as primary, but as secondary homonyms. Salaj and Gašparíková (1983, p. 593) stressed the validity of the name *Whiteinella gigantea* (Lehmann) in sense of the International Code of Zoological Nomenclature, too.

On the other hand, Robaszynski et Caron (1979) although correctly attributing *Whiteinella lehmanni* Porthault under the synonymy of *Whiteinella gigantea* (Lehmann), connected both *Whiteinella gigantea* (Lehmann, 1964) and *W. lehmanni* Porthault, 1969 under *Whiteinella archaeocretacea* (Pessagno, 1967). If these taxa are identical, *Whiteinella archaeocretacea* Pessagno (1967) should be synonymous with *Whiteinella gigantea* (Lehmann). However, distinct morphological differences and different stratigraphic span exclude and discussion about their possible synonymy: *Whiteinella archaeocretacea* (Pessagno) does not occur in Upper Cenomanian strata and never was found in the lower and middle part of the *Helvetoglobotruncana helvetica* Zone.

Due to primary absence of *Whiteinella gigantea* (Lehmann) in several paleoecologicaly specific parts of the Tethyan Realm, Salaj et Samuel (1966, 1984) introduced in Western Carpathians a new Early Turonian *Dicarinella imbricata* Zone with *Dicarinella imbricata*- and *Dicarinella hagni* Subzones, applied by Maamouri et al. (1994) in Tunisia in the frame of the *Whiteinella archaeocretacea* Zone.

It is worth of mention that the new species *Whiteinella hoelzli* (Hagn & Zeil) was described by Hagn & Zeil in 1954, later also *Whiteinella aprica* (Loeblich & Tappan) by its authors in 1961 from this C/T boundary interval. The last species was used by Bellier (1983, p. 156) as index fossil of his new Whiteinella aprica Zone. This author consider the *W. gigantea* as a synonymum of the *W. aprica*. Taking into consideration the big variability of these globular and more-less rugose forms, existing in the same time interval, I think that *W. aprica* is a synonymum of *W. hoelzli* (*Hedbergella hoelzli* in Robaszynski Caron et E.W.G.P.F. 1979).

Moreover, Salaj (1970) considered *W. gigantea* as a synonym of *"Rotundina" cretacea* (d'Orbigny). For this reason, ther name of Early Turonian *"Rotundina" cretacea - "Praeglobotruncana" imbricata* was incorrect.

2. *Helvetoglobotruncana helvetica* (Bolli), which is the index of a homonymous middle Turonian zone, consists of two morphological groups. The first one is represented by small Early Turonian forms. The latter consists of gross, large forms of 3 - 4th depth zone, appearing (fo

example, in the Tunisian El Kef section) at the base of middle Turonian. They are accompanied by another forms posessing large tests like *Dicarinella oraviensis trigona* (Scheibnerová), *Dicarinella biconvexa* (Samuel et Salaj) and *Sigalitruncana turona* (Olbertz). The last mentioned species, as well as *Sigalitruncana sigali* (Reichel) appear always in the uppermost levels of the *Helvetoglobotruncana helvetica* Zone.

It should be stressed that *Helvetoglobotruncana helvetica* (Bolli) is always missing in shallow neritic platform conditions and that sporadic occurrence of this species cannot serve as the criterium of time span range of the zone mentioned (Salaj, 1987).

3. Late Turonian *"Marginotruncana" schneegansi* comprises two phylogenetic lineages with different genetic names. Its attribution into *Marginotruncana* Hofker, 1957 is problematic (Salaj, 1987). Late Turonian foraminiferal zonation will be discussed elsewhere (Salaj, 1997).

Anyway, the presence of Late Turonian *Dicarinella concavata* (Brotzen) in Tunisia, reported by Robaszynski et Caron (1995), is Certain morphotypes, which could resemble this species, belong to *Dicarinella carpathica* (Scheibnerová). Moreover, this species could be also mistaken with *Dicarinella renzi* (Gandolfi) emend. Salaj et Samuel, 1966, or with *Dicarinella paraconcavata* (Hofker).

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"Lombardia" - facies and saccocomid-like sections in Cretaceous sediments: Whose pieces?

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Key words: Echinodermata, Crinoidea, Roveacrinida, Roveacrinidae, Saccocomidae, Saccocoma, Lombardia, Microcalamoides, Microfacies

Nowadays microfaciological analysis is a blue technique to trace back Cretaceous basinal history. This comprehensive investigation used to evidence common echinodermal remains in Cretaceous chalks and limestones, and particularly the well-known *"Lombardia"* - facies. Unfortunately, its stratigraphical use and valuewere hampered by difficulties in fossil fragment recognition. This paper aims to propose a morphological key for roveacrinidal microfacies towards the recognition enhancement of such saccocomid - like sections.

To end up with Cretaceous *Saccocoma*

Generally, almost all particularly odd echinodermal sections are compared or assigned to *Saccocomidae,* especially to *Saccocoma* Agassiz, 1836. This assignment is outrageously abusive since such a determination does not come from a thorough diagnostic analysis and since *Saccocoma* Agassiz gets extinct from Late Kimmeridgian. The only Cretaceous representative of the Saccocomidae is *Applinocrinus* Peck, 1973. Its species are only known from scarce loose calyces while to date in microfacies, the arm plates present the only assignable sections with reasonable confidence. These latter are looking much alike *"Lombardia"* though they are not *sensu stricto* referrable to. Consequently, the only valid name for such a section or microfacies is saccocomid, saccocomidal or *Applinocrinus.* Such decoupling between theca and arm plates enhances the misconception of this particular group and refrains their stratigraphical and taxonomical knowledges. Saccocomidal sections are particularly characterized by the slender nature of arms. The upper surface of its ventro - dorsally flattened theca displays a protruding radial ridge. This very peculiar ornamentation will play a major role in its microfacies determination.

The *Microcalamoides* case

In 1956, F. Bonet described three new forms (or rather section - types) from the lower Aptian - lower Albian deposits of Mexico, all belonging to a sole *incertae sedis* organism: *Microcalamoides diversus.* The main features of these minute calcitic remains of cylindrical shape are longitudinal, wing - like to circular, furrows on their outer surface. These three forms were interpretated as transverse sections of a same organism. When carefully examined, they are looking very close to some sections of Jurassic *"Lombardia"* Bronnimann, 1955 (=*Saccocoma* Agassiz, 1836; Verniory, 1956). Years later, Enos and Stephens (1993) presented them as belonging to planktic crinoids. From a distance, we have to sweep once for all the myth of a planktonic crinoid (Ferré and Bengtson, 1997). Despite of their size, these sections are displaying features of roveacrinidal affinities. Though one is commonly (but wrongly) convinced of the impossibility to determine saccocomidal sections at aspecific level, these three forms are indeed displaying transverse sections of thecal plates, moreover belonging to a single species of *"Saccocoma"*. The only valid Cretaceous relative of *Saccocomidae* is the genus *Applinocrinus* Peck, 1973, with two species: *A. cretaceus* (Bather, 1924) restricted to Boreal and Tethyan Europe (Ferré et al., this volume) and *A. texanus* Peck, 1973 only known from Texas. Therefore, we must now consider *Microcalamoides diversus* vars. Bonet, 1956 as a junior synonym of *Applinocrinus texanus* Peck, 1973.

The recognition of Roveacrinidae

The other Cretaceous family, *Roveacrinidae,* has long been confused with her saccocomid sister-group. Nevertheless, its high stratigraphical value was emphasized by Peck (1943, 1955) and Rasmussen (1961). However, the first appliance came from the outstanding record of the Sergipe Basin (Brazil - Bengtson and Berthou, 1982; Berthou and Bengtson, 1988). This material offered the opportunity of formal orientated sections (Ferré and Berthou, 1994). Such a method was applied and refined on Albian Angolan microfacies (Ferré and Granier, 1997). Thus, recognition of section orientation and therefore of diagnostic specific features leads now to apply for new investigations and reinstatements of such microfacies towards taxonomical and stratigraphical tools (Ferré et al., 1996; Ferré et al., this volume). As Kristan-Tollmann (1970) reckonned an "Osteokrinusfazies" all over the Triassic Tethys Sea, we have now to admit worldwide Cretaceous occurrences for such roveacrinidal events (Ferré et al., this volume). These latter could be used for global scale correlation with a high degree of stratigraphical confidence. As both qualitative and quantitative bio-markers, they appear as first-order correlative biostratigraphical tools for both Tethyan and Boreal realms.

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Roveacrinus berthoui, nov. sp., the earliest representative of the family Roveacrinidae (Roveacrinida, Crinoidea) in the lower Hauterivian of Busot (Alicante, Spain)

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In the Alicante province (SE Spain), Mesozoic series are outcropping due to structural anomalies (Polveche, 1963). In Prebetic and Subbetic domains, during the Early Valanginian, a margin flexure related to the "Berriasian"-platform drowning (Granier, 1993). While the sea invaded large areas on the southern border of the Iberic Meseta, an important flexure wedge developed onto the Berriasian platform slope (Busot) and far beyond. During the Late Valanginan-Hauterivian interval, the initiation of block-tilting induced condensation and/or erosion phenomena, particularly on local highs, and sedimentary trapping in grabens and/or half-grabens. This particular structural environment favored the preservation of deposits from this intrusion in Busot. 20 km NNE from Alicante, the village of Busot is located at the SW end of a Mesozoic belt called "bande á anomalies structurales de Busot-Altea" (Granier, 1987). There, Lower Cretaceous (Valanginian to Aptian) deposits are outcropping within a hard-core extrusion complex. South of this village, two Cretaceous hills are formed by marly limestones. These bioclastic wackestones yield abundant small benthic foraminiferids, echinodermal pieces, ammonites and calpionellids as autochtonous assemblage components. They also contain reworked, worn and micritized microfossils: mostly large benthic foraminiferid sand calcareous algae. However reworking is limited and neither sedimentary slumps nor conglomerates have been evidenced.

This paper purports to describe one of the echinodermal components as it appears to be the genuine and earliest stratigraphical evidence of the family Roveacrinidae, sections of which are commonly erroneously assigned to as Cretaceous saccocomid (Ferré, this volume).

The material herein considered consists of a unique oblique section through the middle of the dorsal cavity (also called aboral cup or basal cavity). The microfaciological terminology was initiated by Ferré and Berthou (1994) and further refined in Ferré and Granier (1997). This section is unquestionably of roveacrinidal affinity (Ferré, this volume). The dorsal cup section is rather large compared to the radial expansion preserved in this oblique plane. There are two tiny indentations on the inner part of the section witnessing the presence of an inner partition. We cannot determine wether this is due to a descending process from the primiradials or merely to the basals. The dorsal cup is rather smooth, if we except the presence of rather low radial ornamentation on the lower sides of the calyx. There is neither interradial ornamentation nor obvious secondary ornamentation on the radials. The ventral cavity is rather low. As for the radials, we have at hand two kinds of section: sub-tangential (cutting nearly the articular facet) and oblique (showing primary ornamentation). The sub-tangential section displays a relatively large radial, the articular facet is fully grown and transverse to the section plane, this induces an oblique articular facet of the radial; this later feature leads to assign this section to genus *Roveacrinus* Douglas, 1908 (Rasmussen, 1961). The oblique section displays a twisted radial expansion. Such a radial twist is known to occur on fully-grown dorsal horns originating from the fusion of radial dorsal expansions. On the specimen at hand, this twist occurs on the ventral expansion and thus constitutes a specific original characteristic. This features a new species *R. berthoui* dedicated to the late Dr Pierre-Yves Berthou as a tribute for his contribution to roveacrinidal paleontology in Brazil.

The ammonite assemblage dates this level of an Early Hauterivian age (Granier et al., 1995). As such, the specimen in hand represents the oldest known representative of the family *Roveacrinidae,* the latter being known from the Middle Albian (Peck, 1943, 1955; Rasmusen, 1961; Destombes, 1984; Griffiths, 1985; Dias-Brito and Ferré, 1997; Ferré and Granier, 1997). This very first roveacrinid displays a major milestone among the Late Tithonian *Saccocomidae,* the dubious *Microcalamoides diversus* Bonet, 1956 (Ferré, this volume) and the later Middle Albian *Roveacrinidae.* As the stratigraphical gap between these taxa is getting shorter, this new evidence calls in question once again the formerly suspected relationships between *Saccocomidae* and *Roveacrinidae,* and pushes back the age of the familial branching if these are really kinned. Furthermore, as Kristan-Tollmann (1975) promoted the "Osteokrinus-fazies" in the late Triassic Tethys Ocean, this material enhances the role of the Tethyan seaway in the Cretaceous appraisal of roveacrinidal microfacies (Dias-Brito and Ferré, 1997; Ferré et al., this volume).

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Specific designation(s) of asymmetrical Upper Cretaceous rhynchonellids, formely considered as "Rhynchonella difformis"

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Key words: Late Cretaceous, Brachiopoda, Taxonomy, Western Europe

Several Cretaceous rhynchonellids with an asymmetrical anterior margin (right or left-handed) are represented as the members of the genus *Cyclothyris* (Owen, 1962). Some of these specimens are recognized as *Rhynchonella difformis* Val. in Lamarck in the Lower Cenomanian of France (Normandy, Le Mans), England (Warminster), Belgium (Tourtia of Tournai), Germany (Essen), in Mid Cenomanian of Indre (France) and probably in organodetritic limestones near Prague (Předboj, Bohemian Basin) (Gaspard, 1991).

It would be interesting to consider now the status of the Senonian specimens also often named as the *Rh. "difformis"*, like to those found in the Pyrenean region (Coniacian: Calcaires et Marnes = E0 Echinides of Boutenac, Bois-du-Vicomte, Fondfroide, Rennes-les-Bains (with *Micraster corbaricus*), Sougraigne..) and S. E. France (Santonian: Le Beausset, La Cadiére, Les Martigues, Gaspard, 1991).

These last specimens compared with members of *Cyclothyris difformis* (Val. in Lamarck) have a massive shell, a thinner and more incurved ventral umbo with a smaller foramen; they are larger and less globular than the Gaspard and Odin in preparation). Coquand (1879) introduced the existence of another species name: *Rh. claudicans,* but without any illustration.

Observations of transverse serial sections in parallel with the external morphological characters of representative specimens of the different series allow to recognize different species, from difformis and globata, in the Coniacian-Santonian horizons. This is in contrast with the data of Motchurova-Dekova (1995) who includes the Santonian specimens from Bulgaria in the species *C. globata* (Arnaud).

It will be interesting to compare the material previously quoted in the Senonian with the figured specimen from the province of Leida (St. Corneli), Spain presented by Muńoz (1985) as *Cyclothyris claudicans* (Coquand).

Thus far, the asymmetrical anterior margin has tendentiously been considered as the preponderant character. Considering the gibbosity of the shell and the curvature of the ventral umbo, specimens from Boutenac and Rennes-les-Bains (for example) do not seem, at first sight, to belong to the same species, however, local conditions must be taken into account.

*UMR 5561 and Contribution to IGCP project 362 (TBC)

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Stratigraphic ranges and palaeoenvironments of the lowermost Cretaceous brachiopods in the Pieniny Klippen Belt (Carpathians, Poland)

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Key words: Early Cretaceous, brachiopods, biostratigraphy, life environment, Western Carpathians, Poland

The Pieniny Klippen Belt (PKB) is a narrow, strongly elongated tectonic unit which follows the Carpathian subduction zone between Inner and Outer Carpathians (Fig. 1). During its Mesozoic history the Pieniny Klippen Belt Basin (PKBB) was a branch of the northern part of the Tethys (Birkenmajer, 1986). In palinspastic reconstruction the basin is well-marked by longitudinal facies zones which correspond to ridges and troughs in the sea floor (Birkenmajer, 1977, 1986, 1988). During the Jurassic and Cretaceous (pelagic "C" stage of Birkenmajer, 1986) the submarine Czorsztyn swell ("pelagic swell" of Mišík, 1994) was an elongated structure, nearly 500 kilometers long and some tens of kilometers wide. Abundant and diversified lowermost Cretaceous brachiopod fauna of the Czorsztyn Succession was (after crinoids) the most frequent constituent of benthic assemblages of the PKB (mainly from the Dursztyn, Lysa and Spisz Fm) in this epoch (Fig. 2). This fauna were studied in detail by Barczyk (1979 with references) and by Krobicki (1994, 1996a, b). Stratigraphic ranges of individual brachiopod taxa in the Polish part of the PKB have been determined on the basis of a rich paleontological material in numerous precisely dated sections (Fig. 3; Krobicki, 1994, 1996b), according to ammonite zonation recognised by Wierzbowski and Remane (1992), Wierzbowski (1994) and Krobicki and Wierzbowski (1996) (the location of the lowermost Cretaceous sections with brachiopods is limited only to both Czorsztyn - Sobótka and Biala Woda Valley sections in this abstract: Figs. 1 and 4).

The most of the taxa have survived the Jurassic-Cretaceous boundary and occur throughout the whole Berriasian. The selected species are limited to the lowermost part of the *Otopeta* Zone of the Lower Valanginian (see Fig. 3). The most important stratigraphic indicators of Valanginian age are: *Fortunella fortunae* Calzada and *F. praemoutoniana* Sulser and Calzada; their age range is probably limited to Early Valanginian. *Dictyothyropsis* sp. is rare in the Spisz Limestone Formation, its stratigraphic value is not yet established. The two *Fortunella* species are new for the Pieniny Klippen Belt.

Differences in quantitative composition of brachiopod assemblages allowed to use them as good ecostratigraphic indicators for local stratigraphic subdivisions. These differences reflected environmental changes with time, caused by intensive Neo-Cimmerian tectonic movements within the Pieniny Klippen Belt during the latest Jurassic to earliest Cretaceous. The appearance and subsequent destruction of submerged horsts were most distinctly marked in the Czorsztyn Succession as sedimentary breaks, limestone breccias (e. g. the Walentowa Breccia Member), neptunian dykes, and redeposited shell fragments (Birkenmajer, 1975, 1986; Krobicki, 1996a). A distinct difference between the Early Berriasian and Late Berriasian brachiopod assemblages could also reflect these tectonic movements. Occurrence of rhynchonellids of the genus *Lacunosella* and a trend of quantitative changes in the occurrence of pygopids (*Pygope* and *Nucleata*) were accepted as the major diagnostic features in this respect. The species *Lacunosella heheneggeri* (Suess) is abundant in the Lower Cretaceous of the Štramberk-type limestones (reef-like carbonate deposits), known as secondary deposits (olistholites and pebbles) within flysch strata of the Outer Carpathians. An abundance of the genus *Lacunosella* suggests shallower marine environments. On the contrary pygopids (genera *Pygope* and *Nucleata*) usually preferred deeper marine, their abundance is indicative of such environments. A marked difference in the ratio of individual brachiopod taxa in faunal pie charts of a given sequence testifies to an environmental change, during the sedimentation of successive members. In the sections of the Biala Woda Valley, this may be seen in the replacement of initially dominating pygopids (*Pygope* and *Nucleata*) within the Walentowa Breccia Mbr by numerous specimens of the genus *Lacunosella* in the Kosarzyska Limestone Member (Bed 3 -

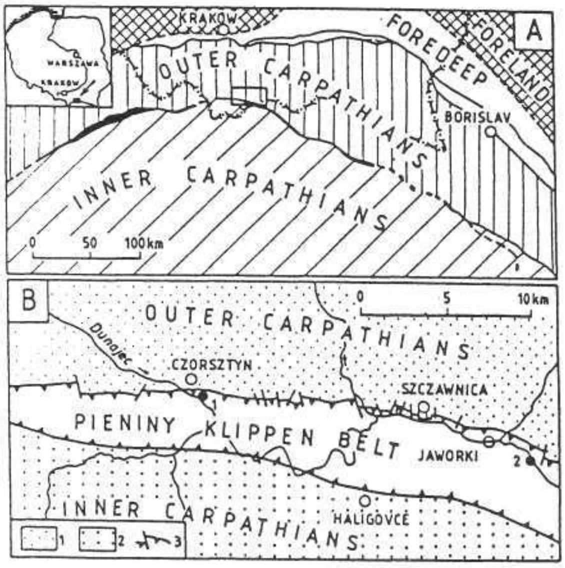

Fig. 1. A - Location of the Pieniny Klippen Belt (*in black*) within the Carpathians. Rectangle - see B. B - Location of the studied sections with Valanginian brachiopods in the Pieniny Klippen Belt, Poland (base map simplified from Birkenmajer, 1963, 1977). 1 - Magura Palaeogene flysch (Magura Nappe); 2 - Podhale Palaeogene flysch (autochthonous); 3 - northern and southern tectonic boundaries of the Pieniny Klippen Belt. Sampling sites: 1 - Czorsztyn - Sobótka; 2 - Biala Woda Valley.

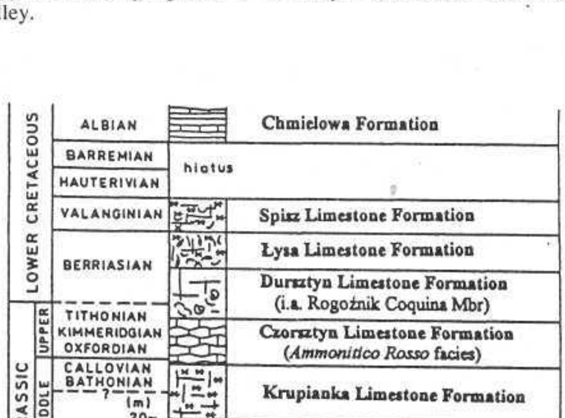

Fig. 2. Simplified profile of the Czorsztyn Succession near Jurassic/Cretaceous boundary (based on Birkenmajer, 1977, modified).

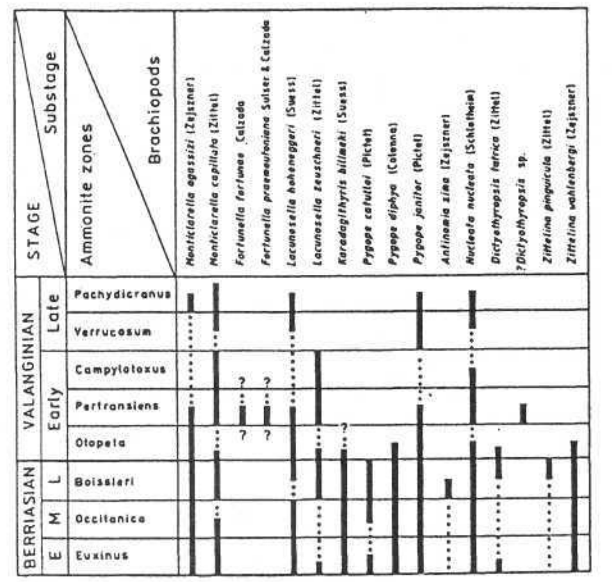

Fig. 3. Stratigraphic distribution of Valanginian brachiopods in the Pieniny Klippen Belt of Poland based on investigated sections described in the text.

Fig. 4). This trend indicates a shallowing-upward sequence (Krobicki, 1994, 1996b).

An almost identical trend in the change of the brachiopod fauna during the Berriasian has been recognized in the Sobótka Klippe section at Czorsztyn. The beds of the Harbatowa Limestone Member (Bed 4 - Fig. 4), which underlies the Walentowa Breccia Member yielded the same brachiopod assemblage as the Walentowa Breccia Member from the Biala Woda Valley. Moreover, the youngest brachiopod assemblage of the Kosarzyska Limestone Member of the Lysa Limestone Formation in the Sobótka Klippe (Bed 6) is almost identical with the younger brachiopod assemblage of the Biala Woda Valley sections (Bed 3 - Fig. 4). Two discussed brachiopod assemblages from the Sobótka Klippe are Late Berriasian in age, corresponding both to the ammonite *Boissieri*- and the calpionellid *Calpionellopsis* (D3) Zone.

Domination of deeper-water brachiopod fauna is the common feature of both Early Valanginian brachiopod assemblages discussed, if compared with the latest Berriasian ones. This tendency, probably even stronger during Late Valanginian, could reflect deepening of the basin.

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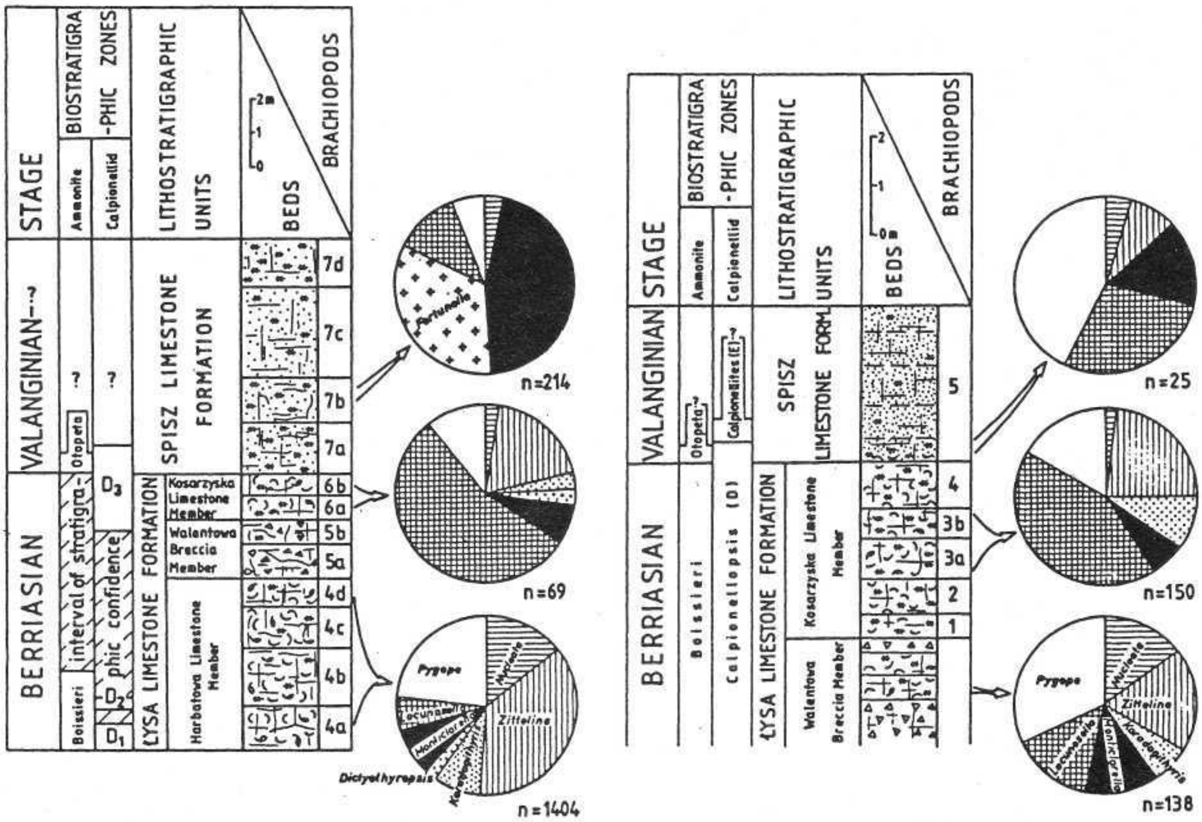

Fig. 4. Trends of change of brachiopod assemblages in Berriasian-Valanginian strata (left - Czorsztyn-Sobótka klippe; right - Biala Woda Valley). Lithostratygraphic units after Birkenmajer (1977); stratigraphy and numbering of beds after: Czorsztyn-Sobótka - Wierzbowski and Remane (1992); Biala Woda - Krobicki and Wierzbowski (1996); brachiopod pie charts - comp. Krobicki (1994, 1996).

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Turonian ammonites from the eastern parts of the Moesian Platform and Fore - Balkan

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Key words: Turonian, ammonites, biostratigraphy, Moesia, Bulgaria

The Upper Cretaceous stratigraphy in North-East Bulgaria was done mainly by Jolkichev (1988, 1989). He recognized lithostratigraphic units but only mentioned part of the ammonite taxa. Some of the Turonian ammonites obtained from the investigated area have been published and figured by Tzankov (1982). The objectives of the study are to determine and (or) to revise the hole ammonite species with Turonian age from this part of the country.

The Turonian sequence in the study region is represented by sandy, slightly silty and chalk-like limestones with extremely abundant carbonate-siliceous concretions (Mogila Formation). This sediments are covered by phosphorite bed and glauconite sandstones (Dobrindol Formation), which are laterally replaced by the limestones of Venchan Formation (Jolkichev, 1989).

More than 150 specimens, fragments and pieces of Turonian ammonites are documented from several sections in North-East Bulgaria. They have relatively high species diversity and are considerably well preserved.

The Lower Turonian is proven by the species *Inoceramus labiatus* Schlotheim (Tzankov et al., 1952, p. 63). The established species *Lewesiceras peramplum* (Mantell) is characteristic for the uppermost Lower Turonian ammonite zone (*Mammites nodosoides*) and for the Middle Turonian *Collignoniceras woollgari* zone.

Middle Turonian ammonites in the investigated sections belong mainly to the genus *Collignoniceras* Breistroffer - *C. woollgari* (Mantell), *C. carolinum* (d'Orbigny) and *C. bravaisianum* (d'Orbigny). The last one also occurs in the Upper Turonian. *Romaniceras ornatissimum* (Stoliczka) is zonal index of the Middle Turonian zone of the same name (Kennedy, 1984, p. 151 - "gallic view").

The following ammonite taxa characterize the Upper Turonian substage: *Subprionocyclus neptuni* (Geinitz), *S. normalis* (Anderson), *Romaniceras deverianum* (d'Orbigny), *Puzosia hernensis* (Schlüter), *P. gaudama* Forbes, *Lewesiceras mantelli* Wright and Wright, *Sciponoceras bohemicus* (Fritsch and Schlöbach), *Scaphites geinitzii* d'Orbigny, *Baculites* sp. The common presence of *Romaniceras deverianum* and *Subprionocyclus neptuni* has to be noted, especially when their first occurrences are uncertain in respect to the middle-upper Turonian boundary (Bengtson, 1996). Unfortunately in our case both species are found in thin phosphorite bed and it is difficult to correlate their ranges. Middle Turonian ammonites are also documented from the same bed, a fact explained by Jolkichev with condensed sections (1989, p. 99).

The review of previously and newly obtained biostratigraphic data gives ground to consider that the three substages of the Turonian are represented in the investigated area.

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Late Jurassic and Early Cretaceous algal and foraminiferal benthic communities and biofacies from the Western Carpathians

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Key words: Tithonian, Early Cretaceous, benthic Foraminifera, algae, biofacies, Western Carpathians, Slovakia

Upper Jurassic - Lower Cretaceous carbonate platforms in the Western Carpathians have been mostly eroded or tectonicaly destroyed. Their remnants occur rarely (Barmstein Limestone in the Nedzov Nappe, Brekov Limestone in the Humenné Mts, Manín Limestone in Strážov Mts. and Vysoká Turnia Fm in the Tatra Mts). The platform-derived material was also accumulated in the slope calciturbidite deposits (Strážovce Turbidite Mb, Muráň Limestone, Solírov Formation). The platform carbonates form klippes (Štramberk Limestone, Ernstbrunn Limestone, "Urgonian" klippes near Nižná, Haligovce klippe) and in pebble associations recycled into syn/postorogenic formations (Upohlav-, Proč-, Jasenov-, Strihovce-, Dobšiná Ice Cave Conglomerate, conglomerates in the Magura and Ždánice Unit, Chvalová Conglomerate, Jablonica Conglomerate Mb etc.). The study of the benthic constituents of these limestones (mainly algae and foraminifers) allows to interprete the successive development of the carbonate platform facies ranging from Oxfordian to the Barremian/Aptian age (see Mišík and Sýkora, 1980, 1981, 1982; Mišík et al., 1981, 1991; Mišík, 1990, etc., Michalík, 1994; Michalík and Soták, 1990; Soták, 1987a, b, 1989; Soták and Mišík, 1993; Reháková, 1995, etc.).

- Oxfordian oolitic-oncolitic limestones with foraminifers *Protopeneroplis striata, Labyrinthina mirabilis, Conicospirillina basiliensis* etc. Dasycladalean algae are notable for the dominance of *Salpingoporella*-species such as *S. pygmaea, S. enayi, S. annulata* and *S. etalloni*. Another dasyclads comprise of *Clypeina caliciformis, Macroporella praturloni, Clypeina? delphica, Suppiluliumaella cf. verae* and *Linoporella? cf. svilajensis*.

- Kimmeridgian to Lower Berriasian Clypeina limestones. The biogenic components are represented mostly by isolated disc-shaped whorls of algae, tests of big cyclamminoid and arenaceous foraminifers (*Pseudocyclammina lituus, Everticyclammina virguliana, Haplohragmium coprolithiformis,* etc.), bryozoans, hydrozoans, Chlorophyta and Cyanophyta nodules (*Rivularia lissaviensis, Carpathocodium anae, Bevocastria toomeyi, Mitcheldeania americana* etc.), encrusting algae *Bacinella irregularis,* spirorbid worms, coprolites (*Favreina salevensis*), nerineacean gastropods, etc. Among dasycladalean algae *Clypeina jurassica* is dominant accompanied with *Actinoporella podolica, Campbelliella striata, Teutloporella obsoleta, Salpingoporella pygmaea, Salpingoporella grudii, S. annulata* and *Pseudotrinocladus piae*.

- Upper Tithonian - Lower Berriasian reefal limestones. (Štramberk Limestone). The limestones are developed mostly as boundstone facies (coralgal limestones with phaceloid and dendroid corals, *Tubiphytes, Ellipsactinia,* sponges *Barroisia sp.*). The framebuilders are also represented by bunch growths of cyanophycean algae (*Rivularia lissaviensis, Suhardiella frollae, Orthonella lemoine, Alpinella distincta*), bushes of dasycladalean algae, algal encrusters *Bacinella irregularis, B. crispa, Lithocodium morikawai, Enigma parvissima* and *Thaumatoporella parvovesiculifera*. Peri-reefal and intraplatform facies are characterized by biomicsparrudites with detritus of reefal skeletons or bahamite particles e. g. coated and micritized grains, pseudoooids, peloids, aggregated lumps. Foraminifers comprise of *Protopeneroplis trochangulata, Neotrocholina valdensis, N. friburgensis* and *Ataxophragmiidae*. Dasycladalean algae are represented by the species of *Triploporella remesi, Neoteutloporella socialis, Salpingoporella pygmaea, S. johnsoni, Dissocladella cf. intercedens, Pseudoepimastopora? jurassica, Terquemella sp., Clypeina jurassica* and *Acicularia aff. elongata*.

- Berriasian to Valanginian Clypeina limestones. They consist of biosparrudites with skeletal detritus of reefal organisms (dasyclads, corals, echinoderm fragments, etc.). The dasycladalean algae are notable for a small forms of *Clypeina* that can be referred to *Clypeina? solkani*. The most frequent alga is, however, *Actinoporella podolica* occurring in numerous isolated whorls. Among the foraminifers *Trocholina alpina, T. delphinensis, T. campanella, Nautiloculina oolithica* and *Haurania arabica* were detected.

- Berriasian to Valanginian reefal limestones. They show features of *Bacinella*-biolithtes and peri-reefal rudites. Their younger age compared with the Štramberk Limestone can be demonstrated by the occurrences of *Choffatella pyrenaica, T. delphinensis* and *T. chouberti*. Dasycladalean algae are rare, presented by *Pseudoclypeina?* sp. and *Salpingoporella sp. (aff. S. melitae)*.

- Berriasian to Valanginian grainstones with ooids, rounded intraclasts, fecal corpuscles etc. The limestones are rich in dissociated skeletons of dasycladalean algae comprising of *Radoiciciella bartheli, Radoiciciella subtilis, Falsolikanella campanensis, Actinoporella podolica, Cylindroporella sp. (aff. C. arabica)* and *Salpingoporella steinhauseri*. The accompanying foraminiferal species consist of *Charentia cuvillieri, Haplophragmoides joukowskyi, Protopeneroplis trochangulata* and *Valvulina lugeoni*.

- Valanginian up to Barremian? sandy intrabiosparitic limestones. The limestones are characterized by the appearance of Pfenderinid foraminifers from two stratigraphical levels: a) Valanginian associations with *Pfenderina neocomiensis, Pseudocyclammina lituus, Rectocyclammina chouberti* and *Pseudotextulariella courtionensis* and b) Hauterivian to Barremian associations with *Pfenderina janae, Pf. flandrini, Pf. aureliae, Pf. cf. ostroviana, Everticyclammina hedbergi* and *Nautiloculina bronnimanni*. Algal assemblages consist of *Carpathocodium anae, Bacinella irregularis, Bouenia hochstetteri, Arabicodium orientalis*, etc. Dasyclads are rather scarce in the Valanginian limestones including the species of *Falsolikanella campanensis* and *Radoiciciella subtilis*.

- Barremian to Albian limestones of the Urgonian facies. They consist of bioclastic grainstones, packstones, rudstones and floatstones. The Urgonian limestones usually contain orbitolinid foraminifers and rich dasycladalean flora. The Barremian facies of the Urgonian limestones contain associations of foraminifers *Orbitolinopsis buccifer Ovalveolina reicheli, Orbitolinopsis flandrini O. kiliani, Orbitolinopsis cuvillieri Paleodictyoconus barremianus*, etc. However, the majority of these limestones, according to abundance of foraminifers *Palorbitolina lenticularis*, belong to Upper Barremian Lower Aptian (Bedoulian). The Aptian age of some Urgonian limestone facies is dated by foraminifers *Orbitolina (Mesorbitolina) parva, Orbitolinopsis reticulata, Sabaudia auruncensis*, etc. The abundance of the Urgonian biotas in these limestones is given by corralline algae (the Albian facies contain the Vimport flora elements as well - *Agardhiellopsis cretacea, Archaeolithothamnium rude*), chlorophycean algae (*Lithocodium aggregatum + Bacinella irregularis, Bouenia hochstetteri, "Pseudocodium" convolvens*, etc.), rodophycean algae (*Ethelia alba*, etc.), hydrozoans (*Actinostromaria cf. carpathica*), sclerites from Alcyonarian (*Pieninia oblonga*), corals (*Mesomorpha excavata, Microsolena distefanoi*, etc.), Acrasiales Fungi (*Paleoguttulina muranii, Fungisporonites sp.*), rudists (*Radiolites sp., Praecaprotina sp., Offneria sp.*, etc.), pelecypods, nerineacean gastropods, serpulide worms, etc. Back-reef facies of the Urgonian limestones consist of miliolid pelmicrites with numerous representatives of foraminiferal genera *Sabaudia, Cuneolina, Urgonina*, etc. The Urgonian platform slope sediments are formed by detrital limestones with assemblages of small miliolids and textularids (*Quinqueloculina minima, Bolivinopsis golertorum, B. labeosa, Textularia alexandri, Gaudryina tuchaensis*, etc.). The rich dasycladalean flora of the Urgonian limestones comprise of species *Salpingoporella muehlbergii, S. genevensis, S. melitae, S. cf. urladanasi, S. verticilata, Triploporella cf. praturloni, T. aff. fraasi, Pseudoclypeina? neocomiensis, Pseudoactinoporella fragilis, Heteroporella? paucicalcarea, H. graeca, Montiella? elitzae, Cylindroporella sugdeni, C. aff. benizarensis, C. pedunculata, C. cf. maslovi, C. elliptica, C. lyrata, Acroporella radoicicae, Praturlonella danilovae, Linoporella? cf. elliotti, Clypeina nigra, C. somalica, Sarfatiella sarda, Vermiporella? tenuipora, Russoella radoiciciae, Neomeris cretacea, Neomeris cf. pferderae* and *Neomeris sp.* The Albian shallow water limestones contain algae of *Trinocladus tripolitanus*.

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Mikrobiostratigraphy of the Jizera and Teplice Formations(Late Turonian, Boreal development) in the Upohlavy quarry, Bohemian Cretaceous Basin

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Key words: Late Turonian, foraminifera, microbiostratigraphy, Bohemian Cretaceous Basin.

The Upohlavy section is situated in the south-eastern part of the Bohemian Cretaceous Basin. This section represents lithological boundary between the Jizera and Teplice Formations (Late Turonian). The microbiological data from the Upohlavy section are based on the study of 63 samples. The boreal foraminiferal assemblages are represented by abundant, well preserved tests of agglutinated and calcareous species. The stratigraphic important benthic species were studied. The foraminiferal assemblage from the Upohlavy section is possible to correlate to foraminiferal assemblage from the Racknitzer and Strehlener Formations in Dresden-Strehlen section in Germany (Wejda, 1993). On the based of the range of these benthic species, two levels with significant change of foraminiferal assemblage was determined.

The first change in the level 0 - 5 m is connected to the disappearance of *Cassidella tegulata, Gaudryina compressa* and *Dorothia pupa.* Sediments between -210 m and 5 m interval are characterized by rich foraminiferal assemblage with high diversity of planktic species. Because a great number of planktic specimens of genera *Marginotruncana* and *Heterohelix* were found in this interval we could suppose good life conditions with the normal salinity (Leckie et al., 1991). The interval 5 - 280 m contained relatively poor assemblage of adult specimens of Foraminifera. Juvenile specimens of planktic genera *Hedbergella* and *Whiteinella* are more frequent there. In this interval, the change of life conditions was recorded. It was probably caused by the fluctuation of the sea level and stressed life conditions.

The interval between 280 - 930 m is characterized by the another sea level change. The life conditions have changed for the better. The foraminiferal assemblage is more rich with higher diversity and new benthic species appear there. In this interval the keeled planktic globotruncanids (*Marginotruncana, Dicarinella*) prevail.

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Lower Turonian radiolarian associations from the silicified sediments of the Czorsztyn Succession of the Pieniny Klippen Belt (Western Carpathians), Slovakia

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Key words: Turonian, Radiolaria, biostratigraphy, Western Carpathians, Slovakia

Silicified sediments which occur in Albian to Campanian parts of the Czorsztyn Succession in the Pieniny Belt are known in several stratigraphical horizons in Slovak and Polish territory. Sediments of ?Upper Berriasian-Lower Campanian age have been investigated in the Vršatec Castle Klippe section (Fig. 1, Sýkora, Ožvoldová & Boorová, in press).

Silicified sequence is represented by brick-red marls and grey-green silicified limestones and marls with reddish-brown, grey-green and scarcely yellowish cherts (Skalki Marl Member of Jaworki Formation, Birkenmajer, 1977). It contains rich radiolarian and foraminiferal microfauna. The uppermost part is of grey-red colour and forms the transitional beds with the overlying light grey - red and red marls. It contains the abundance of radiolarians prevailing over foraminifers.

For the evaluation of the radiolarian microfauna (Fig. 1, samples 5, 6, 8), detailed Middle Cretaceous radiolarian zonation of O°Dogherty (1994) of the Western Mediterranean was used. According to this zonation, the association represent the *Superbum* Zone, which started in the earliest Turonian. The top of this zone has not been recognized in this work.

The *Superbum* Zone comprises Unitary Associations UA 20 (in the lowermost part) and the overlying - UA 21. *Allievium superbum* (Squinabol) is the index of this zone. The sample 6 (Fig. 1) contains *Alievium* cf. *superbum* with broken spines. The further species - *Acanthocircus tympanum* O°Dogherty, *Acanthocircus venetus* (Squinabol), *Cavaspongia antelopensis* Pessagno, *Crucella cachensis* Pessagno, *Dictyomitra undata* Squinabol and *Patellula ecliptica* O°Dogherty also appear in UA 20. In the same Unitary Association last appearence of *Dictyomitra montisserei* (Squinabol) was observed. Rarely, *Dictyomitra multicostata* Zittel, which appears in the following UA 21 can be visible. Therefore, the association can be assigned to the lower Turonian (except for the lowermost part).

According to the investigation of Thurow (1988), it can be confirmed: *Pseudodictyomitra pseudomacrocephala* (Squinabol) disappears above the top boundary of CTBE (Cenomanian-Turonian Boundary Event, which comprises the uppermost part of Cenomanian and the lowermost part of Turonian) and *Dictyomitra multicostata* Zittel appears a little below this boundary. The new radiolarian species *Patellula andrusovi* n. sp. was described in the associations.

The foraminiferal microfauna, analyzed by Boorová (in Sýkora et al., in press) indicates the Helvetoglobotruncana helvetica Zone. According to Salaj (1996) this zone represents Middle Turonian. The biozonation of Robaszynski and Caron (1995) assignes it to the stratigraphical range - Early Turonian (except for the lowermost part) - the middle part of Middle Turonian.

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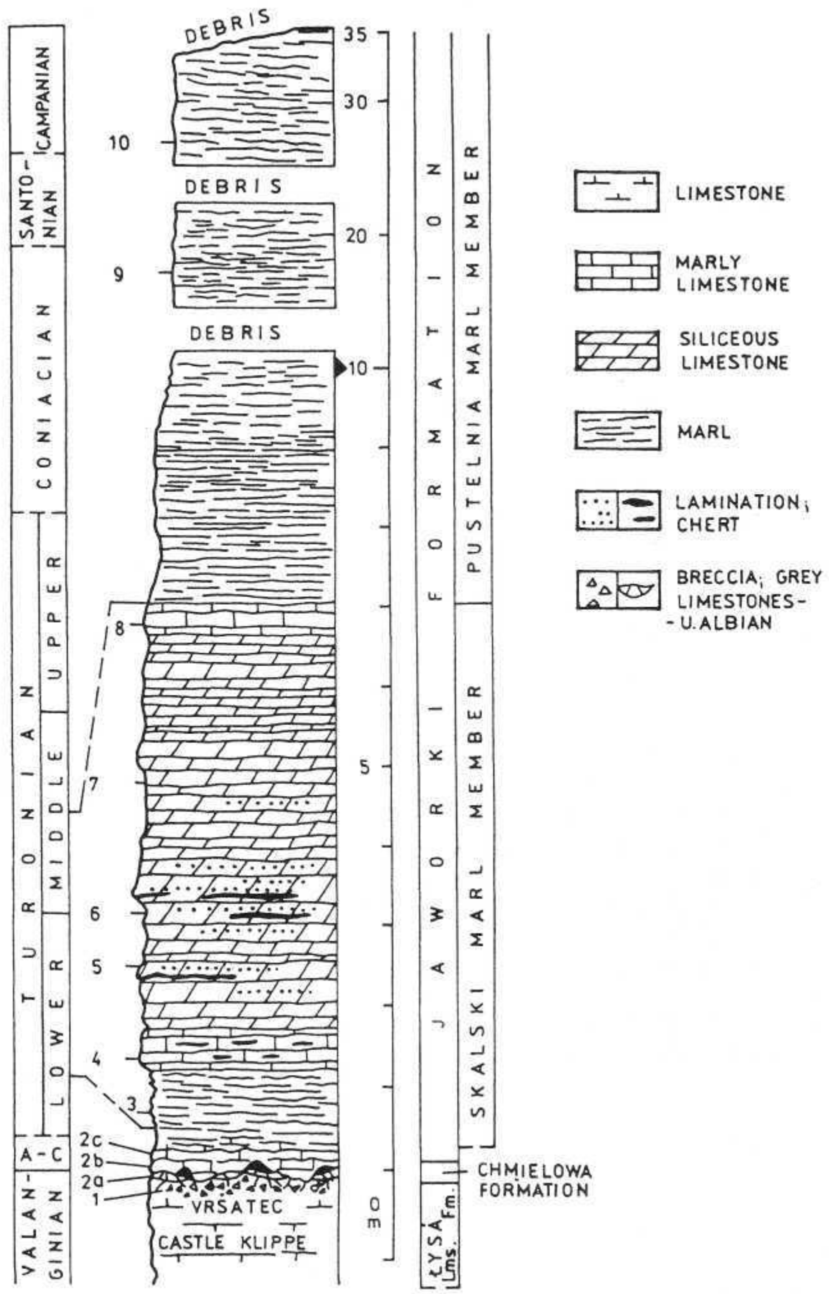

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CAMPANIAN
SANTO-NIAN
CONIACIAN
TURONIAN
UPPER
MIDDLE
LOWER
A-C
VALAN-GINIAN
JAWORKI FORMATION
PUSTELNIA MARL MEMBER
SKALSKI MARL MEMBER
ŁYSA Lms. Fm.
CHMIELOWA FORMATION
LIMESTONE
MARLY LIMESTONE
SILICEOUS LIMESTONE
MARL
LAMINATION; CHERT
BRECCIA; GREY LIMESTONES - U. ALBIAN

Fig. 1.

Evidence of the *Braarudosphaera*-rich Turonian sediments in the Bohemian Cretaceous Basin

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Key words: Turonian, nannoplankton, biostratigraphy, life environment, Bohemian Basin, Czech Republic

Nannofossil assemblages enriched in *Braarudosphaera bigelowii* were observed in the Turonian epicontinental sediments of the Bohemian Cretaceous Basin in the Úpohlavy quarry, NW part of the Czech Republic. Calcareous mudstones (<40 % $CaCO_3$) are exposed at the bottom of the Úpohlavy quarry. They span across the Jizera and Teplice Formations boundary which is marked by the Coprolite Bed. Sediments yield rich and well-preserved nannofossil assemblages.

About 0.3 m above the Coprolite Bed, i. e. the Teplice Formation, the first specimens of *Lithastrinus moratus* and *Marthasterites furcatus* appear giving evidence for the Late Turonian, CC13B Zone sensu Burnett (1996). *B. bigelowii* was not observed here. Above, *Braarudo-sphaera bigelowii* appears abruptly at the base of a rhythmically bedded succession of carbonates where clayey foraminiferal limestones (>75 % $CaCO_3$) alternate in 10 to 70 cm intervals with foraminiferal marlstones (35 - 75 % $CaCO_3$) - see Čech et al. (1996). Relative abundance of *B. bigelowii* fluctuates within this 7.5 m thick carbonate succession. Specimens are rare (<1 %) after their first occurrence at the bottom of the succession (about 1.0 m in thickness), after they are mostly common (>5 %) in the next 3.1 m and abundances continue to be few (1 - 5 %) or rare up to the top of the carbonate succession. There were observed two forms of *B. bigelowii:* one of normal size (10 - 12 μm) and another one represented by small specimens (5 - 8 μm).

The character of nannofossil assemblages is distinctly changed especially in the lower part of the carbonate succession. Poor and poorly preserved nannofossil associations with reduced species diversity contained besides *B. bigelowii* also *Kamptnerius magnificus* and *Lucianorhabdus maleformis* in higher quantities. In contrast, *Marthasterites furcatus, Lithastrinus moratus* and "fragile" nannofossils, such as *Stephanolithiaceae* and related genera disappear at the same horizon. The next occurrence of *L. moratus* was observed more than 7 m higher in the section and *M. furcatus* experienced a gap of about 9 m in its presence, up to the first mudstone intercalations. Both *L. moratus* and *M. furcatus* manifest their inconvenience to be useful markers for precise biostratigraphic conclu-sions. It appears that their presence is strongly influenced by lithological character of sediment.

An analogous event was studied by Siesser et al. (1992) in the Oligocene and Lower Miocene sediments on the Exmouth Plateau, Indian Ocean. They found that *B. bigelowii* had shown its preference for cool and low-salinity waters. Upwelling water brings up dissolved nutrients that are necessary for phytoplankton growth. Berger et al. (1989) suggest that sporadic nutrient originated from a deep reservoir would be stressful to pelagic organisms adapted to low fertility and produce blooms of opportunist algae such as *Braarudosphaeraceae.* In modern oceans, braarudospherids prefer low-salinity, nearshore waters and they are rarely found in the open ocean (Bukry, 1974).

According to Uličný (in Čech et al., 1996), the underlying mudstones represent a transgressive systems tract. The basal surface of the carbonate succession is interpreted as the maximum flooding surface. The upward decrease in $CaCO_3$ content (from >80 % to <70 %) across the succession is explained to result from progressive dilution of pelagic component by fine-grained terrigenous material, during deceleration of sea-level rise or stillstand in sea level. The *Braarudosphaera* enrichment and the reduced diversity in nannofossil assembalges well reflected this change in the paleoecological conditions.

Conclusions

In the carbonate sediments of the Late Turonian age in the Úpohlavy quarry, the input of terrigenous material during the stillstand in sea level probably triggered the abrupt *Braarudosphaera* enrichment. Fine-grained terrigenous components obtained nutrients suitable for the *Braarudosphaera* growth. The absence of "fragile" nannofossils including *M. furcatus* in the carbonate succession may be explained not only by the primary change in the nannofossil assemblage but also by the secondary phenomenon caused by the diagenesis of sediment and by the overgrowth of calcareous fossil component.

Calcareous nannofossils mentioned in the text:

Braarudosphaera bigelowii (Gran and Braarud, 1935) Deflandre, 1947

Kamptnerius magnificus Deflandre, 1959

Lithastrinus moratus Stover, 1966

Lucianorhabdus maleformis Reinhardt, 1966

Marthasterites furcatus (Deflandre in Deflandre and Fert, 1954) Bramlette and Martini, 1964

Tithonian to Valanginian microfossils from the "Cieszyn Beds" in the Outer Western Carpathians (Silesian Unit), Poland

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Key words: Tithonian, Berriasian, Valanginian, Foraminifera, calcareous nannoplankton, microbiostratigraphy, Western Carpathians, Poland

Preliminary results of the analyses of foraminiferal and calcareous nannoplankton assemblages from sediments of the Silesian (Cieszyn) Unit of Polish Western Carpathians are presented. These are a part of a project dealing with the onset of subsidence of the Carpathian flysch basins. The study is based on samples collected from the vicinity of Bielsko-Biala (Lipnik stream, Kamienica stream and quarry) and the Cieszyn-Ustroń area Cisownica, Goleszów).

The Silesian Nappe in the study area consists of two independent tectonic units: the Cieszyn Unit and the Godula Unit. The first one comprises uppermost Jurassic (Tithonian) and Lower Cretaceous strata. Part of this sequence of the so-called "Cieszyn Beds" has been studied for microfossils.

The oldest assemblages from the Tithonian non-flysch marly Lower Cieszyn Shales are dominated by calcareous benthic foraminifera: *Geinitzinita wolinensis, Vaginulinopsis embaensis, Marginulinopsis robusta, Tristix termicra, Lenticulina münsteri, Lenticulina* cf. *ambanjabensis, Frondicularia* cf. *inderica.* Agglutinated foraminifera including *Belorusiella wolinensis, Palaeogaudryina* cf. *taurica* and *Palaeogaudryina varsoviensis* have also been found. Radiolarians, diatoms and fragments of ostracods also occur in these sediments. The first occurrences of *Trocholina (T. aplina, T. molesta, T. solecensis)* and diverse *Lenticulina (L. infravolgensis, L. münsteri, L. ouachensis, L. ponderosa, L.* cf. *vistulae*) is observed. In addition, *Marginulinopsis bettenstaedti, M. striatocostata, Vaginulinopsis embaensis, Saracenaria alata-angularis, Paalzowella feifeli. Spirillina minima* have been recorded in the Cisownica section, at the top of Lower Cieszyn Shales, just below the Cieszyn Limestones.

The Lower Cieszyn Shales are characterized by scarce, poorly preserved nannoplankton assemblages dominated by *Watznaueria* and *Ellipsagelosphaera.* Occasional specimens of *Conusphaera mexicana, Cyclagelosphaera deflandrei, Cy. margerelii, Diazmolithus lehmanii, Zeugrabdotus embergeri. Polycostella beckmanii* have been encountered at the boundary with the Cieszyn Limestones.

The assemblages mentioned above (consisting mostly of foraminifera) are comparable to neritic associations of the European Platform. Nevertheless, the presence of (calcified) radiolarians and agglutinated foraminifera from the Silesian (Cieszyn) Basin suggest the upper bathyal environment. The worldwide Late Tithonian and Early Berriasian regression corresponding to the Neo-Cimmerian orogeny may be responsible for the supply of neritic microfaunal elements into the Silesian (Cieszyn) Basin.

The younger microfossils from the Berriasian calcareous flysch (upper part of Cieszyn Limestones) and Valanginian shaly flysch (Upper Cieszyn Shales) are composed of both calcareous and primitive agglutinated foraminifera representing the slope of Silesian Basin (bathyal zone). Poorly differentiated foraminifer assemblages consist of numerous primitive agglutinated ammodiscids (*Ammodiscus, Glomospira*) and ataxophragmiids (*Pseudoreophax cisovnicensis*) and scarce calcareous benthic forms belonging to Nodosariidae, Involutinidae (*Trocholina paucigranulata*), accompanied by infrequent radiolarians and ostracods. These assemblages resemble the coeval faunas of the Alpine flysch troughs.

The nannoplankton assemblages in the Cieszyn Limestones are similar to those from the Lower Cieszyn Shales. *Nannoconus steinmannii minor* has been found in one sample only. The samples from Upper Cieszyn Shales are barren of calcareous microfossils.

The succession of foraminiferal assemblages and the nature of the calcareous nannoplankton association from the "Cieszyn Beds" reflect the subsidence of collapse of the NE European margin of the platform, the disappearence of areas with shallow carbonate sedimentation, and the formation of the deep basin with flysch sedimentation.

Preliminary results of the palynological research of the Lower Cretaceous deposits of the Skole Nappe (Outer Western Carpathians, Poland)

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Key words: Lower Cretaceous, Palynology, Western Carpathians, Poland

Lower Cretaceous deposits from several localities have been palinologically studied. Special emphasis has been put on the dinocyst assemblages. Studied material included black shales (so called Spas shales) and green shales from the transitional interval to the Dolhe Formation (Skole Nappe, Polish Flysch Carpathians). Almost all samples yielded rich and well preserved dinocyst and other palynomorph assemblages.

The studied section spans from late Barremian to latest Albian (Vraconian). The oldest samples (upper Barremian) contains such markers like *Muderongia neocomica, Paleoperidinium cretaceum, Pseudoceratium securigerum, Fromea quadrugata, Prolixosphaeridium parvispinum* etc. The early-middle Albian has been dated on the basis of the presents of *Carpodinium granulatum, Ellipsodinium rugulosum, Muderongia cf. staurota, Paleotetradinium silicorum, Stephodinium coronatum, Systematophora cretacea, Tehamadinium coummium.* The youngest samples (Vraconian) include *Adnatosphaeridium tutulosum, Epelidosphaeridia spinosa, Palaeohystrichophora infusorioides.*

Lower part of the section contains numerous near-shore taxa (e. g., *Circulodinium distinctum, Pseudoceratium retusum, P. expolitum, P. securigerum, Canningia colliveri*) whereas toward the top of the section an increase of oceanic dinocysts is remarkably visible. This may indicate on relative shallow depositional environment of the Spas shales and gradual deepening during the deposition of its upper part and the Dolhe Formation. However, the large amounts of the terrestrial palynomorphs (spores, pollen grains and land plant tissues) in the lower part of the section may suggest a redeposition of the near-shore material into the deeper parts of the basin, especially, that oceanic dinocysts (e. g. *Pterodinium*) are present in all samples.

The peridinioid/gonyaulacoid ratio is the highest in the lower part of the section and decreases toward the top with another pik in the uppermost part of the section. The high attandance of the peridinioids in the lower part of the section, often present in the environments of the encreased nutrient supply may support the thesis of the river mouths presence. This would also explain the high amount of the terrestrial palynomorphs.

The dinocysts present in the studied material are almost entirely warm-water taxa (e. g., *Subtilisphaera perlucida, S. pirnaensis, Pterodinium cornutum, Dapsilidinium deflandrei, D. warreni, Cometodinium habibi, C. whitei*) indicating on relatively high sea surface temperature during the deposition of the studied interval (late Barremian-latest Albian). The presence of few cold-water species (e. g., *Fromea amphora, F. quadrugata, Hystrichodinium ramoides, Hystrichosphaerina schindewolfii*) in upper Barremian -lower Aptian and lower-middle Albian samples may suggest the connection between the Tethyan and the Boreal provinces.

Palynology of several Santonian - Campanian sections of North Bulgaria

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Key words: Santonian, Campanian, palynology, microbiostratigraphy, Bulgaria

Santonian-Campanian sequences crop out in many sections in the northern Bulgaria. They display considerable facies diversity, being represented by glauconitic sandstones, sandy limestones with glauconite, chalk-like and chalk limestones with chert concretions. These sediments have been sampled for palynological investigation. The obtained palynofloras comprise terrestrial miospores, represented mainly by the *Normapolles* group as well as by diverse marine dinoflagellate cysts. The aim of this paper is to produce an integrated Santonian-Campanian palynostratigraphic biozonation with the use of both dinocyst and sporomorph distribution data.

In the following, the most important palynological data from the sections Novachene, Komunari and Dobrinski dol are summarized. Sample position are relative to the lithostratigraphic subdivision, proposed by Jolkichev (1988, 1989). Dinocyst assemblages usually predominating in the samples were divided into two distinct successive units: *Dinogymnium denticulatum - Dinogymnium microgranulosum* Concurrent-Range-Zone (Santonian) and *Senoniasphaera protrusa* Range-Zone (uppermost Santonian - Lower Campanian). Both zones correlate fairly well and share mutual characteristics with the biostratigraphically well-controlled dinocyst framework established for Western Europe and the Tethyan area (Clarke and Verdier, 1967; Foucher, 1979, 1983).

The representatives of the *Normapolles* group comprise from 25 up to 65 % of the palynomorphs in the investigated sections. The stratigraphic evaluation of their species was made by taking into account the age assessment of the already defined dinocyst zones. So, it could be concluded that the Lower Santonian is characterized by the presence of *Oculopollis zaklinskaiae* together with *O. orbicularis, O. parvoculus* and *Krutzschipollis crassus.* The successive assemblage is characterized by the concurrent presence of *Krutzschipollis crassus* and *Krutzschipollis spatiosus.* Representatives of *Suemegipollis triangularis* and *Plicapollis silicatus* first occur in the Lower Campanian strata.

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Berriasian to Albian dinocysts from the Silesian Unit in the Outer Western Carpathians (Czech Republic)

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Key words: Early Cretaceous, dinoflagellates, biostratigraphy, Western Carpathians, Czech Republic

The abandoned quarry near Horní Líštná village, the sections near villages Komorní Lhotka, Malenovice, Soběšovice and the Pindula section near town of Frenštát pod Radhoštěm were selected for study of acid resistent organic-walled dinoflagellate cysts. The studied sections are situated in the Moravskoslezské Beskydy Mountains which belong to the Godula development (basinal setting) of the Silesian unit of the Outer Western Carpathians.

Vašíček (1981) described ammonites of Early Barremian - Late Aptian age from the Těšín-Hradiště Formation in the Pindula section, Lower Barremian ammonites came from the Soběšovice section, Upper Barremian ammonites were collected in the Satina section. The Early Cretaceous division of the Lhoty Formation in the Komorní Lhotka locality has been based on foraminiferal associations (Hanzlíková, 1966). Lower Cretaceous succession of the Silesian unit in the Godula development comprises the Těšín Limestone, Těšín - Hradiště Formation, Veřovice Member and Lhoty Formation. The Těšín Limestone consists of thick to massive limestone beds, which contain intercalations of dark marls. The Těšín - Hradiště Formation recorded fine rhythmic flysch sedimentation of calcareous siltstones and dark brown-grey calcareous claystones. Upwards, it is followed by pelitic sediments of the Veřovice Member (soft black silicified claystones) deposited in extremely reducing environments. Sediments of the Lhoty Formation are also of the pelagic character and are marked by dark grey and greenish grey calcareous and non-calcareous claystones with chondrites.

The majority of samples from the Těšín Limestone and from upper part of the Těšín-Hradiště Formation yields poorly preserved and low diversity dinocyst assemblages. Samples from the Veřovice Member are extremely poor in dinocysts and their preservation is poor as well. The best preserved and most diverse microfloral assemblages were obtained from the Lhoty Formation.

The age-assessment of the samples is based mainly on biostratigraphic correlation of dinocyst assemblages from on- and offshore Morocco (Below, 1981, 1982, 1984), England (Duxbury, 1980, 1983), France (Davey and Verdier, 1971, 1973, 1974; De Reneville and Raunaud, 1981; Monteil, 1993) and SE Spain (Leereveld, 1995).

In some cases, the stratigraphic calibration of lithological units was based on a combination of palynological data presented herein with previously published palaeontological data. The dinocyst abundance has facilitated the characterization of studied stratigraphic substages of the lithological units studied here like this:

Těšín Limestone: Upper Berriasian - Lower Valanginian (Horní Líštná quarry): presence of *Achomosphaera neptunii, Ctenodinium elegantum, Foucheria modesta, Muderongia longicornis, M. simplex microperforata, Oligosphaeridium complex, Spiniferites ramosus* and *Tuboturella apatela.*

Těšín-Hradiště Formation: Lower Barremian (Pindula and Soběšovice sections): presence of *Cerbia tabulata, Muderongia neocomica, Protoellipsodinium clavulum, P. spinosum, Subtilisphaera perlucida, S. pirnaensis* and *S. terulla.*

Upper Barremian (Pindula and Satina sections): the first occurrence of *Muderongia pariata, Odontochitina operculata, Palaeoperidinium cretaceum, Prolixosphaeridium parvispinum;* the last occurrence of *Avellodinium falsificum, Nexosispinum vetusculum;* presence of *Fromea quadrugata, Heslertonia heslertonensis, Pseudoceratium pelliferum, Spiniferites dentatus, S. speetonensis.*

Lower Aptian (Pindula and Satina sections): the first occurrence of *Apteodinium granulatum, Callaiosphaeridium asymmetricum, Coronifera tubulosa;* presence of *Subtilisphaera perlucida.*

Upper Aptian (Komorní Lhotka, Pindula and Satina sections): the first occurrence of *Florentinia mantelii, Ovoidinium scabrosum, Stephodinium coronatum;* presence of *Hystrichosphaerina schindewolfii, Occisucysta tentorium, Oligosphaeridium djemn, Surculosphaeridium trunculum;* the last occurrence of *Apteodinium granulatum, Cerbia tabulata, Coronifera tubulosa, Muderongia pariata, Oligosphaeridium verrucosum.*

Lhoty Formation: Lower Albian (Komorní Lhotka and Pindula sections): the first occurrence of *Tubulospina oblongata;* the last occurrence of *Tanyosphaeridium boletum* and *Protoellipsodinium clavulum.*

Middle Albian (Komorní Lhotka section): the first occurence of *Litosphaeridium conispinum, Xiphophoridium alatum;* presence of *Carpodinium granulatum* and *Wallodinium luna*.

Upper Albian (Komorní Lhotka, Pindula and Satina sections): presence of *Atopodinium mirabile, Endoceratium dettmanniae, Exochosphaeridium muelleri, Leberidocysta chlamydata, Litosphaeridium siphoniphorum, Palaeohystrichophora infusorioides, Pervosphaeridium pseudhystrichodinium, P. truncatum, Tanyosphaeridium prolixispinosum* and *Xiphophoridium alatum*.

It is only the age of the Veřovice Member that can not be determined on the basis of dinocysts, because they are poorly preserved. This bad preservation is connected with extremely reducing sedimentary conditions.

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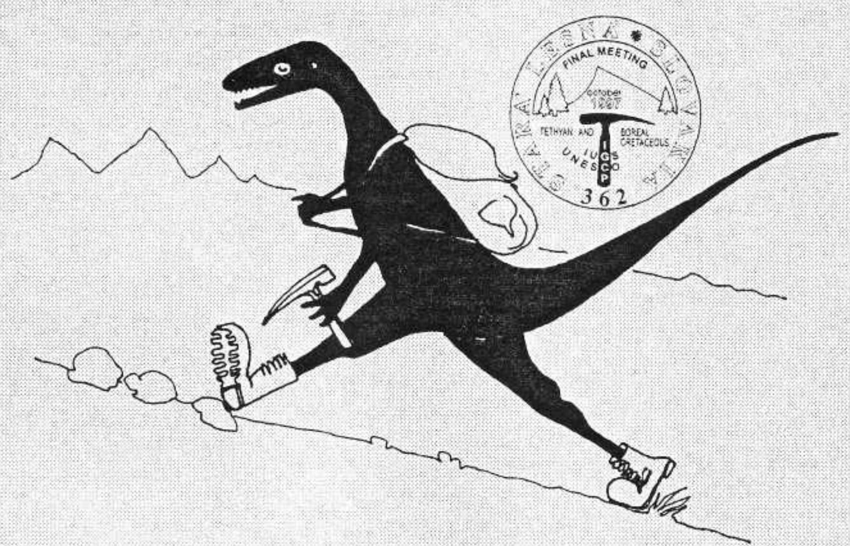
FINAL MEETING OF THE PROJECT N^{o} 362 „TETHYAN/BOREAL CRETACEOUS CORRELATION“

EXCURSION GUIDE BOOK



SEPTEMBER 30TH - OCTOBER 5TH, 1997
STARÁ LESNÁ, SLOVAKIA

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CONTENT:

EDITED BY:
Jozef **Michalík**, Daniela **Reháková**

Bratislava 1997

Mineralia Slovaca, 29 (1997), 357 - 383

Welcome in the field trips of the IGCP Project 362 Final Meeting

Stará Lesná, High Tatra Mts, Slovakia 1997, September 29th, October 5th

During our Conference three field trips will be organized. The routes of these trips were selected with emphasis not only to nice landscapes (this aspect was easy to provide in a beautifull northern Slovakian and southern Polish mountaineous sceneries), but also to give rough overview on the problems of Cretaceous study in this northernmost segment of the Europian Tethysides thrusted onto former boundary with the Boreal Realm. We rely on experience of many members of our TBC Project, who attained succesfull fieldtrips of the Smolenice Annual Meeting (in 1994), which illustrated these problems in western Slovakia and eastern Moravia.

The first, **Tatra Mts fieldtrip** is planned through the High Tatra Mountains Ridge starting from Tatranské Matliare with the altitute 885 m above sea level, Ždiarska Vidla (2142 m a. s. l.), Zadné Meďodoly Valley, Javorová and Biela Voda Valleys to the Lysá Poľana (970 m a. s. l.). The route follows a turistic path, but it could be tirable, especially in bad weather (although we hope to enjoy Indian summer). Therefore, be prepared for any circumstances (in really bad weather, there will be necessary to rely on a "reserve variant" along the valleys ...). Anyway, good boots, raincoat, woolen sweater, physical condition and good move are necessary.

This fieldtrip will demonstrate several selected problems of the Cretaceous stratigraphy, paleogeography and sedimentology in the High Tatra Mts belonging to the margin of Alpine - central Carpathian microcontinent. If the weather will be kind enough to us, we will see an almost complete Mesozoic section of the marginal Fatric Havran Nappe on the slopes (up to the top) of the Mt Ždiarska Vidla. Further on, we will inspect the contact of the Lower Cretaceous biogene Wysoka Turnia Formation with the Albian pelagic dark Zabijak Marlstone in tectonically underlying Tatric unit in the Javorová Valley. Finally, we will study all this Lower Cretaceous sequence in the neghbouring Biela Voda Valley.

Another two field trip days will be easier, with much longer bus ride. The **Orava and Kysuce** field trip will follow the Paleoalpine Accretionary Belt disposed between Central Carpathians and their foreland, covered by flysch nappes of the Outer Carpathians. We will visit the Polomec Hill in the Krížna Nappe (one of the superficial nappes of the Central Carpathians). The local stratotype of the Hauterivian-Barremian boundary is exposed here in a quarry of the Lietavská Lúčka cement works. Locality Brodno in the Kysuca Unit of the Pieniny Klippen Zone is the national stratotype of the Tithonian-Berriasian boundary. The Rochovica profile (the typical section of the Kysuca Unit) in the oposite side of the Kysuca Gate exposes almost complete Berriasian - Albian sequence. Považský Chlmec illustrate Upper Cretaceous sedimentation during involving of this area (margin of the North European shelf) into West Carpathian Paleoalpine accretionary prism. Finally, the Bralo quarry near the Párnica will illustrate Lower Cretaceous sedimentation in the marginal Tatric Šiprúň Basin of the Central Carpathians.

The last, **Pieniny Klippen Belt** field trip will be concentrated on classical localities in the Polish Pieniny Mts area. This trip will be organized by our Polish friends. It will comprise the famous Tithonian-Berriasian Rogoźnik section with plentiful fossil fauna, Mt Macelowa illustrating Upper Cretaceous bio- and lithostratigraphy, Flaki Ridge with complex structure composed of Cretaceous rocks, and the Orlica Hill near Szczawnica Niżna exposing middle and Upper Cretaceous sequence.

We are looking forward to meet you in Stará Lesná fieldtrips.

Jozef **Michalík and** Han **Leereveld**
co-leaders of the IGCP 362 Project
"Tethyan and Boreal Cretaceous"

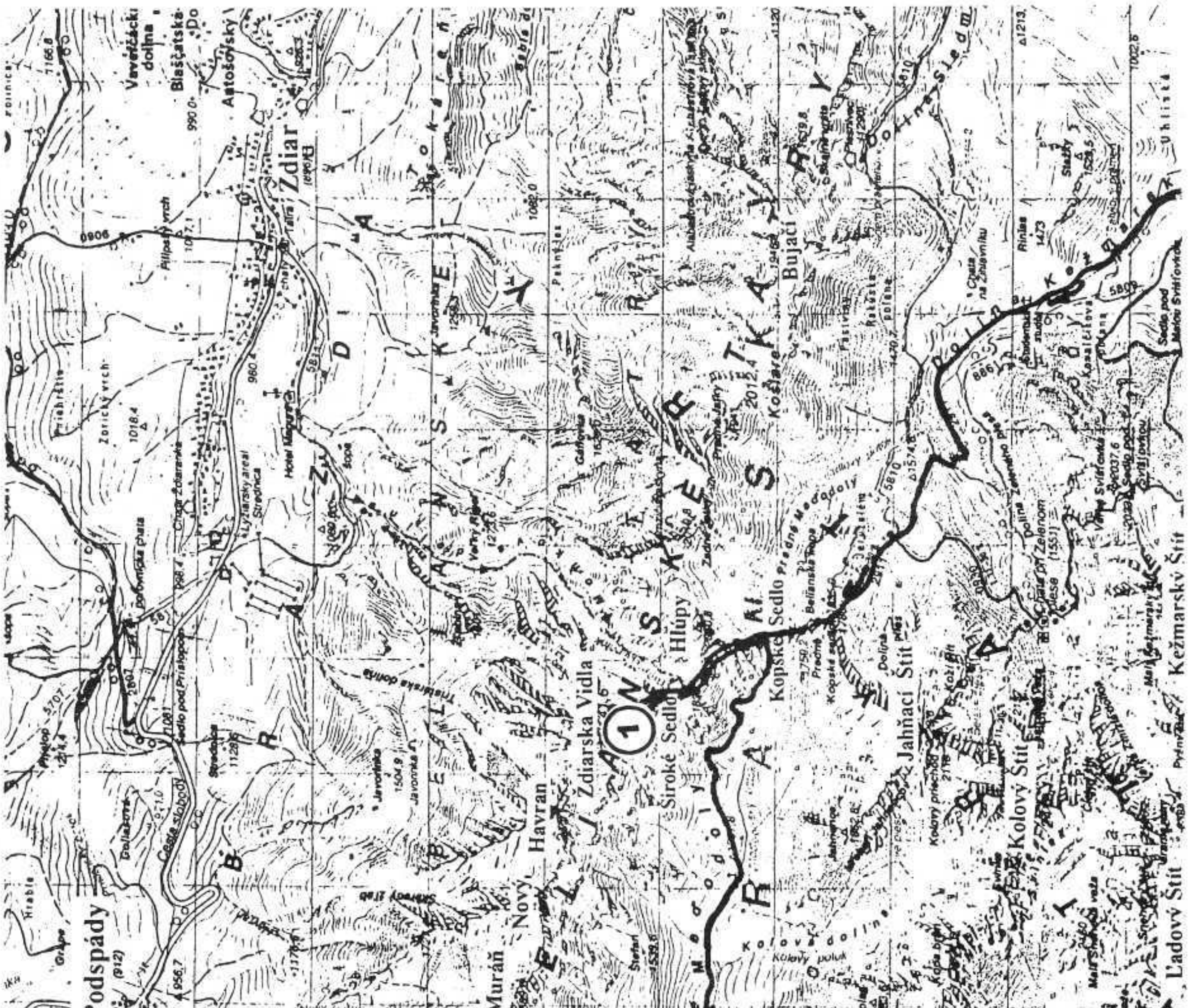

Fig. 1. Sketch of the Belá Tatra Mts with indication of localities visited.

1. THE TATRA MOUNTAINS FIELD TRIP

STOP 1

Mt. ŽDIARSKA VIDLA SECTION

Jozef Michalík

Southern slopes of the Belá Tatra Mts offer the best exposures of Mesozoic sequences belonging to the Fatric superficial nappes in the High Tatra Mountains, naimely the Havran and the Bujačí Nappes. These tectonic units rest on the Tatric megaunit comprising huge bodies of granitoid and crystalline rocks of Variscan orogenic cycle. They are covered by? Upper Permian **Koperšady Conglomerate** and by Lower Triassic **Lúžna Formation**. Upper part of the Mesozoic sequence is tectonically reduced in the vicinity of the Kopa Sattle and Zadné Meďodoly Valley (Fig. 1).

The Havran Nappe consists of Mesozoic sedimentary rocks deposited on the margin of the Krížna (Zliechov) Basin. The sequence starts with quartzitic sandstones of the Lúžna Formation followed by argillaceous **Šuňava Formation** containing intercalations of cellular dolomites (Fig. 2). The Middle Triassic sequence consists of dolomites and dark limestones of the **Gutenstein** and **Ramsau Formations**. The presence of the stromatolitic layers and pseudomorphs after gipsum and anhydrite proves for extremely shallow water environment of the deposition. Upper Triassic complex is represented by characteristic **Carpathian Keuper** deposits formed by varicoloured claystones with sandstone intercalations and with characteristic member consisting of fluvial fine conglomerates, sandstones and thin coal measures. Overlying Fatra Formation forms the topmost member of the Triassic sequence exposed in the vicinity of the Široké Sattle on the foot of the Mt Ždiarska Vidla. It consists of shallow marine limestone/marlstone sequence with plentifull fossils like algae, foraminifers, corals, porifers, brachiopods, bivalves, gastropods, etc.

The onset of the Jurassic sequence is marked by increasing content of siliciclastic material. Sandstones form intercalations in the Hettangian **Kopieniec Formation** but huge accumulations in the Sinemurian **Baboš Quartzite Formation**. The Lotharingian **Janovky Formation** consists of rhythmical bedded spotted limestones with marly interbeds similar to the Alpine Allgäu Beds. Red Toarcian **Adnet Limestone** represent an expressive shallowing event followed by sedimentation of Middle Jurassic siliceous rocks. Upper Jurassic nodular limestones (**Tegernsee Formation**) of Ammonitico Rosso type represent another shallow period of the basin evolution terminated by a new deepening (Pszczólkkowski, 1996).

Thin bedded grey micritic limestones with marly intercalations represent the Berriasian **Osnica Formation.** It is followed by uniform deep basinal Valanginian/ Hauterivian bituminous argillaceous limestones of the **Kościeliska Formation**. During Late Hauterivian/Barremian, this type of deposition was substituted by creation of turbiditic near slope fan consisting of redeposited material (the **Muráň Limestone Formation**) derived from shallow marine carbonate platform on neighbouring Tatric elevation. These limestones form the top parts of the Belá Tatra Mountains Ridge.

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STOP 2

MOKRÁ DIERA IN THE JAVOROVÁ VALLEY

Zdeněk Vašíček and Jozef Michalík

The Mokrá Diera cave is situated on the left side of the Javorová dolina valley. Masive lower Cretaceous limesto-

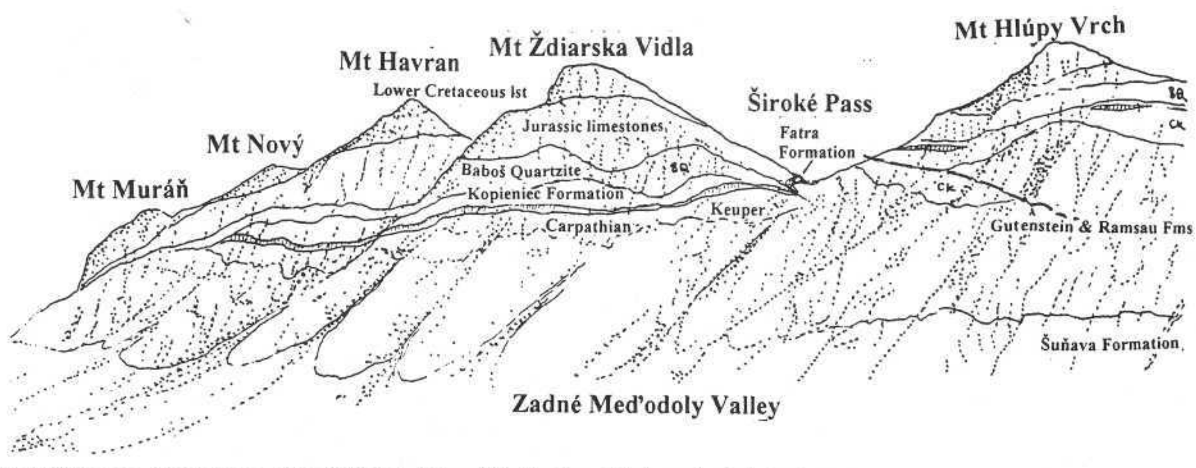

Fig. 2. View on southern slopes of the Belá Tatra Mts with indication of their geological structure.

nes of the **Wysoká Turnia Formation** (Lefeld et al., 1985) built the cave walls. Biogene limestone complex is covered by the Zabijak Marlstone Formation. The topmost part of the limestone sequence has reddish colour and bears marks of karstification (Lefeld, 1968).

The **Zabijak Marlstone Formation** starts with phosphatized - glauconitic limestone bed lying on karstified and eroded limestone basement and filling also neptunic dykes in it (Rakús et al., 1995). This limestone yielded stratigraphically significant Lower Albian ammonites. The zonal species *Douvilleiceras mammilatum* (Schlotheim) is followed by *Tegoceras gladiator* (Bayle), *Sonneratia* cf. *dutempleana* (d'Orb.), *Rossalites* sp., *Tetragonites rectangularis* Wiedmann, *Puzosia* ex. gr. *mayoriana* (d'Orb.), *Beudanticeras* ex. gr. *beudanti* (Brogniart), *Desmoceras* (D.) *latidorsatum* (Michelin) and *Hamites* sp.

Recognized ammonite fauna of the *Mammilatum* Zone indicate upper Early Albian age of the sequence studied. No representatives of the lowermost Early Albian fauna were found. Therefore, we suppose the presence of a stratigraphic gap in our territory at this time.

Uncommonly rich ammonite association comprising about 60 species was described by Marcinowski and Wiedmann (1990) from analogous lithofacies on the Polish side of the High Tatra Mts. Besides above mentioned Slovak species, the subzonal Late Albian indexes were identified: *Diploceras* (D.) *cristatum*, *Hysteroceras orbignyi* (Spath) followed by *Hysteroceras varicosum binodosum* (Stieler), *Hamites* (H.) *rectus* Brown, H. (H.) *virgulatus* (Brogniart), *Hemiptychoceras subgualtianum* Breinstroffer, *Turrilitoides* (T.) *hugardianus* (D'Orb.), T. (T.) *intermedius* (Pictet et Campiche). The Polish collection proves for a longer time of condensation.

The substantial part of the Zabijak Formation consists of dark grey to yellowish grey marlstones and (frequently laminated) marly mudstones with pale fine sandstone intercalations representing distal turbidites.

Differentiated movements of tilted blocks in elevation zones have just led to formation of condensations, accompanied by frequent hardgrounds. Missing of the lowermost Albian sequence, the presence of neptunic dykes as well as their karstification (dissolution) indicate that the Urgonian carbonate platform must have extincted till the end of the Aptian.. Onset of flysch sedimentation should be put into connection with the highest middle, but mainly Late Albian time horizon.

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STOP 3

Mt MURÁŇ SECTION ABOVE THE JAVOROVÁ VALLEY (HIGH TATRA MTS.)

Jozef Michalík and Ján Soták

The scarcity of Lower Cretaceous shallow marine sediments in the Western Carpathians is in apparent contradiction to the abundance of these rocks in the pebbles of younger conglomerates, hence the increased importance of transitional facies (olistolites, slope debris, slumped bodies, near- slope fans, fluxoturbidites etc.) which contain redeposited shallow marine carbonates in pelagic sediments. In the Outer Carpathians, latest Jurassic carbonate platforms, including the famous Štramberk reef, were destroyed during Early Cretaceous basinal development. On the other hand, late Hauterivian to early Albian carbonate platforms, mostly connected by elevated crustal blocks, developed in the Central Carpathians. Subsequently, they were mostly destroyed by erosion following the tectonic uplift (Michalík and Soták, 1990).

The bathymetric contrasts between basins and elevated zones increased suddenly during the Barremian.

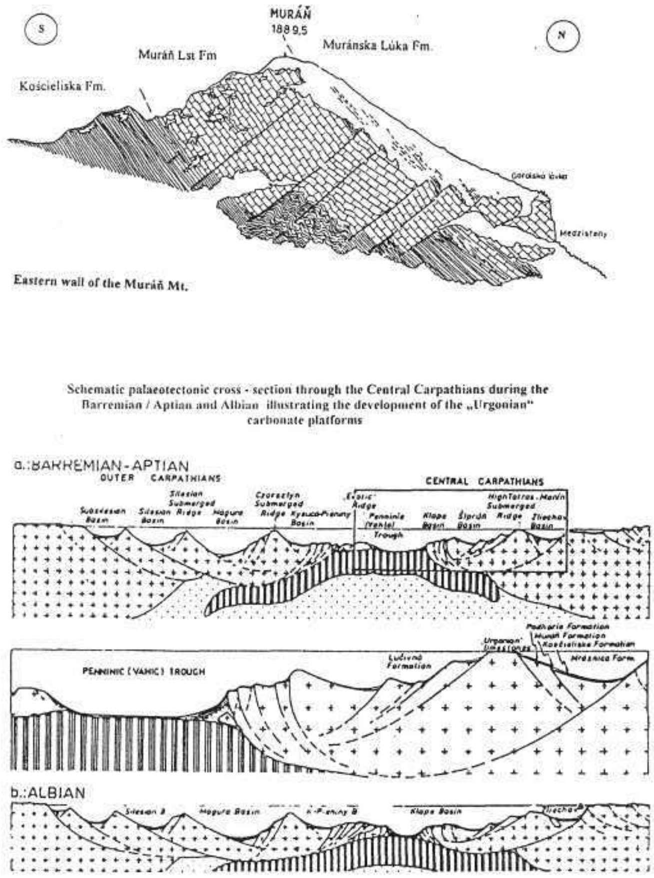

Fig. 3. Eastern wall of the Muráň Mts. Schematic paleotectonic cross-section through the Central Carpathians during the Barremian - Albian illustrating the development of the „Urgonian" carbonate platforms.

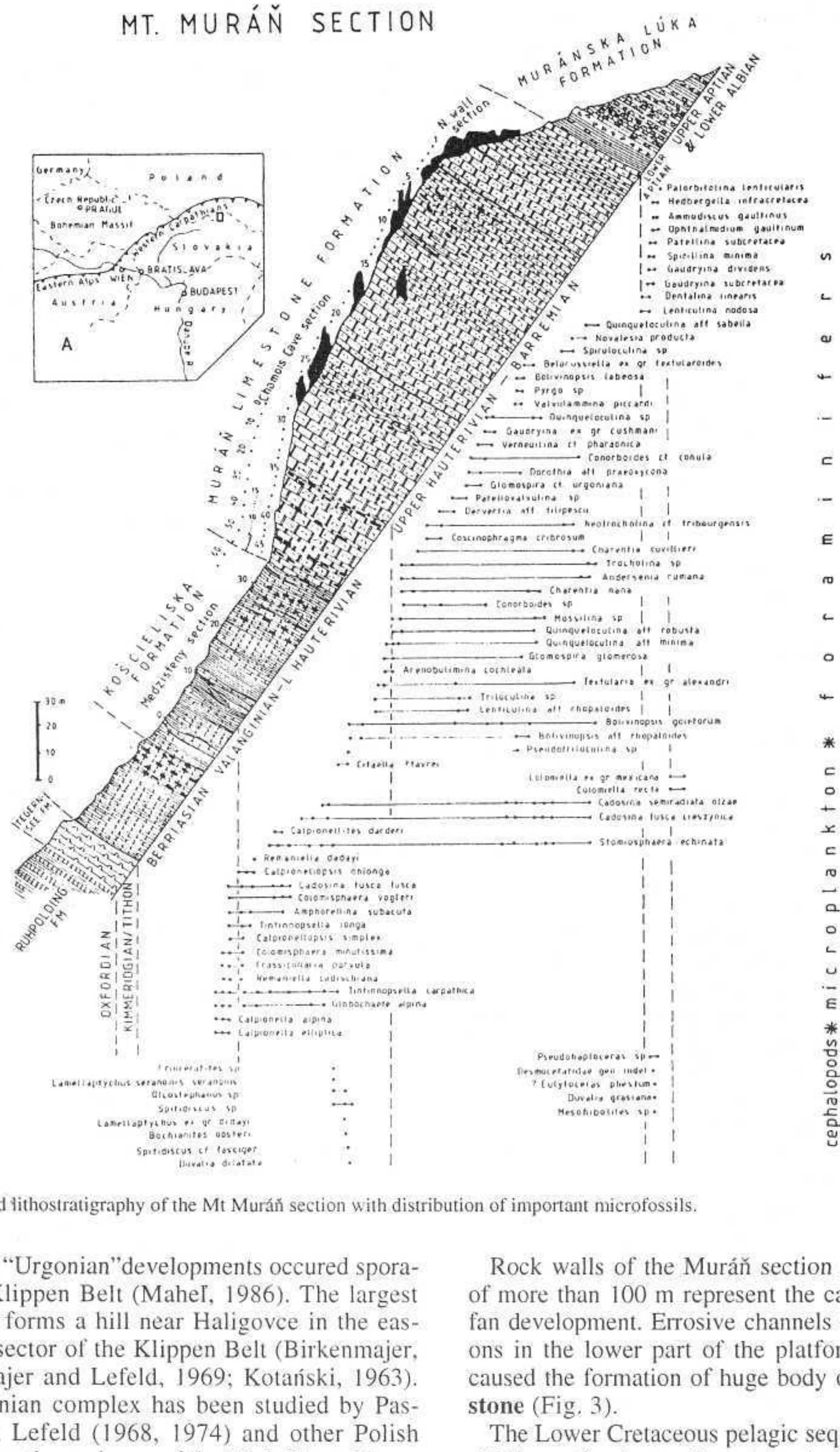

Fig. 4. Lithology and lithostratigraphy of the Mt Muráň section with distribution of important microfossils.

Shallow marine "Urgonian"developments occured sporadically in the Klippen Belt (Mahel', 1986). The largest of these bodies forms a hill near Haligovce in the eastern Slovakian sector of the Klippen Belt (Birkenmajer, 1977; Birkenmajer and Lefeld, 1969; Kotański, 1963). A typical Urgonian complex has been studied by Passendorf (1949), Lefeld (1968, 1974) and other Polish authors on the northern slopes of the High Tatra Mountains. It begins with oolite, and is followed by detrital limestone with echinoid and crinoid remnants. The main part of the deposits consists of Barremian - lower Albian coralgal reefs with *Montivaultia, Salpingoporella,* dasycladaceans, orbitolinids, *Requienia* and other neritic organisms.

Rock walls of the Muráň section reaching a thickness of more than 100 m represent the carbonate near - slope fan development. Errosive channels and submarine canyons in the lower part of the platform slope could have caused the formation of huge body of the **Muráň Limestone** (Fig. 3).

The Lower Cretaceous pelagic sequence below the Muráň Formation is terminated by the **Kościeliska Formation** (Lefeld et al., 1985). It consists of dark bituminous marlstones and marly limestones with small, patchy concentrations of iron sulphides, and is devoid of terrigenous detritus. Authigenic quartz, siliceous bands and cherts are abundant. Occasional organodetrital laminae accompany the fluxoturbidite intercalations in which mudstone and wackestone clasts with Tithonian and Berriasian microfossils and rich fragments of neritic organisms are preserved. The ammonite fauna *Himantoceras* cf. *trinodosum* Thieuloy, *Olcostephanus* sp., *Lamellaptychus* sp., indicates a late Valanginian age (Michalík et al., 1989).

The uppermost beds of the formation contain Hauterivian faunal elements *Bochianites oosteri* Sarasin and Schoendelmayer, *Duvalia dilatata* (Blainville), *Olcostephanus* ex. gr. *astierianus* (d'Orbigny), *Haploceras* cf. *desmoceratoides* Wiedmann, *Spitidiscus* sp. juv. and *Lamellaptychus seranonis seranonis* Coquand.

The basal member of the Muráň Formation is 15 - 20 m thick. It contains frequent marlstone intercalations with a pelagic microfauna, and wedges out in fine detrital grainstones with packestone layers. Calpionellids, sponge spicules and fragments of bivalve and echinoderm hard parts occur together with coated grains (ooids, microoncoids) in carbonate intra- and extraclasts. Sporadic occurrences of the foraminifers *Pseudotextulariella salevensis* Charollais, Brönimann and Zaninetti, *Vercorserella scarselai* (De Castro) and *Citaella ? favrei* Charollais, Brönimann and Zaninetti indicate a Valanginian - early Hauterivian age for the clasts. Moreover, a small form of *Calpionella alpina* Lorenz, found in a biomicritic limestone bed, probably indicating erosion of the basement in the transport channels (Fig. 4).

The middle part of the Muráň Formation is formed by about 30 m of distinctly bedded fine, detrital limestones which are characterized by an alteration of grainstones with packstones. Pseudo-oolitic limestone horizons occur locally. Cherts forming locally stratiform horizons occur close to bedding planes or other discontinuities in the sequence. They yielded rare, well - preserved specimens of *Acrasiales* (Mišík and Locquin). Small miliolids and textulariids (*Quinqueloculina minima* Tappan, Q. cf. *danubiana* Neagu, *Bolivinopsis goletorum* Arnaud - Vanneau, *B. labeosa* Arnaud - Vanneau, *Textularia alexandri* (Lalicker), *Gaudryina tuchaensis* Antonova, *Belorussiella textularoides* (Reuss), and *Andersenia rumana* (Negagu) domitate over other foraminifers. This assemblage indicates a late Hauterivian to early Barremian age for this member.

The thickness of the upper member is in excess of 50 m. Massive pale limestones are formed by monotonous fine detrital grainstones containing only packstone intercalations. On the other hand, rough bioclastic rudstones occur frequently. These contain intraclasts of lithified grainstone and extraclasts of micritic mudstone with calpionellids or sponge spicules, indicating that erosion of the substrate continued in the source channels. The rudstones consist of detritus of bioher organisms, namely corals, hydrozoans, bryozoans, encrusting algae, coralline alga, sessile foraminifera and microproblematics. Characteristic but rare remnants of dasycladacean algae are represented by *Clypeina migra* Conrad and Peybernés, *Salpingoporella muehlbergii* (Lorenz), S. *carpathica* Dragastan, *Halycoryne nerea* Dragastan, Bucur and Demeter together with *Charentia nana* Arnaud Vanneau and *Ch. cuvillieri* Neumann indicate a Barremian age. The uppermost part of the southern section at Mount Muráň contains two layers with rudist fragments, similar to those, described by Lefeld (1974).

Leaf-like disintegrating dark marlstones with black - grey limestone intercalations (**Muránska Lúka Formation**) overlie the Muráň Limestone Formation. Marlstones several tens of metres thick are intensively bioturbated. Nannocone wackestones and mudstones contain calcareous dinoflagellates (*Cadosina semiradiata olzae* Nowak, C. *fusca cieszynica* Nowak, calpionellids (*Calpionellopsella ? maldonadoi* Trejo), ostracodes, echinoderms, bentic foraminifers (*Lenticulina* (L.) *nodosa* (Reuss); *Dentalina nana* (Reuss), *Gaudriina subcretacea* Cushman, *G. dividens* Grabert, *Spirillina minima* Schacko, *Patelina subcretacea* Cushman (Alexander, *Ophthalmidium gaultinum* (Dam), *Ammodiscus gaultinus* Berthelin, and rare planktic foraminifers (Hedbergella infracretacea (Glaessner), H. ex. gr. tardita (Antonova). Microfossils indicate a Bedoulian - Gargasian age for the prevailing bathyal pelagic sediments.

Slumping breccias with small olistolite blocks of neritic ("Urgonian") limestone occur in the higher part of the marlstone sequence. Lefeld (1974) reported findings of early Aptian *Palorbitolina lenticularis* (Blumenbach), the dasyclad algae *Pianella* sp., the hydrosponge *Murania* sp., and coral referable to *Stylosmilia* sp. from blocks 5 - 50 cm in diameter. Dark marlstones filling a small tectonic depression on the top ridge of Mount Muráň yielded an early Aptian ammonite and belemnite fauna (*?Eulytoceras phestum* juv., *Desmoceratidae* gen. indet., *Pulchellidae* gen. indet., *Duvalia grasiana* (Duval - Jouve).

The microfauna recovered from the marly matrix of the blocky breccia consisting of a rich calpionellid association of the *Colomiella* Zone (C. recta Bonet, C. ex. gr. mexicana Bonet and Calpionellopsella ? div. sp.) could mean that the higher part of the Muránska Lúka Formation is of late Aptian or possibly earliest Albian age.

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STOP 4

SPIŠMICHALOVÁ SECTION, BIELOVODSKÁ VALLEY

Jozef Michalík

The Spišmichalová section exposed on the slopes of Mt Horvátov Vrch above the Biela Voda Valley was described by Lefeld (1968). The Cretaceous sequence belonging to the Tatric Unit starts with grey pseudooolitic limestones of the **Raptawicka Turnia Formation** (Lefeld et al., 1985) with sporadic oncoids and ooids. The amount of ooids and organic admixture increase upwards. According to Lefeld (l. c.) oncoids enclose Upper Tithonian to Lower Berriasian calpionellids Calpionella alpina Lorenz and *Tintinnopsella carpathica* (Murg. et Filip.). Dark grey pseudooolitic/oolitic limestones contain infrequent badly preserved ammonites (Fig. 5).

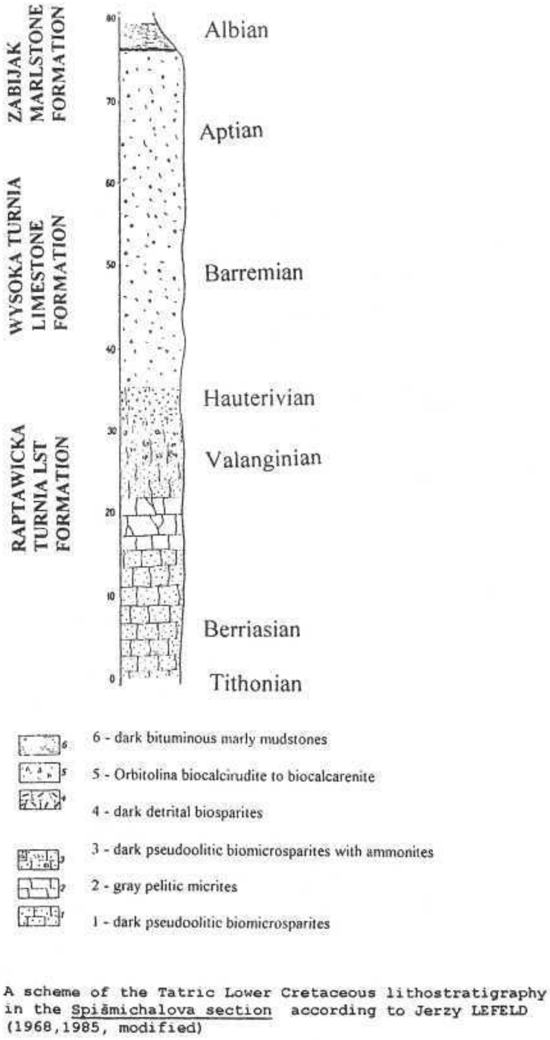

Fig. 5. A scheme of the Tatric Lower Cretaceous lithostratigraphy in the Spišmichalova section, Biela Voda Valley (Lefeld 1968, 1985, modified)

Massive organogene limestones of the **Wysoká Turnia Formation** built the most expressive parts of the rock outcrops. These "Urgonian" type limestones comprise rich debris of shallow marine organisms including algae (*Salpingoporella*), orbitolinid and miliolid foraminifers, and rudistid molluscs. The top surface of the formation was eroded and karstified.

The Albian **Zabijak Formation** consists of dark bituminous marlstones. The base of this formation is formed by glauconitic marlstones containing rich association of ammonites gastropods, bivalves and echinoids.

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2. ORAVA AND KYSUCE FIELD TRIP

STOP 5

POLOMEC QUARRY

Zdeněk Vašíček, Jozef Michalík and Daniela Reháková

Abandoned quarries at the Polomec Hill near Lietavská Lúčka village (now part of Žilina) occur at the very margin of the Strážovské Vrchy Mts. The exposed Lower Cretaceous carbonate sequence belongs to the Zliechov Unit of the Krížna Nappe (Borza et al., 1984; Fig. 6).

The Polomec section has been suggested as the national reference section of the Hauterivian/Barremian boundary. In accordance with the results of the Copenhagen (1983) and Mula (1993) workshops (Hoedemaeker et al., 1993), this boundary was situated between the ammonite *Angulicostata-* and *Hugii* Zones. Recently, the ammonite biostratigraphy of the section was supplemented by the microplankton study (Vašíček et al., 1995). The magnetostratigraphical study is in the progress. The sequence studied can be divided into four lithostratigraphic units, as follows (Fig. 7).

The turbiditic complex similar to the **Strážovce Formation** consists of grey and brownish fine grained sandy

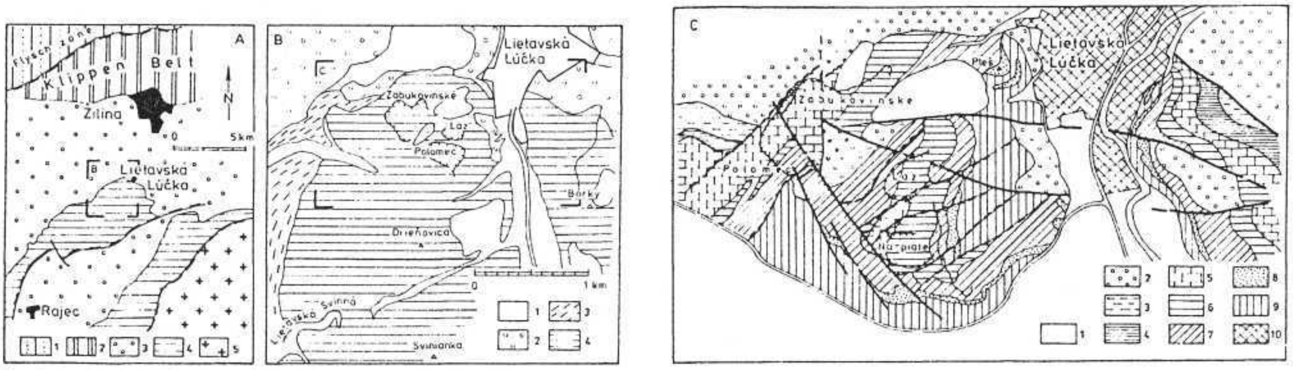

Fig. 6. Geological sketches of the Polomec area, Strážov Mts.

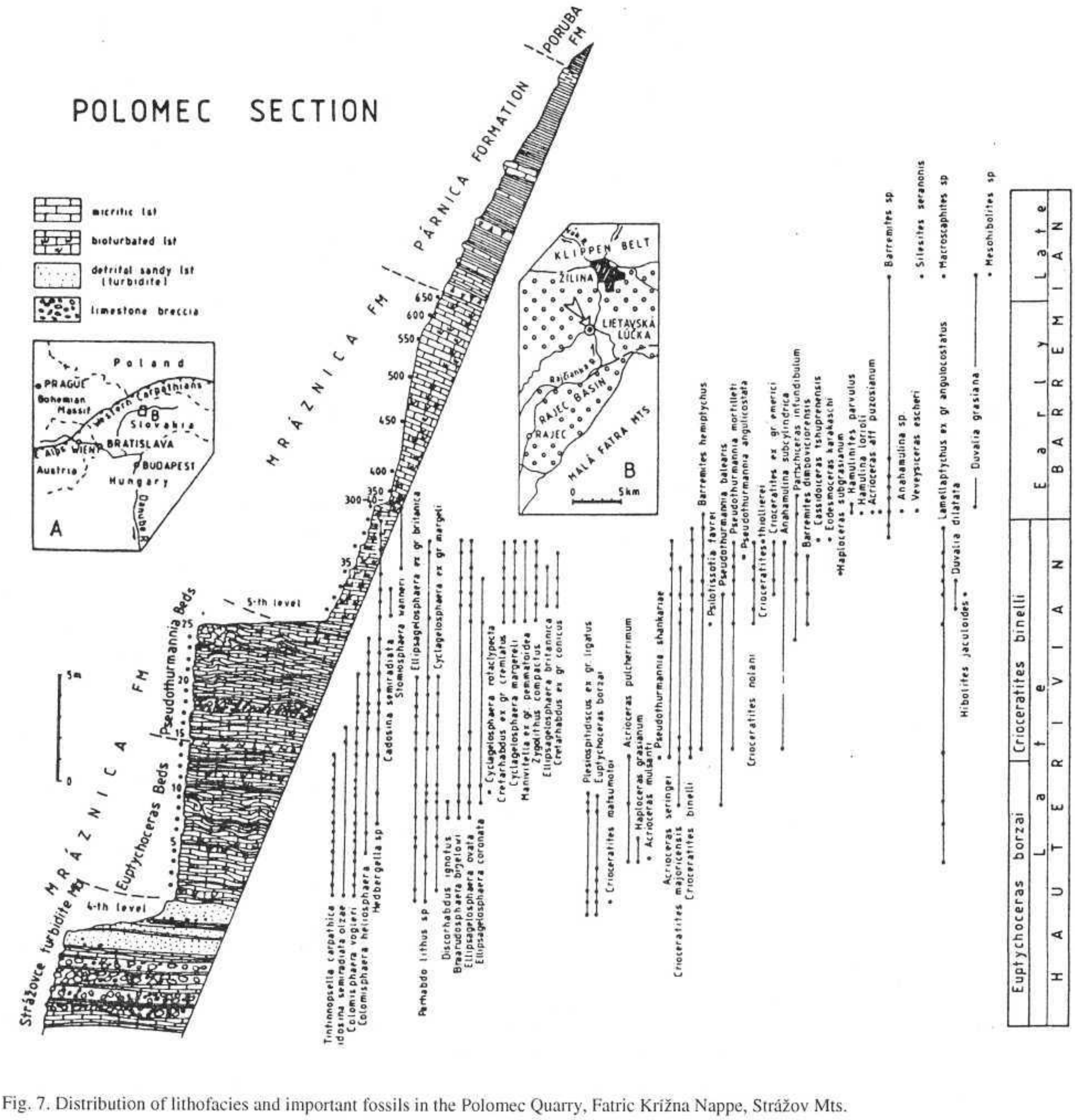

Fig. 7. Distribution of lithofacies and important fossils in the Polomec Quarry, Fatric Křížna Nappe, Strážov Mts.

The upper part of the violet gray limestones consists of nannocone bimicrites still with the *Tintinnopsella* association. In the topmost part, the first hedbergellid foraminifers have been recorded. The nannofloral association is substantionally enriched (*Ellipsagelosphaera* ex. gr. *britanica*, *E. coronata*, *E. ovata*, *Braarudosphaera bigelowi* dominate over *Cyclagelosphaera rotaclypeata*, *C. mergereli*, *Podorhabdus* and *Discorhabdus ignotus*).

The yellowish brown, reddish - grey or greenish grey biomicrites of the **Pseudothurmania Beds** with marly admixture are remarkable for the presence of synsedimentary slumping and brecciated beds (Fig. 8). *Tintinnopsella* no longer occurs, but hedbergellid foraminifers (*Favusella hoterivica*, *Hedbergella subcretacea*) are fairly common. Representatives of *Pseudothurmania* and *Crioceratites* dominate over other ammonite genera in macrofauna. Aptychi (*L. angulocostatus angulicostatus* (Pictet et Loriol)), belemnites (*Duvalia dilatata* (Blainville)), brachiopods (*Terebratulina, Pygites*) are localy abundant. Nannocone biomicrites contain rare silt - sized quartz sand grains, the "usual" spectrum of accessory and authigenic minerals, plus frequent brachiopod, bivalve, aptychus and ostracod fragments: radiolarians, calcareous dinoflagellates are less frequent. *Ellipsagelosphaera* is represented sporadically in the nannofloral association - *Cretarhabdus*, *Zygolithus*, *Braarudospahera* dominate over *Cyclagelosphaera*, *Parhabdolithus* and *Manivitella*. Pseudothurmania beds are regarded as basal Barremian.

Both *Pseudothurmania* and *Crioceratites*, together with the last aptychi, disappear suddenly at the base of the sequence of well bedded limestones with *Barremites difficilis*, *Hamulina lorioli* Uhlig, *Hamulinites* sp., *Karsteniceras* sp., *Holcodiscus* sp. and other ammonites. *Hamulina lorioli*, *Veveysiceras escheri*, and *Spitidiscus* ex. gr. *hugii* occurring more sporadically indicating the *Hugii* Zone (Vašíček and Michalík, 1988). The composition of microfauna is similar to the assemblage mentioned earlier. However, the nannoplankton assemblages are characterized by a sudden increase in the proportion of thick - walled forms (*Parhabdolithus*). Hedbergellid foraminifers (*H. sigali*, *H. subcretacea*) dominate in microfossil association of the Sigali Zone. This part of the sequence is of early Barremian age. The lithology of upper Barremian limestones is unchanged. They contain ammonite indexes *Silesites seranonis* and *S. vulpes*.

Aptian strata consist of dark grey marls with sporadic intercalations of black limestones. They contain rich a ssemblage of planktonic foraminifers. Above lying Albian shales belong to the **Poruba Formation**.

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STOP 6

BRODNO - RAILWAY STATION QUARRY NEAR ŽILINA

Daniela Reháková and Jozef Michalík

Classical section in the "Kysuca Gate" (narrow straits of the Kysuca River between villages Brodno, Rudinka and Vranie north of the town of Žilina) yielded important informations on relatively deep marine sedimentation in contact zone of the Outer - and the Central Western Carpathians, which has been substantionally reduced during later Alpine tectogenesis.

Late Jurassic sedimentation rate has been low, condensed sediments received only limited terrigene clastic support, similarly as in other West Carpathian areas. Extensive areas were characterized by red nodular calcareous ooze of the "Ammonitico Rosso Facies". **Czorsztyn Formation** represents Kimmeridgian and Tithonian sediments of the Kysuca succession.

Biomicrite packstone of the *Saccocoma - Globochaete* and *Saccocoma - Radiolaria* microfacies contain *Colomisphaera pieniniensis* (Borza), *C. fibrata* (Nagy), *Carpistomiosphaera borzai* (Nagy), and *Stomiosphaera moluccana* Wanner indicating Kimmeridgian age.

Reddish nodular cherty and indistinctly nodular biomicrite packstone are rich in *Saccocoma*, radiolarians and globochaetes. Ostracods, foraminifers, filaments, crinoids are common. *Parastomiosphaera malmica* (Borza), *Carpistomiosphaera tithonica* Nowak and *Colomisphaera pulla* (Borza), indicate early Tithonian age of the limestones.

Grey indistinctly nodular micrites contain microfossils of the middle Tithonian *Chitinoidella* Zone sensu Borza (1984) - the Boneti Subzone being documented only. The assemblage is represented by *Ch. tithonica* Borza, *Ch. slovenica* Borza, *Ch. boneti* Doben and rare dinocysts of *Cadosina fusca* fusca Wanner.

Late Tithonian *Praetintinnopsella* and *Crassicollaria* Zones were identified in indistinctly nodular and in well bedded wackestones which contain *Praentintinnopsella an-*

drusovi Borza and calpionellid associations of the *Remanei*, Brevis and *Colomi* Subzones: *Tintinnopsella remanei* Borza, *T. carpathica* (Murg. et Filip.), *Crassicollaria intermedia* (Durand Delga), *Cr. massutiniana* (Colom), *Cr. brevis* Remane, *Cr. parvula* Doben, *Cr. colomi* Doben, *Calpionella alpina* Lorenz, *C. grandalpina* Nagy, *Cadosina fusca fusca*, *C. fusca semiradiata* Wanner dominate over foram fragments, ostracods and bivalve shells. Aptychi - *Lamellaptychus beyrichi* (Opel), *Lamellaptychus* sp., ammonites - *Ptychophylloceras ptychoicum* (Quenstedt), *Perisphinctes* sp., *"Rhynchonella"* spoliata Suess, *Pygope diphya* Colom were described by Scheibner (1962).

Berriasian formations were characterized by strong subsidence but mainly by great acceleration of "planktic rain" of organic matter and calcareous microskeletons. This change detectable in the majority of Western Carpathian successions (Padlá Voda-, Ladce-, and Osnica Formations) created the "majolica" pattern of pelagic sedimentation (**Pieniny Limestone Formation**) in the Pieniny sedimentary basin. This sedimentation continued here until early Aptian. Detailed litho- and biostratigraphical investigation of Late Jurassic and Lower Cretaceous sedimentary complexes of the Brodno section was made by Michalík et al. (1990), Reháková and Michalík (1992), Vašíček et al. (1992).

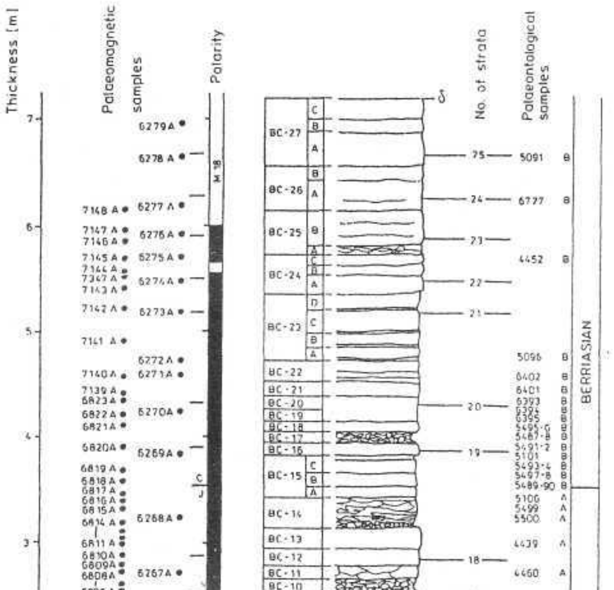

Fig. 9. Magnetostratigraphic and biostratigraphical documentation of the Brodno section near Žilina.

Magnetostratigraphic investigations along the Jurassic/Cretaceous boundary correlated with micropaleontological were provided and published by Houša et al., (1996). According to their results, the base of the standard *Crassicollaria* Zone lies approximately in the middle of magnetozone M - 20n, the base of the standart *Calpionella* Zone, i. e. the Jurassic/Cretaceous boundary, lies in the younger part of the older half of the magnetozone M - 19n (Fig. 9).

Lower Berriasian part of this succession is represented by well bedded pale biomicritic wackestones with *Calpionella - Globochaete* and *Radiolaria - Calpionella* microfacies. *Calpionella alpina* and *Globochaete alpina* are dominating, foram fragments, radiolarians, ostracods, aptychi, ophiuroids, bivalves, juvenile ammonites, *Crassicollaria parvula, Tintinnopsella carpathica, Cadosina fusca, Cadosina semiradiata* are common. Microbreccia layers contain limestone clasts with Tithonian microfossils. *Remaniella ferasini* (Catalano), *R. cadischiana* (Colom) characterize the middle Berriasian part of the formation. *Calpionella elliptica* and *Cadosina minuta* occur in overlied thick bedded cherty limestones.

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STOP 7

ROCHOVICA SECTION NEAR ŽILINA

Jozef Michalík, Daniela Reháková, Zdeněk Vašíček, D. Boorová, M. Peterčáková and Otília Lintnerová

The outcrops in steep sides of the Rochovica and Brodnianska Hora hills squeezing the Kysuca Gate (a break of the Kysuca River into the Váh River Valley by Žilina) yield the classical sections of the Kysuca Unit of the Klippen Belt (Fig. 1). They have been studied by (Andrusov, 1945; Andrusov and Scheibner, 1966; Salaj and Samuel, 1966; Scheibner, 1968; Borza, 1969; Andrusov and Samuel, 1973; Haško, 1973; Samuel et al., 1988; Michalík et al., 1990; Vašíček et al., 1992, etc.).

Upper Jurassic and Lower Cretaceous pelagic sequence in the Rochovica section consists of regularly bedded pale grey cherty "majolica" limestones in contact with the underlying Ammonitico Rosso limestones. This section offers unique possibilities for detailed bio-, sequence-, and isotope stratigraphic investigation. The biostratigraphic framework was based mainly on calpionellid distribution supplemented by calcareous nannofossil, calcareous dinoflagellate-, planktonic foraminifer-, radiolarian-, as well as ammonite- and aptychi zonations (Fig. 10).

Basal member of the Czorsztyn Formation consists of reddish brown nodular limestones with rare cherts. They contain microfossils of the *Borzai* Subzone - *Colomisphaera nagyi* (Borza), *C. fibrata* (Nagy), *Stomiosphaera moluccana* Wanner, *Carpistomiosphaera borzai* (Nagy) indicating Kimmeridgian age.

Nodular biomicritic limestones in the lowermost part of the Rochovica section contain abundant *Saccocoma* Agassiz ramulae and secundibrachialia, zoospores of *Globochaete alpina* Lombard, as well as less frequent *Colomisphaera tenuis* (Nagy), *Schizosphaerella minutissima* (Vogler), *Carpistomiosphaera tithonica* Nowak typical for the early Tithonian *Tithonica* Zone (sensu Borza, 1984).

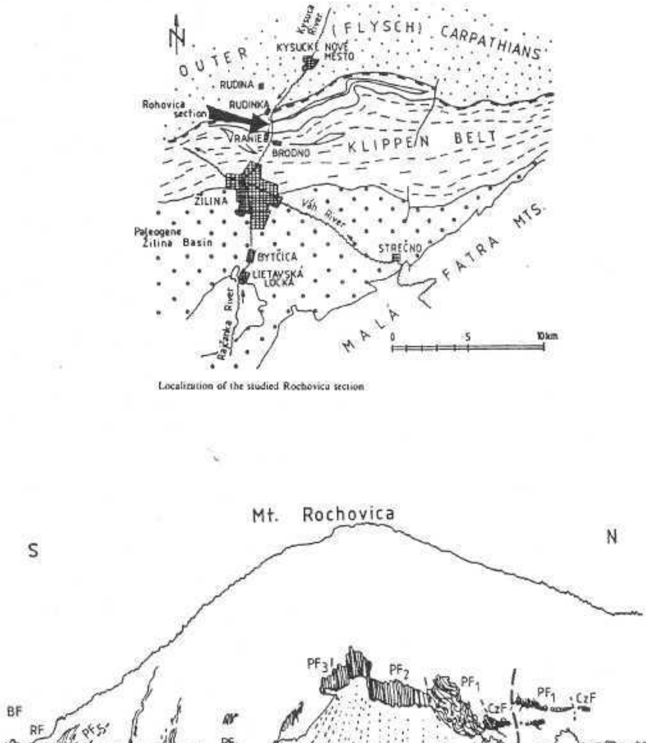

Fig. 10. Localization of the Rochovica section in the Kysuca Gate near Žilina. Abbreviations: CzF: Czorsztyn Formation, PF: Pieniny Formation, BF: Brodno Formation, RF: Rudina Formation.

Middle Tithonian sequence is strongly reduced. Grey pseudonodular limestones contain microfossils of the upper *Boneti* Subzone: *Chitinoidella boneti* Doben *Ch. slovenica* Borza, *Ch. tithonica* Borza. The basal late Tithonian *Praetintinnopsella* Zone has never been found in the Rochovica section, though it was identified in the nearby Brodno section.

Crassicollaria intermedia (Durand Delga), *Cr. massutiniana* (Colom), *Cr. brevis* Remane, *Cr. colomi* Doben, *Calpionella alpina* Lorenz, *C. grandalpina* Nagy, *Tintinnopsella carpathica* (Murg. et Filip.), less frequent saccocomas, globochaetes and calcareous dinoflagellates are present in overlying pale rosa - gray biomicrites intercalating by several breccia layers. Microfossils identified belong to *Remanei*, *Brevis* and *Parvula-Colomi* Subzones of the *Crassicollaria* Zone.

Thin bedded white - gray subpelitomorph limestones of the "majolica" facies with dark cherts (Pieniny Limestone Formation) form substantial part of the Lower Cretaceous sequence. Magnetostratigraphic investigations along the Jurassic/Cretaceous boundary correlated with micropaleontological data from the oposite Brodno section was published by Houša et al. (1996). The early Berriasian age of bedded gray cherty biomicrites was proved by spaerical *Calpionella alpina* dominating the microfaunal assemblage (*Alpina* Subzone). It is followed by associations of *Ferasini* and *Elliptica* Subzones of standart *Calpionella* Zone. Overlying Late Berriasian biomicrite wackestones to packstones of *Calpionellopsis* Zone contain *Calpionellopsis simplex* (Colom), *C. oblonga* (Cadisch), *Lorenziella hungarica* Knauer. Distinct breccia layers appear in the uppermost part of Late Berriasian sequence. Weathering, erosion and runoff recorded during the expressive Be-7 sea level drop event was accompanied by distinct increase of calcareous dinoflagellate abundance.

Microfaunistic association of *Calpionellites* Zone was found in Lower Valanginian rhytmic sequence interrupted by organodetrital and fossiliferous limestone intercalations. Calpionellids are scarce, poorly preserved beeing accompained by abundant nannoconids, frequent radiolarians and sponge spicules which determine the prevailing type of microfacies. Small primitive lamellaptychi and rostrum of early Valanginian belemnite P*seudobelus bipartitus* (Blainv.) have been found in marly intercalations.

Biomicrite to biomicrosparite wackestones with frequent biodetritus yielded late Valanginian ammonite association of *Saynoceras verrucosum* Zone. At the same time, abrupt decrease in calpionellid and nannoconid abundance and diversity was recorded. Increasing temperature accompaning an extensive climatic change could caused the failure of calpionellids (with the exception of *Tintinnopsella*) to produce calcitic loricas. Positive C - isotope excursion was regarded as a time of accelerated carbon cycling coupled with increased burial rates of organic carbon and detrital material in oceanic sediments (Michalík et al., 1995).

Overlying thin bedded limestones with bisquite - shaped chert nodules contain irregular echinoids, *Pygites* sp., belemnite rostra of *Pseudobelus brevis* (Parona) and lower Hauterivian aptychi *Lamellaptychus seranonis* (Coquand). Upper Hauterivian part of sequence contains *Lamellaptychus angulocostatus* (Peters), rich nannoplankton association dominating by nannoconids and diverse radiolarian association (Halásová and Peterčáková in Vašíček et al., 1992). Planktonic foraminifers belonging to the *Hedbergella sigali* Zone were determined by Boorová (?Freiberg).

Dark gray marly spotted limestones of the Brodno Formation are inserted by calciturbiditic layers. Biomicrite wackestone to packstones are rich in radiolarians, sponge spicules accompanying by Barremian planktonic foraminifera association. The uppermost part of this sequence is Aptian in age - it contains microfossils of the *Globigerinelloides blowi* Zone.

Pelagic and calciturbiditic Barremian/Aptian Brodno Limestone sequence is interrupted by the Koňhora Member. An abrupt environmental change is indicated by the substitution of pelagic carbonate sedimentation with almost eight meters thick dark calcareous clays to marlstones with sporadic mica leaflets, coalified plant fragments, pyritized macrofossils and poveryfied nannoplankton association of *Chiastozygus literarius* Zone mainly with abrupt diminishing in nannoconid abundance ("nannoconid crisis" of Erba, 1994). Two limestone intercalations within Koňhora Beds (referrable to the Ap-1 and Ap-3 lowstands respectively), contain diverse radiolarian associations. C isotope excursion (+ 3.3 to 4.9 ‰) observed indicates anoxic marine conditions of the shaly Koňhora Beds deposition. Decreased values of $d^{18}O$ connect with temperature increase and/or with high terrigeneous input.

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STOP 8

POVAŽSKÝ CHLMEC - VRANIE

Jozef Michalík and Daniela Reháková

On the right side of the Kysuca River bed, the road escarpment near Považský Chlmec - Vranie exposes the flysch sequence of the Pieniny Unit of the Klippen Belt (Kysela, 1980). The sequence is divided into two parts.

The lower 100 - 400 thick part, called as the **Snežnica Formation**, consists of sandstones (its thickness is 5 - 60 cm), siltstones and pelites (with the beds up 1 to 40 cm thick), in which Ta intervals of the Bouma's cycle are frequent, as well as of the coarser non-structured layers. Tb and Tc intervals are frequently visible in the marl sequence of the section. Marschalko (1986) supposed that the turbidites of the Snežnica Formation belonged to the C and D facies of the middle and outer part of the fan. The Turonian age is proved by foraminifers. On the Polish sector of the Pieniny Klippen Belt, the corresponding sequence is represented by the Jaworki Marl Formation, deposited in more distal part of the basin. Snežnica siltstone complex form a member covered by red marls (Macelowa Marl Member, Birkenmajer, 1977).

The upper part, the **Śromowce Formation** contains the Coniacian to Santonian polymict conglomerate layers and intercalations in which the inverse gradation can be seen frequently. Their thickness is 2 - 12 m. Conglomerates belong to simmictites, slumpings and olistostromes, proving unstable slope conditions. According to Marschalko (l. c.), the conglomerate flysch sequence belongs to the upper part of the fan. On the base of the lithosome lenght, the material of the fan was transported through the canyon of a considerable size. Conglomerates contain occasionaly calcarenite pebbles and blocks of the **Orlové Sandstone Formation** with *Rhynchostreon suborbiculatum* as well as the small lithoclasts of the Albian marls.

It proves that not only a hypothetical Andrusov Ridge, but the elevated accretionary wedge (Klape Unit) was eroded at the beginning of the Late Cretaceous, as a whole.

Carbonate pebbles dominate, presenting about 45 - 50 % of the conglomerate material. Mišík and Sýkora (1981) distinguished: pebbles of Triassic dolomites, Middle and Upper Triassic Wetterstein Limestone, Carnian algal limestones, Liassic sponge limestones, Upper Jurassic shallow marine limestones with *Protopeneroplis striata, Conicospirillina basiliensis, Cladocoropsis mirabilis, Clypeina jurassica* etc., shallow marine limestones with *Orbitolina* sp. and another ones.

Acid and intermedial volcanites are abundant, too (33 - 35 %). Paleorhyolites and porphyric paleoandesites (with large crystals of plagioclases) are typical for the Považský Chlmec area.

Clastic rocks (sandstones, quartzites, conglomerates) represent about 15 %, while the intrusive rocks (mostly subvolcanic facies of the rocks mentioned above) attain 5 % of the sediment volume. Metamorphic rocks, quartzite metaconglomerates, quartzites and vein quartz are rare (3 %).

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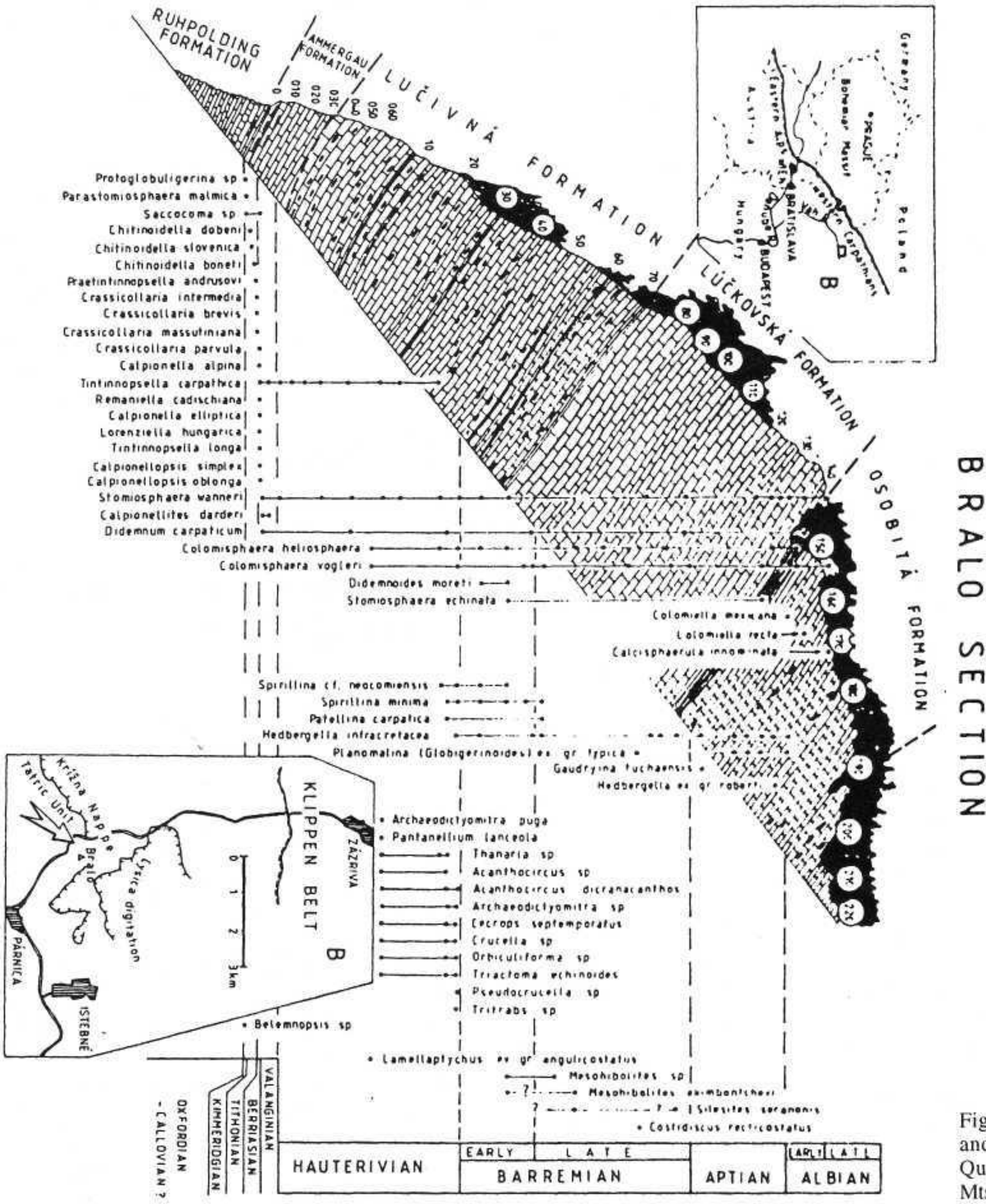

Fig. 11. Distribution of lithofacies and important fossils in the Bralo Quarry section, Tatric, Malá Fatra Mts.

STOP 9

BRALO QUARRY IN THE ZÁZRIVÁ VALLEY

Jozef Michalík and Daniela Reháková

The section is exposed in the western foothill of Mt Bralo in the Zázrivá Valley, 3 km NW from Párnica in the Malá Fatra Mts. It has been selected as the lithostratotype locality of the Lučivná Formation (Polák and Bujnovský, 1979). Michalík et al. (1990) provided its detailed biostratigraphical investigations (Fig. 11).

The limestone sequence, which has been evaluated in the now abandoned quarry, is underlain by Middle Jurassic shales and siliceous limestones.

Argillaceous limestones with dispersed organodetrite and belemnite rostra form the base of the exposed limestone sequence. They contain juvenile bivalve, crinoid columnalia, globuligerinid foraminifers and scarce saccocomas. Their age has been estimated as late Oxfordian, being terminated by condensed horizon with Fe and Mn oxide crusts, Fe and Mn pisolites and rare quartz grains (sole quartz pebble with diameter of 4 mm has been found here).

The base of the overlying biomicritic limestone bed contains concentration of belemnite rostra. The "biancone" limestone complex consists of packestones with Saccocoma - Globochaete Microfacies in which the early Tithonian *Malmica* - and late Tithonian *Crassicollaria* Zone have been identified. Horizon with redeposited aptychi occurs in the higher part of the sequence, containing microfossils of the Berriasian *Calpionella* Zone.

The association of microfossils belonging to the late Berriasian and Valanginian *Calpionellopsis*- and *Calponellites* Zones occurs in bedded marly limestones with indistinctly nodular planes and infrequent cherts.

Lučivná Formation is composed of well bedded cherty limestones containing indeterminable belemnites and echinoid remnants. Scarce aptychi *Lamellaptychus* ex. gr. *angulicostatus* indicate late Hauterivian and the earliest Barremian age. This assumption can be proved by radiolarian microfauna belonging to assemblage of the *Cecrops septemporatus* Zone (Schaaf, 1984) dominated by *Cecrops septemporatus* Parona and *Acanthocircus dicranacanthos* (Squinabol) over *Archaeodictyomitra puga* Schaaf, *Pantanellium lanceola* (Parona), *Triactoma echioides* Foreman, *Crucella* sp. *Thanarla* sp., etc.

The third unit paralelized with the Barremian **Lúčkovská Formation** is represented by platy limestones with marly intercalations and frequent belemnite rostra. Nannoconid wackestones contain crinoids, sponge spicules, radiolarians, dinoflagellates and planktic foraminifers: *Hedbergella infracretacea* Glaessner, *Planomalina* (*Globigerinelloides*) ex. gr. *typica* (Gandolfi). The age is proved by Late Barremian ammonite index *Silesites seranonis* (d'Orbigny) and by belemnite *Mesohibolites ekimbontchevi* Stoyanova - Vergilova.

The higher up lying limestone formation is build up of spotted micrites and microsparites with sparite intercalations of fluxoturbidite origin. They contain Aptian microfauna (*Hedbergella infracretacea*, *Gaudryina tuchaensis* Antonova). Fluxoturbidite grainstones and packstones consist of bioherm organism detritus, namely bivalves, bryozoans, crinoids, rudists and encrusting alga Ethelia alba (Pfender). This beds could be paralelized with the **Osobitá Formation** (Lefeld et al., 1985). Is represents a distal slope - foot facies of the Central West Carpathian "Urgonian" carbonate platform complex.

The topmost limestone formation (**Bebrava Lst Fm**) consists of black biomicrital limestones containing Early Albian microfossils *Colomiella mexicana* and *Colomiella recta*. The age of the shaly beds in its overlier can be proved by Upper Albian microfossil *Calcisphaerula* aff. *innominata* occuring in thin limestone intercalations.

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3. PIENINY KLIPPEN BELT FIELD TRIP

Introduction

(by K. Birkenmajer)

Position and Tectonics. The Pieniny Klippen Belt represent trace of a major axial suture zone in the Carpathian foldbelt, separating the Inner Carpathian from the Outer Carpathians domains (Fig. 12).

Along most of its length amounting to about 600 km, the Klippen Belt is bounded on the south and north by longitudinal strike-slip faults of Miocene age, best recognized in the Polish sector of the Belt.

The Pieniny Klippen Belt was a mega-shear zone of translation during early Neogene clockwise rotation of the Inner Carpathians, respective to the Outer Carpathians. The strike-slip transpressional movement caused megabrecciation and megaboudinage so characteristic of the Belt.

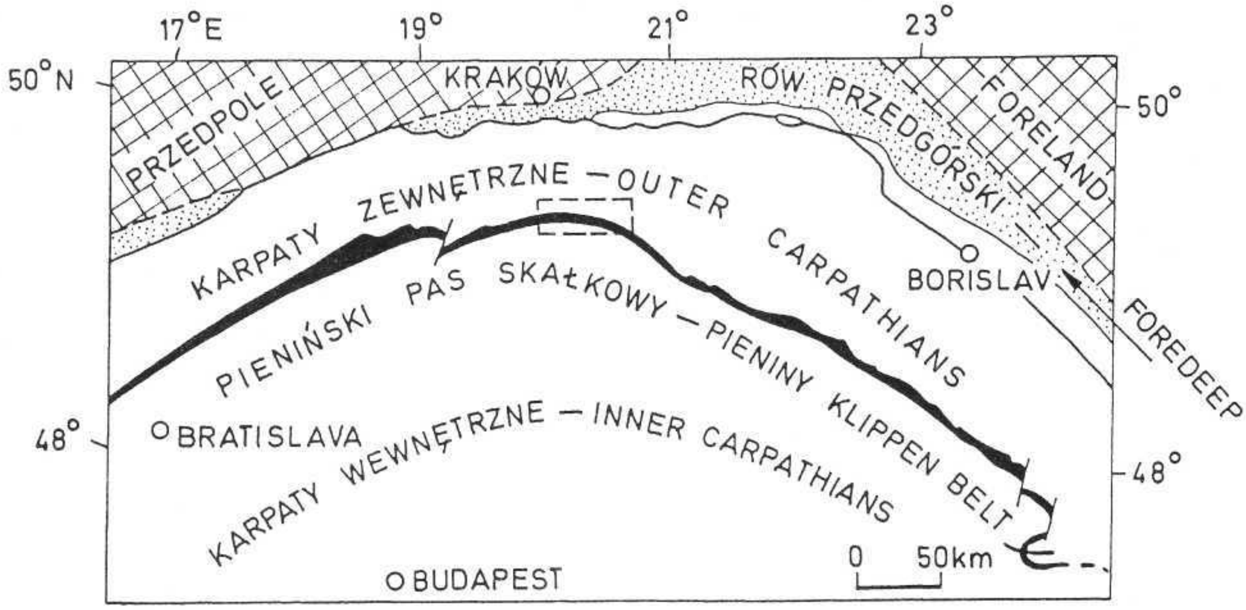


Fig. 12. Position of the Pieniny Klippen Belt (in black) in the Carpathians. Rectangle indicates Polish sector visited.

Neogene (Styrian and Savian) tectonic deformations were preceded by Late Cretaceous (Laramian and late Subhercynian) ones, during which thrust-nappes were formed.

Structure. The Pieniny Klippen Belt is a heterogenous structure, including several groups of tectonic units derived from: (1) the original Klippen Basin (Triassic - Late Cretaceous tectonic units and their Late Cretaceous and Palaeogene cover); (2) the Inner Carpathian domain (Triassic - mid-Cretaceous tectonic units and their Late Cretaceous and Palaeogene cover); (3) the Outer Carpathian Magura Basin (Jurassic - Late Cretaceous and Palaeogene).

Miocene andesite dykes and sills intruded Jurassic through Palaeogene rocks along the northern margin of the Pieniny Klippen Belt.

Klippen successions. The Klippen successions consist of Jurassic (occasionally also Triassic) through uppermost Cretaceous marine deposits. They were folded and thrust for the first time during the Late Cretaceous Subhercynian (late Subhercynian = Ressenian) and Laramian phases.

There was a continuous pelagic deposition at the Jurassic/Cretaceous transition in the deepest part of the Klippen Basin (Branisko, Pieniny and Haligovce successions). In the northern part of the basin, i. e. at the southern slope of the Czorsztyn Ridge (Niedzica, Czertezik and Czorsztyn successions), numerous breaks in deposition have been recognized related to the Neocimmerian phase of positive movements (Tabs. 1 and 2).

Reorganization of depositional pattern in the Klippen Belt during the Cretaceous was caused by subduction of its Triassic oceanic crust under the active Andrusov Cordillera. That eventually caused closing of the basin and formation of nappes during the Late Cretaceous through earliest Palaeogene.

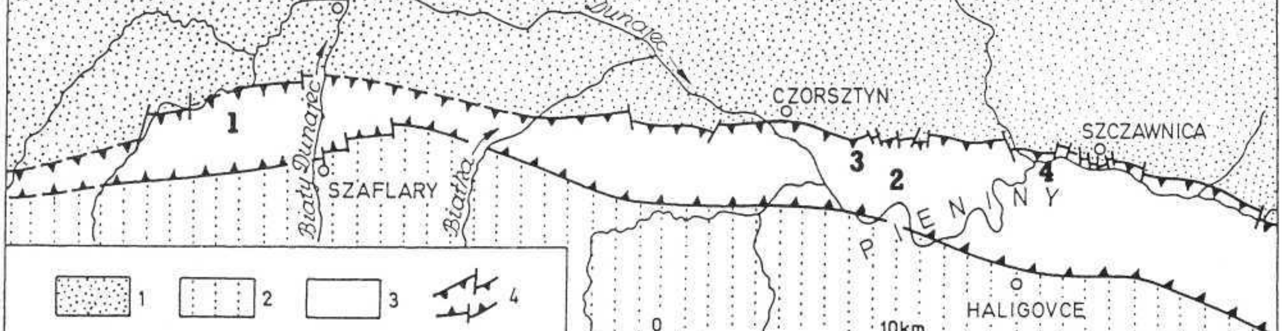
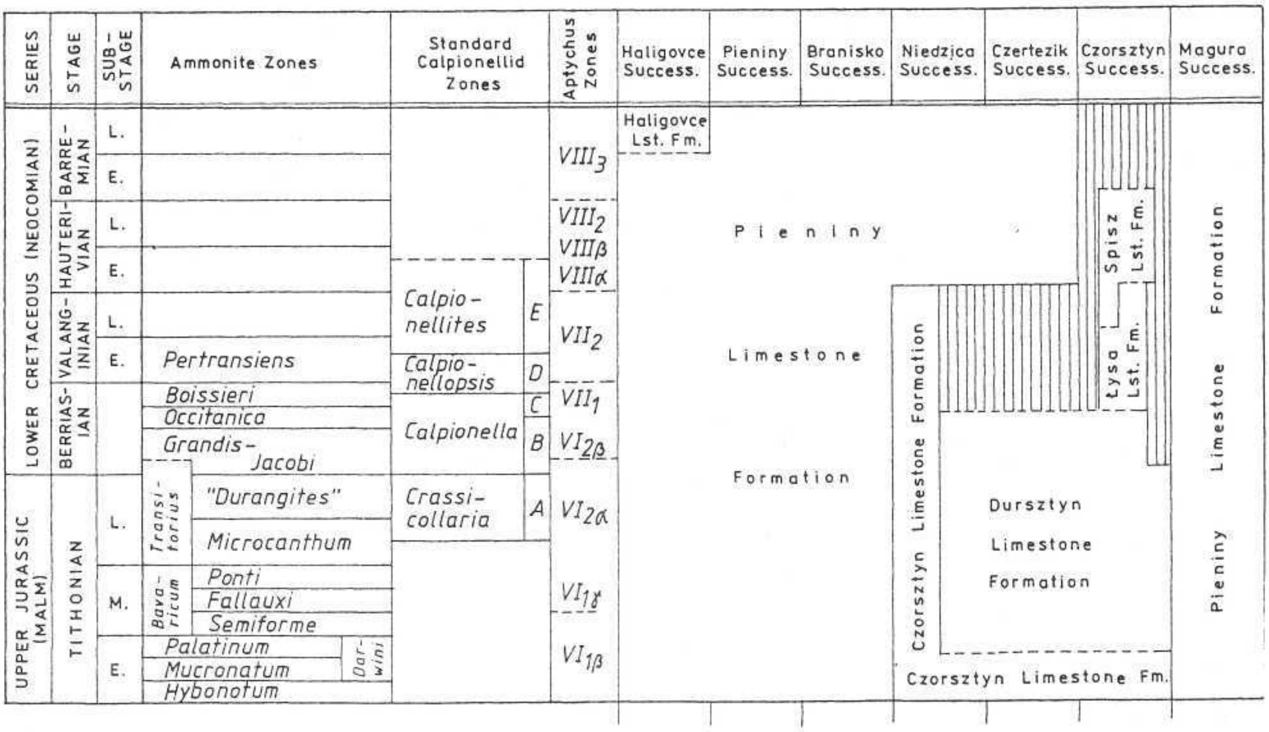
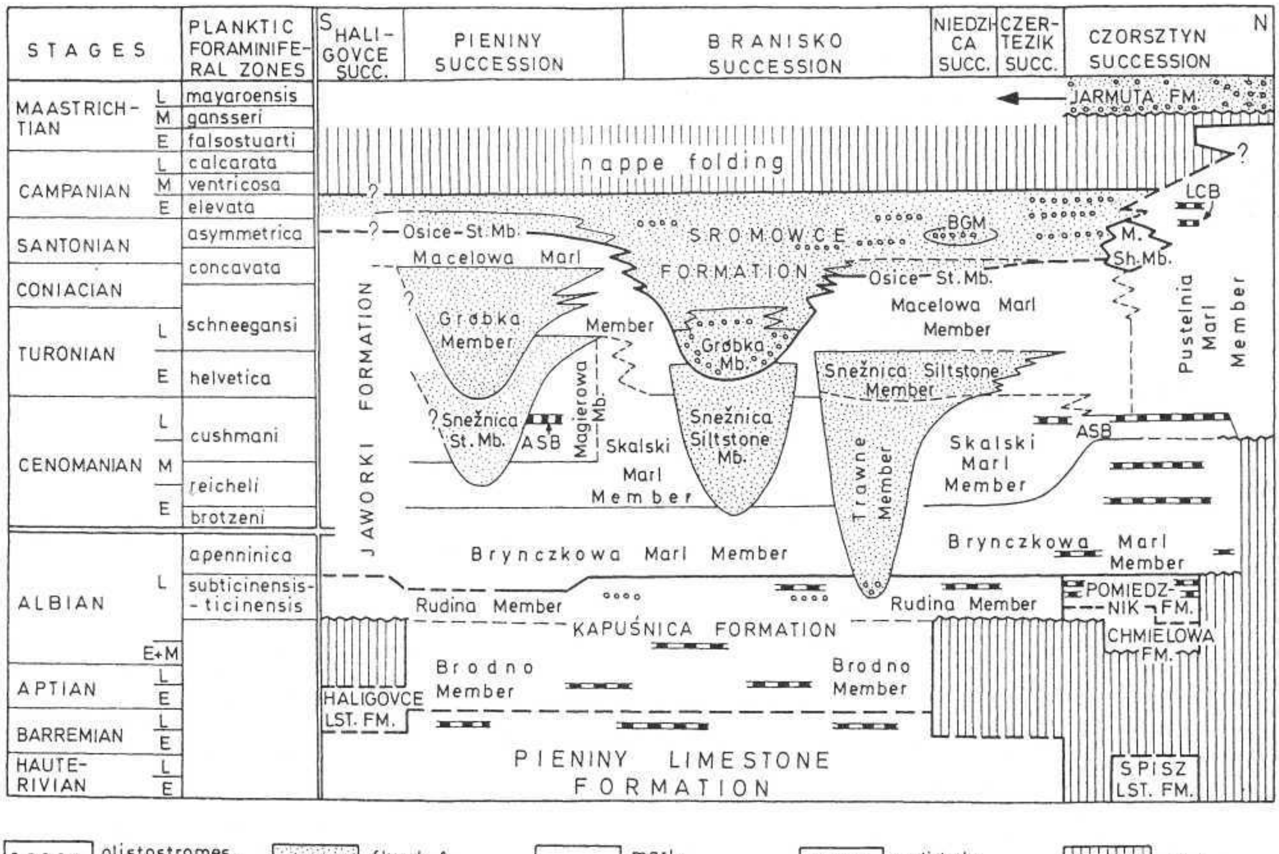


Fig. 13. Excursion stops (1 - 4, circled) in the Pieniny Klippen Belt of Poland. 1 - Magura Paleogene (Nappe); 2 - Podhale Paleogene (cover of Subtatzric nappes); 3 - Pieniny Klippen Belt; 4 - northern and southern tectonic contacts of the Pieniny Klippen Belt.



Tab. 1. Stratigraphy of the Pieniny Klippen Belt in Poland at the Jurassic/Cretaceous transition (Birkenmajer, 1977). Depositional breaks vertically ruled.



Tab. 2. Stratigraphy of the Cretaceous in the Pieniny Klippen Belt of Poland (Birkenmajer and Jednorowska, 1987). ASB - Altana Shale Bed; BGM - Bukowiny Gravelstone Member; LCB - Lorencowe Chert Member; M. Sh. Mb. - Malinowa Shale Member.

The deepest pelagic deposits consisting of dark (anoxic to dysoxic) shales/marls, often with radiolaria shales and cherts, were laid down during Barremian through Early-Middle Albian in the Branisko and Pieniny successions. Breaks in deposition continued in the northern (Czorsztyn through Niedzica successions) and the southern (Haligovce succession) margins of the basin up to Late Albian (Tab. 2).

Starting from the latest Albian, a pelagic Globotruncanid marl facies developed that prevailed over the contracting Klippen Basin through Early Santonian. Turbidite (flysch) deposition interrupted pelagic marl deposition in the deeper part of the basin since Cenomanian (occasionally Late Albian). The flysch deposits initially infilled only separated submarine channels. Later, during Santonian to Early Campanian, they totally replaced the marls in the deeper part of the basin. It was only in the northern marginal part of the basin (Czorsztyn Ridge) that marly pelagic deposition persisted until Early Maastrichtian (Tab. 2).

Klippen Mantle. The post-nappe cover of the Klippen Belt, consisting of Maastrichtian and Palaeogene conglomerates and flysch deposits is referred to as the Klippen Mantle. Its Cretaceous element in the Polish part of the Belt is represented by fresh-water and shallow-marine molasse, and by flysch (Jarmuta Formation).

Observation points: Stops 1 - 4 (Fig. 13). Four observation poits were selected for the excursion in the Polish part of the Pieniny Klippen Belt: (1) Rogoźnik (Tithonian - lowest Cretaceous fossiliferous limestones of the Czorsztyn Succession); (2) Macelowa Mount and vicinity, at Sromowce (Tithonian - Campanian section, Pieniny Succession); (3) Flaki ridge, between Sromowce and Krośnica (Jurassic and Cretaceous, Branisko Succession); (4) Orlica near Szczawnica (Jurassic - Cretaceous section, Pieniny Succession).

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STOP 1

ROGOŹNIK

A. Rogoża klippes

(by A. Wierzbowski)

The Rogoża klippes near Rogoźnik Village in the Pieniny Klippen Belt are well known due to the wealth of ammonites occurring in the ammonite coquinas ("Ammonitenbreccie", "Rogozniker Breccie", Rogoźnik Coquina Member - see Birkenmajer, 1977, and earlier papers cited therein). A good section of these deposits can be seen in small klippes protected as a nature reserve and included into list of World Heritage of Geology. The klippes are disjointed into the north-western (smaller) klippe and the south-eastern (larger) klippe by a small gorge where the beds are obscured by debris. The detailed biostratigraphical survey of this section was given rather recently, and subsequently

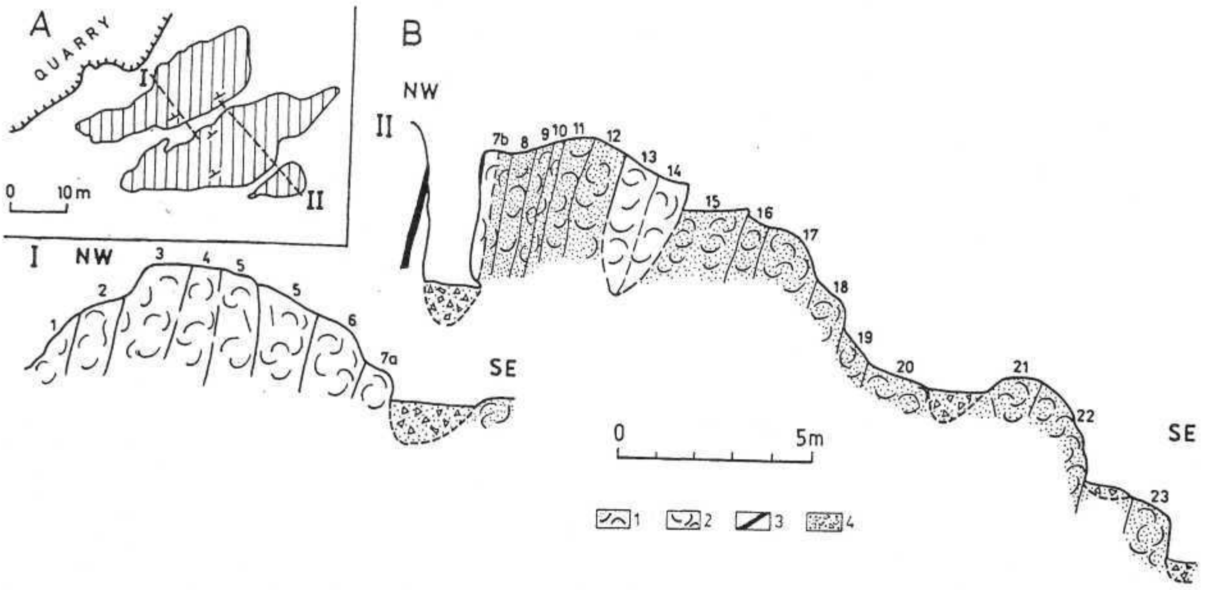
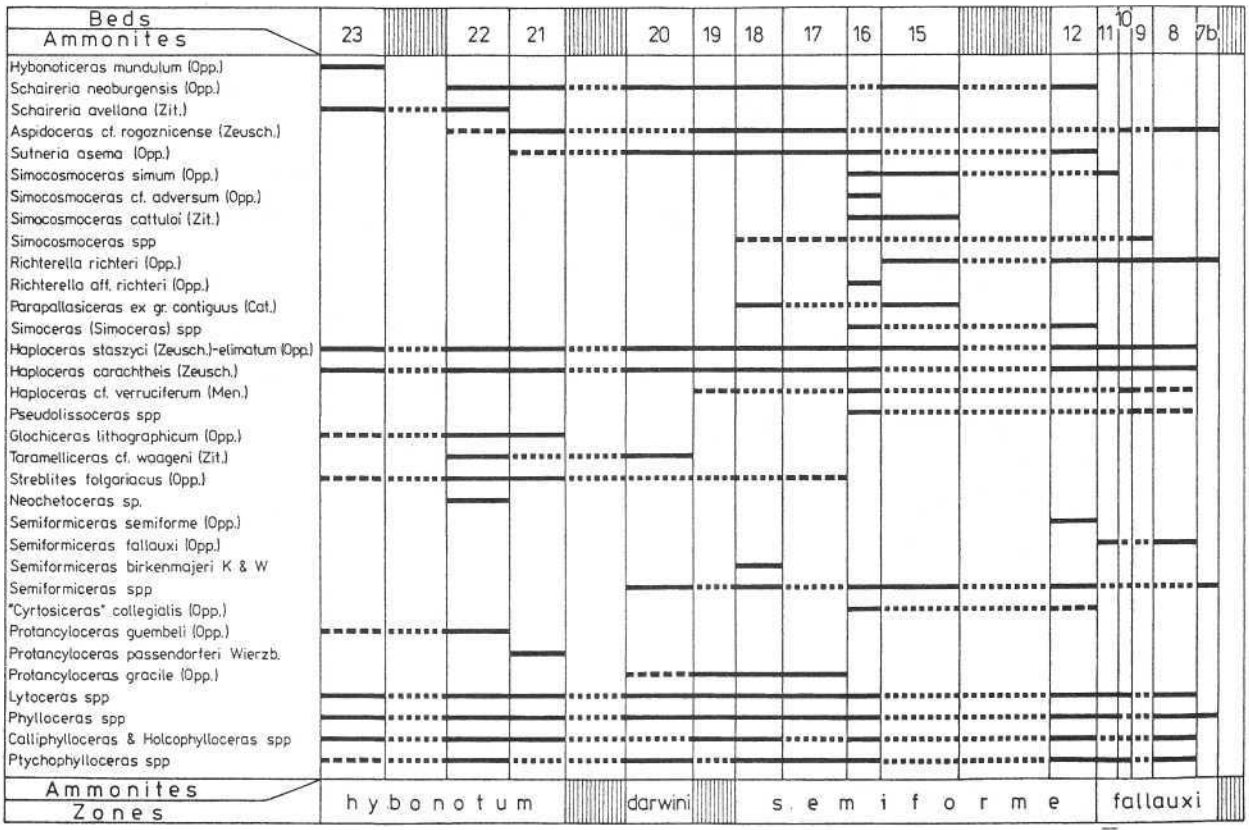
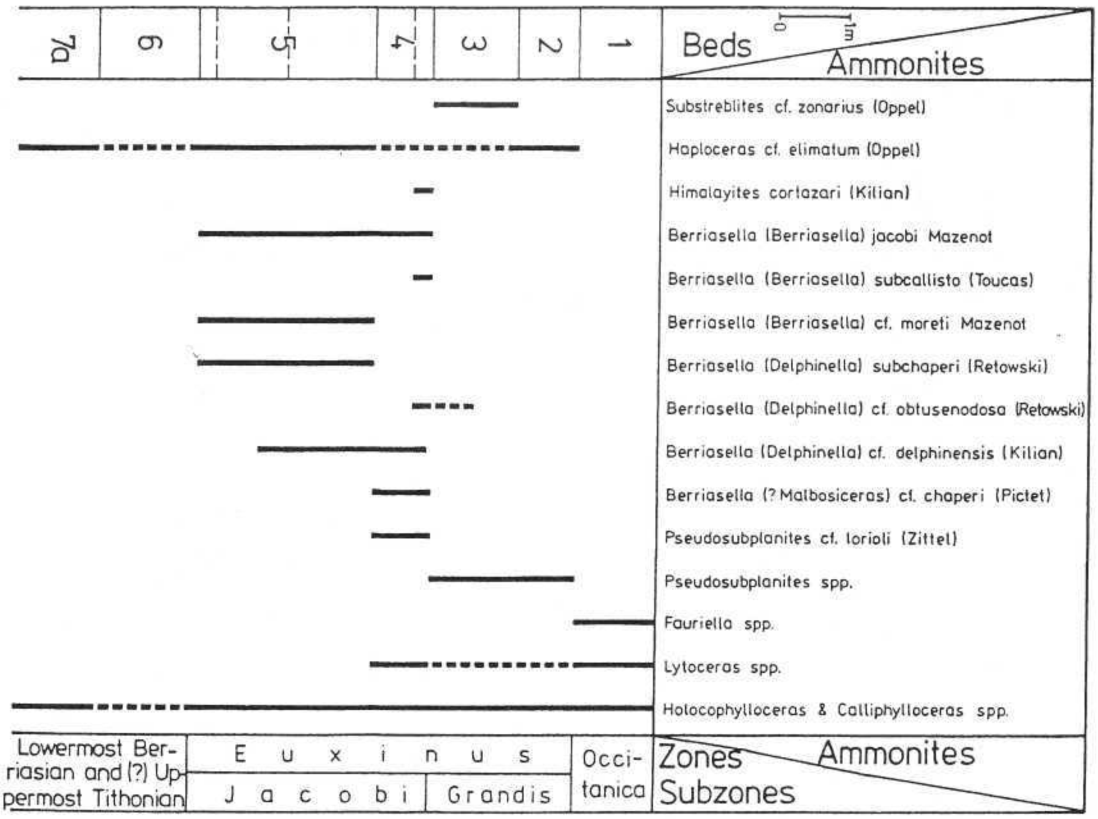


Fig. 14. Cross-section through the Rogoża Klippes (after Kutek and Wierzbowski, 1986): A - sketch map of the klippes showing the lines of the section, B - cross-section through the klippes, 1 - sparry coquinas (Lower - Middle Tithonian), 2 - micritic coquinas, also micritic limestones in neptunian dykes (uppermost Tithonian - Middle Berriasian), 3 - crinoidal limestones in neptunian dyke (?Valanginian), 4 - rubble.



Tab. 3. Stratigraphical distribution of ammonites in sparry coquinas (Lower-Middle Tithonian) representing a lower part of the section at Rogoża (after Cecca et al., 1994).



Tab. 4. Stratigraphical distribution of ammonites in micritic coquinas (Lower-Middle Berriasian) representing an upper part of the section at Rogoża klippes (after Wierzbowski and Remane, 1992).

supplemented during the last decade (se Kutek and Wierzbowski, 1986; Wierzbowski, 1990; Wierzbowski and Remane, 1992; Cecca, Főzy and Wierzbowski, 1990, 1994). It should be remembered, that although the ammonites coming from the Rogoza klippes became famous due to older paleontological papers where several new taxa were established (see e. g. Zittel, 1870), the proper sequence of the ammonite faunas in the section has been unknown until the recent stratigraphical studies (see Fig. 14 and Tabs. 3 and 4).

The oldest deposits in the section are sparry coquinas consisting of densely packed ammonite shells, as well as other fossil remains, such as aptychi, crinoid debris, brachiopods and others. The original micritic matrix has been preserved in places only, whereas it was replaced mainly in the bulk of rock by secondary sparry calcite, white to pinkish, and sometimes even red in colour. Such a litological development, corresponding to the most typical "Ammonitenbreccie", show the beds nos 23 - 15 and 12 - 7b occuring in the southeastern klippe (Fig. 14). These deposits yield the ammonites (Tab. 3) indicative of the Hybonotum and Darwini Zones, as well as the Semiforme and Fallauxi Zones of the Early and Middle Tithonian (in threefold subdivision of this stage), or of the Early Tithonian (in its twofold subdivision).

Still younger are beds nos 13 - 14, and the topmost part of bed 7b in the south-eastern klippe developed as micritic limestones with few macrofossils, but containing calpionellids. The calpionellid indicate the Crassicolaria Zone and the Calpionella Zone, i. e. the lates Tithonian, and the earliest Berriasian. The beds nos 13 - 14 represent the infilling of the stratiform neptunian dyke which has formed at the turn of the Tithonian and Berriasian (Kutek and Wierzbowski, 1986).

The youngest deposits in the section (beds nos 7a-1) occur in the north-western klippe. They are developed as white to cream-coloured micritic ammonite coquinas. The rock is hard and although it contains many ammonites, they are difficult to extract from the micritic matrix. The calpionellids are very common; they indicate the earliest part of the Berriasian in the bed 7a. The ammonites from beds nos 5 - 2 are typical of the Early Berriasian - the Euxinus Zone (Tab. 4); a sharp decline of *Berriasella* (*Delphinella*) at the top of bed no. 4 indicates moreover the transition from the Jacobi Subzone to the Grandis Subzone. Appearance of *Fauriella* and lack of *Subplanites* in bed no. 1 are typical already of the Occitanica Zone of the Middle Berriasian (Wierzbowski and Remane, 1992).

Crinoidal limestones of the neptunian dyke cutting through the discussed Berriasian deposits in the northwestern klippe belong to the Lysa Limestone Formation (Birkenmajer, 1977), and are possibly of Valanginian age.

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B. Brachiopod faunas

(by Michal Krobicki)

Detailed, bed by bed sampling of brachiopods was made in the outcrop discussed (Fig. 15) shows the stratigraphic distribution of this fauna (Barczyk, 1991; Krobicki, 1994). All species from the Jurassic-Cretaceous transition occur in both the Tithonian and Berriasian deposits. A very great difference between Lower-Middle Tithonian (beds 23-7b) and Upper Tithonian-Berriasian (beds 7a-1) brachiopod pie charts (Fig. 16) indicates that palaeoecological factors stimulated differentiation of the brachiopod assemblages. The main diagnostic features are: the presence of rhynchonellids of the genus *Lacunosella*, of dallinid *Dictyothyropsis tatrica*, and trend of quantitative changes in the occurrence of pygopids (*Pygope* and *Nucleata*).

The species *Lacunosella heheneggeri* (Suess) is abundant in the Lower Cretaceous of the Šramberk-type limestones (reef-like carbonate deposits), known as secondary deposits (olistholites and pebbles) within flysch strata of the Outer Carpathians (Książkiewicz, 1974; Nekvasilová, 1977). An abundance of the genus *Lacunosella* suggests shallower marine environments. On the contrary, pygopids (genera *Pygope* and *Nucleata*) usually preferred deeper marine environments (Ager, 1965; Dieni and Middlemiss, 1981); their abundance is indicative of such environments.

High percentage of both rhynchonellid (*Lacunosella*) and dallinid (*Dictyothyropsis*) brachiopods in the younger strata (7a-1) suggests apparently shallower deposition environment of these rocks in comparison with the older part of the sequence (23-7b). More detailed studies proved a gradual transition from pygopid-dominated assemblages through those with the first appearance of the genera *Lacunosella* and *Dictyothyropsis*, up to the *Lacunosella*-dominated ones. In the latter assemblage, the pygopids are subordinate components. Such change in brachiopod fauna corresponds to the upward-shallowing sequence.

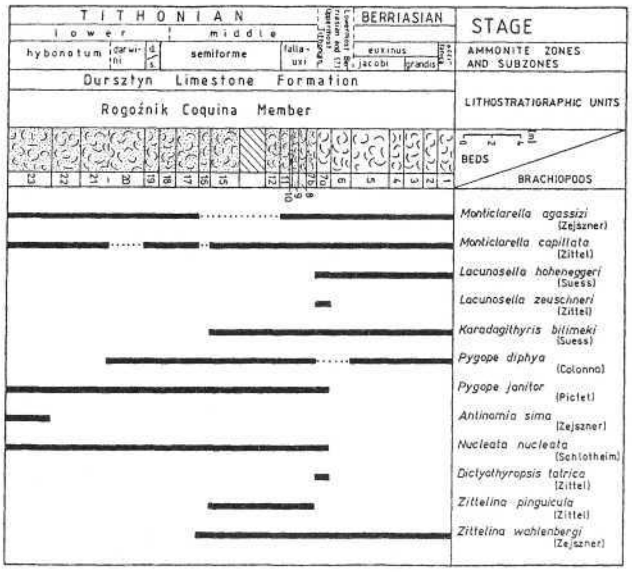

Fig. 15. Stratigraphic distribution of brachiopods in the Rogoża Klippes at Rogoźnik; Czorsztyn Succession (after Barczyk, 1991; modified and supplemented by Krobicki, 1994). Lithostratigraphic units after Birkenmajer (1977); stratigraphy and numbering of beds after Cecca et al. (1994) and Wierzbowski and Remane (1992). For lithological symbols - see Fig. 3.

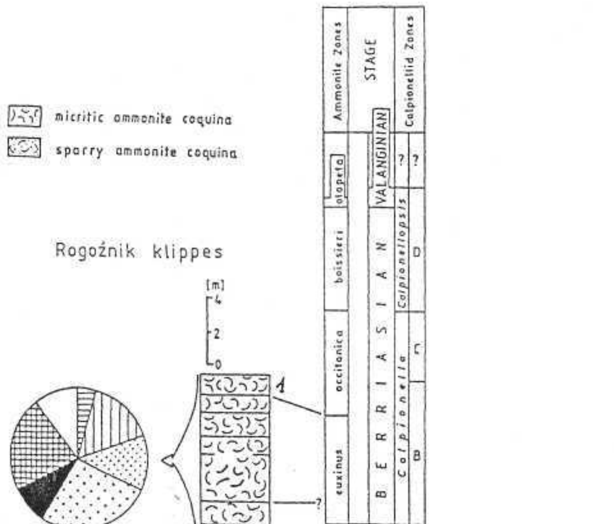

Fig. 16. Trends of change in brachiopod assemblages during Tithonian and Berriasian; Rogoża Klippes at Rogoźnik; Cyorsytzn Succession (after Krobicki, 1996).

These differences reflected environmental changes with time, caused by intensive Neocimmerian tectonic movements within the Pieniny Klippen Belt during the latest Jurassic to earliest Cretaceous (comp. Krobicki, 1994, 1996).

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STOP 2

MACELOWA MOUNT NEAR SROMOWCE

(by Krzysztof Bąk)

Outcrops located on the left side of the Dunajec River present tectonically overturned scales of the Cretaceous rocks of the Pieniny Succession (Fig. 17).

The peaks of the Biala Skala-Żlobiny and Macelowa Góra are built of green radiolarites (Podmajerz Radiolarite Member) and white, light-green limestones (Pieniny Limestone Formation; Birkenmajer, 1977; Fig. 18). The lower boundary of the Pieniny Limestone Formation has been determined by Oberjamer (1986) as the malmica Zone (Early Tithonian). The highest part of this formation is represented by grey siliceous limestones with Stomiosphaera wanneri Borza and Hedbergella sp.

Lower part of the slopes are built of folded members of the Jaworki Formation in tectonically overturned position (Fig. 17). This profile was proposed by Birkenmajer (1977) as the stratotype of the Macelowa Marl Member of cherry-red marls and marly limestones with intercalations of thin-bedded, greenish and bluish calcareous mudstones and sandstones. These facies occur in many profiles in the Carpathians, ("Kysuca beds" in the Slovak part of the Pieniny Klippen Belt) and in the Alps and Apennines ("couches rouges" and "scaglia rosa").

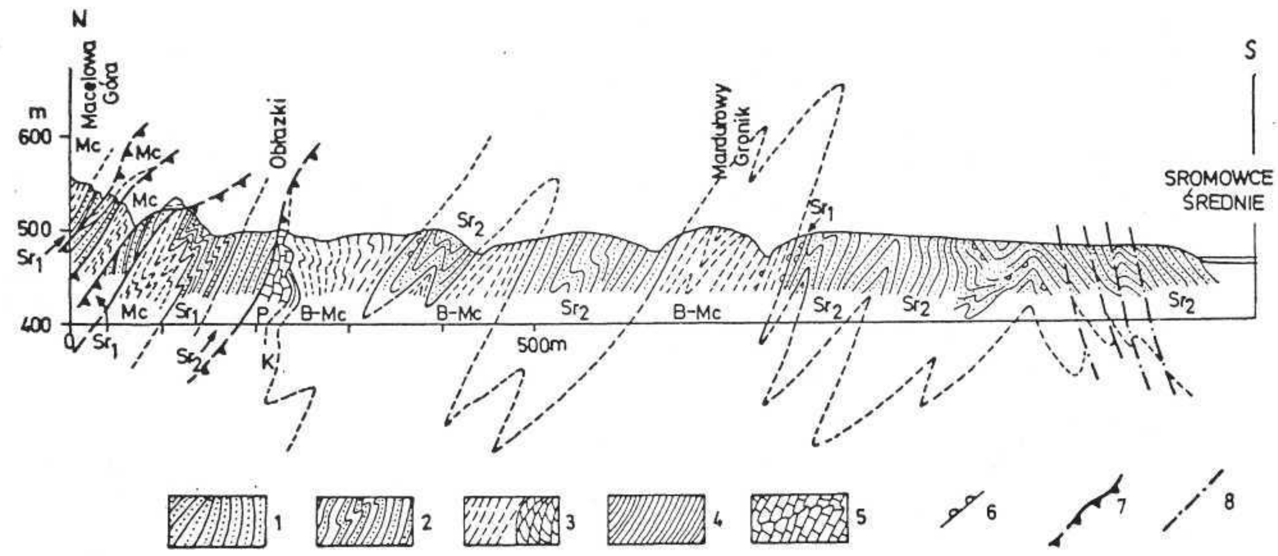

Fig. 17. Geological cross-section of the Pieniny Succession at Marcelowa Góra Mt. - Sromowce Średnie (Birkenmajer and Jednorowka, 1983). P - Pieniny Limestone Formation; K - Kapuśnica Formation; B-Mc - Jaworki Formation (Mc - Macelowa Marl Member); Sromowce Formation (Sr1 - Osice Siltstone Member, Sr2 - flysch); 1 - sandstones and shales; 2 - siltstones and shales; 3 - marls, marly limestones, subordinately sandstone intercalation; 4 - shales and marls; 5 - cherty limestone; 6 - position of sole markings; 7 - overthrusts; 8 - faults.

About 30 m to the west of the mentioned member, tectonically overturned strata of the Snežnica Siltstone Member occur. Lower boundary of the latter member is a gradual transition to variegated marls of the Skalski Marl Member. Dark-green and black marly shales, 1 m thick occur at this transition (Fig. 19).

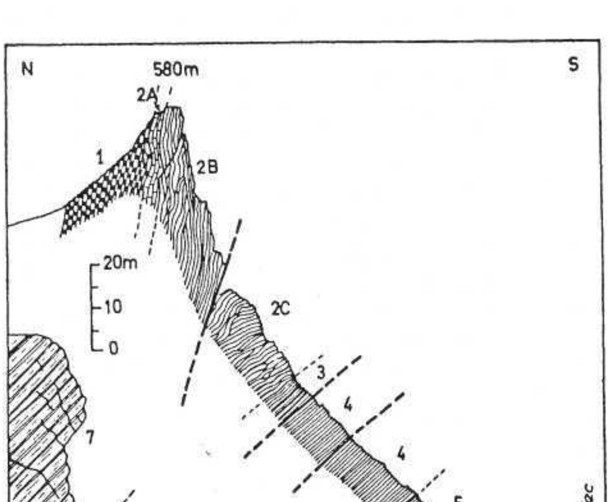

Fig. 18. A, B . Geological cross-section of the Pieniny Succession at Biala Skala Mt. (Birkenmajer, 1979). 1 - Podmajerz Radiolarite Member, 2 - Pieniny Klimestone Formation (A - lower, B - middle, C - upper), 3 - Kapuśnica Formation, 4 - Brynckowa Marl Member, 5 - Skalski Marl Member, 6 - Snežnica Siltstone Member (s - sideritic limestone), 7, 7a - Macelowa Marl Member.

The Macelowa Marl Member is represented by two different lithologies in the stratotype profile. A zone at the base of the Member (samples: Mac-28 - Mac-1) consists of marls and marly limestones with very thin-bedded rare intercalations of mudstones. In a higher part of the Member, the frequency and thickness of the turbidite mudstones and sandstones increase. Moreover, there occurs an about 10-20-cm thick complex of marls, sandstones and mudstones with slump structures, fragments of organogenic limestone (with *Placunopsis*; Krobicki, 1992), and frequent *Subphyllochorda traces* (Bąk, 1995a). It may represent deposits of a dense gravitational flow.

Microfauna in the studied Member is abundant, dominated by agglutinated benthos (Tab. 5). The most frequent are forms belonging to *Haplophragmoides* cf. *bulloides*, *H. kirki*, *Bulbobaculites problematicus*, *Recurvoides* spp., *Gerochammina conversa*, *Karrerulina coniformis* and *Uvigerinammina jankoi*. Plankton occurs only in single samples. It is represented mainly by the genus *Marginotruncana*. *Dicarinellids*, diagnostic for age, have been found only in a few samples, documenting the D*icarinella concavata* and *D. asymmetrica* zones (Figs. 20 and 21). Occurrence in many samples of the *Stensioeina exculpta*, known in the Carpathians from the Coniacian-early Campanian, confirms this stratigraphic position of the Macelowa Marl Member. Lack of deposits, representing the *Marginotruncana sigali* and *Dicarinella primitiva* zones in this section is the result of tectonic reduction. Alexandrowicz's data (1966; samples taken from other slices) confirmed the presence of these biostratigraphical zones in the discussed section.

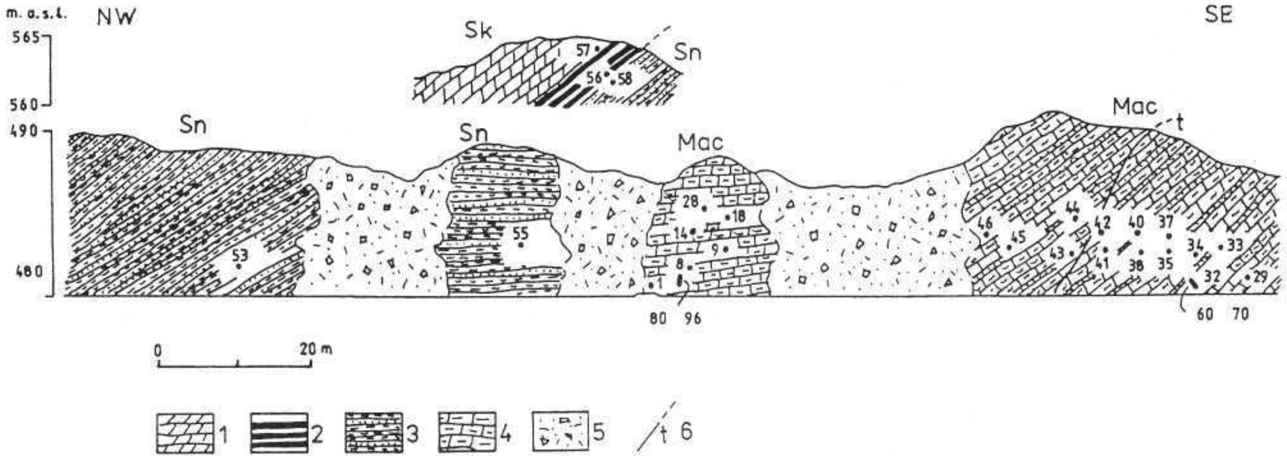

Fig. 19. Geological cross-section of the Pieniny Succession at the Macelowa Góra Mt above the Dunajec river (Bąk, 1995b). Skalski Marl Member (Sk), 1 - variegated marl, 2 - grey-green and black marly shales, 3 - Snežnica Siltstone Member (Sn), 4 - Macelowa Marl Member (Mac), 5 - weathered material, t - larger faults.

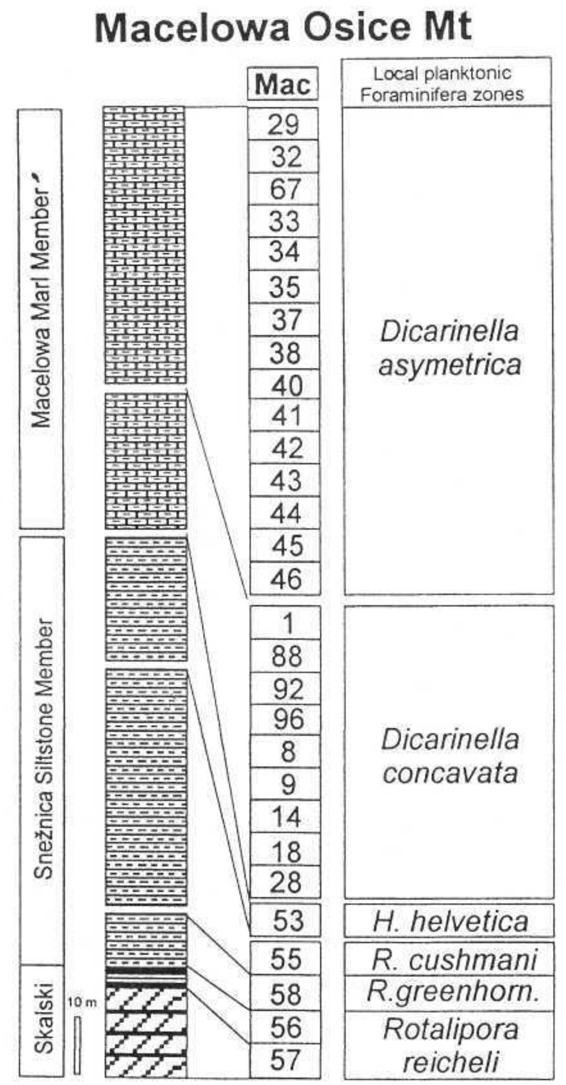

Fig. 20. Lithostratigraphical column of the Skalski Marl, Snežnica Siltstone and Macelowa Marl members (Jaworki Formation) at the Macelowa Góra Mt above the Dunajec River (Bąk, 1995b).

Planktonic foraminifera determined from the Snežnica Siltstone Member (samples: Mac-58 - Mac-53) indicate its age as the *Rotalipora greenhornensis* to *Helvetoglobotruncana helvetica* zones (Fig. 20).

A complex of dark-green and black marls (Mac-56; Figs. 19 and 20) with abundant planktonic foraminifera represents the Rotalipora reicheli Zone. Similar deposits of the same age have been recognized by the present author from the Niedzica Succession (Bąk, 1995b).

Palaeoecological analysis of the Macelowa Marl Member has been carried out in the stratotype profile, by comparing its fragments of profile (Fig. 21), which represent two different facies (Bąk, 1995b): marls-limestones (column A) and marls-turbidites (column B) (Fig. 22). Rate of accumulation of these deposits varied from 6 to 23 mm/1000 years. Populations of benthos were living in extremely oligotrophic conditions. Stratigraphically lower part of the Member represents deep-water pelagic sediments. Its upper part is characterised by high frequency of turbidites. Many marly beds consist of siliciclastic material and contain redeposited microfauna. The depth of deposition corresponded to lower bathyal, near foraminiferal lisocline.

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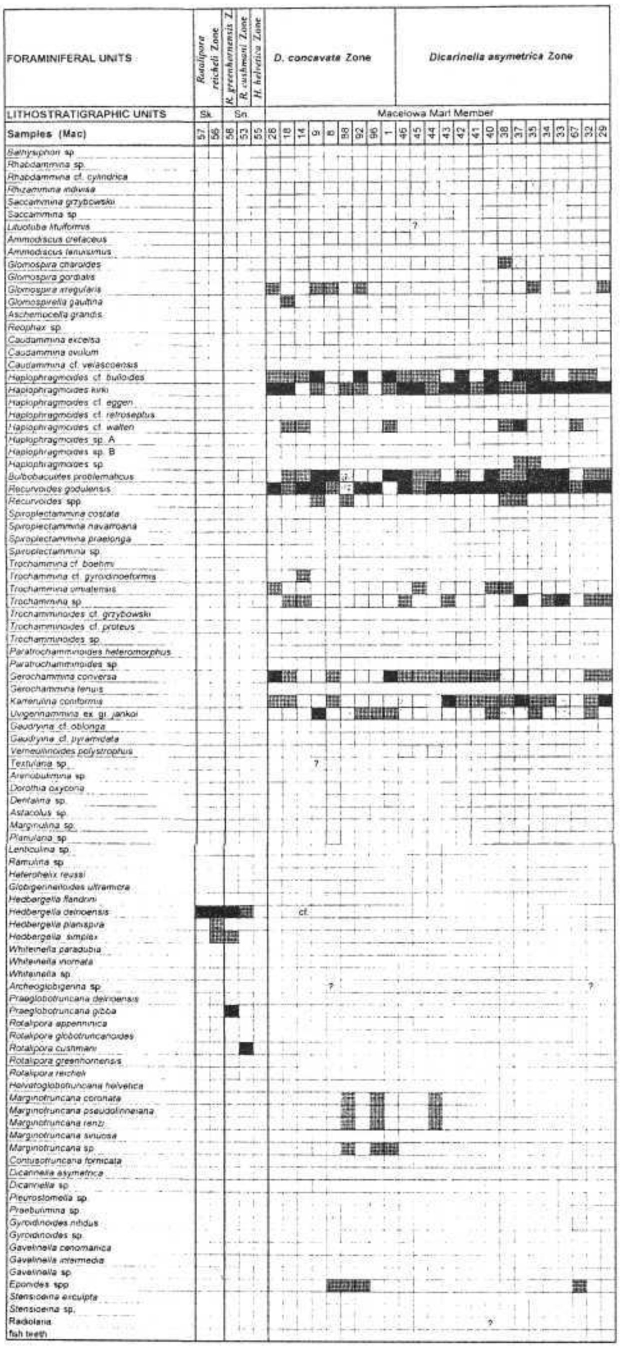

Tab. 5. Foraminiferal microfauna in the Skalski Marl, Snežnica Siltstone and Macelowa Marl members (Jaworki Formation) at the Macelowa Góra Mt above the Dunajec river (Bąk, 1995b). Sk - Skalski Marl Member; Sn - Snežnica Siltstone Member.

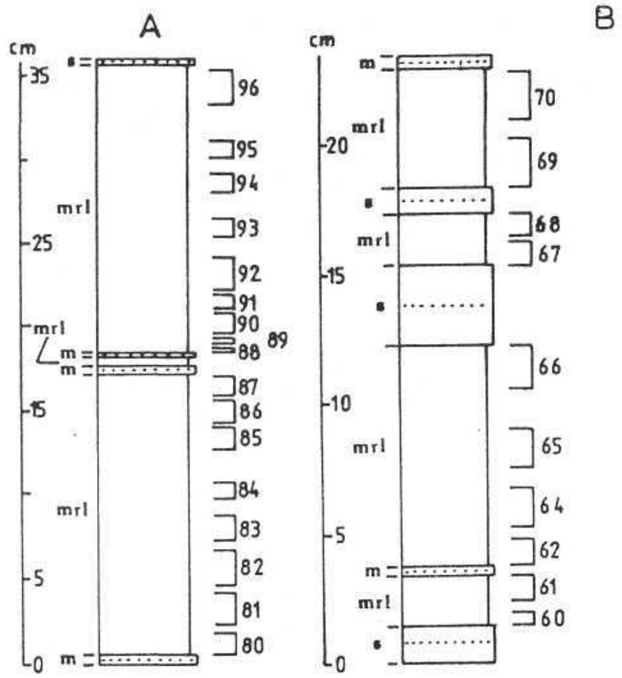

Fig. 21. Lithological column of the Macelowa Marl Member in the stratotype area, selected for detailed micropaleontological analysis; column A (36 cm) - marls and marly limestones, column B (24 cm) - marls and siliciclastic turbidites, mrl - marl, s - sandstone, m - mudstone.

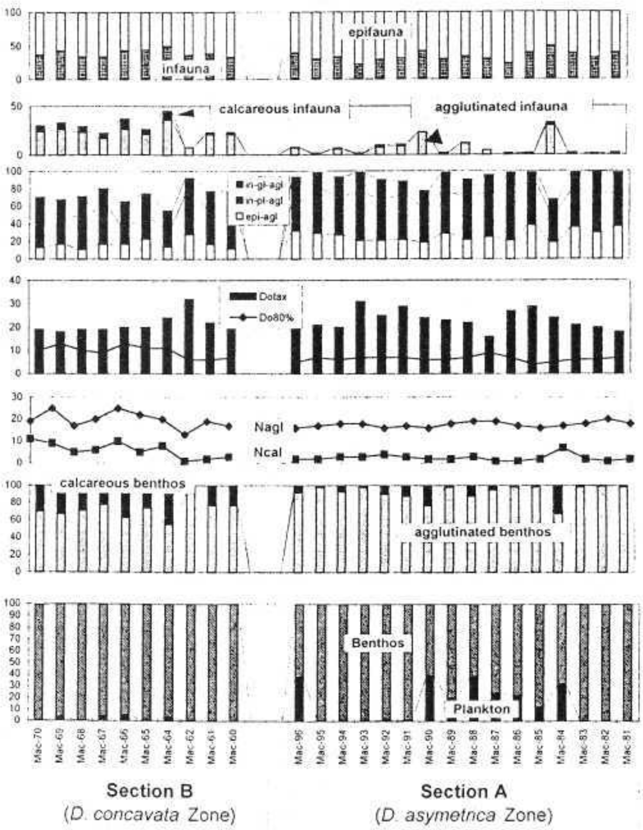

Fig. 22. Features of foraminiferal assemblages in the column A and B (Bąk, 1995b). Nagl - number of agglutinated taxa, Ncal - number of calcareous taxa, Do80 % - number of benthonic taxa composing 80 % of the whole assemblage, Dotax - content (%) of dominated benthonic taxon, epi-agl - agglutinated epifauna, in-pl-agl - shalow agglutinated infauna, in - gl-agl - deep agglutinated infauna. ▶

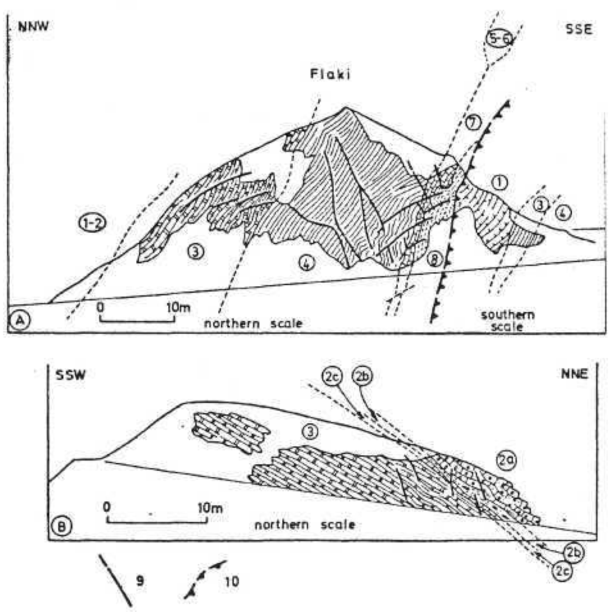

Fig. 23. Exposures in the Branisko Nappe at Flaki, eastern (A) and western (B) sides of the road (Birkenmajer, 1985). 1 - Podzamcze Limestone Fm., 2 - Flaki Limestone Fm. (a - grey cirinoid limestones with cherts in upper part, b - shales and marls with chamosite concretions, c - green limestone), 3 - Sokolica Radiolarite Fm., 4 - Podmajerz Radiolarite Mbr (Czajakowa Radiolarite Fm.), 5 - 6 - Buwald Radiolarite Mbr (Czajakowa Radiolarite Fm.) and Czorsztyn Limestone Fm. (Upszar Limestone Mbr.) tectonically squeezed out in the section, but present higher upslope, 7 - Pieniny Limestone Fm., 8 - Kapuśnica Fm., 9 - faults, 10 - overthrusts.

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STOP 3

FLAKI RIDGE

(by Krzysztof Birkenmajer)

On the way back from Sromowce to Krośnica, we again cross the Pieniny Mountains (Flaki Ridge). The main range is formed of almost parallel ridges of competent rocks belonging to the Branisko Nappe (Pieniny Limestone and Czajakowa Radiolarite formations) forming tightly folded synclines with limbs of strongly tectonically reduced Middle Jurassic limestones and shales. Between the ridges, in gullies and at passes,

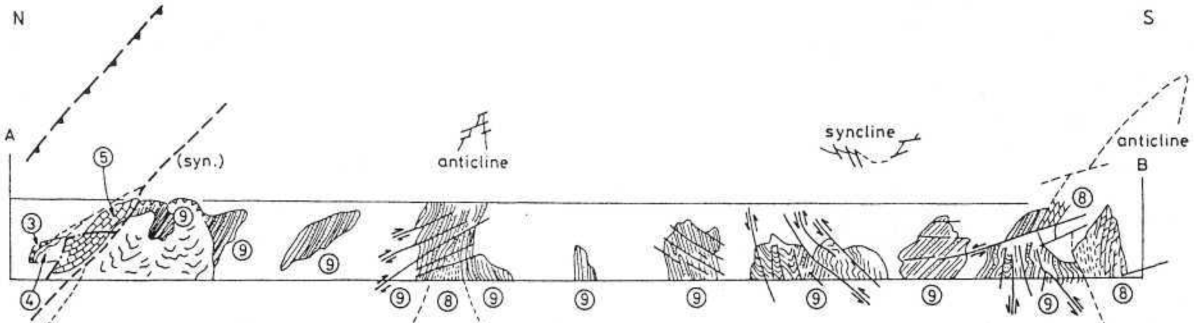

Fig. 24. Geological cross-section of the Pieniny Succession; outler of the Dunajec River Gorge at Szczawnica, along the Pieniny road, after Birkenmajer (1985). 1 - Podzamcze Limestone Formation, 2 - Flaki Limestone Formation, 3 - Czajakowa Radiolarite Formation (Podmajerz Radiolarite Member), 4 - Czorsztyn Limestone Formation, 5 - Pieniny Limestone Formation, 6 - 7 - Kapuśnica Formation (6 - Brodno member, 7 - Rudina Member), 8 - 9 - Jaworki Marl Formation (8 - Brynczkowa Marl and Skalski Marl members, 9 - Snežnica Siltstone Member, 10 - Macelowa Marl Member, 11 - overthrusts, 12 - second order tectonic contacts, 13 - third order tectonic contacts.

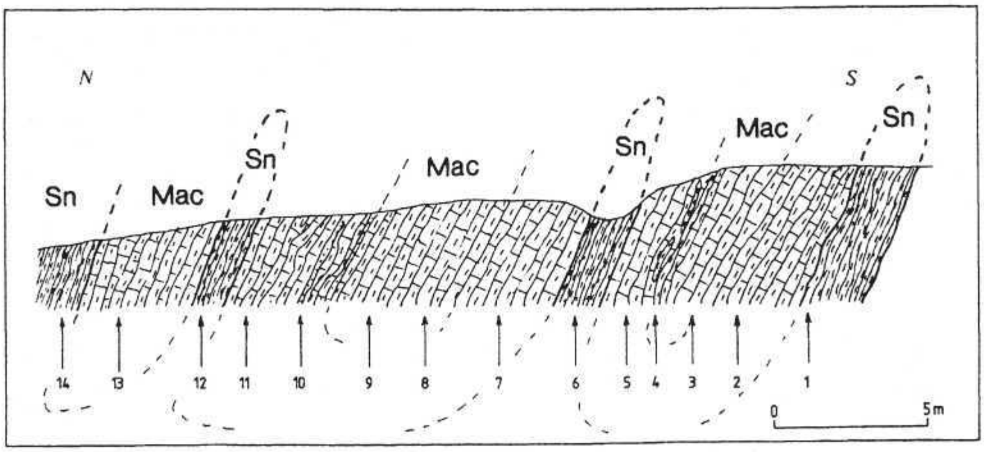

Fig. 25. Fig.Lithostratigraphic profile of Upper Cretaceous deposits under Orlica Hill (Bąk, 1995b).

FORAMINIFERAL ZONE	*Uvigerinammina jankoi* Zone													
LITHOSTRATIGRAPHIC UNITS	Sn. St. Mb.				Macelowa Marl Member									
SAMPLES (Or)	1	6	12	14	5	2	7	11	4	3	8	9	10	13
Bathysiphon sp.	■			▒										
Nothia maxima														
Rhabdammina sp.		■	■		■	■	■		■	▒	▒		▒	■
Rhizammina indivisa														
Rhizammina sp.			■		▒	■		■	▒	▒	■	■	■	■
Saccammina cf. *placenta*														
Ammodiscus cretaceus	■	▒	■		▒					▒	▒	▒	▒	
Glomospira charoides		■	■											
Glomospira gordialis														
Glomospira irregularis					■				▒					
Glomospirella gaultina								▒	▒					
Aschemocella grandis														
Caudammina excelsa														
Caudammina ovulum														
Haplophragmoides cf. *bulloides*					■	▒		▒	■	■	▒		■	
Haplophragmoides eggeri														
Haplophragmoides kirki	▒					▒		■		▒	■	■		▒
Haplophragmoides cf. *walteri*	▒								■	▒	■		■	
Haplophragmoides sp.			▒											
Bulbobaculites problematicus		▒			▒			▒	▒			■	▒	▒
Recurvoides godulensis			▒		■	▒		■	■	▒	■	■	■	
Recurvoides primus														
Recurvoides spp.					▒			▒			▒	▒		
Spiroplectammina costata														
Spiroplectammina navarroana		■			■	■	▒		■	■	■	■	■	
Spiroplectammina praelonga						▒								
Trochammina umiatensis					▒					▒		▒	▒	
Trochammina sp.			▒											
Karrerulina coniformis								▒				▒		
Gerochammina conversa		▒						■			▒	■		
Uvigerinammina ex. gr. *jankoi*														
Gaudryina pyramidata						■	▒							
Verneuilinoides polystrophus														
Tritaxia subparisiensis														
Dorothia oxycona														
Dentalina sp.														
Globigerinelloides ultramicra														
Hedbergella delrioensis														
Whiteinella sp.														
Rotalipora cushmani	?r													
Marginotruncana sp.														
Dicarinella sp.														
Praebulimina sp.														
Gyroidinoides nitidus														
Eponides spp.														
Stensioeina exculpta						cf.								
Radiolaria														
fish teeth														

Tab. 6. Foraminiferal microfauna in the Snežnica Siltstone and Macelowa Marl members (Jaworki Formation) at Szczawnica Nižna (under Orlica hill). After Bąk (1995b).

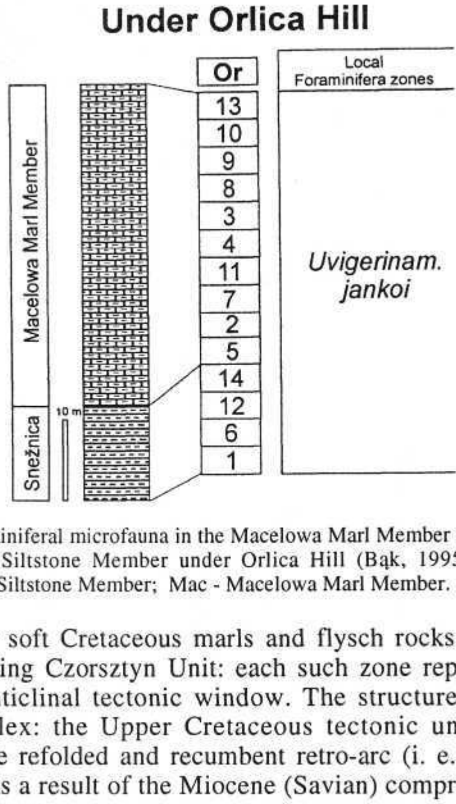

Fig. 26. Foraminiferal microfauna in the Macelowa Marl Member and the Snežnica Siltstone Member under Orlica Hill (Bąk, 1995b). Sn - Snežnica Siltstone Member; Mac - Macelowa Marl Member.

there occur soft Cretaceous marls and flysch rocks of the underlying Czorsztyn Unit: each such zone represents an anticlinal tectonic window. The structure is very complex: the Upper Cretaceous tectonic units (nappes) are refolded and recumbent retro-arc (i. e. to the south) as a result of the Miocene (Savian) compression/transpression.

At Flaki, we see a retro-arc recumbent, partly strongly tectonically reduced, scales of the Branisko Nappe: a good exposure of the Callovian-Oxfordian radiolarites (Sokolica Radiolarite and Czajakowa Radiolarite formations), and their immediate stratigraphic substratum formed of chamosite-bearing marls and crinoid-cherty limestone (Flaki Limestone Formation) - Fig. 23A, B.

STOP 4

SZCZAWNICA NIŻNA (UNDER ORLICA HILL)

(by Krzysztof Bąk)

Strongly folded strata of the Macelowa Marl and the Snežnica Siltstone members belonging to the Pieniny Succession are exposed in the western slope of the Orlica Hill, above a road leading to the tourist hut "Orlica" (Figs. 24 and 25). The thickness of the Macelowa Marl Member is here about 30 m. Its cherry-red marls are strongly cemented. Horizontal and wavy lamination are frequent sedimentary structures. Many beds are bioturbated, and bioturbation structures are filled by coarser material from covering layers of mudstones and sandstones. Content of $CaCO_3$ in the marls ranges from 32 to 52 %.

The age of the Macelowa Marl Member was established approximately. Planktonic foraminifera are practically absent. Only single specimens of *Hedbergella delrioensis* and poorly-preserved *Marginotruncana* sp. and *Dicarinella* sp. have been determined. Abundant and well diversified agglutinated benthos, and the presence of one specimen of *Stensioeina exculpta* constrain the position of these deposits as the *Uvigerinammina jankoi* Zone, corresponding to the uppermost part of the *Praeglobotruncana delrioensis* Zone up to the *Dicarinella asymetrica* zones (Bąk, 1995) - Fig. 26, Tab. 6.

The Snežnica Siltstone Member which consists of dark-grey marly shales alternating with thin-bedded (0.5 - 1 cm) mudstones, probably represents the same *Uvigerinammina jankoi* Zone. In sample Or-1, a single specimen of *Rotalipora cushmani* has been found (probably redeposited). Agglutinated benthos is very similar to that occurring within the red facies. This may suggest that in this profile the Member is younger than the Cenomanian/Turonian boundary.

References

Bąk, K., 1995: Stratygrafia i paleoekologia osadów ogniwa margli z Macelowej i ogniwa margli z Pustelni w polskiej części pienińskiego pasa skalkowego. *PhD thesis, Instytut Nauk Geologicznych, Uniwersytet Jagielloński, Kraków, 147, (in Polish).*

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FINAL MEETING OF THE PROJECT N^{o}. 362 „TETHYAN/BOREAL CRETACEOUS CORRELATION“

SCIENTIFIC PROGRAM

SEPTEMBER 30TH - OCTOBER 5TH, 1997
STARÁ LESNÁ, SLOVAKIA

Monday 29th September

12:00 - 14:00 Registration and Lunch

14:00 - 15:00 **Opening Ceremony**
15:00 - 15:30 **Introductory note of the Project leaders**

15:30 - 16:00 Break

Afternoon session: PALEOCEANOGRAPHY

16:00 - 17:00 **Hay** William W. & **Wold** Christopher N.: The effect of changes of the mean salinity on ocean circulation
17:00 - 18:00 **Weissert** Helmut, **Funk** Hans P., **Wortmann** U., **Kuhn**, O., **Menegatti**, A. & **Hennig**, S.: A transect through the Aptian western Tethys Ocean: Paleoceanography and Paleoclimate

18:00 - 18:15 Break

Evening session: PALEOCEANOGRAPHY 2

18:15 - 18:45 **Kouwenberg**, L. L. R., **Leereveld**, Han & **Galeotti**, S.: Climatic and Oceanographic changes reflected in the palynological record of orbitally induced Late Albian black shale rhythms from central Italy

20:00 > Ice-breaker Party

Tuesday, September 30th: TATRA MTS FIELD TRIP

6:30 - 7:30: Breakfast
7:45: Departure to the field trip: Belianska Kopa Sattle - Mt Ždiarska Vidla - Zadné Meďodoly Valley - Javorova Valley (Mokrá Diera Cave) - Biela Voda Valley (Spišmichalova Valley) (packet lunch in the field)
17:00 - 19:00 Arrival
19:00 - 20:00 Dinner
20:00 > Discussion

Wednesday, October 1st: ORAVA AND KYSUCE FIELD TRIP

6:30 - 7:30: Breakfast
7:45: Departure to the field trip: **Žilina - Brodno - Rochovica - Považský Chlmec - Bralo** (packet lunch in the field)
17:00 - 19:00 Arrival
19:00 - 20:00 Dinner
20:00 > Discussion

Thursday, October 2nd: FIRST DAY OF PLENARY SESSION

7:00 - 8:00: Breakfast

Morning session: TETHYAN/BOREAL PALAEOGEOGRAPHY

8:30 - 9:00: **Baraboshkin**, Evgeniy, J.:The Tethyan/Boreal problem as result of paleobiogeographical changes: Early Cretaceous examples from the Russian Platform
9:00 - 9:30: **Gasinski**, Adam M.: Late Cretaceous Boreal foraminiferal migrants to the Carpathians: an example from the Andrychów Klippen Zone

9:30 - 10:00: **Vašíček**, Zdeněk & **Michalík**, Jozef: Possible Boreal faunal immigration of the Lower Cretaceous ammonites into Outer Western Carpathians related to the global sea - level changes

10:00 - 10:30: Coffee Break

Noon session: PALAEOGEOGRAPHY 2

10:30 - 11:00: **Zakharov**, Victor & **Bogomolov,** Yurii: The Boreal equivalents of the Berriasian and Valangian stages
11:00 - 11:30: **Melinte**, Mihaela Carmen: Cretaceous correlations between Tethyan and Boreal Realms from Romania, based on nannoflora
11:30 - 12:00: **Ferré**, Bruno, **Cros** Pierre & **Fourcade** Éric: Tethyan Mid - Cretaceous (Cenomanian - Turonian) Roveacrinids (Roveacrinida, Crinoidea) as stratigraphical and paleobiogeographical tools

12:30 - 14:00: Lunch Break

Afternoon Session: PALAEOGEOGRAPHY 3

14:30 - 15:00: **Sartorio** Dario, **Tunis** Giorgio & **Venturini** Sandro: Cretaceous evolution of the northeastern margin of the Friuli Platform (NE Italy)
15:00 - 15:30: **Wilpshaar**, M., **Abbasov**, A. B., **Aliev,** G. A., **Alizade**, Ak. A., **Eshet**, Y. **Gadijeva**, T. M., **Hakhverdijev**, N. T., **Schnabel**, G. W., **Tagiyev**, M. F. & **Zeyniyev**, O. A.: Early Cretaceous deposits of the Great Caucasus (Azerbaijan): An overview
15:30 - 16:00: **Czászar** Géza: Sedimentary environments of the Urgonian formations of Hungary

16:00 - 16:30: Tea Break

Evening session: POSTER PRESENTATION 1

16:30 - 16:40: **Bąk** Krzysztof & **Oszczypko** Nestor: Lower/Middle Campanian paleoceanographic event - its record in the Magura Unit (Polish Flysch Carpathians)
16:40 - 16:50: **Guzhikov** Andrew Yuri & **Molostovsky** Edward A.: Some features of the Early Cretaceous sedimentation in the Cis - Caucasia reflected in the rock magnetic properties
16:50 - 17:00: **Lintnerová** Otília, **Michalík** Jozef, **Reháková** Daniela, **Peterčáková** Mária, **Halásová** Eva & **Hladíková** Jana: Sedimentary and isotopic record of the Aptian anoxic "Selli event" in the Pieniny Klippen Belt, Slovakia

17:00 - 17:10: Discussion

17:10 - 17:20: **Sawlowicz** Zbigniew & Bąk Marta: Pyritization of Radiolaria in anoxic water column, anoxic deposits of the Cenomanian - Turonian boundary in the Pieniny Klippen Belt, Poland
17:20 - 17:30: **Ožvoldová** Ladislava: Lower Turonian radiolarian associations from the silicified sediments of the Czorsztyn Succession of the Pieniny Klippen Belt (Western Carpathians)
17:30 - 17: 40: **Bąk** Marta: Mid Cretaceous radiolarian zonation in the Polish part of the Pieniny Klippen Belt (Outer Western Carpathians)

17:40 - 17:50: Discussion

17:50 - 18:00: **Bubík** Miroslav: Agglutinated Foraminifera and thecamoebians from the ?Albian - Cenomanian estuarine sediments on the North Tethyan margin (Blansko Graben, Czech Republic)
18:00 - 18:10: **Ponomaryova** Lyudmila & **Gnylko** Oleg: Foraminifera and sedimentary paleoenvironment of the Lower Cretaceous black shales (Ukrainian Carpathians)
18:10 - 18:20: **Hradecká** Lenka: Microbiostratigraphy of the Jizera and Teplice Formations (Late Turonian, Boreal development) in the Upohlavy Quarry, Bohemian Cretaceous Basin

18:20 - 18:30: Discussion

18:30 - 18:40: **Boorová** Daniela & **Rakús** Miloslav: Lower Albian limestones from frontal parts of the Krížna Nappe in the Strážovské Vrchy Mts (Western Carpathians, Slovakia)
18:40 - 18:50: **Salaj** Jozef: Turonian planktonic foraminifera biozonation - the problems of taxonomy a synonymy of index species

18:50 - 19:00: **Bąk** Krzysztof: Deep - water Upper Cretaceous variegated facies in the Czorsztyn Succession, Pieniny Klippen Belt, Western Carpathians

19:00 - 19:10: Discussion
19:00 - 20:00: Dinner

Friday, October 3rd: SECOND DAY OF PLENARY SESSION

7:00 - 8:00: Breakfast

Morning session: INTEGRATED STRATIGRAPHY

8:30 - 9:00: **Bąk** Marta & **Bąk** Krzysztof: Correlation of Cretaceous radiolarian, planktonic and agglutinated foraminifera zonations in the Pieniny Klippen Belt, Western Carpathians, Poland
9:00 - 9:30: **Bubík** Miroslav, **Bąk** Marta & **Švábenická** Lilian: Integrated microbiostratigraphy in the Maastrichtian to Paleocene distal - flysch sediments of the Uzgruň section (Rača Unit, Outer Western Carpathians, Czech Republic)
9:30 - 10:00: **Lakova** Iskra, **Stoykova** Kristallina & **Ivanova** Daria: Tithonian to Valanginian bioevents and integrated zonations of calpionellids, calcareous nannofossils and calcareous dinocysts from the western Balcanides, Bulgaria

10:00 - 10:30: Coffee Break

Noon Session: CALPIONELLID STRATIGRAPHY

10:30 - 11:00: **Pop** Grigore: Tithonian to Hauterivian praecalpionellids and calpionellids: bioevents and biozones
11:00 - 11:30: **Houša** Václav: Magnetostratigraphic and calpionellid biostratigraphic scales correlation in the Jurassic/Cretaceous boundary strata
11:30 - 12:00: **Reháková** Daniela & **Michalík** Jozef: Calpionellid associations versus Late Jurassic and Early Cretaceous sea-level fluctuations

12:30 - 14:00: Lunch Break

Afternoon Session: POSTER PRESENTATIONS 2

14:30 - 14:40: **Hoedemaeker** Philip J., **Houša** Václav, **Krs** Miroslav, **Man** Otakar, **Parés** Josep M., **Pruner** Petr & **Venhodová** Daniela: Magnetostratigraphic and petromagnetic studies of the Jurassic/Cretaceous limestones from the Río Argos (Caravaca, SE Spain), Carcabuey (S Spain) and the Bosso Valley (Umbria, central Italy)
14:40 - 14:50: **Houša** Václav, **Krs** Miroslav, **Krsová** Marta, **Man** Otakar, **Pruner** Petr & **Venhodová** Daniela: High - resolution magnetostratigraphy across the Jurassic - Cretaceous boundary strata at Brodno near Žilina, Western Carpathians, W Slovakia
14:50 - 15:00: **Fomin** Vladimir A. & Eremin Vitaly N.: Comparision of the Maastrichtian biostratigraphic scales from Daghestan and Kopet Dagh according to palaeomagnetic data

15:00 - 15:10: Discussion

15:10 - 15:20: **Szydlo** Andrzej & **Jugowiec** Malgorzata: Tithonian to Valanginian microfossils from the "Cieszyn Beds" in the Outer Western Carpathians (Silesian Unit), Poland
15:20 - 15:30: **Švábenická** Lilian: Evidence of the Braarudosphaera-rich Turonian sediments in the Bohemian Cretaceous Basin
15:30 - 15:40: **Kraia** Saimir & **Kici** Vangjel: New stratigraphic refinements of the Cretaceous deposits of the eastern Albanian Mirdita and Krasta zones on the basis of calcareous nannofossils

15:40 - 15:50: Discussion

15:50 - 16:20: Tea Break

Evening session: POSTER PRESENTATIONS 3

16:20 - 16:30: **Pavlishina** Polina: Palynology of several Santonian - Campanian sections of N Bulgaria
16:30 - 16:40: **Skupien** Petr: Berriasian to Albian dinocysts from the Silesian Unit of the Outer Western Carpathians (Czech Republic)
16:40 - 16:50: **Gęndl** Elżbieta: Preliminary results of the palynological research of the Lower Cretaceous deposits of the Skole Nappe (Outer Western Carpathians, Poland)

16:50 - 17:00: Discussion
17:00 - 17:10: **Ion** Jana, **Antonescu**, E., **Melinte** Mihaela Carmen & **Szasz**, L.: Upper Cretaceous Integrated biostratigraphy of Romania
17:10 - 17:20: **Gnylko** Oleg: The sedimenetary environment and genetic types of the Lower Cretaceous deposits in the Ukrainian Carpathians
17:20 - 17:30: **Serjani** Afan & Pirjeni Agim: Sedimentary paleonvironment of Coniacian phosphatic beds in the Ionian Basin (Mediterranean Tethys)

17:30 - 17:40: Discussion

17:40 - 17:50: **Gaspard** Daniéle: Specific designation of asymmetrical Upper Cretaceous rhynchonellids, formerly considered as "Rhynchonella difformis"
17:50 - 18:00: **Krobicki** Michal: Stratigraphic ranges and paleoenvironments of the lowermost Cretaceous brachiopods in the Pieniny Klippen Belt (Carpathians, Poland)
18:00 - 18:10: **Minev** Velislav: Turonian ammonites from the eastern parts of the Moesian Platform and Fore-Balkan
18:10 - 18:20: **Gallemi**, J., Kuechler, T., Lamolda, M., Lopez, G., Martinez, R., Munoz, J., Pons, J. M. & Solder, M: The Coniacian - Santonian boundary in Northern Spain, the Olazagutia section

18:20 - 18:30: Discussion

18:30 - 18:40: **Ivanov** Marin & **Stoykova** Kristalina: The Albian ammonites, nannofossils and sequence stratigraphy in Bulgaria
18:40 - 18:50: **Bodrogi** Ilona, **Yazykova** Elena A. & **Fogarasi** Atila: Revision of Upper Cretaceous ammonite fauna from the Bakony Mts
18:50 - 19:00: **Blau** Joachim & **Grun** Beate: Late Jurassic/Early Cretaceous revised calpionellid zonal and subzonal division and correlation with ammonite and absolute time scales
19:00 - 19:10: **Hoedemaeker** Philip J.: Correlating the uncorrelatables

19:10 - 19:20 Discussion
19:20 - 20:00: Dinner

Saturday, October 4th: FINAL PLENARY SESSION

7:00 - 8:00: Breakfast

Morning session: PALAEOBIOLOGY

8:30 - 9:00: **Beniamovskii** Vladimir N. & **Kopaevich** Ludmila F.: Late Santonian - Maastrichtian benthic foraminiferal zonation in the European palaeobiogeographical area (EPA)
9:00 - 9:30: **Soták** Ján & **Mišík** Milan : Late Jurassic and Early Cretaceous algal and foraminiferal benthic communities and biofacies from the Western Carpathians
9:30 - 10:00: **Ferré** Bruno & **Granier** Bruno: Roveacrinus berthoui, nov. sp. the earliest representative of the family Roveacrinidae (Roveacrinida, Crinoidea) in the Lower Hauterivian of Busot (Alicante, Spain)

10:00 - 10:30: Coffee Break

Noon Session: SEDIMENTOLOGY

10:30 - 11:00: **Árgyelán**, G. B.: Ophiolitic detritus in the Lower Cretaceous sandstone of Gerecse Mountains, Hungary: petrography, detrital modes, provenance

11:00 - 11:30: **Gabdullin** Ruslan R.: The origin of rhythmical bedding in Middle Cenomanian carbonate rocks in the Bakhchisarai Region (SW Crimea)
11:30 - 12:00: **Ferré** Bruno: *"Lombardia"* - facies and saccocomids - like sections in Cretaceous sediments: Whose pieces

12:30 - 14:00: Lunch Break

Afternoon Session: PALAEOMAGNETISM

14:00 - 14:30: **Guzhikov** Andrew Yuri & **Baraboshkin** Yuri E.: Long - period variations of paleomagnetic declination in the Barremian beds from the North Caucasus and their importance for detailed correlations
14:30 - 15:00: **Krs** Miroslav & **Pruner** Petr: Petromagnetic and palaeomagnetic investigations of Jurassic - Cretaceous limestones aimed at magnetostratigraphy in the Tethyan Realm.

15:00 - 15:30: Tea Break

15:30 - 18:30: Evening session: Discussion on the Project future, preparation of the Final Volume

19:00 - 20:00: Dinner, Farewell Party

Sunday, October 5th: PIENINY KLIPPEN BELT FIELD TRIP

6:30 - 7:30: Breakfast
7:45: Departure to the field trip Rogoznik - Macelowa -Flaki - Sczawnica
13:00 - 13:30 Packet lunch in the field
17:00 Arrival to Stara Lesna
17:30 Arrival to the Poprad railway station

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1. Úprava textu včítane zoznamu literatúry prispôsobte súčasnej úprave článkov v časopise.
2. Text sa má písať s dvojitou linkovou medzerou (riadkovač 2), na strane má byť 30 riadkov, šírka riadku je asi 60 znakov.
3. Abstrakt aj s nadpisom článku sa píše na samostatný list. Obsahuje hlavné výsledky práce (neopakovať to, čo je už vyjadrené nadpisom), nemá obsahovať citácie a jeho rozsah nemá byť väčší ako 200 slov. (Abstraktu treba venovať náležitú pozornosť, lebo slúži na zostavovanie anotácií.)
4. Text má obsahovať úvod, charakteristiku (stav) skúmaného problému, resp. metodiku práce, zistené údaje, diskusiu a záver.
5. Zreteľne treba odlíšiť východiskové údaje od interpretácií.
6. Neopakovať údaje z tabuliek a obrázkov, iba ich komentovať a odvolať sa na príslušnú tabuľku, resp. obrázok.
7. Text treba členiť nadpismi. Hlavné nadpisy písať do stredu, vedľajšie na ľavý okraj strany. Voliť najviac tri druhy hierarchických nadpisov. Ich dôležitosť autor vyznačí ceruzkou na ľavom okraji strany: 1 - hierarchicky najvyšší, 2 - nižší, 3 - najnižší nadpis.
8. V texte sa uprednostíňuje citácia v zátvorke, napr. (Dubčák, 1987; Hrubý et al., 1988) pred formou ... podľa Dubčáka (1987). Ani v jednom prípade sa neuvádzajú krstné mená.
9. Umiestnenie obrázkov a tabuliek sa označí ceruzkou na ľavom okraji rukopisu, resp. stĺpcového obťahu.
10. Grécke písmená použité v texte treba identifikovať na ľavom okraji slovom (napr. sigma).
11. Pri písaní starostlivo odlišujte pomlčkou od spojovníka.
12. Symboly, matematické značky, názvy skamenelín, slová a pod., ktoré treba vysádzať kurzívou, autor v rukopise podčiarkne vlnovkou.
13. K článku je treba pripojiť kľúčové slová.
14. Abstrakt, resumé, vysvetlivky k obrázkom a názvy tabuliek predloží autor redakcii aj v angličtine.

Ilustrácie

1. Musia byť vysokej kvality. Majú dokumentovať a objasňovať text. Originál (pred zmenšením) môže mať rozmer najviac 340 x 210 mm. Maximálny rozmer ilustrácie vytlačený v časopise je 170 x 230 mm. Skladacie ilustrácie treba úplne vylúčiť.
V prípade, že ide o počítačovo vytvorené ilustrácie, prosíme o ich zaslanie na diskete 3,5" vo formáte CorelDraw (PC), Adobe Illustrator (PC, Mac) alebo Aldus FreeHand (Mac).
2. Ilustrácie pripravovať s vedomím, že sa budú zmenšovať (zvyčajne o 50 %) na šírku stĺpca (81 mm) alebo strany (170 mm). Podľa toho pripravovať ich veľkosť a formou, resp. ich zoskupenie.
3. Voliť takú veľkosť písma a čísel, aby po zmenšení najmenšie písmená boli 1,2 mm. Úmerne zmenšeniu voliť aj hrúbku čiar.
4. Obrázky popisovať šablónou, nie voľnou rukou.
5. Všetky ilustrácie včítane fotografií musia obsahovať grafickú (metrickú) mierku.
6. Zoskupené obrázky, napr.: fotografie, diagramy, musia byť pripravené (nalepené) ako jeden obrázok a jeho časti treba označiť písmenami (a, b, c atď.). Takto zoskupené obrázky sa citujú ako jeden obrázok. Zoskupené fotografie treba starostlivo upraviť a nalepiť na biely kriedový papier.
7. Fotografie musia byť ostré, čiernobiele, kontrastné a vyhotovené na lesklom papieri. Je vhodné, aby sa zmenšovali minimálne o 50 %.
8. Na všetkých obrázkoch sa na okraji (na fotografiách na zadnej strane) ceruzkou uvedie číslo obrázku a meno autora. Na fotografiách sa šípkou doplní aj orientácia obrázku.
9. Na mapách a profiloch voliť jednotné vysvetlivky, ktoré sa uvedú pri prvom obrázku.
10. Názvy obrázkov a vysvetlivky sa píšu strojom na osobitný list.
11. Všetky ilustrácie sa musia citovať v texte.
12. Ilustrácie sa zasielajú redakcii už imprimované, teda pri korektúre ich už nemožno opravovať a dopĺňať.
13. Farebné ilustrácie sú vítané, ale náklady na ich tlač hradí autor.

Tabuľky

1. Tabuľky sa píšu na osobitný list. Rozsah a vnútornú úpravu tabuliek zvoľte tak, aby sa tabuľka umiestnila do stĺpca alebo na šírku strany. Rozsiahlejšie tabuľky sa neprijímajú.
2. Údaje zoraďujte do tabuľky iba vtedy, ak sa nedajú uviesť v texte.
3. Nadpis tabuľky a prípadný sprievodný text sa píše strojom na osobitný list (úpravu nadpisov pozri v časopise).
4. Vertikálne čiary v tabuľkách nepoužívať.
5. Tabuľky sa číslujú priebežne a uverejňujú sa v číselnom poradí.

Literatúra

1. V zozname literatúry sa v abecednom poriadku uvádza iba literatúra citovaná v danom článku. Citácia označená „v tlači" sa môže uviesť v zozname, len ak je z citovaného článku aspoň stĺpcová korektúra. Citácie s doplnkom „v prípade", „zadané do tlače" sú neplnohodnotné a nemajú sa používať ani v texte. Citácia „osobná informácia" sa cituje iba v texte (Zajac, os. informácia, 1988).
2. Používať nasledujúci spôsob uvádzania literatúry:
Kniha
Gazda, L. & Čech, M., 1988: Paleozoikum medzevského príkrovu. Alfa Bratislava, 155.
Časopis
Vrba, P., 1989: Strižné zóny v komplexoch metapelitov. Mineralia Slov., 21, 135 - 142.
Zborník
Návesný, D., 1987: Vysokodraselné ryolity. In: Romanov, V. (red.): Stratiformné ložiská gemerika. Špec. publ. Slov. geol. spol., Košice, 203 - 215.
Manuskript
Radvanský, F., Slivka, B., Viktor, J. & Srnka, T., 1985: Žilné ložiská jedľoveckého príkrovu gemerika. Záverečná správa z úlohy SGR-geofyzika. Manuskript - archív GP Spišská Nová Ves, 28.
3. Pri článku viac ako dvoch autorov sa v texte cituje iba prvý autor s dodatkom et al., ale v zozname literatúry sa uvádzajú všetci.
4. Ak sa v článku (knihe) cituje názov, údaje a pod. iného autora, ktorý nie je spoluautorom publikácie, potom sa v texte cituje vo forme (Gerda in Kubka, 1975), ale v zozname literatúry sa uvádza iba Kubka, J., 1975.