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# Senonian to Paleogene palaeogeographic and tectonic development of the Myjavská Pahorkatina Upland (West Carpathians, Czechoslovakia)

By

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With 5 figures in the text

## ABSTRACT

The sediments studied formerly designated as Gosau sediments are found on the southern side of the Klippen Belt at its western border. The Senonian sediments are designated as the Brezová group and the Paleogene sediments as the Myjava group. We distinguish here: the Bradlo (southern), Stará Turá (transitional), Surovín (northern) and Rašov developments. The first two, on the contrary to other developments, have the basal Coniacian – Campanian conglomerate lithofacies resting transgressively on the horst system of the Brezovské hory and Čachtické hory mountains Mesozoic. The last two developments about which we conclude that there was no interruption in sedimentation (in the Middle Cretaceous), are conformable with the substratum formed by the Triassic to Lower Cretaceous.

This Mesozoic, on the basis of pebble analysis of Albian conglomerates, on the contrary to the opinion of Mišík and Sýkora (1981), we consider as a remnant of the preserved horst of the Klape sedimentation zone, emerged and prevailingly eroded away to its crystalline substratum in the Albian to Turonian.

Before the preserved part of the mentioned horst was flooded by the Senonian sea, freshwater schizophyte limestones (Hanáček 1956) and brackish coal seams (Dropa, verbal communication) deposited on it. Later, during the Laramide phase of folding it was squeezed out diapirically from the substratum, on the contrary to the opinions of other authors, who consider its Mesozoic as a Gemeride nappe thrust the south during the Subhercynian folding.

## KURZFASSUNG

Am westlichen Ende der Westkarpaten auf der Südseite der Klippen-Zone treten Oberkreide-Ablagerungen auf, die man früher als Gosau bezeichnete. Sie werden als Brezova-Gruppe zusammengefaßt, ihre palaeogene Fortsetzung als Myjava Gruppe.

Es lassen sich vier unterschiedliche Einheiten unterscheiden: Bradlo im Süden, Stará Turá als Übergangsfazies, Surovin weiter nördlich und die Rašov-Einheit im Norden. In den Bradlo- und Stará Turá-Einheiten setzte die Sedimentation im Gegensatz zu den übrigen Abfolgen erst in der Oberkreide ein. Basale Konglomerate des Coniac bis Campan transgredieren über turone Süßwasser-Algenkalke und brackische Kohle-Flöze, die ihrerseits dem horstartig herausgehobenen Mesozoikum der Brezovské hory und Čachtické hory Berge auflagen. In den beiden nördlichen Abfolgen liegt dagegen unserer Meinung nach eine seit der Trias kontinuierliche Sedimentation vor, die sich ohne mittelkretazische Unterbrechung bis in die Oberkreide fortsetzt. Aufgrund von Geröll-Analysen der Alb-Konglomerate sehen wir im Gegensatz zu Mišik & Sykora (1981) im Mesozoikum der beiden ersten Einheiten einen Rest der Sedimentation in der Klape-Zone, die in der Zeit vom Alb bis in das Turon stärker herausgehoben, und im Osten bis auf die kristalline Unterlage erodiert wurde, und nicht Reste der Gemer-Decke. Während der laramischen Faltungsphase wurde die mesozoische Abfolge von ihrer Unterlage diapirisch abgequetscht, und nicht als Gemer-Decke bereits während der subherzynen Phase nach Süden abgeschert.

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# INTRODUCTION

At the southwestern termination of the West Carpathians in Slovakia, between the mountains of Little Carpathians in the south – unit of the Central Carpathians – and the Klippen Belt in the north, Upper Cretaceous and Paleogene sediments are lying, which for their position and lithofacial similarity were considered as equivalent of the Gosau development in the Alps (ŠTÚR 1860, ANDRUSOV 1959, SALAJ 1960).

# LITHOFACIAL AND STRATIGRAPHIC CHARACTERIZATION

It has been proved by detailed studies (SALAJ & BEGAN 1963) that there are lithofacial and stratigraphical differences, which permitted to distinguish these sediments of the Myjavská pahorkatina Upland as a particular development.

On the basis of lithofacial and stratigraphical differences as well as of palaeogeographical interpretations we divided the Upper Cretaceous and Paleogene sediments into 4 developments; from south to north they are: 1. Bradlo development (southern), 2. Stará Turá development (transitional), 3. Surovín development (northern), 4. Rašov development (northernmost).

1. The Bradlo development is characteristic in basal sediments transgreding on the horst system of the Brezovské Karpaty and Čachtické Karpaty mountains Mesozoic (Fig. 1). Before transgression, however, on this horst, which was part of the Klape ridge, freshwater schizophyte limestones (HANÁČEK 1956) and brackish coal seams deposited (DROPA, verbal communication). On the contrary to present interpretation we do no consider the underlying Mesozoic as part of the Gemeride nappe but we suppose that it was partially diapirically squeezed out from the substratum of the Klape sedimentation area to the surface in the time of the pre – Senonian folding.

The Senonian transgression begins with the Valchov conglomerates (SAMUEL, SALAJ & BEGAN 1980), which are accompanied by carbonate sandstones and clastic limestones. With advancing transgression the age of this formation is Coniacian to Campanian. The Upper Coniacian is represented by the Štverník marls. The overlying formation of Hurbanova dolina is of flysch character and Santonian age. The Lower Campanian, variegated, predominantly red marls, make up the Košariská formation; the Middle and Upper Campanian represents the Podbradlo formation – flysch with prevalance of marls and layers of microconglomerates. The Upper Campanian to Lower Maastrichtian are formed by organodetrital and organogenic limestone, socalled orbitoids limestones of Široké bradlo; the facies of blue marls with inocerams – Mosnáčov marls – is Lower Maastrichtian; the Podlipovec flysch is represented by Upper Maastrichtian marls, marlstones, sandstones and fine-grained conglomerates. The stratigraphical hiatus between the Cretaceous and Paleogene, characteristic of this development, corresponds to the Danian and Montian. Upper Paleocene to Lower Eocene is the Kravariky formation, which is of transgressive character and represented by conglomerates, sandstones and reef blocks. It is resting conformably on its underlier. The development is terminated with the Priepastné formation – Upper Paleocene to Lower Eocene – flysch alternation of calcareous sandstones, claystones and variegated marls.

2. The Stará Turá development is represented at surface only by the youngest – Lubina formation, formed by detrital and organic limestones, conglomerates, sandstones and marlstones of stratigraphical range Middle Paleocene to Lower Eocene. This formation was encountered by a deep borehole (LU-1) (LEŠKO et al. 1978). In its underlier the Middle Cretaceous was drilled, which we suppose to be part of the Klape ridge and so also of the substratum of Upper Cretaceous and Paleogene sediments of the Myjavská pahorkatina Upland.

3. The development of Surovín is, similarly as the Stará Turá development, incomplete and at surface we know the youngest sediments only.

The Polianka formation of Upper Campanian to Danian age is formed by marls and marlstones with layers of calcareous sandstones. It is overlain by algal-coral limestones allodapic in its lower part, conglomerates and marls of Middle – Paleocene to Lower Eocene age, designated as Dedkov vrch formation. The Middle and Upper Eocene is represented by sandstones, shales and red claystones of the Jablonka formation. This development is terminated with shales of menilite type, belonging to the uppermost Eocene.

4. The Rašov development. As a marginal type of sedimentation at the northern margin of the Klape sedimentation zone we distinguished the Rašov development, which occurs at the tectonic contact with the Klippen Belt and was considered as part of the "klippen mantle" (ANDRUSOV 1959). It is a formation of sandstones, conglomerates, marls and organogenic limestones of Santonian – Campanian age.

For comparison we mention the bed sequence of the Gosau Cretaceous and Paleogene as we compared it near Gosau in the Eastern Alps.

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# COMPARISON OF THE GOSAU DEVELOPMENT OF THE NORTHERN CALCAREOUS ALPS AND OF THE BREZOVÁ GROUP IN THE WEST CARPATHIANS

In the last time we had the possibility to see some type localities of the Gosau of the Northern Calcareous Alps near Gosau (TOLLMANN 1976; PLÖCHINGER, in OBERHAUSER et al. 1980), accompanied by geologists studying this problem mainly from a stratigraphical standpoint (KOLLMANN and SUMMESBERGER).

The bed sequence of this Upper Cretaceous in Gosau is as follows:

1. Basal Lower Coniacian conglomerates – Kreuzgrabenschichten of variable thickness, maximum 200 m. The material is local. This member is coincident with basal transgressive lithofacies of the Brezová group.

2. The Streiteckschichten beds are represented by sandy limestones, calcareous sandstones with corals, bivalves and gastropod *Actaeonella laevis*, with layers of conglomerates of similar type as the basal conglomerates. The whole sequence is 100–150 m thick. It is interpreted as Coniacian in age (PLÖCHINGER in OBERHAUSER et al. 1980). We compare this formation with higher Coniacian sandy limestones with *Actaeonella gigantea* and recrystallized echinoids.

3. The Grabenbachschichten beds belong to the Upper Coniacian also at the locality Gosau, as mentioned by PLÖCHINGER (in OBERHAUSER et al. 1980). They are slightly sandy dark marls, 150–250 m thick. We compare them with the Upper Coniacian Štverník marls. On the basis of new knowledge (KOLLMANN & SUMMESBERGER, verbal communication) at least a part of these marls must belong to the Lower Santonian, as proved by finds of *Inoceramus unduloplicatus* and *Texanites* sp.

4. The overlying Hochmoosschichten beds are already Santonian. They build up a 300 m thick formation of solid marls with intercalations of sandy marlstones to marly sandstones with isolated layers (2–3) of conglomerates with exotic material and several layers of hippurite limestones, which are predominating mainly in in uppermost layers of the formation. This formation is terminated with a distinct sandstone bank. Besides hippurites *Actaeonella laevis*, *Parapuzosia conicus*, *Placenticeras* sp. and *Muniericeras* sp. are found here. In the sense of KOLLMANN & SUMMESBERGER (verbal communication) this formation belongs to the Upper Santonian.

Although there is some analogy with the Santonian flysch sequence of the Brezovské hory Mts., the differences are mainly: a) stratigraphically – the Brezovské hory Mts. flysch corresponds to the whole Santonian, in Gosau it represents the Middle to Upper Santonian only; b) the whole Santonian of the Brezová group is of flysch character; hippurite limestones with a fauna like in Gosau are missing at all. An analogy with the Brezová group Santonian is the presence of exotic conglomerates and thin, 2 mm–1 cm thick layers of coal.

5. Randoschichten beds – Lower Campanian marls with *Globotruncana elevata*. Although a different formation, we put it into relation with variegated marls of the Košariská formation.

6. Ressenschichten beds – marls with layers of sandy marls, with sporadical layers of microconglomerates, thickness 200–300 m. The formation contains *Inoceramus mülleri;* from the microbiostratigraphical viewpoint it is still the *Globotruncana elevata* Zone – Middle Campanian.

7. Higher up there are the Glaselbachschichten – a flyschoid formation with fine-grained conglomerates (thickness about 300 m). In the Myjavská pahorkatina Upland we put both these formations into relation with the Middle Campanian flyschoid formation of the Podbradlo formation.

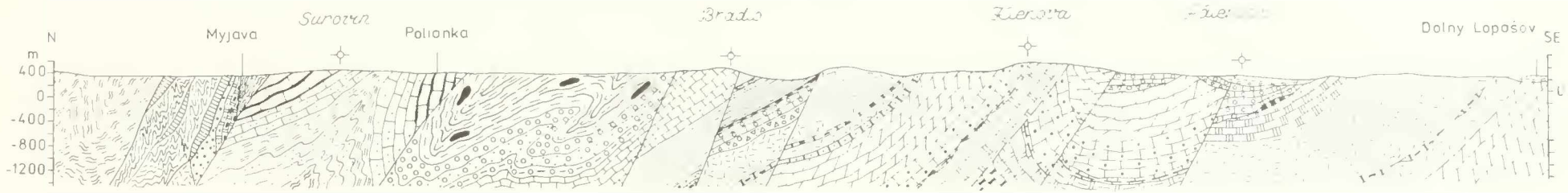
8. Overlying are the Nierentaler Schichten beds of Upper Campanian to Lower Maastrichtian age, 400 m thick. This formation of variegated marls could be equivalent in age, but quite different in lithology, with the Upper Campanian to Lower Maastrichtian orbitoid limestones and *Inoceramus* marls.

9. The youngest Cretaceous – Paleogene formation is represented by the Upper Maastrichtian – Eocene Zwieselalmschichten beds, which are transgressive. In the lower part there are exotic conglomerates (30–50 m) of Maastrichtian age. This formation can be partly correlated with the flysch sequence of the Podlipovec formation with orbitoid conglomerate limestones and exotic conglomerates in the lower part. The Paleogene part of the Zwieselalmschichten beds, not studied nearer in the area of Gosau, is represented by a flysch sequence with layers of conglomerates with variegated marls in the Upper Paleocene and foraminifer-rich marls with layers of sandstones in the Eocene. Interesting is the presence of pebbles of reef algal-coral limestones probably of Upper Paleocene to Lower Eocene age. In our opinion, however, the Zwieselalmschichten beds can mainly be correlated with the Kravariky formation and Priepastné formation.

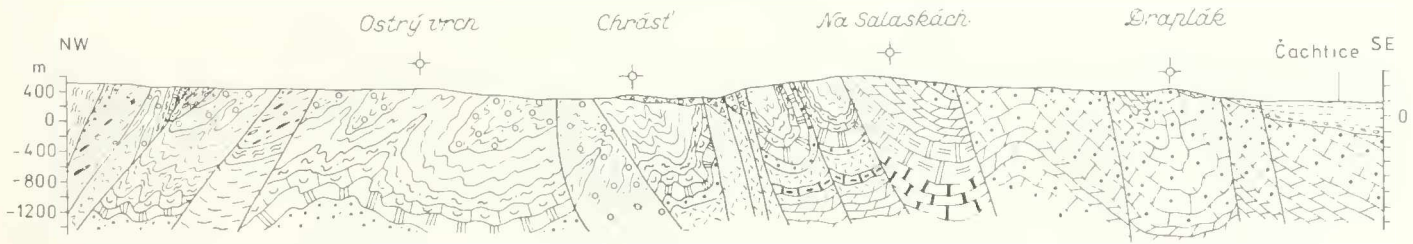
It is evident that in the Myjavská pahorkatina Upland Cretaceous and Paleogene sediments are largely different from those of the Gosau development of the Northern Calcareous Alps. In the Gosau of the West Carpathians only sediments with marls and hippurite limestones (besides conglomerates) should be included. They are residual sediments preserved in the southern parts of the West Carpathians only.

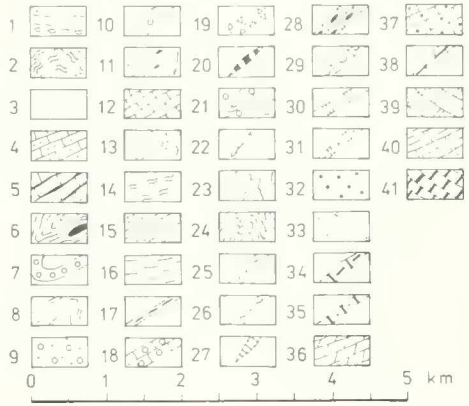
# GEOLOGICAL PROFILES THROUGH THE MYJAVSKÁ PAHORKATINA UPLAND, BREZOVSKÉ HORY AND ČACHTICKÉ HORY MOUNTAINS (After J Salaj 1981)

I PROFILE THROUGH THE BREZOVSKÉ HORY MOUNTAINS AND MYJAVSKÁ PAHORKATINA UPLAND
(Compiled by A Began, J Mello & J Salaj)




II PROFILE THROUGH THE ČACHTICKÉ HORY MOUNTAINS AND MYJAVSKÁ PAHORKATINA UPLAND
(Compiled by A Began, J Hanáček & J Salaj)




Compiled on the basis of manuscript archival geological map of the Myjavská pahorkatina upland, Brezovské hory and Čachtické hory mountains 1 50 000
(A Began, J Hanáček, J Mello & J Salaj 1981)

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# PALAEOTECTONIC DEVELOPMENT OF THE AREA

In the substratum of the Upper Cretaceous and Paleogene sediments of the Myjavská pahorkatina Upland the Mesozoic of the Brezová Carpathians and Čachtice Carpathians and the Mesozoic of the White Carpathians occur (Fig. 1). The Mesozoic of the former two areas has so far been interpreted as part of a higher Subtatric nappes. The Mesozoic of the Čachtice Carpathians is represented by the Nedzov nappe (Andrusov 1936), while the Mesozoic of the Brezová Carpathians and White Carpathians is formed by the Jablonica nappe (Mahel' et al. 1962).

On the basis of analysis of pebbles (Mišík, Mock & Sýkora 1977; Mišík & Sýkora 1981; Salaj & Began in Salaj 1982) we conclude that the Mesozoic of both mountains represents the preserved remnant of the Ultrapieninic ridge, which we consider as part of the Klape ridge (Fig. 2).

Toward the east this ridge was eroded and supplied material for Cretaceous interformational conglomerates of the Upohlava type, which form various stratigraphical horizons in the Klape Group from the Albian to the Maastrichtian. They point to a vertical intensity of the tectonic processes, linked with an extensive horst system of this ridge in its eastern part. In the area of the Myjavská pahorkatina Upland these processes terminated in the Cenomanian before the Coniacian freshwater Turonian coal seams (Dropa, verbal communica-

Fig. 1. Geological profiles I and II.

1 = Neogene – Eggenburgian (= Burdigalian); basal conglomerates, sandstones and shales;
2 = Eocene; Zlín beds of the Magura Paleogene;
3 = Middle to Upper Eocene; flysch, at the base with variegated claystones (Surovín development);
4 = Middle to Upper Paleocene; allodapic limestones with *Discocyclina seunesi;*
5 = Upper Paleocene to Lower Eocene; reef-algal-coral limestones, with layers of marls with *Discocyclina seunesi;*
6 = Lower to Middle Eocene; flysch sequence with olistoliths of reef limestones (Surovín development);
7 = Upper Paleocene to Lower Eocene; polymict conglomerates with exotic material, sandstones sandy shales with olistoliths of reef and orbitoid limestones (Bradlo and Stará Turá developments);
8 = Upper Campanian to Danian; greyish-green marls (Surovín development);
9 = Upper Maastrichtian; fine- to medium-grained carbonate conglomerates, sandstones, marls with *Abathomphalus mayaroensis;*
10 = Lower Maastrichtian; marls with inocerams;
11 = Campanian to Maastrichtian; conglomerates, organogenic hippurite and orbitoid limestones, sandstones and marls;
12 = Upper Campanian to Lower Maastrichtian; orbitoid limestones, fine-grained conglomerates (southern development);
13 = Upper Campanian; flyschoid sequence – marlstones, marls and calcareous sandstones;
14 = Lower Campanian; variegated marls with *Globotruncana arca;*
15 = Santonian; flyschoid sequence – sandstones, marls;
16 = Coniacian to Santonian; flysch sequence – sandstones, marls;
17 = Upper Coniacian; grey marls;
18 = Middle to Upper Coniacian; sandy limestones and fine-grained conglomerates;
19 = Coniacian, Santonian, Campanian; basal conglomerates;
20 = ? Turonian to Lower Coniacian; schizophyte brackish to continental limestones;
21 = Albian, in places Cenomanian to Turonian; marls, sandstones and conglomerates;
22 = Barremian to Lower Cenomanian; greyish-green spotted marls;
23 = Tithonian to Aptian; grey spotted limestones, in the Upper Aptian dark organoclastic limestones;
24 = Tithonian to Hauterivian; grey spotted cherty and calpionel limestones;
25 = Upper Malm; grey and pinkish massive muddy limestones with cherts;
26 = Oxfordian to Kimmeridgian; red nodular, cherty to radiolarite limestones, in places the Kimmeridgian – Tithonian in reef development (Plassen limestone) or in facies of marly limestones will allodapic limestones (Barmstein limestone) with *Clypeina jurassica* (Favre) and with *Pseudocyclammina lituus* (Yokoyama);
27 = Callovian to Kimmeridgian; radiolarites and nodular limestones;
28 = Liassic; Gresten beds, spotted marly limestones with cherts and layers of grey crinoidal cherty limestones;
29 = Liassic to Lower Dogger; sandy limestones, rarely spotted marls, redish Adneth, grey and red crinoidal limestones;
30 = Rhaetian; Dachstein and lumachelle limestones with *Triasina hantkeni;*
31 = Rhaetian; dark-grey sandy limestones and lumachelle limestones with *Triasina hantkeni;*
32 = Norian; variegated clayey shales, intercalations of dolomites and quartzites – Carpathian Keuper;
33 = Carnian to Norian; Hauptdolomit;
34 = Carnian; Opponitz limestones;
35 = Julian; Lunz beds with *Duostomina alta;*
36 = Ladinian to Cordevolian; dolomites;
37 = Ladinian; Wetterstein limestones with *Diplopora annulata;*
38 = Upper Anisian (Illyrian) to Ladinian; Reifling limestones;
39 = Illyrian; Schreyeralm limestones with *Pilammina densa* Pantić;
40 = Pelsonian to Illyrian; Steinalm limestones with *Meandrospira dinarica* Kochansky-Devidé & Pantić;
41 = Anisian; Gutenstein limestones with *Meandrospira insolita* (Ho).

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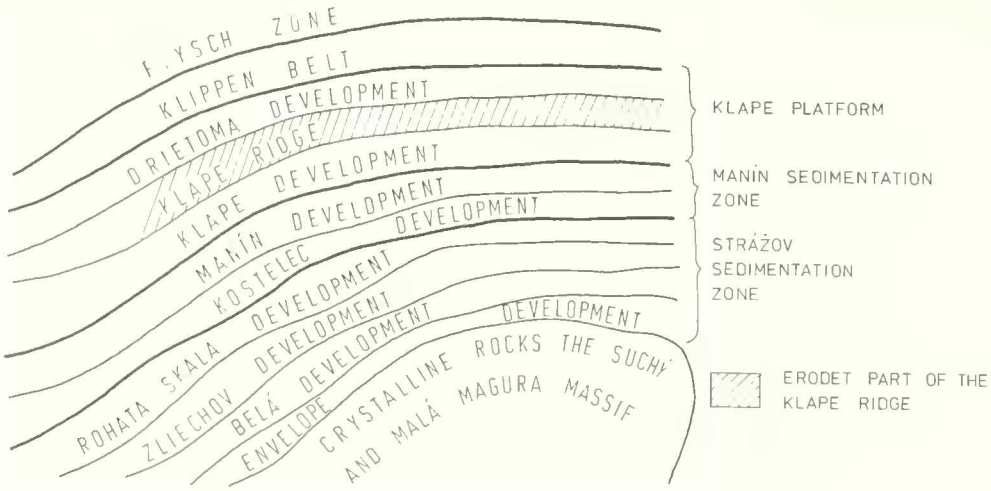


Fig. 2. Sedimentation zones of NW Slovakei (West Carpathians)

tion) and schizophytic freshwater limestones (Hanaček 1956) were deposited. To the west in direction to the Northern Calcareous Alps we put the Mesozoic of the Čachtice Carpathians, Brezová Carpathians and White Carpathians in connection with the Ötscher (= Čachtice Carpathians) and Lunz facies of the Northern Calcareous Alps. These considerations are based on the results of Oberhauser et al. (1980), Tollmann (1972, 1976) and Wessely (1974). In both regions, the Western Carpathians and Northern Calcareous Alps, both these tectonic units have an equal bed sequence and their linking is mainly stressed by the presence of the Dachstein Limestones as well as locally of the facies of Kimmeridgian – Tithonian allodapic limestones = Barmsteinkalke of the Čachtice Carpathians with *Clypeina jurassica* (Favre) and *Pseudocyclammina lituus* (Yokoyama). These limestones with the mentioned microorganisms have been found at several localities (Mišík & Sýkora 1982). In the last time the reef facies (= Plassen limestones with the same fossils) was found in the Brezová Carpathians (Mello in Began et al. 1982). The existence of these organo-detrital limestones in Čachtice Carpathians was pointed out first by Kullmanová (1964).

As already mentioned the Klape ridge (= Ultrapieninic ridge – Mahel 1980) was essentially eroded to the east and northeast. The study of bed sequences of the individual series as well as the analysis of the pebbles of Albian conglomerates of the Klape Groups in this area permit us to divide the Klape sedimentation area as follows: north of the Klape ridge we place sediments of the Drietoma development with the presence of the Carpathian Keuper, Kössen beds, incomplete Gresten facies and spotted limestones and marls, crinoidal and cherty limestones, dark quartzy shales, radiolarites, nodular and calpionel limestones, marly spotted cherty limestones and Aptian – Albian dark marls (= Tannheimer Schichten of the Northern Calcareous Alps). Important is the presence of flysch with sandy limestones with orbitolines and conglomerates with exotic materiál (= Losensteiner Schichten). In the Northern Calcareous Alps the Frankenfels facies would correspond to the Drietoma development.

Into this part of the sedimentation area we place the Senonian sediments (variegated marls, flysch with exotic material, variegated clays and marls in the Paleocene and Eocene flysch). This facies association can be related with sediments of the Gieshübel depression the Northern Calcareous Alps. We introduce for this development of the Senonian and Paleogene, according to the type locality Kvašov, the name Kvašov development.

In the area of the Myjavská pahorkatina Upland this development does not occur at surface. We suppose, however, that it remained underlying the older members of the Drietoma development.

South of the Klape ridge we place the Klape development sensu stricto (Jurassic and Lower Cretaceous near the Klape klippe, Albian – Coniacian flysch with exotic conglomerates, spherosiderite beds, Upohlava conglomerates, Orlové beds).

The Upper Cretaceous sediments deposited south of the Klape ridge, we compare in the area of Považská Bystrica with sediments of the Myjavská pahorkatina Upland in spite of some differences.

We place the sedimentation area of the Streženice, Manín and Kostelec developments south of the sedimentation area of the Klape development (Fig. 2).

The Kostelec development and Rohatá skala development (northern margin of the Strážov sedimentation area) are of the character of a sedimentation on an elevated substratum (seamount chain), which is accompanied by stratigraphic hiati and condensed sedimentation in the Jurassic.

For completeness of the stratigraphical concept is should be mentioned that the new Strážov sedimentation area (Salaj 1982) was defined, in which we suppose that the units thrusted later from the south have been formed here. The mechanism of formation of the present-day tectonic structures (Salaj 1982) of this area is presented in Fig. 3. As a consequence of such an interpretation of the tectonic structure of the area the question of correlation of West Carpathian and Northern Calcareous Alpine units requires a new approach.

For completing it is necessary to remark that Mahel' (1980) defined the sediments of the Klape development, exotic ridge and Upper Cretaceous sediments of the Manín development as the Periklippen Zone, later Mahel' (1981) called them the Váhicum. Salaj (1982) assigned the uneroded part of the Klape ridge, i. e. the Mesozoic of the Brezová Carpathians and Čachtice Carpathians to the Váhicum too.

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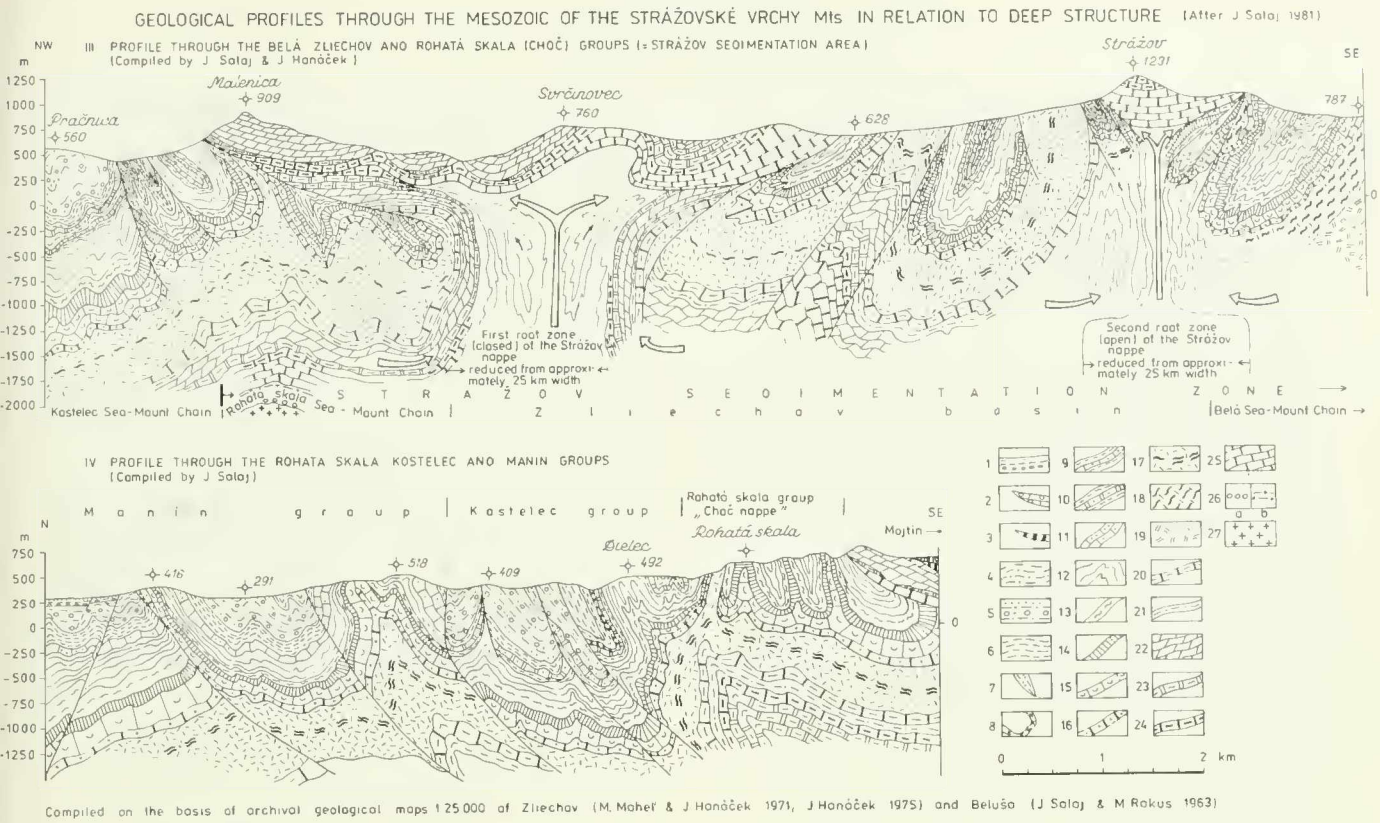


Fig. 3. Geological profiles III and IV.

1 = Eggenburgian; basal conglomerates, sandstones and shales;
2 = Lower Eocene; basal conglomerates and conglomerate limestones with *Alveolina oblonga;*
3 = Middle to Upper Paleocene; bauxites;
4 = Upper Cenomanian; fine-rhytmical flyschoid sequence of the Praznov beds with *Rotalipora cushmani;*
5 = Middle Cenomanian; coarse rhytmical flyschoid sequence of the Belušské Slatiny beds with *Rotalipora montsalvensis* – sandstones, sandy shales and fine-grained exotic conglomerates;
6 = Middle Albian to Lower Cenomanian; marls with planktonic foraminifers;
7 = Upper Albian; flyschoid sequence – sandstones, marls and sandy marls;
8 = Middle Albian; ultrabasic rocks;
9 = Aptian to Middle Albian; dark organo-detrital orbitoline limestones, grey limestones, marls and glauconite limestones;
10 = Aptian to Middle Albian; dark organo-detrital orbitoline limestones, layers of grey Urgonian type limestones, glauconite limestones and marls;
11 = Barremian to Lower Albian; organogenic and organo-detrital orbitoline and hippurite massive limestones (Urgonian facies);
12 = Tithonian to Neocomian; grey banked calpionel limestones (in the Manin Group with layers of chert) and marls;
13 = Upper Oxfordian to Kimmeridgian; light-grey, brownish and pinkish platy limestones;
14 = Callovian to Lower Oxfordian; cherty limestones, nodular limestones, in the Zliechov Group radiolarites;
15 = Liassic to Lower Doggerian; spongolite limestones, sandy light-pinkish, red crinoidal limestones, locally in the Zliechov Group spotted limestones and marls;
16 = Rhaetian; dark-grey sandy limestones and lumachelle limestones with *Triasina hantkeni;*
17 = Upper Carnian to Norian; Hauptdolomit with layers of Keuper shales;
18 = Norian; Carpathians Keuper rocks;
19 = Carnian; dolomites;
20 = Carnian; Opponitz limestones;
21 = Julian; Lunz beds;
22 = Ladinian to Lower Carnian; Wetterstein dolomites;
23 = Ladinian; Wetterstein limestones with *Teutloporella herculea;*
24 = Illyrian; reddish Schreyeralm crinoidal and grey dark cherty Reifling limestones with *Pilammina densa;*
25 = Anisian; dark Gutenstein and Steinalm limestones with *Meandrospira dinarica;*
26 = Scythian; *a* – shales, *b* – basal quartzites and conglomerates;
27 = Pre-Mesozoic basement; Crystalline rocks.

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# CONCLUSIONS

The main contribution of this study is a different interpretation of the sedimentation zones (Fig. 2.) of the tectonic units of the Brezová Carpathians and Čachtice Carpathians. We substantiate that these units are not derived from the Gemer area but are part of the Klape Zone.

The presented palaeogeographical considerations require a consideration of the individual phases of folding with emphasis of the Klape Zone.

The first tectonic effects which can be analysed in this zone, were in the Triassic. In the Carnian a certain part of the Klape Zone was uplifted. In the Brezová Carpathians and Čachtice Carpathians limestones were deposited in the southern part. On the other hand in the sunken part of the block the facies of the Lunz beds dominated durins the Carnian.

Smaller vertical movements were during the Jurassic, mainly in the Kimmeridgian and Tithonian. Distinct tectonic movements have been at the Aptian – Albian boundary, during which the Klape ridge was uplifted. We suppose that these movements of vertical character persisted until the Turonian. In the Coniacian subsidence of the ridge took place and Coniacian to Upper Eocene or Oligocene sediments were deposited in the Myjavská pahorkatina Upland.

The Laramide phase was only partly expressed in this zone, – a hiatus during the Danian and Montian in the Bradlo development.

During the Savian phase the Brezová Carpathians and Čachtice Carpathians were folded. A part of them was uplifted in form of a horst and eroded.

The area under study has acquired its present-day character during the Bukovec phase (Salaj 1982) before the Upper Karpatian when distinct imbrication and upthrusts have developed. A part of the horst was upthrust (Dobrà Voda upthrust) to the south on Upper Cretaceous and Eggenburgian sediments. During these processes also the northern part of sediments of the Myjavská pahorkatina Upland – Surovín development was overthrust on the southern part along a distinct tectonic line of east-western direction. This phase was also effectively expressed in the Klippen Belt, where the Eggenburgian conglomerates and sandstones were folded in tectonic slices of the Klippen Belt (Fig. 4–5).

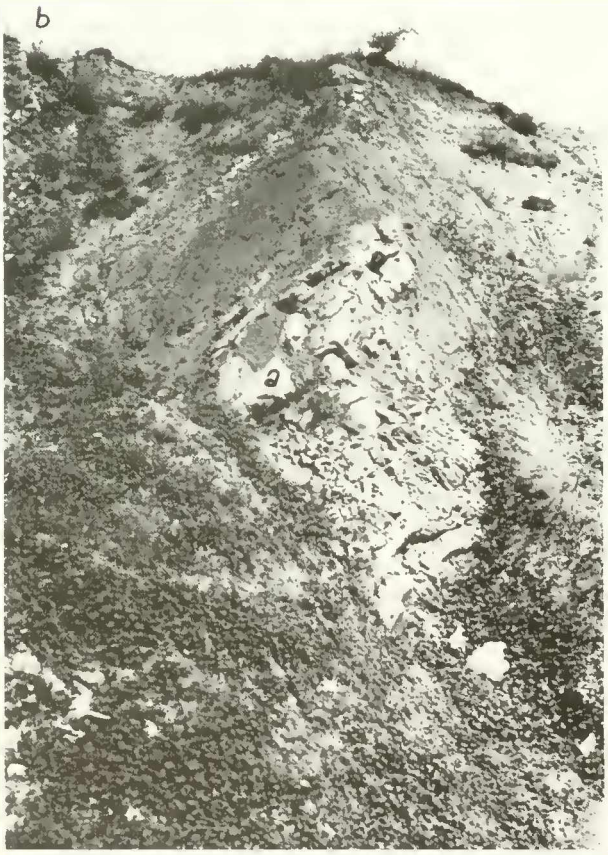


Fig. 4. The Upper Eggenburgian calcareous sandstones (left – b) in tectonic contact with the Neocomian – Albian of the Kysuca Group succession. In the Albian is a further slice of the Upper Eggenburgian (a). Locality: Abandoned quarry in Majeričky near Myjava.

Fig. 5. Detail of tectonic contact of vertically upright Neocomian of the Kysuca Group succession with a higher member of the Eggenburgian (calcareous sandstones).

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