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GEOLOGICAL ASSOCIATION**

**Guide to Excursion D**

**Triassic of the West  
Carpathians Mts.**

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## Introduction

In the West Carpathians, the Triassic is one of the thickest and most frequent mesozoic formations. It is in all the principal tectonic units of the Inner Carpathians, and in the Klippen Belt. It is only missing in the Outer Carpathians, in the basement of the flysch; due to the continental ridge, the so-called "Vindelice-Beskydy wall" (D. Andrusov 1965), or due to the transport of the Lower and Middle Triassic during the Upper Triassic. Then the submarine ridge emerged and formed a source of detrital material of the Lunz beds and of the Carpathian Keuper (A. Bielý — J. Bystrický 1964).

Since the beginning of the geological investigations in Slovakia, the stratigraphy of the Triassic sediments is based on the correlation of lithostratigraphical units of the West Carpathians with those of the Triassic in the East Alps. Lithostratigraphic units equivalents of which are in the East Alps, are denominated by terms of the Alpine stratigraphical nomenclature (for example: Gutenstein limestones, Wetterstein limestones, and others). For lithostratigraphic units formerly regarded as Cretaceous, without their equivalents in the Cretaceous of the East Alps, new terms were introduced (for example: the Choč dolomite, the Veterník limestone, the Rachsthurn limestone, and others). The terms became unnecessary after the lithostratigraphic units mentioned proved to be Triassic sediments; the terms were, however, used for quite a long time in literature.

At present these lithostratigraphic units are distinguished in the Triassic:

### The Lower Triassic

1. beds of the Seissian; 2. beds of the Campilian (Lower and Upper); 3. basal quartzites (the equivalents of the Alpine Semmering quartzite, D. Andrusov 1968).

### The Middle Triassic:

4. the Gutenstein limestones and dolomites; 5. the Annaberg limestones and dolomites; 7. the Steinalm limestones and dolomites; 8. the Schreyeralm limestones; 9. the Wetterstein limestones; 10. the Wetterstein dolomites; 11. the Reifling limestones.

## The Upper Triassic:

12. the "Aon beds"; 13. the Lunz beds; 14. the Reingraben shales; 15. the Raming limestones; 16. the Oponitz limestones (the Cardita beds); 17. the Hauptdolomite; 18. the Carpathian Keuper; 19. the Tisovec limestones; 20. the Furmanec limestones; 21. the Dachstein limestones; 22. the Hallstatt limestones; 23. the Aflenz limestones; 24. the Zlambach beds; 25. the Rhaetic limestones (non divided); 26. the Kössen beds.

For some lithostratigraphic units no terms exist because of difficulties with their correlation (for example limestones and dolomites of the Middle Triassic in the High-Tatra zone).

The Triassic in the West Carpathians has been studied for more than hundred years, its biostratigraphy has only 15 years' tradition. Its stratigraphy is based on paleontological studies of Cephalopoda (V. Andrusovová), Lamellibranchiata (M. Kochanová), Gastropoda (M. Kochanová), Brachiopoda (M. Siblík, J. Michalík), Foraminifera (O. Jendřejáková), calcareous sponges (E. Jablonský), conodonts (R. Mock), Dasycladaceae (J. Bystrický) and other problematica (M. Mišík, K. Borza), and on data from earlier literature (only partially revised so far).

This guide to excursion cannot comprise a detailed treating of all the stratigraphical problems; we can only concentrate to problems concerning individual profiles and facial areas demonstrated by the excursion route.

To enlighten the problems concerning the Triassic of the West Carpathians, first the survey of its geologic structure (in fact, in literature the Triassic is mostly treated according to individual tectonic units) and of its facial areas is presented.

In the excursion route we shall find the Triassic of:

1. The Gemeric: a) Slovak Karst (localities: Meliata — "the Meliata series"=the? "Upper Permian"; Skalica — Gemerská Hôrka = Middle Triassic; Kečovo = Middle Triassic; Gombasek — Middle Triassic; Zakázané — Middle Triassic; Silická Brezová = Middle — Upper Triassic; Drnava — Upper Triassic — Liassic). b) The Stratenská hornatina mountains (locality of Geravy — Upper Triassic). c) The Muránska plošina plateau (the locality of Veľká Lúka — Lopusná = Middle and Upper Triassic; Rhaetic; Liassic).

2. The Hronic: a) The Nízke Tatry mountains: the Chočnappe (localities: Hybe = the Kössen beds, Svarín = Middle and Upper Triassic; Liptovský Hrádok = the Lunz beds; Turík = Middle and Upper Triassic; Liptovská Osada = Upper Triassic (Hauptdolomite); Liptovská Osada = Middle and Upper Triassic

— (the Raming limestones). b) The Veľká Fatra mountains: the Šturec nappe (localities: Malý Šturec=Middle Triassic).

3. The Fatric: a) The Veľká Fatra mountains: the Krížna nappe (the locality Čremošné — Upper Triassic). b) Strážovská hornatina mountains: Krížna nappe (localities: Valaská Belá — Upper Triassic, Špania Dolina = Upper Triassic — Carpathian Keuper; Donovaly — Middle — Upper Triassic).

4. The Tatric: a) Nízke Tatry mountains: basal quartzites of the Lower Triassic (the locality of Donovaly).

#### The division and terminology

The Triassic is divided in accordance with the international stratigraphical scale, regarding the new results of biostratigraphical division — as far as permitted by correlation.

So far in the Lower Triassic the Scythian stage with the substages of the Seissian and the Campilian are distinguished. The new division (into three stages: the Gandarian, Owenitan, Spathian) is still impossible because of insufficient knowledge of fauna (particularly ammonites) of the Lower Triassic.

In the Middle Triassic the Anisian stage is divided into: a) the Lower Anisian (formerly "Hydaspien"); b) the Pelsonian; c) Illyrian (sensu J. Pia 1930).

According to R. Asseretto (1969), the bottom border of the Illyrian is indicated by the appearance of the genus *Paraceratites* and so includes into the Illyrian also the zone with *P. binodosus* formerly regarded as the Ammonite zone of the Pelsonian, and the zone with *Aplococeras avisianus*. At present there is a tendency to regard the zone with *Aplococeras avisianus* as the most lower zone of the Ladinian (Fassanian) (H. Kozur 1972).

*The Ladinian is divided into:* a) Fassanian; b) Langobardian.

*The Carnian in the Upper Triassic is divided into:* a) Cordevolian (the first appearances of *g. Trachyceras*); b) Julian, c) Tuvalian;

*and the Norian into:* a) Lower Norian (formerly called "Lac.", now non-designated); b) Middle Norian (Alaunian); c) Upper Norian (Sevastian).

*The Rhaetic is non-divided.*

Naturally, by referring the Cordevolian to the Carnian, terminological problems concerning lithostratigraphic units were evoked. When the Cordevolian was regarded as the most upper substage of the Ladinian, the Ladinian/Carnian boundary was approximately identical with the contact of two facially different lithostratigraphical units (the Upper Triassic commenced with the "Aon beds" or the Lunz beds). When the Cordevolian is referred

to the Lower Carnian, then the boundary of the Middle and Upper Triassic is in a lithologically indivisible sequence, in the so-called Wetterstein limestones (Fassanian to Cordevolian) or in the Reifling limestones (Illyrian to Cordevolian) and in the Ramsau dolomites. Consequently, the stratigraphical definition of these lithostratigraphic units must be revised.

## **THE GEOLOGICAL STRUCTURE OF THE WEST CARPATHIANS**

The West Carpathians consist of two fold systems: of the Outer Carpathians (the flysch zone) in the North, and the Inner Carpathians (The Central Carpathians) in the South. Both systems differ in their lithostratigraphic contents and in the age of their origin. In the Outer Carpathians, the principal tectonic processes producing the flysch nappes, passed during the Miocene (the Helvetian - Savian phase) and lasted to the Upper Tortonian. Then the flysch nappes were thrust further northwards over the Miocene of the foredeep (the Styrian phase). In the Inner Carpathians the principal alpinotypical orogenetic processes passed after the Turonian and before the Senonian (the Mediterranean phase). In the interval between the Middle Turonian and Coniacian a complicated nappe structure was formed; the consequent orogenetic processes (Laramide, Illyrian, Savian), were reflected in faults and overthrusts.

On the contact between these tectonic zones is a narrow Klippen belt, complicated and chaotic structure of which is due to several alpine folding phases. The Middle-Cretaceous folding produced north-vergent nappes; the post-Paleogene (Helvetian - Savian) damaged the formed system of nappes, and produced south-vergent slices and folds.

Since the Triassic is known only in the Klippen Belt and in the Inner Carpathians, we shall only present the sketch of the geological structures of the two tectonic units.

### **The Klippen Belt**

The Klippen Belt is about 550 km long, 2—5 km wide; the maximum width is 20 km. It is designated according to its characteristic feature — viz. the morphology of its relief. Limestone klippen project from the gently dissected relief composed of marly and flyschoid sediments ("Klippen mantle"). The limestone klippen have different size and shape (several m to a few km), composed of Jurassic and Lower-Cretaceous limestones and Triassic dolomites. According to the relationship between the

limestone klippe and the "klippen mantle" several types of the klippe are distinguished.

Most frequently the limestone klippe is separated from its mantle tectonically (the "so-called Pieniny type"); in other types the limestone klippe (Jurassic — Neocomian) are incorporated in a continuous bed sequence, or the "klippen mantle" rests transgressively on the limestone klippe. The block klippe (olistolites) also appear.

According to the Jurassic and Lower-Cretaceous facies the following principal facial zones were distinguished in the Klippen belt:

1. The zone with the Czorsztyn facies characterized by shallow-water sediments (crinoidal limestones in the Doggerian, the Rogoźnik breccia in the Tithonian and Lower Neocomian). This is the most northern zone.

2. The zone with the Kysuca ("Pieniny") facies with deep-sea sediments (spotty marls in the Liassic, radiolarites in the Dogger and Malm).

3. The zone with the Klape facies with crinoidal and nodular limestones of the Upper Liassic and Middle Dogger without the Liassic spotty marls and without radiolarites).

Among the zones mentioned are some intermediary sequences of regional or local importance.

The distribution of the klippe of the three principal facial zones represents them as facial areas of the three principal tectonic units thrust northward over each other in the form of nappes (the Czorsztyn Kysuca and the Klape nappes), during the Upper Cretaceous.

In the Váh r. valley (Považie), along the southern border of the Klippen Belt runs the Manín zone partially connected with the Klippen Belt and partially with the most northern tectonic unit of the Inner Carpathians — with the Tatric. In some places the Manín zone is dissected as the Klippen Belt, in other parts are only north-vergent recumbent folds (without any traces of the post-Paleogene southern vergency). For this reason the Manín zone is once regarded as Klippen belt (D. A n d r u s o v 1968), another time — as the marginal zone of the Inner Carpathians (M. M a h e l 1967, 1968). The tectonic position of this zone is not the only cause of contradictory interpretation — such is also its lithological - stratigraphical content. Once Liassic — Turonian sediments are regarded as its lithological—stratigraphical filling (D. A n d r u s o v 1968), another time also the Triassic (the Carpathian Keuper and Rhaetian) — the lower part of the Kysuca nappe in the Klippen Belt (M. M a h e l 1967, 1968).

For the paleogeography of the Triassic in the West Carpathians particularly important is the so-called "Pieniny ridge" (D. Andrusov 1938, 1968). It was between the Klape and Manín sedimentation areas (D. Andrusov 1968) as a source of "exotic material" (Crystalline, Carboniferous, Permian quartzose porphyries, Melaphyres, Triassic, Jurassic limestones of the so-called "Upohlav conglomerates" of the Albian or Cenomanian age (K. Borza 1972). "The Pieniny ridge" emerged and yielded material for conglomerates of the Klape zone (in Pieniny also for those or the Czorsztyń zone) in the Aptian to the Maastrichtian (K. Borza 1972).

## **The Inner Carpathians**

The pre-Senonian (Mediterranean) folding produced extensive nappes thrust from the south to the north over a distance of about 60—100 km.

The main pre-Senonian units:

The Tatric (formerly: Tatrídes).

The Fatric (formerly: "the Lower Subtracicum", "the Ultratrídes").

The Veporic (formerly: Veporides).

The Hronic (formerly: Middle Subtracicum, "the Ultraveporides").

The Gemic (formerly: Gemicides and "Upper Subtracicum").

### **The Tatric**

is the most northern sedimentation area of the Mesozoic of the Inner Carpathians. It is the most lower tectonic unit emerging from below the higher nappes of the Fatric in the form of tectonic (windows) inliers, in individual mountain-ranges. The Tatric comprises all crystalline cores of the "Core mountains" and the respective Paleozoic and Mesozoic as their original sedimentary mantle.

The crystalline cores consist mostly of granitoids, partially of crystalline schists.

The Paleozoic is locally represented by continental Carboniferous and the Permian in the facies "verrucano". The substantial part of the sedimentary mantle is the Mesozoic (Lower Triassic — Lower Turonian) with numerous hiatuses (especially in the Rhaetian), a part of the Tatric (the High-Tatric zone) emerged in the form of a horst in the Liassic.

In spite of considerable facial varieties of the Jurassic, the tectonics of the Tatric is quite simple, only in some mountains (the Vysoké Tatry, Nízke Tatry mountains) are recumbent folds (with crystalline cores) or partial nappes issuing from the mountains in which they exist.

The partial tectonic units:

- a) the High-Tatric zone (only in the Vysoké Tatry mountains);
- b) the Lubochňa zone (the Malá and Veľká Fatra mountains, the Strážovská hornatina mountains);
- c) the Ďumbier zone (the Nízke Tatry mountains, the Tribeč mountains).

These zones with different Jurassic are mostly tectonic units superimposed on each other from the south to the north: the Lubochňa zone over the High-Tatric, and the Ďumbier zone over the Lubochňa zone.

### **The Fatric**

is an extensive tectonic unit superimposed from the Tatric.

The Fatric consists of the crystalline, younger Paleozoic and mostly of the Mesozoic. At present the crystalline is only near Banská Bystrica (the Staré Hory mountains) and on the northern margin of the Suchý mountains. The Permian is the "verrucano" facies. The Mesozoic (Lower Triassic - Cenomanian) is without stratigraphic hiatuses.

The partial units:

a) the Vysoká nappe — unextensive; only in Western Slovakia (the Malé Karpaty mountains, the Suchý mountains) it is characterized by shallow-water Jurassic facies (the so-called "Vysoká series" and "Belá serie"; M. M a h e l 1967, 1968).

b) The Krížna nappe — the most extensive nappe in the Inner Carpathians. Since the Vysoká nappe is spatially limited, the Krížna nappe rests immediately on the Mesozoic of the Tatric. Its structure is simple: only in some places it consists of several partial nappes or digitations (Banská Bystrica). It is a typical shear nappe with the typical oblique truncation ("Troncature basale"). For this reason in its frontal parts the Mesozoic sequence commences with the Middle Triassic, in the south by the Lower Triassic, then with the Crystalline and the Permian.

Since the Fatric rests on the Tatric and crops out only to the north of the tectonic "Čertovice line", the line is regarded as a scar comprising the root parts of the Fatric. Along the line the Veporic is superimposed on the Tatric.

## The Veporic

It is the principal tectonic unit formed of the crystalline and of its original sedimentary mantle. The crystalline (crystalline shales with granitoids) of the pre-Carboniferous age was affected by alpine diaphthoresis and dissected into 4 subzones (from N to S: Lubietová, Kraklová, Kráľova hoľa and Kohút subzones).

The Permian is in the "verrucano" facies with quartzose porphyries and the corresponding vein type, especially in the Lubietová subzone. The Mesozoic of the Veporic is generally dynamically metamorphosed; in both northern zones (Lubietová and Kraklová) it is resembling the Mesozoic of the Krížna nappe and called the Veľký Bok series.

Both southern zones (Kráľova hoľa and Kohút) have intensively metamorphosed sedimentary mantle with incomplete bed sequence. It is the so-called "Foederata series" ("the Dobšiná Mesozoic", M. M a h e l 1956, "The Struženik series", M. M a h e l 1965, 1967).

## The Hronic

(the Middle Subatricum; the Choč nappe s.l.). On the Krížna nappe — in tectonic superposition — are masses or small klip-pes of limestones and dolomites so far designated "the Choč nappe". In "the Choč nappe" several bed sequences were distinguished according to the facies of the Middle Triassic: "the Biely Váh facies", "the Čierny Váh facies", "the Strážev facies". They were interpreted as facial areas of one principal sedimentation area, digitations of "the Choč nappe" (M. M a h e l 1967), or as partial tectonic units of "the Choč nappe". The partial units of "the Choč nappe" with the Triassic Biely Váh facies were designated as "the Svarín partial nappe", those with the Čierny Váh facies — as "the partial nappe of Boca" and the "partial nappe of Malužiná" (A. Biely 1967 in A n d r u s o v D. 1967). The so-called "Strážov facies" were considered typical of the higher nappe called the Strážov nappe (D. A n d r u s o v, 1938, A. Biely — J. B y s t r i c k ý — O. F u s á n 1968).

The new data on the facies and stratigraphy of the Triassic in these tectonic units show that it is a group of nappes of a principal tectonic unit called the Hronic.

Consequently, the Hronic is principal tectonic unit with the crystalline about which no data are available so far. We only know that it is separated from the northern main tectonic unit — the Veporic — by an extensive tectonic plane resembling the

Čertovica line. In the plane is a scar comprising the entire root area with the crystalline. The tectonic plane is called the "Lubeník — Margecany line" and separates tectonically the Veporic from the principal inner tectonic unit — from the Gemeric.

Its partial units are:

- a) the Šturec nappe (the most lower one),
- b) the Choč nappe s. s. ("the Svanín partial nappe", "the Biely Váh partial nappe").

The Hronic bed sequence commences with the Middle Carboniferous without limestone layers, still with the bodies of basical rocks. The Permian is in a particular bed sequence presented as "the Melaphyre series". The Triassic commences with basal quartzites and terminates in the Rhaetian of varied facies.

Among younger Mesozoic beds are Lias — Dogger crinoidal limestones, Dogger and Malm nodular limestones; shales Tithonian and Neocomian marly shales and limestones in the form of small slices and shreds. Middle — and Upper — Triassic Limestones and dolomites prevail absolutely.

The Šturec nappe is a nappe in the Middle — and Upper — Triassic dolomite facies. These are most frequent in and typical of the Veľká Fatra mountains (Veľký and Malý Šturec, after which the nappe is called).

The Choč nappe is a nappe with the Reifling limestones in the Middle Triassic and with the Lunz beds in the Upper Triassic which are present in the mountain group of the Choč (in the Chočské pohorie mountains). Properly these are the so-called "Biely Váh facies"; present also on the northern slopes of the Nízke Tatry mountains in the valley of the river Čierny Váh.

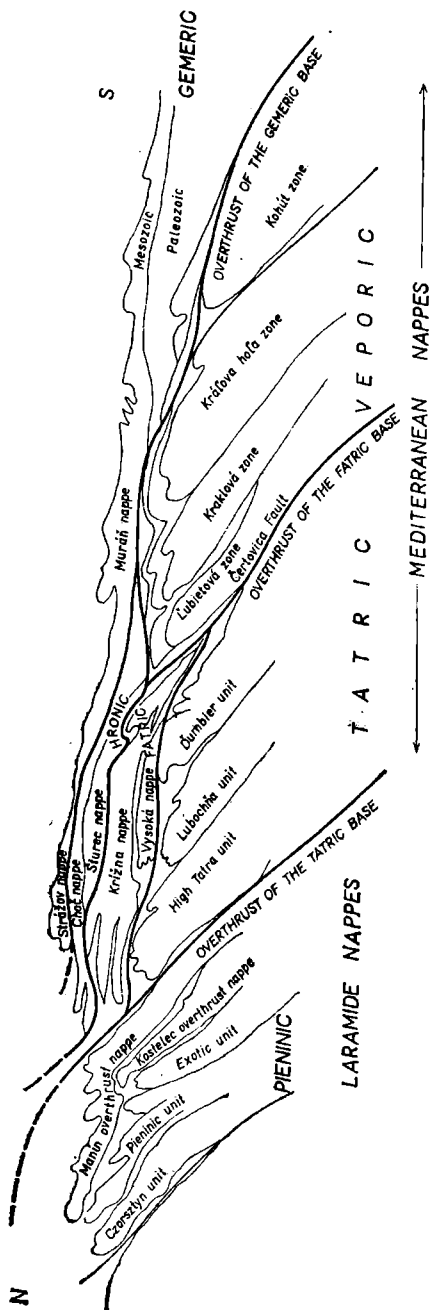
The Šturec and the Choč nappes (s. s.) appear mostly as nappe outliers situated side by side on a common basement, i. e. on the Neocomian (or the Cenomanian) of the Krížna nappe. In some places the nappes appear in a distinct tectonic superposition (the northern slopes of the Nízke Tatry mountains, the Strážovská hornatina mountains): the Choč nappe on the Šturec nappe.

### **The Gemeric**

is the most inner principal tectonic unit of the Inner Carpathians. It is formed of the Paleozoic of the Spišskogemerské rudohorie mountains and of the Mesozoic of the Slovak Karst, of the Stratenská hornatina mountains and of the Galmus mountains.

The Mesozoic rests paraautochthonously on the Paleozoic of the Spišsko-gemerské rudohorie mountains. The Mesozoic in the

Fig. 1. Scheme of pre-Paleogene tectonic units of West Carpathians



distinct nappe position, thrust over the more northern tectonic units (the Veporic or over the nappes of the Hronic), is defined as nappe outliers of unknown mutual relationship. The nappe outliers are therefore designated as the Muráň nappe with the partial Vernár nappe (both resting on the nappes of the Hronic around Banská Bystrica), and the Strážov nappe with the partial nappes of Vetrník and Havranica in the Malé Karpaty mountains, with the Nedzovské (Čachtické) pohorie mountains; and the partial nappe of Tlstá in the Veľká Fatra mountains and the Tematín partial nappe in the Povážský Inovec mountains.

The relationship between the Gemic and the external main tectonic units (the Veporic and Hronic) was explained above.

## FACIAL AREAS OF THE TRIASSIC IN THE WEST CARPATHIANS

The facial areas of the Triassic were sketched by V. Uhlig (1903, 1907). When defining the principal tectonic units (nappes), V. Uhlig distinguished the High-Tatric, Sub-Tatric facial areas, the facial area of "the Inner Belt" and that of the Hungarian Transdanubian Central mountains; and explained their mutual relations based on the principle of the tectonic independence of the main facial areas. The new data on the stratigraphy and facies of the Triassic [for example: the determination of the Ladinian age of "the Choč dolomites" regarded as Upper-Cretaceous by V. Uhlig] completed or changed V. Uhlig's scheme, still they did not deny the main principle of the idea of the nappe structure: that each nappe is an original sedimentation area of the nature of a longitudinal geosynclinal zone. At present — in the same sense — the following facial areas are distinguished in the Triassic: the Tatric, Fatric (= Krížna), Veporic (Struženik; M. Maheľ, 1967, 1968, 1971), the Hronic (= Choč) and the Gemic.

In 1960 M. Maheľ tried without success to interpret the main facial areas as autochthonous zones rimming the crystalline cores of individual mountain ranges.

The definition of the principal facial areas of the Triassic (i. e. of the main tectonic units: nappes, and autochthonous units) is based upon various geological events and especially upon the criterion of facies of the Upper Triassic (the facies of the Carpathian Keuper in the Tatric and Krížna nappe facial areas; the facies of Hauptdolomite and of the Lunz beds in the Choč facial area; and the facies of light-coloured massive limestones in the Gemic [facial area]; their detailed classification is, however, still obscure. Unexplained is the relationship between a partial facial area and a tectonic unit (the main or the subsidiary); and it is not clear whether tectonic units regarded as partial units are not tectonic units of the first order (for example the case of the Strážov nappe, of the partial nappes of the Choč nappe: the "Biely Váh" and "Čierny Váh nappes", and others). We do not know for sure in which case there is a "Vielfaziesdecke" or a "Teilfaziesdecke" in the sense of A. Tollmann (1966). With respect to the facies of the Triassic and of the Lower Cretaceous, the Krížna nappe is a typical "Faziesdecke", but regarding the facies of the Jurassic, it is a "Vielfaziesdecke". The Choč nappe (sensu M. Maheľ 1968) with both "partial nappes" is a "Vielfaziesdecke", but its partial nappes are "Faziesdecken", etc.

The correlation is considerably obscured by different, very arbitrary usage of the term "series". Once it is used in lithostratigraphical sense (as the largest lithostratigraphical unit of the regional scale corresponding to the English terms group or formation), other time in facial or tectonical sense (M. Mahe I, 1967, 1968). In some cases "a series" means facial areas of the Triassic (in the Choč nappe: the Biely Váh, the Čierny Váh series; in the Gemerides: the Stratenská, the Vernár, the Muráň series, etc.); in other cases facial areas of the Jurassic are meant (in the Krížna nappe: »the Zliechov series" = the Liassic in the facies of spotty marls, "the Belá series" = the Liassic in the facies of crinoidal limestones). If these "series" are at the same time regarded as tectonic units (M. Mahe I, 1967, 1968), then most complicated is tectonics of the Tatric where — on the basis of the Triassic facies mainly of the Jurassic and Lower Cretaceous — even more "series" were distinguished than crystalline cores.

Because of the above obscurities the definition of facial areas of the Triassic is based solely on lithofacial and stratigraphical criteria.

The criterion of simultaneity being the category of division of the international chronostratigraphical scale (= "Series" in English, "Serie" in French, in German; "otdel" in Russian; cf. D. Andrusov — E. Scheibner 1964, p. 169) the following facial areas may be distinguished:

#### The Lower Triassic

a) the facial area of quartzites, quartzose sandstones and conglomerates; b) the facial area of variegated sandstones, clayey and marly schists.

The first one occupies the entire region of the Tatric, of the Krížna nappe, and in the Seissian it extends to the region of the Choč nappe; the second covers the entire region of the Gemeric and in the Campilian extends to the Choč nappe.

#### The Middle Triassic

a) the facial area of the Steinalm — Wetterstein limestones and dolomites; b) the facial area of the Reifling limestones; c) the facial area of the Annaberg limestones and Ramsaudolomites.

a) The facial area of the Steinalm — Wetterstein limestones and dolomites occupies the entire region of the Gemeric (the Slovak Karst), the Muráň nappe (the Muráňská plošina plateau; the Stratenská hornatina mountains, the Galmus mountains, the so-called Vernár Belt in the Nízke Tatry mountains, the Drienok

nappe in the Zvolenská hornatina mountains), of the Strážov nappe (in the Veľká Fatra, Strážovská hornatina, Považský Inovec, Malé Karpaty and Nedzovské pohorie mountains). By its lithological and biofacial nature the facial area represents an extensive "reef complex", dissected irregularly to "reef cores" and "lagoons". In some places the Steinalm and Wetterstein limestones are separated by a sequence of the Schreyeralm limestones or of Reifling limestones. They — as "basin facies" — represent sediments affected rather by volcanism in the Bükk mountains than by altered bathymetric conditions.

b) The facial area of the Reifling limestone covers properly the region of the Choč nappe in the so-called Biely Váh Facies. Most typical of this area are the Reifling limestones. In their basement are Ramsau-dolomites of the Pelsonian, or Pelsonian-Annaberg limestones.

This being the most southern part of the Choč nappe, nearest to the previous facial area of the Steinalm — Wetterstein limestones, the Reifling limestones may be regarded as its basin sediments.

The influence of the southern facial area is only in the Lower Carnian (Cordevolian — Lower Julian) in the deposition of bioherms of the Raming limestones.

c) The facial area of the Annaberg limestones and Ramsau-dolomites occupies the northern part of the Hronic (the so-called Čierny Váh facies = the Šturec nappe), the entire region of the Križna nappe and a considerable part of the Tatric (with the exception of "the High-tatric zone").

The stratigraphy and facies of this area are insufficiently described so far.

Perhaps, the partial facial areas could be determined according to the stratigraphical diapason of dark limestones (the Guttenstein-Annaberg limestones, and the limestone layers in the Ladinian dolomites). The relationship of this facial area to be southern facial area of the Reifling limestones is unknown (the partial "Čierny Váh nappe" is facially so different from "the partial Biely Váh nappe" that it may perhaps be regarded as an independent nappe, the more so that its spatial extension may be traced along the whole West Carpathians).

### The Upper Triassic

The facial areas in the Upper Triassic are much more distinct than those in the Middle Triassic. It is mostly due to the facies of the Carpathian Keuper in the sedimentation area of the northern zones (the Tatric, the Križna nappe) and due to dolo-

mites and limestones present in the sedimentation area of the southern zones (the Choč nappe, the Gemic).

On the basis of the existing data the following facial areas may be distinguished in the Upper Triassic:

a) the facial area of the Dachstein limestones (Dachstein Kalk, Dachstein-Riffkalk); b) the facial area of Hauptdolomite; c) the facial area of the Carpathian Keuper.

a) The facial area of the Dachstein limestones is most southern and occupies the entire region of the Gemic. It is an extensive reef complex of facies of the reef core (the Tisovec and Furmanec limestones) and of lagoons (the Dachstein limestones), rimmed by the facies of the Hallstatt limestones (the Norian) and of the Zlambach beds (the Norian — Rhaetic) on the south; and by dark cherty limestones (equivalent to the Aflenz limestones) — the basin sediments on the north. Northwards this facial area links up with the facial area of Hauptdolomite (the Triassic of Vernár).

b) The facial area of Hauptdolomite is very extensive. It covers the northern part of the Gemic, the entire region of the Strážov and Choč nappes (all its partial nappes) and extends to the Krížna nappe.

In the areas of the Reifling limestones, in the substratum of Hauptdolomite are Lunz beds, which only in this place reach the maximum thickness (approx. 300 h), while in other regions (the northern part of the Gemicides, the Krížna nappe, the Šturec nappe) they are only some tens of metres thick which is hardly enough for the differentiation of the Cordevolian dolomites (Ramsadolomites) from the Tuvalian dolomite (Hauptdolomite).

The stratigraphy of this facial area is only partially known; still the data on the area of the Nízke Tatry mountains (the valley of the river Revúca) and the Veľká Fatra mountains show that in the Carnian (Tuvalian) Hauptdolomite is not only lagoonal sediment of the reef complex of the facies area of the Dachstein limestones, but a particular reef complex of facies of the reef core and of lagoons.

c) The facial area the Carpathian Keuper is the most northern known area of the Upper Triassic in the West Carpathians. It covers the region of the Krížna nappe, of the Tatric, the inner parts of the Klippen Belt (D. Andrusov 1968) lastly referred to the Manín unit (M. Mahel 1967, 1968). Differences in the development of the Carpathian Keuper of the Tatric and of the Krížna nappe are in more abundant conglomerates and coarse-grained quartzose sandstones in the Tatric, and in more distinct "Keuperdolomite" in the Krížna nappe. Differences in strati-

graphical diapason (Carnian — Norian in the Tatric) Norian in the Križna nappe) are not paleontologically evidenced so far. The stratigraphical — facial table for the Triassic shows that distribution of individual facial areas of the Middle and Upper Triassic does not fully correspond to the course of the main tectonic units. An exception is the facial area of the Reifling limestones, related only to the so-called "Biely Váh partial nappe" (= Choč nappe). The facial area of the Steinalm-Wetterstein limestones is a common substratum of the facial area of the Dachstein limestones and of the predominant part of the facial area of Hauptdolomite. Observed is also local extension of the reef complex to the area of the basin sedimentation (the Raming limestones in the facial area of the Reifling limestones). The shifting and interpenetration of various facial areas in the Middle and Upper Triassic cause different or contradictory tectonic interpretation, especially of the partial units of the Choč nappe to which sometimes also the Strážov nappe is referred (M. Maheľ 1967, 1968).

## The Slovak Karst

The Slovak Karst is the most southern range of the West Carpathians in the Slovak territory. The Mesozoic of the Slovak Karst, mostly the Middle Triassic light-coloured massive limestones (limestones of the Steinalm and Wetterstein types) represent the surficial and subsurficial karst phenomena (the caves Domica, Gombasek, Rožňava — Krásnohorská Dlhá Lúka, etc.). At the first sight, the mountain range has the appearance of a simple limestone table dissected by canyon-like valleys into individual karst plateaus. Actually, it is a peneplanated system of N-W striking folds. Frequently the limbs of folds are broken or cut off younger overthrusts. In the cores of anticlines are Seissian beds, while in the cores of syncline remnants of the Upper Triassic and Jurassic preserve (as late as the Dogger or Malm). On the present-day surface no beds younger than Malm (Lower and Middle Cretaceous) are known. Most likely, they were eroded and denuded off during the long continuous emergency prior to the Senonian and during the earlier Tertiary. In the south, Aquitanian transgressed on the peneplanated Mesozoic Wetterstein limestone; on other regions the latter is overlain by a gravel formation (Pannonian), in the east by a "coal-bearing series" with intercalations of fresh-water limestones (Pontian) or by Upper Cretaceous conglomerates with bauxite lenses on their base. The conglomerates are referred to the Senonian. The Paleozoic of the Spišsko-gemerské rudohorie mountains is overlain by the Mesozoic of the Slovak Karst. The contact of the latter with the Paleozoic is tectonical, the northward thrust in the form of an overthrust mass is, however, not so conspicuous as in the Muránská plošina (Plateau).

The thrust is only traceable in tectonic outliers (Radzim, Krásna Hôrka hill) and in tectonic reduction (boudinage) along the northern periphery of the Mesozoic. Products of the tectonic activity during the Cretaceous orogenetic phase (a system of folds, the northward thrust) are considerably disguised by younger N-striking longitudinal thrusts. Basing upon the thrusts, some partial fold structures are distinguished (from the north southwards: the Hačava — Jasov, Silica — Turňa, Plešivec — Brezová and the Kečovo fold structures). The age of these thrusts is not definitely known so far; the overthrust of the Mesozoic on the Pontian sediments indicated the Miocene orogenetic phases. An extensive system of transverse faults is also a product of several orogenetic phases.

The so-called Meliata formation [cf. the locality Meliata] is

underground of the paleontologically proved beds of Seissian age. The Meliata formation is represented by light-coloured massive or thick-bedded, coarse-crystalline limestones, varied radiolarites and a thick sequence of dark, red and green clayey shales. In the shale sequence are large bodies of anhydrite and gypsum. In the Meliata formation are also deposits of haematite, strata of diabase and their tuffs. The age of the Meliata formation cannot be strictly defined. Its position below the beds of Seissian age indicates Upper Permian. Most likely it is equivalent to the marine Upper Permian or to the most lower Seissian in the Bükk Hills in Hungary, or to both.

The sequence of beds in the Mesozoic of the Slovak Karst is as follows:

#### Lower Triassic

a) Varied sandstones and varied clayey shales containing *Claraia clarai* (Emmer.), *Claraia aurita* (Hauer) (Kobeliarovo, Hucín).

b) Varied clayey and marly shales with sandstones and micaceous limestone layers (containing *Tirolites spinosus* Mojs., *Costatoria costata* (Zenk.), *Turba rectecostatus* (Hauer) etc. Locally (Plešivčická planina) appear oolitic limestones, the so-called "Gastropodenoolit" with lamellibranchiates and gastropods (Lower Campilian).

c) Grey and green marly shales alternating with bedded green and grey limestones, mostly with darkgrey to dark limestones; fauna: *Tirolites castanus* (Quenst.), *Carniolites carniolicus* (Mojs.), *Dinarites evoluttor* Kittl.,? *Diaplococeras circumplacatum* (Mojs.), *Costatoria costata* (Zenk.) and other typically Campilian (Upper Campilian) fossils.

The Campilian terminates with limestone breccia reflecting partly the local emergency and partly their tectonic origin.

#### Middle Triassic

a) Gutenstein limestones and dolomite. Dark, bedded limestones, poor in fossils. So far only infrequent small gastropods (*Natica* sp.) and among foraminifers *Pilamina densa* Pantić (Borza 1970) are known. The limestones are overlain by grey, dark-grey bedded dolomites of the same outlook as the dolomite layers in the Gutenstein limestones. They are designated as Gutenstein dolomites. They also comprise beds of red limestones and reddish dolomites.

Gutenstein limestones and Gutenstein dolomites are referred to the Lower Anisian.

b) Steinalm limestone. They are light, massive, organodetrital limestones with lenses of light or pinkish saccharoidal dolomites.

Two zones with Brachiopoda are in this bed sequence: the Zone of *Decurtella decurtata* (loc. Štítník, J. Bystrický 1964, M. Siblík 1971; loc. Aggtelek — Z. Schréter 1935) and the Zone of *Piarorhynchia trinonosi* (loc. Brzotín; Zakázané. — J. Bystrický 1964, M. Siblík 1971). When correlated with the dasycladean zones, both the above zones correspond to the zone of *Physoporella pauciforta*. The most upper dasycladacean zone of the Steinalm limestones — the zone of *Diplopora annulatissima* — is equivalent to the zone with Ammonites in the Upper part of the Schreyeralm limestones, in red nodular limestones (cf. locality Kečovo). Stratigraphical range of the Steinalm limestones corresponds to the Pelsonian or Pelsonian and Illyrian (sensu R. Assereto 1969), in some places extending into the Zones with Aplococeras avisianus.

A more detailed division of the zone of *Physoporella pauciforata* cannot be done so far. Foraminifera from the Zone of *Physoporella pauciforata*: *Citaella dinarica* (Koch. — Dev. et Pantič), *Citaella cf. insolita* (Ho.), *Pilamina densa* Pantič.

Lamellibranchiata (only small specimens embryonal tests): *Daonella pichleri* Gumb., *Valdidenella dieneri* Alma, J. Bystrický 1964; loc. Gemer. Hôrka).

Calcareous sponges (Sphinctozoa): *Colospongia catenulata* Ott, *Dictyocoelia manon* (Muenster), *Vesicocaulis alpinus* Ott. Bryozoa are frequent, taxonomically non-classified.

The limestones with *Diplopora annulatissima* contain this only species of Dasycladacea. Frequent are crinoid segments, rare Ammonites, and common species of Foraminifera (cf. loc. Kečovo).

c) Schreyeralm limestone. The sequence regarded as equivalent to the East-Alpine Schreyeralm limestones consists of two facies differing in colour or in facies. The two facies are situated either near-by or above each other. At the bottom are dark or black, bedded, nodular limestones with dark cherts, or thick — bedded and organodetrital limestones. Higher up are red or pink, bedded, nodular limestones with layers of red yellow cherts. In some profiles one of the facies is predominant.

c1) Dark nodular limestones recall the Reifling limestones by their facies. They contain mostly Conodonta (cf. loc. Gombasek). In lenses of crinoidal limestones are Brachiopoda and Foraminifera (*Pilamina densa* Pantič; cf. loc. Gombasek).

Among these in the Plešivecká planina (plateau) are *Tetracti-*

nella trigonella (Schloth), *Koeveskallina koeveskalyensis* (Stur), "*Spiriferina*" cf. *piä* Bittn., *Decurtella vivida* (Bittm.), *Decurtella(?) illyrica* (Bittn.), *Pexidella marmorea* (Bittn.).

c2) Dark grey, thick-bedded organodetrital limestones are mostly on the Plešivecká planina [plateau] (Berc.). From these limestones originates fauna of Ammonites *Ptychites acutus* Mojs. [J. Bystrický 1964] and Conodonts [R. Mock 1971] indicating the Illyrian: *Enantiognathus petraeviridis* (Huckriede), *E. zieglerei* (Diebel), *Gondolella excelsa* (Mosher), *Hibardella lautissima* (Huckriede), *Hindeodella (Metaprioniodus) suevica* (Tatge), *Lonchodina hungarica* Kozur—Mostl., *L. posterognathus* (Mosher), *Neoplectospathodus muelleri* Kozur—Mostl., *Ozarkodina tortilis* Tatge, *Prioniodina (Cypridodella) muelleri* (Tatge), *P. (C.) venusta* (Huckriede).

c3) Red and pink nodular limestones contain Ammonites in more localities (cf. Zakázané, Skalica; J. Bystrický 1964, V. Andrusovová 1967), indicating the zone with *Aplococeras avisianus (Flexoptychites flexuosus* Mojs., *Ptychites acutus* Mojs., *Ptychites megalodiscus* Beyrich, *Discoptychites* sp., *Monophyllites sphaerophyllus* Hauer, *Pleuromutilus* sp., *Atracites* sp., *Orthoceras* cf. *campanile* Mojs., *Norites apioides* Arth).

Conodonts from these limestones are from the Plešivecká planina [plateau] (loc. Berc), and Silická planina [plateau] (cf. loc. Gombasek). On the Plešivecká planina is the assemblage *Chirodella dinodoides* (Tatge), *Dichodella alternata* Mosher, *Diplododella bidentata* (Tatge), *Enantiognathus petraeviridis* (Huckriede), *E. zieglerei* (Diebel), *Gladigondelella tethydis* (Huckriede), *Gondolella excelsa* (Mosher), *G. mombergensis* Tatge, *G. navicula* Huckriede, *Hibbardella lautissima* (Huckriede), *Hindeodella (Metaprioniodus) pectiniformis* (Huckriede), *Hindeodella (Metaprioniodus) spengleri* (Huckriede), *H. (M.) suevica* (Tatge), *Lonchodina hungarica* Kozur—Mostler, *L. posterognathus* (Mosher), *Neohindeodella dropla* (Spasov—Ganev), *Neoplectospathodus muelleri* Kozur—Mostler, *Ozarkadina tortilis* Tatge, *Prioniodina (Cypridodella) muelleri* (Tatge), *P. (C.) venusta* (Huckriede). [R. Mock 1971.]

Foraminifera are known only partially so far: the species *Citaella* cf. *insolita* (Ho.) and *Nodosaria armeniensis* Efim. (cf. loc. Gombasek).

The Schreyeralm limestones in the above sense, i. e. dark

nodular limestones and red nodular limestones are referred to Upper Illyrian here (cf. the stratigraphical table) and regarded as equivalent to the zone with *Diplopora annulatissima*. The ammonites found in these limestones allowed to refer them to the zone with *Aplococeras avisianus*. More accurate age determination is not possible; since in their substratum is *Piarorhynchia trinodosi* (Bittn.) typical of the *Paraceratites trinodosus* zone, i. e. of the Illyrian.

Recently, in both sequences of the Schreyeralm limestones conodonts were found facilitating age determination with respect to the new conception of the zone with *Paraceratites trinodosus* sensu Assereto 1971 and of a zone with *Aplococeras avisianus* (R. Assereto 1969).

Both sequences of the Schreyeralm limestones belong to this "excelsa assemblage zone" (H. Kozur — H. Mostler 1972), in the sense of zonal division of the Middle Triassic into zones of conodonts. Dark limestones in Berc (the Plešivecká planina) and dark nodular limestones of the Gombasek winding paths (the Silická planina) with *Gondolella excelsa* belong to subzone I referred to the Illyrian (the zone with *Paraceratites trinodosus* sensu R. Assereto), while the overlying red nodular limestones with *Gondolella excelsa* and *Gladigondolella tethydis* are referred to "subzone II" comprising the zone with *Aplococera avisianus* and the zone with *Protrachyceras reitzi*.

Dark limestones overlying the Schreyeralm limestones of Fasanian age contain conodonts of the "subzone II."

According to the sequence of beds in the profiles mentioned, red nodular limestone, i. e. the lower sequence, should be referred to the zone with *Aplococeras avisianus*, and dark, sometimes cherty overlying limestones — to the zone with *Protrachyceras reitzi*.

Consequently, we may expect that two ammonite zones are in the Schreyeralm limestones: the zone with *Paraceratites trinodosus* in dark limestones (in Berc only indeterminable ammonites were found so far), and the zone with *Aplococeras avisianus* in red nodular limestones. The first one is generally considered an Anisian zone, the second — the uppermost zone of the Illyrian (R. Assereto 1969, 1971) or the lowermost zone of the Ladinian (H. Kozur — H. Mostler 1972).

The relationship of these zones to the dasycladacean zone is not quite clear (E. Ott, 1972, regards the Avisianus zone as the Uppermost Illyrian with *Diplopora annulata*).

Near Kečovo the zones with *Diplopora annulatissima* is between the Steinalm limestones with *Physoporella pauciforata* and the

Wetterstein limestones *Diplopora annulata*. On the contact between the zone with *Physoporella pauciforata* and the zone with *Diplopora annulatissima* are lenses or red limestones containing conodonts of the "subzone I".

Since the zone with *Diplopora annulatissima* is situated higher up, it corresponds to the lower part of the "subzone II" (the Avisianus zone), and *D. annulata* zone begins in the upper part of the "subzone II." (the Reitzi zone).

The correlation shows that *D. annulatissima* zone is chronologically equivalent to red nodular limestones of Berc and Gombasek winding paths. This is in accordance with the exact data about the presence of *D. annulatissima* in red Schreyeralm limestones in the Muránská plošina [plateau].

The problem of the Anisian — Ladinian boundary may be solved by the examination of all the finds of Ammonites fauna and by a complex evaluation of other fossil groups. At present it does not seem right to refer the Avisianus zone to the Ladinian (the first appearances of *Diplopora annulata*. It is, however, necessary to take in consideration that the sequence of the Schreyeralm limestones is facially variable, and laterally interbedding dark, red and light-coloured limestones in the sequence.

In Mokrý Lúka (the Silická planina), in the overlies of the Steinalm limestones and in the substratum of the Fassanian cherty limestones only dark nodular cherty limestones appear as a lateral equivalent of both sequences of the Schreyeralm limestones, and in other places (the plateau Koniart) they are represented only by light-pink and red limestones. Lithological criteria cannot be applied in this classification.

In the Ladinian are two different facies arranged either side by side or above each other:

the facies of dark, bedded limestones with cherts, and the facies of lightcoloured massive organodetrital limestones — the Wetterstein limestones.

d) The dark, bedded limestones overlies the Schreyeralm limestones. In some regions they contain dark-grey cherts and recall — to a certain extent — the Reifling limestones (only they are not nodular). In their lower part are local layers of dark shales, of green quartzose argillites, and thin layers of green tuffs and tuffites.

The dark cherty limestones did not yield any macrofossils. Found were only conodonts (loc. Berc in the Plešivecká planina, R. M o c k 1971), viz. *Gondolella excelsa* (M o s h e r) and *Gladi-gondolella tethydis* (H u c k r i e d e), *Enantioognathus petraeviridis* (H u c k r i e d e), *Hindeodella (Metaprioniodus) suevica*

(Tatge), *Prionodina (Cypridodella) muelleri* (Tatge), *P. (C.) venusta* (Huckriede), — as assemblage of species known from red nodular limestones (the Schreyeralm limestones) in the substratum.

The dark, bedded limestones without cherts contain on their base *Daonella tyrolensis* Mojs., *D. indica* Bittner (cf. loc. Gem. Hörka); in the place of the lateral transition into the Wetterstein limestones they contain *Teutoporella herculea* (Stopp.) Pia, and conodonts (cf. loc Gombasek) indicating their commencement in the Fassanian.

The upper stratigraphical boundary may be determined according to the presence of *Teutoporella nodosa* (Schafh.) on the base of the overlying Wetterstein limestones (K. Balogh 1953). In their overlier no *Diplopora annulata* was found.

e) The Wetterstein limestones. They are light-coloured massive limestones recalling the Steinalm limestones. They comprise parts or layers of dark-grey to dark organo-detrital limestones. According to fossils two main facies may be distinguished in the limestones: the facies of Sphinctozoa and that of Dasyclasaceae. In the latter are again two facies: the one with *Teutoporella herculea* and another with *Diplopora annulata*. All the facies mentioned are distinctly demarcated, with the exception of the facies with Sphinctozoa in which sporadic *T. herculea* occurs. The vertical stratigraphical range of the facies with sphinctozoa and of that with *T. herculea* is between the base of the Ladinian and extends to the Cordevolian, where as the facies with *Diplopora annulata* occupies only the lower part of the Wetterstein limestones, mainly the Fassanian and perhaps also Langobardian. In profiles both facies with Dasycladaceae frequently appear in superposition. Down is the facies with *D. annulata*, higher up — that with *Teutoporella herculea*.

The Wetterstein limestones are poor in macrofossils. Gastro-poda, if any, are mostly indeterminable. We only know *Trachynerita quadrata* Stopp. (cf. loc. Kečovo); among Lammellibranchiata *Daonella lomelli* Mojs. (cf. loc. Skalica and Kečovo) appears. Microfossils are more frequent. The facies of Sphinctozoa: *Colospongia catenulata* Ott, *Vesicocaulis alpinus* Ott, *Colyphina submarginata* Muenst., *Dictyocoelia manon* (Muenst.), *Cryptocoelia zitteli* Steinm., *Colospongia cf. dubia* Laube, *Follicatena cautica* Ott. *Dasycladaceae* facilitate distinguishing of several zones; as e. g. the zones with *Diplopora annulata* with both varieties: *v. annulata* and *v. dolomitica* (Pia) Herak, with *Macroporella beneckeii* Salomon. Perhaps the zone with

*Teutloporella aequalis* (Guemb.) Pia and *T. nodosa* (Schafh.) Pia is its lateral equivalent.

The uppermost part of the limestones with *Teutloporella herculea* extends to the zone with *Poikiloporella duplicata* (Pia) Ott, commencing in the Cordevolian.

Foraminifera of the Wetterstein limestones with *Teutloporella herculea* (cf. Tab. Nr. 2.).

Tab. Nr. 2 — Foraminifera of the Wetterstein limestones  
Species

Species	Locality			
	1	2	3	4
<i>Agathammina austroalpina</i> Kr.-Toll. et Toll.		○	○	○
<i>Ammobaculites radstadtensis</i> Kr.-Toll.			aff.	
<i>Ammobaculites</i> sp.	?			
<i>Austrocolomia cordecolica</i> Oberh.			aff.	
<i>Ammodiscus</i> sp.			○	
<i>Glomospira</i> sp. 1			○	○
<i>Glomospira gordialis</i> (Jones et Parker)			cf.	
<i>Glomospira vulgaris</i> Ho			aff.	
<i>Glomospira kutham</i> (Salaj)				cf.
<i>Glomospirella</i> sp.	○	○	○	○
<i>Glomospirella friedli</i> Kr.-Toll.		aff.		
<i>Glomospirella paralella</i> Kr.-Toll.				aff.
<i>Glomospirella irregularis</i> Moeller				○
<i>Diploremina astrofimbriata</i> Kr. -Toll.	○	aff.	○	
<i>Duostomina alta</i> Kr.-Toll.		aff.	○	
<i>Neoendothyra reicheli</i> Reitl.				○
<i>Endothyra kuepperi</i> Oberh.		○		○
? <i>Guttulina</i> sp.				○
<i>Involutina sinuosa sinuosa</i> (Weynsch.)			○	○
<i>Involutina sinuosa pragsoides</i> (Oberh.)			○	○
<i>Involutina gaschei</i> (Koehn-Zan. et Brön.)			○	○
<i>Involutina gaschei praegaschei</i> Koehn-Zan.			○	○
<i>Involutina plamidiscoides</i> (Oberh.)				○
<i>Involutina eomesozoica</i> (Oberh.)			cf.	○
<i>Involutina</i> sp.		○	○	○
<i>Trochammina alpina</i> Kr.-Toll.		○		
<i>Trochammina almtalensis</i> Koehn-Zan.	cf.			
<i>Ophthalmidium exiguum</i> Koehn-Zan.				○
<i>Variostoma crassum</i> Kr.-Toll.			aff.	
<i>Variostoma pralongense</i> Kr.-Toll.		○		

1. The Wetterstein limestones with *T. herculea* — the basal part (loc. Zakázané)

2. The Wetterstein limestones with *T. herculea* — the uppermost part (loc. Sil. Brezová, the Plešivecká planina — Holá skala)

3. The Wetterstein limestones with *T. herculea* and *Poikiloporella duplicata* (loc. Včeláre, Španie pole, Budikovany)

4. The Wetterstein limestones with *Poikiloporella duplicata* (Ostré vršky, Plešivecká planina).

### The Upper Triassic

Formerly the uppermost part of light-coloured massive limestones with *Teutloporella herculea* and *Poikiloporella duplicata* (Cordevolian) was referred to the Ladinian, and designated as the Wetterstein limestones. At present, the Cordevolian is included into the Upper Triassic, owing to ammonites (the first appearances of the genus *Trachyceras*), to alternations in microfauna (conodonts, sclerites of *Holothuria*) and to the first appearances of the genus *Poikiloporella*.

Considering this conception of the Cordevolian, the Upper Triassic in the Slovak Karst is extended more than it was formerly assumed. Cordevolian limestones with the above dasycladacean assemblage are in almost all karst plateaus and in all tectonic units. Cordevolian macrofossils are not known so far. The foraminiferal assemblage accompanying Dasycladaceae is characterized by the first appearances of the genus *Involutina* (cf. Tab. 2.).

The upper part of the Carnian, the Julian or the Julian and the Tuvalian are not so extensive. It was paleontologically proved only in the Plešivecká planina (Ostré vršky, Malý vrch hills, and near Silická Brezová).

In the Plešivecká planina are light-coloured massive limestones with *Poikiloporella duplicata*, containing lenses of dark-grey oncolitic limestones with *Girvanelles*; lenses of red oolitic limestones with crinoids and lenses with minor *Lamellibranchiata* and *Brachiopoda*.

Among *Brachiopoda* only the species *Laballa suessi* (Winkl.), infrequent *Koninckina* are known; among *Lamellibranchiata* — *Halobia superba* Mojs., *Halobia cf. austriaca* Mojs. These are, however, of no importance for a detailed classification. From these limestones with small *Lamellibranchiata* and *Poikiloporella duplicata*, comes the fauna of conodonts — *Gondolella polygnathiformis* Budurov — Stefanov. Basing upon these, the uppermost part of the light-coloured massive limestones in the Plešivecká planina may perhaps be referred to the Tuvalian (R. M o c k, 1971). Foraminifera — see the list Tab. 2.

The Julian and the Tuvalian in the facies of the light-coloured limestones around Silická Brezová are proved by ammonites occurring with *Brachiopoda*. These beds are characterized by dasycladacean assemblages which are known from this only region. The assemblage comprises new species *Physoporella heraki*

B y s t r., *Uragiella supratriasica* B y s t r., *Macroporella (Pianella) sturi* B y s t r., *Macroporella (Pianella) humilis* B y s t r., *Poikiloporella brezovica* (B y s t r.) B y s t r. occurring in the zone with *Poikiloporella duplicata* overlying the Wetterstein limestones with *Teutloporella herculea* and underlying the limestones with Ammonites "*Styrites cf. tropitifformis* M o j s.," "*Arcestes (Pararcestes) sublabiatus* M o j s." and *Megaphyllites jarbas* M o j s. (cf. loc. Silická Brezová).

The Norian in the Slovak Karst, in the south is in limestones of the Hallstatt type, in the north — in the Furmanec limestones. The former is in unextensive blocks near Silická Brezová (cf. loc. Silická Brezová), around Bohúňovo, the latter — around Drnava and Kováčová (cf. loc. Drnava) and from the valley Miglinc.

The Hallstatt limestones rest on light-coloured, bedded Carnian limestones. They are bedded, nodular, clastic, brecciated, in some places with red cherts. Infrequent macrofossils indicate their Norian age (*Monotis salinaria* B r., *Monotis haueri* M o j s. — Silická Brezová; *Halobia cf. halorica* M o j s. — Budikovany). Ammonites are small and damaged. Condodonts in Hallstatt limestones were found in basal beds (Silická Brezová), and in the upper part in the substratum of the Zlambach beds (Bohúňovo). The basal beds contain the assemblage with *Tardogondolella abneptis* (H u c k r i e d e) indicating Lower Norian; near Bohúňovo they contain the assemblage with *Tardogondolella abneptis* (H u c k r i e d e) and *Tardogondolella bidentata* (M o s h e r), indicating their Upper Norian age (R. M o c k, 1971).

The Furmanec limestones are light-coloured, massive, organodetrital Norian limestones. To the Furmanec limestones belong the limestones from Drieňovec (cf. loc. Drnava) formerly designated as "the Dachstein limestones" according to the presence of megalodonts and grey, thick-bedded limestones in the valley Miglinc. In the uppermost part of the Furmanec limestones in Drieňovec are beds of dark-grey massive limestones with lenses of dark-grey crinoidal limestones rich in Lamelli-branchiata, Brachiopoda and Cephalopoda of the Upper Norian (Sevastian) age, known as "the fauna from the Bleskový prameň spring" (V. A n d r u s o v o v á — M. K o c h a n o v á 1972).

Light-coloured massive limestones contain besides solitary corals, *Calcareous sponges*, also Dasycladaceae *Heteroporella carpatica* B y s t r. and other taxonomically indetermined species of the genus; *Diplopora* sp. div., ? *Macroporella* sp. div. and Foraminifera. Among macrofossils are megalodonts (*Lycodus* sp.).

They are unidentifiable because of bad preservation (as ammonites). The Furmanec limestones in the valley Miglinc are darker, thick-bedded (over 2 m), with frequent mudballs of red to carmine finely laminate marlstones. Their substratum is unknown (as in Drieňovec) since they are separated by a tectonic plane from the Cordevolian Wetterstein limestones (with *Teutloporella herculea* and *Poikiloporella duplicata*) and from the (Julian — Tuvallian?) skin-rose limestones with *Poikiloporella duplicata*.

Among macrofauna they contain megalodonts. Dasycladaceae (*Heteroporella crosi* Ott, *Diplopora* cf. *muranica* Bystr.) and Foraminifera (*Triasina hantkeni* Majzon) indicate that the Furmanec limestones may extend to the Rhaetic. In fact, the assemblages of Dasycladaceae and Foraminifera are the same as in grey limestones in the Muránska plošina (plateau) also with *Rhaetavicula contorta* (Portl.) owing to which they are referred to the Rhaetic.

So far, no Rhaetic limestones have been found in the Slovak Karst. Most likely there is a stratigraphical hiatus between the Sevatian and Pliensbachian.

The Zlambach beds. The problem of the Rhaetic in the Slovak Karst is, however, unsolved when considering beds of dark marly shales overlying the Upper Norian Hallstatt limestones near Bohúňovo. The dark marly shales contain layers of dark marly limestones (dark-spotted in some places). Their position (above the Hallstatt limestones and below the brecciated Hierlatz and Adneth Liassic limestones) and their facies may be correlated with that of the Zlambach beds in the East Alps.

The beds near Bohúňovo did not yield any fauna indicating the Rhaetic age.

A bed sequence of analogous facial nature, with light-grey limestones is on the Malý Mlýnský vrch (hill) to the east of Silická Brezová. Perhaps Ammonites in these limestones may facilitate solving of the problem of the Rhaetic in the Slovak Karst.

## DESCRIPTION OF LOCALITIES

### 1. Meliata

the Meliata series to the north of the village Meliata; the Upper Permian? (Fig. 2)

The term "Meliata series" was introduced by V. Čekalová (1954) for a sequence of variegated radiolarites and dark shales on the left bank of the river Muráň, to the north of the village Meliata; regarded as a particular sequence of the Upper Seissian. Later on the sequence was also found near the village Držkovce and on the northern slopes of the Plešivecká planina plateau (J. Bystriický 1954, M. Maheř 1954). To the same sequences are also referred light-coloured massive limestones of facies and position identic with those of white coarse-crystalline limestones near Meliata, in the substratum of the so-called "Meliata series", regarded as Carboniferous limestones (V. Homola 1951, V. Čekalová 1954). As for its age, the Meliata series was referred to the Seissian (J. Bystriický 1954, 1955) or to the Campilian (M. Maheř 1954).

Its age is not yet determined definitely. We only know it is a sequence in the substratum of sandstones and schists of Seissian age (the loc. of Hucín, Držkovce); owing to which the Meliata series is ascribed Upper Permian — basal Seissian age (J. Bystriický 1964). The finds of pollen in dark shales (boreholes VB-1—VB-20 between the villages Strelnice and Bohúňovo) indicate Upper Permian, too (Ž. Ilavská 1965).

On the type locality of the Meliata series is the following sequence of beds (Fig. 2.).

a) Light-grey and white crystalline limestones. These are massive coarse-grained limestones with smudges or lenses of red clayey, or sandy shales. Thin-sections are microsparitic or sparitic. Grains are allotriomorph, confined, oriented (of elongated shape) due to pressure. Larger grains are twinning — lamellated. Among clastic admixture are quartz grains. In the microsparite part are infrequent fragments of juvenile shells of Lamellibranchiata.

Between the light-coloured and red-brown limestones are:

b) pink micrite and microsparite limestones. Red and red-brown limestones are compact, of small thickness. They are microsparitic with partially oriented grains: the orientation being emphasized by haematite pigment and hydromicas. Among organic remains are infrequent radiolaria, recrystallized through calcite fragments of Lamellibranchiata, crinoidal seg-

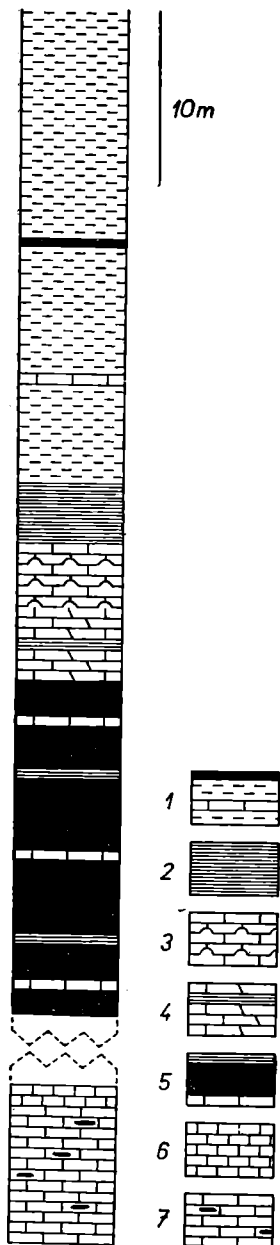


Fig. 2. Lithological section of Meliata series near the village Meliata (K. Borza)

1. black clayey shales with layers of radiolarites and limestones;
2. grey-green clayey shales;
3. grey flaggy, indistinctly nodular limestones;
4. grey-green flaggy limestones with intercalations of green shales;
5. red, grey, grey-green flaggy radiolarites with intercalations of red and green clayey shales and of radiolarian limestones;
6. red and red-brown compact limestones;
7. grey and white coarse-grained crystalline limestones with lenses of red clayey shales.

ments, and rare *Globochaete alpina* Lombard. Among clastic admixture are quartz grains, rare feldspar grains, folias of muscovite, chlorite, zircon and tourmaline. Among autigene minerals are quartz, feldspars (Albite) and chlorite restricted to smudges with limonite pigment.

c) Variegated radiolarites are red in the bottom part, pink in the higher and greenish in the top part. Red radiolarites are rich in haematite pigment as the shale intercalations.

The texture of red radiolarites is organogene. Electronmicroscopical examination showed that they were composed of microcrystalline quartz (M. Harman, K. Borza 1970). Among organic remains are radiolaria and sponge spicules. Clastic admixture are fine folias of hydromicas, autigene rhombohedrons of carbonates, microlites of rutile, and tourmaline.

In red radiolarites are thin layers of red-brown compact micritic limestones. Among organic remains are fragments of juvenile Lamellibranchiata, frequently quartzified. Limestones contain aleuritic admixture of clastic quartz, infrequent folias of muscovite and hydromicas.

Grey and green radiolarites do not contain haematite pigment, otherwise their composition is analogous with that of red radiolarites.

The shale intercalations in radiolarites consist of hydromicas. The shales contain admixture of clastic quartz (3—5 %; size 0.01—0.05 mm), fine folias of muscovite, biotite, chlorite, zircon, rutile and tourmaline.

d) Radiolarites are overlain by grey-green flaggy limestones with intercalations of shales (5 m) overlain by grey, flaggy, nodular limestones. Both sorts of limestones are micritic and microsparitic. They contain slight admixture of clastic quartz, among autigene minerals quartz and feldspars. Pyrite is infrequent.

The overlying grey-green clayey shales are composed of hydromicas with slight admixture of sericite. The shales contain admixture of clastic quartz (1—2 %; size 0.02 mm). Infrequent are folias of muscovite, biotite and rutile. Among autigene minerals are tourmaline, rutile and chlorite.

e) Dark grey and black clayey shales are facially variable. Generally it is a complex of dark-coloured shales with layers of silicites and darkgrey, sometimes dolomitic limestones.

Darkgrey and black shales are sometimes spotted. The matrix is pelite material, dark-coloured due to organic pigment. The pigment concentration is more distinct in dark smudges. The

shales are mostly composed of illite, less frequently of kaolinite-forming "phenocrysts".

Among terrigene minerals are quartz grains [to 2%; size 0.02 mm], muscovite, biotite, chlorite, infrequent grains of rutile. Among epigenetic minerals in the shales is pyrite, scattered in the form of small crystals.

In this sequence intercutting with red and green clayey shales (their facies reminding the schists in the Seissian beds), are bodies of anhydrite and gypsum (Bohúňovo, Gemerská Nová Ves, Šankovce), or layers of diabase tuffs (Bretka, Držkovce). Characteristic of the Meliata series are also deposits of haematite (with baryte) alternating with anhydrite (Šankovce) or radiolarites rich in haematite (Bradlo).

The haematite deposits are considered sedimentary — effusive.

A lithological cross-section through the Meliata series to the north of the village Meliata (Fig. 2.).

## 2. Skalica — Gemerská Hôrka,

the Koniart plateau, the Slovak Karst; the Middle Triassic (Fig. 3)

The locality of Skalica is on the Koniart plateau about 2 km to the west of the village Gemerská Hôrka near the highway between Plešivec and Licince. It is a small hill formed of Middle Triassic limestones emerging from below a cover of gravel formation (the Pannonian). In the past the limestones were mined from a small quarry. The quarry as now abandoned, and the Triassic beds are insufficiently exposed.

The sequence of beds of the Middle Triassic:

a) The Steinalm limestones are light-coloured,

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Fig. 3. Gemerská Hôrka — the Koniart plateau, the Slovak Karst (J. Bystrický)

1. Steinalm limestones (Pelsonian—Illyrian); 2. Schreyralm limestones (?Illyrian—Upper Illyrian); 3. Dark-grey indistinctly bedded limestones (Fassanian); 4. Wettersteindolomite (Ladinian); 5. Dasycladacea: Skalica: *P. p. v. pauciforata*, *Ph. p. v. sulcata*, *Ph. p. v. gemerica*, *Ph. varicans*, *Ph. dissita*, *Ph. cf. praealpina*, *Macroporella alpina*, *Dipl. hexaster v. hexaster*; Červená hora hill (mount.): *Olig. pilosa v. intusannulata*, *Ph. dissita*, *Macrop. alpina*, *Dipl. hexaster*; Hôrka: *Ph. p. pauciforata*, *Ph. p. v. gemerica*, *Ph. p. v. sulcata*, *Ph. dissitta*, *Ph. cf. praealpina*; 6. *Teutloporella herculea* (Stopp.) Pia; 7. Macrofauna:

1. Cephalopoda of the loc. Skalica; 2. Lamellibranchiata of the loc. Skalica; (*D. lommeli*); 3. *D. tyrolensis*, *D. indica* of the loc. Hôrka; 4. *Ptychites sp.* of the loc. Hôrka; 5. *Daonella pichleri*, *Valdinella dieneri* — loc. Hôrka.

# GEOLOGICAL MAP AND OCCURENCE OF FOSSILS W FROM GEM. HÔRKA (KONIART PLATEAU)

(J. Bystrický)

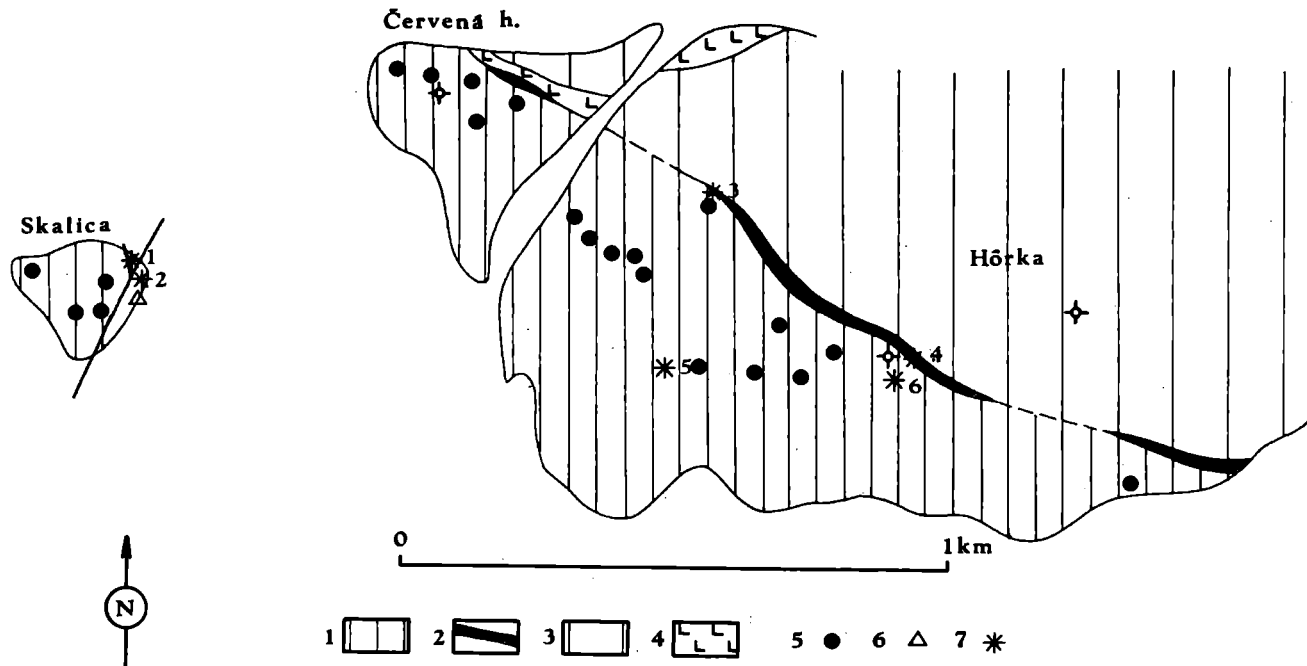


Fig.3

massive, organidetrital and they form the substantial part of the hill Skalica. They contain small Lamellibranchiata (in small „nests“ and irregular smudges), Dasycladacea and Foraminifera. Among Dasycladacea are the species from the zone of *Physoporella pauciforata*: *Ph. pauciforata* (Guemb.), *Steinm. v. pauciforata* and its varieties *v. undulata* Pia, *v. sulcata* Bystr., *v. gemerica* Bystr., and also *Ph. varicans* Pia, *Physoporella dissita* (Guemb.) Pia, *Ph. cf. praelpina* Pia, *Diplopora hexaster* (Pia) Pia *v. hexaster*, *Macropollera alpina* Pia. Among Foraminifera are *Citaella dinarica* (Koch.-Dev. et Pantič), *Pilammina densa* Pantič, *Endothyra kuepperi* Oberh., *Diplotremina astrofimbriata* Kr. Toll., *Amnobaaculites wirzi* Koehn — Zan.

b) The Schreyeralm limestones — they are not in the typical beds as in other places. They are bedded, brecciated, pink. They overlie the Steinalm limestones only in the western part of the quarry, and contain Cephalopoda: *Atractites* sp., *Discoptychites* sp. *Flexoptychites* sp., *Ptychites acutus* Mojs., *Ptychites megalodiscus* Beyrich, *Monophyllites sphaerophyllus* (Hauer), *Pleuromutilus* sp.

c) The Wetterstein limestones — in the eastern part of the quarry and on the eastern foot-hill of Skalica are somewhat darker limestones than the Steinalm limestones and in some places even dark-grey. These are organodetrital limestones representing the Ladinian Wetterstein limestones. They contain lumachelles of Lamellibranchiata: *Daonella lommeli* (Wissm.), *Daonella paucicostata* Tornq., *Daonella subtenuis* Kittl, *Daonella boeckhi* Mojs., *Posidonia alta* Mojs., *Posidonia idriana* Mojs., *Posidonia wengensis* (Wissm.), and sporadical *Teutloporella herculea* (Stopp.) Pia.

In the assemblage of the Lamellibranchiata quoted was also *Arcestes (Proarcestes) boeckhi* Mojs. (L. Barkó 1953); still it was not evidenced by further finds. Most likely these limestones are Langobardian. They are separated from the bed sequence of Skalica (the Steinalm and the Schreyeralm limestones) by a transversal N—S striking fault.

Most probably the Skalica sequence is the western continuation of beds of the Červená hora hill situated farther in the north. A karst area to the north of highway belongs to the southern part of the Koniart plateau (the southern limb of the syncline). Here the bed sequence is the same as in Skalica, only that here it is an immediate overlies of the Schreyeralm limestones. The sequence of beds (see the geological map, fig. 3) is as follows:

a) The Steinalm limestones. They form a karst area immediately above the railway-track to the north of the highway (slopes covered by red-soil — terra rossa). They contain numerous Dasycladacea from the zone of *Physoporella pauciforata*. Besides species known from Skalica, there is also *Oligoporella pilosa* Pia v. *intusannulata* Pia. Among Lamellibranchiata occurring in small nests is *Daonella pichleri* Mojs., *Valididennella dieneri* Alma (J. Bystrický 1964), among Foraminifera: *Citaella dinarica* (Koch. — Dev. et Pantič), *Endothyra kuepperi* Oberh., *Diploremina astrofimbriata* Kr. Toll., *Trochammina almtalensis* Koehn — Zan.

b) The Schreyeralm limestones are red, nodular in some places, occurring in the form of an elongated lense. So far only some unidentifiable ammonites are known there. The Schreyeralm limestones pass laterally into light-coloured organodetrital limestones.

c) Dark-grey, indistinctly bedded limestones immediately overlie the Schreyeralm limestones and light-coloured organodetrital limestones. In their basal part are *Daonella tyrolensis* Mojs. and *Daonella indica* Bittn. They are regarded as equivalent to dark, bedded Fassanian limestones from the Gombasek winding paths. The predominant part of the Koniart plateau consists of light-coloured Wetterstein limestones with *Teutlopora herculea* (Stopp.) Pia.

### 3. Kečovo —

Anisian and Ladinian zones with Dasycladaceae (Fig. 4)

The area between the village Dlhá Ves and the Domica Cave, and wider vicinity of the village Kečovo is the southernmost part of the Silická planina (plateau) in the Slovak territory. Actual-

Fig. 4. Geological map and occurrence of fossils near Kečovo (J. Bystrický)

1. Wettersteindolomite (Ladinian); 2. Steinalm-Wetterstein limestones (Anisian-Ladinian; Pelsonian-Langobardian); 3. loam, gravels (Pliocene), 4. Dasycladaceae: *Physoporella pauciforata* (Guemb.) Steinm. v. *pauciforata*, *Ph. p.* (Guemb.) Steinm. v. *undulata* Pia, *Ph. p.* (Guemb.) Steinm. v. *gemicica* Bystr. *Ph. dissita* (Guemb.) Pia; 5. *Diplopora annulatissima* Pia; 6. *Diplopora annulata* (Schafh.) Schafh. v. *annulata*, *D. annulata* (Schafh.) Schafh. v. *dolomitica* (Pia) Herak; 7. Cephalopoda: *Flexoptychiles* sp.; 8. Conodonts: *Gondolella excelsa* (Mosher), *Ozarkodna tortilis* Tatge, *Prionodina excavata* Mosher.

# GEOLOGICAL MAP AND OCCURENCE OF FOSSILS NEAR KEČOVO

(J. Bystrický)

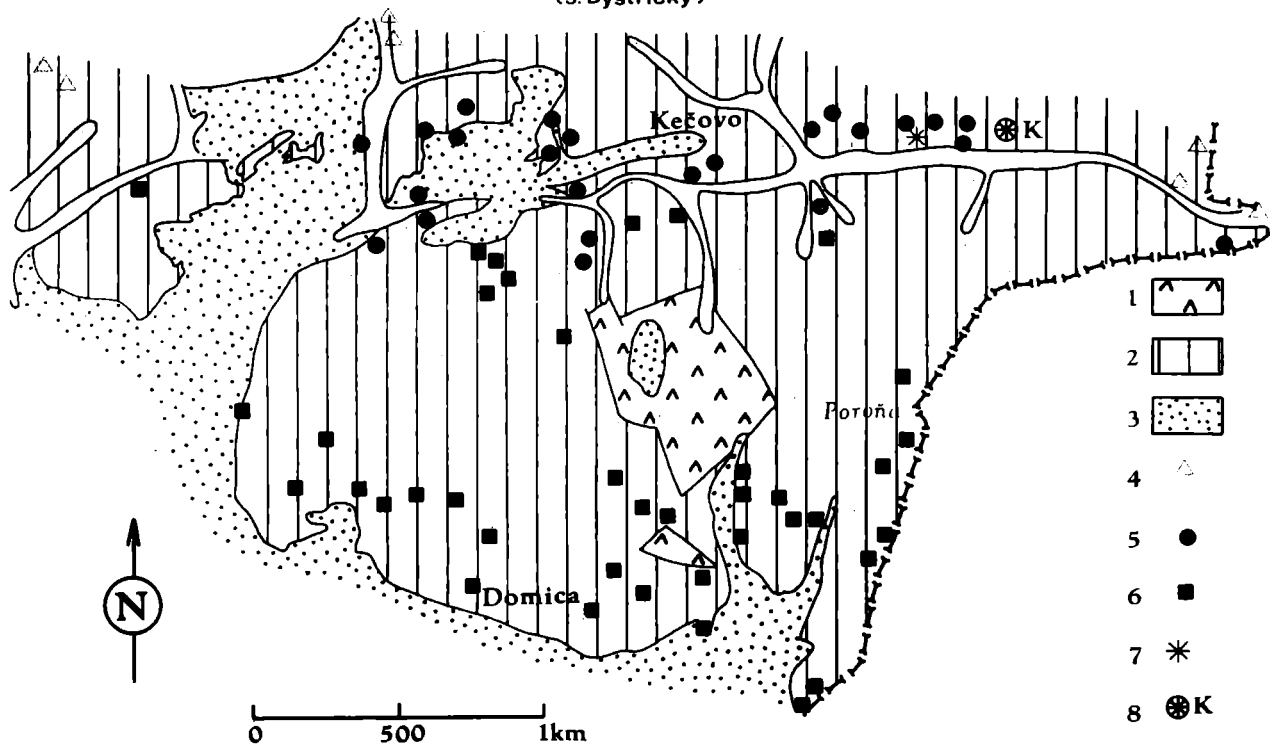


Fig.4

ly it is a W — striking anticline cut by the Štítňik fault in the west. The western part of the anticline in Slovakia is called “the Kečovo anticline”, its eastern part in Hungary is called “the anticline of Josva”. In the core of the anticline in Slovakia are Gutenstein limestones and Lower Anisian dolomites (near Dlhá Ves), in Hungary — also beds of the Seissian and Campilian age.

The northern limb of the Kečovo anticline comprises a complete sequence of beds from the Anisian to the Norian (see the loc. Silická Brezová); its southern limb is mostly covered by a gravel formation (Pannonian). Due to this in the profile only the Middle Triassic is observed in Slovakia, whereas in Hungary also the Carnian limestones (Szölösárdó).

In the northern and southern limbs of the anticline, the Gutenstein limestones and dolomites are overlain by a thick complex of light-coloured massive limestones of the Wetterstein type. The complex may only be divided after detailed biostratigraphical and microfacial investigations. In contrast to the northern tectonic units in the Silická planina, with their Uppermost Anisian (Upper Illyrian) in the Schreyeralm limestones, and their Lower Ladinian (Fassanian) in dark, bedded limestones (in some places with cherts), in the Kečovo anticline (near Kečovo) the two lithologically different, conspicuous sequences are missing. In the northern limb a several m thick sequence of pink limestones with layers of grey and dark-grey limestones of indistinct stratification, (Maloldal) extending from the west, may be regarded as an equivalent of the Schreyeralm limestones. In the southern limb the most Upper Anisian and Lower Ladinian are only in the beds of light-coloured massive limestones.

Around the village Kečovo is a sequence of zones with Dasycladaceae, independent of the facies. There are three such zones:

a) The zone of *Physoporella pauciforata*: It is the most lower zone characterized by an assemblage of Dasycladaceae: *Physoporella pauciforata* (Guemb.) Stein v. *pauciforata*, Ph. p. (Guemb.) Stein v. *undulata* Pia, Ph. p. (Guemb.) Stein v. *gmerica* Bystr., *Physoporella dissita* (Guemb.) Pia, *Diploporella hexaster* (Pia) Pia v. *hexaster* (in other places, for example in Silická Brezová the assemblage is accompanied by the species of the genus *Oligoporella*, *Macroporella alpina* Pia, *Diploporella subtilis* Pia, v. *subtilis*).

b) The zone of *Diploporella annulatissima* is represented by the only species.

c) The zone of *Diploporella annulata* follows the zone of *D. annu-*

latissima. It is characterized by both varieties of *D. annulata* (Schafh.) Schafh., viz v. *annulata* and v. *dolomitica* (Pia) Herak and by *Macroporella beneckeii* (Salom.) Pia.

The Wetterstein limestones of the northern limb of the anticline are in the sphinctozoan facies, so Dasycladaceae are absent here. Only in the top part of the Wetterstein limestones (the loc. of Silická Brezová) are *Teutloporella herculea* (Stopp.) Pia and *Poikiloporella duplicata* (Pia) Ott.

Besides Dasycladaceae, the light-coloured limestones near Kečovo contain the following macro- and microfossils.

The Steinalm limestones

a) The zone of *Physoporella pauciforata*: Brachiopoda *Tetractinella trigonella* (Schloth), *Mentzelia mentzeli* (Dunk.) Koeveskallina *koeveskalyensia* (Stur), *Coenothyris vulgaris* (Schloth.), *Aulacothyris angusta* (Schloth.), "Zeilleria" *angustaeformis* (Boeckh) and *Decurtella decurtata* (Gir.) (local. Aggtelek, Z. Schréter 1935).

The Foraminifera: *Citaella dinarica* (Koch. — Dev. et Pantič), *Citaella* cf. *insolita* (Ho), *Earlandinita oberhauseri* Salaj, *Earlandinita elongata* Salaj, *Endothyra kuepperi* Oberh., *Trochammina* aff. *almtalensis* Koehn — Zan.

b) The zone of *Diplopora annulatissima* contains — besides crinoidal segments — rare Cephalopoda: *Flexoptychites* sp., and Foraminifera: *Diplotremina astrofimbriata* Kr. — Toll., *Ammobaculites radstadtensis* Kr. — Toll., *Endothyra* cf. *kuepperi* Oberh., ?*Earlandinita elongata* Salaj.

Between the limestones in the zone of *Physoporella pauciforata* and the limestones in the zone of *Diplopora annulatissima* is a small lense of red micritic limestones with conodonts *Gondolella excelsa* (Mosher), *Ozarkodina tortilis* Tatge, *Prioniodus excavata* Mosher.

The Wetterstein limestones (the zone of *Diplopora annulata*) contain solenoporaceae, calcareous sponges, Gastropoda and infrequent Lamellibranchiata. Quoted are *Trachyerita quadrata* (Stopp.) from the vicinity of the cave Domica, and *Daonella lommelli* (Wissm.) from the locality of Aggtelek in Hungary. The last case may, however, be the limestones with *Teutloporella herculea*.

#### 4. The Gombasek winding panths

Middle Triassic, the Silická planina plateau, the Slovak Karst (Fig. 5)

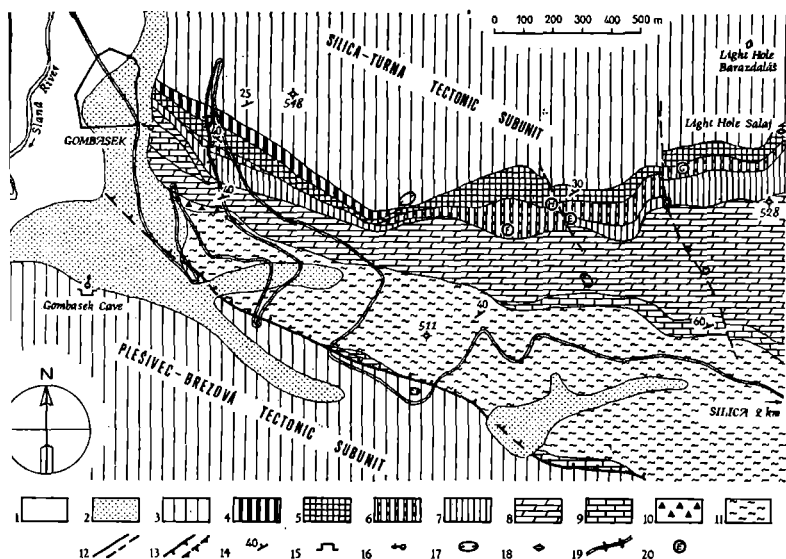


Fig. 5. The geological map of the Silická planina to the east of Gombasek [J. Mello]

1.—2. Quaternary: 1. alluvium, 2. alluvium; 3.—11. Triassic: 3. Wetterstein limestones (Ladinian), 4. dark, bedded limestones (Fassanian), 5. red nodular limestones (Upper Illyrian), 6. dark nodular limestones with cherts (Illyrian), 7. Steinalm limestones with layers of saccharoidal dolomites (Pelsonian-Illyrian?), 8. grey and dark-grey dolomites (Lower Anisian), 9. Gutenstein limestones (Lower Anisian), 10. breccia and graywackes (the contact of Lower and Middle Triassic), 11. grey marly limestones and shales (Campilian); 12. faults (found and presumed); 14. geological position of beds; 15. caves; 16. springs; 17. important drillingholes; 18. abysses; 19. highway Gombasek-Silica with marked segment of interest; 20. fossil finds; E. Steinalm limestones: *Trochammina alpina* Kr. Toll.; F. dark crinoidal limestones — the lense in the »Reifling limestones«: *Pilamina densa* Pantič, *Neoendothyra reicheli* (Reitl.), *Nodosaria armeniensis* Efim., *Duostomina* sp.; G. dark crinoidal limestones — the lense in the »Reifling limestones«: *Mentzelia mentzeli* (Dunk.); H. red nodular limestones: *Nodosaria armeniensis* Efim., *Citaella cf. insolita* (Ho).

From the highway between Rožňava and Plešivec, running through the Canyon-like valley of the river Slaná between the Plešivecká planina (to the west) and the Silická planina (to the east), in Gombasek we turn to the by-road leading to the surface of the Silická planina and to the village Silica.

In the large quarry opposite the by-road to the village Silica, light-coloured massive limestones of the Plešivecká planina are

mined. These are limestones of the Wetterstein type, of Cordevolian — Julian age (*Poikiloporella duplicata* (Pia) Ott, *Glomospira kuthani* (Sala j)).

The Karst cavities are filled by black shales and sandstones of Upper Cretaceous and Paleocene age as showed by pollen analyses (J. Mello — P. Snopková, 1972 in press).

In the cut of the road between Gombasek and Silica are Lower and Middle Triassic beds of the southern limb of the Silica—Turňa fold structure, and the Wetterstein limestones of the southern Plešivec—Brezová fold structure. Both fold structures meet on the younger thrust plane inclined steeply northwards.

In the cut of another winding path is the following profile of the Middle Triassic:

A. Dark, compact, bedded dolomites with intercalations of variegated shales (Gutenstein dolomites) are overlain by light-coloured and light-grey massive Steinalm limestones with layers of light-coloured saccharoidal dolomites. The light-coloured limestones contain here *Physoporella pauciforata* (Gue mb.) Stein m. v. *pauciforata*, *Ph. pauciforata* (Gue mb.) Stein m. v. *undulata* Pia, *Physoporella* cf. *varicans* Pia, *Macroporella alpina* Pia.

The Steinalm limestones are organodetrital (biosparitic, less biomicritic). Among bioclasts prevail fragments of dasycladacean tests, frequent are Foraminifera *Citaella* cf. *insolita* Ho), *Trochammina* cf. *almtalensis* Koehn — Zan., *Earlandinita grandis* Sala j, *Endothyra kuepperi* Oberh., *Diploremmina astrofimbriata* Kr. Toll., *Calcitornella* sp.?, *Variostoma* sp., *Nodosaria* sp., *Bryozoa*, fragments of shells of Lamellibranchiata, Gastropoda and crinoides. Frequent are shreds of dark muddy matter («lumps»).

Light-coloured saccharoidal dolomite unconformable layers in limestones arose owing to diagenetic dolomitization of light-coloured limestones as showed by relict structures and slow transitions through dolomite limestones.

B. Above the light-coloured limestones and saccharoidal dolomites is a sequence of bedded nodular limestones, about 40—50 m thick, corresponding to the Schreyeralm limestones of Eastern Alps. The sequence of the Schreyeralm limestones consists of two sequences differing in colour: dark limestones with grey cherts at the bottom. Among beds are thin intercalations of grey-green shales. This sequence reminds of the Reifling limestones and is extremely rich in conodonts: *Enantiognathus petraeviridis* (Huckriede), *Gondolella excelsa* (Mosher), *G. navicula* (Huckriede), *Hibardella lautissima* (Huckriede), *Hindeodella*

(*Metaprioniodus*) *multithamata* (Huckriede), *H. (M.) suevica* (Tatge), *Lonchodina posterognathus* (Mosher), *Prioniodina (Cypridodella) muelleri* (Tatge), *P. (C.) venusta* (Huckriede) — (R. Mock 1971).

They are more or less recrystallized fossiliferous micritic, pelmicrites and biomicrites with abundant sections of thin-walled Lamellibranchiata, with detritus of crinoidal segments and bad-preserved Foraminifera.

In the top part of the sequence are red nodular limestones with red cherts, light-coloured and pink or red nodular limestones, in some places with intercalations of red shales. Elsewhere the sequence contains ammonites (in the Plešivecká planina plateau, Berc; the Silická planina, Zakázané); here only Conodonta were found: *Dichodella alternata* Mosher, *Diplododella bidentata* (Tatge), *Enantiognathus petraeviridis* (Huckriede), *E. ziegléri* (Diebel), *Gladigondolella tethydis* (Huckriede), *Gondolella excelsa* (Mosher), *G. mombergensis* Tatge, *Hindeodella (Metaprioniodus) suevica* (Tatge), *Lonchodina hungarica* Kozur et Mostler, *L. posterognathus* (Mosher), *Prioniodina excavata* Mosher, *P. (Cypridodella) muelleri* (Tatge), *P. (C.) venusta* (Huckriede).

Microscopical character of the red nodular limestones is analogous with that of the underlying dark nodular limestones. Again they are partially recrystallized pelmicrites, biomicrites with abundant sections of thin-walled Lamellibranchiata and rare, bad-preserved Foraminifera.

The Conodonta indicate the Illyrian age of the dark nodular limestones, and the Upper Illyrian age of the red nodular limestones (R. Mock 1971).

C. Above the Schreyeralm limestones are dark-grey and grey bedded limestones of the Fassanian.

This sequence is about 50 m thick and is quite frequent in other parts of the Slovak Karst (the Plešivecká planina plateau) and contains a considerable amount of cherts especially in its lower parts. In this profile the cherts are missing and the sequence passes laterally and vertically into the Wetterstein limestones, in some places through light-coloured bedded limestones (see the locality of Zakázané).

The dark bedded limestones contain Conodonta: *Chirodella dinodoidea* (Tatge), *Dichodella alternata* Mosher, *Enantiognathus petraeviridis* (Huckriede), *Gladigondolella tethydis* (Huckriede), *Gondolella excelsa* (Mosher), *G. navicula* (Huckriede), *Hindeodella (Metaprioniodus) suevica* (Tatge), *Lonchodina posterognathus* (Mosher), *Prioniodina*

(*Cypridodella*) *venusta* (Huckriede). They evidence the Lower Ladinian age (Fassanian) of the limestones, *Ceratobairdia gombasekensis* Kozur here appears from Ostracods.

Their age is also controlled by their position in the profile and by fossils found elsewhere (see Skalica—Gemerská Hôrka: *Daonella tyrolensis* Mojs., *Daonella indica* Bittn.). They are recrystallized fossiliferous micrites, with some sections of thin-walled Lamellibranchiata and bad-preserved Foraminifera.

In the top part of the sequence of dark, bedded limestones appear beds of light-coloured limestones followed by a complex of light-coloured massive Wetterstein limestones.

### 5. Zakázané —

Middle Triassic of Silická planina (Fig. 6)

The sequence of the Schreyeralm limestones in the cut of the road from Gombasek to Silica (loc. 4) continues eastwards and may be well traced in outcrops on the surface of the Silická planina in the area of Zakázané.

The locality of Zakázané is a profile of Middle Triassic limestones, about 2,5 km to the north of the village Silica, evidenced by Ammonites, Brachiopoda, Foraminifera and Dasycladaceae. When leaving the village Silica for the northward field way, we leave behind the region of grey bedded limestones, and marly shales of the Campilian. In the area around the spring Jašterkový prameň and on the slope of Fabianka to the NW of the village Silica they contain *Eopecten albertii* (Goldf.), *Gervillia mytiloides* (Schloth.), *Gervillia* cf. *modiola*

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Fig. 6. Zakázané — the Silická planina, the Slovak Karst [J. Bystrický — J. Mello]

1. Gutenstein dolomite (Lower Anisian); 2. Steinalm limestones (Pelsonian — Illyrian); 3. Schreyeralm limestones (Upper Illyrian); 4. Wetterstein bedded limestones with layers of dark-grey limestones with cherts (Fassanian); 5. Wetterstein [massive] limestones (Fassanian — Langobardian); 6. Dasycladacea: *Macroporella alpina*, *Olig. pilosa* v. *inutusannulata*, *Olig. pilosa* v. *varicans*, *Physoporella pauciforata* v. *pauciforata*, *Ph. pauciforata* v. *undulata*, *Ph. pauciforata* v. *sulcata*, *Ph. pauciforata* v. *gemicrica*, *Ph. dissita*, *Ph. cf. praealpina*, *Diploporella hexaster* v. *hexaster*, *Dipl. hexaster* v. *helvetica*, *Favoporella* sp. ?; 7. Dasycladacea: *Teutloporella herculea*; 8. Cephalopoda: *Flexoptychites flexuusus*, *Orthoceras* cf. *campanile*; 9. Brachiopoda: 1. *Piarorhynchia trinodosi*, *Caucasorhynchia altaplecta acuticostata*, »*Rhynchonella*« *mentzeli*, *Spiriferina fragilis*, *Koebesakallina koeseskaljensis*, *Mentzelia mentzeli*, *Tetractinella trigonella*, »*Retzia*« *mojsisovicsi*, *Pexidella marmorea*, *Aulcothyris angusta*, *Aucothyris incurvata*, 2. »*Rhynchonella*« *brasoviae*.

# GEOLOGICAL MAP AND OCCURENCE OF FOSSILS OF SILICA PLATEAU NEAR ZAKÁZANÉ

(J. Bystrický - J. Melló)

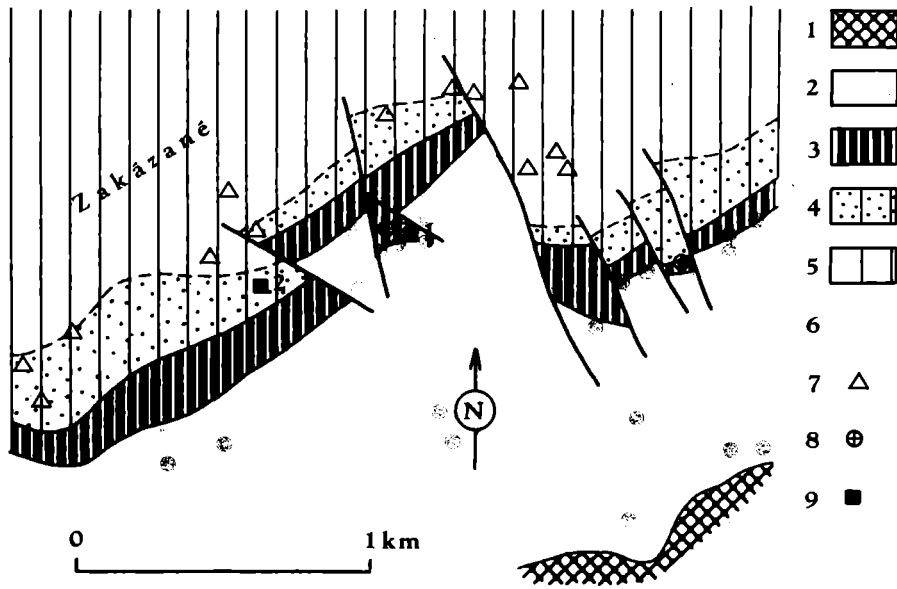


Fig.6

(Frech.), *Costatoria costata* (Zenk.), *Natiria subtilistriata* Frech, *Eumorphotis* sp.? and Ammonites). Now we enter the limestone—dolomite complex of the Middle Triassic of the Silická planina. At the northern margin of the village are dark bedded limestones (Gutenstein), farther in the north replaced by dark-grey bedded dolomites (Gutenstein dolomites) of the Lower Anisian age. Light-coloured and white massive limestones above the church-yard are Pelsonian in age (*Physoporella pauciforata* (Gue mb.) Steinm. v. *pauciforata*, *Ph. pauciforata* (Gue mb.) Steinm. v. *sulcata* (Bystr.). They are the core of the extreme eastern part of a small syncline, whose northern limb is truncated by a longitudinal overthrust. The syncline is deformed by transversal N—S striking faults. Owing to the tectonic we enter again the top part of the Campilian beds to observe another sequence of the Lower Anisian (mainly Gutenstein dolomites). The next complex of light-coloured massive limestones with uneven layers and lenses of light-coloured saccharoidal dolomites (they are mined in a small pit), is Pelsonian (*Macroporella alpina* Pia, *Diplopora hexaster* (Pia) Pia v. *hexaster*, *Physoporella pauciforata* (Gue mb.) Steinm. v. *pauciforata*, *Ph. pauciforata* (Gue mb.) Steinm. v. *gemerica* Bystr., and Foraminifera *Citaella dinarica* (Koch. Dev. Pantič), *Citaella* cf. *insolita* (Ho), *Endothyra kuepperi* Oberh. Farther in the north is a longitudinal overthrust on which emerged Gutenstein limestones and dark-grey bedded Gutenstein dolomites with layers of reddish limestones and dolomites, from below the light-coloured Pelsonian limestones.

The Gutenstein dolomites are ore-mineralized on the transversal MNW-SSE striking fault. On a small pile (a relict of old prospecting works) are only secondary minerals (malachite, azurite).

The next segment of the field road over well-exposed light-coloured Pelsonian limestones with Dasycladaceae from the zone of *Physoporella pauciforata* (see the list in the geol. map -fig. 6) and with Foraminifera: *Citaella dinarica* (Koch. Dev. et Pantič), *Citaella* cf. *insolita* (Ho), *Pilamina densa* Pantič, *Earlandinita oberhauseri* Salaj, *Diploremmina astrofimbriata* Kr. — Toll., *Glomospirella semiplana* (Koch.—Dev. et Pantič), *Earlandinita* aff. *grandis*. In their top part, about 2—3 m below the Schreyeralm limestones is a 1—2 m thick layer of grey crinoidal limestones with Brachiopoda: *Piarorchynchia trinodosi* (Bittn.) — see the list in the geol. map (fig. 6.).

The sequence of the Schreyeralm limestones commences with me beds of grey nodular limestones; above them is a sequence

of red nodular limestones with Cephalopoda (see the list in the geol. map). Higher-up they contain red cherts and some lenses of crinoidal pelletal limestones.

The Schreyeralm limestones are overlain by light-coloured organodetrital limestones with lenses of dark compact bedded limestones. These are here the lateral equivalent of dark bedded Fassanian limestones in the cut of the road above Gombasek (loc. 4). Dark bedded limestones and light-coloured organodetrital limestones contain infrequent Brachiopoda. In dark limestones was *Spiriferina fragilis* Schloth., in the light-coloured »*Rhynchonella*« *brasoviae* Jek. The next upper sequence are already the Wetterstein limestones with *Teutloporella herculea* (Sopp.) Pia, and with Foraminifera, *Trochammina almtalensis* Koehn — Zan., *Diplostromina astrofimbriata* Kr. Toll., *Glomospirella*, sp., *Glomospira* sp.

The sequence of the Schreyeralm limestones is dissected into several segments by transversal faults.

In the eastern segment the sequence of bedded Schreyeralm limestones and of bedded organodetrital limestones in their overlier pass eastward into light-coloured massive limestones, so their further course in the complex of the Steinalm-Wetterstein limestones cannot be traced anymore.

## 6. Silická Brezová —

Middle — Upper Triassic of Slovak Karst (Fig. 7, 8)

The village Silická Brezová is situated on the tectonic contact

Fig. 7. Silická Brezová — Geological map and occurrence of fossils (J. Bystrický)

1. Variegated sandstones, schists (Scythian, Lower Campilian?); 2. Tisovec limestones (with layers of crinoidal limestones; Cordevolian — Tuvalian); Wetterstein limestones (Langobardian); 4. Hallstatt limestones (Norian); 5. loam; 6. Brachiopoda and Ammonites; 7. Lamellibranchiata (*Monotis salinaria*, *Monotis haueri*); 8. Dasycladaceae: *Teutloporella herculea*; 9. Dasycladaceae: *Poikiloporella duplicata*; 10. Dasycladaceae: *Uragiella suprastriasica*, *Physoporella heraki*, *Macroporella (Pianella) sturi*, etc;

Brachiopoda and Ammonites:

1. *Halorelloidea rectifrons*; 2. *Halorelloidea curvifrons*; 3. *Aulacothyris supina*, *Aul. waehneri*, *Aul. zugmayeri*, *Koninckina telleri*, *Laballa suessi*, *Megaphyllites jarbas*, »*Styrites* cf. *tropitiformis*«, »*Arcestes (Pararcestes) sublabiatus*«; 4. *Laballa suessi*, *Spiriferina halobiarum*, *Spiriferina* sp., *Arcestes (Proarcestes)* cf. *rayeri*, *Discotropites quinquepunctatus*, *Paratropites phoebus*; 5. *Koninckina telleri*, *Laballa suessi*, »*Rhynchonella*« sp., *Spiriferina* sp.; 6. *Laballa suessi*, »*Rhynchonella*« sp. div., *Spiriferina* sp. div.

# GEOLOGICAL MAP AND OCCURENCE OF FOSSILS W FROM SILICKÁ BREZOVÁ

(J. Bystrický)

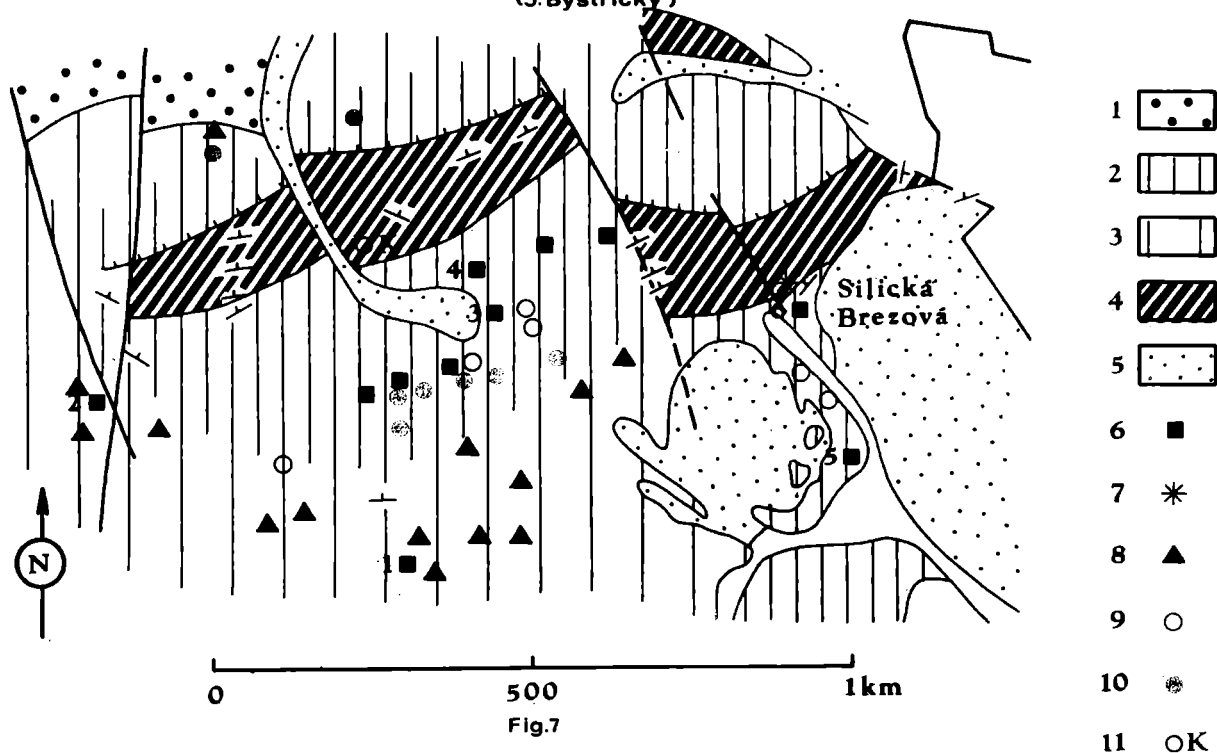


Fig.7

between two tectonic units of the Slovak Karst. The course of the contact on the surface is emphasized by variegated schists of the Seissian and marly schists of the Campilian. These — as the bottom sequence of the Triassic in the southern limb of the northern fold (the Plešivec—Brezová tectonic unit) are tectonically connected with limestones of the Upper Triassic in the southern fold (the Kečovo tectonic unit).

So in the nearest vicinity of the village Silická Brezová, may be traced almost entire sequence of the Middle and Upper Triassic of the Slovak Karst.

The southern limb of the Plešivec—Brezová fold structure commences with variegated shales with sandstone layers (Seissian—Lower Campilian beds) considerably tectonically compressed, similarly to the sequence of dark-grey marly shales and limestones (Upper Campilian beds). The bed sequence of the Middle Triassic is represented by the Gutenstein limestones and dolomites (Lower Anisian) containing *Pilammina densa* Pantič; the Steinalm limestones with lenses of saccharoidal dolomites containing numerous Dasycladaceae: *Oligoporella pilosa* Pia v. *pilosa*, *Olig. pilosa* Pia v. *intusannulata* Pia, *Olig. pilosa* Pia v. *varicans* Pia, *Diplopora hexaster* (Pia) v. *hexaster* (the locality described by J. Pia 1940 is farther in the north, below the village Silická Brezová, K. Balogh 1940). These are frequently accompanied with *Physoporella pauciforata* (Guemb.) Steinm. v. *pauciforata*, *Ph. pauciforata* (Guemb.) Steinm. v. *undulata* Pia, *Ph. p.* (Guemb.) Steinm. v. *gemerica* Bystr., *Ph. p.* (Guemb.) Steinm. v. *sulcata* Bystr., *Physoporella dissita* (Guemb.) Pia, *Macroporella alpina* Pia and Foraminifera: *Citaella dinarica* (Koch.—Dev. et Pantič), *Citaella* cf. *insolita* (Hö), *Pilammina densa* Pantič, *Endothyra kuepperi* Oberh., *Endothyranella* sp., *Diplotremina* sp. etc.

The Schreyeralm limestones (Upper Illyrian — the most Upper Illyrian?) are a very variable sequence. Dark nodular limestones with cherts sometimes laterally replace the sequence of red nodular limestones. These contain infrequent ammonites: *Flexoptychites flexuosus* (Mojš.), and Conodonta: *Enantiognathus patraeviridis* (Huckriede), *E. zieglerei* (Diebel), *Gondolella excelsa* (Mosher), *G. mombergensis* Tatge, *G. navicula* Huckriede, *Hindeodella (Metaprioniodus) spengleri* (Huckriede), *H. (M.) suevica* (Tatge), *Lonchodina posterognathus* (Mosher), *Nechindeodella dropla* (Spasov et Ganev), *V. triassica* (Mueller), *Ozarkodina tortilis* Tatge, *Prionio-*

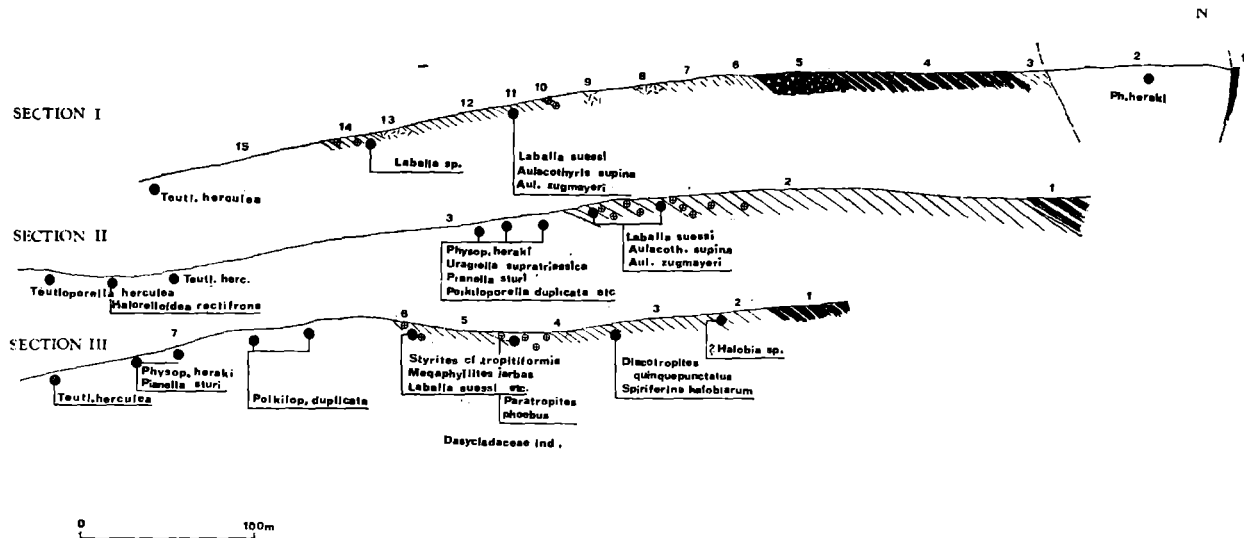


Fig. 8. Slická Brezová — Middle — Upper Triassic (J. Bystrický)

### Section I.

1. Variegated sandstones and shales (Seissian — Lower Campilian?); 2. Light massive limestones (Carnian; partially also Ladinian?); *Physoporella heraki*, *Uragiella supratriasica*, *Macroporella (Pianella) sturi*. In the tectonic contact with the Lower Triassic occurs *Teutloporella herculea*; 3. Pink and light-pink, indistinctly bedded limestones (Norian?); 4. Pink and red bedded nodular limestones (Hallstatt limestones), with red cherts in the top part (Norian); 5. Brecciated, graded-bedded limestones. Fragments of white limestones in red matrix. In fragments of white limestones and in red matrix are *Globochaete alpina* Foraminifera, *Ostracoda*, echinoderm spines; 6. Pink compact limestones with layers of limestone breccia; 7. Light-grey, pink-spotted bedded limestones with red cherts in upper parts, and light-grey cherts in the lower; 8. Brecciated limestones (fragments of limestones, size: to 3 cm); 9. Pink and light-coloured limestones with layers of brecciate limestones; 10. Light-coloured and pink fine-crinoidal limestones with »nests« of embryonal Lamellibranchiata; 11. Light-grey massive limestones: *Laballa suessi*, *Aulacothyris supina*, *Aulacothyris zugmayeri*; 12. Light-pink massive limestones, brecciated in some places. *Globochaete alpina*, Foraminifera, *Ostracoda*; 13. Brecciated limestones. Fragments of light-coloured in the red *Globochaete alpina*; 14. Light-coloured massive limestone with layers of fine-crinoidal limestones. *Laballa* sp., embryonal Lamellibranchiata; 15. Light-coloured massive limestones. In the top part: *Gyroporella* sp., in the lower part: *Teutloporella herculea*.

### Section II.

1. Pink and red bedded nodular limestones (Hallstatt limestones), with red cherts in the top part (Norian); 2. Light-coloured bedded limestones with layers of light and pink limestones in lower parts: *Laballa suessi*, *Aul. supina*, *Aul. zugmayeri*, »*Rhynchonella*« sp. div., *Spiriferina* sp. div.; 3. Light massive limestones. In the top part are Dasycladaceae: *Physoporella heraki*, *Uragiella supratriasica*, *Macroporella (Pianella) sturi*, *M. (P.) humilis*, *M. (P.) spectabilis*, *Poikiloporella duplicata*, *Poikiloporella brezovica*. In the lower part: *Teutloporella herculea*; with a fissure filled by light-coloured limestones with mass occurrence of *Halorelloidea rectifrons*.

### Section III.

1. Pink and red bedded and nodular limestones (Hallstatt limestones). Norian; 2. Grey and light-grey thick-bedded limestones, pink-spotted in some places. On the base is a bed with *Halobia styriaca*?; 3. Light-grey thick-bedded to massive limestones. In the lower part are *Discotropites quinquepunctatus*, *Arcestes (Proarcestes) cf. rayeri*, *Spiriferina halobiarum*, »*Rhynchonella*« sp. div.; 4. Grey and pink massive limestones, in some places with irregular lenses of crinoidal limestones with *Paratropites phoebus*; 5. White and light-grey bedded limestones with layers of crinoidal limestones. *Styrites cf. tropitiiformis*, *Megaphyllites jarbas*, *Arcestes (Pararcestes) sublabiatus*, *Laballa suessi*, *Aulacothyris supina*, *Aul. zugmayeri* etc.; 6. Light-coloured massive limestones. In the top part are Dasycladaceae: *Poikiloporella duplicata*, *Physoporella heraki*, *Uragiella supratriasica*, *Macroporella (Pianella) sturi*; in the lower part of the profile is *Teutloporella herculea*.

Tab. Nr. 3 — Foraminifera of the Wetterstein limestones and Tisovec limestones

Species	Locality			
	1	2	3	4
<i>Agathammina austroalpina</i> Kr.-Toll. et Toll.	○	○	○	○
<i>Ammobaculites</i> sp.		○	○	
<i>Ammobaculites radstadtensis</i> Kr.-Toll.		○		
<i>Ammobaculites wirzi</i> Koehn-Zan.			aff.	
<i>Austrocolomia marschali</i> Oberh.			aff.	aff.
<i>Ammodiscus</i> sp.		○		
<i>Diplotremina biconvexa</i> Kr. - Toll.		aff.		
<i>Diplotremina astrofimbriata</i> Kr.-Toll.		○	○	
<i>Diplotremina</i> sp.	○	○	○	
<i>Duostomina alta</i> Kr.-Toll	aff.	○	○	
<i>Duostomina turboidea</i> Kr.-Toll.				aff.
<i>Duostomina</i> sp.	○	○	○	
<i>Earlandinita</i> sp.		?		
<i>Earlandinita elongata</i> Salaj		?		
<i>Endothyra kupperi</i> Oberh.	○	○	○	○
<i>Endothyra</i> sp.		○	○	○
<i>Neodothyra reicheli</i> Reitl.	○	○	aff.	○
<i>Endothyranella</i> sp. 1		○		
<i>Endothyranella</i> sp.	○	○	○	
<i>Fronicularia</i> sp.		○	○	○
<i>Fronicularia woodwardi</i> Howchin			○	○
<i>Fronicularia globulosa</i> Küb.-Zwingl.		aff.		
<i>Glomospira</i> sp. 1	○	○	○	○
<i>Glomospira kuthani</i> (Salaj)		cf.	cf.	
<i>Glomospira irregularis</i> Moeller			cf.	
<i>Glomospira</i> sp.	○	○	○	
<i>Glomospirella paralella</i> Kr.-Toll.		aff.		
<i>Glomospirella vulgaris</i> Ho		aff.		
<i>Glomospirella spirillinoides</i> (Grozd. et Gleb.)		aff.		
<i>Glomospirella friedli</i> Kr.-Toll.	aff.	aff.		
<i>Glomospirella</i> sp.		○	○	○
<i>Geinitzia</i> sp.		?		
<i>Hemigordius chialingensis</i> (Ho)				?
<i>Involutina sinuosa sinuosa</i> (Weynsch.)		○	aff.	
<i>Involutina sinuosa pragsoides</i> (Oberh.)	○	○	○	○
<i>Involutina gaschei</i> (Koehn.-Zahn. et Brön.)		○	cf.	
<i>Involutina gaschei praegaschei</i> Koehn-Zan.		○	cf.	
<i>Involutina eomesozoica</i> (Oberh.)		○		○
<i>Involutina planidiscoides</i> (Oberh.)	aff.	aff.	aff.	
<i>Involutina impressa</i> (Kr.-Toll.)		aff.	aff.	
<i>Involutina muranica</i> Jendr.		cf.		
<i>Involutina tumida</i> (Kr.-Toll.)		cf.	aff.	
<i>Involutina</i> sp.		○	○	
<i>Nodosaria armeniensis</i> Efim.		aff.		
<i>Nodosaria</i> sp.		○		
<i>Ophthalmidium exiguum</i> Koehn-Zan.				cf.
<i>Ophthalmidium</i> sp.		○		
<i>Polypanmina</i> sp.			?	?
<i>Textularia</i> sp.	○	○	○	○

<i>Trocholina crassa</i> Kr.-Toll.		○
<i>Trochamina aplina</i> Kr.-Toll.	○	cf.
<i>Tetrataxis inflata</i> Kr.		○
<i>Variostoma pralongense</i> Kr. -Toll.	○	
<i>Variostoma</i> sp.		○
<i>Valvulina</i> sp.		○

Locality:

1. Silická Brezová, the Wetterstein limestones with *Teutloporella herculea* (Stopp.) Pia;
2. Silická Brezová, the Tisovec limestones with *Physoporella heraki* Bystr., *Uragiella supratriasica* Bystr., *Macrop. (Pianella) sturi* Bystr., *Poikiloporella duplicata* (Pia) Ott;
3. Silická Brezová, the Tisovec limestones with *Poikiloporella duplicata* (Pia) Ott;
4. Silická Brezová, the Tisovec limestones with Brachiopods and Cephalopods.

*dina excavata* Mosher, *Prioniodina (Cypridodella) muelleri* (Tatge), *P. (C.) venusta* (Huckriede).

The Fassanian is represented by bedded dark-grey and dark limestones with cherts in some places. In their basal parts is a layer of green tuffs and tuffites, argillites, dark schists. Toward the overlier they pass into the Wetterstein limestones with Dasycladacea *Teutloporella nodosa* (Schafh.) Pia, *Teutloporella herculea* (Stopp.) Pia at the bottom and with *Teutloporella herculea* (Stopp.), Pia and *Poikiloporella duplicata* (Pia) Ott, in the top part.

The above sequence of the Middle Triassic may be traced in the profiles to the north of the village Silická Brezová. The profiles of the Upper Triassic are 1 km to the west of Silická Brezová, in the area of quarries of the so-called "Brezová marmor" (= the Norian Hallstatt limestones).

On the well-exposed moderate slope with karst sinkholes the bed sequence of the Kečovo unit may be traced from the top part of the Middle Triassic through the Carnian to the Norian. This is the only region of the Slovak Karst (and of the West Carpathians generally) with facies of the Hallstatt limestones in the Norian.

In the bottom part of the profile are the Wetterstein limestones with *Teutloporella herculea* (Stopp.) Pia, in some places indicating its stratification into beds about 1 m thick (with small megalodonts). Lumachelles of Brachiopoda *Halorelloidea rectifrons* (Bittn.), formerly regarded as the base of Carnian (Julian) — limestones, are only the filling of the fissures in the Wetterstein limestones.

Above the Wetterstein limestones of the Ladinian age is a complex of light-coloured massive organodetrital limestones, macroscopically indistinguishable from underlying Wetterstein

limestones. Lithologically approximately 3 parts may be distinguished in them.

a) light-coloured massive organodetrital limestones correspond with the dasycladacean zone of *Poikiloporella duplicata*. This species without *Teutloporella herculea* (Stopp.) Pia, yet in association with *Physoporella heraki* (Bystr.) v. *heraki*, *Ph. heraki* Bystr., v. *tenuipora* Bystr., *Uragiella supratriasica* Bystr., *Macroporella (Pianella) spectabilis* (Bystr.), *M. (P.) sturi* Bystr., *M. (P.) humilis* Bystr., *Poikiloporella brezovica* (Bystr.) and various species of the genus *Gyroporella* extends to the substratum of limestones with *Ammonites "Styrites cf. tropitiformis Mojs."* These limestones are the next higher sequence. Foraminifera also appear with Dasycladaceae (see Table 3);

b) light-coloured bedded limestones with layers of light-coloured and pink crinoidal limestones with Brachiopoda and Ammonites. In this sequence are two ammonite horizons. The lower one with "*Styrites cf. tropitiformis Mojs.*", *Arcestes (Pararcestes) sublabiatus* Mojs., and *Megaphyllites jarbas* (Muenst.), from the higher horizons we only know *Paratropites phoebus* Dittmar. In both horizons are numerous Brachiopoda *Laballa suessi* (Winkl.) and others (see the list in the Explanatory notes to the geol. map — fig. 7) to be revised.

This sequence passes laterally into light-coloured massive limestones with Brachiopoda known from the crinoidal limestones, with small, recrystallized Dasycladaceae. In the limestones with Brachiopoda and ammonites (*Styrites cf. tropitiformis Mojs.*) are Conodonta: *Enantiognathus ziegleri* (Diebel), *Gondolella navicula* Huckriede, *G. polygnathiformis* Budurov-Stepanov; according to which (*G. polygnathiformis*) the limestones would belong to the Tuvalian (R. Mock 1971) and not to the Julian as could be indicated by ammonites (V. Andrusovová 1967);

c) The next upper sequence consists of light-coloured limestones. They are thick-bedded, with pink spots, and mostly compact (micrites). In the basal part are Brachiopoda: *Spiriferina halobiarum* Bittn. (and undetermined species), and Ammonites: *Discotropites quinquepunctatus* Mojs. "*Arcestes (Pararcestes) cf. rayeri* Mojs." In the most upper part, several m below the Hallstatt limestones of the Norian (below the lowest of the quarries in the Western block) is *Lumachelle* of *Halobia styriaca*.

Light-coloured limestones of the Carnian are overlain by the Norian limestones. It is a sequence, about 70 m thick, composed of bedded red or pink nodular limestones, of clastic limestones

light-coloured and pink bedded limestones with red cherts, and of pink and red massive limestones in some places. The sequence of the Hallstatt limestones is divided in two parts by a transversal N—S striking fault. In the eastern block with a new quarry are mostly massive and clastic limestones with *Monotis salinaria* Br., *Monotis haueri* Kittl., (in the quarry and to the east of it), less frequent are bedded and nodular limestones with small unidentifiable Ammonites.

In bedded limestones in the fresh quarry (the most lower beds exposed) are Conodonta: *Chirodella dinodoides* (Tatge), *Ch. gracilis* Mostler, *Enantiognathus zieglerei* (Diebel), *Gondolella navicula hallstattensis* (Mosher), *Gondolella navicula navicula* Huckriede, *Hibardella magnidentata* (Tatge), *Hindeodella (Metaprioniodus) spengleri* (Huckriede), *H. (M.) suevica* (Tatge), *Neohindeodella dropla* (Spasov—Ganev), *N. triasica kobayashii* (Igo et Koike), *N. triasica praecursor* Kozur—Mostl., *N. triasica summesbergeri* Kozur—Mostl., *N. triasica triasica* (Mueller), *Ozarkodina tortilis* Tatge, *Prioniodina excavata* Mosher *Prioniodina (Cypridodella muelleri)* Tatge, *Tardogondolella abneptis* (Huckriede). In brecciated limestones: *Tardogondolella abneptis* (Huckriede), *Hindeodella (Metaprioniodus) suevica* (Tatge).

In the western block with a group of smaller quarries are mostly bedded pink limestones with layers comprising red cherts and red nodular limestones with small and unidentifiable Ammonites (*Arcestes* sp., *Arcestes* sp. ex. gr. *bramanteri* Mojs., *Celittes* sp.?).

In the Hallstatt limestones of the lowest quarry (some m above the light-coloured limestones of the Carnian) is the fauna of Conodonts: *Diplododella meissneri* (Tatge), *Enantiognathus zieglerei* (Diebel), *Gondolella navicula hallstattensis* (Mosher), *G. navicula navicula* (Huckriede), *Hibbardella magnidentata* (Tatge), *H. zapfei* Kozur—Mostl., *Hindeodella (Metaprioniodus) suevica* (Tatge), *H. (M.) spengleri* (Huckriede), *Neohindeodella dropla* (Spasov—Ganev), *Neohindeodella triasica triasica* (Mueller), *Neoptectospathodus muelleri* Kozur—Mostler, *Ozarkodina tortilis* Tatge, *Prioniodina excavata* Mosher, *P. (Cypridodella) muelleri* (Tatge), *Tardogondolella abneptis* (Huckriede). The layer of white crystalline quartzose limestones contains *Tardogondolella abneptis* (Huckriede). On the basis of the Conodonta, of the species *Tardogondolella abneptis* (Huckriede), the

lower part of the Hallstatt limestones from Silická Brezová may be referred to the Lower Norian (R. M o c k 1971).

The stratigraphical range of the top part of the Hallstatt limestones from Silická Brezová is not paleontologically evidenced. The overlying light-coloured organodetrital limestones with layers of pink crinoidal limestones contain — on their tectonic contact with the variegated sequence of Seissian — *Teutloporella herculea* [Stopp.] Pia and somewhat farther in the south — an assemblage of Dasycladaceae as known from the Julian: *Physoporella heraki* B y s t r., *Uragiella supatriassica* B y s t r., *Macroporella (Pianella) sturi* B y s t r. Consequently, the light-coloured limestones are not the overlies of the Hallstatt limestones, but a system of slices of light-coloured Ladinian and Carnian limestones with subsided smaller blocks of the Norian Hallstatt limestones. The system runs along the tectonic contact of the two fold structures mentioned. The normal overlies of the Hallstatt limestones are dark-grey marly limestones with layers of marly schists (the Zlambach beds) known from other localities (for example from the village Bohúňovo and from the Mlynský vrch hill to the east of Silická Brezová). The facies of light-coloured limestones of Norian age is only known from the filling of fissures in the Wetterstein limestones. The filling contains *Halorelloidea rectifrons* (Bittn.) and elsewhere *Halorelloidea curvifrons* (Bittn.). Light-coloured lumachellar limestones with Lamellibranchiata and Brachiopoda are considered the filling of fissures in the *Hallstatt limestones* (R. M o c k 1971); their age being unknown so far.

The Norian is unknown in light-coloured limestones around Silická Brezová. It is also unknown in other southern areas of the Slovak Karst. The light-coloured limestones of Norian age are only in the north (the Furmanec limestones on the hill Drieňovec near Drnava), yet without Brachiopoda corresponding to those in the filling of fissures.

## 7. Drnava —

The Bleskový prameň spring, Norian in the Furmanec limestone facies (Fig. 9, 10)

Near the village Lipovník we turn from the highway between Rožňava and Košice to the by-way leading to the village Drnava. From this village we get by a field-road over a valley, 1,5 km southeastwards to a karst spring known as the spring Bleskový prameň.

In the cut of the field-road, behind the village Drnava, are variegated shales and sandstones of the Seissian — Lower Campilian. Crossing the brook, we get to the debris of dark, marly, dark-spotted limestones with spongolite cherts referred to "the spotty marls" of the Liassic. Among the debris are variegated radiolarites overlying the spotty marls. Their age is not determined precisely.

Upper Triassic and Lower Liassic limestones will be found in site near the karst spring mentioned. The spring flows out of dark-grey and dark limestones with lenses of dark-grey and grey crinoidal limestones rich in Brachiopoda, Lamellibranchiata and Cephalopoda.

The locality of the spring Bleskový prameň is unique as for the amount and the composition of fauna not only in the Slovak Karst, but in the entire West Carpathians. The presence of Brachiopoda regarded as Rhaetic species and of Cephalopoda characteristic of the Upper Norian, was usually explained by two horizons in crinoidal limestones or in dark compact limestones: a horizon with Rhaetic Brachiopoda ("the Kössen beds"), and another with Sevatian Cephalopoda. At present it is clear that it is one association in one horizon of Upper Norian (Sevatian) age evidenced by Ammonites. "The Kössen beds" are not paleontologically evidenced.

The locality of the spring Bleskový prameň is also interesting from the view of stratigraphy of the Upper Triassic and the Lias of the Slovak Karst.

Also it is one of two known areas of the Upper Triassic (Norian) in the facies of light massive organodetrital limestones.

The hill Drieňovec (formerly Drienková hora) on whose southern foothill is the karst spring Bleskový prameň, is the topmost part of the Mesozoic sequence of the Slovak karst in its extreme northern tectonic unit — the Hačava—Jasov unit. It is tectonically overlain by Lower Triassic beds of the southern fold structure of Silica—Turňa (in the cut of the field road near the village Drnava). On the hill Drieňovec is only the topmost part of the Triassic sequence (Norian) with Jurassic in its overlier. The Upper Triassic complex of the Drieňovec hill is separated from the lower Triassic members (the Wetterstein limestones, the Schreyeralm limestones, the Steinalm limestones) by the E—W striking "Rožňava fault". Owing to this the Upper Triassic is in a tectonic contact with the Paleozoic of the Spišsko-gemerské rudohorie mountains (see the geological map.; fig. 9).

The Upper Triassic complex of the Drieňovec hill consists of light-coloured massive limestones presented in literature as the

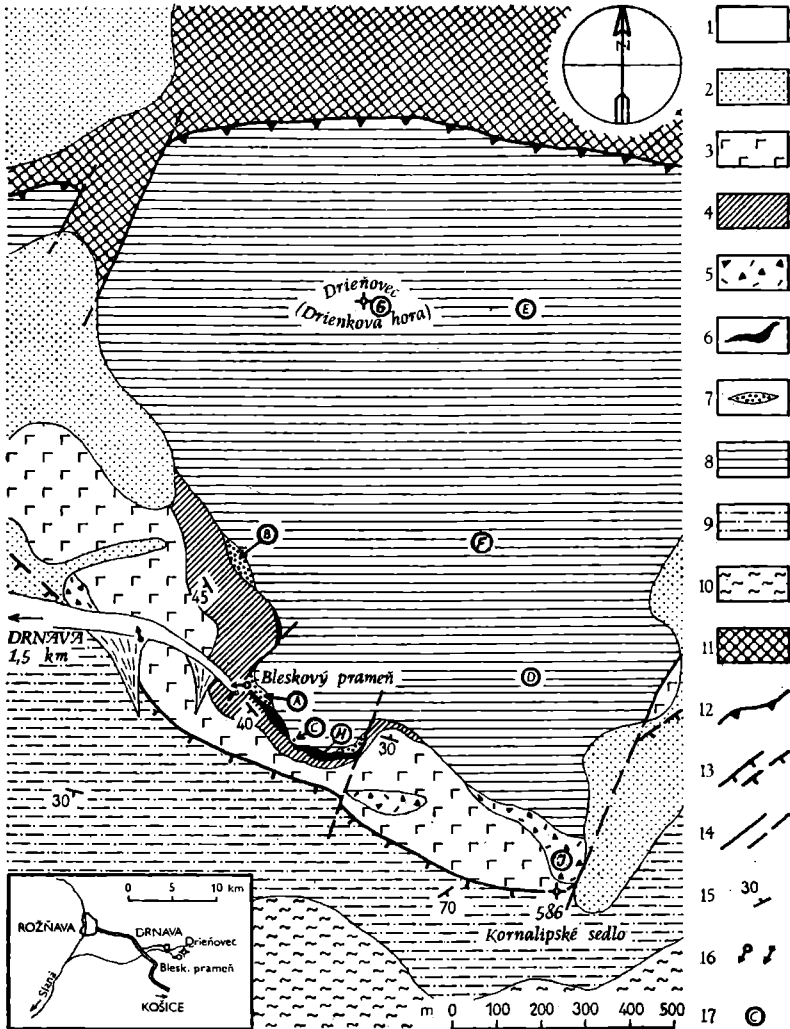


Fig. 9 The geological map of the area around the spring Bleskový prameň (J. Mello)

1.—2. Quaternary: 1. aluvium; 2. eluvium; 3.—6. Jurassic: 3. dark-green, grey and red radiolarites (Dogger — Malm); 4. dark marly limestones, sometimes spotty (Fleckenmergel); the Uppermost Lias Lower Dogger; 5. endostratic? varied breccia (Lias); 6. red crinoidal and nodular limestones, brecciated in some places (Lias); 7.—10. Triassic: 7. darkgrey

Dachstein limestones. (J. Stürzenbaum 1879, E. Mojsisovics 1896). These are the type of the Wetterstein limestones called the Furmanec limestones. Their age and facies may be correlated also with those of the "Dachsteinriffkalk" in the East Alps. The Carnian or Ladinian age of the part of this complex has not been determined so far. The Furmanec limestones of the Drieňovec hill are a complex of organogene and organodetrital limestones with some transitions into oncolite and muddy limestones. They contain corals, stromatopores,

and grey crinoidal limestones with the fauna from the spring Bleskový prameň (Norian, Sevatian); 8. Light-coloured and grey massive limestones (the Furmanec limestones, the Norian); 9. variegated sandstone — schistose beds (Seissian-Lower Campilian); 10. grey marly limestones and schists (Upper Campilian); 11. The Late Paleozoic (Carboniferous — Permian, undissected); 12. »The Rožňava line«; 13. an overthrust separating the Hačava — Jasov unit from the Silica — Turňa unit; 14. faults determined and presumed; 15. geological position; 16. springs and debouchures; 17. finds of fossils.

Fossils in the area around the spring Bleskový prameň

A. grey crinoidal — lumachellar limestones (Norian — Sevatian); the spring Bleskový prameň (the list in text);

B. grey crinoidal — lumachellar limestones (Norian — Sevatian): *Parallelodon cf. buchi* (Boehm), *Indopecten* sp. (ex gr. *cligneti*) Krumbeck), *Lima cf. cumaunica* (Bittn.), *Gonodon mellingi* (Hauer), *Placites* sp.?

C. darkgrey organodetrital coral limestones (Norian — Sevatian): *Diplopora phanaerospora* Pia;

D. light-grey organodetrital — oncolite graded-bedded limestones (Norian): *Heteroporella cf. carpatica* Bystr., *Diplopora* sp. div., *Involutina cf. communis* (Kr.), *Involutina sinuosa sinuosa* (Weynsch), *Involutina tumida* (Kr. Toll.), *Involutina tenuis* (Kr.), *Involutina cf. muranica* Jendr., *Involutina ex gr. gaschei* (Koehn-Zann-Brönn.), *Involutina* sp., *Agathammina austroalpina* Kr. Toll.-Toll., *Agathammina* sp., *Trocholina crassa* Kr. Toll., *Duostomina* sp., ?*Guthulina* sp., ?*Ammobaculites* sp., *Textularia* sp.;

E. darkgrey organodetrital limestones (Norian): *Coelostylinia* sp.;

F. light-grey organodetrital limestones (the Furmanec limestones, Norian): *Heteroporella carpatica* Bystr., *Cephalopoda (unreparable)*, *Glomospirella cf. friedli* Kr., *Textularia* sp., *Agathammina austroalpina* Kr. Toll.-Toll., *Involutina sinuosa sinuosa* (Oberh.), *Involutina planidiscoidea* (Oberh.), *Involutina cf. communis* (Kr.), *Involutina sinuosa sinuosa* (Weynsch.), *Trocholina premodiscoidea* (Oberh.), *Triassina cf. hantkeni* Majzon;

G. The Furmanec limestones (Norian): *Trocholina premodiscoidea* (Oberh.), *Involutina* sp. 1. Broenn., Poiss et Koehn-Zan., *Involutina aff. parva* Broenn., Poiss et Koehn.-Zan., *Involutina* sp.;

H. Red brecciated crinoidal and nodular limestones (Liassic): (see the list in text);

J. Variegated brecciated limestones (Liassic): »*Terebratula*« *adnethensis* Suess.

sponges, sessile and vagile Foraminifera, calcareous algae (solenopores, Codiaceae, Dasycladaceae); infrequent Gastropoda, megalodonts and ammonites (see the list of localities, fig. 8).

The preliminary evaluation of textures and of mutual relationship among organism shows that it is a part of a reef complex with indications of a transition into the area of the "back-reef". The reef complex is formed of unequally distributed "patch-reefs" surrounded by rounded graded-bedded detritus of organism or by varieties of muddy-wispy, algal or oncolite limestones.

The dark and dark-grey limestones with lenses of crinoidal and lumachellar limestones — from which the spring Bleskový prameň flows out—are the topmost part of the Furmanec limestones. In these originates "the fauna from the spring Bleskový prameň", found by J. Stürzenbaum (1879) and examined by A. Bittner (1890) and E. Mojsisovics (1896). Recently the fauna was examined by M. Siblík, V. Andrusovová and M. Kochanová. The locality still offers rich fauna [2 small artificial piles remained after sampling about 40 m southeast-eastwards from the spring: (the locality A in the geological map, fig. 9).

The complete list of the fauna cannot be presented here, details may be found in works by the authors quoted. Here only an orientational selection is presented.

Cephalopoda (according to V. Andrusovová in V. Andrusovová — Kollárová et M. Kochanová 1972): *Pleuro-nautilus ramsaureri* (Hauer), *Paranautilus simonyi* (Hauer), *Peripleurites boeckhi* Mojs., *Peripleurites stuerzenbaumi* Mojs., *Cycloceltites annulatus* (Mojs.), *Cycloceltites* sp. nov., *Cycloceltites arduini* (Mojs.), *Arcestes* (*Stenarcestes*) *subumbilicatus* (Hauer), *Cladiscites tornatus* (Bronn), *Megaphyllites insectus* Mojs., *Eopsiloceras clio* (Mojs.), *Tragorhacoceras occultum* (Mojs.), *Atractites alveolaris* Quenst; *Lamellibranchiata* (M. Kochanová in V. Andrusovová — Kollárová — M. Kochanová 1972: *Cassianella gemerica* Kochan., *Chlamys fascistriata* Kochan., *Chlamys silicensis* Kochan., *Variamusium schafhaeutli* (Winkl.), *Lima drnaviensis* Kochan., *Lima georgiiboehmi* Wilckens, *Plagiostoma sturi* Kochan., *Conodon mellingi* (Hauer), *Cardita carpatica* Kochan;

Gastropoda: *Tutcheria slovenica* Kochan., *Temnotropis carinata* (Muenst.), *Anoptychia supraplecta* (Muenst);

Brachiopoda (M. Siblík 1967): *Zeilleria norica* (Suess.), *Zeilleria elliptica* (Zugm.), *Zeilleria austriaca* (Zugm.), *Aulacothyropsis conspicua* (Bittn.), *Rhaetina pyriformis*

(Suess.), *Lobothyris hungarica* (Bittn.), *Triadithyris gregariaeformis* (Zugm.), *Thecospira stuerzenbaumi* (Bittn.), *Neoretzia superbescens* (Bittn.), "*Retzia*" aff. *arara* Laube, ?*Pexidella* aff. *strohmayeri* (Suess.), *Koninckina leopoldi-*

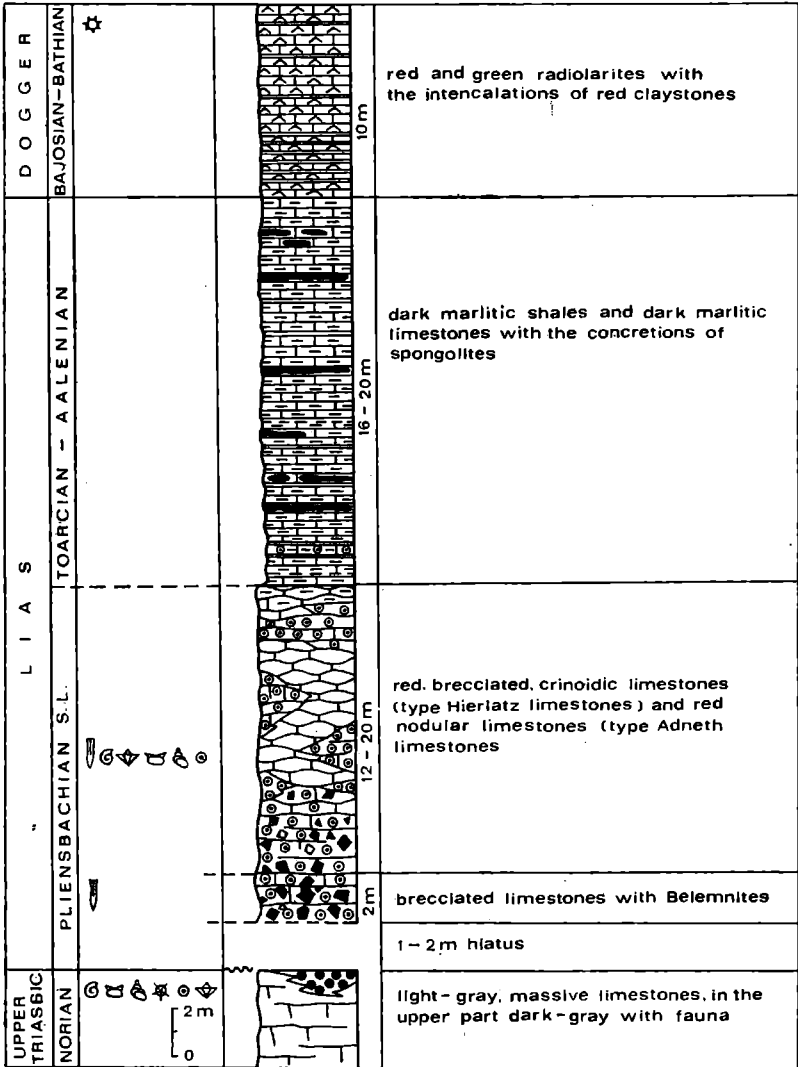


Fig. 10 Locality Bleskový prameň, boundary Triassic-Lias

*austriacae* Bittn., *Lepismatina austriaca* (Suess.), *Zugmayerella koessenensis* Zugm.), *Laballa suessi* (Winkl.), *Guseripia acerrina* (Bittn.), *Sinuocosta subtilicostata* (Bittn.), *Halorella amphitoma* (Bronn.), ?*Euxinella* sp., "*Rhynchonella*" *fissicostata* Suess., "*Rhynchonella*" *subrimosa* (Schafh.), Dasycladaceae (J. Bystrický 1964): *Diplopora* cf. *phanaerospora* Pia.

An analogous association is in the locality approximately 300 m to the NNW of the spring Bleskový prameň (the locality B in the geol. map).

The Rhaetic is not evidenced so far. In grey limestones 16 m to the SE of the spring Bleskový prameň (the locality C in the geological map), in the place where the top part of massive limestones extends to the left bank of the brook in coral biosparrudites are fragments of the tests of Dasycladaceae *Diplopora phanaerospora* Pia. Still — from the view of the existing data — they do not evidence the Rhaetic age.

The Jurassic beds of considerably varied composition transgressed on the uneven surface of Upper Triassic bioherm limestones, frequently into deep rifts in the form of "clastic dikes" (neptunic dikes).

Near the spring Bleskový prameň in the overlier of the Norian limestones the following profile may be traced (M. Rakús 1967; Fig. 10).

Light-brown and grey brecciated (the size of fragments is up to 15 cm, 5 cm in average) and slightly crinoidal limestones with numerous damaged rostra of Belemnites. The thickness observable is 1—2 m.

Red crinoidal brecciated and nodular limestones (nodules of compact red limestone, cement consists of coarse-crinoidal limestones. Is it the intermixture of the Hierlatz and Adneth facies. In some places the sequence has grey colour shades. In red limestones is the following fauna (the locality I in the geol. map): *Zetoceras* cf. *zetes* (d'Orb.), *Juraphyllites* sp., *Androgy-noceras* cf. *capsicorum* (Schloemb.), *Chlamys (Velata)* n. sp. "*Terebratula*" cf. *adnethensis* Suess, *Belemnites* (fragments of rostra), sequents, stems of crinoids (type *Pentacrinus*). The association evidences the Pliensbachian age of the sequence.

In the overlier of red limestones is a complex of grey and dark-grey bedded (up to 30 cm) spotty marly limestones alternating with unequally thick layers of marly schists of the same colour. No fossils were found in the beds. The quotation of *Daonella* sp., *Posidonia wengensis* is erroneous.

In the valley Miglinc, about 18 km to the east of the spring Bleskový prameň, in spotty marly limestones (in the same position) in the Jurassic sequence is *Cenoceras cf. intermedius* Sow. (V. Andrusovová — Kollárová 1961). In an analogy with the northern zones of the West Carpathians the sequence is referred to the Uppermost Lias (Toarcian), or to the base of the Dogger (Aalenian).

The sequence is overlain by red and green radiolarites with infrequent intercalations of red shales. The sequence is referred to the Dogger—Malm (without paleontological evidence).

### **The Stratenská hornatina mountains**

The Stratenská hornatina mountains and the Galmus mountains to the east of the Stratenská hornatina are usually regarded as the eastern continuation of the Mesozoic of the Muránska plošina (plateau). In fact, the sequence of beds and the facies of the Triassic are similar to those of the Muránska plošina.

In contrast to the Mesozoic of the Muránska plošina the character of a nappe outlier in the Mesozoic of the Stratenská hornatina is not so conspicuous. The Mesozoic of the Stratenská hornatina rests on the Veporic crystalline of the Kohút zone and on its metamorphosed Mesozoic, but in most part it is directly overlying the Paleozoic of the Spišsko-gemerské rudohorie mountains.

The stratigraphical — lithological content of the Mesozoic is mostly Triassic again; among younger sequences of the Mesozoic beds of the pre-Gossau tectonic unit of the Gemeric on the present-day surface only the Lias is known, preserved in the cores of narrow synclines.

The tectonics of the Mesozoic in the Stratenská hornatina resembles that in the Slovak Karst and the Muránska plošina. Again it is a system of more or less parallel fold structures with elongated limbs. The fold structures are divided by later (post-gossau) overthrusts into several partial tectonic units — blocks (slices).

On the folded Mesozoic transgressively rests the Upper Cretaceous (conglomerates from Dobšinská Ladová jaskyňa Ice Cave) and the Central Carpathian Paleogene in the north. Among the transversal faults regarded as the latest tectonic elements, most extensive is the so-called "Muráň line" separating the Mesozoic of the Stratenská hornatina from the Mesozoic (Triassic) of the Muráň nappe (Vernár partial nappe) of the Gemeric.

## The bed sequence of the Triassic

### A. The Lower Triassic:

a) Variegated red and green clayey shales alternating with the layers of variegated quartzose sandstone. They are beds of the Seissian with poor fauna: *Claraia clarai* (Emmer).

In some places in this sequence are anhydrite and gypsum bodies accompanied with graywackes (Dedinky, Biele Vody).

b) variegated marly shales alternating with layers of calcareous sandstones with the fauna characteristic of Campilian beds: *Eumorphotis telleri* (Bittner), *Claraia tridentina* (Bittner), *Unionites fassaensis* (Wissmann), *Unionites canalenensis* (Cattani), *Gervillia exprorecta* Leps., *Gervillia mytiloides* Schloth., *Costatoria costata* (Zenker), *Turbo rectocostatus* Hauer, *Natiria costata* Muenster, *Tirolites cassianus* (Quenstedt), *Tirolites quenstedti* Mojs.

c) Grey-green, grey-brown marly schists alternating with layers of dark marly schistose and bedded limestones. This sequence is the top part of the Lower Triassic and is characterized by rich Campilian fauna: *Natiria costata* Muenster, *Turbo rectocostatus* Hau., *Costatoria costata* (Zenker), *Gervillia modiola* Frech, *G. exprorecta* Leps., *G. incurvata* Leps., *Neoschysodus laevigatus* (Alberti), *Unionites fassaensis* (Wissmann), *Tirolites spinosus* Mojs., *Dinarites nudus* Mojs.

### B. The Middle Triassic:

a) The Gutenstein dolomites. The base of the Middle Triassic consists of grey somewhere dark-grey or black, bedded dolomites with intercalations of bedded dolomitic limestones. The sequence of Lower-Anisian dolomites would only be 10–20 cm thick, without any fossils.

b) The Gutenstein limestones and dolomites. It is a sequence formed in some places mostly of dark, bedded limestones with a variable share of layers of grey and dark dolomites. The sequence with the maximum share of dolomite layers is regarded as a particular bed sequence (the so-called Klaus beds, M. Mahel 1957).

Somewhere the Gutenstein limestones contain nodules of cherts because of which the dark cherty limestones of the Illyrian age were erroneously referred to them (as the cherty limestones from the Čertova dolina valley); the dark cherty limestones of the Upper Triassic were also designated as the Gutenstein limestones (Červený Štros, M. Mahel 1957, 1968).

The Gutenstein limestones and dolomites are particularly poor in fossils. Only in their top part, in the immediate substratum

of light-coloured massive Pelsonian limestones are some Dasycladaceae *Physoporella* cf. *praealpina* Pia.

c) The Steinalm limestones resemble those in the Muránska plošina plateau. Again they are light-coloured and white massive limestones, frequently organodetrital, with Dasycladaceae: *Physoporella pauciforata* (Gue mb.) Steinm. v. *pauciforata*, *Ph. pauciforata* v. *undulata* (Pia), *Ph. pauciforata* v. *sulcata* B y s t r., *Ph. pauciforata* v. *gemeric*a B y s t r., *Ph. varicans* Pia, *Ph. dissita* (Gue mb.) Pia, *Ph.* cf. *praealpina* Pia (Kolísky, Jablůň, za Vyšné Rovne, Suchá Belá).

Besides *Physoporella* quoted is also *Diplopora annulatissima* Pia (J. B y s t r i c k ý 1957, Pl. 7, Fig. 3). So far this is the only specimen found and should be referred most likely to a species of the recently determined genus *Favoporella* Sokač (B. S o k a č 1968), since its branches are not metaspondylous, but arranged in alternating whorls. In this mountain group no typical specimens of the species *D. annulatissima* Pia were found so far.

From these limestones were also quoted the following Brachiopoda: *Koiveskallina koiveskalyensis* (Stur), *Mentzelia mentzeli* (Dunk.), *Retzia schwageri* Bittn., *Aulacothyris wageni crassula* (Bittn.) (the locality Červený Štros, M. Maheľ 1957) and corals: *Montivalitia norica* Frech., *Montivalitia* sp. *Thecosmilia badiotica* Volz, *Thecosmilia* cf. *granulata* Volz., *Thecosmilia sublaevis* Muenst., *Crespedophyllia maheli* Kolosv., *Margarophyllia* sp. *Conophyllia* sp., *Stylophylloopsis* sp., (the locality Obergarten, M. Maheľ 1957, 1967): the limestones of these localities are of Upper Triassic age (M. Maheľ 1967, 1968).

From light-coloured Anisian limestones quoted are also *Flexoptychites flexuosus* (Mojš.), (sub. ? *Ptychites flexuosus* Mojš., D. Andrusov — J. Kováčik 1955; M. Maheľ 1957, 1967, 1968). We do not, however know for sure whether it is an occurrence in light-coloured micritic limestones overlying the light-coloured limestones containing *Physoporella* in the locality mentioned.

d) Dark, bedded limestones with cherts. The Schreyeralm limestones resembling those in the Slovak Karst and the Muránska plošina plateau were not found in the Stratenská' hornatina mountains. Most likely the indistinctly bedded pink and light-coloured limestones with nodules of cherts and intercalations of green-grey and reddish schists, are equivalent to the Schreyeralm limestones. In some places these limestones are overlying organodetrital limestones with Anisian Dasycladaceae. We still do not know whether the dark bedded limestones with cherts

from the Čertova dolina valley are equivalent to the lower part of the Schreyeralm limestones in the Slovak Karst or whether they are still lower level. They contain Ammonites: *Acrochordiceras* sp., *Arthaberites alexandrae* Diener, *Flexoptychites flexuosus* (Mojs.), *Beyrichites* sp., *Danubites* sp., *Ceratites* sp. (V. Andrusovová 1967) and are regarded as the Illyrian limestones with the zone of *Paraceratites trinodosus* sensu E. Mojsisovics (V. Andrusovová 1964, 1967).

e) The Wetterstein limestones. In contrast to the Steinalm limestones they comprise — besides light-coloured and white — also dark massive limestone. They would be organodetrital and rich in *Teutloporella herculea* (Stopp.) Pia. Owing to this they are designated as "Teutloporella limestones" (M. MaheI 1957, 1967).

Besides Dasycladacea, the limestones contain Gastropoda *Omphaloptycha retracta* Kittl. and *Omphaloptycha irritata* Kittl. and corals *Stylophylloopsis* cf. *polyactis* Frech. *Cassianella* cf. *rosenbuchi*, Philipp (M. MaheI 1967) appears actually in Upper Triassic limestones.

Stratigraphical range of the Wetterstein limestones is uncertain because *Teutloporella herculea* (Stopp.) Pia is insufficient for accurate determination of the stratigraphical diapason. Since the Wetterstein limestones are overlain by the Wetterstein dolomites with *Teutloporella herculea* (Stopp.) Pia, they occupy, perhaps, mostly the lower part of the Ladinian.

f) The Wetterstein dolomites. The dolomites overlying the Wetterstein limestones are massive, light-coloured. They form a thick complex with local lenses of dark shales and are referred to Upper Ladinian and Carnian (M. MaheI 1957, 1967). i. e. Cordevolian — Tuvanian. In the lower layers they contain *Teutloporella herculea* (Stopp.) Pia, and higher — up (below the layer of dark shales) recrystallized determinable shales Dasycladaceae of the species *Poikiloporella duplicata* (Pia) Ott (the locality Dešťanky, a pass between Dešťanky and Červený Štros). Most likely, their upper part may be referred to the Cordevolian. The next upper sequence of dark schists does not yield any fossils and the stratigraphical orientation is obscure.

### C. The Upper Triassic:

The top part of dolomites belongs to the Cordevolian (Lower Carnian).

a) Dark shales (the Reingraben schists?). The sequence of black and dark-grey clayey shales, several m thick is in the

Tab. Nr. 4 – Stratenská hornatina mountains. Foraminifera in the Tisovec and Furmanec limestones

Species	Locality						
	1	2	3	4	5	6	7
<i>Agathammina austroalpina</i> Kr.-Toll. et Toll.	○	○	○	○	○		○
<i>Ammodiscus</i> sp.					○		○
<i>Ammobaculites</i> sp.			○		○	○	○
<i>Ammobaculites radstadtensis</i> Kr.-Toll.			○				
<i>Astacolues</i> sp.							○
<i>Earlandinita</i> sp.				?			
<i>Endothyra</i> sp.				○			○
<i>Endothyra keupperi</i> Oberh.				○			○
<i>Neoendothyra reicheli</i> Reitl.				○			aff.
<i>Endothyranella</i> sp.				○	○		
<i>Diploremmina subangulata</i> Kr.-Toll.				aff.		aff.	
<i>Diploremmina astrofimbriata</i> Kr.-Toll.		aff.	aff.				
<i>Diploremmina</i> sp.				○	○		○
<i>Duostomina</i> sp.				○	○	○	○
<i>Duostomina alta</i> Kr.-Toll.			cf.				
<i>Duotaxis</i> sp.			○		○		
<i>Dentalina</i> sp.				○			
<i>Frondicularia</i> sp.					○		
<i>Glomospira</i> sp.					○		○
<i>Glomospira</i> sp. 1		○	○				
<i>Glomospira tenuifistula</i> Ho					aff.		
<i>Glomospirella</i> sp.	○						
<i>Glomospirella friedli</i> Kr.-Toll.		aff.	aff.	aff.	aff.	○	aff.
<i>Glomospirella amplificata</i> Kr.-Toll.					aff.		
<i>Guttulina</i> sp.				aff.			
<i>Lenticulina</i> sp.				○			
<i>Nodosaria ordinata</i> Trif.					○		○
<i>Involutina sinuosa sinuosa</i> (Weynsh.)	aff.						
<i>Involutina</i> sp.				○	○	○	○
<i>Involutina sinuosa pragsoides</i> (Oberh.)		○		○	○	○	○
<i>Involutina sinuosa obehauseri</i> (Salaj)					aff.		○
<i>Involutina gaschei</i> (Koehn-Zan. et Brön.)							○
<i>Involutina gaschei praegaschei</i> Koehn-Zan.		aff.					
<i>Involutina tumida</i> (Kr.-Toll.)	○	○	○		○		aff.
<i>Involutina plamdiscoides</i> (Oberh.)			aff.				
<i>Involutina minuta</i> Koehn-Zan.					aff.		
<i>Involutina communis</i> (Kr.)				aff.	aff.	cf.	○
<i>Involutina tenuis</i> (Kr.)				aff.			
<i>Involutina parva</i> Brön., Pois. et Koehn-Zan.						○	
<i>Involutina eomesozoica</i> (Oberh.)	○						
<i>Involutina muranica</i> Jendr.	aff.	aff.			aff.	aff.	aff.
<i>Planinvoluta deflexa</i> Leisch.				aff.			
<i>Trocholina multispira</i> Oberh.							aff.
<i>Trocholina permodiscoides</i> Oberh.		○		○	○	○	○
<i>Triasina hantkeni</i> Majzon					aff.		
<i>Textularia</i> sp.							○
<i>Variostoma crassum</i> Kr.-Toll.							aff.
<i>Nodosaria ordinata</i> Trif.			○				

Locality: 1. „Obergarten“; 2. Samalova dolina; 3. Deštanky; 4. Remiaška; 5. Geravy; 6. „Lipovec“; 7. Dolka-quarry.

Tab. Nr. 5 — Stratenská hornatina mountains

Species	Locality						
	1	2	3	4	5	6	7
<i>Aulacothyrus frontalis</i> Bittn.		○					
<i>ruedii</i> Bittn.	○						
<i>rupicola</i> Bittn.	○						
cf. <i>ramsaueri</i> Suess	○						
cf. <i>kuehni</i> Jaek.	○	○	○				○
<i>Aulacothyropsis conspicua</i> (Bittn.)	○	○		○			
<i>reflexa</i> (Bittn.)		○					○
<i>Austriella intercurrentis</i> (Bittn.)	○			○			○
<i>juvavica</i> (Bittn.)				○			
cf. <i>nux</i> (Suess)	○						
cf. <i>lingulina</i> (Bittn.)						○	
<i>Diplospirella</i> cf. <i>wissmanni</i> (Muenst.)	○	○				○	
<i>Guseriplia acerrima</i> (Bittn.)	○	○		○	○		
<i>Halorella amphitoma</i> Bittn.	○		○	○			○
<i>Lobothyris hungarica</i> (Bittn.)	○	○		○			
<i>Neoretzia superbescens</i> (Bittn.)				○			
<i>Oxycolpella oxycolpos</i> (Emmr.)		cf.	cf.			cf.	cf.
<i>eurycolpos</i> (Bittn.)	○	○	○	○		○	
„ <i>Retzia</i> “ <i>schwageri fastosa</i> Bittn.	○	○					○
<i>Rhaetina piriformis</i> (Suess)	○					○	○
„ <i>Rhynchonella</i> “ <i>subrimosa</i> (Schafh.)	aff.		○				
<i>spreti</i> Bittn.			○				
cf. <i>superba</i> Bittn.			○				
<i>Septaliphoria fissicostata</i> (Suess)	aff.	○	○			○	○
<i>Sinucosta emmrichi</i> (Suess)						○	○
<i>subtilicostata</i> (Bittn.)	○				○	○	○
<i>Spiriferina praecursor</i> Zugm.		○				○	
„ <i>Terebratula</i> “ <i>hikum</i> Bittn.	○						
<i>raxana</i> Bittn. ○	○						
<i>Zeilleria elliptica</i> (Zugm.)							
<i>Zeilleria elliptica</i> (Zugm.)	○						
<i>Cassianella angusta</i> Bittn.						○	
<i>Halobia parasicula</i> Kittl	○						
<i>Halobia</i> cf. <i>hoernesii</i> Kittl							○
<i>Halobia</i> cf. <i>digona</i> Kittl							○
<i>Monotis rudis</i> Gemm.							○
<i>Halobia</i> cf. <i>wiereri</i> Kittl.							○
<i>Arcestes</i> sp.	○	○		○			
<i>Arcestes</i> cf. <i>planus</i> Mojs.	○						
<i>Arcestes</i> cf. <i>intuslabiatus</i> Mojs.			○				
<i>Cladites</i> cf. <i>tornatus</i> Bronn.							○
<i>Megaphyllites</i> sp.	○						
<i>Placites</i> sp.							○
<i>Orthoceras lateseptatum</i> Huer			○				
<i>Conophyllia boletiformis</i> Muenst.			○				
<i>Conophyllia</i> sp. <i>juv.</i>		○					
<i>Bavarosmia bavarica</i> (Frech)							○
<i>Elysastrea fischeri</i> Volz		○					
<i>Montivaltia norica</i> (Frech)	○	○	○				○
<i>Montivaltia marmorea</i> Frech		○	○				

Species	Locality						
	1	2	3	4	5	6	7
<i>Phyllocoenia</i> cf. <i>incrassata</i> Frech			○				
<i>Stylophylloopsis</i> <i>mojsvari</i> Frech		○					
<i>Stylophylloopsis</i> cf. <i>timorica</i> Vinas.		○					
<i>Stephanocoenia</i> cf. <i>schafhaeuti</i> (Win.)							○
<i>Thecosmilia</i> <i>defillipi</i> (Stopp.)							○
<i>Thecosmilia</i> cf. <i>defillipi</i> (Stopp.)		○	○				
<i>Thecosmilia</i> <i>clathrata</i> Emmr.					○		

Locality:

1. Holý kameň; 2. Červená skala; 3. Geravy — Suchý vrch; 4. Geravy (plateau, k. 1100, caves); 5. Geravy — Gačovská skala; 6. Havrania skala; 7. north of the Hotel „Dobšinská ladová jaskyňa“, (Dolka-quarry, Spálenisko, Deštanky).

top part of the dolomite complex in the form of several small lenses. We cannot say for sure whether there is only one layer on the contact of the Cordevolian and the Julian or there are more layers (M. Mahel 1957 quoted them also from dolomites in the substratum of the Norian limestones).

b) Light-coloured massive limestones (The Tisovec and the Furmanec limestones).

In the overlies of the dolomites with a layer of dark shales are light-coloured massive organodetrital limestones. They may be considered equivalent to the Tisovec and the Furmanec limestones in the Muránska plošina plateau. The lower part of these limestones is referred to the Julian—Tuvalian, to the Upper part of the Norian. Their top part is perhaps of the Rhaetic age (M. Mahel 1957, 1967).

In their lower part are some localities of fauna;

1. The valley of the river Hnilec, opposite the crossroads near Hrabušice:

a) the right bank: *Cruratula eudoxa* Bittn., *Rhynchonella carantana* Bittn., *Zeilleria elliptica* (Zugn.), *Zeilleria dualis depressa* (Bittn.), *Diplospirella* cf. *wissmanni* (Muenst.), *Daonella* cf. *proboscidea* Kittl., *Cassianella angusta* Bittn., *Chlamys* cf. *repositi* (Mer.), *Posidonia obliqua* (Hauer), *Ammonites* sp.

b) the left bank: “*Rhynchonella*” *fissicostata* Suess, *Daonella* cf. *teltschenensis* Kittl., *Posidonia praealpina* Kittl.;

2. Spálenisko (to the north of the Hotel Dobšinská Ladová jaskyňa): *Halobia* cf. *beyrichi* (Mojs.).

3. Vysoký vrch: *Daonella* cf. *proboscidea* Kittl. These limesto-

nes regarded as Carnian (Julian — Tuvalian; M. Maheľ 1957, 1967) have their equivalent in the light-coloured limestones with corals (the localities of Obergarten, Untergarten, cf. p. 64 and with Brachiopoda (Červený Štros) referred to the Anisian (cf. p. 64). These limestones contain some Dasycladacea *Poikiloporella duplicata* (Pia) Ott, and especially Foraminifera which are neither Anisian nor Ladinian; they belong mainly to higher stages, beginning with the Cordevolian (see the table 4 of occurrences of Foraminifera, localities 1, 2, 3).

c) Dark grey bedded cherty limestones with layers of dark and black marls. This sequence of limestones (frequently crinoidal and organodetrital), and dark shales were formerly considered a normal overlier of Lower Triassic beds and were ascribed Anisian age. The sequence was a particular type of the Anisian limestones with the fauna of Brachiopoda: *Rhynchonella protractifrons* Bitt., *Rhynchonella ottomana* Bitt., "*Zeilleria*" *angustaeformis* (Boeckh), *Terebratula lacrimontana* Bitt., (M. Maheľ 1957). Later on were quoted *Coenothyris vulgaris* (Schloth.), *C. krafftii* (Bittn.), *C. cucensis* Bittn. *Mentzelia mentzell* (Dunk.), *Mentzelia mentzeli acrorhyncha* (Lor.), *Pexidella sturi* (Boeckh), and from shales: *Palaeoneilo lineata minutissima* (Frech.), *Macrodontella lamellosa* (Assm.), *Turritella* cf. *striata* Pic. (M. Maheľ 1967, 1968), and also *Dimyodon* (*Dimyopsis*) *intusornatus* (Bittn.) and *Chlamys* cf. *subal-ternicostata* (Bittn.), according to which it is considered as two sequences of different age. The first one with the fauna of Brachiopoda was regarded as the Anisian sequence, the second with Lamellibranchiata — as the Carnian sequence.

Since the latest data on the Anisian and Carnian fauna are inaccurate (without the names of localities), the stratigraphical orientation is very difficult. Perhaps it is one sequence running along the western margins of the limestone complex in the Stratenská hornatina mountains, as the basement of light-coloured massive limestones of the Carnian age (M. Maheľ 1957 described a continuous transition to the overlying light-coloured limestones which may be considered Anisian). Improbable is that the sequence may contain tectonic slices of limestones identic as for facies, and different in age. Dark bedded limestones with cherts and with frequent crinoid segments, cropping out in a pass to the north of Červený Štros (on a locality of Anisian Brachiopoda; M. Maheľ 1957), contain also Dasycladaceae: *Macroporella* (*Pianella*) cf. *sturi* Bystr., and *Physoporella* cf. *heraki* Bystr., i. e. the forms resembling the species from the Carnian limestones of the Slovak Karst.

d) Light massive limestones of the Norian (the Furmanec limestones). The most part of light massive limestones of the Upper Triassic are of the Norian age. Their facies and their age correspond to the Furmanec limestones in the Muránska plošina (plateau). Again there are light-coloured, massive, organodetrital limestones with Corals, Brachiopoda, Lamellibranchiata, Ammonites, Foraminifera and Dasycladacea. In the top part they are darker, even dark-grey.

The list of fauna from the area of Geravy, see table Nr. 5.

The list of Foraminifera, see Table Nr. 4, localities 4, 5, 6, 7.

Interesting is also the locality to the north of the Hotel "Dobšinská Ľadová jaskyňa", (Dolka, the quarry), owing to the finds of *Montivallia norica* Frech, *Thecosmilia defilippi* (Stopp.), *Bavarosmilia bavarica* (Frech.), *Stephanocoenia* cf. *schafhautli* (Winkl.), *Palaeostrea* sp., *Pinacophyllum* sp., *Sinuocosta subtilicostata* (Bittm.), "Retzia" *schwageri fastosa* Bittn., *Rhaetina pyriformis* (Suess.), *Oxycolpella* cf. *oxycolpes* (Emmer.), *Halorella amphitoma* Bronn., *Cladiscites* cf. *tornatus* Bronn., *Placites* sp. [M. Mahel 1957]. From the locality come also Foraminifera (see the list loc. 7), and Dasycladaceae *Heteroporella carpatica* Bystr., *Gyroporella* cf. *vesiculifera* Guemb., *Griphoporella* sp. and other species, taxonomically indetermined so far.

Dasycladaceae mostly occur in the part of the complex, in dark-grey and grey limestones. In Geravy, Remiaška, Lipovec are *Heteroporella* cf. *carpatica* Bystr., *Heteroporella* sp. div., *Gyroporella* cf. *vesiculifera* Guemb., *Diplopora* cf. *muratica* Bystr., the new species of the genus *Macroporella*. The Rhaetic age of the sequence is not paleontologically evidenced.

e) Black and dark-grey massive and bedded limestones with black cherts (equiv. to the Aflenz limestone?) are particular beds of the Norian age. They are only in the northeastern part of the Stratenská hornatina mountains (the loc. Matka Božia), and contain *Halorella amphitoma* Bronn.

They are referred to the Lower Norian because they are overlain by light-massive limestones regarded as the top part of the Norian (M. Mahel 1957).

## 8. Geravy Plateau (Fig. 11)

The top part of the above Triassic sequence of the Stratenská hornatina, i. e. light massive Norian limestones with dark-grey, organodetrital limestones in their top part, will be seen near Geravy-Plateau.

## The Muránska plošina (plateau)

The Mesozoic of the Muránska plošina (Triassic-Liassic) is a nappe outlier on metamorphosed sedimentary mantle (Late Paleozoic and Mesozoic) of the crystalline in the Kráľova hoľa subzone. The structure of the nappe seems simpler than the structure of the Mesozoic in the Slovak Karst and in the Stratenská hornatina mountains. Due to the existing ways of lithological and stratigraphical division of the extensive mass of light-coloured massive limestones of the Middle and Upper Triassic, the structure has an appearance of a peneplanated system of folds, affected only by faults. A system of longitudinal overthrust plains steeply declining northwards, is distinct owing to thin belts of the Gutenstein limestones or Lower Triassic schists in the southern limb, to the east of Tisovec, in light-coloured limestones. It cannot be traced in the morphologically less dissected relief. This is why considerably less partial fold structures are distinguished by tectonic division of the nappe outlier on the Muránska plošina than in the formerly mentioned mountain groups. Distinguished is "the syncline of the Dudlavá skala" running to the north of the valley of the Hron river along the southern foothill of the Nízke Tatry mountains, and the "syncline of the proper Muránska plošina" (also called "the syncline of Tesná skala") extending to the south of the valley of the Hron river.

The lithostratigraphical filling of the "Dudlavá skala syncline" consists of Lower Triassic — Rhaetic beds. Over these rest transgressively sediments of the Upper Cretaceous (limestone breccia, limestones with Radiolites: *Durania*, *Radiolites*, *Destefanella*)

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Fig. 11 Geological Map and Occurrence of Fossils of Geravy-Plateau

1. Conglomerates, sandstones; shales (»verrucano« facies) — (Permian); 2. Variegated sandstones, shales (Skythian; Seissian — Lower Campilian); 3. Marly shales and limestones (Skythian; Upper Campilian); 4. Gutenstein dolomites (Lower Anisian); 5. Hauptdolomite (Cordevolian — Tuvalian); 6. Steinalm limestones (Pelsonian — Illyrian); 7. Wetterstein limestones (Passanian — Langobardian); 8. Tisovec and Furmanec limestones (Carnian — Norian; Tuvalian — Sevatian); 9. Grey and darkgrey limestones [Upper Norian (Sevatian) — Lower Rhaetic?]; 10. Crinoidal limestones and dark shales (Liassic); 11. loam, debris; 12. Occurrences of Brachiopoda, Cephalopoda, Corals:

1. Locality: Holý Kameň; 2. Locality: Červená skala; Locality: Suchý vrch; 4. Locality: Geravy; 5. Locality: Gačovská skala; 6. Locality: Geravy (Liassic); *Rhynchonella plicatissima* O p p e l, *Rh. variabilis rimata* Geyer, *Rh. retusifrons* O p p e l, *Waldheimia engelhardi* O p p e l, *W. ewaldi* O p p e l, *Phylloceras* sp., *Belemnites* sp. 13. Occurrences of Dasycladaceae



and with *Hippurites*, and dark marls with Senonian Foraminifera. In the syncline of the Muránska plošina are Lower Triassic to Liassic (Lotharingian-Domerian) beds. The axis of the syncline is NE-SW oriented, declining northeastwards. On the south-eastern side, the syncline is truncated with a very conspicuous fault, the so-called "Muráň line". This one also separates the Veporic crystalline and its autochthonous Mesozoic mantle of the Kráľova hoľa subzone from the Veporic crystalline and its metamorphosed autochthonous Mesozoic mantle of the Kohút subzone. The "Muráň line" runs diagonally to the axis of the syncline (and to the shear thrusts in the southern limb to the east of Tisovec). So all members of the northern and southern limbs and of the core of the syncline are in tectonic contact with the crystalline of the Kohút subzone. The northern limb is simpler in its structure than the southern. The latter is sliced and deformed by transversal faults and by faults parallel to the "Muráň line". The most extensive system of transversal faults is around Tisovec. The system is connected with subsidence of the most western segment of the syncline in the Muránska plošina and with Tertiary volcanism (the contact metamorphism of the Wetterstein limestones on their contact with (diorite, scarns and erlanš).

In the Muránska plošina is the following Triassic bed sequence:

#### 1. The Lower Triassic

a) Red (red and green) and light-coloured quartzose sandstones with layers of variegated (red and green) clayey shales. Such Seissian beds are known from the Slovak Karst and from the Stratenská hornatina mountains. Fauna is rather poor (*Unionites fassaensis* (Wis m.); *Lingula tenuissima* Br.).

The age of porphyries in these beds is unknown. In the outlier of the nappe Drienok to the south of Banská Bystrica, with its Triassic development identical with that of the Muránska plošina plateau, are quartzose porphyries (paleoandesites) of the Campilian age (M. Slavkay 1965).

b) Variegated (red and greenish) marly shales with layers and beds of light-coloured and greenish limestones. In the top part of the sequence are sometimes grey sandy limestones, and limestones rich in crinoid segments.

Fauna is typical of the Campilian (*Costatoria costata* (Zen k.), *Naticella costata* Muenst., *Eumorphotis* aff. *inaequicostata* (Ben.), *Gervillia mytiloides* (Schloth.), *Gervillia exporrecta* Leps., and Ammonites.

#### 2. The Middle Triassic

a) Grey bedded dolomites (the Gutenstein dolomites). They are bedded dolomites identical with the Gutenstein dolomites of the Slovak Karst. Somewhere in the base are 10 m thick layers of bedded, dark Gutenstein limestones. The dolomites and the layer of dark limestones did not yield any fossils.

b) Dark bedded limestones (Gutenstein limestones). The above mentioned dolomites are overlain by thick-bedded (1—3 m), dark limestones with local black cherts in such an amount that they may be designated as "cherty limestones". In the bed sequence of dark limestones are layers of bedded dolomites, and in the top part is a layer of light-coloured bedded and massive limestones. The layer is maximally 50 m thick. In the layer and in the overlying dark limestones appear first occurrences of Middle Triassic Dasycladaceae: *Physoporella pauciforata* (Guemb.) Steinm. v. *pauciforata*, *Ph. pauciforata* (Guemb.) Steinm. v. *gemerica* Bystr., *Physoporella* cf. *praealpina* Pia, *Physoporella dissita* (Guemb.) Pia, *Diplopora hexaster* (Pia) Pia v. *hexaster*, *Oligoporella pilosa* Pia v. *ind.* The upper part of the sequence is regarded as Pelsonian. Quoted is also *Daonella* cf. *sturi* (Ben) in bedded limestones with cherts in the valley of the river Hron.

c) Light-coloured massive limestones (the Steinalm limestones). The limestones overlying the Gutenstein limestones are light-coloured and massive, organodetrital, with abundant crinoidal segments (especially in their top part). So far only Dasycladaceae and Foramonifera are known. *Physoporella pauciforata* (Guemb.) Steinm. v. *pauciforata*, *Ph. varicans* Pia, *Physoporella dissita* (Guemb.) Pia, *Ph.* cf. *praealpina* Pia; *Citaella* cf. *insolita* (Ho).

Light-coloured massive limestones containing only *Diplopora anulatissima* Pia are in the complex of the Wetterstein limestones with *Diplopora annulata* and we cannot yet say whether they are the immediate substratum of the Wetterstein limestones (Steinalm limestone) or their basal part.

d) Bedded light-coloured and pink slightly nodular limestones (the Schreyeralm limestones). The facies of these limestones reminds of the Schreyeralm limestones. In their substratum dark or dark-coloured limestones are missing: Such are only in the northern limb of the syncline in the valley of the river Hron (the summit of the hill Grúň to the north of the village Červená Skala. The pink slightly nodular limestones are here the immediate overlier of light-coloured massive limestones with *Physoporella dissita*

(G u e m b.) P i a and other species of the genus. They also contain Ammonites: *Flexoptychites flexuosus* (M o j s.) *Discophyllites megalodiscus* (B e y r i c h), and "Orthoceras" sp., and Dasycladaceae *Diplopora annulatissima* P i a.

e) Light-coloured massive limestones (the Wetterstein limestones). Light-coloured Anisian massive limestones are overlain by light-coloured massive organodetrital limestones with irregular layers of dark-grey and dark organodetrital limestones and light-coloured dolomites. In these several biofacies may be distinguished: the sphinctozoan-coral, the facies with *Teutloporella herculea*, and the facies with *Diplopora annulata*. They are situated partially next to each other between the base of the Wetterstein limestones and their top part (the facies with Sphinctozoa and the facies with *Teutloporella*), or they are restricted to their bottom part (the biofacies with *Diplopora*). The limestones with *Diplopora annulata* are the substratum of the limestones with *Teutloporella herculea*. The facies with Sphinctozoa contains: *Colospongia catenulata* O t t, *Vesicocaulis alpinus* O t t, ? *Dictyocoelia manon* M u e n s t., *Montivaltia* cf. *obliqua* M u e n s t., infrequent *Teutloporella herculea* (S t o p.) P i a. Macrofossils: *Pecten* cf. *broili* P h i l i p p, *Aviculopecten wissmanni* (M u e n s t.).

The facies with *Diplopora annulata* contains both varieties of the species *v. annulata* and *v. dolomica* (P i a) H e r a k, with forms resembling the genus *Acicularia*. Foraminifera are comparatively infrequent represented only by *Diplotremina astrofimbriata* K r., T o l l., *Ammobaculites radstadtensis* K r., T o l l., *Endothyra kuepperi* O b e r h., *Earlandinita* cf. *oberhauseri* S a l a j.

The facies with *Teutloporella herculea* contains in its basal part also *T. aequalis* (G u e m b.) P i a.

Lenses of light-coloured dolomites in the Wetterstein limestones contain the same species of Dasycladaceae as found in their immediate surrounding.

f) Light-coloured massive saccharoidal dolomites (the Wetterstein dolomites). Besides the dolomite lenses in the Wetterstein limestones there is also a thick sequence of dolomites in their overlier. In the north-eastern part of the Muránska plošina (plateau) it is approximately 300 m thick, south-westwards it is in a finger-like form passing into the mass of light-coloured limestones (the hill Kastier). Dolomites overlying the Wetterstein limestones are lithologically identic with dolomites situated higher-up, in the overlier or dark shales.

In the bottom part of dolomites (near the village Muráň) is

*Teutloporella herculea* (Stopp.) Pia, in the higher part (Tisovec — the hill Kastier) also *Poikiloporella duplicata* (Pia) Ott. *Diploporella annulata* (Schafh.) was not found. Perhaps the sequence of dolomites is of the Cordevolian age: and in some places commences in the Langobardian (the presence of *T. aequalis* in their immediate substratum).

### 3. The Upper Triassic

If the Cordevolian is regarded as the lower stage of the Carnian, then the boundary of the Middle and Upper Triassic is not on the base of dark shales dividing the dolomite sequence in two parts, but in the sequence of the dolomites, and therefore it cannot be lithologically indeterminate.

a) Dark and black shales. The sequence of dark and black shales in dolomites is only several m thick (max. 10 m) and difficult to trace. It is only known from some small exposures, mostly from the cut of the road from Muráň to Veľká Lúka. They contain: "*Spiriferina*" *pectinata* Bittn., "*Spiriferina*" aff. *lipoldi* Bittn., "*Cyrtina*" aff. *gracillina* Bittn., *Isocrinus tirolensis* Laube, *Halobia* sp. They are, however, insufficient for age determinations. They are regarded as a lateral equivalent of the Lunz beds (the Reingraben shales), still they may also be equivalent to "the Aon beds".

b) Light-grey saccharoidal dolomites. Dolomites in the overlier of the dark shales did not yield any fossils. In the southwestern part (the hill Kastier) in their top part they contain thin layers of light-coloured and pink limestones with poor Dasycladaceae represented by *Poikiloporella duplicata* Pia (Ott.).

c) Light-coloured massive limestones (the Tisovec limestones). By the term Tisovec limestones designated are light-coloured massive limestones whose facies corresponds to that of the Wetterstein limestones. They are light-coloured organodetrital limestones with structures of "grosso-lites" with oolitic limestones and infrequent chert concretions. Along fossils found were Ammonites, Foraminifera, Dasycladaceae, corals. They form a thick sequence in the overlier of the above mentioned dolomites and in the substratum of similar almost lithologically identic Furmanec limestones. Their upper confinement is inconspicuous.

Ammonites are represented by an association found in a quarry above the town Tisovec, and by an association from the hill Devov vrch. The first association consists of *Anatomites* aff. *fischeri* Mojs., *Megaphyllites jarbas* (Muenst.), *Megaphyllites jarbas jarbasides* Kuehn, *Placites placodes* Mojs., the second consists

of *Placites placodes* Mojs., *Megaphyllites jarbas* (Muenst.) and *Sirenites* cf. *senticosus* (Dittmar, jun.). Basing upon these associations, the Tisovec limestones are referred to the Tuvalian.

Dasycladaceae are only represented by *Poikiloporella duplicata* (Pia) Ott, accompanied in one case by the form related to *Teutloporella herculea* (Stopp.) Pia. (J. Bystrický 1967.)

Corals are represented by *Montivaltia* cf. *marmorea* Frech and *Thecosmilia* sp., they were, however, not thoroughly examined so far.

Foraminifera are quite frequent, represented by an association characterized by the species of the genus *Involutina*. See the list in Table 6.

d) Light-coloured and light-grey massive limestones (the Furmanec limestones). During the Norian the sedimentation area is differentiated into a reef area with massive organodetrital limestones, and a lagoonal area with bedded limestones containing megalodonts.

It was already mentioned that the Tisovec limestones are overlain by light-coloured massive organodetrital limestones. Here they are of the Norian age. They are called the Furmanec limestones, yet by their facies and age they are equivalent to the alpine "Dachsteinriffkalk". They differ from the Tisovec limestones in darker colour-shades. Their Norian age is evidenced by the fauna of Ammonites their base being microfacially characterized by the appearances of Dasycladaceae of the genus *Heteroporella*.

Associations of Ammonites are known from the localities Javorina, Kereška (both to the west of the valley Furmanec), the hill Kastier (to the east of the valley Furmanec) and the hill Dedov vrch in the northeastern part of the Muránska plošina (plateau).

Javorina: *Arcestes* cf. *intuslabiatus* Mojs., *Drepanites* cf. *marস্যas* Mojs., *Megaphyllites* sp. occurring together with Brachiopoda: *Oxycolpella* cf. *oxycolpos* (Emm r.), *Rhaetina pyriformis* (Suess); "*Rhynchonella*" cf. *fissicostata* Suess.

Kereška: *Placites oxyphyllus* Mojs., *Megaphyllites* sp. The hill Kastier: *Placites postsymmetricus* Mojs., Brachiopoda: *Oxycolpella oxycolpos* (Emm r.), *Diplospirella* cf. *wissmani* (Muenst.), *Sinuocostata* cf. *emmrichi* (Suess), "*Retzia*" *schwageri fastosa* Bitt, "*Rhynchonella*" *jugeri stenoglossa* Bitt. The hill Dedov vrch: *Placites polydactylus* Mojs.; Lamellibranchiata: *Halobia fallax* Mojs., *Variamussium schafhautli* (Winkl.). Among Lamellibranchiata were found *Halobia plicosa* Mojs., and *Neritopsis compressa transversa* Koken (to the northwest of Tisovec). Corals: *Montivaltia* cf. *marmorea* Frech, *Thecosmilia* sp.

ind., *Elyastrea* sp. ind., *Stylophyllopsis* sp. Dasycladaceae: *Heteroporella carpathica* Bystr. accompanied with a form related to the species *T. herculea* (Stopp.) Pia., and by other taxonomically indetermined species of the genera *Heteroporella*, *Gyroporella*, *Macroporella*. Foraminifera are represented especially by the species of the genus *Involutina* accompanied by the species *Trocholina permodiscoides* Oberh., and *Triasina* aff. *hantkeni* Majzon. (See the list in Table 6.)

Conodonta were only found in one locality (to the east of Velká Lúka): *Enantiognathus zieglerei* (Diebel), *Gondolella navicula hallstattensis* (Mosher), *G. navicula* Huckriede, *Hindeodella (Metaprioniodus) spengleri* (Huckriede), *H. (M.) suevica* (Tatge), *Neohindeodella dropla* (Spasov et Ganév), *Ozarkodina tortillis* Tatge, *Prioniodina excavata* Mosher, *P. (Cypridodella) muelleri* (Tatge), *Tardogondolella abneptis* (Huckriede) — R. Mock 1971.

e) Bedded limestones with megalodonts (the Dachstein limestones). The Furmanec limestones pass laterally into light-grey, grey, pink, compact bedded, sometimes brecciated limestones with layers of dolomitic limestones and dolomites. In the base of the sequence are also light-coloured and pink nodular limestones. By their facies they recall the Hallstatt limestones. Among fossils most typical are megalodonts (*Megalodus complanatus* Gue mb.). In the limestones recalling the Hallstatt limestones among lumachelles are *Monotis salinaria* Br. More frequent are microfossils, especially in their top part; in organodetrital grey and dark-grey limestones with lumachelles of Brachiopoda. These limestones, owing to the presence of *Rhaeticavicula contorta* (Portl.) may be referred to limestones of Rhaetian age. They contain Dasycladacea *Heteroporella crosi* (Ott) Ott, *Diplopora muranica* Bystr., *Gyroporella* aff. *vesiculifera* Gue mb., and among Foraminifera mainly *Triasina hantkeni* Majzon. In "the syncline Dudlavá skala" the most upper Triassic sequence are dark limestones with *Rhaetina gregaria* (Suess) present in the overlies of the Furmanec limestones with Brachiopoda: "*Retzia*" *schwageri media* Bittn., *Rhaetina* aff. *pyriformis* (Suess), *Dioristella indistincta* Beyrich, *Mentzelia fraasi* Bittn.

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Foraminifera of the Upper Triassic: 1. Velká Lúka, Tesná skala (the Tisovec limestones; Carnian); 2. Tisovec, the spring Teplica (the Tisovec limestones; Carnian); 3. Velká Lúka (the Furmanec limestones; Norian); 4. Tisovec, the elevation point 878.5 (the Furmanec limestones; Norian); 5. Krajcová (the Furmanec limestones; Norian); 6. Velká Lúka (dark-grey limestones in the overlies of the Dachstein limestones, Rhaetic).

## Tab. Nr. 6 — The Muránska plošina (plateau)

Species	Carnian		Norian		Rhaetic	
	1	2	3	4	5	6
<i>Agathammina austroalpina</i> Kr. Toll. et Toll.	+	+	+		+	+
<i>Ammobaculites wirtzi</i> Koehn-Zahn.						
<i>Ammobaculites</i> sp.						+
<i>Austrocolomia</i> sp.	+					
<i>Diploremina</i> sp.	+		+			
<i>Diploremina astrofimbriata</i> Kr. Toll.			aff.			
<i>Diploremina subangulata</i> Kr. Toll.				+		
<i>Bigenerina</i> sp.						+
<i>Duostomina</i> sp.	+		+	+	+	+
<i>Endothyra keupperi</i> Oberh.	+		+			
<i>Endothyra</i> sp.			+	+		
<i>Endothyranella</i> sp.			+	+	5	
? <i>Earlandinita</i> sp.				+		+
<i>Fronicularia</i> sp.	+	+		+		+
? <i>Flabellamina</i> sp.		+				
<i>Glomospira</i> sp. 1	+			+		
<i>Glomospira kuthani</i> (Salaj)	+	cf.	cf.			
<i>Glomospira tenuifistula</i> Ho						aff.
<i>Glomospira</i> sp.	+	+				
<i>Glomospirella paralelln</i> Kr. Toll.	cf.					
<i>Glomospirella spirillianoides</i> (Groz./Gleb.)			aff.			
<i>Glomospirella friedli</i> Kr. Toll.						+
<i>Glomospirella</i> sp.	+					+
<i>Involutina sinuosa sinuosa</i> (Weysch.)	+		+	+	+	+
<i>Involutina sinuosa pragsoides</i> (Oberh.)	+	+	+	+	+	+
<i>Involutina sinuosa oberhauseri</i> (Salaj)			+	+	aff.	aff.
<i>Involutina gaschei</i> (Koehn-Zan. et Brön.)	+				aff.	
<i>Involutina gaschei praegaschei</i> Koehn-Zahn.	+					
<i>Involutina planidiscoides</i> (Oberh.)	cf.					
<i>Involutina muranica</i> Jendr.				+	aff.	+
<i>Involutina tumida</i> (Kr. Toll.)			+			+
<i>Involutina impressa</i> (Kr. Toll.)					+	+
<i>Involutina communis</i> (Kr.)						+
<i>Involutina tenuis</i> (Kr.)						+
? <i>Labyrinthina</i> sp.		+				
<i>Neoendothyra reicheli</i> Reitl	cf.	cf.				
<i>Nedosaria</i> sp.	+					+
<i>Ophthalmidium triadicum</i> Kr. Toll.			cf.	+		
<i>Ophthalmidium</i> sp.	+	+				
<i>Trochammina multispira</i> Oberh.	cf.					
<i>Trochammina almtalensis</i> Koehn-Zahn.		cf.		cf.		
<i>Trochammina</i> sp.	+	+		+		
<i>Trocholina permodiscoides</i> Oberh.					+	+
<i>Trocholina crassa</i> Kr. Toll.		cf.		+		
<i>Trocholina acuta</i> Oberh.						cf.
<i>Triasina hantkeni</i> Majz.					aff.	+
<i>Variostoma crassum</i> Kr. Toll.						

Schafh., *Austrirynchia cornigera* (Schafh.), *Sinuocosta emmrichi* (Suess), *Zugmayerella koessensis* (Zugm.), *Oxytoma inaequivalvis intermedia* (Emmrich), *Plagiostoma* cf. *praecursor* (Quenst.), which may, perhaps, be referred to the Uppermost Norian — the base of the Rhaetian.

The top part of the Mesozoic is formed of grey crinoidal Lias limestones overlain by dark-grey spotted marly limestones and marls with Ammonites: *Oxynoticeras* cf. *oxynotum* (Quenst.), *Protogrammoceras normanianum* (d'Orb.), *Lytoceras* sp., *Androgyroceras* sp., which belong to the Lias (Lotharingian — Dommerian).

In the bed sequence of the Triassic in the Muránska plošina (plateau) the excursion will show:

- Seissian and Campilian beds in the cut of the road between Švermovo and the village Červená Skala,
- Rhaetic limestones (with *Rhaetavicula contorta*, *Dasycladaceae* and Foraminifera), the Dachstein limestones with megadolodonts, the Furmanec limestones (with *Dasycladaceae* and *Conodonta*), the Tisovec limestones with *Dasycladaceae* and Foraminifera, cropping out in the cut of the forest road to Veľká Lúka,
- Upper-Triassic (Carnian) dolomites the Wetterstein limestones with *Teutloporella herculea* and the Wetterstein limestones with *Diplopora annulata*, cropping out in the cut of the forest road from Veľká Lúka to the gamekeepers's cottage Studňa; and dark-grey Wetterstein limestones with *Teutloporella herculea* on a meadow to the north of the hill Lopušná.

## 9. Veľká Lúka —

The Dachstein limestones in the cut of the road

On the road between Červená Skala and Muráň a forest road turns to Veľká Lúka. In the cut of the road are the Dachstein limestones in a sequence of grey, light-grey and dark limestones with layers of red limestones, or brownish or reddish "enclosures". In these are sporadic anorganic forms of calcite filling the vesicles. These are the so-called evinosponges (Gross-oolites).

In the southwestern part of the Muránska plošina, in the overlier of the Dachstein limestones and in the substratum of dark shales regarded as Lias, are grey and light-grey crinoidal limestones (the hill Gošťanová) with Brachiopoda and Lamellibranchiata: *Rhaetina pyriiformis* (Suess), *Zeilleria norica* (Suess), *Zeilleria elliptica* (Zugm.), "*Rhynchonella*" *subrimosa*

Among macrofossils in the cut of the road only megalodonts were found: *Megalodus companatus* G u e m b.

In thin section the texture of the Dachstein limestones is considerably varied (micrites, biomicrites, microsparites).

a) In red limestones are infrequent organic remains, while in grey and dark-grey limestones organic remains are more frequent. In some places these limestones are overfilled with the organic remains and may be designated as biomicrites. They contain Foraminifera: *Involutina gaschei* (K o e h n. — Z a n. et B r o n n.), *Involutina minuta* K o e h n - Z a n., (Involutina are mostly recrystallized); *Fronicularia* sp., *Lenticulina* sp., *Trocholina* sp. and others. Besides Foraminifera there are Gastropoda, Ostracoda, fragments of juvenile Lamellibranchiata, Coprolites, Radiolaria, rare *Praecalpionellopsis gemerensis* B o r z a, *Acicularia* sp. and *Aeolisaccus* sp.

Among Dasycladaceae are sporadic *Gyroporella* cf. *vesiculifera* G u e m b.

Sometimes limestones contain intraclasts of the size 0.04—0.15 mm. Rarely the limestones are dolomitized. In the dolomitized part organic remains were not preserved. Autigene minerals are represented by quartz.

b) Grey fine-grained and medium-grained bedded limestones contain several microfacial types. Such are oolitic limestones (oosparites) with oolites of the size of 0.3—0.8 mm observable on the weathered surface.

The oolites are spherical and oval, with indistinctly concentric and radiate structure. In the cores of the oolites are fragments of limestones, rare Foraminifera, fragments of Lamellibranchiata, spines of echinoderm. Mostly they are poor in organic remains. In the oolitic limestones are intraclasts. Matrix is microsparite.

c) The next group of limestones are calcarenites formed of unrounded fragments of limestones. The limestones fragments are micritic and microsparitic, of the size of 0.1—1.0 mm. There also appear coarse-grained varieties of grey bedded limestones with clastics of the size of 3 cm and even more. Clastic material in the coarse-grained varieties are mostly unsorted. Frequently they contain recrystallized fragments of Lamellibranchiata, Crinoid segments, Gastropoda, infrequent Foraminifera. The latter are represented by *Involutina muranica* J e n d r., *Duostomina* sp. and others.

Of this type are also dark limestones in the overlies of bedded light-grey Dachstein limestones containing Dasycladaceae and Foraminifera: *Diplopora muranica* B y s t r., *Heteroporella crosi*

(O t t.), *Gyroporella* aff. *vesiculifera* G u e m b., *Triasina hantkeni* M a j z o n. Macrofossils are represented by *Rhaetavicula contorta* (P o r t l.).

Matrix of calcarenites is sparite indicating an environment of highenergy.

The Dachstein limestones occupy here Middle und Upper Norian, and their top part extends to the Rhaetic. Their substratum contains the Furmanec limestones with *Heteroporella*, *Cónodonta*, *Ammonites* and *Lamellibranchiata*. They are overlain by grey crinoidal limestones and dark-grey spotted marly limestones of the Lias.

### The Nízke Tatry mountains (Fig. 12)

The Nízke Tatry are the only core mountains in Slovakia whose crystalline core is formed of two tectonic units of the 1st order: the Tatric and the Veporic.

The contact between them is on approximately the middle of the mountains running through the pass (saddle) Čertovica and is known as "the Čertovica line". It is regarded as a deep tectonic scar that absorbed the crystalline of the Križna nappe (A. Biely — O. Fušán 1967).

The region extending to the west of the Čertovica line — the mountain group of Ďumbier (the maximum height 2.043 m above sea level) is the Tatric unit. Its crystalline core — the subzone of Ďumbier — is formed of intensively metamorphosed and granitized crystalline shales (mostly in its southern part), and of granitoids (in its northern part).

The Mesozoic of the Tatric is represented mainly by the Lower Triassic. Middle or Upper Triassic sediments are infrequent, and Jurassic and Cretaceous sediments are only in the western part of the mountain-range. The tectonics of the Tatric Mesozoic is complicated; the Mesozoic is frequently folded-in deep in the crystalline (Trangoška) or folded into recumbent folds ("the recumbent fold Tlstá" etc.).

#### *The Triassic of the Tatric*

The Tatric Triassic commences with a sequence of quartzose sandstones with layers of conglomerates (see the locality Nr. 16 Donovaly). Upwards they contain first the layers of variegated clayey shales, above them variegated shales predominate absolutely. The sequence yields no fossils. Only the layer of slightly marly greenish shales in the top part of variegated shales contains *Costatoria costata* (Z e n k e r) indicating the Campilian — similar to the beds of grey-yellow laminated dolomites.

TECTONIC SCHEME OF THE NORTHERN SLOPES OF  
THE NÍZKE TATRY MTS. IN THE VICINITY  
OF MALUŽINÁ (according to A. Biely  
in D. Andrusov 1967)

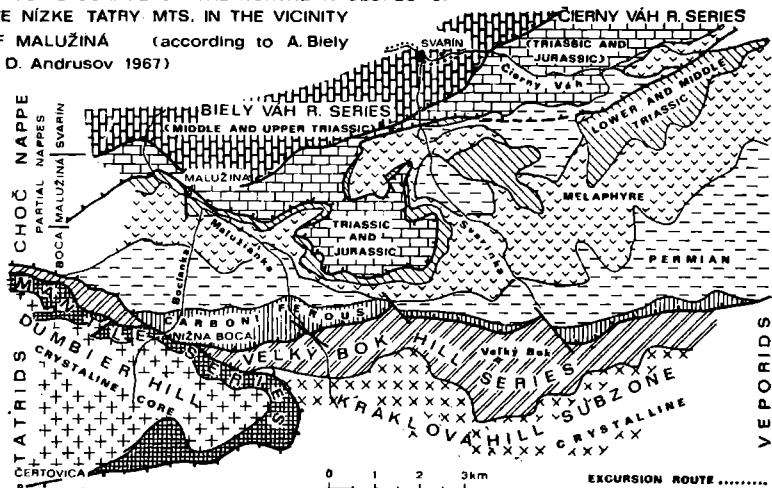


Fig. 12

The Middle Triassic is represented mainly by the Gutenstein limestones. They are bedded and flaggy; there are also layers of vermicular limestones and intercalations of crinoidal limestones. In the basal part of the Gutenstein limestones is the fauna of *Trachynerita gaillardoti* (Lefr.), *Neritaria stanensis* (Pichl.), and *Costatoria sp.* As the higher part of the Middle Triassic are regarded bedded dolomites present only in small and isolated folded lenses.

The Upper Triassic is in the facies of the Carpathian Keuper, mainly in the form of bedded quartzites and conglomerates with intercalations of variegated shales. Beds of the Rhaetic age are missing.

The bed sequence of the Tatric Mesozoic ends, by beds of the Cenomanian age. On the beds rests the Krížna nappe with the bed sequence of the Middle Triassic up to the Albian. Only in the western part of the mountains (the Staré Hory) are the Lower Triassic, Permian ("the verrucano-facies") and the crystalline.

In the Krížna nappe several facies of the Jurassic were distinguished (therefore in literature various "series" are quoted, as for example: "the Zliechov series" containing the Jurassic in spotted marls, "The Belá series" in crinoidal limestones, "the Hľanova series", etc.). In the Triassic of these "series" the differ-

ences are not so distinct. In the area of the "Ilanova series" in the Anisian predominante dark, bedded and massive limestones ("the Gutenstein and Annaberg limestones") in the area of "the Zliechov series" dolomites predominate. Dark limestones on the base of the Middle Triassic are 30—40 m thick and their distribution is reduced.

Some smaller differences are also in the higher sequences of the Triassic; still they are not so decisive as to support the precise determination of partial facial areas.

The Gutenstein limestones are particularly frequent in the area of the Demänovská dolina (valley) — the karst area with caves. They are bedded, dark limestones with layers of vermicular limestones, and higher-up thick-bedded and massive limestones with layers of crinoidal limestones. The latter contain Lamellibranchiata and Brachiopoda, in their top part also Dasycladaceae in the layers of light-coloured limestones.

The association of the Anisian Brachiopoda is known from numerous localities. The species *Decurtella decurtata* (Gir.) is only in one of them: in the Demänovská dolina (valley) as quoted already by D. Štúr (1868). Here it is also in the bed sequence with *Tetractinella trigonella* (Schloth.), *Coenothyris vulgaris* (Schloth.), *Mentzelia mentzelii* (Dunk.), *Mentzelia mentzeli mentzeli* (Dunk.), *Mentzelia mentzeli* cf. *judicaria* (Bittn.), "Retzia" *schwageri* Bittn., *Spiriferina fragilis* (Schloth.), *Spiriferina bonii* Sachi-Vialli, ?*Encrinurus liliiformis* Miller; elsewhere only *Entolium discites* (Schloth.), *Coenothyris vulgaris* (Schloth.), *Mentzelia mentzeli* (Dunk.) and *Tetractinella trigonella* (Schloth.) — in the Demänovská and Ilanovská dolina (valleys), or *Mactromya rectangularis* (Seeb.) and *Elegantinia elegans* (Dunk.) — the Demänovská dolina valley.

Dark-grey dolomitic limestones and limestones of higher colour-shades in the top part of the sequence contain Dasycladaceae *Physoporella dissita* (Gueb.) Pia and Foraminifera *Citaella* cf. *insolita* (Ho), *Citaella dinarica* (Koch. Dev.-Pantič), *Pilamina densa* Pantič, *Citaella* aff. *irregularis* (Sala j).

The next higher dolomite sequence commences in the zone with *Physoporella pauciforata* (*Physoporella dissita* (Gueb.) Pia, in the Demänovská dolina valley) and extends to the substratum of the Lunz beds. In the mass of dolomites are some layers of dark, dark-grey, fine-grained limestones of the biosparite type. One of the layers contains *Physoporella praealpina* Pia and ? *Diplopora annulatissima* Pia with Foraminifera *Citaella dinarica*

(Koch. Dev. - Pantič), *Citaella* cf. *insolita* (Ho), *Ammobaculites* cf. *radstadtensis* Kr. Toll., *Endothyranella* sp.

Another layer contains solely the species *Diplopora philosophi* (Pia) with Foraminifera *Fronicularia woodwardi* Howch., *Ammobaculites* aff. *wirzi* Koehn-Zann. The mutual relationship between the layers is not clear, they were found in different cross-sections. We only know that the layer with *Diplopora philosophi* (Pia) is in the substratum of dolomites with *Diplopora annulata* (Schafh.). The top layer of the dark limestones is about 10 m thick sequence of black, thin-bedded compact limestones with *Costatoria goldfussi* (Alb.) above dolomites with *Diplopora annulata* and about 30—40 m below the Lunz beds.

The Lunz beds are here only thin lenses in dolomites. The Norian and in some places also Tuvalian are in the Carpathian Keuper. In its lower part is white and yellow, well bedded dolomite with nodules of cherts and with fine intercalations of green shales (Keuperdolomite), in the higher part are mainly green and red clayey shales with layers of quartzose sandstones.

Limestones and shales overlying the Carpathian Keuper are generally dark and represent Rhaetic beds in the Carpathian and Schwab facies. In the area of the Nízke Tatry mountains and in other mountain-groups the Rhaetic beds use to be rich in fossils. The most important locality (Bystrý potok) is on the northern foothill of the Veľká Fatra mountains. It is a type of the so-called Carpathian facies. The beds contain: *Rhaetina gregaria* (Suess), *Zeilleria norica* (Suess), *Zugmayerella uncinata* (Schafh.), *Austrirhynchia cornigera* (Schafh.), *Dimyodon intusstriatus* (Emmr.), *Plagiostoma praecursor* (Quenst.) *Lophahaidingeriana* (Emmr.), *Placunopsis alpina* (Winkl.) and from the higher part *Rhaetavicula contorta* (Portl.), *Variamusium schafhautli* (Winkl.), *Chlamys valoniensis* (Defr.), *Placunopsis alpina* (Winkl.), *Myophoria inflata* (Emmr.) — (D. Štúr 1868, M. Kochanová 1965).

In the area of the Nízke Tatry mountains, paleontological localities of the Rhaetic are not completely available. There are associations with 1. *Chlamys mayeri* (Winkl.), *Chlamys* cf. *mayeri* (Winkl.), *Placunopsis alpina* (Winkl.), *Rhaetavicula contorta* (Portl.) — Červený grúň; 2. *Pleurophorus* cf. *elongatus* More, *Placunopsis alpina* (Winkl.), *Parallelodon* sp., *Rhaetavicula contorta* (Portl.) — the Revúcka dolina valley; 3. *Rhaetina gregaria* (Suess), *Thecosmilia clathrata* (Emmr.) — the Ludrovianska dolina valley.

The next higher tectonic unit is the system of shear nappes or slices, designated as "the Choč nappe". Different development

of the Middle Triassic in the northern slopes of the Nízke Tatry Mountains was the basis of its dividing into the dolomite development ("the Čierny Váh series", "the Čierny Váh subunit" by M. Maheľ 1967, 1968) and the development with Reifling limestones ("the Biely Váh series", "the Biely Váh subunit").

Tectonic units where the Middle Triassic is in the dolomite development — the Šturec nappe — ("the partial nappe of Malužiná" and "the partial nappe of Boca", A. Biely 1966) are the tectonic substratum of the Choč nappe s. s. ("the Svarín nappe", A. Biely 1966). Both Triassic developments form two-nappe system in superposition on the northern slopes of the Nízke Tatry mountains. In other mountain-ranges, in the overlier of the Krížna nappe only one of the systems is present (for example: the Choč Mountains, the eastern part of the Veľká and Malá Fatra Mountains) only the Choč nappe, in the western part of the Veľká Fatra Mountains, in the Považský Inovec Mountains only the Šturec nappe or nappe outliers of both the nappes (the southern part of the Veľká Fatra Mountains, the Strážovská hornatina Mountains).

The partial nappe of Boca as on the bottom tectonic slices of the Šturec nappe is characterized by the Permian in the "melaphyre series" and by dolomites of the Middle or also Upper Triassic. The partial nappe of Malužiná commences with Lower Triassic quartzites overlain by Middle and perhaps also Upper Triassic dolomites with a slice of grey limestones containing *Myophoria fissicostata* (Woehrm.), *Trigonodon cf. rablensis* (Gredl.). According to them there are beds of the Carnian and slices of dark-grey, somewhere oolitic limestones accompanied with dark marly shales containing *Chlamys winkleri* (Stopp), *Rhaetavicula contorta* (Portl.), *Austriachynchia cornigera* (Schafh.) referred to the Rhaetic (M. Maheľ 1967; A. Biely in Biely — Bystrický 1966).

Most extensive is the Choč nappe s. s., ("the Biely Váh partial nappe" — M. Maheľ 1971). Its Middle Triassic is a type of the "Biely Váh series". Its bed sequence commences with the Gutenstein limestones (the Lower Triassic is only on the southern slopes of the Nízke Tatry mountains) and terminates with Rhaetic beds (the so-called Kössen beds).

### The Gutenstein limestones

They are bedded, somewhere massive, in the top part with a layer of light colour shades or with layers or vermicular limestones. Among macrofossils found was *Modiolus triqueter* (Seeb.). Stratigraphically important are Dasycladaceae, espe-

cially in the layer of light-coloured limestones. In numerous profiles of the northern slope of the Nízke Tatry mountains are: *Physoporella pauciforata* (Guemb.) Steinm. v. *pauciforata*, and perhaps its varieties v. *sulcata* Bystr., v. *gemerica* Bystr., *Physoporella dissita* (Guemb.) Pia, Ph. cf. *praealpina* Pia, together with Foraminifera: *Citaella* cf. *insolita* (Ho), *Citaella* cf. *dinarica* (Koch. Dev. - Pantič), *Trochammina almtalensis* Koehn. - Zann., *Ammobaculites* aff. *radstadtensis* Kr. Toll., *Valvudina* sp., *Endothyra* sp.

### Dolomites

The Gutenstein limestones are overlain by a sequence of grey bedded, somewhere massive and saccharoidal dolomites, very poor in fossils. Quoted is only *Tetractinella trigonella* (Schloth.), and Dasycladaceae from several localities: *Macroporella* cf. *alpina* Pia, *Physoporella pauciforata* v. *pauciforata*, Ph. *pauciforata* v. ? *gemerica* Bystr., Ph. *dissita* (Guemb.) Pia, *Physoporellae* cf. *praealpina* Pia.

From the southern slopes of the Nízke Tatry mountains, from the village Predajná comes the association *Physoporella pauciforata* (Guemb.) Steinm. v. *pauciforata*, Ph. *pauciforata*, (Guemb.) Steinm. v. *sulcata* Bystr., Ph. *pauciforata*, (Guemb.) Steinm. v. *gemerica* Bystr., Ph. *pauciforata* (Guemb.) Steinm. v. *undulata* Pia, Ph. cf. *praealpina* Pia.

The top part of the dolomites contains dark-grey and light-grey cherts, forming thus transition into the next higher sequence of dark cherty limestones designated as the Reifling limestones.

### The Reifling limestones

They are grey, bedded, muddy limestones, either containing dark cherts or being distinctly nodular, or both. Microfacies are mainly fibrous and fibrous-globochaete (with thin shells of *Lamellibranchiata*). The source of the chert nodules are radiolaria and sponge spicules. Sometimes beds of limestones alternate with thin intercalations or thicker layers (to 0.5 m) of grey-green shales; particularly in the lower part of the sequence. Stratigraphical range of the maximally 30–40 m thick sequence is considerably variable. The sequence commences in the Upper Anisian and extends to the lower boundary of the Aon beds or organodetrital and bioherm limestones, sometimes laterally alternating with them (see the localities Svarín, Turík, Liptovská osada).

Fossils of the lowest beds: *Piarorhynchia trinodosi* (Bittn.), known also from the northern and southern slopes of the Nízke

Tatry mountains (from the village Predajná; in the Svätôjánska dolina valley), *Physoporella dissita* (G u e m b.) P i a, *Pilamina densa* P a n t i č, *Ammobaculites radstadtensis* K r. - T o l l., *Citaella dinarica* (K o c h. D e v. - P a n t i č), *Citaella* sp., *Duostomina* sp., (the southern slopes of the Nízke Tatry mountains, Vajsková, Záturčie); Conodonta: *Gladigondolella tethydis* (H u c k r i e d e), *Gondolella excelsa* (M o s h e r), *Enantiognathus petraeviridis* (H u c k r i e d e) (Homôlka, the Strážovská hornatina mountains), and Lamellibranchiata: *Daonella taramelli* M o j s. (the quarry Svarín), *Daonella* cf. *pichleri* M o j s., *Daonella* cf. *tyrolensis* M o j s. (the quarry Turík) — they are somewhat lower.

In the top part (Cordevolian) of the filling limestones are *Monophyllites aonis* (M o j s.) — (M. R a k ú s 1960). The occurrence of *Daonella lommeli* M o j s. in shales overlying the Reifling limestones in the Strážovská hornatina mountains (M. M a h e l in R. M o c k 1971) is important for the determination of the stratigraphical diapason of the Reifling limestones. It is, however, not evidenced by material.

The Reifling limestones are overlain by "the Aon beds" or by the Raming limestones. The first are referred to the base of the Julian, the latter commence in the Cordevolian.

#### "The Aon beds"

are dark marly shales with layers of bedded nodular and cherty limestones or marly limestones with *Monophyllites simonyi* H a u e r (the quarry Svarín), with the fauna of indeterminate Lamellibranchiata and with Foraminifera *Trocholina multispira* O b e r h., *Trocholina ventroplana* O b e r h., *Rhizammina* cf. *sulimbata* K r. - T o l l., *Nodosaria epheiloculata aglabra* K r. - T o l l., *Endothyra keupperi* O b e r h., *Variostoma pralongense* K r. - T o l l. (the quarry Turík).

#### The Raming limestones

Light-coloured massive organodetrital limestones overlying the Reifling limestones already known earlier (A. M a t ě j k a 1927, Z. R o t h 1939), only they were not considered stratigraphically and facially important, neither after their correlation with the Wetterstein limestones (E. S p e n g l e r 1932).

Their facies and position correspond to the Raming limestones, recently distinguished in the Alps (A. T o l l m a n n 1966).

The Raming limestones are light-coloured massive and thick-bedded limestones. Their facies recalls the Wetterstein limestones. In contrast to the Wetterstein limestones, they do not contain Dasycladaceae, since they are bioherm limestones in a sphinctozoan or cidarise biofacies.

According to their facies, several types were distinguished:  
— light-grey and light-coloured limestones or thick-bedded limestones with "the fauna of the Choč dolomites" (B. Dornya y 1918, A. Matějka 1927, D. Andrusov 1964, M. Maheř 1967, 1968); *Cidaris dorsata* Mü nst., *Encrinus cassianus* Klipst., *Entrochus silesiacus* Bayer, *Cidaris* cf. *schwageri* Wöhrm., *Crurātula* cf. *carinthiaca* (Rothpl.), *Encrinus (Cassiocrinus)* cf. *varians* Mü nst. (the surrounding of Ružomberok, especially on the slopes of Mnich, B. Dornya y 1918, V. Vogl 1918, E. Spengler 1932).

Light-coloured limestones to the southeast of Podsuchá, with "*Terebrātula*" aff. *sturi* Laube, *Diplospirella wissmanni* (Muenst.) and especially light-coloured limestones from Liptovská Osada with *Cidaris*, Sphinctozoa, Hydrozoa, Foraminifera and some problematic fauna (see the locality of Liptovská Osada).

— grey and dark organodetrital thick-bedded limestones with Brachiopoda "*Terebrātula*" *neglecta* Bittn., "*Terebrātula*" *ladina* Bittn., *Aulacothyris ruedti* (Bittn.), "*Spiriferina*" *gregaria* Suess, "*Terebrātula*" aff. *sturi* Laube, "*Terebrātula*" *oppeli* Bittn., *Dioristella indistincta* (Beydrich), (to the SE of Ludrová), *Crurātula carinthiaca* (Rothpl.), "*Spiriferina*" *gregaria* Suess, *Dioristella indistincta* (Beydrich), *Aulacothyris ruedti* (Bittn.), *Anisactinella quadriplecta* (Muenst.), *Pecten ? octoplicatus* Bittn. (to the E of the village Ludrová).

— dark micritic limestones with the fauna of Brachiopoda. They overlie the previous types of limestones (see Liptovská Osada) and perhaps they are equivalent to "the Aon beds". In fact, they are overlain by the Lunz beds.

### The Lunz beds

The shales with layers of sandstones are designated as the Lunz beds or sometimes as "the Reingraben shales", form a lithologically important bed sequence. The Sequence divides the dolomites into two parts. Dolomites in the substratum were regarded as Middle Triassic; those in the overlies as Upper Triassic-equivalent to Hauptdolomite in the Alps. Thickness of the Lunz beds is very variable (perhaps owing to tectonic reduction).

Only in the area of the Choč nappe between Kráfová Lehota and Liptovský Hrádok and Liptovský Mikuláš its thickness is about 300 m which is unknown in other mountain-ranges.

Fossils of the Lunz beds are mostly represented by the species found by D. Štúr (1868) on the southern slopes of the Nízke

Tatry mountains: *Halobia haueri* Stur, *Leda elliptica* Goldf., *Leda sulcatella* Wissm., in shales designated as "the Rein-graben shales". At present we know several localities with Lamellibranchiata *Halobia rugosa* Guemb., *Halobia* cf. *miesenbachensis* Kittl, from the northern slopes, *Halobia rugosa* Guemb., *Halobia* cf. *miesenbachensis* Kittl, *Leda deffneri* O p p e l, *Entolium discites* (S c h l o t h.), *Gervillia* cf. *muscoloides* (S t o p p.), *Myophoriopsis rosthorni* (B o u é), *Pleurotomaria* sp., *Cuculea* sp. *Lima* sp. from the southern slopes of the Nízke Tatry (M. Pulec 1965). Stratigraphically important are two finds of Ammonites *Carnites floridus* (Wulfen) (V. Andrusovová 1960, 1967) indicating that the Lunz beds commence by the zone with *Carnites floridus* of the Lower Julian. Somewhere miospores appear (see the locality 12 — Liptovský Hrádok).

The upper stratigraphical line of the Lunz beds is not evidenced by fossils. It may, however, be determined according to fauna and flora of dolomites in their overlier.

#### Hauptdolomite

The dolomites overlying the Lunz beds were generally ascribed Norian age. The only occurrence of *Neomegalon triqueter pannonicus* (Frech.) — (D. Andrusov 1938), was regarded as the Norian fossil. At present we know further occurrences of fossils from dolomites overlying the Lunz beds — megalodonts: *Neomegalodon triqueter pannonicus* (Frech.), *Neomegalodon laczkoi* (Hoernes), *Neomegalodon carpathicus* Kochanová, Gastropoda and Lamellibranchiata: *Ampulospira paludinaris* (Muenst.), *Ampulospira* cf. *sanctae crucis* (Wissm.), *Neoschizodus* sp., *Trigonodus* sp., *Naticopsis* sp., *Hologira* sp. (see the locality 14 Liptovská Osada); and Dasycladaceae. In all the localities known are *Poikiloporella duplicata* (Pia) Ott (Zámotie on the southern slopes of the Nízke Tatry mountains; Liptovská Osada — the western slopes of the Nízke Tatry; Svít — the northern slopes of the extreme eastern part of the Nízke Tatry). The lower part of the Hauptdolomite is of the Upper Carnian (Turalian) age; the upper part — of the Norian.

#### The Dachstein limestones

The Hauptdolomite is the top sequence known in the nappe outliers of the Choč nappe. The higher members of the Triassic are presented in isolated cases when the Choč nappe is represented by extensive masses as in the northern slopes of the Nízke Tatry. In the valley of the river Biely Váh the Hauptdolomite is overlain by light-coloured and grey bedded limestones designated as

the Dachstein limestones and referred to the Norian. Macrofossils were not found except *Zeilleria elliptica* (Zugm.), *Austrirhynchia cornigera* (Schafh.), *Placunopsis alpina* (Winkl.), *Placunopsis intustiata* (Emmr.) quoted by M. Mahel 1964.

The lower part consists of about 3 m thick beds of grey limestones with layers of brecciated and oolitic limestones. Upwards the thickness of beds decreases, the limestone get fine-grained or compact. They contain Foraminifera: *Involutina communis* (Kr.), *Involutina tumida* (Kr., Toll.), *Involutina sinuosa pragsoides* (Oberh.), *Inv. sinuosa sinuosa* (Weynsch.), *Inv. sinuosa oberhauseri* (Sala), "*Semiinvolutina clari* Kr., Toll.", *Triasina hantkeni* Majz., *Trocholina permodiscoides* Oberh., *Trocholina acuta* Oberh., *Paalzowella austriaca* (Kr., Toll.), and isolated Dasycladaceae recalling the genus ? *Acicularia* sp. The relationship between these limestones and the next higher sequence — "the Kössen beds" is not quite clear, because tectonics is more complicated here than it was formerly assumed.

#### The Kössen beds

The top sequence for the Triassic in the Choč nappe, rich in fossils are dark bedded limestones and dark marly shales to the south of the village Hybe in the valley of the river Biely Váh. The fauna was studied by W. Goetel (1917); D. Andrusov (1934) found an *Ammonite Arcestes* (*Arcestes*) cf. *rhaeticus* (Clark) and F. Prantl (1938) — Bryozoa. At present the fauna of the Kössen beds is studied by M. Kochanová (1965) and J. Michalík (see the locality Hybe). Brachiopoda: *Sinuocosta emmrichi* (Suess), *Zugmayerella uncinata* (Schafh.), *Z. koessenensis* (Zugm.), *Lepismatina austriaca* (Suess), *Oxycolpella oxycolpos* (Emmr.), *Septaliphoria fissicostata* (Suess), "*Rhynchonella*" *subrimosa* Schafh., *Austrirhynchia cornigera koessenensis* (Zugm.), *A. cornigera carpatica* (Zugm.), *Rhaetina gregaria* (Suess), *Rhaetina pyriformis* (Suess), *Zeilleria norica* (Suess), *Zeilleria elliptica* (Zugm.), *Zeilleria waldegiana* (Zugm.), *Zeilleria* cf. *austriaca* (Zugm.), *Thecospira haidingeri* Suess, *Thecidea* (*Pterophlocus*) *emmrichi* Suess, *Discina* (*Orbiculoidea*) *insignis* Suess. Lammelli-branchiata: *Rhaetavicula contorta* (Portl.), *Oxytoma inaequivalvis intermedia* (Emmr.), *Cassianella inaequiradiata* (Schafh.), *Plagiostoma gigantea* (Sow.), *Plagiostoma gigantea punctata* (Sow.), *Mantellum subdupla* (Stopp.), *Lima alpissordidae* (Winkl.), *Lima pectinoides* (Sow.), *Terquenina arietis* Quenst., *Chlamys valoniensis* (Defl.), *Chlamys favrii* (Stopp.), *Chlamys simkoviczi* (Goetel), *Velopecten* cf. *brau-*

nii Kon., *VELOPECTEN zejschneri* Goetel, *VARIAMUSSIUM schafh utli* (Winkl.), *ENDOLIUM hehlii* d'Orb., *DIMYODON intusstriatus* (Emmr.), *HARPAX* aff. *spinosa* (Sow.), ?*Plicatula archiaci* Stopp., *Placunopsis alpina* (Winkl.), *Lopha haidingeriana* (Emmr.), *Ostrea anomala* Terq., *Modiola hybbensis* (Goetel), *Modiola schafh utli* (Stur), *Leda deffneri* Oppel, *Parallelodon hettangiensis* (Terq.), *Myophoria inflata* Emmr., *Myophoria liassica* Stopp., *Myophoria liassica exaltata* Goetel, *Cardita austriaca* (Hau), *Cardita multiradiata* (Emmr.), *Protocardia rhaetica* (Mer.), *Pleuromya* cf. *suevica* Rolle, *Chlamys winkleri* (Stopp.), *Chlamys falgeri* (Mer.); Cephalopoda: *Arcestes (Rhaetites)* cf. *rhaeticus* (Clark); Bryozoa: *Berenica hybensis* Prantl, *Stomatopora* sp.: Echinoderms: *Pentacrinus bavaricus* Winkl., *Cidaris subverticillata* Gott., *Cidaris (Rhabdocidarid?)* sp.; Foraminifera: *Hyperammina stabilis* Kr., Toll., *Glomospira* sp., *Nodosaria apheilocula aglebra* Kr., Toll., *Nodosaria pupiformis* Terq., *Dentalina absoleta* Schwager, *Marginulina solida* Terq., *Lenticulina polygonata* (Frankel), *Astacolus manutina informis* (Schwager), *Astacolus pediaca* (Tappan), *Astacolus inquisita* (Terq.), *Falsopalmula* aff. *arignota* Kr., Toll., *Frondicularia rhaetica* Kr., Toll., *Lenticulina subquadrata* (Terq.), *Frondicularia gerkei* Kr., Toll., *Marginulina solida* Terq., *Austrocolomia marschali* Oberh. (O. Jendr kov  — J. Salaj 1967). Conodonts: ?*Gondolella navicula* Huckriede (J. Pevn  — K. Budurov 1970).

In the bed sequence of the Cho  nappes we may trace:

1. The Rhaetic K ssen beds, the Dachstein limestones and the top part of the Hauptdolomite (the locality 10, Hybe);
2. The Middle Triassic and the base of the Upper Triassic (dolomites, the Reifling limestones, "the Aon beds", the base of the Lunz beds), the locality 11, Svar n;
3. the top part of the Lunz beds (the locality 12, Liptovsk  Hradok);
4. the Middle Triassic and the base of the Upper Triassic (dolomites with diplopores, the Reifling limestones); "the Aon beds" (the locality 13, Tur k);
5. the top part of the Reifling limestones, the Raming limestones (the locality 15, Liptovsk  Osada);
6. the lower part of the Hauptdolomite in the reef and lagoonal facies (the locality 14 of Liptovsk  Osada).

In the sequence of the Tatric:

7. the sequence of Lower Triassic quartzites (the locality Nr. 16 Donovaly).

## 10. Hybe -

the Kössen beds (Fig. 13, 14)

In the locality is an outcrop of Rhaetic rocks in the outer bank of the meandre of the river Biely Váh under the northern foothill of the Nizke Tatry mountains. The river penetrated through the thin cover of Paleogene rocks into Upper Triassic sediments of the Choč nappe.

The oldest rock near the locality is the Upper Triassic (Carnian — Norian) dolomite (Hauptdolomite) of grey-lightgrey colour. The rock was not studied in detail. The higher situated light-coloured and grey bedded limestones of the Norian ("the Dachstein limestones") frequently contain small detritus, mostly of Gastropoda and Bivalvia fragments. In the little rocks above the lateral valley below the locality, the limestones contain frequent intercalations of pink limestones, indistinctly spotted limestones, brown-red limestones with indications of nodularity. In higher layers, exposed by the cut of the railway-track, J. Koutek (1927) described brecciated limestones. (Breccia fill there deepening in light-coloured limestones, and are distinctly graded-bedded. They pass into yellow marly limestone intercalations. The lateral transition is organodetrital limestone.) In the top layers of the sequence are light-coloured oolitic limestones, getting darkgrey towards the overlier.

A part of the higher sequence is exposed by an artificial exposure. Its tectonic position makes detail conclusions on stratigraphy obscure. According to the existing results its sequence is as follows:

1. Dark-grey, fine-crinoidal biosparitic limestones. They are comparatively well sorted, containing isolated shells of Brachiopoda, and valves of oysters on the base. The limestones display no traces of microfauna; the absence of the marly component facilitates recrystallization of the rock, in some places. These beds are in the cores of two recumbent anticlines.

2. Beds of grey organodetrital biomicrosparitic and biosparitic limestones. They contain frequent lenticular layers of lumachelles of larger Bivalvia. Most frequently the valves are oriented towards the overlier by their arch. The surface of the limestone beds is waved-eroded, the filing of the deepening is graded. The fine-grained rock mass contains small segments of crinoids, spines of echinoderm, sclerites of Holoturia, Foraminifera and protoconchs of Mollusca. In thin sections small pyrite aggregates may be found.

3. The next higher sequence consists of rhythmically alternating marly layers overlapped by beds of organodetrital limestones.

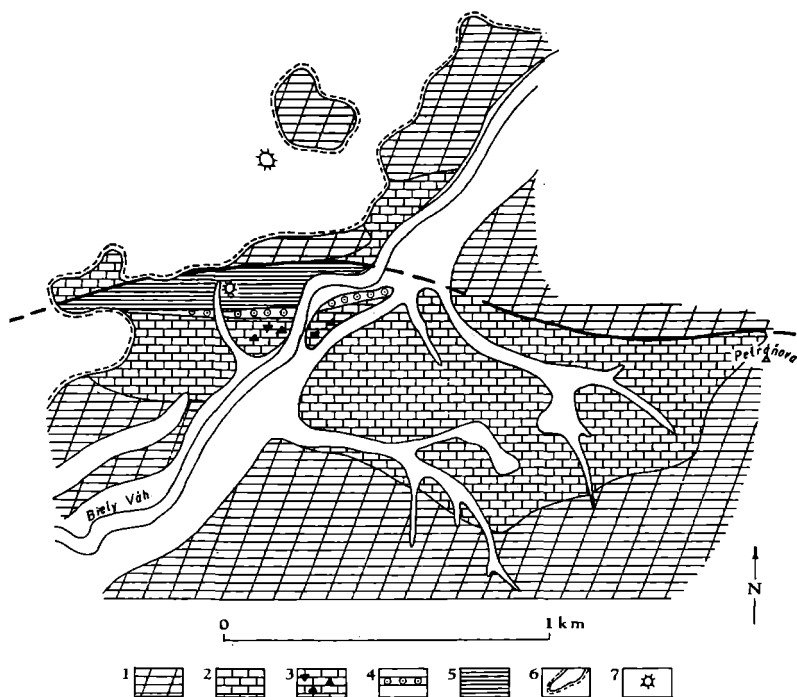


Fig. 13 A schematic geological map of the locality of Hybe (modified according to the Geol. map by R. Kettner and V. Šťastný 1925—1930)

1. Upper Triassic dolomite; 2. Dachstein limestones; 3. layers with slump bodies in light-coloured limestones; 4. light-coloured and dark-grey oolitic limestones; 5. a dark sequence of rhythmically alternating marls and detrital limestones; 6. the line of the cover of Paleogene deposits; 7. sinkholes.

Rhythms are 30 cm—2 m thick. Beds of organoclastic limestones consist of crinoid segments, fragments of calcareous shells of *Bivalvia* and *Brachiopoda*, fine organic detritus and a small amount of marly material. In the lower rhythms the limestones have an character of biomicrosparite, it contains a lot of microfauna, in sections are observable burrows of burrowing animals. Among macrofauna generally *Bivalvia* of all ecological types and larger *Brachiopoda* prevail. The rests of valves are damaged by transport. In the limestone intercalations of the higher rhythms the fine material is less abundant (biosparites); among fauna nectobenthonic types of *Bivalvia* prevail.

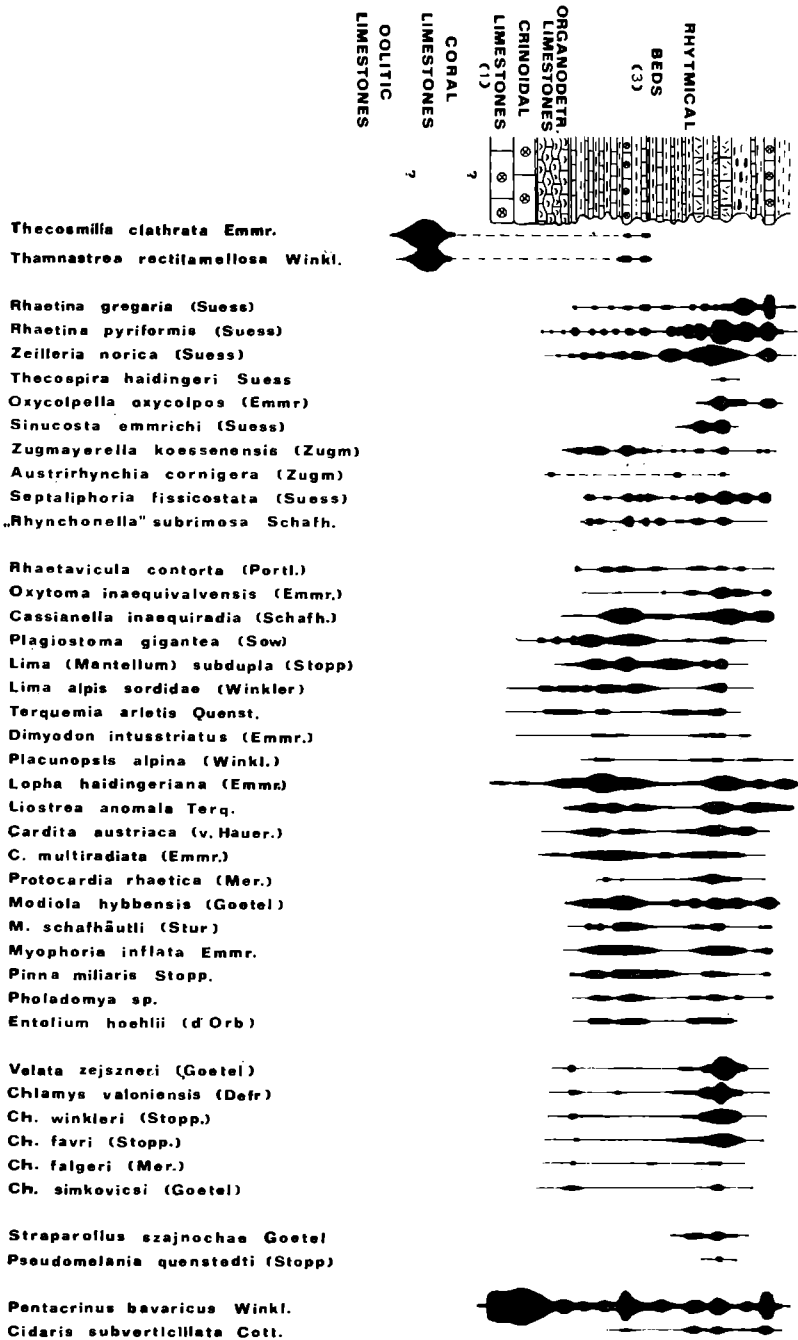


Fig. 14 The Table of occurrences of the most important fossils in the exposure in the locality Hybe. Slightly schematized.

Layers of marls are distinctly affected by tectonics and their internal structure is predominantly rubbed. Somewhere are rests of the former vertical division in three zones the lower — the calcareous, the middle — the bituminose, and the surficial thin oxidic crust. Elsewhere the regularity was complicated by re-sedimentation. In the immediate overlier of the limestone bed is sometimes a thin layer of yellow-grey marl. The limestones bed is overlain by grey calcareous marlstone with frequent concretions of marly limestones and with abundant Bivalvia, Brachiopoda, Echinoderms, Gastropoda and isolated damaged nuclei of nautilide Cephalopoda. Brachiopoda and Bivalvia are sometimes preserved in the living position. The horizon is 10—60 cm thick and passes continuously into the layer of black marlstone with considerable amount of bituminose admixture. Its dark colour is due to the iron monosulphide dispersed in the rock. In section we may observe lamines of detritus or yellow-brown sediment, discontinuous or lenticular. The rock contains isolated shells of Brachiopoda (mainly *Z. norica*). The top line of the layer of black marlstone is the bed of brown-ocre-yellow oxidic sediment. The marly rock contains numerous fine shell-fragments; larger organic remains are infrequent. Its nature varies: somewhere it recalls oxidated residue of black marl, elsewhere resedimented material; sometimes it is irregularly striped or intermixes with dark marl. It is overlain by a bed of organodetrital limestone. In the exposed beds the sequence is repeated 9 times.

Since the overlier of the rhythmical "dark" sequence is not exposed, its stratigraphical diapason is problematic so far. In limestone fragments in debris on the higher slope was found an Ammonite described as *Arcestes (A.) rhaeticus* (Clark) (D. Andrusov 1934). The conodont *Spathognathodus hernsteini* found by D. Majerská in layer XXXII is a typical fossil of the Sevatian. The locality is tectonically very complicated, insufficiently investigated so far.

## 11. Svarín —

Middle and Upper Triassic (Fig. 15, 16)

From the road between Hybe and Liptovský Hrádok we turn first to the south (to the Bocianska dolina valley, to Čertovica) then to the left on the way eastward to the Čiernovážska dolina valley. About 6 km from the village Kráľova Lehota is the village Svarín, where the Svarínska dolina meets the Čiernovážska. Then along the left bank of the river Svarínka and through the Čiernovážska dolina (along the right bank of the river Čierny Váh)

after walking about 650 m we reach the locality. The exposure is in an abandoned quarry (in the cut of the railway-track), on the southern slopes of the highland between the Biely and Čierny Váh river basin. The Highland represents the extreme northern protrusions of the Nízke Tatry mountains (the orientation map is on the illustration, Fig. 15).

In the valley of Svarínka, the Mesozoic of the Hronic (the main pre-Senonian unit) is represented by slices (partial nappes sensu A. Biely 1965 in D. Andrusov 1967 b): the Boca and Malužiná slices belonging to the nappe of Šturec. In the valley of the river Čierny Váh, is only the Choč nappe (the illustration 15). Here the Middle and Upper Triassic are exposed in the typical "Biely Váh facies": in the Middle Triassic — limestones of the Reifling type; in the Carnian — the Lunz beds (somewhere 300 m thick). In contrast to the Choč nappe ("Biely Váh facies"), in the Šturec nappe ("Čierny Váh facies") are extensive dolomite complexes in the Middle and Upper Triassic.

The lower part of the "typical Biely Váh facies" may be followed in the Svarínska dolina valley. The Anisian age of the sediments is evidenced by Dasycladaceae. The base of the Middle Triassic in the Svarínska dolina is formed by:

— Dark Gutenstein-Annaberg limestones (thickness about 250 m), mostly bedded. Guide fossils were not found, except *Modiolus triqueter* (Seeb.). Most likely it is the lower part of the Anisian — the upper "Hydaspien".

— Light-grey, fine-grained massive limestones (biosparite) form an important several meters thick layer in the top part of the Gutenstein limestones. In the layer of light-grey limestones near Malužiná were found: *Physoporella pauciforata* (Gue mb.) Stein m. v. ind., *Physoporella* cf. *praealpina* Pia, *Physoporella dissita* (Gue mb.) Pia (J. Bystrický 1964).

— The Gutenstein limestones are overlain by an extensive complex (about 300—400 m) of grey, compact, massive, somewhere bedded dolomites. Elsewhere they are saccharoidal. In the Upper part the dolomites contain cherts. Their Middle-Anisian age is evidenced by *Physoporella dissita* (Gue mb.) Pia.

In the cut of the narrow-gauge railway in the Čiernovážska dolina valley we may see the top part of the dolomite sequence, i.e. bedded dolomites with concretions of cherts, not far from the quarry where we shall trace the continuation of the bed sequence of the "Biely Váh facies" (from the Upper Anisian to the Upper Carnian). The bed sequence commences in the quarry with the limestones of the Reifling type. They are overlain by "the Aon" beds. The top part of the quarry is occupied by the Lunz

LITHOLOGICAL SECTIONS OF MIDDLE AND UPPER TRIASSIC FROM SVARÍN QUARRY

V. Andrusovová

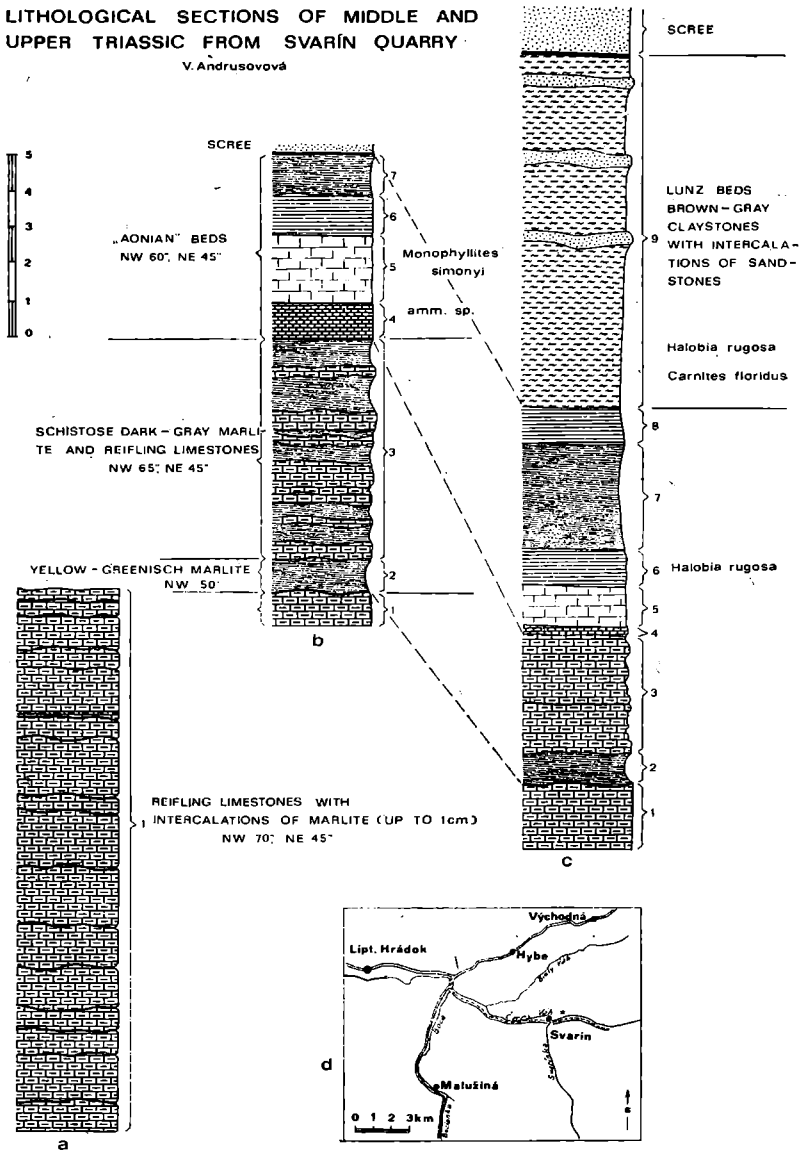


Fig. 15 Explanatory notes to the lithological profile of the Middle and Upper Triassic in the quarry near Svarín (V. Andrusovová)  
1, 2, 3 — Dark-grey, bedded, compact, nodular limestones of the Reif-

ling type with the intercalations or irregularly dispersed nodules of dark rusty weathering cherts (about 23 m).

1. In the lower part of the limestones (profile a, 1) are thin intercalations of dark marlstones (marly shales, of thickness to 1 cm); 2. A layer of light-coloured, green-yellow marlstones (profile b, position nr. 2, thickness about 1 m); 3. The layers of marly dark-grey and black shales are thicker (to 120 cm) and alternate with limestone beds more frequently (profile b); in thin-sections the limestones are micritic and microsparitic. Somewhere they contain a lot of organic remains. Most frequent are fragments of juvenile Lamellibranchiata; Radiolaria, Ostracoda, *Globochaete alpina* Lomb., crinoid segments and isolated Foraminifera. In the upper part of the limestones is *Verihachium* sp. (*Acrytarcha*). Limestones contain isolated pellets; rare silt grains of quartz from the clastic admixture, among autigene minerals pyrite — sometimes limonitized.

Cherts are most frequent in the upper part of the limestones. They are formed of micro-grained and short-fibrous chalcedony.

Dolomite layers in the lower part of the Reifling limestones are compact and brecciated; in thin-sections micrograined. Marly dolomites in the middle part of the Reifling limestones are micro-grained, without organic remains. They contain pyrite. (The dolomites are out of the profile described).

The Reifling limestones stratigraphically correspond to the Upper Anisian and Ladinian. In an adjacent smaller quarry (about 150 m to the west) they contain *Daonella taramellii* Mojs.

4, 5, 6, 7, 8 — »The Aon« beds. They are dark-grey and black clayey and marly shales, and dark or black flaggy limestones (in the profile b the sequence is about 5,5 m thick, in the profile c — about 6,5 m).

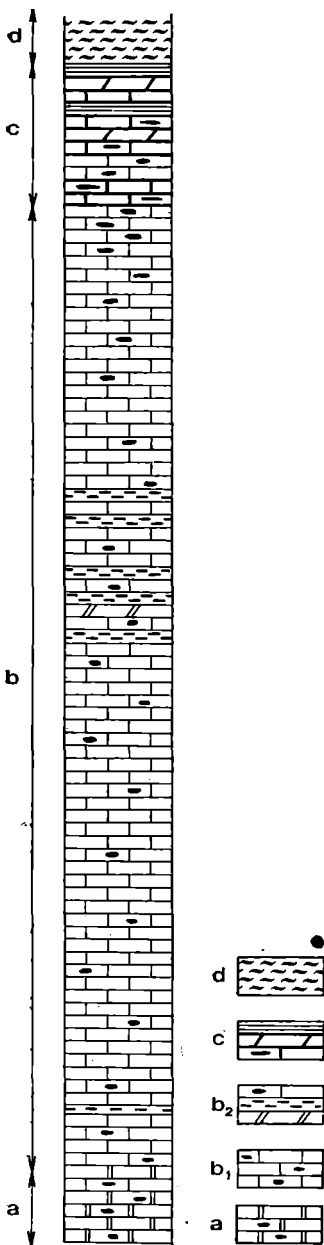
4. Dark and black thin-bedded limestones (to 20 cm) with indeterminate Lamellibranchiata and juvenile Ammonoid Cephalopoda (profile b, horizon 4); 5. Flaggy, dark-grey and black marly, on some places schistose limestones with thin layers of cherts. They contain indeterminate deformed Lamellibranchiata, *Monophyllites simonyi* (Hauer) and fragments of *Sturia* sp. (profile b); 6. Dark-grey, solid clayey rusty weathering shales (profiles b and c, about 120 cm). They contain lumachelles of Lamellibranchiata (compresses, indeterminate). Identified was only *Halobia rugosa* (Gue mbel); 7. Dark-grey and black marly shales (profile c — up to 3 m); 8.=6. profile c, thickness 120 cm.

In rock slices the limestones and marls are micritic or microsparitic. Mostly they are poor in organic remains. Most frequent are fragments of juvenile Lamellibranchiata, infrequent are Foraminifera, Radiolaria, Ostracoda, *Globochaete alpina* Lomb., sponge spicules and *Osteocrinus* sp. Limestones contain dolomite whorls in brownish smudges. Epigenetic minerals are represented by pyrite, frequently limonitized.

»The Aon beds« have different facies in this area (in the western quarry). Somewhere they contain more layers of dark shales — sometimes in the upper part of the limestones of the Reifling type (profile b, horizon 3).

9. The Lunz beds. Dark, grey-brown clayey shales with layers of fine-grained sandstones in the higher level (in the profile c 5—10 m may be seen). In this exposure, in the base of the Lunz beds, were found *Garnites floridus* (Wulfen) and *Halobia rugosa* (Gue mbel).

Here, too, the Lunz beds commence with the Julian — the zone with *Trachyceras aonoides*, subzone with *Carnites floridus* i. e. with the



Middle Julian. The stratigraphical position of their top line is unknown so far.

Dasycladaceae were determined by J. Bystrický; Lamellibranchiata — by M. Kochanová. Microscopical evaluation of rock slices — K. Borza.

beds. The most part of quarry is covered by talus, so we cannot follow the whole cross-section through the Reifling limestones. The cross-sections a, b, c in the illustration 15 show the upper, well exposed part of the quarry, and particularly beds containing macrofossils. In this exposure the age of "the Aon" and the Lunz beds is evidenced by Ammonoid Cephalopoda of the Julian substage, i.e. of the zone with *Trachyceras aonoides*: *Monophyllites simonyi* (Hauer) the cross-section b, the horizon nr. 5) and *Carnites floridus* (Wulfen) the cross-section c, the horizon 9). In dark clayey shales (in the horizon 6, cross-section c) and in the lower of the Lunz beds (horizon 9, cross-section c) *Halobia rugosa* (Gumbel) was found.

Fig. 16 Lithological cross-section through the Middle and partially the Upper Triassic to the east of the village Svarín (the evaluation of the river Čierny Váh) (K. Borza)

a) Dolomites with cherts;  
 b1) Reifling limestones with cherts;  
 b2) Reifling limestones with layers of green clayey and marly shales and marly dolomites;  
 c) Dark-grey and black limestones with black cherts, marly limestones and black marly shales (»the Aon beds«);  
 d) Dark clayey shales. »The Lunz beds).

A detailed description of the bed sequence is in explanatory notes to the lithological profile of the Middle and Upper Triassic in the Svarín quarry (Fig. 15).

Dark-grey and black clayey-marly shales and flaggy limestones with cherts, above the limestones of the Reifling type (mostly some meters thick) — called “the Aon” beds are usually regarded as the top part of the Reifling limestones and referred to the Ladinian.

The stratigraphical positions of the top line of the Reifling limestones in the Choč nappe was determined exactly by the find of *Monophyllites aonis* Mojs. near Východná to the Cordevolian — the zone with *Trachyceras aon* (M. R a k ú s 1960).

## 12. Liptovský Hrádok – Podtureň;

The Lunz Beds (Fig. 17)

The Lunz beds are well exposed in the cuts of the road and in the quarries between Liptovský Hrádok and Podtureň. They are a characteristic constituent of the Triassic of the Choč nappe in the so-called Biely Váh facies. Here they are approximately 300 m thick. Such thickness they do not reach nowhere in the West Carpathians. The bed sequence consists of many sandstone beds alternating in black and dark-grey claystones. The beds of sandstones are 3—4 cm thick, in average 15—80 cm. Layers thinner than 3 cm form in claystones current ripple lamination with uneven upper surface. The beds of sandstones cumulate in three larger megarhythms. Here sandstones claystones ratio is 1:2 to 1:20. Some megarhythms commence suddenly with thick beds and their thickness gradually decreases upwards. The upper megarhythm commences with thinner beds thickening in the middle and thinning upwards. Thus the symmetrical megarhythm is formed. The megarhythm C comprises also the quarry Podtureň — the object of our excursion.

The thickness of the beds of sandstones is stable, and they are well traceable in the exposure. The alternation of the sandstone beds in claystones recalls the rhythmical structure of flysch, and many authors regard the Lunz beds as a flyschoid formation.

Stratigraphically the Lunz beds commence in the Middle Julian (Carnites floridus Zone) as evidenced by the quarry Svarín. The upper stratigraphical boundary is unknown so far. As seen on the locality Liptovská Osada, they are overlain by dolomites of the Carnian, commencing perhaps in the Tuvalian.

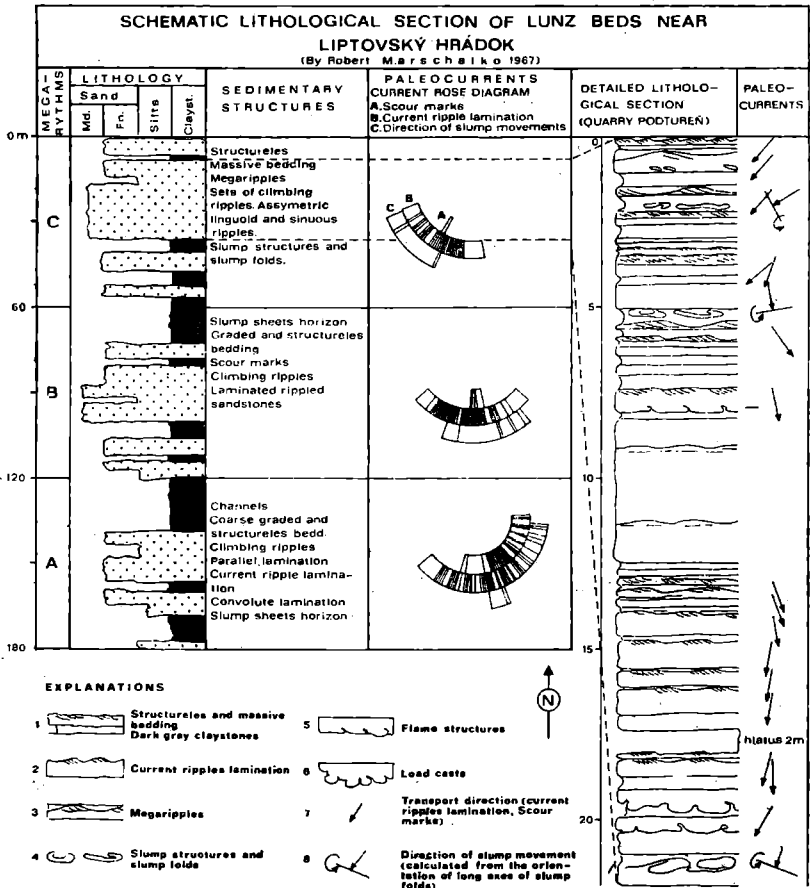


Fig. 17

### Internal and external structures of the Lunz beds

The Lunz beds display a lot of sedimentary structures, as internal (graded bedding, structureless bedding, current ripple lamination), so external (current lineation, asymmetrical ripples), facilitating the determination of transport direction and depositional slope.

Graded bedding is characterized by diminution of grain size from the base of a bed upwards. The bedding was only detected

by petrographical analysis of two samples taken from the base and from the top of the bed. The graded bedding is inconspicuous, since the coarse grains refining upwards form only a slight admixture in the homogeneous fine-grained matrix (Md of grains is between fine-grained sandstone and siltstone). Most sandstone beds display structureless massive bedding, without distinct sorting.

In the top part of the beds (above 3 cm thick), current ripple lamination is almost a regular type of bedding. The current ripple lamination terminates the cycle of forming of the sandstone bed. In some thin beds (less than 10—15 cm) current ripple lamination is all over their thickness and forms independent units.

The current ripple lamination for 1—4 series deposited above each other with equal dip of laminae 10—18°. Since they were formed by migrating current ripples, the latter are usually well preserved and exposed on the upper surface of the beds. Since the stoss side of current ripple laminae was not truncated by erosion, the laminae were formed under the condition of traction movement of sands in current ripples at a rapid fall-out of grains from the suspension flow. The ripples as a surficial form of current ripple laminae — form several types; as for example: asymmetrical linguloid ripples accompanied with sometimes sinusoid crests; straight crests of asymmetrical cross-section with truncated stoss side. Symmetrical current ripples were not found.

A detailed study showed the current ripple lamination together with massive structureless bedding and both they arose by gradual sorting from one turbidity current. Since the beds may be continuously traced in exposures, and show a sharp undersurface, and frequent claystone intraclasts eroded from underlying claystones during the previous upper flow regime; we may assume that they arose by rapid deposition from slowly waning turbidity currents. Unidirectional transport (by currents), evidenced by sole marking of scour origin and by current ripple lamination in the upper part of the same beds, and in whole sequences, arose owing to alternation and weakened traction force of the waning turbidity currents.

In sandstone beds (the quarry Podtureň), three slump horizons were found. The slumps were caused by destruction of water-saturated sediments and formed were small slump folds with more-or-less distinct preferred orientation axis. Slumping of sandstone beds passed below water, on low depositional slopes, and it was gravity — controlled. The research of the sedimentary

deformations in the quarry Podtureň, and in the entire sequence of the Lunz beds near Liptovský Hrádok showed that the dip of slope, undermining the slump movement and sedimentary deformations, also controlled the movement of currents from the NNE to the SSW and S. That is, the movement medium was in accordance with gravitational forces. Consequently, the preferred directions of currents and slumps from the N to the S and SSW represent the direction of paleoslope and sedimentary trend. I suppose the source zone of the Lunz sandstones, modifying and controlling the transport of clastics by turbidity flows to have been situated to the north of the direction and to the sedimentary area of the Choč nappe. Sandstones were transported into a basin, situated in the south. Its thickness also increased in the direction.

The absence of shallow-water organisms and of the evidences of their living activities proves the origin of the Lunz beds in deeper and badly aerated sea. Missing shallow-water sedimentary structures and low-tide channels also support the deep-sea interpretation of the Lunz beds. In fact sediments in shallow-water would hardly preserve lamination, and slump structures would be destructed by wave activity.

On this locality, the Lunz beds did not yield any fossils; in close vicinity they contain *Halobia rugosa* (G u e m b.), and to the north of Liptovský Mikuláš (the village Hutý) pollen were found:

*Dictyophyllidites cf. harristi* Couper, *Cyathidites minor* Couper, *Conbaculatisporites mesozoicus* Klaus, *Lophotriletes novicus* Singh, *Anguisporites minutus* Singh, *Lycopodiacidites keupperi* Klaus, *Cingulizonates delicatus* Orlov/Zvoliň, *Cirratriradites surrangei* Singh, *Lueckisporites cf. vtrkkiae* Pot./Klaus, *Ovalipollis lunzensis* Klaus, *Ovalipollis ovalis* Krutz., *Ovalipollis grebieae* Klaus, *Alisporites cf. ovatus* (Bal./Hemn.) Jans, *Pteruchipollenites pannelai* Jain, *Vesicaspora jansoniusii* Jain, *Alisporites minutisaccus* Clarke, *Vitreisporites pallidus* (Ress.) Nilss., *Platysaccus papillionis* Po./Klaus, *Alisporites cf. australis* de Jers., *Klausipollenites cf. decipiens* Jans., *Klausipollenites cf. staplinii* Jans., *Inaperturopollenites* Jans., *Klaucipollenites cf. staplinii* Jans., *Inaperturopollenites globulus* de Jers., *Ginkgocycadophytus nitidus* (Bal.) de Jers., *Ginkgocycadophytus magnus* de Jers., *Circulisporites parvus* (de Jers.) Norr., *Micrhystridium cf. fragile* Defl., *Micrhystridium cf. privetiaui* Valen., *Micrhystridium recurvatum* Val.

### 13. Turík -

#### Middle and Upper Triassic (Fig. 18)

To the north of the village Turík in the Chočské pohorie mountains we shall trace the Middle and partially Upper Triassic of the Choč nappe. This is one of the first localities to evidence the age of the so-called "Choč dolomites". Distinguished are (see the schematic lithological profile):

a. Grey dolomites with cherts in their upper part. The dolomites contain *Physoporella dissita* (G u e m b.) P i a, and are referred to the Pelsonian.

b. The Reifling limestones. The dolomites are overlain by green clayey, somewhere dolomitic shales with marly dolomites, Reifling limestones and dolomites, especially in their lower part. The Reifling limestones alone occur in the upper part. They are bedded, with nodules of grey and black cherts. In thin-sections, the limestones are micritic and microsparitic. They contain organic remains. Most frequent are fragments of juvenile *Lamellibranchiata*. Less frequent are *Radiolaria*, *Globochaete alpina* L o m b., *Ostracoda*, crinoid segments, and in the higher part of the profile also *Osteocrinus* sp. Limestones contain infrequent pellets; isolated quartz grains; autigene minerals being represented by pyrite. Somewhere is also brown phosphate mineral.

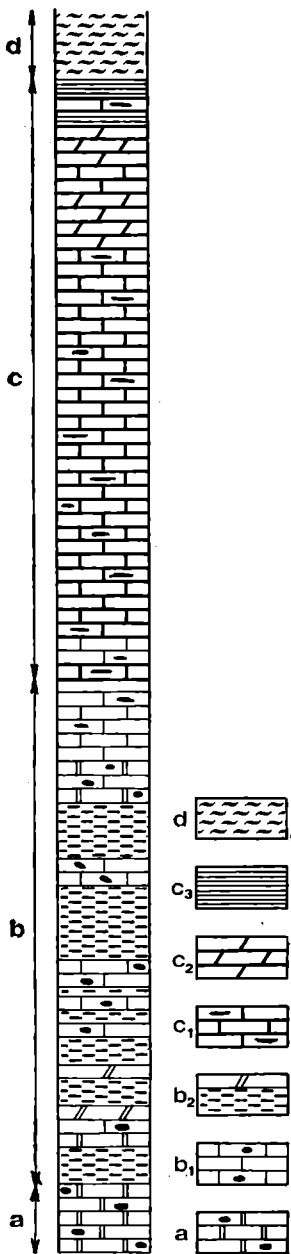
Sometimes limestones are dolomitized; dolomite is in the form of whorls of the size of 0.01—0.03 mm. The limestones contain cherts in the form of nodules. They consist of micrograined and short-fibrous chalcedony, and contain carbonates in the form of small whorls.

Layers of dolomites in clayey shales or in the Reifling limestones are compact; in thin sections — micrograined and fine-grained.

Layers of marly dolomites in clayey shales are micrograined, with isolated crinoid segments and pyrite.

These limestones were distinguished by V. V o g l (1918) for the first time. V. V o g l quotes from the limestones *Daonella* cf. *pichleri* M o j s. and *Daonella* cf. *tyrolensis* M o j s. The fauna served an evidence of the Ladinian age of the "Choč dolomites". "The Choč dolomites" in wider sense comprise limestones and dolomites. Actually the above fossils are in the lower parts of the Reifling limestones (the last southern quarry). Stratigraphically the Reifling limestones correspond to the Upper Anisian and Ladinian.

c. "The Aon beds". In the Upper part the Reifling limestones alternate with dark-grey and black, limestones referred to the



Aon beds. They are represented by the above mentioned dark limestones, in the upper layers by marly limestones and marly shales. The limestones are thin-bedded, with platy disintergration. They contain thin layers of black cherts. In the lower parts of dark limestones are concentric cherts. Thickness of "the Aon" beds" is about 15 m.

Dark-grey and black limestones and marly limestones are micritic, rarely microsparitic, in thin sections. They contain bituminous admixture forming smudges, sometimes. Organic remains: Radiolaria, fragments of juvenile Lamellibranchiata, Ostracoda, Globochaete alpina, Osteocrinus sp., in higher parts are also sponge spicules. Infrequent in limestones are pellets of the size of 0.02—0.26 mm; and grains of clastic quartz and clayey minerals — kaolinite?. Autigene minerals: crystals of quartz, pyrite.



Fig. 18 Schematic lithological profile of the Middle and partially Upper Triassic to the North of the village Turik  
 a) Dolomites with cherts;  
 b) Reifling limestones with cherts;  
 b<sub>2</sub>) Green clayey shales and marly dolomites;  
 c<sub>1</sub>) Dark-grey marly »Aon« limestones;  
 c<sub>2</sub>) Dark-grey marly »Aon« limestones;  
 c<sub>3</sub>) Dark-grey marly »Aon« shales;  
 d) Dark clayey shale. »The Lunz beds«

Sometimes the limestones are dolomitized — dolomite forming small whorls. Rare are laminated quartzose limestones, lamination is due to the alternation of quartzose lamines with those of limestones with bituminose admixture.

Thin layers of black cherts in limestones consist of micro-grained or short-fibrous chalcedony. The cherts contain carbonates.

Concentric cherts with rhythmical SiO<sub>2</sub> are mostly in the lower parts of dark limestones. The concentric structure is due to the alternation of light-coloured layers with dark brown layers with sharp termination of rings. Transition from the light-coloured layer to the dark is slow. Chert is overfilled with carbonate rhombohedrons.

In marly schists are badly preserved Lamellibranchiata and outwashable Foraminifera. J. Salaj, O. Jendřejáková (1967) determined: *Trocholina (Trocholina) multispira* Oberhauser, *Trocholina (Trocholina) ventroplana* Oberhauser, *Rhizammina cf. eulimbata* Kr.-Toll., *Nodosaria apheiloculata aglabra* Kr.-Toll., *Neoendothyra keupperi* (Oberhauser) *Variostoma pralongense* Kr.-Toll. Among other organic remains are fish teeth and small gastropoda.

"The Aon beds" are referred to the base of the Julian.

d. Above "the Aon beds" are the Lunz beds represented by dark clayey shales. In their upper part are sandstone layers. The Lunz beds commence most probably with the zone of *Carnites floridus* Wulfen. We know, however, no fauna from there. The fauna of the Lunz beds was found in the locality Svarín (locality 11).

The Lunz beds are transgressively overlain by the Paleogene: conglomerates with larger Foraminifera.

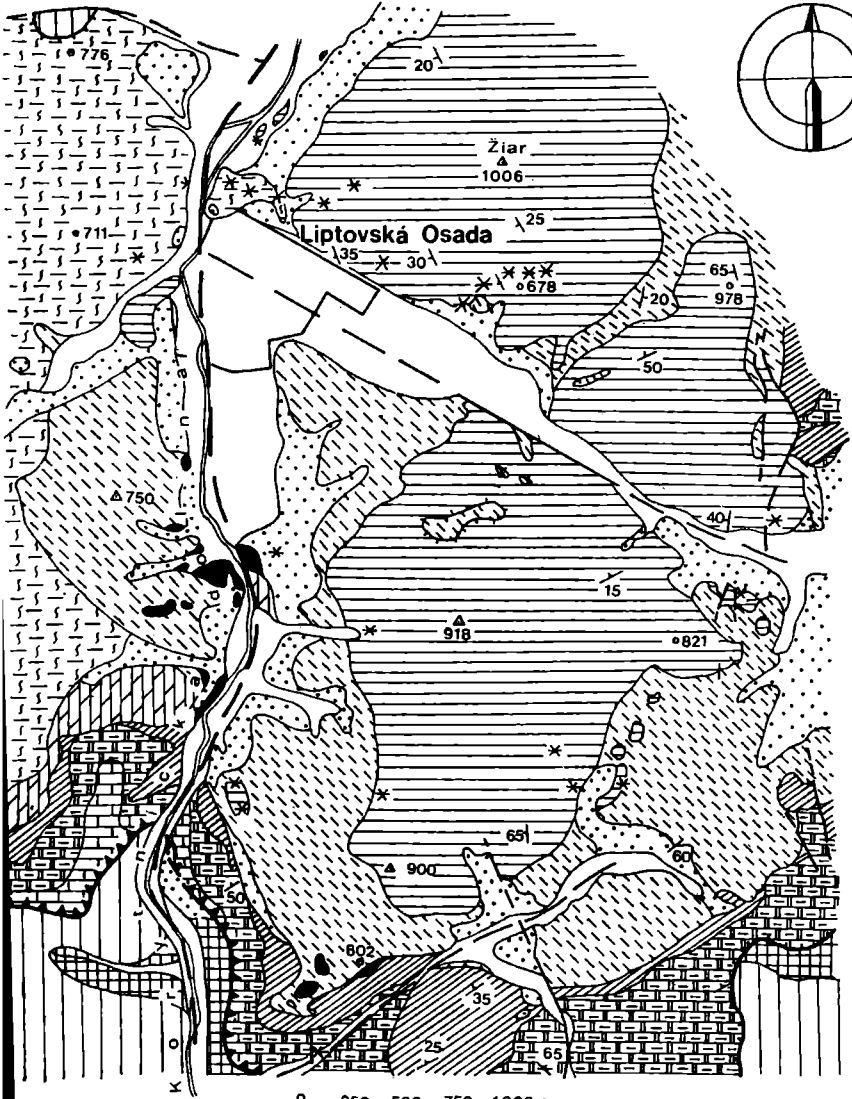
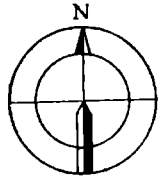
#### 14. Liptovská Osada —

"The Reef Complex" of Hauptdolomite (Fig. 19, 20)

The Hauptdolomite (the Tuválian — Lower Norian) is on the contact of the Nízke Tatry and the Veľká Fatra mountains the youngest cropping-out Triassic sequence of the Choč nappe. Its total thickness is about 250 m. Basing upon the lateral distribution of organism and upon microfacial characteristics, Hauptdolomite may be regarded as a reef complex, and distinguished there "the central reef area" — "the reef core" and the lagoonar area — "the back reef". In the latter may also be distinguished "the near — reef zone".

Stopping-place 1: The cut of the road from Banská Bystrica to Ružomberok, to the north of the village Liptovská Osada.

Dolomites exposed in the cut of the road are lagoonar facies —



0 250 500 750 1000 m

- |  |   |  |    |  |    |  |    |  |    |  |   |  |
|--|---|--|----|--|----|--|----|--|----|--|---|--|
|  | 2 |  | 3  |  | 4  |  | 5  |  | 6  |  | 7 |  |
|  | 9 |  | 10 |  | 11 |  | 12 |  | 13 |  |   |  |

— “the back reef”. They are regular-bedded dolomites with laminae of mm rhythmites and with intercalations of red pelitic shales. Regularly replaced shale intercalations above a thicker bed indicate cyclic sedimentation in the shallow-water lagoonal environment.

In the lower part of dolomites are numerous algal rhythmites of stromatolitic type with pellets and oolites of the maximum size 0.72 mm. In dolomites are frequent intraclasts passing to intraformational breccia. In contrast to dolomites of the “reef core” (the central reef area), porosity is infrequent here. Besides intercrystalline porosity most pores are due to weathered stems of Dasycladaceae (calcareous algae) and to the tests of megalodonts.

In the “near reef zone”, in the transition to internal basin, in the dolomite bed are isolated small coral reefs — “patch reef”.

The “near reef zone” is characterized by well-rounded biogenic detritus and lagoonal biotope: macrofauna of Lamellibranchiata and Gastropoda with predominance of the family Megalodontidae. Numerous megalodonts in the cut of the road are in the thicker dolomite beds. Towards the “reef core” the thickness of beds increases up to 1.2 m, accompanied with the increase of organogenic detritus. Fauna and flora of Hauptdolomite indicate the Tuvallian — Lower Norian.

#### F a u n a:

a) Megalodontidae: *Neomegalodon* (*Neomegalodon*) *triqueter pannonicus* (Frech), *Neomegalodon* (*Neomegalodon*) cf. *triqueter pannonicus* (Frech), *Neomegalodon* (*Neomegalodon*) *laczko*i (Hoernes), *Neomegalodon* (*Neomegalodon*) cf. *laczko*i (Hoernes), *Neomegalodon* (*Neomegalodon*) *carpaticus* Kochanová, *Neomegalodon* (*Neomegalodon*) sp. 1, sp. 2, sp. 3, sp. 4.

←  
Fig. 19 Geological map of the Choč nappe in the Korytnica valley (A. Bujnovský)

#### The Křížna nappe:

1. Marly limestones and marls (Upper Berriasian — Hauterivian);  
2. Shales, limestones, sandy-glaucinitic limestones (Barremian — Lower Albian)

#### The Choč nappe:

3. Gutenstein limestones (Lower Anisian — Pelsonian); 4. Dolomite (Pelsonian); 5. Reifling limestones (Illyrian — Langobardian); 6. Light-coloured organogene reef limestones = Raming limestone (Cordevolian); 7. Gravel and coral limestones, shales (Lower Julian); 8. Lunz beds (Julian); 9. Massive Hauptdolomite (Tuvallian — Lower Norian); 10. Bedded Hauptdolomite (Tuvallian — Lower Norian); 11. Debris; 12. Thrust planes and faults; 13. Paleontological localities.

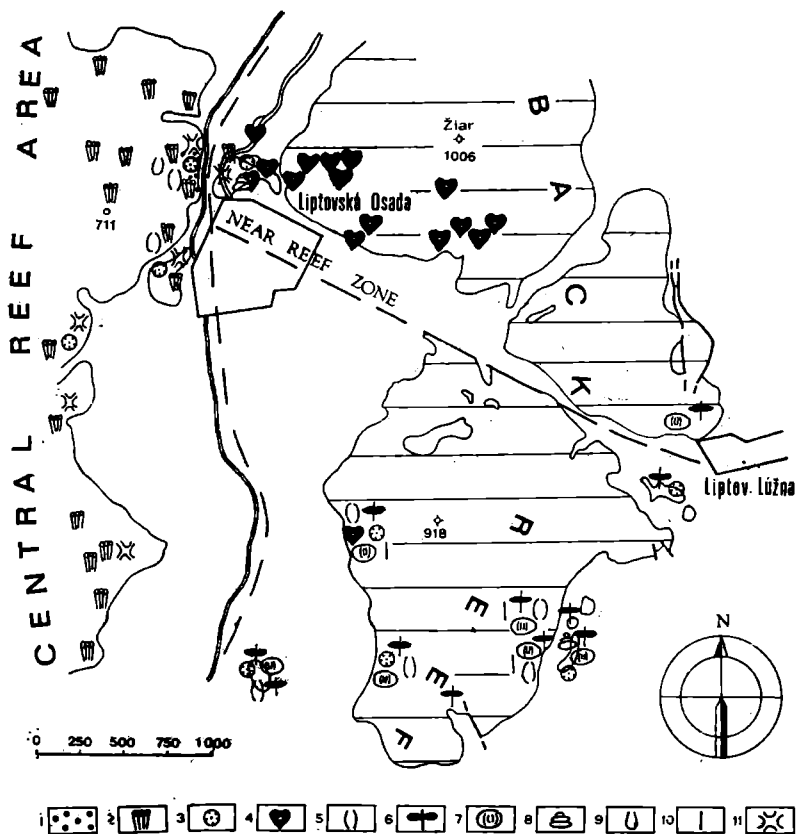


Fig. 20 Distribution of organisms in the reef complex of Hauptdolomite (A. Bujnovský).

1. hydrozoa; 2. corals; 3. crinoids; 4. megalodonts; 5. other lamellibranchiates; 6. dasycladacea; 7. foraminifers; 8. gastropods; 9. calcisponges; 10. ostracods; 11. evinospongy structures.

b) Gastropoda and Lamellibranchiata: *Neoschizodus* sp., *Trigonodus* sp., *Naticopsis* sp., *Hologira* sp., *Ampulospira paludinaris* (Muenster), *Ampulospira cf. sanctaecrusis* (Wissman).

c) Foraminifera: *Involutina* sp. (abundant sessile Foraminifera).

Flora:

a) Dasycladacea: *Poikiloporella duplicata* (Pia) Ott.

Besides these fossils there are Ostracoda, Cyanophyceae and problematic specimens.

Stopping-place 2: The cut of the railway-track near the village Liptovská Osada.

"The central reef area" — "reef core" is a body of massive dolomites with its locus typicus in the cut of the railroad. In the light-coloured massive dolomite, detritus prevails over the skeleton of the reef. The dolomite is characterized by distinct porosity after separate fossils.

Chemical analyses of massive dolomites from the "reef core" show lower MgO content than bedded dolomites of the "back reef".

The organogene part consists of a construction association of organism typical of the central reef area — "the reef core" — of the reef complex. The most important component is detritus and preserved stems of crinoids — *Encrinus* sp., colonial corals, Hydrozoa — *Stromatomorpha* sp., calcareous sponges, sponge spicules, Gastropoda, Lamellibranchiata — *Cassianella* sp.? *Entolium* sp., Echinoidea — *Cidaris* sp., detritus of Codiaceae and problematic *Tubiphytes obscurus*. Numerous are evinosponge structures in the form of laminated crusts in the vesicles of the reef skeleton.

#### 15. Liptovská Osada —

Raming limestone; (Upper Triassic) (Fig. 21)

About 500 m to the south of the village Liptovská Osada, on the eastern side of the highway is a small quarry in the Middle Triassic limestones of the Choč nappe. Their basement is not exposed here; they are overlain by the Lunz beds.

In the middle of the quarry are grey massive bioherm limestones of "the patch reef" type. Their reef nature is evidenced morphologically by the crustification structure, by the muddy filling of the reef caverns and by numerous well preserved organisms are infrequent. As for their structure, bioherm limestones

The reef skeleton consists of calcareous sponges (*Inozoa and Sphinctozoa*), of calcareous Algae (problematic *Tubiphytes obscurus Maslov*) and by Hydrozoa to a considerable extent. Other organisms are infrequent. As for their structure, bioherm limestones may be designated as biosparites; in the reef caverns are micritic varieties. Frequent are geopetal structures — "top-and-bottom":

Bioherm limestones pass continuously into thick-bedded organodetrital limestones. They are formed of fragments of fossils participating in the structure of the reef alone and of "the near-reef zone". Skeletal elements of echinoderms predominate. There

are biosparites; intraclasts and the micritic component are unimportant.

In bioherm and organodetrital limestones are local silicification phenomena — brownish spherulites SiO<sub>2</sub> and suppression of tests (mainly of Lamellibranchiata) by chalcedony. Locally skeletal elements of organisms are dolomitized.

On the northern side of the quarry (in the left and middle part) the above limestones are overlain by black micritic limestones of this composition: CaO — 41.94 %; MgO — 3.88 %; FeO — 0.62 %; insoluble component 14.05 %. Isolated are black cherts, lumachelles of Lamellibranchiata and Brachiopoda collapsed owing to compaction of calcareous mud.

The locality is interesting in the reef body with continuous transitions into organodetrital limestones, and by fauna and flora.

Fossils: In bioherm limestones

Sphinctozoa: *Follicatena cautica* Ott, *Vesicocaulis depressus* Ott, *Vesicocaulis reticuliformis* Jabl., *Cystothalamia bavarica* Ott, *Uvanella irregularis* Ott, *Cryptocoelia zitteli* Steinm., *Stylothalamia dehmi* Ott.

Inozoa: *Peronidella* sp.

Hydrozoa: *Spongiomorpha* cf. *acyclica* Frech, *Spongiomorpha* cf. *gibbosa* Frech.

Ostracoda (according to H. Kozúr): *Lobobardia ? laevis* Kozur, *Ceratobairdia longispinosa* Kozur, *Triebelina (Mirabairgruenbachensis tollmannae* Kozur, *Triebelina nodosa* Kozur.

Spines of Echinoderms: *Cidaris dorsata* Braun, *Cidaris hausmanni* Wissm.

Problematica: *Ladinella porata* Ott, *Lamelitubus cauteus* Ott., *Acolisaccus tintinniformis* Mišík, *Hicorocodium* cf. *carinthiacum* Flügel and particularly reef-forming *Tubiphytes obscurus* Maslov.

Corals are infrequent. Calcareous Algae are represented by Solenopora, Codiaceae, Stromatolite Algae, — still not completely examined. By solution in organic acids we got skeletons of Holoruria, Conodonta and Ostracoda (the family Bairdaceae), still under study. Bryozoa and skeletons of Balans are rare.

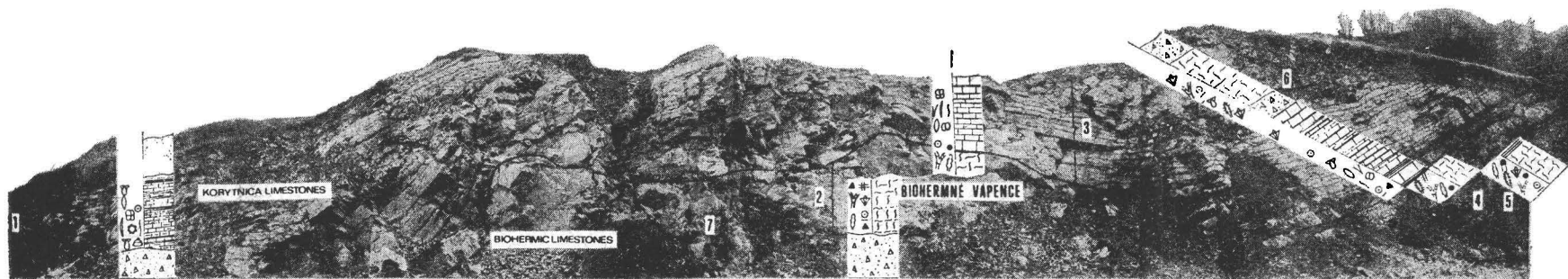
In organodetrital limestones:

Foraminifera: *Involutina sinuosa pragsoides* (Oberh.), *Turritella* sp. and lagenide and sessile forms.

In black micritic limestones:

Brachiopoda: *Dioristella indistincta* (Beyr.), *Aulacothyris subangusta* (Muenst.), *Aulacothyris ruedti* (Bittn.), *Diplospirella wissmanni* (Muenst.), *Amphiclina amoena* Bittn., "*Tere-*

Fig. 21 Typ locality of »Korytnica limestones« S from Liptovská Osada (A. Bujnovský)



- |  |   |  |   |  |   |
|--|---|--|---|--|---|
| <p><b>BIVALVIA: 1</b></p> <p><i>Molbia cf. rugosa</i></p> <ul style="list-style-type: none"> <li>○ echinoidy</li> <li>○ calcisponge</li> <li>○ krinoidy</li> <li>● Tubiphytes obscurus</li> <li>   koraly</li> <li>   stromatopory</li> <li>∩ brachiopody</li> <li>○ ostrakody</li> <li>⊞ globochacty</li> <li>( thlice húb /Spicules of sponges)</li> </ul> | <ul style="list-style-type: none"> <li>∩ vlákná (juv. bivalvi.)</li> <li>∩ bivalvia</li> <li>∩ Acolisaccus</li> <li>⊞ foraminifery</li> <li>○ radiolarie</li> <li>△ gastropody</li> </ul> | <p><b>Biohermic limestones</b><br/>biohermné vápence /ladin/+ cordevol</p> <p><b>Dark grey limestone</b><br/>tmavosivé vápence<br/>Intercalations<br/>of calcareous shales<br/>vločky vápnitých<br/>bridlic</p> <p><b>Limestones with cherts</b><br/>vápence s rohovcami</p> <p><b>Intractions breccias</b><br/>intraklasty, brekcie</p> <p><b>Scree</b><br/>SUL</p> | <p><b>CALCAREOUS SPONGES</b><br/>VÁPŇITÉ HUBY 2</p> <p><i>Follicatena caetica</i><br/><i>Vesicocaulis depressus</i><br/><i>V. carinthiacus</i><br/><i>Cystothalamia bavarica</i><br/><i>Uvanella irregularis</i><br/><i>Cryptocaelia zitteli</i><br/><i>Stylothalamia debmi</i></p> <p><b>BIVALVIA</b> <i>Orthispecten liptovensis</i> sp. n.</p> | <p><b>BRACHIOPODY: 3</b></p> <p><i>Dioristella indistincta</i><br/><i>Aulacothyris subangusta</i><br/><i>Diplospirella wissmanii</i><br/><i>Amphiclina amoena</i><br/>"Terebratula" aff. stuzi<br/>"Terebratula" aff. pyriformis<br/><i>Aulacothyris rüdti</i><br/><i>Euractinella contraplecta</i><br/><i>Spiriferina gregaria</i></p> <p><b>BIVALVIA:</b> <i>Misidioptera submulticostata</i> sp. n.</p> | <p><b>BRACHIOPODY: 4</b></p> <p>"Terebratula" aff. stuzi<br/><i>Anisactinella quadrifecta</i><br/><i>Dioristella indistincta</i></p> <p><b>ECHINOIDS: 5</b></p> <p><i>Cidaris dorsata</i><br/><i>Encrinurus cassianus</i></p> <p>6 <i>Cidaris dorsata</i><br/><i>Cidaris hausmani</i></p> <p>7 "Rhyncobonella" aff. cannabina</p> |
|--|---|--|---|--|---|

*bratula*" aff. *sturi* Laube, "*Terebratula*" aff. *pyriformis* Suess, *Euractinella contraplecta* (Muenst.).

Lamellibranchiata: *Ornithopecten liptoviensis* Koch., *Mysidioptera submulticostata* Koch.

Scolecodonta were found by solution in acids.

Bioherm limestones may form in stenohaline, shallow, pure and lighted water rich in nourishment. Calcareous sponges and Ostracoda indicate optimal depth of 4—18 m. Black micritic limestones sedimented perhaps in deeper water (to 50 m) as indicated by Ostracoda and Scolecodonta (oral communication by H. Kozúr).

The age of the sequence is not yet known precisely. The basement is unknown (perhaps the Reifling limestones cropping-out in the close vicinity of the locality). The sequence is overlain by the Lunz beds (in the fields above the quarry) commencing in the Nízke Tatry, in the zone with *Carnites floridus* (the Julian).

Basing upon Sphinctozoa, J. Jablonský (1971) correlates the sequence with the Cassian beds. This is in accordance with the sclerites of Holothuria and Conodonta indicating most probably the Cordevolian (oral communication by H. Kozúr). For the more precise stratigraphical determination, the study of the nature of Conodonta and Holothuria in stratigraphically well evidenced profiles of the Alps is inevitable. Black bedded limestones overlying the organodetrital, may be referred to the base of the Julian according to Brachiopoda (A. Bujnovský — J. Pevný 1972).

#### 16. Donovaly —

quartzites of the Tatric; the Lower Triassic (Fig. 22)

In the cut of the road from Korytnica to Donovaly is exposed the complete section of the Lower Triassic quartzites of the Nízke Tatry Envelope Unit (the Ďumbier zone). The basement of quartzites is formed by the crystalline — the autometamorphic granodiorite of the Prašivá type with pink feldspars. The contact of the quartzites with granodiorite is not visible, it is covered under the scree. The quartzite complex can be divided into several divisions.

The first division consists of the medium- up to coarse-grained light-coloured (pink, grey or white) quartzites with irregularly scattered pebbles mostly of quartz, maximum 2 cm large. Cross-bedding is indistinct. Fine-grained quartzites with or without lamination and inconspicuous cross-bedding appear in the upper part of this division.

50m

## DONOVALY - LOWER TRIASSIC QUARTZITES

O. Fejdlová

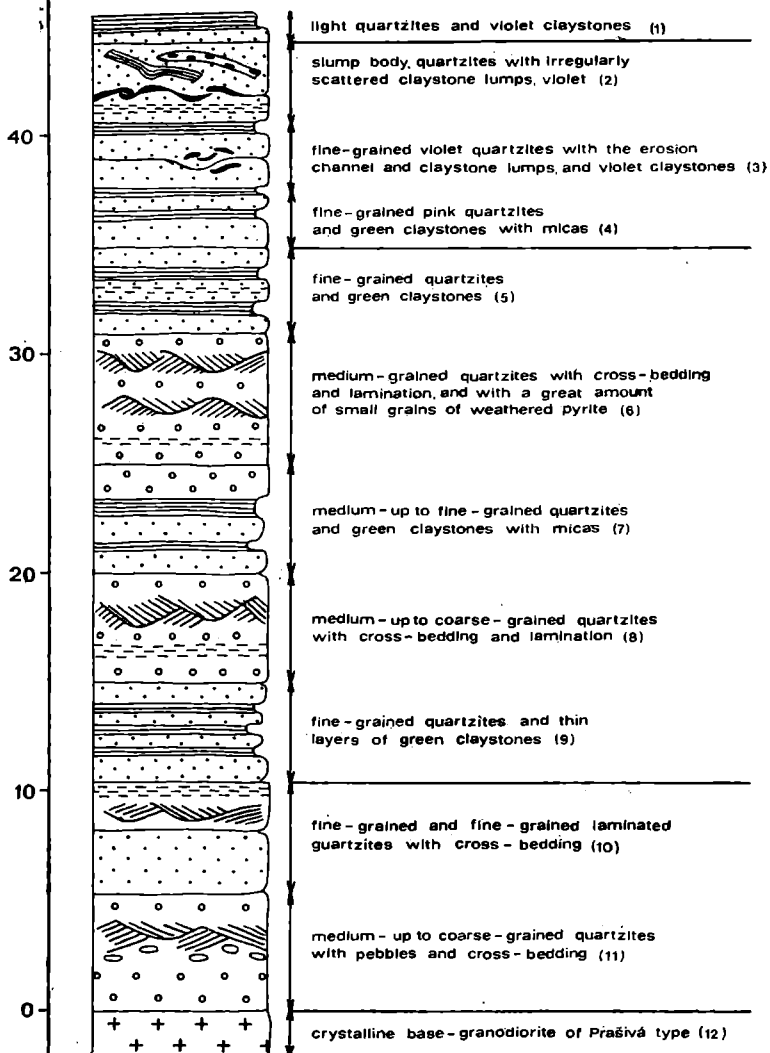


Fig. 22

The second division is of the greatest thickness and there begin to appear the green claystones. In the lower part is the predominance of the medium- up to coarse-grained light-coloured quartzites, which are getting finer towards the top of the division. Cross-bedding and lamination is very frequent. The appearance of claystones is preceded by the irregular intercalations of claystones at the boundaries between two quartzite beds. The thickness of claystone layers does not increase towards the upper part of division, but the frequency of their occurrence increases. In the upper part of the division, the claystones contain great amount of small brown grains (probably weathered pyrite) and a lot of micas.

The third division is characteristic with violet colour of quartzites and claystones as well, however, there occur also green claystones. Quartzites are fine-grained, laminated, and contain a lot of micas. Claystone are sandy and rich in micas too. In the upper part of the division occurs an erosive channel, formed by the quartzite layer, whereby claystone fragments are scattered along the boundary of both layers. In the upper part of the division occurs the slump body consisting of quartzite layer with a fragment of convolute laminated violet claystone inside, and a fragment of thin (about 5 cm) layer of light-coloured quartzite with a lot of violet claystone pebbles, maximum 2 cm in diameter. The whole texture of layer is very irregular, chaotic.

The highest division, which is visible in the outcrop, begins with the layer of light-coloured quartzite and ends in the scree, where appear beds of violet claystones.

According to the mineralogic composition, the Lower Triassic quartzites belong to the sandstonic quartzites in sense of Z. K u k a l's (1957) classification. In some cases, there occur varieties with higher content of feldspars, which can be considered arkosic.

The Lower Triassic quartzites can be correlated with modern clastic sediments from shallow-water, marine or beach environment, which was affected by the great influence of rivers transporting fine-grained material into the sea. The result is sediment, which can be characterized by relatively high mineralogic maturity (up to 98 % of clastic quartz), whereby textural maturity is markedly low (sorting is moderate up to poor).

#### **17. Donovaly –**

dark-grey limestones; the Upper Triassic (Fig. 23, 24, 25)

Most frequent are dark-grey bedded limestones (recalling the Gutenstein limestones). Somewhere they contain striped structu-

res (light and dark stripes) passing into the so-called vermicular limestones. The "worms" are produced by syndimentary damage of lamines. Partially they are burrows. They are perpendicular to bedding. Somewhere the limestones are dolomitic with dispersed dolomitization (white dolomite rhombohedrons weather conspicuously) infrequently with epigenetical "spongy" dolomitization and with intercalations of dolomite.

In the right wing of the quarry (at the sight from the road) are two intercalations of light-grey organogene limestones of nature identical with that of the bioherm limestones from the quarry to the south of Liptovská Osada (*Sphinctozoa*, *Tubiphytes obscurus* Maslov, *Aeolisaccus dunningtoni* Elliot, Spines of *Cidaris*, echinoderms, rare Bryozoa, Brachiopoda, Hydrozoa and problematic Algae). Microscopical examination shows biosparite cemented in two phases (firstly brown fibrous crustification cement; the rests of caverns being filled with equigranular mosaic). In places its texture is damaged by epigenetical dolomite rhombohedrons.

Chemical compositions: CaO — 54.45 %; MgO — 1.20 %; FeO — 0.07 %; loss by insulation 43.74 %; insoluble residue 0.05 %.

Fossils: Calcareous sponges (*Sphinctozoa*): *Follicatena cautica* Ott., *Vesicocaulis reticuliformis* Jabl., *Uvagella irregularis* Ott., *Cystothalamis bavarica* Ott. and *Cryptocoelia zitteli* Steinm.

Foraminifera: *Ophthalmidium* cf. *exiguum* Koeh.-Zan.; *Diplo-tremina* aff. *astrofimbriata* Kr.-Toll.

In the middle part of the exposure is a submarine slide body of blocks (maximum 5 m) of yellow, marly limestones. In places they recall laminated calcisiltites with graded bedding.

Chemical composition: CaO — 50.73 %; MgO — 2.11 %; FeO — 0.42 %; loss by insulation 41.54 %; insoluble residue 4.64 % (SiO<sub>2</sub> — 65.89 %; Al<sub>2</sub>O<sub>3</sub> — 13.86 %).

Limestones were deformed in semiplastic state (convolute textures, mechanoglyphs "frondescient marks"). These shreds contain fragments of dark-grey limestones and coarse-grained dolomites (with the texture of two-phase dolomitization). Analogous are fragments in endostratic breccia in the surroundings of the slide body. Yellow marly limestone fills isolated neptunic dikes in dark-grey limestones.

Paleontological and lithological characteristics are identical with those of organogene limestones from the quarry to the south of Liptovská Osada and indicate the same stratigraphical horizon.

The tectonical appurtenance is discussed. J. Jaroš (1966) assumes the Triassic of the Tatric mantle series; M. Mišík

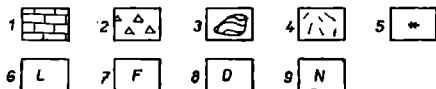
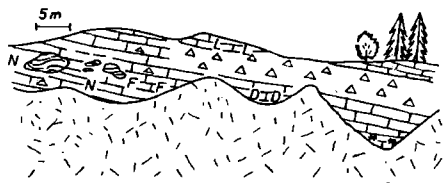


Fig. 23 Schematic section of Middle Triassic in quarry near Donovaly (M. Mišík) 1. Dark-grey bedded limestones with dolomite layers; 2. Endostratic breccia with fragments of limestones and dolomites (maximum 8 cm); 3. Blacks and plates of yellow marly limestones with synsedimentary deformations; 4. Debris; 5. Intercalations of organogene limestones; 6. Striped limestones; 7. »Vermicular« limestones; 8. Dolomitization of the spongy type; 9. Neptunic dikes.

(1968) — the Triassic of the Krížna nappe.

Since the organogene limestones are in all localities of the Choč nappe, this one could also be regarded as a part of the Choč nappe. It is, however, difficult to explain it tectonically. About 2 km to the SW of Donovaly is a similar slide body positively in the Krížna nappe. This may evidence the appurtenance of this locality to the Krížna nappe.

## The Veľká Fatra Mountains

It is a typical bilateral core mountain-range. Its central part is the crystalline massif (the Lubochňa massif) surrounded on all sides by the Mesozoic of the Tatric, Krížna nappe, Šturec nappe and Choč nappe. The highest tectonic unit is the Strážov nappe, its outliers being only known in the western slopes of the mountain-range.

The Tatric Mesozoic: the Lower Triassic — the Albian, with a hiatus in the Rhaetic. Essentially there is no difference from the Tatric Triassic of the Nízke Tatry mountains and from that of the Malá Fatra mountains. Detail data on its stratigraphy are missing so far.

The Krížna nappe is the principal tectonic unit of the mountain-range. It is called after the hill Krížna. Its stratigraphical range is the Lower Triassic — the Albian. The Triassic of the Krížna nappe is not different from the Triassic of the Krížna nappe in the Nízke Tatry. There the Anisian and Ladinian age of Middle Triassic dolomites (Ramsau dolomite) is paleontologically evidenced; here only data on the Pelsonian age exist (the

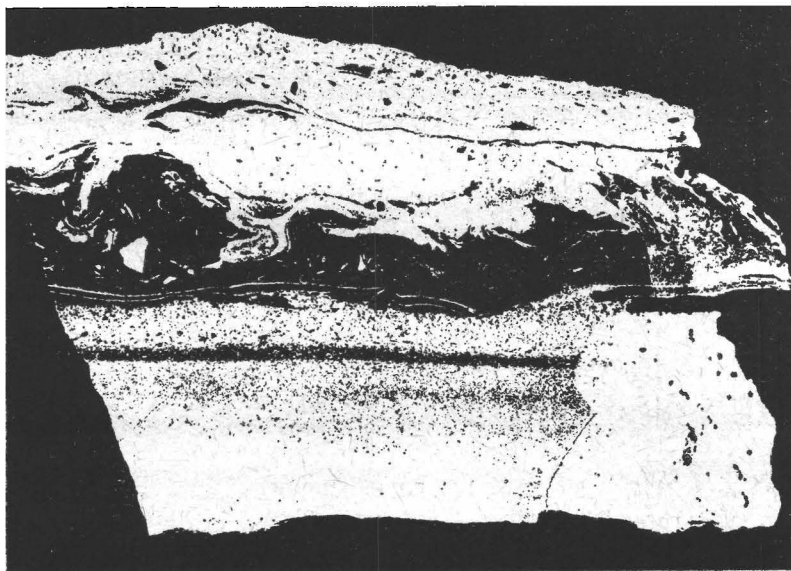


Foto Fig. 24

Synsedimentary slumps with convolute bedding. On the eroded surface is calcisiltite with graded bedding. Yellow marly limestones — blocks of the submarine slide. Polished; natural size.

Photo: Oswald.

locality Katova skala: *Physoporella dissita* (Gue mb:) Pia, *Physoporella praealpina* Pia., *Diplopora hexaster* (Pia) Pia v. *hexaster*, although there is no doubt about the Ladinian age of their higher part. The Lunz beds in the dolomite mass form a several tens m thick lenticular layer. In places they form the basement of the Carpathian Keuper.

The facies in the Carpathian Keuper is the same as in other mountain ranges, the Rhaetic limestones (the Carpathian facies) and marly shales, and dark marly limestones (the Schwab facies) appear alongside or above each other. Stratigraphy and facies of the Rhaetic are not yet thoroughly examined in this mountain-range and the relationship of the rocks is not clear. Besides coral limestones in the Rhaetic are frequent oolitic, sometimes chamositic and haematic limestones. The latter were mined in the past.

Mesozoic of the Hronic (the principal tectonic unit) appears in the form of nappe outliers of different size, formed mostly of the Gutenstein limestones and Middle Triassic dolomites. Their

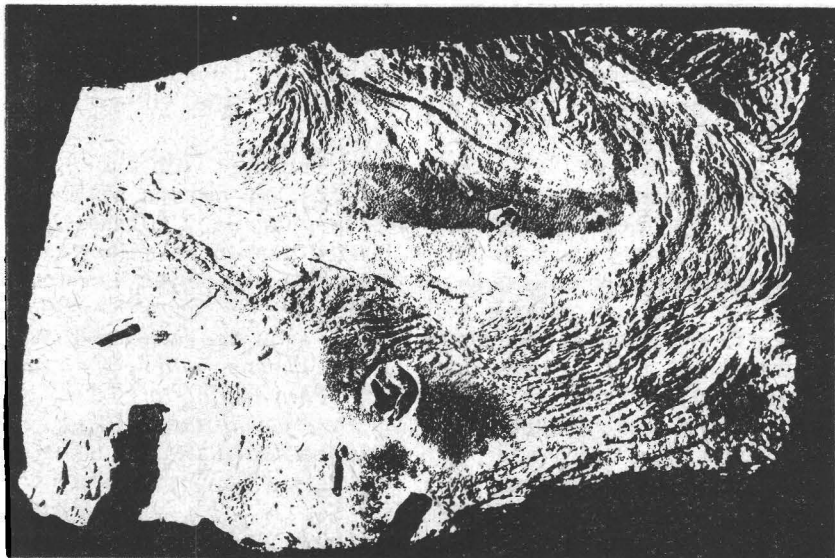


Foto Fig. 25

A hieroglyph »frondescens-mark« (»cabbage leaf«). Yellow, marly limestones from the slide body. Reduced by 1/2.

Photo: Oswald.

stratigraphy is not completely known and we cannot refer them to the respective nappe (Choč nappe or Šturec nappe).

The Choč nappe is mostly in the northern part of the mountain-range, which is actually its continuation from the northern slopes of the Nízke Tatry and the Chočské pohorie mountains. In the southern part (Veľký Šturec), and especially, in the northern slopes of the Veľká Fatra mountains (Malý Šturec — the Gaderská and Blatnická dolina valleys) is only the Šturec nappe.

The bed sequence of the Triassic in the Choč nappe is identical with the sequence on the northern slopes of the Nízke Tatry mountains (the localities Svarín, Liptovská Osada) or in the Chočské pohorie mountains (the locality Turík). The fossils quoted by B. Dornay (1918): *Cidaris dorsata* Muenst., *Cidaris* cf. *schwageri* Woehrm., *Cidaris* sp., *Entrochus silesiacus* Bayer., *Encrimus cassianus* Klipst., and later on by V. Vogl (1918): *Cidaris dorsata* Muenst., *Cruratula* cf. *carinthiaca* (Rothpl.), *Entolium* sp., *Gyroporella* sp. as the evidence of the Ladinian age of the so-called "Choč dolomites" are not in these dolomites but in light-coloured Raming limestones (the

localities Ūboč on the NW slope of Mních, Kalvária near Ružomberok, Ružomberok). Dolomites of this tectonic unit are of Pelsonian age *Ph. dissita* (Gue mb.) Pia in dolomites of Veľký Choč, and in dolomites to the north of the village Turík, (J. Bystrický 1967 a).

The Triassic of the Šturec nappe commences with a 10–20 m thick sequence of dark-grey dolomites. They are the basal constituent of the nappe and crop out sporadically. The base of the Middle Triassic are mostly dark, bedded limestones — the Gutenstein limestones, with layers of dolomites and oolitic limestones in their top part. So far only indeterminate Lamellibranchiata are known from this sequence. Perhaps as in the Považský Inovec mountains, (here, too, they contain *Physoporella pauciforata* (Gue mb.), Steinm. v. *pauciforata*, *Ph. pauciforata* (Gue mb.) Steinm. v. *undulata* Pia, *Ph. pauciforata* (Gue mb.) Steinm. v. *sulcata* Bystr., *Physoporella dissita* (Gue mb.) Pia, *Ph. cf. praealpina* Pia, — loc. laz Plavusov) and their top part extends to the Pelsonian.

They are overlain by a large complex of dolomites formerly known as “the Choč dolomites”. In the lower part, the dolomites are grey, dark-grey, higher-up light-coloured, yellow and white. The latter are more-or-less distinctly bedded or laminated (Malý Šturec), and rich in *Diplopora annulata* (the Gaderská, Blatnická, Žarnovická dolina valleys, Malý Šturec) and in some places (Horný Harmanec) *Teutloporella herculea* is again abundant. The Lunz beds are a 5–10 m thick sequence of shales and sandstones, represented by infrequent small lenses in dolomites. In places are 1 dm thick layers of rusty-brown flaggy oolitic-algal limestones with nodules of Cyanophyceae, with Foraminifera, small Gastropoda, Ostracoda, tests of Lambellibranchiata, spines of Echinoidea and isolated *Globochaete alpina* Lomb.

The dolomite mass overlying the Lunz beds is Hauptdolomite. We do not know anything about its stratigraphical diapason and facies. It is dolomite recalling that overlying the Lunz beds, only with no finds of fossils. In some places are also the Opponitz limestones in a 10 m thick sequence in the lower part of the Hauptdolomite approximately 10 m above the Lunz beds. They are grey, massive limestones, bedded in their bottom part. They occur in some small lenses only.

The highest tectonic unit of the northern slopes of the Veľká Fatra mountains is the nappe outlier of dark and light-coloured limestones, formerly regarded as the Middle Triassic of the digitation of the Choč nappe (J. Ilavský — Ž. Červeňová 1952), then as the Upper Triassic (M. Maheľ 1964) and at last

as the nappe outlier of the Strážov nappe, called here "Tlstá nappe" (M. Peržel 1967) — "the partial nappe of the Ostrý vrch" hill (M. Maheľ 1967, p. 219).

The Middle Triassic of the nappe outlier commences with dark, bedded limestones, getting light-coloured towards the overlier, and passing into light-grey and light-coloured massive limestones. Dark limestones are without fossils, the higher light-coloured part contains Dasycladaceae: *Oligoporella pilosa* Pia v. *varicans* Pia?, *Oligoporella pilosa* Pia v. *pilosa*, *Physoporella dissita* (Gue mb.) Pia, *Physoporella* cf. *praealpina* Pia, *Diplopora hexaster* (Pia) Pia v. *hexaster*, *Diplopora* sp., *Teutloporella* sp. (Tmavá dolina valley, Selenec, Lubená dolina valley, Baglov, Temný kút), and Foraminifera: *Citaella dinarica* (Koch. Dev. — Pantič), *Ammobaculites* sp., *Tetrataxis* sp., ? *Endothyra* sp., *Agathamina* sp.

Light-coloured massive limestones (the Wetterstein limestones) contain mostly *Diplopora annulata* (Schafh.) Schafh. v. *annulata*, *D. annulata* (Schafh.) Schafh. v. *dolomitica* Pia (Blatnica, Červené, Dubiny, Plešovica), in some localities (Dubiny, Korský dol) accompanied with *Teutloporella herculea* (Stopp.) Pia.

The above fossils indicate the Anisian and Ladinian age of the sequence and its tectonical position above the dolomite complex of the Šturec nappe. Basing upon the facies of the Wetterstein limestone, characteristic of the Middle Triassic of the Geric and of its Strážov nappe, the nappe outlier is regarded as the outlier of the Strážov nappe (M. Peržel 1967).

On the route Banská Bystrica — Turčianske Teplice we shall meet Upper Triassic dolomites, Carpathian Keuper and the Rhaetic of the Krížna nappe (the locality Čremošné), and the bed sequence of the Čierny Váh partial nappe (the locality Malý Šturec).

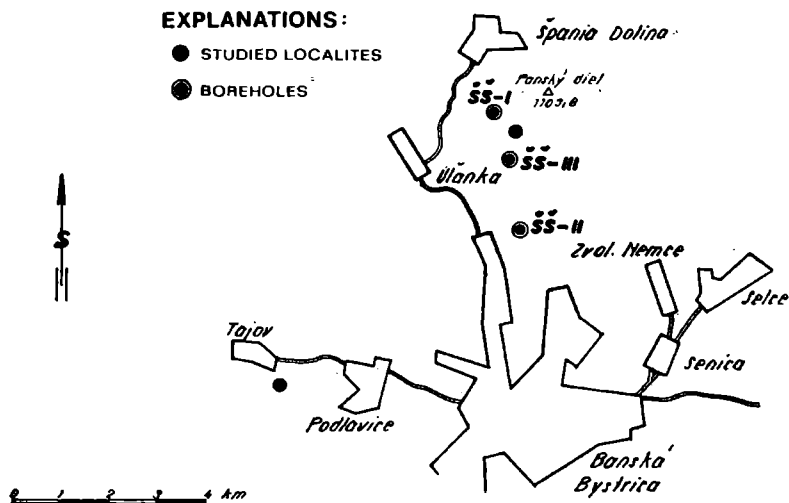
### 18. Banská Bystrica —

the Carpathian Keuper (Fig. 26, 27)

In wider vicinity of Banská Bystrica the Krížna nappe is represented by the Upper Triassic composed of considerably variegated continental-lagoonar formation — the so-called "Carpathian Keuper". It consists of claystones, shales, sandstones with frequent intercalations and layers of dolomites and quartzites; and isolated gypsum.

Precise stratigraphical position of the "variegated sequence" is uncertain. It is above dolomites of Middle-Triassic-Lower Carnian

Fig. 26 Situation map of studied Localities (M. Vedejová)



age (for instance: the locality Tajov). Generally, these beds are overlain by limestones — dolomite layers — perhaps Norian, more frequently by the shaly-limestone sequence of the Rhaetic. The sequence is well evidenced, so the “Carpathian Keuper” is referred to the Carnian or Carnian-Norian. Detailed study of the “Carpathian Keuper” was carried out in localities Tajov and Špania dolina, mainly in the prospection bore-holes ŠŠ I, II and III situated as showed in Fig. 26. The existing results show considerably varied “Carpathian Keuper” in this area.

Near Tajov, the Middle-Triassic dolomites (?) are closely overlain predominantly by dolomites in the “Carpathian Keuper” sequence. Claystones and shales appear in thin layers (several cm to 1.5 m). Towards the overlier the amount of carbonatic component (dolomites and dolomite marls) decreases; predominant being shales, sandy shales and sandstones with isolated dolomite and dolomite-marl layers and intercalations of the maximum 1 m thickness (see Fig. 27, profile III).

Most frequently, the dolomites are light-grey or light-grey-green. They are compact, with indistinct bedding and uneven or conchoidal fracture. Distinct parting after bedding planes is only in the parts between shales and sandstones.

Microscopical examination shows dolomicrites, or dolomicrites with the admixture of clastic material — quartz and muscovite — to the maximum of 5%. In isolated cases — when the marly

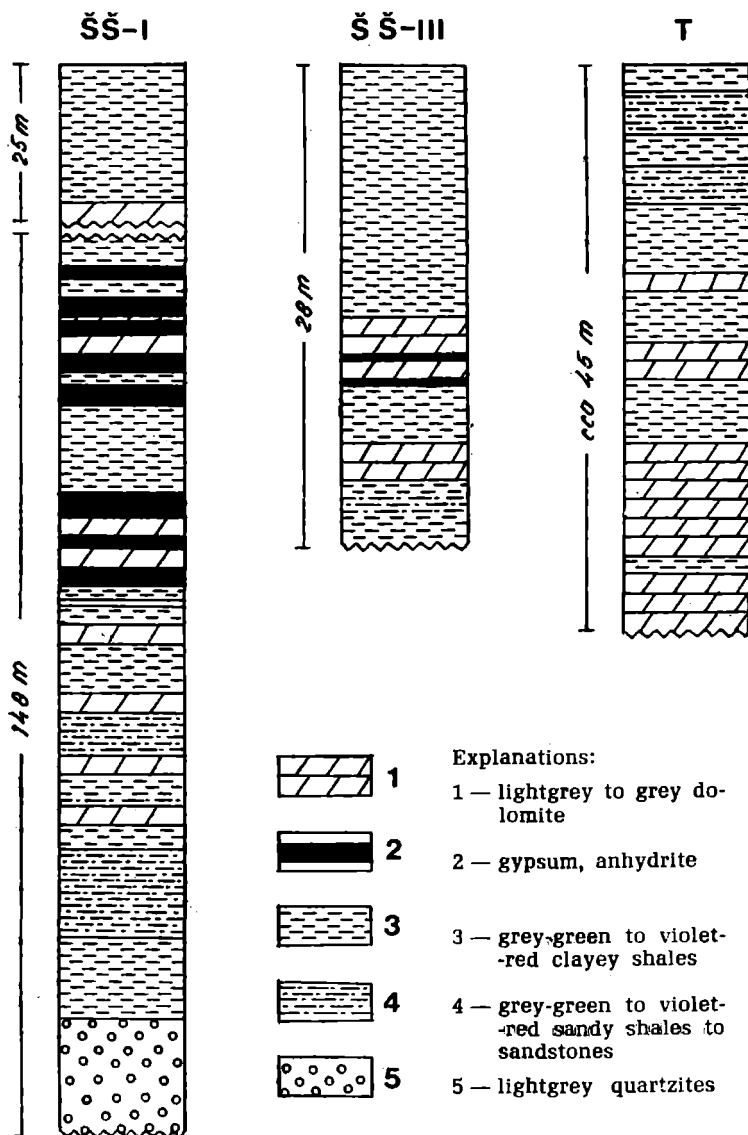


Fig. 27 Lithological Elements of »Carpathian Keuper« in Banská Bystrica Region  
 Area: Špania dolina valley. Area Tajov

component is present — they may be regarded as slightly marly dolomicrites. Generally, their texture is submicroscopical or microcrystalline (grain size to 0.03 mm). They are dark-pigmented. In some cases the dolomicritic mass is differentiated, the rock is of cloddy or pseudoolitic character. Then it may be designated as pseudopelletal dolomicrite. Clastic quartz in the dolomite mass is dispersed, and grain size does not exceed the size of silt grains (maximum 0.07 mm; rarely 0.35 mm). Quartz grains are angular, semirounded and corroded; extinction is undulatory. In compressed dolomites, joints are healed by white secondary dolomites, rarely by quartz.

Organic remains are indistinctly indicated by phantoms — Ostracoda, Radiolaria?. Present are pyrite, dark opact minerals dispersed as pigment; less frequent are grains of indistinct confinement; of the maximum size of 0.10 mm.

Clay shales, sandy shales and sandstones are of light-grey-green, green, violet and violet-red colours. They and their equivalents will be characterized in the description of the area around Špania dolina.

In the »Keuper« near Špania dolina predominate clayey shales, sandy shales and sandstones. Less frequent are layers of dolomites and quartzites; isolated are finds of gypsum and gypsum-sands.

Claystones — as near Tajov, are grey-green, pink, violet-brown and red. They consist of clayey minerals affected by sericitization, of microcrystalline angular and subangular quartz grains. In the area of Špania Dolina, their veins are filled with anhydrite and with polysynthetically lamellated gypsum grains. Quartz veins are common.

Siltstones form a transition between sandstones and claystones. Their composition is similar to that of claystones, with markedly increased amount of clastic quartz grains (of about 0.05 mm size). Infrequent are clastic micas. Their texture is aleuritic.

Sandstones alternate with shales. Their principal component is angular and subangular quartz of 0.4—0.6 roundness. Abundant are micas, particularly muscovite. Feldspars are infrequent — mainly plagioclase. Their cement is clayey, porous, slightly sericitized. In places they are markedly haematitized, of violet-brown colour. Texture of the sandstones is subangular or semi-oval psammitic. In both areas the sandstones are mostly fine-grained, coarse-grained sandstones are only around Špania Dolina — the bore-hole ŠŠ III/30, of subangular — psammitic, porous

and basal texture. They contain more feldspars (plagioclase) and may be classified among coarse-grained arkose sandstones.

#### Chemism of grey, green and red clayey shales

Nr. of sample	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	MgO	SO <sub>3</sub>	TiO <sub>2</sub>	loss by insulation
ŠŠ I/20	19.70	6.45	2.86	20.43	10.70	14.53	0.28	22.38
ŠŠ I/24	17.14	5.57	2.00	21.40	12.75	10.39	0.13	28.55
ŠŠ I/74	18.42	5.59	3.57	16.13	14.39	23.03	0.17	16.75

Analyzed in laboratories of the Geologický prieskum Turčianske Teplice.

Quartzites are medium- and coarse-grained. They consist of quartz grains, of feldspars (plagioclase) and accessories (zircon). They are carbonitized and sometimes contain gypsum grains.

#### Chemical analysis

N. of sample	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	TiO <sub>2</sub>
ŠŠ I/83	69.38	2.61	0.92	0.06

Dolomites are in the form of flags and beds in a sequence of shales and sandstones. Frequent are calcite veins, less frequent gypsum veins. Sometimes gypsum replaced calcite veins and dolomite mass. Also their petrographical character is roughly identic with that of dolomiteš in the locality Tajov. They are mostly dolomicrites, sometimes pseudopeldolomicrites. In some dolomite beds of this area are layers of fine — and medium — crystalline dolosparites.

Gypsum was found in bore-holes in Špania Dolina. Gypsum forms small veins unevenly dispersed in the above mentioned rocks. In dolomites, claystones and shales are layers of gypsum, about 3 m thick (bore-hole ŠŠ I — 219.5 — 223.5 m). Gypsum grains are distinctly polysynthetic, lamellatel, of 4.0—0.16 mm size. They are unevenly confined; they enclose groups of calcite grains and dolomite rhombohedrons. Sometimes there are fragments of micrite enclosed in gypsum or suppressed by the latter. Pyrite grains are infrequent.

## Chemical analysis

Nr. of sample	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	MgO	SO <sub>3</sub>	TiO <sub>2</sub>	loss by	
								dessic.	insul.
ŠŠ I/13	9.90	0.24	0.15	32.64	1.08	42.18	0.07	17.55	22.97
ŠŠ I/12	0.50	0.17	0.11	33.33	0.39	43.58	0.02	17.91	22.22
ŠŠ I/14	2.37	0.51	0.25	31.13	2.56	39.83	0.03	16.49	23.29

Analysed in the laboratories of the Geologický prieskum in Turčianske Teplice.

### 19. Malý Šturec

(Fig. 28)

The highway from Banská Bystrica to Turčianske Teplice runs over two tectonic units: the Křížna nappe and the Šturec nappe. Leaving Banská Bystrica, we meet marls and marly limestones of the Neocomian of the Křížna nappe. They are mined for the local cement works. Then we get through Liassic and Rhaetic limestones to Middle and Upper Triassic dolomites. Near the village Úfanka we enter a variegated Lower Triassic sequence of fine-grained clayey and sandy shales and sandstones on the base with quartzites and quartz conglomerates resting transgressively and discordantly on green-grey and red-brown sandstones, arkoses and conglomerates of the Permian in a verrucano facies (the exposure in the cut of the new road near the village Úfanka). In the village Harmanec we cross the crystalline of the Křížna nappe (mica schists, mica-schist gneisses — migmatitized to various extent) emerging from below the Permian sediments. Since the crystalline and the Permian of the Křížna nappe form here a moderate arch (the so-called "Staré Hory window"), in the village Harmanec we again cross the sequence of the Křížna nappe, only in a reverse order: from the bottom (Lower Triassic) to the top Mesozoic sequences (Neocomian), and near the village Horný Harmanec we enter the complex of Triassic limestones and dolomites of the Šturec nappe.

Its bed sequence commences here with grey massive and brecciated dolomites (lower constituents: Lower Triassic, Permian in the facies of "the Melaphyre series" and Carboniferous are farther in the south because of the truncation of the limestone and dolomite complex from the plastic basement — ("truncature basale", D. Andrusov 1968). These "basal dolomites" are overlain by dark bedded Gutenstein limestones and Annaberg lime-

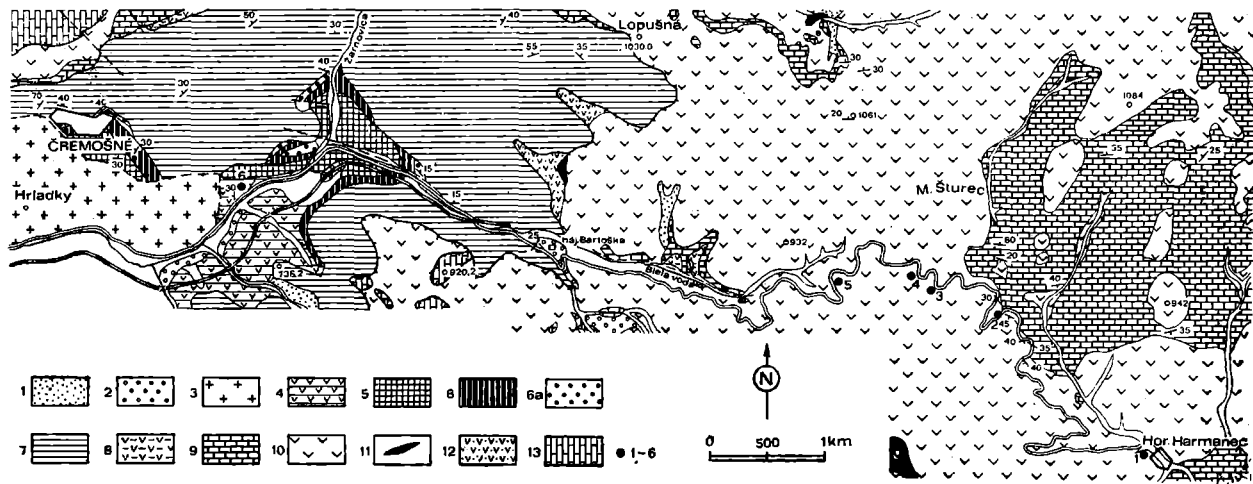


Fig. 28 Geological map of the southern part of Velká Fatra Mts. (Malý Štůrec Region)

According to D. Andrusov and M. Peržel compiled J. Bystrický

**Explanations:**

1. loam, debris; 2. gravels — terrace; 3. Miocene; 4. grey bedded dolomites [partly stromatolitic — Carnian ?]; 5. »Carpathian keuper« (Norian); 6. dark limestones [Rhaetian]; 6a. (Malm — Tithonian); 7. Marls limestones and limestones [Neocomian]; 8. grey dolomites (Lower Anisian); 9. Gutenstein — Annaberg limestones (Pelsonian — Illyrian?); 10. Ramsau dolomite (Ladinian); 11. Lunz beds (Lower Carnian; Julian); 12. Hauptdolomite (Upper Carnian — Norian); 13. grey a light-grey massive and banked limestones (Pelsonian — Ladinian); 2.—7. Křižna nappe; 8.—12. Štůrec nappe; 13. Strážov nappe.

stones (here are the Harmanec caves, to the south of Horný Harmanec). Near the Čierny potok brook the Gutenstein and Annaberg limestones submerge below dolomites of predominantly Ladinian age. On the extreme northern end of the village Horný Harmanec they contain a lot of Dasycladaceae: *Teutloporella herculea* (Stopp.) Pia (Stopping place 1).

In the cut of the road in further part we may observe exposures of dolomites, and in the higher part of the winding path are dark bedded and thick-bedded Gutenstein limestones emerging from below the former. In their top part — somewhat lighter in colour — are Dasycladaceae: *Diplopora annulata* (Schafh.).

The overlying dolomites are typical of the Šturec nappe. In the lower part they are dark-grey, in the upper — light-grey or yellow, thick-bedded or massive and finelaminated. In some places they contain abundant Dasycladaceae *Diplopora annulata* (Schafh.).

Stopping place 2: Dolomites with *Diplopora annulata* in the cut of the road between km 12 and 13.

Stopping place 3: Thick-bedded laminated dolomites with *Diplopora annulata* (Schafh.) to the west of the pass Malý Šturec in the cut of the road.

The segment of the road to the west of the pass is in Ladinian dolomites (somewhere with badly preserved *Diplopora annulata*, with calcareous sponges?); from below the dolomites — near the gamekeeper's hut Bartoška — emerges the top part of the Gutenstein limestones and from below these — Neocomian marls and marly limestones of the Krížna nappe.

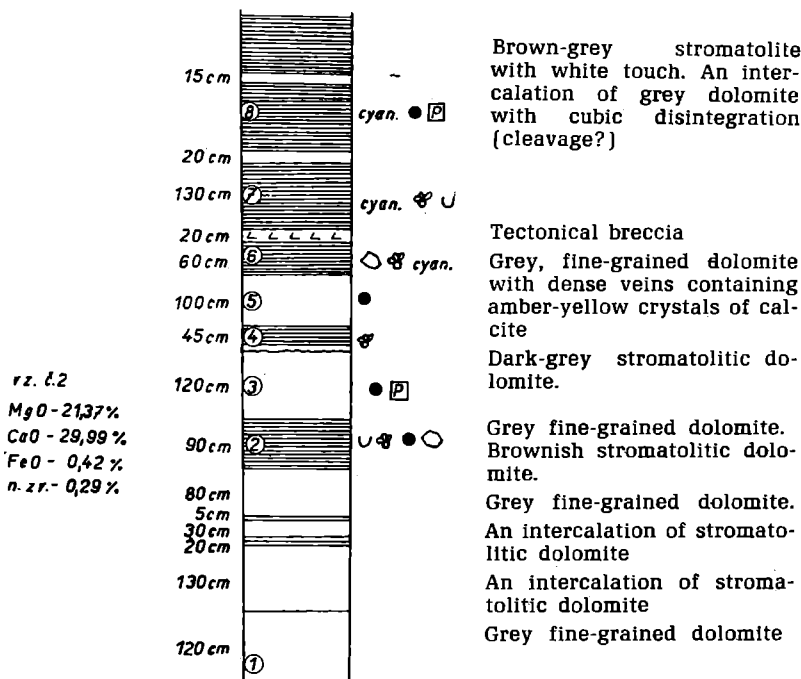
## 20. Čremošné —

the Veľká Fatra mountains: The Upper Triassic of the Krížna nappe (Fig. 29, 30, 31, 32)

Near the gamekeeper's hut Bartoška, the highway between Banská Bystrica and Turčianske Teplice cuts into the tectonic basement of the Šturec nappe. The basement is the upper part of the Mesozoic of the Krížna nappe, emerging in the form of a tectonic inlier (window).

In the cut of the highway the Mesozoic of the Krížna nappe is represented by marly shales and marly Neocomian limestones (the cut of the road to the west of the Bartoška hut) and by the Upper Triassic, dolomites, the Carpathian Keuper, and Rhaetic limestones (the cut of the road near huts, near the end of the Žarnovická dolina valley, in this valley, and in the cut of the railway track).

Fig. 29 Rhythmical alternation of stromatolitic and grey, fine-grained dolomites (the cut of the road in the Žarnovická dolina valley) (M. Mišík 1972)



1. Fibres of Cyanophyceae; 2. Foraminifera; 3. Ostracoda; 4. Intraclasts; 5. Pellets; 6. Pyrite

a) The dolomites exposed in the cut of the highway near the mouth of the brook Čierna voda into the brook Žarnovica, are the bottom sequence of the Triassic of the Križna nappe. The sequence is known from surficial outcrops. The dolomites are bedded (the thickness of beds is 30–80 cm) dipping north-westwards 30°. Since they did not yield any fossils, their age may only be determined according to their position.

They are the so-called even stromatolites, sometimes slightly waved, of the LLS-S type (the classification by B. V. Logan — R. Rezák — R. N. Ginzburg 1964). They are characterized by typical sparite spots and identic with the so-called “loferites” in the Alps.

A. G. Fischer (1964) interpreted the spots as the filling of

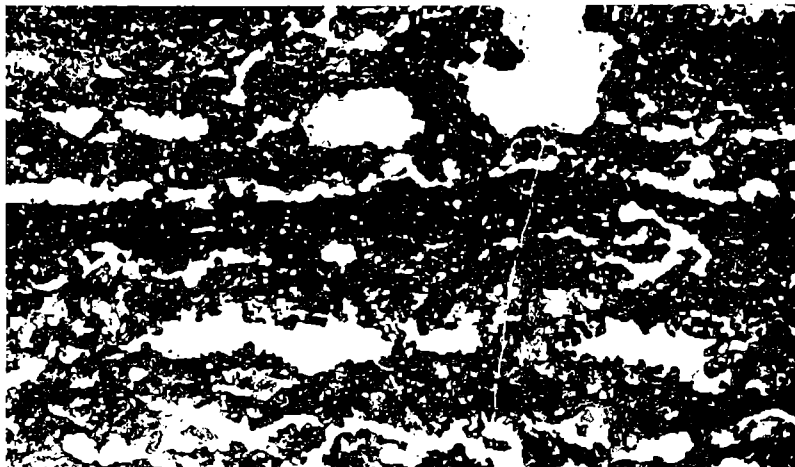


Foto Fig. 30  
Stromatolitic dolomite »loferite« with typical sparite spots (shrinkage cavities produced by dessication of sediments).  
Magn 11x. Photo: Oswald



Foto Fig. 31 Stromatolitic dolomite — »loferite«. In the top part is a minute »volcano« produced by escaping gas. The surface is polished; size — natural. Photo: Oswald

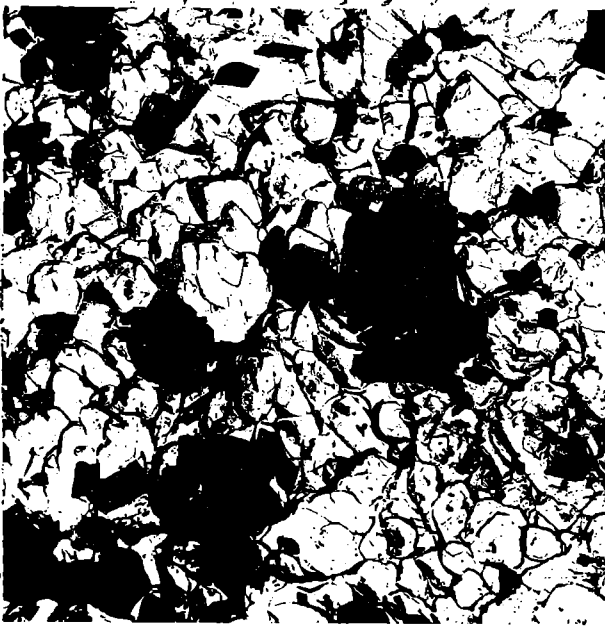


Foto Fig. 32 Electronmicroscopical photograph of a replica from the fracture surface of stromatolitic dolomite.  
Magn. 7000 x. Photo: H. Gerthofferová

shrinkage pores produced by dessication of sediments. G. E. Tebutt — C. D. Conley — D. W. Boyd (1965) designated them as “fenestraea”. In this case it is perhaps “laminoïd — fenestral fabrics”, type Wyoming A.

The shrinkage cavities are filled with drusy dolosparite. The results of the planimetric analysis of a typical sample: micritic mass of stromatolites: 60.48 %; sparitic mass of pores 39.52 %. The bottom of some caverns is covered with mud falling down from the walls of caverns (“internal sedimentation”). Geopetal textures (minute “volcanoes” forming by the escape of gas from sediments, also exist) are also a criterion of polarity. Stromatolites formed by mud sticking to the adhesive surface of the algae “pillows” (lamines thick 0.5—2.0 mm).

In rock slices are distinct fibres of cyanophyta in vertical position. Isolated are Ostracoda and Foraminifera of the Glomospira type. Frequent is admixture of pellets and intraclasts. They, together with stromatolites — are typical components of

recent dolomite crusts in the Persian Bay and in the Caribbean region ("penecontemporaneous dolomites").

Lithologically, the stromatolite mass is dolomicrite of extremely fine granularity (electron microscopical photographs showed the granularity varying between 0.3 and  $3.5\mu$ , maximum  $1\mu$ ).

Chemically it is almost pure dolomite: MgO 21.37 %; CaO 29.00 %; FeO 0.42 %; solution residuum 0.29 %.

b) The Carpathian Keuper. The dolomites are overlain by variegated clayey shales and sandstones. Here they are not completely exposed, so their course and position may only be traced in fragments included in debris. In the cut of the road is the Carpathian Keuper cropping out in the bend of the road near the flowing of the Biela Voda brook into the brook Žarnovica. It is an about 10 m long out crop of red-violet clayey shales, green-grey clayey shales with layers of quartzites and quartzose sandstones and dark-grey bedded dolomites ("keuperdolomites").

c) The Carpathian Keuper is overlain by grey bedded limestones with layers of lumachellar limestones and with intercalations of grey and dark-grey shales. It is a Rhaetic sequence in the so-called Carpathian facies with *Rhaetina gregaria* (Suess.).

The limestones contain Foraminifera: *Trocholina crassa* Kr., *Glomospirella friedli* Kr.-Toll., *Diploremina subangulata* Kr., *Involutina turgida* Kr., *Tetrataxis nanus* Kr., *Agathammina austroalpina* Kr.-Toll. et Toll.

The Carpathian facies of Rhaetian is in the entire region of the Veľká Fatra mountains. Because of incomplete exposures in the Čremošné tectonic inlier (window), the stratigraphical range of the sequence may be determined only approximately.

The Rhaetic limestones are overlain by the so-called Gresten beds (Lower Liassic) — brownred sandstones and brown claystones.

## Strážovské pohorie Mts.

### 21. Valaská Belá – Hireška –

Carpathian Rhaetic facies (Fig. 33, 34, 35)

The locality is exposed in the cut of the road from Ilava to Prievidza. 100 m of the cut were described by M. M a h e l (1958). The beds in the cross-section display complicated slice tectonics which affected this part of the Križna nappe. In the cross-section are exposed two slices of different tectonic structure. Their lithological and stratigraphical filling is almost the same.

The oldest Rhaetic rock exposed in the cross-section is dark

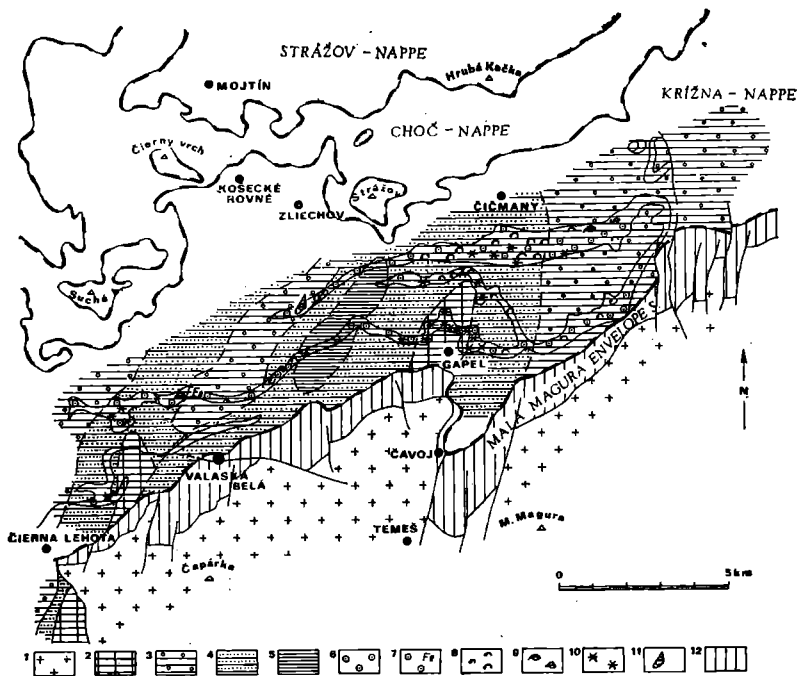


Fig. 33 The facies-distribution of the Rhaetic deposits of the Krížna nappe in wider surroundings of the locality Valaská Belá — Hreška. The scheme consists of 27 cross-sections through Rhaetic deposits in the area studied. 1. The crystalline of the cores Suchý and Malá Magura, 12 — the mantle series of Malá Magura; 2. the facies of coral limestones; 3. the facies of depressions with muddy, detrital and oolitic limestones; 4. the intermediary facies of lumachellar, detrital and oolitic limestones; 5. the lagoonar — terrestrial (?) facies of sandy-clayey deposits with breccia, marly and quartzose limestones etc.; 6.—11. important fossils and lithological elements: 6. oolites; 7. ferruginous oolites; 8. lumachelles of *Bivalvia* and *Brachiopoda*; 9. *Brachiopoda*; 10. corals; 11. important finds of *Gastropoda*

detrital-crinoidal limestone (1). With intercalations of dark-grey marly limestones, brown-grey detrital limestones, dark detrital limestones with *Brachiopoda*, they are the substantial part of the eastern slice. Its basement is the Carpathian Keuper consisting of varicoloured claystones with intercalations of light-grey silstone dolomites. The contact of both sequences is slightly tectonically modified. Dark detrital-crinoidal limestones are the basal constituent of the Rhaetic also in exposures in wider vicinity. Some "nests" of *Brachiopoda*, mainly *Rhaetina gregaria* (S u e s s),

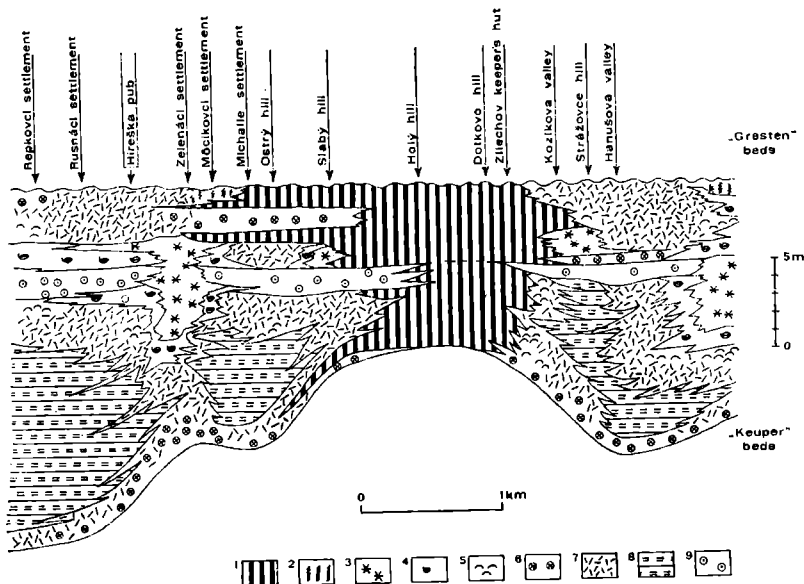


Fig. 34 The schematic lithological cross-section through the Rhaetic sequence of the Krížna nappe in the area of Čierna Lehota — Valaská Belá — Gápeľ. Heightened; thickness — ratio in individual profiles is preserved. 1. the lagoonar-terrestrial facies; 2. »lateritic« intercalations and mud cracks ?; 3. corals; 4. Brachiopoda; 5. lumachelles of Bivalvia and Brachiopoda; 6. crinoidal limestones; 7. organic detritus; 8. muddy limestones; 9. oolitic limestones. Individual profiles are marked with arrow-heads.

in limestones beds of the exposure indicate the original living position of these animals, elsewhere preserved in lumachelles as relicts.

Higher up is a sequence of muddy limestones (2). Graded-bedded layers and thin strips of detritus in fine-grained matter of other beds indicate sedimentation in deep environment, affected by currents. The current transported larger fragments of valves of bivalvia into fine-grained sediments. They occur in several horizons. Transported were also ocre-yellow marly rocks recalling chemogene weathering products of limestones. They would accompany thin, confined lenses of limestone breccia.

The thick sequence (12 m) of muddy limestones is followed by beds with greater marl content. They contain shells of Bivalvia and Brachiopoda. They are overlain by some beds of muddy limestones, by dark crinoidal limestone with dark marl, and crinoidal detrital limestone. In the upper part of the sequence,

SCHEMATIC SKETCH OF THE SITUATION OF OUTCROPE  
RHAETAN LIMESTONES NEAR VALASKÁ BELÁ

J. Michalik

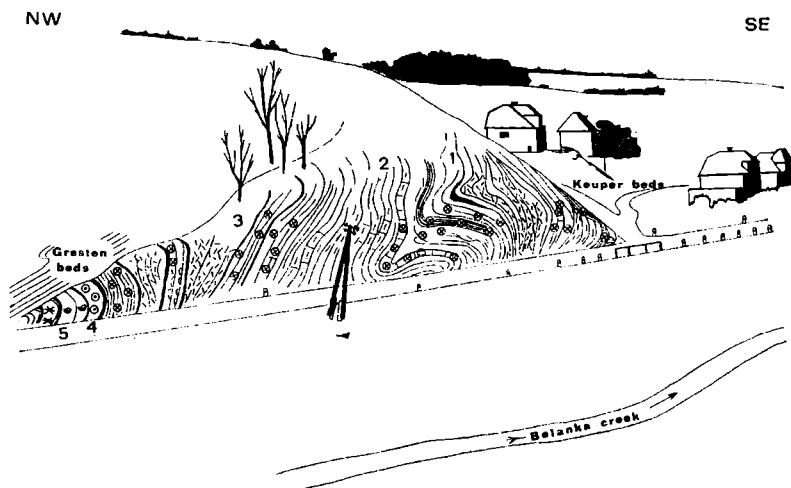


Fig. 35 The schematical situation-sketch in the eastern slice of Rhaetic limestones in the exposure near the pub Hřeška in Valaská Belá. Symbols — as in the preceding figures.

to the south of the profile, are again marly lumachellar limestones, limestones with Brachiopoda and with corals. Somewhere (the settlement Zelenáci, the village Gápel) they are even 6 and more m thick. Total thickness of whole sequence is up to 10 m thick (3).

The sequence described is overlain by comparatively thick beds of oolitic limestone (4). Its character varies: in the profile is limestone consisting of medium-sized (about 1 mm) oolites with segments of crinoids; in exposure on the slopes of the Čierny vrch hill are limestones of large oolites containing fragments of valves of thick-walled Bivalvia. Around the settlement Škrípov near Valaská Belá and northwards from Trebichava are frequent limestones with haematite — chamositic oolites. Around the hill Holý Vrch, to the north of Valaská Belá, are beds of quartzose of dark claystones. In the overlier of thick layers of coral limestones the horizon with oolites is sometimes missing, although in the close surrounding are oolitic limestones with coral fragments. The common thickness of a bed of oolitic limestones is to 2 m.

The horizon is followed by limestones with abundant *Rhaetina gregaria* (Suess), higher up-by coral limestones (5). The bed of coral limestones is replaced by limestones containing lumachelles and Brachiopoda in the surrounding of the locality. They are more frequent than coral limestones below the oolite horizon. The thickness of the coral layer above the horizon of oolitic limestones is rather low (0.5—1 m) and invariable. Near the Holý Vrch hill, to the north of Valaská Belá, the coral limestones wedge out in a sequence of dark clays, quartzose limestones with pyrite and dark clayey sandstones. On their contact are infrequent ocre-yellow and grey marly limestones with textures recalling mud cracks.

In the western slice the coral limestones are overlain by marly lumachellar and detrital limestones. In this last part of the Rhaetic sequence are in other exposures also dark crinoidal limestones, limestones with Brachiopoda, quartzose brecciated limestones and grey marly limestones with ocre-yellow bodies inside and on the surface of beds.

The last limestone constituent is overlain by a sequence of brown-grey claystones with intercalations of brown quartzose limestones and clayey sandstones. These beds separate the western slice from the eastern. Their stratigraphical position and lithological character indicate their appurtenance to the Lowest Liassic (the "Gresten beds").

## **22. Valaská Belá —**

Carpathian Keuper; Norian, the Krížna nappe

The exposure is on the northern side of the village Valaská Belá (see Fig. 34). The Keuper is here about 90—100 m thick. Its sequence contains varicoloured (red, red-brown, green and green-grey) aleuritic and pelitic rocks (silt-stones, claystones, clayey-sandy and clayey shales); sandstones (graywackes, sub-graywackes); carbonatic rocks (dolomites) and mixed types (dolomitic claystones and clayey dolomites).

Predominate pelitic, aleuritic and mixed rock types. Sandstones and dolomites are less frequent. They are only in thin layers. Characteristic are gradual transitions between individual types of rocks. Sandstones are medium and fine-grained; parallel-cross — and diagonal-bedded. Dolomites are microcrystalline and pelitomorphic.

The ratio of the rocks indicates predominance of mechanical sedimentation over chemical. The alternation of sandstones, shales, and dolomites indicates rhythmical sedimentation of predominantly flyschoid-lagoonar character.

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