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**Abstrakt**

Mladopaleozoická sedimentácia z výskytov v oblasti Nötsch a Veitsch vo Východných Alpách je zrovnávaná s obdobnými sedimentačnými podmienkami z oblasti Ochtinej, príp. ostatných ekvivalentných častí severogemeridnej zóny v Západných Karpatoch. Uvažovaný je jednotný plytkomorský sedimentačný priestor s morskou molasovou sedimentáciou, s narastajúcimi ríftmi (alebo časťami s vývojom plytkovodných organizmov), ktoré boli prekrývané vrchnokarbónskymi, regresívnymi deltovými, deltovo-riečnymi sedimentárnymi fáciami a miestami i permskými fanglomerátmi. Pre jednotlivé časti tohoto sedimentačného priestoru bol diskutovaný devónsky metamorfný podklad. Toto sedimentačné prostredie charakterizuje sutúru medzi dvoma rozdielnymi mikroplatňami, menovite medzi metamorfovanou vnútornou zónou variskeho orogénu a vonkajšou zónou so spodnokarbónskou hlbokovodnou sedimentáciou.

**Zusammenfassung**

Die jungpaläozoischen Ablagerungen von Nötsch, Veitsch der Ostalpen werden mit solchen von Ochtiná und vergleichbaren Abfolgen der Nordgemeriden der Westkarpaten korreliert. Ein einheitlicher mariner Flachwasserraum mit mariner Molassesedimentation und dazwischen sich aufbauenden Riffen (oder Tells mit Flachwasserorganismen) wird postuliert, die von oberkarbonischen regressiven Delta- und Flußablagerungen und von vermutlich permischen Fanglomeraten überlagert werden. Ein devonisch metamorphosiertes Fundament von Teilen dieses Ablagerungsraumes wird diskutiert. Dieser Sedimentationsraum charakterisiert die Sutur zwischen zwei verschiedenen Mikroplatten resp. Terranes, nämlich einer metamorphen Internzone des variszischen Orogens und einer Externzone mit unterkarbonischen Tiefwassersedimenten.

# BIOSTRATIGRAPHICAL EVALUATION OF WEAKLY METAMORPHOSED SEDIMENTS OF WECHSEL SERIES AND THEIR POSSIBLE CORRELATION WITH HARMÓNIA GROUP IN THE MALÉ KARPATY MTS.

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## Introduction (A. Pahr)

The Wechsel mountain group in the Central Eastern Alps has aroused the attention of geologists for a long time. The reason for this may have been a particular rock assemblage and problems with its tectonic position.

After the fundamental works by H. Mohr (1911—1919) detailed studies by Faupl, Vetters, Huska, Halbmayer, Lemberger (1968—1970) have brought about important new results. Mohr's litho-stratigraphic division of the Wechsel rocks into (top to bottom) Wechsel schists and Wechsel gneiss (with the Permoskythian transgression on top) could be improved by the studies of P. Faupl (1970). His new division (Fig. 1) shows the sequence of the Wechsel gneisses at the bottom, followed by the Underlying (= Liegende) and the Overlying (= Hangende) Wechsel schists, and then, after a gap, by the ABP- (= Arkose-Breccia-Porphyroid) series (= Rotliegendes) and the Semmering quartzite (Skythian).

Recent conclusions concerning the tectonic position of the Wechsel unit have shown it as a deeper part of the Lower Austro-Alpine nappe system after a variety of attempts to find its right position in the tectonic scheme of the Eastern Alps (Fig. 2). This was possible after it had turned out that the Wechsel nappe is not restricted to the Wechsel mountain group proper but is widely spread under the overthrusted Grobgneis nappes of the Central Alpine

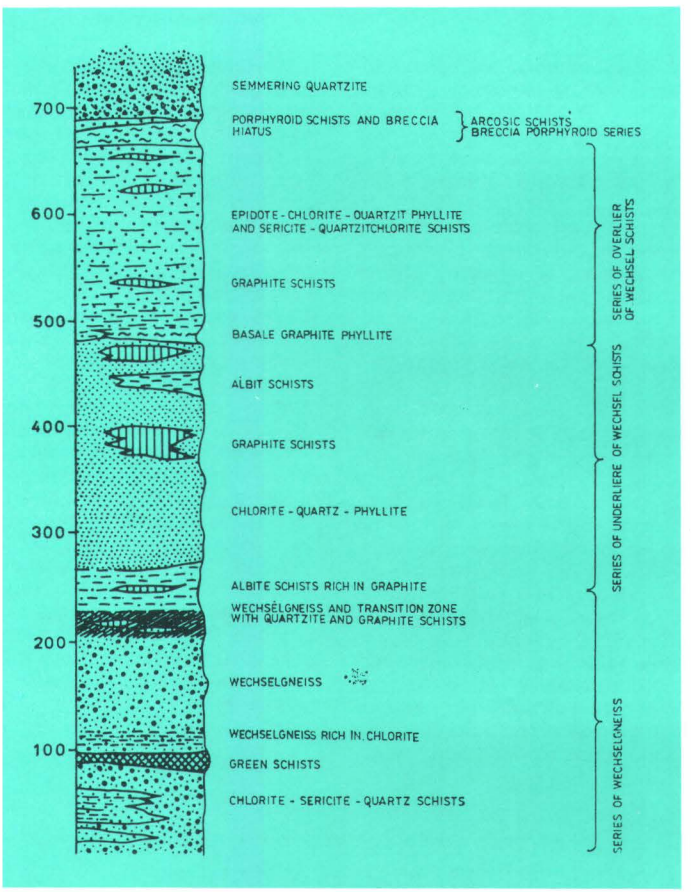



Fig. 1: Lithostratigraphic profile of the Wechsel series (after Faupl, 1970).

Zone in Austria, overlapping the Penninic in the East and emerging in several tectonic windowss below the Grobgneis nappes in the Northeast and North (Pahr 1972, Tollmann 1976).

### The problem of the stratigraphic position of the Wechsel Series

Whereas there were no problems about the lithostratigraphic ranging of the overlying Permoskythian, there have only been assumptions about the stratigraphic position of the underlying Wechsel schists due to the lack of fossils. In 1907 G. A. Koch announced the discovery of Carboniferous plants north of the village Mariensee (near Aspang), but this turned out to be a mystification as H. Mohr found out and published in 1922 (on the place mentioned by Koch there is only albitic gneiss and a quartz vein cropping out!).

On the other hand H. Mohr stressed the possibility of a (late) Carboniferous age of the graphite-bearing Wechsel schists (1913). His opinion was shared by L. Kober (1912) and K. Bistritschan (1939).

In 1970 P. Faupl considered the Early Paleozoic the most probable age of the Wechsel schists after comparing them to similar Early Paleozoic rocks in the Eastern Alps and the Carpathians. His opinion is based, above all, on the basic tuffaceous intercalations in the Wechsel schists.

A. Tollmann (1957) supported the theory of an Early Palaeozoic age, whereas H. Wieseneder (1971) insisted on Late Carboniferous, because the underlying and overlying Wechsel schists were not metamorphosed (in the Quartz-Albite-Muscovite-Chlorite subfacies of the greenschist facies) before the Alpidic orogenesis. According to H. W. Flügel (1976) Wieseneder's view fits his idea of a Palaeozoic sedimentation trough of the Northern Alpine Variscan belt.

To H. P. Schönlaub (1977) the dark quartzites indicate Silurian age and so in his geological column we find the Wechsel schists ranged in the Silurian for the most part, with the top just going up into the early Devonian.

The fact, that the Wechsel unit extends much farther to the East than the "traditional" Wechsel mountain group (Pahr 1970) widened the scale of Wechsel schists and Wechsel gneisses, but could not as yet provide any proof for a stratigraphic ranging either. The occurrence of (elongated) quartz pebbles in graphitic quartzites around Bernstein could be interpreted as a hint for a (late) Carboniferous age of these rocks.

### Palynological evaluation of epizonally metamorphosed sediments (E. Planderová)

Since metasediments of the Wechsel series and of the Harmónia group in the Malé Karpaty Mts. have similar lithological characters (A. Pahr, M. Maheľ, O. Miko), both complexes were palynologically studied for the purpose of age correlation.

The study was aimed at information on the age of metasediments of the Wechsel series, more precise age data on dark graphitic schists of the Harmónia group and at their correlation.

Biostratigraphical evaluation of epizonally metamorphosed sediments was based on sporomorphs and acritarchs from chloritic and sericitic phyllites and graphitic schists.

Rich palynomorph assemblages were obtained from about 50 samples from the whole Wechsel series and the Harmónia group in the Malé Karpaty Mts.

The preservation of palynomorphs shows that changes in temperature and dynamometamorphosis had only partial influence upon exines of sporomorphs. So it was possible to determine the genera, and in many cases also species of palynomorphs. Graphitization damaged exines to 40—70 %. Most sediments were affected by temperatures ranging up to 200 °C, on the locality Weinweg to 170—180 °C. Samples of sediments affected by higher metamorphosis contained palynomorphs with exines with dark graphite remains and they were regarded sterile with respect to their age.

The degree of preservation of palynomorphs indicated approximately the same degree of metamorphosis as of palynomorphs resedimented in Wechsel series and in the Harmónia group and a higher degrees of metamorphosis in chloritic and sericitic schists from the locality E of Bad Schönau (HM—1, 2).

The determination of palynomorphs was based on the modern systematic-morphological publications by A. Eisenack (1973), F. H. Cramer (1964), J. Doubinger, D. C. Rauscher (1962), J. Doubinger (1968), D. C. McGregor (1973), D. C. McGregor (1977), A. Moreau-Benoit (1980), J. B. Richardson — R. Lister (1969), E. V. Tchibrikova (1972).

### Wechsel area

For the above mentioned reasons the samples from the Wechsel area were repeatedly treated to get assemblages so rich in species as to enable age determination of sediments from the following cross sections:

A. Weinweg (samples 1—8)
B. Bernstein (samples 1—3)

In cross section Weinweg and Bernstein were 80 % of autochthonous Late Paleozoic palynomorphs and 20 % of palynomorphs redeposited from the Early Paleozoic rocks.

### A. Cross section Weinweg

It is on a road cut N of the village Trattenbach. The cross section is in darkgrey sericitic phyllites (Fig. 3).

The sporomorph composition is as follows:

Locality 1: Wilsonia pseudopraetecta Inosova, frequent in the Upper Carboniferous (Stephanian C — Autunian base). Frequent were species of Thymospora tiessenii (Kos.) Alp, Lycospora punctata Kos. — mainly in the Stephanian — Lower Permian: and species of the genus Verrucatosporites, Florinites antiquus (Schopf.) Alp, Torispora securis Alp., Colluminisporites ovalis Peppers, Dictyotriletes reticulocingulum (Loose) Schmidt, and various species of the genus Cordaitina. The above mentioned spore assemblage is typical of the Stephanian — Lower Permian. Since the percentage of monosaccate pollen was not higher than that of trilete spores. The sediments are ranged to the Stephanian C.

Sample 3—4 contained poorly preserved sporomorphs representing the following species: Cordaitina ornata Samoil., Scabratisporites scabratus Teteriuk, Torispora securis Alp., Raistrickia sp., Florinites luberae Samoil. — species frequent in the Stephanian — Lower Permian. There were also spores of the genus Potonieisporites, Punctatisporites punctatus (Kos.) Alp. and unidentifiable species of the genus Pityosporites. Sediments from this locality are also ranged to the Stephanian C — Lower Permian.

Locality 5: Sediments of this locality did not contain any monosaccate nor bisaccate pollen; they only contained spores of Spermophyta: Punctatisporites cingulatus Alp., Apiculatisporites irregularis Alp., Punctatisporites granifer Pot. Kr., Spinosporites aff. peppersi Alp., Densosporites crassipterus (Waltz) Schwartzm., Spinosporites peppersi Alp., Punctatosporites sp., Aumancisporites sp. All the species are indicative of the Upper Stephanian.

Locality 6: The sporomorph assemblage is well preserved and diversified in species. The effect of metamorphosis on exines are minimal. The assemblage comprised Triquitrites triturgidus (Looze) Wils. et Ven. occurring in the Stephanian, Lophotriletes commisuralis (Kos.) Pot. Kr. occurring in the Stephanian B—C, Punctatosporites cingulatus Alp. occurring in the Stephanian B—C, Cordaitina sp. — in the Stephanian — Lower Permian, Wilsonia pseudopraetecta Inos. in the Stephanian C, and especially in the Lower Permian; Thymospora thiessenii (Kos.) Alp., Colluminisporites ovalis Peppers., Torispora sp. occurring mostly in the Stephanian C—D, cf. Dictyotriletes bireticulatus (Ibr.) Pot. — in the Westphalian B.

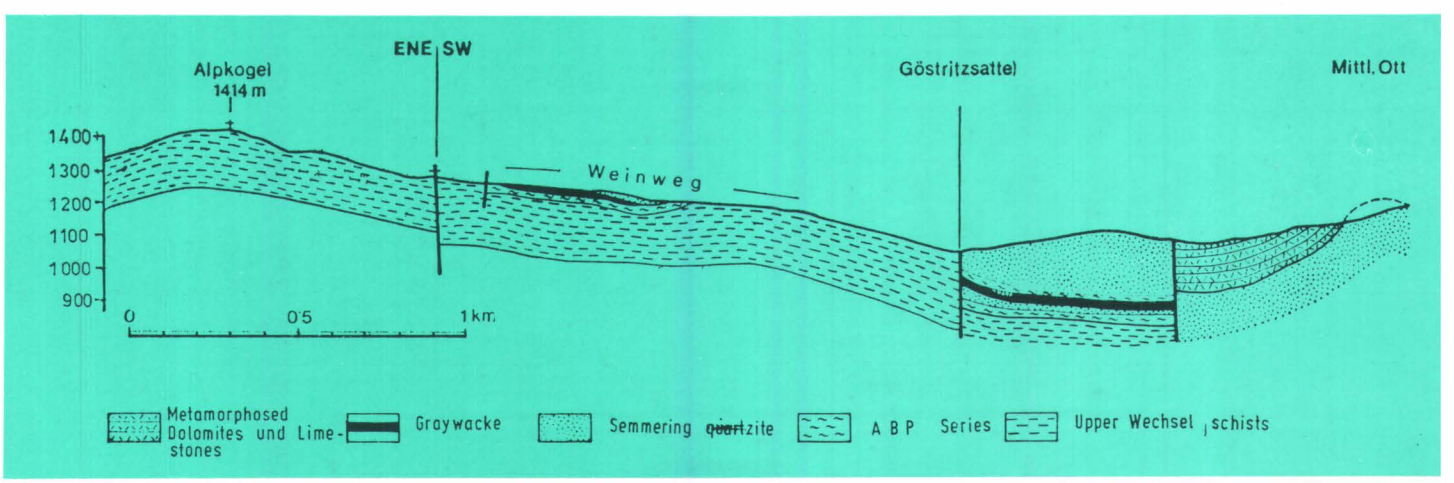
The composition of the spore-pollen assemblage and its stratigraphic range are indicative of the Stephanian — Lower Permian.

Locality 7: The sample contained well preserved sporomorphs: Lycospora cf. granulata Kos., Triquitrites perornatus Radondy-Doub., Tripartites sp., Endosporites globiformis (Ibr.) S. W. B., Densosporites sp., Lycospora sp., Cymatiosphaera sp., Acritarcha indet. These species occur in the Upper Stephanian.


Fig. 2: Geological situation around the Wechsel group (after Tollmann, 1977).

Locality 8 is the last one in the cross section through the schistose formation at the end of the forest road to Weinweg. The sporomorph assemblage consists of Punctatosporites sp., Punctatosporites cingulatus Alp., Punctatosporites punctatus Kos. and Colluminisporites ovalis Peppers Stephanian C — Lower Permian. Limitisporites sp., Potonieisporites sp. are more frequent in the Permian. The species Illinites unicus Kos. and Colluminisporites ovalis Peppers are frequent in the Stephanian C — Lower Permian. Sediments of this locality contain mostly Lower Permian microfloral elements indicative of the Lower Permian (Fig. 4).

Fig. 3: Geological profile of Weinweg (after Faupl, 1970).

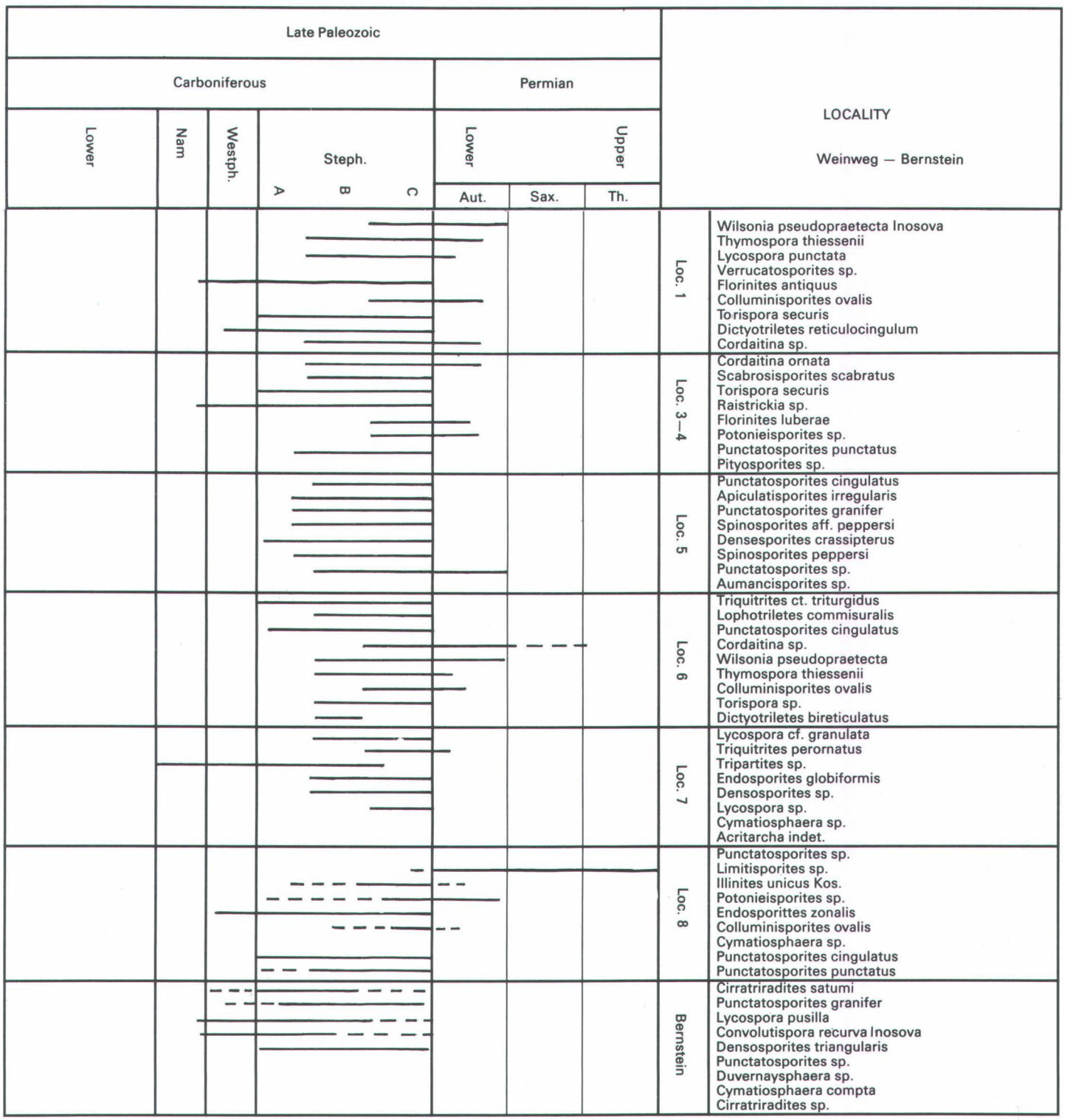


### B. Locality Bernstein

The locality is in a road cut near the village Bernstein. It is in graphitic schists (Fig. 5). The degree of preservation of organic remains shows that graphitization was not extensive. The samples contained the following palynomorph species: Cirratriradites saturni (Ibr.) S. W. B., frequent in the Upper Carboniferous, mainly in the Stephanian; Punctatosporites granifer (Pot. Kr.) Alp., occurring in the Stephanian, Lycospora pussilla Alp., — occurring in the Stephanian, Convolutispora recurva Innosova — in the Stephanian B—C, Densosporites triangularis (Kos.) Alp., occurring in the Stephanian B—C, Punctatisporites sp., Cirratriradites sp. The sea plankton was represented by Duvernaysphaera sp. and Cymatiosphaera compta resedimented from the Early Paleozoic. These species are indicative of the Stephanian age of sediments of this locality. They are related microfloristically to samples from Weinweg loc. 5.

The biostratigraphical evaluation of sediments from cross section Weinweg and Bernstein proves that they were deposited in the Late Paleozoic time. According to microflora the Upper Permian and the uppermost part of the Lower Permian age is excluded, and the sediments from the localities 1—7 are Stephanian B — Stephanian C in age. Sediments from the locality 8 might already be ranged to the base of the Permian.

Fig. 4: Abundance of palynomorphs in the samples of profile of Weinweg and Bernstein.



From paleoecological viewpoint these sediments were deposited most likely in a shallow marine environment. Spores of Spermophyta are indicative of a humid swamp zone. The low percentage of cordaite and bisaccate pollen indicates a higher relief distant from the sedimentation area. The locality E of Bad Schönau (Fig. 2 point 4) was also palynologically studied.

**Area of the Malé Karpaty Mts. (Harmónia group)**

Locality Pezinok. Palynological data on the Harmónia group resulted from the study of many samples from several localities. Most important are the localities of a quarry near the road to Pezinská Baba. Čorná (1968) studied samples from localities in Lamač and presented biostratigraphical data also on the Harmónia group. On the basis of study of cuticles, she ranged the rocks to Silurian — Devonian.

Detailed examination of samples from the Harmónia group revealed a rich palynomorph assemblage mostly composed of acritarchs. It consisted of the following species: Rhabdosporites langi (Eis.) Rich., occurring in Lower — Middle Devonian, Dictyotriletes emsiensis (Alen) McGregor — in Lower — Middle Devonian, Dibolisporites echinaceous (Eis.) Rich., Lower — Middle Devonian, Dibolisporites sp., Verrucosisporites pseudospinosus Streel — Middle Devonian, Retusotriletes triangulatus Streel — end of Middle Devonian, Stenozonotriletes extensus Naum. — Middle Devonian, Emphanisporites minutus Allen — Lower Devonian, Hymenozonotriletes sp. Raucher — Lower Devonian, Azonomonoletes usitatus Tschibr. — end of Lower Devonian, Acritarchs were represented by the species Micrhystridium lapellum Loebl., Wic. from Upper Silurian — Lower Devonian, Cymatiosphaera nebulosa Downie — end of Silurian and base of Devonian, Cymatiosphaera leonensis Cramer — end of Silurian, Cymatiosphaera sp. Raucher — end of Silurian — Lower Devonian, Quadratidium fantasticum Cramer — Lower — Middle Devonian, Discina asperella Tschibr. — Lower Devonian, Acantodiacrodium sp. "2" Martin — Upper Devonian, Duvernaysphaera tennuicingulata Stapl. — Lower Devonian, Dictyopsophosphaera polygona (Stapl.) Tschibr. — Lower Devonian, Pulvinosphaeridium deunffi Moreau-Benoit — Lower — Middle Devonian, Ammonidium loriferum Deunff. — Lower Devonian, Ammonidium rigidum (Deunff.) Lister, Ammonidium sannemani Deunff. — Lower Devonian, Ammonidium cf. allciteaui (Deunff.) Moreau-Benoit — end of Silurian — Lower Devonian, Baltisphaeridium tuberosum Sanneman — Lower — Middle Devonian, Tunisphaeridium cf. tentloculoferum (Martin) Eis. — Lower — Middle Devonian, Pterospermella pernambucensis (Britto) Eis. — Lower — Middle Devonian, Onandogella deunffi Cramer — Upper Silurian — Lower Devonian, Riculosphaera fissa Loebl. et Drugg — Upper Silurian — Lower Devonian, Moyera uticansis Thusu — Upper Silurian — Lower Devonian, Evittia granulatispinosa (Down.) Lister — Upper Silurian — Lower Devonian, Multiplicisphaeridium raspa (Cramer) Eis. — Silurian — Lower Devonian, Multiplicisphaeridium ramusculosum (Deunff.) Eis. — Lower — Middle Devonian, Multiplicisphaeridium cf. rabiosum Cramer — Upper Silurian — Lower Devonian, Lagenochitina — Silurian — base of Devonian. On the basis of the plentiful palynomorphs and their age dispersion we can range the metamorphosed sediments of the Harmónia group to the Lower Devonian.

**On the age of epizonally metamorphosed sediments**

The existing opinions about the age of sericitic, chloritic and graphitic schists of the Wechsel series were contradictory, not reasoned by paleontological data. Metamorphosed sediments were regarded as unfossiliferous "barren". We have collected palynomorphic material by palynological method and on the basis of the material we can determine the age of the sediments under study. The age determination of metasediments was complicated by the character of rocks, by destruction of palynomorph exines by metamorphosis, and particularly by a high percentage of resedimented palynomorphs in some cross sections. Repeated sampling and treatment of probes, determinations on the basis of plentiful palynological literature showed that cross sections Weinweg and Bernstein are most suitable for the age determinations of sediments.

a) Samples from the profiles contained well preserved Stephanian — Lower Permian sporomorph assemblages and a low percentage of redeposited palynomorphs from the Silurian — Lower Devonian (mainly plankton).

The Upper Permian age is denied by the sporomorph assemblage without typical Upper Permian species especially monosaccate and bisaccate pollen.

b) Weakly metamorphosed sediments of the Harmónia group in Malé Karpaty Mts. are ranged to the Lower Devonian on the basis of the palynomorph assemblage.

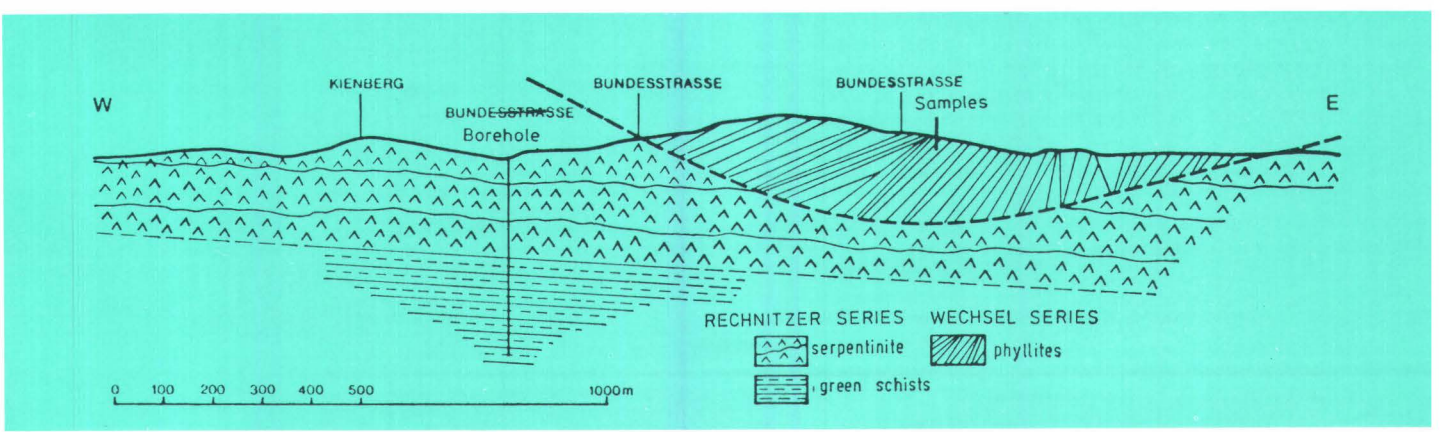
**Possible correlation between sediments of Wechsel series and of Harmónia group in Malé Karpaty Mts.**

The results of our study show that in spite of the possibility of lithological correlation, the existing data are not sufficient for biostratigraphical correlation between metasediments of the Wechsel series and of the Harmónia group.

Redeposited Silurian-Devonian palynomorphs from cross section E of Bad Schönau (HM—1, 2, WS—8, WS—9) may be correlated with palynomorphs of the Harmónia group; i. e. the original Silurian-Devonian sediments may be correlated to phyllites of the Harmónia group.

The question remains open for further lithological, petrographical and palynological investigations.

Fig. 5: Geological profile of Bernstein East (after Pahr, 1983).



Biostratigraphical study of sediments in these areas may result in new data on age and enlighten the relationship between the Alpine and Carpathian systems. At the present state of our knowledge it would be better to correlate the Harmónia group with the Gemeric Paleozoic (perhaps the Gelnica group).

### Paleoecological evaluation

With respect to paleoecology we take into concideration the depositional environment, i. e. a) the water environment, and b) the terrestrial environment with plants producing pollen and spores transported to the places of sedimentation by wind and water. Significant are the distance of the respective localities from dry land and climate (temperature, humidity).

### Palynological research of metasediments also revealed paleoecological conditions

a) Silurian — Lower Devonian period in Malé Karpaty Mts. There was a marine depositional environment with dominant marine plankton of Dinoflagellata and Acritarcha, and less terrestrial plants. The deposition proceeded further from dry land. Destruction of spore exines and of Acritarcha shows that the degree of metamorphosis must have been higher in the Malé Karpaty Mts. than in the Graz Paleozoic.

b) Upper Carboniferous Stephanian C to lowest Permian. Cross section of the Wechsel series contained palynomorph assemblages with dominant spores and pollen of terrestrial plants, mostly Pteridophyta growing on humid swampy substrata in favourable climatic conditions. It is likely, that the localities of the Wechsel series — although deposited in a marine environment — were not far from dry land with plentiful Pteridophyta and Arthrophyta. The lack of coniferous saccate pollen indicates flat dry land relief.

Redeposition of Early Paleozoic palynomorphs into sediments of the Wechsel series may indicate restless depositional environment.

### Palynological conclusions

Palynological research of lithologically similar, epizonally metamorphosed sediments results in the following conclusions:

a) The Late Paleozoic (Stephanian C — the lowest Permian) age of sericitic, chloritic and graphitic schists of the Wechsel series was determined reliably for the first time.

b) The age of the Harmónia group is Lower Devonian.

c) It is not yet possible to correlate metasediments of the Wechsel series with the Harmónia group.

Biostratigraphical research of weakly metamorphosed sediments by palynological methods may result in reliable information on the age of sediments so far referred to as fossilless. The study is enabled by exine resistance to all kinds of metamorphosis except that of high degree. This is proved by our results, and by data collected in the Carpathians in the past decade. The relation of metamorphism to preservation of fossil organisms in sediments is now studied all over the world with respect to chemical structure of sporopollenine and to biostratigraphical and geological facts.

The submitted results are the first and will be further complemented and precised by detail palynological research of a complete cross section in the Malé Karpaty Mts. and of some units of the Alpine system.

## Geological conclusions (A. Pahr)

A geological evaluation of the palynological results shows that we have Late Carboniferous — Lower Permian schists in the topmost branch of the Wechsel schists in the "traditional" Wechsel mountain group (Nr. 3, Weinweg), and we also have palynomorphs of the same age outside of it (Nr. 5 east of Bernstein).

The occurrence of early and late Paleozoic in this profile can be explained in two ways:

1) There are schists of early Paleozoic age in (deeper) parts of the Wechsel schists and the sequence is tectonically piled up in the profile.

2) We have late Paleozoic (Upper Carboniferous — Lower Permian) age in the whole sequence, with a lot of early Paleozoic palynomorphs resedimented in the younger formation.

Both possibilities may occur in different places. At present no decision in this problem is available, further detailed investigation will have to decide it.

The authors are quite aware that all the work done by them up to now, is just a first step in the research of a region, which was, for the most part, devoid of fossils, but nevertheless seems important for structural problems in this part of the Eastern Alps and Little Carpathians.

As to the correlation of the Wechsel group with the Harmónia group in the Little Carpathians detailed geological and petrological correlation is necessary and is being planned.

In this respect it should be mentioned that recently the Borinka limestones and Marianka schists are thought to represent the Penninic zone of the Eastern Alps (without ophiolites) and that they are overthrust by the rocks of the Pezinok — Pernek unit or by the Bratislava granitoids and their cover schist respectively (Pahr 1983). D. Plašienka (1986) gave a refined picture of the Borinka unit: He subdivided it into four lithostratigraphic subunits: Prepadlé — Korenec — Marianka — and Somar formations, all of Jurassic to Lower Cretaceous age. He assumes that the sedimentation of these units occurred in southern marginal zones of the Penninic oceanic trough. In this publication the granitoids of Bratislava are shown in overthrusting position in profiles and maps.

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**Abstrakt**

V práci sa jedná o palynologickom výskume slabometamorfovaných sedimentov wechselskej série v Rakúsku a sedimentov harmónskej skupiny v Malých Karpatoch. Litologicky majú obe série veľa spoločných znakov. Palynologickým výskumom sa mala potvrdiť aj ich veková identita. Zistili sme, že metasedimenty wechselskej série obsahujú sporomorfy mladopaleozoického veku stefan C — spodný perm (Torispora securis Alp., Colluminisporites ovalis Pepp., Cordaitina div. sp. a iné). Palynomorfy z harmónskej skupiny Malých Karpát obsahovali rody a druhy hlavne zo skupiny Acritarcha veku vrchný silúr — spodný devón (Emphanisporites minutus Allen, Cymatiosphaera nebulosa Down., Duvernaysphaera tenuicingulata Stapl. a iné). Tým sa preukázalo, že vek metasedimentov wechselskej série neodpovedá veku metasedimentov z harmónskej skupiny Malých Karpát.

**Zusammenfassung**

Die vorliegende Arbeit behandelt die palynologische Untersuchung von gering metamorphen Ablagerungen der Wechsel-Serie in Österreich und der Ablagerungen der Harmónia-Serie in den Kleinen Karpaten. Lithologisch betrachtet gibt es viele Ähnlichkeiten in den beiden Serien. Durch palynologische Untersuchung sollte man auch deren Altersidentität bestätigen. Wir haben festgestellt, daß die Metaablagerungen der Wechsel-Serie die Sporomorphen des jungpaläozoischen Alters Stefan C — Unterperm (*Torispora securis* Alp., *Colluminisporites ovalis* Pepp., *Cordaitina* div. sp. und andere) beinhalten. Die Palynomorphen der Harmónia-Serie der Kleinen Karpaten enthielten Familien und Arten vor allem aus der Gruppe Acritarcha des Alters Obersilur — Unterdevon (*Emphanisporites minutus* Allen, *Cymatiosphaera nebulosa* Down., *Duvernaysphaera tenuicingulata* Stapl. und andere). Dadurch wurde festgestellt, daß es nach derzeitiger Kenntnis keine Altersübereinstimmung zwischen den Metasedimenten der Wechsel-Serie und denen aus den Kleinen Karpaten gibt.

## BIOSTRATIGRAPHY OF THE VLÁRA DEVELOPMENT OF THE BÍLÉ KARPATY UNIT ON THE BASIS OF CALCAREOUS NANNOFOSSILS

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The Bílé Karpaty Unit is situated in the area of the Bílé Karpaty Mts., on the boundary between Moravia and Slovakia. The sediments are characteristic by conspicuous facial changes both in the transverse and longitudinal direction. On the basis of these changes Matějka and Roth (1956) defined two lithostratigraphic units from the bottom to the top: 1. the lower part of the Paleogene represented namely by variegated beds; 2. the upper part of the Paleogene represented by flysch beds with noncalcareous claystones and flysch beds with calcareous claystones. In the upper part of the Paleogene they delimited three developments: the Vlára, the transitional and Hluk developments. Micropaleontologic part in the work of Matějka and Roth was written by E. Hanzlíková.

The concept of the Bílé Karpaty Unit structure of Stráník, Krejčí and Menčík (1988) is based on the classical division of Matějka and Roth. They proposed some changes in the upper part of the Paleogene and gave up the theory of an independent status of the transitional development. They delimited a new lithofacial member — the Kopanice development — along the Klippen Belt (Fig. 1).

This contribution deals with the biostratigraphy according to the calcareous nannofossils in the Vlára development of the Bílé Karpaty Unit.

Matějka and Roth (1956) defined the Vlára development as the beds of the upper part of the Paleogene with finely to medium rhythmic flysch with prevalence of sandstones. Stráník, Krejčí and Menčík (1988) include into the Vlára development the Gbely variegated beds as the oldest component, which according to Hanzlíková (1984) and Švábenická (1986) belong to the Cenomanian till lower Paleocene. Above them lie finely to medium rhythmic flysch beds which were established as a new stratigraphic member — the Javorina Formation — by Stráník, Krejčí and Menčík (1988). The flysch beds with calcareous claystones — the Svodnice Formation — are the youngest component (Pesl 1968).

Calcareous nannofossils were determined in all calcareous sediments of the Vlára development of the Bílé Karpaty Unit. Taphocenoses usually showed a greater species diversity and contained forms which permitted to asses the relative age within stages to zones precision (see Fig. 2). Only on the basis of nannofossils it was possible to distinguish which sediments were of Cretaceous and which of Paleogene age. Parallelly studied microfauna contained agglutinated foraminifers and very rarely minute plankton. Their species composition usually indicated a wider stratigraphic range from the upper Senonian to the Paleogene.

The Gbely Member is marked by a dominant development of red-brown noncalcareous claystones. The red and greenish calcareous claystones and marlites of the Santonian and the Campanian to Maastrichtian which form thin layers and intercalations, testify of fading of the variegated calcareous sedimentation of the Gbeľany Member towards NW, with the growing distance from the Klippen Belt. The age of the Gbely Member was determined on the basis of agglutinated foraminifers as the Cenomanian to upper Senonian with a possible overlap to the lower Paleocene (Stráník, Krejčí and Menčík 1988).

In the variegated calcareous claystones of the Gbely Member (Vlára development of the Bílé Karpaty Unit) there were determined nannofossil taphocenoses of Santonian — Campanian — Maastrichtian age without Paleogene indications. The oldest nannoplankton assemblage with Reinhardtites anthophorus, Lithastrinus grillii, Micula decussata, Marthasterites furcatus and Einffellithus eximius corresponds to the lower Santonian CC15 Zone (sensu Sissingh 1977). In the Campanian and Maastrichtian a gradual appearance of the following stratigraphically important species can be observed: Aspidolithus parcus parcus, A. parcus constrictus, Arkhangelskiella specillata, Ceratolithoides aculeus, Quadrum sissinghii, Q. trifidum, Arkhangelskiella cymbiformis, Prediscosphaera grandis, Lithraphidites quadratus, Micula murus, Nephrolithus frequens and very rarely Micula prinsii. The youngest established sediments of the Gbely Member belong to the CC26 Zone (the highest part of the Maastrichtian).

The Javorina Formation is a complex of finely to medium rhythmic flysch sediments characterized by blue-grey, fine- to coarse-grained calcareous greywacke sandstones and green-grey to grey, usually noncalcareous and variably sandy claystones. This formation exhibited nannoplankton ta-