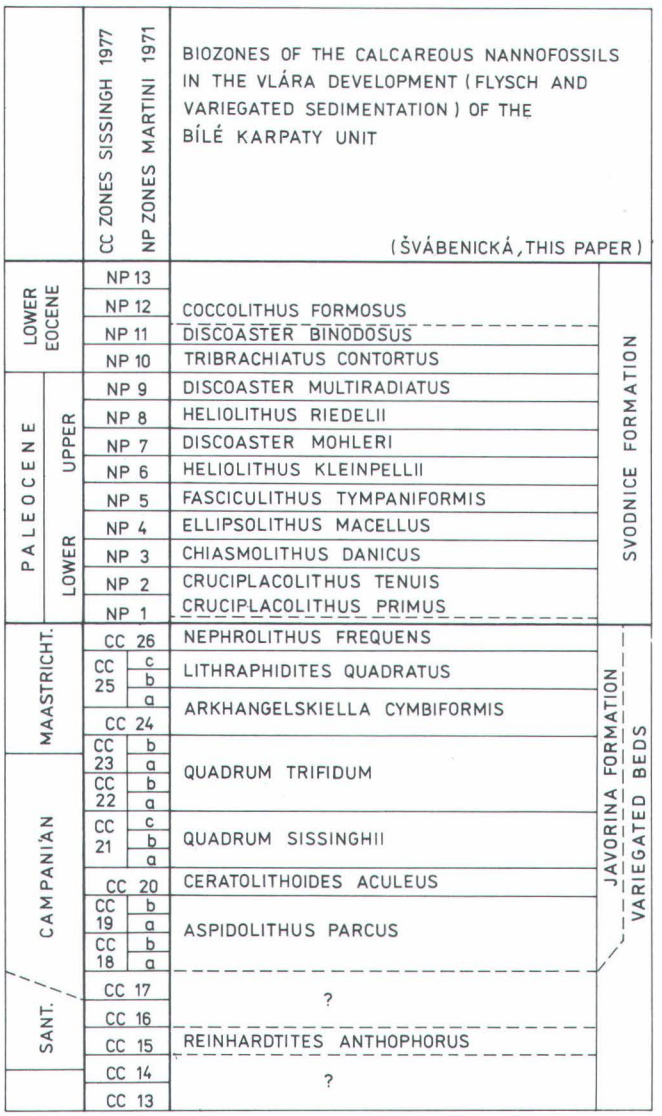

Fig. 2: Biozones of the calcareous nannofossils in the Bílé Karpaty Unit.

Abstrakt

V sedimentech vlárského vývoje bělokarpatské jednotky (flyšové sedimenty a pestré vápnité jílovce) byla zjištěna relativně dobře zachovaná společenstva vápnitého nanoplanktonu s vyšší druhovou diverzitou. Tafocenózy nanofosilií obsahují stratigraficky důležité druhy, pomocí kterých můžeme stanovit relativní stáří s přesností na stupně až zóny v rozmezí santon—spodní eocén. Na hranici křída/terciér předpokládáme sedimentaci bez velkého přerušení.

Zusammenfassung

In Sedimentgesteinen der Vlára-Entwicklung der Bílé Karpaty- (Weißkarpaten-) Einheit (Flyschablagerungen und bunte Kalktonsteine) wurden verhältnismäßig gut erhaltene Vergesellschaftungen des kalkigen Nannoplanktons von einem größeren Artenreichtum ermittelt. Die Taphozönosen der Nannofossilien enthalten stratigraphisch wichtige Arten, aufgrund deren das relative Alter mit einer Genauigkeit auf Stufen bis Zonen in der Zeitspanne von Santon bis zum Untereozän bestimmt werden kann. An der Kreide/Tertiär-Grenze nehmen wir die Sedimentation ohne eine größere Unterbrechung an.

GRANITOID CLASTICS ON THE SE MARGIN OF THE VIENNA BASIN AND BASIN GENESIS

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Breccias and conglomerates on the southeastern margin of the Vienna Basin — on the foothill of the Malé Karpaty Mts. — mostly consist of granitoid material. They crop out at the village Borinka and between the villages Stupava and Lozorno. They were revealed in a surprising thickness by the borehole DNV—1 near Devínska Nová Ves (Vaškovský et al. 1988). Other boreholes show their wedging-out over a shorter distance towards the inside of the Vienna Basin i. e. southwestwards of their outcrops.

The borehole DNV—1 near the brick-kiln of the village Devínska Nová Ves (Fig. 1) drilled the granitoid conglomerates and breccias in total thickness of about 330 m and offered thus biostratigraphical scissors for the determination of age of the clastics studied (Fig. 2). Granitoid clastics are overlain by calcareous friable siltstones and claystones including sandstone layers. The sediments are equivalent to the Studienka Formation of the Vienna Basin and contain Upper Badenian (Kosovian) foraminifers of the Bulimina — Bolivina and Rotalia zone, including the species Bulimina elongata, Bolivina dilatata, Uvigerina venusta liesegensis (Kyjovská — Kučerová 1986). The calcareous nannofloral assemblage comprises species most frequent in Upper Badenian: Cyclococcolithus macintyrei, Cycloperfolithus carlae, Helicosphaera wallichi, H. walsberdorfensis, H. selli, H. obliqua, Sphenolithus abies. The index species of the zone NN 6 — Discoaster exilis is scarce as well as the index species of the zone NN 7 denoted as Discoaster cf. kugleri (Lehotayová 1986) in the upper part of the formation.

The granitoid clastics are underlain by conglomerates with plentiful pebbles of Mesozoic carbonates with pelite layers containing calcareous nannoflora including the index form of the zone NN 5: Sphenolithus heteromorphus, and Discoaster variabilis and Coronosphaera sp. (Lehotayová l. c.). So the age of the granitoid clastics may be Middle Badenian.

Detailed lithological and sedimentological study of the clastics was performed on two natural exposures near Borinka and Lozorno, and in the borehole DNV—1 near Devínska Nová Ves.

On the northern periphery of the village Borinka — in a gorge — with a forest path and a tourist route to the

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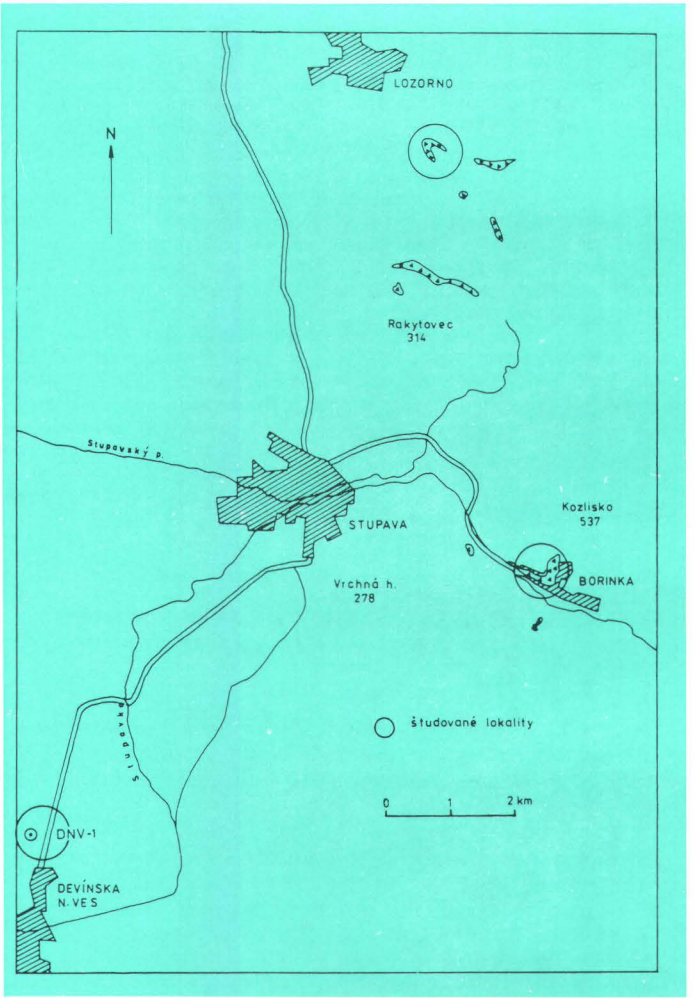


Fig. 1: Sketch of localities of Devínska Nová Ves Formation. Localities studied are in circles.

Pajštún castle ruins, and in gorges cutting the piedmont terrace NE of Stupava there are monomict granite breccias consisting of chaotical angular granitoid blocks.

In the mentioned forest road cut on the northern periphery of the village Borinka the breccias consisting (in about 95 %) of granitoid material are exposed. The diameter of largest blocks ranges to 1.5 m. The granitoid blocks are angular and their distribution is chaotic (Fig. 3). Usually the blocks are unsupported and matrix represents the supporting structure. Blocks of muscovite-biotite- and of two-mica granodiorites are dominant. Frequent are blocks of muscovite-biotite granites whereas blocks of biotite granites and fragments of aplite muscovite granites are infrequent. Vein varieties like muscovite aplites and pegmatites occur sporadically. Granitoid blocks and fragments underwent medium- to intrusive cataclastic metamorphosis. They are intensely weathered. Feldspars are intensely sericitized, kaolinized; epidotization was less intensive.

Metamorphites are represented by sporadical metapelites and metapsammites, biotite mica-schist gneisses and paragneisses. Clasts of these rocks are intensely weathered.

Matrix is silty-sandy, with a high muscovite content, noncarbonatic or partly carbonatic, unsorted, visually resemblant to granite material. It represents the washed material of fossil weathering crust on crystalline, mostly granitoid rocks.

In the entire profile studied near Borinka the granitoid blocks and pebbles are intensely weathered. The strength of considerably friable matrix and of the most part of weathered granite blocks and of crystalline schists is practically equal.

The exposure near the village Lozorno is now inundated with water of an artificial water reservoir. There are two layers of coarse clastics separated by a coarse-sandy layer containing well-rounded granitoid pebbles up to 2 cm in size (Fig. 4). The coarse clastics resemble the granitoid clastics from Borinka. Blocks range up to 80 cm in diameter. They are angular or poorly rounded. The composition of clasts is somewhat more variable than in Borinka. Besides dominant granitoids there are also metamorphic rocks (10 %), Lower-Triassic quartzites clasts (5 %). Among granitoids most frequent are medium- to coarse-grained muscovite-biotite- and biotite granodiorites. Medium-grained, two-mica and aplitoid muscovite granites are also frequent. Metamorphic rocks are mostly represented by clasts of metapelites-phyllites, sandy metawackes and mica-schist gneisses with indications of periplutonic metamorphism.

Lower Triassic quartzite fragments are epimetamorphosed. There is a unique occurrence of most likely Neogene fine-sandy siltstone with clastic mica. The siltstone clast is an evidence of intraformational cannibalism — common in rocks of the analogous type. The grain-supporting matrix surrounding the blocks, is gravelly-sandy, nonsorted, composed of granitoid material with infiltrations of Fe-oxides.

Clastic material is distributed chaotically, without indications of imbrications or arrangement of blocks. Blocks are smaller there than at the locality Borinka. The material is less weathered in lower parts of the exposure, in upper parts the extent of weathering is similar to that at Borinka.

Weathering of blocks and pebbles of granitoids and crystalline rocks is typical of both localities described.

Intensely weathered angular granitoid blocks must inevitably disintegrate to sand and fine debris when falling down the rock cliffs during their transport of any kind. The weathering process must have followed the deposition of breccias. It is also proved by the results of a comparison of mineral composition of the clay fraction of weathered granitoid blocks and of matrix from both localities studied.

Clay minerals of grain-size fraction < 0.002 mm from weathered granitoid blocks at Borinka are represented by kaolinite and illite. In some samples kaolinite evidently dominates over illite. Kaolinite has also been found in the clay fraction from granitoid blocks from the locality Lozorno with dominant illite. It is absent at both localities or montmorillonite is present there in a small amount.

Mineral composition of the clay fraction of matrix from both localities is different from the composition of clay minerals from weathered granitoid blocks. Montmorillonite and illite predominate at the locality Borinka. Kaolinite with partly ordered structure is actually an admixture. Mineral composition of clay fraction of matrix from Lozorno is analogous. Minerals from weathering crusts preserved on granitoids and crystalline schists of the Malé Karpaty Mts. (Kraus 1986, Kraus in Vass et al. 1988) have a similar composition.

So the weathering crusts preserved on crystalline complexes of the Malé Karpaty Mts. are fossil. They most likely formed before the Middle Badenian time. Clay minerals of weathering crusts and of matrix of Badenian clastics have a similar composition, mostly containing montmorillonite. Redeposition of granitoid blocks of Badenian clastics was followed by exposure and weathering resulting in preferred formation of kaolinite. Granitoid clastics buried, for example, in borehole DNV—1 protected with a 100 m thick layer of mostly impermeable sediments, were not affected by weathering processes.

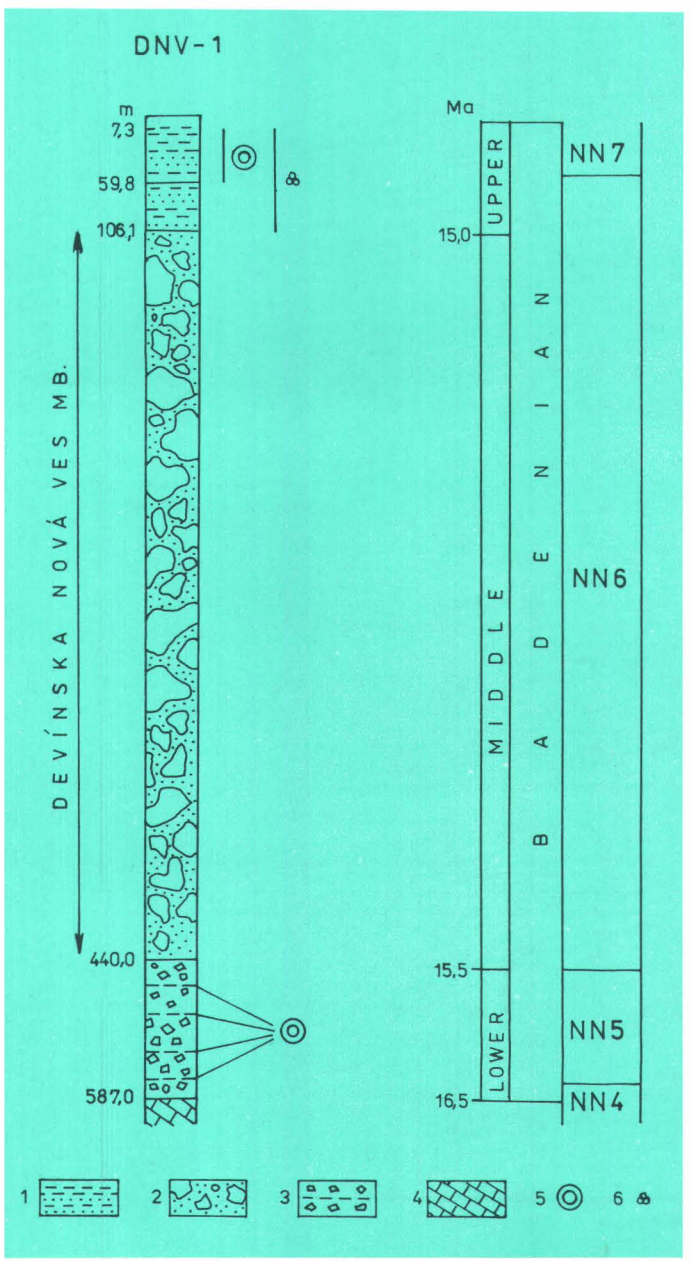
About 330 m thick granitoid clastics were drilled by borehole DNV—1 near Devínska Nová Ves. Blocks and pebbles of Malé Karpaty Mts. granitoids, and of analogous types like in Borinka and Lozorno are dominant (85—90 %). Pegmatite fragments are interestingly variable. The clastic ma-

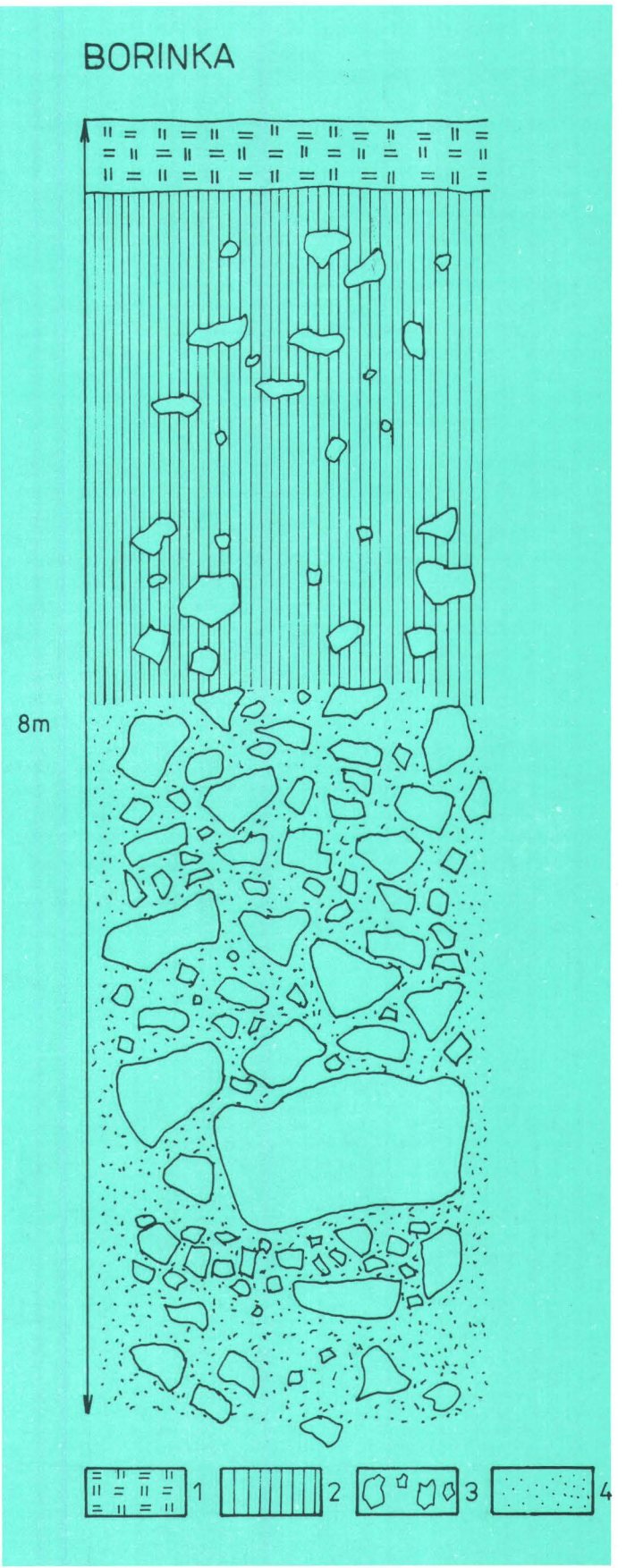
terial contains almost all types of pegmatites known from the Malé Karpaty Mts.

Among metamorphites are common metapelites and metapsammites, frequently affected by metamorphism — biotite mica-schist gneisses to paragneisses, phyllites, metamorphosed wackes and metabasites, metatuffs — mainly various types of amphibolites and actinolite phyllites. Less frequent are clasts of contact-metamorphosed rocks of the Harmónia Group and sporadical graphite metaquartzites. At present similar rocks only occur on the north around Kuchyňa (Putiš 1987) in the Bratislava Massif.

An approximately 200 m thick upper part of the Devínska Nová Ves member consists excludingly of crystalline rock clasts. Fragment of Lower Triassic quartzites appear in the borehole at the depth of about 300 m and their amount in-

Fig. 2: Schematical section of Devínska Nová Ves member in borehole DNV—1, and position of biostratigraphically dated layers in their overlier and underlier. 1 — calcareous clays and sands, 2 — granitoid clastics, 3 — polymict clastics, 4 — underlying Mesozoic sediments, 5 — calcareous nannoflora, 6 — foraminifers. ▼





▲ Fig. 3: Profile of Devínska Nová Ves member at locality Borinka. 1 — soil, 2 — loam, 3 — boulders and granitoid clasts, 4 — matrix.

creases with the depth. They are partly recrystallized like quartzite clasts from Lozorno. At the depth of 365 m carbonate clasts appear in the borehole and the lower part of the Devínska Nová Ves Formation shows a polymict character.

The composition of clastics changed markedly at the depth of about 440 m. Mesozoic rock clasts dominate over granitoids fading out completely at the depth of about 490 m. At the level of 505—515 m the Lower Triassic quartzites fade out and the interval down to 575 m consists of conglomerates from Mesozoic carbonates. The interval 575—595 m consists of "tectonic breccia" from underlying, probably Jurassic limestones and the final interval 595—618 m consists of Jurassic limestones.

The Devínska Nová Ves Member has the siltstone-sandstone matrix in the borehole DNV—1. Blocks and fragments in the upper part are unrounded or poorly rounded (breccia). In the lower part the clastic material is medium-rounded (transition to conglomerates). Clastic material beneath the Devínska Nová Ves Member is medium to well rounded.

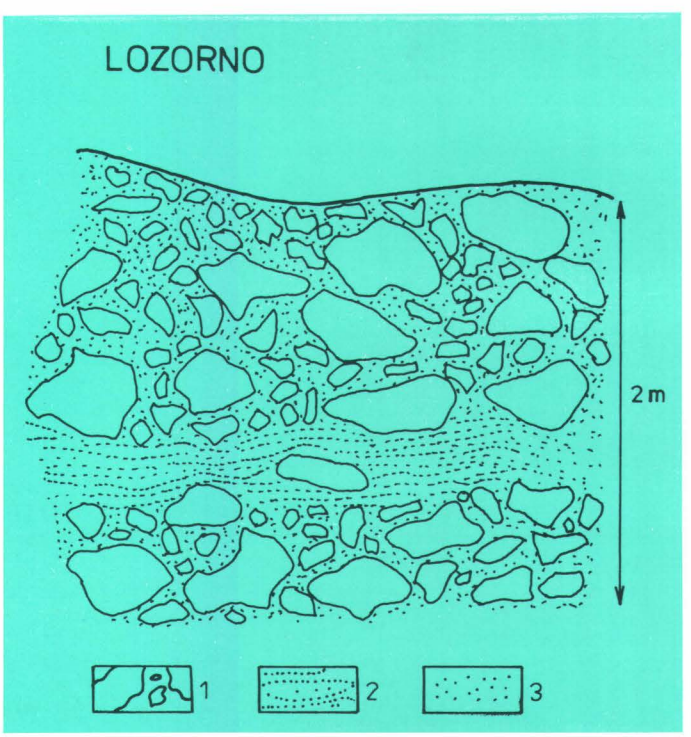
There are differences in the composition of clasts — upper part: 90 % granitoids, 10 % metamorphites, lower part: 75 %—80 % granitoids, 10 %—15 % metamorphites and 5 %—10 % Mesozoic rocks.

A detailed analysis of clastics in the borehole DNV—1 shows that their lower part is polymict, although granitoid material is dominant. This may be explained in two ways:

1. At the beginning of the Middle Badenian the uplift of the Malé Karpaty Mts. was slow. Transport to the basin was more extensive, the clastics have polymict character. Gradually, after the removal of the Mesozoic envelope (partial unloading) the uplift rate increased and only crystalline rock clasts, mainly granitoids got into the basin.
2. The primary source area with dominant Mesozoic material got to a greater distance from the accumulation of the Devínska Nová Ves member — owing to the sinistral strikeslip fault of the Malé Karpaty block (Fig. 5). In the new source area the crystalline rocks, mainly granitoids, dominated.

The material of conglomerates and breccias is not weathered. This is a striking difference from granitoid clastics at Borinka and Lozorno.

Fig. 4: Profile of Devínska Nová Ves member at locality Lozorno. 1 — boulders, fragments and granitoid pebbles, 2 — sandy layer, 3 — matrix.



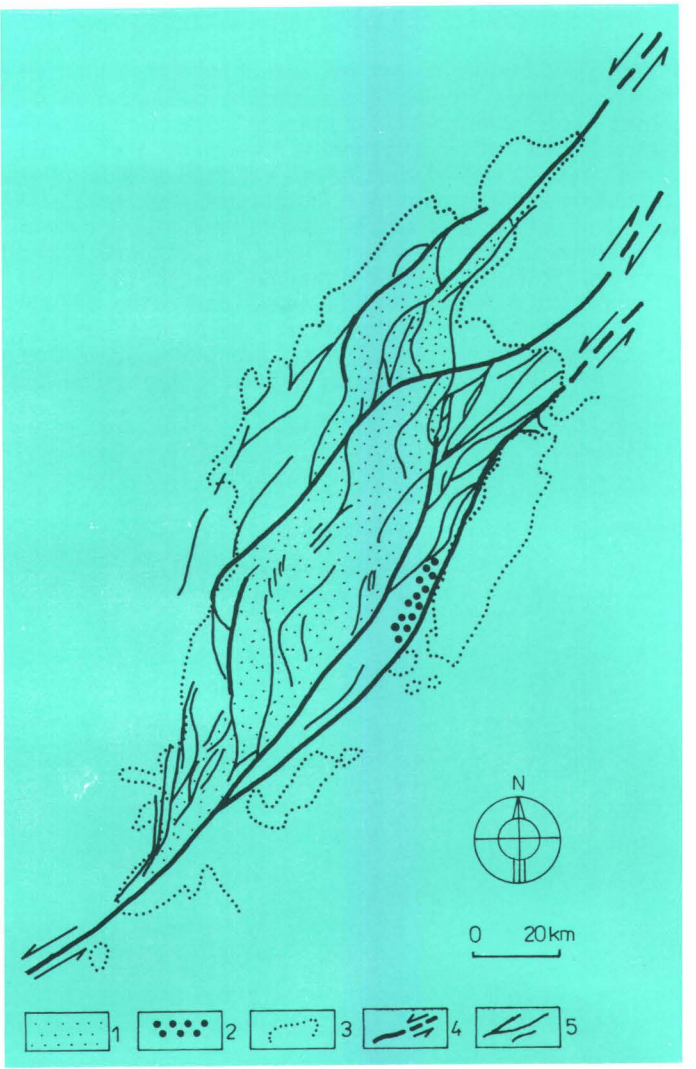


Fig. 5: Position of Devínska Nová Ves member on SE periphery of Vienna Basin and course of main faults with significant lateral movement. 1 — area of rapid Badenian sedimentation, 2 — olistostromes and piedmont clastic cones (Devínska Nová Ves member), 3 — present basin contours, 4 — main faults and presumable movement direction, 5 — other faults.

The granitoid clastics resemble olistostromes. According to Raymond (1978) the term olistostrome generally denotes clastic beds or formations, or mélange of sedimentary origin. Middle Badenian granitoid clastics on the SE periphery of the Vienna Basin show the following characters identical with typical features of olistostromes:

— chaotic ordering
— lens shape (clastic bodies rapidly wedge-out into the basin)
— lack of true bedding
— position among marine bedded sequences (proved by DNV—1 well log).

The granitoid clastics have not a heterogeneous composition and this perhaps is not the general feature of olistostromes. For example, olistostromes with huge olistoliths in the contact zone between Tjan-Shan and Pamir (Pridarvazie) have a monomict composition (Shcherba 1975).

Piedmont clastic cones, talus cones, mure cones (Borinka) and alluvial cones with material partially rounded during a short transport in aqueous environment (Lozorno) represent another genetic type of sediments ot he Devínska Nová Ves Member.

This member has been formed of debris, mostly granitoid material, either accumulated on the margin of the Vienna Basin, or slumped down as chaotic mass — a mixture of rigid rock blocks and mud in the form of submarine gravita-

tional slides over a certain distance into the opening Vienna Basin inundated with the sea (Fig. 5).

The Devínska Nová Ves Member represents one of the largest known coarse-clastic accumulations in the West Carpathians (e. g. maximum thickness of Badenian detritus from Foredeep near Ostrava is about 300 m). Perhaps only clastics of the alluvial fan from the Spišsko-gemerské rudohorie Mts. sedimented in the Košická kotlina basin (Košice gravel formation) may be thicker than the Devínska Nová Ves Member. The genesis of the clastic formation from the Spišsko-gemerské rudohorie Mts. lasted long: it commenced in the Badenian and continued during the entire Sarmatian time, i. e. about 4 m. y. The genesis of the Devínska Nová Ves Member had a shorter duration: Middle Badenian period lasted for only about 0.5 m. y. (Fig. 6). No wonder that the clastics show the features of olistostromes. The formation of olistostromes in the zone of contrast vertical movements may easily be explained:

— The steep relief on the margin of the Vienna Basin tended to rockfall and to gravitational sliding into the subsiding basin inundated with the sea.

— Seismic shocks cannot be excluded (a geophysically indicated segment of the Záhorie—Humenné seismoactive fault is running along the western margin of the Malé Karpaty Mts.).

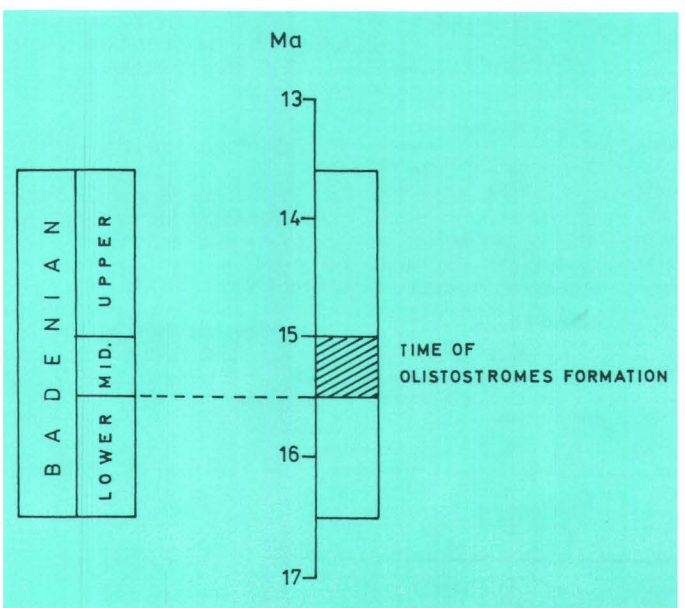
The seismic shocks might have triggered disintegration of rock massifs and activation of debris masses to submarine gravitational slides.

The origin of the beds decribed was associated with differentiated movements on the margin of the opening Vienna Basin in the Middle Badenian time. According to the recent opinions, the basin was opening as a "pull-apart" basin. But in respect of new facts about its structure a particular model has been suggested for the basin: faults, along which the horizontal block movements proceeded controlling the basin opening, were rather shallow (thin-skinned pull-apart, Royden 1985). The Vienna Basin shows some features typical of pull-apart basins (rapid episodical subsidence, quick basin deepening, a. o.) although some of them do not characterize excludingly this basin type.

1. The formation of a steep topographic relief on margins of such basins resulted (Reading in Ballance — Reading 1980, p. 13, 14; Christie — Blick — Biddle 1985, p. 22, 25; Mitchell — Reading in Reading 1978, p. 512) in:

— coarse-detrital facies along the basin margin and sudden lateral facies change towards the basin centre

Fig. 6: Time of origin of Devínska Nová Ves member.



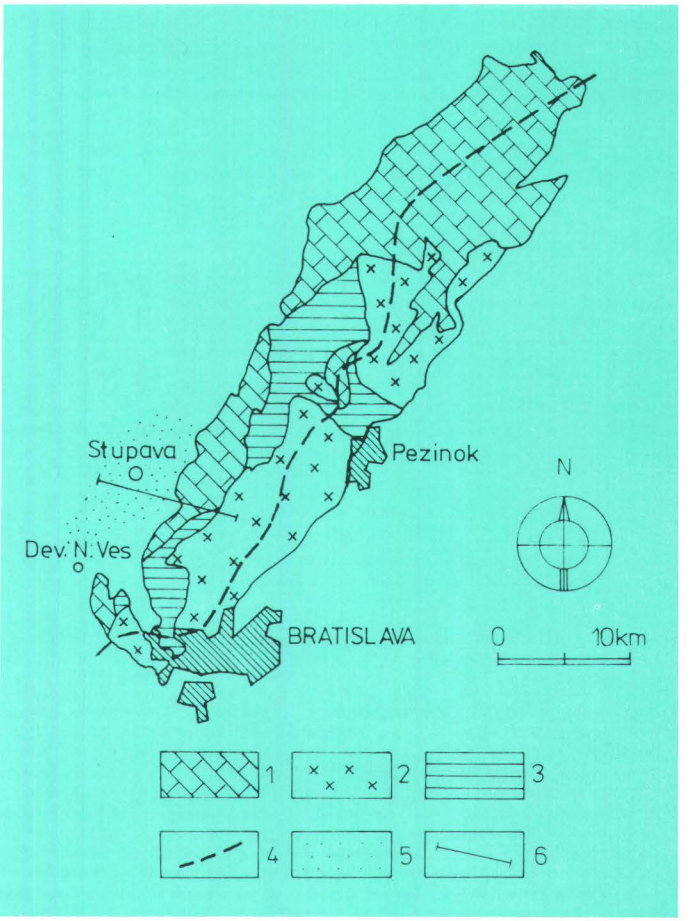


Fig. 7: Scheme of distribution of rocks forming Malé Karpaty Mts. (present situation). The figure shows that the NW slopes of the Malé Karpaty Mts. consist mostly of Mesozoic, less of Paleogene rocks and of pre-Mesozoic metamorphites. The present mountain range and its SE slopes consist of granitoids. 1 — Mesozoic, partly Paleogene sediments, 2 — granitoids, 3 — pre-Mesozoic metamorphites, 4 — axis of highest peaks of Malé Karpaty Mts., 5 — presumable extent of Devínska Nová Ves member, 6 — schematic section line with Middle Badenian reconstruction of NW slope of Malé Karpaty Mts.

— coarse-detrital sediments: conglomerates and breccias form piedmont clastic cones including slumped blocks (olistoliths) and debris flow

— coarse-grained detrital sediments show the features of a very proximal source (poor roundness, monomict petrographic composition).

The Devínska Nová Ves Member proves the existence of a steep relief on the basin margin in the Middle Badenian time and corresponds to the criteria applied on coarse-grained clastics usually accumulating on the periphery of an opening basin of the pull-apart type.

To complete the tectonic background of the Middle Badenian opening of the Vienna Basin it should be mentioned that in this period the megaanticlinoria or horst megaanticlinoria of the present core mountain ranges formed in the West Carpathians. The beginning of the Badenian uplift is dated by fission tracks of apatites from crystalline cores of the core mountain ranges (Kráľ 1977). The Middle Badenian uplift of the Carpathian Arch caused a crisis of salinity in the Carpathian Foredeep (Wieliczka) and in intramontane basins in the Transcarpathian b. (evaporites of the Zbudza Formation in East Slovakia) and in the Transylvanian b. (salt diapirs).

The analysis of the Devínska Nová Ves Member and particularly the evidence of its almost monomict composition with absolutely dominant clastic material of the Malé Karpaty granitoids contribute to the explanation of dynamics of the origin and evolution of the Vienna Basin and to the elucidation of ancient structure of the Malé Karpaty Mts.

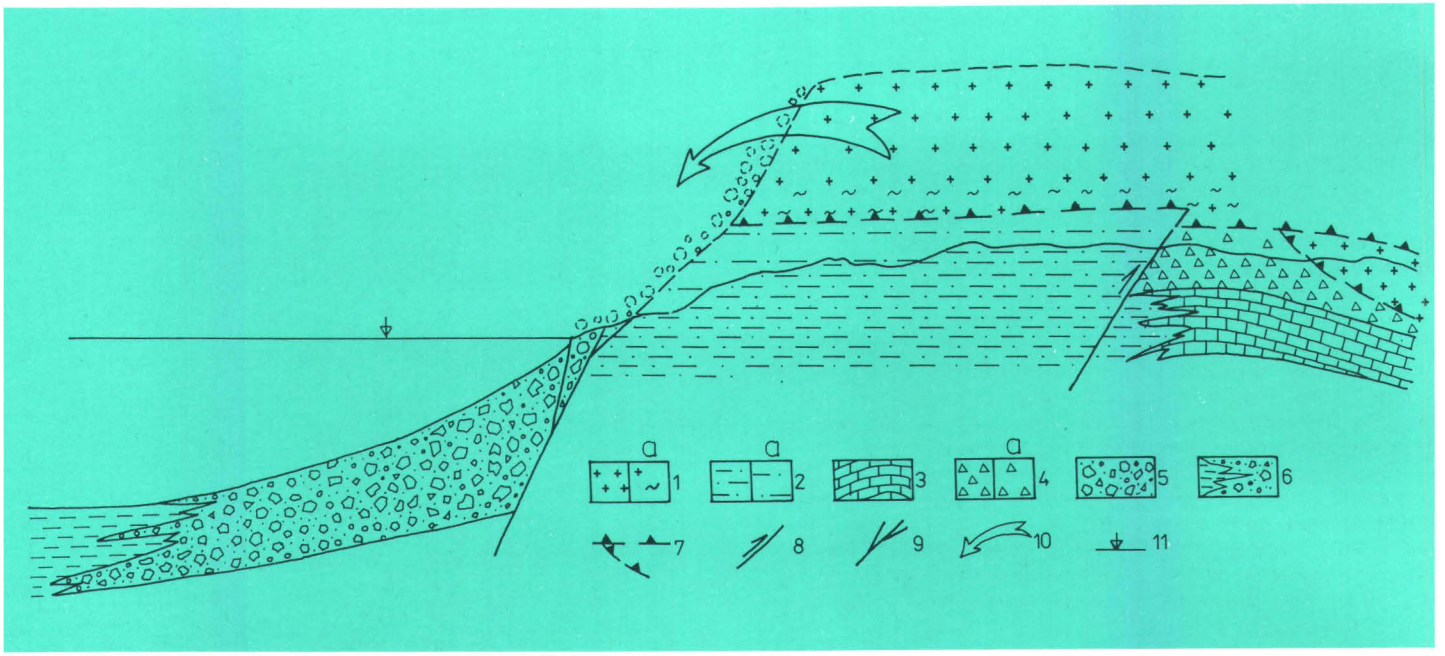


Fig. 8: Reconstruction of Middle Badenian NW slope of Malé Karpaty Mts. in area of Prepadlé—Kozlisko — no scale. For situation of section see Fig. 7 (modified after Plašienka). 1 — Malé Karpaty crystalline complexes, mostly granitoids — Bratislava nappe, a) denuded, 2 — Borinka sequence (mostly in flyschoid facies), a) denuded, 3 — Borinka limestones, 4 — Somár breccia, a) denuded, 2—4 Borinka sequence (Jurassic), 5 — Devínska Nová Ves member, 6 — transition of Devínska Nová Ves member to basinal facies, 5—6 Middle Badenian, 7 — overthrust planes of Bratislava nappe, 8 — reverse fault, 9 — significant strike-slip fault in Badenian, 10 — rockfall from steep paleorelief, 11 — Badenian sea level in Vienna Basin

Direct evidence of allochthoneity of the Malé Karpaty granitoids was presented by Kullman (1957), new data are postulated by Plašienka and Putiš (1987), a. o. Thick coarse granitoid clastics on the northwestern foothill of the Malé Karpaty Mts. represent indirect evidence of their allochthoneity: almost monomict composition of the Devínska Nová Ves Member indicates that their source area — NW slopes of the Malé Karpaty Mts. uplifting in the Middle Badenian — must have consisted of the Malé Karpaty granitoids in the tectonic overlier of Mesozoic series forming the present NW slopes of the Malé Karpaty Mts. (Fig. 7).

In respect of presumable sinistral strike-slip fault of the Malé Karpaty block during the opening of the Vienna Basin, the material of the lower part of the Devínska Nová Ves Member originated from the Malé Karpaty range which is now distant on NE from the granitoid clastics occurrence (Fig. 5).

If we presume that the strike-slip fault of the Malé Karpaty blocks terminated in the Middle Badenian, then the material of the upper part of the Devínska Nová Ves Member (composed excludingly of crystalline material in the borehole DNV—1) originates from a crystalline nappe whose deeper part is exposed in the Prepadlé valley W of Stupava (Fig. 8.)

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Abstrakt

Svedkami dynamického procesu otvárania viedenskej panvy sú úpätné kužele, suťové kužele a olistostromy. Hruboklastické sedimenty sú zložené prevažne z malokarpatských granitoidov a tvoria akumulácie na jv. okraji viedenskej panve.

Zusammenfassung

Den dynamischen Ablagerungsprozeß des Wiener Bekkens bezeugen Schuttkegel an Hangfüßen und Olisthostrome. Grobklastische Sedimente sind vorwiegend aus Granitoiden der Kleinkarpaten zusammengesetzt und bilden Anhäufungen am SO-Rand des Wiener Beckens.