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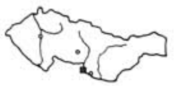
PETROGRAPHIC-MICROFACIAL ANALYSIS OF PEBBLES AND INTERPRETATION OF SOURCES AREAS OF THE JABLONICA CONGLOMERATES (LOWER MIOCENE OF THE NW MARGIN OF THE MALÉ KARPATY MTS.)

(Fig. 1, Pls. I — XII, Tab. 1)



A b s t r a c t: The methodic principles of reconstruction of sources areas (deductive and inductive approach) are formulated. Analyses of 7 localities with evaluation of 170 thin sections, 10 extractions of conodonts, 5 extractions of sporomorphs are commented in detail. On the whole were established: the Devonian (?) — metamorphosed limestones of the Harmónia Group with anomalous content of authigenic feldspars; Permian — arkoses, sandstones; Lower Triassic — quartzites; Middle and Upper Triassic, shallow water (dolomites, Gutenstein and Wetterstein limestones), basinal Middle and Upper Triassic (Reifling and grey muddy limestones with Norian conodonts), Rhaetian—Hettangian (oolitic limestones); dynamic - metamorphosed Liassic Borinka limestones of the Tatricum; Liassic—Dogger of the Krížna unit (dark and pink crinoidal limestones with *Involtina liassica* „Fleckenmergel") basinal Dogger—Malm (e. g. with *Saccocoma, Crassicolaria*); Malm of the Vysoká nappe with *Crassicolaria*-crinoidal microfacies: shallow - water Malm with *Conicospirillina basiliensis* and *Clypeina jurassica*, pelagic Lower Cretaceous with tintinnids, Albian sandstones of the Tatricum with authigenic feldspars in cement, Upper Cretaceous freshwater limestones with characeans, marine Senonian with rudists and *Nummofallotia cretacea*, Paleogene—Lower Eocene with *Distichoplax biserialis*, Lutetian with *Nummulites subramondi etc.* Dedolomitization of a part of the dolomite pebbles is interesting. Triassic rocks of higher nappes dominate, showing the material coming mostly from the near environment. A longer transport from SW can be proved (dynamic - metamorphosed limestones, Crassicolaria limestones, garnet - staurolite mica schist etc.) and from NE (shallow - water Malm, freshwater Cretaceous, marine Senonian; redeposition of pebbles of quartz porphyries and probably also of basinal Norian limestones from Cretaceous conglomerates of the Brezová Group and Klippen Belt is evidences).

Р е з ю м е: В статье формулированы методические принципы реконструкции районов происхождения (дедуктивный и индуктивный подходы). Детально обсуждаются анализы из 7 местонахождений с оценкой 170 шлифов, 10 экстракций конодонтов, 5 экстракций спороморфов. В целом были установлены: девон (?) — метаморфические известняки гармонской группы с аномальным содержанием автигенных полевых шпатов, пермь — аркозы, песчаники, нижний триас — кварциты, мелководный средний и верхний триас (доломиты, гутенштайнские и веттерштайнские известняки), бассейновый средний и верхний триас (райфлингские и серые иламовые известняки с норийскими конодонтами), рэт — геттанг (оолитовые известняки), динамометаморфические лейасовые боринские известняки татрикума, лейас — доггер крижнянской единицы (темные и розовые криноидные извест-

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няки с *Involutina liassica*, „Fleckenmergel"), бассейновый доггер — мальм (напр. с *Saccocoma, Crassicolaria)*, мальм высоцкого покрова с калпионелово-криноидной микрофацией, мелководный мальм с *Conicospirillina basiliensis* и *Clypeina jurassica*, пелагический нижний мел с тинтинидами, альбский песчаник татрикума с автигенными полевыми шпатами в цементе, пресноводные верхнемеловые известняки с харацеами, морской сенон с рудистами и *Nummofallotia cretacea*, палеоцен — нижний эоцен с *Distichoplax biserialis*, лютет с *Nummulites subramondi* и т. д. Интересна дедоломитизация части доломитовых галек. Преобладают триасовые породы высших покровов показывающие, что материал происходит большей частью из близкой окрестности. Хорошо можно документировать более долгий транспорт с ЮЗ (динамометаморфические известняки, криноидно-калпионеловые известняки, гранат-ставролитовые слюдяные сланцы и т. д.) и с СВ (мелководный мальм, пресноводный мел, морской сенон; доказано переотложение галек кварцевых порфиров и вероятно также бассейновых норийских известняков из меловых конгломератов брезовской группы и утесового пояса).

Introduction and data from older works

The polymict Jablonica conglomerates (Karpatian) are found in the depression between the Pezinské Karpaty and Brezovské Karpaty Mts.; through this area the connection between the Neogene of the Vienna and Danube basins was situated. So far little attention was devoted to them only.

Březina in Buday (1963, p. 147) mentions the presence of these rocks in prebbles (in parentheses are my remarks): light-coloured Upper Triassic limestones (they are obviously Wetterstein limestones, mainly Middle Triassic), darker limestones, probably Lower Triassic (they should be Middle Triassic Gutenstein limestones), limestones of the Keuper (in the Keuper only fine--grained limestones breccias in intercalations are known), Liassic red limestones, Paleozoic limestones of the Harmónia Group, Triassic dolomites, arcoses and arcose sandstones of the Verrucano and Lower Triassic, similar rocks, perhaps of Early Paleozoic age (Harmónia Group), leucocratic coarse-grained granites and other granitoid rocks, mica schists, mica schist gneisses, quartz porphyry, melaphyres of Lower Triassic age (according to present-day knowledge Permian), conglomerates to greywacke arcose conglomerates (Triassic and Verrucano), quartzites, silicites, brown cherts, Cretaceous sandstones, clayey and sericite sandstones. The author notices enrichment of noncarbonate clasts into finer-grained fractions, which, however, by far is not so high as the mentions (in fraction more than 5—6 cm 95 % carbonate rocks, in fraction 10—2 mm 22 %). He states that rocks of the immediate margin of the basin are perhaps least represented. The material testifies, according to him, to a transport from SE, from places covered with the Neogene of the Danube basin at present. The material represented a gravelous cone, displaced during transgression along the basin margin.

In the work of Brestenská et al. (1961) the locality Naháč — Dvor Prekážka is described and a transport from SE is also supposed. Seneš (1968) describes the locality Rozbehy near Cerovo — Lieskovo; he mentions pebbles of the Triassic, Verrucano, Upper Paleozoic, Liassic, Cretaceous, granitoids, mica schists and epiquartzites.

In orientational analysis of pebbles I expressed the assumption that a part of pebbles is redeposited from Cretaceous—Paleocene conglomerates of the Klippen Belt and Brezová (Gossau) Group. This supposition was confirmed by the diploma work of Illášová (1977), directed by me. Extensive knowledge from pebble analyses obtained in the last years (Marschalko—Mišík—Kamenický, 1976; Mišík—Mock—Sýkora, 1977; Mišík—Sýkora, 1980, 1981; Mišík—Jablonský—Mock—Sýkora, 1981) make possible a relatively exact typification of source areas of the Jablonica conglomerates, what I tried to carry out in the y. 1984—1985 in the frame of a new complex investigation of the Malé Karpaty Mts. Parallely with the petrographic - microfacial analysis of pebbles an extent field investigation was taking place, carried out by RNDr. M. Kováč, CSc. (including the morphometry of pebbles, measuring of their inclination for establishing of transport directions etc.). Regarding to total characterization of the Jablonica conglomerates I refer to this work, published in this number.

Regarding to the material composition, there are considerable differences between individual localities of the Jablonica conglomerates in the ratio of individual component (Tab. 1). This points the existence of several piedmont cones, mutually overlapping, which descended from the raised margins of the Jablonica — Dobrá Voda depression. The presence of the mass of Karpatian conglomerates in this depression proves strong vertical movements along faults of direction transversal to the course of the Malé Karpaty Mts. To the question, wether the Jablonica conglomerates formed at least partly in terrestrial - fluviatile environment or there is only a marine littoral sediment, I refer to the work of Kováč (1985), also to the question of their distinguishing from conglomerates of Eggenburgian age.

For extraction and determination of Triassic conodonts I express thanks to RNDr. T. Puškárová, for extraction and determination of sporomorphs from pebbles of freshwater limestones I thanks RNDr. P. Snopková, CSc., for determination of large foraminifers from Paleogene pebbles RNDr. E. Köhler, CSc.

The method of reconstruction of source areas

In thorough reconstruction of source area of certain basin we are not satisfied only with the sketch of the paleogeographic map of the territory, but in the areas designated as dry land we try to draw the paleogeological map — to situate there complexes, which were just eroded, at the outcrops in that time.

In our case in analysis of the Jablonica conglomerates we try to compile the paleogeological map for the Karpatian in three supposed source sectors: I. Malé Karpaty Mts. (Pezinské Karpaty Mts.), II. adjacent part of the Danube basin (the basement of which was still uncovered in that time), III. Brezovské Karpaty and Čachtické Karpaty Mts. In searching for sources, as comprehensible, we set out from the geologic map of adjacent terrains, in the given case 1 : 200 000 (Mahel' — Boday et al., 1963) and 1 : 50 000 (Mahel', 1972) and from the boreholes into the basement of the Danube basin (Biely, 1978). Before the beginning of field investigation we apply the deductive method, which answere us the question, which type of rocks from which sector we can expect in the given conglomerates (compare the scheme Fig. 1).

The deductive approach includes these operations:

1. *Addition of the column of rocks carried away by erosion.* Setting out from the geologic map, from the present-day level of cut, we must "add" reconstruct eroded column of rocks in these areas, which were rising from the Karpatian. It is necessary to reckon with the presence of higher sequences and contingently of higher tectonic units, which were removed from the given place in the meantime. An important logical rule is that we cannot reckon with uncovering of lower sequences, lower units in places, where they are till now covered by higher units, by pre-Miocene complexes. For example, for the locality Hradište p/V. we cannot consider uncovering of the Krížna nappe, mantle succession or crystalline core during the Karpatian (if such rocks were found, there would certainly be supply from a distant area). This is valid also for terrains covered by younger Neogene sediments. For example, the locality Dubová - 1, where the borehole into the substratum of the Neogene passed through many sequences and units (Biela, 1978), only the sequence found close below the Badenian can be important for our purposes, consequently the Carnian—Norian, because only this was uncovered in the place given in the Karpatian.

The estimation of thickness of the column of rocks removed can be very approximate only. For comparison of some estimations of the velocity of erosion from neighbouring region: for the Alps Trümpy (1973) mentions 200—600 mm/1000 y., for the Bohemian massif Pačes—Moldán (1979) 8.5—130 mm/ /1000 y., for Moravian karst Štelcl and col. (1960) 25 mm/1000 y. According to Kukal (1983, p. 34) the average velocity of orogenetic uplifts is 400— —600 mm/1000 y. The mass of the Jablonica conglomerates makes surmise that the surface area was at least so mountainous as the present-day Malé Karpaty Mts. If we accept as estimation an erosian of 150 mm/1000 y., for 17 millions of years it would be a column of 2550 m. At the profiles of Mahel' to the map 1:50 000 is the average dip of Mesozoic complexes from the NW border of the Malé Karpaty Mts. around 30° to NW. After addition of a column 2550 m thick it is necessary to shift the boundary between the units for the time of the Karpatian (e.g. the boundary of the Mesozoic and crystalline rocks) by about 5100 m, so nearly by about 5 km in direction to SE. We are aware that the whole surface was not rising and not eroded equally. It is probable that the SW segment of the Malé Karpaty Mts. raised more rapidly as testified by the axial elevation in this place.

2. *Rule of older erosion cuts.* In addition to sequences, which were carried away in the interval of the Karpatian—Holocene we must not proceed mechanically, but take into consideration erosion cuts sealed by older trangressions. For example, south of Jelenec, basal Triassic quartzites are resting on granitoids, thus already before the Triassic the crystalline schists of the mantle were removed by erosion from this batholith, so that we neither can suppose the presence of crystalline schists, nor the Permian for the Karpatian in the given area. Similarly in the area of Buková the Paleogene overlies everywhere the Triassic complexes of the highest nappes. It implies that the Jurassic members were carried away already before the Paleogene and so we cannot reckon with their erosion during the Karpatian. For the same reasons we cannot admit extension of Senonian marine sediments up to the mentioned area, what is

proved also by missing of pebbles of Senonian rocks in Paleogene conglomerates of the Buková syncline.

3. *Redeposition of pebbles from older conglomerates.* Besides primary sources we must reckon with secondary sources, when they occur in the supposed source area. In our case there are Senonian—Paleocene polymict conglomerates of the Brezová Group and Cretaceous conglomerates of the Klippen Belt (nearer p. 000). Incidental redeposition from monomict Paleogene conglomerates from the Buková syncline is less interesting. Theoretically it would be possible to suppose also redeposition from conglomerate intercalations in Albian of the Tatricum and Krížna unit (material from the localities Majdánske, Lošonec, Bošáca, investigated by Mišík—Jablonský—Sýkora—Mock, 1981). These bodies are, however, so small that they hardly could be effective as a secondary source for the Jablonica conglomerates.

4. *The rule of association of source rocks and correction of their original proportions.* When we suppose that a certain rock (e.g. Lower Triassic quartzite) is derived from a concrete source area, we verify whether also other rocks, uncovered together with it in the source area, are present (for example, granite, Gutenstein limestone). However, when granites were eroded in the source area at a territory 5 times larger than quartzites, we cannot expect that the ratio of their pebbles in conglomerate would be 5 : 1. We carry out corrections of proportions with regard to suitability of the rock to formation of pebbles (for example, tectonically crushed dolomites, dolomites disintegrated into dolomite flour or strongly tectonically affected serpentines will not provide pebbles in fraction more than 3 m, investigated by us, similarly neither highly weathered granites, desintegrated already into individual grains). We carry out further correction of proportions for resistance to transport and intrastratal dissolving (it si proved that with transport the association is impoverished in limestone pebbles to the detriment e.g. of vein quartz). The rule of association and correction is valid also for redeposition of pebbles from older conglomerates. For example, at the find of pebble of quartz porphyry, in which we suppose redeposition from the Cretaceous "Upohlava" conglomerates. it is necessary take into account that at the same locality also other rocks should be redeposited, which were represented in higher per cent in the "Upohlava" conglomerates. In redeposition, however, we must reckon with distinct enrichment of the associations in more resistant components (quartzites, vein quartz, quartz porphyries).

The inductive method is applied in the next step-field analysis of pebble composition, we make it more precise by microscopic study. The found rocks are confronted with rocks of supposed source areas, we compare the established facts with the deduced assumptioms. Besides establishing of pebble composition, the measurements of imbrications of pebbles for establishing the transport direction are an important contribution to the question of source areas (for Jablonica conglomerates Kováč, 1985).

In the following text we present a list of sedimentary rocks, found in pebbles of the Jablonica conglomerates with microscopic characteristic of the types decisive for solution of sources: in others rocks the criteria for their stratigraphic assignment are only briefly mentioned. Then the matrix of conglomerates and sandstone intercalations in them are discussed. The quantitative analyses of 7 localities are mentioned (the sums from 153 to 220 pebbles from fraction more than 3 cm of size — Tab. 1. were evaluated); analyses from further localities are presented by K o v á č (1985).

In the conclusion of the contribution we recapitulate the question of the redeposition of pebbles and characterization of rocks, playing leading role in searching for source areas.

Stratigraphic and tectonic assignment of pebbles on the basis of petrographic and microfacial analysis

D e v o n i a n (?) — metamorphosed limestones of the Harmónia Group

Yellowish limestone with metamorphic foliation with minute folds of mm size, with admixture of silt quartz (quarry above the tunnel near the gamekeeper's lodge Raková). Laminae originated by metamorphic differentiation are formed (first type) by fine-grained calcite with Fe-hydroxide pigment, preferentially concentrated into strips; they contain minute lenticles of secondary quartz, calcite (pseudosparite) and chlorite. Laminae of the second type contain microcrystalline calcite. They are pierced by veins oblique to the course of foliation. These veinlets are filled up with aggregate of chlorite, the scales of which are oriented parallely with foliation (Pl. II, Fig. 2); they reflect stretching. The abundant admixture of chlorite may be deduced from the original pyroclastic admixture of basic volcanism.

Pinkish weakly-metamorphosed limestone with abundant authigenic feldspars and isoclinal mm-folds, lying at the level of foliation (Hradište p/V——Varianková—Pl. I, Fig. 1). Metamorphic differentiation is shown in individualization of laminae of coarse-grained calcite with relatively more abundant authigenic albite. It is mostly idiomorphic rods of up to 0.4 mm length, in places clusters of crystals are formed. It contains some inclusions of calcite. Besides polysynthetic lamellation according to albite law, tetramerous intergrowths of Roc-Tourné type are frequent (Pl. I, Fig. 2). In the calcite ground mass in places palisade aggregates of calcite occur, probably relicts of calcite veins torn by metamorphic flow. Minute grains and globules of hydrated pyrite and rhombohedrons of Fe-dolomite up to 0.2 mm in size are found (Pl. II, Fig. 1). In relation to albite they are idiomorphic, however, probably are not younger than it. We suppose that albite replaced only calcite and not Fe-dolomite. It is a carbonate rock, richest in authigenic albite from the West Carpathians so far. By means of point integrator (2705 points) 27.7 volume % of authigenic albite, 61.8 % of calcite and 10.5 % of Fe-dolomite were established (pyrite pigment was not included in the amount). Albite perhaps formed to the detriment of clayey admixture, the original rock was probably marly limestone.

For interpretation of the age two groups with metamorphosed limestones in the Malé Karpaty Mts. can be taken into consideration; the Harmónia Group (Devonian?) and Borinka succession (Mesozoic). The marly character, yellowish--pinkish colour, presence of Roc-Tourné compound crystals, the formation of which is probably supported by pore waters derived from evaporites offer an interpretation, that metamorphosed Campilian could be present (authigenic feldspars from Campilian marly limestones of the Nízke Tatry Mts., were al-

Table 1

Petrographic and microfacial analysis of conglomerates

	Prievaly	Lipovec	Mníšek	Bosý jarok Buková railw. st.	Naháč	Dobrá Voda	Hradište p/V.
limestones	70 %	82.3 %	60.1 %	68 %	77 %	41.5 %	79.5 %
dolomites	4	+	+	7.5	3	9.3	—
sandstones (arcoses)	5.5	7.2	11.8	11	11	32.7	9.5
quartzites	10	5.5	15.7	8	1.5	9.8	9.1
volcanics	1	1.1	5.9	+	2	6.2	+
silicites	2	3.9	3.3	2	4	0.5	1.4
vein quartz	0.5	—	2.0	3.5	1	—	0.5
granite	5	—	0.6	+	0.5	+	+
metamorphites (Pz.)	2	+	0.6	+	—	—	—
	100 %	100 %	100 %	100 %	100 %	100 %	100 %
from the limestones:							
Paleogene	—	0.5	—	—	+	—	—
Senonian marine	+	+	—	—	—	—	0.4
freshwater Senonian	+	2.2	+	+	+	—	+
pelagic Tithonian-Neocomian	+	4.4	1.3	+	+	—	5.4
shallow-water Malm	—	+	0.6	+	+	—	—
pelag. Dogger-Malm	—	3.9	2.0	+	—	—	0.9
pink crinoidal-Lassic	+	0.5	1.3	+	—	—	+
„Fleckenmergel"	+	+	—	—	+	+	1.4
Liassic (dark, sandy)	+	14.4	26.8	+	+	4.6	24.1
Rhaetian-Hettangian	+	+	0.6	+	—	+	—
Norian with conodonts	+	2.2	—	—	—	1.5	2.3
Reifling (type)	+	2.6	2.6	+	—	0.5	+
Wetterstein (type)	+	24.3	12.5	+	+	25.9	21.8
Gutenstein (type)	+	25.4	11.2	+	+	5.2	21.4
marlstones (Campilian?)	—	—	—	—	—	2.6	—
dynamic-metam. limestones	+	1.1	1.3	+	—	+	1.8

ready mentioned by Koutek, 1931, p. 459; from the Spišsko-gemerské rudohorie Mts. by Mandáková, 1964). Campilian marly limestones, however, are not known from the Borinka succession.

Compound crystals of Roc-Tourné type have been found in dolomites of the Permian or Lower Triassic accompanying anhydrites in a borehole near Rožňava (Mišík, 1962, Pl. XVIII, Fig. 3), in septaria concretions from the Permian near Poráč (Turan—Vančová, 1981) and in Triassic dolomite from the Orava exotic ridge pebbles from the higher part of the Podhale Paleogene from Brezovice (Mišík—Fejdiová—Köhler, 1968, Pl. XIII, Fig. 1; in the West Carpathians so far authigenic feldspars of this sample are visible also macroscopically). Further, I know them from fragments of dolomite from a breccia of a submarine slide of Senonian or Paleogene age from the Klippen Belt near Litmanová, from dolomite fragment from fine-grained conglomerates of Senonian age from the substratum of the Vienna basin in the borehole Smolinské-7, 1211 m. For their origin in dolomites connection with evaporite environment may be supposed.

Formation of authigenic albite with Roc-Tourné compound crystals in limestones, however, is connected with their initial metamorphism. I know them from the weakly-metamorphosed Liassic Borinka limestones (loc. Propadlé), they were found in a pebble of coarse-grained metamorphosed limestone (Paleozoic?) from Albian conglomerates at the loc. Borháj in the Strážovské vrchy Mts. (Mišík et al. 1981, p. 19). From metamorphosed limestones of the Eastern Alps they are mentioned by Exner—Erkan (1971). The Harmónia Group has not been investigated in such details so that we could admit it as the source for the examined pebble. Because of the presence of minor folds, I consider the origin from it as more probable than from the Borinka unit.

Permian (?) — clastic rocks

White coarse-grained arcose (Dobrá Voda — d). The angular grains are sporadically also more than 2 mm. Quartz is undulatory, often jointed. Clastic feldspars very often belong to sericitized orthoclase and plagioclase (plagioclase are very rarely found also without sericitization), myrmekite, chessboard albite, which is partly replaced by calcite. Baueritized biotite and chlorite are sporadical. The interstitial mass from the sericitized aggregate shows initial metamorphism; calcite cement is rare, incoherent.

White coarse-grained sandstone with pink grains, weakly metamorphosed (Dobrá Voda —f). Quartz often undulatory with indications of pressure lamellae, fragments of quartzites, vein quartz, quartz-chlorite aggregate. Two grains of

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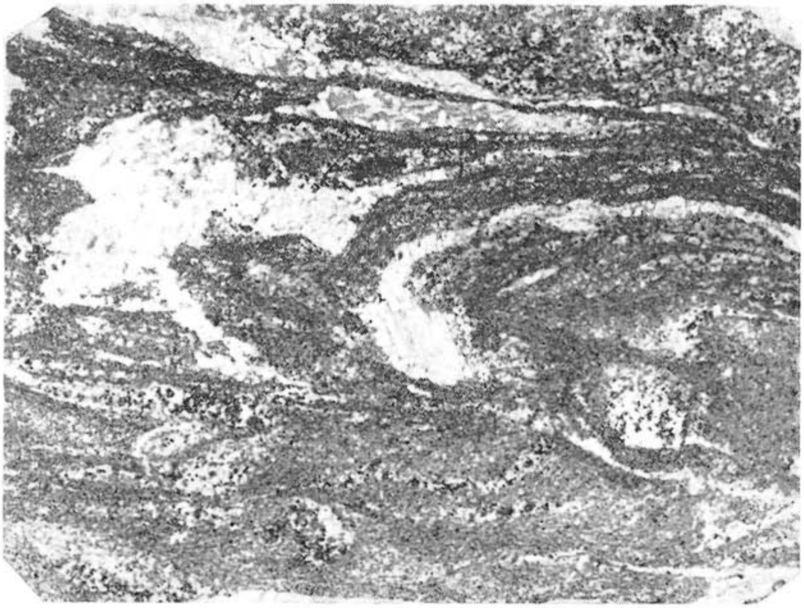
Plate 1

Fig. 1. Metamorphosed, detailly folded limestone with abundant authigenic feldspars. Probably the Harmónia Group — Devonian. Pebble from the Jablonica conglomerate (Karpatian). Hradište p/V. — Varianková. 336/1. Thin section no. 14569, magnif. 9 ×.
Fig. 2. Authigenic albite with compound crystals-quadruplets according to Roc-Tourné law. As in the preceding. Polarized light, magnif. 95×.



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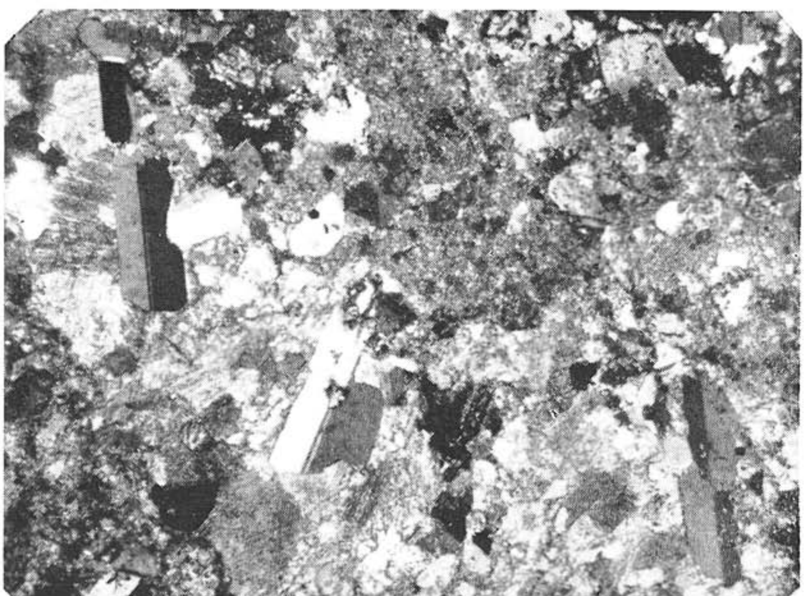

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beta - quartz shape from volcanics with partial magmatic corrosion are present. The sporadical feldspars belong to microcline, muscovite is frequent, baueritized biotite rare. The recrystallized clayey matrix shows marks of anchimetamorphism oriented overgrowths of clasts, in places is weakly directed at the level of foliation. The weak metamorphism and the presence of pyroclastic admixture of quartz porphyry volcanism would testify to an origin most probably from the Permian of the Tatricum, which, however, occurs at the SE end of the Malé Karpaty Mts. (Hainburg hills). An other solution is also possible, so as for pebbles of quartz porphyries, for which we suppose redeposition from Cretaceous conglomerates of the Klippen Belt.

Middle and Upper Triassic of shallow-water development

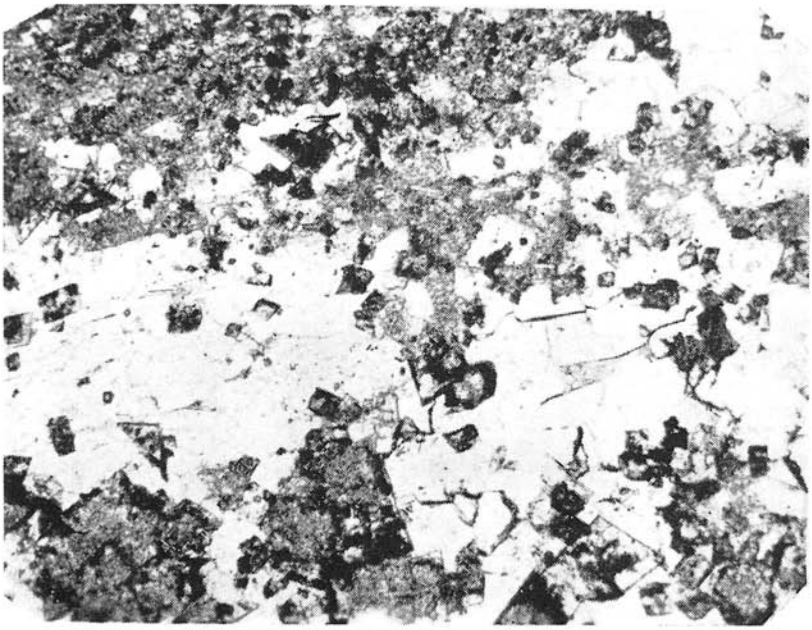
The dolomites can be derived from all tectonic units of the adjacent area (Tatricum, Krížna nappe, Fatricum, Choč nappe-Hronicum, the highest Subtatricum nappes, - Silicium, redeposition from Upper Cretaceous and Paleogene conglomerates). They were not observed micriscopically. The cases of dedolomitized rocks are mentioned in p. 000.

The Gutenstein type can come from all units as well. It was controlled by thin sections sporadically only. A distinguishing criterion on the contrary to Liassic limestones of dark colour is the complete absence of clastic quartz, frequent partial dolomitization, uncommon poverty in organic remains. It is of the texture of micrite and microsparite with sporadical ostracodes. *Earlandia* sp., *Frondicularia woodwardi* and other. Sometimes they display sedimentary lamination.

Wetterstein type. It is the most abundant component in pebbles of numerous localities. The source are the highest nappes, rarely also the Choč nappe, seldom it can represent also redeposited pebbles. Macroscopically it can be well distinguished; it was controlled by 12 thin sections. Characteristic marks: presence of crustification cement (radiaxial cement, "reef tufa" in intrasparrudites etc.), frequent dolomite rhombohedrons, mainly in micrite parts, *Turbiphytes obscurus*, *Codiaceae*, fragments of calcareous sponges, *Bacinella* sp., *Earlandia* sp., *Frondicularia* sp., *Austrocolomia marshalli* OBERHAUSER (Lipovec - II - 3), *Diplotremina astrofimbriata* KRISTAN—TOLLMANN (Mníšek — k), sporadical echinoderm stems, fragments bivalves, gastropodes; rare pellets, fenestrae-pores of desiccation, complete missing of clastic quartz. Authigenic idiomorphic quartz was found sporadically (Lipovec - II - 4). Dasycladaceae *Teutloporella herculea* were found in a pebble at the locality Dobrá Voda.

Plate II

Fig. 1. Cluster of authigenic albite (white) and Fe-dolomite (darker rhombohedrons) in metamorphosed limestone. As in Pl. I, magnif. 95×.
Fig. 2. Metamorphosed limestone with silt admixture, with chlorite laminae and veinlets of oblique course to lamination, which are filled up with chlorite. Probably the Harmónia Group — Devonian. Pebble from the Jablonica conglomerates. Gamekeepers'cottage Raková — E. Thin section no. 8394, magnif. 20×.



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Middle and Upper Triassic of basinal development

They appear macroscopically as grey and brownish, sometimes nodular limestones with cherts. They can be mistaken macroscopically for limestones of basinal facies of the Later Jurassic and Neocomian and therefore the thin section control of several pebbles of this type is necessary. Even by thin sections it is not always possible to prove competence reliably, so far as they contain juvenile bivalves („filaments") and calcified radiolarians only. Even the negative result of extracting conodonts cannot exclude Triassic origin as the extraction is carried out from much less ammount of material (e.g. one half of pebbles 5 cm large) when compared with several kg of sample taken for this purpose from outcrops. The extraction and determination of conodonts from selected pebbles was carried out RNDr. T. Puškárová. I present description of rocks of proved age only.

Middle Triassic — Reifling limestones, brownish-grey, fine-nodular (Dobrá Voda — h). From the insoluble residue *Gondolella* sp. of Middle Triassic age was extracted. The intrabiomitrite contains abundant short „filaments", calcified radiolarians (especially abundant in some „nodules" — intraclasts), ostracodes with both valves, corroded echinoderm particles corroded globochaetes, sporadical foraminifers (*Nodosaria, Dentalina, Ophtalmidium*), echinoid spine and scarse clastic quartz of silt category.

Carnian—Norian brownish-grey muddy limestone with Osteocrinus microfacies (Prievaly - 1). Biomicrite with traces of bioturbation contains: ostracodes, *Glocochaete alpina* LOMBARD, juvenile bivalves of Halobia type („filaments"), debris of planktonic crinoids *Osteocrinus* sp. (Pl. III, Figs. 1, 2), sporadically lagenid foraminifers, *Frondicularia woodwardi* HOWCHIN, echinoid spine. The Osteocrinus microfacies is typical from the Eastern Alps to the Himalaya for the Carnian, sporadically found in the Norian and Rhaetian. It is found with Norian microfauna in exotic pebbles of the Flysch Belt (Soták, 1985) and Klippen Belt (Mišík et al., 1977).

Norian — light-grey muddy limestones (Dobrá Voda — c). The biomicrite contains „filaments", calcified radiolarians and silicisponge spicules, ostracodes, sporadical globochaetes and echinoderm debris. The extracted conodont *Metapolygnathus abneptis* (HUCKRIEIDE), proves a Norian age, more precisely the Middle Sevatian.

Norian — light-grey muddy limestone (Hradište p/V — f). The biomicrite with traces of bioturbation (contrusive structure of „filaments") contains abundant

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Plate III

Figs. 1 — 2. Limestone-biomicrite with plates of planktonic crinoid *Osteocrinus* sp., pelagic facies of the Carnian. Pebble from the Jablonica conglomerates. Prievaly — 1. Thin section no. 8260, magnif. 40×.

Fig. 2. Metamorphosed limestone probably the Liassic Borinka formation of the Tatricum of the Malé Karpaty Mts. Metamorphic lamination and swelling of the light coloured lamina from coarser-grained calcite above three echinoderm plates with dense polysynthetic lamellation are visible. Pebble from the Jablonica conglomerate. Prievaly — g. Thin section no. 8253, magnif. 10 ×.

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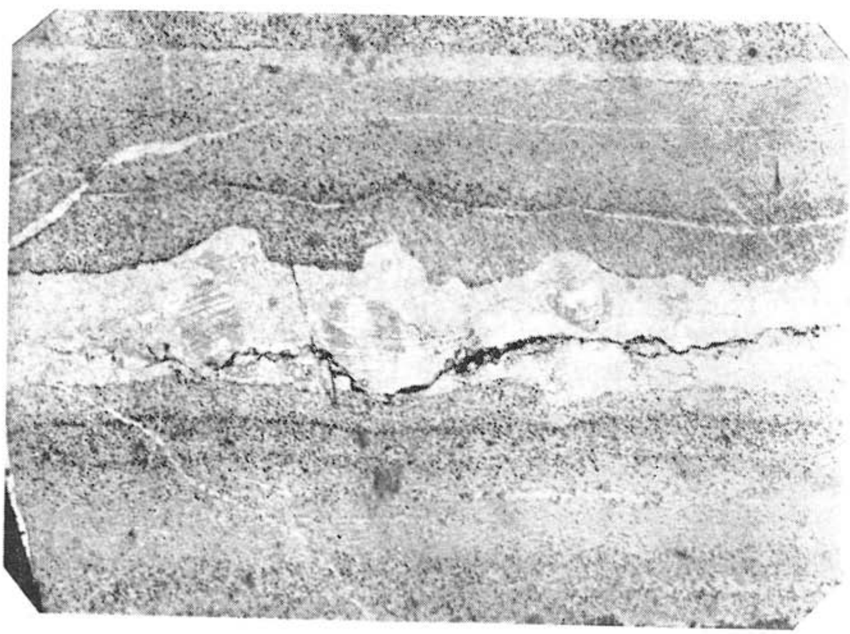

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calcified radiolarians, abundant „filaments", sporadical calcified sponge spicules, globochaetes, ostracodes, agglutinated foraminifers, sporadical grains of silt quartz and microstylolites coloured with Fe - Mn oxides. Conodont *Metapolygnathus bidentatus* (MOSHER) from the insoluble residue points to the Sevatian.

Lower Norian — cream limestone with intraclasts (endostratic breccia) — (Lipovec - II - m). The groundmass is of biomicrite character with filamental - radiolarian microfacies, globochaetes, ostracodes and juvenile bivalves. With intraclasts up to 2 cm in size they belong to three various microfacies: radiolarian, filamentous Globochaete and filamentous foraminiferal. From the pebble *Metapolygnathus echinatus* (HAYASHI), *Gondolella navicula* (HUCKRIEDE), *Prioniodina sweeti sweeti* KOZUR—MOCK and particles of *Roveacrinidae* were extracted.

The occurrence of grey and brownish muddy limestones of the Norian basinal facies is surprising as in the Malé Karpaty Mts. including the Čachtické pohorie Mts. no such facies has been mentioned in literature so far. The Norian is only known in form of the Dachstein limestones and Hauptdolomit from the highest nappes in this area. Recently, however, it was possible to find out outcrops of pelagic limestones with Norian conodonts in the area of Vrátno in the Brezovské Karpaty Mts. (oral communication of RNDr. T. Puškárová), so that as the first alternative we may derive the origin of pebbles from here.

In exotics of the Pieninic exotic ridge basinal limestones with Carnian conodonts have been found so far only (Mišík—Mock—Sýkora, 1977). We called attention to the fact that conodonts in these exotic pebbles are present in much greater concentration than in rocks of the Choč and Silica nappes or Meliata unit. This is also characteristic of the rocks described here. It is not excluded that with thorougher investigation pebbles of identical limestones with Norian conodonts will be found among exotic pebbles of the Klippen Belt and therefore as second alternative we suppose the redeposition from this source. The Norian basinal facies were recently described as exotic pebbles from conglomerates of the Flysch Belt by Soták (1985). His work is a significant support of our opinion on differentiation of the Upper Triassic area of sedimentation, on formation of the embryonal trough in the region of the Klippen Belt sedimentary area during the Upper Triassic (Mišík—Mock—Sýkora, 1977).

Rhaetian—Hettangian of the Krížna unit

Dark-grey oolitic-fine-lumachelle limestone (Prievaly — f).

The oobiosparite with oolites of 0.8 mm diameter contains fragments of terebratulid brachiopods, small gastropods, echinoid spines, clastic quartz of size up to 0.6 mm (accumulated in microstylolites) and rhombohedrons of epigenetic Fe-dolomite.

Brown fine-lumachelle limestones (Lipovec - II - 1, Mníšek — 1). They are biosparites with bivalves, Terebratulide (punctate) brachiopods and echinoderm particles, with admixture of silt quartz and muscovite and rhombohedrons of epigenetic Fe-dolomite.

Liassic of the Tatricum — metamorphosed limestones of the Borinka succession

Typical of the Liassic limestones on the whole, mainly of Lower Liassic is the terrigenous admixture of clastic quartz and muscovite. Dynamic - metamorphosed limestones, which agree well with the Liassic of Borinka development, display metamorphic lamination, sometimes also metamorphic differentiation into laminae, metamorphic flow, rarely minor folds.

Grey limestone with discontinuous yellowish metamorphic laminae (Prievaly — g). The laminae are maximum 2 mm thick. The lighter — coloured from them are formed by calcite aggregate from approximately isometric grains (of average size 0.08 mm). They contain several echinoderm (perphaps crinoid) particles up to 1 mm large with considerably disturbed twinning-lamellae. Around echinoderm particles the laminae are thicker (metamorphic flowing-round, Pl. III, Fig. 3). Darker laminae are from finer-grained calcite aggregate from individuals of medium diameter 0.03 mm, which are weakly elongated in the foliation plane or their elongation forms an acute angle with it. Relicts of pellets are found. Authigenic allotriomorphic quartz up to 0.2 mm occurs in lighter-coloured (coarser-grained) laminae. Authigenic pyrite is epigenetic, found in proximity of veinlets only.

Grey limestone with little distinct undulate metamorphic lamination (Mníšek — p). It is formed by fine-grained calcite aggregate (less than 0.02 mm), the individuals of which are, however, distinctly elongated in the foliation plane accompanied also by formation of sutures. It contains sporadical echinoderm particles.

Yellowish weakly metamorphosed limestone with black spots (Hradište p/V. — i). It was originally a weakly sandy limestone with crinoidal debris and minute cherts. Distinct metamorphic foliation with initial differentiation into streaks with S - shaped bent calcite individuals, with imperfect Fe-dolomite rhombohedrons, formed. Some laminae are bordered by authigenic fine-grained allotriomorphic quartz. Echinoderm particles are highly corroded; their pressure twinning was mostly wiped out to the shape of undulatory extinguishing aggregate.

The described rocks may be compared well with the Liassic Borinka limestones, affected by Alpine metamorphism, for instance, the quarry Propadlé near Medené Hámre, where metamorphic lamination, flowing round of echinoderm stems and in places also admixture of clastic quartz are well visible. It is neccessary, however, to call attention to the fact that I observed metamorphic flowing round of echinoderm stems sporadically also in Early Paleozoic limestones of the Harmónia Group. The following three samples were affected by high pressure with formation of authigenic quartz and authigenic feldspars, however, without formation of distinct metamorphic foliation.

Brown limestone, originally sandy biomicrite (Dobrá Voda — a). It contains rare bivalves and echinoderm particles. Almost all clastic quartz was transformed into authigenic quartz with abundant calcite inclusions, with partial idiomorph. Epigenetic Fe-dolomite in form of rhombohedrons also penetrates into veinlets. In calcite of older veinlets pressure twinning-lamellae are bent, in places the original homogeneous optical orientation of grain completely disappeared.

Grey weakly sandy limestone with small dolomite fragments (Bosý Jarok —

10). It contains small echinoderm particles highly disturbed by recrystallization and granulated fragments of bivalves. Grains of clastic quartz up to 0.7 mm are fractured and healed by calcite, fragments of fine-grained dolomites (up to 2 mm) are present. The interstitial mass was mostly subjected to degrading recrystallization (granulation); in places under the effect of pressure the aggregates of fibrous calcite began to form, however, not of equal optical orientation everywhere. In the interstitial mass rhombohedrons of epigenetic Fe-dolomite are scattered. Calcite veinlets contain authigenic quartz and authigenic plagioclase.

Grey weakly-sandy limestone (Hradište p/V — Varianková). Originally sandy biomicrite, highly recrystallized. It contains rare and poorly preserved echinoderm particles and fragments of bivalves. The clastic quartz is in corroded grains with undulatory extinction, however, mostly transformed into authigenic allotriomorphic quartz with abundant calcite inclusions. Authigenic plagioclase (up to 0.15 mm) with polysynthetic lamellae is frequent, only rarely with perfect idiomorphic delimitation.

Liassic (prevailingly of the Krížna unit)

Dark-grey and brown Liassic limestone. As they may come from all units, we present a total description only. There are weakly recrystallized biomicrites with weak admixture of clastic quartz usually of silt size. From organic remnants they contain echinoderm particles, bivalves, silicisponge spicules, lagenid foraminifers, scarely brachiopods, gastropods, ostracodes and echinoid spines SiO_2 from silicisponges is usually concentrated into imperfect differentiated cherts, sporadically selective silicification of foraminifers occurs. The presence of brown rhombohedrons of epigenetic dolomite is common.

Red muddy limestone with *Involutina liassica* and *belemnites* (Cerové — Na Nivách). Biomicrosparite with foraminifer - crinodal microfacies. It contains *Involutina liassica* (JONES), *Nodosaria* sp., *Lenticulina* sp., *Paalzowella* sp., small columnalia of crinoids, abundant echinoid spines, sporadical *Globochaete alpina*, silicisponge spicules. Fe-hydroxides are concentrated into cavities in foraminifers and pores of echinoderms. Replacement of part of foraminifers by chlorite was found sporadically. Intraclasts of iron crusts from hardground and clusters of brown alumosilicate colloids are present. Red weakly crinoidal limestones with *Involutina liassica* are mainly typical of the Middle Liassic of the Krížna unit (Mišík, 1961).

Liassic to Dogger of the Krížna unit

Pink crinoidal limestones. They are present almost at all localities but always in sporadical pebbles only. They are typical of the Vysoká (Krížna) nappe and also of the higher nappes. In the material of pebble biomicrites are prevalent over biosparites. Besides dominating crinoid particles bivalves, lagenid foraminifers, punctate brachiopods, scarce gastropods, ostracodes, uniserial bryozoans, calcified silicisponge spicules, chitinose membranes of foraminifers ("microforaminifers") are present. The rare grains of clastic quartz display sporadically also formation of pressure rims from filamentous calcite, as I also know from the Vysoká unit. Authigenic idiomorphic quartz sometimes grows on the clastic core. Recrystallization of calcite under the influence of Fe - colloids was observed (Mišík, 1968); microstylites are common.

Grey and brownish-grey spotted marly limestone ("Fleckenmergel" facies) are found at most localities but in small amount. They are typical mainly of the Krížna unit of Zliechov development, which is subordinately represented in the Malé Karpaty Mts. Summary description: biomicrites with traces of bioturbation; they contain calcified radiolarians and silicisponge spicules (mainly monaxon, only rarely filled up with chalcedony), juvenile bivalves ("filaments") often silicified, sporadical echinoderm particles ostracodes and lagenid foraminifers. SiO_2 is sometimes concentrated into chert concretions. Characteristic is the presence of clusters of globular pyrite.

Upper Dogger—Lower Malm of the Borinka succession (Tatricum)

Pink muddy fine-lumachelle limestones with indication of metamorphic foliation (Mníšek — h). Biopelmicrite with ostracodes, calcified radiolarians, foraminifers (*Lenticulina, Dentalina, Frondicularia, Spirillina, Tetrataxis*), scarely chitinose membrane („microforaminifers") *Globochaete alpina* LOMBARD, echinoderm particles (also connected infrabazalia from calyx of crinoid), juvenile ammonite, aptychus, echinoid spine, pellets of perphaps coprolite origin. Pressure twinning affects organic remnants; there are indications of metamorphic foliation.

Grey muddy limestones with indications of metamorphic foliation (Hradiště — c). It contains calcified radiolarians and silicisponges, more rarely „filaments" (partly silicified) and *Cadosina* sp. Indications of formation of metamorphic foliation are connected with flattening (deformation) of radiolarians and intensive twinning of calcite in older veinlets.

The mentioned two rocks are not so distinctly affectes as metamorphic rocks described in p. 000. Observations, however, show that in the Borinka succession by far not all members are affected equally; most liable to metamorphism are just the Liassic Borinka limestones.

Dogger—Lower Malm in pelagic development

Brown muddy limestones often with cherts (Lipovec - II - e, f, g; Mníšek — f). Biomicrites with radiolarian, more rarely „filamentous" microfacies, sometimes with traces of bioturbation. Very abundant, however, poorly preserved radiolarians (cavities after radiolarians filled up with calcite druse), similarly are calcified silicisponge spicules (monaxon, sporadically tetraxon), „filaments", rare foraminifers, globochaete, echinoderm particles, juvenile ammonite. In the chert and its proximity radiolarians are filled up with fibrous chalcedony or monocrystal of calcite.

Kimmeridgian —Lower Tithonian in pelagic development

Pinkish muddy limestone with Saccocoma-Globochaete microfacies (Bosý Jarok — 6). Biomicrite with abundant debris of planktonic crinoid *Saccocoma* (Pl. IV, Fig. 1), abundant *Globochaete alpina*, rare echinoderm particles several aptychi, juvenile ammonites, echinoid spines, ostracodes, sporadical brachiopods and gastropods. Cavities filled up with calcisiltite and pellets were found. The rock probably comes from the Vysoká succession (Krížna nappe), may be, however, also from higher nappes.

Upper Tithonian of neritic (transitional) facies

Pink muddy limestone (Bosý Jarok — 3). The biomicrite to dismicrite contains echinoderm debris, tintinnids of the genus *Crassicolaria*, calcified silicisponge spicules, lagenid foraminifers, globochaetes, sporadical ostracodes, echinoid spines, fragments of bivalves, ophiuroid plate. The rock contains cavities with top - and - bottom structure (inner sediment in form of calcisiltite with pellets and intraclasts) and one neptunic microdyke. The pressure effect was shown by formation of subparallel veinlets (shear joints), filled up with fibrous calcite oriented perpendicularly to the direction of veinlets.

Brownish muddy limestone (Hradište p/V — g). Biointramicrite with crinoidal - calpionel microfacies. Echinoderm particles stems are disturbed by boring algae; abundant but deformed *Crassicolaria* sp., echinoid spines, foraminifers, scarcely uniserial bryozoans, fragments of bivalves and brachiopods, phosphate fish scale; small muddy intraclasts. The pressure was shown by formation of shear veinlets.

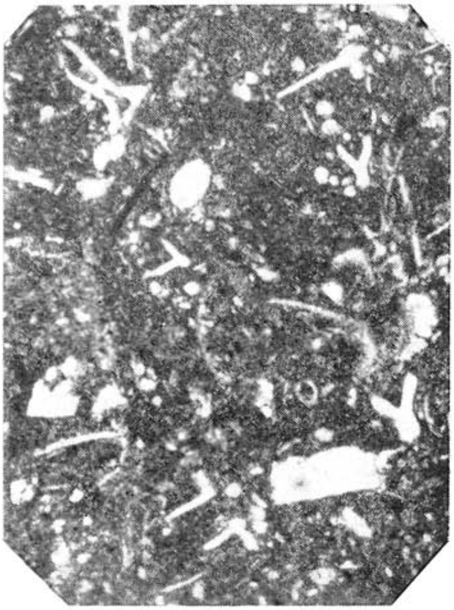
Both mentioned rocks indicate the Upper Tithonian of neritic facies with crinoidal - calpionellid association with cavities and microdykes. It is conspicuously different from the shallow-water facies with *Clypeina jurassica*, as well as from pelagic facies of the same age, in which *Tintinnidae* are almost exclusively associated with planktonic and nectonic organisms. The described rocks agree with the Upper Tithonian of the Vysoká succession from the big quarry near Pernek.

Upper Tithonian, Berriasian, Lower Valanginian of pelagic facies

Grey and yellowish muddy, sometimes spotted limestones - biomicrite with tintinnids. The "*Crassicolaria*" Zone (Mníšek — o) is represented by C. *brevis* REMANE and C. *intermedia* (DURAND DELGA), abundant globochaetes, rare *Saccocoma* etc. The "*Calpionella*" Zone (Naháč - I - II - 9, Bosý Jarok — 4, Mníšek — 1) with C. *alpina* LORENZ, sporadical *Crassicolaria* sp., calcified radiolarians, globochaetes etc. The *Calpionellopsis* Zone (Lipovec - II - i, Hradište p/V — 1)

Plate IV

Fig. 1. Microfacies with plates of planktonic crinoids *Saccocoma* sp. in Kimmerdgian — Lower Tithonian biomicrite. Pebble from the Jablonica conglomerates. Bosý Jarok — 6. Thin sec. no. 9211, magnif. 48×.
Fig. 2. *Salpingoporella annulata* CAROZZI in oobiosparite from Malm shallow-water facies. Pebble from the Jablonica conglomerate. Naháč-II-9. Thin section no. 9205, magnif. 25×.
Fig. 3. *Macroporella* sp. As before.



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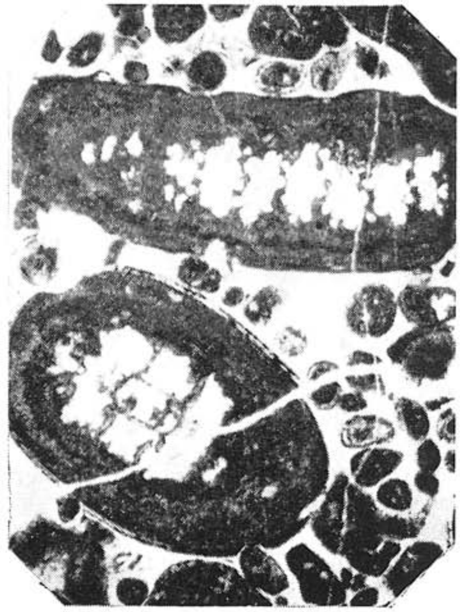

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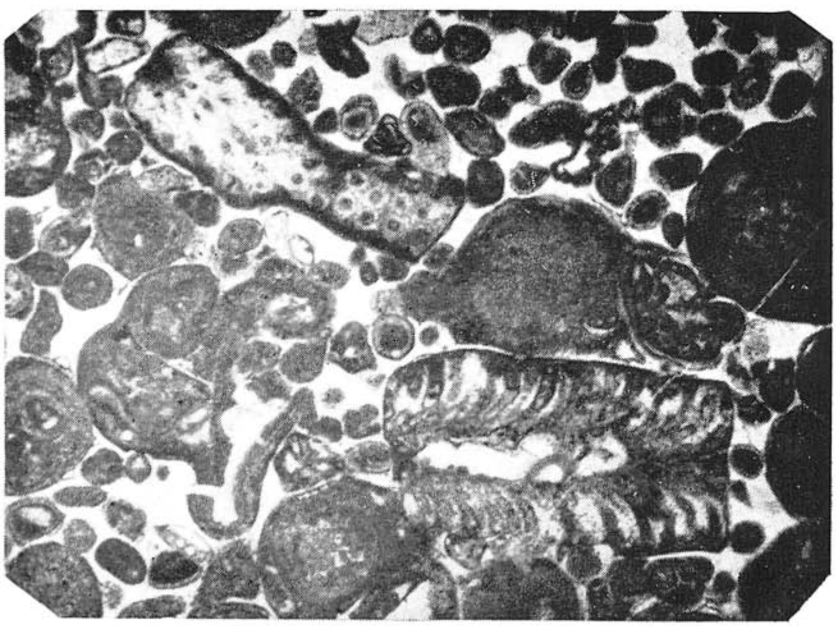

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with C. *oblonga* (CADISCH), *Calpionella elliptica* CADISCH in association with calcified radiolarians, globochaetes, juvenile ammonites etc. Analogous rocks are known from almost all units of the West Carpathians.

Malm of shallow-water facies

All found five pebbles have identical cream colour.

Limestones with Conicospirillina basiliensis, microoncolites - three localities. Naháč — 9: Intrabiosparite with microoncolites and ooids, organic remnants: *Salpingoporella annulata* CAROZZI (Pl. IV, Fig. 2); *Macroporella* sp., (Pl. IV, Fig. 3); *Conicospirillina basiliensis* MOHLER; *Protopeneroplis striata* WEYNSCHENK (Pl. V, Fig. 1); *Labyrinthina mirabilis* WEYNSCHENK; miliolids, ophthalmids; textularids; nubecularid foraminifers; minute gastropods; echinoderm particles; echonoid spines; *Actinostromaria* sp. and fragments of other hydrozoans; *Lithocodium* sp.; *Thaumatoporella parvovesiculifera* RAINERI. The microoncolites are of average 1.2 mm size; with ooids or foraminifers in the core. The ooids are of medium diameter 0.2 mm with frequent peeling off envelopes (this phenomenon was also observed from Malm shallow-water limestones of the Silica unit) — (Mišík—Sýkora, 1980. p. 253, also from the Silicicum of the Čachtické Karpaty Mts. — Mišík—Sýkora, 1982, p. 60). Pressure solution of allochems was taking place before formation of cement — sparite. Calcite veinlets mostly evade ooids (bent on them — Pl. V, Fig. 3), thus cracking was still before perfect lithification of sediment. Loc. Buková — 2 is roughly identical composition except of more sporadic dasycladaceans, rareness of foraminifers and missing ooids. Moreover, a fragment of serpulid worm and bryozoan was present. The microontolites attained size of up to 3 mm. Loc. Mníšek — a contains also *C. basiliensis*, *P. striata*, *L. mirabilis*, ophthalmids, echinoderm, debris, *T. parvovesiculifera*, *Lithocodium* cf. *aggregatum*, gastropods, echinoid spines, *Codiaceae*, fragments of dasycladaceans, *Gemeridella minuta*, ooids, microoncolites.

Limestones with *Clypeina jurassica* (Lipovec - II — k). Oobiomicrite with *Clypeina jurassica* FAVRE (Tab. V, Fig. 2); lituolids, textularids, *Thaumatoporella parvovesiculifera* RAINERI, *Bacinella* sp., *Didemnoides moreti* (DURAND DELGA). It contains undistinct micritized ooids 0.02 mm, mostly initial.

Limestones with *Tubiphytes obscurus* (Naháč — 2). Pelmicrite with *Tubiphytes obscurus* MASLOV, *Thaumatoporella parvovesiculifera* RAINERI, ophthalmids, small sessile foraminifers, rare echinoderm plates, ostracodes, *Gemeridella minuta* BORZA et MIŠÍK and *Bellidispongia* sp., (Mišík—Borza, 1978, Pl. V, Fig. 5). We only suppose assignment to the Malm in this latter case; rocks of such colour are not known in the Triassic.

Stratigraphic range of the limestone with *Clypeina jurassica* is Kimmeridgian—Upper Tithonian. Limestones with *Conicospirillina basiliensis* are found in the Alpine—Carpathian region from the Oxfordian to Upper Tithonian. As *C. basiliensis* begins to appear earlier, its occurrences not associated with *C. jurassica* usually belong to the Oxfordian—Kimmeridgian, however, the absence of *C. jurassica* in the individual thin sections may be accidental.

Origin of pebbles. The only exposures of rocks with *Conicospirillina basiliensis* and *C. jurassica* are known just from the Čachtické pohorie Mts. of the Malé Karpaty Mts. (Mišík—Sýkora, 1982, pp. 58—61); they are the Barmstein limestones — turbidite intercalations in pelagic development of the

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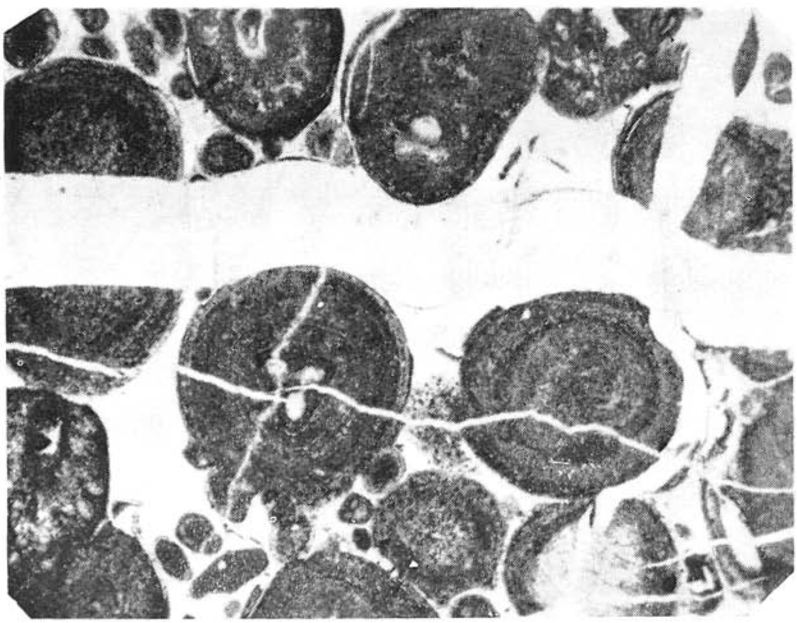

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Plate V

Fig. 1. *Protopeneroplis striata* WEYNSCHENK in Malm shallow-water limestone. Pebble from the Jablonica conglomerates. Naháč-II-9. Thin section no. 14166, magnif. 80×.

Fig. 2. *Clypeina jurassica* FAVRE in Tithonian shallow-water limestone. Pebble from the Jablonica conglomerates. Lipovec-II-6. Thin section no. 14130, magnif. 20×.

Fig. 3. Calcite veinlet with undulated course mostly evades oolites. Such joints were formed in the sediment only partly consolidated, in which with drying up of ooids just peeling off the last concentric layer from their envelope was taking place. Limestone of the shallow-water Malm. Pebble from the Jablonica conglomerates. Naháč-II-9. Thin section no. 9025, magnif. 30 ×.

Kimmeridgian with radiolarians and Tithonian with calpionelids. In form of pebbles the Barmstein limestones cannot be distinguished from the Plassen limestones, which are of identical composition, however, represent an autochthonous sediment deposited in shallow-water environment. The origin from the Čachtické Karpaty Mts. (eventually also by redeposition of pebble from the Senonian Valchov conglomerates) is quite probable. Agreement in composition is considerable except missing partial silicification of organic remnants, occurring in the Barmstein limestones of the Čachtické pohorie Mts. even in 82 % of investigated thin sections. Redeposition from conglomerates of the Central Carpathian Albian (Mišík et al., 1981, pp. 29—30) cannot be taken into consideration because of the small volume of these conglomerates, also for different grey colour of the limestones with *C. basiliensis* found here. Limestones of the shallow-water Malm of the Silica nappe (this development is known from pebbles only — Mišík—Sýkora, 1980, pp. 243—246, 252—254) have on the contrary to the pebbles described here distinct terrigenous admixture. On the contrary, there is resemblance to pebbles of limestones with *C. basiliensis* and *C. jurassica* from the Pieniny exotic ridge (Mišík—Sýkora, 1981, pp. 25—31), so that as the second alternative of origin we postulate redeposition of these pebbles from Cretaceous conglomerates of the Klippen Belt.

Valanginian—Baremian (Neocomian) of pelagic development

Grey weakly-marly limestones — biomicrites with globochaetes, calcified radiolarians etc. (two samples each from the loc. Lipovec and Prievaly) did not contain any index microorganism; their age is supposed according to lithological analogy only.

Albian of the Tatricum (?)

Grey coarse-grained oligomict sandstones with authigenic plagioclases (Prievaly — k, m). Quartz grains are slightly prevalent over limestone clasts; grain size is bimodal, quartz grains are somewhat smaller than fragments of limestones. A fragment of quartzite and silicite, clastic orthoclase, muscovite and epidote were found sporadically. Quartz grains were cracked with pressure, their parts shifted to each other and healed with calcite. Limestone fragments represent micrites without organic remnants with very abundant, partly idio-

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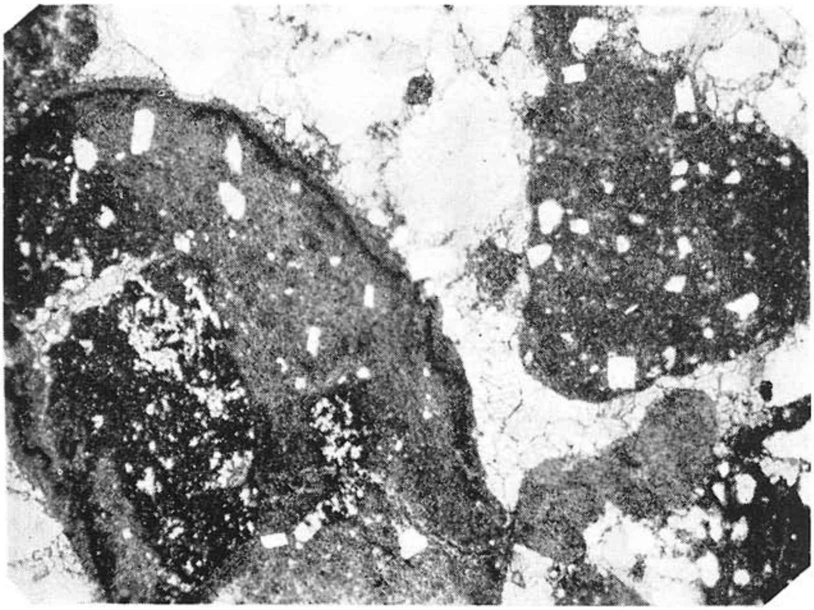
Plate VI

Fig. 1. Abundant authigenic feldspars in rounded fragments of micrite limestones in coarse-grained sandstone, probably from the Albian of the Tatricum. In the largest fragment close to its margin a ferric ring (Liesegang rings) is formed, testifying that the fragment being was exposed to weathering for a longer time before transportation. Pebble from the Jablonica conglomerates. Prievaly — k. Thin section no. 8268, magnif. 30×.

Fig. 2. As before. It is visible that authigenic plagioclase is also formed in the interstitial mass of sandstone and overgrowths into micrite fragment (evidence that authigenic feldspars have not formed in mother rocks before their transportation but only in sandstone). Thin section no. 14174, polarized light, magnif. 95 ×.



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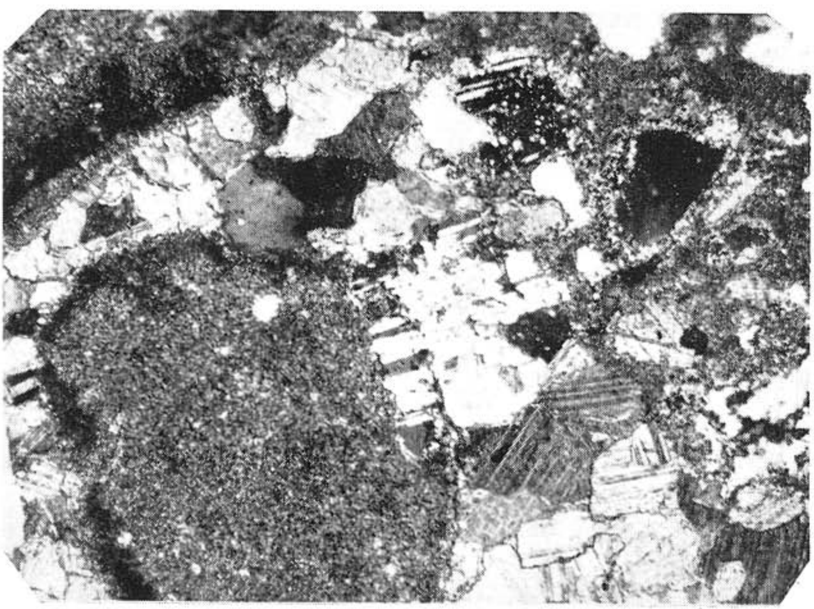

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morphic plagioclases (up to 0.25 mm) and authigenic allotriomorphic quartz, which is overfilled with calcite inclusions. Part of authigenic SiO_2 is bound to the periphery of limestone clasts. Some limestone clasts have a red ring (Liesegang rings — Pl. VI, Fig. 1) at certain distance from the surface, indicating that they were exposed to weathering factors for sometime before transportation. The cement is coarse-grained calcite highly twinned by pressure. Authigenic plagioclases have not been formed in mother limestones and transported in fragments but formed later in the sandstone only. They are demonstrably present in the cement (Pl. VI, Fig. 2) and often pierced the boundary of clasts and cement.

It may be summarized that the rock shows strong traces of pressure effect or even anchimetamorphism, connected with migration of substances with formation of abundant authigenic plagioclase. Already with analyses of pebbles of carbonate rocks from conglomerates of the mantle Albian (Tatricum) we expressed the opinion (Mišík—Jablonský—Mock—Sýkora, 1981, pp. 34—39), that abundant authigenic quartz and authigenic plagioclases formed only in conglomerate with initial metamorphism as also testified by thermic affecting shown by the change of colouring of extracted conodonts. Therefore I suppose that the described pebbles most likely belong to Albian sandstones of the Tatricum and certainly not to any sequence younger than the Albian. A ecrtain difference is the lack of dolomite fragments (verified by colouring with alizarine), which sometimes form even one third of psephite fraction in the Albian sequence (l.c. p. 8). An alternative explanation could be that they are sandstones of the Keuper (rimming of clasts with indications of Liesegang rings is known from them), however, the colour of Keuper sandstones is different. Competence to Liassic sandstones of the Tatricum even cannot be excluded.

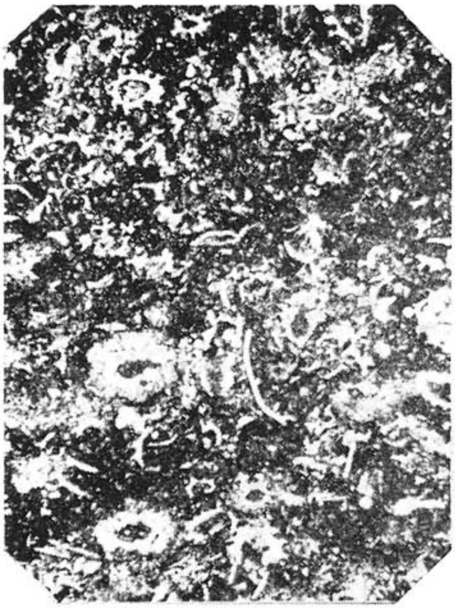
Freshwater Upper Cretaceous

Pebbles of freshwater limestones were found at five localities. Closing their description we shall summarize the criteria for their facial and stratigraphic assignment.

Brown muddy limestones with characeans and irregular spots (Prievaly — c, Mníšek — s). Biomicrites with abundant crush of characeans (Pl. VII, Figs. 1—3), rare ostracodes and thin-valved bivalves fractured with compaction of sediment. Spotted colouring is coused by pigment from Fe-hydroxides. The terrigenous admixture is completely missing.

Plate VII

Fig. 1. Freshwater limestone with debris of characeans. Upper Cretaceous. Pebble from the Jablonica conglomerates. Prievaly — c. Thin section no. 8275, magnif. 26×.
Fig. 2. As before. Magnif. 50×.
Fig. 3. Cross section through a stem of *Characeae*. As before. Mníšek — s. Thin section no. 14159, magnif. 95 ×.
Fig. 4. Alga in freshwater limestone. As before. Lipovec-II-d. Thin section no. 14304, magnif. 48×.



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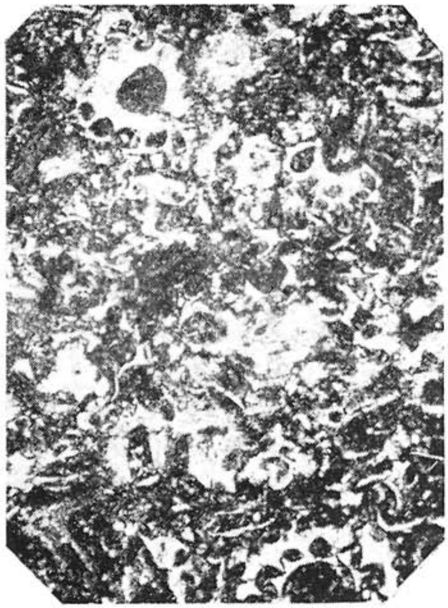

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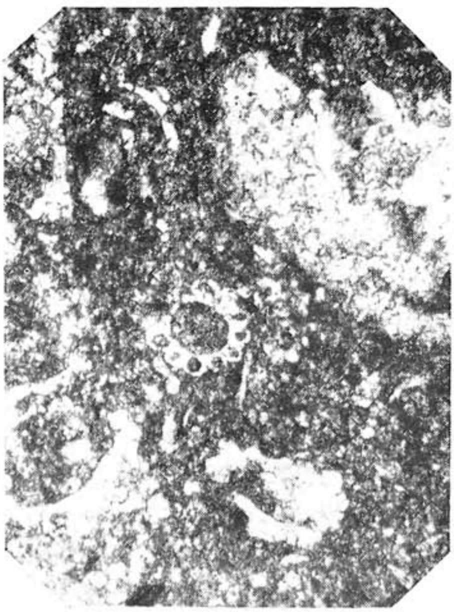

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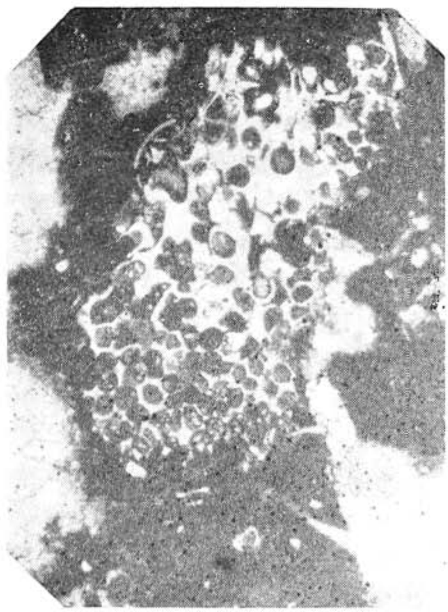

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Yellowish-brown fine-spotted limestone (Lipovec - II - d). Biomicrite with abundant freshwater algae (Pl. VII, Fig. 4, Pl. VIII, Fig. 1) resembling the occurrence in Turonian—Coniacian freshwater limestones from the Dobšiná Ice Cave. Microoncolites are rarely present; fenestrae — probably cavities after desiccation of sediment are frequent, also with internal sedimentation (textures of polarity) and clusters of pyrite grains.

Cream-coloured muddy limestone with grey veinlets and filled up cavities (Hradište p/V — j). Biointramicrite with abundant ostracodes (Pl. VIII, Fig. 2). sporadical blue-green algae aggregate and *Didemnoides* (?) sp. Muddy interclasts are coloured by bituminous substances, laminae of calcisiltite are found. The sediment cracked with desiccation as testified by synsedimentary veinlets and cavities filled up with mud of grey colour. Clusters of hydrated pyrite grains and microstylolites filled up with Fe-hydroxides are frequent.

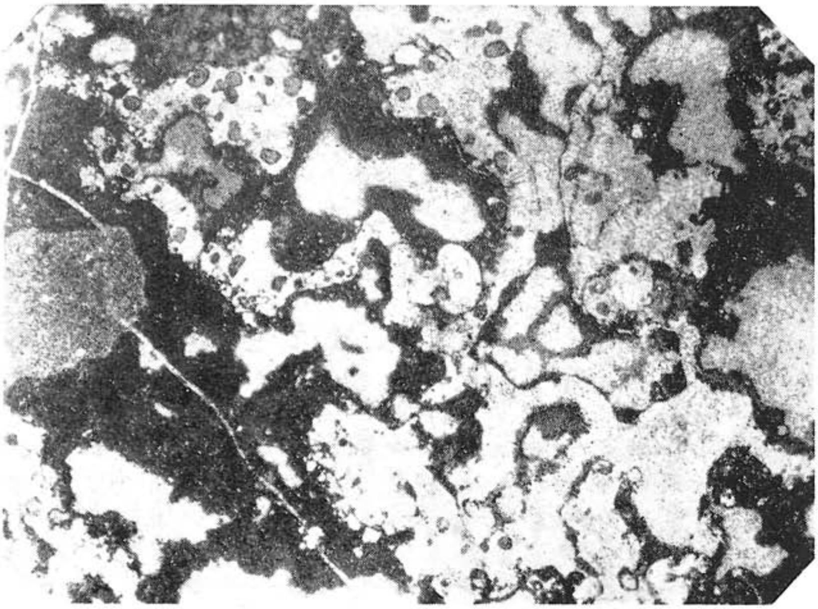
Yellowish weakly-spotted limestones (Lipovec - I - c, Naháč - D, II - 7). Microsparites and pelmicrosparites with quite sporadical organic remnants: ostracodes. fragments of thin-valved bivalves, *Didemnoides* (?) sp. Unclear pellets formed by agglutination. Spotted colouring comes from hydrated pyrite pigment. The first of the samples carries traces after bioturbation and synsedimentary cracking in form of a veinlet with micrite sediment on the lower side (polarity texture).

C o n c l u s i o n. Freshwater origin is indicated by monotonous associations of characeans, ostracodes and thin-valved bivalves. An extremely shallow-water origin is proved by desiccation traces, of cracking of sediments. A common feature is yellowish to brown spotted colouring, caused by unequal accumulation and hydratation of pyrite grains. The terrigenous admixture is completely missing. For palynological analysis five small pebbles were given, from which it was possible to separate too light-coloured sporomorphs from the pebble of Mníšek - s only. RNDr. P. S n o p k o v á, CSc. determined from them *Toroisporites* sp., *Baculatisporites* sp., *Cycadopites* sp., *Plicapollis* sp., *Minorpollis* sp., *Interpollenites* sp., *Oculopollis* cf. *minoris* W. KR., *Monocolpopollenites tranquillus* (R. POT.) TH. et PF. and 1 dinoflagellate. The majority of species are ranging from the Senonian—to Middle Eocene. The Neogene age may be excluded.

We succeeded in reconstruction of original extensive occurrences of freshwater Upper Cretaceous limestones (Coniacian or Turonian—Coniacian) with characeans and ostracodes from pebbles of Senonian conglomerates near the Dobšiná Ice Cave and Egerian conglomerates near Chválová (M i š í k—S ý k o r a, 1980, pp. 246—252, 254), thus from the Stratenská hornatina Mts. to the South Gemeride region. Their age was confirmed by RNDr. P. S n o p k o v á

P l a t e VIII

Fig. 1. Alga in Upper Cretaceous freshwater limestone. Pebble from the Jablonica conglomerates. Lipovec-II-d. Thin section no. 14536, magnif. 30×.
Fig. 2. Ostracodes in freshwater limestone. Cracking of sediment caused by desiccation is visible, the cracks are partly filled up with calcisiltite. Pebble from the Jablonica conglomerates. Hradište p/V. — j. Thin section no. 14223, magnif. 20×.



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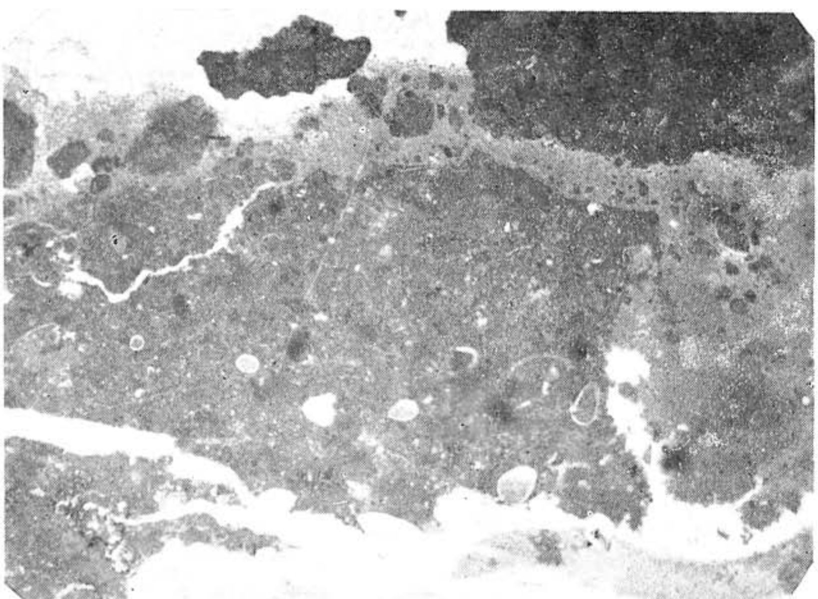

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(l.c. p. 250). The relict of the exposure of these freshwater limestones with *Munieria grambasti* BYSTRICKÝ was described by J. Bystrický directly from the Dobšiná Ice Cave; however, he considered their age as Lower Cretaceous and them as marine. Further relicts represented by oncolite limestones we verified at exposures near Betlanovce where they are resting with angular disconformity on the Jurassic and where already Mahel (1967, p. 303) considered them as Upper Cretaceous, however, not as freshwater environment.

An exposure of brown limestones with oncolites is known from the Čachtické pohorie Mts. (formerly Nedzovské pohorie Mts.). They were described them as náček (1954; 1956) as schizophyte limestones, but he considered them as marine Middle Triassic. After the revision of this exposure I consider them as Upper Cretaceous freshwater limestones lying disconformably on the Triassic substratum. Their most probable age is Turonian to Coniacian, from the period of extensive emergence of the Central Carpathians. They were deposited in depressions of the peneplanized territory, at the beginning of differentiation movements, of sinking, followed by transgression of the Senonian sea. This is testified by the fact that pebbles of brownish limestones with cyanophyte pisolites (thus oncolites) up to 5 cm large are mentioned by Borza (1962, p. 243, 251) from the Senonian Valchov conglomerates, also Paleogene conglomerates of the Brezovské pohorie Mts. Borza (l.c.) called attention to their resemblance with limestones found by J. Hanáček, however, not arguing with the opinion of their Triassic age.

Near Grünbach in the Eastern Alps amids a marine complex of the Gosau Group (Senonian—Paleocene) a coal-bearing sequence (Campanian) is found, on the basis of which occurrences of Characeae from brackish-limnic facies were signalized (Plöchinger, 1961); from washings of marls were determined here: *Tectochara* cf. *conica* MÄDLER; T. *ulmensis* (STAUB) MÄDLER and *Tolypella* sp. Thus I consider as the second, less probable possibility that the freshwater limestones with characeans described here could be derived from analogous freshened horizon amidst the Senonian of, the Brezová Group.

The occurrences of pebbles of freshwater limestones and characeans indicate that Upper Cretaceous freshwater limestones were taking up extensive area at NE termination of the Malé Karpaty Mts.

Senonian of the Brezová Group

Pebbles of Senonian limestones of marine development were found at three localities; they are organodetrital, sometimes sandy limestones; the main criterion for stratigraphy assignment are rudist fragments.

Plate IX

Fig. 1. Fragment of rudist shell in organodetrital limestone of Senonian shallow-marine facies. Pebble from the Jablonica conglomerates. Hradište p/V.—d. Thin section no. 14210, magnif. 26×.
Fig. 2. *Nymmofallotia cretacea* (SCHLUMB.) in Senonian limestone. Pebble from the Jablonica conglomerate. Prievaly — d. Thin section no. 14160, magnif. 26×.
Fig. 3. As before. Thin section no. 8276, magnif. 40×.
Fig. 4. As before. Thin section no. 14168, magnif. 40×.

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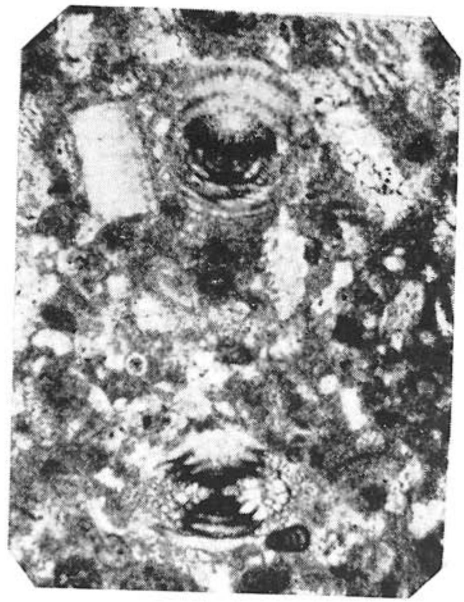

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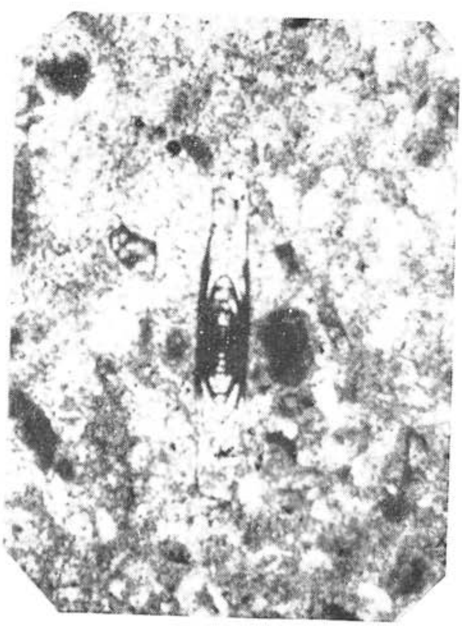

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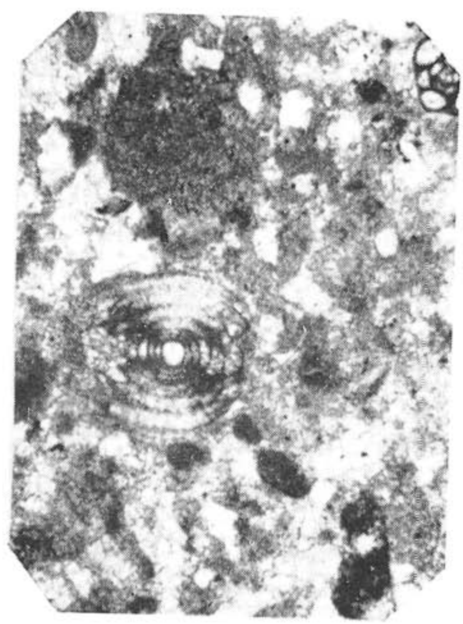

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Yellowish organodetrital-muddy limestones with rudist fragments (Hradište p/V — d, m. Lipovec - II - a). They represent biomicrites ("packed biomicrites") from angular fragmentes of radiolarites (Pl. IX, Fig. 1), oysters and other thick-valved bivales. The fragments are poorly sorted according to size (mean diameter 0.8 mm), much penetrated by boring algae. Rare echinoderm plates, coralline algae including *Archaeolithothamnium* sp., fragments of hydrozoans, *Pieninia oblonga* BORZA et MIŠÍK, sporadical echinoid spines, *Ethelia alba* (PFENDER), *Didemnoides moreti* (DURAND DELGA), miliolids, ophthalmids, *Planorbulina cretae* (MARSSON), *Globigerina* sp., gastropod, serpulid worm, ostracodes are joined. Without terrigenous admixture except one lithoclast of limestone with "filamentous" microfacies.

Brownish-grey fine-grained limestones with *Nummofallotia cretacea* (Prievaly — d). Foraminifers of a considerable number of genera including *Marsonella, Ophthalmidium, Textularia* and numerous specimens of *Nummofallotia cretacea* (SCHLUMBERGER, Pl. IX, Figs. 2—4) dominate. Fragments of bivalves much disturbed by boring algae (rudists, oysters, also bivalves with distinct prismatic layer), rare ostracodes, echinoid spines, *Pieninia oblonga* BORZA et MIŠÍK and much indeterminable debris of organisms follow. Weak admixture of clastic quartz of silt category.

The stratigraphic range of *Nummofallotia cretacea* (SCHLUMBERGER) is Coniacian—Maastrichtian. It was signalized from Slovakia once only, from orbitoid development of the Senonian in the Klippen Belt near Žilina and from pebbles in Paleogene conglomerates of the Periklippen zone near Považská Bystrica — in both cases there are Maastrichtian limestones (Köhler—Borza—Samuel, 1979). R. Oberhauser (in Plöchinger, 1961, p. 389) mentions from the Gosau depression of the Eastern Alps an abundant occurrence of *Nummofallotia* ex aff. *cretacea* (SCHLUMBERGER) from washings from marls (underlying *Acteonella* limestone of the coal-bearing series — Campanian). According to the mentioned author the abundance of this form testifies to proximity of dry land or brackish influences.

Yellowish-brown calcarenite-calclitite (Hradište p/V. — h). Fragments of older limestones sporadically affected by silicification, rare fragments of dolomites, considerable admixture of quartz of silt category predominate. Sporadically a fragment of rudist, *Pieninia oblonga, Ethelia alba* and echinoderm particles were present.

Coarse-grained sandstone and fine-grained conglomerate with *Ethelia alba* (Prievaly — a, j). I range them to the Senonian conditionally only. Besides rare fragments of *Ethelia alba* (PFENDER) they contain scarse fragments of bivalves

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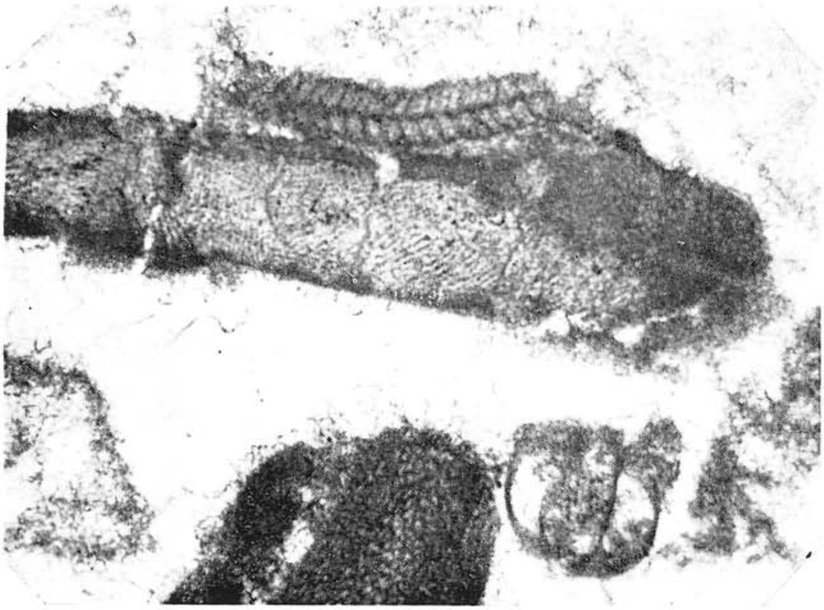
Plate X

Fig. 1. *Distichoplax biserialis* (DIETRICH) and *Ethelia alba* (PFENDER) in Paleocene—Lower Eocene limestone. Pebble from the Jablonica conglomerate. Naháč-1-3. Thin section no. 8724, magnif. 88 ×.

Fig. 2. *Nummulites subramondi* DE LA HARPE and *Discocyclina fortisi* (D'ARCHIAC) in Lower Lutetian sandy limestone. Pebble from the Jablonica conglomerates. Lipovec - II - b. Thin section no. 14227, magnif. 30×.



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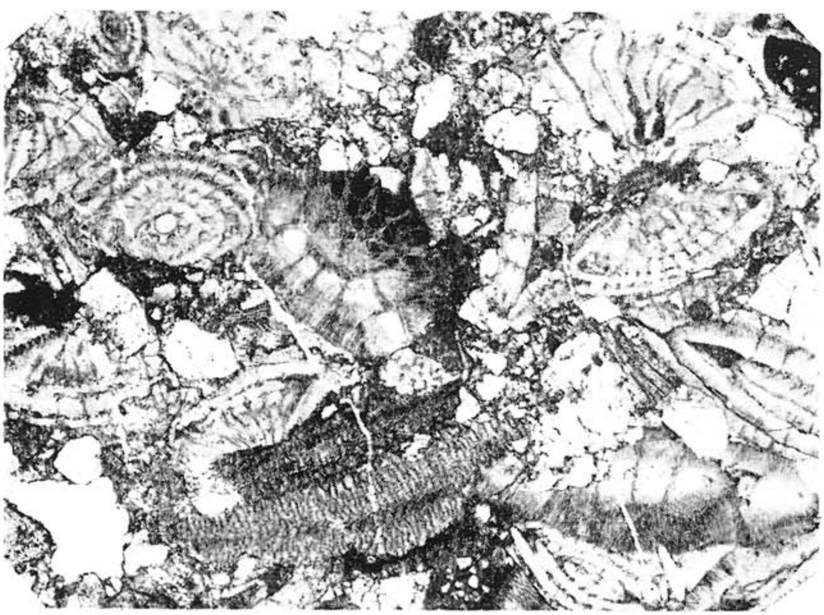

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(rudists ?) and *Archaeolithothamnium* sp. They are polymict clastic rocks with prevailing limestone fragments ("filamentous" and radiolarian biomicrites, also a fragment of Wetterstein type with radiaxial cement), with angular fragments of silicites and dolomites (mostly dedolomitized). Mutual pressing in of allochems connected with dissolution is frequent.

The mentioned rocks may be derived from the Senonian of the Brezovské Karpaty Mts. (Brezová Group), which was of larger surficial extension than at present. A small erosion remnant was found also at the margin of the Pezinské Karpaty Mts., near Rozbehy (Köhler—Borza, 1984).

Paleogene

Larger foraminifers from pebbles of Paleogene limestones were determined by RNDr. E. Köhler, CSc. In his opinion, the majority of associations point to a local origin from the Paleogene of the Buková syncline of the Malé Karpaty Mts., one sample is of distinctly exotic origin.

Greyish-yellowish organodetrital algae limestone with *Distichoplax biserialis* (Naháč — 3). Coralline algae (mainly the genus *Lithophyllum*), *Ethelia alba* (PFENDER), *Distichoplax biserialis* (DIETRICH) (PIA) (Pl. X, Fig. 1), rotalians, fragments of bivalves, sessile foraminifers, *Asterocyclina* sp., *Elianella elegans* PFENDER et BASSE = *Parachaetetes asvapatii* PIA et RAS., bryozoans, weak admixture of clastic quartz are present. Age: Paleocene—Lower Eocene; origin from the Paleogene of the Buková syncline.

Yellowish organodetrital limestones with *Peyssonelia antiqua* (Hradište p/V — e). Biomicrite with content of corraline algae *Lithophyllum* sp., *Peyssonelia antiqua* JOHNSON, fragments of originally aragonite bivalves, rotalians, bryozoans, *Ethelia alba* (PFENDER), fragments of dasycladaceans, rare silt quartz. Age: Paleocene—Lower Eocene; origin from the Paleogene of the Buková syncline.

Yellowish organodetrital limestones with *Discocyclina archiaci* (Lipovec - II - c, I - j). The subparallel structure is given by arrangement of coralline algae (mainly *Lithophyllum* sp.), which were highly fractured with compaction of sediment, further it contains *Ethelia alba* (PFENDER), *Parachaetetes asvapatii* PIA et RAS., *Discocyclina archiaci* (SCHLUMB.), abundant bryozoans, echinoderm plates, echinoid spines, admixture of clastic quartz, also scarce fragments of sandstone and silicites. Age: Lower Eocene; origin uncertain (from the Buková syncline or Brezovské Karpaty Mts.).

Brown sandy organodetrital limestones (Lipovec - II - b). Contains *Nummulites subramondi* DE LA HARPE (Pl. X, Fig. 2), *N. campesinus* SCHAUB, *Assilina* cf. *tenuimarginata* HEIM, *Discocyclina fortisi* (D'ARCHIAC.), *Asterocyclina* sp., scarce fragment of oyster and echinoderm particles. Often is breaking of tests by transportation and mutual pressing connected with dissolution. Abundant admixture of clastic quartz in grains more than 1 mm, fragments of sandstone and basic volcanic rock. Age: Lower Lutetian; origin probably from the Paleogene of the Buková syncline.

Yellowish-grey nummulite limestones (Naháč - II - 6). Contains *Nummulites spirectypus*, *Assilina placentula* DESHAYES, *Discocyclina archiaci* (SCHLUMBERGER), *Asterocyclina* sp., bryozoans, rotalians, *Ethelia alba* (PFENDER), abundant clastic angular quartz of medium diameter 0.3 mm and sporadical muscovite. The tests are undamaged, deposited subparallely. Age: Eocene; according to RNDr. E. K ö h l e r, CSc. there is an exotic pebble with association so far unknown from the West Carpathians; N. *spirectypus* was in the Alps.

Interstitial mass of the Jablonica conglomerates — Karpatian

The matrix of the Jablonica conglomerates is of the character of porous yellowish lithic sandstone with disseminated pebles, or of the character of fine-grained conglomerate; sporadically also thin intercalations of fine-grained sandstones are present in conglomerates. It is a disadvantage that we have no available samples from boreholes, because at outcrops the matrix is considerably affected by weathering factors. From eleven samples mostly two thin sections each were prepared (coloured by alizarine and uncoloured). Representation of individual clasts in this complex was as follows:

G r a i n s o f m i n e r a l s: quartz 11/11 feldspars (always in sporadical grains only), plagioclase 8/11, orthoclase 7/11, microcline 1/11, perthite 1/11; micas in sporadical scales only — biotite 5/11, muscovite 4/11; garnet (one grain each) 2/11, spinel 1/11.

F r a g m e n t s o f r o c k s: muddy limestones 11/11 (from them with filamentous microfacies 5/11, with *Calpionella alpina* — Upper Tithonian to Berriasian 5/11, with calcified radiolarians 2/11, Wetterstein limestones 3/11); dolomites (undisturbed by dolomitization) 9/11, dedolomitized fragments 5/11, silicites 9/11 (from them red with radiolarians 3/11, with smal carbonate rhombohedrons 5/11 — thus they are mostly fragments from chert concretions from limestones); grey-wackes and sandstones 8/11 (from them with ferric cement 2/11), quartzites 5/11, clay shales 2/11; phyllites 7/11, metaquartzites and metapsammites 3/11, weakly metamorphosed limestones 3/11; granitoids 5/11, basic volcanics 5/11, felzites 4/11, quartz porphyry 1/11, marl with globigerines 1/11, fragment of quartz - tourmaline rock or veint filling (from the Malé Karpaty Mts. it is know from Lower Triassic quartzites — M i š í k—J a b l o n s k ý, 1978).

The cement is almost always from medium-grained calcite. On the whole, the matrix contains fragments of all main types of rocks present in the shape of pebbles in fraction more than 3 cm. Fragments of carbonate rocks are usually prevailing over other ones (7—11), rarely are in approximate equilibrium (2—11) or in minority (2—11) on the contrary to non-carbonate clasts. The psammite fraction is on the contrary to psephite fraction enriched in some types of easy-friable or desintegrated rocks at outcrops as silicites and dolomites (compare M i š í k—S ý k o r a, 1981, p. 54). More abundant representation of small aggregates of granitoid rocks on the contrary to their rare occurrence in fraction more than 3 cm is surprising; perhaps granitoid rocks were desintegrated at exposures, however, such small fragments could have been redeposited also from arcoses.

Organic remnants in the interstitial mass have not been found except one fragments of coralline alga (Lipovec - II - g), autochthonity of which is also not sure. This would seem to testify for non-marine environment of deposition of conglomerate, however, the very rare occurrence of organic remains in conglomerates is generally known.

Dedolomitization (calcification) of small dolomite fragments is a remarkable phenomenon in the matrix; it has been found in almost one half of samples. Without doubt it has only in conglomerate, so there is no supply from any dedolomitized mother rocks. Sometimes it is to be seen already megascopically at outcrops that the core of small dolomite pebble (up to 5 mm) is of different colour than its peripheral part, which is affected by dedolomitization.

In 5 samples from ten only dolomite fragments unaffected by dedolomitization were found (from them Prievaly — 1 and Bosý Jarok — ch, they contained dolomite fragments with thin coatings from Fe-hydroxides — analogous observation see Marschalko—Mišík—Kamenický, 1976, p. 85), in two samples affected and unaffected fragments were found together and in two samples all fragments were affected by dedolomitization (recalcification) at least to certain extent.

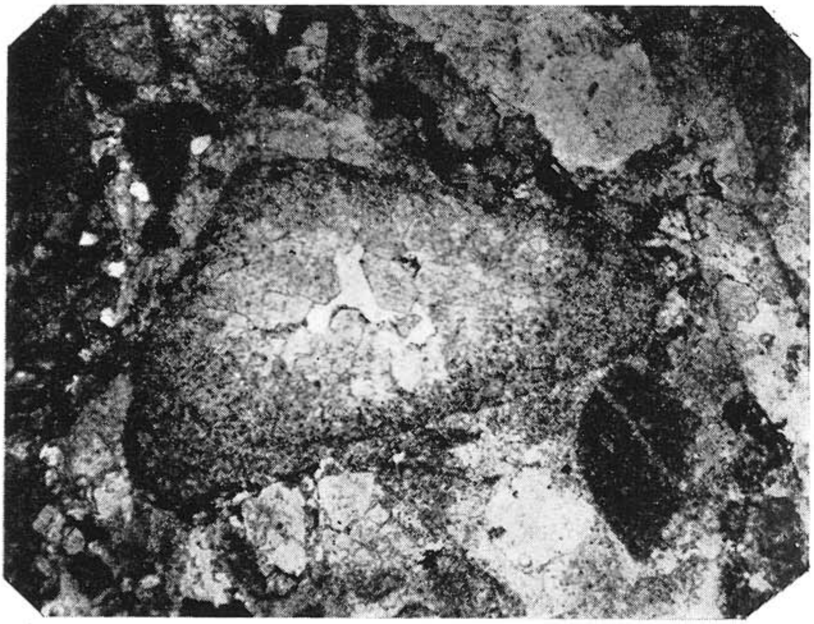
In thin sections coloured by alizarine it is to be seen that dedolomitization is taking place centripetally (beginning from the periphery of pebbles), the centre of pebbles is less affected or unaffected. Pebbles completely dedolomitized have usually abundant small dolomite inclusions — relicts in the peripheral part. The calcite druse enlarges its grain towards the centre of pebble, the centre is clean, without inclusions (Pl. XI, Fig. 1). This shows that in the initial phase in the surficial part of pebble dolomite was replaced by calcite whereas the centre of pebble was leached and calcite already precipitated into empty leached out space. This process is also indicated by frequent negative after leached pebbles (probably of dolomite), and hollow pebbles (Pl. XI, Figs. 2, 3), from which dedolomitized crust has preserved only. In some partly leached pebbles a druse of calcite crystals protrudes into the cavity.

The second way the „loop dedolomitization" (Pl. XII, Fig. 1) occurs in clasts of medium — and coarse-grained dolomites. Calcite penetrates into dolomite along intergranulars and replaces the individual grains from the periphery. Dolomite is penetrated by poikilotopic calcite. We described dedolomitization in the shape of phantoms after pebbles, visible only owing to relict pigmentation, from the Upohlava conglomerates (Mišík—Sýkora, 1981, p. 73); this type has not been found in the Jablonica conglomerates.

The described dedolomitization is of relatively young date; it was probably taking place under the influence of hypergenic processes in the zone of phreatic waters with sulphate ions. Leaching of dolomite and partly dedolomitized pebbles is taking place under conditions of subaerial weathering also at present; it characterizes the weathered parts of the exposure of locality Mníšek. Here all small clasts were dedolomitized and even in fraction more than 3 cm tested with HCl no dolomite pebble has been found.

Plate XI

Fig. 1. Dedolomitized small pebble in the interstitial mass of the Jablonica conglomerates of Karpatian age. Lipovec - I. Thin section no. 14533, magnif. 30×.
Fig 2. Hollow, leached pebble of dolomite in the Jablonica conglomerates. Mníšek, slightly magnified.
Fig. 3. Hollow pebble of dolomite partly filled up with verrucose sinters. As before.



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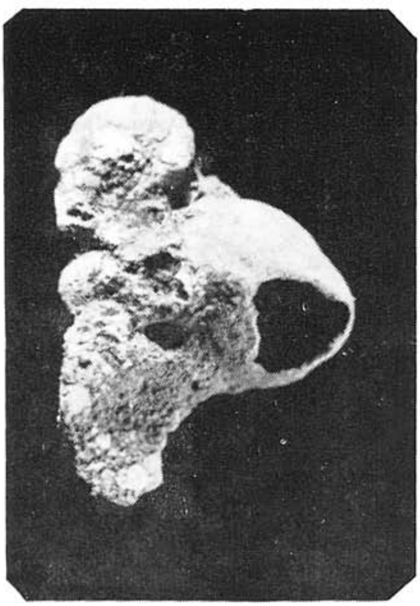

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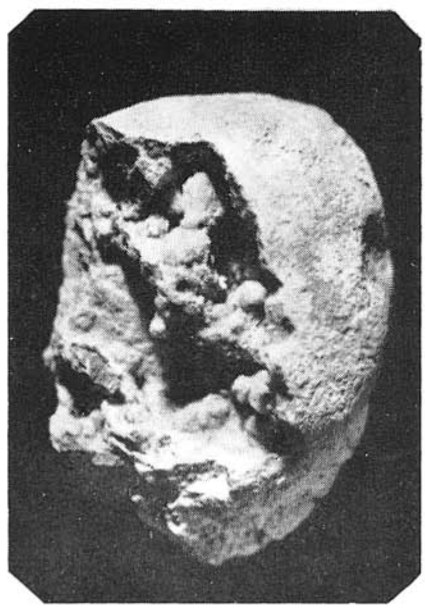


3

I ascribe to subrecent and recent processes formation of small speleothems on the lower side of pebbles — verrucose sinters (Pl. XII, Fig. 2), sporadically they are also found in interstitial mass.

At the loc. Prievaly pebbles of granites and phyllites are highly weathered, desintegrate when touched. Their desintegration can be taken into consideration, caused by percolation of acid solutions from a peat-bog, which was probably found in the overlier and later removed by erosion (such a peat is exploited in the not far deposit Cerová Liesková). The limestone pebbles, however, are not showing traces of etching by such solutions.

Representation of main types of rocks in pebbles (fraction more than 3 cm)

Limestones. Their content varies between seven investigated localities (Tab. 1), within the limits of 41.5 % (Dobrá Voda) to 79.5 % (Hradište p/V.), otherwise besides the former mentioned locality is always more than 60 %. In general, the most frequent type are limestones of Wetterstein facies.

Dolomites are represented from 0 % to 9.3 % (Dobrá Voda). Their low portion is obviously caused by the fact that already in original source sequences desintegrated dolomites (tectonic breccias, dolomite flours) were exposed, so that they may be abundant in psammite fraction only. In elimination of dolomite also dedolomitization in Karpatian sediments was taking part.

Psammites. Their content varies from 12.7 % (Lipovec) to 42.5 % (Dobrá Voda). From them the share of quartzites is from 1.5 % (Naháč) to 15.7 % (Mníšek).

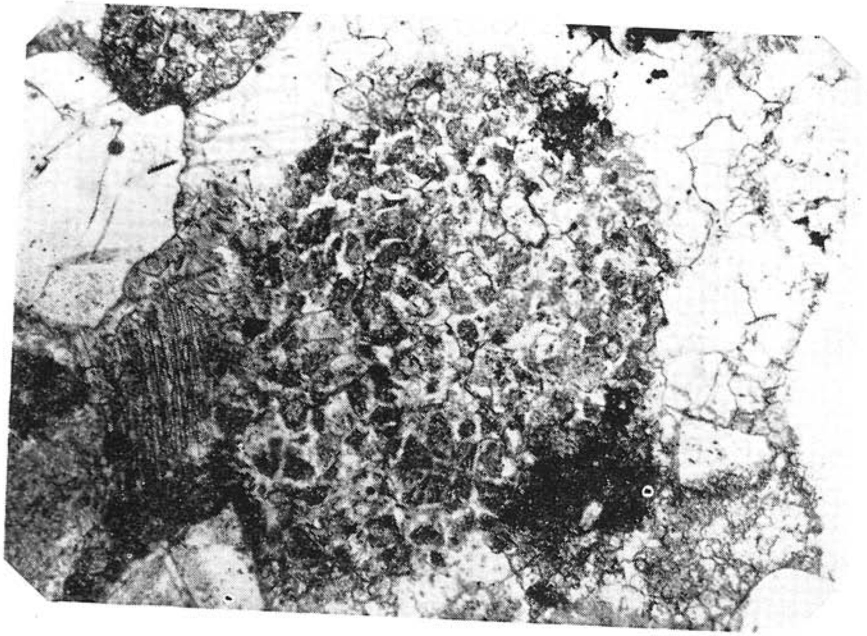
Volcanics. Their share is around 1—2 %, only at the locality Dobrá Voda it was 6.2 % and at the loc. Mníšek 5.9 %. It is noteworthy that at these two localities is also the highest share of psammites. This would support the assumption that there are Permian volcanics, however, at the locality Dobrá Voda only one pebble of red sandstone was found (basic volcanics including amygdaloids are prevalent ever acid ones here). At the loc. Mníšek quartz porphyries (5.3 % on the contrary to 0.6 % of basic volcanics) conspicuously dominates, at the loc. Lipovec acid volcanics have been found only.

Silicites. They are in amount 0.5—4 %; a part from them comes from chert concretions, as is also evident from the occurrence of pebbles of cherty limestones.

Vein quartz. Occurs from 0 % (Dobrá Voda) to 3.5 % (Bosý Jarok and railway station Buková); almost everywhere is, however, less than 1 %.

Plate XII

Fig. 1. Loop dedolomitization of dolomite clast from sandstone interstitial mass of the Jablonica conglomerates — Lipovec - I. Thin section no. 14299, magnif. 95×.
Fig. 2. Speleothem in the shape of verrucose sinter formed recently on the lower side of pebbles, and in porous matrix of the Jablonica conglomerates. Thin section no. 9205, magnif. 48×.
All photographs are from material of the author, photo by L. Osvald.



1

2

G r a n i t e s. Present in scarce specimens only (everywhere less than 1 %), except the westernmost locality Prievaly (5 %), where they are derived distinctly from granitoid massifs of Malé Karpaty Mts. Sporadical granite pebbles from other localities could be redeposited from Cretaceous conglomerates, as is also indicated by complete absence of amphibolites, abundant in crystalline rocks of the Malé Karpaty Mts.

M e t a m o r p h i t e s. Paleoezoic metamorphites are only scarcely present (less than 1 %), except the westernmost locality Prievaly (2 %), where also garnet - - staurolite mica schist was found. In the easternmost localities they are missing (Naháč, Dobrá Voda, Hradište p/V.). This would testify to a supply of Paleozoic metamorphites from SW. The same picture is in dynamic—metamorphosed Mesozoic limestones with the only exception Hradište p/V., where they were found in an amount of 1.8 %.

Leading rocks with regard to supply directions

Some rocks play a decisive role in searching for source area of the Jablonica conglomerates. We recapitulate rocks proving the supply from two contrasting directions.

T r a n s p o r t a t i o n f r o m SW:

Dynamic - metamorphosed limestones may come only from the Borinka development of the mantle unit — Tatricum and from the Harmónia Group, what in our case clearly implies supply from SW. In Cretaceous—Paleocene conglo-

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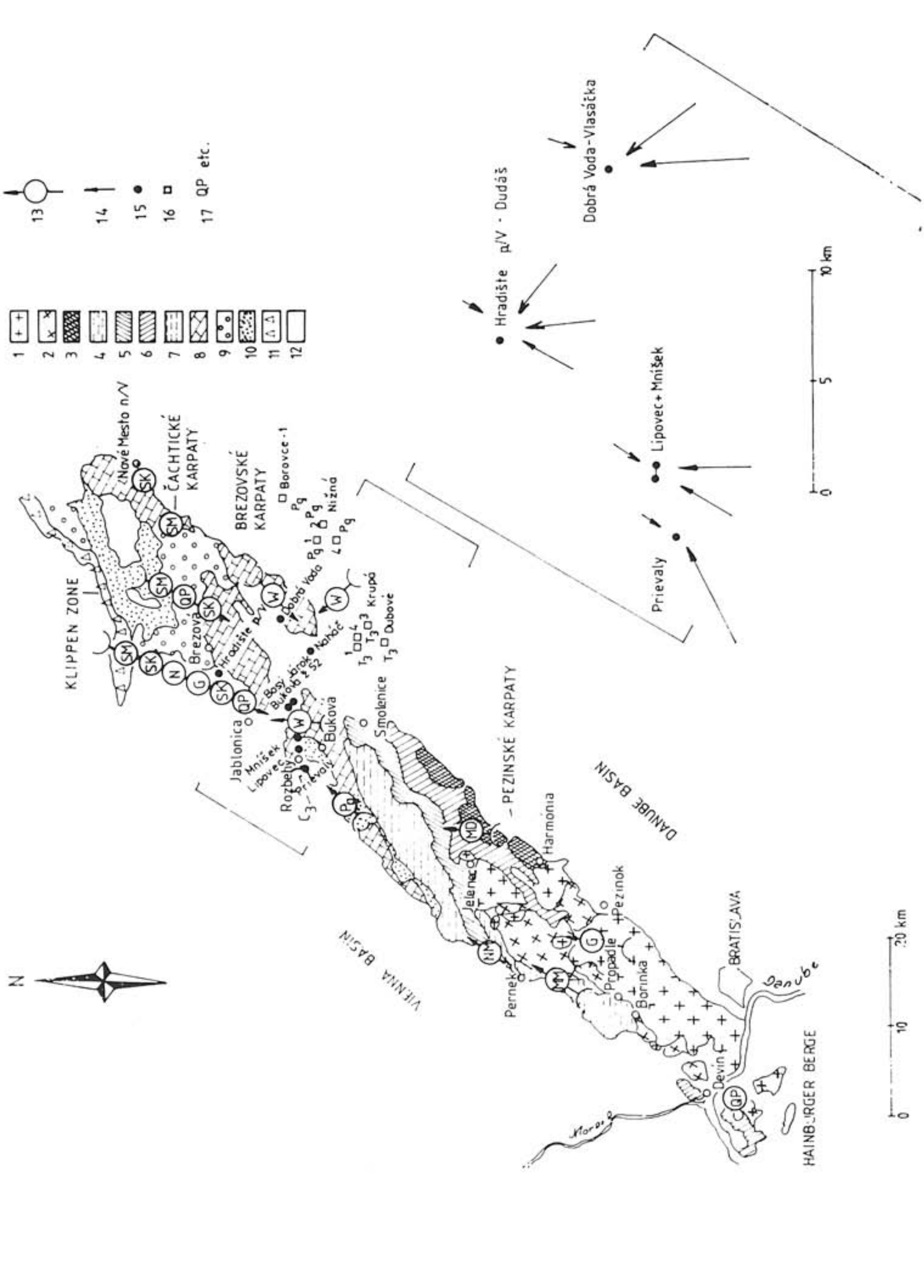
Fig. 1. Source areas of the Jablonica conglomerates with indicated leading types of rocks.

Explanations: 1 — crystalline core of the Malé Karpaty Mts. (granitoids with sunken blocks of gneisses and amphibolites); 2 — Pezinok-Pernek Group (metamorphosed Paleozoic of non-carbonate character); 3 — Harmóna Group (metamorphosed complex with carbonate intercalations, probably Devonian); 4 — Borinka succession of the Tatricum (mantle of crystalline massifs, T_1—K_2 in places metamorphosed); 5 — Devín and Orešany succession of the Tarticum (T_1—K_2, in the Devín succession also P); 6 — Krížna nappe — Fatricum (T_1—K_2, mostly Vysoká succession); 7 — Choč nappe — Hronicum (P—T_3, Permian—Malužiná unit with melaphyres); 8 — highest Subtatric nappes (in the Pezinské Karpaty Mts. exclusively Triassic with dominating Wetterstein limestones and dolomites, in the Čachtické Karpaty Mts. also J—K_1); 9 — Brezová Group (including the Valchov conglomerates, K_3 — Senonian); 10 — Paleogene; 11 — Klippen Belt (J_1—K_3); 12 — Neogene and Quaternary; 13 — supposed source of the leading rock for the Jablonica conglomerates; 14 — the arrows are not indicating the direction of deposition for the individual localities but the origin of material; their length is proportional to representation in the association of pebbles; 15 — investigated localities of the Jablonica conglomerates (Karpatian); 16 — boreholes; 17 — some leading rocks in pebbles: G granitoids (Carboniferous), K — Upper Cretaceous (Senonian) in marine development, MD — metamorphosed Devonian, MM — metamorphosed Mesozoic, NM — neritic facies of the Malm (association of crinoids + tintinnids), N — Norian limestones with conodonts, QP — quartz porphyry, SK — freshwater Cretaceous, SM — shalow-water facies of the Malm (with *Clypeina, Conicospirillina*), W — Wetterstein facies of the Triassic.



KLIPPEN ZONE
Nové Mesto n/V
ČACHTICKÉ KARPATY
BREZOVSKÉ KARPATY
Borovce-1
Nižná
Brezová
Hradište p/V
Dobrá Voda
Naháč
Krupá
Dubové
Bosý járok
Buková
Jablonica
Mníšek
Lipovec
Rozbehy
Prievaly
Smolenice
PEZINSKÉ KARPATY
DANUBE BASIN
VIENNA BASIN
Harmónia
Jelenec
Pezinok
Pernek
Propadle
Borinka
BRATISLAVA
Danube
Devín
HAINBURGER BERGE
Morava
Hradište p/V - Dudáš
Dobrá Voda - Vlasáčka
Lipovec + Mníšek
Prievaly
0
5
10 km
0
10
20 km
17 QP etc.

merates of the Klippen Belt and Periklippen region pebbles of the dynamic-metamorphosed Mesozoic are not present. Carbonate rocks with a greater amount of authigenic feldspars may only come from the mantle and Krížna unit of the Pezinské Karpaty Mts., thus again supply from SW as authigenic feldspars are almost completely missing in carbonate pebbles from Cretaceous conglomerates of the Kysuca and Klape units (Mišík—Sýkora, 1981) as well as from the Brezová Group. The Upper Tithonian of neritic (transitional) facies with association of calpionels and crinoid debris is derived from this direction from the Vysoká unit (this microfacies is known to me from the quarry of Pernek). Garnet - staurolite mica schist obviously comes from the crystalline core of the Malé Karpaty Mts. (in Cretaceous conglomerates pebbles of crystalline schists are sporadical, this type has not been found in them).

Generally it is surprising that in the association of rocks supplied from SW granites and crystalline schists are so little represented; this perhaps is connected with their desintegration by the weathering at exposures of that time. Surprising is also lacking of basic volcanics, which could have been derived from the „Melaphyre Group" (Malužiná formation of the Permian of the Choč nappe). Lacking red sandstones disprove derivation of rare pebbles of basic volcanics from this sequence (e.g. at the locality Dobrá Voda - Vlasáčka only one such pebble was found, which rather can be belong to the Lower Triassic). At the locality Prievaly with most distinct supply of rocks occurring in the SW part of the Malé Karpaty Mts. most melaphyre pebbles could be expected, however, only one amygdaloid pebble was found, which rather can be attributed to redeposition from Cretaceous conglomerates. As I know abundant small fragments of melaphyres (basalts) in sandstones of the higher part of the Buková Paleogene, it is clear that the Malužiná Group must have been uncovered already in the Karpatian. If it were completely covered with Paleogene sea later, Paleogene pebbles must have been abundant at the locality Prievaly, but it is not so. It is necessary to remark that melaphyres (basalts) have not been drilled in the substratum of the Vienna basin and their continuation into the Eastern Alps is not known, thus wedging out of the Malužiná Group in this direction is most probable. The source of material for the locality Prievaly were, according to all indications, rocks from continuation of the Malé Karpaty Mts., hidden below the Badenian of the Vienna basin at present. We have no reason even to affirm that the Malužiná formation with melaphyres continues from the area of Sološnica - Smolenice to the NE and it was hidden there below the Neogene of the Danube basin margin. Melaphyres have not been encountered by any borehole in this region (Biela, 1978). They were probably removed by erosion from this region still before the Neogene, as indicated by an ascial elevation with the tectonic window of the Krížna unit outcroping from beneath the Choč unit at the eastern end of the Pezinské Karpaty Mts. near Smolenice.

Transportation from NE:

In this question is a contradiction between the results of Kováč (1985), who has not established such a direction of transportation by measuring of pebble orientation and our results proving transportation from NE. The direction of deposition need not alway have been identical with the character of total trajectory, which the pebble passed through from the source area to definite deposition. We refer to primary occurrences of critical rocks and mainly to redeposition of pebbles from polymict Upper Cretaceous conglomerates from the Klippen Belt, described by Mišík—Sýkora (1981) and from the Valchov conglomerates of the Senonian of the Brezová Group (previously designated as the Gosau formation) and from the Periklippen Paleogene described by Borza (1962), completed by own observations. This redeposition is most distinct for quartz porphyries (paleorhyolites). To a certain extent, however, the absence of pebbles of the Urgonian (mainly Orbitolina) limestones is surprising, because they are a frequent component in the mentioned Cretaceous conglomerates. With redeposition there was obviously high enrichment in resistant rocks to the detriment of carbonate rocks.

A remarkable phenomenon is the complete absence of redepositions from transgreding Eggenburgian breccias and conglomerates, proving a larger extension of the sedimentation area of the Karpatian than of the Eggenburgian.

Norian limestones with conodonts. These brown and grey muddy limestones (nearer p. 000) have not been known from the Central Carpathians so far (similar facies is only mentioned by Mock, 1980, from the Meliata succession of the Gemericum). At present, however, outcrops with Norian conodonts have been established in the Brezovské Karpaty Mts. (oral communication by dr. K. Puškárová). An alternative explanation of the origin is redeposition of pebbles from Cretaceous conglomerates of the Klippen Belt, where from we mentioned similar exotic pebbles with abundant Carnian conodonts (Mišík—Mock—Sýkora, 1977). Pebbles of the Upper Triassic of the Klippen Belt as well as the studied pebbles from the Jablonica conglomerates are characterized by uncommon density in representation of conodonts on the contrary to other conodont-bearing sequences from the West Carpathians. Data on their density in Norian pelagic limestones of the Brezovské Karpaty Mts. are missing so far. Both mentioned sources indicate a supply from NE, what is especially distinct for the locality Lipovec.

Limestones of the shallow-water Malm with *Conicospirillina basiliensis* and *Clypeina jurassica* may be derived from two sources, both imply supply from NE. There is either redeposition of these pebbles from the mentioned Upper Cretaceous—Paleocene conglomerates, or they are derived directly from the Barmstein limestones of the highest nappes, small relicts of which are known from the Čachtické Karpaty Mts. (Mišík—Sýkora, 1982). It is evident from the position of the Paleogene above the Triassic in the area of Buková that already before the Paleogene the Jurassic of the highest nappes was eroded from these area and so in no case we may count with their occurrence during the Karpatian.

Fresh-water limestones of probably Upper Cretaceous age may be derived from primary exposures analogous to the only occurrence in the Čachtické Karpaty Mts. (described by Hanáček, 1954, 1956, originally considered as marine Middle Triassic; more in detail p. 000). Rocks of equal character were found by Borza (1962) in form of pebbles in Senonian and Paleogene conglomerates of the Brezovské Karpaty Mts. where according to our experience (Mišík—Sýkora, 1980) also pebbles of limestones with characeans may be expected.

Senonian limestones with marine organisms come from the Brezová Group. Although their westernmost relict has found near Rozbehy (Köhler—Borza, 1984) hardly it may be counted with their original extension in the

Karpatian in the area south of Buková as the Paleogene is everywhere resting directly on the Triassic there. Attribution to the Senonian is proved by fragments of rudists, the association of algae and foraminifer *Nummofallotia cretacea* (SCHLUMBERGER).

Quartz porphyries (rhyolites) I explain by redeposition from Cretaceous conglomerates, most probably from the „Upohlava" conglomerate of the Klippen Belt. If we searched for some primary localities, the nearest are situated at the SW end of the Malé Karpaty Mts. in the Hainburg hills, already at Austrian territory (Tollmann, 1977), in the Permian of the Tatricum of Devín development. They are about 60 km distant. From nearer areas the Permian of the Tatricum was eroded still before transgression of the Triassic as testified by basal Triassic quartzites resting directly on granitoids. The further nearest primary occurrence (also about 50—60 km) is formed by quartz porphyries in the Permian of the Tatricum of the Považský Inovec Mts. They are, however found in subordinate amount, mostly described from boreholes only. In the Permian „Melaphyre Group" (Malužiná Group of the Choč nappe) of the Malé Karpaty Mts. no quartz porphyries (rhyolites) are present. Bajaník—Hovorka—Miko—Vozár (1981) mention sporadical paleoandesites only. As already mentioned, even in boreholes of the adjacent part of the Danube basin no volcanic intercalations have been found in Permian or other sequences. The supposed continuation of the Veporicum below the Neogene could be found here at a distance of around 80 km. When also in this zone quartz porphyries are abundant in the Hron valley, boreholes do not indicate that we should count with their presence here.

The size of pebbles of quartz porphyries excludes far transportation. The most suitable explanation is their redeposition from Senonian conglomerates of the Brezová Group (distance around 10 km) or from Cretaceous conglomerates of the Klippen Belt (about 10—15 km). The size of pebbles is not contradictory to these assumptions. It attains in the Jablonica conglomerates maximum 17 cm (loc. Mníšek), or 12 cm (loc. Lipovec), whereas in the supposed source areas — —in Cretaceous conglomerates of the Klippen Belt at the nearest locality Branč they attain up to 20 cm; loc. U Škulcov 25 cm; loc. Starý Háj 22 cm. We remark, however, that at more distant localities of the Klippen Belt much greater diameters were observed, e.g. Nosice — elev. p. 565 a pebble up to 55 cm large. Whereas in the Jablonica conglomerates quartz porphyries only sporadically reach 5 %, in the area 1—2 km ESE from Rozbehy residual (?) gravels are found, in which pebbles of quartz porphyries reach up to 90 %. The genesis of these gravels has not been cleared up.

Translated by J. Pevný

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Errata

In the paper M. Kováč: Lower Miocene sedimentation... Geol. Zbor. Geol. carpath. 1/37/1986, on the page 8 a reference M. Mišík in the present issue of Geol. Zbor. is incorrect. It should be: Mišík (4/37/1986 Geol. Zbor.).