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A NOTE TO THE STRATIGRAPHY AND OCCURRENCE OF THE TERTIARY AUTOCHTHONOUS SEDIMENTS OF THE BOHEMIAN MASSIF IN THE SUBSTRATUM OF THE MORAVIA-SILESIAN BESKIDS

O STRATIGRAFII A ROZŠÍŘENÍ TŘETIHORNÍCH AUTOCHTONNÍCH SEDIMENTŮ V PODKLADĚ MORAVSKO-SLEZSKÝCH BESKYD

(Textfigs. 1–2, Plates V–X)

Abstract. On the basis of deep borings were found the Tertiary autochthonous sediments of the Bohemian massif in the substratum of the Moravia-Silesian Beskids.

Approximately to the year 1905 as autochthonous mantle of the eastern part of the Bohemian massif were regarded all postcarboniferous sediments in the Moravia-Silesian Beskids. When H. Beck (1906) and W. Petrascheck (1906) proved by investigations of boring in the Beskids, by L. Höhenegger (1861) observed overthrust of the Cretaceous on the Paleogene, V. Uhlig (1907) has created, on the basis of this and earlier interpretations of Lugeon (1903) and Limanowski (1905), new nappe conception of Carpathians. While H. Beck and Petrascheck regarded the "subbeskid" Paleogene as autochthonous (Petrascheck partly as separated from the substratum), V. Uhlig (1907, 1908) supposed larger overthrust of the "subbeskid" Paleogene to the north-west on the Neogene. Despite T. Fuch's (in Petrascheck, 1912) Neogene "Schlier" macrofauna, found in the Bruzovice drilling in the substratum of Carpathians, which served as evidence of the correctness of the Uhlig's opinion, predominated up to the year 1950 the Petrascheck's opinion that the "subbeskid" Paleogene is in essentiality autochthonous (D. Andrusov, 1936, 1937). M. Vašíček (1950, 1951), V. Homola, E. Hanzlíková (1954) proved again on the basis of drillings the overthrust of the Cretaceous and Paleogene of Carpathians on the Neogene of the Bohemian massif. T. Fuchs (l. c.), E. Hanzlíková (1954, 1958), V. Homola, M. Holzknecht (1957) supposed in the substratum of Carpathians older Miocene, but only J. Cicha and J. Paulík (1959) presented up to present valid opinion that all the sedimentary filling of the Carpathian foredeep belongs to the Neogene of the Carpathian formation (Carpathian).

Also up to present accepted overthrust of the Carpathians on the foredeep and the original position of the sedimentary district of its series were regarded very variably. While before the year 1905 all the postvariscian sediments, in essentiality autochthonous, Limanowski (1905) regarded as belonging to the sedi-

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mentary district of the flysch zone of Carpathians into the Dinaridy region and V. Uhlig (1907) into the district of Central Carpathians, W. Petrascheck (1906, 1912) proved on the basis of character of exotics that the productive Carboniferous of Uppersilesian type was a constituent of source region of the "subbeskid Paleogene", and therefore he supposed the Paleogene sedimentary district in the eastern part of the Bohemian massif. In general, this is valuable (see Z. Roth and coll., 1962). Already W. Petrascheck (l. c.) supposed a tearing off and movement of the "subbeskid Paleogene" in regard to variscian substratum. T. Fuchs (l. c.), E. Hanzlíková and V. Homola (l. c.), and in the last time I. Cicha (1961), proved that these sediments are overthrust on the Neogene of Carpathian foreland more that 20 km. Thus was proved a great tectonic independence of original "subbeskid Paleogene" on the variscian block and contemporaneously (E. Hanzlíková, E. Menčík, V. Pesl, 1953, A. Matějka, Z. Roth, 1953) the fact that a great part of the "subbeskid Paleogene" is composed of the Upper Cretaceous and therefore we changed the name "subbeskid Paleogene" to Subsilesian (Subsilesia-Ždánice) unit (Roth, 1957). Drillings show that 1. the thickness of the Carpathian Neogene formation (autochthonous mantle of the Bohemian massif) in the substratum of Carpathians southward from the buried Maleník–Příbor–Žukov ridge increases, and the Carpathian we may microbiostratigraphically and lithobiostratigraphically divide, 2. by the stratigraphical position of the variegated beds in the subsilesian series it is possible, in its Beskid section, to distinguish the sediments of interior and exterior part of the sedimentary district, 3. in southern part of the sedimentary district of Subsilesia-Ždánice unit in the Frýdek beds besides the usual Upper Senonian was included also Turonian and Lower Senonian (Z. Roth, E. Hanzlíková, I. Cicha, 1963).

Existing opinion on the stratigraphy and lithological division of sediments of recent eastern part of the Bohemian massif buried under overthrust Carpathians in the region of Moravia-Silesian Beskid we may conclude as follows: the Silesian sedimentary district was in eastern part of the present Bohemian massif. North-west of the Silesian district, during the transgression of the Upper Cretaceous, developed the Subsilesian sedimentary district which we may divide into exterior and interior parts. North-west of the exterior Subsilesian district developed then the sedimentary district of the Carpathian which, however, in eastern part of Beskids transgreded also on the Upper Cretaceous (drilling near Oldřichovice, W. Petrascheck, 1928, E. Menčík, 1960). Up to the present the subsilesian and Silesian sediments are known only from the allochthonous structure of Carpathians. Only on the southern slope of the Maleník–Příbor–Žukov ridge (buried) some drilling uncertainly indicated a local transgression of the Middle Eocene (Z. Roth, 1957) on the Carboniferous under the "Carpathian". Very frequent redeposition of microfauna and fragments of rocks of the Subsilesia-Ždánice unit in the "Carpathian" serves as an evidence of probable transgressive character of the "Carpathian" on the Subsilesia-Ždánice unit.

Study of the Cretaceous and Tertiary from the drilling NP 307 near Ženklava (Z. Roth, 1962) afforded a found of almost 100 m thick normal sequence of the Paleocene to Upper Eocene proved by E. Hanzlíková (1959) on which lies almost unaffected Carpathian formation in form of lenses on the basis of Carpathians. On the basis of Paleocene and Lower Eocene age of the variegated Subsilesian beds in the mentioned fragment, we see, that it represents well preserved part of the exterior sedimentary district of Subsilesia-Ždánice series. A little discontinuity of sequence in the fragment and presence of the "Carpathian" in the upper parts of the drilling allows with certain probability to suppose that also south of Ženklava the exterior part of the Subsilesia-Ždánice sedimentary district was covered by transgressive "Carpathian". In regard to occurrence of the "Carpathian", which in Beskids represent autochthonous or parautochthonous formation, we mark also the fragment with the Paleogene series as parautochthonous. Comparision with similar, formerly known fragments of the exterior part of the Subsilesia-Ždánice series, allows reconstruction of the earlier constituents than that of the mentioned fragment from the drilling NP 307 and investigation of fresh-water variegated sediments in this drilling, and in other ones, on the base of the autochthonous Tertiary (Z. Roth, E. Hanzlíková, I. Cicha, 1962) with help of micropaleontological and palynological methods, also comparision of the deepest Tertiary beds, autochthonous with the mentioned parautochthonous Paleogene.

Description of the drilling NP 307 (Ženklava)

The drilling NP 307 near Ženklava south of Štramberk passed through the Subsilesia-Ždánice unit (364,0 m) represented by the Frýdek beds (Maastrichtian), further by the Třinec beds (Paleocene–facies of spotted and black-grey claystones) and higher by the Třinec Subsilesian beds (Upper part of the Middle to Upper Eocene). In this unit there is in some narrow belts uplifted Těšín–Hradiště suite with eruptives of the těšinite formation (Neocomian to Aptian).

In the depth of 364 to 388 m was found the Neogene Carpathian formation with microfauna (see I. Cicha, 1961; Z. Roth, E. Hanzlíková, I. Cicha, 1962) again with tectonic fragments of the Těšín–Hradiště suite (Aptian?). In the depth of 388,0 to 414,2 m penetrated the drilling the Carpathian formation with microfauna and tectonically mantled with the variegated subsilesian beds (the Lower to Middle Eocene) and the Třinec beds (facies of black-grey claystones of the Paleocene).

In further part of the drilling (414,2–523,6 m), which is especially interesting due to its weak tectonic disturbance and special facial character, occurs the "Carpathian" Neogene formation in the "Schlier" development (414,2–423,5 m) (with 5 micropaleontological samples). Here occur claystones (locally hard) slightly sandy, calcareous and (or noncalcareous), green-grey with fine (a few mm) laminae of fine-grained, light-grey sandstone, locally on fissures also of red-brown colour caused by limonite. The claystones are impregnated by rusty limonite. In the depth 420,55–423,5 m were in these beds observed to 1 cm thick veins of gypsum, in the depth of 418,8–419,5 m thin intercalations of diatomite. Inclination of beds, found in the depth of 419,0–421,7 m, was 0–10°. On the surface of rocks were observed frequent tectonic mirrors.

In the depth 424,5–464,1 m passed the drilling through the Třinec beds in the facies of spotted claystones. They are very hard, greenish to brownish-grey, calcareous, with chondrites, locally on the fissures with rusty coverings. They contain macroscopically visible microfauna and intercalations of fine-grained (also clayey) sand to sandstone with pale mica, light-grey, calcareous, locally with rusty bands, occassionally with small fragments of sandy marls to light-grey limestones, green-grey non calcareous claystones or dark-grey laminated (fine-grained) sandstone. Fragments reach more than 10 cm in diameter. Intercalations and lenses of sand and sandstone reach the thickness of 20 cm. In these beds in the depth 438,85–439,0 m was observed the lens of coarse-grained to breccia like light-grey non calcareous sandstone. The breccia-like sandstone contains fragments of dark-grey and green claystones, non calcareous, with pale mica and light-grey calcareous claystone. In the depth 435,0–440,0 m in the core of the drilling was an inclination of beds 22°, in the depth 423,5–439,5 m the veins of calcite were folded (Z. Roth – Z. Stráník, 1959).

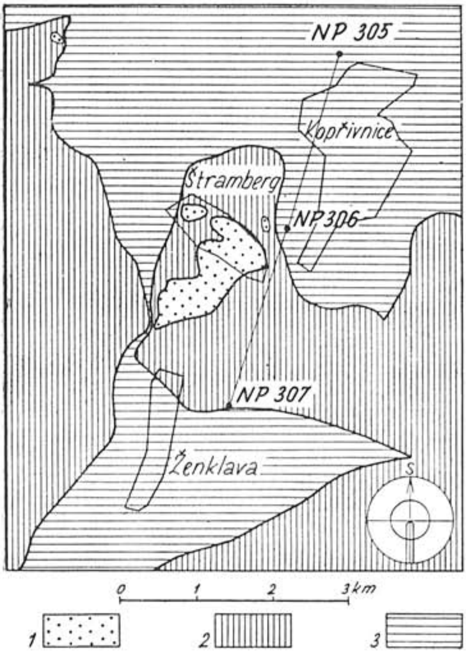


Fig. 1. Geological scheme showing position of the borings NP 305, NP 306 and NP 307 (scale of the general geologic map Ostrava). 1 – Štramberk limestone, 2 – Cretaceous of the Silesian unit, 3 – Cretaceous and Paleogene beds of the Subsilesia-Ždánice unit.

On the basis of micropaleontological analysis (9 samples) there is the upper Lower Eocene, Middle Eocene and the basis of the Upper Eocene.

In the depth of 464,1–491,0 m passed the drilling through the Paleocene to Lower Eocene variegated Subsilesian beds. They are represented by brownish-red, greenish-grey spotted calcareous claystones with intercalations of grey calcareous fine-grained sandstones with pale mica. The thickness of the last is 2–10 cm. The sandstones pass into claystones. In the depth 480,6–481,7 m were observed 10 interlayers of sandy non calcareous light-grey pelocarbonate. The age was stated on the basis of 9 micropaleontological samples.

In the depth 494,0–505,0 m the drilling passed through the Paleocene in the facies of spotted claystones of the Třinec beds. They represent solid, light-grey greenish-grey sandy claystones with dark-grey spots (chondrites) and pale mica. They occur locally in intercalations of some cm in thickness with numerous lamina (2 cm thick) of fine-grained white-grey sandstones to sands. In the depth 415,0—495,4 m in the core of the drilling was inclination of beds approximately 25°. The stratigraphy was stated on the basis of one micropaleontological sample.

In the depth of 509,0—509,3 m the drilling passed again the variegated Subsilesian beds composed of calcareous claystones of grey and dark-grey colours with fine smudges of reddish and light greenish-grey calcareous claystones.

In the depth of 509,3—523,6 m were again the Paleocene Třinec beds in the facies of spotted claystones. They are hard, locally sandy with pale or dark mica, locally indistinctly dark-grey (or rusty and yellowish-grey, probably secundary), spotted calcareous claystones. Occasionally they content 10 cm thick intercalations of sandy, light-grey calcareous claystones, in the depth of 518,0—520,0 m fine intercalations of fine-grained sandstones to light-grey sands and in the depth 520,5—520,55 m one smudge of light-reddish brown claystones (after description of Z. Stráník, 1959). The age of this portion was stated on the basis of the micropaleontological content.

In the depth of 523,6—556,0 m the bore passed through the Neogene Carpathian formation in the "Schlier" lithofacial development with tectonically mantled fragments of variegated Subsilesian beds and the facies of spotted claystones of the Třinec beds (Paleocene to Upper Eocene) and in the dept of 556,0—668,5 m of the Carpathian Neogene formation in the lithofacial "schlier" development mostly with moderate to medium inclinations of beds in the core. Then, in the depth of 671,5—678,5 m, were euhaline beds of the Carpathian formation (Z. Roth—E. Hanzlíková, I. Cicha, 1962) and in the depth of 681,5—726,0 m the basal Tertiary beds. In the depth of 732 m the bore reached the Upper Carboniferous and continued in these beds to its end.

The basal beds of the postvariscian autochthonous mantle of the Bohemian massif lay normally under the beds of marine Carpathian. By the paleogeographic circumstances the beds are with a great probability of Upper Cretaceous to Middle Miocene age. Therefore there was of exceptional importance, aspecially for a correlation with the Paleogene, the "paraautochthon" fragment originally of the exterior part of the Subsilesia-Ždánice series from the bore NP 307. Accordingly to I. Cicha (in Z. Roth, E. Hanzlíková, I. Cicha, 1962), they represent the fresh-water deposits. In the depth of 681,5—708,0 m they are represented by claystone, locally with scarce pale mica of red, brownish-grey, brown-black, black-grey, rusty colours, irregularly spotted, non calcareous, locally secondary covered by red limonite on fissures. The thickness of these intercalations is between some dm to 10 m. The claystones are alternating with intercalations of sandstone, coarsely breccia-like (with fragments of green-grey claystones to the diameter of 3 cm). The sandstone is clayey, light-grey (greenish), grey, locally to some degree rusty, secondary spotted and non calcareous. It contains carbonized plant fragments. The intercalations of the sandstone are of 20 cm to 2,85 m in thickness. In the samples from these beds E. Hanzlíková (1960) found redeposited Paleogene microfauna and small siderite concretions. The redeposited Paleogene microfauna in this section of the bore eliminates the Cretaceous age.

To some degree deeper, (713,9—714,0 m) in the bore, was found in the basal beds layer of medium-grained conglomerate with pebbles of white, dark-grey quartz and pebbles of sandy-calcareous claystones of grey-brown and grey colours. The pebbles reach the diameter of 4 cm. The basal mass of the conglomerate is made up of calcareous sandstone. In the depth of 714,0—726,0 m the matrix is composed of solid fine sandy non calcareous claystone with mica, of red-grey, brown-red, green-grey, grey-green colours, locally with red-brown and green-grey spotts. It occurs in the intercalations of 15 cm to 4 m thickness, separated by intercalations of solid or crumbled non calcareous sandstone of light green-grey colour, locally with little canals with clayey filling of 3 mm diameter. The sandstone composes intercalations of 85—100 cm thickness which locally distinctly grade into claystone. The rocks at the direct contact with the basal beds of the autochthonous postvariscian mantle from the Upper Carboniferous (bore NP 307) are unknown. Microscopically (E. Hanzlíková, 1960) the beds of the lower part of the basal beds afforded indiferent microfauna, probably of Paleogene age.

By the palynological investigations, we obtained rich associations (Naděžda Gabrielová) from the uppermost part of the basal beds (in the depth of 678,5—684,0 m) — uppermost part of the core. They are composed of representatives of families: *Polypodiaceae* from the group *Pteridophyta (Laevigatisporites* sp., Ibra., 1933, *Laevigatosporites haardti* R. Pot. et Ven., 1934) and single grains of the group of genus *Lygodium (Laevigatisporites* cf. *pseudomaximus* Pflug et Thoms., 1953). As belonging to the group *Gymnospermae* we may regard pollen grains of *Inaperturopollenites* sp. Pflug et Thoms., 1953 from the family *Taxodiaceae* — *Cupressinae.* Pollen grains of *Conifera* are represented by genus *Pinus (Pityosporites microalatus* P. Pot., 1931) were found only in single specimen. Predominate representatives of angiosperm plants. Mostly they are represented by triangular grains with simple germinal apparatus from the family *Myricaceae (Triatriopollenites* sp. Pflug, 1953). Besides these occurs a great number of various tricolpate and tricolporate types from the family *Cupuliferae.* There are also some pollen grains of the genera *Alnus, Carya* and probably *Pterocarya.* In this association are numerous spores of Sponges in single specimens and also in chains.

In this sample were found sporomorphs which after P. W. Thomson and A. D. Pflug (1953), G. Kremp (1949), R. Potonié (1951, 1953) occur mostly in the Miocene sediments. The representatives of the group *Extratriporopollenites* Pflug (1953) were not found, which may serve as evidence, that the age of the suite is not older than Miocene. Besides, here do not occur the representatives of palms, *Lauraceae* or of the family Sapotaceae which may serve as evidence of the Lower Miocene, because during this period occured associations with predominant thermophilic elements. Studied assemblages show that the clima was colder, less favourable for development of thermophilic flora. From these reasons we may suggest Middle Eocene age.

On the basis of the micropaleontological and palynological investigations the upper part of the basal beds (probably inclusively conglomerate intercalation) the most probable age is the Middle Miocene, approximately the Helvetian or Carpathian. In the older portions of the basal beds in the bore NP 307 we cannot eliminate on the basis of the mentioned investigations also Paleogene age.

From the basal beds of postvariscian mantle (bore NP 305 to NP 307) were gained 18 samples of claystones (only scarcely with Slight sandy admixture). After preliminary treatment by $ZnCl_2$ (method of Zolyomi, 1953) were gained macerates mostly with undeterminable fragments of plansts. Only in

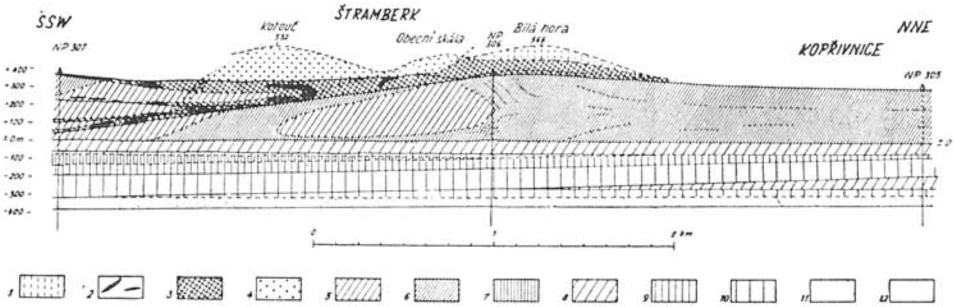


Fig. 2. Geological profile of the post-variscian formations occuring between the borings NP 305 and NP 307 near Štramberk and Kopřivnice. 1–4 – Silesian unit, 1 – Baška beds, 2 – extrusives of the těšinite formation, 3 – Těšín–Hradiště suite, 4 – Štramberk limestone, 5–7 Subsilesia-Ždánice unit, 5 – Frýdek beds, 6 – Třinec beds and variegated Subsilesian beds, 7 – paraautochthonous fragment of the exterior marginal development of the Paleogene of the Subsilesia-Ždánice unit, 8 – tectonic breccia of the Carpathians formation and of the more interior development of the Subsilesia-Ždánice unit, 9 – tectonic breccia from the Carpathian formation of the exterior marginal development of the Subsilesia-Ždánice unit, 10–11 – Carpathian Neogene formation of the mantle of the Bohemian massif, 10 – beds of the „Schlier" character, 11 – basal beds of the Tertiary mantle, 12 – productive Carboniferous (Namurian A).

form of samples from the bores NP 305 and 306 (besides the described samples) were found single pollen grains of the family *Myricaceae*, *Triatriopollenites* sp. Pflug, 1953 and *Taxodiaceae – Cupressinae (Inaperturopollenites* sp. Pflug et Thoms., 1953), grains of the group *Cupuliferae* (variou types of *Tricolporopollenites* sp. Pflug et Thoms., 1953).

All these pollen grains and further numerous fragments of tissues and indetermined grains were more or less corroded. From this follows, that they are probably redeposited.

Analysis of results of investigation of the bore NP 307

As micropaleontological analysis of samples showed the normal stratification of the Paleocene to Upper Eocene (between the depth 424,5–523,6 m) and the lithology was identical with that of the Paleogene of the Subsilesia-Ždánice unit, namely the lithology of beds deposited in the marginal north-western part of the Subsilesian sedimentary district (see Z. Roth – E. Hanzlíková – I. Cicha, 1962), we paid to this section an extraordinary attention.

As it seems, it was the first known case of continuous Paleogene sequence in the exterior part of the Subsilesia-Ždánice sedimentary district in its Beskid section. Up to present the sediments, filling originally the exterior part of the sedimentary district, were known in small fragments, mainly on the basis of the overthtrust Carpathians. Further was showed, that preserved almost about 100 m thick sequence of the Paleogene is less destructed and sandstones are less diagenetically consolidated than the majority of the Subsilesia-Ždánice sequence. At last, the profile of the bore shows that only imperceptibly tectonically affected Neogene of the Carpathian formation in the section from

Stratigraphical Distribution of Foraminifera in the Bore Hole Ženklava NP 307

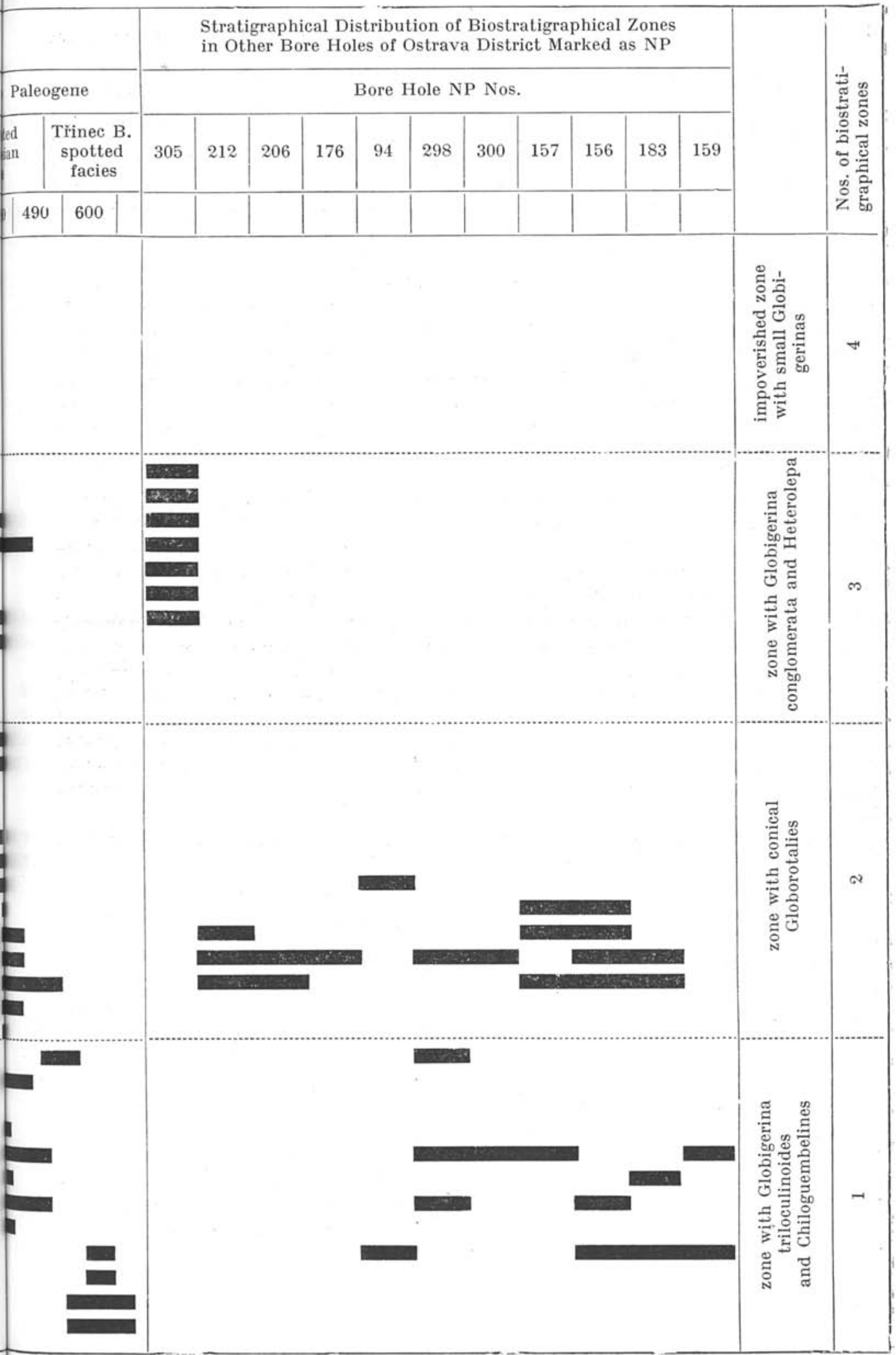
Stratigraphical Divisions	e-3	e-2			
Lithografacial Development in the Bore Hole NP 307		Třinec Beds facies of spotted clays			
Depth in M	420	430	440	450	460

Important microfossils:

Fish remains:
Dendrophrya sp.
Globigerina ex gr. *ciperoensis* Bolli
Globorotalies ex gr. *suteri* Bolli
Globorotalia ex gr. *centralis* Cushm. et Berm.
Hastigerina micra (Cole)
Globigerinoides cf. index (Finlay)
Globigerina conglomerata Schwager
Globorotalia crassata (Cushman)
Globigerina frontosa Subbotina
Globigerina yeguaensis Weinzierl et Applin
Globorotalia rotundimarginata (Subbotina)
Globorotalia spinulosa Cushman

Heterolepa grimsdalei (Nuttall)
Rotalia div. sp.
Globorotalia pseudotopilensis (Subbotina)
Globorotalia crassaformis (Gall. et Wissler)
Haplophragmoides suborbicularis (Grzyb.)
Reophax pilulifer Brady
Hantkenina liebusi Shokhina
Stilostomella div. sp.
Globigerina cf. *inflata* d'Orb.
Clavulinoides alpinus (Cushman)
Globorotalia ex gr. *aragonensis* Nuttall

Globorotalia irrorata Loeblich et Tappan
Globorotalia aequa Cushman et Renz
Globigerina ex gr. *pseudoeocaena* Subbotina
Gaudryina foeda (Reuss) — *G. eocaenna* (Gümbel)
Globorotalia tribulosa Loeblich et Tappan
Eponides trümpyi (Nuttall)
Globigerina ex gr. *inaequispira* Subbotina
Rotalia div. sp. — *Eponides* div. sp.
Eponides toulmini Brotzen
Globigerina triloculinoides Plummer
Chiloguembelina crinita (Glaessner)
Globorotalia esnaensis Loeblich et Tappan
Globorotalia convexa (Subbotina)
Globorotalia velascoensis (Cushman)
Globorotalia angulata (White)
Nodellum velascoense (Cushman)
Glomospira charoides (Jones et Parker)


Stratigraphical Distribution of Biostratigraphical Zones in Other Bore Holes of Ostrava District Marked as NP
Paleogene
Bore Hole NP Nos.
Třinec B. spotted facies
305
212
206
176
94
298
300
157
156
183
159
490
600
Nos. of biostratigraphical zones
impoverished zone with small Globigerinas
4
zone with Globigerina conglomerata and Heterolepa
3
zone with conical Globorotalies
2
zone with Globigerina triloculinoides and Chiloguembelines
1

414,2—423,5 m lies transgressively on the Paleogene suite. This profile is known almost continuously (with gap of about 1 m) without distinct tectonic movements such as we may see in thick zones of tectonic breecias in the bore between 414.2—523,0 m depth. On the basis of the great extension of the Carpathians Neogene formation in the mentioned zone of the tectonic breccias we suggest, that subhorizontal Neogene Carpathian formation originally represented the parautochthonous block, thrust to the north-north-west, torn off the substratum together with comparatively less consolidated Paleogene.

Detailed micropaleontological analysis aff-orded in the section between 424,5—523,6 m depth consinuous biofacial development from the Paleogene to the Upper Eocene. In this very detailly studied section of the bore was succeced to state four biostratigraphical zones which we may compare not only with fragments of the series of the exterior part of the Subsilesia-Ždánice sedimentary district, but also with associations of the same age of the south-western part of the Subsilesia-Ždánice unit, all the silesian unit and some exterior parts of the Magura district compared now with pre-Magura unit of Polish authors.

On the base of the studied Paleogene there is a zone with Globigerina triloculinoides, Chiloguembelinas and sporadic more-chambered Globorotalias from the group of *Globorotalia velascoensis* (Cushman) and *Globorotalia angulata* (White). This zone represents the Paleocene and Lowermost Eocene. It grades upwards into the zone with conical Globorotalias, such as *Globorotalia rex* Martin, *Globorotalia aequa* Cushman et Renz, *Globorotalia aragonensis* Nuttall. This zone belongs to the Lower Eocene. Higher occur various associations, mainly of arenaceous Foraminifera, and here is a quite sharp boundary. On the plate 1 these associations are included into the zone of conical Globorotalias. These Globorotalias are missing and predominates arenaceous and calcareous benthos. The plankton is composed mainly of Globigerinas (*Globigerina* cf. *inflata-yeguanensis* with typical *Globigerina yeguanensis* Weinzierl et Applin). The age of this zone is the lower part of the Middle Eocene.

Higher continues the biostratigraphic zone of the upper part of the Middle Eocene with *Globigerina conglomerata* Schwager, *Globorotalia crassata* (Cushman). The calcareous benthos is represented by *Heterolepa perlucida* Nuttall and *Heterolepa grimsdalei* Nuttall. This zone grades upwards into younger zone.

As belonging to the upper biostratigraphic zone we regard about 1 m thick bed with planctonic association with *Globigerinoides* cf. *index* (Finlay). Here occurs also *Pseudohastigerina micra* (Cole), resembling *Globigerina postcretacea* Mjatljuk. Higher are about 10 m thick beds with fish remains (mainly fragments of teeth and bones). Together with these remains, we may find fragments of little thin chalcedone forms Dendrophrya sp. These remains resemble those of the menilite beds.

The microfauna of whole the mentioned Paleogene is very rich and frequently represent all the content of washed sample. The microfauna is planctonic. Benthos, calcareous and agglutinated, is of red colour as plankton and is composed of genera: *Rotalia, Eponides, Heterolepa, Reophax, Dendrophrya* and *Haplophragmoides*. These associations are not identical with those of the Ždánice section of the Ždánice-Subsilesian unit.

Associations of the mentioned Paleogene suite from the bore NP 307 differ strongly by their species content, mainly of genus Globorotalia, from the Paleogene of the inner sedimentary district of the Subsilesia-Ždánice series of the Beskid section, where in the Třinec beds and in variegated subsilesian beds the plankton is represented mainly by species of Globigerina. These qualitative differences make similar the studied development to the southern development of the Paleogene, mainly to that, which is now regarded as belonging to the pre-Magura unit (E. Hanzlíková, E. Menčík, V. Pesl, 1962) and to the Paleogene of the Ždánice section of the Subsilesia-Ždánice series (V. Pokorný, 1960). Very similar is this development to the upper Middle Eocene and Upper Eocene of the silesian unit in the region of general map (Olomouc).

With the Paleocene and Eocene of the Ždánice section of the unit we may compare only the zone of conical Globorotalias and upper zones, in which we did not find Cyclammina in this bore. The lowermost zone of our profile was not yet found in the exterior parts of the unit, however, it is probably an equivalent of the Paleocene and Danian of the interior zones of the Ždánice section (E. Hanzlíková, 1956).

Despite the qualitative correspondence between the "paraautochthonous" Paleocene to Eocene from the bore NP 307 and Paleogene of the Ždánice section of the Subsilesia-Ždánice unit in the plancton, the benthos is qualitatively different. Qualitatively identical associations of the zone with conical Globorotalias in the Ždánice section are in light-grey calcareous claystones with more than 50 % $CaCO_3$. Variegated claystones in the Ždánice section occur only in the upper biostratigraphical zones. They contain gypsum and concrecias of oligonite with covers of epsomite. Similar concretions were not found in our profile.

Only the upper beds of the Subsilesia-Ždánice unit in the Ždánice section contain the same species of plankton as in our profile, but they are composed only of species of *Hantkenina*. Both the associations contain acarinate Globorotalias [*Globorotalia crassaformis* Subb., *Globorotalia pseudotopilensis* (Subb.)]. V. Pokorný (1960) regards these associations of the Ždánice section as corresponding to the zone of *Cyclammina*. In profile of NP 307 correspond with them the faunas of the zone without conical Globorotalias. They contain numerous arenaceous species [*Haplophragmoides, Reophax, Dendrophrya,* fragments of *Stilostomella* and species *Clavulinoides alpinus* (Cushman)].

In the inner (more southern) zone of the sedimentary district of the Beskid section of the Subsilesia-Ždánice unit and in the same section of the Silesian sedimentary district correspond them the associations with *Cyclammina*.

The associations, equivalent with our fourth zone, V. Pokorný (1960) does not distinguish in the Ždánice section. In the section of the bore NP 307 and NP 305 these beds contain identical calcareous benthos such as we may find in the Ždánice section. In the Beskid section such benthos occurs together with younger associations without conical Globorotalias.

The associations of our youngest biostratigraphical zone (zone of Globigerinoides) are qualitatively almost identical with those in the Ždánice section of the Subsilesia-Ždánice and Silesian units. However, they do not contain Hantkeninas, typical for the mentioned regions.

The microfauna of the studied profile is almost identical with that of the

Paleogene, regarded recently as belonging to the pre-Magura unit (near Bílá and Jablunkov) (E. Hanzlíková, E. Menčík, V. Pesl, 1962). They are identical in all the stratigraphical members of the Paleocene to Middle Eocene. Only the upper Middle Eocene and Upper Eocene do not clearly belong to the pre-Magura unit. They are developed mainly in the form of red calcareous claystones.

The mentioned comparision shows that the northern marginal development of the Subsilesia-Ždánice series of the Beskid section, studied in details in the bore NP 307, is closely allied to the development known from the marginal exterior parts of the Magura unit of the Beskid section (described as pre-Magura unit — E. Hanzlíková, E. Menčík, V. Pesl, 1962) and lesser to the beds of the same age of the Ždánice section of the Subsilesia-Ždánice unit and Silesian unit (in both the sections). This affinity is more close than that to the inner part of the Subsilesia-Ždánice series of the Beskid section. In the Paleogene of the series of the exterior sedimentary district of the Subsilesia-Ždánice unit in the Beskid section, Ždánice section of this unit, Silesian series of both the sections and exterior parts of the Magura district (regarded by E. Hanzlíková, E. Menčík, V. Pesl, 1962 as belonging to the pre-Magura unit) we may find the plankton of the tropic sea with *Globorotalia* and *Globigerina*. This observation corresponds with the paleographic conclusion made on the basis of lithological analysis (Z. Roth, 1962), which shows, that the mentioned regions with thermophilic plankton represented the shallower environment bordering the Paleocene and Lower Eocene quickly deepening inner parts of the Subsilesia-Ždánice sedimentary district (and exterior part of the Silesian sedimentary district) in the Beskid section of both the units.

To make clearer the tectonic of Post-Beskid we have studied about 70 deep bores from the region between Stonávka, Frenštát p. Radh. and Nový Jičín on the basis of more detailed knowledge of the exterior development of the Subsilesia-Ždánice unit from the "paraautochthonous" fragments of the bore NP 307. This study proved that similar beds (identified by variegated subsilesian beds of Danian-Lower Eocene age) occur in this region always on the base of the overthrust Carpathians, as it was known earlier (Z. Roth, E. Hanzlíková, I. Cicha, 1962). The oldest element of these fragments represent the Danian variegated subsilesian beds, unknown in the bore NP 307. As is obvious from the bores NP 114 (north of Paskov), NP 183 (east of Brušperk), NP 139 (west of Paskov) and NP 213 (north of Staříč) the Danian variegated subsilesian beds of the exterior parts of the Subsilesia-Ždánice sedimentary district are characterized by red coloured plankton with *Globigerina daubjergensis* Bronnimann and by comparatively shallow-water benthos. As it seems, of the same age are less calcareous associations of the variegated Subsilesian beds without plankton, with arenaceous species. They are in the region between Vratimov, Paskov, Žabeň and Fryčovice also on the basis of the overthrust Carpathians in the bores NP 99, 100, 111, 155, 158, 159, 183, 185, 202, 213. In the bore NP 307 this oldest zone is unknown.

The first biostratigraphical zone of the bore NP 307 (zone with Globigerina — Chiloguembelina) was found in the tectonic fragments of the variegated Subsilesian beds on the base of the Carpathians in the vicinity of Kopřivnice (NP 298, 299 — see Z. Roth, E. Hanzlíková, I. Cicha, 1962, NP 307) near Brušperk (NP 183) and Paskov (NP 114). In some further bores lack

Chiloguembelinas. The zone of conical Globorotalias is connected with fragments of the variegated subsilesian beds on the base of the Carpathians, in the region of the occurrence of the former biostratigraphical zone, but appears also near Václavovice (NP 206), near Vratimov (NP 157), Krmelín (NP 94) and east of Frýdek.

The younger zones in the other bores were not studied.

Conclusions

Found lens of almost 100 m thick Paleocene to Upper Eocene covered by transgressive Neogene Carpathian formation in the bore NP 307 near Ženklava shows, that the exterior (northern) part of the Subsilesia-Ždánice sedimentary district is characterized in the Beskid section by development of variegated Subsilesian beds in the Paleocene and Lower Eocene, while the main Subsilesia-Ždánice series in this section is characterized by variegated subsilesian beds in the Middle to Upper Eocene (Z. Roth, E. Hanzlíková, I. Cicha, 1962).

Associations of Foraminifera prove the affinity of found marginal development of the Paleocene to Upper Eocene of the Subsilesia-Ždánice unit in its Ždánice section, as shows also the lithological development between Hranice and Holešov (Z. Roth, 1962).

Associations of Foraminifera also show, that both allied developments of the Ždánice-Subsilesian unit, micropaleontologically connected with beds near the exterior boundary of the Magura group, are of the same age (described recently as belonging to the pre-Magura unit on Czechoslovak territory — E. Hanzlíková, E. Menčík, V. Pesl, 1962) and also to equivalent beds of the interior part of the silesian unit.

Affinity of associations of all the mentioned suites in the thermophilic plancton, missing in the Paleogene of the interior part of the Beskid section of the Subsilesia-Ždánice unit, the sedimentary district of which was surrounded by the mentioned allied development at the north-north-west, south-west and south.

Lithological affinities of the mentioned development are: a) in a great extension of the variegated beds in the Paleocene and Lower Eocene, b) im missing of the reduced development mainly in the Paleocene to Lower Eocene which is known first of all in the Subsilesia-Ždánice (but also in the exterior Silesian part) series of the Beskid section.

The thickness of the Paleogene in the exterior marginal part of the Beskid district of the Subsilesia-Ždánice district is many times as lesser than its thickness in other Subsilesia-Ždánice and Silesian series of the same section of Carpathians.

Geology of the studied tectonic lens from the bore NP 307 shows, that the exterior marginal part of the Subsilesia-Ždánice sedimentary district in the Beskid section was covered by the sea after hiatus (in the Oligocene to Helvetian s. s.) of the Carpathian foredeep. This explains and proves older conclusions and observations and especially frequent redepositions of the Carpathian microfauna.

As "paraautochthonous" we regard the studied tectonic lens from the bore NP 307. The Paleogene of this lens is covered by transgressive Carpathian formation in the "Schlier" development, known from the autochthon, and not intensive tectonic destruction may serve as evidence of unimportant tectonic transport.

Presence of "paraautochthonous" fragment and reconstruction of overthrust planes (see profile) shows, that the exterior autochthonous margin of the Subsilesia-Ždánice sedimentary district we may expect in the substratum of Carpathians at the depression of Rožnovská Bečva and southern margin of the recent occurence of Carpathian formation on the substratum of Carpathians probably more southwards.

Fragments of the variegated Subsilesian beds found at the base of the overthrust Carpathians in other bores in Beskids may serve as evidence of presence of the Danian in facies of variegated Subsilesian beds unter the Paleogene series known from the bore NP 307. The variegated Maastrichtian quoted formerly from some bores in Beskids by revisional studies was not found.

The basal beds of post-variscian autochthonous mantle of the Bohemian massif composed mainly of the variegated claystones are of the Tertiary (partly Middle Eocene) age. We did not prove their stratigraphic equivalence with the Paleogene beds of the exterior part of the Subsilesia-Ždánice district.

Translated by V. Scheibnerová.

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Review by D. V. Ager, London.

Plate V

Fig. 1 a—c. *Globorotalia aequa* Cushman et Renz, association of conical Globorotalias, depth of 464,00—482,00 m. — Fig. 2 a—c. *Globigerina triloculinoides* Plummer, abundant in the depth of 488,00—494,000 m. — Fig. 3 a, b. *Globorotalia pseudotopilensis* (Subbotina), Lower Eocene red marlstones, depth of 464,00—470,00 m (1,30—1,70 m). — Fig. 4 a—c. *Globorotalia convexa* Subbotina, basal part of paraautochthonous development of the Paleogene, depth of 488,00—494,00 m (0,00—1,00 m). — Fig. 5 a—c. *Globorotalia acarinata* (Subbotina), red marlstones of the Lower Eocene, depth of 464,00—470,00 m (1,30—1,70 m). — Fig. 6 a—c. *Globorotalia perclara* Loeblich et Tappan, red marlstones, Paleocene, depth of 488,00—494,00 m. — Fig. 7 a—c. *Globorotalia esnaensis* (Le Roy), red marlstones, depth of 488,00—494,00 m.

Plate VI

Fig. 1 a—c. *Globorotalia spinulosa* Cushman, Middle Eocene, depth of 446,00—452,00 m. — Fig. 2 a—c. *Globorotalia rex* Martin, associations of conical Globorotalias, depth of 464,00—470,00 m. — Fig. 3, 4. *Chiloguembelina crinita* (Glaessner) two various specimens from red marlstones, depth of 488,00—494,00 m (0,00—1,00 m). — Fig. 5 a—c. *Globorotalia angulata* (White), association of conical Globorotalias, red marlstones, depth of 482,00—494,00 m. — Fig. 6 a—c. *Globorotalia velascoensis* (Cushman), red marlstones, depth of 482,00—488,00 m.

Plate VII

Fig. 1 a—c. *Globorotalites* ex gr. *sutteri* Bolli, Upper Eocene, upper part of the paraautochthonous suites, depth of 423,50—429,50 m (0,80—1,00 m). — Fig. 2 a—c. *Globigerina* ex gr. *yeguanensis* Weinzierl et Applin, most abundant association from the depth of 423,50—429,50 m (0,80—1,00 m). — Fig. 3 a, b. *Globigerina frontosa* Subbotina, Upper Eocene association, depth of 423,50—465,00 m. — Fig. 4 a, b. *Globigerina pseudoeocaena* Subbotina, common in the depth of 468,00—488,00 m. — Fig. 5 a, b. *Globigerinoides* cf. *index* Finlay, Upper Eocene of the paraautochthonous development of the Paleogene, depth of 423,50—429,50 m (0,80—3,00 m).

Plate VIII

Fig. 1 a—c. *Globorotalia* ex gr. *centralis* Cushman et Bermudez, Upper Eocene association, depth of 423,50—429,50 m. — Fig. 2 a—c. *Globorotalia (Acarinina) rotundimarginata* (Subbotina), Upper Eocene association, depth of 423,50—429,00 m. — Fig. 3 a—c. *Globigerina* ex gr. *ciperoensis* Bolli, rare fossil from the Upper Eocene association, depth of 423,50—429,50 m. — Fig. 4 a, b. *Hastigerina micra* (Cola), rare fossil from the Upper Eocene association, depth of 423,50—429,50 m. — Fig. 5 a—c. *Globorotalia* ex gr. *crassata* (Cushman), typical fossil from the Upper Eocene of the paraautochthonous development, depth of 424,00—445,00 m. — Fig. 6 a, b. *Globigerina inaequispira* Subbotina, Paleocene associations from the depth of 470,00—490,00 m. — Fig. 7. *Hantkenina liebusi* Shokhina, rare fossil from the Middle Eocene, depth of 446,00—452,00 m.

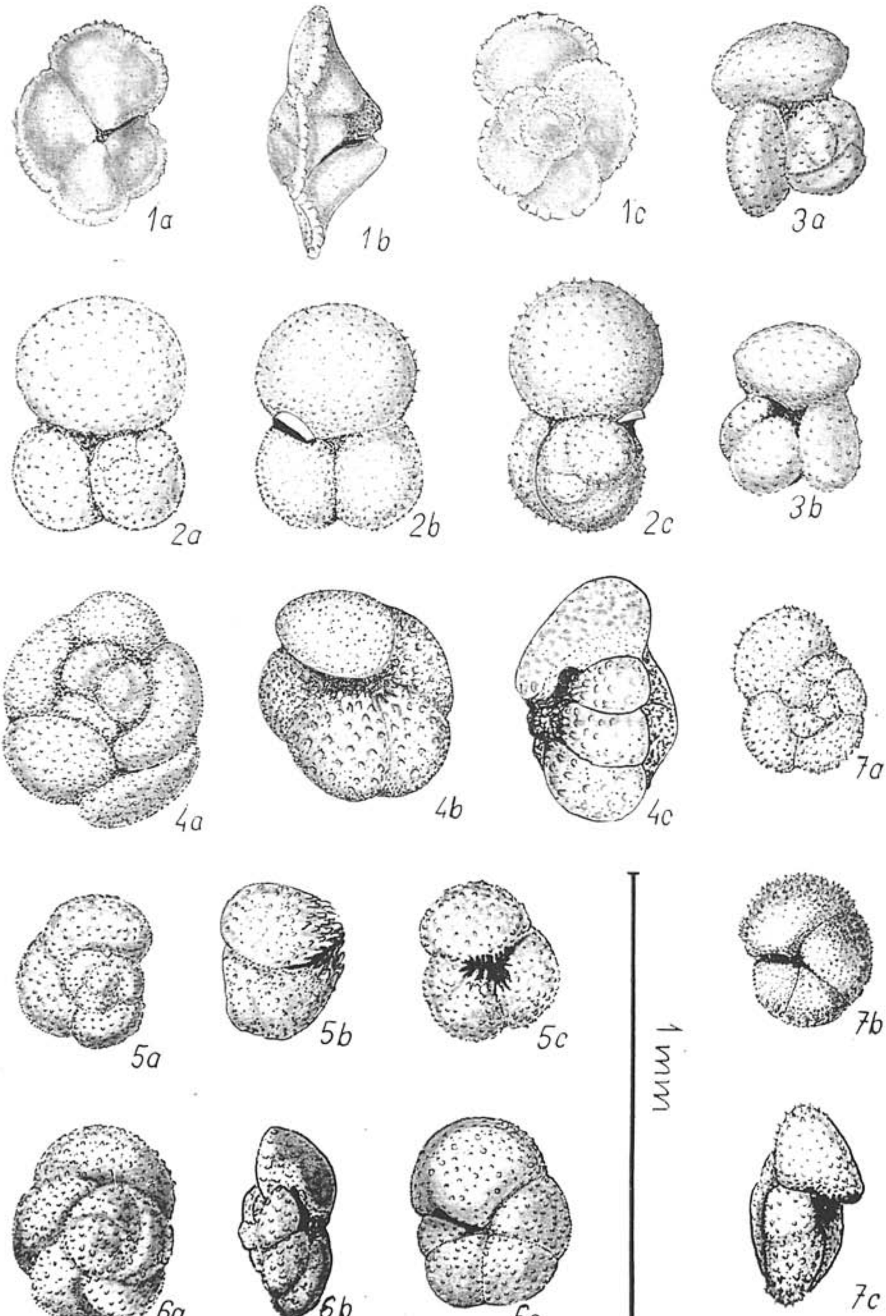

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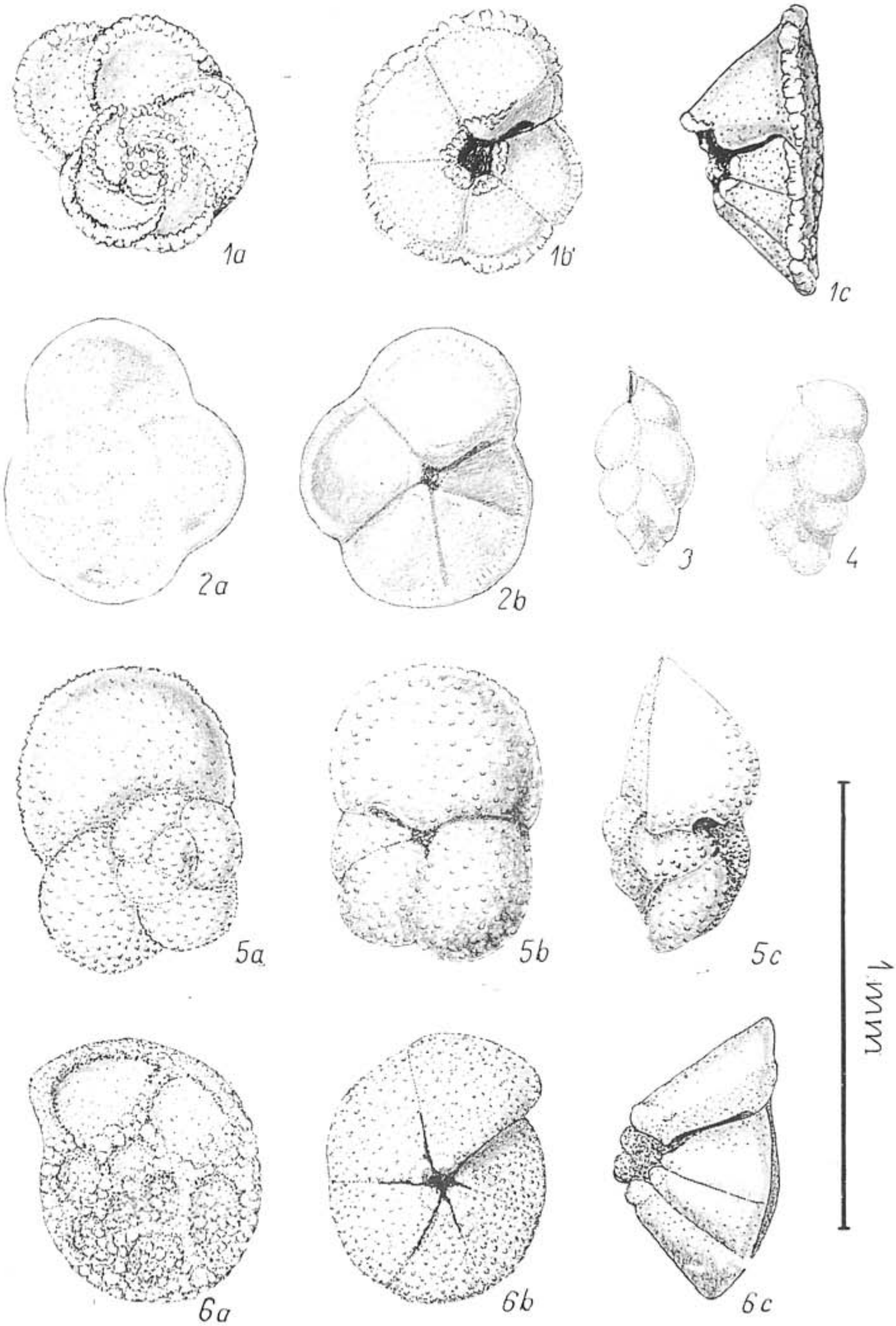
Plate VI



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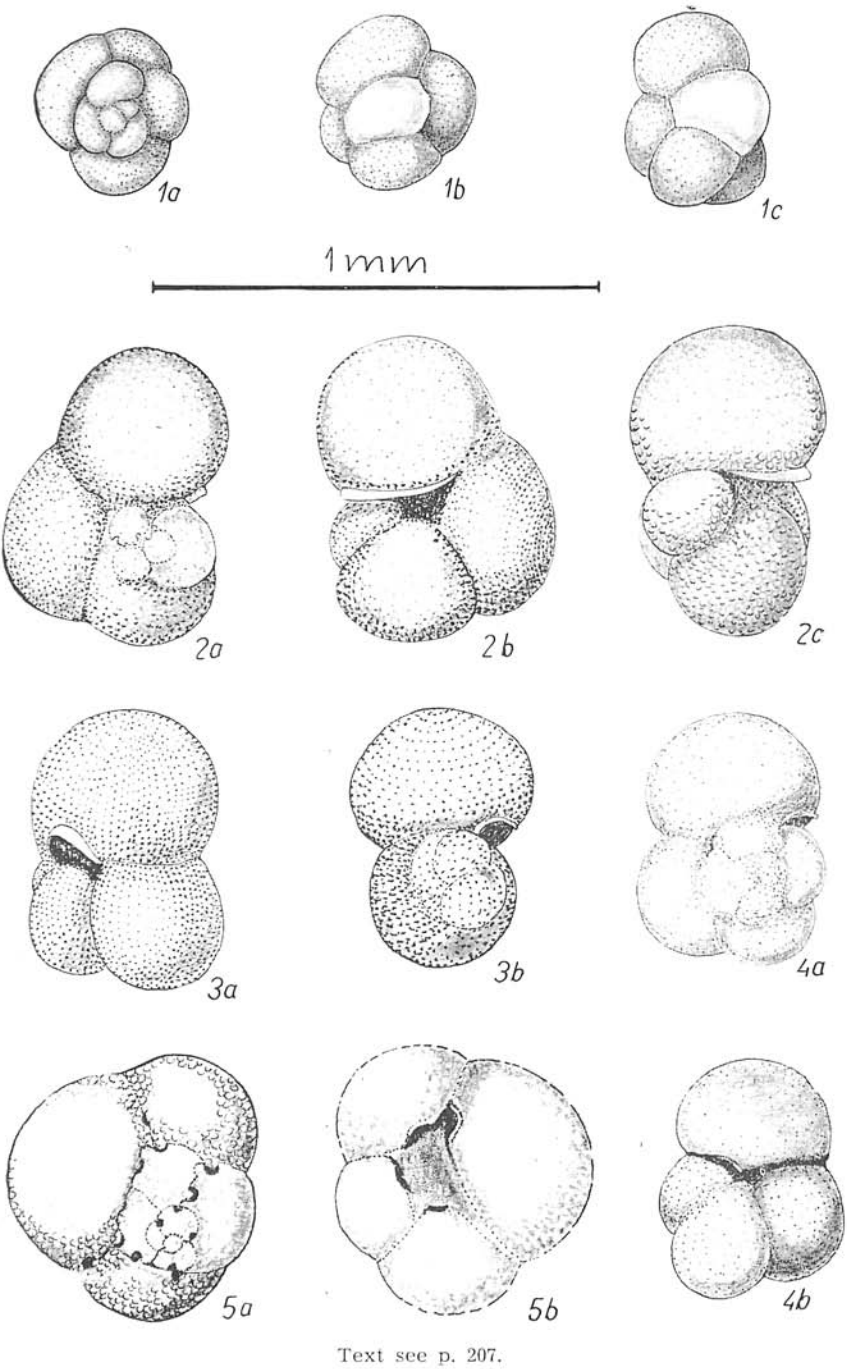

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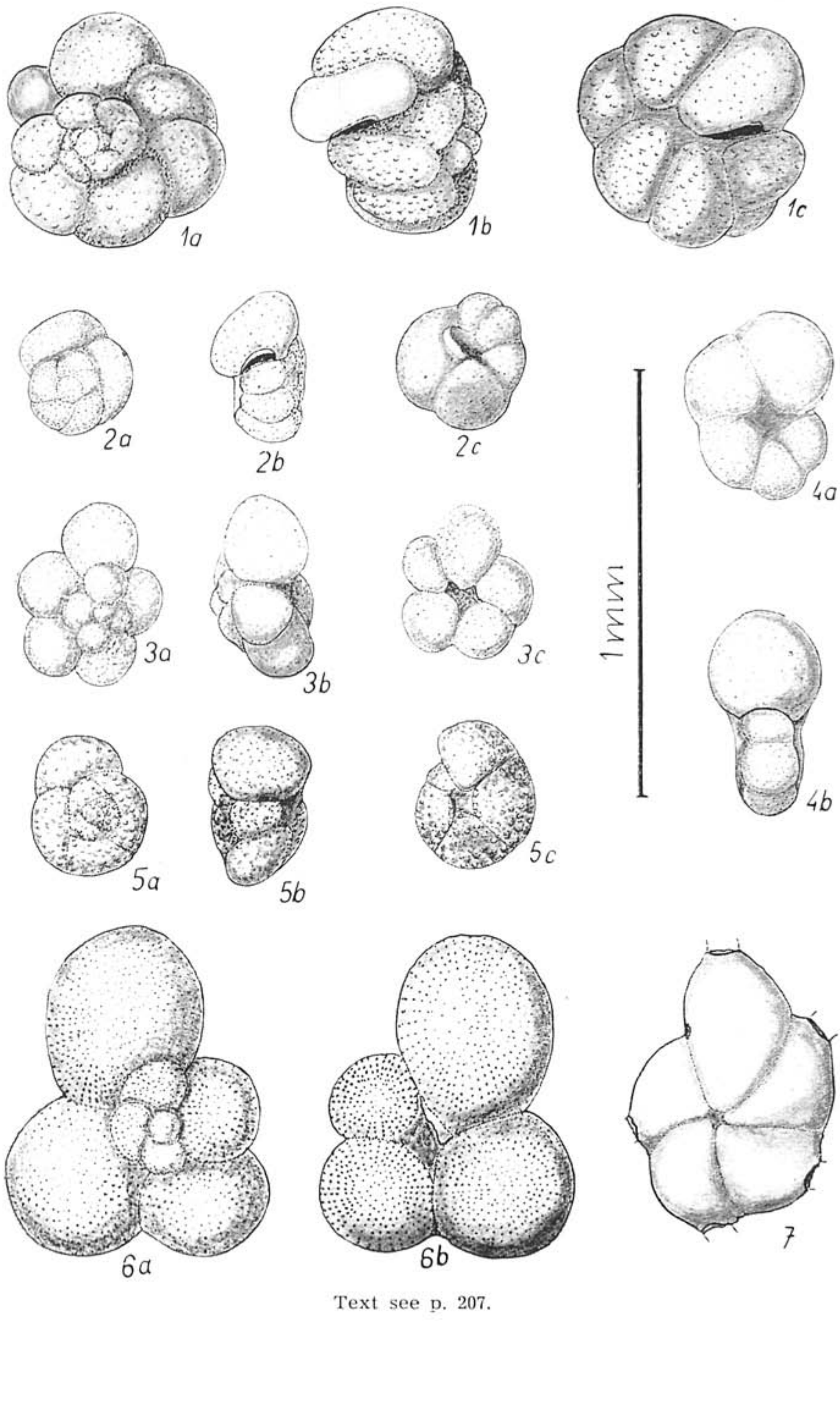

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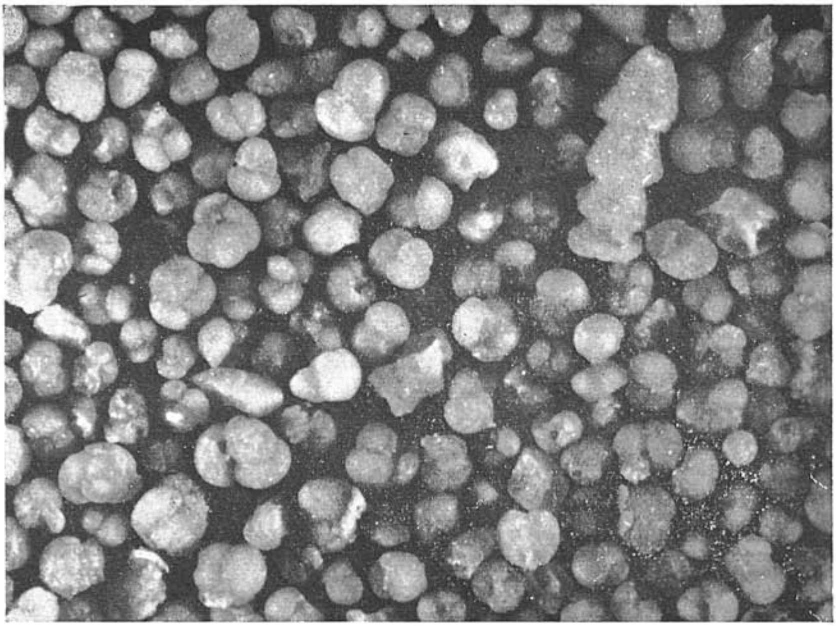


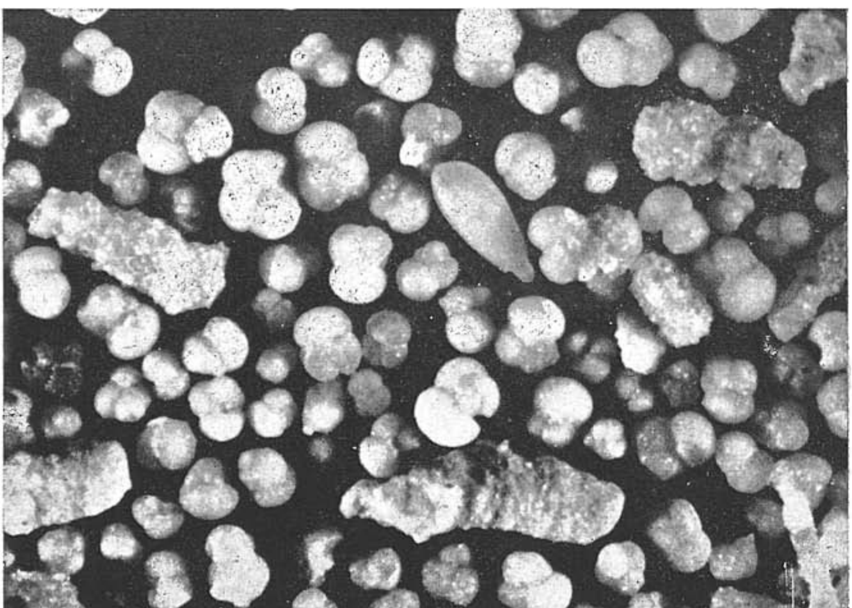
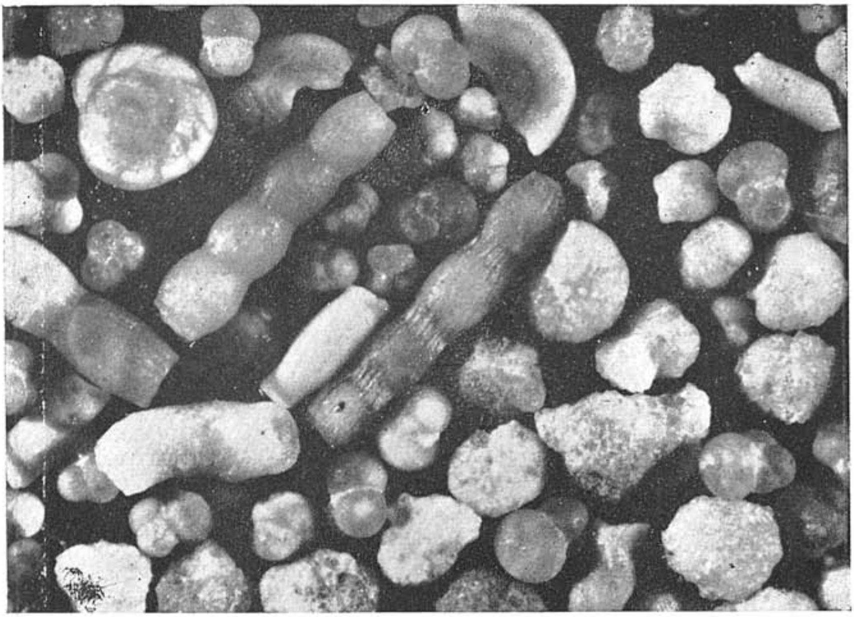


Fig. 1. Associations of Foraminifera from red marlstones with predominant Globorotalias, depth of 482,00—488,00 m (0,30—0,70 m). $\times$ 26. — Fig. 2. Association of Foraminifera from light-grey marlstones with chiloguembelinas, depth of 470,00—476,00 m (4,30—5,00 m). $\times$ 26.



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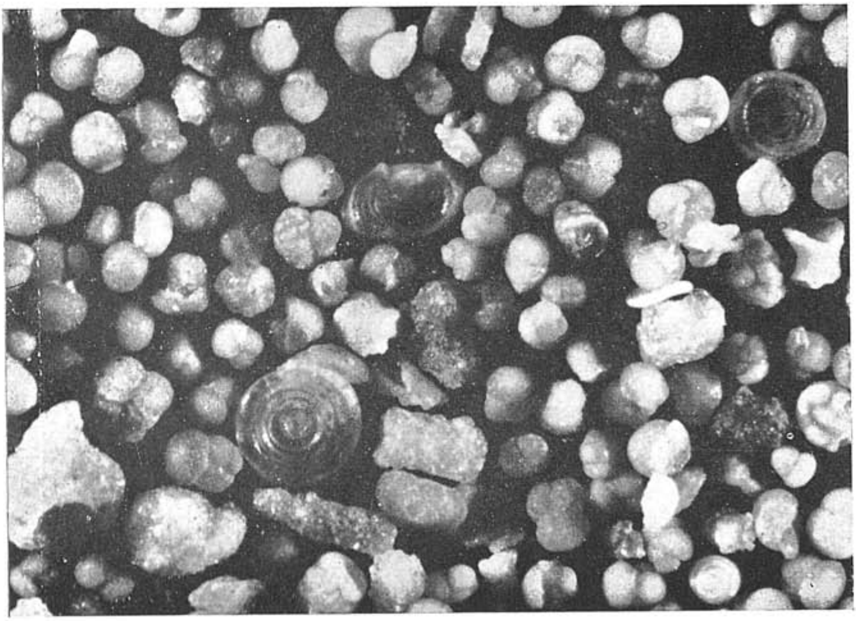

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Fig. 1. Association of Foraminifera from the lower part of the Upper Eocene, depth of 423,50–429,60 m (3,00–3,50 m). × 26. — Fig. 2. Association of Foraminifera from zone with conical Globorotalias, depth of 476,00–482,00 m (1,00–1,50 m). × 26. Photo V á ň o v á.