

Borové Formation of Middle Eocene age east of the Tatra Mts.

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Abstract. Recently in stratigraphic literature the opinion has become common that in the Paleogene of the Subtatric Group the Borové Formation becomes younger from west to east and/or from NW to SE as a consequence of gradual transgression in this direction. The study of literary and examination of samples from Kamenica and borehole Lipany-6 show that the Middle Eocene basal formation was also deposited east of the Tatra Mts. as far as the area of Sabinov. Associations of Middle Eocene larger foraminifers (characterized by the species *Nummulites puschi* D'ARCHIAC, *N. perforatus* (MONTFORT), *Assilina schwageri* (SILVESTRI)) belonging to the SBZ Zone 17 (38–41 m.y.) were found in situ, in blocks in the Pucov Member, in pebbles of the Šambron Member and as isolated tests redeposited into the Šambron Member. The composition of the associations of larger foraminifers testifies to the fact that there is continuation of the Borové Formation which was deposited at the northern slopes of the Tatra Mts. Different ages of the transgressive consequence of the transgression of the Eocene sea into an environment highly dissected morphologically which formed barriers to the advancing sea. Frequent redeposition of larger foraminifers tests from the Borové Formation into the Šambron Member testifies to considerable tectonic unrest in the time of sedimentation of the Šambron Member and intense disintegration of the Borové Formation in that time (due to sinking sea level it could have been partly uncovered and eroded).

Key words: Subtatric Group, Borové Formation, Šambron Member, larger foraminifers, Middle Eocene, SBZ 17, area east of the Tatra Mts.

Introduction

In the year 1963 Andrusov & Köhler called attention to the fact that with extensive transgression in the second half of the Eocene the sea did not cover the territory of the Western Carpathians at once, but gradually, some areas were not flooded at all (e. g. the Spišsko-gemerské rudohorie Mts. or Nízke Tatry Mts. (Král' 1977)). The tendency of gradual rejuvenation of the transgressive formation (Borové Formation in the sense of Gross et al. 1984) from NW to SE in the Liptovská kotlina depression was recorded by Gross & Köhler et al. (1980) and for the Paleogene of the Subtatric Group of the Western Carpathians generalised by Köhler & Salaj (1997) and Buček et al. (1998). Detailed examination of the data from literature as well as investigations in the last time have shown that the Middle Eocene transgression reached the area far to the east from the Tatra Mts.

Latest knowledge on the geological structure and lithostratigraphy of the Subtatric Group to the east of the Tatra Mts. are summarized in the work by Gross et al. (1999a, b) and Janočko et al. (2000a, b) and it is not necessary to repeat it here.

Data in literature

At the eastern margin of the Tatra Mts. basal Paleogene sediments of Middle Eocene age (= Bartonian according to present-day terminology, compare Serra-Kiel et al. 1998) are already not found in situ nowadays and

according to Bieda (1963) and Köhler (in Janočko et al. 1999, 2000b) the basal formation between Tatranská Kotlina and Ždiar (Spišská Magura Mts.) is of Upper Eocene (Priabonian) age. However, in the conglomerate body overlying the basal beds (in the Pucov Member in the sense of Gross et al. 1982, 1984) near Ždiar Vaňová (1962), Marschalko & Radomski (1970) and Köhler (in Janočko et al., l.c.) found pebbles to blocks of dark-grey sandy limestones with tests of *Nummulites puschi* D'ARCHIAC, *N. brongniarti* D'ARCHIAC et HAIME and *N. perforatus* (MONTF.) which are indubitably of Middle Eocene age. With regard to the size of blocks transportation at a greater distance is excluded and it rather should be supposed that the basal Paleogene Formation covered a larger part of the Tatra Mts. than at present. Already in the Upper Eocene erosion and displacement of sediment in form of blocks into the Pucov Member could have taken place in the area of the present-day Tatra Mts.

The occurrence of the Borové Formation at Veľká Kýčera (elevation point 966) west of Vyšné Ružbachy (Spišská Magura Mts.) is also known. According to Vaňová (in Nemček & Vaňová 1977) dark compact limestones in mass amount contain the species *Nummulites perforatus* (MONTFORT) and discocyclines. The mentioned authors also quote Bieda (1963) who from limestones covering the Ružbachy Mesozoic mentions the species *Nummulites rotularius* DESHAYES, *N. perforatus* (MONTF.) and *N. puschi* D'ARCHIAC, thus an association, which is often found at the northern slopes of the Tatra Mts. (compare Bieda 1963, Kulka 1984). The quotation is

erroneous, because in the monograph from the year 1963 Bieda does not mention Paleogene sediments near Vyšné Ružbachy, probably an unpublished datum of this author is concerned.

Further data were provided by borehole PU-1 near Šambron in the Spišsko-Šarišské medzihorie Intermountains (Nemčok et al. 1977), which penetrated the lower part of the Šambron Member (cf. Samuel in Andrusov & Samuel et al. 1985, p. 252–253) with layers of conglomerates and sandstones, neither reached the basal beds, nor the substratum (terminal depth 2004 m). Larger foraminifers from the interval 29.1 to 1997 m were evaluated by Vaňová (in Nemčok et al., l.c.). She found tests in compact coarse grained sandstones and conglomerates and considered them as redeposited.

In the associations from the individual depth intervals are found the species *Nummulites variolarius* (LAMARCK), *N. gallensis* (HEIM), *N. cf. millecaput* BOUBÉE, *N. perforatus perforatus* (MONTFORT), *N. anomalus anomalus* HARPE, *N. puschi* D'ARCHIAC, *N. discorbinus* (SCHLOTHEIM), *N. cf. striatus striatus* (BRUGUIÈRE), *N. striatus pannonicus* (ROZLOZNIK), *N. striatus minor* D'ARCHIAC, *N. incrassatus incrassatus* DE LA HARPE, *N. cf. chavannesi* DE LA HARPE, *N. ex gr. fabianii* (PREVER), *Operculinoides vaughani* COLE, *O. nassauensis* COLE (both these species are re-assigned to *Assilina gomezi* (COLOM et BAUZÁ)), *Discocyclina roberti llarenai* RUIZ DE GAONA and *Discocyclina fortisi* (D'ARCHIAC). Most frequent species *Nummulites puschi* D'ARCHIAC and *N. perforatus* (MONTFORT). The associations are mixed, composed of typically Middle Eocene and Upper Eocene forms. Their displacement took place in the Upper Eocene or later and on the basis of larger foraminifers the interval with the latter in borehole PU-1 Šambron is considered as Upper Eocene or even younger. Allocthonous are also associations of smaller foraminifers, pollen and spores.

The frequent presence of the species *Nummulites puschi* D'ARCHIAC and *N. perforatus* (MONTFORT) testifies to the fact that the original basal transgressive formation in the area of Šambron was Middle Eocene.

Nemčok & Vaňová (1977) also called attention to some slump bodies in sediments of the Subatric Group east of the Tatra Mts. They mention the occurrence in Kamenica/Torysa r. (Spišsko-Šarišské medzihorie Intermts.) with species *Nummulites perforatus sismondai* D'ARCHIAC et HAIME in the Šambron Member. It is not clear why they consider this occurrence as Middle Eocene (Upper Lutetian- according to present-day terminology Bartonian) and do not take into account redeposition of larger foraminifers.

At the northern margin of the village Jakubovany (Spišsko-Šarišské medzihorie Intermts.) a slump body is found in the lower part of which Vaňová (in Nemčok & Vaňová 1977) identified the species *Nummulites variolarius* (LAMARCK), *N. perforatus perforatus* (MONTFORT), *N. anomalus anomalus* DE LA HARPE, *N. kovacsiensis* HANTKEN et MADARASZ, *Operculinoides* sp. and *Discocyclina* sp., in the slump body itself *N. perforatus perforatus* (MONTF.), *N. striatus minor* D'ARCHIAC

et HAIME, *N. chavannesi* DE LA HARPE and *N. pulchellus* DE LA HARPE. Overlying the body the species *Nummulites variolarius* (LAMARCK), *N. cf. millecaput* BOUBÉE, *N. kovacsiensis* HANTKEN et MADARASZ, *Discocyclina roberti llarenai* RUIZ DE GAONA, *D. fortisi* (D'ARCHIAC) and *D. discus* (RÜTIMEYER). Slump body was ranged to the Lower Priabonian by Nemčok & Vaňová (l.c.). It again contains mixed Middle and Upper Eocene associations of larger foraminifers.

The quoted authors also mention further occurrences of larger foraminifers in the Šambron Member. There are the localities Šarišské Dravce (*N. perforatus sismondai* D'ARCHIAC et HAIME and *N. incrassatus incrassatus* DE LA HARPE), Dlhý potok brook (*N. perforatus sismondai* D'ARCHIAC et HAIME, *N. perforatus perforatus* (MONTFORT), *N. anomalus anomalus* DE LA HARPE and *N. cf. striatus* (BRUGUIÈRE)). North of the village Jakubovany (form transitional from *Nummulites striatus minor* D'ARCHIAC et HAIME to *N. striatus pannonicus* (ROZLOZNIK)) and south of the village Milpoš (sandstones with *Nummulites perforatus sismondai* D'ARCHIAC et HAIME, *N. perforatus perforatus* (MONTFORT), *N. incrassatus incrassatus* DE LA HARPE, *N. chavannesi* DE LA HARPE, *N. cf. budensis* HANTKEN and form transitional from *N. fabianii* (PREVER) to *N. fichteli fichteli* MICHELOTTI).

The presence of *Nummulites perforatus* (MONTFORT) in these associations indicates again that the original source of the material redeposited into Šambron Member were also rocks of transgressive lithofacies - the Borové Formation of Middle Eocene age.

In the year 1983 evaluation of borehole Lipany-1 was published (Leško et al. 1983). The borehole penetrated the Šambron Member (to depth of 2600 m), the basal Paleogene formation (2600 - 2747 m) and in the interval 2747 to 4000 m it drilled through Triassic rocks. Larger foraminifers from clasts and the groundmass were evaluated by Vaňová (in Leško et al., l.c.). In the Šambron Member (interval 660 to 2654 m) she found the species *Nummulites variolarius* (LAMARCK), *N. anomalus anomalus* DE LA HARPE, *N. perforatus perforatus* (MONTFORT), *N. perforatus sismondai* D'ARCHIAC et HAIME, *N. puschi* D'ARCHIAC, *N. striatus minor* D'ARCHIAC et HAIME and *Operculina parva* DOUVILLÉ. It is an association of Middle Eocene species. In the basal formation at depth of 2651 to 2653 m she found an Upper Eocene association consisting of *Nummulites chavannesi* DE LA HARPE, *N. pulchellus* DE LA HARPE, *N. bouillei* DE LA HARPE and *N. budensis* HANTKEN, but below depth of 2653 m only the Middle Eocene species *Nummulites perforatus perforatus* (MONTFORT), *N. ex gr. perforatus* (MONTFORT), *N. striatus minor* D'ARCHIAC et HAIME, *Operculina* sp. and *Discocyclina* sp. are found. The association testify to the fact that in borehole Lipany-1 the Borové Formation is Middle to Upper Eocene in age. The Šambron Member contains an association redeposited from the lower Middle Eocene part of the Borové Formation and their age was determined as Upper Eocene on the basis of pollen and spores (Snopková in Leško et al. 1983).

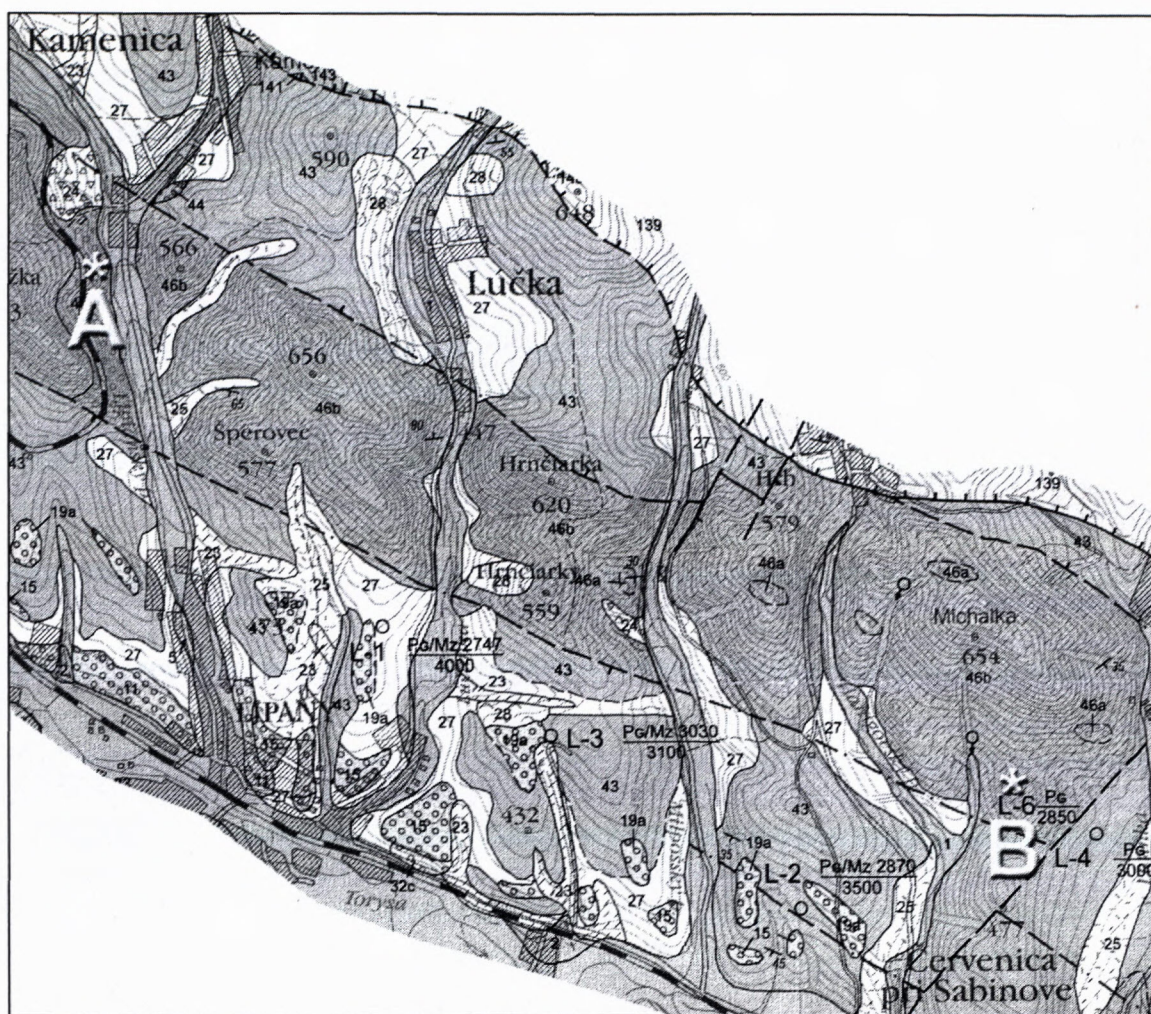


Fig. 1. Part of geological map 1: 50 000 (Gross et al. 1999) of the territory between the villages Kamenica and Červenica near Sabinov and localization of the localities: A - locality Kamenica, B - borehole Lipany-6.

Explanations: Quaternary (Holocene): 1 – fluvial sediments, 2 – proluvial flood plain loams; Quaternary (Pleistocene): 5 – fluvial sandy gravels, sandy gravels and loams of the bottom accumulation (Würm), 11 – fluvial sandy gravels and gravels (Younger Riss), 15 – fluvial sandy gravels and gravels (Older Riss), 19a – fluvial gravels and sandy gravels (Mindel); Quaternary undivided (Pleistocene/Holocene): 23 – deluvial-fluvial out-wash loams and sandy loams, 24 – loamy-stony, sandy, sandy-stony to stony scree, 25 – slope loams, 27 – deluviums, 28 – landslides; Tertiary (Neogene): 32c – conglomerates, sandstones (Lower Miocene); Subtatic Group, Huty Formation (Late Priabonian – Early Oligocene): 43 – claystones, clay-siltstones predominating over sandstones, 46a – Šambron Member, beds of polymict conglomerates, 46b – Šambron Member, fine-rhythmic flysch, or claystones; Klippen Belt: 139 – Proč-Jarmuta Formation, Carbonate flysch (Paleocene-Middle Eocene), 141 – red and grey-green sandy claystones (Paleocene-Middle Eocene), 143 – brick-red marlstones with sandy limestones intercalations (Cenomanian-Turonian).

New evaluations of larger foraminifers associations

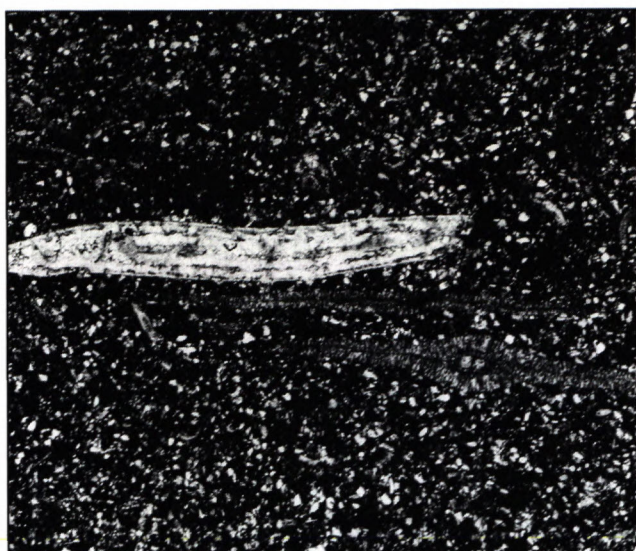
The author had samples coming from the localities Kamenica (NW of the village Lipany) and from borehole Lipany-6 (NE of the village Červenica near Sabinov) available (see Fig. 1).

Kamenica

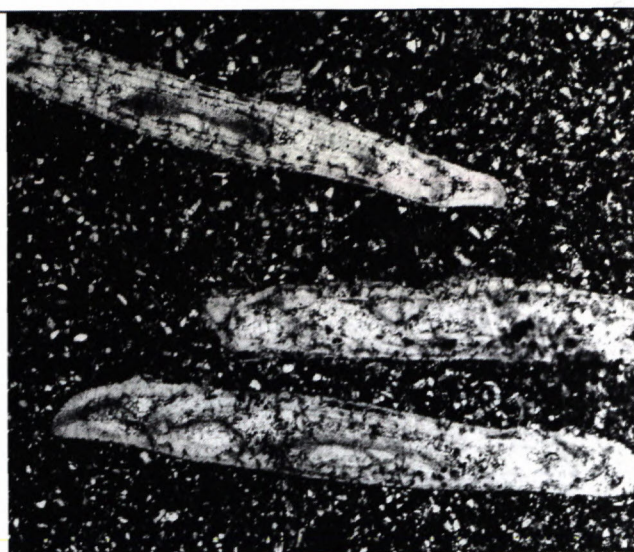
The Šambron Member in the railway cut near the railway station in Kamenica awakes deserved attention in the last time (Plašienka et al. 1998, Jacko 2000). During the excursion to this area the author with RNDr. P. Gross, CSc. obtained pebbles from a conglomerate layer in the Šambron Member at an abandoned quarry, which is situ-

ated about 250 m southeast of the railway station Kamenica (500 m W of el. p. 566). Six from the observed pebbles contain larger forams. Their evaluation is as follows:

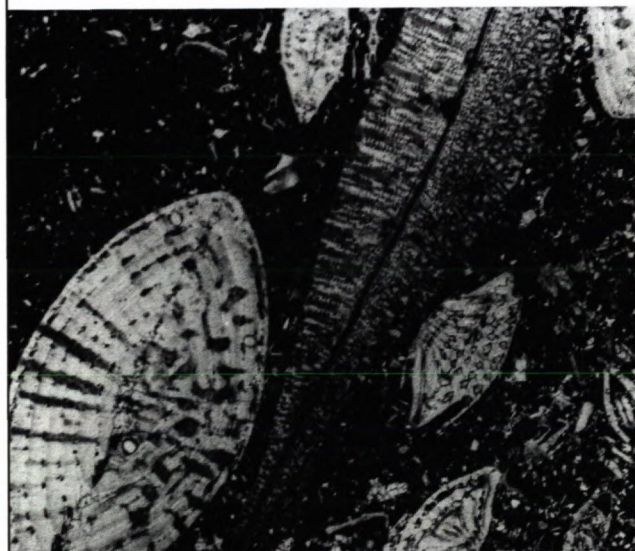
Pebble 1 (Pl. I, Figs. 1-2): Extraclast-bioclastic, nummulitic sandy wackestone formed by fragments of quartz, carbonates and siltstones (average size 0.1 mm), scarce are glauconite grains (up to 0.3 mm). The cement is carbonate. The association of larger forams is formed by *Nummulites puschi* D'ARCHIAC, *N. cf. semicostatus* (KAUFMANN), *N. striatus minor* D'ARCHIAC et HAIME, *Assilina schwageri* (SILVESTRI), *Discocyclina sella* D'ARCHIAC and *Discocyclina* sp. Small fragments of coralline algae, cross sections of problematic alga *Pieninia oblonga* BORZA et MIŠÍK, fragments of cyclostomate



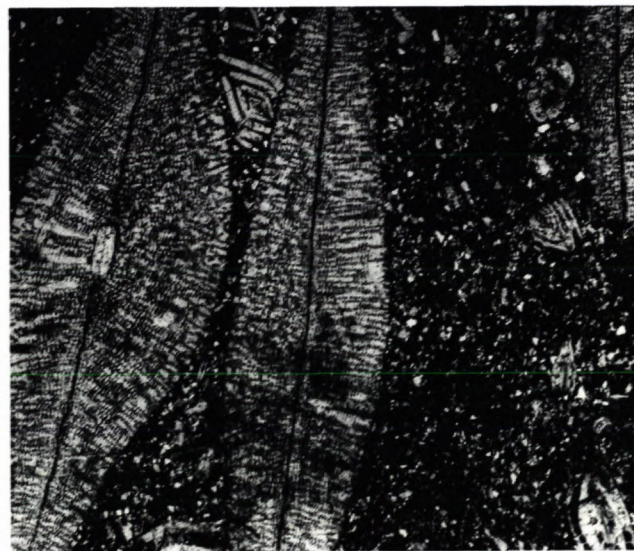
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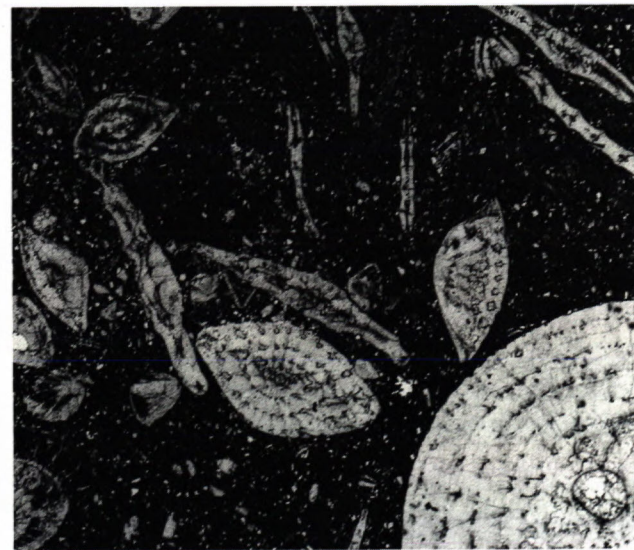
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bryozoans, lamellibranchs, echinoid spines, worm tubes (*Ditrupa* sp.) are also not missing, from smaller forams rotalid, miliolid and agglutinate forms (indeterminable under microscope) are scarcely found. The sediment is Middle Eocene in age (SBZ 17 in the sense of Serra-Kiel et al. 1998), shallow-water, damages of tests indicates that they were found within the reach of wave activity.

Pebble 2 (Pl. I, Figs. 3-4) is not very different in petrographic composition from pebble 1 (nummulitic sandy rudstone), does not contain extraclasts, but organic remnants are more frequent. An interesting phenomenon is drilling of nummulite tests and filling up of cavities originated this way with chalcedony. The association of larger forams is formed by: *Nummulites puschi* D'ARCHIAC, *N. perforatus* (MONTFORT), *N. cf. semicostatus* (KAUFMANN), *N. striatus minor* D'ARCHIAC et HAIME, *N. aff. parvus* (PREVER), *Assilina schwageri* (SILVESTRI), *Discocyclina discus* (RÜTIMEYER) and *Discocyclina* sp. Fragments of coralline algae, lamellibranchs, brachiopods, segments of crinoids, worm tubes are also present, smaller forams are rare (rotalid, miliolid and agglutinate forms). Complete absence of planctonic forms in the association testifies to shallow-water nearshore sedimentation, frequent damages of tests to wave activity. The pebble is Middle Eocene in age (SBZ 17).

Pebble 3 (Pl. I, Figs. 5-6): Nummulitic sandy packestone containing clasts of quartz, carbonates of average size 0.10 mm. The cement is carbonate with frequent coatings of Fe-oxides. Scarcely boring of nummulite tests and filling up of the cavities with chalcedony is visible. The association of larger forams is formed by: *Nummulites anomalus* DE LA HARPE, *N. aff. parvus* (PREVER), *N. perforatus* (MONTFORT), *N. semicostatus* (KAUFMANN), *N. striatus minor* D'ARCHIAC et HAIME, *Assilina schwageri* (SILVESTRI), *Discocyclina cf. sella* D'ARCHIAC and *Discocyclina* sp. Very often there are fragments of coralline algae (up to 0.5 mm diameter), cross sections of cyclostomate and cheilostomate bryozoans, lamellibranchs, ostracodes, crinoides are rare, worm tubes, from smaller forams rotalid, miliolid and agglutinate forms are also present. The only cross section belongs to a planctonic globigerinid form. The predominating float tests of *Assilina schwageri* (SILVESTRI) testify to a somewhat deeper environment of origin than in preceding pebbles, but the abundant debris of coralline algal thaluses is an evidence of proximity of an environment with intense wave activity. As to age, the pebble does not differ from preceding ones (SBZ 17).

Pebble 4 (Pl. II, Fig. 1): Nummulitic sandstone formed by fragments of quartz and carbonates 0.10-0.15 mm in size, in the carbonate cement coatings of Fe-oxides are not rare. The association of larger forams is formed by: *Nummulites cf. puschi* D'ARCHIAC, *N. perforatus* (MONTFORT), *N. semicostatus* (KAUFMANN), *N. striatus minor* D'ARCHIAC et HAIME, *Assilina* sp. Calcareous algae are crushed, damaged are also shells of cyclostomate bryozoans, lamellibranchs, crinoid stems. From smaller forams, besides rotalids and miliolid forms, also the sessile *Acervulina linnearis* HANZAWA is found. The sorted clastic material, absence of discocyclines and on the contrary, the presence of nummulites with thick solid tests indicate a shallow-water environment within the reach of wave activity. Age - Middle Eocene (SBZ 17).

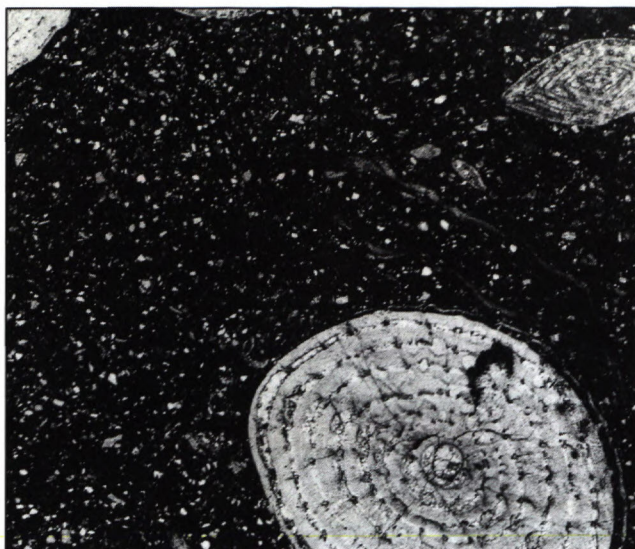
Pebble 5 (Pl. II, Figs. 2-3): Nummulitic sandy rudstone. From clasts mainly fragments of quartz and carbonates of size 0.05-0.15 mm are represented. In the carbonate cement precipitations of Fe-oxides are found. Remarkable is the deformation of embryonal parts of some nummulites, which must have taken place still during life and could have been caused by oscillations of some environmental factors (temperature, salinity etc.). The association of larger forams is formed by: *Nummulites perforatus* (MONTFORT) (in great number, both generations), *N. striatus minor* D'ARCHIAC et HAIME, *N. cf. semicostatus* (KAUFMANN), *Assilina schwageri* (SILVESTRI) and *Discocyclina* sp. Small fragments of coralline algae, fragments of cyclostomate bryozoans, lamellibranchs, crinoid stems are also present, from smaller forams sessile *Acervulina linnearis* (HANZAWA) is found. The rock formed in shallow-water environment in the Middle Eocene (SBZ 17).

Pebble 6 (Pl. II, Fig. 4): Nummulitic sandstone formed by angular fragments of quartz and carbonates (0.08-0.15 mm), very often are small fragments of coralline algae. The cement is carbonate. The association of larger forams is poorer and formed by: *Nummulites perforatus* (MONTFORT), *N. cf. semicostatus* (KAUFMANN), *N. striatus minor* D'ARCHIAC et HAIME, fragments of lamellibranchs are also found, rotalid forams are scarce. The debris of coralline algae again testifies to a shallow-water environment within the reach of wave activity. Age - Middle Eocene (SBZ 17).

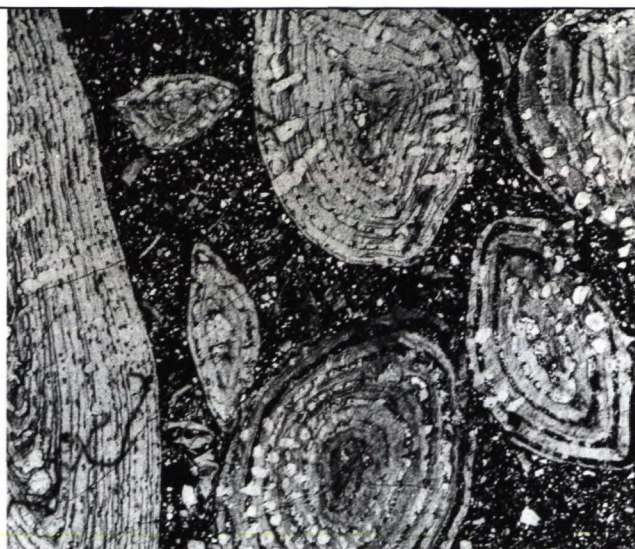
The data on localisation of the sample, which from Kamenica/Torysa r. was evaluated by Vaňová (in Nemčok & Vaňová 1977), are not known. Its association is not differing from that found in pebbles 1 to 6. The

Plate I

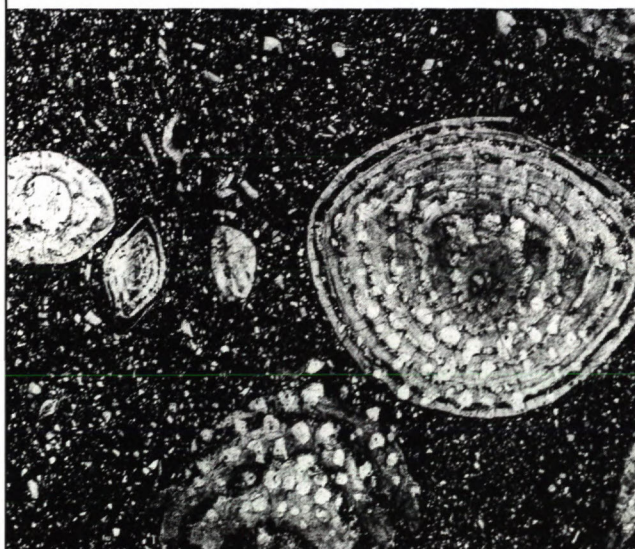
Fig. 1 – Nummulitic sandy wackestone with cross sections of tests of *Nummulites puschi* D'ARCHIAC and *Discocyclina sella* (D'ARCHIAC). Kamenica, pebble 1, thin section 7; Fig. 2 – Nummulitic sandy wackestone with cross sections of tests of *Nummulites puschi* D'ARCHIAC. Kamenica, pebble 1, thin section 3; Fig. 3 – Nummulitic sandy rudstone with cross sections of tests of *Nummulites perforatus* (MONTFORT), *Nummulites* sp. and *Discocyclina discus* (RÜTIMEYER). Kamenica, pebble 2, thin section 1; Fig. 4 – Nummulitic sandy rudstone with cross sections of tests of *Discocyclina discus* (RÜTIMEYER), *Nummulites striatus minor* D'ARCHIAC et HAIME and *Nummulites* sp. Kamenica, pebble 2, thin section 6; Fig. 5 – Nummulitic sandy packestone with cross sections of tests of *Nummulites striatus minor* D'ARCHIAC et HAIME, *Assilina schwageri* (SILVESTRI). Kamenica, pebble 3, thin section 1; Fig. 6 – Nummulitic sandy packestone with cross sections of tests of *Nummulites perforatus* (MONTFORT), *N. aff. parvus* PREVER and *Assilina schwageri* (SILVESTRI). Kamenica, pebble 3, thin section 5. All figures magnif. 10x. Photo by the author.



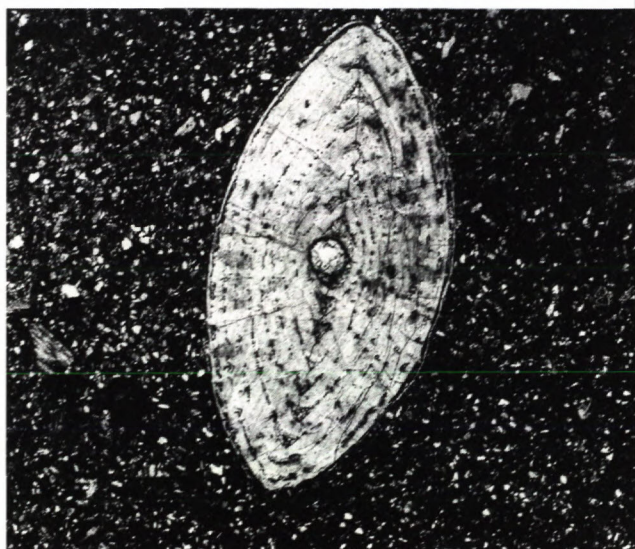
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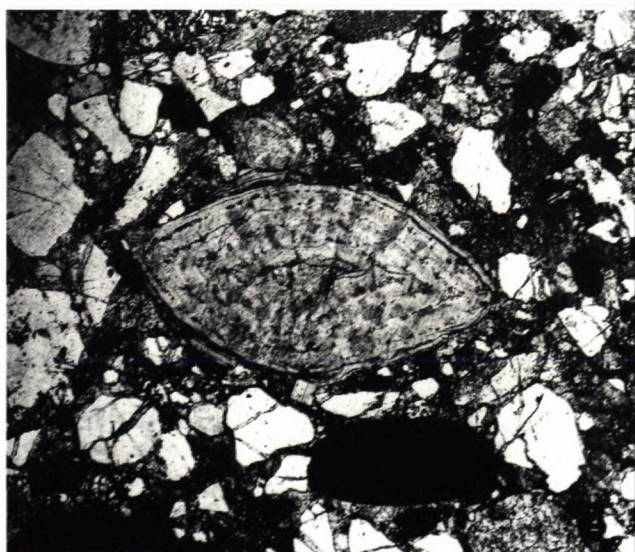
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partial silicification of nummulites and *Rotalia* by quartzine at the locality Stránske (Rajec basin) was mentioned by Mišík (1995, p. 158).

Borehole Lipany-6

While the borehole Lipany-1 was published also with evaluations of larger forams (Vaňová in Leško et al. 1983), the data on borehole Lipany-6 have not been published. The author had available samples from depth of 2369 to 2396 m. There is indubitably the Šambron Member. The rock is formed by fine grained conglomerates to breccias with clasts of size up to 15 mm (scarcely also more) with variegated composition: quartz, crystalline rocks, various carbonates (among them Cretaceous marly limestone). The cement is formed by finer grained fraction. Organic remains are very scarce. In Pl. II, Fig. 5 a clast of sandy limestone with cross sections of tests of *Nummulites perforatus* (MONTFORT) and *Assilina schwageri* (SILVESTRI) is seen. Isolated tests of *Nummulites perforatus* (MONTF.) in Pl. II, Fig. 6, *N. puschi* D'ARCHIAC and *Discocyclina* sp. are also found.

These larger forams are of Middle Eocene age and were indubitably redeposited into the Šambron Member from the Borové Formation.

Conclusions

In the Paleogene of the Subtatric Group between the Tatra Mts. and Sabinov associations of larger forams of Middle Eocene age were found:

1. in situ - Veľká Kýčera near Vyšné Ružbachy, borehole Lipany-1,
2. in blocks in the Pucov Member - Ždiar,
3. in pebbles in the Šambron Member - Kamenica, borehole Lipany-6,
4. isolated tests, redeposited into the Šambron Member - boreholes Lipany-1, Lipany-6, PU-1 Šambron, Jakubovany, Šarišské Dravce, Dlhý potok brook, Milpoš.

The association formed by the species *Nummulites perforatus* (MONTFORT), *N. puschi* D'ARCHIAC, *N. striatus minor* D'ARCHIAC et HAIME, *Assilina schwageri* (SILVESTRI), *Discocyclina discus* (RÜTIMEYER), according to latest dating (Shallow Benthic Zones - see Serra-Kiel et al. 1998), belongs to the SBZ 17 of Middle Eocene - Bartonian age with range of time 38 - 41 mil. years. The frequent presence of the association in the region between the Tatra Mts. and Sabinov testifies to the fact that there the Borové Formation was not rejuvenated

in direction to the east, but sedimented in an approximately equal time interval including the SBZ 17 (38 - 41 mil. years), i. e. in the upper part of the Middle Eocene.

The presence of *Nummulites puschi* D'ARCHIAC and absence of larger assilines *Assilina exponens* (SOWERBY) is typical of the Borové Formation at the northern Tatra Mts. slope (so called "Tatric Eocene" sensu Bieda 1963). Therefore it is necessary to suppose that the Paleogene of the Subtatric Group between the Tatra Mts. and Sabinov is the continuation of this northern strip of the "Tatric Eocene".

The different ages of the Borové Formation south of the Tatra Mts. are either a result of gradual flooding of the territory much dissected in morphology south of the Tatra Mts. or of distinct tectonic unrest.

Very frequent redepositions of larger forams tests from the Borové Formation into the Šambron Member are an evidence of intensive disintegration of the Borové Formation in the time of the Šambron Member deposition. As a consequence of sinking sea level throughout the Upper Eocene partial uncovering of the Borové Formation and its erosion could have taken place in that period, but erosion of the Borové Formation could also have been a result of tectonics.

Acknowledgement

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Plate II

Fig. 1 - Nummulitic sandstone with cross sections of *Nummulites perforatus* (MONTFORT) and *N. striatus minor* D'ARCHIAC et HAIME. Kamenica, pebble 4, thin section 2; Fig. 2 - Nummulitic sandy rudstone with numerous cross sections of tests of *Nummulites perforatus* (MONTFORT), both generations. Kamenica, pebble 5, thin section 5; Fig. 3 - Nummulitic sandy rudstone with cross sections of *Nummulites perforatus* (MONTFORT) and *N. striatus minor* D'ARCHIAC et HAIME. Kamenica, pebble 5, thin section 3; Fig. 4 - Nummulitic sandstone with cross section of test of *Nummulites perforatus* (MONTFORT). Kamenica, pebble 6, thin section 4; Fig. 5 - Fine grained conglomerate, in the middle a fragment of sandy limestone with cross sections of tests of *Nummulites perforatus* (MONTFORT) and *Assilina schwageri* (SILVESTRI). Borehole Lipany-6, depth 2396 m; Fig. 6 - Fine grained conglomerate with cross section of redeposited test of *Nummulites perforatus* (MONTFORT). Borehole Lipany-6, depth 2396 m. All figures magnif. 10x. Photo by the author.

- map of Popradská kotlina basin, Hornádska kotlina basin, Levočské vrchy Mts., Spišsko-Šarišské medzihorie depression, Bachureň Mts. and Šarišská vrchovina highland 1:50 000. MŽP SR – Geologická služba SR, Bratislava.
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