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# THE SÚĽOV PALEOGENE OF THE DOMANIŽA BASIN IN THE LIGHT OF NEW FINDINGS

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**Abstract**: The newly defined Svinské Chlievy Formation in the Pružina part of the Domaniža Basin, is equivalent in age to the laterally represented Súľov Formation. It corresponds to the uppermost Paleocene (base of the Ilerdian) and the greater part of the Lower Eocene. It is a complex of rocks, which, apart from transgressive marine basins, originated in continental conditions of sedimentation.

**Key words:** Súľov Paleogene, continental and marine sediments, Domaniža area, Western Carpathians, Slovakia.

Individual lacustrine cycles are distinguished by various fresh water horizons (9 are proved) of variable types of Malenice limestones of varied colour (=Malenica onyxite), precipitated by spring and stream surface water saturated by mineral. Light bands of a sinter or travertine character were precipitated in winter, and of dark "aragonite" character in the summer monsoon, relatively hotter period.

The Svinské Chlievy and Súľov Formation, together with the Domaniža Formation (Upper Lutetian - Middle Oligocene) belong to the newly defined Súľov Paleogene, occurring in Middle Váh dale (Fig. 1).

It is a transitional facial type between the Klippen Belt - Periklippen Belt and the Central Carpathian Paleogene.

## Introduction

While mapping the Paleogene of the Domaniža Basin, the author (Salaj 1991) identified two horizons of banded fresh water limestone, in the Súľov conglomerates, in the area of Svinské Chlievy (Pl. 1, Figs. 1 - 3). They originated by precipitation from flowing surface waters saturated with mineral materials, from paleokarst areas of the Mesozoic of the former Strážov Mts. The author was able to divide the Súľov conglomerates into at least perhaps three independent sedimentary cycles.

As a result of the serious problems, which originated as a result of the first identification of Malenica onyxite in Paleogene conglomerate sediments, not only in our country, but in the world in general, the author devoted further study to them, as well as their spatial distribution. The overlying Domaniža Formation, defined by Samuel (1972) was studied mainly in the area of Domaniža, Malá Lednica and Rajec. The Paleogene of the Domaniža Basin is identified by Samuel (1972) as the Domaniža development of the Peri-klippen Belt of the Považie-Hanušovce section. It was studied by various authors (Marschalko & Kysela 1980; Marschalko et al. 1980). Andrusov (1951, 1957), and Andrusov & Kuthan (1943, 1946) mapped the Paleogene of the Domaniža, Rajec and Žilina Basins. Later Marschalko rewalked the area (in Began et al. 1963; Marschalko & Kysela 1979), and Maheľ et al. (1981) accepted this rewalked version of the Strážov Mtts. In relation to the fact that Mesozoic rocks of the Strážov and Rohatá skala Units form the substratum of the Domaniža and Rajec Basins (Fig. 2), this Paleogene has the basic character of the Central Carpathian Paleogene, but with earlier transgression and more significant Savian folding. At the same time, it has many features in common with the Paleogene of the Peri-klippen Belt zone (a great number of reefs, a shallower water character). Therefore, I favour the description of the Paleogene as a transitional facial development between the Paleogene of the Peri-klippen Belt zone (occurring in the Drietoma, Klape and Podháj Units, Salaj 1991) and the actual Central Carpathian Paleogene, where the transgression began later, in the Bartonian. I propose the name Súľov Paleogene for this specific, in places continental, transitional development. The appropriate stratigraphic division, which Gross et al. (1984) introduced for the Central Carpathian Paleogene, cannot be applied to the newly defined Súľov Paleogene of the Domaniža, Rajec and Žilina Basins for the reasons mentioned above.

It is therefore, evident that according to the author's new research, the Súľov Paleogene has its own independent paleogeographic and tectonic position, and cannot be included either in the Central Carpathian Paleogene, where Andrusov (1959) placed it, or in the Peri-klippen Belt Paleogene, where it was placed by Samuel (1972). The inverted Paleogene slices, to the south-east in the strip Podskalie - Prečín - Bodiná - Vrchteplá - Hričov have a specific tectonic position (Fig. 2). They are limited from the north-west by the Manín Unit (partly also the Kostolec Klippes), and from the south-east by the Kostolec Unit, represented with the Hradná succession (the Súľov - Hradná strip, and north of Bodiná). By its tectonic position this strip of Paleogene could be joined to the Peri-klippen zone, but by its facial development it also corresponds to the Súľov Paleogene (apart from the internal slice of Peri-klippen Belt between Jablonová and Hričovské Podhradie, the stratigraphic succession of which was studied in detail by Samuel et al. 1972). In the Žilina Basin, only a narrow strip (Hričovské Podhradie - Žilina - Teplička - Nededza , Fig. 1) near the southern edge of the Klape Unit belongs to the Peri-klippen Paleogene (Salaj 1990). It is

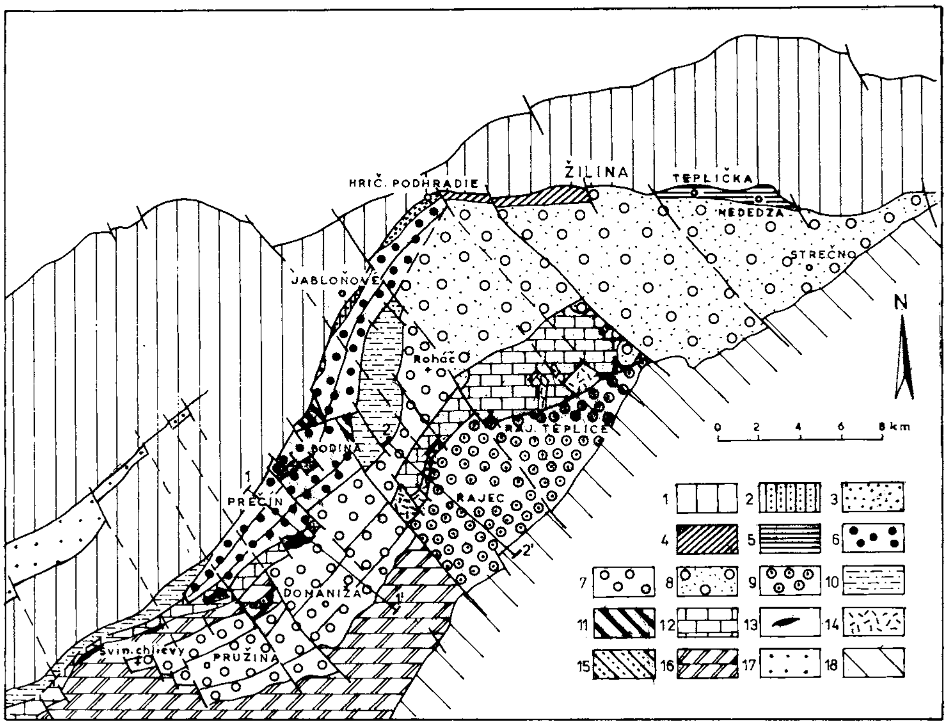


**Fig. 1.** Outline of Považská Bystrica-Žilina area tectonic structures (after Salaj 1992).
*Klippen and Peri-klippen Belt:* 1 - Peri-klippen Belt Paleogene, 2 - Jablonová strip, 3 - Hričovské Podhradie strip, 4 - Žilina strip (south of Hradisko), 5 - strip in the section Teplička-Nededza; *Súľov Paleogene:* 6 - slice of the strip Podskalie-Bodina-Hričovské Podhradie (underlying the Kostolec Unit), 7 - slice of the Prečín-Domaniža Basin with continuation in the area of the Roháč elevation point, 8 - Paleogene of the Žilina Basin, 9 - Paleogene of the Rajec Basin; *Kostolec Unit:* 10 - mostly Cretaceous, 11 - Jurassic; *Rohatá Skala Unit:* 12 - Lower - Middle Cretaceous, 13 - Jurassic, 14 - Triassic of the Strážov type; *Strážov Unit:* 15 - Liassic crinoidal limestone, 16 - Triassic; 17 - Neogene; 18 - rock complex of the NW slopes of the Malá Fatra Mts.; 19 - profiles studied.

divided from the fill of the other part of the Žilina Basin by a series of overthrust faults inclined to the south. The essential part of the Žilina Basin (just as the Domaniža and Rajec Basins) is underlain by Mesozoic rocks of the higher tectonic units of the Central Carpathians (Šalaga et al. 1976), so it is also included in the Súľov Paleogene. I am introducing this new name in honour of D. Štúr, who first used the term "Súľov conglomerates" in this area.

## Stratigraphy and notes on the nomenclature of individual lithostratigraphic units of the Paleogene of the area studied

### *Súľov Formation*

Andrusov (1965, p. 230) defined the Súľov conglomerates, originally described by Štúr (1860), as the Súľov Formation. They are formed by a series of conglomerates, sandstones to sandy limestones and dolomitic sandstones formed by dolomitic material, sometimes with inserts of sandstones and sandy mudstones to marlstones of a flysch character, which originated mainly in a marine environment. In the studied area, they correspond mainly to the Lower Eocene to Lower Lutetian. The term Súľov Formation, in the sense of the basal transgressive lithofacies (Marschalko in Began et al. 1963) can be related only to the Domaniža, Rajec and Žilina Basins, since locally the transgressive base corresponds to the uppermost Paleocene (loc. Riedka, Salaj 1991), or the basal part of the Cuissian, as Samuel & Salaj (1963) showed near Mojtín. It has to be mentioned that these transgressive parts were amputed practically in each vertically erected beds of the Súľov conglomerates as a result of their strong tectonic reduction.

In connection with the Súľov Formation, it is necessary to mention the transgression of this Paleogene in the eastern part of the Domaniža Basin, in the Domaniža - Malá Čierna strip, and in the actual Rajec Basin. It is generally known that in the Rajec Basin the transgression came later, in the Lutetian (Köhler 1967; Samuel & Salaj 1968) mainly in the Lower Lutetian. In the strip west of Domaniža - Malá Čierna, the conglomerates rest on the Upper Triassic dolomites of the Strážov Unit (Pl. 1, Fig. 4).

At the base the conglomerates are breccia-like and breakable, while higher up, they are well worked. There are deposits of sandstones and shales in them. Although they are transgressive, they are significantly different from the masses of basal Lower Eocene Súľov conglomerates. We interpret these conglomerates as lateral representation of the Domaniža Flysch Formation with bodies or significant deposits of fresh water conglomerates, with reef facies as well, from which one horizon is transgreded on subducted horst-like deformation, of a Mesozoic island zone belonging to the Strážov and Rohatá skala Units with Lower to Middle Cretaceous of Zliechov type (the Triassic facies are very similar to the Veterlín Nappe of the Malé Karpaty Mts., Salaj et al. 1991).

Their Mesozoic facies were sedimented close together in a single northerly situated sedimentation (Strážov) area (Salaj & Hanáček in Salaj 1982, p. 216; Salaj 1987, p. 133). Apart from the Eocene, it is necessary to note that as early as the Albian - Turonian, this Mesozoic island zone could represent one emerged cordillera zone (connected or insular), with a slanting course to the original Klippen and Peri-klippen Belt (from Domaniža with a continuation to Rajec and the Žilina Basin, and a probable continuation to Terchová and further to the east). If this view corresponds to reality, it would partly elucidate the presence of rounded pebbles of basin type of the Mesozoic of

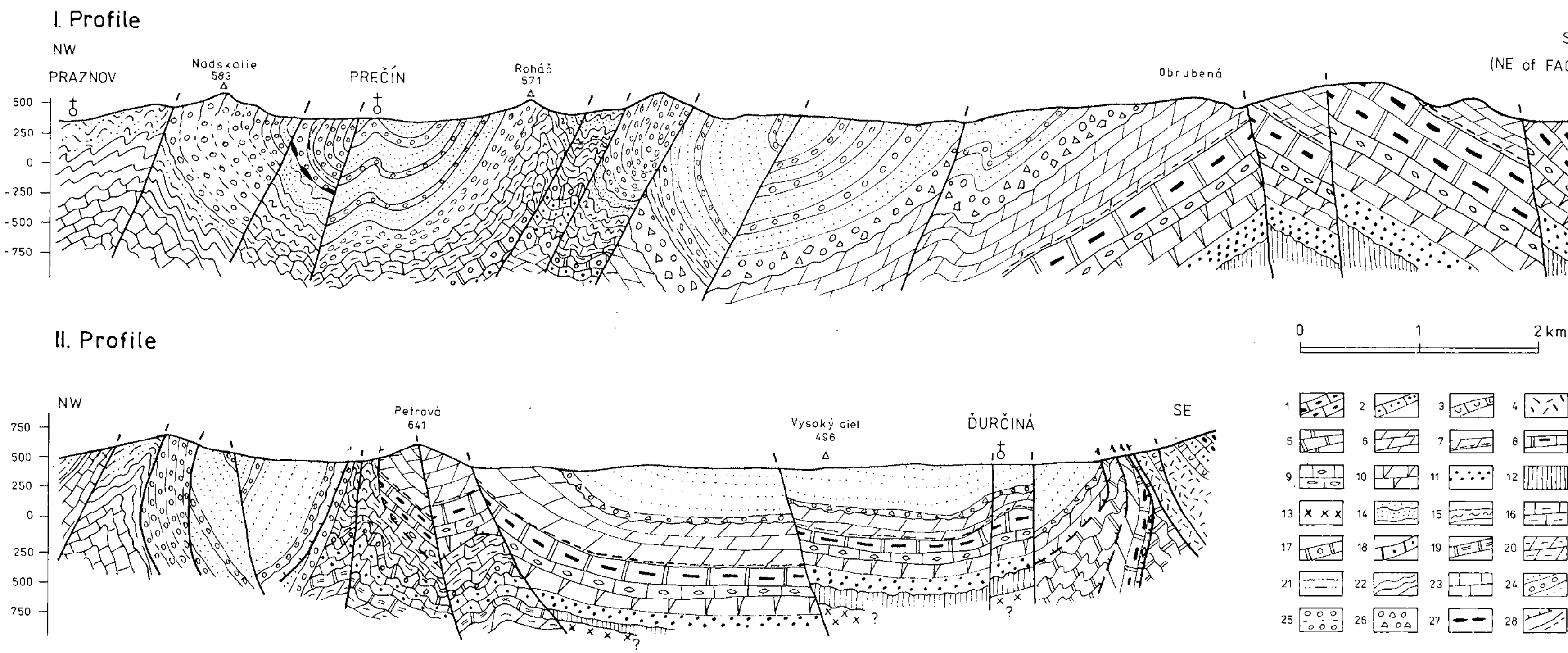


**Fig. 2.** Geological profiles I and II through the Mesozoic and Paleogene of the Fačkov-Rajecká Lesná-Domaniža-Prečín area (after Salaj).
*Legend:* **I. Krížna Unit:** a - Ďurčiná succession: 1 - Sinemurian: dark spongolite limestones; 2 - Hettangian: marls and grey sandy crinoidal limestones; 3 - Rhaetian: dark-grey sandy limestones and lumachelle limestones; 4 - Norian: Carpathian Keuper; b - Zliechov succession: 5 - Tithonian to Neocomanian: grey banked calpionellid limestones and spotted marly limestones; **II. Strážov Unit:** 6 - Upper Carnian to Norian: Hauptdolomit; 7 - Upper Carnian: dolomitic green Raibler shales at the base of the Hauptdolomit, locally missing and sporadically hardground is present (quarries of Veľká Čierná and Lietavská Svinná); 8 - Ladinian to Carnian: Raming limestones, locally in the upper part red and grey shales (Partnach beds); 9 - Middle Anisian to Lower Ladinian: Reifling cherty limestones; 10 - Anisian: Gutenstein limestones and dolomites; 11 - Scythian: basal quartzites and conglomerates, variegated shales; 12 - Upper Paleozoic (Permian - is related to the outcrops of the Permian, as well as the Scythian beds to the north-west of Ďurčiná); 13 - crystalline rocks are supposed as substratum of the Paleozoic and Strážov Unit; **III. Rohatá skala Unit:** 14 - Middle to Upper Albian: flyschoid sequence - sandstones, marls and sandy marls; 15 - Aptian to Lower Albian: dark organodetritic limestones, grey limestones and marls; 16 - Tithonian to Neocomian; grey banked calpionellid limestones, breciated limestones, dark sandy barremian limestones and rare intercalations of marls; 17 - Callovian to Oxfordian: red nodular, platy limestones and radiolarites; 18 - Liassic to Aalenian: grey and red spongolites and crinoidal cherty limestones; 19 - Rhaetian (Norovica Formation): dark-grey limestones to sandy and lumachelle limestones; 20 - Upper Carnian to Norian: Hauptdolomit. **IV. Kostolec Unit (Hradná succession):** 21 - Upper Albian to Lower Cenomanian: flyschoid sequence - sandstones, sandy marls and marls; 22 - Aptian to Lower Albian: dark organodetrital orbitoline limestones and marls; 23 - Tithonian to Neocomian: grey banked calpionellid limestones, spotted marly limestones, brecciated limestones and marls. **V. Paleogene of Súľov** (intermediary facial development between the Paleogene of the Peri-klippen Belt and Central Carpathian Paleogene): 24 - flysch of the Middle Eocene to Oligocene with conglomerate horizons; 25 - transgressive Súľov conglomerates of the Lower Eocene (laterally passing to the Svinské Chlievy Formation to the SW); 26 - Lower Eocene: coal intercalations and coal shales; 27 - Lower Lutetian: transgressive conglomerates and breccias; 28 - overthrust lines and faults.

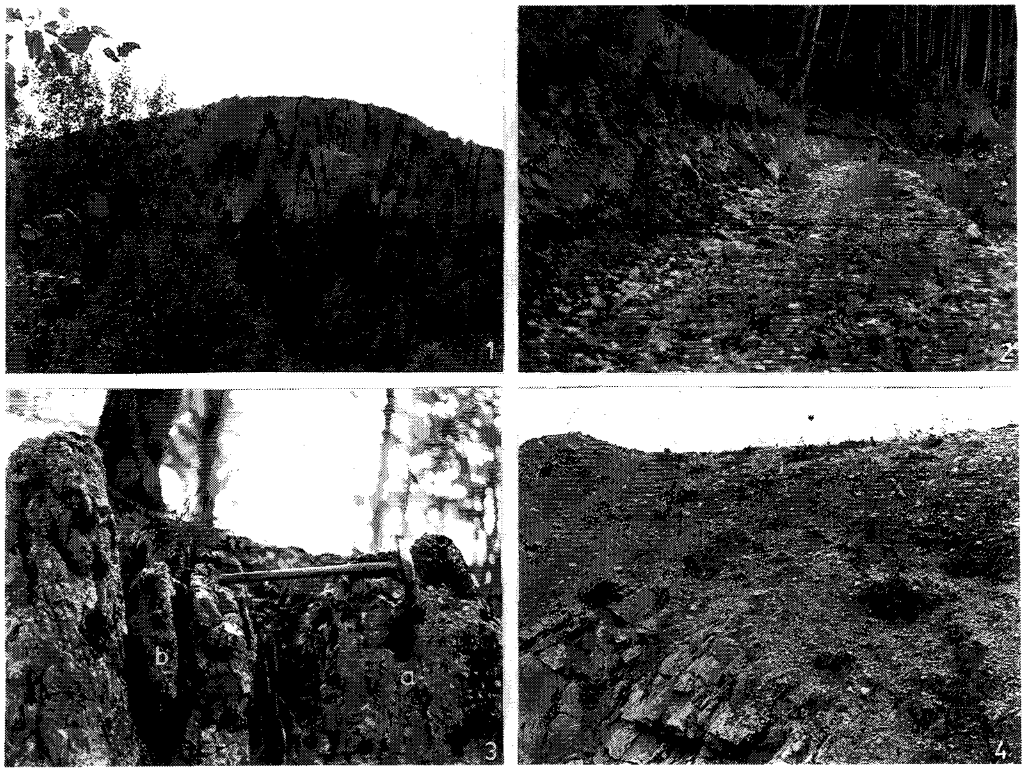

**Plate 1:** Fig. 1 - cutting on a forest road in the Svinské Chlievy massif, at the locality of the Svinské Chlievy Formation (uppermost Paleocene - Lower Eocene). Fig. 2 - cutting on a forest road, Svinské Chlievy. Transgressive base (a) of the Svinské Chlievy formation (4 m) (in the basement are Wetterstein limestones), above are conglomerates with three deposits of red clays. Fig. 3 - vertically erected horizon of Malenica onyxites: *a*-underlying, *b*-overlying Súľov conglomerates. Fig. 4 - transgression of Lutetian conglomerates on Upper Triassic dolomites of the Strážov Unit. Quarry at Malá Čierna.

the Strážov Mts. in the Middle Cretaceous and Coniacian conglomerates of the Klape and Drietomá Units of the Žilina section of the Peri-klippen zone and also in the Cenomanian conglomerates of the Kostolec Unit (Hradná succession).

The so predisposed, lightened Mesozoic basement of the Rajec and Žilina Basins significantly subsided during the Upper Eocene - Lower Oligocene.

It is necessary to note that in the course of the Savian folding, part of the underlying Mesozoic rocks mentioned of the Fačkov strip with Lutetian conglomerates, and further in the section Malá Čierna - Jaseňovo - Rajecké Teplice - Lietavská Lúčka was significantly folded, pressed from the underlying strata and two-directionally overfaulted on neighbouring downslip faulted, mainly Paleogene, or Lower Cretaceous blocks. There is another significant Savian line to the south-east near Rajecká Lesná - Ďurčiná (Maheľ et al. 1964), according to which the Paleozoic - Mesozoic complex of the Malá Fatra Mts. is overfaulted onto the Paleogene of this basin. At the same time, it is necessary to add that the Rajec Basin is less folded (the basement is Triassic and the author supposes that it probably as is supposed by author is formed by parautochthonous Paleozoic and crystalline rocks too) and from the previous Pružina Basin (significantly folded, lying on a higher member of the Mesozoic Jurassic - Middle Cretaceous) divided by a significant transverse fault (Fig. 2).

This, as well as other transverse faults are of post-Eggenburgian age, from the argument that they break Lower Miocene marine sediments of the Ilava and Bytča Basins. Sediments by the main road at the turning to Pružina (up to now considered Pontian - Pliocene) also belong to the Eggenburgian. The lowest part of sediments of continental origin are also exposed here.

### *The Svinské Chlievy Formation, new term*

The Svinské Chlievy Formation, equivalent in age to the Súľov Formation, is formed by a complex of conglomerates (500 - 700 m), in which various horizons of Malenica onyxite (20 - 40 cm thick) occur. The Súľov conglomerates are thus divided into various sedimentational cycles. In the lower one, three deposits of green shales and resedimented bauxite or red paleo-soils (terra rossa) occur. The transgressive base of the conglomerates (Pl. 1, Fig. 2a), about 2 - 4 m thick is marine (there are deposits of coarse grained calcareous sandstones to sandy limestones). The main part of the Svinské Chlievy Formation originated in lagoonal-lacustrine and especially lacustrine conditions, although occasional very short marine ingressions are not excluded.

The type locality of the newly defined formation is in the cutting for a forest road in the Svinské Chlievy mountain massif (Pl. 1, Figs.1, 2; Fig. 1). Its profile is given in a previous work of the author (Salaj 1991, Fig. 2, p. 216). In relation to the fact that then the author did not find large foraminifers at the base of this formation, his proposed interpretation of its wide age range (Danian - Montian - Thanetian) was not correct. After repeated and detailed searching and study of further thin-sections, large foraminifers were found at the base of the Svinské Chlievy Formation at the first locality studied (documentational points PB-1053 and PB-1058, cf. Salaj 1991, Fig. 2, p. 216). There are occurrences of species of the genus *Miscellanea* Pfender, *Daviesina* Smout, *Operculina* d'Orbigny, *Alveolina* d'Orbigny, *Discocyclina seunesi* Douvillé and *Nummulites* aff. *solitarius* de la Harpe. This microfauna allowed the assignment of the base of the Svinské Chlievy Formation

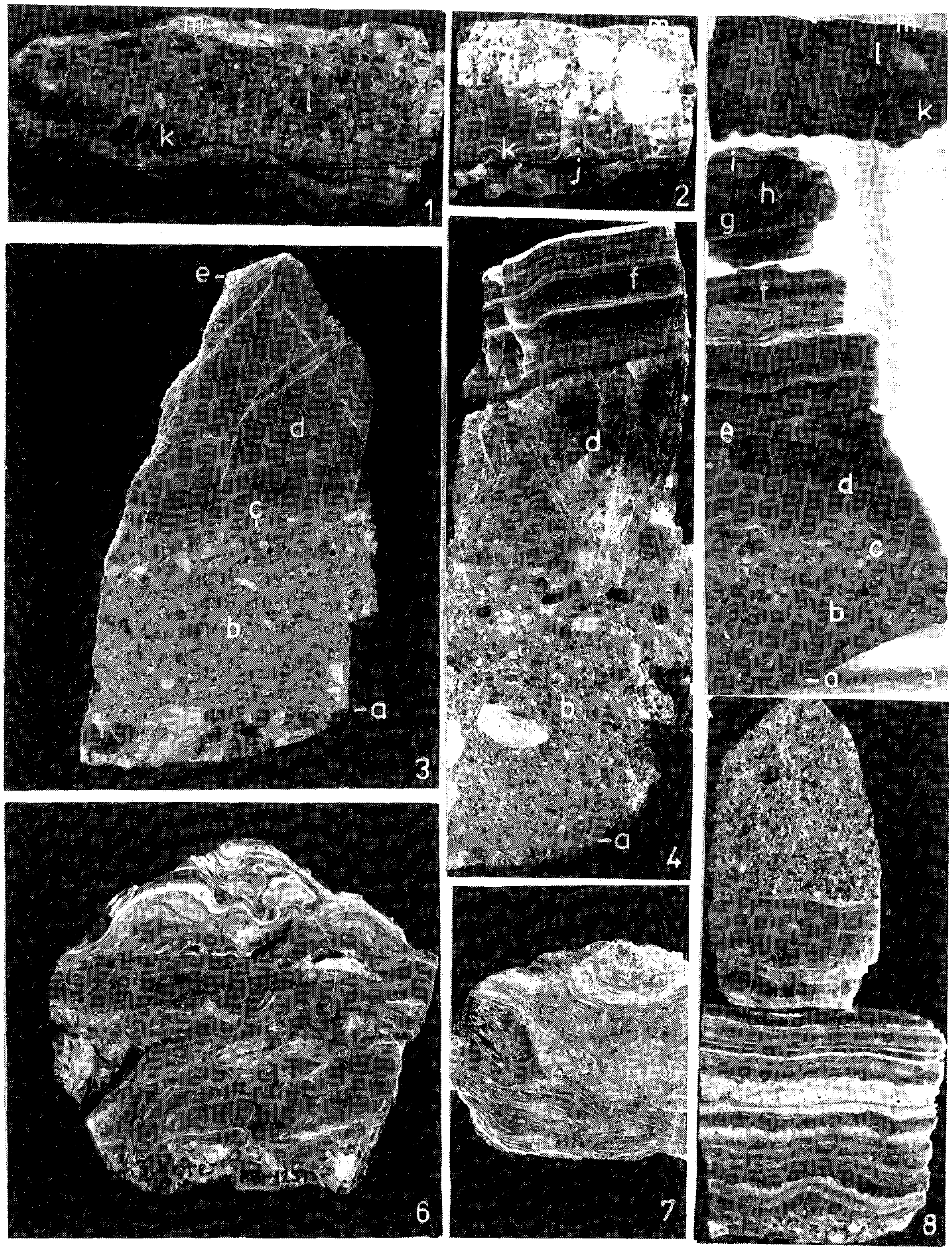


**Plate 2:** Figs.1-5 - the third more cyclic horizon of Malenica onyxites (originally described as the first horizon of fresh water banded limestones): *a* - surface of discontinuity (filled by a 1 mm thick lamina of sinter limestone), dividing the last inundation cycle of lacustrine conglomerates; *b* - transgraded emerged surface; c - the first two lower cycles of Malenica onyxites; *d* - further horizons of Malenica onyxites with an oblique course in the direction of layers (as a result of a cascading current of water) on underlying onyxites; *e* - surface discontinuity and erosion; *f* - banded onyxites - alternation of bands precipitated in summer and winter periods; *g* -"lumpy" fresh-water limestones sedimented in a calm bay and originating from the resedimentation of very fine grains of the Malenica onyxites; *h* - hard ground; *i* - finely precipitated Malenica onyxites sedimented from very small springs; between horizons *i* and *k* sedimented lacustrine clay with small pebbles from the conglomerates (deposit 2 - 5 cm thick); *j* - lower surface of a further cycle of Malenica onyxite, *k* - continuing on underlying clays; *l* - 1-4 cm thick inundation cycle of lacustrine conglomerates, on which, after drying of the lake, short term (1 season) surface water flowed lamina of light sinter limestone *m* - 1-2 mm thick, distinguishing a further complex from an inundation cycle of lacustrine conglomerates. Figs.6, 7 - the second horizon of Malenica onyxites precipitated from flowing waters. At the base is contact with underlying limestones. Fig. 8 - the highest (ninth) horizon of Malenica onyxites.

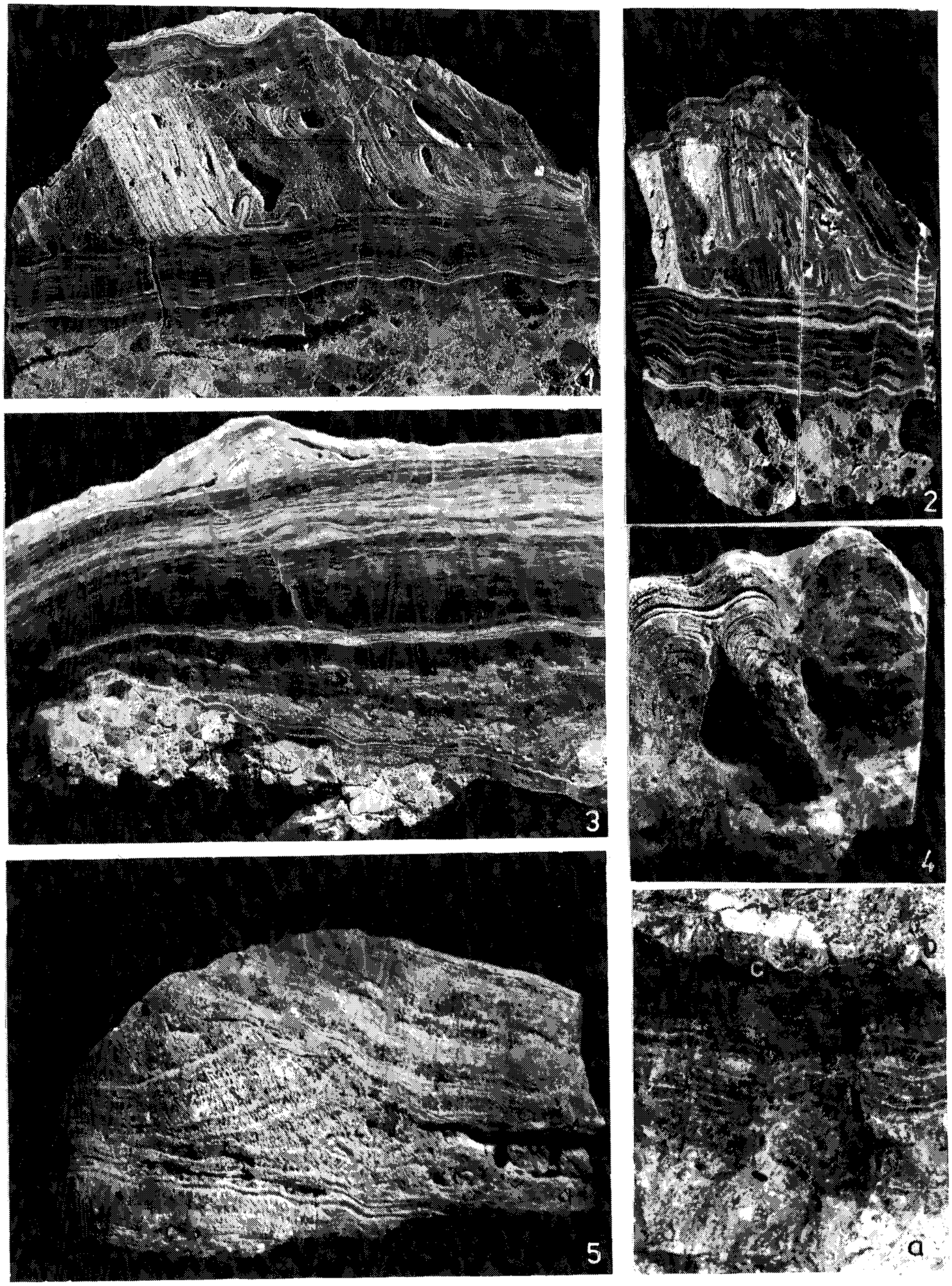


**Plate 3**: Figs. 1, 2 - seventh horizon (variable depth of polished section) of Malenica onyxite. This is strongly deformed by pressure immediately above the inundation conglomerates. Figs. 3, 4 - fifth horizon of Malenica onyxite. In the lower part, three horizons with reworked grain fragments from older freshwater limestones. Fig. 5 - fourth horizon of Malenica onyxite with significant erosional discontinuities between the lower and upper parts. Fig. 6 - detail of an outcrop of the third horizon of Malenica onyxite: *a* - underlying conglomerate, *b* - overlying conglomerate, *c* - deposit of clays with small pebbles of conglomerate.

to the uppermost Paleocene (=base of the Ilerdian). This may confirm that the Svinské Chlievy Formation is in essence the age equivalent of the Súľov beds from the Riedka profile - elevation point Stráže. We intend to use the term "Súľov conglomerates" in future in both formations with the view that it is not exclusive, and that their part in the formation beside the Súľov Fm. may also be of lacustrine origin.

For the horizons of freshwater laminated limestones, I am introducing the new term: Malenica limestone, as well as the technical name Malenica onyxite (for distinction by origin from more or less similar Quarternary onyxes).

The detailed description of two studied horizons, up to 800 m in length was already mentioned (Salaj 1991). In the course of further field research, the author proved the existence of a further 7 horizons of Malenica onyxite, while the existence of more horizons is not excluded.

The oldest of them, perhaps 1 - 2 cm thick, is above the third claystone horizon with resedimented red paleo-soils (terra rossa), and a low percentage bauxite admixture, originating from reworked bauxite. The second, noticeably wavy horizon (11 cm thick) of Malenica onyxite precipitated from wildly flowing waters (Pl. 2, Figs. 6, 7) is a short distance below the original first described horizon of Malenica onyxite (Pl. 2, Figs. 1 - 5), now the third.

A further two significantly thick (20 - 40 cm) horizons of Malenica onyxite (Pl. 3, Figs. 3 - 6) are between the first (documentational point PB-1060; Salaj 1991, Fig. 2, p. 216) and the second horizons (documentational point PB-1059 and PB-944; Salaj 1991, Fig. 2, p. 216) "overfolded" Malenica onyxite (Pl. 3, Figs. 1, 2), now the seventh.

From the other horizons, with thicknesses of cca.10 - 15 cm, one is in the underlying rocks and a further two in the rocks overlying (the uppermost 7th horizon, Pl. 2, Fig. 8) the "overfolded" horizon, originally noted as the second horizon of Malenica limestone. The overfolding, or more correctly deformation of this horizon (Pl. 3, Figs. 1 - 2) was caused by pressure from the immediately overlying conglomerates, deposited by inundation, especially their gravitational subsidence.

Apart from the facial variety of the Malenica onyxites (with moderately wavy or significantly and irregularly wavy laminae - formed as a result of flowing water and the morphology of the underlying rocks), there are occasional cavities in them, as traces of vegetation. With detailed study of polished section material, it was found that the type of non-laminated lumpy onyxite sedimentation in the calm zone (Salaj 1991, Fig. 5g, p. 220) is formed from very fine reworked grains (up to 1 mm) of Malenica onyxite, which are cemented by more or less the same precipitated limestone cement. It is necessary to emphasize the presence of blue algal coverings (identified by J. Soták from the author's materials), which had very ideal conditions for their origin and formation in a calm environment of slowly flowing water.

Deposits with resedimented coarser grains of Malenica onyxite also exist in the Malenica onyxites (Pl. 3, Fig. 3). These deposits (0.2 - 10 mm) also allow us to determine the direction of transport and current of the Lower Eocene water flowing on the surface.

In this work, we again emphasize the connection and concordant deposition of the beds of Malenica onyxite, with the underlying and overlying conglomerates, with which they show Savian folding.

The complex of the Svinské Chlievy Formation is more or less vertically raised at an angle of 45 - 90°. We note that the third horizon of Malenica onyxite (originally described as the first - Salaj 1991; Figs.3, 1, p. 217), well exposed in the cutting of the forest road is raised at an angle of 45 - 60°, while on the crest of the summit of the elevation point (Pl. 1, Fig. 1) of Svinské Chlievy is a further fourth horizon, together with vertically raised underlying and overlying conglomerates (Pl. 1, Fig. 3).

## Sedimentational environment

After a short and rapid transgression (Pl. 1, Fig. 2a), a lowering of the sea level occurred, and so a sudden change of the marine regime to a lagoonal-lacustrine one, with isolation of a partly intramontane, evidently originally very extensive gulf, then a lake.

Basically, we have three more or less independent sedimentary cycles, in the first cycle defined by the author. These are represented by:

**1** - a basal complex of marine carbonate conglomerates and conglomerates to sandy limestones with scarce fauna of large foraminifers, cca. 2 - 4 m thick;

**2** - a section of chaotically sedimented conglomerates with three deposits 20 - 30 cm thick of green lacustrine shales, and resedimented, already low percentage bauxites and terra rossa, where on the uppermost such horizon are deposited 1 - 2 cm of Malenica onyxite. Up to now, this is the oldest and first proved horizon of Malenica onyxite. It documents emergence and short term sedimentation in dryland conditions. Material from supralitoral - eulittoral to litoral (Bench platform) zone with rooted vegetation, prograded into the lake following transgressive and regressive phases, related to inundation sedimentary cycles;

**3** - a conglomerate complex of lacustrine sediments is entirely formed by mostly thick (50 cm - 2 m) benches of conglomerate cca. 100 - 150 m thick.

Laminae, 1 - 2 mm thick, of light limestones of sinter character (Pl. 2, Figs. 3a, 4a, 5a) confirm the short term periodical and irregular interruption of sedimentation as a result of short term seasonal drying of the lake. After another rapid flooding of the lake depression with water, as a result of periodic flooding, these limestone laminae are generally preserved from deposition of very fine grained, irregularly grained calcareous conglomerates.

The uppermost of these minicycles of conglomerate (Pl. 2, Fig. 3b), before the main emergence and sedimentation of the lower complex of fresh water laminated limestones (Salaj 1991, p. 219 - 220; the present 3rd horizon of Malenica onyxite), has a thickness of 3 - 6 cm (Salaj 1991, p. 219).

In relation to the fact that in the further "two" sedimentary cycles of Súľov conglomerates divided by the upper complex of Malenica onyxite (Salaj 1991, p. 220), further horizons of Malenica onyxite and several 1 - 2 mm thick laminae of limestones of sinter character, it is clearly shown that we have the activity of various sedimentary cycles of lacustrine sediments in the framework of the Svinské Chlievy Formation.

Although we did not find marine macrofauna or a microfauna of large foraminifers, it cannot be excluded that it occurred in short term marine ingressions, at least in the uppermost part of the Svinské Chlievy Formation.

There is no doubt that the final sedimentary minicycles before the sedimentation of Malenica onyxite were lacustrine, and that their surface represents the dry land after the drying up of the lake. Equally, after the sedimentation of each horizon of Malenica onyxite, or only of their 1 - 2 mm thick laminae (varved sediments), a return to sedimentation in lacustrine conditions must have occurred. Rapid flooding of dried up depressions and the creation of lakes occurred as a result of catastrophic inunda-

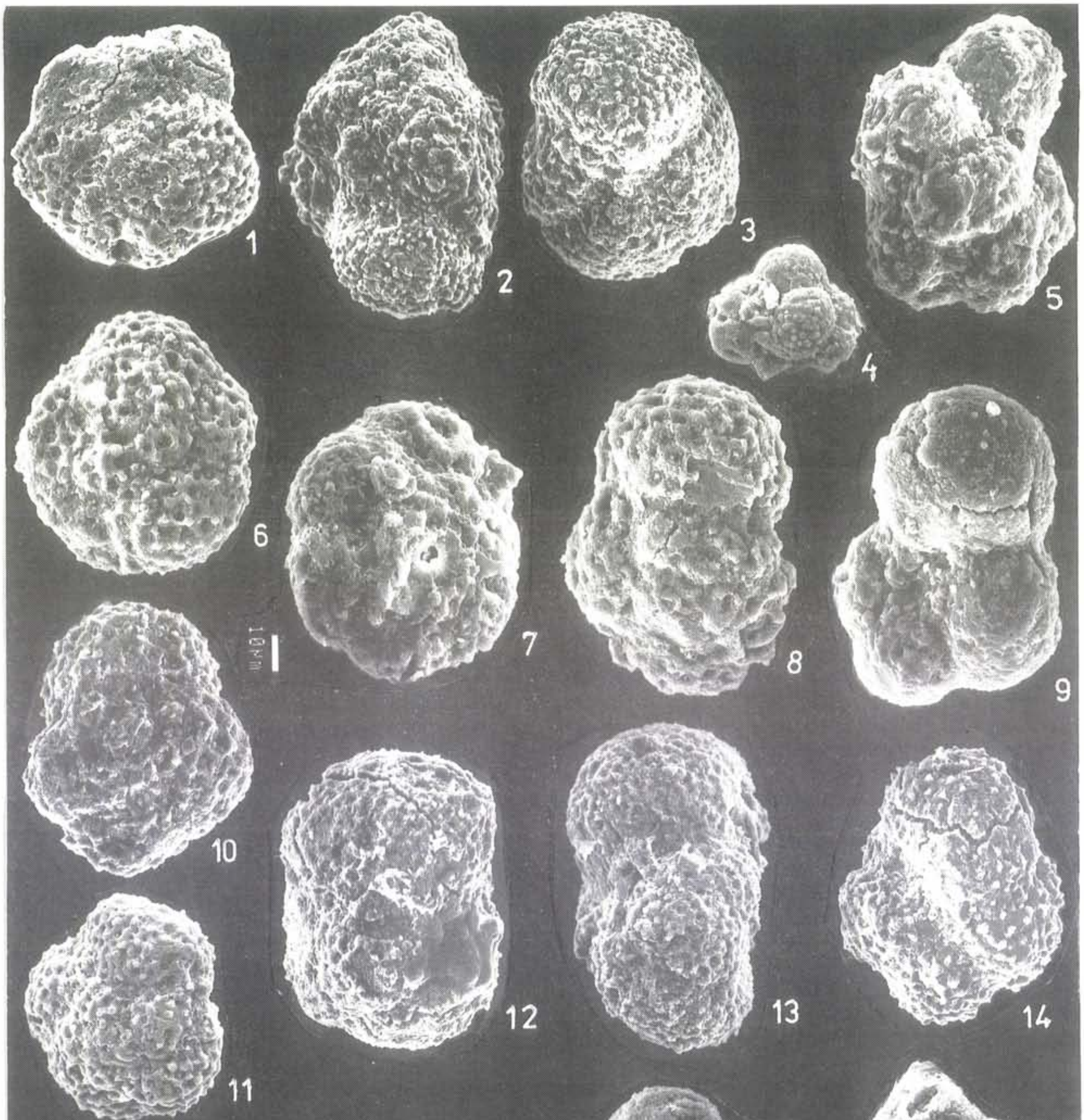


**Plate 4:** Figs. 1-3 - *Globorotalia increbescens* (Bandy), x 225, x 150, x 135; sample PB 1282 - loc. 500 m W of Malá Lednica, Middle Oligocene. Figs. 4, 5 - *Cassigerinella chipolensis* (Cushman & Ponton), x 250, x 425; sample PB 1282, Malá Lednica. Fig. 6 - *Globorotalia opima nana* (Bolli), x 300; sample PB 1282, Malá Lednica. Fig. 7 - *Globorotalia* sp., x 500; sample PB 1282, Malá Lednica. Figs. 8, 9 - *Globigerina ouachitaensis ouachtaensis* Howe & Wallace, x 350, x 450; sample PB 1282, Malá Lednica. Figs. 10, 11 - *Globigerina parva* Bolli, x 250, x 225; sample PB 1282, Malá Lednica, Middle Oligocene of Domaniža Basin. Figs. 12-14 - *Truncorotaloides danvillensis* (Howe & Wallace), x 225, x 200, x 200; sample PB 1282, Malá Lednica. Fig. 15 - *Globigerina euapertura* Jenkins, x 350; sample PB 1282, Malá Lednica. Fig. 16 - *Globigerina postcretacea* Myatliuk, x 425; sample PB 1282, Malá Lednica. Figs 17, 18 - *Chiloguembelina gracillina* (Andreae), x 325, x 425; sample PB 1282, Malá Lednica.

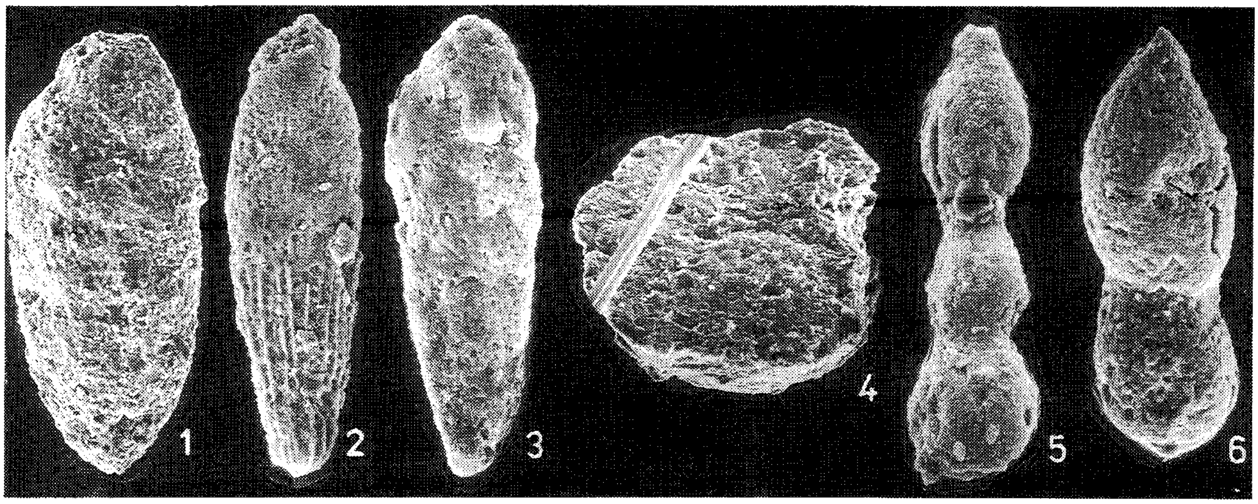


**Plate 5:** Fig. 1 - *Bolivina budensis* (Hantken), x 125; sample PB 1283, loc. 500 m W of Malá Lednica, Oligocene. Fig. 2 - *Bolivina nobilis* Hantken, x 175; sample PB 1282, Malá Lednica. Fig. 3 - *Bolivina microlanceliformis* Subbotina, x 225; sample PB 1282, Malá Lednica. Fig. 4 - *Cibicides lobatulus* (Walker & Jacob), x 135; sample PB 1282, Malá Lednica. Fig. 5 - *Nodosaria consobrina* (d' Orbigny), x 300; sample PB 1282, Malá Lednica. Fig. 6 - *Nodosaria capitata* Bolli, x 275; sample PB 1282, Malá Lednica.

tion, leading to rapid, chaotic and ungraded sedimentation. The sediments represented by the conglomerates, especially immediately overlying the Malenica onyxites could not destroy these limestones, as a result of the very low energy and rapid sedimentation of detritus. Their uppermost laminae (or only the uppermost) are usually not at all (Pl. 2, Fig. 8), or only very weakly damaged (Pl. 2, Figs. 1b, 2k, 5k). In the event not only of a marine transgression, but also as a result of the ebb and flow of tides, these horizons of Malenica onyxite, as well as their individual weak light laminae of limestones of sinter character would have been destroyed.

It will be necessary to devote attention to the solution of problems it is still necessary to note that the complex of the Súľov Formation considered as marine. It is necessary to admit the possibility, that at least its major part could have originated only in lacustrine conditions, but in lakes with a deeper water regime and which did not dry up. Apart from this, it is necessary to take into account, the views of Andrusov (1965) about the occurrence of coal inserts, or of Marschalko & Kysela (1980, p. 53) about the alochthonnous coal inserts in the Súľov Formation. These were found at the base of Súľov Formation in the borehole Pružiná RK-27, at a depth of 39 m Šalaga et al. (1976).

These coal deposits of coal argiles also occur in the Jablonová Formation of the Peri-klippen Paleogene in the Jablonová quarry. This detritus could originate from the formerly rich flora of the coastal zone, dividing the sea where neritic sediments with a fauna of large foraminifers were deposited from the continental zone, mostly of intramontane lakes.

## The Domaniža Formation

It was defined by Samuel (1972), and still partly represents the Lower Eocene, but mainly Lutetian to Oligocene flysch. In the Lutetian, there are deposits of coarse conglomerates 50 - 100 m, with sandy limestones in places especially at the bottom, rich in foraminifers of the Lower Eocene, among which *Nummulites burdigalensis* Harpe (Vaňová in Samuel & Salaj 1968). The beds of marls, in places varied, contains a rich Lutetian, mostly planktonic microfauna (loc. Riedka), studied and described by Samuel & Salaj (1963, 1968). It is a microfauna of the zone of *Turborotalia (Acarinina) densa, Globigerinatheka subconglobata* and *Truncorotaloides rohri*. Layers of varied Lutetian marls are also exposed in Bodina (football field).

The Domaniža Formation in the Pružiná section of the Domaniža Basin mostly corresponds to the Lutetian. We note that west of Malá Lednica, in fine rhythm flysch formation with a prevalence of marls, apart from Upper Eocene - Lowest Oligocene (Samuel & Salaj 1968) we found Middle Oligocene microfauna, represented mainly by the species: *Globigerina euapertura* Jenkins, *Cassigerinella chipolensis* (Cushman et Ponton), *Chiloguembelina gracillima* (Andreae), *Cibicides lobatulus* (Walker et Jakob) and others (Pls. 4, 5).

## Conclusion

Nine proved horizons of Malenica onyxite originated in continental conditions, by the activity of surface flowing water, at least locally divide, various Lower Eocene sedimentary cycles. In the lowest, evidently still Upper Paleocene cycle, reworked low percentage bauxites, red paleo-soils (terra rossa) and green shales were sedimented. Together they formed three 20 - 50 cm thick horizons in the conglomerates.

At the same time as this alternation of types of continental sediments, a significant variation is observed of the level of the Lower Eocene sea, lying near lagoons and lakes.

It is necessary to emphasize that the main mass of conglomerates of the Svinské Chlievy Formation (like the Súľov) was sedimented in the Lower Eocene, corresponding according to Odin & Kennedy (1982) to time section 8 MY.

Significant tectonic activity, also connected with significant variation of sea level also continued during marine sedimentation in the Middle Eocene. In the flysch of the Domaniža Formation (in the lower part), various 50 - 100 m thick complexes of conglomerate were sedimented. Their material originated mainly from an emerged Mesozoic island zone, which was submerged in the course of the Middle Eocene. On these higher, therefore younger horizons, of significantly broken up, but well worked conglomerates, transgressed. In the island, therefore significantly shallow water zone, reef limestones also originated, were destroyed by the destructive activity of the water mass, and transferred as olistoliths to the conglomerate beds.

A deepening of the sea occurred in the course of the Upper Eocene to Lower Oligocene, when fine-rhythmic distal flysch with a prevalence of claystones to marlstones with occasional deposits of fine grained conglomerates. Coarse grained Oligocene sandstones from Konská represent the regressive and shallow water facies (Šalaga et al. 1976).

Tropical elements of planktonic microfauna represented by globorotaloid genera in the Eocene - Oligocene formations of the area studied are lacking, or apart from the lowest Eocene (*Morozovella subbotinae* Zone) are only very sporadically represented. It was evidently an area in which there was a significant differentiation between a summer (monsoon) and winter cooler season. This was clearly indicated in the Lower Eocene on the basis of the presence of fresh water Malenica onyxites and evidently continued into the Oligocene.

The nearness to the coast and the impurity of the relatively shallow water basin by deposition of detritus, especially in the Middle Eocene. In the Upper Eocene and in the Oligocene, although there was a significant deepening of the sedimentary environment, there was evidently a cooling, chiefly in the Middle Oligocene, as has been observed in world literature by Douglas & Savin (1973), Schackleton & Kennett (1975) and Haq et al. (1977). The development of only small benthic and planktonic foraminifers are evidence of this cooling.

It is necessary to note that this Oligocene microfauna are not intercepted by washing on mill silk. Only larger reworked Middle Eocene examples remain on it, often generally damaged. Their redeposition is evident only where there is also an Oligocene microfauna. This is caught thanks to washing through a sieve with holes of 0.008 mm.

Translated by M.C. Styan

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