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GUIDE TO EXCURSION B1 (POST-CONGRESS)

LOWER–MIDDLE MIOCENE FORMATIONS IN THE FOLDED AREA OF THE EAST CARPATHIANS

by

Mircea Săndulescu, Mariana Mărunţeanu, Gheorghe Popescu

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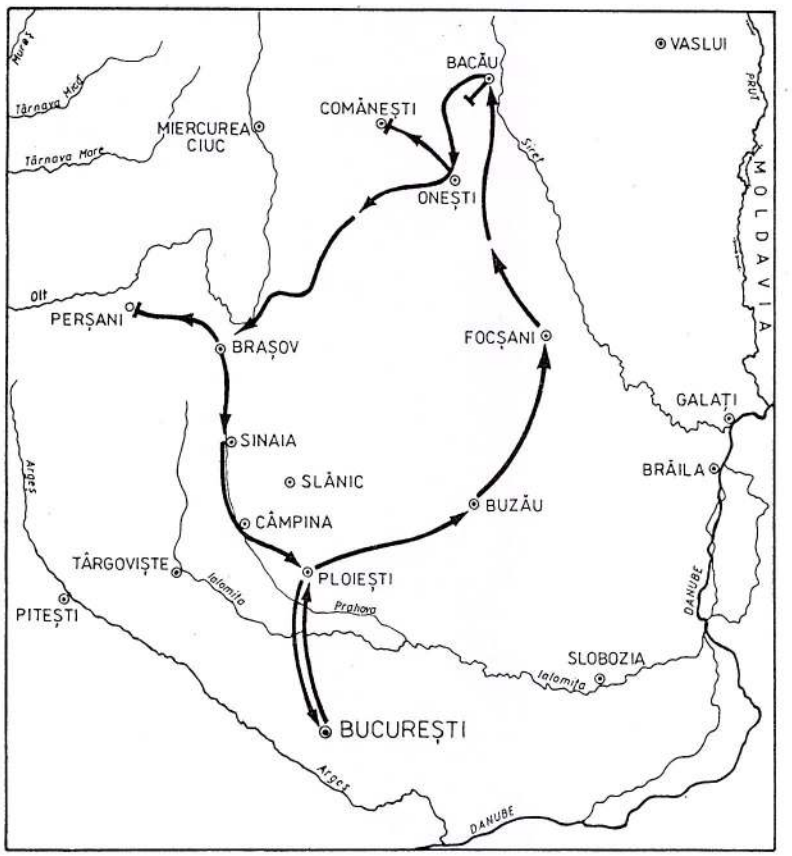


Excursion itinerary (B1)

GENERAL OUTLOOK ON THE EAST CARPATHIANS STRUCTURE

The East Carpathians are a segment of the deformed European continental margin and can be divided into several major structural units which generally group together nappes of similar type and of synchronous age of tectogenesis.

The East Carpathians can be divided in several structural zones according to different criteria. Taking into account the petrographic constitution and the geographic position there were distinguished (from inside toward outside): the Transcarpathian Flysch Zone, the Crystalline-Mesozoic Zone, the Flysch Zone and the Subcarpathian Zone. Following the age of the main deformation and the mutual areal position there were separated (Fig. 1): the Transylvanian Nappes, the Median Dacides (Central East Carpathians Nappes), the Outer Dacides and the Moldavides. A molassic Foredeep runs outward to the Moldavides, partly overlapping their frontal part. A Neogene Volcanic Arc develops above the inner part of the East Carpathians. In the northern part of the East Carpathians, the Pienides group together nappes prolongating southeastward the Pieniny Klippen Belt and Măgura Nappe of the West Carpathians, overthrust above the postnappe cover of the Median Dacides.

The Transylvanian Nappes are obduction-type nappes being built up of Mesozoic sedimentary formations (pre-Cenomanian) and ophiolitic complexes. They constitute units tectonically overlying the uppermost Central East Carpathian Nappe (the Bucovinian Nappe). The ophiolites associated with the Transylvanian Nappes are of Middle and Upper Triassic or Middle and Upper Jurassic ages. These nappes proceed from the Major Tethyan Suture which is the squeezed oceanic crust bearing Tethys.

The Central East Carpathian Nappes group together continental basement shearing units each of them consisting of crystalline formations (Precambrian and/or Paleozoic in age) and Mesozoic (pre-Cenomanian) sedimentary formations. From top to bottom the Bucovinian Nappe, the Subbucovinian Nappe and the Infrabucovinian nappes were separated. The age of the overthrusting of the Central East Carpathian Nappes is Mid-Cretaceous.

An Upper Cretaceous and/or Paleogene post-nappe (post-tectogenetic) cover lies discordantly over the partly eroded Transylvanian and/or Central Carpathian nappes, in some areas even ceiling their contacts.

The innermost nappes belonging to the East Carpathian Flysch Zone constitute the Outer Dacides (Fig. 2). They proceed from an intra-continental margin rift within which developed a thinned crust or (locally) oceanic-type crust of Jurassic age, covered by Tithonian-Lower Cretaceous flysch formations, followed locally by Albian conglomerates and few pelagic Upper Cretaceous formations. The main nappe of this group is the Ceahlău Nappe characterized by the development of the Sinaia Flysch (Tithonian-Neocomian). The Black Flysch Nappe and the Baraolt Nappe develop inward. The structure of the Ceahlău Nappe is very complex, several subunits (digitations) being distinguished within it.

The outer part of the East Carpathians consist of nappes which were overthrust in the Miocene time and which are grouped into the Moldavides. They represent the most important part of the Flysch Zone and of the Subcarpathians. From inside (west) toward outside (east)

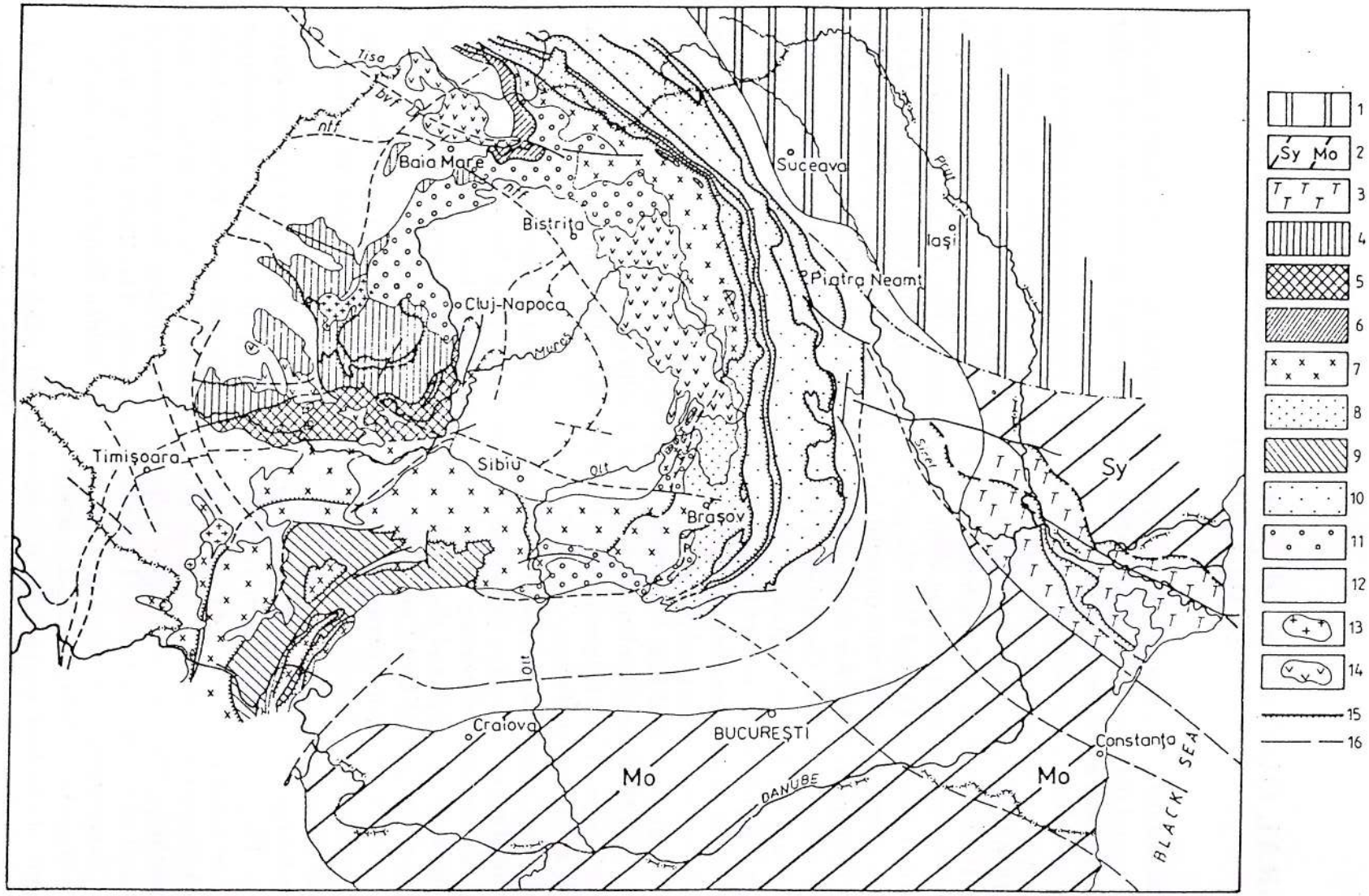


Fig. 1 – Tectonic Sketch of Romania, Carpathian Foreland: 1, East European Platform; 2, Scythian (Sy) and Moesian (Mo) platforms. 3, North Dobrogea Orogen Carpathians; 4, Inner Dacides; 5, Transylvanides; 6, Pienides; 7. Median Dacides; 8, Outer Dacides; 9, Marginal Dacides; 10, Moldavides; 11, Post-tectogenetic covers; 12, Neogene Molasse depressions and Foredeep; 13, Upper Cretaceous - Paleocene magmatic arcs; 14, Neogene magmatic arcs; 15, thrust-sheets; 16, faults.

there occur: the Convolute Flysch, Macla, Audia, Tarcău, Marginal Folds and Subcarpathian nappes. The overthrustings of the Moldavidian nappes are of Lower Miocene (intra-Burdigalian) and Middle Miocene (intra-Badenian ? and intra-Sarmatian) ages. Thus, Inner Moldavides (Convolute Flysch, Macla and Audia nappes) of Lower Miocene overthrusting and Outer Moldavides (Tarcău, Marginal Folds and Subcarpathian nappes) of Middle Miocene overthrusting can be distinguished. Excepting the Subcarpathian Nappe, the Moldavidian units are mainly built up of flysch-type deposits of Cretaceous and Paleogene ages, with which shaly, pelagic or bituminous formations are associated at different levels. Molasse formations are known mostly in the Subcarpathian Nappe but also in the Marginal Folds and even in the Tarcău nappes.

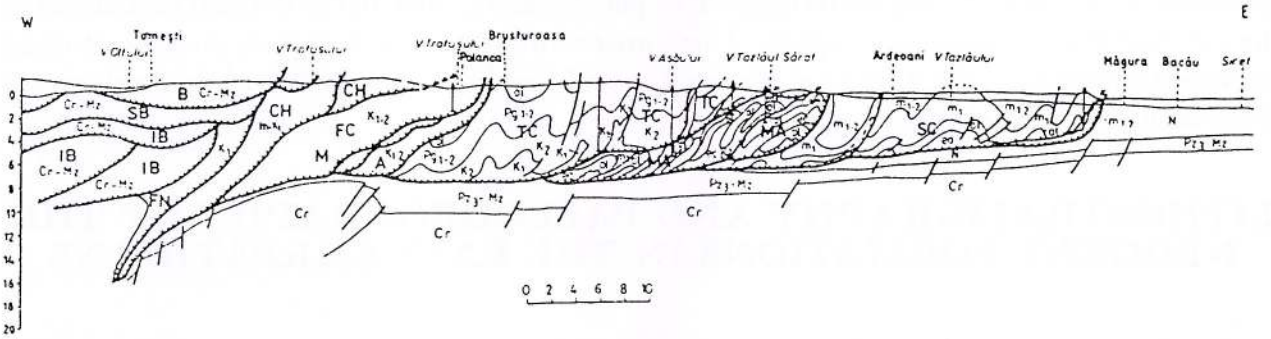


Fig. 2 - Geological cross-section through the East Carpathians Flysch Zone (in central Moldavia). B - Bucovinian Nappe, SB - Subbucovinian Nappe, IB - Infrabucovinian Nappe, FN - Black Flysch Nappe, CH - Ceahlău Nappe, FC - Convolute Flysch Nappe, M - Macla Nappe, A - Audia Nappe, TC - Tarcău Nappe, MA - Marginal Folds Nappe, SC - Subcarpathian Nappe; Cr, crystalline formations; Pz-3, Upper Paleozoic; Mz, Mesozoic; N, Neogene; Th, Tithonian; K_1, Lower Cretaceous; K_2, Upper Cretaceous; Pg_1, Paleocene; Pg_2, Eocene; ol, Oligocene; m_1, Lower Miocene; m_2, Middle Miocene.

The Foredeep is the outermost molassic trough filled up with clastics proceeding from the folded chain, younger than the last tectogenesis of the Moldavides, namely the Bessarabian-Pleistocene molasses. The Foredeep is superposed over the outer part of the folded Moldavides and over the Foreland (Platforms). It shows two zones: the Inner Zone of the Foredeep which is folded during the Lower Pleistocene and the Outer Zone of the Foredeep which is located mostly on the Foreland and which is an asymmetrically subsiding area. Between the Trotuş and Buzău rivers develops the most subsiding segment of the Outer Foredeep - the Focşani Depression - where about 10 km (in the central part) of Sarmatian-Pleistocene formations accumulated.

The Volcanic Arc which develops in the internal part of the East Carpathians was generated by consumption of thinned and oceanic-type crust which represented the primary basement of the Outer Dacidian and the Moldavidian troughs. Even if some Late Cretaceous shortenings occur in the Flysch Zone the most important consumptions were the Miocene ones. Consequently the Volcanic Arc is of Neogene age.

The Foreland of the East Carpathians is represented by platforms of different ages. The East European Platform is the oldest one, with a Proterozoic crystalline basement and a Vendian-Neogene sedimentary cover (with some important stratigraphic gaps in Upper Paleozoic, Triassic and Oligocene-Miocene). South and west of the East European Platform (Fig. 1) the Scythian Platform develops, which has a pre-Mid Devonian folded basement and an Upper Carboniferous-Neogene sedimentary cover, with various local developments. The westernmost part of the Scythian Platform is underthrust below the Moldavidian nappes of the East Carpathians (Fig. 2).

South of the Scythian Platform, in the Foreland of the Carpathians (Fig. 1) the North Dobrogea Orogen, a Cimmerian folded belt is situated, which involves in deformation Paleozoic crystalline and sedimentary formations, Triassic and Jurassic sedimentary and magmatic rocks (with Triassic within-plate ophiolites).

South of the Nord Dobrogea Orogen and between the Carpathians and the Balkans, the Moesian Platform (Precambrian crystalline basement and Cambrian-Neogene sedimentary cover, with stratigraphic gaps in Lower Jurassic and Oligocene-Lower Miocene) is situated. In central Dobrogea a part of the basement of the Moesian Platform crops out, represented here by the Green Schists Formation (Vendian-Lower Cambrian anchimetamorphosed flysch-type rocks); similar rocks can be recognised, as pebbles and grains, in the detrital formations of the external East Carpathians nappes. They proceed from the Green Schists domain situated paleogeographically in front (toward the Foreland) of the depositional areas of the Cretaceous-Miocene formations mentioned above.

LITHOSTRATIGRAPHY AND PALEOGEOGRAPHY OF THE NEOGENE FORMATIONS IN THE EAST CARPATHIANS

The Neogene sedimentary formations known in the central and southern segments of the East Carpathians are situated in different structural (geotectonic) frameworks: (1) involved in Moldavidian nappes, (2) constituting a part or the whole of post-tectogenetic covers (post-nappe covers = neoautochthons) and (3) filling the Foredeep or some intramountains depressions. The Lower and Middle Miocene formations demonstrate the first two situations; the Upper Miocene and the Pliocene formations, the third one.

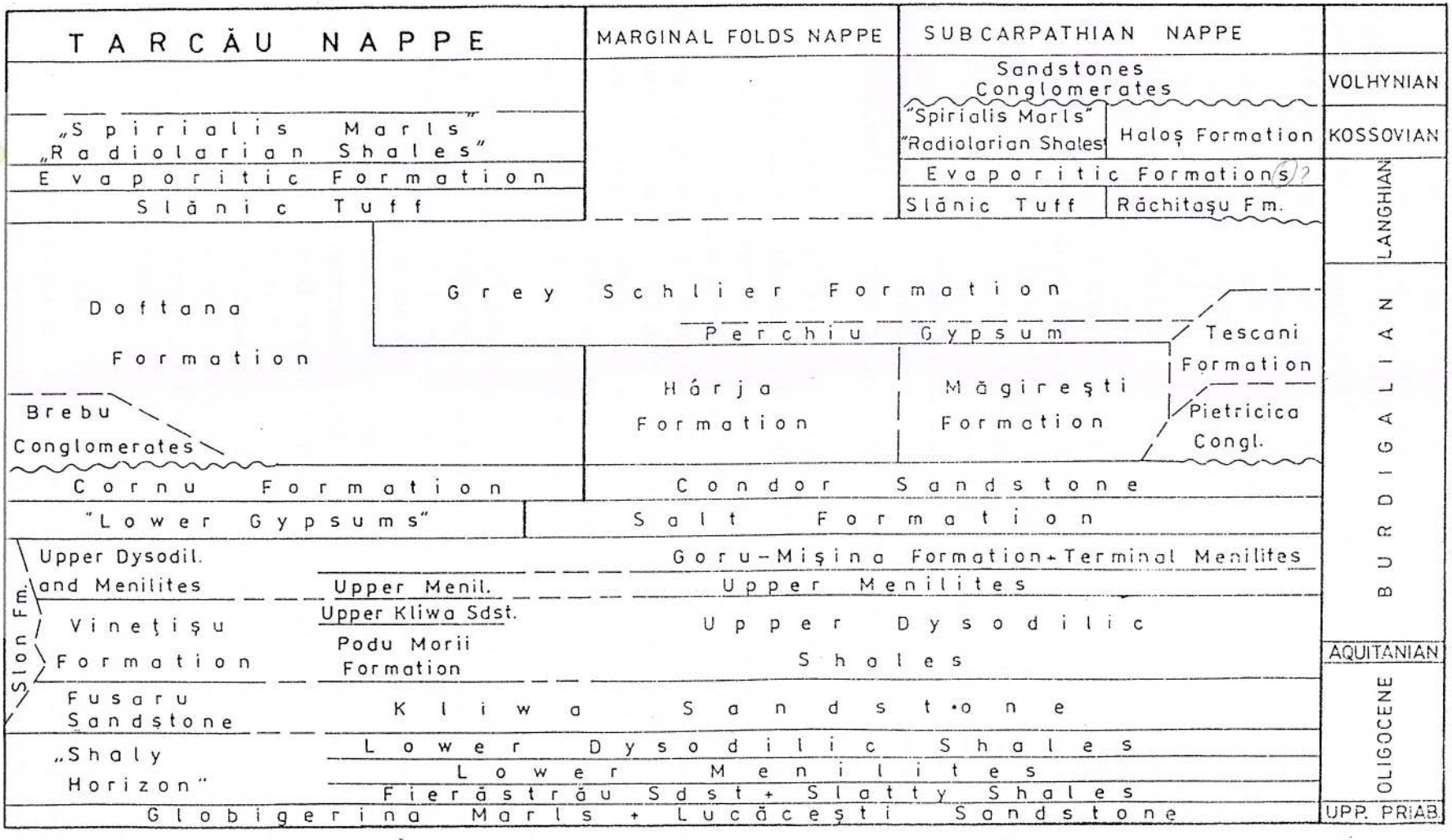
The Oligocene/Miocene boundary is not marked by any lithological changes, crossing homogeneous lithostratigraphic units (Table) isochronous but heteropic. There are two main depositional areas for the Oligocene-Lower Miocene formations: the Moldavidian domain (external) and the Transcarpathian domain (internal).

Moldavidian Domain

Oligocene-Lower Miocene Flysch and Bituminous Formations. The Oligocene-Lower Miocene formations accumulated in the Moldavidian domain are largely developed in the Tarcău, Marginal Folds and Subcarpathian nappes; they are also known, but in restricted areas, in the Audia and Convolute Flysch nappes (in the southern sector of the Bend Area). In the Tarcău and Marginal Folds nappes continuous sedimentary successions from Barremian up to Lower Miocene can be reccognized, situation which stresses out the importance of this subsiding basin. There are two specific lithofacies for the Oligocene-Lower Miocene formations: the Bituminous Lithofacies with Kliwa sandstones in the external part and the Fusaru-Pucioasa Lithofacies in the internal part. Transitional lithofacies, between the two ones, are also known.

Bituminous Lithofacies with Kliwa sandstones. Following the typical "Globigerina Marl" development of the Uppermost Priabonian (well known in the whole Tethyan area) the depositional framework changes to predominantly anoxic conditions which dominated during the whole Oligocene and a part of the Lower Miocene. The external part of the Moldavidian Domain is the best exemple. Bituminous clays – the dysodilic shales – and bituminous silicolites – the menilites - develop in successive sequences (Table). At one or

Correlation Table of the Oligocene, Lower and Middle Miocene Lithostratigraphic Units of the Outer Moldavides in the Central and Southern East Carpathians



two moments (following the different zones) important orthoquartzitic arenites were transported into the depositional basin proceeding from the Foreland margin of it (actually underthrust below the Moldavidian nappes); they constitute the Kliwa Sandstone and following the sectors there are one or two levels of Kliwa Sandstone (Table). The silicolitic levels – the menilites – constitute the best correlations levels; there are generally two levels: the Lower Menilites (associated also with bituminous marly limestones = the "Brown Bituminous Marls") and the Upper Menilites (without "Bituminous Marls"). In some areas a third menilitic level occurs: the Terminal Menilites (Table). The Oligocene/Miocene boundary is situated below the Upper Menilites, within the Upper Dysodilic Shales Formation (in the Marginal Fold Nappe) or within the Podu Morii Formation (turbiditic sequence isochronous with a part of the Upper Dysodilic Shales, in the Tarcău Nappe). Consequently the Upper Menilites are of Lower Miocene age. Above them the Bituminous Lithofacies is still developed: (1) Goru-Mişina (Gura Şoimului) Formation, mostly coarse-grained sandstones, microconglomerates and small conglomerates, very rich (80–90%) in Green Schists pebbles and grains; Dysodilic Shales and Kliwa type sandstones are intercalated or constitute locally a lower sequence of the Formation. (2) "Supramenilitic Horizon", in the external part of the Tarcău Nappe, with Dysodilic Shales, Kliwa type sandstones, polymictic and arcosic sandstones, as well as marls. The youngest lithostratigraphic unit of the Bituminous Lithofacies is represented by the Terminal Menilites (menilites and dysodilic shales) which are known only in the Marginal Folds Nappe and even there only locally.

F u s a r u – P u c i o a s a L i t h o f a c i e s. In the internal half of the Tarcău Nappe the stratigraphical equivalent of the Bituminous Lithofacies is the Fusaru-Pucioasa Lithofacies, also of Oligocene-Lower Miocene age. Its lower boundary is situated above the "Globigerina Marls" of the Uppermost Priabonian; the lowermost sequence is a predominantly pelitic one (the "Shaly Horizon"): dark coloured marls and clays with thin sandy intercalations. In some areas dysodilic shales and sometimes even menilites are intercalated in thin sequences. An important specific feature of the Fusaru-Pucioasa Lithofacies concerns the arenites and their source area: this is different in respect to the Bituminous Lithofacies, being situated on the internal margin of the basin (the so called "carpathian source" opposite to the "foreland source").

The main arenitic sequence of this internal lithofacies is the Fusaru Sandstone (Table). It is rich in micas and shows subgreywacke features (lithic fragments about 25 %); the Green Schists of the Foreland type are completely absent, the metamorphic rocks fragments being represented mostly by mesometamorphics. The fluxoturbiditic-type of the Fusaru Sandstone is stressed out by the coarse-grained intercalations which develop at different levels.

Above the Fusaru Sandstone develops an important flysch-type sequence (1,000–2,000 m and more) - the Vineţişu Formation; the Oligocene/Lower Miocene boundary is situated within this Formation. As the Fusaru Sandstone the arenites of the Vineţişu flysch are supplied by the "carpathian source" area with the difference that the Vineţişu arenites are more fine-grained than the Fusaru ones. The pelites of the Vineţişu Fm. are mostly subsequently argilitic. Some cineritic levels known in both Vineţişu and Podu Morii formations supported a good correlation of the internal and external lithofacies: Vineţişu Formation = Podu Morii Fm. + Upper Kliwa Sandstone = Upper Dysodilic Shales.

The Pucioasa development, known in the south-western part of the Bend Area, has as specific features the association (intercalations) of dysodilic shales with the pelitic sequences of the whole internal lithofacies and the predominance of the dark coloured marls in this sequence

(Pucioasa Marls). In some areas a part of the Vineţişu Flysch is replaced by Pucioasa Marls.

The youngest lithostratigraphic unit of the Fusaru-Pucioasa Lithofacies is represented by Dysodilic Shales and Menilites, an equivalent to the Upper Menilites of the external lithofacies.

A peculiar lithologic development occurs in the innermost parts of the Fusaru-Pucioasa Lithofacies area: the Slon development. In fact there is the same lithostratigraphic succession as in the whole internal lithofacies area with the difference that at several levels, and mainly at the Vineţişu Fm. level, wildflysch (olistostrome) sequences are intercalated. The allochthonous resedimented or slided rocks are red and cherry-red Senonian and Paleocene marls and/or argilites, light coloured Eocene marls and even Oligocene rocks.

Transitional ("intermediate") lithofacies are known between the internal and external ones. They are stressed out mainly by the mixture of the arenites proceeding from the "foreland source" area (Kliwa Sandstone) with them proceeding from the "Carpathian source" area (Fusaru Sandstone). The insertion of the Podu Morii Formation (which is a flysch with a "carpathian source" supply) between the two Kliwa Sandstones (the Lower and the Upper) (Table) may be also considered a "mixed" lithostratigraphical succession.

Lower Miocene Evaporitic Formations. In the whole Moldavidian Domain both Bituminous and Fusaru lithofacies (as well as their equivalents) are followed by a predominantly evaporitic sequence.

In the Subcarpathian and Marginal Folds nappes at this level the Salt Formation (argilaceous-silty, dark-coloured, matrix with sedimentary breccias, conglomerates, saliferous clays or marls intercalations, gypsums and discontinuous salt bodies) develops; in some areas this "chaotic" assemblage is followed by a more or less layered sequence of marls, clays and sandstone or by arcosian coarse-grained sandstones (Condor Sandstone). The areal distribution of the Lower Miocene Salt Formation is discontinuous; this situation is determined by both paleogeographical (deposition zones separated by emergent ridges) and tectonic (diapiric bodies) conditions.

In the Tarcău Nappe and in more internal Moldavidian areas, the Lower Miocene Evaporitic Formation is represented by gypsums (the so called "Lower Gypsum"), the salt being, with few exceptions (some outermost zones of the nappe), generally absent. Above the Lower Gypsum a shaly-sandy sequence (Cornu Formation *s. str.*) develops, with marine faunas and microfaunas; it can be a correspondent of the Condor Sandstone.

Early Molasse Formation. The Lower Miocene Evaporitic formations are followed in the whole Moldavidian Domain by the begining of the molasse-type deposition. As older formations there are two source areas for the molasse: the external one emphasized by the participation of pebbles or grains of "Green Schists" proceeding from the foreland covering the detritics of the Subcarpathians and Marginal Folds nappes and the internal one, with "Carpathian" material, supplying the Tarcău Nappe molasses.

On both marginal sides of the early molasse depositional basin the lithostratigraphical succession starts with conglomerates. In the external part of the Subcarpathian Nappe these massive conglomerates (with different local names: Pietricica, Pleşu, Bârseşti conglomerates) are very rich in "Green Schists" pebbles, with which sedimentary rocks (Jurassic and Eocene limestones, Permo-Triassic sandstones, Jurassic marls) are associated. The conglomerates are followed by sandy-marly molasse (Tescani Formation) or sandy massive molasse (Moişa Sandstone), both rich in "Green Schists" grains. More distal zones of the depositional basin (inner parts of the Subcarpathian Nappe and the Marginal Folds Nappe) show only the sandy-marly molasse (Măgireşti Formation or Hârja Formation respectively) which corresponds with

the more external conglomerates and a part of the above situated sandy or sandy-marly rocks (Table). In the Subcarpathian Nappe, mostly, and also in a part of the Marginal Folds Nappe above the molasse follows a schlier development - predominantly pelitic (mostly marls), with sandy sequences and thin sandstones intercalations, showing one or two evaporitic levels - the so called Grey Schlier Formation. The boundary between the Lower and the Middle Miocene runs within this Grey Schlier Formation. Similar lithological and paleogeographical developments show the molasse formations of the Tarcău Nappe. In the internal parts of the nappe the lithostratigraphic succession starts with conglomerates (Brebu Conglomerates) which have a "carpathian" supply of pebbles, followed by sandy or sandy marly molasses. In the external part of the Tarcău Nappe - in a distal position in respect to the "carpathian" source - only sandy molasses develop (Table), followed by a Grey Schlier Formation similar to that of the more external units.

The sedimentary framework of the molasses are of shallow-water to fluvio-deltaic types. A small deepening of the basin may be accepted for the schlier formations.

Langhian Cineritic Formations. A very specific Langhian sequence, characterized by the cineritic (tuffitic) rocks, develops in the Tarcău and Subcarpathian nappes. This sequence has a well-dated stratigraphic position being correlatable with similar levels of the Transylvanian Depression. With the cineritic (tuffitic) rocks (the Slănic Tuff) are associated, as interlayerings, marls (rich in planktonic microfauna) and, in the external part of the Subcarpathian Nappe, limy sandstones (Răchitaşu Formation).

The widespread development of the Langhian cineritic formations - in East Carpathian Moldavidian Domain, in South Subcarpathians, in Transylvania, Maramureş and Transcarpathian Ukraine - may be connected with the rising of the activity in the Carpathian Neogene volcanic arc.

Langhian Evaporitic Formations. In the uppermost Langhian, below the boundary with the Kossovian, and above the cineritic sequence, evaporitic formations are known in the Tarcău and Subcarpathian nappes. They are represented by gypsums and/or salt formation. The differences between the Langhian and the Burdigalian salt formations concern not only the age but also the origin of the detrital material involved in their matrix. In the Langhian Salt Formation the "Green Schists" debris is absent, which is abundent in the Burdigalian one. The discontinuous areal development of the Langhian evaporitic formations may be determined by a discontinuous development of the sedimentary basins and/or by slight erosion processes occurring before the deposition of the Kossovian deposits.

Kossovian Formations. The Upper Badenian rocks show, generally, two lithofacies: arenitic (sandstone and sands) or pelitic (marls). In some areas (south sector of the Carpathian Bend area) it is possible to distinguish a lower sequence - the "Radiolarian Shales" Formation (sand and sandstones with more or less developed intercalations of siltic shales rich in radiolarians) - and an upper sequence - the Spirialis Marls (predominantly pelitic with subsequent intercalations of sandstones or sands). In the northern sector of the Carpathian Bend area and farther toward north the whole Kossovian is represented by massive sands or sandstones with interlayerings of marls (Haloş Formation).

Foredeep Domain

The most important volume of molasse deposits develop in the Volhynian-Lower Pleistocene time, the most important part of it in the Carpathian Foredeep. In a general way the most

frequent rocks are represented by the sands and the sandstones, in massive layers. At different levels dominant marly sequences or shallow water limestones or limy organogenous sandstones can predominate.

The Volhynian formations are still involved in the Subcarpathian Nappe structures, the overthrusting of this outermost nappe occurring in the Bessarabian. The Bessarabian (Upper) and more younger deposits fill the Carpathian Foredeep (with its two zones, the inner deformed and the outer not deformed) or post-tectogenetic depressions as the Comăneşti one, in the central segment of the Moldavidian nappes.

Transcarpathian Domain

On the inner slope of the East Carpathians folded chain more or less large post-tectogenetic sedimentary basins superposed on the Mid-Cretaceous deformed units develop. Consequently, this basin contains Upper Cretaceous and/or Tertiary formations (pre-Badenian).

In the inner part of the Carpathian Bend area, in the so-called Vlădeni Couloir, Upper Cretaceous, Paleogene and Lower Miocene deposits, which belong to the Transcarpathian Domain crop out.

The Oligocene-Lower Miocene formations show a relatively homogeneous lithofacies predominantly pelitic with subordinate sandstone intercalations. The lower part of the succession shows predominantly slight bituminous marls and clays, with limy sandstone interlayerings. The upper part is dominantly constituted of marls, the limy sandstones being also present and at some levels containing large foraminifera of Lower Miocene age.

On the whole the Oligocene-Lower Miocene succession of the Vlădeni Couloir is correlatable with the Pucioasa-Fusaru Lithofacies, excepting the massive sandstone sequences of the latter one.

DESCRIPTION OF ITINERARIES AND OUTCROPS

First Day: Bucureşti–Bacău

The first half of the day is devoted to journey from Bucureşti to Bacău; the second half to examine the frontal part of the Subcarpathian Nappe.

From Bucureşti the field-trip proceeds toward north, near the Ploieşti town turning toward east. Between the Ploieşti and Buzău towns the hills which appear north of the highway correspond with the most external anticlines of the Inner (folded) Zone of the Foredeep. These structures were generated during the so called Wallachian Tectogenesis ("Phase") which has its climax in the Lower Pleistocene.

From Buzău the highway turns progressively toward north, the field-trip runing more or less along the axial zone of the Outer Foredeep (Focşani Depression), which grows smaller from the Mărăşeşti locality toward north.

The Bacău town is situated eastward but in the proximity of the frontal overthrust of the Subcarpathian Nappe.

1st Stop: Sărata Locality : Frontal Part of the Subcarpathian Nappe

In the western margin of the Sărata village Lower Miocene formations of the Subcarpathian

Nappe crop out, in an imbricated structure. The oldest rocks are represented in a small outcrop by menilites (Upper Menilites), constituting the core of a thrust-fold with east (external) vergency. Above the menilites develop the Lower Miocene Salt Formation represented in a small outcrop by silty and argillaceous shales, with coarse-grained intercalations (with "Green Schists"), ending on top with a gypsum layer. Several hundreds of meters upstream massive conglomerates (Pietricica Conglomerates) very rich in "Green Schists" pebbles crop out.

A small nannoplankton assemblage of Lower Burdigalian age was determinated from the clayly intercalations of the Salt Formation: *Reticulofenestra pseudoumbilicus, Helicosphaera ampliaperta, H. kamptneri, H. mediterranea*, corresponding to the Discoaster druggii Zone (NN_2), Helicosphaera ampliaperta Subzone (NN_{2b}).

2nd Stop: **Pietricica Hill (on the highway) : Tescani Formation** (Fig. 3)

Above the Pietricica Conglomerates a sandstone-marly sequence – the Tescani Formation develops. The sandstones are rich in quartz grains which are associated with lithic fragments represented by "Green Schists" (mostly) and red quartzites (Permian? Triassic?); micas fragments are also present. The marls or silty marls are of gray, green or reddish colours. The arenite/lutite associations are pararhythmic, direct, reverse or cyclic gradded bedings being developed. Occasionally the Tescani Formation contain very poor nannoplankton assemblages with *Helicosphaera ampliaperta* and *Coccolithus miopelagicus*, in the lower part of the Formation and with *Helicosphaera ampliaperta, Calcidiscus leptoporus* and *C. macintyeri*, in the upper part of it; the age of the Tescani Formation may thus be accepted as Upper Burdigalian-Lowermost Langhian.

3rd Stop: **Pietriceaua Village : Grey Schlier Formation (Stufu Gypsum) and unconformable Langhian deposits (Carageaua Hill)**

The Grey Schlier Formation (=Grey "Horizon" or Grey Formation) overlying the Tescani Formation is divided by the Stufu Gypsum in two parts. The lower part shows several massive sand intercalations (Lărguţa Sands) and also thin red marls discontinuous levels (Valea Carelor Red Marls), which are lacking above the Stufu Gypsum. Excepting the Stufu Gypsum which is a massive widespread evaporitic sequence, at several levels of the Grey Schlier Formations thin gypsum intercalations as well as thin laminated dolomitic-calcareous rocks are interbedded.

In the axial part of the Carageaua Syncline, the Răchitaşu Sandstone with cineritic intercalations unconformably overlap the Grey Schlier Formation. The Răchitaşu Sandstone is a polymictic calcareous sandstone, with quartz and lithic (also "Green Schists") grains, Lithothamnium fragments and reworked Paleogene foraminifera. The dacitic cineritic levels develop mainly in the lower part of the Răchitaşu Sandstone. The interbedded marls contain a rich assemblage of planktonic foraminifera and calcareous nannoplankton. The typical, for N_8 Zone, foraminiferal assemblage contain *Candorbulina universa, Globigerinoides triloba, G. immaturus, G. bisphericus* etc. The nannofossil assemblage contain *Sphaenolithus heteromorphus, Discoaster exilis, D. variabilis, D. musicus, Cyclolithella annula* etc., corresponding to the NN_5 Zone. The presence of *Triquetrorhabdulus rugosus* in the lowermost part of the sequence indicate the upper part of the NN_5 Zone.

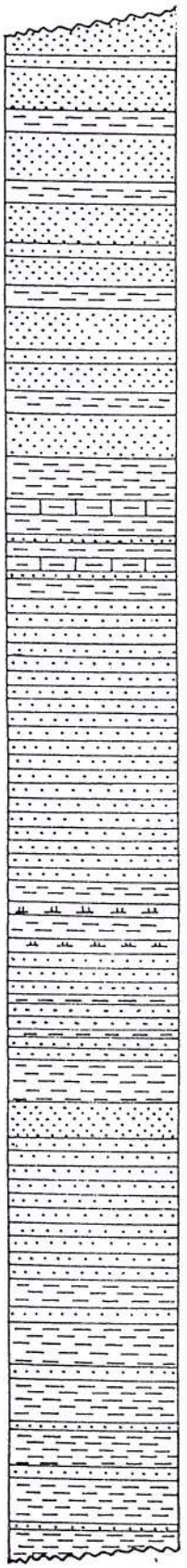


Fig. 3 – Pietricica Hill Section
Upper Tescani Formation
(Pietricica Digitation)

LEGEND

Marls
Clays
Siltitstones
Sandstones
Sands

0
1
2 m

From Pietriceaua the field-trip returns to the Bacău town.

S e c o n d D a y: Bacău–Scăriga–Oneşti

The aim of the second day of the field-trip is to show the main lithostratigraphic units of the inner sub-unit of the Subcarpathian Nappe (the Scăriga-Perchiu Digitation).

From Bacău the field-trip proceeds toward west (on the same highway as the first day) reaching at Sănduleni the Tazlăul Mare Valley. There it turns toward south.

4th Stop: **Scăriga : Salt Formation/Condor Sandstone/Măgireşti Formation in the Frontal Part of the Măgireşti-Perchiu Digitation** (Fig. 4)

At the Scăriga Village along the Berzunţu Brook a lithostratigraphic succession can be followed in the Lower Miocene deposits of the inner sub-unit of the Subcarpathian Nappe.

The oldest lithostratigraphic unit which crops out on this cross-section is the Lower Miocene Salt Formation. In the thalweg of the Berzunţ Brook the "salt breccia" consisting of an argillaceous-silty matrix crops out, in which "Green Schists" as well as Kliwa Sandstone and Eocene limestones pebbles are disseminated. On the right bank of the brook the succession continues with a gypsum level, followed by a marly sequence above which a predominantly sandstone sequence develops (an equivalent to the Condor Sandstone).

Several tens of meters upstream, also on the right bank of the brook, the Măgireşti Formation crops out. The outcrop shows an irregular alternation of conglomerates, microconglomerates, sandstones, marls and silty marls. The coarse-grained rocks are rich in "Green Schists" fragments: the sandstones have a marly or limy matrix; the marls or silty marls are of reddish or grey colour. The intercalations of conglomerates in this (lower) part of the Măgireşti Formation is a distal effect of the conglomeratic fans which generated the Pietricica Conglomerates in more external areas (Pietricica Digitation – 1st Stop).

The age of Condor Sandstone and Scăriga Formation were able to be precised by nannoplankton assemblages, which characterized the Discoaster druggii Zone (NN_2) – Helicosphaera kamptneri Subzone (NN_{2b}) for the Condor Sandstone and the Sphaenolithus belemnos Zone (NN_3) for the Măgireşti Formation respectively. Thus the both lithostratigraphic units are of Lower Burdigalian age.

5th Stop: **Ouşoru Hill : Perchiu Gypsum**

An important correlation level in the Subcarpathian Lower Miocene is represented by the Perchiu Gypsum. This is a sequence of 10–100 m thick, constituted exclusively of gypsums, in the case of small thicknesses, or by gypsums alternating with marls and sandstones. The outcrop situated at the foot of Ouşoru Hill demonstrates the second case.

Several packages of gypsum are separated by a more or less rhythmical alternation of marls and limy sandstones (which often show graded-bedding). The sedimentological features of the sandstones – as: current marks, flow marks, laminated convolute bedding – stressed out that the depositional framework needs a certain depth of the water. This conclusion is supported also by the marine microfossil content of some marls.

In these circumstances the genetical model of the Perchiu Gypsum sequence should accept an alternation of sabkha-type conditions with subsiding-type conditions when terrigenous material and pelitic rocks with marine microfauna were deposited over the evaporitic plain and in the adjacent sea.

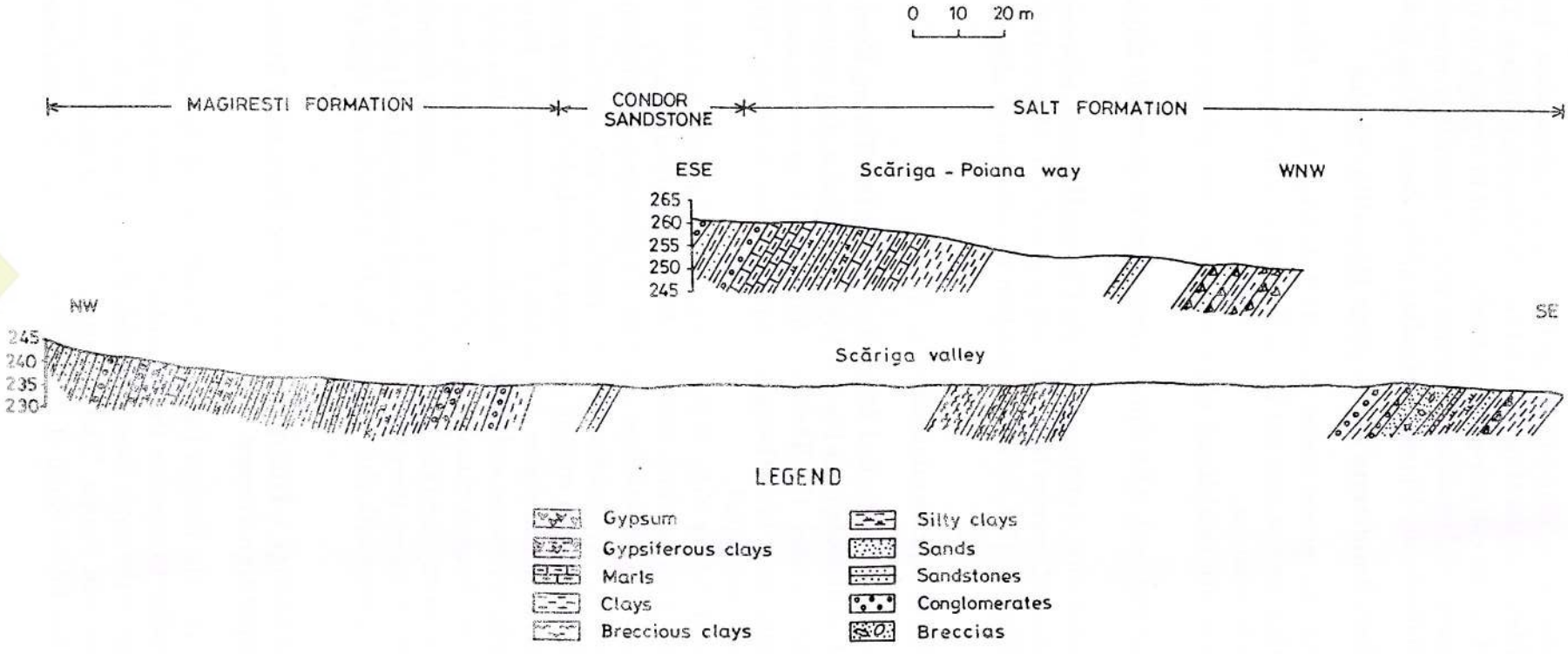


Fig. 4 – Scăriga Valley Section Lower Miocene deposits (Măgireşti-Perchiu Digitation)

The Perchiu Gypsum is the lowermost sequence of the Grey Schlier Formation. Its lower boundary represent the boundary between the Măgireşti and Grey Schlier Formations. The age of the Perchiu Gypsum is stressed out by calcareous nannofossils, found in argilaceous intercalations, as *Helicosphaera ampliaperta, Sphenolithus heteromorphus, Coccolithus miopelagicus* and *Discoaster deflandrei* which indicate the Upper Burdigalian (NN_4 Zone – NN_{4a} Subzone).

6th Stop: **Ciortea Hill : Kliwa Sandstone and Upper Dysodilic Shales**

The Ciortea Hill is one of the few places where deposits belonging to the Bituminous Lithofacies of Oligocene/Lower Miocene age crop out in the Subcarpathian Nappe area.

In few exposures it is possible to examine:

– Kliwa Sandstone (orthoquartzitic sandstone) which contains also pebbles of "Green Schists";

– Dysodilic Shales (bituminous argilites), with thin intercalations of quartzitic sandstones (of Kliwa type).

The deposits of Bituminous Lithofacies, cropping out in the Ciortea Hill area, represent tectonically an "extrusive" body, unrooted, carried in the frontal scales of the Măgireşti-Perchiu Digitation of the Subcarpathian Nappe. This structural position is documented also by boreholes.

7th Stop: **Helegiu Dam : Răchitaşu Sandstone** (Fig. 5)

In the vicinity of the confluence of the Tazlăul Mare River with the Trotuş River, in a squeezed syncline situated in front of the Măgireşti-Perchiu Digitation (belonging consequently to the innermost part of the Pietricica one), the Răchitaşu Sandstone (calcareous sandstone, with quartz and lithic grains, fragments of Lithothamnium and Bryozoa, develops. "Globigerina Marls" and dacitic cinerites are associated.

The micropaleontological content is very rich. It consists mainly of planktonic calcareous organisms (foraminifera, nannoplankton) to which some benthic fossils are added.

The foraminifera are represented by *Candorbulina universa, C. glomerosa, Globigerinoides bulloideus, G. triloba, G. bisphericus, G. transitoria.* The medium-grade bioclastic sandstones interbedded in the base of the outcrop contain numerous reworked (intraformational) foraminifera as *Planostegina costata, Amphistegina bohdanowiczi, A. mammilla, Planularia ostraviensis, Sphaerogypsina globula*, bryozoans and small brachiopods, thali of Rhodophytae.

The planktonic foraminiferal assemblage is characteristic of the Upper part of N_8 and lower part of N_9 zones (Langhian). It is worth mentioning the presence of benthonic foraminifera (Lower Lagenide Zone). In the same outcrop, there was found a well-preserved and rich nannoplankton assemblage typical for NN_5 Zone with *Discoaster exilis, D. variabilis* and *Sphenolithus heteromorphus.*

8th Stop : **Slobozia Mielului Village : Disconformity of the Foredeep Molasse above the Subcarpathian Nappe**

About 1 km south (downstream) of the Helegiu Dam, on the left bank of the Tazlău River, in Slobozia Mielului Village, is possible to examine the disconformity between the Kersonian-Meotian molasse (Fig. 6), belonging to the outer (non-deformed) Foredeep and the folded Grey Schlier Formation, of the Subcarpathian Nappe. This situation stress out that the youngest deformation in the frontal part of the folded chain of the East Carpathians is pre-Kersonian

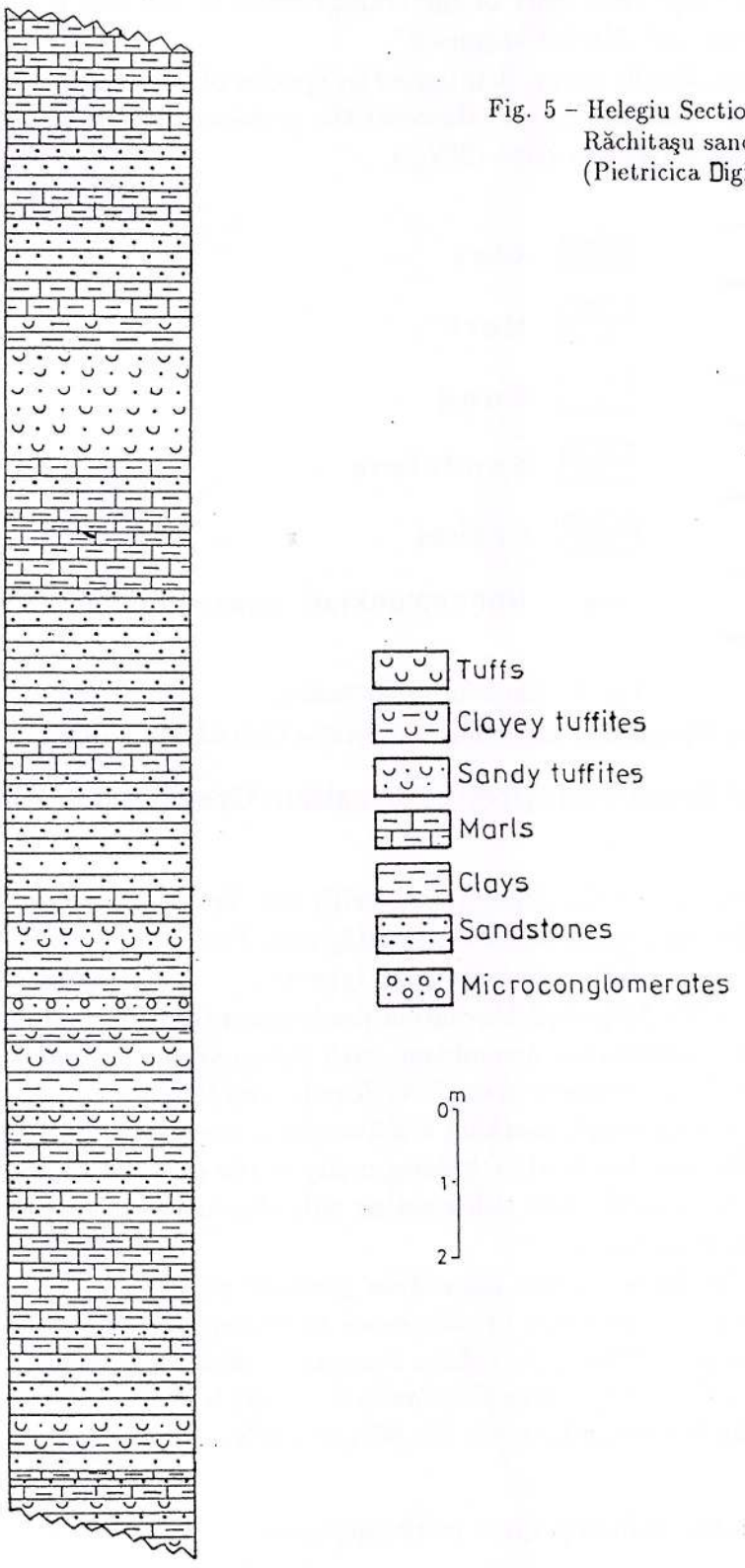


Fig. 5 – Helegiu Section
Răchitaşu sandstones
(Pietricica Digitation)

(possibly intra-Bessarabian); this is the so-called "Moldavian Phase".

The Kersonian age of the lower part of the transgressive formations is documented by a fauna with *Mactra caspica* and *Mactra bulgarica.*

Scarce calcareous nannofossils occur, dominated by species of *Thorocosphaera* and *Scyphosphaera.* These are mostly facies indicators. However the presence of *Scyphosphaera campanula* seems to indicate Discoaster calcaris Zone (NN_{10}).

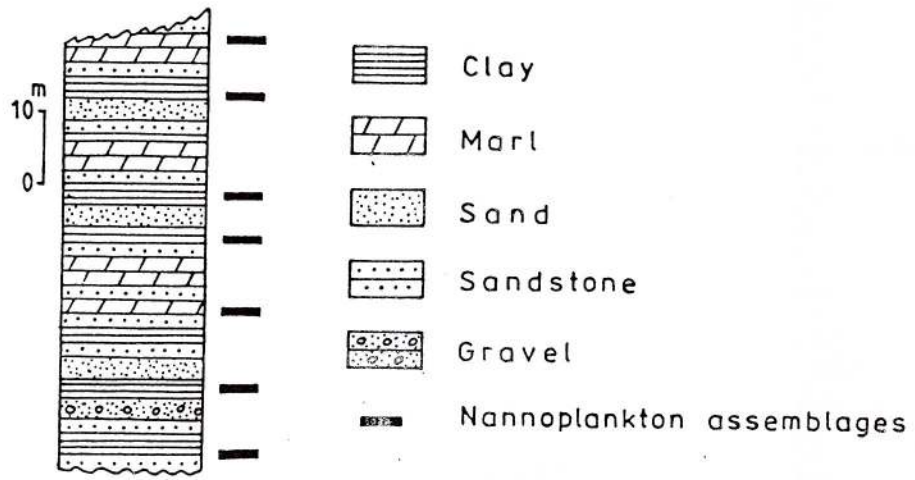


Fig. 6 – Caraclău Valley Section
Lower Miocene Deposits (Măgireşti-Perchiu Digitation)

9th Stop : **Caraclău Brook : Măgireşti Formation/Grey Schlier Formation** (Fig. 7)

In the confluence area of the Caraclău Brook with the Trotuş River are exposed in an uninterrupted outcrop the uppermost levels of the Măgireşti Formation and the Lower part of the Grey Schlier Formation (including the Perchiu Gypsum).

The uppermost part of the Măgireşti Formation predominantly pelitic (Poiana Marls) contain, on this section, a nannoplankton assemblage with *Sphenolithus belemnos, Helicosphaera ampliaperta* and *Sphenolithus heteromorphus* (NN_3 Zone). The Perchiu Gypsum is thin and is exclusively represented by evaporites, marking a difference in respect with the Ouşoru section (6th Stop). Thus is emphasized the relative heterogeneity of the depositional framework of the Perchiu Gypsum: zones with small, but still existing subsidence (Ouşoru-type), versus zones of uplifting dominated by evaporites.

Downstream follow the Grey Schlier Formation younger as the Perchiu Gypsum. It is predominantly marly with interlayerings of calcareous sandstones or fine grained sands. The nannofossil content of this part of the Grey Schlier Formation shows *Helicosphaera ampliaperta, Coccolithus miopelagicus, Cyclocargolithus floridanus* etc., which indicate Discoaster adamanteus Subzone (NN_{4a}). The boundary between the NN_3 and NN_4 zones there is probably within the Perchiu Gypsum.

From Caraclău Brook the field-trip turns to Oneşti town.

T h i r d D a y : Oneşti-Târgu Ocna-Comăneşti-Oneşti

The field-trip will follow upstream the Trotuş Valley. From Oneşti as far as Târgu Ocna

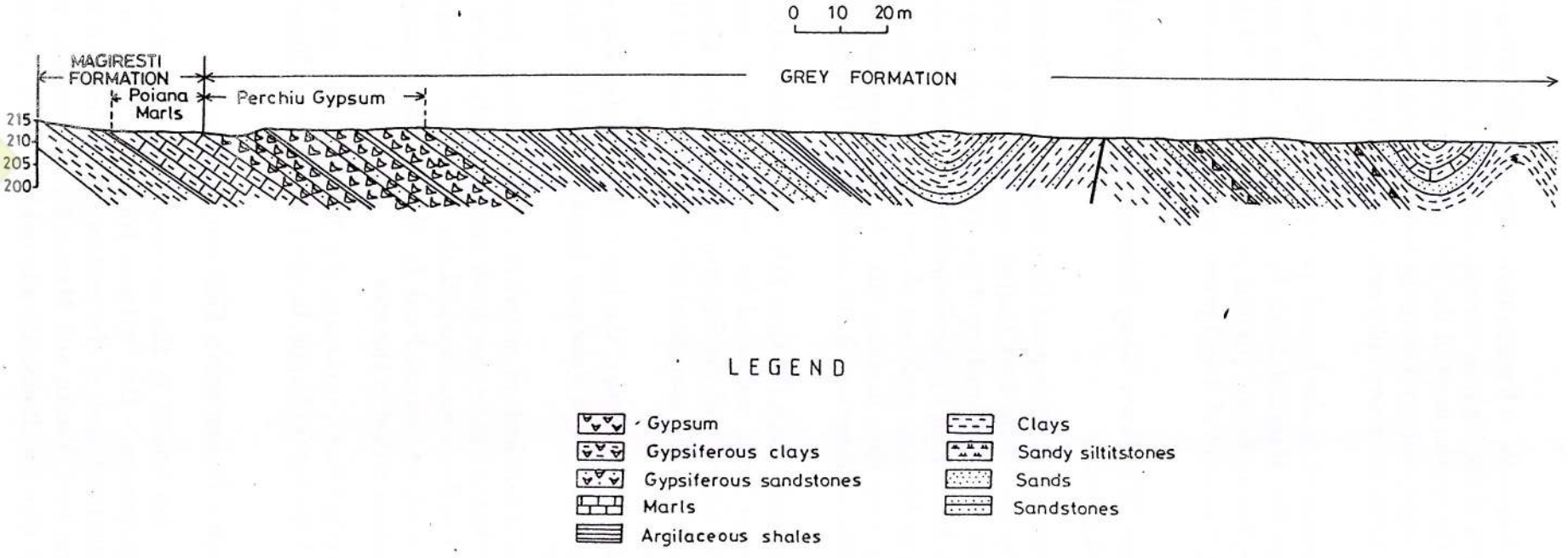


Fig. 7 – Caraclău Valley Section Lower Miocene deposits (Măgireşti-Perchiu Digitation)

town the Subcarpathian Nappe is crossed. A few kilometers east of Târgu Ocna a morphological well expressed hill situated north of the highway corresponds with a synclinal structure – the Viişoara Syncline – marked by the development of the Volhynian molasse (massive sandstones and conglomerates). It is one of the lowest syncline of the Subcarpathian Nappe, the Volhynian formations being slightly unconformable above older ones (Grey Schlier Formation and Slănic Tuff).

The Târgu Ocna town is situated in the frontal part of the Flysch Zone nappes, with a complicated structure: above the Marginal Folds Nappe, which crops out in a tectonic window (Vâlcele Window), the Tarcău Nappe (frontal part) and several "Rabotage outliers" are situated carried by the nappe in front of it and proceeding from the innermost part of the Marginal Folds.

10th Stop: **Vâlcele Tectonic Window : Grey Schlier Formation, Salt Formation and Tectonic Evidence**

In the Vâlcele Tectonic Window (Fig. 8) crop out the younger known formations belonging to the Marginal Fold Nappe, in the whole East Carpathians. Thus it is possible to stress out the oldest time boundary for the overthrusting of the Tarcău Nappe above the Marginal Folds one. The youngest one is determined by the disconformable overlapping, of both partly eroded units, by the Bessarabian-Meotian molasses of the Comăneşti Depression (stops 11, 12, 13). In this relatively large time span it seems that the very moment of the overthrust is Mid-Badenian, possibly contemporaneous with the deposition of the Langhian evaporitic formations.

In the western slope of the Vâlcele Brook the Grey Schlier Formation rocks crop out. They are represented by several gypsum levels, separated by sands, sandstones and marls, which are an equivalent to the Perchiu Gypsum of the Subcarpathian Nappe. Downstream follow marls, sandstones and sands which may be correlated with the lower part of the Grey Schlier Formation, still Lower Miocene in age.

In the upper part of the Vâlcele Brook slope, the Lower Miocene deposits of the Marginal Folds Nappe are tectonically covered by the Paleogene formations of the Tarcău Nappe and the "Rabotage outliers" (Fig. 8).

In the Vălişoara Brook, several hundreds of meters east of the Vâlcele Brook, the eastern tectonic contact of the Vâlcele Window can be examined. Geometrically, above Lower Miocene Salt Formation rocks follow Eocene flysch formations of the "Rabotage outliers" unit.

The tectonic relationships which are stressed out by the Vâlcele Tectonic Window are largely confirmed by many boreholes drilled in the area.

From Târgu Ocna the field-trip follows, upstream, the Trotuş Valley. As far as Dofteana Village it crosses several scales of the Tarcău Nappe, in which Eocene and Oligocene formations are involved.

11th Stop: **Dofteana Village : Bessarabian Dofteana Molasse**

The oldest lithostatigraphic unit known in the post-tectogenetic Comăneşti Depression is represented by massive conglomerates – the Dofteana Formation (Fig. 9) – supposed of Bessarabian age. The most important part of the pebbles are represented by Eocene and Oligocene rocks proceeding from both Tarcău and Marginal Folds Nappes, situation which emphasizes that these two units were simultaneously affected by erosion. Nevertheless, there

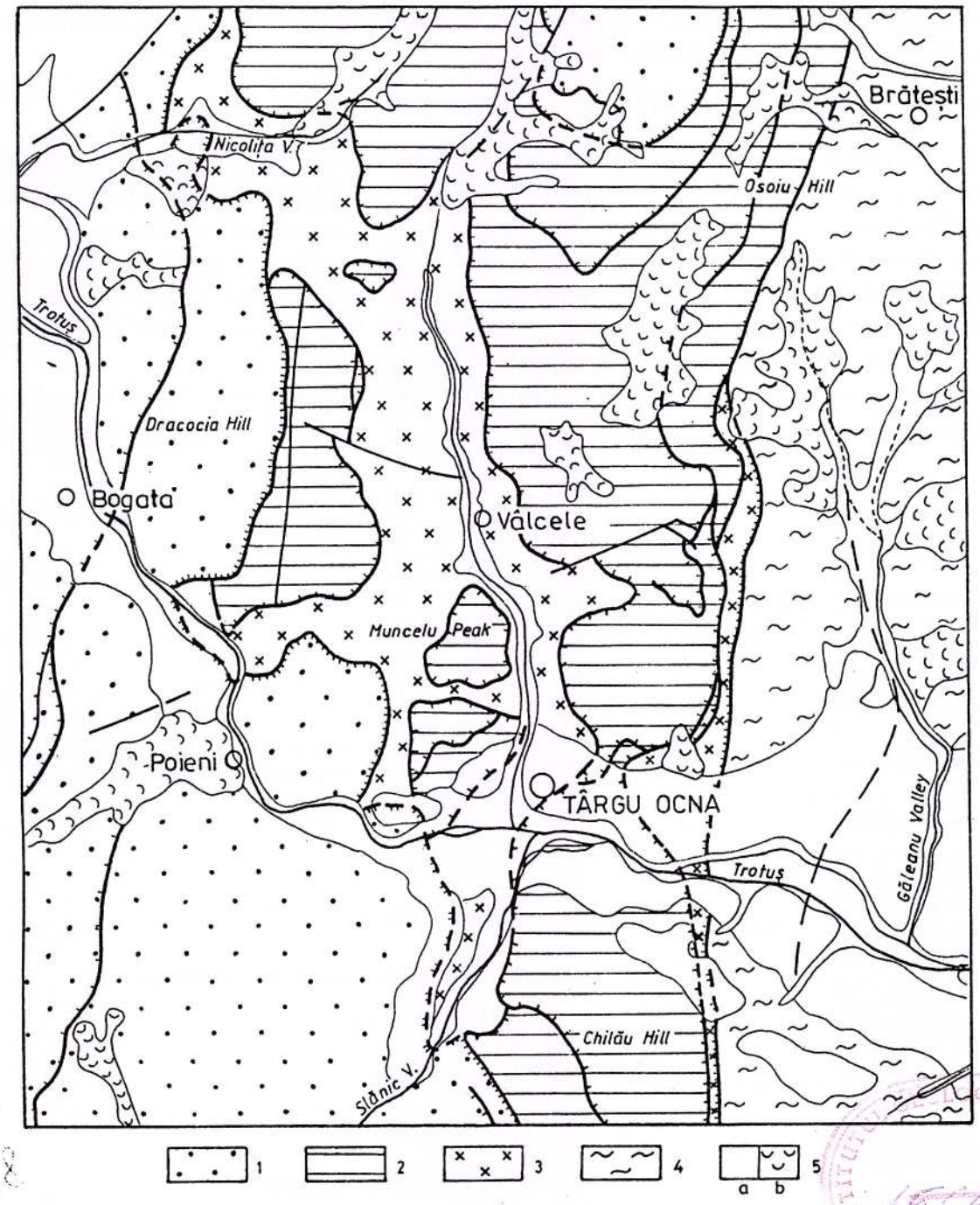


Fig. 8 – Structural Sketch of the Târgu Ocna Area.
1, Tarcău Nappe; 2, "Rabotage Outliers"; 3, Marginal Folds Nappe; 4, Subcarpathian Nappe; 5, Cuaternary aluviums (a) and landslides (b)

are also pebbles of metamorphic rocks which may have an uncertain origin: they may proceed from some conglomeratic levels of Eocene or Oligocene ages intercalated in the succession of the mentioned nappes or they have a more distant source situated in the inner zones of the East Carpathians.

The discontinuous areal distibution of the Dofteana Formation, as the first sequence de-

posited in the Comăneşti basin, suggests that it was sedimented in several small separated basins possibly in a fluvio-lacustrine framework.

12th Stop: **Dărmăneasca Village : Meotian Dărmăneşti Formation**

In the northern vicinity of the Dărmăneasca Village, in the right bank of the Trotuş River, deposits belonging to the youngest lithostratigraphic unit of the Comăneşti Depression – the Dărmăneşti Formation crop out. They are constituted of coarse- and medium-grained sands and sandstones, frequently of massive shapes, and of silty marls and marls. At several levels the coarse grained rocks are rich in andesitic grains or pebbles. These andesites proceed from the volcanic chain, situated in the inner side of the East Carpathians. They were submitted to a fluvial transport before they arrived in the depositional area.

The Meotian age of the Dărmăneşti Formation is documented by a fauna with *Anodonta maeotica, Rumanunio moldavicus, Helix mrazeci* etc.

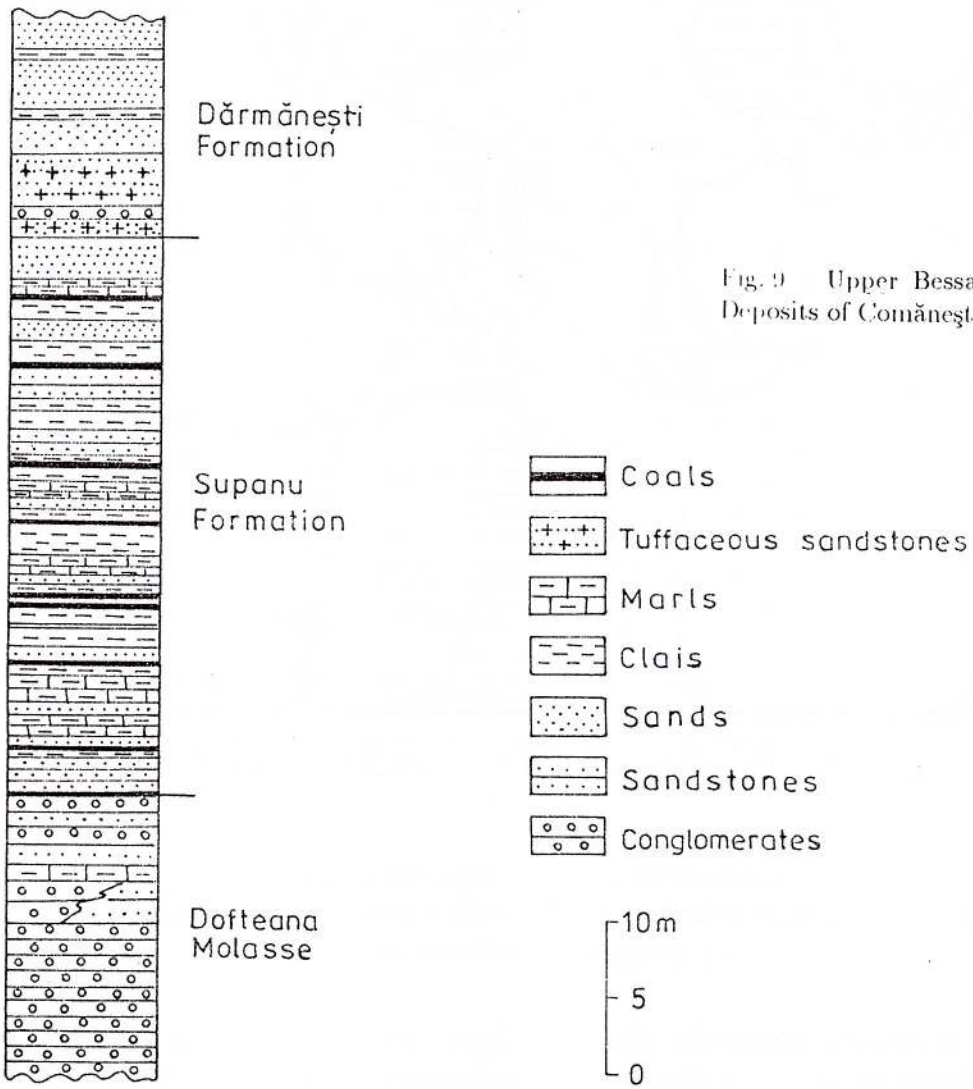


Fig. 9 Upper Bessarabian-Meotian Deposits of Comăneşti Basin

13th Stop: **Comăneşti Town (Şupanu Valley) : Upper Bessarabian-Kersonian Şupanu Formation**

In the Şupanu Valley, in the southern margin of the Comăneşti town, the middle lithostratigraphic units of the Comăneşti basin succession can be shown. The Şupanu Formation (Fig. 9) is built up by predominantly arenitic sequences alternating with coal bearing ones. The arenites are mostly fine-grained sands or weak sandstones, with an oligomictic (quartzitic) composition; marls and silty marls are subordinately intercalated. The coal layers are associated with predominantly pelitic sequences.

The Şupanu Formation is arealy more widely developed than the underlying Dofteana Formation, marking the maximum development of the Comăneşti basin.

The age of the Şupanu Formation is stressed out by a fauna with *Congeria carpathiaca, C. diversa, C. moldavica, Mactra bulgarica* and *M. caspica* as well as the mammals *Hipparion primigenium* and *Aceratherium incisivum.*

F o u r t h D a y : Oneşti-Braşov

From Oneşti the field-trip makes to the west following the Oituz Valley which crosses the outer Moldavidian nappes (Subcarpathian, Marginal Folds and Tarcău). Between Oneşti and Oituz Village the Subcarpathian Nappe is crossed. In several large outcrops as well as in the right and in the left banks of the Oituz River rocks of the Măgireşti and Grey Schlier formations are exposed.

14th Stop: **Oituz (Grozeşti) Village : Lower Miocene Salt Formation in the frontal part of the Marginal Folds Nappe**

The Oituz Valley crosses at Oituz (Grozeşti) Village the frontal contact of the Marginal Folds Nappe. This contact is marked by the thrusting of the Salt Formation belonging to the Marginal Folds over the Grey Schlier Formation of the Subcarpathian Nappe. This frontal part of the Marginal Folds Nappe crops out in a narrow strip, the nappe being tectonically covered toward west by the external part of the Tarcău Nappe and also by the "Rabotage Outliers".

Large outcrops of the Salt Formation are exposed in the right (southern) bank of the Oituz River. The dark-coloured, non-layered massive matrix of the Salt Formation may be examinated. Lens-shaped breccia, microconglomerates (both rich in "Green Schists" fragments), gypsums, are developed. Saliferous clays are intercalated. At Grozeşti the massive salt was reached by boreholes, at a depth of several hundreds of meters.

In a narrow synform an outlier constituted of Priabonian-Oligocene rocks is situated tectonically above the Salt Formation. It belongs to the "Rabotage Outliers" carried in front of the Tarcău Nappe.

From the Salt Formation a poor nannoplankton assemblage with *Reticulofenestra pseudoumbilicus, Helicosphaera ampliaperta, H. pallaeocartei* etc., which corresponds to the Lower Burdigalian (Discoaster druggii Zone – Helicosphaera kamptneri Subzone = NN_{2b}) is exposed at Oituz (Grozeşti).

In the same locality – Oituz – the Condor Sandstone is cropping out which develops in the Salt Formation. It is a coarse-grained massive arenaceous sandstone.

15th Stop: **Fierăstrău Village : Panorama on the tectonic contact between the Tarcău and Marginal Folds nappes**

At Fierăstrău, several kms west from Oituz (Grozeşti) the Marginal Folds crop again in a half-window, below the Tarcău Nappe. The Fierăstrău Anticline – structure of the Marginal Folds – shows an axial periclinal dipping toward north being periclinal tectonically covered by the Paleogene formations of the Tarcău Nappe, just north of the Oituz Valley, where the Lower Miocene Salt Formation of the northern periclinal dipping of the anticlinal crop out.

16th Stop: **Area of confluence of the Feschi Creek with the Oituz River : Upper Dysodilic Shales and Goru-Mişina Formation** (Fig. 10)

In the eastern vicinity of Hârja Village on the northern periclinal dipping of another marginal Folds structure the Upper Dysodilic Shales, within which is situated the Oligocene/Miocene boundary is situated, may be examined.

In small outcrops near the highway the bituminous clayey shales with thin quartzose sandstone interlayerings can be shown. Above them in a small hill the coarse-grained rocks of the Goru-Mişina Formation crop out. In respect to the general lithostratigraphical succession of the Oligocene-Lower Miocene Bituminous Lithofacies in this area the Upper Menilites are absent, which commonly are situated between the Upper Dysodilic Shales and the Goru-Mişina Formation. This peculiar local situation may be interpreted as the result of a submarine erosion realised in a submarine canyon through which the coarse material which constitute the Goru-Mişina Formation was transported. A peculiar feature of the Goru-Mişina Formation croping out in the confluence area of the Feschi Creek is the interlayerings of gypsums between the coarse grained rocks. These evaporites seems to be redeposited, proceeding from a shallow-water area situated in the litoral proximity of the sedimentary basin, it means external in respect with the Moldavidian realm.

The nannoplankton assemblage determined from the pelitic intercalations of the Goru-Mişina Formation corresponds to the Discoaster druggii Zone (NN_2) – Helicosphaera kamptneri Subzone (NN_{2b}) of Lower Burdigalian age.

17th Stop: **Hârja Village : Hârja Formation**

The "locus tipicus" for the Hârja Formation is the Oituz Valley area. Large outcrops of these deposits are visible all around the locality with the same name. It is a pararhythmic alternance of sandstones and marls (grey, green or redish), where the arenites are rich in grains of "Green Schists", red Permo-Triassic sandstones and quartz. The matrix is frequently limy.

The Hârja Formation represents the innermost deposits whose arenites are supplied by the Foreland; it is an equivalent to the Măgireşti Formation (of the Subcarpathian Nappe), also of Burdigalian age (a nannoplankton assemblage with *Helicosphaera ampliaperta* and *Sphaenolithus belemnos* - NN_3 Zone).

18th Stop: **Hârja Village (Pârâul lui Pătru Brook) : Upper Oligocene/Lower Miocene succession of the Bituminous Lithofacies in the Marginal Folds Nappe**

Below the slightly unconformable Hârja Formation the upper part of the Bituminous Lithofacies succession shows the following sequence (beginning with the uppermost part and taking into account that in this section the Salt Formation is lacking):

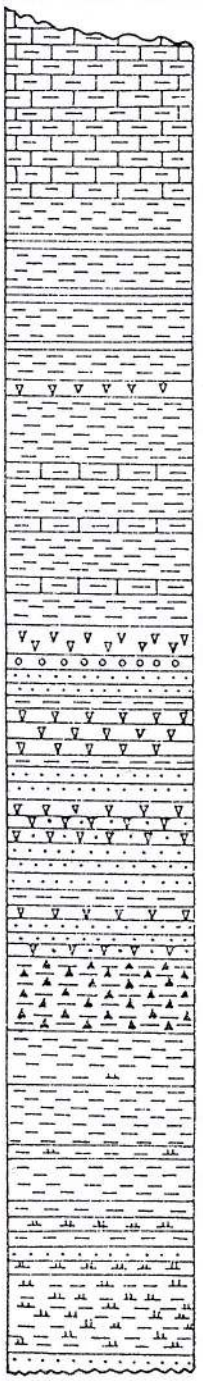


Fig. 10 – Feschi Section
Goru-Mişina Formation
(Marginal Folds Nappe)

LEGEND

- Gypsum
- Gypsifereous sandstones
- Marls
- Argilaceous shales
- Bituminous shals
- Clays
- Silty clays
- Siltitstones
- Sandstones
- Microconglomerates

0
2
4m

– Terminal Menilites: layered bituminous cherts (menilites) with interbedded dysodilic shales;

– Goru-Mişina Formation: microconglomerates and coarse grained sandstones, rich in "Green Schists" fragments, marls interlayerings; Kliwa Sandstone and Dysodilic Shales at the lower part;

– Upper Menilites, layered bituminous cherts – like the lower or terminal ones, but in a different lithostratigraphic position;

– Upper Dysodilic Shales: fine-layered argillaceous shales, with thin inlayerings of quartzose sandstone, sometimes in rhythmic alternance.

Following regional correlations the Oligocene/Miocene boundary passes into the Upper Dysodilic Shales.

From Hârja Village as far as Breţcu Village the field-trip crosses the Paleogene formations of the Marginal Folds and, mostly, of the Tarcău Nappe.

19th Stop: **Fusaru Sandstone on the western slope of the East Carpathian water-shade**

Although the Fusaru Sandstone is not a Miocene lithostratigraphical unit the aim of this stop is to compare the difference between the outer detrital source (Kliwa) and the "carpathian" one (Fusaru).

The massive Fusaru Sandstone is a polymictic arenite with quartz, micas and lithic grains. It is a coarse- and medium-grained sandstone, the matrix being generally argillaceous.

From Breţcu as far as Braşov town the field-trip crosses intramountain depressions. They are filled with Plio-Quaternary deposits, lacustrine and fluvio-lacustrine. These intra-mountain depressions generated on the inner side of the Carpathian Bend area in an distensive regime, possibly as a retort of the "Wallachian" compressions occurring in the outermost part of the Bend. The Upper Pliocene deposits are coal-bearing, the Pleistocene ones are coarse-grained. The normal fault development on the border of the depression is visible in the Braşov (south of the town) area.

F i f t h D a y : Braşov-Vlădeni-Braşov-Câmpina-Bucureşti

From Braşov the field-trip makes toward west and after passing the Codlea town reaches the Vlădeni Couloir, situated between the easternmost Făgăraş Mts and the Perşani Mts.

20th Stop : **Brădet Brook Section** (Fig. 11)

The southernmost Oligocene-Lower Miocene formations belonging to the Transcarpathian post-tectogenetic zone, cropping out in the Vlădeni Couloir, may be examinated west of the Vlădeni Village, in the Brădet Brook.

The lithostratigraphic succession is as follows (from youngest to oldest formations):

– (1) underlying Perşani Tuffs, a thick set of strata (shales, clays, sands, tuffits, conglomerates) known as Perşani Formation (Lower Langhian) is cropping out;

– (2) this formation lies over a silty-clay complex with conglomerates and sandstones bearing glauconite in its base (Brădet Formation);

– (3) the Brădet Formation lies transgressively over shaly-bituminous clays, deposits recalling the Pucioasa facies form Outher Carpathians.

Fossil remnants were recorded from Brădet Formation (see samples A, B and C, Fig. 11).

The foraminifera are represented by planktonic and benthonic species, similar to those from Chechiş or Cornu formations. The assemblage contains of *Planostegina heterostegina, Globigerina praebulloides, Globigerinoides primordius, Globigerinoides triloba, Globorotalia semivera.* Planktonic foraminiferal assemblage belongs to N_{4-5} Zone (Aquitanian-Lower Burdigalian).

The presence of the calcareous nannoplankton in the Lower Miocene deposits from Brădet Valley is very rare. Only three samples (A, B and C – Fig. 11) contain nannofossils.

The nannoplankton content of the A sample is represented by *Helicosphaera ampliaperta, H. kamptneri, Reticulofenestra pseudoumbilicus, Cycligargolithus abisectus, Cy. floridanus* that characterize the Discoaster druggii Zone NN_2 - Helicosphaera kamptneri Subzone NN_{2b}.

In the C and D samples the nannofossils assemblages, with *Helicosphaera ampliaperta* and *Sphaenolithus belemnos*, indicate the Sphenolithus belemnos Zone NN_3 (Lower Burdigalian).

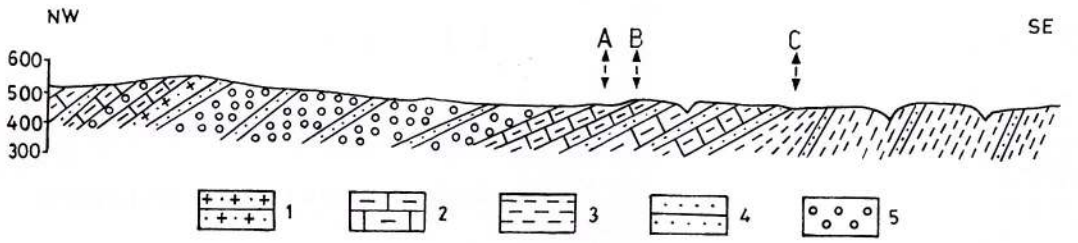


Fig. 11 – Brădet Valley Section. Lower Miocene Deposits.
1, tuffites; 2, marls; 3, clays; 4, sandstones; 5, conglomerates and nannoplankton presences

21st Stop : **Langhian Perşani (Dej) Tuffs of the Transylvanian Depression**

In several small quarries it is possible to examine the dacitic tuffs of Langhian age. These are here named Perşani Tuff but in general it corresponds to the Dej Tuffs generally developed in the whole Transylvanian Depression.

Reaching the south-eastern border of the Transylvanian Depression the field-trip returns to Braşov and makes toward south crossing the whole East Carpathian chain as far as Bucureşti.

Between Braşov and Comarnic towns the inner part of the Flysch Zone is crossed. The different outcrops along the highway belong to Cretaceous flysch deposits, the main part corresponding to the Ceahlău Nappe, one of the innest units of the East Carpathian Flysch Zone.

22nd Stop : **Prahova Valley : Lower Miocene Formation in the Slănic Syncline**

Along the left bank of the Prahova Valley, south of Comarnic town Lower Miocene formations (Fig. 12) crop out. There lithostratigraphical succession (from older to younger sequences) is, as follows:

– Slon Breccia (200 m) consists of a dark silty matrix with clayey and marly blocks proceeding from Upper Cretaceous and Paleogene deposits. It crops out in the thalweg of the Prahova Valley. The calcareous nannoplankton assemblage recorded from the immediately underlaying deposits (uppermost "Pucioasa Facies with Fusaru Sandstones") is typical for NP_{24}.

– "Lower Gypsum" Formation (10–25 m) which overlays Slon Breccia is here represented by an alternance of clayey gypsums and gypsiferous sandstones. In small lens interbedded in

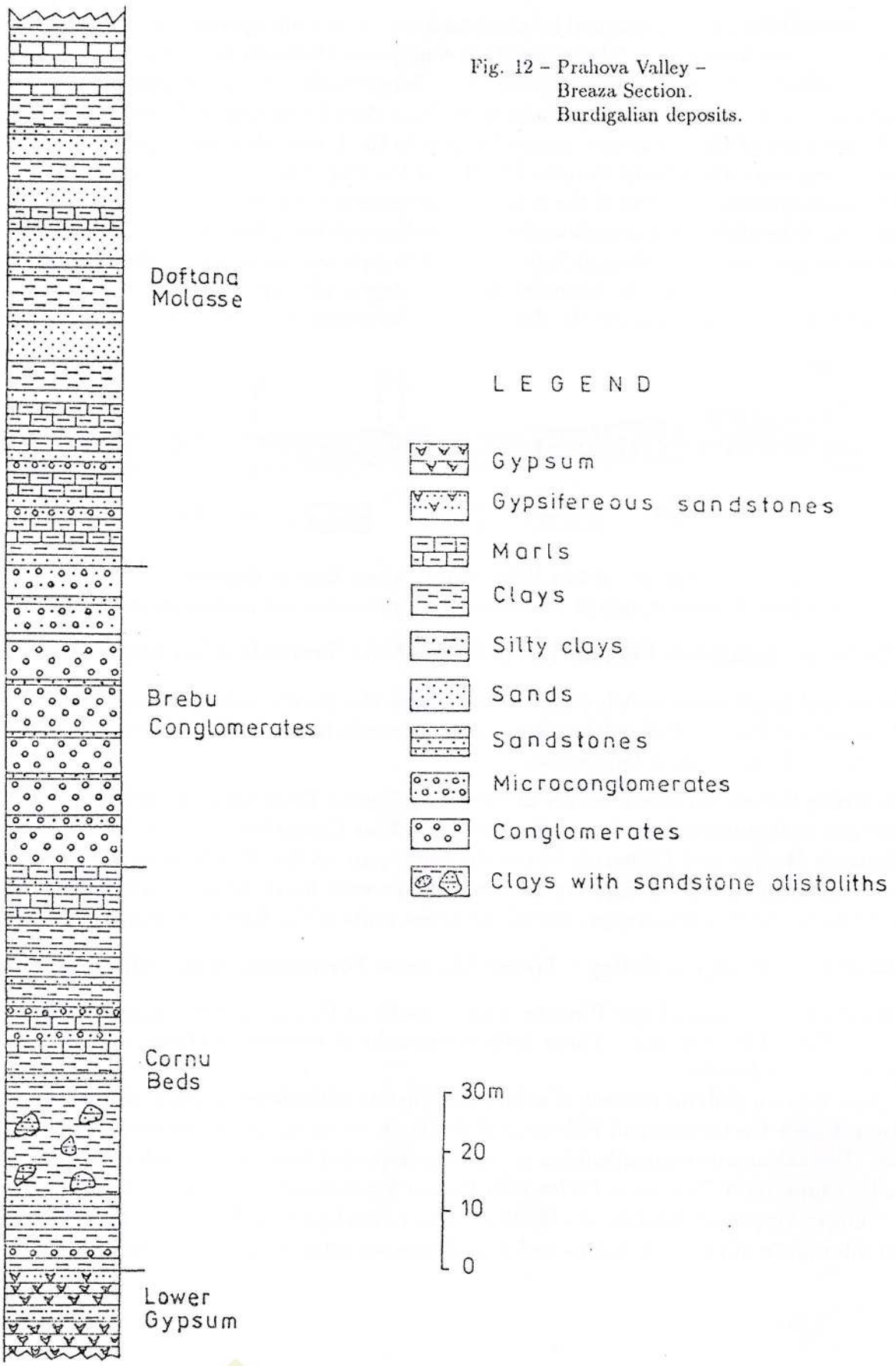


Fig. 12 – Prahova Valley – Breaza Section. Burdigalian deposits.

this formation, a scarce nannoplankton assemblage with *Reticulofenestra pseudoumbilicus, Helicosphaera ampliaperta, H. mediterranea* of the Discoaster druggii Zone (NN_2)– Helicosphaera kamptneri Subzone (NN_{2a}) Lower Burdigalian) was determinated.

– Cornu Formation (80–100 m) is made up of two main sequences:

(1) coarse sandstones (sometimes microconglomerats), and medium or fine sized glauconitic sandstones (grauwacke type), containing fragments of pectinids and large foraminifera (*Operculina, Planostegina, Miogypsina*), interlayered with sands, silty clays marls, in the lower part;

(2) silty-clays with rare sandy intercalations, containing a rich foraminiferal assemblage belonging to N_6 Zone, in its upper part.

The calcareous nannoplankton is characteristical for NN_3 Zone. The first occurrence of *Sphaenolithus belemnos*, which defines the beginning of the Sphaenolithus belemnos Zone NN_3, was recorded from the lower part of the Cornu Formation (Burdigalian).

– Brebu Conglomerates (200–250 m), discordantly overlaying the Cornu Formation, is represented by an alternance of conglomerates and microconglomerates, sands, argillaceous sands or silty-clays.

– Doftana Molasse (450 m thick). The Brebu Conglomerates gradually pass to the upper part into sands, sandstones, clays or silty clays which, lithostratigarphically represent the following formation: Doftana Molasse.

The Doftana Molasse consists, roughly, of two components:

(1) the lower part, with sands, microconglomerates and clays and

(2) the upper part, predominantly constituted of clay and sands.

The oldest clayey intercalations contain a nannoplankton assemblage with *Helicosphaera ampliaperta* and *Sphaenolithus heteromorphus*, indicating the lower part of H. ampliaperta Zone (NN_4). Towards its upper part also occur rarely specimens of *H. ampliaperta B. & W.* and *Calcidiscus leptoporus* which characterize the upper NN_4 Zone. After nannoplankton, the Doftana Molasse is Burdigalian - ?Lower Langhian in age.

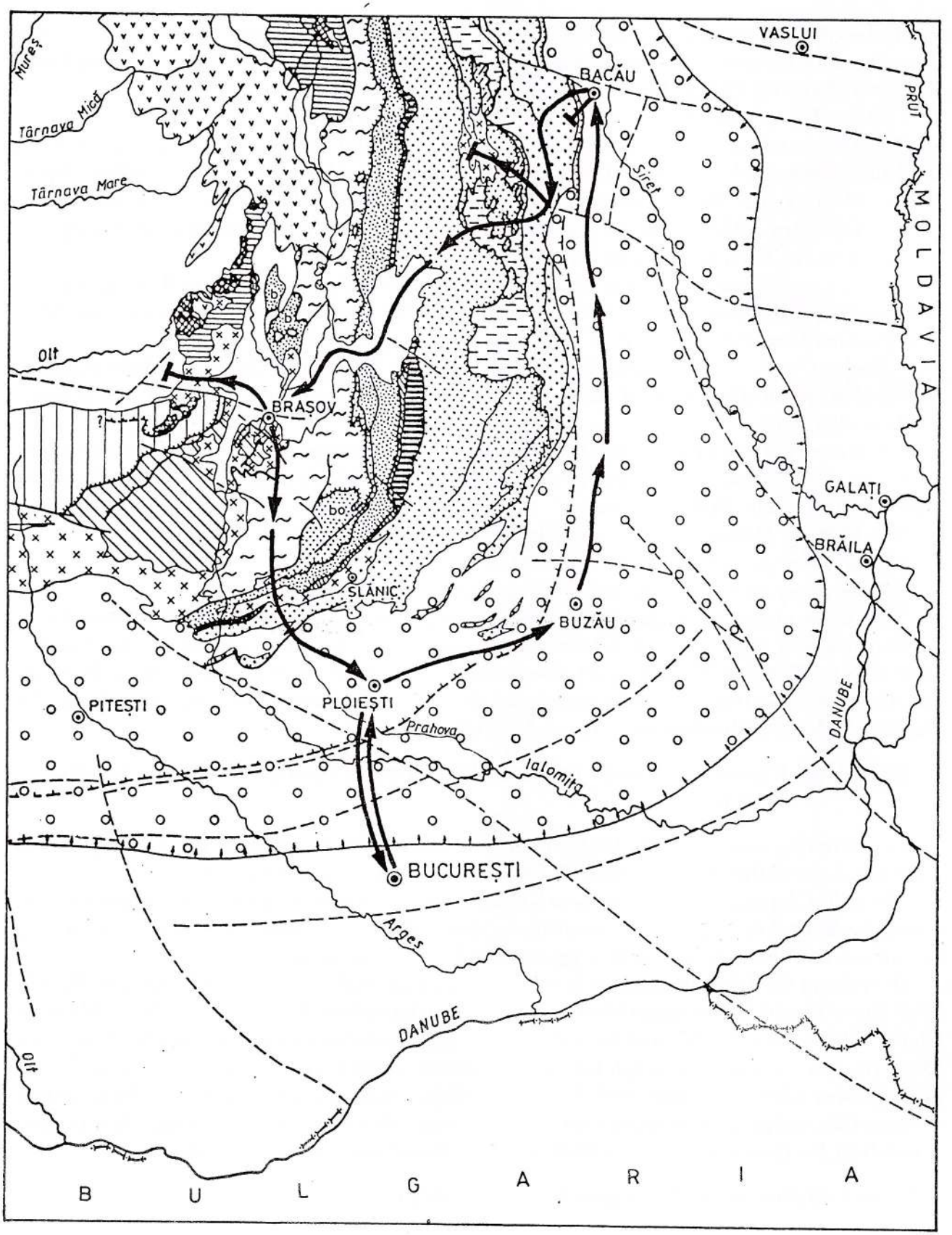
23rd Stop : **Câmpina : Lower and Middle Miocene Formations in the Drajna Syncline**

At Câmpina, along the left bank of the Prahova Valley, but also in its thalweg, on the northern slope of the "Garii Anticline", Lower and Middle Miocene deposits occur.

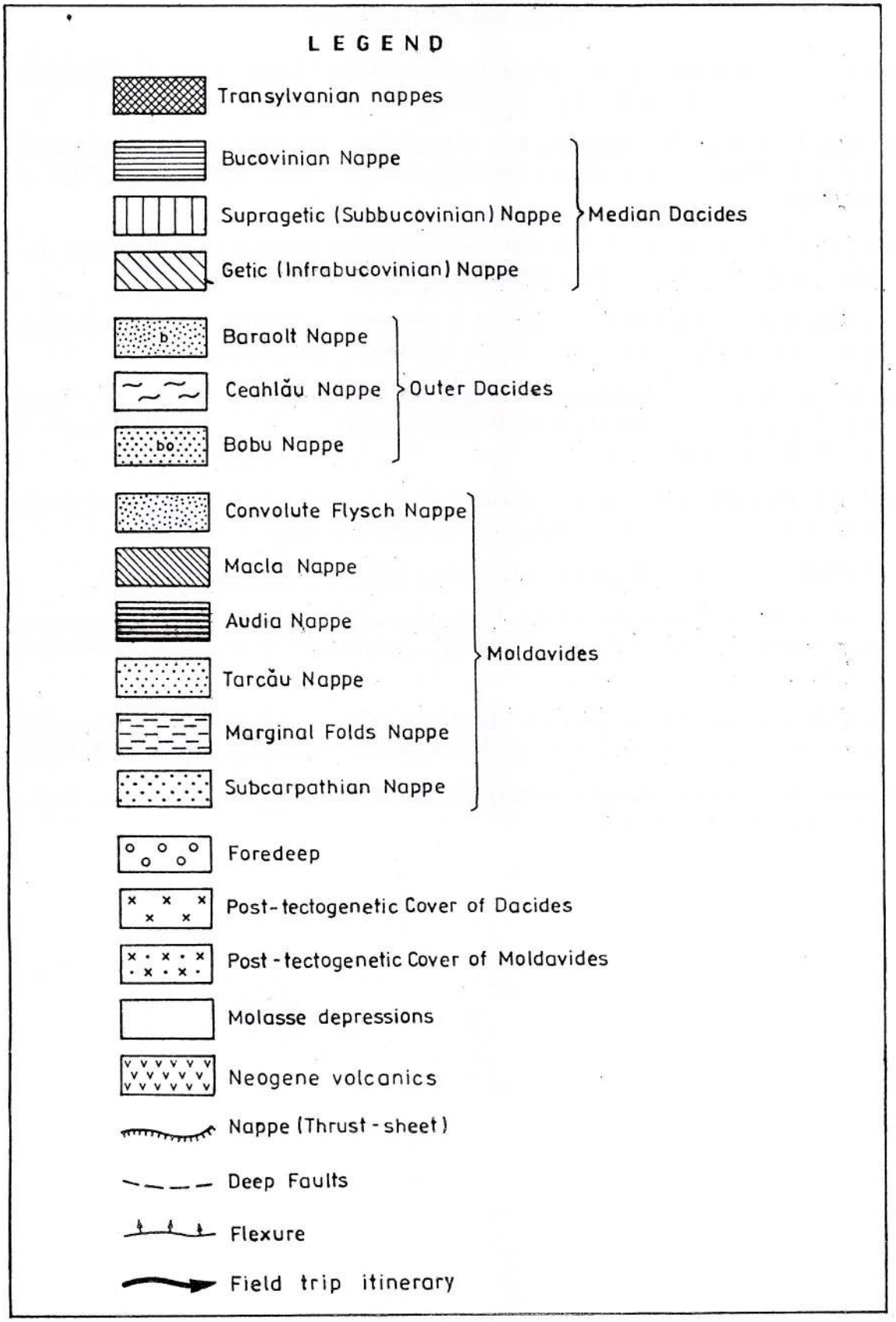
The oldest deposits outcropping here belong to the upper part of the Doftana molasse represented by detrital deposits (sands, sandstones, clays, silty-clays, marls). It is worth mentioning the presence of two marker levels: a gypsum (4–5 m) and an algal limestone.

Overlaying the Doftana Molasse, in the thalweg of the Prahova Valley "Globigerina Marls", "Salt Breccia" and "Radiolarian Shales" occur. These formations belong to the Middle Miocene. Thus, "Globigerina Marls" contain a rich planktonic foraminifera assemblage (N_8 Zone); the "Salt Breccia" is barren (except for some reworked fossils); the "Radiolarian Shales" contain silicious microorganisms (radiolarians, ebridians, diatoms, silicoflagelates), foraminifera (*Velapertina indigena, Globigerina tarchanensis*) and calcareous nannoplankton (NN_6), characteristical for Kossovian age (= Lower-Middle Serravallian = Upper Badenian).

From Câmpina the field-trip goes back to Bucureşti.



Tectonic sketch of the Southern East Carpathians



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