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GUIDE TO EXCURSION A1 (pre-Congress)

NEOGENE FROM TRANSYLVANIA DEPRESSION

by

Gheorghe Popescu, Mariana Mărunţeanu,
Sorin Filipescu

Institutul Geologic al României
Bucureşti – 1995

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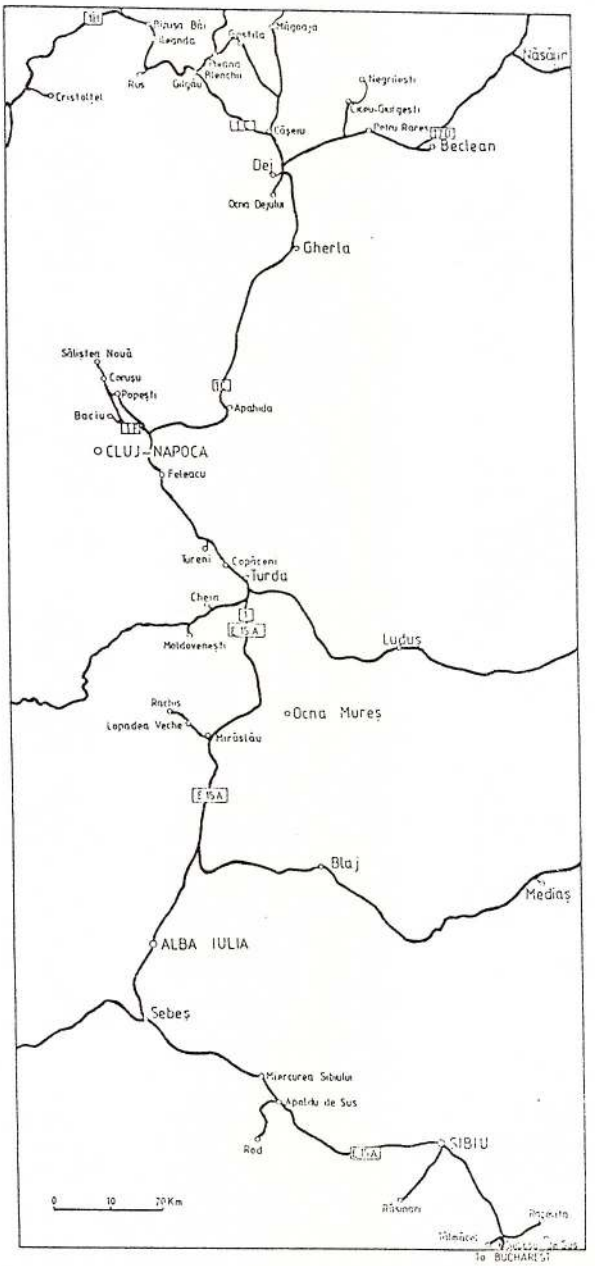

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Institutul Geologic al României

NEOGENE FROM TRANSYLVANIA DEPRESSION

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1. Introduction

The area of the Transylvania Depression began to function as a sedimentary basin after the Upper Cretaceous alpine tectogenesis. The deposits accumulated in the Senonian-Burdigalian interval constitute the post-tectogenetic cover, represented by normal marine and brackish epicontinental formations, mostly carbonatic, which alternate with lacustrine continental deposits (in the stratigraphic interval between the Senonian and the Lower Oligocene), followed by mostly terrigene marine and continental lacustrine formations (in the Lower Oligocene-Lower Miocene interval).

The outlining of the Transylvania Depression took place during the Lower Miocene and it was finished (in the actual geomorphologic aspect) (Fig. 1) in the Middle Miocene (Laughian) concomitantly with the beginning of the active molasse sedimentation.

The sedimentary deposits of the depression lie over two tectonic stages: the first stage consists of fragments of the Dacids and Transylvanids, and the second one of Senonian-Burdigalian post-tectonogenetic deposits (Săndulescu, 1984).

The areal distribution of the sedimentary deposits accumulated in the Upper Oligocene and Lower Miocene is asymmetrical: thicker, mostly marine in the northern and north-eastern part and thinner, with alternations of marine and continental facies in the north-western, western and southern part of Transylvania. This distribution suggests the existence of continuous connections with the outer Carpathians and the Pannonian Depression through the northern part of the depression, between the Ţicău-Preluca crystalline massif to the west and the Rodna massif to the east. These connections existed in the Middle and Upper Miocene, as well.

In Transylvania there is a great variability of the lithologic constitution of the Miocene deposits. Their correlation raised several questions, some of them solved, at least partially, by the researches carried out in the last decade.

2. Lithostratigraphy

The main Neogene formations will be presented further on.

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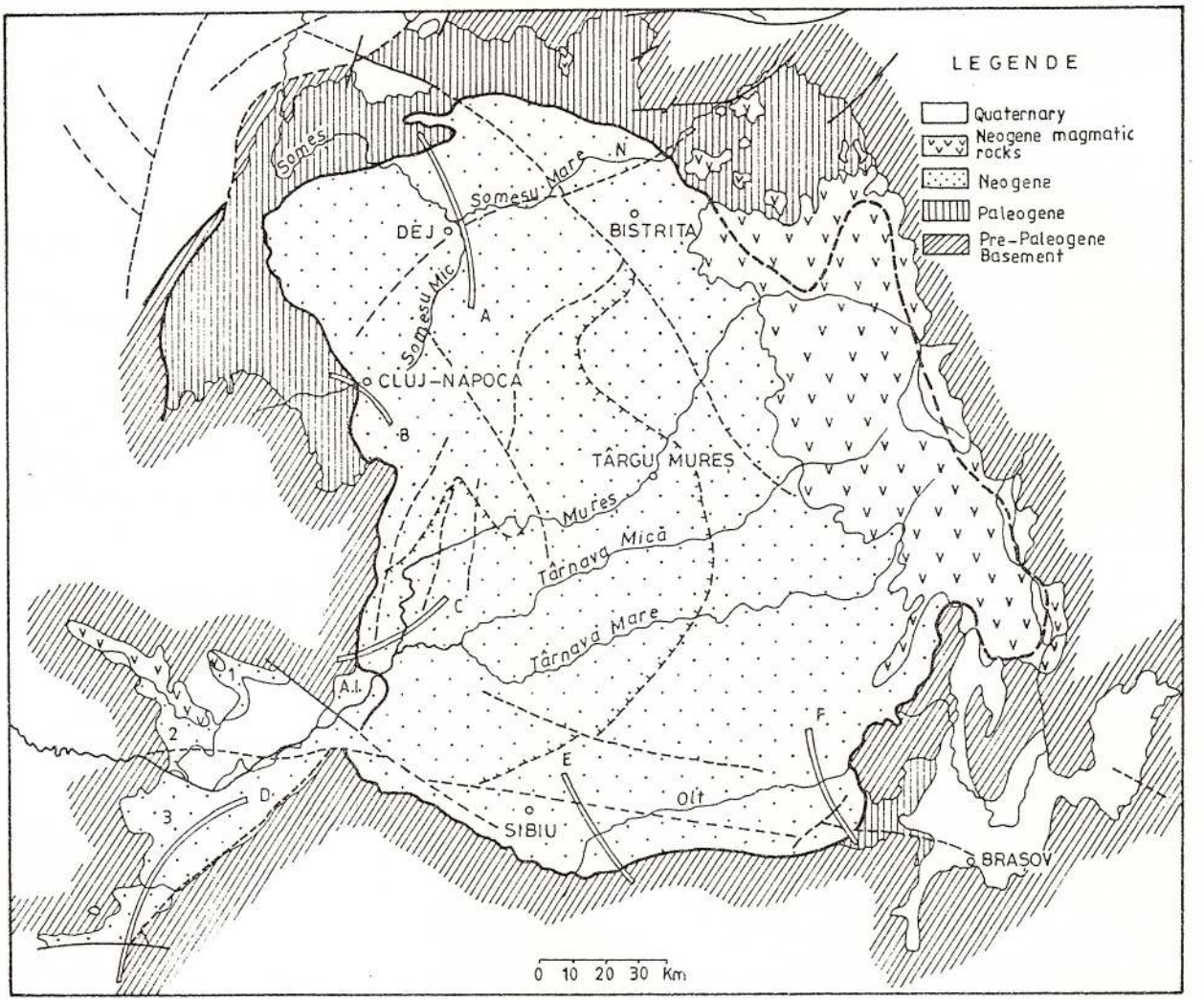

Fig. 1 – Tectono-structural sketch of the Transylvania Depression (according to Săndulescu, 1984, simplified). 1, Zlatna-Almaşu Mare Basin; 2, Brad-Săcărâmb Basin; 3, Strei-Haţeg Basin; 4, F, sections (see Fig. 7).

2.1. Vima Formation, Lăzărescu, 1957, emend. Rusu, 1969
(Upper Rupelian-Lower Burdigalian/Kiscellian-Eggenburgian)

The marine pelitic deposits overlying the Ileanda Formation and overlain by the Someş Formation constitute a well outlined lithostratigraphic unit in the northern part of Transylvania (south and south-east of the Preluca crystalline massif). This formation covers the Upper Rupelian-Lower Burdigalian stratigraphic interval (Popescu, 1972), Kiscellian-Eggenburgian respectively, if we consider the regional chronostratigraphic scale. The lateral equivalents of this formation (westwards) are, as follows: Buzaş, Valea Almaşului, Var, Cuzaplac, Cubleş, Dealu Cotului, Coruş and Chechiş formations (Rusu, 1989).

The Vima Formation contains rich fossil assemblages especially represented by molluscs, foraminifers and calcareous nannoplankton. Towards west and south-west, the Vima Formation passes laterally to detrital marine facies, coarse-grained, beginning with the lower part.

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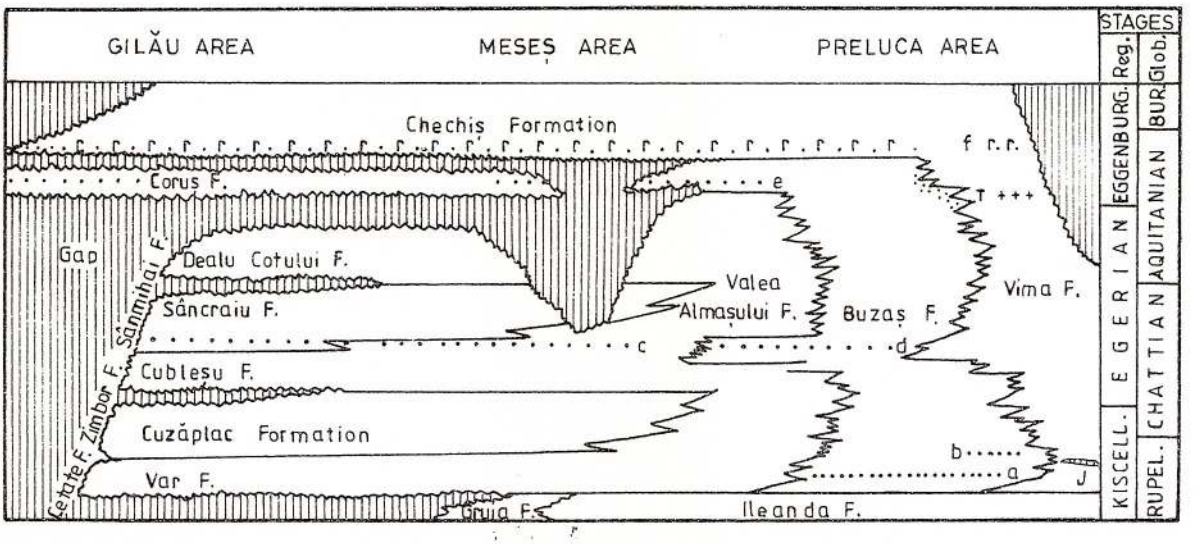

Fig. 2 – Lithostratigraphic correlation of the late Oligocene and early Miocene of NW Transylvania (after Rusu, 1989, modified). a, *Tritaxia szaboi* level: b, *Bolliella navazuelensis* level: c, *Crassostrea cyathula* level; d, *Amusiopecten burdigalensis* level; e, *Chlamys gigas* level: f, glauconitic level: j, Jaslo coccolithic limestones level; T. Valea Cocii Tuffs.

Such a situation is found at Poiana Blenchii, on the Valea Runcului section where the lower part of the formation is replaced by the marine detrital facies (Buzaş Formation). The thickness of the formation in sections on the Valea Imoasa (north of the locality of Vima Mare) and Valea Cocii (west of the locality of Magoaja) has been estimated at 250–300 m.

2.2. Buzaş Formation, Dumitrescu, 1957
(Upper Rupelian-Lower Burdigalian/Upper Kiscellian-Eggenburgian)

Detrital, coarse and seldom siliciclastic, more rarely clayey or friable deposits in marine facies have been separated under the name Buzaş Formation. They overlie the Ileanda Formation and are overlain by the Chechiş Formation. Their thickness reaches 300–450 m. Cartographically, this formation can be separated between the meridians of the localities of Solona (to the west) and Magoaja (to the east). It includes numerous fossil remnants which have been studied by Hofmann (1887), Rusu (1969, 1972, 1977) and Şuraru (1970).

The Buzaş Formation can be seen in the Valea Runcului section (west of the locality of Poiana Blenchii) and on the Dej-Jibou highway in the escarpment on the left side of the highway, close to the locality of Rus.

2.3. Valea Almaşului Formation, Răileanu & Saulea, 1955
(Upper Rupelian-Aquitanian/Upper Kiscellian-Eggenburgian)

The coarse siliciclastic deposits (sands, sandstones) in brackish facies with coals, between the Ileanda and Coruş formations, cartographically separated west of the locality of Solona on the lower course of the Almaş Valley, are known as the Valea Almaşului Formation. Although it is quite unitary from the lithologic point of view, it breaks up towards west and south-

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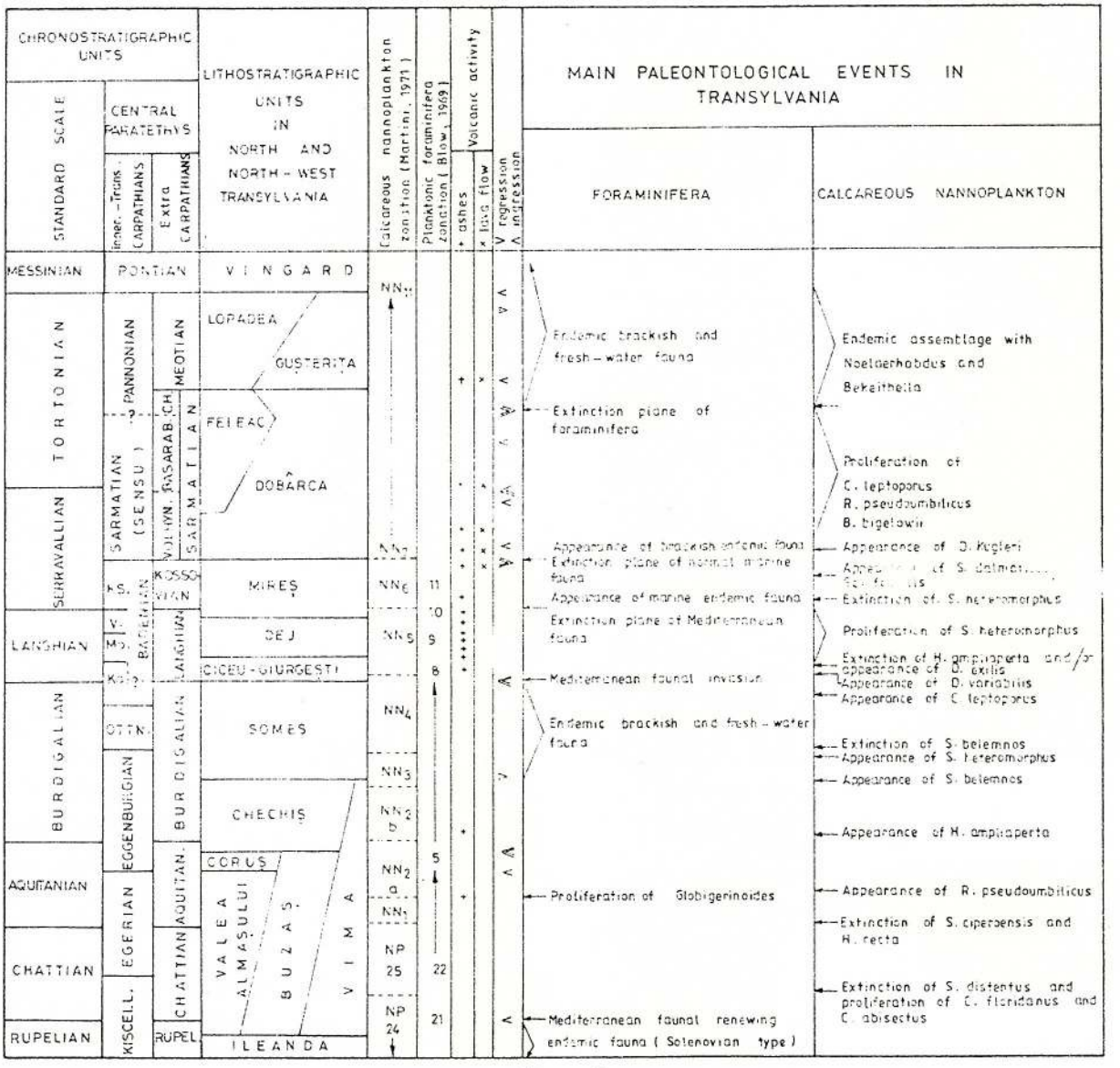

Fig. 3 – Synoptic table of the main paleontological events in the Neogene from Transylvania.

west into smaller, brackish and continental lithostratigraphic units. A sketch of the lateral lithostratigraphic variations has been elaborated by Rusu (1989) (Fig. 2).

2.4. Coruş Formation, Hauer & Stache, 1863
(Upper Aquitanian/Eggenburgian)

It is a strong transgressive formation which, on the margins of the sedimentation area, lies over older formations (e.g. Cubleşu Formation in the Coruş quarry, in the Lornitii Hill or the Var Formation in the Popeşti quarry). In places, the Coruş Formation can conformably lie over the Dealul Cotului Formation or the Valea Almaşului Formation. It consists of white, fine-

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or coarse-grained sands, with a parallel or cross bedding, with intercalations of fossiliferous carbonatic sandstones or lentiform clayey levels with coals and/or plant remains.

Usually, the Coruş Formation contains a rich molluscan fauna (see Răileanu & Negulescu, 1964; Culda, 1972, 1975: Moisescu et al., 1979; Pop, 1993). The distinctive paleontologic element is represented by the presence of the species, *Chlamys gigas* SCHLOT., regarded as index fossil for the homonymous biozone (Moisescu & Popescu, 1980) or as a marker in the regional correlations (Rusu, 1989).

This formation (with thicknesses between 10 and 40 m) displays a continuous areal development on the north-western border of Transylvania, between Solona and Cluj-Napoca. The outcrops of the Coruş Formation have been mentioned on the Sălătruc Valley, south of Petroşani (Pop, 1993). In the Iara "gulf" (at Petreştii de Sus) and in the Bilag Hill (near Alba Iulia), the Coruş Formation occurs in an atypical facies.

2.5. Chechiş Formation, Hofmann, 1879
(Upper Aquitanian-Lower Burdigalian/Eggenburgian)

In the north-western sector of the Transylvania Depression, approximately between the localities of Cluj-Napoca and Glod on the Someş River, the Coruş or Buzaş formations are overlain by a packet of deposits, unitary in lithologic respect, made up of compact clays, locally siltic, known as the Chechiş Formation (with a thickness varying between 20 and 80 m). Between the localities of Cluj-Napoca and Cristolţel, a glauconitic level can be distinguished in the base of the formation (Şuraru, 1967). It is possible that it can extend also eastwards because at about the same stratigraphic level, on Valea Cocii (at Magoaja), as well as in the south-eastern part of the depression (in the base of the Brădet Formation, on the Brădet Valley, north of the locality of Perşani, Fig. 4) glauconitic sandstones have been found, as well.

The Chechiş Formation includes molluscs and a rich foraminiferal assemblage (Popescu, 1975). The best preserved organic remains came from the basin of the Almaş and Agriş valleys and the neighbourhood of the locality of Coruş (at ca 1 km north of the Coruş quarry).

The Chechiş Formation has been sampled at Coruş and in the Feleac quarry, at Coasta Cea Mare, where the Chechiş Clays unconformably overlie the Coruş Formation and are overlain by the Dej Formation (Langhian/Lower Badenian).

In the south of Transylvania, east of the Olt Valley (on the Sebeşul de Sus Valley, upstream the locality with the same name) the crystalline basement is overlain by siltic clays with rare sandy intercalations, locally strongly micaceous, rich in organic remains (foraminifers), described as the Sebeş Formation (Gheorghian, 1971; Gheorghian & Gheorghian, 1994), a stratigraphic equivalent to the Chechiş Formation. The Sebeş Formation is transgressively overlain by the Tălmaciu Conglomerates (Ilie, 1955), an equivalent to the Ciceu-Giurgeşti Formation in the north of Transylvania.

In the south-easternmost part of the Transylvania Depression, in the Vlădeni couloir, on the Brădet Valley, a packet of compact clays (Brădet Formation, Gheorghian, 1975) crops out, which starts with a level of glauconitic sandstones rich in fragments of large foraminifers (*Planostegina*). This packet, which contains fossil faunas similar to those in the Chechiş Formation, transgressively overlies the deposits constituted of dark-coloured, laminated clays, which resemble the Oligo-Miocene Pucioasa-type facies, and are transgressively overlain by the Perşani Conglomerates. The deposits sequence between the Pucioasa facies and the Perşani Conglomerates (Fig. 4) should be correlated with Chechiş and, probably, lower part of the

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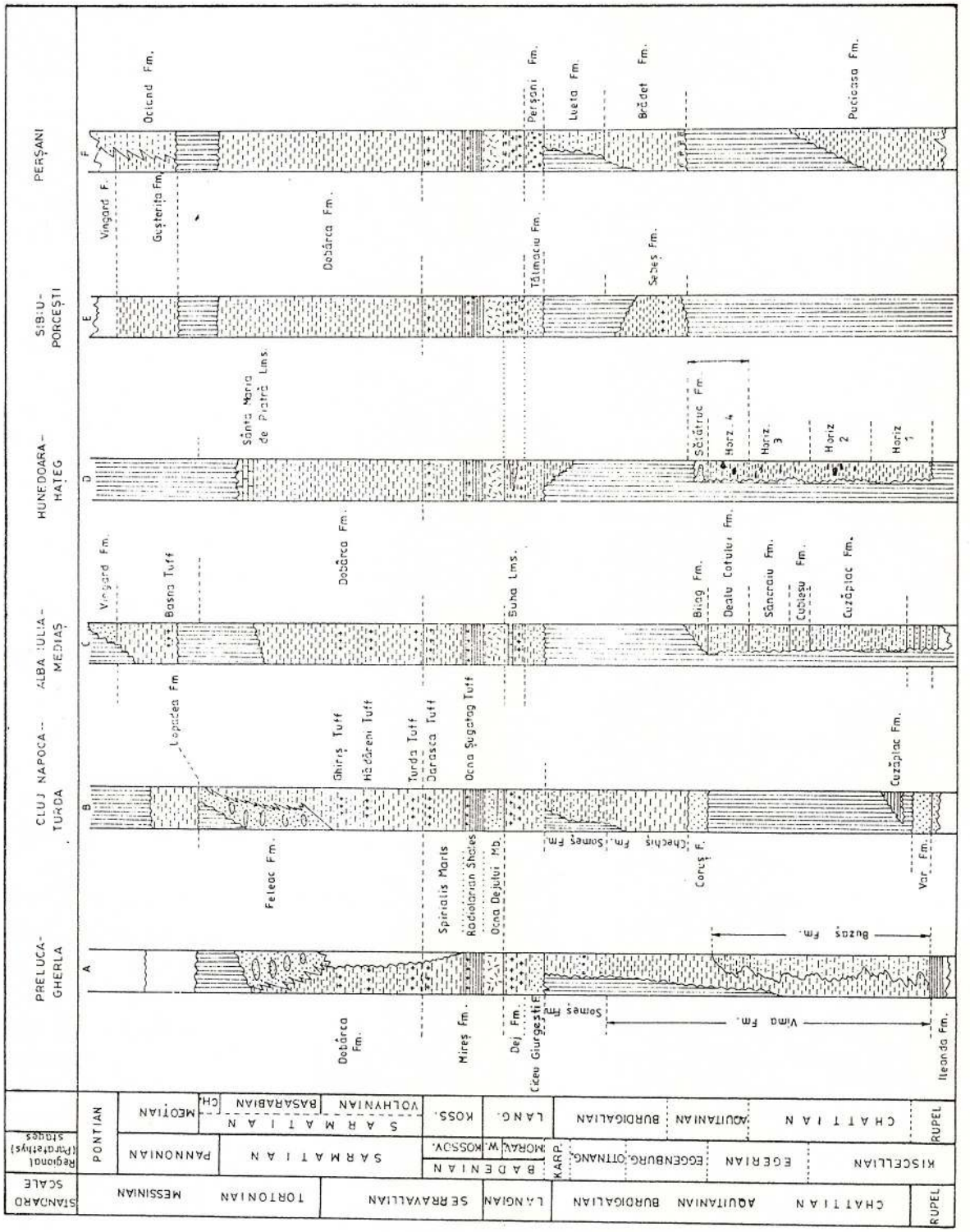

Fig. 4 – Lithostratigraphic correlations of the Neogene deposits from Transylvania.

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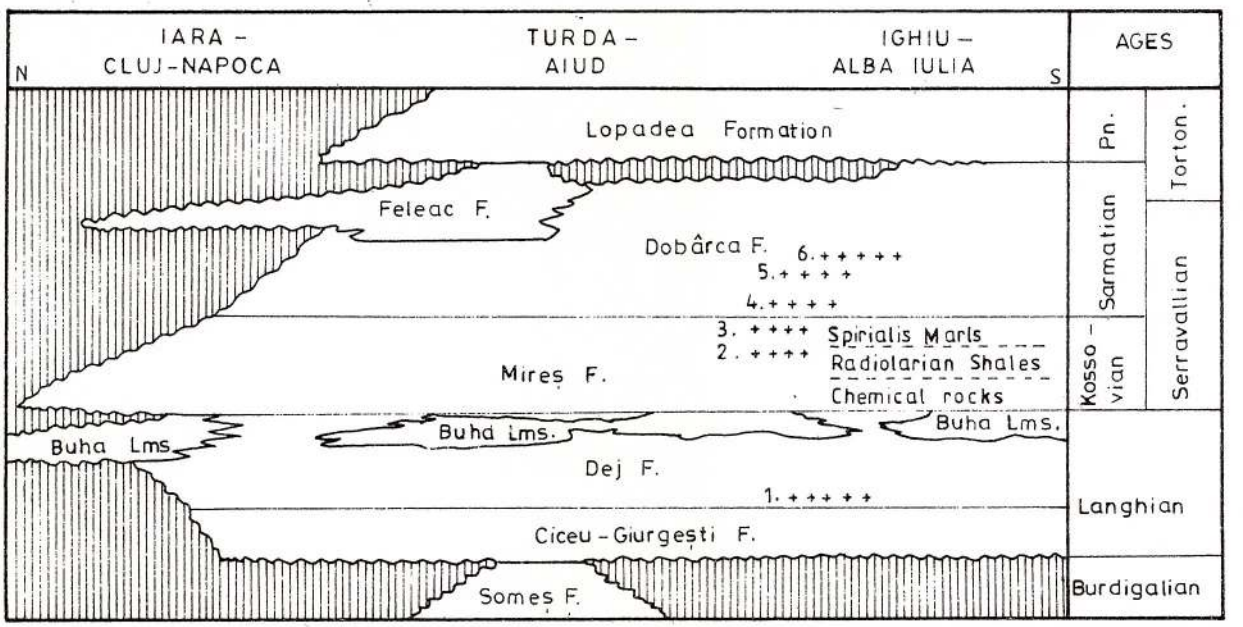

Fig. 5 – Lithostratigraphic correlation of the Middle and Upper Miocene in the western part of the Transylvania Depression. 1, Dej Tuff; 2, Şugatag Tuffs; Dărasca Tuffs; 4, Turda Tuffs; 5, Hădăreni Tuffs; 6, Ghiriş Tuffs.

Someş Formation.

2.6. Someş Formation, Popescu, 1971
(Burdigalian/Eggenburgian-Ottnangian)

In his paper "Die Tertiarbildungen des Siebenbürgischen Beckens, II, Neogene Abt.", Koch (1900) separated the deposits between the Chechiş Formation and the base of the Dej Tuff under the name Hida Formation. The packet of sediments separated includes a fluvial deltaic megasequence with scarce fossil remnants and a strongly transgressive, marine sequence that belongs to a new sedimentation cycle: the lower sequence was named Someş Formation and the upper one Ciceu-Giurgeşti Formation.

The Someş Formation, well exposed between the localities of Magoaja and Casei, where its thickness reaches more than 2500 m, consists of mostly detrital, coarse-grained terrigene deposits with pelitic intercalations, which become more frequent and then they are prevailing towards the top of the succession. Excepting the reworked fossil remnants, in the upper part of the Someş Formation two fossiliferous levels can be distinguished: a lower level with *Ostrea* and an upper level with laminated, algal limestones with *Hydrobia* and ostracods, recognized also in the Subcarpathians in the same stratigraphic position.

2.7. Ciceu-Giurgeşti Formation, Popescu, 1970
(Langhian/Lower Badenian)

The Ciceu-Giurgeşti Formation displays a marked transgressive character and it consists of conglomerates or pebbles in the base and siltic clays with thin intercalations of tuffs or tuffites

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at the upper part.

The beginning of this formation coincides with the opening of the Paratethys towards the Mediterranean Sea, a moment which coincides with the renewing of the whole Central Paratethys with marine faunas (Popescu, 1976). The fossiliferous content is rich in the whole succession.

The Tălmaciu Conglomerates (Ilie, 1955), developed on the northern border of the Făgăraş and Cibin Mts and the Perşani Formation (Gheorghian, 1975), situated in the south-eastern part of Transylvania (Brădet-Perşani sector), represent lithostratigraphic equivalents to the Ciceu-Giurgeşti Formation.

2.8. Dej Formation, Popescu, 1970
(Langhian/Lower Badenian)

The Dej Formation (=Complex of the Dej Tuffs, Popescu, 1970) is constantly found in the whole Transylvania Depression and consists of tuffs and tuffites with intercalations of clays and siltic clays, organogene tuffitic limestones and fossiliferous compact marls in the upper part of the succession. On the borders of the Transylvania Depression, probably at the same stratigraphic level with the compact marls, a packet of algal, bioclastic limestones can be individualized; it occurs as a continuous belt only on the western border of the depression. The limestones consist of thali of Rhodophyceae (Bucur & Filipescu, 1994), foraminifers and bryozoans, molluscs and echinid debris and they can mainly be cartographically separated (Buha Limestones) in the sector delimited by the Ampoi Valley (to the south) and the Arieş Valley (to the north).

The base of the Dej Formation coincides, in the whole Carpathian area, with the beginning of a strong explosive volcanic activity. Quite often, as one can see also in the Dosului Valley (east of the locality of Ciceu-Giurgeşti), in the Dej Formation occur 3–5 ignimbritic levels (Szakacs et al., 1993) which might be a proof of close eruption centers. There are no precise indications as regards their location: possible emission centers of the volcanic ashes occur in the intra-Carpathian area (Măgura Ciceului, Oaş-Gutâi-Ţibleş volcanic chain, Metaliferi Mountains) and probably outside the Carpathians, too.

2.9. Mireş Formation, Popescu, 1972
(Langhian/Badenian)

The Mireş Formation comprises the deposits overlying the Dej Formation, which include the chemical precipitation rocks (Ocna Dejului Member), the Radiolarian Shales and Spirialis Marls. Very often at the upper part of the succession occur intercalations of calcareous sandstones, locally sands, which contain a rich molluscan fauna (Buitur-type faunas).

The clayey shales overlying the chemical precipitation rocks contain numerous fossil remnants represented by siliceous microorganisms (Dumitrică et al., 1975; Dumitrică, 1978) and calcareous plankton (foraminifers and nannoplankton). The clays with pteropods or the Spirialis Marls, overlying the Radiolarian Shales and consisting of siltic clays with rare sand intercalations, are also rich in fossil remnants (foraminifers, calcareous nannoplankton and molluscs). In the upper part of the Radiolarian Shales and in the upper part of the Spirialis Marls a tuffitic level (Şugatag Tuff and Darasca Tuff, respectively), usually about 0.52 m thick is intercalated. Only in the north of the country, at Şugatag (in Maramureş), and west of Zalău (in the Sylvania "gulf") the Şugatag Tuff displays considerable thicknesses. It is to note that the

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two tuffitic levels are found constantly both in the intra-Carpathian and the extra-Carpathian areas.

The paleontologic content of the Mireş Formation is characterized by the presence of numerous endemic species, typical of the Central Paratethys. Most of the species of Mediterranean origin, whose penetration is mentioned in the base of the Ciceu-Giurgeşti Formation, disappear in the base of the Mireş Formation. The paleontologic element of correlation of these deposits with those in the Mediterranean Sea is the calcareous nannoplankton which indicates the NN_6 Zone.

The transition from the marine Mireş Formation to the upper formation, which contains brackish-type fossils (Dobârca Formation), takes place abruptly without any lithologic changes. This is one of the reasons for which it is necessary to specify the precise age of the tuffitic intercalations considered as marker levels.

The Borşa-Turda Tuff (Ciupagea et al., 1970) (Fig. 4) is usually considered as a marker of the lower boundary of the overlying Dobârca Formation.

2.10. Dobârca Formation, Lubenescu, 1981
(Sarmatian)

The alternations of compact, conchoidal clays, within which calcareous, thin, hieroglyphic sandstones, sands and tuffites are intercalated, have been separated as Dobârca Formation. In its lower part a level of lenticular gypsum, with a maximum thickness of 3 m, is quite often found.

The gypsum in the lower part of the Sarmatian has a regional development: it has been found in some boreholes on the eastern margin of the Pannonian realm (at Caransebeş, Zlăgniţa borehole) or exposed in the section on the Cavnic Valley, near Baia Mare, where its thickness exceeds 7 m, as well as in the outer Carpathians.

Numerous calcareous white intercalations (centimetric or subcentimetric) or laminated clayey shales, rich in siliceous microfossils (diatoms and silicoflagellates), are often found in the middle of the Dobârca Formation (Upper Volhynian-Upper Basarabian).

The thickness of this formation increases progressively from the borders of the Transylvania Depression (300 m on the Rodului Valley, near Apoldu de Sus or Şteaza Valley, at Răşinari) toward its center (more than 1000 m).

The deposits forming the Dobârca Formation are poor in fossil traces: they have been mentioned mostly on the border of the depression.

In the Iris quarry in the Colina Hill (north-east of Cluj-Napoca, in the left side of the Chintău Valley) occurs a rich foraminiferal assemblage (Gabos et al., 1985), typical of the Upper Volhynian and Lower Basarabian (with *Varidentella*, *Porosononion* and *Elphidium* beside ostracods from the genera *Argilloecia* and *Candona* and statholits of *Mysidae*). A rich microfauna has been also mentioned and illustrated from the Steaza Valley (Gheorghian, 1972) and Rodului Valley (Gheorghian, 1975).

2.11. Feleac Formation, Koch, 1884
(Sarmatian)

In the north-west of Transylvania (in the surroundings of the town of Cluj-Napoca and of the Iara "gulf") there is a heterochronous, mostly detrital (sands, sandstones, conglomerates, pebbles and more rarely argillaceous intercalations), transgressive formation named the Feleac

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Formation. This is intercalated in the Bobârca Formation and it could be considered a member of it. This formation is characterized by the sands with reniform or convolute concretions known as "trovants".

In the section in the Colina Hill (Iris quarry), the Feleac Formation lies over the Volhynian-Lower Basarabian argillaceous deposits, containing tuffitic intercalations.

2.12. Lopadea Formation, Lubenescu, 1977
(Pannonian)

The Lopadea Formation, transgressively overlying the Dobârca Formation, is made up of clayey deposits in the base and sandy deposits in the upper part. The type profile is in the neighbourhood of the locality of Lopadea Veche, on the Lopadea Valley (north-west of the town of Aiud). The samples collected from the lower part of the formation, on the Lopadea Valley, nearby the locality of Miraslău, contain a rich ostracod assemblage (Olteanu, 1995, in Popescu & Olteanu MS): *Amplocypris abcissa* (Rss.), *A. recta* (Rss.), *Plannonocypris auriculata* (Rss.), *Lineocypris trapezoidea* (Zalani), *Hemicytheria josephinae* Koll., *Caspiocypris pontica* Sokac, *Cyprideis pannonicum* Olteanu. This assemblage is typical of the Upper Pannonian. It is to note that no species is exclusively Pontian, but some of the taxa occurring in the Pannonian and surviving till the Pontian.

Within the same stratigraphic section occurs a rich molluscan fauna (Lubenescu, 1977) with *Congeria firmocarinata* Papp., *C. martonfii* Lor., *C. banatica*, R. Hoernes, *Limnocardium undatum* Rss., *L. cekusi* Gorj. & Kr., *L. asperocostatum* Gorj. & Kr., *L. tuberosum*, Jek., *Melanopsis fossilis* (Martini & Gmelin), *M. constricta* Handm., *M. vindobonensis* Fuchs, *M. pygmaea* Hoern., *Velutinopsis velutina* (Desh.), *Undulotheca pancici* (Brus.) as well as reworked specimens from the Langhian and Sarmatian deposits. In the southern part of the Transylvania Depression synchronous deposits have been described under the name Săcădate Formation or Gusteriţa Formation or Valea Rodului Formation (Lubenescu, 1981).

2.13. Vingard Formation, Lubenescu, 1981
(Upper Pannonian)

The Lopadea Formation is transgressively overlain by a packet of mostly detrital deposits, about 30–40 m thick. In some places, on the south-western margin of the Transylvania Depression (e.g. Râposu Hill, nearby the locality of Vingrad), these deposits contain a rich molluscan fauna represented by *Congeria subglobosa longitesta* Papp., *C. ungulacaprae* (Muenster), *Eolymnium atavus* (Partsch) and *Melanopsis vindobonensis* Fuchs. This fauna points to the uppermost Pannonian to Pontian.

3. Evolution of the Fossil Assemblages

The succession of the fossil assemblages in the Transylvania Depression shows some peculiarities in relation to the global evolution, induced by the regional tectonic and paleogeographic evolution.

After the separation of the northern area of the Tethys, the so-called Eo-Paratethys, in the Lower Oligocene, the evolution of the fossil assemblages has a different development in comparison with that of the Mediterranean assemblages.

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The isolation of the Paratethys led to the extinction of the marine faunas and the occurrence of endemic faunas. During the evolution process moments of re-establishing of the connections with the marine sedimentation areas existed, which determined the renewing of the faunas. Two such moments are known in the faunal evolution in the Paratethys: the first one occurred in the Upper Rupelian (Kiscellian), which continued with small interruptions till the Lower Burdigalian (/Ottnangian), and the second at the base of the Langhian.

After the appearance of the Solenovian-type endemic faunas (Rusu, 1988) in the Lower Oligocene, the first return of the Tethys-type marine faunas is recorded in the Upper Rupelian. Thus, in the base of the Vima Formation (Upper Rupelian-Chattian) there is a foraminiferal assemblage, named "Kiscell-type" (Popescu & Iva, 1971; Popescu, 1975), which contains Mediterranean faunas. The Kiscell-type foraminiferal faunas were compared with the Mediterranean ones by Poignant & Sztrakos (1986) who concluded, due to numerous common elements, that at this stratigraphic interval communications between the Tethys and the Paratethys existed. Among the benthonic foraminifers common in Spain and Hungary, also occurring in Transylvania, mention should be made of: *Alabamina budensis* (HANTK.), *Almaena hieroglyphica* SIGAL, *Allomorphina macrostoma* KARRER, *Amphicoryna tunicata* (HANTK.) , *Bolivina nobilis* HANTK., *Latibolivina reticulata* (HANTK.), *Cyclammina (Reticulophragmium) rotundidorsata* (HANTK.), *C. (Reticulophragmium) acutidorsata* (HANTK.), *Cylindroclavulina rudislosta* (HANTK.), *Ellipsoglandulina vasharhelyii* (HANTK.), *Globocassidulina globosa* (HANTK.), *Fursenkoina halkyardi* (CUSH.), *Lenticulina arcuatostriata* (HANTK.), *L. princeps* (RSS.), *Oridorsalis umbonatum* (RSS.), *Palmula budensis* (HANTK.), *Planularia kubinyii* (HANTK.), *Tritaxia haerigensis* (CUSH.), *T. kruhelensis* (WOJCZIK), *T. szaboi* (HANTK.), *Unicosiphonia zsigmondyii* (HANTK.), *Uvigerina hantkeni* CUSH. & EDW., *Vaginulinopsis pseudodecorata* (HAGN.).

Significant changes in the fossil assemblages took place during the Lower Miocene (in the Coruş Formation and more obviously in the Chechiş Formation) when the Mediterranean elements were more scarce. The lack of the low latitude planktonic foraminifers is worth mentioning.

As a consequence of the break of the connections between the Central Paratethys and the Mediterranean, at the level of the Someş Formation (Transylvania) and Doftana Molasse (Subcarpathians), the marine faunas are replaced by brackish or fresh-water ones. The connection with the Tethys was brutally re-established at the level of the Ciceu-Giurgeşti Formation (basal Langhian) when the marine faunas occur again. They reach their maximum proliferation in the Upper Langhian (see the well-known fossiliferous sites at Lăpugiu de Sus and Coştei, whose foraminiferal assemblages were described by Neugeboren (1851-1856) and Karrer (1868).

At the base of the Serravallian (Kossovian) a new biotic threshold occurs close to the base of the N_{10} Zone of planktonic foraminifers or to the boundary between the NN_5 and NN_6 nannoplankton zones. At this moment, the Mediterranean-type fauna disappeared and a new marine assemblage (with endemic elements) with boreal influences (Dumitrică et al., 1975; Dumitrică, 1978) occurred. The correlation based on nannoplankton (NN_6) indicates that the subsequent marine deposits are equivalents to the Lower Serravallian.

Finally, at the end of the Kossovian and the beginning of the Sarmatian (base of NN_7 Zone) the marine faunas disappeared and the endemic brackish faunas occurred and proliferated. In the Upper Basarabian, close to the boundary with the Chersonian, the degradation of the marine environment exceeded the survival limit of the foraminifers and, consequently, they disappeared entirely (at least in Transylvania). The faunas which survived this new biotic

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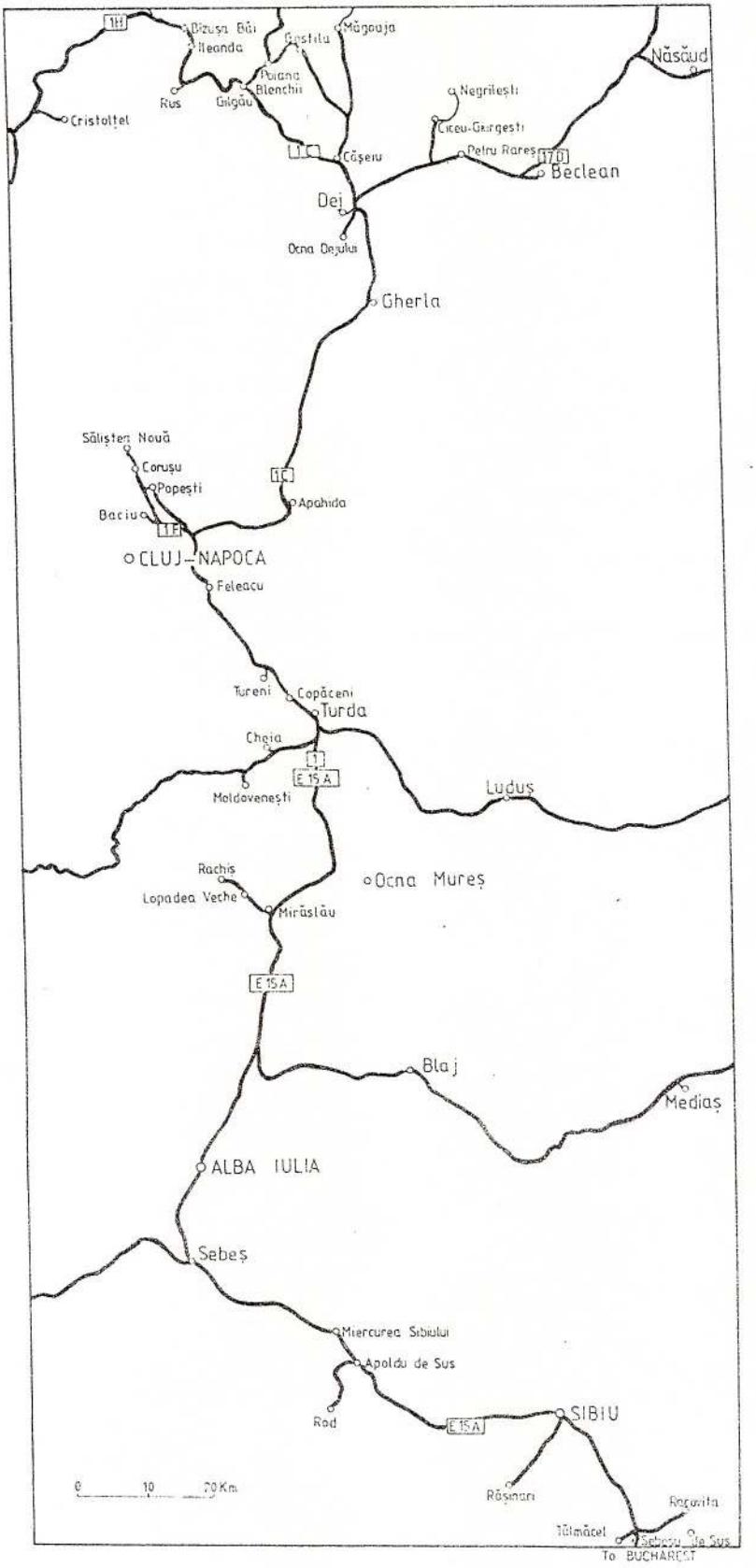

Fig. 6 – Sketch of the excursion itinerary.

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threshold are represented by endemic molluscs. It is to note that in the post-Sarmatian deposits outside the Carpathians there were found levels of calcareous nannoplankton very significant for detailed stratigraphic correlations between Tethys and Paratethys (Mărunţeanu, 1991).

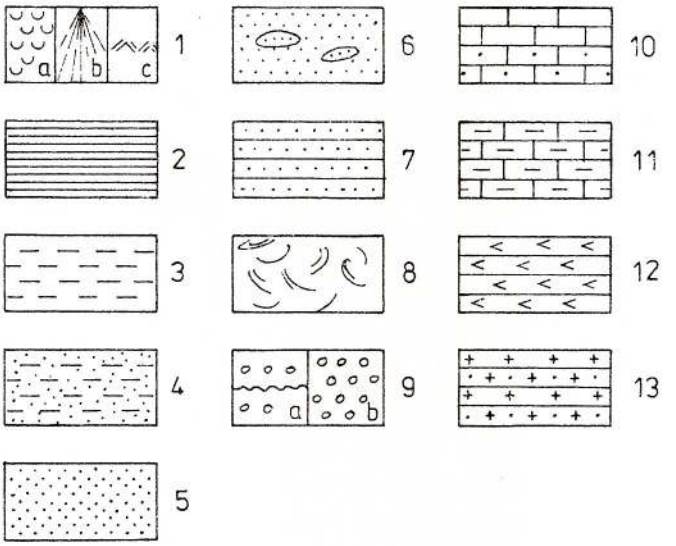

Fig. 7 – General legend of the geological columns and sections: 1, Quaternary deposits (a – slidings; b – alluvia; c – soil); 2, shales; 3, clays; 4, siltic clays; 5, sands; 6, sands with gritty concretions ("trovants"); 7, sandstones; 8, slumpings; 9 a, conglomerates; 9 b, gravels; 10, limestones, calcarenites, oolitic limestones; 11, chemical precipitation marly-limestones; 12, gypsum; 13, tuffs, tuffites.

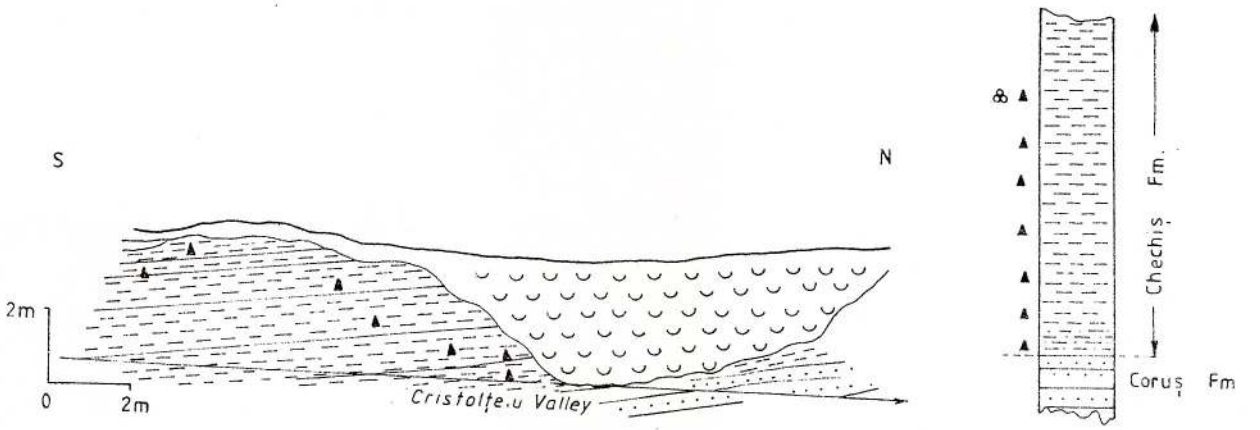

Fig. 8 – Cristolţel Valley section.

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4. Description of the sections

The sections which will be presented further on include Vima Formation (the upper part), Coruş Formation, Chechiş Formation, Ciceu-Giurgeşti Formation, Dej Formation, Mireş Formation, Lopadea Formation and Sebeş Formation (Fig. 6).

4. 1. Cristolţel section (Chechiş Formation)
(Upper Aquitanian-basal Burdigalian/Eggenburgian) (Fig. 8)

This section is situated 8 km east-south-east of Surduc, upstream the Cristolţel Valley, at the end of the Cristolţel locality. Up here, on both sides of the valley, deposits belonging to the Valea Almaşului Formation are to be found. The immediately suprajacent deposits (about 10 m thick), which belong to the Coruş Formation, are overlain by a recent sliding, followed by the exposure of the lower part of the Chechiş Formation, represented by (Fig. 8):

- 1.5 m siltic clays with glauconite,
- 3 m compact siltic clays,
- 5 m grey-bluish, compact clays.

The Coruş Formation is cropping out in the right side of the valley, close to the access gallery in the "Cristolţel" coal mine. Here, Rusu (1975) found the level with *Chlamys gigas* SCHLOT., representing the easternmost place where the Coruş Formation can be recognized.

The micropaleontologic content of the samples collected from the basal part of the Chechiş Formation is quite poor as compared to the samples collected from the same level in other places. *Ammodiscus* sp., *Cyclammina cancellata* BRADY, *C. (Reticulophragmium) acutidorsatum* (HANTK.), *Lenticulina calcar* (LINNE), *Lenticulina* spp., bryozoan *Batopora rosula* RSS., spicules of sponges have been recognized.

The nannoplankton assemblages are constituted of: *Coccolithus pelagicus* (WALLICH), *Discoaster druggii* BRAM. & WILCOX., *D. deflandrei* BRAM. & RIEDEL, *Cyclocargolithus abisectus* (MULLER), *Helicosphaera intermedia* MARTINI, *H. mediterranea* MULLER, *H. paleocarteri* THEOD., *Reticulofenestra pseudoumbilica* (GARTNER), *Sphaenolithus moriformis* (BRONN. & STRAD.). This assemblage belongs to the *Discoaster druggii* Zone, NN_2 (Martini, 1971), *Sphaenolithus dissimilis* Subzone NN_{2a} (Mărunţeanu, 1992).

4. 2. Valea Runcului section (the top of the Vima Formation)
(Upper Aquitanian/Eggenburgian)

The marine calcareous sandstones belongings to the Buzaş Formation are overlain by siltic clays with glauconite belonging to the Vima Formation. The samples collected from the pelitic facies of the Vima Formation are poor in foraminifers and nannoplankton. Foraminifers are represented by: *Spirorutilis carinata* (D'ORB.), *Saccammina* sp., *Cyclammina cancellata* BRADY, *C. praecancellata* VOLOSH., *Bathysiphon* sp., *Amphicoryna* sp., *Nonion* sp., *Uvigerina* cf., *U. hantkeni* (CUSH. & EDW.), *Plectofrondicularia* cf. *P. striata* (HANKT.), *Hemirobulina hantkeni* (BANDY), *Stilostomella* sp., *Lenticulina* sp. The calcareous nannoplankton, poor in species and individuals, is represented by: *Coccolithus pelagicus* (WALLICH), *Discoaster deflandrei* BRAM. & RIEDEL, *Reticulofenestra pseudoumblica* (GARTNER), *Helicosphaera intermedia* MARTINI, *H. euphratis* HAQ., *Pontosphaera multipora* (KAMPTNER), *Sphaenolithus moriformis* (BRON. & STRAD.). Due to the presence of the species *R. pseudoumbilica*, this can be assigned to the NN_2 Zone, namely in its lower part (NN_{2a}).

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Glauconite grains were found in all the samples collected, which quantitatively decrease towards the upper part of the section.

4. 3. Valea Dosului section (east of the Ciceu-Giurgeşti locality)
(Langhian/Lower Badenian)

At about 1 km east of the Ciceu-Giurgeşti locality, on the Dosului Valley, there is one of the most interesting exposures, where the Ciceu-Giurgeşti and the Dej Formations crop out. The subjacent Someş Formation on the Dosului Valley is covered by the alluvial fan; it can be seen on a ravine situated to the east.

The Ciceu-Giurgeşti Formation consists of two lithological sequences. The lower one is represented by a 4–5 m thick bank of weakly cemented polygenic gravels with well processed pebbles enclosed in a sandy-clayey matrix. In this matrix the first paleontological elements indicating the beginning of the great marine Mediterranean invasion in the base of the Middle Miocene occur.

The upper sequence, approximately 12 m thick, consists of well stratified grey-blackish clays with 6–7 tuffite intercalations.

The foraminiferal content of the Ciceu-Giurgeşti Formation is represented by rich assemblages belonging to the N_8 Zone, namely: *Globigerinoides triloba* (RSS.) and *Candorbulina glomerosa* (BLOW.). The calcareous nannoplankton (Gheţa & Popescu, 1975) characterizes the NN_5 Zone with:*Coccolithus pelagicus* (WAL.), *Cycloargolithus abisectus* (MULLER), *Reticulofenestra pseudoumbilicus* (GARTNER), *Calcidiscus leptoporus* (MURRAY & BLAK.), *Cyclolithella annula* (COHEN), *Pontosphaera multipora* (KAMPTNER), *Holodiscolithus macroporus* (DEFL.), *Helicosphaera kamptneri* HAY & MOHLER, *Sphaenolithus heteromorphus* DEFL., *S. moriformis* (BRONN. & STRAD.), *Discoaster exilis* MATR. & BRAM., *D. variabilis* MART. & BRAML.

The suprajacent Dej Formation, 120 m thick, begins with a 5 m thick bank of ignimbrites with lithic elements, being overlain by more or less regular alternations of tuffs, tuffites, clays, marls, and calcareous, hard sandstones. Organogenic limestone and siltic marl interbeds rich in foraminifers typical of the N_9 Zone occur towards the median part of the formation.

The last clay levels from the top of the Dej Formation contain a foraminiferal microfauna typical of the *Uvigerina asperula* Zone (N_9/N_{10} Zone with *Globorotalia praefohsi-G. peripheroacuta*).

In this section, selected as stratotype for the Ciceu-Giurgeşti and Dej Formations, the Ocna Dejului Member from the base of the Mireş Formation also crops out, but discontinuously.

Fragments of the "*Spirialis* marls" (Kossovian) with velapertines are to be found at 50–100 m laterally in the slidings over the chemical precipitation deposits.

It is worth mentioning that the petrographic studies on the intercalations of volcanic deposits pointed out the existence of at least five ignimbrite levels (Szakacs et al., 1993 MS). Of these, the level in the base of the Dej Formation is the best outlined.

4. 4. Valea Slatinei section, west of Dej
(Late Langhian) (Fig. 9)

On the outskirts of the Dej locality, towards the Condor locality on Slatina Valley the upper part of the Dej Formation and the lower part of the Mireş Formation, the Ocna Dejului Member respectively, crop out.

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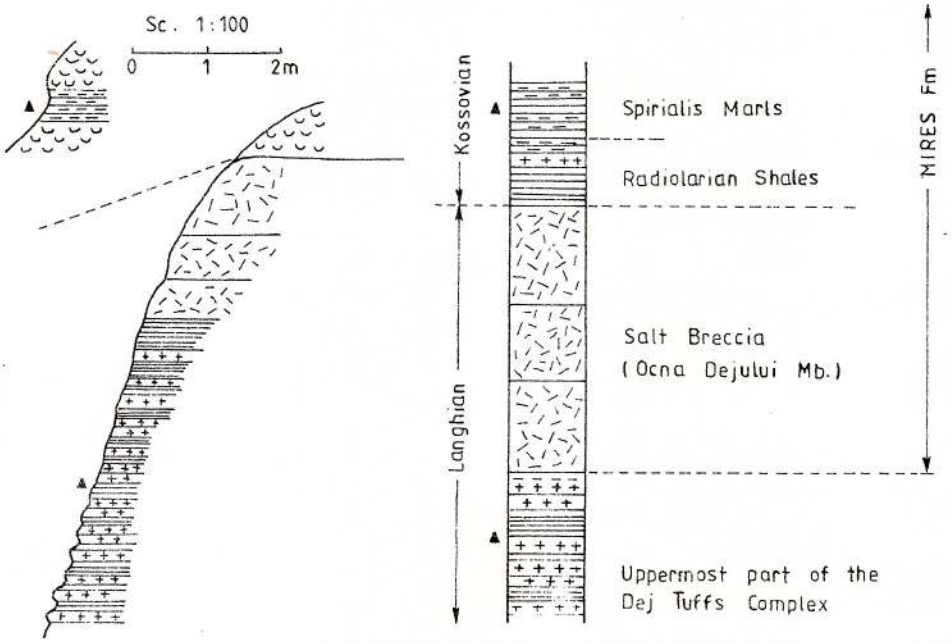

Fig. 9 – Slatina Valley section.

The terminal part of the Dej Formation is represented by clay deposits with tuffite interbeds (6–10 m) containing foraminifer microfaunas typical of the *Uvigerina asperula* Zone. One should mention that here, in addition to the index species, the first specimens of *Globorotalia peripheroacuta-G. praefohsi* (the base of the N_{10} planktonic foraminifer Zone) occur. Gradings to breccias with rare gypsum intercalations which constitute the Ocna Dejului Member (8–10 m thick) can be further noticed. South-east of the Slatina Valley the chemical precipitation deposits of the Ocna Dejului Member, represented by sedimentary breccias and salt, reach 500 m or more in the vicinity of the Gherla locality. The next lithostratigraphic terms of the Mireş Formation are covered by land slidings on the Slatina Valley (radiolarian schists and *Spirialis* marls). These deposits include fragments of *Spirialis* marls rich in specimens of *Velapertina indigena* (Lucz.) and *Globigerina tarchanensis* Subb. & Chutz. (Kossovian) as well as in calcareous nannoplankton characteristic of the NN_6 Zone.

4. 5. Coruş quarry section, Lorniţi Hill
(Upper Aquitanian/Eggenburgian)

The Coruş Formation is exposed in several outcrops at Coruş, on the left bank of the Seaca Valley. It overlies transgressively red argillitic deposits (Cuzaplac Formation) and begins with a 2 m bank of fine, limonitic sands containing marine faunas (cardiids, lutrariids and psammobiids), followed by 6 m of coarse, quartz sands, in places with cross-bedding, containing numerous fragments (soft pebbles) of clays or brownish clay interbeds with plant remains. Of these intercalations, Givulescu (1970) described an Aquitanian paleoflora in an outcrop near Coruş.

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The level with plant traces is overlain by fine, locally coarse sands showing cross-bedding (2 m), which contain 2–3 levels of hard, calcareous limestones, very rich in molluscs and, very rarely, foraminifer faunas (Iva, 1971). The most frequent molluscs are as follows: *Glycymeris fichteli* (DESH.), *G. pilosus* (L.), *Arca fichteli* (DESH.), *Chlamys gigas* (SCHLOT.), *Calista lilacinoides* SCHAF., *Laevicardium kübecki* (HAUER), *Turritella terebralis* LMK., *T. vermicularis* BROC., *Dentalium sexangulum* SCHROETER (Şuraru, in Marinescu, ed., 1972, p. 37).

The famous fossil site at Coruş is situated in the right side of the Seaca Valley, opposite the quarry, in the Gânaş Hill, in the place called "La Bliduţ". Here the most diverse and best preserved mollusc faunas have been found (Răileanu & Negulescu, 1964).

The sands with fossil sandstone interbeds are overlain by siltic clays devoid of fauna (10–15 m) and transgressively overlain by the Chechiş Formation (clays) exposed northwards (ca. 1,000 m) on the Seaca Valley (Fig. 10). Here, the richest, most diverse, and best preserved foraminiferal assemblages from the whole outcropping area of the formation are to be found (Popescu, 1975). As regards the calcareous nannoplankton content, the assemblages indicate the NN_2 Zone (upper part).

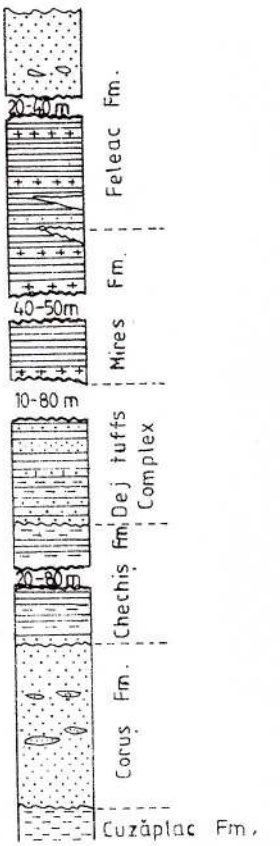

Fig. 10 - Lithological column at Coruş, Lorniţi Hill.

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4. 6. Popeşti quarry section, west of the Popeşti locality, in the right side of the Seaca Valley

(Langhian/Lower Badenian) (Fig. 11)

The section is situated in the southern extremity of the quarry. Fine, kaolinitic sands crop out along 4,5 m in the base, being overlain by a sandstone bank with a red altered surface belonging to the Var Formation. The Var Formation is unconformably overlain by the Dej Formation which here consists, in stratigraphic succession, of: 4 m of medium-grained gravels; 2 m of sands with clay intercalations; 2 m of white sand; 3–5 m of blackish, siltic clays, very rich in organic remains, in which slumpings are locally to be found; 8–10 m of prevailingly sandy deposits, rich in faunas. The level with slumpings provided a rich foraminiferal assemblage (*Amphistegina lessonii* D'ORB., *A. bohdanowiczi* BLEDA, *A. mammilla* (FICHT. & MOLL), *Amphicoryna* spp., *Candorbulina glomerosa* (BOLW.), *C. universa* JEDL., *Cylindroclavulina rudis* (COSTA), *Elphidium crispum* (L.), *E. flexuosum* (D'ORB.), *Globigerinoides triloba* (RSS.), *G. subsacculifer* CITA, PREMOLI & ROSSI, *Karreriella victoriensis* (CUSH.), *Lenticulina clypeiformis* (D'ORB.), *L. vortex* (FICHTEL & MOLL), *L. formosa* (CUSH.), *Lamarckina erinacea* (KARRER), *Marginulina hirsuta* D'ORB., *Hemirobulina haytkeni* (BANDY), *Planularia auris* DEFR., *P. ostraviensis* VAS., *Planopulvinulina granulosa* (KARRER), *Planostegina costata* (D'ORB.), *Psammolinguluina papillosa* (NEUG.), *Uvigerina pygmoides* PAPP & TURN., *U. macrocarinata* (P. & T., etc.).

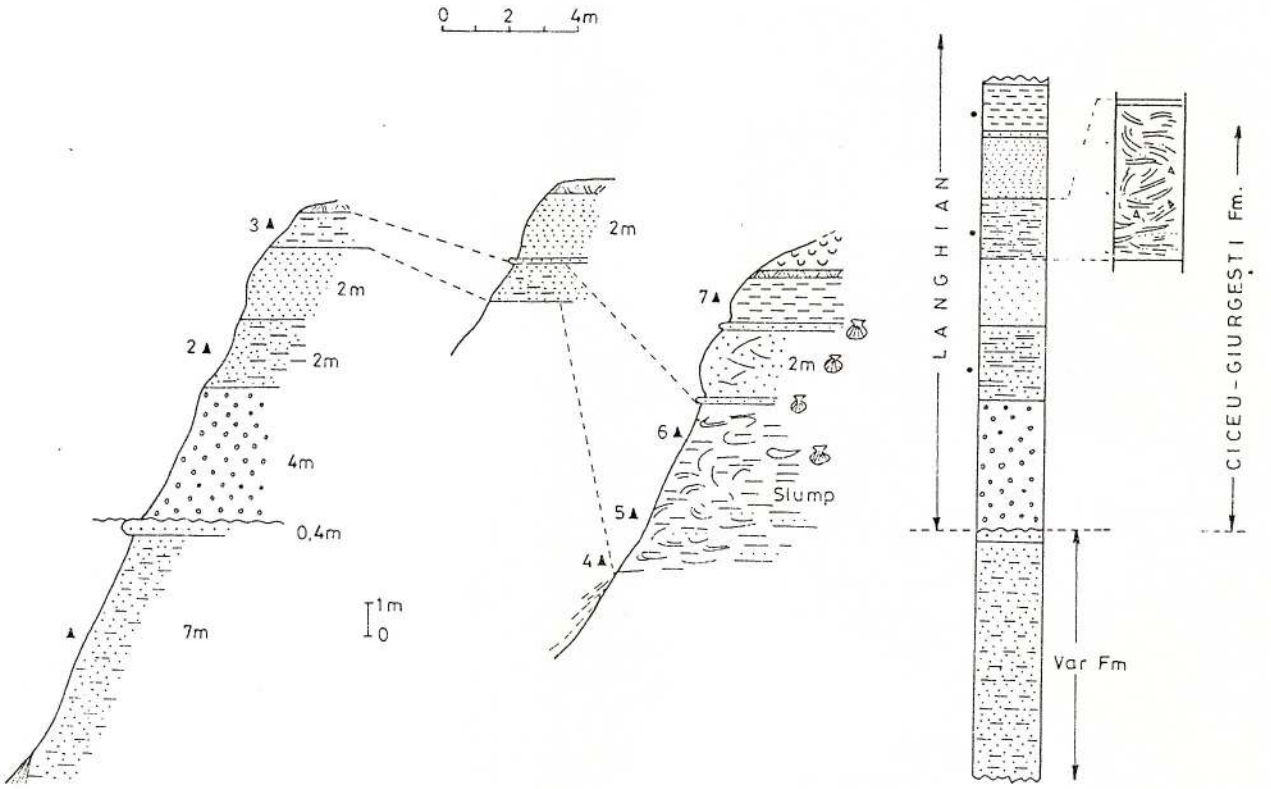

Fig. 11 – Popeşti quarry section.

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The calcareous nannoplankton assemblage furnished by the pelitic intercalations is represented by: *Braarudosphaera bigelowii* (GIAN & BRAARUS), *Calcidiscus leptoporus* (MURRAY & BLOCK.), *C. macintyrei* (BUKRY & BRAML.), *Coccolithus pelagicus* (WALLICH), *C. miopelagicus* BUKRY, *Discoaster exilis* MARTINI & BRAML., *D. formosus* MARTINI & WORSLEY, *D. musicus* STRAD., *D. variabilis* MARTINI & BRAML., *Helicosphaera kamptneri* HAY & MOHL., *H. stelis* THEOD., *H. wallichii* (LOHMAN), *Reticulofenestra pseudoumbilica* (GARTNER), *Cyclocargolithus floridanus* (ROTH.), *Coronocyclus nitescens* (KAMPTNER), *Sphaenolithus heteromorphus* DEFL., *S. moriformis* (BRON. & STRAD.), *Cyclolithella annula* (STRAD.), *Pontosphaera multipora* (KAMPT.). The assemblage is completed with the first occurrences of the species *Triquetrorhabdulus rugosus* BRAM. & WILC. in the samples collected from the upper part of the section, which could mark the terminal part of the NN_5 Zone.

4.6 a. The outcrop downstream Popeşti
(Langhian/Lower Badenian)

At kilometer 3 + 800 on the way to Cluj-Napoca, sands crop out on the left margin of the road, which are locally argillaceous with intercalations of grey-bluish compact clays belonging to the Dej Formation. They are very rich in globigerinas typical of the N_9 zone (=*Candorbulina universa/Globorotalia bykovae* Zone). Here benthonic foraminifers are rare. The calcareous nannoplankton is identical to the one mentioned in the upper part of the Popeşti section.

4. 7. Iris quarry (Colina Hill) in the left side of the Chintău Valley
(Sarmatian)

Two quarries for the exploitation of clays are to be found in the Colina Hill. The first one exposes grey-bluish siltic clays with fine, pellicular white intercalations of millimetric beds consisting of calcium carbonate. This lower sequence is over 15 cm thick; there follows a packet of white tuffs consisting of an 1.7–2 m thick principal tuff overlying some other 5–6 centimetric tuffite intercalations. The outcrop ends with clays (4–10 m thick). Above it, sands with spheroidal or reniform sandstone intergrowths (calcareous concretions) crop out, probably transgressively, which are typical of the Feleac Formation.

The second quarry, situated 500 m west of the first one, is similar. There is a larger outcrop here, which reaches 40 m in height and 200 m in width. The succession in the first quarry is easily recognizable; 15 m of compact clay beds in the base are followed by a tuffitic complex consisting of a 3 m thick principal intercalation, overlying another 6–7 tuffitic levels that reach 20–25 cm.

The tuffitic complex is overlain by an over 15 m thick clay packet, which is in its turn transgressively overlain by the Feleac Formation.

The microfauna encountered below or between the tuffite intercalations (Gabos et al., 1985) makes up an assemblage typical of the Sarmatian (Upper Volhynian-Lower Basarabian). It contains: *Sinuloculina consobrina* (D'ORB.), *Varidentella sarmatica* (KARRER), *V. reussi* (BOGD.), *Articularia articulinoides* (GERKE), *Articulina problema* BOGD., *Nonion bogdanowiczi* VOLOSH., *Porosononion martkobi* (BOGD.), *P. subgranosum* (EGGER), *Elphidium aculeatum* (D'ORB.), *E. reginum* (D'ORB.), *Ammonia* sp., etc., mysid [(*Sarmysis sarmaticus* (KHAL)] statoliths. It is worth noting that south-east of Cluj-Napoca, round the Sănduleşti locality, the same stratigraphic level includes clay shales containing numerous organic remains of siliceous microfossils (silicoflagellates and ebridians similar to the famous assemblages at

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Carand, Zarand basin, on the eastern border of the Pannonian Realm) or from the Getic Depression, or from Dobrogea (Dumitrică, 1974). Their co-occurrence with mysid statoliths is related with the opening of the Paratethys towards the northern seas (Dumitrică et al., 1975). Mysid statoliths are accompanied also by a diatoms assemblage characteristic of the cold waters (Pestra, 1995, MS), of which we mention the species *Coscinodiscus marginatus* EHR., and *Bidulphia aurita* (LYNGBYE) BRABISSON & GODEY. The new paleontological data support the hypothesis of the penetration of some waters of boreal type in the Paratethys at this stratigraphic level.

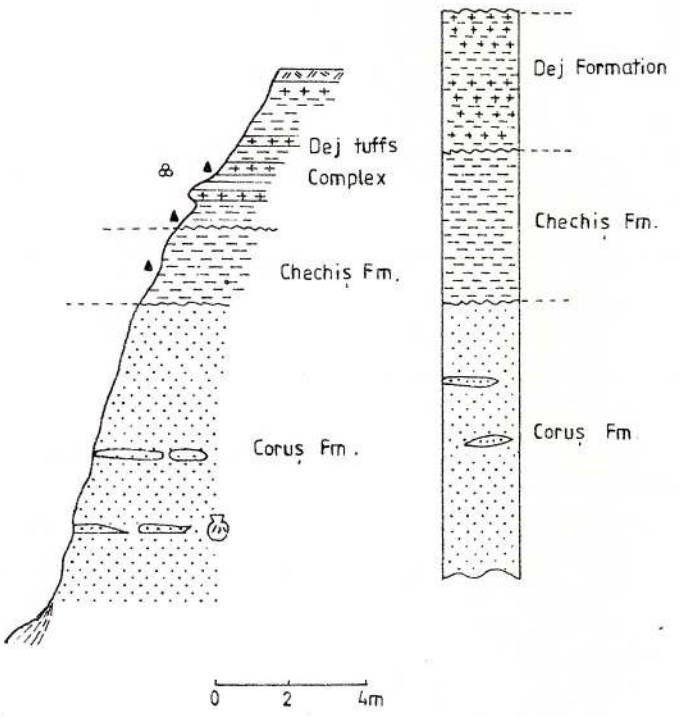

Fig. 12 – Feleac quarry section.

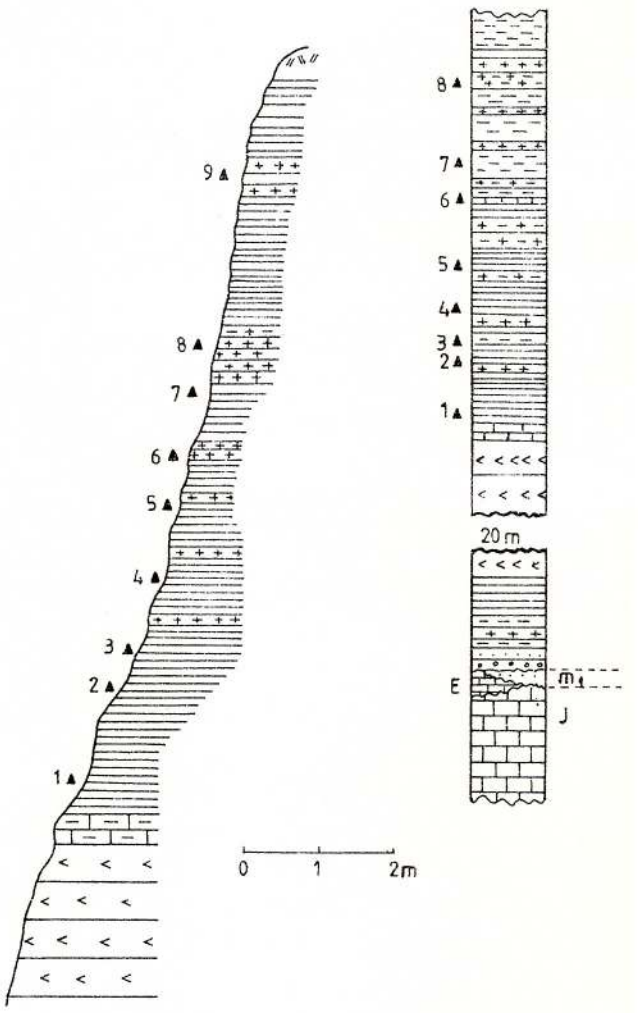

Fig. 13 – Cheia quarry section.

4. 8. Feleac quarry, south-east of Cluj-Napoca in the place called "Coasta cea Mare" (Aquitanian-Burdigalian-Langhian/Eggenburgian-Ottnangian-Badenian)

South-east of Cluj-Napoca one of the most important sand quarries of the city is situated, where the white sands of the Coruș Formation are being worked. The Coruș Formation, the Chechiș Formation and the Dej Formation crop out in this quarry (fig. 12).

18–20 m of white sands are exposed in the quarry, in which there occur 2–3 fossiliferous sandstone interbeds (*Chlamys gigas* level) which are as rich in fossil remains as in the Coruș

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quarry. The sands are transgressively overlain by greyish, blackish siltic clays with foraminifers representing the Chechiş Formation (4–5 m). In the upper part of the quarry there are greyish-bluish (when fresh) or whitish (altered) marls with tuff and tuffite interbeds belonging to the Dej Formation (Langhian). The last packet of deposits is also transgressive; it is very rich in fossils (globigerinas typical of the N_9 Zone and the calcareous nannoplankton, NN_5 Zone).

4. 9. The Outcrop at Copăceni, on the highway (E 15) between Cluj-Napoca and Turda (Kossovian)

Between the Tureni and Copăceni localities, at 1.8 km from Copăceni, in the left side of the road, whitish, tuffitic marls, locally with tuff intercalations (Mireş Formation) crop out, which contain a fauna rich in foraminifers (*Velapertina* Zone, equivalent to the N_{10-11} Zone) and nannoplankton (NN_6 Zone). Foraminifers are represented by numerous benthonic species (*Glandulina laevigata* (D'ORB.), *Reticulophragmium crassum* (RSS.), *Haplophragmoides* sp., *Sphaeoridina variabilis* RSS., *Melonis pompilioides* (F.& M.), *Cibicidoides crassiseptatus* (LUCZ.), *Velapertina indigena* (LUCZ.), *Globigerina tarchanensis* (SUBB. & CHUTZ.) (mentioned in the order of their frequency) as well as numerous specimens of representatives of the genus *Spiratella*.

4. 10. Cheia quarry north of the Cheia locality
(Late Langhian-Kossovian) (Fig. 13)

The quarry is still in use, which determines the frequent changes in its morphology. In the south-western part of the quarry there is an exposure (with high preservation probability) in which the deposits overlying the gypsum (the Ocna Dejului Member, base of the Mireş Formation) crop out.

The gypsum (over 20 m thick) is overlain by a 0.3–1 m thick lense-shaped level of chemical precipitation vacuolar limestones. The vacuoles are sometimes filled with gypsum and locally celestite or baryte crystals (more frequent in some sectors, as in the vicinity of the Tureni and Săndulești localities). Lithostratigraphically the limestones belong to the Ocna Dejului Member.

The limestones are overlain by argillitic, locally siltic shales containing numerous secondary gypsum crystals, in which radiolaria, silicoflagellates and diatoms, more rarely foraminifers, occur. There are numerous centimetric tuffitic intercalations in the shales; a thick one (60 cm) occurs in the upper part. The samples collected from the upper part of the outcrop are rich in foraminifers (*Velapertina* Zone), the benthonic ones prevailing (*Caucasina, Bolivina, Sphaeroidina, Glandulina* and a few milliolids).

The calcareous nannoplankton assemblages exhibit some peculiarities such as: the abundant presence of the species *Calcidiscus pataecus*; the lack of the discoasterids; the excessive development of the species *Calcidiscus leptoporus* and *C. macintyrei*; the existence of some *C. leptoporus* morphotypes in which the modifications manifest in the morphology of the central part (that may be loose or covered by calcitic crystallites ordered in sieves, bars or crosses). Although it does not contain calcareous nannoplankton typical of a certain zone, we suppose that this assemblage belongs to the NN_6 Zone.

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4. 11. Valea Lopadei section, at Miraslău, 6 km north of the Aiud town
(Pannonian)

Along the Lopadea Valley (towards the Lopadea Veche locality) there is an outcrop (8 m high) in the right side, near the Miraslău locality, in which grey-bluish siltic clays are exposed (locally containing clayey elements due to the slumpings). These contain numerous organic remains consisting of molluscs (Lubenescu & Lubenescu, 1977) and ostracods (Olteanu, 1995, MS) of Pannonian age.

4. 11 a. Valea Buhii section, south of Lopadea Veche
(Langhian)

At the upper part of the Dej Formation, a body of algal bioclastic limestones can be individualized. These are mentioned in some other zones of the country, too. The limestones have been reported on the eastern border of the Pannonian Realm (Caransebeş, Bega, Baia Mare Basins), on the western margin of the Transylvania Depression as well as in some connected basins (e.g. Lower Strei Basin). This calcareous body is best outlined on the western margin of the Transylvania Depression, between the Ampoi Valley (to the south) and the Arieş Valley (to the north). This was named the Buha Limestones, after the name of the valley in which they are very well exposed.

On the Buha Valley, left tributary of the Lopadea Valley, a paleorelief consisting of Jurassic ophiolites is transgressively overlain by conglomerates and sands in the base (well exposed west of this section, close to the Rachiş locality, which are covered by 35–40 m of calcareous deposits with *Lithothamnium* marl and calcareous tuffite intercalations; a level of tuffs or tuffitic marls rich in foraminifers is constantly lying above. The limestones consist mainly of *Rhodophycaee* thalli (Bucur & Filipescu, 1994) in addition to foraminifers and molluscs. A level with amphisteginas [(*A. bohdanowiczi* BIEDA, *A. mammilla* (FICHTEL & MOLL)] and planosteginas [*P. costata* (D'ORB.)] has been found in the base, besides which there are also planktonic and benthonic foraminifers typical of the upper Lagenidae zone.

The section on the Buha Valley also reveals an intraformational angular discordance, probably generated by the tectonic (compression) movements during the Langhian.

4. 12. Valea Rodului section west of the Apoldu de Sus locality
(Kossovian, Sarmatian)

On the Rod Valley, 700 m upstream from the Apoldu de Sus locality, Gheorghian (1975) describes a section in which deposits belonging to the upper part of the Kossovian and Sarmatian are exposed. Here bluish-purple siltic clays belonging to the Mireş Formation (250–300 m thick) crop out. They contain a rich foraminifer fauna [*Pavonitina styriaca* SCHUB., *Siphotextularia inopinata* LUCZ., *S. concava* (KARRER), *Valvulineria complanata* (D'ORB.), *Velapertina indigena* (LUCZ.), *Uvigerina bellicostata* (LUCZ.)] as well as *Spiratella* specimens.

The Kossovian deposits are overlain by clay deposits in which *Anomalinoides dividens* LUCZ., *Articulina problema* BOGD., *Glabratella imperatoria* (D'ORB.), *Elphidium aculeatum* (D'ORB.) have been reported (in the Lower Sarmatian). A similar assemblage in which mysid statoliths occur (*Sarmysis sarmaticus* CHAL.), considered to belong to the Upper Vol-

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hynian/Lower Basarabian, has been recorded in the immediately suprajacent deposits.

4. 13. Valea Streaza section, south-west of Sibiu
(Kossovian, Sarmatian)

The section was also presented by Doina Gheorghian in 1972, at the 5th Meeting of the Working-Group for the Paratethys (Marinescu, ed., 1972, p. 50). The Streaza Valley is situated in the immediate vicinity of the Răşinari locality (12 km south-west of Sibiu).

The crystalline basement, after a likely tectonic contact, is overlain by argillaceous, siltic deposits with carbonized plant traces, containing a typical Kossovian foraminiferal assemblage: *Martinottiella communis* (D'ORB.), *Quinqueloculina akneriana* (D'ORB.), *Sigmoilinita tenuis* (CZJZ.), *Sphaeroidina variabilis* RSS., *Pulleina bulloides* D'ORB., *Reussella spinulosa* (RSS.), *Globigerina tarchanensis* SUBB. & CHUTZ. In addition to this assemblage, there are numerous *Spiratella* specimens. The stratigraphic succession continues with grey blackish clays with siltic interbeds containing *Anomalinoides dividens* LUCZ (Lower Volhynian) and bluish-purple siltic clays with *Sinuloculuina consobrina* (D'ORB.), *Varidentella reussi* BOGD., *Articulina problema* BOGD., *Bolivina* sp., *Glabratella imperatoria* (D'ORB.), *Elphidium aculeatum* (D'ORB.), *E. antoninum* (D'ORB.), *E. reginum* (D'ORB.) (Upper Volhynian). The fine suprajacent argillitic deposits with white laminas consisting of calcium carbonate crystals ("banded clays") and tuffitic levels already contain numerous paleontological elements that indicate the Upper Volhynian-Basarabian.

The next deposits (probably separated by a fault) are represented also by siltic clays with sandstone intercalations that contain Pannonian ostracods (Olteanu, personal information).

4. 14. Sebeşul de Sus section, situated upstream from the Sebeşul de Sus locality
(Burdigalian/Eggenburgian)

On the Moaşa Valley the crystalline deposits of the Carpathian basement are transgressively overlain by breccias consisting of elements from the crystalline basement enclosed in a clay, siltic matrix (3–4 m) followed by clays, siltic clays with centimetric sandstone or sand interbeds. The fine argillaceous deposits were separated by Gheorghian (1971) under the name of the Sebeş Formation. Here Gheorghian reports a very rich foraminiferal assemblage. The samples collected from the base of this formation include *Globigerina ottnangensis* ROGL., *G. ciperoensis* BOLLI, *G. praebulloides* BLOW, *Globigerinoides primordius* BLOW, *G. triloba* (RSS.), *G. irregularis* LE ROY, *Globigerinella* cf. *G. obesa* (BOLLI), *Paragloborotalia semivera* (HORN.), *Spirorutilis carinatus* (D'ORB.), *Lenticulina* sp., *Amphicoryna* sp., *Marginuluina dingdeni* DAM. & REINH., *Siphonina reticulata* CZJZ., *Reussella* sp., *Uvigerina* cf. *U. farinosa* HANTK., *Uvigerina posthantkeni* PAPP & TURN., *Pappina* cf. *P. bononiensis* (FORNASINI) as well as numerous reworkings from the Eocene deposits (*Nummulites, Discocydinas, Operculina*, etc.). The nannoplankton studies indicated the NN_{2b} Zone (Lower Burdigalian).

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Papers should be submitted in duplicate to the secretary of the Editorial Board, including the reproduction-ready original figures. The manuscript should comprise: text (with a title page which is the first page of it), references, key words, abstract, illustrations, captions and a summary for technical purposes.

Author(s) should add a separate sheet with a short title (colontitle) of maximum 60 strokes and a summary indicating the hierarchy of headings from the text listed in decimal classification (1; 1.1; 1.1.1) but not exceeding four categories.

Text should be double-spaced typed (31 lines/page with 64 strokes each line) on one side of the paper only, holding an empty place of 3–4 cm on the left side of the page. The text cannot exceed 20 typewritten pages (including references and figures).

Front page (first page of the text) should comprise: a) title of the paper (concise but informative) with an empty space of 8 cm above it; b) full name(s) of the author(s); c) institution(s) and address(es) for each author or group of authors; d) text.

Footnotes should be numbered consequtively.

Citations in the text should include the name of the author and the publication year. Example: Ionescu (1970) or (Ionescu, 1970). For two authors: Ionescu, Popescu (1969) or (Ionescu, Popescu, 1969). For more than two authors: Ionescu et al. (1980) or (Ionescu et al., 1980). For papers which are in course of print the publication year will be replaced by "in press". Unpublished papers or reports will be cited in the text like the published ones.

Abstract, of maximum 20 lines (on separate sheet), must be in English, summarizing the main results and conclusions (not a simple listing of topics).

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Examples:

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Giuşcă, D. (1952) Contributions à l'étude cristallochimique des niobates. *An. Com. Geol.*, XXIII, p. 259–268, Bucureşti.

– , Pavelescu, L. (1954) Contribuţii la studiul mineralogic al zăcămîntului de la Muşca. *Comm. Acad. Rom.*, IV, 11–12, p. 658–991, Bucureşti.

b) special issues:

Strand, T. (1972) The Norwegian Caledonides. p. 1–20. In: Kulling, O., Strand, T. (eds.) Scandinavian Caledonides, 560 p., Interscience Publishers.

c) books:

Bălan, M. (1976) Zăcămintele manganifere de la Iacobeni. Ed. Acad. Rom., 132 p., Bucureşti.

d) maps:

Ionescu, I., Popescu, P., Georgescu, G. (1990) Geological Map of Romania, scale 1:50.000, sheet Cîmpulung. Inst. Geol. Geofiz., Bucureşti.

e) unpublished papers or reports:

Dumitrescu, D., Ionescu, I., Moldoveanu, M. (1987) Report. Arch. Inst. Geol. Geofiz., Bucureşti.

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