VIIIth CONGRESS OF THE REGIONAL COMMITTEE ON MEDITERRANEAN NEOGENE STRATIGRAPHY

VIIIth RCMNS CONGRESS

1985 HUNGARY

EXCURSION A1 (Pre-Congress)

GEODYNAMIC EVOLUTION OF INTRAMONTANE BASINS

NEOGENE STRATIGRAPHY IN NORTHERN HUNGARY AND IN BUDAPEST

10–14 September, 1985

FIELD GUIDE

HUNGARIAN GEOLOGICAL SURVEY

EXCURSION

A 1

/PRE-CONGRESS/

/Budapest - Eger - Miskolc - Tokaj - Rudabánya - Sámsonháza - Budapest - Tinnye - Budapest/

GEODYNAMIC EVOLUTION OF INTRAMONTANE BASINS. NEOGENE STRATIGRAPHY IN NORTHERN HUNGARY AND IN BUDAPEST

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F I E L D   G U I D E

Hungarian Geological Survey

Budapest

1985

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Készült a Magyar Állami Földtani Intézetben
IBM "kopierer" eljárással, munkaszám: 722-85
Példányszám: 400

CONTENTS

INTRODUCTION

/P. MÜLLER/

Excursion A/1 to N Hungary is to demonstrate the typical Hungarian representations of the Neogene and late Paleogene. The five-day itinerary of the bus trips leads from the NE part of Hungary to the vicinity of Budapest. On the first day the excursion participants will be shown Egerian formation developed in the SW part of the Bükk Mountains, at the strato-type localities of the Egerian stage. On the second day the Pannonian deposits occuring east of the Bükk and the most characteristic exposures of the Miocene volcanic complex of the Tokaj Mountains will be presented. In addition, the participants will be offered an opportunity to examine core samples, spanning from the Pleistocene to Karpatian interval, of an 1,500 m deep exploratory borehole drilled near the Slovakian border. On the third day the participants will be shown round and given in-formation on the rock sequence and geological setting of the Lower Miocene Borsod Coal Basin and they will pay a visit to the Pannonian exposure in the iron ore mine of Rudabánya that has yielded a rich mammal fauna and famous hominid finds. At Nekézseny, on the NW fringes of the Bükk Mountains, seashore deposits of Karpatian age will be presented. On the fourth day the participants will visit the Neogene rock sequence of the areas between the Mátra and Cserhát Mountains as exposed in outcrops and in two boreholes of considerable depth. These include marine, brackishwater, evaporitic and volcanic forma-tions. On the fifth day classic fossiliferous Badenian, Sarma-tian and Pannonian localities will be visited.

In the first two chapters of the Guidebook the major characteristics of Neogene sedimentation in Hungary have been briefly summarized with special emphasis on the North Hungarian facies and on the very thick and peculiar brackish-water Pannonian deposits that are important from both the scientific and economic points of view. These beds have yielded an endemic fauna that is unique from paleontological point of view. The information on each particular stop was written by the specialist dealing with the given area and a more detailed explanation will be given on the spot. For some of the exposures, the relevant description is the first account ever given of the site involved. Even in case of old exposures, however attempts have been made to include the new results. Some of the exposures are so-called key sections, i. e. types or points of reference concerning Hungarian formations. Their revision has been already partly completed, and partly, it is being carried out now. The itineary of the excursion is shown on the enclosed geological map on scale 1:500,000.

N HUNGARY IN THE LIGHT OF THE MIOCENE HISTORY OF HUNGARY

/G. HÁMOR/

Northern Hungary is an area with an extremely mobile basement and a diversified structural setting. In a broad overview, this means that this region is where the complete Paleo--Mesozoic sequence belonging to the Alpine megatectonic unit comes in contact /or in plate tectonic terms: converges/ with the intra-Carpathian Paleo-Mesozoic basement sequence that is discontinuous and thus completely different from the former.

It was above the mobile basement /partly as a result of the revival of older structural elements/ that the four Neogene orogenic cycles produced the structural systems in which the Miocene--Pliocene sedimentation took place.

Consequently, the N Hungarian Miocene is characterized by two essential features:

-- Hungary's most complete Miocene sequence can be found here

-- the complete lateral set of isochronous igneous, continental and marine facies can be identified.

The Hungarian Miocene deposits lie unconformably, with a break in sedimentation, on the Paleo-Mesozoic basement /S Hungary/ or they overlie peneconformably the late Paleogene /Oligocene/ deposits /N Hungary/. In the latter region, it is therefore difficult to draw a stratigraphic boundary biostratigraphically. To overcome this difficulty, an Oligomiocene transitional stage /Egerian/ has been used in the regional stratigraphic nomenclature of the Paratethyan region, though geologycally this represents the final regressive member of the Oligocene sedimentary cycle. In this stratigraphic scale, the Lower Miocene is represented by the Eggenburgian--Ottnangian (24--19 Ma by K/Ar method), the Middle Miocene is by the Karpatian--Lower to Middle Badenian (19--16 Ma by K/Ar method), the Upper Miocene by the Upper Badenian--Sarmatian--Pannonian (16--10 Ma K/Ar age).

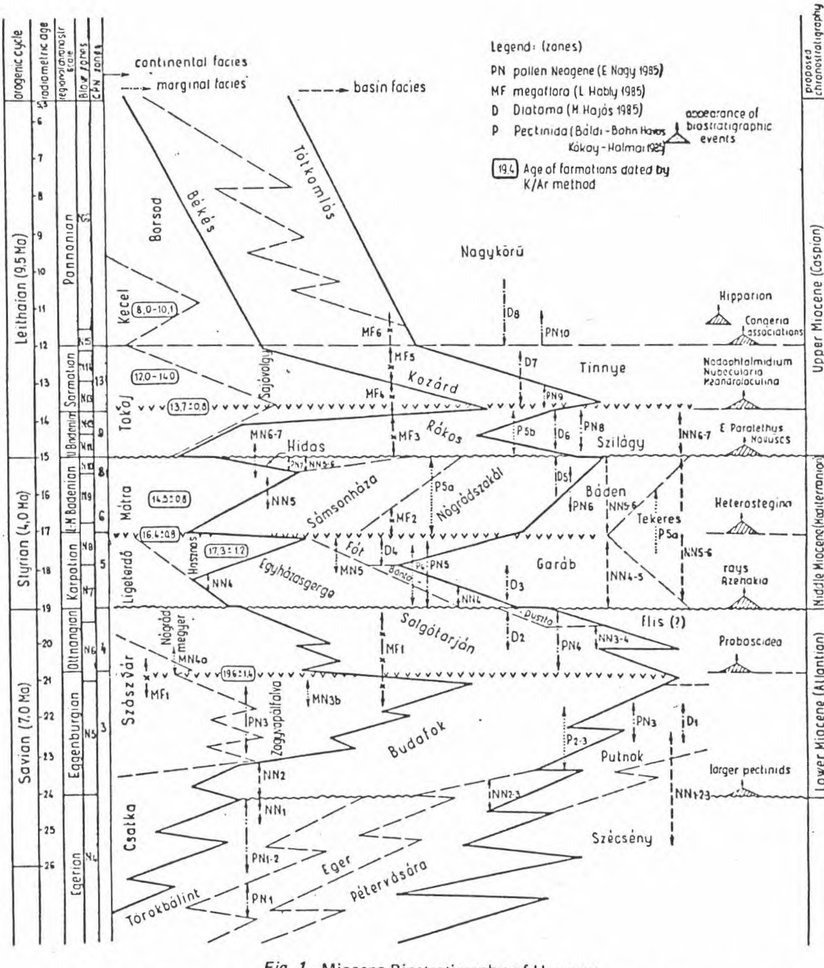

Fig. 1. Miocene Biostratigraphy of Hungary
(G. Hámor – T. Báldi – M. Bohn, Havas – L. Hably – M. Hajós – J. Halmai – J. Kókay – L. Kordos – I. Korecz, Laky – E. Nagy – A. Nagymarosi – L. Völgyi)

The Miocene is overlain by hundreds of metres of Pliocene /Fig. 1/.

The Lower Miocene formations form a complete geological cycle. The compressive subphase of the Savian orogenic phase during the Eggenburgian resulted in an uplift in the WSW of the Alpine background. At the same time, in its foreland /SW Hungary/, 1,000 m of continental, fluviatile coarse clastics and variegated clays were deposited /Szászvár- and Csatka Formations/. In NE Hungary, marine littoral sand and sandstone beds /Budafa Sandstone Formation, "Larger Pecten Beds"/ and openwater argillaceous deposits /Putnok Schlier Formation, 400 m thickness; NN2 zone/ were laid down as the isochronous facies counterparts of the former formations. Because of the intensification of the uplift of the background the sedimentary basin at the cycle's end was gradually filled up by deltaic and then by contiental-fluviatile gravel, sand and variegated clay deposits /Zagyvapálfalva Formation/. On one of the bedding surfaces, rich mammal, bird footprint and plant remains were preserved /Ipolytarnóc Beds/.

In the Ottnangian the sedimentary cycle had the same trend as in other sedimentary basins of identical paleogeographic position. The tension subphase of the Savian orogeny brought about new graben downfaultings, and rhyolite flood tuffs emerged along the marginal faults of these structures (Gyulakeszi Rhyolite Tuff Formation, 100-200 m thickness, 19.6 ± 1.4 Ma by K/Ar method). Above the basal clastics of the cyclothem, limnic /W Hungary/ and brackish-water, paralic /E Hungary/ browncoal seams were formed, respectively /Brennberg and Salgótarján Browncoal Formations/. The end of the cycle here is marked by continental fluvial accumulation.

During the Early Miocene the paleogeographic connections were oriented NW--SE, via the N Alpine molasse foreland--Vienna Basin--NE Hungary--Transylvania--Caucasus, with the mixing of marine Atlantic and Indopacific faunas.

The Middle Miocene also consist of two complete geological cycles. The sedimentary basin, however, is perpendicular to the preceding one: under the influence of the Styrian orogenic phases, with the downfaulting of the Dinarides, a direct communication with the Mediterranean Basin was opened up. The transgression progressed from the SW to the NE as far as the already uplifted Carpathians. The Karpatian sedimentary cycle is constituted by brackish-water basal beds (Congeria-, Oncophora /Rzehakia/ Beds), by 400 m of littoral conglomerate and sandstone /Ligeterdő-, Budafa- and Egyházasgerge Formations/, by a pelagic /openwater/ molasse sequence /Tekeres Formation, Garáb Schlier Formation, NN4 zone/ and by the cycle-terminating Bryozoan-Balanus-bearing reef formations /Fót Formation/ /a total of 1,000-1,500 m/.

The cycle's end is marked by local andesite- and nationwide rhyodacite tuff (Tar Dacite Tuff Formation, 16.4 $\pm$ 0.8 Ma, K/Ar method) volcanism.

The next, Early Badenian, cycle is characterized by repeated transgression, basal beds and open-water clays-claymarls /Baden Clay Formation, NN5 zone/, in the W by cycle-terminating brackish--water--palustrial browncoal /Hidas-, Várpalota- Browncoal Formations/, in the E by 3,000 m of regional andesite volcanics (Mátra Volcanics Formation, 14.5 $\pm$ 0.4 Ma by K/Ar method).

The Middle Miocene fauna is of Mediterranean character with a rich Pectinida, Uvigerina, Heterostegina and Lagenida fauna. The emergence at the cycle's end resulted in evaporites of lagoonal facies /E Slovakia, Transylvania/.

The Upper Miocene sequence was formed in one geological cycle. During the Leithaian orogenic phase, the Alpine-Carpathian range continued uplifting and--with the final emergence of the Dinarides--the Mediterranean connection of the Carpathian Basin were lost forever and at the same time new connection towards the Aralo-Caspian Basin came into existence.

The sedimentary cycle that followed the down-faulting of the Pannonian Basin is characterized by Upper Badenian, trans-gressive, unconformable, reefal "Leithakalk" /Rákos Formation/

and argillaceous deposits /NN6 zone/; the Sarmatian is by brackish-water coarse-grained limestones /Kozárd and Tinnye Formation/ and claymarls /a total of 300 m in thickness/ and the Pannonian--Pontian by brackish-water-lacustrine, intramontane molasse-like fine-sandy-argillaceous /1,500 m/ deposits. During the filling-up of the basin the Mediterranean marine fauna was replaced by brackish-water, Aralo-Caspian one and subsequently by an endemic Congeria--Melanopsis fauna. The products of the andesitic --rhyolitic volcanism that culminated in the Late Miocene, in the Sarmatian exceeded even a thickness of 2000 m in the NE part of the country /Tokaj Mountains, Nyírség/.

The tectonic character of the Miocene was determined by the afore-mentioned orogenic phases, but the present-day structural forms were brought about by the post-Pannonian Rhodanian orogenic phase. This has been responsible for the overwhelmingly NW--SE-oriented, block-faulted, graben-horst tectonics, i. e. for its various manifestations including slight folds in the basins and thrust-sheets in the marginal areas.

The geological excursion will touch the following geological units:

1/ the basin of the SW foreland of the Bükk Mountains (stops 1/a-b); the Pannonian formations of the zone, where the S mountain margin and the Great Hungarian Plain meet (Stop 2/a); the Lower Miocene formations of the Bükk's E foreland, the so-called "Borsod Basin" (Stop 3/b) and the Karpatian littoral basal formations of the NW margin (Stop 3/c).

2/ The Miocene volcanic complex of the Tokaj Mountains (Stop 2/b).

3/ The Pannonian prehominid locality of the Aggtelek--Rudabánya Mountains (Stop 3/a) and the Middle--Upper Miocene sequence of the foredeep depression extending well into the territory of E Slovakia (Stop 2/c).

4/ The complete Egerian--Miocene sequence of the Nógrád--Cserhát area (Stops 4/a, b).

5/ The Middle--Upper Miocene formations of the Pest Plain (Stops 5/a, b, c).

6/ The Sarmatian--Pannonian formations of the S margin of the Transdanubian Central Range (Stop 5/d).

Fig. 2. Extension of the Pannonian formations in the Carpathian Basin

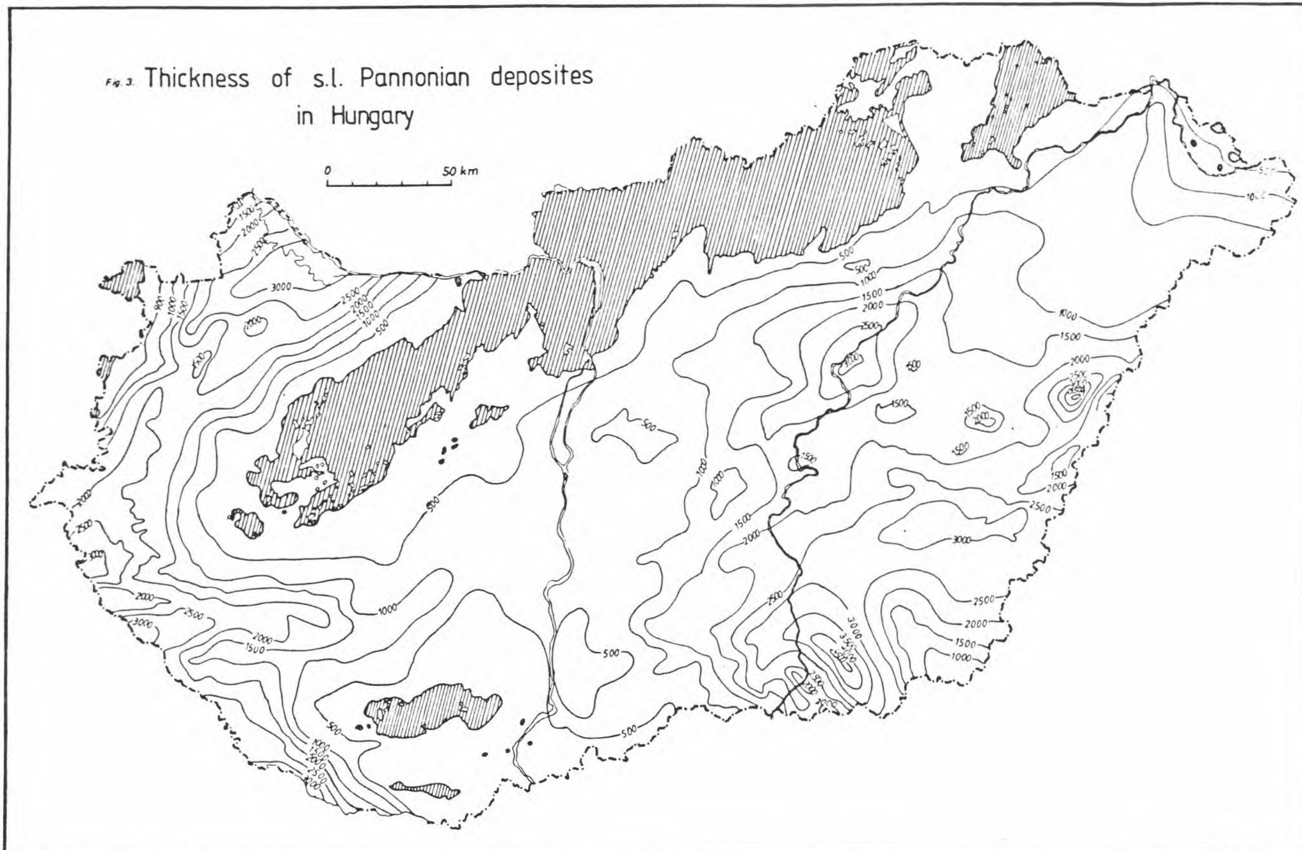
Fig. 3. Thickness of s.l. Pannonian deposites in Hungary
0
50 km
500
1000
1500
2000
2500
3000

GENERAL CHARACTERISTICS OF HUNGARY'S PANNONIAN S. L.

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Under Pannonian formations s. l., known traditionally from the literature, the thick, fine-clastic, brackish-water inland seawater sequence between the Carpathian Basin's Sarmatian and Pleistocene deposits are understood. Their extension is limited to the Pannonian basin system forming the central part of the Paratethys sea branch and to the Transylvanian Basin /Fig. 2/. Pannonian s. l. constitutes the last but one geological megacycle of the history of filling up of these basins. Here this megacycle took place in the time range of 11.6 and 1.8 Ma or possibly 11.6 and 2.4 Ma B. P., and was independent not only from the world ocean, but from the E Paratethyan sea branch as well. As a result of these processes the inland sea in the basin, that had been formed above the unstable basement of an area that lay between the African and Eurasian plates, gradually started to become a freshwater one and was filled up completely in spite of the fact that the basement had subsided maximum of 4,000 and of an 1,300 m as average, owing to the extension. Some fossils of the Pannonian deposits prove the temporary existence of restricted marine communication between the Central and E Paratethys.

The Pannonian s. l. formations in Hungary occur, over three-fourth of the country's area /about 75,000 km^2/, mostly beneath the Pleistocene. Only a few Paleo-Mesozoic inselbergs rise above the Late Cenozoic basin surface situated at present, as a consequence of Pleistocene movement, between 90 and 250 m a. s. l. Outcrops of Pannonian formations occur in basin margin areas and in the Transdanubian hilly country. Moreover, their geological features are known to us from thousands of deep hydrocarbon exploratory wells and shallow boreholes drilled in search for solid minerals and water resources as well as from hundreds of seismic logs.

Unaffected by tectonic deformation, the Pannonian s. l. basin fill has a total volume of about 95,000 km^3. Its thickness is extremely varied in spite of the small size of the basin, increasing quite rapidly or quite slowly, as one proceeds away from the margin of the inselbergs. The greatest thicknesses are found in the NE part of the Great Hungarian Plain /Fig. 3/.

The Pannonian s. l. sequence gradually develops out from the Sarmatian sequence underlying it. In some areas of comparatively higher position, the mode of superposition is paraconformable. In such cases the two sequences show the same dip and both are brackish-water deposits, usually argillaceous, and there is no indication that should suggest a break in sedimentation or terrestrial erosion. Detailed paleontological studies, however, have proved the absence of the Limnocardium praeponticum mollusc Oppel Zone as a whole, and that of the lower half of the Pleurozonaria ultima praeponticum dinoflagellate zone, respectively. This mode of superposition is interpreted as a result of synsedimentary or postsedimentary subaquatic erosion. The pre-Sarmatian formations are overlain by the Pannonian s. l. sequence unconformably, transgressively. On the basis of the results hitherto achieved , transgression in Pannonian time took place in three different stratigraphic horizons /middle and upper Lower Pannonian and lower Upper Pannonian/, and resulted in covering larger and larger areas.

The Pannonian s. l. sequence is overlain, over the overwhelming majority of the country, after manifestations of considerable terrestrial danudation, by an Upper and Middle Pleistocene periglacial sequence usually represented by fluviatile sands, gravels and loess which show a slightly different dip. Above the deepest basin portions, the Pleistocene rock sequence is complete, evolving with no hiatus from the Pannonian and being represented by a fluviolacustrine facies similar to the deposits lying immediately underneath, regardless of whether the 2.4 Ma date or the 1.8 Ma date be regarded as an age boundary.

As suggested by the above results the bottom of the Pannonian Basin system must have been heavily dissected and rough, the greatest contemporaneous water depth occurred in what are now the deepest depressions /Makó Graben, Békés Depression, Little Hungarian Plain, etc./ and the maxima may have exceeded even the 500 m figure. This inland sea basin of considerable size was filled up by sediments deposited in a deltaic sedimentary regime which came into existence basically at the middle of the Lower Pannonian and which revived an expanded extensively in earliest Late Pannonian time. The major elements of this regime included: a water household that had become strikingly positive as a result of a climatic change in earliest Pannonian period, a salinity that was reduced after showing seasonal fluctuations for quite a long time prior to the reduction, and the resulting added selectivity that affected the bios of the inland sea /small Limnocardium faunas/. At that time the argillaceous-calcareous sedimentation coupled with accumulation of thin rhyolite tuff strings took place in the basin depressions. In middle Lower Pannonian the source areas were uplifted and a remarkable drainage system was formed. The basin was affected by heavy subsidence which proceeded at different rates in different parts of the basin. That was the time when the first delta system came into being in which slope-base and slope environments prevailed, delta plain facies being known at present only in the E part of N Hungary. Around the swells, seamounts and inselbergs within the basin, extensive sandy-gravelly abraded shore environments, and argillaceous-diatom-rich lagoonal environments evolved. At the same time, on the areas of what are now the Danube-Tisza Interfluve and the Little Hungarian Plain subaquatic and subaerial volcanic processes went on, basaltic in the first case and trachytic in the second. The second large delta system was formed in earliest Upper Pannonian /Pontian/ time.

With the progress of time, the delta plain environments came more and more into prominence and eventually, once completely filled up, the Pannonian basin system developed into a lowland characterized by fluvio-lacustrine sedimentation.

Simultaneously with the birth of the second delta system, in Transdanubia and N Hungary, a basaltic volcanism linked to more than a hundred independent eruption centres took place. In this area the volcanic activity continued in Pleistocene too.

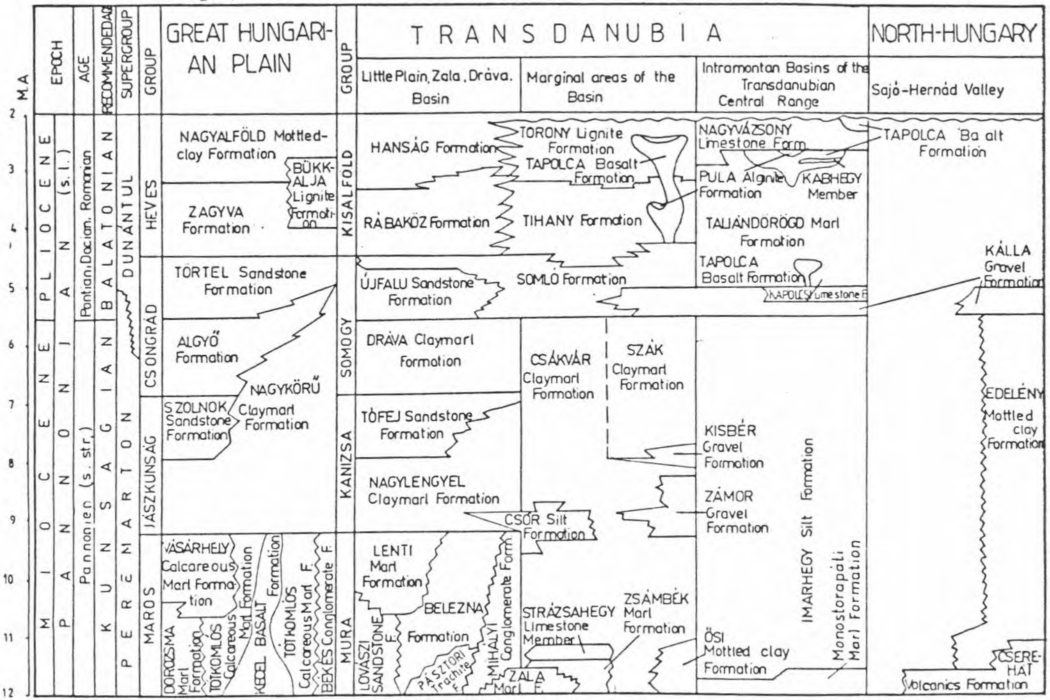
The stratigraphic classification schemes of the Pannonian are presented in Fig. 4 and 5 . Lithostratigraphically, the Pannonian sequence is bipartite. In accordance with earlier practice, the lower, overwhelmingly argillaceous part is called the Peremarton Supergroup, the upper one the Dunántúl Supergroup. The lower part of the Peremarton Supergroup is constituted by marls and calcareous marls, the upper one by claymarls, but both contain sandy and gravelly intercalations.

The Dunántul Supergroup is made up of frequently alternating sands /40--50%/, claymarls-clays /45--58%/, subordinately carbonaceous clays and lignites. The individual formations have been selected according to the characteristics offerred by the main facies areas and facies units.

At present already nine different fossil groups can be used for the biostratigraphic subdivision /Fig.5/ these the Mollusca, Ostracoda and microplankton records are the best tools for the calibration of the basin marginal sequences, though the evaluation of the thick central basin sequences is the scarcity of fossils due to water depth and the concomitant worse conditions for preservation. The vertebrate, nannoplankton, Foraminifera, Thecomoeba, Diatoma, spore-pollen and trace fossil remains frequently provide a valuable support to the stratigraphic assignation of particular rock sequences, but their use could not have become universal owing to the special conditions of occurrence of the fossils involved.

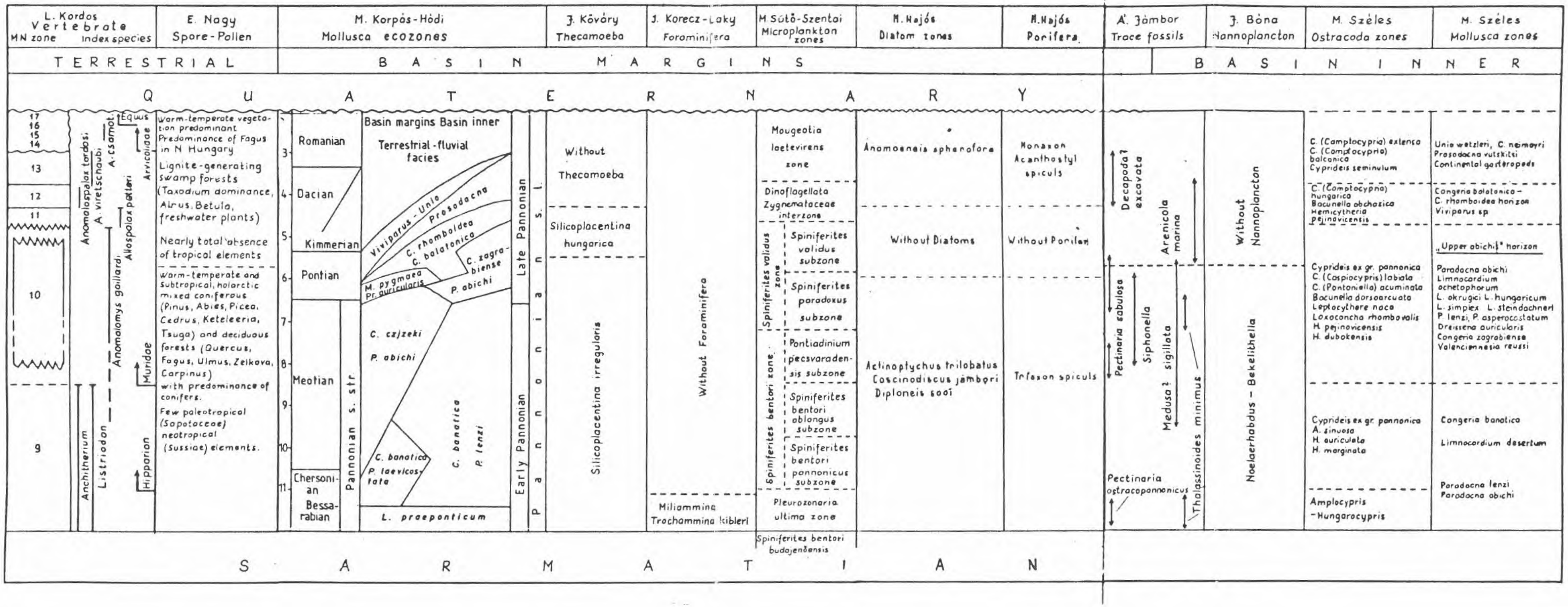
Lithostratigraphical Classification of the Pannonian s.l. Formations in Hungary

Fig. 4.



BIOSTRATIGRAPHIC SUBDIVISION OF PANNONIAN SEQUENCES

Fig. 5.



In basin centre areas, well-logging markers, seismic logs and sedimentation trend analysis have also proved quite handy tools for the stratigraphic assessment of the Pannonian s. l. sequence. However, there are marked controversies between correlations offerred by the various stratigraphic methods and approaches.

The Pannonian sequence is one of the nation's most important formation from the point of view of mineral exploration. It contains the overwhelming bulk of the nation's oil and natural gas resources. The formation includes considerable reserves of lignite, potable water and thermal water, too. Among the nonmetallic mineral raw materials, minerals like bentonite, oil-shale, kaolinite and building raw materials /clay, sand, gravel/ are worth mentioning.

Pannonian s. l. formations are rather widespread in the areas to be visited by this excursion, too. The Zagyva Graben is to be regarded as an extension of the vast Great Plain depression, whereas the deposits of the minor mountain marginal and intramontane basins will be available for studying at a number of stop for excursion participants.

1ST DAY

STOP 1.

OPEN-PITS OF THE "THOREZ" MINES /PONTIAN/

/L. MADAI/

The area of the "Thorez" open-pits of the Mátraalja Collieries covers those parts of the Mátraalja lignite-fields which are situated between the villages of Abasár, Visonta, Halmajugra, Det, Domoszló and Markaz.

Geology

The coal-bearing complex exposed by the open-pit is the youngest member of the Pontian succession the thickness of which increases gradually from the foothills of the Mátra Range towards the Great Hungarian Plain. The majority of the succession is built up of freshwater sediments with afternating loose sands, clays and linite-seams. They have a gentle dip of about 2 to 3 degrees to the Southeast /towards the Plain/. Along the borders of the Mátra Range they are unconformably overlain by the terrestriál--fluviatile sediments of the Pleistocene. At places also the contact of the lower horizons /likewise unconformable/ with the Mátra andesites can be recognized.

During the exploration the lignite-seams were numbered from top to bottom. The numbering of the sandy intercalations between the deposits is adjusted to the numbering of the coal-seams concerned. There are seven industrial-grade coal-seams exposed within the area of the "Thorez" open-cast mine.

The thickness of the coal-seams is rather variegated: figures from 1 to 2 m up to 10 to 15 m are equally frequent with an average thickness of about 4 to 6 m /see Fig. 17/.

The depth of the coal-seams increases to the SSE; they wedge out towards the basin or get pinched into several small seams of uneconomic thickness. Not all seven coal-seams are present over the entire area of the open-pit. At any given place usually only three of four of them can be worked at the same time. The thickness of the coverbeds is about 20 m along the northwestern face of the open-pit. It increases to the Southeast, thus at the southeastern boundary it reaches even 80 to 100 m.

STOP 2

EGER, WIND'S BRICKYARD

/T. BÁLDI/

Located in the SE outskirts of Eger, it is the stratotype of the Egerian stage. The sequence is built up of deeper and shallow marine sublittoral terrigenous sediments with brackish intercalations in the upper part. The layers dip to the S and are gently tilted /30^{o}/. /Fig. 6, 7/.

The underlying Kiscell Clay of Kiscellian age /Middle Oligocene, nannozone NP 24/ is not cropping out in the clay pit, it is known only from core-holes. The Egerian grades out of the Kiscell Clay without hiatus.

The 140 m thick Egerian sequence can be divided into four members.

The lowermost one, lying upon the Kiscell Clay, is a glauconitic, tuffaceous sandstone and sandy marl of 18 m thickness with sporadic occurrence of Pectinids /P. burdigalensis/, solitary corals, shark teeth. The nanno-flora indicates still NP 24, then the Kiscellian /Egerian boundary lies within this zone. The K/Ar date of the glauconite is controversial.

The next member upwards is the so called molluscan clay /48 m thick/, which is exploited for the brick factory. It is rich in micro- and mesofauna. Planctonic and benthic foraminifera, deep sublittoral molluscs are abundant. In its lower part sporadic occurence of Miogypsina formosensis has been recorded.

The molluscan clay is overlain by an alternating succession of clay and sandstone /15 m/. Some of the sandstone beds /"x" and "k" layers/ contain classic, shallow marine mollusc fauna of Eger, described for the first time by K. Telegdi Roth in 1914. This part of the section is already NP 25. Both the micro- and mollusc fauna indicate a Late Oligocene age, though some

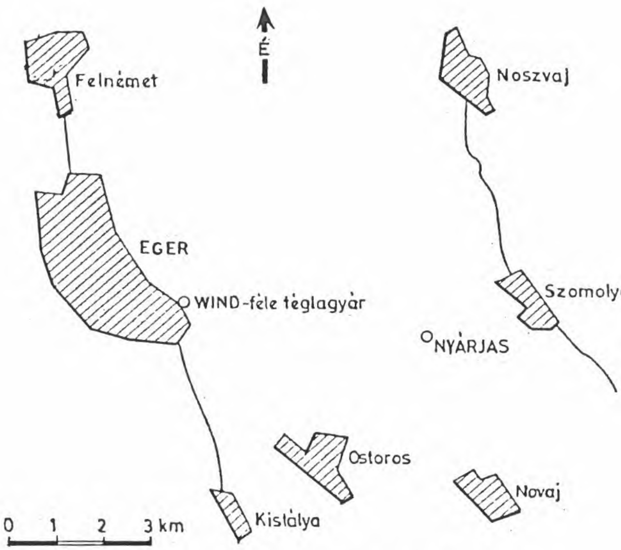


Fig. 6. Map sketch of the Eger and Novaj area

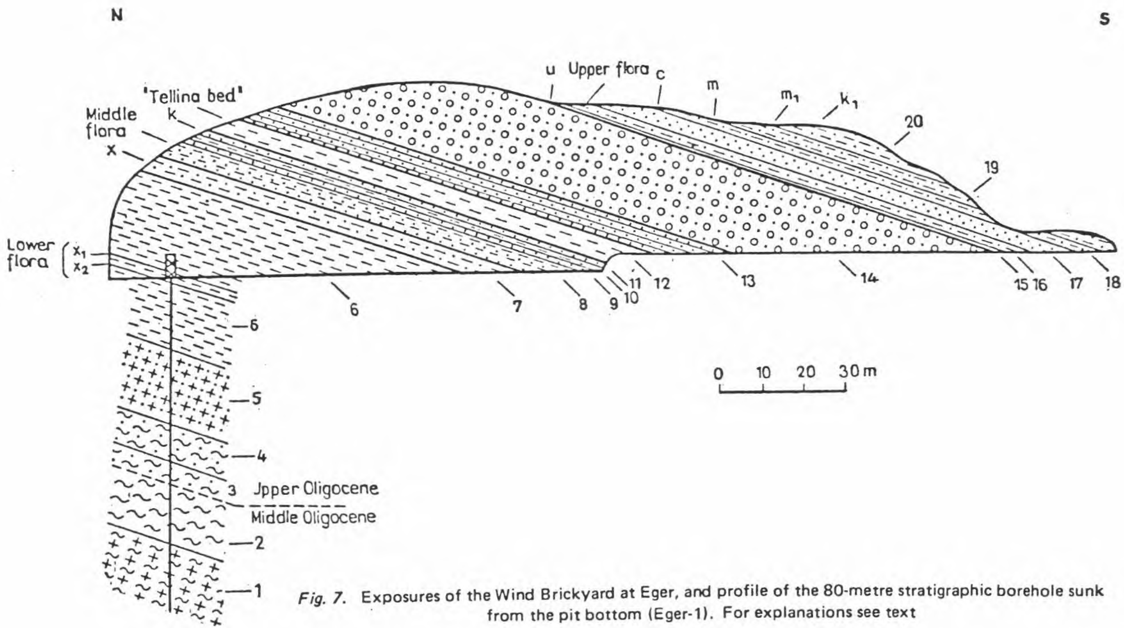


Fig. 7. Exposures of the Wind Brickyard at Eger, and profile of the 80-metre stratigraphic borehole sunk from the pit bottom (Eger-1). For explanations see text

Miocene taxa are present too.

The topmost part consist of sand-bar and lagoonal deposits, with brackish mollusc fauna. Freshwater and marine intercalations were also recorded. Thin brown coal lenses also crop out. The famous flora of Eger: leaf-imprints /"upper flora"/ were found in some clayey intercalations of this member.

The whole Egerian section is overlain uncomformably by a non-layered rhyolite tuff of 21 Ma age.
Vine cellars have been cut in this Late Eggenburgian Ottnangian tuff.

STOP 3

NOVAJ, NYÁRJAS

/T. BÁLDI/

Cropping out in abandoned vine-yards, the Novaj, Nyárjas site is one of the "faciostrato-types" of the Egerian. The locality lies less than 10 km E of Wind's brickyard of Eger. Therefore the available part of the section is rather similar to its counterpart in Eger /Fig. 8/.

The lowermost member of the sequence here is the Kiscell Clay which crops out in 5 m thickness. Clay and bentonitic clay, rich in Foraminifera, represent this formation of Kiscellian age.

The uncovered Egerian sequence is scarcely 10 m thick.

Glauconitic, tuffaceous sandstones of 2.5 m thickness lie on the Kiscell Clay. There is a rather sharp and distinct transition. The glauconitic sandstone yields a poorly preserved, but rich, Late Oligocene Mollusca and an ahermatypical coral fauna and sporadically, also Heterostegina and Lepidocyclina. The nannoflora is indicative of the NP 24 zone.

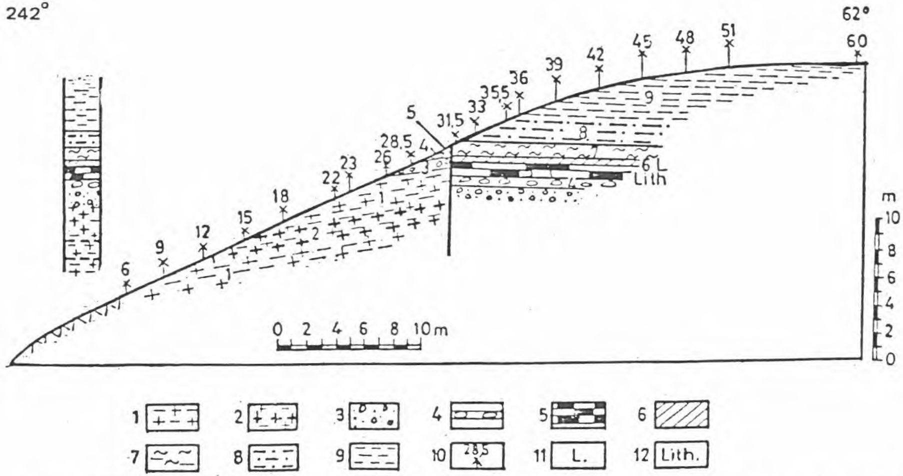
0.3 m thick oil-grey marl full of Lepidocyclina

1.0 m thick lithothamnian limestone

3.0 m of glauconitic, silty marl, silty sandstone with Miogypsina septentrionalis, Miogypsina formosensis, Lepidocyclina, Heterostegina, Operculina, solitary corals in large quantity, and with sporadic pectinids.

5.0 m of molluscan clay, similar to the one cropping out in Eger. A rich planktonic foraminiferal fauna and a deep-sublittoral, possibly shallow-bathyal Mollusca fauna can be found. Nannozones NP 24-25 are present here, as suggested by a latest revision by M. B.-Beke.

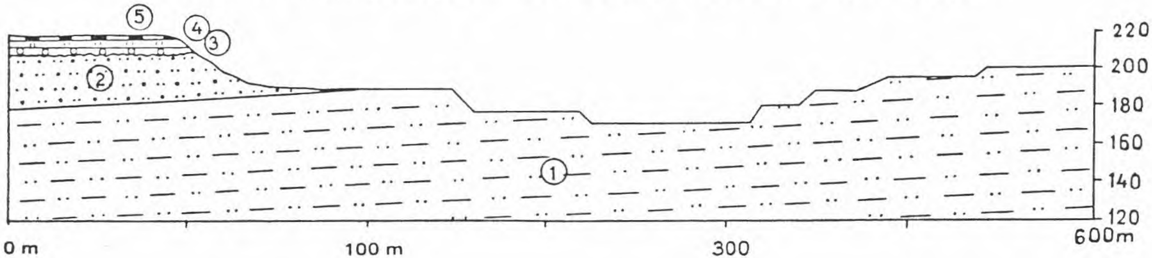
The higher part of the section is too deepley covered by Quaternary and talus deposits. As shown by earlier observations, the facies succession is the same as in Wind's brickyard of Eger. Also here, the Lower Miocene Rhyolite Tuff lies unconformably on the Egerian sequence.



L e g e n d: 1. Tuffaceous clay (Kiscell clay), 2. Bentonitized tuff intercalation, 3. Coarse glauconitic sandstone sporadically with quartzite gravels and volcanic bombs, 4. Oil-grey Lepidocyclina marl, 5. Lithothamnian limestone, 6. Lepidocyclina limestone, 7. Marly-clayey glauconitic silt with Miogypsina, 8. Clayey, glauconitic fine-sandstone, 9. Molluscan clay, 10. Sampling points, 11. Lepidocyclina, 12. Lithothamnium (1–2. Kiscellian, 3–9. Egerian)

Fig. 8. The Novaj (Nyárjas) profiel on the basis of the ditch made in 1972

Fig. 9. Schematical geological section of the brickyard clay pit of Mályi M = 1:2000



L e g e n d: 1. Bluish-grey argillaceous molluscan silt (Peremarton Supergroup), 2. Yellowish-white, fine-grained, silty quartz sand (Dunántúl Formation), 3. Grey small-grained gravel, 4. Vivid-red clay, 5. Redbrown clay (3–5. Lo er Pleistocene)

2ND DAY

STOP 1

MÁLYI

/Á. JÁMBOR/

The clay pit of the brickyard of Mályi is located on the W side of the so-called Sajó Gate, between the Bükk and Tokaj Mountains, at the SE foothills of the Bükk Mountains. The Neogene sequence dips here rather steeply /at 10^{o}/ owing to the diapir-like uplift of the Bükk Mountains in the Pleistocene. Beneath the 10 to 50 m thick Pleistocene fluviatile alluvial fan of the Sajó Gate, however, the Pannonian beds are almost horizontal, dipping only 0--2^{o}.

The section can be split up into five parts /Fig. 9/.

1. The thickest, basal part, is represented by bluish-grey claymarls assignable to the Peremarton Super group /earlier referred to as Lower Pannonian formations/, showing rather good agreement with its overall basin marginal facies. This formation dips S at 8--10^{o}. Its total thickness, as counted from the floor of the Sajó Valley, is estimated to 100 m but only the uppermost 21 m are now available for study. This 21 m interval consists overwhelmingly of bluish-grey molluscan claymarls. The sequence is wellstratified. Composed of 50 to 250 cm thick layers of bluish-grey claymarl of laminated-conchoidal jointing, the sequence under consideration is interrupted by 5 to 15 cm thick, brownish-grey more carbonate-rich claymarl to marl layers, by 5 to 15 cm thick and 10 to 15 m long mollusc-lumachelle /Dreissena auricularis/ lenses and, in the uppermost seven metres, by three 5 to 15 cm thick silty fine sand intercalations.

In the upper part of the claymarl section, 5 to 15 cm thick and 20 to 50 cm wide, lenticular hard limestone concretions were occasionally also observed.

The bluish-grey claymarl beds are lithologically rather monotonous. The silt fraction is 40--70%, the clay fraction is 30--40%, while the sand fraction is 0.0--5%. Some of the sand grains are not "real sand", but are composed of bacterio-pyrite and mollusc shell fragments. Among the allothigenic grains the predominant role is played by quartz, to be follo-wed in importance by the micas /muscovite, shlorite/ and then by feldspar.

In the argillaceous fraction the most frequent clay mineral is illite, it is followed by chlorite and then by smectite and montmorillonite. Quartz and feldspar are present in considerable amounts, too.

Among the autigenic /interformational/ components, the amount of $CaCO_3$ is about 20%, and that of the /iron-containing/ dolomite is about 10%.

The bluish-grey claymarl sequence is abundantly fossili-ferous. In general, dispersed mono-valves distributed accord-ing to stratification are observable, though shell fragments are also frequent. Double-valved Limnocardium remains occur less frequently. Specimens fossilized in their original position are scarcely observable.

Both Lower and Upper Pannonian forms occur in the Mollusca fauna and there is no differentiation as far as their vertical distribution is concerned. On the one hand, younger forms occur in the deeper horizons as well, on the other hand, older forms are not restricted to these horizons. The fauna is not yet elaborated in detail. Rather frequent forms are:

Lymnocardium penslii Fuchs
Lymnocardium schmidti M. Hörnes
Congeria czjzeki M. Hörnes
Dreissena auricularis Fuchs
Congeria hoernesi Brus.

The Ostracoda fauna of the bluish-grey claymarls is abundant too, but its elaboration is still to be done.

The microplankton flora and the spore-pollen remains were studied by M. Sütő-Szentai /OFKFV, Komló/ in 1980. As she pointed out, these beds belong to the Spiniferites validus Zone and are rich in both Dinoflagellata and spore-pollen remains.

The afore-mentioned claymarl is overlain by 300--120 cm of layered sand. The real thickness of this formation is unknown, because it is unconformably overlain by a Pleistocene sequence. Its exposed thickness at present is about 11 m. It is dipping SE at 8--10^{0}, similarly to the case of the underlying bluish-grey claymarl. Although it is quite distinct from the underlying rock, the contact between the two is essentially a transition with an alternation of strata.

The sand is fine- to small-grained, silty, wellsorted, scarcely calcareous. In spite of its fine grain size, it is very poor in both mica minerals and feldspar. The overwhelming majority of the grains is composed of metamorphic quartz. As shown by general experience, these quartz-rich sands are produced, as a result of early diagenetic processes, by the alternating acidic--alkaline chemism of the formation waters and by repeated intraformational redeposition. Lithostratigraphically, they can be identified quite convincingly with the Kálla Sand Formation that represents, as it is here the case, too, the basal formation of the Dunántúl Supergroup /= Upper Pannonian as referred to earlier/.

The sequence is devoid of megafossils. Its rather poor microfauna makes it belong to the Spiniferites validus Zone in quite a convincing way. Thus the most significant lithostratigraphic boundary of the Pannonian s. l. sequence does not coincide with the most significant microplankton boundary /= Spiniferites bentori/S. validus/ here either.

The Pannonian s. l. in this profile is overlain by Pleistocene deposits including three types of formations: 3. terrace gravel, 4. red clay, 5. redbrown clay.

3. In the SW corner of the 4 horizons worked in the brickyard clay pit, at an altitude of 212 m or so, grey fluviatile terrace gravels are exposed in a total thickness

of about 1 m. They overlie, with a quite distinct erosional unconformity, the underlying Kálla Formation. Granulometrically, the sediment is evenly sorted, its pebbles varying between 2 and 40 mm in diameter, the grains of 8--11 mm size being the most frequent. They are composed for the most part of white or pale-grey quartz /80--90%/. Grains consisting of dark grey and red quartz and ones constituted by brown chert occur, too.

While the former are excellently to well rounded, the grains of the last-mentioned rock type are scarcely or very weakly rounded or completely angular.

The origin of the terrace gravel is not known exactly. Its well-rounded quartz matter probably derives from the erosion of a coarser facies of the Kálla Formation, the brown cherts may derive from the Bükk Mountains. This means that a minor tributary of the Sajó River entering the river from the NW rather than the main stream was responsible for the accumulation of the gravel which was deposited still in the Lower Pleistocene. There is no fossil record that should be diagnostic of its age, but the underlying rock and the relation of the gravel to it, and the Lower Pleistocene red clay overlying it, testifies to its belonging to the Kisláng Formation.

4. The terrace gravel or, on the NW side of the exposure, the Kálla Formation is overlain by vivid-red Lower Pleistocene clay of about 5 m thickness. These deposits here were not analyzed for their mineralogical-petrographical-composition, but they are rich in fire-clay and are stained with hydrohematite-limonite: these can be considered quite general features. The rock is unfossiliferous. Assigned to the Tengelic Formation, it represents the oldest part of the Lower Pleistocene as developed on the mountain margins.

5. The youngest bed of the exposure here is 1.5 to 3.0 m of reddish brown Pleistocene clay which, in this profile, is the afore-mentioned red clay, overlying the bluish-grey clay-marl of both the Kálla Formation and the Peremarton Super-group. Its age is Lower or Middle Pleistocene. The uppermost few decimetres were affected by humification in Holocene time.

STOP 2

MÁD, RÁTKA, TOKAJ

MIOCENE VOLCANISM IN THE TOKAJ MOUNTAINS

/P. GYARMATI, E. MÁTYÁS/

In the Neogene rock sequence three volcanic megarythms can be identified. These are connected with the Styrian, Attic I, Attic II orogenic maxima. The volcanic activity in the Badenian was exclusively subaquatic, whereas a considerable part of the Late Sarmatian–Pannonian activity took already place under subaerial conditions. The maximum of the volcanic aftermath and the bulk of the resulting mineral deposits are linked to the Late Sarmatian volcanic megarythm. In the Rátka--Mád area the products of the last Neogene, i. e. Upper Sarmatian--Pannonian volcanic activity are exposed as a result of puedmont erosion and tectonic movements. The pyroclastics of the initial,acid explosion activity are assignable to four explosion horizons /I--IV/ /Fig. 10/. The subaquatic pyroclastics of the IInd and IIIrd explosion horizons are zeolitized /zeolite deposits /. The terrestrial eruptions of the IVth and partly also of the IIIrd explosion horizons produced unconsolidated, pumiceous pyroclastics /pumicite/.

The pyroclastics on the mountain's fringes are capped by rhyolite /perlite/ bodies. E of Mád village terrestrial postvolcanic areas /solfataras, fumaroles/ developed and produced zoned hydroquartzite and siliceous kaolin deposits along active faults in the pyroclastics of the youngest explosion horizon /No V/ /Mád--Királyhegy mine pit, Fig.10 . NW of Mád, in the vicinity of Rátka village, a shallow-water limnic basin came into being in the Upper Sarmatian. The basin-filling deposits are underlain by andesite lava flows.

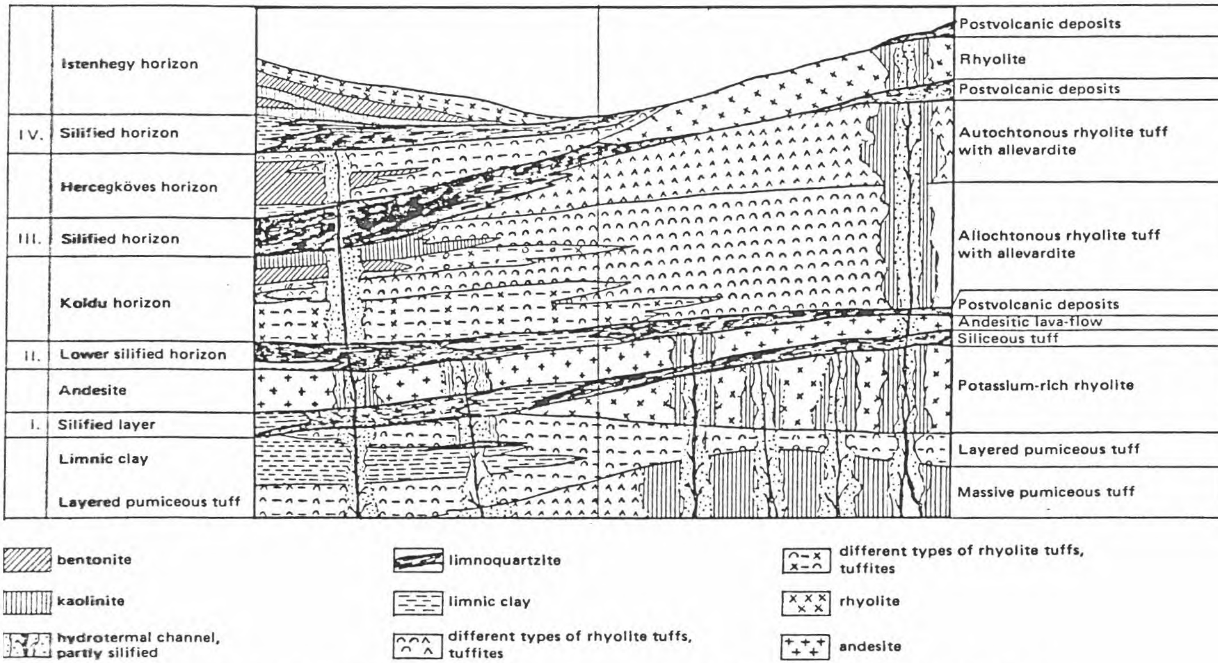


Fig. 10. Palaeogeographic relationship of Sarmatian–Pannonian coastal and basin deposits in the Tokaj-Mountains

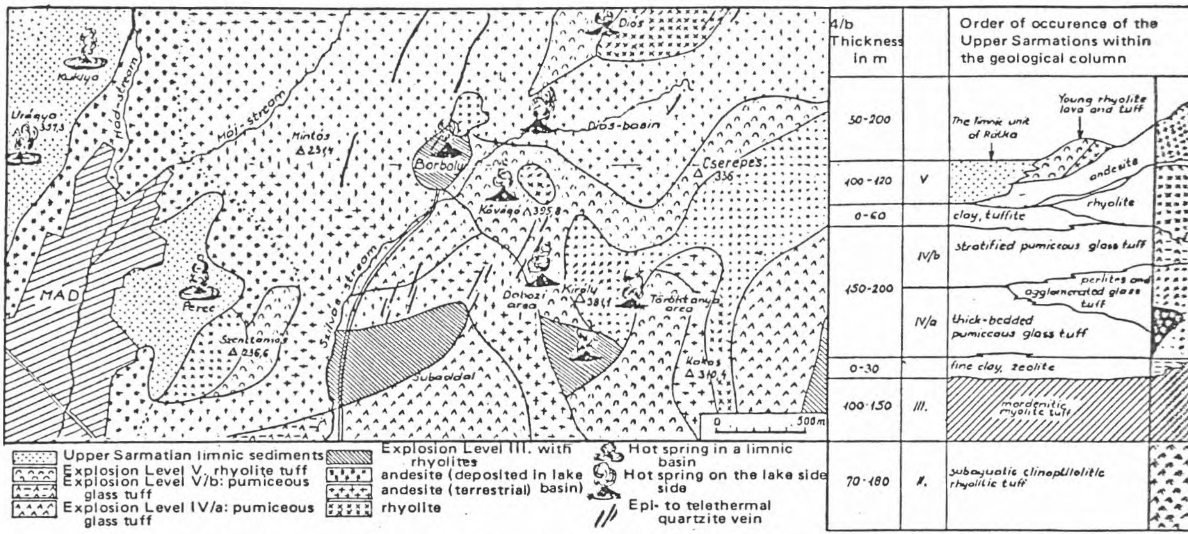


Fig. 11. The extended geological environment is represented by Sarmatian–Pannonian volcanic and post-volcanic products

Simultaneously with the deposition of the volcanictes syngenetic accumulation of explosional pumice took also place in the basin. The subaquatic thermal spring manifestations of the volcanic aftermath revived four times within the 100 m thick sedimentary sequence of the basin fill. The intensity maxima are marked by limnoquartzite horizons. In the intervals among the hydrothermal activity maxima hydrothermal argillization took place in the liquid muds of the basin bottom. In the central part of the subaquatic thermal spring centres limnoquartzite deposits were formed, in the horizons in between and mainly on the gringes of the centres kaoliniferous and bentonitic high-grade clay deposits came into being. The quartzite or kaolin and bentonite mining industries in the basin are based on these deposits /Fig.10/.

STOP 3

TOKAJ, PATKÓ QUARRY

/ P. GYARMATI, E. MÁTYÁS/

The pyroxene dacite cone of Kopasz-Hill at Tokaj, separated from the main body of the Tokaj Mountains, rises abruptly like a spine from the flat surface of the Great Hungarian Plain and stands in geologically alien surroundings. One of its finest exposures is the Patkó quarry near the village, at the confluence of the rivers Bodrog and Tisza.

The light grey, porphyritic pyroxene dacite of laminated jointing is covered by a thick loess blanket. The grain size distribution of the dacite is as follows: crystal grains or groundmass smaller than 10 u, 70--75%; small phenocrysts /10--1,000 u/, 15--18%; large phenocrysts /over 1,000 u/, 10--12%. The mineralogical composition is a follows: twinned, zoned, xenomorphic plagioclase /An 20--30/ full of inclusions, 15--17%; augite, 2--3%; hypersthene, 2--3%; magmatically resorbed quartz, up to 1%. As in the acid pyroxene andesite that predominates in the Tokaj Mountains, nodules made up of unzoned basic plagioclase and pyroxene of diabase texture are typical of this rock, too; these may be regarded as the nodules of minerals of intratelluric origin, representing "cognate inclusions". Of similar origin are the "diorite-porphyric" inclusions with an intersertal texture, often as large as 5--10 cm, that occur quite frequently in this quarry.

A striking feature of this rock is a light pink veining parallel to the lamination; the veins consist of 80--85% calcite, 10--15% tridymite, with some cristobalite, oligoclase, sericite, montmorillonite and chlorite.

These "veins" are deflected around larger inclusions,showing that they are lamellar slips that developed quite early, when the lava was still plastic. They were referred to as "Venen" by Philipp /1936/.

STOP 4

BOREHOLE HIDASNÉMETI-1

/M. BOHN-HAVAS, I. JANKOVICH, Á. JÁMBOR, I. KORECZ-LAKY, L. BARANYAI/

For practical reasons, the material of borehole Hidasnémeti-1 will be presented at Rátka, though the borehole site is located not too far away from the Slovak border, near the Tokaj Mountains which is visited on the second day of the excursion. Cored continuously down to a depth of 1,539.0 m, it was drilled at a distance of 200 m north of Hidasnémeti village. The drill intersected the Neogene sequence shown on Fig. 12. The significance of this sequence can be summarized as follows:

a/ On the basis of its geological features, it fits very well the Neogene profiles of the neighbourhood.

b/ The thickness of the Middle Rhyolite Tuff is remarkably reduced /only 120 m/, in spite of the closeness of the volcanic mass of the Tokaj Mountains.

c/ Its Badenian sequence is made up of characteristic central basin deposits of overwhelmingly marine facies, coarser at the base and finer higher in the section, but in the middle part, the presence of manifestations of the Wieliczka regression with brackish-water and terrestrial beds can be identified.

d/ Its Sarmatian sequence is the thickest of all ever discovered in this country, attaining a total of 977 m in thickness. Its lower part is represented by brackish-water marine sandy claymarls corresponding to the Carpathian Basin average, but its upper part is composed of fluviatile-lacustrine sand, gravel and clay beds testifying to heavy regression with an accumulation regime. Its lower part includes two rhyolite tuff /upper rhyolite tuff, Galgavölgy Rhyolite Tuff Formation/ intercalations.

e/ The Lower Pannonian sequence begins with 12 m of pumice-rich rhyolite tuff /the so-called uppermost rhyolite tuff/.

f/ Reduced to a thickness of only 8 m, the fluviatile Pleistocene beds overlie unconformably the Lower Pannonian beds.

1. The Karpatian schlier /Garáb Schlier Formation/ was intersected in a thickness of 45.6 m between 1,599.0 and 1,493.4 m. The underlying formation was not hit. The schlier is overlain by the Middle Rhyolite Tuff /= Tar Dacite Tuff Formation/.

2. Spanning the 1,372.7--1,493.4 m interval, the Middle Rhyolite Tuff /Tar Dacite Tuff Formation/ is represented by diversified products of repeated explosions and eruptions and volcanoclastic deposits in between.

Enclosed between dacitic effusive rocks, the rhyolite tuff is indicative of two volcanic centres that were active at the same time and that supplied materials of different chemical composition.

Some rock types of the volcanic sequence were dated by K/Ar method /E. Árva-Sós, Z. Pécskay and Dr. Kadosa Balogh, ATOMKI, Debrecen/. Obtained for separated biotite, an age of 14.0 $\pm$ 0.8 Ma was determined. The data indicate Badenian age. However, no explanation for the values substantially postdating the Middle Rhyolite Tuff sequence hitherto investigated has been found so far.

3. The Lower Badenian sequence /= Abony Formation/ was intersected in a thickness of 87.7 m in the 1,372.7--1,285.0 m interval.

4. The Middle Badenian sequence /= Hidas Browcoal Formation/ was intersected in a thickness of 88.8 m in the 1,285.0--1,196.2 m interval. The sequence has a rough erosion surface at its bottom.

Towards the Upper Badenian the sequence is closed by a 90 cm thick dolomitic limestone layer in which there are already marine faunal elements /Cardium, Hydrobia and Decapoda in fragments/.

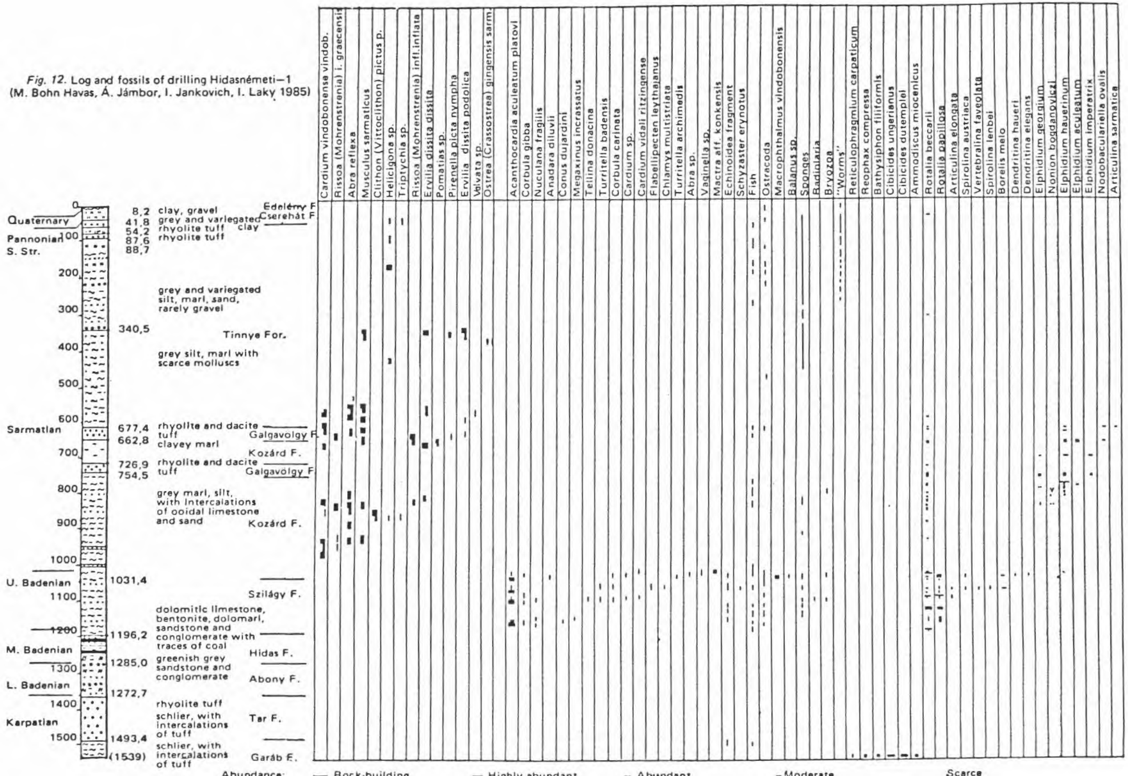


Fig. 12. Log and fossils of drilling Hidasnémeti–1 (M. Bohn Havas, Á. Jámbor, I. Jankovich, I. Laky 1985)

5. The Upper Badenian sequence /= Szilágy Claymarl Formation/ was intersected in a thickness of 164.8 m in the interval of 1,196.2--1,031.4 m. The faunal assemblage of the fine-grained sandstone intersected in the 1,034.7--1,035.5 m interval is characterized by small Cardium, Abra and Mactra aff. konkensis specimens accompanying Acanthocardia vidalense ritzingense. This assemblage is indicative of a shallow-sublittoral environment of more reduced depth, as compared to the former. Here, however, there are already forms which suggest a slight reduction in salinity.

6. The Lower Sarmatian sequence /= Kozárd Formation, Galgavölgy Rhyolite Tuff Formation/ was intersected in the 1,031.4--755.0 and 726.9--662.8 m intervals. The Galgavölgy Rhyolite Tuff Formation in the Lower Sarmatian sequence is represented by the 755.0--726.9 and 662.8--627.4 m intervals. Lithologically, the sequence is composed of about 70% of dacite tuff and of about 10% of limestone, rhyolite tuff, and claymarl and silt, respectively.

7. The Upper Sarmatian sequence was intersected /= Tinnye Formation/ in a thickness of 573.2 m between 627.4 and 54.2 m. It develops with an abrupt change from the underlying rock. From the overlying dacite tuff sequence it is separated by a very rough limonitized surface.

8. The lower boundary of the Pannonian was drawn, in accordance with the former practice, at the base of the "uppermost rhyolite tuff" in the geological profile of borehole Hidasnémeti-1 /at 54.2/. Namely, this tuff layer is usually easily identifiable E of the Sajó River.

The Pannonian sequence intersected by the borehole is divided into two sharply distinguishable parts. The lower one-quarter of the sequence is constituted by pumice-rich rhyolite tuff, the upper three-quarters are made up of 33.2 m of variegated clay.

The 33.2 m of fine-clastic sediment above the uppermost rhyolite tuff has been assigned, from lithostratigraphic considerations, to the Pannonian s. str. /= Lower Pannonian/ sequence.

9. The Quaternary formations are represented by 7.8 m of Pleistocene fluviatile deposits and 0.4 m of Holocene soil overlying them.

The gravels are derived from the Spis-Gemer Ove Mountains. The sand material is medium-grained, poorly sorted. Because of the unsuitable drilling facilities the proportion of the gravels could not be determined.

The coarse-detrital fluviatile streamline deposits are overlain by 3.6 m of fine-grained, argillaceous flood-deposited, lacustrine sediment or flood-deposited variegated clay.

The 0.4 m thick soil is a dark greyish-brown, fairly humus-rich, noncalcareous material which may be classed as argillaceous silt from the petrographic viewpoint.

The Quaternary formations contained no fossils.

3RD DAY

STOP 1

FIELD-GUIDE FROM MISKOLC TO RUDABÁNYA

/L. GODA, A. JUHÁSZ, GY. RADÓCZ/

From Miskolc, through Felsőnyárád as far as Felsőkelecsény /nearly up to Rudabánya/ the excursion will be traversing the Sajó Graben tectonic unit /the so-called "E Borsod Browncoal Basin", Fig. 13 /, where the Neogene is constituted, similarly to the case of the Nógrád and W Borsod /Egercsehi--Ózd/ basins, by Eggenburgian--Sarmatian and Pannonian clastic /intramontane molasse/ deposits of varied Lithology and by pyroclastics that were erupted in several phases, the thickness being generally 300 m or occasionally even more than 500 m. An important element of the geological setting of the basin is the Ottnangian /or Ottnangian--Karpatian/ browncoal measures /Salgótarján Browncoal Formation/ which is the object of mining exploitation. Browncoal seams of more restricted significance occur in the Eggenburgian, Sarmatian and the adjoining Pannonian sequences as well.

The separation of the Lower Miocene /Eggenburgian/ clastic deposits frequently attaining several hundred m in thickness beneath the so-called /Lower Rhyolite Tuff/ /Gyulakeszi Rhyolite Tuff Formation/ from the Oligocene formations of similar lithofacies is still controversial in many cases. The freshwater browncoal beds of a Lower Miocene /Eggenburgian/ sequence predating the Lower Rhyolite Tuff were discovered in the vicinity of Felsőnyárád /Felsőnyárád Formation/. Rocky shore basal formation of the marine Lower Miocene is the detrital Bretka Limestone Formation that is known only in the mountain-marginal areas adjoining from the N and NW the Borsod Basin.

The Lower Rhyolite Tuff is overlain by a freshwater sequence followed with oscillation by a new marine sequence with 8 to 10 browncoal seams most of which are workable. The Ottnangian brown-

coal sequence becomes gradually marine upwards and the process of coal formation extends well into the Karpatian.
In the course of mining 5 main browncoal seams have been distinguished within the browncoal measures /with Seam V at the base/. The less extensive or less thick, so-called accessory seams lying close to the main seams are indicated by letter symbols written beside the number of the relevant main seam /e. g. IIIa/. The browncoal measures are most complete in the deeper, E part of the basin, attaining more than 250 m in thickness. Here in E Borsod, the upper one or two seams are supposed to be coeval with the "overlying" sequence of Nógrád, i. e. with the Egyházasgerge Sandstone Formation and the Garáb Schlier Formation.

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The bus is progressing across the southern part of the Borsod Basin, via the Lyukóvölgy road in the NE foreland of the Mesozoic mass of the Bükk Mountains. At Lyukóbánya village, you can see, in close-up, a shaft-tower serving the exploitation of Seam IV. From the vicinity of Parasznya village, the itinerary will go northeast in the valley of Nyögő brook, getting away from the marginal zone of the browncoal basin. In the vicinity of Radostyán and Sajólászlófalva there are outcrops of Seams IV, III, II and I of the browncoal measures and the fossiliferous beds associated with them are exposed, too.
Between Sajólászlófalva and Sajókápolna, the excursion will proceed past the onetime openwork pits in which Seam II used to be worked and then the broad NW-SE oriented Sajó Valley will be entered.
At Sajószentpéter, the bridge across the Sajó River will be passed and after a short travel, we arrive to the coal mines of Edelény. It is worth mentioning that the so-called "Borsodi-viz" /Borsod Water/ has been tapped here in the sand bed between Seams II and III and that the water recovered is bottled here on the

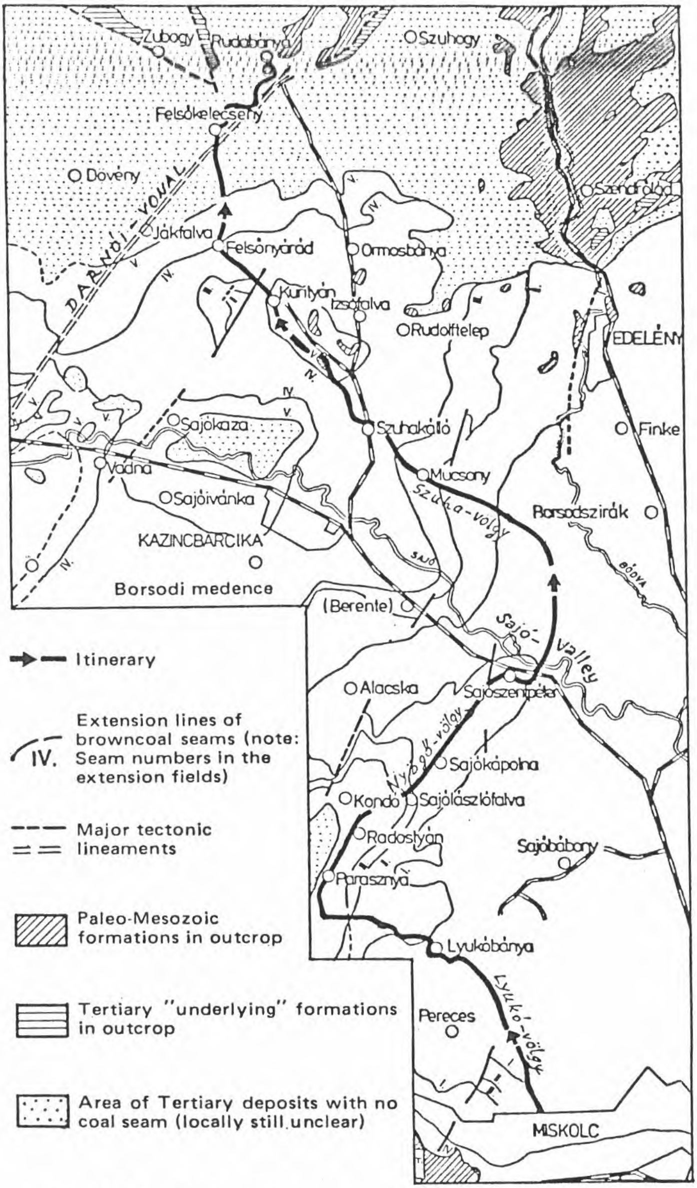
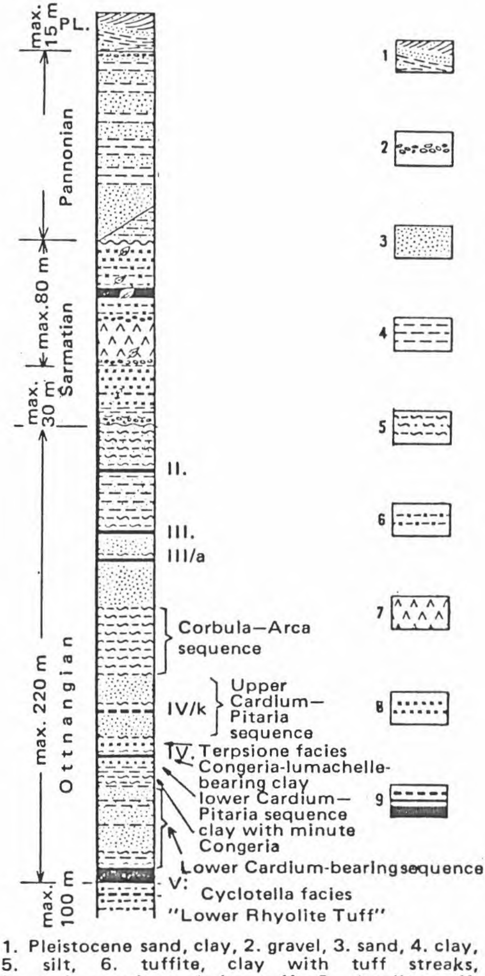


Fig. 13. Middle Miocene browncoal seams of the Borsod Basin
(Gy. Radócz)



1. Pleistocene sand, clay, 2. gravel, 3. sand, 4. clay, 5. silt, 6. tuffite, clay with tuff streaks, 7. agglomeratic andesite tuff, 8. rhyolite tuff, 9. browncoal seam and traces of it (with the symbol of the seam involved)

Fig. 14. Schematic profile of the Neogene layers near Felsőnyárád

spot. By the road, at Mucsony in the valley of the Szuha River /Kossuth Street 223/, the excursion participants will be shown Seam III and the beds associated with it, as exposed in outcrop by the road. Between Kurityán and Felsőnyárád, by the Miners' Restaurant, Sarmatian agglomeratic andesite tuffs, clays, silts and the so-called "uppermost" rhyolite tuff /with spheroidal inclusions/ will be seen. The idea of their assignation to the Lower Pannonian has recently been put up. In the Cellar Lane of Felsőnyárád rather large exposures have been cut into the spheroidal rhyolite tuff. Between Felsőnyárád and Felsőkelecsény the excursion participants will leave the E Borsod Basin area and at Felsőkelecsény, they will cross the Darnó Line, a lineament of NNE--SSW direction. On the western side of the lineament several metres thick Oligocene and Lower Miocene formations are the predominant. The surface is constituted generally by Pannonian clay, sand and transitions between the two, now and there with lignite beds /Fig. 14/.

In the Rudabánya area, almost directly above the basement units, lignitiferous Pannonian sequences are exposed even in a geodesic position higher than that of the basin area.

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Along the itinerary, the excursion participants will be offered opportunities to see the rock sequences intersected by brown coal exploratory drillings as exhibitions of sample blocks.

STOP 2

RUDABÁNYA -- A PREHOMINID LOCALITY

/L. KORDOS/

Rudabánya is situated at a distance of 40 km N of Miskolc, in the Borsod Basin.

The Triassic limestones and dolomites of Rudabánya are metasomatically mineralized. In prehistoric times, first copper ores and subsequently silver- and gold ores were mined on the site. From the middle of the last century, Rudabánya became one of the major iron ore mines of Hungary. In the last forty years it was the only iron ore mine in this country, but by now the exploitation has been stopped owing to its becoming uneconomic.

The mine area is reached from the onetime mining town /now only a village/ through the town mine road constructed upon the waste-banks. From the look-out built on the margin of the mine pit, the view of the 4 km long, 4--500 m wide and 2--300 m deep opencast iron ore pit unfolds along the mountain range. From here one can have a good view of the prehominid site which is represented by lignitiferous-argillaceous sediments filling up the valley system developed along the range.

The prehominid site at present is a nature conservation area. Site II lies under the roof of the Conservation Hall. It is from here that, along with fossils of stratigraphic significance, most of the prehominid finds have been recovered.

The lignitiferous clay is of Lower Pannonian age /Bódvaian in the local terrestrial stratigraphic scale/ that corresponds to the Lower Vallesian /MN 9 Zone, i. e. 11--12 Ma/. As a result of excavations carried out between 1971 and 1976 a megaflora and pollen assemblage consisting of a total of 125 taxa, a Mollusca fauna including 41 taxa, representatives of Ostracoda and 87 vertebrate species have been found. Kretzoi described three primates from Rudabánya: Rudapithecus hungaricus, Bodvapithecus altipalatus and Pliopithecus /Anapithecus/ hernyaki. As he determined, Rudapithecus belongs to the Ramapithecus taxon marking the earliest stage of the evolution that has led to Homo sapiens, Australopithecus being excluded from the same taxon. Bodvapithecus is a Pongo-Hominid ape of larger stature, whereas Pliopithecus is the youngest species of this genus. According to the recent international revisions, Rudapithecus is closely related to the Dryopithecus group -- a finding that may prove quite significant for the understanding of the hominization process. Bodvapithecus is to be assigned to the Sivapithecus group, being an early representative of the lineage that has led to the orang-outang.

STOP 3

NEKÉZSENY, GRAVEL PIT

/M. BOHN-HAVAS, E. CLIFTON, P. MÜLLER/

In the Ózd--Egercsehi graben, NW of the Bükk Mountains, there is a Lower and Middle Miocene sequence of considerable size. East of Nekézseny, the gravelly-sandy sequence of the Egyházasgerge Formation transgresse directly over the Paleozoic carbonata basement. In the exposure, this can be seen in full, i. e. in a thickness of about 20 m. At its top, the gravel grades into fossiliferous marl of the Garáb Formation. Although the lateral extent of the gravel is uncertain, it appears to be a localized deposits. The gravel consists of mostly fine, angular to well-rounded carbonate rock pebbles, most or all of which are derived from the underlying Paleozoic rock. Bivalve borings /Lithophaga/ on many of the pebbles /and on the underlying rock surface/, disarticulated and worn bivalve shells and large claylined burrows attest to a marine origin. Quartz sand is present as matrix or thin beds only in the lower part of the gravel. Stratification in the gravel is defined by thin, laterally impersistent beds, many of which are texturally graded. Those in the lower part of the gravel typically have a fine quartz sand matrix at their top. Thin layers of silty fine calcarenite and marl occur locally in the upper part of the gravel. Varying directions of imbrication in the gravel suggest a deposition under the influence of waves. Although the depth of deposition was probably never more than just a few metres, no systematic vertical trend in gravel character is evident. The gravel is interpreted as having been formed at the base of a Miocene sea cliff on a carbonate rock island during an episode of rising sea level. The rate of a cumulation was by and large equivalent to the rate of sea level rise. As the regional shoreline retreated

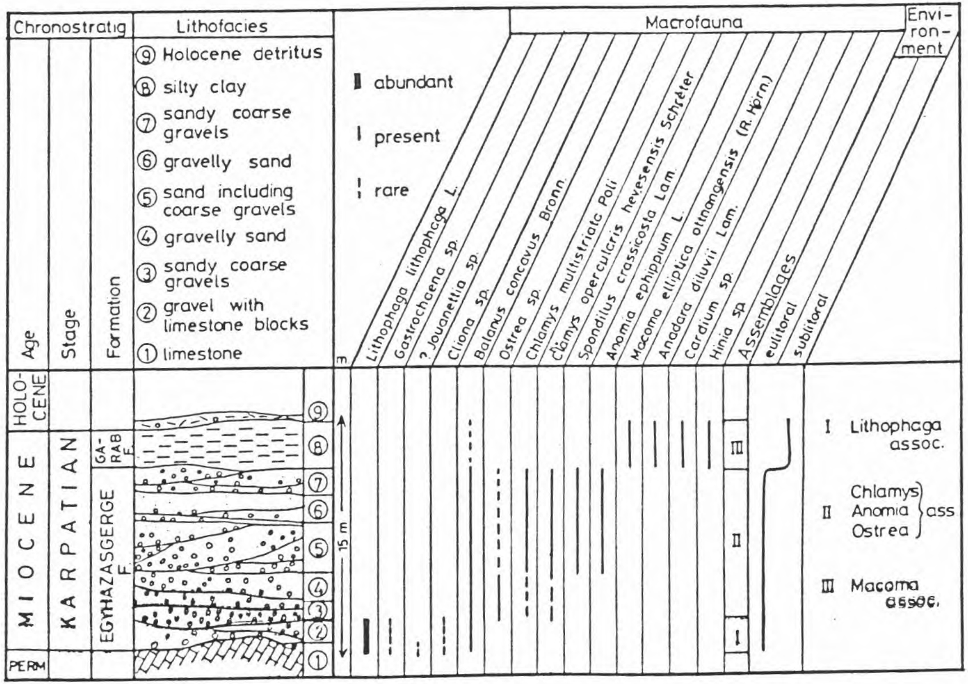


Fig. 15. SECTION OF THE NEKÉZSENY DEPOSIT SHOWING THE ALTERNATION OF MEGAFAUNAL ASSOCIATIONS

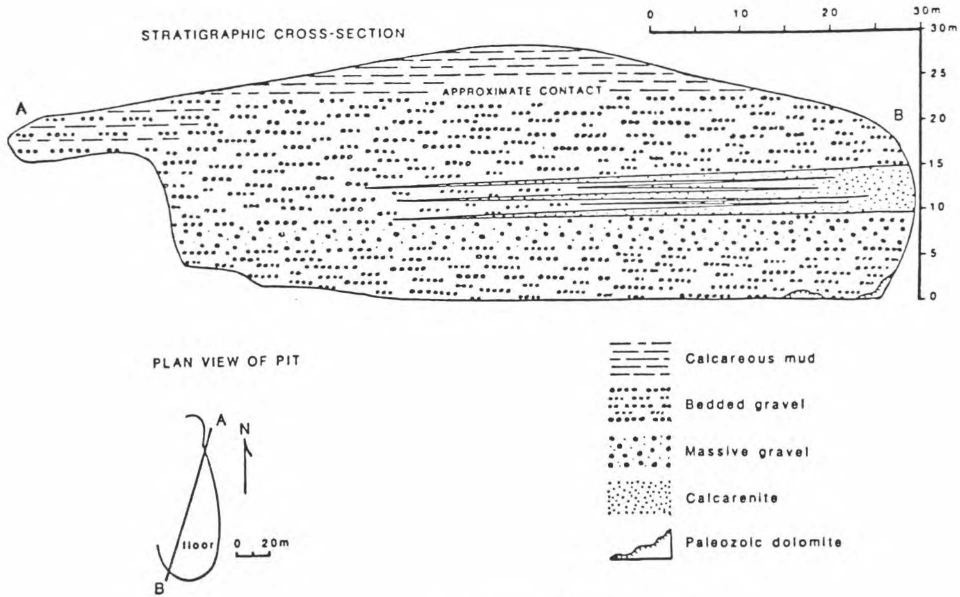


Fig. 16. Stratigraphic cross-section of Nekézseny gravel-pit

to the north, the abundance and grain size of the silicoclastic material in the gravel decreased. Inundation of the island put an end to gravel deposition and led to accumulation of basinal marl /Figs. 15, 16/.

4TH DAY

EGERIAN, MIOCENE SEQUENCE OF THE NÓGRÁD--CSERHÁT AREA

/G. HÁMOR/

The geological excusion has been intended to present the geological setting of two mesotectonic units of the study area. The Etes Graben is a structure of NW-SE trend and was formed during the Savian orogeny in the Early Miocene /Eggenburgian--Ottnangian/.
The Zagyva Graben running perpendicularly to the former /NE--SW/ was formed during the Styrian orogeny in the Middle Miocene /Karpatian--Early, Middle Badenian/. Its filling up continued in Late the Miocene (Late Badenian--Sarmatian--Pannonian and Pliocene /Pontian/). The geological setting is presented as illustrated by a geological section and two geological key sections obtained by continuous core drilling / Fig. 17/.

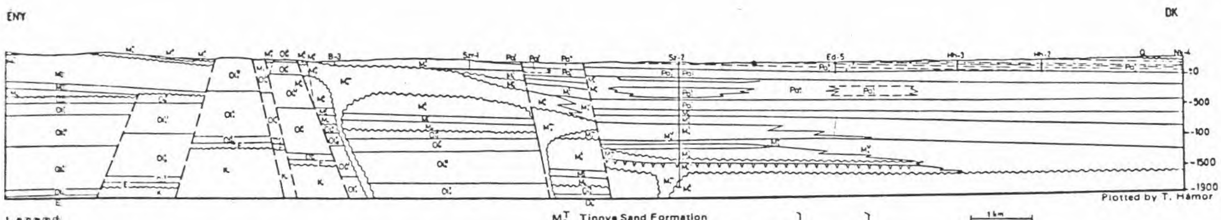
STOP 1

KAZÁR VILLAGE, ROAD-CUT

/G. HÁMOR/

The exposure is the point of intersection of the NW--SE-oriented Lower Miocene Etes Graben and the NW--SE-oriented Middle Miocene Zagyva Graben. Accordingly, the basal beds of the exposure represent the final beds of the Ottnangian Salgótarján Browncoal Formation, the upper part being constituted by Karpatian basal beds.

The Salgótarján Browncoal Formation in this area is represented by three coal seams. To the east, in a bird's eye perspective, the Ottnangian underlying rock, the so-called "Lower Rhyolite Tuff" /Gyulakeszi Rhyolite Tuff Formation,



Legend

- Q — Quaternary formations

Dunántúl Supergroup (Upper Pannonian formations)

- $Pa_2^{B...ISa}$ — Bukkalja Lignite Formation (the upper index numerals indicate coal seam groups)
- Pa_2^{Z} — Zagyva Formation
- Pa_2^{C} — Csór Silt Formation

Peremarton Supergroup (Lower Pannonian formations)

- Pa_1^{N} — Nagykörü Claymarl Formation
- Pa_1^{S} — Szolnok Sandstone Formation
- Pa_1^{Z} — Zámor Gravel Formation
- Pa_1^{T} — Tótkomlós Calcareous Marl Formation

MIOCENE

Sarmatian:

- M_s^{T} — Tinnye Sand Formation
- M_s^{G} — Galgavölgy Rhyolite Tuff Formation
- M_s^{K} — Kozárd Sandstone–Siltstone Formation
- M_s^{S} — Sajóvölgy Formation

Badenian:

- M_b^{Sz} — Szilágy Claymarl Formation
- M_b^{R} — Rákos Limestone Formation
- M_b^{H} — Hidas Browncoal Formation
- M_b^{S} — Sámsonháza Formation
- $M_b^{M\alpha}$ — Mátra Volcanics Formation

Karpatian:

- $M_k^{T\alpha}$ — Tar Dacite Tuff Formation
- $M_k^{H\alpha}$ — Hasznos Andesite Formation
- M_k^{G} — Garáb Schlier Formation
- M_k^{E} — Egyházasgerge Sandstone Formation
- M_a — Lower Miocene formations at large

(PANNONIAN spans M_s^{K} to $M_k^{T\alpha}$)

OLIGOCENE

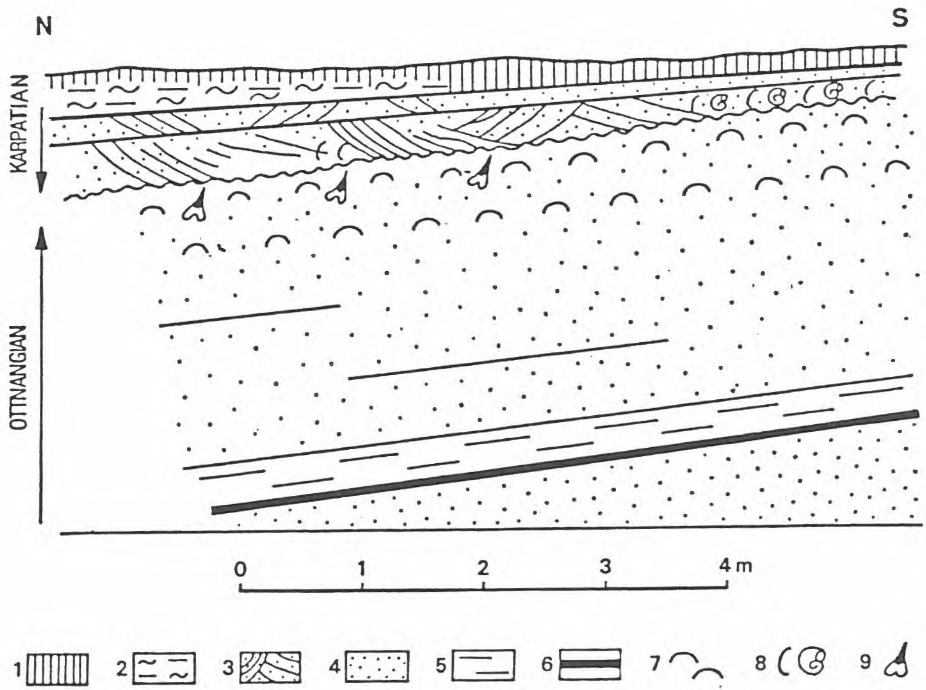
Egerian:

- Ol_e^{B} — Becske Formation
- Ol_e^{P} — Pétervására Sandstone Formation
- Ol_e^{Sz} — Szécsény Schlier Formation

Kiscellian:

- Ol_k^{K} — Kiscell Clay Formation
- Ol_k^{T} — Tard Clay Formation
- E — Eocene formations at large
- K_r — Lower Paleozoic metamorphics

Fig. 17. Schematical geological profile of the NW part of the Zagyva Graben



1. Soil, 2. schlier deposits, 3. cross-bedded sandstone, 4. sand, 5. clay, 6. lignite, 7. Cardium-bearing beds, 8. Congeria–Rzehakiabeds, 9. shark teeth

Fig. 18. Geological section of the Kazár road-cut

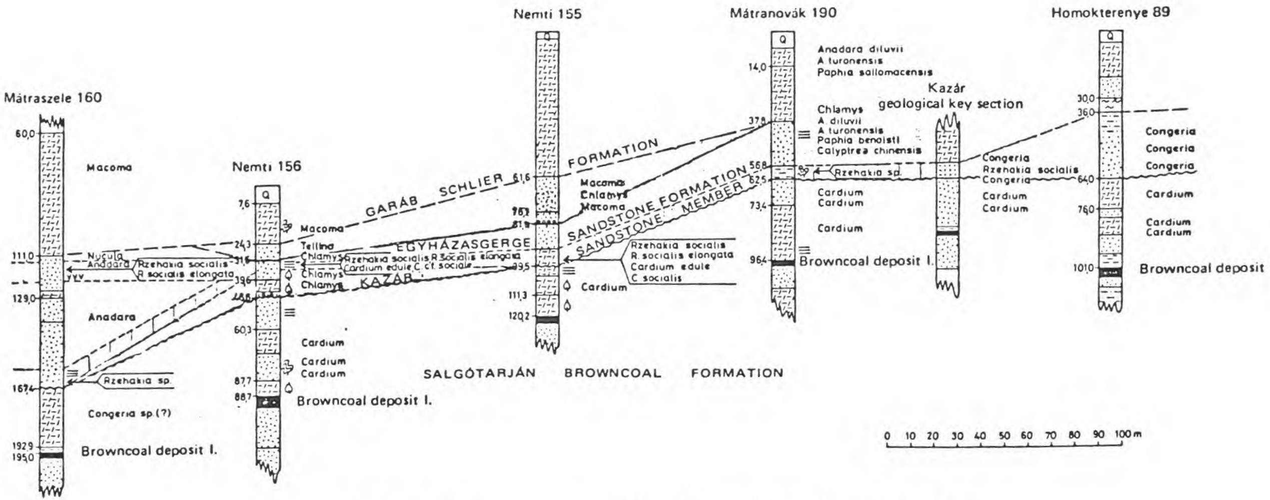


Fig. 19. Position and facies conditions of the Kazár Sandstone Member ("Oncophora beds")
(Plotted by G. HÁMOR, 1980, with the use of data also by H. SZEMEREY and M. BOHN–HAVAS)

19.6 ± 1.4 Ma can be seen ; to the southeast there is an openpit in operation in which the lowermost coal seam /Seam III/ is being worked. The deeper underlying rock is represented by Eggenburgian marine and terrestrial beds. In a pit beneath the road the uppermost seam /Seam I/ of the browncoal formation is exposed. The older seams are of limnic facies, this one being already oligo-miohaline to paralic. The overlying rock /in the road-cut/ is constituted by oligo-miohaline to brackish-water "Cardium Sand" /Salgótarján Browncoal Formation, Kisterenye Member, Vizslás Sand Beds/ /Figs. 18, 19/.

At the S end of the road-cut, the afore-mentioned formations are overlain with a regional unconformity by Middle Miocene /Karpatian/ yellow, thingly laminated, fine-grained sandstones with internal moulds of Congeria--Oncophora /Rzehakia/ species.

The transgression, that was progressing from the southwest at the time of deposition of these beds, reached up to this point. The marginal facies in the exposure is represented by shallow-water deposits of estuarian-shoreline lagoonal facies with shoreline-controlled cross-bedding /Egyházasgerge Sandstone Formation, Kazár Sandstone Member/. These contain the following megafauna /as determined by M. Bohn-Havas/:

Lamellibranchiata: Rzehakia socialis Rzeh., R. socialis keshae Merklin, R. socialis elongata Rzeh., R. socialis ilonae Cech.-Hano, Rzehakia sp., Cardium edule L., C. edule arcella Duj., C. cf. sociale Kr., Cardium sp., Limnocardium sp., Congeria amygdaloides Dunk., C. brardii Brong., Congeria sp.
Gastropoda: Melanopsis sp.

The vertebrate faunal wave of the new transgression /shark's teeth bed/ includes, as determined by L. Kordos, the following forms:
Hexanchus primigenius /Agassiz/, Odontapsis /Synodontapsis/ acutissima /Agassiz/, O. /S./ cuspidata /Agassiz/, Squatina biformis /Le Hon/, Aetobatus arcuatus /Agassiz/, Galeocerdo aduncus /Agassiz/, Eugaleus minor /Agassiz/, Hypoprion acenthodon /Le Hon/, Prionodon sp., Scoliodon sp., Hemipristis serra

Agassiz, Sphyrna prisca Agassiz, Lamna rupeliensis /Le Hon/, Lamna cattica /Philippi/, Isurus desori /Agassiz/, Isurus hastalis hastalis /Agassiz/, Heterodontus sp., Alpias exiqua /Probst/, Raja antiqua Agassiz, Myliobatis sp., Sparus sp., Pagrus sp., Diplodus sp.

On the basis of nannoplankton data, A. Nagymarosi has assigned the Kozár Sandstone Member to the NN4 zone.

The uppermost siltstone and claymarl beds in the exposure already represent the completely marine Garáb Schlier Formation with rich planktonic and benthonic Foraminifera fauna. The mode of superposition and facies relations of the formations of Karpatian age are shown in Figs 20 and 21 based on the geological mapping and core drilling results of the extended neighbourhood.

STOP 2A

NORTH HUNGARIAN CORE DEPOSITORY OF THE HUNGARIAN GEOLOGICAL INSTITUTE. RÁKÓCZIBÁNYA-TELEP

/G. HÁMOR/

The borehole Sámsonháza 16/a, exhibited here has intersected a discontinuous Egerian--Upper Badenian sequence of marginal facies developed in the Zagyva Graben area. The results of laboratory analyses by 16 different methods are demonstrated in situ /Fig. 22, Fig. 24 /. The interpretation of the results may be outlined as follows:

Egerian formations /possibly extending well into the Eggenburgian interval/: from 1,200 to 1,012 m: Szécsény Schlier Formation /"Chattian Schlier"/, from 1,012 to 842.6 m: Pétervására Sandstone Formation /"glauconitic sandstone"/.

Regressive final formations of the marine Oligocene sedimentary cycle of the Paleogene depression beneath the Zagyva Graben. There is an upward trend of intensification

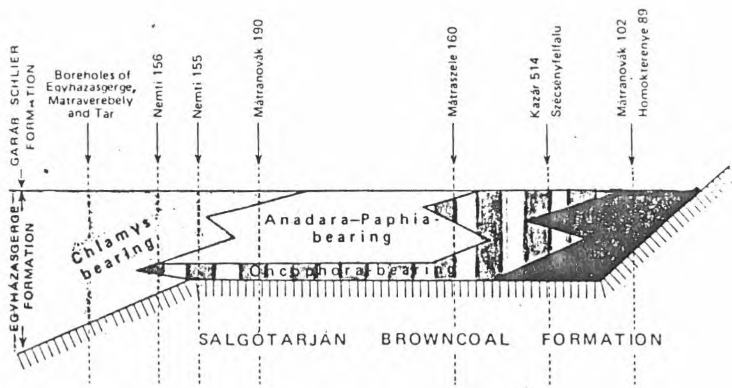


Fig. 20. Biofacies of the Egyházasgerge Formation and theirs interrelation

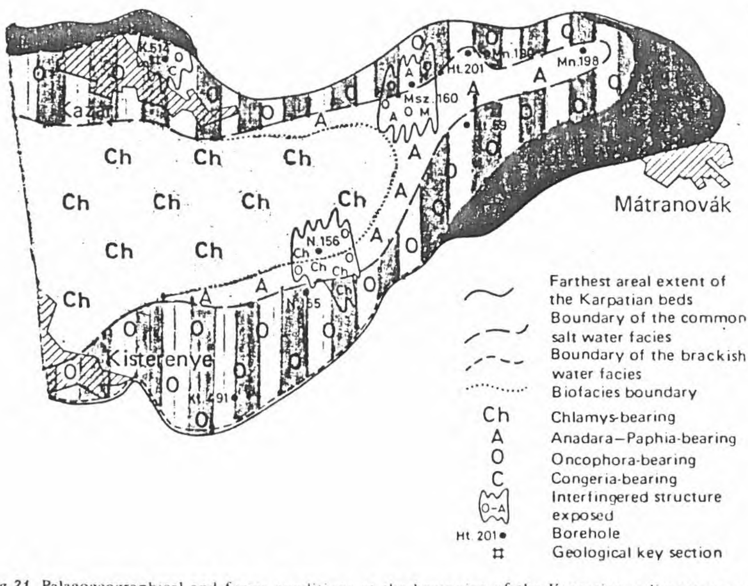


Fig. 21. Palaeogeographical and facies conditions at the beginning of the Karpatian sedimentary cycle (basal beds)

Fig. 22. Analytical logs of borehole Sámsonháza 16/a

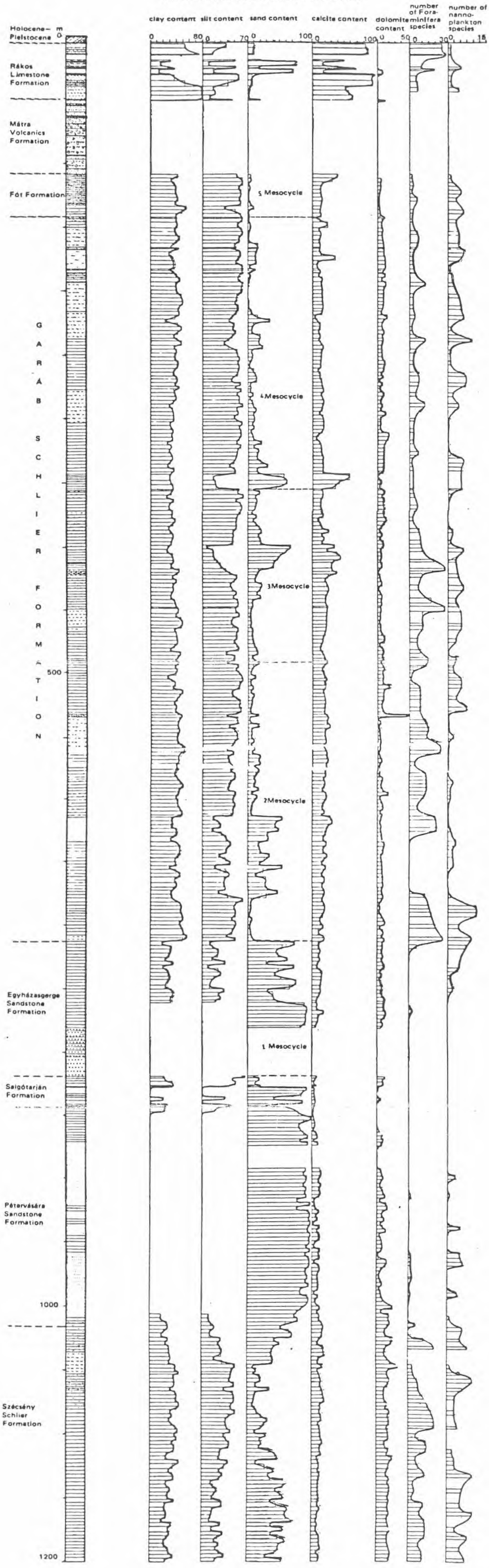
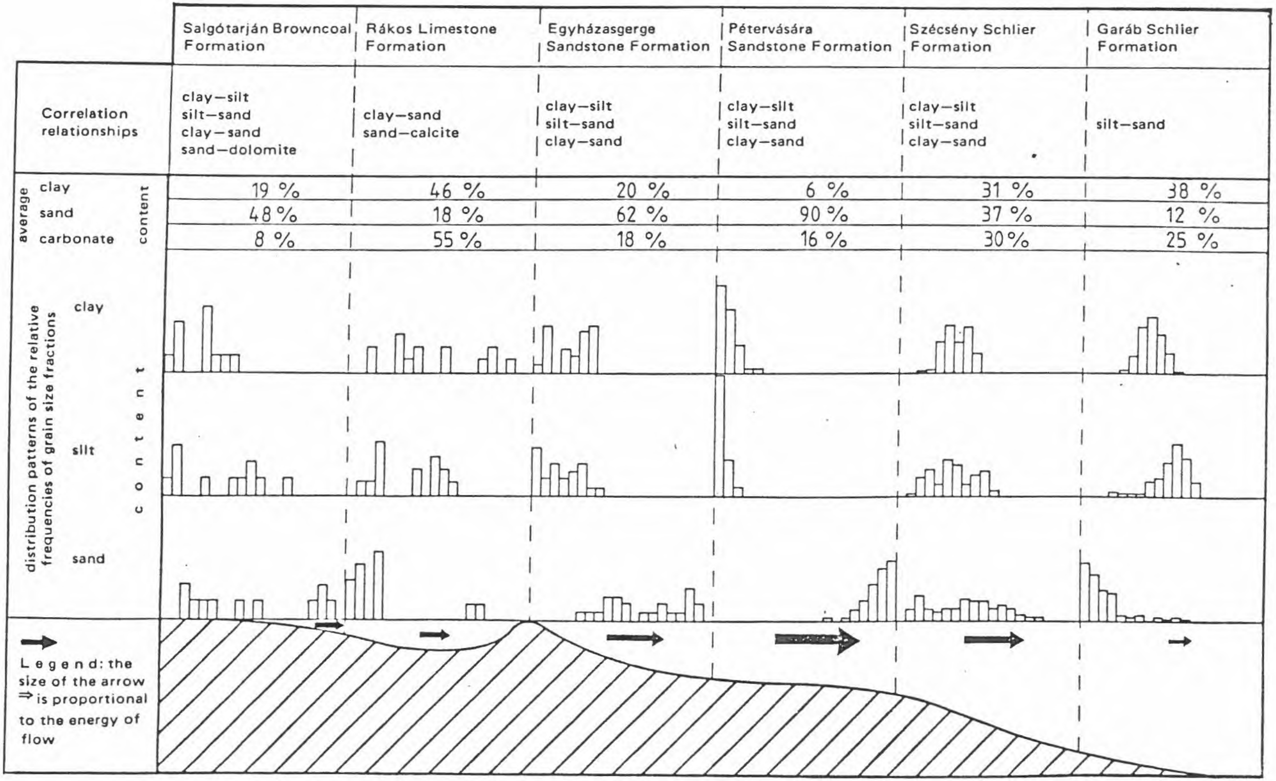


Fig. 23. QUANTITATIVE SEDIMENTOLOGICAL RELATIONSHIPS BASED ON OLIGOCENE–MIOCENE FORMATIONS INTERSECTED BY BOREHOLE SÁMSONHÁZA 16/a (T. HÁMOR 1984)



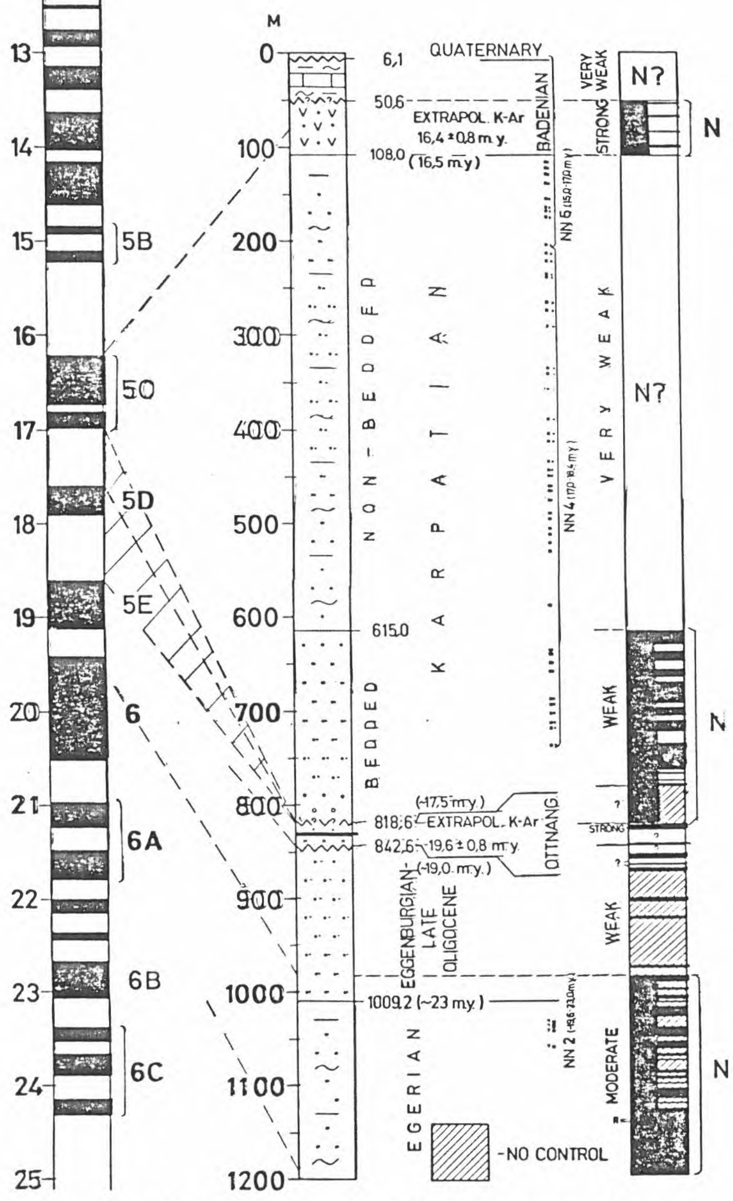


Fig. 24. Magnetostratigraphy of drilling Sámsonháza 16/a.
9D. P. Elston – M. Lantos 1984)

of the emergence--accumulation regime with a regressive impoverishment of the fauna.

Eggenburgian--Ottnangian formations:

842.6--818.6 m: Salgótarján Browncoal Formation, Kisterenye Member, claymarl beds of Mátranovák overlying Seem I /"Cardium-bearing shale"/.

As evident from the palaeogeographical position of this area /lying outside the Early Miocene Etes Graben sedimentary basin/, the time-span involved is characterized for the most part by a break in sedimentation. The only expansion of transgression manifested here on the graben margin must have taken place in the Upper Ottnangian, as indicated by the cycle-initiating, variegated silts and sands and by the reduced thickness /24.0 m instead of 40--180 m/.

Karpatian formations:

- 816.6--712.6 m: Egyházasgerge Sandstone Formation /"Chlamys Sandstone"/
- 712.6--142.0 m: Garáb Schlier Formation
- 142.8--108,5 m: Fót Formation /"bryozoan beds"/

The Zagyva Graben began to be formed in the Styrian orogeny in the Lower Karpatian. The three formations make up a complete geological megacycle from a marine ingression beginning with gravelly basal beds through the culmination of the transgresssion /openwater "schlier beds" with marks of sea currents and a rich microfauna/ up to the regressive final beds. The cyclicity is repeated several times in the three formations of the megacycle. Remarkably enough, towards the end of the Karpatian, the products of the volcanism that was widespread throughout the study area /Hasznos Andesite Formation, Tar Dacite Tuff Formation/are represented in the core material only as volcanic intercalations, strings.

Badenian formations:

- 108.5--50.6 m: Mátra Volcanics Formation /"andesite complex"/
- 50.6-- 6.1 m: Rákos Limestone Formation /"Upper Leithakalk"/

As follows from the palaeogeographical position of the study area, the Lower Badenian deposits are absent. Thus the Lower Badenian is represented by andesite agglomerates, tuffs and lavas accumulated under subaerial conditions. Their age is 14.5 $\pm$ 0.8 Ma. A new transgression in Late Badenian time resulted, in a reefal-archipelagic environment, in the deposition of lithothamnian limestones, calcarenites and, subsequently, sandstones and marls that resulted from the reworking of the volcanic material.

STOP 2 B

NORTH HUNGARIAN CORE DEPOSITORY OF THE HUNGARIAN GEOLOGICAL INSTITUTE, RÁKÓCZIBÁNYA-TELEP

/G. HÁMOR, Á. JÁMBOR/

The borehole Szirák 2, a 2,000 m deep core drill with continuous core recovery, that intersected the Karpatian--Quaternary sequence of the part of the Zagyva Graben stituated closer to the Budapest facies area is exhibited here /Fig. 25/.

Karpatian formations:

- /2,000.0/ -- 1,918.4 m: Garáb Schlier Formation
- 1,918.4--1,618.4 m: Hasznos Andesite Formation /so-called "Lower Andesite"/
- 1,618.4--1,600.1 m: Tar Dacite Tuff Formation /so-called "Middle Rhyolite Tuff"/

The borehole was stopped in the Garáb Schlier Formations. The total thickness that the Garáb Schlier Formation was expected to have been 500--600 m. In the uppermost 20 metres of the formation the first traces of the andesite volcanism already appear. In the final analysis, it was this volcanic cycle the filled up the Karpatian sedimentary basin. So in this area /on the NW limb of the Zagyva Graben/ the Fót Formation closing the Karpatian cycle has not developed. The Hasz-

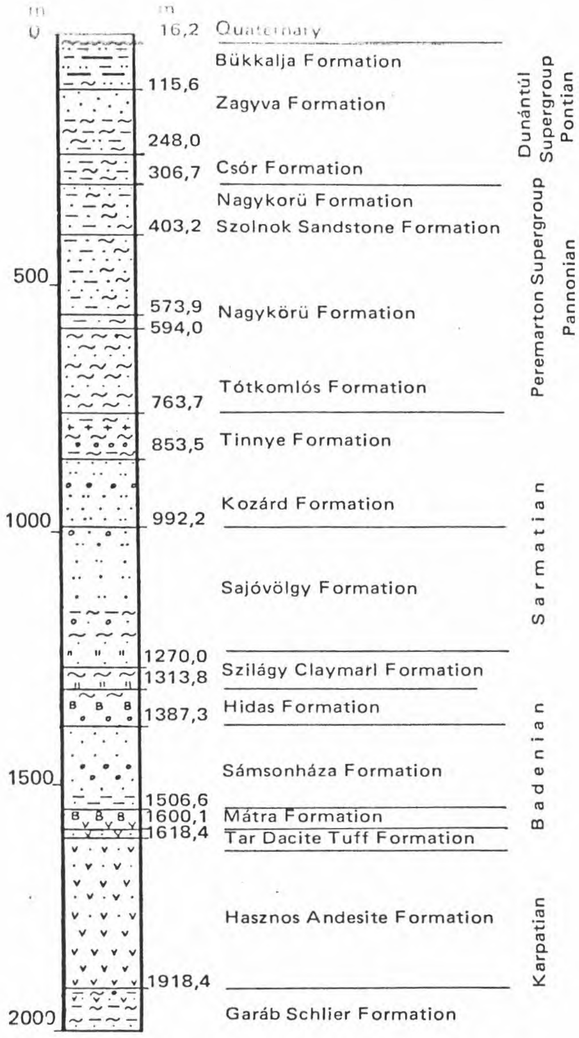


Fig. 25. Schematical rock sequence of borehole Szirák 2
by
G. Hámor – J. Halmai – Á. Jámbor

nos Andesite Formation is dated at 17.3 $\pm$ 0.8 Ma.

Lower Badenian formations:

- 1,600.1--1,566.6 m: Mátra Volcanics Formation
- 1,566.6--1,387.3 m: Sámsonháza Formation

Middle Badenian formations:

- 1,387.3--1,313.8 m: Hidas Formation

Towards the central part of the Zagyva Graben, the Mátra Volcanics Formation is pinching out /attaining already only 33.5 m in the borehole/, having been accumulated, by all probability, among underwater conditions /amygdaloids, chalcedony veinlets/. The Lower-Middle Badenian sequence in this part of the graben contains a lot of clastic material and red or variegated formations. The dissoluble NaCl content is high and the Foraminifera species show a cyclical decrease in number upwards in the profile. The Lower-Middle Badenian is proved by the NN5 zone.

Upper Badenian formations:

- 1,313.8--1,270.0 m: Szilágy Claymarl Formation.

The difference, as compared with borehole Sámsonháza 16/a, is that in this part of the Zagyva Graben the marginal-facies Rákos Leithkalk Formation is missing, being replaced by open-water, argillaceous deposits. In the whole rock sequence intersected by the borehole it is this formation that exhibits most strikingly the presence of a far offshore environment, the number of Foraminifera species is here the highest and the NN6 zone can be identified.

Sarmatian formations:

- 1,270.0--992.2 m: Sajóvölgy Formation
- 992.2--853.5 m: Kozárd Formation
- 853.5--763.7 m: Tinnye Formation

As a consequence of the heavy uplift of the background and that of the large-scale material input, the filling up of the Zagyva Graben was speeded up /fluviatile, deltaic and lagoonal facies of the Sajóvölgy Formation/. Having been cyclically isolated, several times hypersaline conditions with evaporite formation developed in the sedimentary basin /gypsum and anhydrite/. Subsequently, renewed and intensified transgression resulted in a new brackishwater, nearshore formation with new mega- and microfaunas /Kozárd Formation/ and, later on, in a more argillaceous offshore sequence of sediments deposited in rather agitated waters /Tinnye Formation/. The continuous subsidence of the bottom is attested to by a banded stratification and by the frequent traces of slumping.

Pannonian formations: /Fig. 26/.

- 763.7--594.0 m: Tótkomlós Formation
- 594.0--306.7 m: Nagykörü Formation intertonguing with the Szolnok Sandstone Formation.

The filling up of the Zagyva Graben continues under the same paleogeographical conditions, but already with no seawater recharge. Molasse-like, rhythmically alternating argillaceous sand, sandy clay and silt beds are deposited with an endemic fauna.

Pontian formations: /Upper Pannonian s. l./

- 306.7--248.0 m: Csór Formation
- 248.0--115.6 m: Zagyva Formation
- 115.6-- 16.2 m: Bükkalja Formation

The termination of the bottom subsidence and the filling-up of the graben are indicated by expansive, transgressive Pliocene /Pontian, previously "Upper Pannonian"/ deposits and, expecially, by the Bükkalja Formation, characterized by browncoal deposition in a swampy environment.

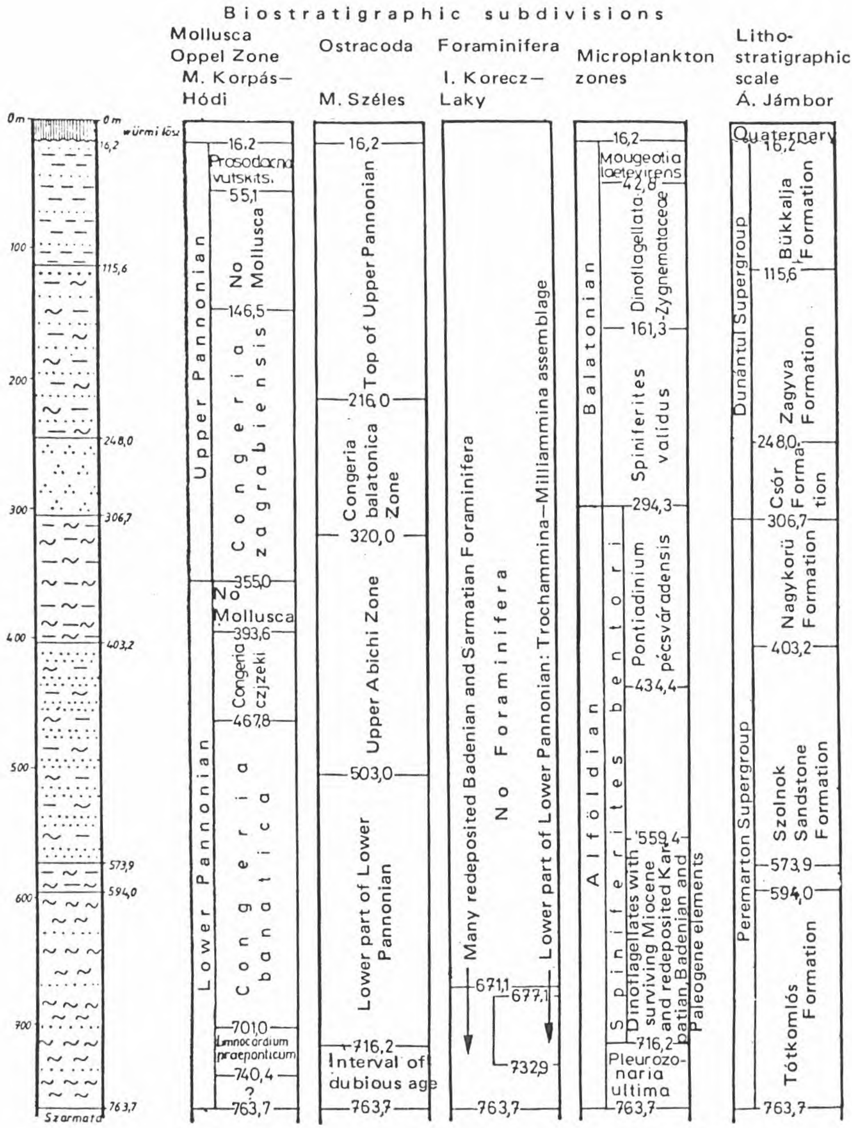
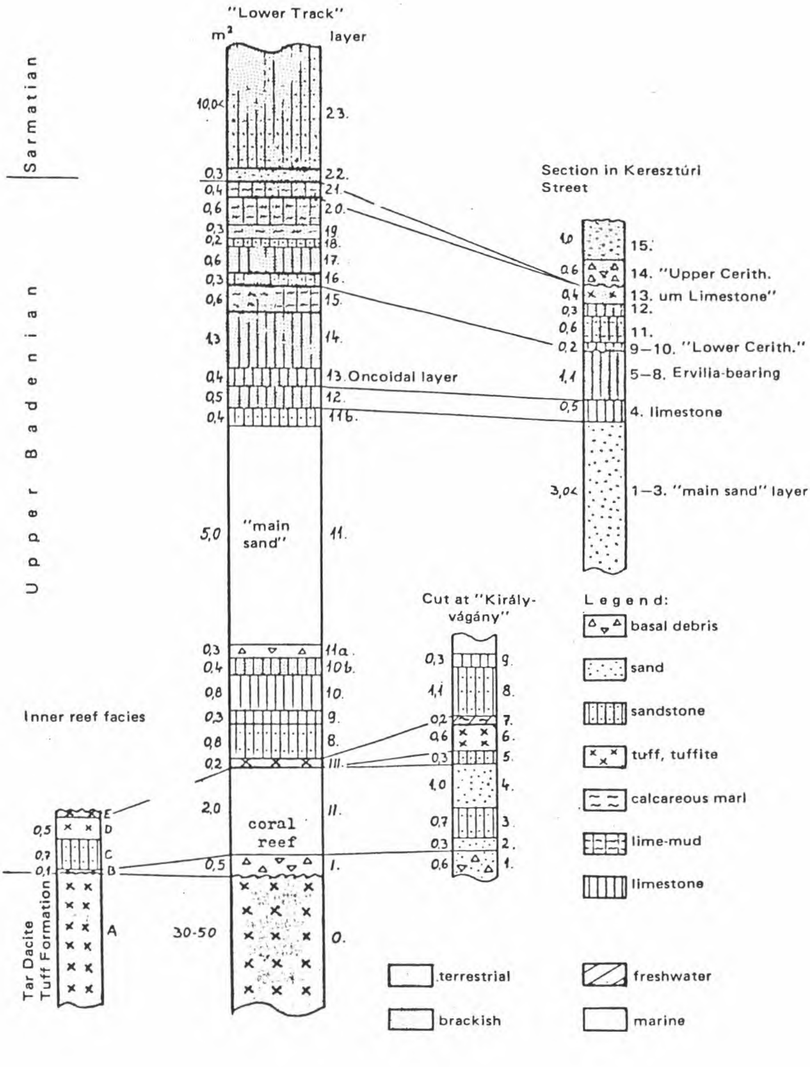


Fig. 26. Stratigraphic subdivisions of Pannonian s.l. formations in borehole Szirák 2

Fig. 27. Section of the railway-cut at Rákos ("Delta") (I. Kókay – P. Müller 1984.)



5TH DAY

RÁKOS AREA, BADENIAN DEPOSITS

/J. KÓKAY, P. MÜLLER/

The area of what is now Budapest was invaded by the Badenian sea in the Middle Badenian, surrounding the Buda Hills semicircularly /from the E and W/. According to the results of drilling for the Budapest Metroline, the regression of the Middle Badenian sea was followed by a terrestrial period for a short time, then the Late Badenian sea re-invaded the area from southern direction, and it extended northwards and eastwards well beyond the extension of the Middle Badenian deposits. Thus in the Rákos area the Upper Badenian sequence overlies the older/Upper Karpatian or Lower Badenian/ dacite tuffs /Tar Dacite Tuff Formation/ rather than the Middle Badenian deposits. The rock sequence in question can be seen in the low hill range extending on the left bank of the Danube, along the Rákos rivulet. It is made up of tuffs, tuffites, tuffaceous sands, sandy tuffaceous limestones and pure limestone showing very diversified petrographic-textural characteristics.

STOP 1

The railway cut is a classic exposure, its first geological description /J. Szabó/ was given in 1879. The exposure has been designated as a key section representing the faciostratotype of the Rákos Leithakalk Formation, the Hungarian equivalent of the Leithakalk. Best exposed is the section of the so-called "lower track". Here the afore-mentioned, 30--50 m thick dacite tuff sequence /Tar Dacite Tuff Formation/ /o./ is overlain with basal clasts /Fig. 27 / by the Upper Badenian marine sequence. The clasts include tuff boulders with traces of borer-bivalves, some of the boulders attaining even 30 cm in diameter. Next a coral patch reef follows /Bed II./ made up practically of Porites sp. specimens alone. These are preserved as internal moulds of subvertical tentacles 5 to 10 cm in diameter. The tentacles are locally coated by red algae or less frequently by bryozoa. The rock filling the moulds is tuffaceous sandstone at the base, and tuffaceous limestone at the top. The fill contains mollusc casts /most frequently Lithophaga sp. and other species of borer-bivalves as well as barbatia clathrata and Cerithium michelotti, making a total of about 80 taxa/ as well as Decapoda species /mainly Chlorodiella mediterranea/.

The patch-reef is traceable over a length of about 50 m in the railway-cut, pinching out in both direction. The fauna of the formations deposited between the landmass and the reef can be readily identified with that of the reef, but nearly 30% of the Mollusca taxa are philobrackish forms, of small stature and euhaline , a characteristics that can be explained by freshwater influence from the mainland.

The formations can be well identified on the outer /seaward/ slope of the reef, too, but the fauna there is comparatively poorer.

The reef and its isochronous facies counterparts in the "lower track"-cut are overlain by 10 to 20 cm of coarse-grained dacitic pumice-tuff of terrestrial origin.

The next subcycle /Bed 8 in the profile/ begins with tuffaceous sandstone of 0.3--0.8 m thickness with a rather poor Mollusca fauna /most frequently Pitar and Acanthocardia species/ as well as with a very rich Decapoda assemblage which is different from that of the coral reef /Matuta brocchii, Calappa heberti, Callianassa species/.

The next bed /20--30 cm/ is sandy limestone /9./ with lots of Linga columbella casts, abundant in other larger Mollusca species as well. The two formations grade with no sharp contact into about 0.8 m of Ostrea-Pecten limestone /Bed 10/. The most frequent taxa are: Flabellipecten leythajanus, Pecten aduncus, Ostrea lamellosa. Scutella vindobonensis occurs, too.

Bed 10 grades into 10b /0.4/ which is completely different regarding its fossil content. It is rich in tiny molluscs. One-third of the 89 taxa are philobrackish elements, the euhaline species /e. g. Linga columbella/ being small, stunted forms. All these facts suggest that the seawater had been diluted /about 25%o salinity/.

Bed 10b is followed by a thicker /5.0 m/ unconsolidated, small-grained sandstone /"main sand"/ /Bed 11/ with calcareous tuffite and tuffaceous limestone boulders deriving from the contemporaneous shoreline, as suggested by the presence of root traces in them /this may be regarded as the beginning of a new subcycle/. The rock is poorly stratified, of overwhelmingly tuffaceous matrix, and crumbling. Characteristic feature is the abundance of bioturbations /Ophiomorpha/ and by the high frequency, especially in the upper part, of double-valved Flabellipecten leythajanus as well as of huge Calappa heberti specimens and Callianassa species. Borelis melo specimens abound. Schizaster, forms belonging to the infauna, are rather frequent. The bed in question is closed by a more strongly cemented stratum with poorly preserved Mollusca casts.

The next layer /Bed 12/ is a 0.5 m thick, richly fossiliferous limestone characterized by masses of Cardium /Acanthocardia/ barrandei schafferi, Cerithium and Ervilia. The representatives of Cardium do not attain the size of a normal adult, being subjuvenile to juvenile in growth. The Mollusca assemblage is dominated by "philobrackish" elements, the euhaline forms being stunted. Decapoda /Matuta brocchii and Pilumnus mediterraneus/ and Foraminifera /Borelis melo/ are quite frequent.

The richly fossiliferous layer is overlain /at the base with micro-oncoids, at the top with megaoncoids 3 to 10 cm in diameter/ by 0.4 m of limestone /Bed 13/.

Bed 14 /1.0--1.3 m/ is cross-bedded, "cellular" micro-oncoidal limestone with Cerithium nests /"Lower Cerithium Limestone"/. Bed 15 which overlies the former /0.6 m/ is marly lime-mud that can be observed over a short distance on the S side of the road-cut. On the N side it grades into a formation that is similar to Bed 14, but this one is not cross-bedded.

It can be very well seen on the cleaned S side of the railway-cut that the slightly uneven surface of Bed 15 is overlain by the micro-oncoidal limestone /No. 16/ with rounded clasts of the "Lower Cerithium Limestone", with small quartz and andesite pebbles, in a total thickness of about 0.3 m. /a new subcycle/. This one is followed without any distinct contact by Bed 17 /0.6 m/ which is made up of sandy, unconsolidated, ooidal Cerithium-bearing limestone /"Upper Cerithium Limestone"/. Stunted and subjuvenile Cerithium europeum specimens are quite frequent being accompanied by other philobrackish elements. Among the Foraminifera, mainly the Spiroline species are frequent.

The overlying 0.2 m thick, slightly tuffaceous sandston and 0.3 m of calcareous marl /also tuffaceous!/ can be observed to contain Miliolidea species. Bed 20 /0.6 m/ is represented by dirty-white lime-mud with greenish bentonitic veinlets and nodules and, at the base, with pumice fragments and, less frequently, with tiny representatives of Miliolidea.

The Upper Badenian sequence ends with 0.4 m of lime-mud with traces of plant roots /Bed 21/.

The Sarmatian sequence begins with Bed 22 /0.3 m/ which conformably overlies the afore-mentioned formation, being lithologically quite different from the Upper Badenian: light grey quartzose medium- to small-grained sand. A yellowish-white marly sandstone sequence is the next with sandstone banks containing lumps of pumice and mollusc-imprinted beds with an assemblage typical of the Sarmatian /Volhynian/.

In the exposure cut into the "Király-vágány", part of the railway-delta site, the coral reef is absent, being replaced here by an isochronous, more offshore counterpart of the reef facies: a tuffaceous, foraminiferal sandstone of 0.7 m thickness /Bed 3/ and a tuffaceous foraminiferal sand bed of 1.0 m thickness /Bed 4/. Higher there is 0.3 m of sandstone /Bed 5/ with philobrackish molluscs /Terebralia bidentata lignitarium, Pirenella nodosoplicata, Loripes dujardini/ marking the end of the first subcycle. Above it there is 0.5 m of pumice-tuffite /Bed 6/ which corresponds to the 0.2 m thick formation overlying the reef. It is followed by 0.2 m of freshwater calcareous marl /Bed 7/ of lenticular development with terrestrial gastropods. The remaining part of the profile is identical with the sequence of the "lower track" site.

STOP 2

The profile of the "Kereszturi Street" site farther north is parallel to the section of the railway-cut, but it is exposed only from the "main sand" /Bed 11 in the railway-cut/ down to the very base of the Sarmatian. The "main sand" /Beds 1--3/ abounds with Foraminifera /overwhelmingly Borelis melo/ and contains rather unfrequent Pecten forms /Flabellipected leythajanus/, consisting of tuffaceous sandstone at the base and of sand at the top. This is overlain, in 0.5 m thickness, by Ervilia Limestone /Bed 4/ which is strikingly porous owing to the dissolved shells of Ervilia taxa. Philobrackish species other than Ervilia are also present. In addition, stunted, juvenile specimens of forms favouring waters of higher salinity can be also confound in the rock.

The lower part of the "Lower Cerithium Limestone" /Beds 5--8/includes black, bituminous limestone detritus /"black pebbles"/ and Cerithium-bearing /C. turonense/ beds, grading upwards into an obliquely stratified microoncoidal limestone. The next subcycle overlies this unconformably, with basal clasts. The detrital limestone bed is overlain by a bryozoans-matted limestone bed /Nos 9--10/ /0.2 m/ which passes upwards into 0.6 m of tuffaceous, unconsolidated, calcareous, Cerithium-bearing sandstone /Upper Cerithium Beds/ with subjuvenile specimens of C. europeum and philobrackish forms as well as pumice fragments. To be seen above this is a Bryozoan-detrital bed /Bed 12/ with Miliolidea.

This is followed by 0.4 m of greenish-coloured, slightly bentonitized tuffite /Bed 13/.

The rough surface of the tuffitic layer is overlain in a thickness of about 0.6 m by coarse clastics in which the clasts of tuffs and lime-muds reworked in situ are to be found /Bed 14/, representing the basal detritus of the Sarmatian sedimentary sequence, unconformably overlying the Upper Badenian sequence. Higher up /Bed 15/ thin sand and limestone bands will follow with fragments of pumice. The limestone bands grow thicker higher up in the profile and they contain the external moulds of Mollusca species that are diagnostic of a Sarmatian age.

Radiometric dates

Based on separated biotite of two samples from the sequence under consideration, the radiometric age determination was carried out by the staff of the Institute of Nuclear Physics of Debrecen /Kadosa Balogh and his associates/ who used the K/Ar method. The lower bed /Király-vágány No. 6/ gave a result of 15.6 $\pm$ 0.8 Ma B. P. The upper one /Kereszturi Street, No. 1--3 = Lower Track, No 11/ yielded a result of 13.4 $\pm$ 0.6 Ma B. P. The first value coincides with the dates obtained for the Upper Karpatian--Lower Badenian rhyolite tuff ejections /Tar Dacite Tuff Formation/, whereas the second one is by and large identical with the expected geological age. Thus the tuff of the lower bed probably derives from redeposition of an underlying tuff deposit of wide occurrence, whereas that of the upper one may be regarded for the most part as the product of a fresh ejection.

Paleogeographical conclusions

The coral reef must be considered to have been formed at the lower limit of a seawater of normal salinity /about 30 ‰/. This is suggested by the almost exclusive presence of a coral genus /Porites/ which best endures such a salinity /or even likes it/ and by the small stature of the euhaline Mollusca species. After the formation of the reef a marked reduction in salinity and eventually terrestrial sedimentation took place. A new transgression follows which was characterized by a rich fauna of normal salinity. The end of a new subcycle is marked by the upper brackish faunal assemblage of Bed 10b. The "main sand" marks the start /Bed 11/ of a new subcycle /with basal clasts/. Higher up in the profile, this one passes into a definitively brachyhaline sedimentary sequence. At its base the Cardium-Evilia limestone in the railway-delta exposure is found. This corresponds to the Ervilia limestone /Bed 4/ of Kereszturi Street. Both occurrences are b rackish-water deposits, but the deposit of Kereszturi Street was formed in a more shallow-water environment of lower salinity. Farther north, along Kerepesi Street, in Örs Vezér Square, a limestone with a rich marine fauna occurs, representing an isochronous facies counterpart of the Erviliabearing and the "Lower Cerithium" sequence deposited in deeper waters of normal salinity.

In formations of more reduced salinity a lot of forms of Mollusca indicative of connections with the Eastern Paratethys /e. g. Cardium ruthenicum, C. praeplicatum, C. platovi, Mactra basteroti konkensis, etc./ were found. The "Upper Cerithium Beds" correspond to the Upper Konkian /= Veselyankian, Buglowian/ beds of the Eastern Paratethys, whereas the beds underneath are correlated with the Lower Konkian /Sartaganian/ beds. These observations are in agreement with the results obtained in other part of the country.

STOP 3

JÁSZBERÉNYI STREET, BRICK-YARD CLAY PIT

/J. FARKAS-BULLA, Á. JÁMBOR/

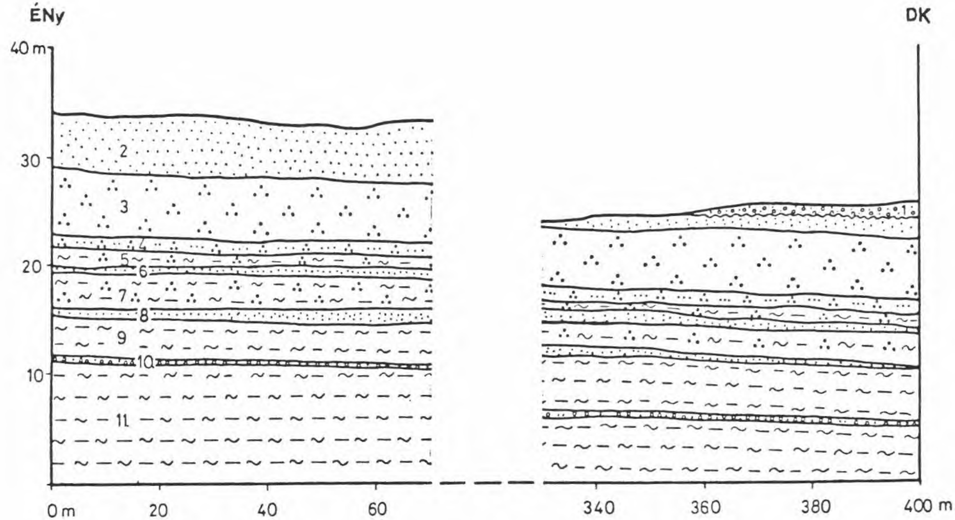
In E Budapest, Pannonian deposits have been extracted for brick-laying formany decades now. The best exposure is presently available on the S side of Jászberényi Street, where the Upper Pannonian /Pontian/ sequence is visible in 35 m thickneşs as exposed in a 400 m long wall. The sequence is made up here of alternating bluish-grey claymarls, silts and fine-grained sands dipping at 4--5^{o} SE /Fig. 28/.

The lowermost 15 m of the profile have been assigned to the Somló Formation. Lithologically, these beds are constituted by a rather uniform sequence of bluishgrey claymarls, claymarly silts, and silty claymarls interbedded with 10 to 15 cm thick layers of small gravels, and muscovitic, limonite-dotted sandstones. This interval is intersected by a steep fault recording a dislocation of a few decimetres and dying off higher in the profile.

The argillaceous and sandy beds, too, are rich in Mollusca remains. In addition, the sand layers contain coalified vegetal detritus and even log fragments.

As determined by M. Korpás-Hódi, the most frequent Mollusca remains in the Somló Formation are: Limnocardium apertum, L. secans, L. penslii, Congeria rhonboides, C. ungulacaprae, Dreissensiomya intermedia, Phyllocardium complanatum. The site is the only place in the central Pannonian Basin, where the afore-mentioned two Congeria species have ever been found together.

The about 20 m assigned to the Tihany Formation in the section of this exposure is composed of alternating bluish-grey claymarly silts, silts and fine- to small-grained sands. The sand layers are cross-bedded, being rich in muscovite and coalified-limonitized vegetal detritus. The contacts, as a rule, are quite distinct, the thickness of the individual beds is unsteady, though its alteration is slow in the section.



PLEISTOCENE: 1. Yellow sandy Danube gravel
PLIOCENE, Dunántúl Group
2. Grey small- to fine-grained cross-laminated sand
3. Grey well-sorted silt
4. Grey silty sand
5. Grey claymarly silt
6. Grey fine-grained cross-laminated sand
7. Grey claymarly silt

(2–7: Congeria balatonica Horizon)

8. Grey, yellow-patched, small- to fine-grained, cross-laminated sand with Mollusca remains
9. Bluish-grey mollusc n claymarl
10. Grey, yellow-patched molluscan sandy gravel
11. Bluish grey molluscan claymarl

(8–11: Congeria ungulacaprae Horizon)

Fig. 28. Profile of the clay pit, Jászberényi Street, Budapest–Kőbánya

The beds of the Tihany Formation contain comparatively fewer Mollusca remains, though their preservation state is similar to that, observed in the Somló Formation. As determined by M. Korpás-Hódi, their forms include: Melanopsis decollata, Congeria triangularis, C. sp., Limnocardium sp.

The sand beds contain fewer fossilc than the sediments of clay size do, the uppermost sand layer is unfossiliferous.

The Pannonian sequence is followed by an erosional unconformity, after heavy denudation, by Lower Pleistocene limonitic, fluviatile, coarse gravels, gravelly sands, etc. which were deposited here by the Danube. This formation has developed into a terrace due to a subsequent emergence.

The sequence, visible in the exposure, epitomizes rather well the mean basin-marginal facies of the Pannonian. At the base the deposition of the sediment was taking place still under shallow-sublittoral, brackish-water environmental conditions of an open inland sea. Eventually, as observable in the upper part of the section, already substantially more shallow-water deposits were accumulated, testifying to overall emergence of the remote source area.

STOPS 4--5

ZSÁMBÉK BASIN /TINNYE, SŐREG, BUDAJENŐ/

J. BODA, M. BOHN-HAVAS, J. FARKAS-BULLA, Á. JÁMBOR, A. KORECZ, I. KORECZ-LAKY, M. KORPÁS-HÓDI, CS. RAVASZ

The area to be presented here is the Zsámbék Basin: a Paleogén-Neogéne intramontane depression of about 8 X 12 km size elongated in N-S direction on the W side of the Buda Mountains /Fig. 29/.

The Neogene sequence is characterized by a discontinuous Lower and Middle Miocene and a fully developed Upper Miocene /frequently represented by marginal-lagoonal facies/.

STOP 4

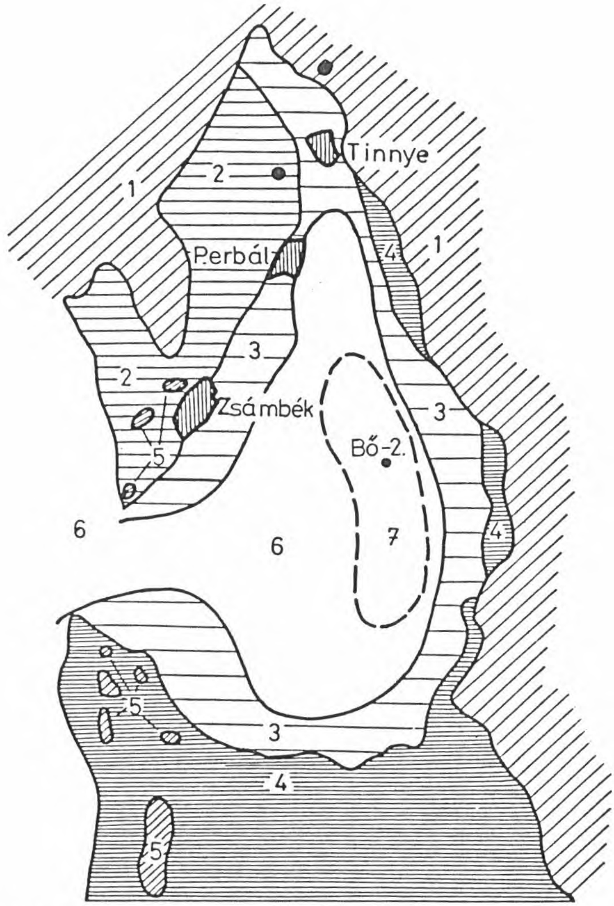
North of Tinnye village, at a distance of km, in a N extension of the basin there is an abandoned sand pit in which a total of 5 m of poorly gravelly, Melanopsis-bearing quartz-sands is exposed, representing the marginal facies of the Pannonian. It is underlain, as exposed by deep-ploughing, by about 5 m of gravels. Above these basal gravels the greyish-white, Melanopsis-bearing quartz sand sequence follows with a sharp contact. This sequence here is small-grained, well sorted and divided by quartz streaks into 0.5 to 2.5 cm thick layers. The fauna of the locality was studied and described in 1903 by I. Lőrenthey.

Gastropoda:

Papyrotheca mirabilis Brus., Planorbis verticillus Brus., P. ptycophorus Brus., P. sabljari Brus., Melanopsis marziniana Fér., M. impressa Krauss, M. vindobonensis Fuchs, M. scripta Fuchs, M. bouéi Fér., M. defensa fuchs, M. sturi Fuchs, M. zujovici Fuchs, M. serbica Brus, M. avellana Fuchs, M. cfr. leobersoderfensis Handm., M. fuchsi Handm., M. stricturata

Fig. 29. PALEOGEOGRAPHIC SKETCH OF THE SARMATIAN LAGOON OF THE ZSÁMBÉK BASIN

Scale = 1:200 000



L e g e n d: 1. Mesozoic-Paleogene formations of the Buda Hills and the Gerecse, in outcrop, 2. Sarmatian littoral oöidic limestone range of the Strázsa-hegy at Zsámbék, 3. Area of occurrence of the Sarmatian littoral oöidic limestone framing the Zsámbék Basin buried under younger deposits, 4. Outcrops of oöidic limestone, 5. Triassic dolomite outcrops on the basin margin, 6. Area of occurrence of central-basin Sarmatian claymarls buried under Pannonian deposits, 7. Organopelitic, evaporitic deposits (with native sulphur) in deeper parts of the basin with the location of borehole Bő–2, ● Stops

Brus., Tinnyea vásárhelyi Hant., Hydrobia vidovici Brus., H. stropida Brus., H. dybowskii Brus., H. vujici Brus., H. minima Lőrent., Micromelania bielzi Brus., Prosothenia pontica Lőrent., Orygoceras cultratum Brus., O. corniculum Brus., Neritodonta pilari Brus., N. zografi Brus., N. unici Brus., Nacella pygmaea Stol., Lamellibranchiata: Congeria partschi Czjz., C. ornithopsis Brus., C. tinnyeana Lőrent., C. ramphophora Brus., C. scrobiculata Brus., C. gitneri Brus., C. mártonfi Lőrent., C. pseudoauricularis Lőrent., C. minima Brus., C. doderleini Brus., Limnocardium robici Brus., L. jagici Brus., L. pseudoobsoletum Fuchs.

The Melanopsis-bearing gravels and quartz sands /Zámori Formation/ are a characteristic facies of the coastal zone of the Pannonian s. l. inland sea, thus being encounterable in many places on the one time basin margin /Transdanubian Central Range, Mecsek, Sopron Mountains, etc./. In the centre of the Zsámbék Basin, they are replaced by silt beds.

STOP 5/A

Sóreg-domb, quarry

It is a type section of the Tinnye Formation representing the upper part of the Hungarian Sarmatian.

For a detailed description of the locality, see: Chronostratigraphie und Neostratotypen. Miozan. M_5. Sarmatien. 1974. Bratislava.

The quarry has exposed about 7 m of characteristic ooidic limestone which is frequently encountered in the Sarmatian of Hungary.

As proved by deep-drillings in the study area, the older Sarmatian is represented underneath, too, and even the Badenian can be found deeper undergroud. Also according to drilling results, the overlying rock is represented by Pannonian deposits.

Rock sequence exposed in the quarry as listed from the bottom to the top:

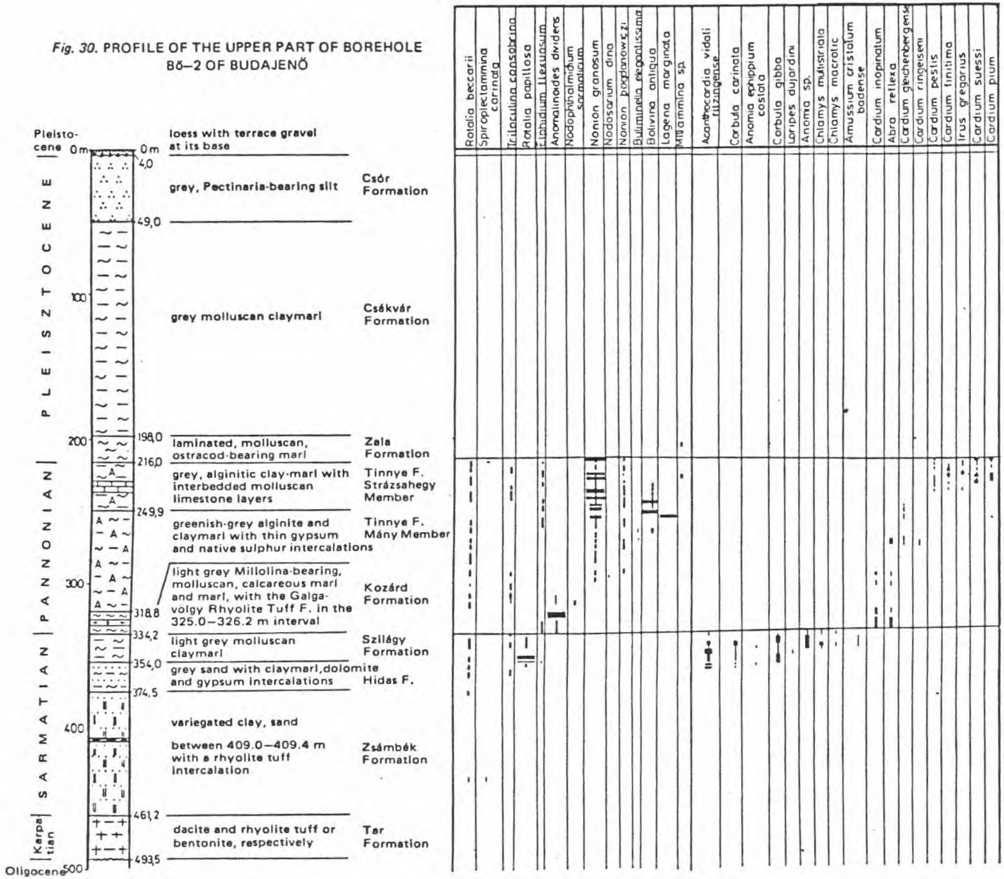
1. 40 cm of yellowish-white, unconsolidated limestone with tiny ooids. The nuclei of the ooids are constituted by representatives of Miliolina /Miliolina limestone/.
2. 30 cm of yellowich-white, unconsolidated limestone with small ooids. The faunal content is quite rich /few species, great number of individuals/. The bivalves lie with their convex sides upwards /biostratonomical feature/.
3. 16 cm of light yellow, unconsolidated lumachelle.
4. 20 cm of yellowich-white, ooidic limestone.
5. 81 cm of whitish-yellow, coarse-ooidic limestone with coasts of bivalves. The nuclei of the ooids are mainly fragments of bivalve shells.
6. 131 cm of whitish-yellow, coarse-ooidic limestone. Locally, casts of gastropod shells occur in oriented position. Spirolina austriaca /Foraminifera/ occurs quite frequently in the ooid nuclei.

7a. 16 cm of green calcareous clay. Its megafauna consists of juvenile gastropods.

7b. 15 cm of greenish-brown clay and green calcareous clay in alternation. The sediment contains lots of Pirenella.

8. 33 cm of yellowish-white, ooidic limestone with Spirolina.
9. 5 cm of unconsolidated, crumbling limestone and, in part, lime-mud.
10. 50 cm of greyish-white, slightly ooidic limestone.
11. 10 cm of unconsolidated limestone and lime-mud.
12. 20 cm of lime-mud.
13. 70 cm of slightly ooidic limestone.
14. 150 cm of redeposited, unconsolidated limestone and lime-mud. Frequent megafossils: Cerastoderma vindobonense latisulcum, Ervilia podolica, Mactra eichwaldi, Modiolus incrassatus, Musculus sarmaticus /coloured/, Solen subfragilis, Gibbula picta, Calliostoma poppelacki, Dorsanum duplicatum, Pirenella picta mitralis. Microfossils: Elphidium hauerinum flexuosum, Rotalia beccarii, Nonion granosum, Spirolona austriaca, Ostracoda sp.

Fig. 30. PROFILE OF THE UPPER PART OF BOREHOLE Bő–2 OF BUDAJENŐ



Complementary remarks:

Lithologically and faunistically, the Hungarian representations of the Sarmatian agree with most of all Austrian and Czechoslovakian occurrences.

The average thickness of the Sarmatian in Hungary is 120 m. Faunistically, it can be split up into two parts.

The older part contains the faunal elements of the Volhynian substage, though it is much poores as far as the number of the species is concerned.

The younger part, which is most frequently thicker, can be characterized, faunistically, by the absence of some species known from the older part /Abra reflexa, Loripes dujardini, Clavatula doderleini, Mohrensternia species, etc./. This two-membered pattern is reflected in the microfauna as well.

The faunal composition of the younger part corresponds to that of the older part of the Bessarabian substage. This is the upper substage of the Hungarian Sarmatian and it has been named Tinnyeian, for Tinnye village, because it is not completely identical with the Bessarabian.

Consequently, the lower part is called Kozardian -- a name based on the type locality by Kozárd village, Cserhát Mountains, N Hungary /it is equivalent with the Volhynian/.

STOP 5/B

Presentation of the core material of borehole Budajenő-2.

The borehole was drilled in the deepest point of the basin, at a distance of about 7 km SSE of this stop-point in 1974. Practically not affected by tectonic deformation, the Neogene beds /dipping at 0--3^{o}/ have a total thickness of 489.5 m in the profile. They unconformably overlie, at 493.5 m, the Oligocene formations dipping at 5--12^{o} underneath, being overlain, similarly unconformably, by 4 m of Upper Pleistocene terrace gravel and loess /Fig. 30/.

The intersected Neogene and Quaternary sequence can be outlined as follows:

11. 0.0--4.0 /4.0 m/ Upper Pleistocene loess with terrace gravel at its base.

Pannonian

11. 4.0--49.0 m /45.0 m/ Csór Formation; grey Pectinaria-bearing silt.
9. 49.0--198.0 m /149.0 m/ Csákvár Formation; light grey molluscan claymarl.
8. 198.0--216.0 m /18.0 m/ Zala Formation; light grey laminated molluscan, ostracod-bearing marl.

Sarmatian

7. 216.0--249.9 m /33.9 m/ Tinnye Formation, Strázsahegy Member; grey, alginite-bearing claymarl with interbedded layers of molluscan limestone.
6. 249.9--318.8 m /68.9 m/ Tinnye Formation; Mány Member; greenish-grey alginite and claymarl with thin intercalations of gypsum and native sulphur.
5. 318.8--334.2 m /15.4 m/ Kozárd Formations; light grey Miliolina-bearing, molluscan limestone and marl. The 325.0--326.2 m interval is spanned by the Galgavölgy Rhyolite Tuff Formation /the socalled Upper Rhyolite Tuff/

Badenian

4. 334.2--354.0 m /19.8 m/ Szilágy Claymarl Formation; light grey molluscan claymarl.
3. 354.0--374.5 m /20.5 m/ Hidas Formation; grey sand, claymarl, with interbedded layers of dolomite and gypsum.

2. 374.5--461.2 m /86.7 m/ Zsámbék Formation; variegated clay and sand with rhyolite tuff intercalations in the 409.0--409.4 m interval.

Karpatian

1. 461.2--493.5 m /32.3 m/ Tar Dacite Tuff Formation /the so-called Middle Rhyolite Tuff/

Oligocene

493.5 m

The formations, intersected in the borehole, are discussed, from the bottom to the top, as follows:

1. The Tar Formation /= Middle Rhyolite Tuff/ is common in the Carpathian Basin owing to the enormous volcanic eruptions that took place in latest Karpatian time.

The similarly variegated, gravel--silt--clay layer of 2.7 m thickness at the very base of the Tar Formation is worth of special attention because it may be regarded as the result of deposition in torrential rain streams immediately after the subsidence of the Neogene basin.

2. The Zsámbék Formation shows a gradual development for the Tar Rhyolite Tuff Formation, the topmost part of which is becoming gradually more and more argillaceous. It is composed of variegated clays and sands with gravel strings. With its geological features, it differs substantially from the marine sequences known from the Transdanubian Central Range and the N Hungarian Central Range. The fact is that the environment here was much shallower and the sediments were being deposited and diagenized here in lagoons that frequently ran dry, similarly to the case to be presented in borehole Szirák 2.

The fauna of the Zsámbék Formation is very poor. Its molluscan remains were represented merely by a few shell fragments. The foraminiferal content is very low, too, though the the assemblage recovered from the 395.1--438.0 m interval made possible its assignation to the Lower Badenian /= Moravian/

/see Fig. 30/.

3. The Hidas Formation is constituted by rocks that are very similar to the underlying rock as far as its granulometric composition is concerned, though both the sand and the claymarl beds are grey in colour. Along with detrital rocks, the formation is interrupted by four thinly laminated dolomite layers and one, similarly laminated, stroncianite-rich gypsum intercalation. These geological features testify to an overal regression that took place in the Middle Badenian in the Paratethys. As a result, hypersaline or, on the contrary, brackish- or even freshwater deposits were laid down in a number of shallow-water bays and lagoons /Wielicien/. The appearance of gypsum and dolomite beds here suggests a temporal landlocking of the Zsámbék Basin lagoon and an evaporation of its waters.

A comparatively rich Upper Badenian foraminiferal and molluscan fauna has been recovered from the beds of the formation. In spite of this fact, the assignation to the Middle Badenian will not be disproved, because the regression "event" in this case is a much more reliable time-marker than the bentonic foraminiferal fauna.

4. The Szilágy Claymarl Formation is constituted by monotonous, light-grey, laminated molluscan and foraminiferal claymarls.

Characteristic species of the foraminiferal fauna recovered from the Hidas and Szilágy Formations are Rotalia papillosa Brady, Borelis melo /F. M./, Borelis rotella d'Orb., and Penelopsis pertusus Forsk.

Molluscs of the Szilágy Formation: Acanthocardia vidali ritzingense, Corbula gibba, Myrthea spinifera, Chlamys multistriata, Amussium cristatum badense.

The Upper Badenian faunas are indicative of a shallow-sublittoral environment of normal seawater salinity.

5. The Sarmatian sequence in this section is tripartite, though in many places elsewhere in the Carpathian Basin only two parts can be distinguished. The first radical reduction in the salinity of the waters of the Paratethyan basin took

place abruptly at the Badenian-Sarmatian boundary. Thus, as a rule, brackish-water faunas with a high number of individuals but a low number of species are characteristic of the entire Sarmatian sequence. The section being visited here shows a different picture. The Lower and Upper Sarmatian contain definitely brackish-water faunas, but in the Middle Sarmatian period foraminiferal fauna, indicating that the salinity of the seawater has become normal, appears. The Mollusca fauna, however, does not show that the waters of the sedimentary basin of the middle part should have become normally saline: in fact, no change in size or in the number of species took place, the deposit has preserved its brackish-water character.

The Kozárd Formation is the oldest unit of the Sarmatian. With its light grey colour, its high /46--70%/ lime content and with the abrupt change in the fauna, it is sharply distinct from the underlying rock, though it evolves from it continuously. The relatively homogenous sequence can be subdivided on the basis of changes in the colour shade and in faunal content. In fact, molluscan beds /Cardium, Musculus and Ervilia mono-valves/ and beds with larger Miliolina can be distinguished. As a proof for an intensification of the evaporation, the $CaCO_3$ content increases from 36% at the bottom to 70% at the top.

The formation contains, in the 325.0--326.2 m interval, a rhyolite tuff body which, in terms of its mode of superposition, geological features and radiometric age /14.1 Ma/ is readily correlable with the Galgavölgy Rhyolite Tuff Formation.

6. The Tinnye Formation, as developed in this section, can be split up into two quite distinct parts. The lower part, the Mány Member, is composed of well-stratified, overwhelmingly greenish-grey to light grey, argillaceous or claymarly, alginitic, laminated microlaminated silt beds which, when fresh, have a "petrol"-like odour and which in accordance with this, contain 3 to 28 % organic matter.

The argillaceous rocks are interbedded with 17 evaporite layers of 2 to 60 cm thickness. In the mineralogical composition of these, along with gypsum, native sulphur /0.9 to 38.9% with an average of 11.5%/ and coelestine /about 1%/ play an interesting role. The proportion of native sulphur was observed to be the highest in the middle part of the bed.

The alginites and evaporites testify to that the Sarmatian lagoon of the Zsámbék Basin was occasionally locked away from the rest of the sea and that it was then eutrophized and then evaporated. The intraformational breccias prove that the lagoon in two cases was completely dried up, and that the dessiccation-cracked sediment was redeposited by torrential reinwater streams or by the floods of a returning sea.

7. The Strázsahegy Member of the Tinnye Formation is constituted by greenish-grey, laminated algnitic claymarls and grey molluscan claymarl beds. In addition, the laminated or interformationally brecciated dolomitic limestone intercalations are also characteristic features of the member. The argillaceous rocks, when fresh, smelt with "petrol" here too. The sequence to be seen here represents an isochronous facies counterpart, deposited in deeper water and more offshore environments, that testifies to largely eutrophic conditions, of the type section of Sőreg.

The Sarmatian-Pannonian boundary in the borehole section is worth of particular attention. The laminated marl sequence, with its very tiny Cardium--Limnocardium fauna, represents a distinctly continuous transition between the two stages, though the Diatoma and Dinoflagellata flora and the Foraminifera fauna testify to relatively rapid and quite drastic changes.

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Paleontological characterization of the Sarmatian.

The Mollusca fauna shows features that are quite different from the usually rich and diversified Sarmatian faunas. The predominance of the bivalves is striking, the relatively high specific and individual numbers of the thin-shelled Cardium forms as a contrast to the rare occurrence of the gastropods are conspicuous. In the megafauna the molluscs are predominant, being accompanied by worms /Pectinaria/, fish remains /otholite, fish scales/, coalified leaf casts and vegetal detritus.

Characteristic faunal associations:

296.6--334.2 m: Abra reflexa--Cardium inopinatum. The eponymous species may be accompanied by Musculus sarmaticus, Modiolus incrassatus, Ervilia dissita, etc. At about 272 m new Cardium species appear. It is here that Cardium gleichenbergense, the most marked form of the higher tracts of the profile, makes its first appearance, being accompanied by unfrequent C. ringeiseni. The appearance of the species refers to the upper part of the Volhynian substage, though it may occur in the upper part of the Bessarabian substage as well.

Above 239 m, Cardium suessi, C. finitima and C. pesti appear with simultaneous appearance of transitional forms.

Above 224 m, a new change can be observed which is characterized by the disappearance of Cardium gleichenbergense and the entry of two new species /Cardium sarmaticum and C. pium/. The association is dominated by the eponymous forms, though C. suessi and C. finitima occur quite frequently, too. The associated fauna is characterized by an occasional increase in the individual number of Irus species.

Biostratigraphic evaluation:

Borehole Bő-2 has intersected the entire Sarmatian /Kozardian--Tinnyeian/ at least in the Hungarian sense. The formations characterized by the Abra reflexa--Cardium inopinatum assemblage are dated as Lower Sarmatian /Volhynian/, whereas the C. saematicum--C. pium association refers to the part Lower Bessarabian substage. The first appearance of C. gleichenbergense certainly corresponds to the Lower Sarmatian /upper part of the Volhynian/, whereas its becoming predominant marks the upper part of the Hungarian Sarmatian.

8. The visited profile includes practically the full succession of the Pannonian /= Lower Pannonian/. From the lithostratigraphic point of view as already mentioned it is divided into three parts. All the three formations are argillaceous deposits and all are fossiliferous. Their Mollusca and Ostracoda faunas and their microplankton and Diatoma floras agree very well with the average pattern typical of the deposits of the Pannonian inland sea, testifying to continuous regional reduction of salinity.

The Zala Formation evolves quite continuously from the somewhat darker grey, Sarmatian laminated marls and their bulk shows, similarly, seasonal fine lamination features, though massive intercalations also occur within the monotonous marl and claymarl sequence. The $CaCO_3$ content of the beds in question is 55--60%, falling below 30% only in two cases. The proportion of the clay fraction is strikingly high as compared to other regions, varying between 60 and 82%, so that the amount of the silt fraction is as low as 18--40%. The formation contains the following characteristic fossils: Mollusca: Limnocardium praeponticum, Planorbis praeponticum, Lymnaea croatica, Ostracoda: Amplacypris sp., Candona sp. and Leptocythere sp.as well as Pectinaria ostracopannonicus and Y-shaped ichnofossils.

The most characteristic, zonal index form of the microplankton flora is, as determined by M. Sütő-Szentai, the Pleurozonaria ultima.

Some Foraminifera species have been found, too. All belong to the genus Miliolina.

9. The Csákvár Formation is dominated by argillaceous rocks such as claymarly silt and silty claymarl. A feature diverging from the mean Pannonian pattern is lent to this formation by the occurrence of three intercalated huminitic clay layers testifying to the nearby presence of marshland environment. This phenomenon is in agreement with the reduction of water depth suggested by the Mollusca fauna /there are lots of gastropods/ and also with the basin marginal occurrence of the transgression.

This formation is, that, correlated with the Zámor Formation we could see in a sand pit by Tinnye village. Together with the sedimentological features, the richness of the Mollusca fauna, the Melanopsis forms, and the presence of Orygoceras also testify to this fact.

The Ostracoda fauna is characterized by the high frequency of Hungarocypris and Cyprideis pannonica /A. Korecz/. The most frequent and at the same time the zonal index fossil form in the microplankton is Spiniferites bentori ssp. pannonicus /M. Szentai/.

10. The Csór Silt is also characterized by a monotonous composition. However, the silt fraction is always preponderant as compared to the clay fraction in the grey beds under consideration. The monotony of the formation is interrupted by the intercalation of some argillaceous, huminite-stained silt layers.

The most characteristic and abundant fossil in the Csór Formation is an arenaceous Pectinaria genus which is difficult to observe. It is primarily in the well-sorted silt beds that this form occurs in abundance, and can be observed as a structure resembling to a compressed tube, 5 to 8 mm wide, parallel to the stratification. The animal, when alive, was coating its organic tubular body by agglutinizing silt grains and as a result of the decomposition of the organic matter after the death of the animal, its one time existence can be inferred only from the oriented pattern of the silt grains.

The age of the formation is delineated by the Mollusca and Ostracoda fauna belonging to the Upper Pannonian s. str. and by the microplanktonic flora marking the Middle Pannonian s. str. /Spiniferites bentori - Pontidinium pécsváradensis/.

The faunal associations represent all three biostratigraphic horizons of the Pannonian.

Lower horizon: 215.4--199.2 m Limnocardium praeponticum
Middle horizon: 199.2--51.8 m Orygoceras-Melanopsis
/regressive/
Upper horizon: 51.8--4.0 m Parvidacna laevicostata
/transgressive/

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