A review of the Hungarian Middle Cretaceous key and reference sections

Übersicht der Basis und Referenzprofile der Mittelkreide Ungarns

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Mit 21 Abbildungen

Abstract. From the 10 comparatively well-known lithostratigraphic units of formation rank of the Hungarian Middle Cretaceous distributed within the major structural units, the author presents a review of the lithological structure, stratigraphy and fossil content of the following seven formations:

- Alsópere Bauxite
- Tés Clay
- Zirc Limestone
- Pénzeskut Marl
- Nagyharsány Limestone
- Bisse Marl
- Vékény Marl

The review reflects the present state of the key section analysis. The surface and drilled key and reference sections of the Tés, Zirc and Pénzeskut Formations (investigations completed), one drilled reference section each of the Alsópere, Nagyharsány and Bisse Formations (investigation largely completed) and the surface key section of the Vékény Marl (investigation in its initial stage) are discussed.

The paper aims to serve as both a frame and basis for the forthcoming publications on the Hungarian Middle Cretaceous of this volume.

Zusammenfassung. Von den zehn relativ gut bekannten lithostratigraphischen Einheiten von Formationsrang der Mittelkreide Ungarns, die sich auf zwei großtektonische Einheiten des Landes verteilen, wird über die lithologische Gliederung sowie Fossilführung der folgenden sieben Formationen berichtet:

- Alsópere Bauxit Formation
- Tés Tonmergel Formation

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- Zirc Kalk Formation
- Pénzeskut Mergel Formation
- Nagyharsány Kalk Formation
- Bisse Mergel Formation
- Vékény Mergel Formation

Die Übersicht zeigt den gegenwärtigen Stand der systematischen Basisprofiluntersuchungen. Dabei werden beschrieben: Die obertags und in Bohrungen erschlossenen Basis- und Referenzprofile der Tés, Zirc und Pénzeskut Formationen, deren Untersuchung abgeschlossen ist, je ein Bohr-Referenzprofil der ebenfalls bereits untersuchten Alsópere, Nagyharsány und Bisse Formationen sowie das Obertag-Basisprofil der Vékény Mergel Formation, deren Untersuchung noch in ihrem Anfangsstadium ist.

Die Publikation bildet den Rahmen und die Grundlage für die anschließenden Beiträge.

1. Introduction

This review has two aims. On the one hand it is supposed to provide an adequate basis and frame for the following special stratigraphic or even paleogeographic and ecologic papers. On the other hand, it reports on the work already accomplished on this subject.

Before acquainting ourselves with the sections, we should briefly deal with the state of Middle Cretaceous research in Hungary. The formations described here occur in three zones of two tectonical units (Fig. 1), in the Transdanubian Central Range zone of the Central Range unit and in the Mecsek and Villány zones of the SE Hungarian or Tisza unit. On the surface, Middle Cretaceous formations occur only in the Transdanubian region, mainly in the Transdanubian Central Range.

Our official stratigraphic table (Fig. 2) includes at present 10 formation-rank lithostratigraphic units, their greater part may be found in the Transdanubian Central Range, although additional 2–3 occurrences are known from the Mecsek zone in the continuation of the Alföld.

From the originally planned 11 borehole sections 7 have been processed; work is now in progress on two further sections. Plans are being made to replace the two remaining boreholes with new ones in the less known Mecsek zone. In the frame of a national key section programme, several sections were exposed on the surface. Six of these have been investigated in detail and are maintained for future work.

The degree of processing of the sections varies according to the potential inherent in them and to the degree to which a need for them exists. Key sections are regularly subject to a complex paleontological and mineralo-petrographical processing, while in the case of reference sections, the sphere of analyses and their volume could be limited to the task at hand.

The results were prepared by either one of two methods: One is the complete recording of all the results, while the other—as stipulated by the Working Group—includes only selected results.

The sections investigated on the surface and from the borehole include six of the 10 well-known units of formation rank. Four of these are in the Transdanubian Central Range (Fig. 3).

2. Description of sections

2.1. Transdanubian Central Range

2.1.1. The Alsópere Bauxite Formation

Borehole Olaszfalu Ot-84 is regarded as the key section of this formation. Here, the 6.7 m thick bauxite layer resting on the Dachstein Limestone Formation reveals a significant erosion (Fig. 4).

Lithologically it may be subdivided into three units: In the lower 0.90 m a red bauxitic clay with limestone debris exists. In the middle part (4.2 m) the structure consists of a smooth or breccia-like brownish-red bauxite, while in the upper 1.6 m we find pisolithic bauxite of "tiger's structure". The allite content, consisting mainly of boehmite and subordinate gibbsite, increases upwards except in the uppermost, resilicified sample. This feature is also well expressed in the modulus Al_2O_3/SiO_2 showing values between 6.5 and 9.1 in the upper unit. The characteristic associated mineral is kaolinite.

Reference sections include two boreholes. Tés Tt-27 (Fig. 4), where the Alsópere Bauxite Formation is again underlain by the Triassic Dachstein Limestone Formation and overlain by the Tés Clay Formation and Padrag Pa-7 (Fig. 5), where the Alsópere Bauxite Formation is represented by thin intercalations within the Zirc Limestone Formation and by the insoluble residue of the limestone.

2.1.2. The Tés Clay Formation

Apart from the terrestrial bauxite sediment mentioned above, the first member of the Middle Cretaceous sedimentary cycle deposited over much of the Central Range is represented by the Tés Clay. Being insufficiently resistant, only its basal beds are eventually preserved in outcrops as in Zirc, Pintérhegy (Fig. 6) and Lókutidomb (Fig. 7). Because of a significant regional difference in its makeup, several reference sections had to be chosen in addition to the original stratotype borehole section (Tés Tt-27; Fig. 8). Merely the 46 m thick stratotype section, built up mostly of variegated pelites with some carbonate, can be subdivided into 9 cyclothems on the basis of its variable grey-mottled colour. The most characteristic macrofaunal element is *Liostrea*. In three horizons it attains a lumachelle-type abundance while other macrofauna is sparse. The most abundant fossils in the stratotype section are Ostracoda. In the grey-coloured layers sporomorphs including even highly developed angiosperms, are frequent. In several localities *Muniera*-like forms ar present in rock-forming quantities. The fossils prove the presence of a brackish-water, subordinately lacustrine sequence with some marine interbeddings.

The reference section in the central part of the basin is the borehole Zirc Zt-61 (Fig. 9). Drilling here penetrated a 62.7 m thick sequence which was less variegated than the former. The ratio of variegated to grey is 0.53. Characteristic are frequent limestone and calcareous marl intercalations as well as sandy layers in the upper part and conglomerates near the base. It may be further subdivided into 9 cyclothems which, however, cannot be correlated to the cyclothems of Tt-27. Its fossil content is richer and more variable than in the former, particularly in the upper part. The macro-

fauna is overwhelmingly represented by brackish-water and euryhaline forms. In addition to a rich Ostracoda assemblage of facies- or stratigraphic index value, a significant amount of Foraminifera, including some planktonic forms and several nannoplanktonic organisms, are also present. In addition to rockforming *Munieria* and abundant fruits of *Chara* other algae can be observed mainly in the upper part of the section. Its sporomorph content is also quite high and varied, with a predominance of pollen grains of relatively highly developed angiosperms. Taking this and the Ostracoda content into account, the age of this formation can be considered to be Middle Albian.

The NW wing of the sedimentary basin is represented by borehole Sur-1 (Fig. 10). The sequence (223.8 m) is the thickest known at present and the ratio of variegated layers to grey ones is 3.55 and therefore higher than in the other sections. Besides of the presence of conglomerates, frequent sandstone intercalations are also characteristic. The number of cyclothems is the highest (25). The fauna is poor.

Three more reference sections exist. The borehole Olaszfalu Ot-84 (Fig. 11) shows a transition between Zt-61 and Tt-27, while the borehole Csehbánya Cseh-13 (Fig. 12) is in many respects more similar to Zt-61. Borehole Urkut U-421 (Fig. 13), with its basal layers consisting of a weathering product and chert detritus of continental origin, reminds us even more of the borehole Zt-61. The overlying 3 m thick brackish-water and marine strata indicate a nearby pinching-out of the formation in a southwest direction.

Only two of the small number of exposures are worth mentioning (although even the others are informative as to the mode of occurrence of the formation). Bentonitic clay was deposited in the karstic cavities of Lower Liassic limestones of the Pintérhegy quarry at Zirc (Fig. 6). This was subsequently overlain by conglomerates including Jurassic and Lower Cretaceous detritic chert pebbles, then by Ostracoda bearing variegated clays with siltstone.

In the Lókut section (Fig. 7) a calcareous bank of *Munieria* lumachelle follows upon the Lower Cretaceous calcareous marl (Biancone facies). It is associated with pebbles at its base. Above it, within variegated layers, bentonitic intercalations several centimetres in thickness can be observed.

2.1.3. The Zirc Limestone Formation

It has an intermediate position within the Middle Cretaceous sedimentary cycle. With its massive or thickbedded development it is rather well exposed at the surface in the northern Bakony facies area, where the formation can be subdivided into three members: The stratotype of the Eperkéshegy Member has been chosen on the Eperkéshegy at Olaszfalu (Fig. 14). It comprises the entire member except for the lowermost layers. In addition to rockforming Pachyodonta (mainly *Agriopleura* species) other bivalves, gastropods, and diverse algae occur.

The greater part of the middle and upper member-rank units is exposed in the Jásd-2 section (Fig. 15). The middle member, mainly of intrapelspary texture, is rich in benthonic Foraminifera, in many cases *Orbitolina*. The member ends with a lumachelle including *Rynchostreon* and worm-tubes. Slightly sandy, glauconite-rich, echi-

nodetritic limestones of the upper member overlie its slightly karstic surface and fill its cavities. The section Bakonynána-1 (Fig. 16) includes the topmost part of the upper member and the base of the Pénzeskut Marl Formation which terminates the sedimentary cycle. Due to rapid pelite and glauconite accumulation and to argillization of the limestone the transition is continuous, although in the portion with smaller nodules one can even observe slightly rounded rock debris. In the uppermost layers of the Zirc Limestone, ammonites of chronostratigraphic value *(Stoliczkaia dispar)* and planktonic foraminifera as well as abundant representatives of Calcisphaerula are present. The section Jásd-1 (Fig. 17) has exposed the same strata with an unconform contact.

In the northern Bakony, the entire formation is exposed in the stratotype section of Olaszfalu Ot-84 (Fig. 11) and in the reference section Pénzesgyör Pgy-5 (Fig. 18).

In the southern Bakony the formation attains its greatest thickness in the borehole Urkut U-421 (Fig. 13). The slightly variegated, thin-bedded limestone is characterized by a predominance of gastropod faunas of varied composition; occasionally even layers with Pachyodonta or Chondrodonta appear. The appearance of *Munieria* and *Chara* is indicative of freshwater or brackish-water influences.

Specific features of section Padrag Pa-7 (Fig. 5) are frequently intercalations of bauxitic marl, the flaming red colour, and the high dolomite content.

2.1.4. The Pénzeskut Marl Formation

This is the final member of the cycle. Its boundary stratotype with the Zirc Limestone is in the Bakonynána-1 section (Fig. 16). The base of the formation is constituted by calcarodetritic, nodular, ammonite-bearing, glauconite-rich limestones passing gradually upward into dolomitic marls with limestone lenses. In the Jásd-1 section (Fig. 17) the bulk of the post-hiatus basal detritus is made up of ammonites or other molluscs. The borehole Jásd-42 (Fig. 19) has been chosen as a stratotype section. The 470 m thick section can be subdivided into three units of quite similar thickness: the lower part is a grey dolomitic marl with dolomitic limestone lenses, in the middle part there are dolomitic marls without nodules, while the upper third is a sequence of alternating siltstones and sandstones. The latter shows an upwards increase in abundance and grain size. The extremely rich micro- and macrofossil content (mainly Foraminifera represented by about 200 taxa and ammonites) decreases considerably in the upper third, suggesting freshwater influences as a result of terminating cycles. While basal detritus is missing in the section, a high glauconite content persists. The reference borehole sections of Pénzesgyö Pgy-5 (Fig. 18) and Olaszfalu Ot-84 (Fig. 11) show the contact of the two formations. Accordingly, a poor detrital basal layer is recognizable in both formations. The glauconite content in the first one is subordinate.

2.2. Southern Transdanubia

Two Middle Cretaceous formations are known from the Villány Mountains and one from the Mecsek Mountains.

2.2.1. The Nagyharsány Limestone Formation

The occurrence of this formation, which is dissected by huge reef bodies of Urgon facies, and is exposed in outcrops and diggings in the Villány Mountains, bears witness to the fact that virtually identical conditions must have prevailed throughout the area from Barremian through Early Albian time.

As a result of selective coring, the borehole Nagybaracska B-27 (Fig. 20) intersected the formation for 38 m (24 m of core). It overlies the diabase found around the Jurassic/Cretaceous boundary. On the basis of the Orbitolina record its age would roughly correspond to the Aptian/Albian boundary.

2.2.2. The Bisse Marl Formation

This formation is known from a single outcrop in the Villány Mountains. It was penetrated by the water prospect well Nagybaracska B-28 (Fig. 20) and is 60 m thick (33 m of core). It was observed to show an anomalous development. The upper part, constituting the bulk of the sequence, is composed of grey feldspar-bearing gravelly sandstones. From this it can be deduced that it may be a single lenticular or tongue-like body enclosed in silty claymarl. In the absence of angiosperms and with a rich fauna of planktonic foraminifera its age roughly corresponds to the base of the Early Albian. The absence of the Nagyharsány Limestone Formation below the Bisse Marl formation may indicate a tectonic hiatus.

2.3. The Vékény Marl Formation of the Mecsek Mountains

The tectonic situation of the unique Middle Cretaceous red nodular marl with calcareous marl and limestone in the Mecsek Mountains has not yet been cleared up (Fig. 21). Enclosed as exotic lenses within the weathered, locally clastic diabase, the formation has been analysed only for its microfaunal content. This examination proved that the marls are of pelagic origin and may thus be assigned to the Lower Turonian. Their detailed analysis will be important even from the tectonic viewpoint.

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Fig. 1

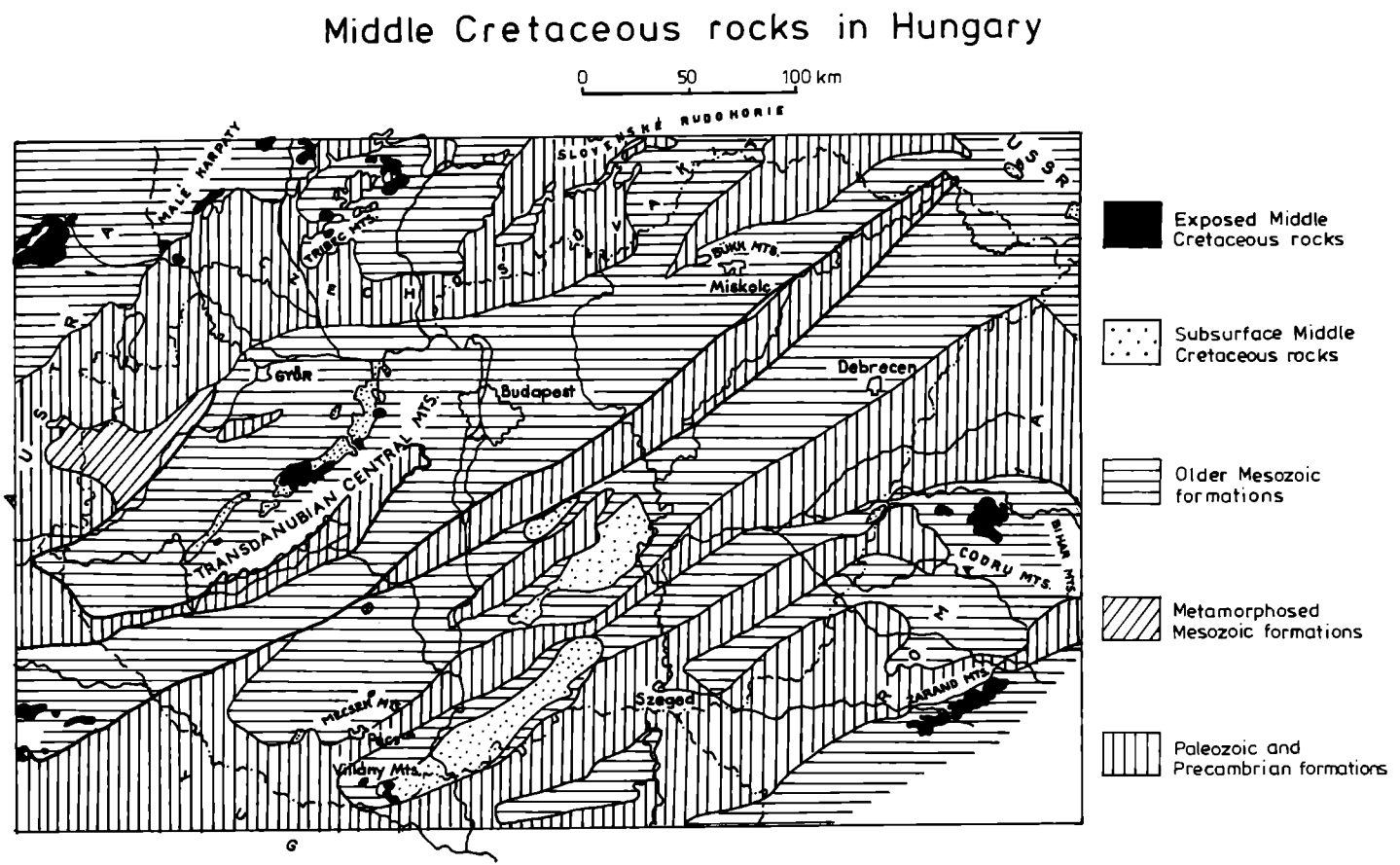

Middle Cretaceous rocks in Hungary
0 50 100 km
MALE KARPATY
SLOVENSKÉ RUDOHORIE
U S S R
BÜKK MTS.
Miskolc
Debrecen
GYÖR
Budapest
TRANSDANUBIAN CENTRAL MTS.
CODRU MTS.
BIHAR MTS.
Szeged
MECSEK MTS.
Pécs
Villány Mts.
BARANYA MTS.
Exposed Middle Cretaceous rocks
Subsurface Middle Cretaceous rocks
Older Mesozoic formations
Metamorphosed Mesozoic formations
Paleozoic and Precambrian formations

Fig. 2

MIDDLE CRETACEOUS FORMATIONS OF HUNGARY

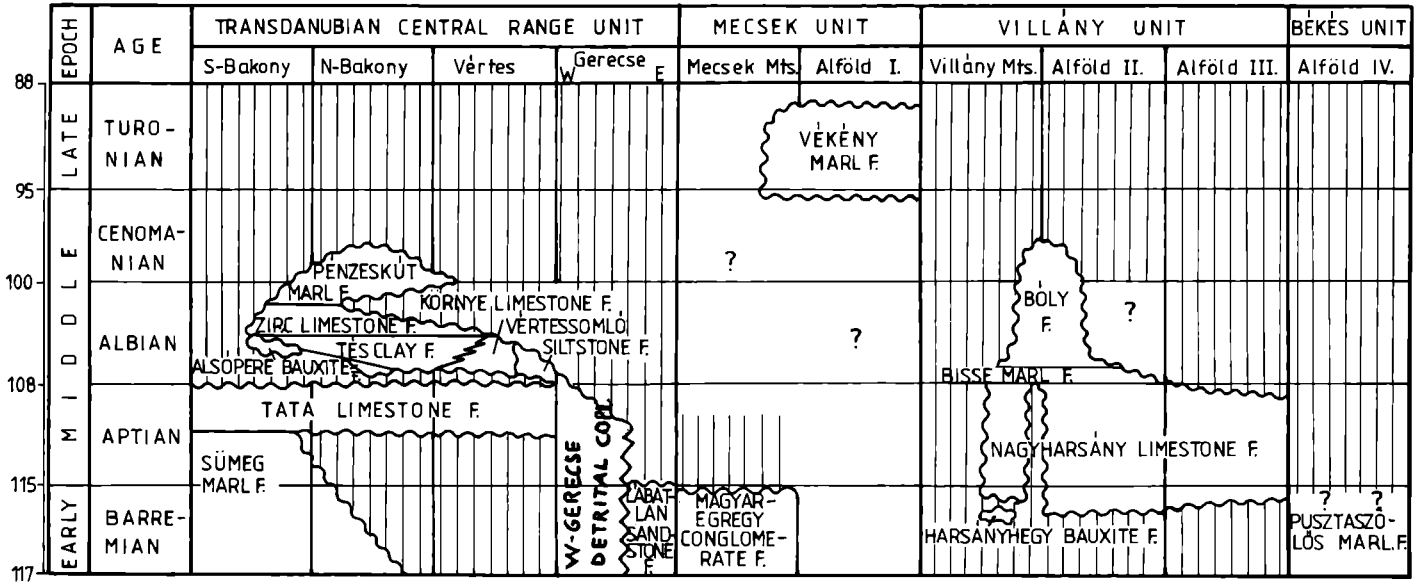


Fig. 3

MIDDLE CRETACEOUS FORMATIONS OF THE TRANSDANUBIAN CENTRAL RANGE

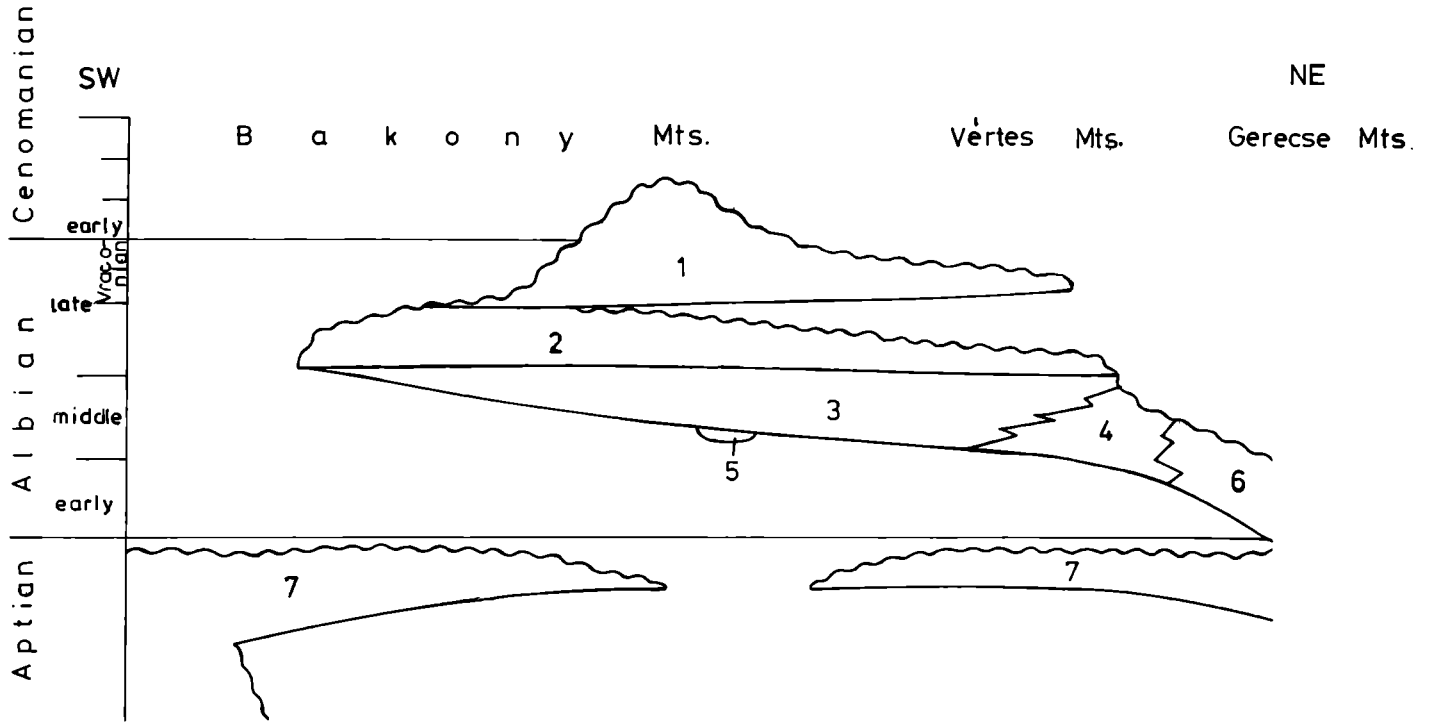
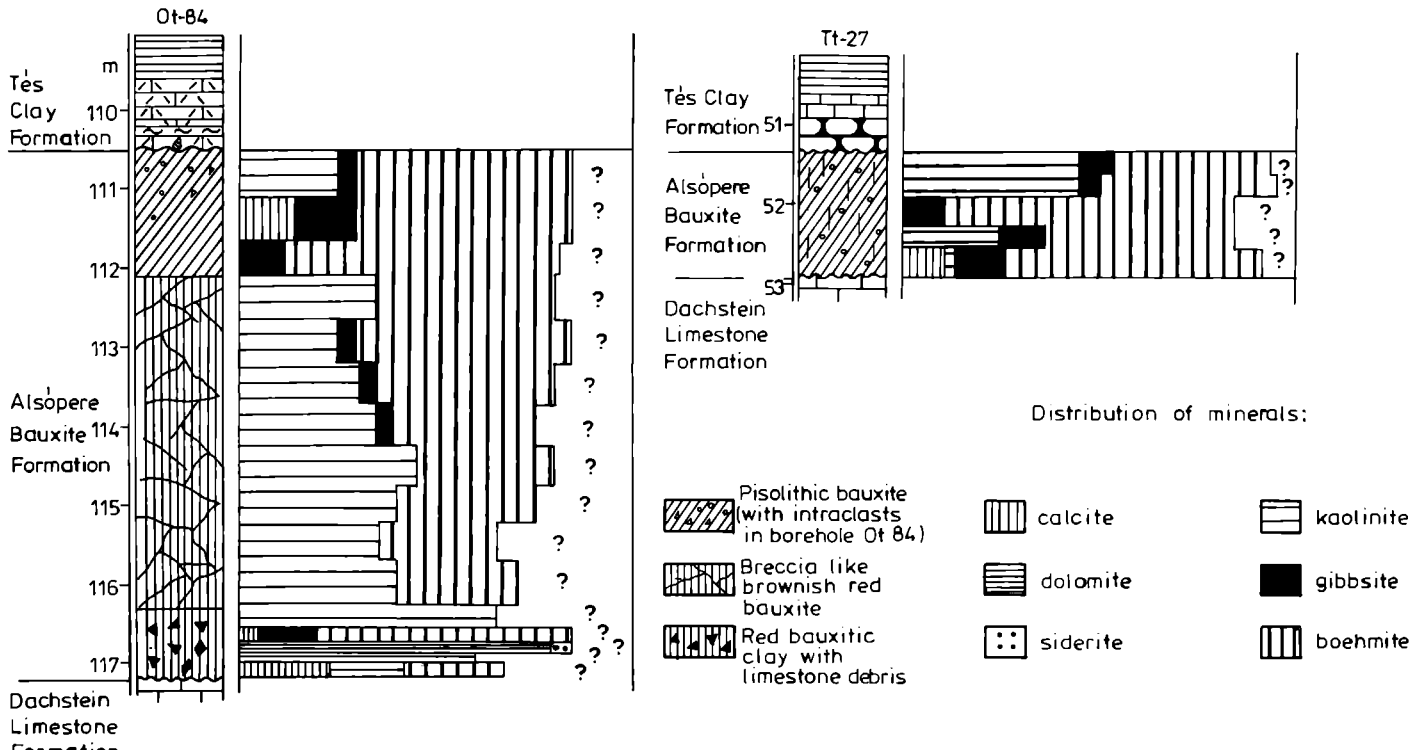


Fig. 4

ALSÓPERE BAUXITE FORMATION IN THE BOREHOLES OLASZFALU Ot-84 AND TÉS Tt-27

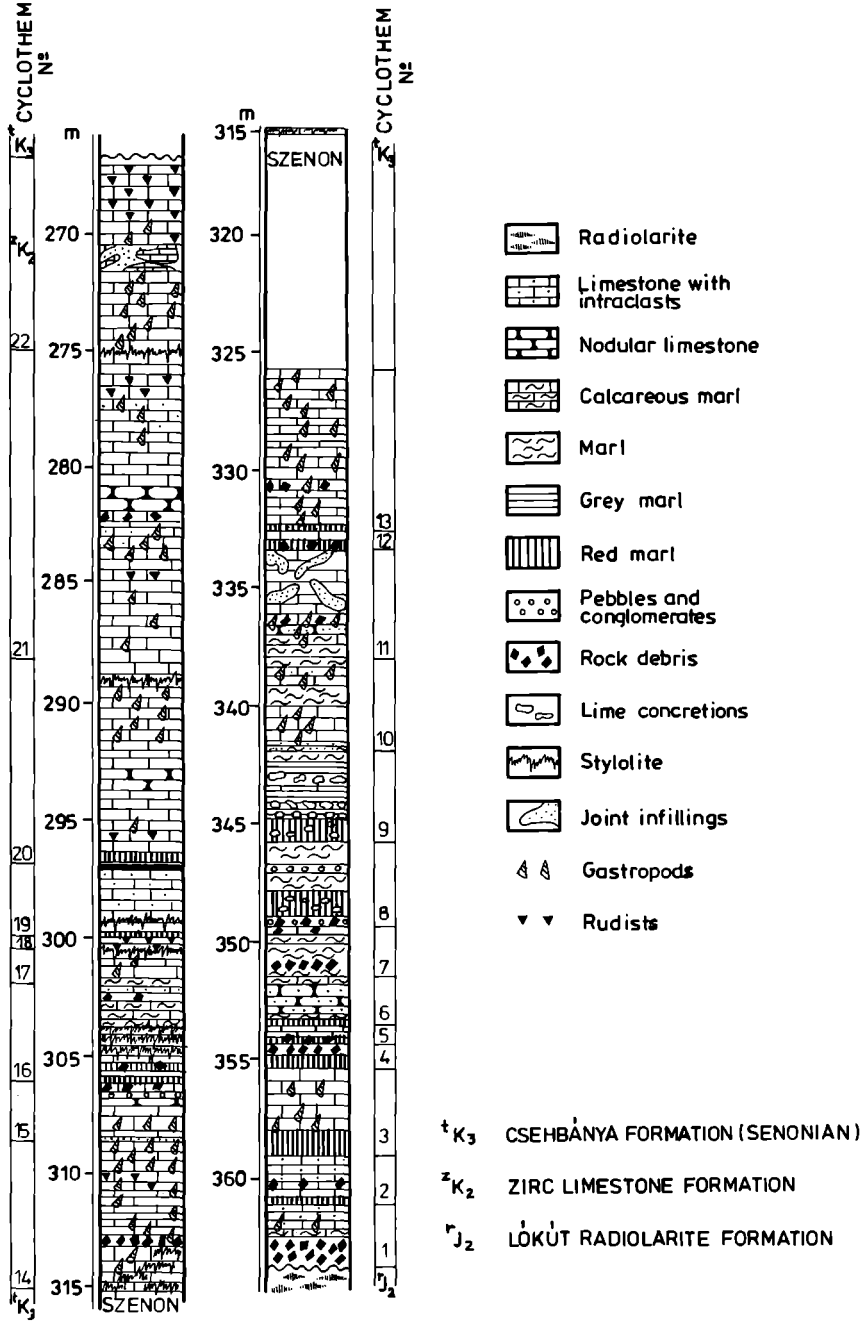


REFERENCE SECTION OF THE ZIRC LIMESTONE FORMATION

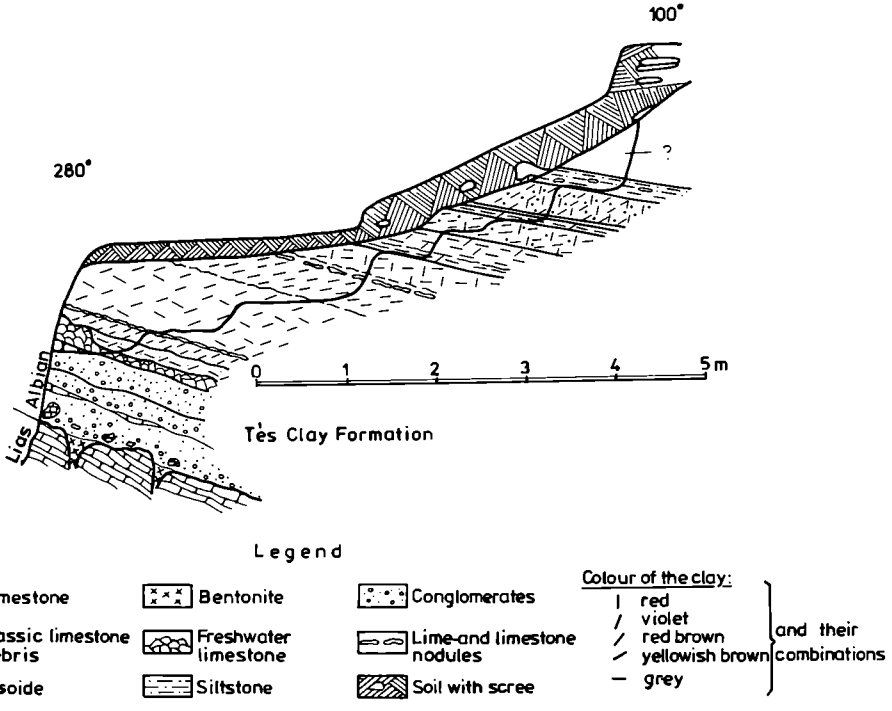
IN THE BOREHOLE PADRAG PA-7

(ÚRKÚT LIMESTONE MEMBER)

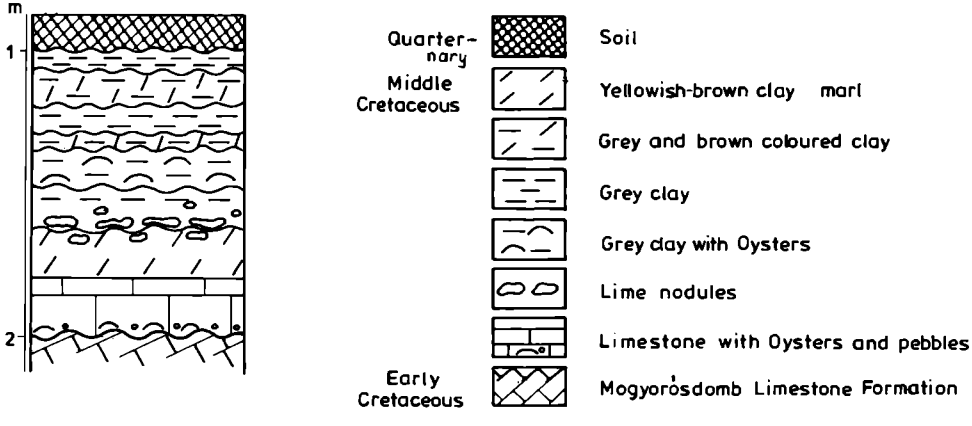
Fig. 5



BASAL LAYERS OF THE TÉS CLAY FORMATION IN THE PINTÉR-HEGY QUARRY AT ZIRC Fig. 6

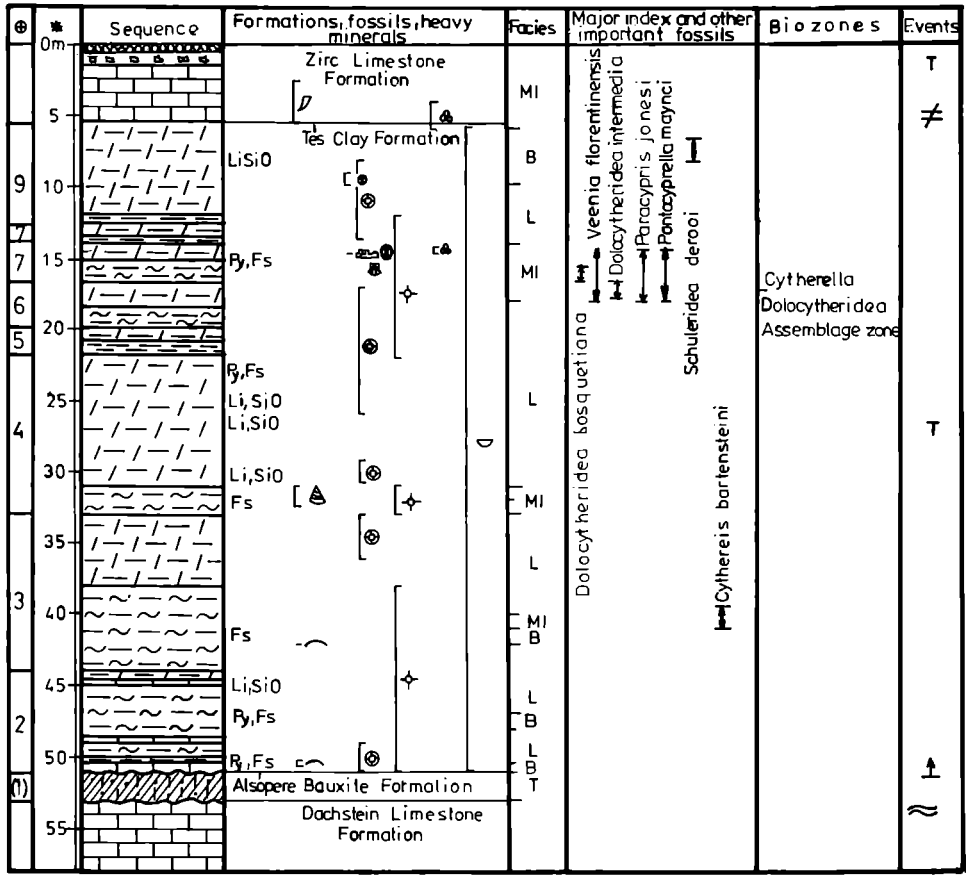


BASAL LAYERS OF THE TÉS CLAY FORMATION ON THE LÓKÚTI-DOMB Fig. 7

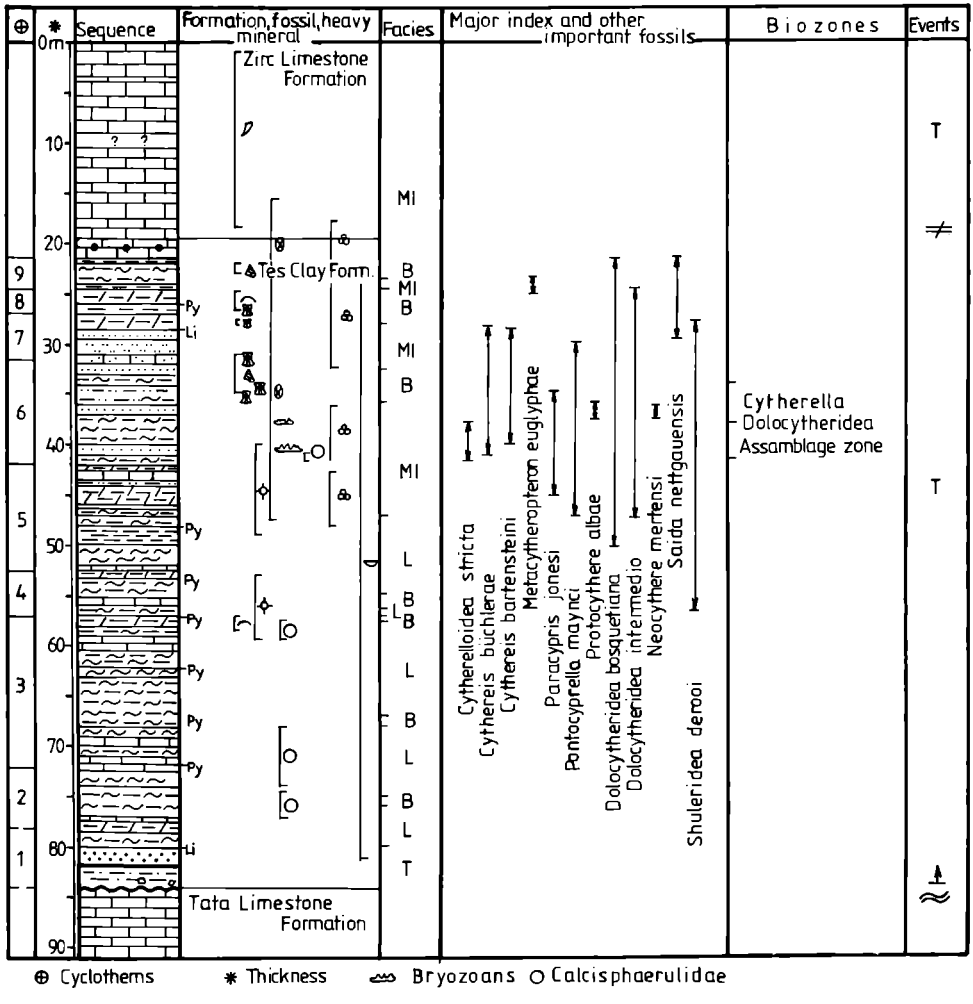


STRATOTYPE SECTION OF THE TÉS CLAY FORMATION IN THE BOREHOLE TÉS Tt 27

Fig. 8



REFERENCE SECTION OF THE TÉS CLAY FORMATION IN THE BOREHOLE ZIRC Zt 61 Fig. 9



REFERENCE SECTION OF THE TÈS CLAY FORMATION IN THE BOREHOLE SÙR Sr-1

Fig. 10

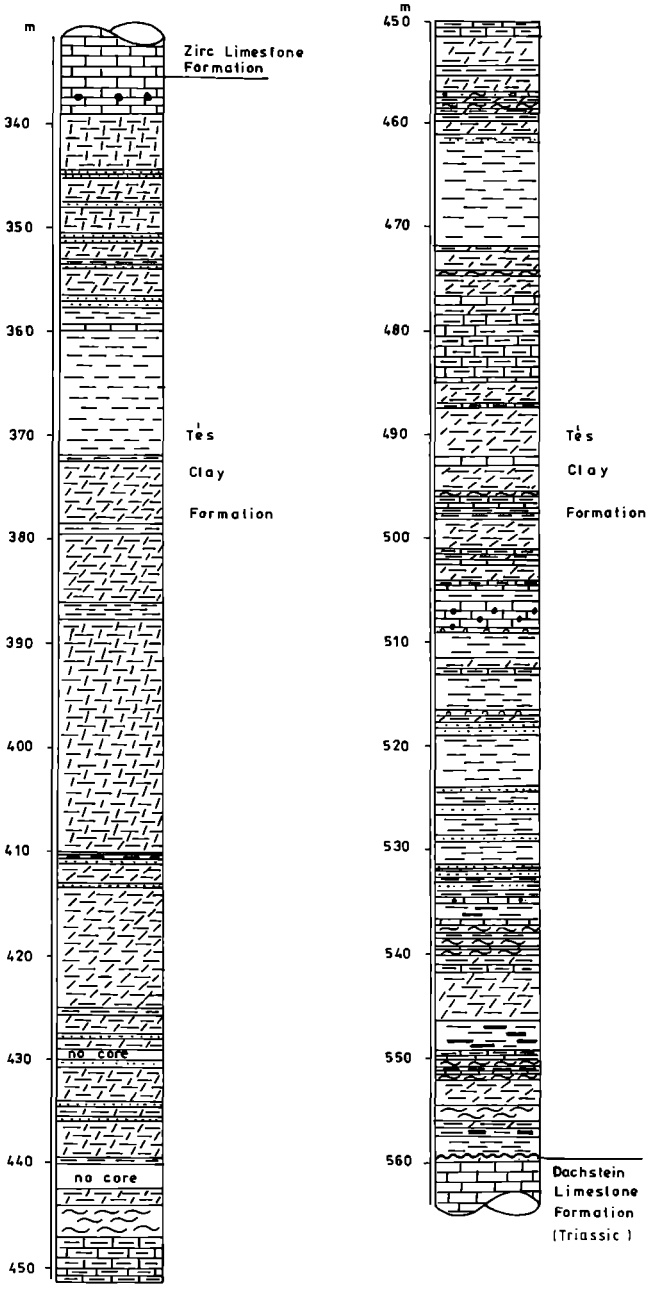
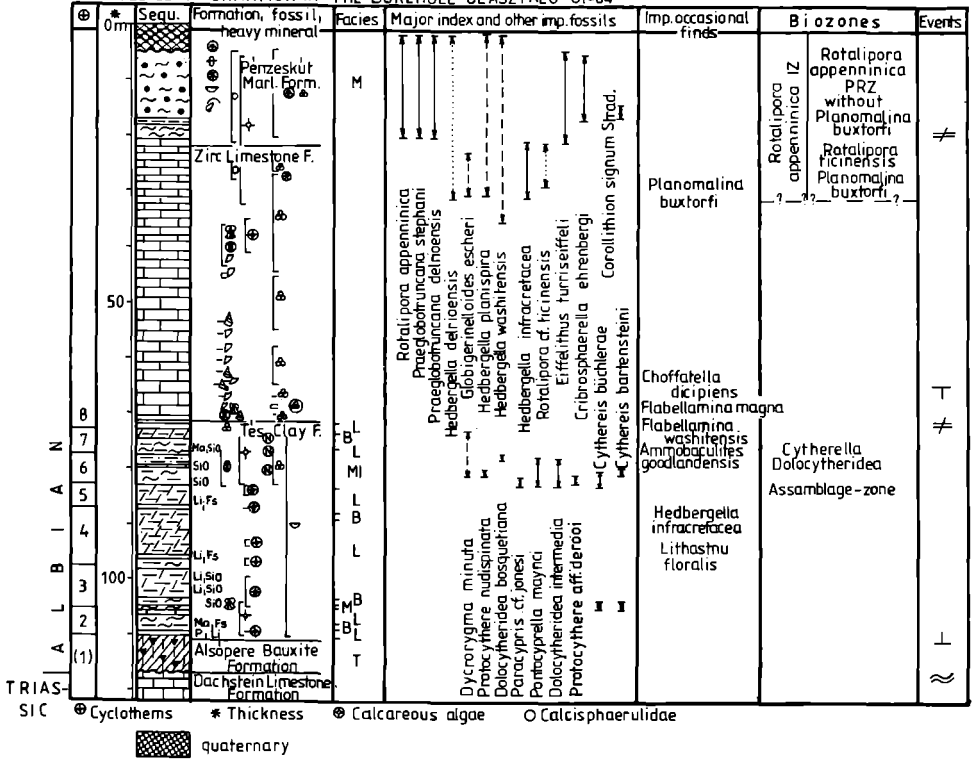


Fig. 11

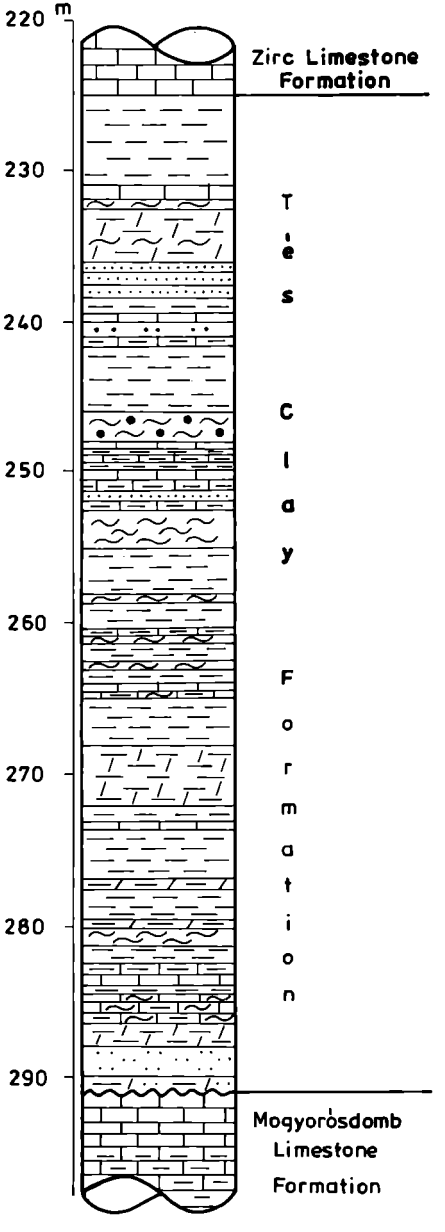
MID-CRETACEOUS REFERENCE SECTION OF THE PÉNZESKÚT MARL FORMATION, ZIRC LIMESTONE FORMATION, AND TÉS CLAY FORMATION IN THE BOREHOLE OLASZFALU 01-84



REFERENCE SECTION OF THE TÉS CLAY FORMATION IN THE CSEHBÁNYA BASIN

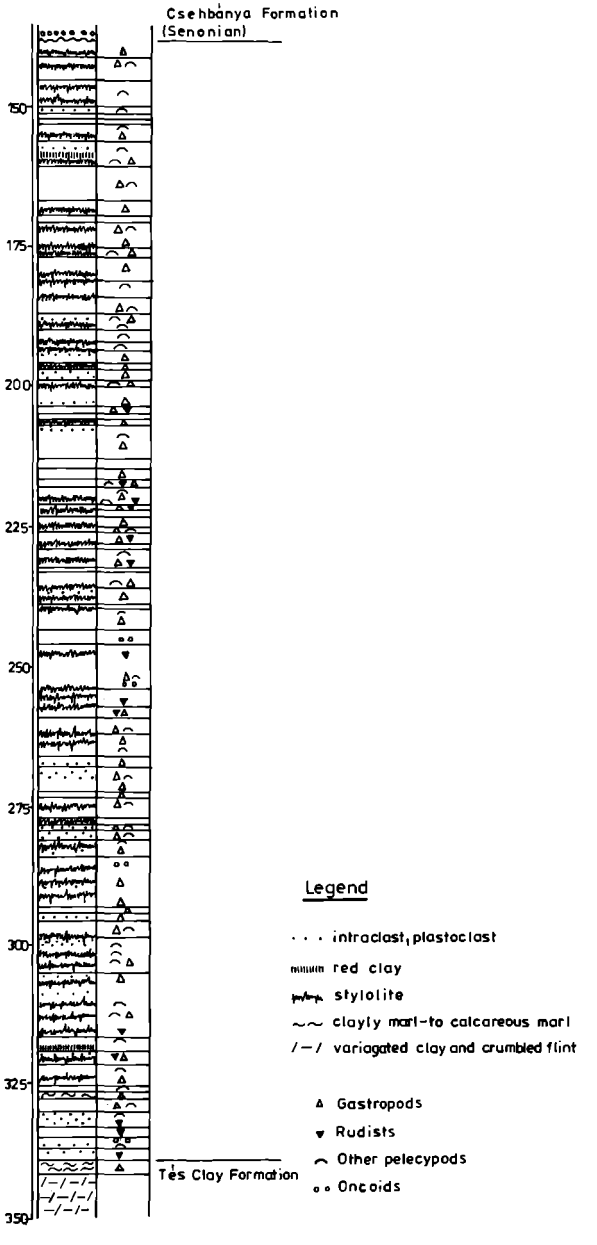
Fig. 12

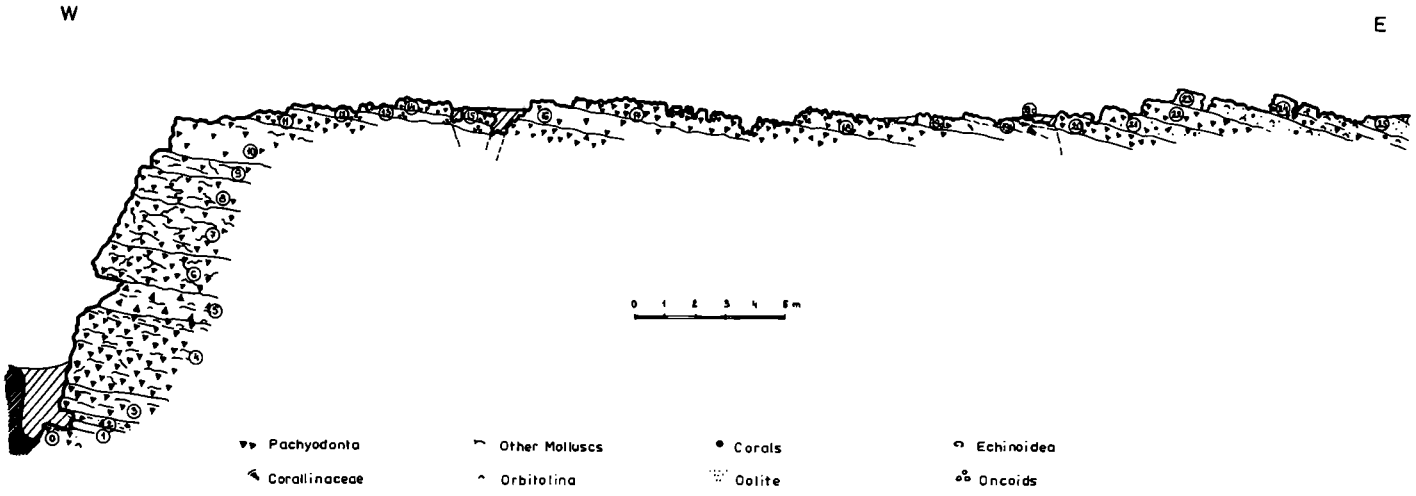
/CSEHBÁNYA Cseh-13/



REFERENCE SECTION OF THE ZIRC LIMESTONE FORMATION IN THE ÚRKÚT BASIN Fig. 13

BOREHOLE 421 NEAR ÚRKÚT





STRATOTYPE SECTION OF THE ZIRC LIMESTONE FORMATION ON THE EPERKÉS-HEGY AT OLASZFALU

MIDDLE PART OF THE ZIRC LIMESTONE FORMATION Fig. 15

IN A QUARRY NEAR JÁSD

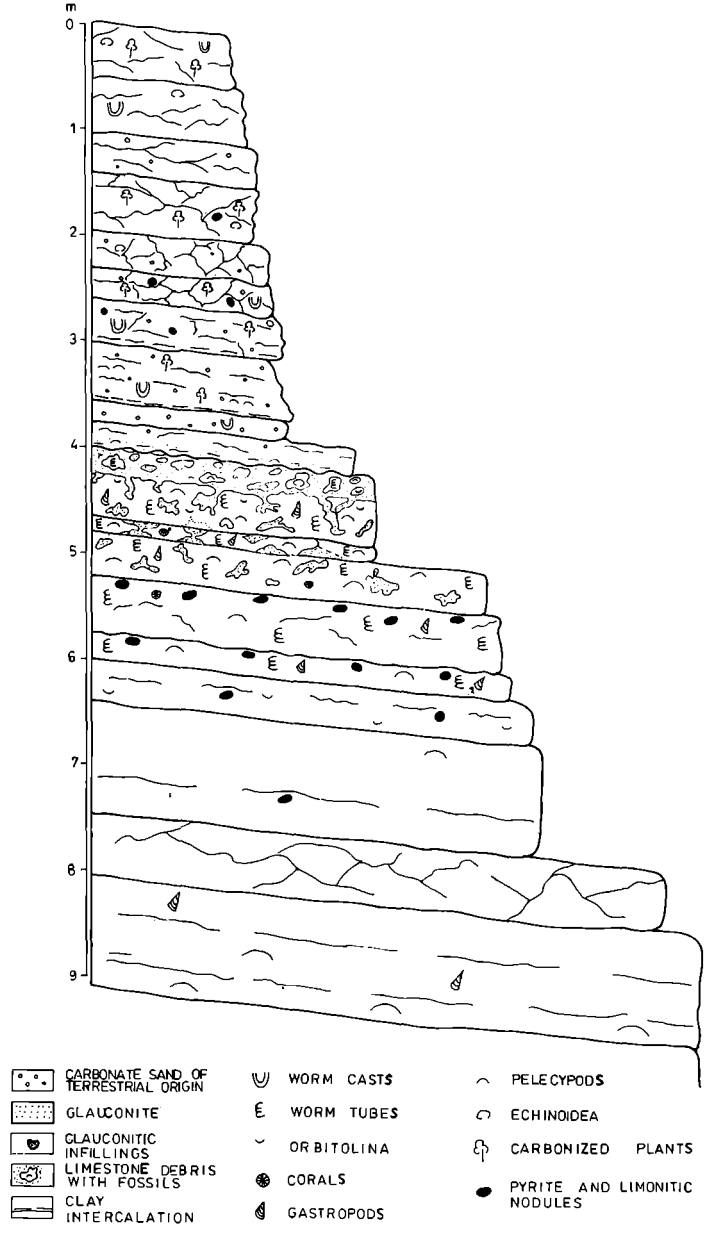


Fig. 16

UPPER MEMBER OF THE ZIRC LIMESTONE FORMATION AND THE BASAL LAYERS OF THE PÉNZESKÚT MARL FORMATION ON THE ZSIDÓ-HEGY BAKONYNÁNA

[BOUNDARY STRATOTYPE SECTION]

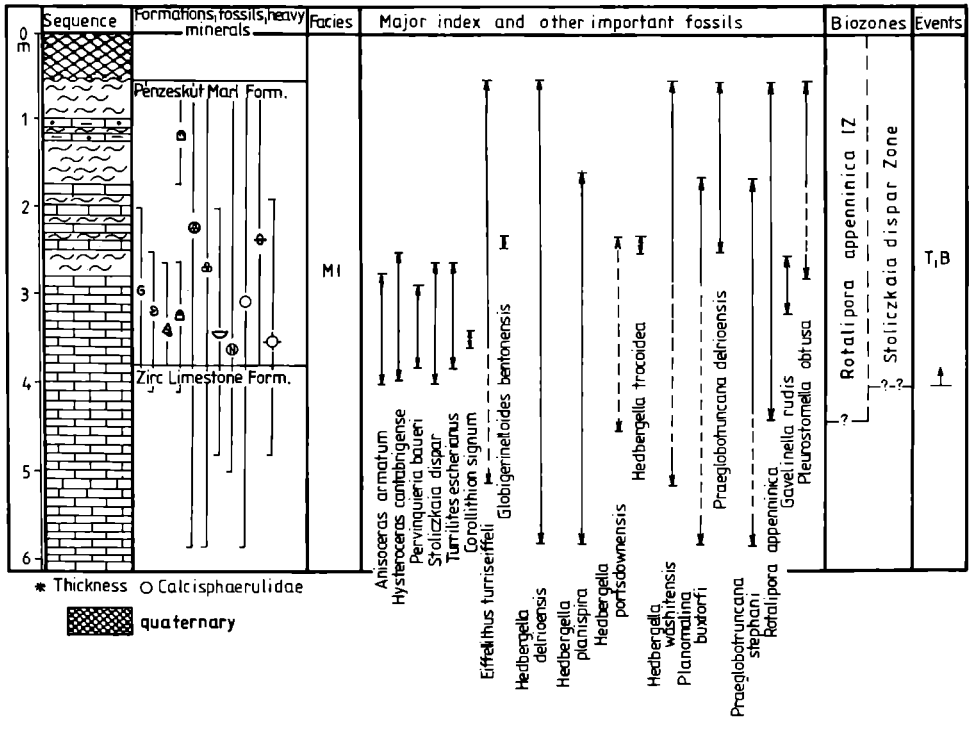
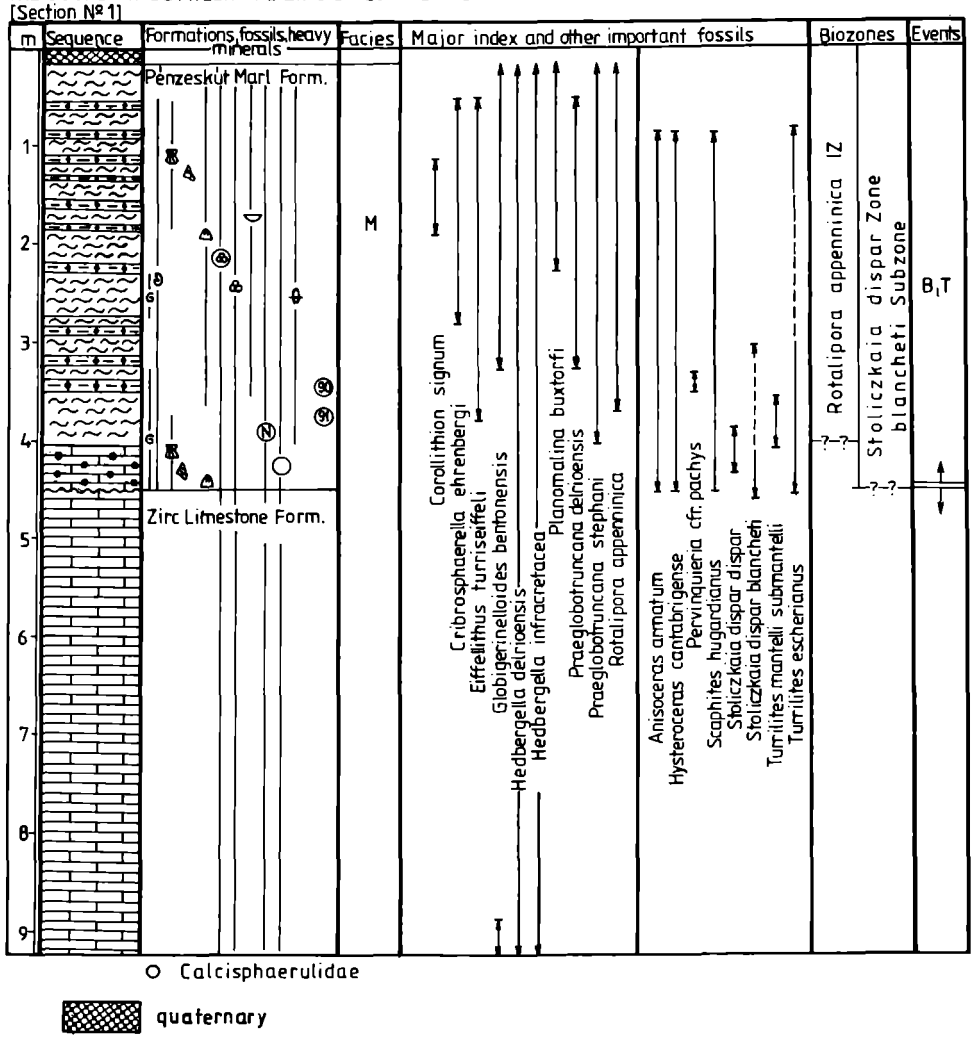


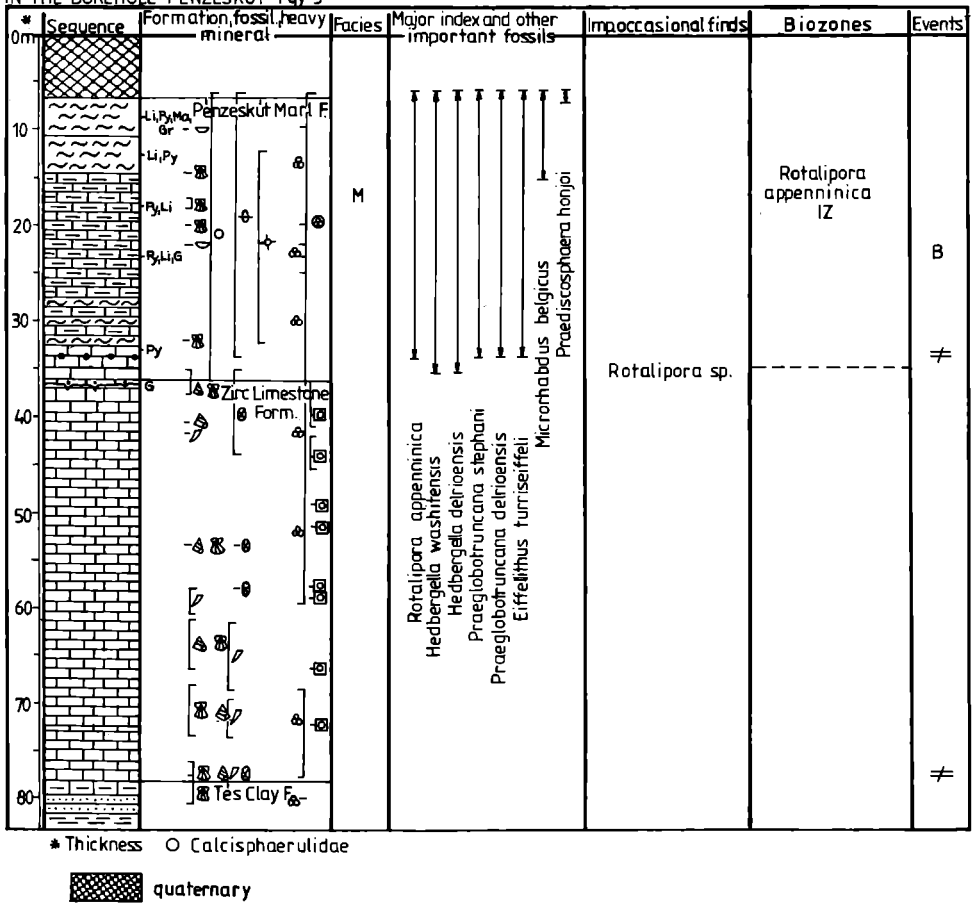
Fig. 17

THE BOUNDARY BETWEEN THE ZIRC LIMESTONE AND THE PENZESKÚT MARL IN A CUARRY NEAR JÁSD
[Section Nº 1]



REFERENCE SECTION OF THE PÉNZESKÚT MARL FORMATION AND ZIRC LIMESTONE FORMATION IN THE BOREHOLE PÉNZESKÚT Pgy 5

Fig. 18



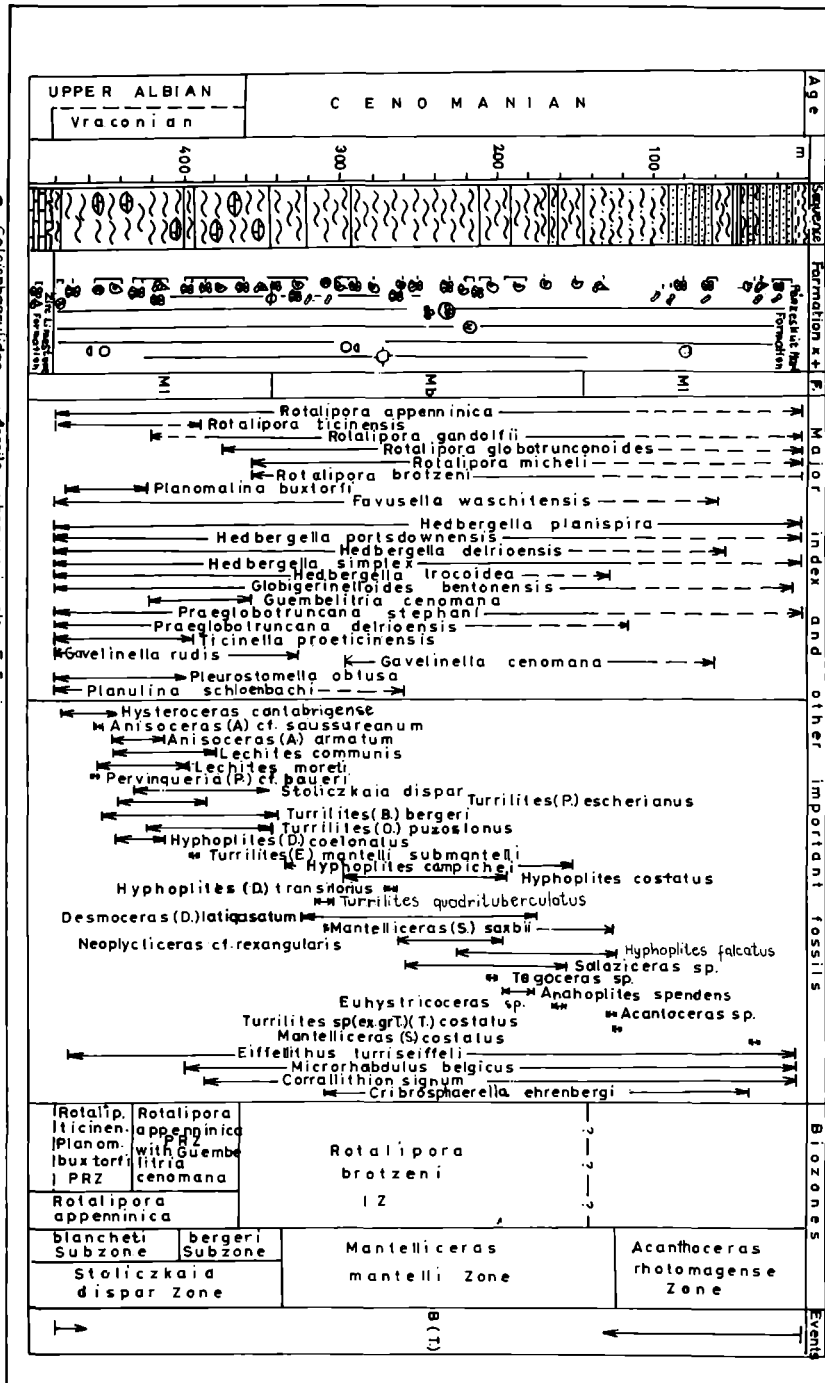


Fig. 19 Stratotype section of the Pénzeskút Marl Formation in the borehole Jásd 42.

O Calcisphaerulidae x fossils + heavy minerals F Facies

CRETACEOUS FORMATIONS IN THE BOREHOLES NAGYBARACSKA B-27 AND NAGYBARACSKA B-28

Fig. 20

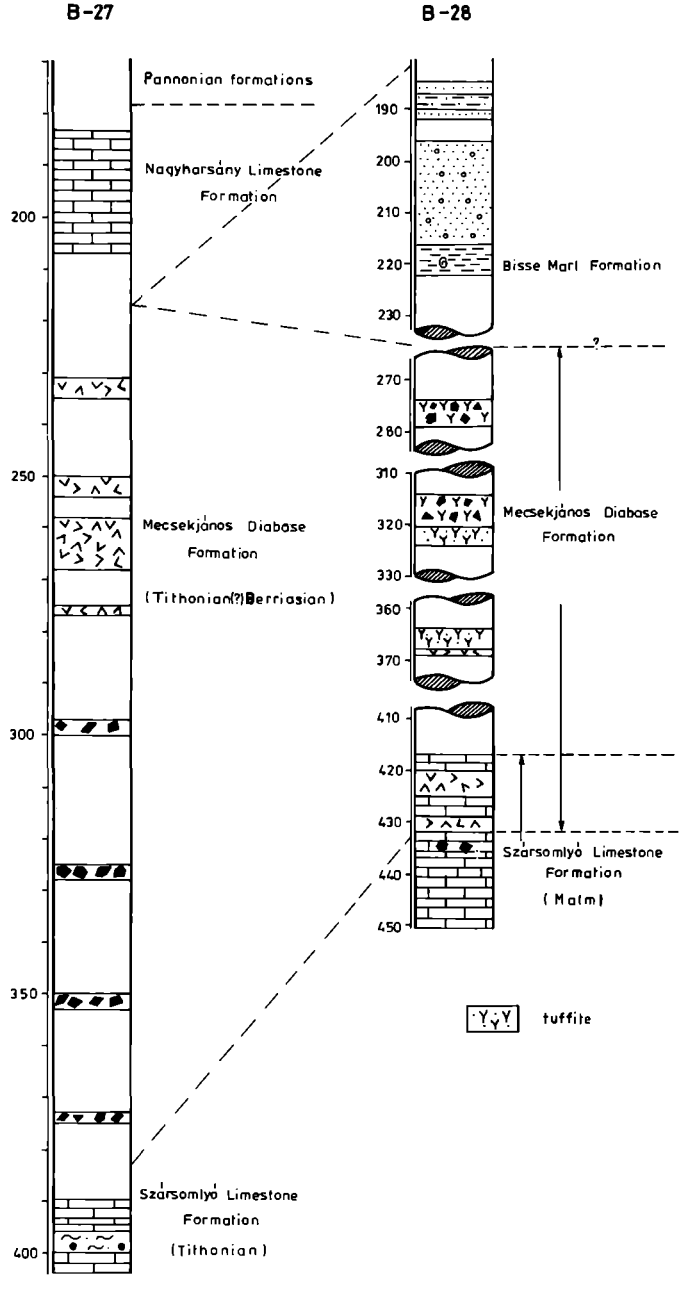


Fig. 21

STRATOTYPE SECTION OF THE VÉKÉNY MARL FORMATION IN THE VÉKÉNY-VALLEY

(a sketch)