Biostratigraphic Aspects and Depositional Environments of Eocene Deposits of Northwestern Suluova (Amasya, Northern Turkey)

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Abstract

The Eocene deposits which are interpreted as deposits of the northern branch of Neo-Tethys crop out over a wide area in northern Turkey, in an approximately E-W belt. The biostratigraphic characteristics and depositional environments of the Celtek and Armutlu formations in Suluova (Amasya) were investigated. Four stratigraphic sections were measured and analyzed. Eight planktic foraminiferal genera with fourteen species and thirty benthic foraminiferal genera with five species were identified. Two planktic foraminiferal biozones from the Early Eocene (Morozovella aragonensis and Acarinina pentacamerata biozones) and one benthic foraminiferal biozone from the Middle Eocene (Nummulites laevigatus biozone) were defined. The charophytes (with Nitellopsis and Harrisichara) associated with these sediments can be probably attributedto the Disermas-Piveteaui zones. These biozones establish the age of the Armutlu Formation as Early-Middle Eocene. Sedimentological and paleontological data indicate that the Celtek and Armutlu formations were deposited in delta, lagoon, and shallow marine environments.

Keywords: Biostratigraphy, Depositional environments, Eocene, Foraminifera, Charophytes, Amasya-Turkey.

1. Introduction

The Eocene deposits crop out over a wide area of the Cankırı–Corum Basin of northern Turkey, in an approximately E-W belt. The Armutlu Formation is interpreted as deposits of the north branch of Neo-Tethys Figs. 1, 2). Brown coals located in the study area are quality within brown coals Turkey has. They have an important role for area economy. Therefore, the areawas measured across the exposure belt along with detailed paleontological sampling for age determinations.

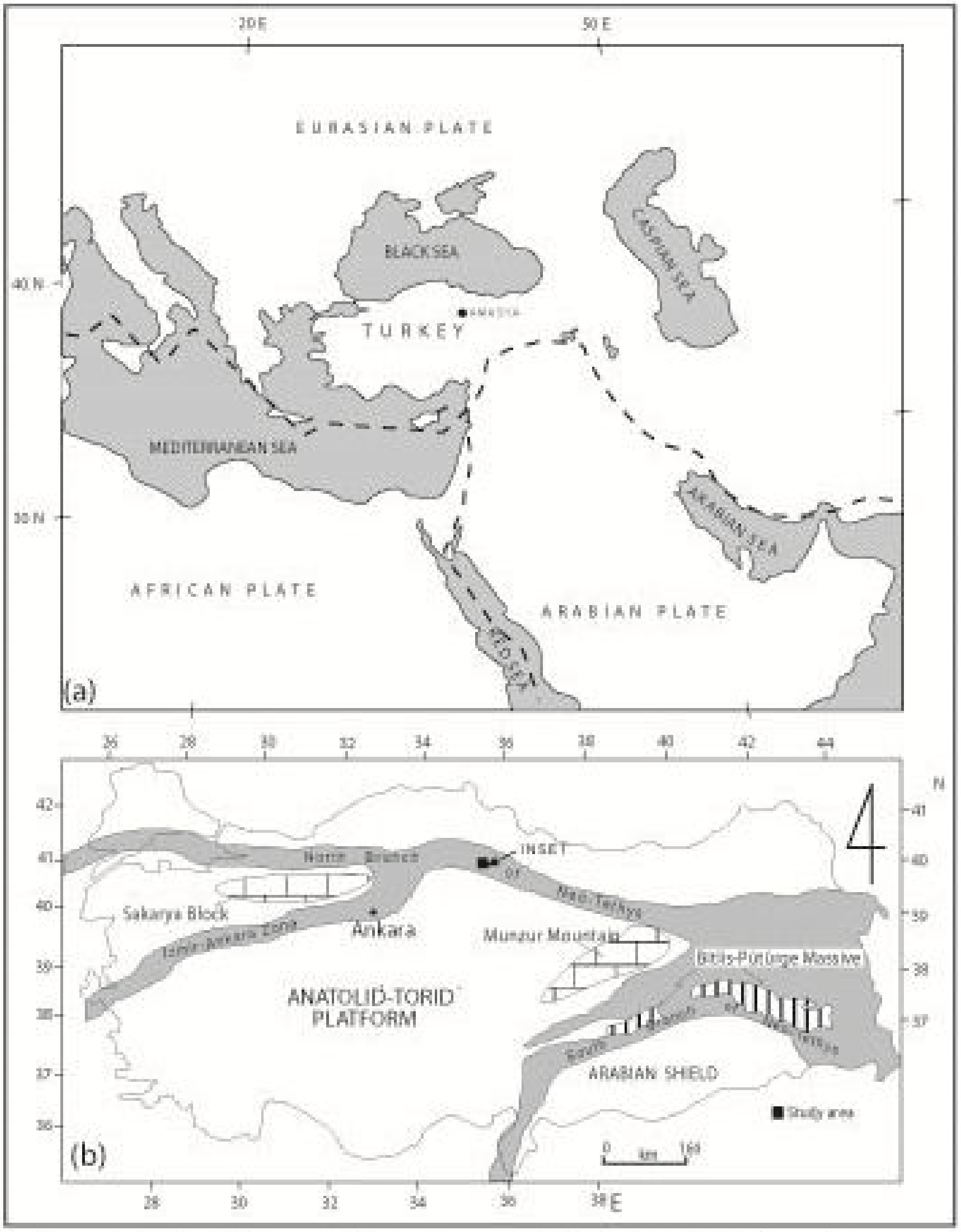

Figure 1. a-Location map of the study area, b-Position of the Armutlu and Çeltek Formation within Neo-Tethys realm (Sengör and Yilmaz, 1983)

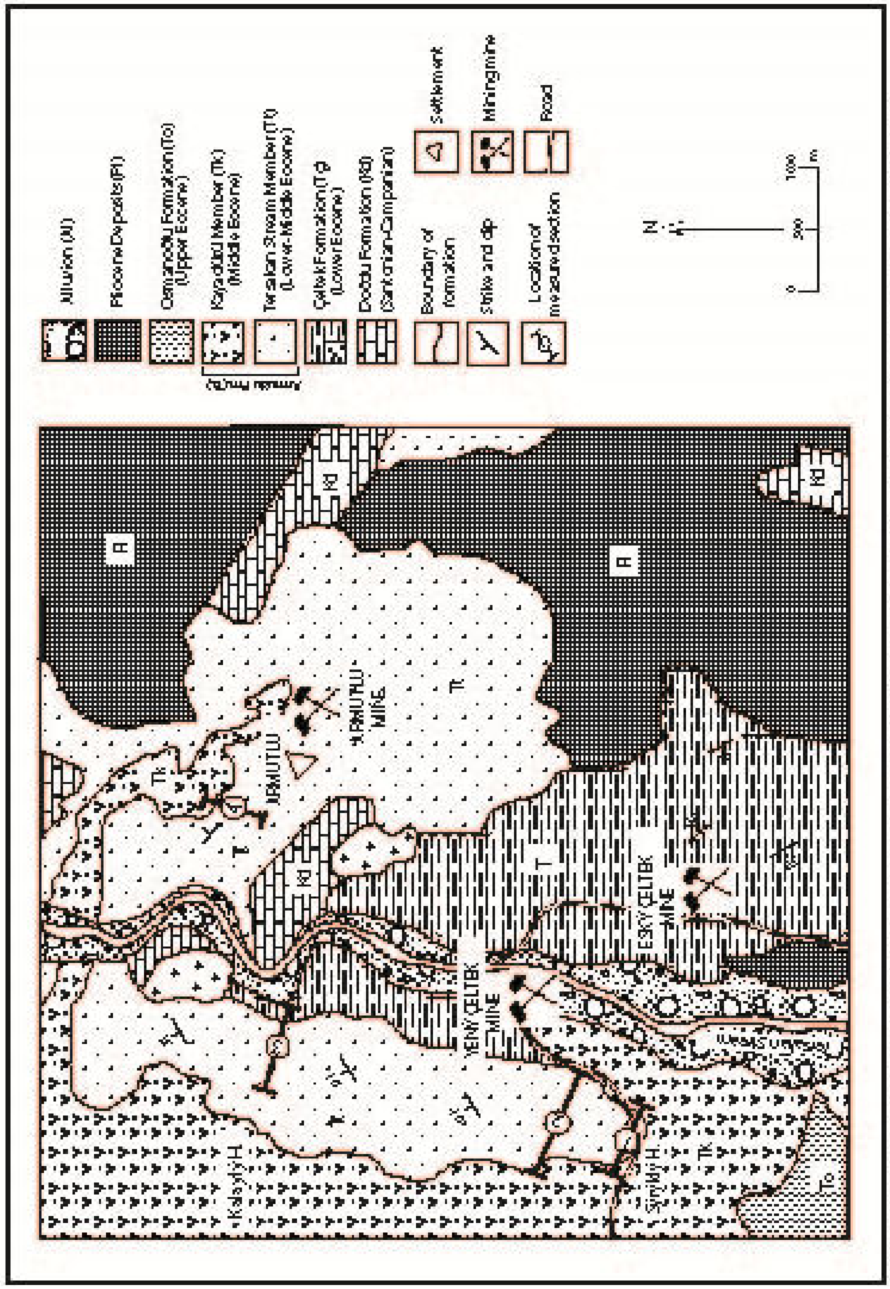

Figure 2 The geological map of the study area and location of the measured sections (modified from Özdemir and Pekmezci 1983 and Gümüşsu 1984)

2. Material and methods

Four measured sections were analyzed in the study area. The systematic samples were collected from the measured section the samples which were collected through the measured sections range from 50 cm to 15 m. From these samples, benthic and planktic foraminifera and charophytes were identified. Quantitative analyses of benthic foraminifera were carried out on 54 samples in total of which 23 were rock thin sections and 31 were soft rock samples. In addition some of the selected soft rock samples were prepared oriente (18 individual) sections. Soft rock samples were washed through a 63 µm sieve using a 17% hydrogen peroxide solution for 24 hours. The remaining fraction was oven-dried and dry sieved at 63 µm, 125 µm and 250 µm. In the end of micropaleontological examinations, 19 species and 38 genera of foraminifera were identified at all localities. Some representatives of every investigated species were examined with a scanning electron microscope (SEM).

3. Biostratigraphy

The Celtek and Armutlu formations are generally dated as Early-Middle Eocene. A more precise age is determined through the measurement of four sections in the study area (Figs. 3-7). Two planktic and one benthic foraminiferal biozones were identified in the calcite-cemented mudstone and sandstone as well as in the marl alternations of the Armutlu Formation. Determination of the foraminiferal genera and species was based on Ellis and Messina, 1966; Beckmann et al., 1969; Bolli, 1957a, b, 1966; Ejel, 1967; Postuma, 1971; Toumarkine, 1978 and Toumarkine and Luterbacher, 1985; Serra-Kiel et al., 1999.

Foraminifera

Planktic foraminifera include: *Globorotalia* sp.,*Planorotalites* sp., *Acarinina pentacamerata* (SUBBOTINA), *Acarinina primitiva* (FINLAY), *Acarinina soldadoensis soldadoensis* (BRONNIMANN), *Morozovella acuta* (TOULMIN), *Morozovella aequa* (CUSHMAN and RENZ), *Morozovella aragonensis* (NUTTALL), *Morozovella caucasica* (GLAESSNER), *Morozovella formosa formosa* (BOLLI), *Morozovella subbotinae* (MOROZOVA), *Truncorotaloides* sp., *Pseudohastigerina wilcoxensis* (CUSHMAN and PONTON), "*Globigerinoides" higginsi* BOLLI, *Globigerina inaequispira* SUBBOTINA, *Globigerina linaperta* FINLAY, *Globigerina* velascoensis CUSHMAN, *Hastigerina* sp..

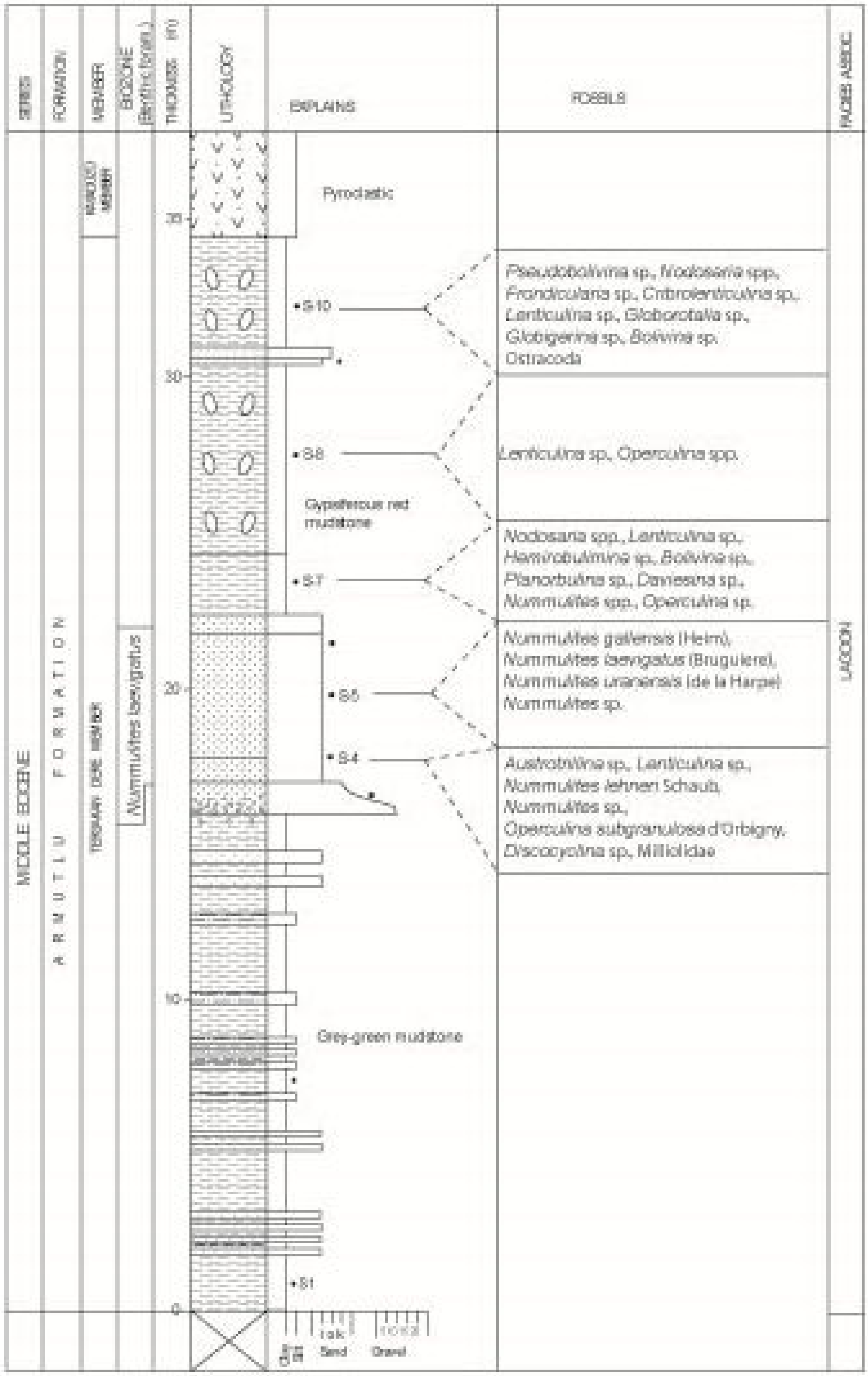

Figure 3. Sirikli Hill measured section

Benthic foraminifera include: *Ammodiscus* sp.,*Vulvulina* sp., *Pseudobolivina* sp., *Verneuilina* sp., *Dorothia* sp., *Semivulvulina* sp., *Textularia* sp., *Austrotrillina* sp., *Dentalina* sp., *Nodosaria* sp., *Frondicularia* sp., *Cribrolenticulina* sp., *Lenticulina* sp., *Robulus* sp., *Marginulinopsis* sp., *Percultazonaria* sp., *Hemirobulimina* sp., *Marginulina* sp., *Epistomina* sp., *Bolivina* sp., *Praebulimina* sp., *Bulimina* sp., *Buliminoides* sp., *Planorbulina* sp., *Anomalina* sp., Anomalinoides sp., *Daviesina* sp., *Nummulites gallensis* (HEIM), *Nummulites laevigatus* (BRUGUIERE), *Nummulites lehneri* SCHAUB, *Nummulites uranensis* (de la HARPE), *Nummulites* sp., *Operculina subgranulosa* d'ORBIGNY, *Discocyclina* sp..

In addition fossil ostracodes and gastropods, such as *Bayania* sp. and *Burtinella* sp. were also found.

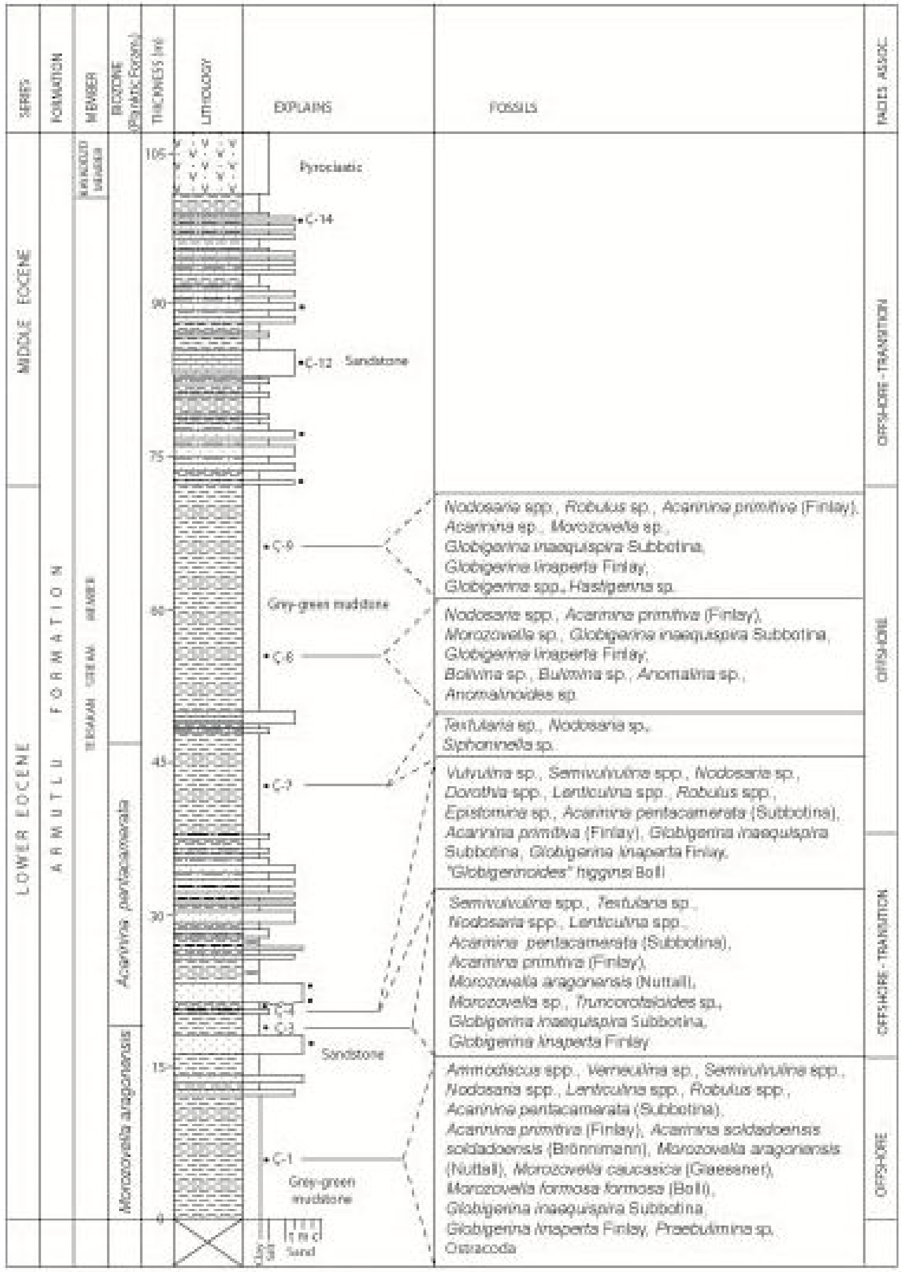

Figure 4. New Celtek measured section

Charophytes

Three samples of the Tersakan member yielded charophyte gyrogonites. The sample A0.1 contains several small gyrogonites of *Peckichara vel Sphaero*chara.

*Peckichara vel Sphaero*chara (sample A0.1) spheroid gyrogonites are 540 x 600 mu in length; 540 x 600 mu in size. The ISI is 0.98-1.03. A 7-8 plano-convex convolution and very weak ornamentation (some disseminated points) were noted. The cells are not thinner and narrower on the apex, the apical nodules are absent. Basal pore is 40 to 60 mu in diameter. It is surrounded by convex nodules. The basal plate is thick and straight (80 mu diam. and 60 mu thick). These forms could be attributed to *Peckichara* or *Sphaerochara*. The size and basal plate plaid in favor of *Sphaerochara* (as for example *Sph. edda* or *Sph. hirmeri*) but the general shape and cell ornamentation is very similar to *Peckichara disermas* or *P. piveteaui.*

In samples A0.2 and A0.5, there are several big forms clearly attributed to *Nitellopsis* sp. It is an ovoid gyrogonite of 1080-1180 mu in length and 920-960 mu in size. The ISI is 1.12-1.28; there are 8-9 plano-convex convolutions; the cells are only slightly thinner and narrower on the apex, the apical nodules are prominent. The base forms a small column. This taxon is a *Nitellopsis*; generally the older forms of this genus (Paleocene and

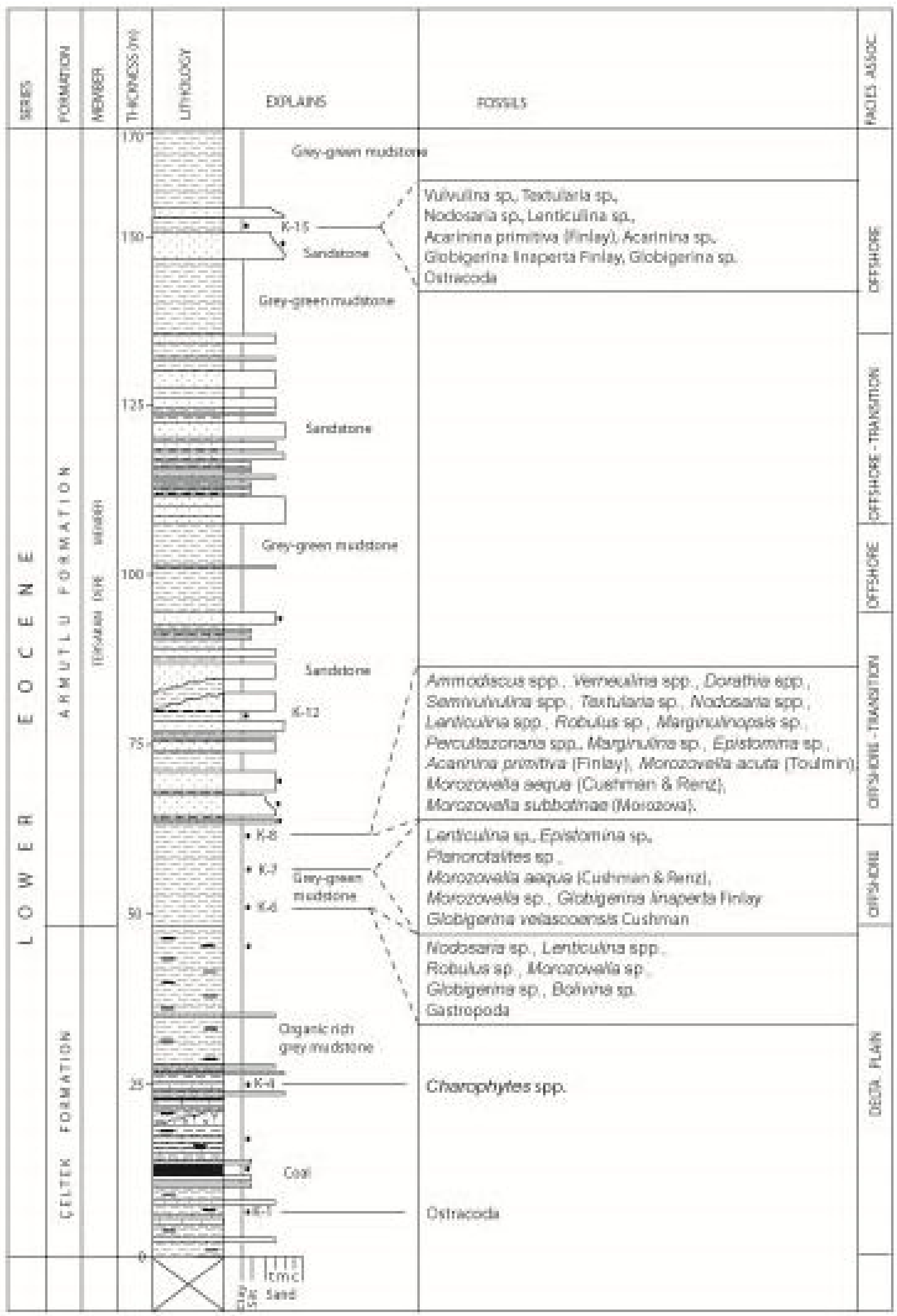

Figure 5. Kalayli Hill measured section

Eocene) are ornamented (*N. thaleri*, *N. dutemplei*) or very big (*N. major*, *C. helicteres*). The number of gyrogonites is too small to give a specific species level here, but they clearly represent small and unornamented forms of *Nitellopsis*. They show some affinities with N.C. sigali (ornamentation and size), but the number of convolutions is higher in sigali (9-11) than in the Celtek species (6-8).

In sample A02, one badly preserved *Harrisichara* is identified. The small size and the ornamentation indicate perhaps *Harrisichara triquetra*, but it could be also a small example of *H. tubercu*lata.

3.1. The Benthic Foraminiferal Biozone

3.1.1. Zone I, *Nummulites laevigatus* Range Zone (=SBZ13)

Age: Middle Eocene (Early Lutetian)

The lower boundary of this biozone has been defined by the first occurrence of *Nummulites laevig*atus (BRUGUIERE). The upper boundary has been determined by the disappearance of *Nummulites laevigat*us (BRUGUIERE). In addition to the markers of this zone, several foraminiferal species have been recorded: *Nummulites gallensis* (HEIM), *Nummulites lehn*eri SCHAUB, *Nummulites uranensis* (de la HARPE).

The *Nummulites laevig*atus Range Zone has been recognized in the Sirikli Hill section in the study (Fig. 3).

3.2. The Planktic Foraminiferal Biozones

3.2.1.Zone I, ***Morozovella aragonensis*Zone** (=P8 zone of TOUMARKINE and LUTERBACHER, 1985, P6b sub-zone of BERGGREN et al., 1995 and P7 zone of OLSSON et al., 1999)

Age: Early Eocene

Author: BOLLI (1957a, b)

This biozone is defined here as the partial range from the last occurrence datum (LOD) of *Morozovella formosaformosa* (BOLLI) to the first occurrence datum (FOD) of *Acarinina pentacamerata* (SUBBOTINA).

This zone is defined as the interval between the first occurrence of *Acarinina pentacamerata* (SUBBOTINA) and the last occurrence of *Morozovella formosa formosa* (BOLLI). In addition to the markers of this zone, several foraminiferal species have been recorded: *Ammodiscus* spp., *Verneuilina* sp., *Vulvulina* sp., *Semivulvulina* sp., *Textularia* sp., *Nodosaria* spp., *Dorothia* spp., *Lenticulina* spp., *Robulus* spp., *Acarinina pentacamerata* (SUBBOTINA), *Acarinina primitiva* FINLAY, *Acarinina soldadoensis soldadoensis*(BRONNIMANN), *Morozovella aragonensis* (NUTTALL), *Morozovella caucasica* (GLAESNER), *Morozovella formosa formosa* (BOLLI), *Globigerina inaequispira* SUBBOTINA, *Globigerina linaperta* FINLAY, *Praebulimina* sp. *Acarinina pentacamerata* Zone conformably overlies this zone. It coincides with the P8 zone of TOUMARKINE and LUTERBACHER, 1985; P6b sub-zone of BERGGREN et al., 1995 and P7 zone of OLSSON et al., 1999. It is also equivalent to that identified by BECKMANN et al., 1969; POSTUMA, 1971. According to the above-mentioned records an Early Eocene age is suggested to this biozone.

The *Morozovella aragonensis* Zone has been recognized in the New Celtek section, in this study (Fig. 4).

3.2.2. Zone II, ***Acarinina pentacamerata* Zone** (=P9 zone of TOUMARKINE and LUTERBACHER, 1985)

Age: Early Eocene

Author: KRASHENINNIKOV (1965) as Subzone

This zone is defined as the first occurrence of *Acarinina pentacamerata* (SUBBOTINA) and "*Globigerinoides" higginsi* BOLLI and the disappearance of *Morozovella aragonensis* (NUTTALL) at the bottom of the zone. In addition to the markers of this zone, several foraminiferal species have been recorded: *Vulvulina* sp., *Semivulvulina* spp., *Textularia* sp., *Nodosaria* spp., *Dorothia* spp., *Lenticulina* spp., *Robulus* spp., *Epistomina* sp., *Planorotalites* sp., *Acarinina pentacamerata* (SUBBOTINA), *Acarinina primitiva* FINLAY, *Acarinina* sp., *Morozovella* sp., *Globigerina inaequispira* SUBBOTINA, *Globigerina linaperta* FINLAY, *Globigerina* spp., "*Globigerinoides" higginsi* BOLLI, *Hastigerina* sp., *Bolivin*a sp., *Bulimina* sp., *Siphoninella* sp., *Anomalina* sp., *Anomalinoides* sp.. This zone coincides with the P9 zone proposed by TOUMARKINE and LUTERBACHER, 1985. It is also equivalent to that defined by KRASHENINNIKOV, 1965.

The *Acarinina pentacamerata* Zone has been recognized in the New Celtek section in this study.

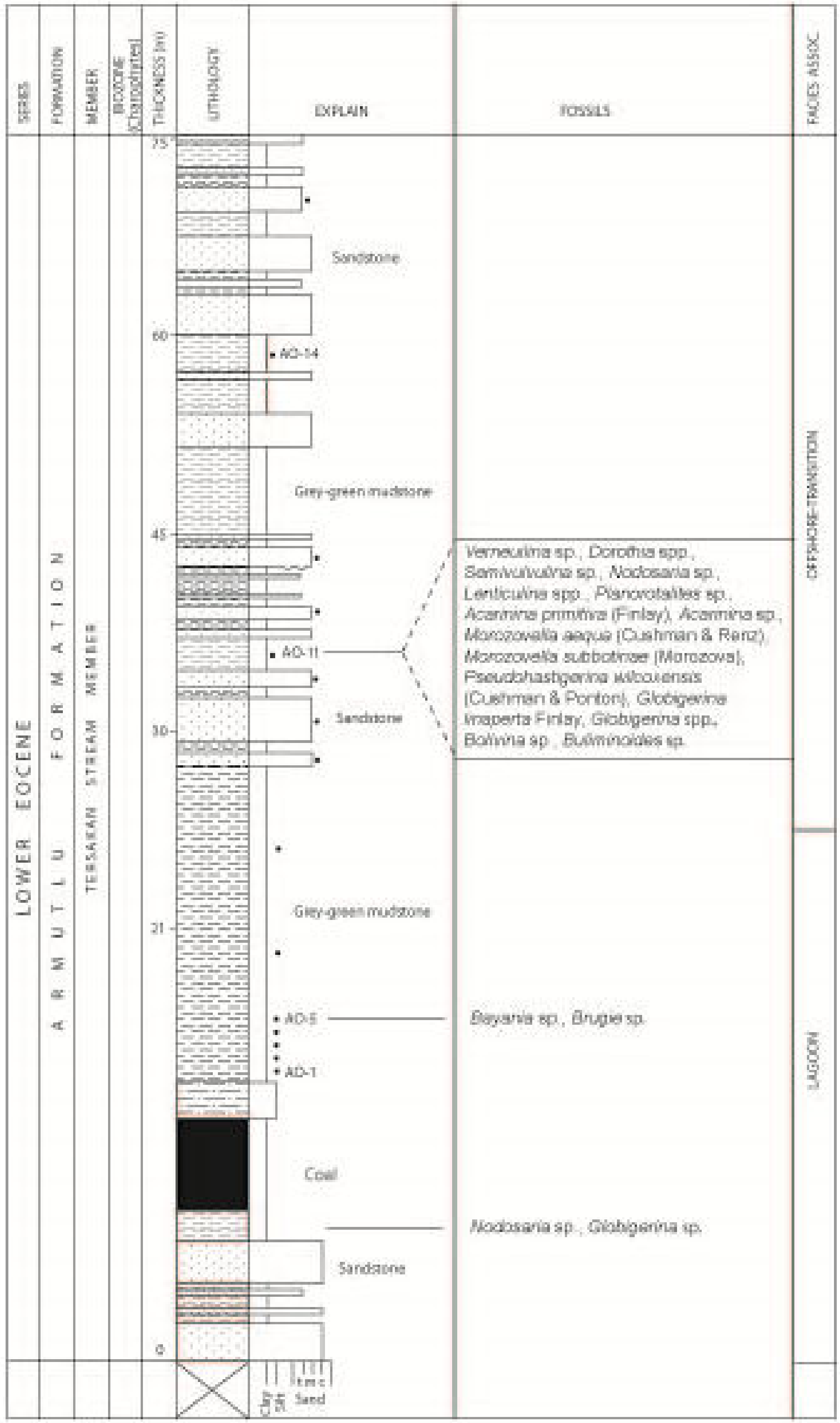

Figure 6. Armutlu Village measured section

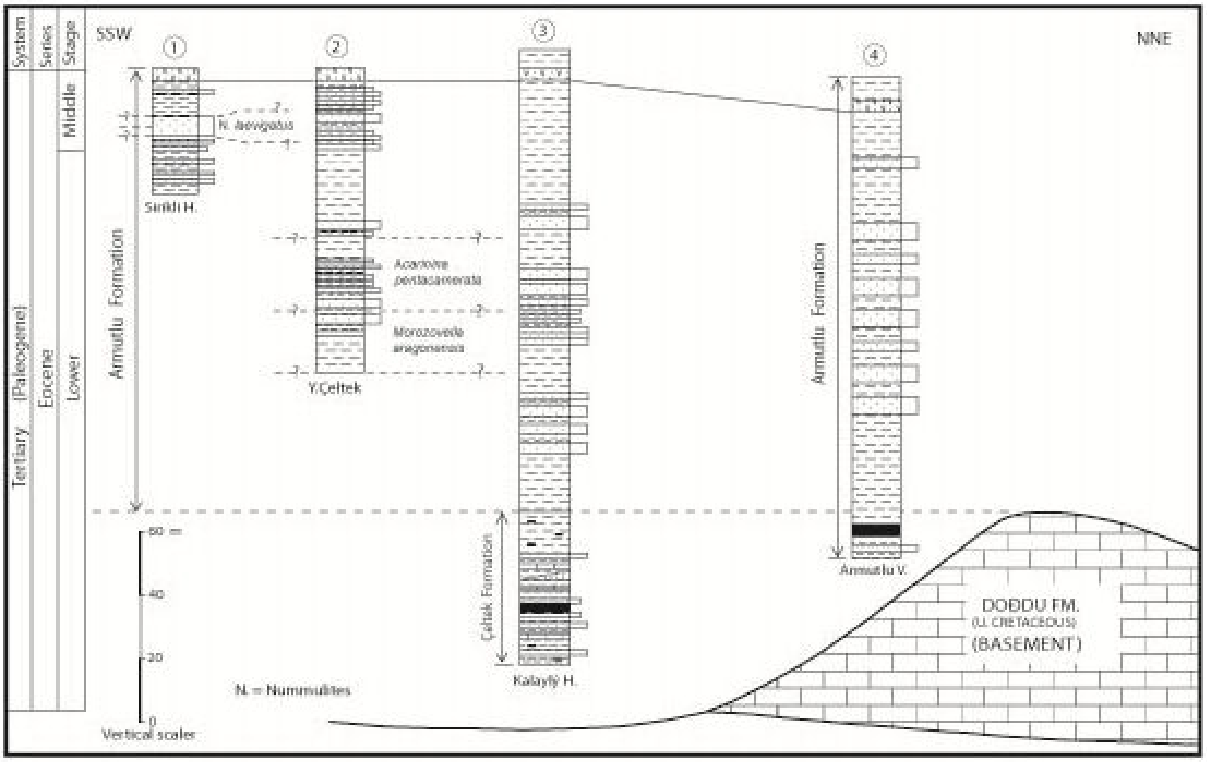

Figure 7. Biostratigraphic correlation of Çeltek and Armutlu formations (modified from Koç 2002). For location of sections see Figure 3.

4. Sedimentology and Paleoecology

The Celtek Formation consists of delta plain and delta front facies associations. The delta plain deposits include organic rich grey mudstone and coal while delta front deposits have compositions of benthic foraminiferous grey-green mudstones, siltstone, stratified sandstone and lenticular body conglomerate. The coals were deposited in pond water and the delta swamp plain (Fig. 5).

The Armutlu Formation consists of lagoon, shoreface and offshore facies associations (Fig. 6). The lagoon facies consists of sandstone, red mudstones containing benthic foraminifera, and grey-green mudstone containing charophytes and coal. The coal was formed in a lagoon marsh. The Shoreface facies is characterized by large scale cross-bedded quartz arenitic sandstones. These sandstones commonly include bioturbation and occasionally include benthic foraminifera. The Offshore-transition facies association is composed of an alternation of parallel laminated sandstones, waved-bedded sandstones, grey-green mudstones and red mudstone facies. The Offshore facies associations consist of grey-green mudstones which include fine grained sandstone levels. There is lateral-vertical transition between the Celtek and Armutlu formations (Koc, 2002; Koc and Turkmen, 2002; Koc et al., 2002) (Fig. 8).

Gastropoda such as *Bayania* sp. and *Burtinella* sp. indicate a littoral environment. Dominance of benthic foraminifera indicates a very shallow marine paleoenvironment. The *Charophytes* genera discovered in the samples are clearly freshwater ones, and the depth of the watersurely didn't exceed 5 meters. Transportation of these forms is possible but improbable; the *Charophytes* are too numerous for all of them to be transported.

5. Results

In this study, eight genera with fourteen species of planktic foraminifera and thirty genera with five species of benthic foraminifera were defined in the samples collected from the measured sections of the Celtek and Armutlu formations of the Corum-Cankırı basin of northern Turkey.

In addition, two planktic foraminiferal biozones and one benthic foraminiferal biozones were described from the Celtek and Armutlu Formations in the Amasya region. These are named the Lower Eocene *Morozovella aragonensis-Acarinina pentacamerata* and the Middle Eocene *Nummulites laevigatus* biozone. These zones were determined using the samples of the Armutlu Formation only.

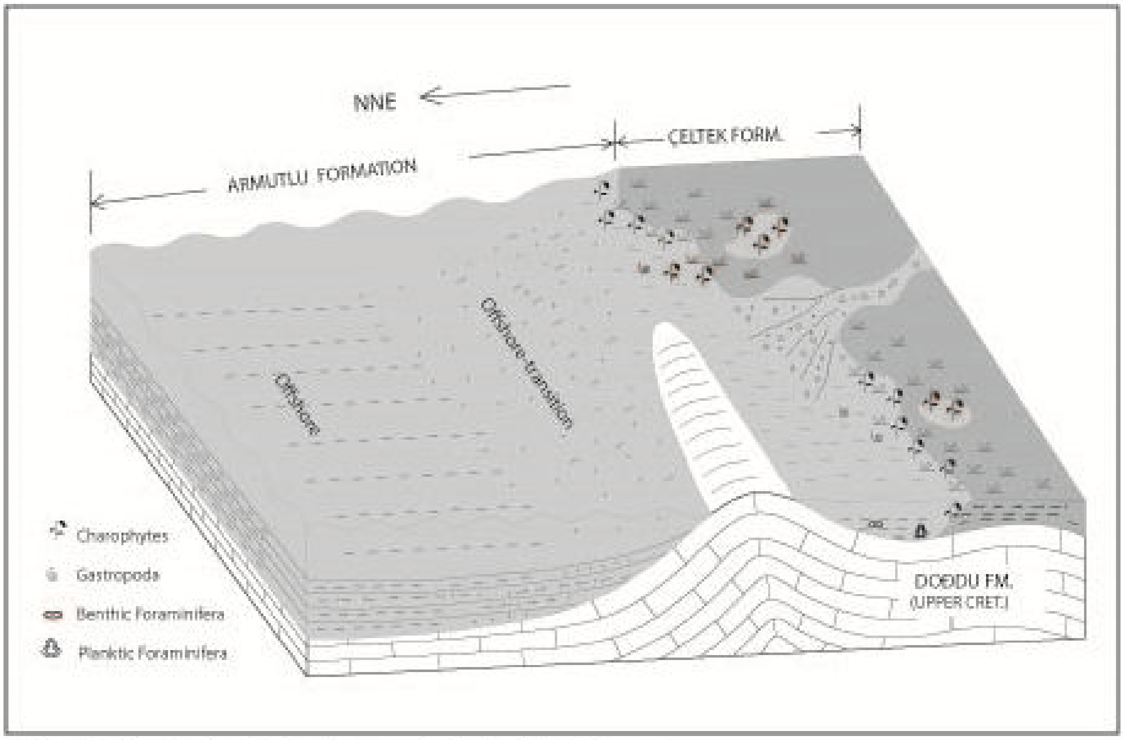

Figure 8. Schematic depositional environments of Çeltek and Armutlu Formations

Concerning the charophytes, a precise datation remains hypothetical, because of the taxonomic uncertainties discussed before. According to obtained data, a Lower Ypresian age (Pivetaui to *Disermas* zone, see Riveline et al., 1996) can be attributed to the sediments if:

- the *Nitellopsis* is effectively an *N. sigali* one
- the small *Charophytes* belong to Peckichara
- the *Harrisicha*ra is an *H. tiquetra* one.

Paleontological and sedimentological data indicate that the Celtek and Armutlu formations were deposited in delta, lagoon and shallow marine environments.

6. Acknowledgements

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Fig. 1.

a) Location map of the study area.

b) Position of the Armutlu and Celtek formations within Neo-Tethys realm (after Sengor and Yilmaz, 1983).

Fig. 2. Geological map of the study area and location of the measured section (modified from Ozdemir and Pekmezci, 1983).

Fig. 3. Sirikli Hill measured section.

Fig. 4. New Celtek measured section.

Fig. 5. Kalayli Hill measured section.

Fig. 6. Armutlu village measured section.

Fig. 7. Biostratigraphic correlation of Celtek and Armutlu formations (modified from Koc, 2002) For location of sections, see Fig. 2.

Fig. 8. Schematic depositional environments of Celtek and Armutlu formations.

Plate I

Acarinina pentacamerata (SUBBOTINA)
Figure 1. Umbilical side, sample no. 4, New Celtek section.

Acarinina soldadoensis soldadoensis (BRONNIMANN)
Figure 2. Vertical section, X100, sample no. 1, New Celtek section.

Morozovella acuta (TOULMIN)
Figure 3. Vertical section, X100, sample no. 8, Kalayli Hill section.

Morozovella aragonensis (NUTTALL)
Figure 4. Spiral side, sample no. 1, New Celtek section.

Figure 5. Side view, sample no. 1, New Celtek section.

Morozovella subbotinae (MOROZOVA)
Figure 6. Vertical section, X100, sample no. 11, Armutlu Village section.

PLATE I

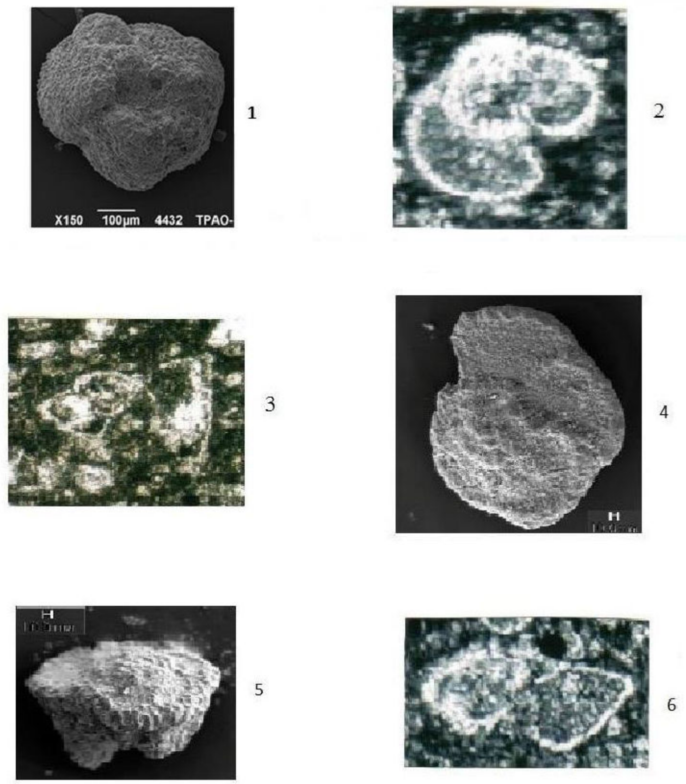

Plate II

Nummulites laevigatus (BRUGUIERE)

Figure 1. Equatorial section, microspheric form, X3, sample no. 5, Sirikli Hill section.

Figure 2. Axial section, microspheric form, X2.5, sample no. 5, Sirikli Hill section.

Figure 3. Surface view, microspheric form, X3, sample no. 5, Sirikli Hill section.

Figure 4. Equatorial section, macrospheric form, X5.5, sample no. 5, Sirikli Hill section.

Figure 5. Axial section, macrospheric form, X7, sample no. 5, Sirikli Hill section.

Nummulites lehneri SCHAUB

Figure 6. Equatorial section, microspheric form, X6, sample no. 4, Sirikli Hill section.

Figure 7. Axial section, microspheric form, X5.5, sample no. 4, Sirikli Hill section.

Figure 8. Equatorial section, macrospheric form, XI3, sample no. 4, Sirikli Hill section.

Figure 9. Axial section, macrospheric form, X9, sample no. 4, Sirikli Hill section.

Figure 10. Axial section, macrospheric form, X8, sample no. 4, Sirikli section.

Figure 11. Equatorial section, macrospheric form, X6.5, sample no. 4, Sirikli Hill section.

Nummulites uranensis(dé la HARPE)

Figure 12. Equatorial section, microspheric form, X6.5, sample no. 5, Sirikli Hill section.

Figure 13. Axial section, microspheric form, X5, sample no. 5, Sirikli Hill section.

Figure 14. Equatorial section, macrospheric form, X7, sample no. 5, Sirikli Hill section.

Figure 15. Equatorial section, macrospheric form, X8, sample no. 5, Sirikli Hill section.

Figure 16. Axial section, macrospheric form, X9, sample no. 5, Sirikli Hill section.

PLATE II