DELTA JOURNAL OF SCIENCE 2006, 30, 17- 40

STRATIGRAPHY AND MICROFACIES STUDIES ON SOME TERTIARY ROCKS IN NORTH GALALA PLATEAU, NORTH EASTERN DESERT, EGYPT

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(Received : 7-1-2006)

ABSTRACT

The early and middle Eocene successions of Wadi El Qena (Sec. II) and Wadi El Agramiya (Sec. I) surface sections in west El Galala El-Baharia area, north Eastern Desert, were examined in detail. Their planktonic foraminifera and microfacies associations were used to interpret the stratigraphy of these sections.

A total of twenty species and subspecies of planktonic foraminifera belonging to eight genera as well as six microfacies associations were also indentified and their stratigraphic ranges were given. The succession was divided into distinct litho and biostratigraphic units. The distribution of foraminifera allows the subdivision of studied sections into three foraminiferal zones from the base upwards as: Acarinina pentacamerata Zone, Nummulites gizehensis Zone and Dictyoconus aegyptiensis Zone related mostly to early and middle Eocene age. Besides, microfacies studies on thin sections representing Minia Formation, Gabal Hof Formation and Observatory formation were carried out. The paleoenvironmental conditions that prevailed during sedimentation were interpreted in accordance.

INTRODUCTION

The accumulation of knowledge during the last decades has emphasized the value of planktonic foraminifera as guide fossils for stratigraphical zonation and regional as well as world-wide correlation. The present work deals with the lithostratigraphic and biostratigraphic study of the Eocene rocks in Wadi El Qena (Sec. II) and Wadi El Agramiya (Sec. I) west of Galala El Baharia area northern of Eastern Desert of Egypt (Fig. 1). The stratigraphy and microfacies of the investigated horizon in Egypt were treated in many works, among them: Zittel (1883), Sadek (1926), Ghorab & Ismail (1957), El-Dawoody (1970,1992), Barkat & Abu Khadra (1971), El Boukhary (1973), Strougo (1979), Benjamini (1980), Boukhary & Abdel Malik (1983), Strougo & Boukhary (1987), El Dawoody & Abdel Magid (1989), Swedan (1991) and El-Dawoody (2000-2005). The stratigraphic classification of the Nile valley area (including Mokattam and Helwan) based mainly on fundamental rock units established by Said (1960-1962) and Said & Martin (1964) and also given in the lexique stratigraphique international (Awad & Said, 1966). Schaibon member was introduced in Beni Suef area and stratigraphically equivalent to the Giushi Member (Mokattam Formation).

In the present study both the microfacies studies and co-existent planktonic foraminifera are identified and are used to interpret the stratigraphy of the region. The larger foraminifera, particularly the Nummulites represents the main guide fossils upon which the zoning of the Eocene was accomplished. Unfortunately much of the work treated these forms as one major taxonomic unit, thus belittling the value of their importance as index fossils. Said (1963) recognized that the splitting of these species into its different taxonomic units would make possible their use in biostratigraphy.

During progress of this work it was possible to separate several diagnostic planktonic species which characterize the lowermost Eocene, and middle Eocene rocks of many parts in Egypt. In the middle Eocene sequence, these species occur in strata which interfinger beds with well identified Nummulites species. In the studied sections represented by two wadies in Northern El Galala area, Northern Eastern Desert; Wadi El Qena and Wadi El Agramiya. These wadies drainge from Wadi El Ghweibba and Wadi El Shona (Fig. 2).

ISSN 1012 – 5965

Wadi El Ghweibba is considered the largest and most important drainage line in the district under consideration. It extends for some 70 kilometers, from east to west, parallel to the line of Galala escarpment and at an average distance of 15 kilometers to the north of it. The rest of its course being known as Wadi El Shona. This is made up by the joining of three tributaries namely Wadi El Qena, Wadi El Agramiya and Wadi El Sheikh. The first of these three tributaries forms the south-western edge of studied area, while the other two, are almost entirely outside, it originates in the heart of the Arabian Desert, over twenty kilometers to the west of studied area. From the function of these three tributaries near the well known Bir El Qena. Wadi El Shona takes an easterly course between low scarps of Eocene limestones.

Wadi El Qena, starts high up Gabal El Galala El Baharia near its southern edge and winds its way northwards through an increasingly deeper channel and finally issuing to the open plain north of El Galala scarp.

One of the most impressive topographical feature in the northern part of Gulf of Suez, is the great massive block known as El Galala El Baharia (Northern Galala). It extends as a high plateau bounded by scarps that rise as sheer vertical cliffs from the waters of the Gulf and is flanked on the north and south by the wide depressions of El Ghweibba and Araba respectively. In the central part it seems an available evidence to preserve its plateau. The vertical scarp forming the southern limit of district is a bedding cliff extending over 60 kilometers from east to west and reaching its highest point of 977 meters above sea level near its eastern end. To the west it gradually rests lower by virtue of the slight south westerly dip, manifested by its component strata until near the western edge of the area mapped it does not exceed 700 meters above sea level.

The wadies (Wadi El Qena and Wadi El Agramiya) draining this side of El Galala have been enumerated when discussing Wadi El Shona. The sides of both Wadi El Qena and Wadi El Agramiya are made mainly of massive limestone of Eocene (Ypresian and Lutetian) age.

LITHOSTRATIGRAPHIC REVIEW

The stratigraphic succession in the two studied sections is subdivided into the following rock units from older to younger (Fig. 3).

Minia Formation

The name was first introduced by Said (1960) For the "Alveolinen kalk" or "ober libysch stufe" of Zittel (1883). It corresponds to the reefal facies of the early middle Eocene (early Lutetian) represented by the snow white Alveolina limestone (Said 1962). It is overlain by the white weathered grey limestone of the Mokattam Formation and underlain by the Thebes Formation. At Gabal Abu Treifiya, Cairo Suez District ,this unit represents the lowermost middle Eocene unit. It is made up of chalky to snow white limestone and is highly fossiliferous with Alveolina frumentiformis Schwager.

At Wadi El Agramyia, the succession of Minia Formation is represented by the lower 74 m of the section while at Wadi El Qena it includes the lower 158m .The Minia Formation (at the two sections) is made up of white chalky limestone which change into limestone and marl at top, with few gypsum veinlets.

Gabal Hof Formation

The name was introduced by Ghorab and Ismail (1957) to describe the hard, white limestone and chalky limestone alternating with thin bands of hard grey dolomitic limestone in Helwan area. In the present study, the Gabal Hof Formation is represented by 104m of mainly marl and marly limestone. It is overlain by the Observatory Formation and underlain by the Minia Formation. Notice the field photos (pls. 1, 2).

Observatory Formation

The name "Observatory Formation" was first indroduced by Farag and Ismail (1959) to describe the Upper Lutetian sequence in Helwan area. In the studied area it crops out only in Wadi El Agramiya section. It measures about 35 m in thickness and formed of yellowish white chalky limestone. It is also burrowed, laminated, thin bedded, nodular and dolomitized.

The Gabal Hof and Observatory formations may be equated with the Mokattam Formation, the "Mokattam Stufe" was first introduced by Zittel (1883) to cover the whole section overlying the Minia Formation and represented by massive limestone including the top brownish beds of Gebel Mokattam. At its type locality, Gebel Mokattam, east of Cairo, the base is unexposed and the section attains a thickness of about 133 m. To the South, at Minia, the yellowish massive limestones and marls of the Mokattam formation rests conformably over the snow white limestones of the Minia Formation.

The Minia and Mokattam limestone formations are dated respectively as lower and upper middle Eocene in age, although the upper part of the Mokattam limestone may be of late Eocene age (Cuvillier, 1930; Said, 1962).

BIOSTRATIGRAPHIC ZONATION AND CORRELATION

The biostratigraphic zontation proposed here for the early Eocene and middle Eocene depends on both planktonic foraminifera and large foraminifera. The planktonic and larger foraminifera serve as excellent biostratigraphic tools, due to their abundance, widely distributed and evolve rapidly with many short ranging forms. They form a good base for zoning the Ypresian, early-middle Lutetian and late Lutetian in the studied section.

The recorded large foraminifera throw more light on the stratigraphy of the section. Their occurrence in other parts of Egypt as well as in different parts of the world indicates that they could be successfully used for biozonation and worldwide correlation. The following is a discussion for the delineated zones based on their both planktonic foraminifera and larger foraminiferal species:

The investigation of planktonic and large foraminiferal species helped in the delineating the following foraminiferal zones: arranged from top to base.

3- Dictyoconus aegyptiensis (larger foraminifera) Zone.

2- Nummuilites gizehensis (Larger foraminifera) Zone.

1- Acarininia pentacamerata (Planktonic foraminifera) Zone.

1) Acarinina pentacamerata Zone

This zone was originally introduced by Krasheninnkov (1965) as a subzone corresponding to the Glohorotalia palmera Zone of Bolli (1957). The zone was recognized in many parts of the world. (Beckmann *et al.*, 1969, Toumarkine & Luterbacher, 1985). In Wadi EL Qena and Wadi El Agramyia, the base of this zone was defined by the first occurence of Turborotalia frontosa (Subbotina). In Wadi EL Qena and Wadi El Agramyia this zone constitutes the base of the section. The zone is of late Early Eocene age and lies within, the Minia Formation. It covers the interval between 0 – 158.5 mts. in section (I) and 0 – 74.5 mts. in section (II).

The most common species found in this zone in the studied samples are: Acarinina pentacamerata (Subbotina), Acarinina spinulin-flata (Bandy), Acarininia broedermanni

(Cushman and Bermudez), Acarinina bullbrooki (Bolli), Turborotalia frontosa (Subbotina), Pseudo hastigerina wilcoxensis (Cushman and Ponton), Globigerinoides higginsi (Bolli), Subbotina senni (Beckmann), Subbotina inequispira (Linne), Subbotina linaperta Finlay, Morozovella aragonensis (Nuttal), Morozov-ella quetra (Bolli), Acarinina soldadoensis (Bronnimann), Acarinina angulosa (Bolli), Acarinina primitiva (Finlay), Hastigerina bolivariana (Petters), Truncorotaloides rohri Bronnimann and Bermudez (Fig. 4). Age: early Eocene.

2) Nummulites gizehensis Zone.

The Nummulites gizehensis Zone includes the interval of the occurrence of the marker species. It is represented in Wadi El Agramiya section by about 105m. thick and about 104m. thick at Wadi El Qena. The most common foraminiferal species of this zone are Nummulites beaumonti D' Archiac & Haime, Nummulites discorbinus (Schlotheim), Operculina sp. This zone overlies the Acarinina pentacamerata Zone. It is of an early to middle Lutetian age.

3) Dictyoconus aegyptiensis Zone.

The Dictyoconus aegyptiensis Zone covers the interval of the occurrence of the marker species. This zone is represented in the topmost 32 m. of Wadi El Agramiya section, while it is not recorded in the Wadi El Qena section. The most common foraminiferal elements of this zone are Nummulites beaumonti D' Archiac & Haime. Nummulites subbeaumonti De La Harpe, some milioid species and fabularia sp. It is equivalent to Dictyconus aegyptiensis (Chapman). It is of late Lutetian age.

This part is mainly concerned with the analysis of the studied forminiferal assemblages within the investigated section. It makes possible the zoning of such sections in a way that would make the interregional correlations of the Eocene succession feasible (Fig. 6). The recorded formainifera, in corboration with other microbiostratigraphic tools, build up the main skeleton of such trial. Accordingly, two chronostratigraphic units are encountered, early Eocene and middl Eocene. The classification of the foraminiferal species would make possible their use in biostraigraphy.

Early Eocene

The late early Eocene of the studied sections (Wadi EL Qena and Wadi El Agramyia) is relatively open marine sediment (deep marine) as suggested by the common occurrence of planktonic foraminifera genera (globorotalids and globigerinids), such as Acarinnia, Morozovella, Truncorotaloides, Globigerina and Subbotina. The benthonic species are relatively rare of deep marine. The sediments were probably laid down in the upper bathyal bathymetric zone.

Middle Eocene

The early - middle and late Lutetian ages in the studied sections were characterized by reefal environment as indicated by the presence of frequent large foraminifera of the Nummulites, Operculina, Discocyclina, Fabularia, Miliolidae and Dictyoconus in the carbonate facies.

1- Open marine (outer bathyal zone) including planktonic foraminifera

2- Shallow marine (Middle and outer neritic zone) includes large foraminifera (Nummulites, Discocyclina, and Operculina)

3- Shallow marine (inner neritic zone) represented in the top of section II (Dictyoconus, Fabularia, and Miliolidae).

Outline on the Classification of the Planktonic and Larger Foraminifera:

In the present work the classification of McGowran (1968) was adopted. The generic names of (Acarinina, Morozovella and Truncorotaloides) were used for the Globigerinidae. The classification of planktonic foraminifera according to Loeblich & Tappan (1988) was introduced at the supergeneric level. The suprageneric assignment of the foraminiferal genera together with the index species recognized in this paper follows:

Phylum PROTOZOA
Class RHIZOPODA
Order FORAMINIFERIDA
Superfamily GLOBOROTAL1ACEA

Family: Globorotaliidae Cushman 1927
Genus: Turborotalia Cushman & Bermudez 1949
Turborotalia cerroazulensis frontos (Subbotina)
Turborotalia cf. graiffinae Blow
Family: Truncorotaloididae Loeblich & Tappan 1961
Genus: Acarinina Subbotina, 1953
Acarinia broedermanni (Cushman & Bermudez)
Acarinina bullbrooki (Bolli)
Acarinina pentacamerata (Subbotina)
Acarinina primitiva (Finlay)
Acarinina soldadoensis angulosa (Bolli)
Acarinina soldadoensis soldadoensis (Bronnimann)
Acarinina spinuloinflata (Bandy)
Genus: Morozovella McGowran, 1968
Morozovella aragonensis (Nuttall)
Morozovella cf. lensiformis (Subbotina)
Morozovella quetra (Bolli)
Morozovella spinulosa (Cushman)
Genus: Truncorotaloides Bronnimann & Bermudez 1953
Truncorotaloides rohri Bronnimann & Bermudez
Family: Catapsydracidae Bolli, Loeblich & Tappan, 1957
Genus: Guembelitroides El Naggar, 1971
Guembelitroides higginsi (Bolli)
Genus: Subbotina Brotezen & Pozarsk, 1961
Subbotina inequispira (Subbotina)
Subbotina linaperta (Finlay)
Subbotina senni (Beckmann)

Superfamily GLOBIGERINACEA

Family: Hastigerinidae Bolli, Loeblich & Tappan, 1957
Genus: Hastigerina Thomson, 1876
Hastigerina bolivariana (Petters)
Genus: Pseudohastigerina Blow & Banner, 1959
Pseudohastigerina wilcoxensis (Cushman & Ponton)

Superfamily NUMMULITACEA

Family: Nummulitidae de Balainville, 1827
Genus: Nummulites Lamarck, 1801
Nummulites gizehensis (Forskal)

Superfamily ROTALIACEA

Family: Rotaliidae Ehrenberg, 1839

Genus Dictyoconus Blanckenhorn, 1900

Dictyoconus aegyptiensis (Chapman)

The following short comments and selected synonyms are rather fragmentary. Besides, the stratigraphic ranges of the most common planktonic foraminiferal species encountered here are introduced (Fig. 4). Only the zonal foraminiferal species are discussed herein.

Genus: Acarinina Subbotina, 1953

Acarinina pentacamerata (Subbotina)

(Pl. 1. Fig. 8 in El Dawoody, 2005)

1947 Globorotalia pentacamerata Subbotina; Vses. Neft. Nauchno-Issled. Geol. Razved., VNIGRI., P. 128, Pl. 7, figs. 12-17, pl. 9, figs. 24-26.

1980 Acarinina pentacamerata (Subbotina) – Benjamini; J. Paleont;, 54: 339, pl. 1, figs. 15-17.

Remarks: Bandy (1964) suggested that Globorotalia pentacamerata Subbotina is a junior synonym of G. aspensis Colom.

Stratigraphic range: The species was first described from the later part of the early Eocene in northern Caucasus. It is used as a zonal index ranging throughout the early and middle Eocene. This form has been reported from the early Eocene (late early Eocene) in the studied sections.

Genus: Nummulites Lamarck, 1801

Nummulites gizehensis (Forskal)

(Pl. 4, Figs. 1, 2, Pl. 5, Fig. 2)

1930 Nummulites gizehensis (Forskal) – Cuvillier, pl. XIV, fig. 2; pl. XIV, fig. 7.

1951 Nummulites gizehensis (Forskal) – Said, p. 120, figs. 2-8.

1972 Nummulites gizehensis (Forskal) – Blondeau. p. 151. Pl. 26. figs.

1981 Nummulites gizehensis (Forskal) – Schaub, p. 115, pl. 36, figs. 37-40; pl. 37, fig. 5.

Remarks: Nummulites gizehensis (Forskal) was originally created by Forskal in 1775 as species: Nautilus (?) gizehensis (among the Testacea fossilia Kahirensia). Later it was named N. gizehensis (Forskal). This species was studied by de La Harpe (1883), Cuvillier (1930), Said (1951). He recognized eight species: - N. ehrenbergi, N. lyelli, N. champollioni, N. pachoi, N. zitteli, N. viquisneli and N. caillaudi in addition to the proper N. gizehensis.

Genus Dictyoconus Blanckenhorn, 1900

Dictyoconus aegyptiensis (Chapman)

(Pl. 6, Fig. 4.)

1925 Dictyoconus aegyptiensis (Chapman) - Silvestri. p. 43. fig. 10

1931 Dictyoconus aegyptiensis (Chapman) - Nuttall & Brighton p. 75, pl. 4. Figs. 4 - 6

Remarks: According to Blanckenhorn. 1900; Dictyoconus aegyptensis (Chapman) characterizes the Unter Mokattam Ober gizehensis Stuffe" which he considered it to represent the upper part of Middle Eocene. In the present study, this zone is found at the top of section (II) Wadi El Agramiya (32 m thick).

MICROFACIES STUDIES

The hard beds, which are unfavorable for any appropriate washing techniques, were thin sectioned and studied for their microfacies. A series of monographs were published dealing with microfacies of many parts of the world (Misik, 1966, Howritz & Potter, 1971, Scholle, 1978 and Flugel, 1982). In Egypt, several authors were engaged in the Tertiary microfacies including:

Ismail & Selim (1967); Barakat & Fahmy (1968); Barakat & El-Dawoody (1975); El-Dawoody & Morsi (1998) are the most prominent.

The terminology proposed by Folk (1962) and Dunham (1962) in describing the different carbonate rock types is followed in the present study. Dunham's calssification is essentially textural and is most valuable when used in a purely descriptive way for lithified rocks. Textutal maturity is implied in that the least mature varieties are richer in mud matrix. However, depositional deductions based on these textural characters alone need great care.

In this study the main bulk of the sampled beds examined are allochemical rocks (having > 10 % allochems). These are either micro-crystalline allochemical rocks (in which the microcrystalline ooze matrix > sparry calcite cement) or sparry allochemical rocks (in which the sparry calcite cement > microcrystalline ooze matrix). If the rock includes a large proportion of organic remains, it is classified either as "Biomicrite" or "Biosparite" respectively. Biomicrosparite is a combination of both Biomicrite and Biosparite. Rocks consisting of microcrystalline ooze with 1 – 10 % scattered fossils are termed "Fossiliferous micrites".

The indurated interbeds were thin-sectioned and microscopically examined. The study of such rock samples was found necessary to throw more light on the evolutionary history of the sedimentation basin (Folk, 1959, 1962). The paleoenvironmental conditions that prevailed during sedimentation of the different lithostratigraphic units were interpreted.

(i) Early Eocene (Upper Ypresian):

1- Foraminiferal Biomicrite

(pl. 3, figs. 1-8, pl. 5, figs. 3,4)

The rock is dark greyish yellow, cryptocrystalline, fine grained, highly argillaceous, fossiliferous with planktonic species (Acarinina Morozovella and Globigerina spp), together with some benthonic forms and undifferentiated organic remains.

This biomicrite facies is recorded mainly in the Minia Formation (late early Eocene) and in some samples of the Gabal Hof Formation. The foraminiferal biomicrite association suggests an open marine condition (outer neritic) environment where no coarser terrigenous material is accumulated.

Middle Eocene Microfacies

(ii) Lower – Middle Lutetian:

2- Operculina & Discocyclina Biomicrite

(pl. 5, figs. 5,6)

The rock is composed, of white, chalky, foraminiferal biomicrite, wholly composed, of large foraminifera especially Alveolina frumentiformis Schwager, Operculina praespira Douville, Discocyclina sp. and Nummulites sp. in less abundance, and some small unidentifiable foraminifera embedded in a fine grained, and well sorted micrite. Quartz grains are distributed in the ground mass but less frequent in the lower levels of this rock unit. They are rounded to subrounded, slightly turbid and irregularly scattered. The rock is fairly well sorted and dolomitized in part.

This biomicrite was reported in the southeastern corner of Gebel Abou Treifiya. It belongs to the Lower Lutetian (Barakat & Abou Khadrah, 1971) recorded in the Cairo - Suez district. To the south, in Wadi El Agramiya section, such a facies was dated back to Lower – Middle Lutetian.

The nature of this association reflects deposition in a fairly warm, well aeriated and shallow to reefal environment. This is justified by the abundance of large foraminifera as well as the occurrence of well sorted quartz grains which are derived from a nearby landmass.

3- Nummulitic (Numulites gizehensis) Biomicrite
(pl. 4, figs. 1-3, pl. 5, figs. 1,2, pl. 6, figs. 1,2)

The rock is grey to yellowish grey, sometimes greyish white, very hard, coarse grained, highly dolomitized and nummulitic. It is packed with Nummulites gizehensis (Forskal), Nummulites perforatus, Nummulites beaumonti D'Archiac & Haime and other species, small Foraminifera are also common in the matrix. Lamellibranch fragments, Ostracods together with minute undifferentiated organic remains are met with. Allochems and fauna exhibit no proper orientation.

Typical Nummulites gizehensis biomicrites are recorded in G. Hof Formation in both studied sections. The Nummulites gizehensis biomicrites occur above the planktonic forminiferal Acarinina pentacamerata Zone in the whole section.

Such a type of faunal association reflects a reefal environment which have been strongly affected by water agitation caused by waves on a reef body.

4- Nummulitic (Nummulites gizehensis) Biosparite
(pl. 4, fig. 4, pl. 6, fig. 3)

The rock is yellowish white, ranging in grain size from medium calcarinite to fine calcirudite. Large foraminifera are the most abundant, being represented by Nummulites gizehensis (Forskal), Nummulites beaumonti D'Archiac & Haime, Nummulites discorbinus (Schlotheim) and Nummulites spp. Corals, Bryozoa and Lamellibranch fragments are noticeable. Allochems and fauna exhibit no preferable orientation.

This biosparite is known in Wadi El Agramiya, Sample no. 61 interbedded with Nummulites gizehensis biomicrite of the same section.

This association reflects deposition in a relatively shallow to reefal environment that have been affected by high level of energy caused by waves.

5. Foraminiferal Biosparite

The rock is chalky white, moderately hard and coarse grained in texture. Clusters of Nummulites spp. and Operculina sp. predominate. Small foraminifera are common. Echinoid remains together with Bryozoa and Ostracods are also encountered. Allochems and fauna show no preferable orientation. This biosparite is known only in the Wadi El Qena section within the Nummulites gizehensis Zone (sample No. 296).

This association reflects marine environment of shallow neritic zone with well ventilated warm sea floor of normal salinity. Secondary crystallization is probably attributed to ascending hydrothermal solutions.

(iii) Upper Lutetian:

6. Foraminiferal Biomicrosparite
(pl. 6, figs. 4-6)

The rock is yellowish white, moderately hard, slightly sandy, fine grained, fossiliferous and nummulitic. The rock possesses abundant voids filled with secondary calcite grains. Canalicular skeleton, chambers and the proloculum of many nummulitic species are filled with calcite crystals. The microfacies is fossiliferous with Nummulites sp, Operculina sp, Miliolidae, Fabularia sp and Dictyoconus aegyptiensis (Chapman). Recrystalline sparry calcites are rarely represented. The grainstone associtaion is recorded in G. Hof and Observatory Formations. Small foraminifera and Ostracods are rare. Few echinoid plates and Bryozoa are dissiminated through out the matrix.

The foraminiferal biomicrosparite is known only in the Wadi El Agramiya section above the Nummulites gizehensis Zone (sample no 68). This association reflects marine environment of shallow neritic zone with well ventilated warm sea floor of normal salinity.

The following, paragraphs are concerned with the relationship between the organisms met with in thin sections and their habitat medium. This paleoccological analyses elucidate the conditions under which sedimentation took place. Moreover, fossil organisms and the sediments in which they are embedded are frequently good indicators for the evaluation and adaptation of the organisms to the conditions that dominated during their life (Hecker, 1965). Wadi El Qena/W. El Agramiya section embraces the stratigraphic interval between the early Eocene (Upper Ypresian) and the middle Eocene (Upper Lutetain).

The early Eocene (Upper Ypresian) of both sections along west in North Galala Plateau is represented by open marine facies with planktonic elements, few benthonics and undifferentiated organic remains. This outer neritic facies dominated this region. Similar sequence of facies, irrespective of aging, was pointed out in Ezz El-Orban area (Barakat & Fahmy, 1968).

The Lower Lutetian of Abou Treifiya area (Cairo - Suez district) is characterized by reefal to inner neritic facies. This reflects gradual shallowing of the sea where large Forams, miliolids and Bryozoa have been accumulated. This biocommunities include the fore - reef association which denote a transitional zone existing between the lower outer neritic zone and the upper back reef facies of shallower condition in the belt of turbulent water.

During the middle Eocene (Lower - Upper Lutetian), in Abou Treifiya & south in the studied sections, more shallowing took place and the occurrence of shallow to proper reefal facies is detected. This environment has been affected, by a moderately energetic medium where good illumination, better food and Oxygen are the most diagnostics. Intermittent short lived marine encroachment and retreat took place and resulted in the formation of alternating thin bedded micrites and biomicrites with remarkable percent of clastics. The micrites and biomicrites enclose minute admixture of calcareous matter and planktonic elements reflecting deep conditions. By retreat, shallowing is repeated again and ill-bedded bioherms of molluscan shell fragments with few large Forams have been accumulated under aeriated warm sea of normal salinity.

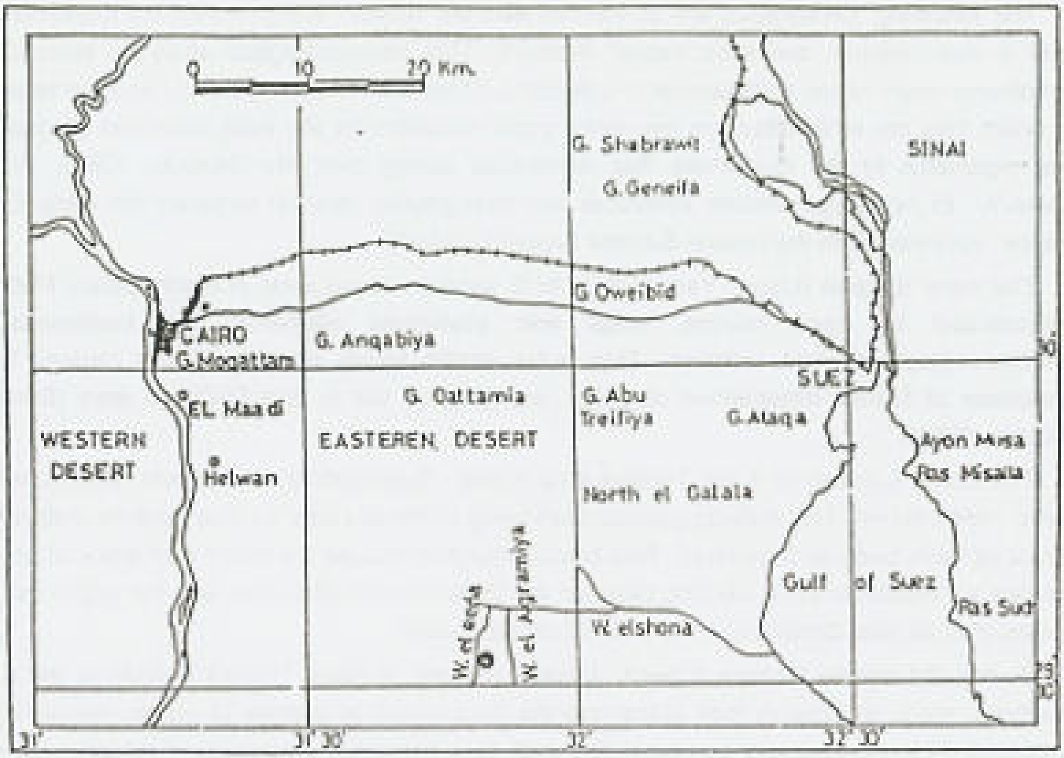

Fig:I. Location map of study sections

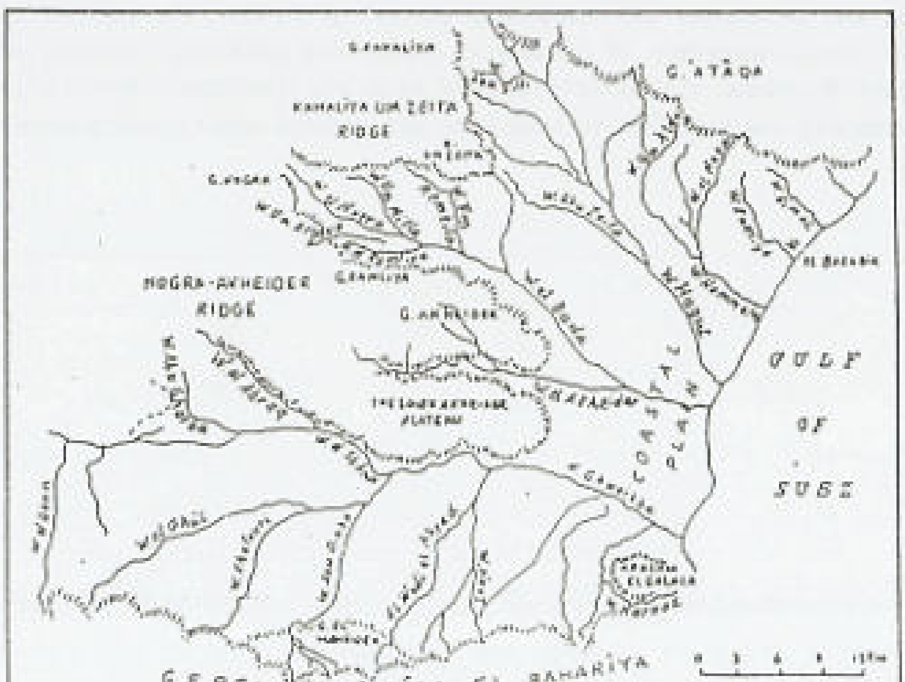

Fig. (2). Sketch plan showing main hill-ranges & drainage lines in North El Galala (After Sadek, 1926).

Fig (3) COLUMNAR SECTION OF WADI EL-ABRAMIYA / WADI EL-QENA AREA, NORTH EL GALALA, NORTH EASTERN DESERT, EGYPT

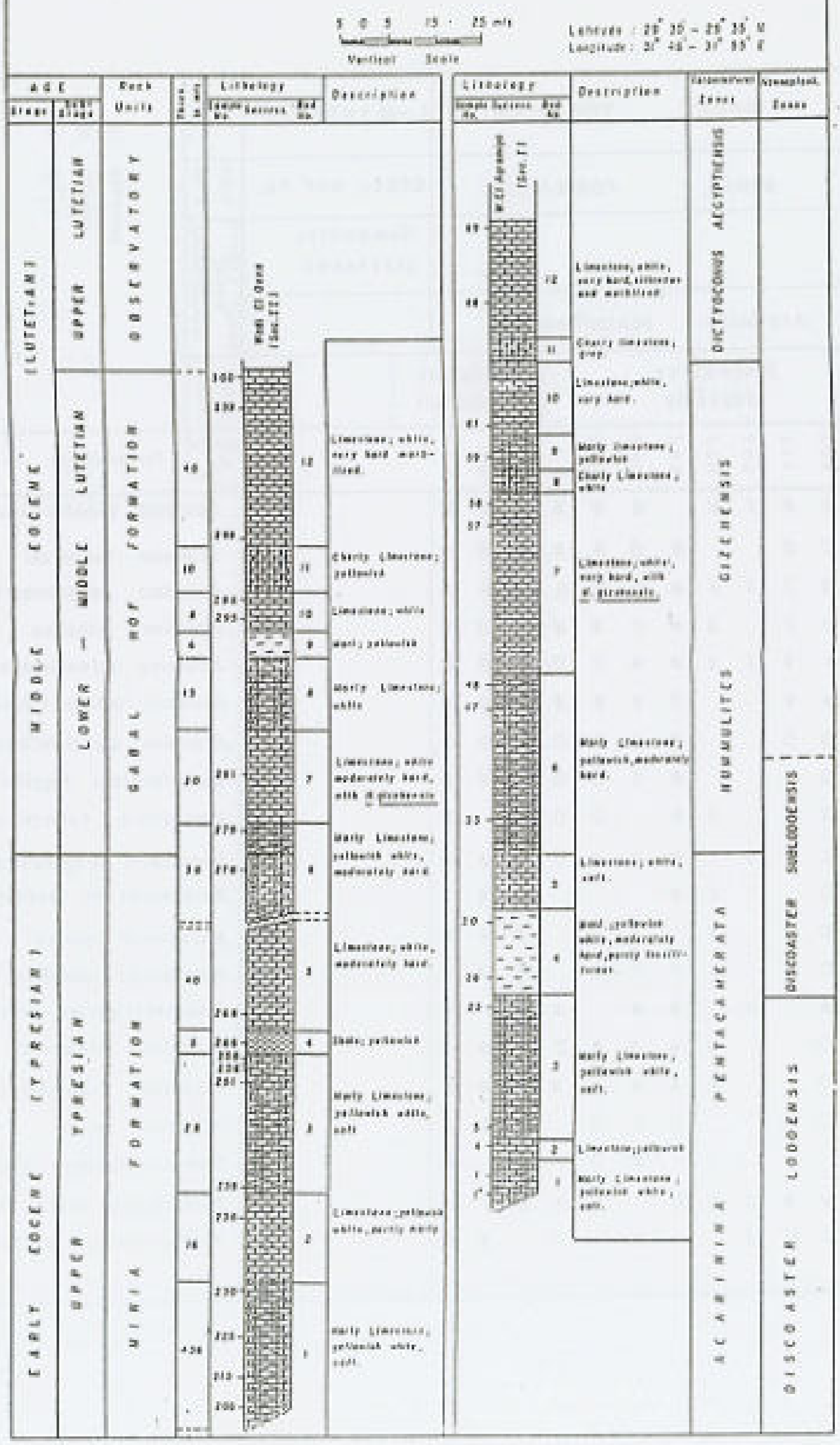

Fig. 4: FREQUENCY CHART OF PLANKTONIC FORAMINIFERA SPECIES OF THE STUDIED SECTIONS.

X Rare
O Common
● Abundant

Age	UPPER YPRESIAN											L.-M. LUTETIAN
Rock Units	MINIA FORMATION											GABAL HOF FM.
Foraminiferal Zones (Large)												Nummulites gizehensis
Foraminiferal Zones (Plank.)	Acarinina pentacamerata											
Nanno. Zones	Discoaster lodoensis							Discoaster sublodoensis				
Sample No. / Foraminiferal species	206	215	223	230	256	262	266	1	5	25	278	
Acarinina bráedermanni	●	●	X	X		●	●	●	●	●	●	
Acarinina bullbrooki	O	●			●	O	●	●	●	●	●	
Acarinina pentacamerata	●	O	X	X	●	●	●	●	●	●	●	
Acarinina primitiva	O	O		X	●	O	●	●	O	O	●	
Acarinina soldadoensis angulosa	●	●	X	X	●	●	O	O	●	●	●	
Acarinina soldado. soldadoensis	●	●			O	●	●	●	●	●	●	
Acarinina spinuloinflata	O	O			●	O	●	O	O	O	●	
Gumbelitroides higginsi	O	●			●	O	O	O	X	X	●	
Hastigerina bolivariana	X	X		X	●		O	O	X		●	
Morozovella aragonensis	X	●	X		●	O	O	O		●	●	
Morozovella cf. lensiformis	O			X	●				X	X		
Morozovella quetra	O	O		X		O	O		X	X	●	
Morozovella spinulosa	O	O		X	O	X	X		X	X	O	
Pseudohastigerina wilcoxensis	●		X		●	●		●	X		●	
Subbotina linaperta	O			X	●	●	●	O		●	●	
Subbotina inequispira	O			X	X	●	X	●		●	●	
Subbotina senni	O	X			X	O	O		X	O	O	
Truncorotaloides rohri						●	O		X		●	
Turborotalia cerro. frontosa	●	●	X	X	X		X	X	O		O	
Turborotalia cf. griffinae	O	O	X			●		X		●	O	

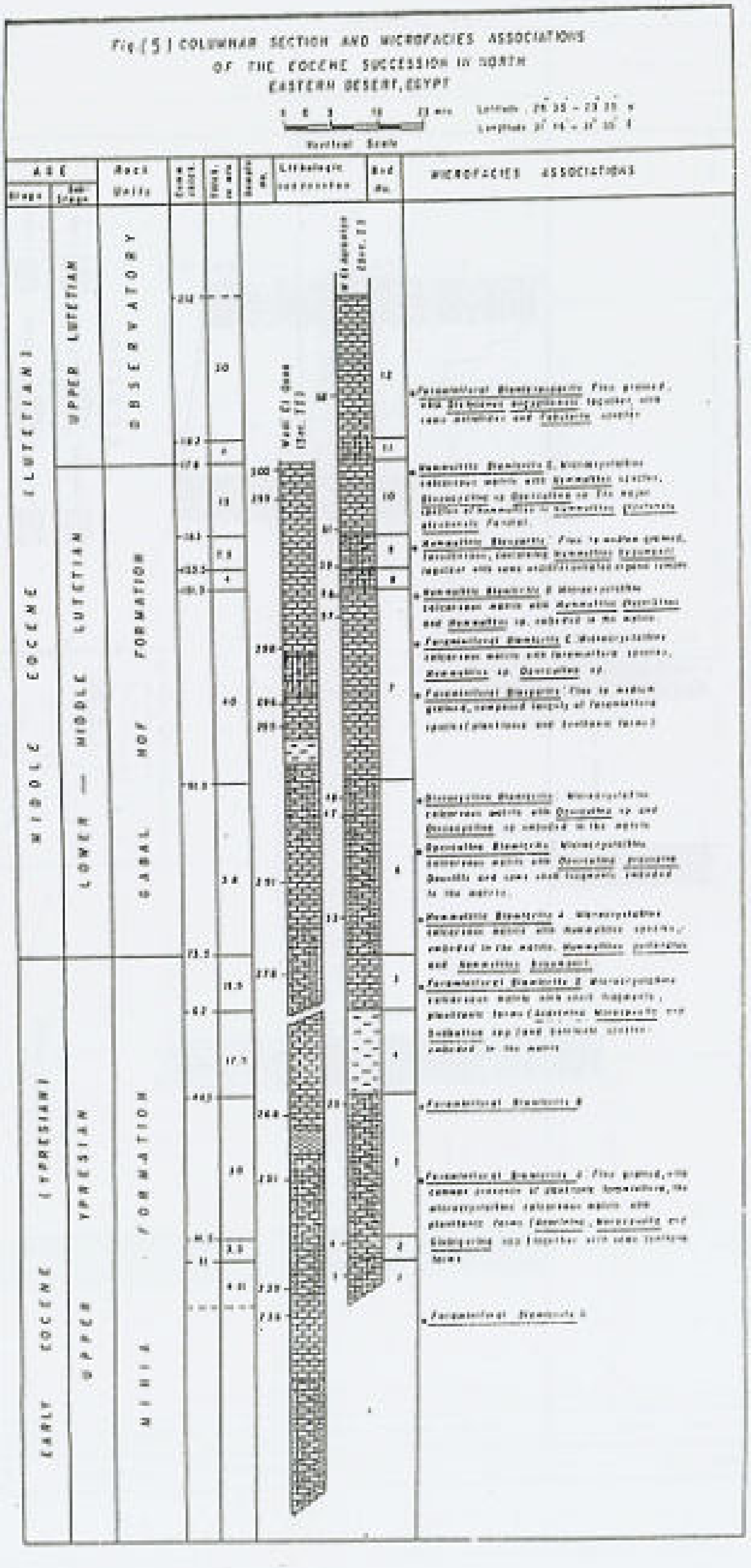

Fig (5) COLUMNAR SECTION AND MICROFACIES ASSOCIATIONS OF THE EOCENE SUCCESSION IN NORTH EASTERN DESERT, EGYPT

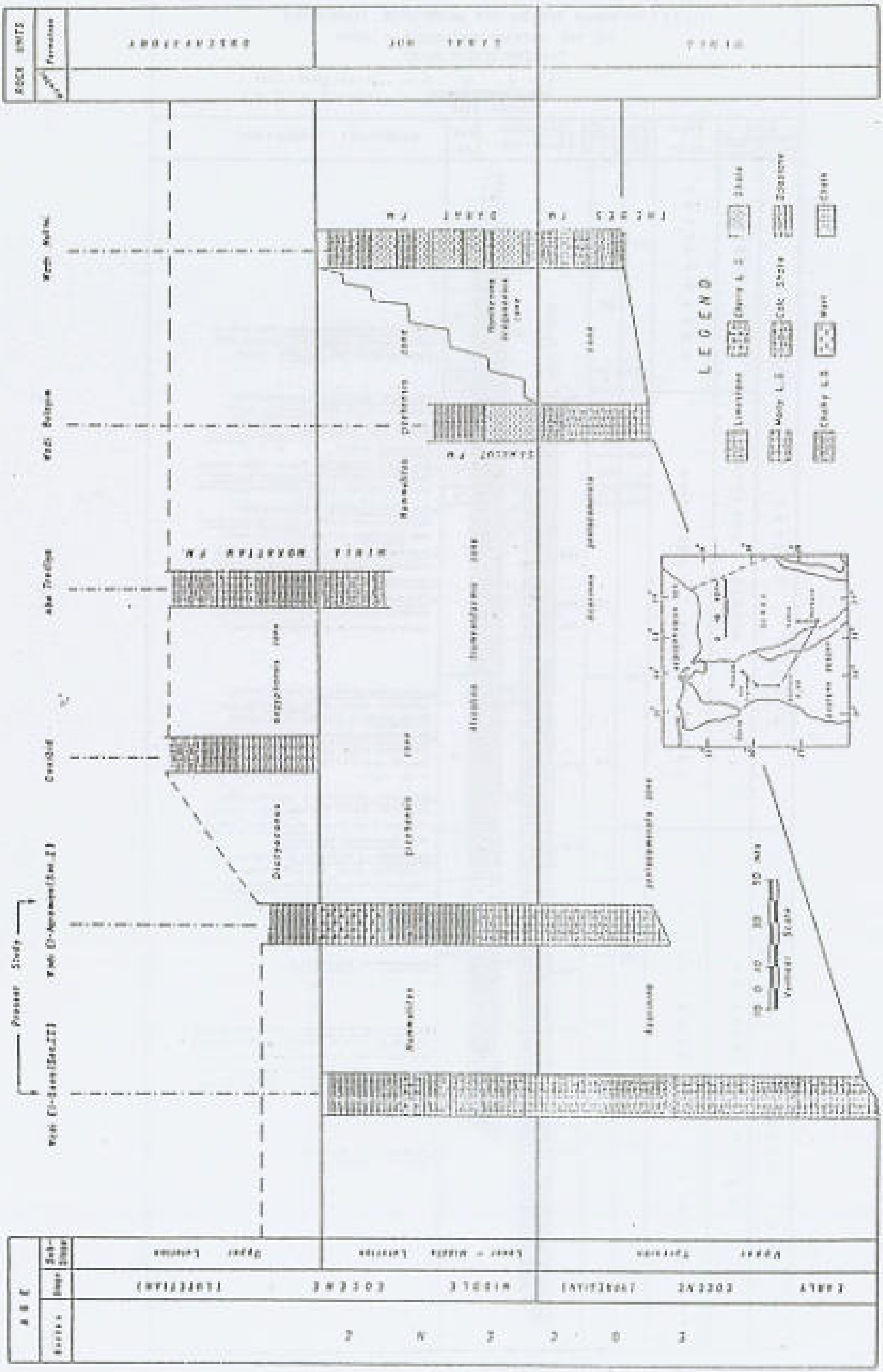

Fig.6 CORRELATION CHART OF THE EARLY AND MIDDLE EOCENE SUCCESSION
(By means of Foraminifera)

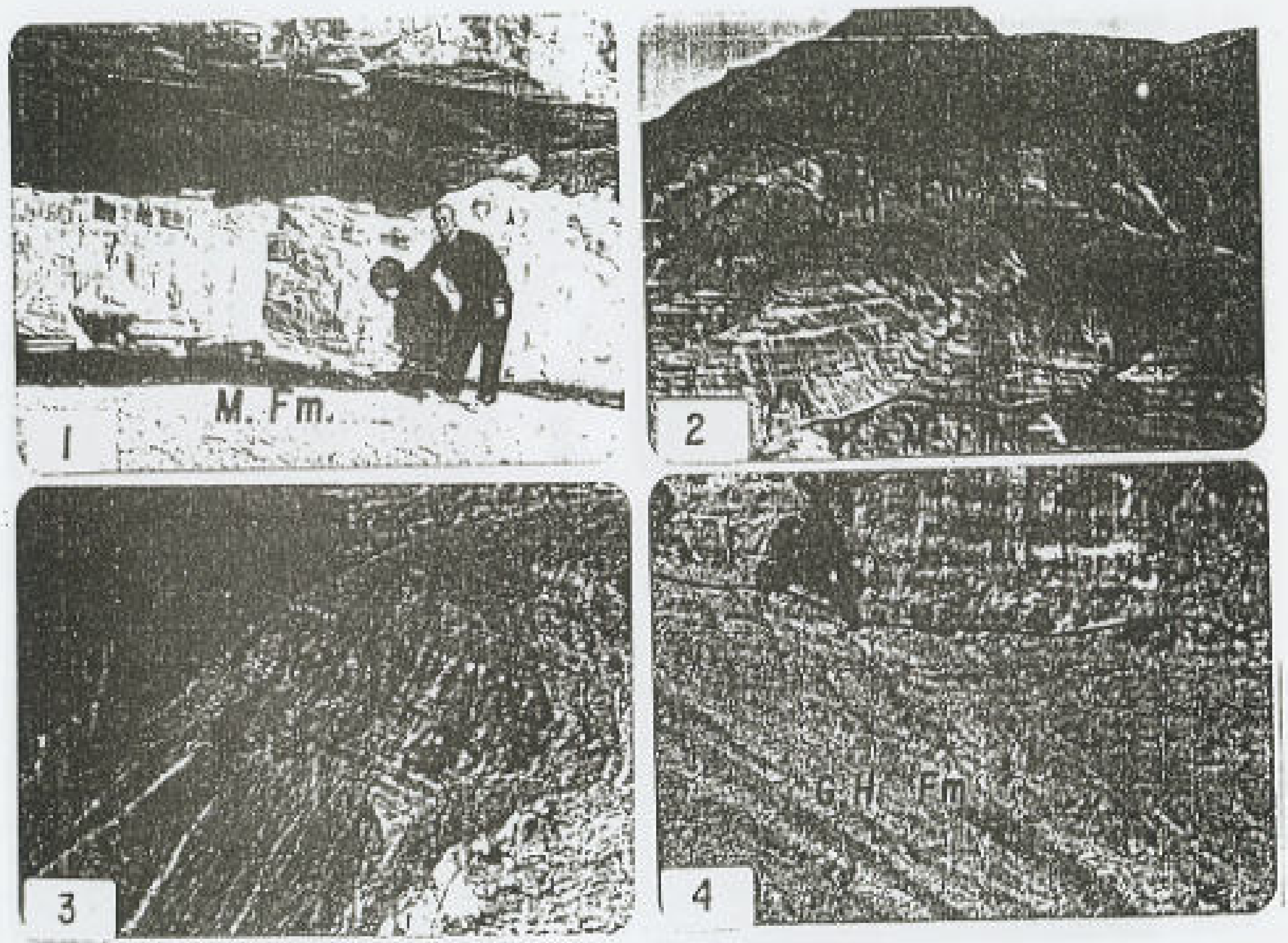

Plate 1

Figure 1. Marl and Marly limestone of lower parts of the Minia Formation. The base of Minia Formation is unexposed. Notice the fractural system in the hard limestone under cutting in the soft marly limestone at the base of the photo Minia Formation (M. Fm), Wadi El Agramiya section I.

Figure 2. General view of Wadi El Agramiya Section I, from base to top, Minia Formation (M. Fm) Gabal Hof Formation (G.H. Fm) and Observatory Formation (Ob. Fm) Notice the fractural system and stratification in the upper part of the section.

Figure 3. General view of the middle part of Wadi El Agramiya about 100-120 mts from ground level. Notice the inter bedding of beds at the top and the beds dipping in NW - SE direction.

Figure 4. General view of the Gabal Hof Fm; (Wadi El Agramiya) Notice the two beds, first in the base composed or marly limestone (soft) and the second composed of chalky and Marly limestone.

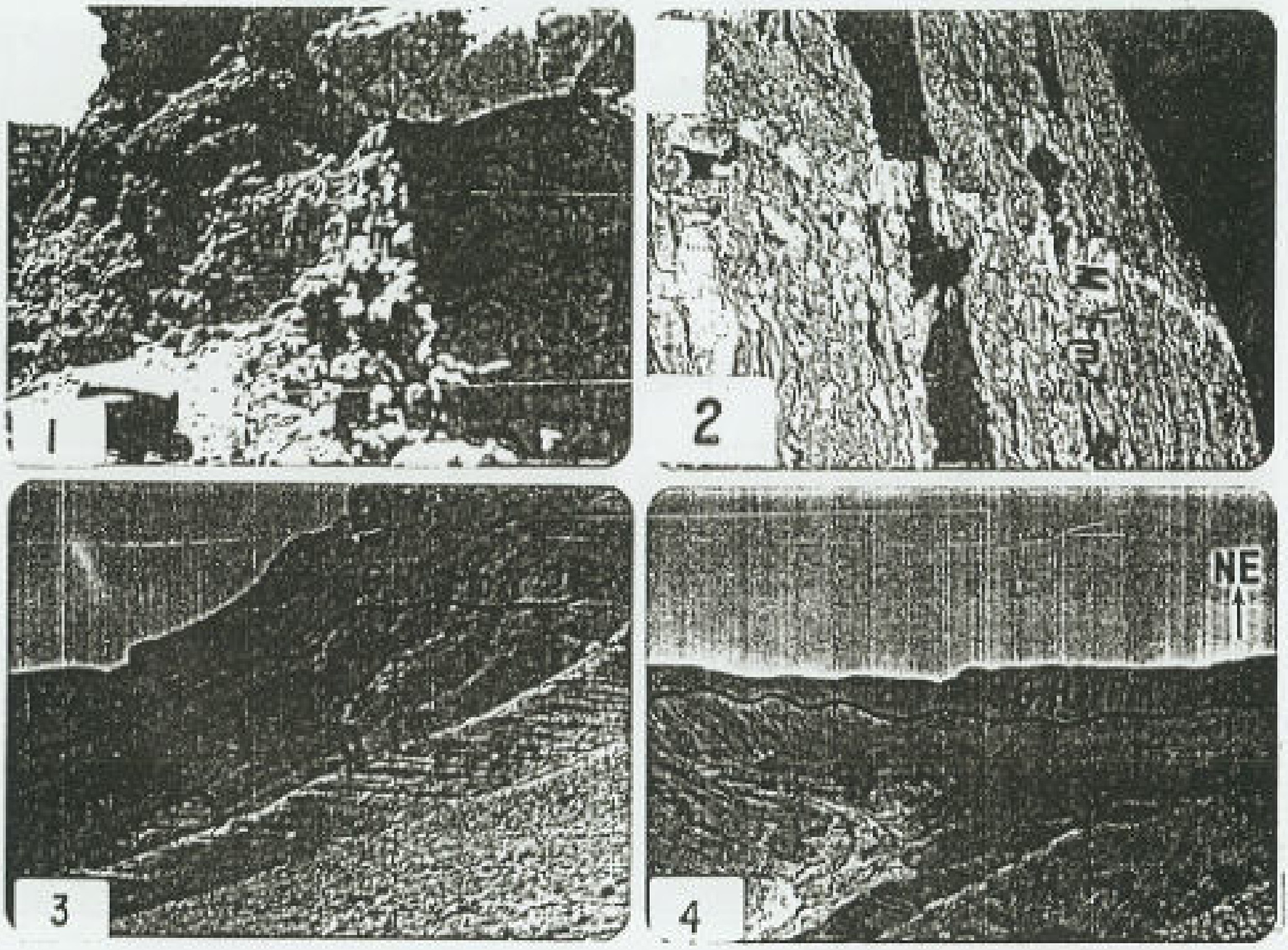

Plate 2

Figure 1. In this photo the Nummulites gizehensis is very characteristic in this bed. Notice the lower part of this photo, the stratified chalky limestone with zigazag lines (Gabal Hof Formation, G.H. Fm), Wadi El Agramiya (Section I).

Figure 2.
General view of the lower part of section II, Wadi El Qena composed of Marly limestone, Marl and soft limestone. Notice the lower part unexposed and the stratification of these beds in marl and the fractural structure occurrence at the top of this photo. The Minia Formation (M. Fm) at the base of the section, the beds are steeply dipping.

Figures 3,4.
General view of Wadi El Qena, section II, from base to Top, Notice the stratification and some fractural system in some beds. The dipping of beds NW-SE direction, the lithology of this section composed of Marl, Marly limestone, limestone, chalky limestone and some chert at the top of the section. The formation in this section Minia (M. Fm) at the base and Gabal Hof (G.H. Fm) at the top.

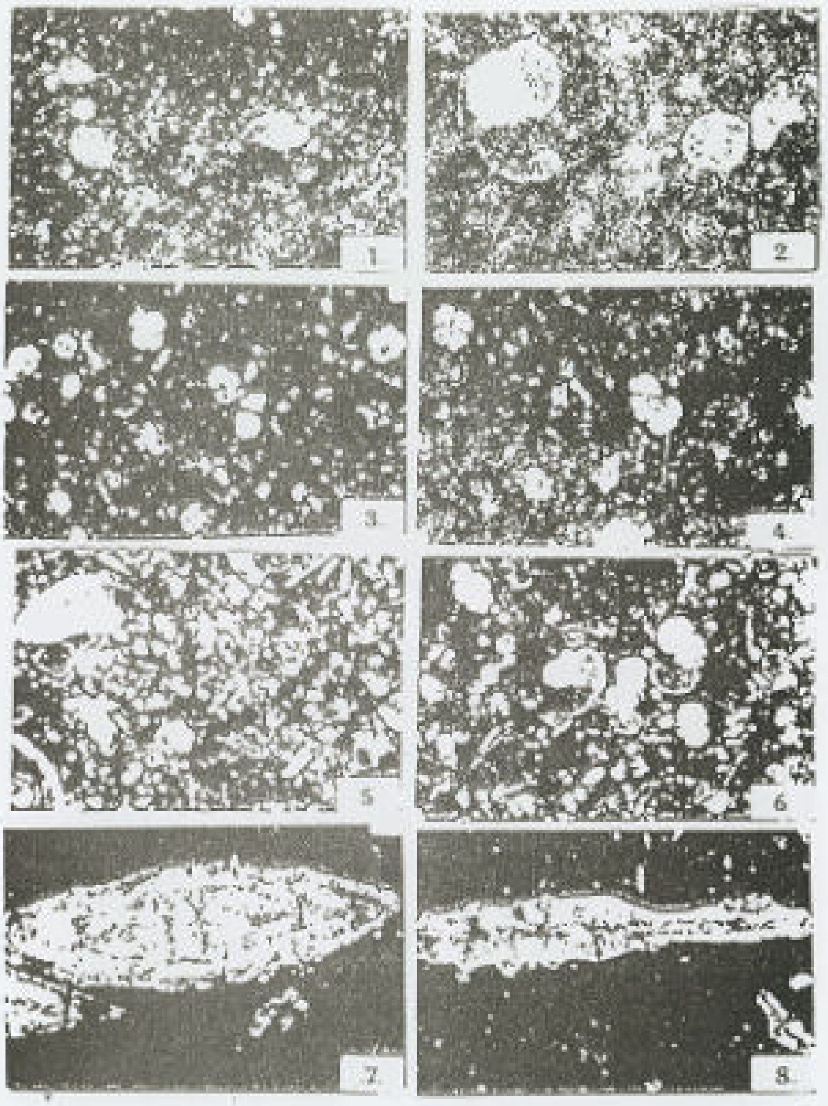

Plate 3

Figures 1,2. Forammiferal Biomicrite (X 70). Fine grained with common presence of planktonic foraminifera, Notice the numerous shell fragments embeded in the matrix. The matrix consists of microcrystalline calcite with planktic foraminifera Globigerinidae and Globorotaliidae.

Age: early Eocene (Upper Ypresian)
Locality: Wadi El Qena, sample no. 239
Environment: Open marine (outer bathyal zone).

Figures 3,4. Foraminiferal Biomicrite (X 70). Fine grained with common presence of planktonic foraminifera. The microcrystalline calcareous matrix with planktonic forms (Acarinina, Morozovella and Globigerina spp), together with some benthonic forms.

Age: early Eocene (Upper Ypresian)
Locality: Wadi El Qena, sample no. 268
Environment: Deep marine (open marine).

Figures 5,6. Foraminiferal Biomicrite (X 70). Microcrystalline calcareous matrix with shell fragments, planktonic forms (Acarinina, Morozovella and Subbotina spp) and benthonic species in the matrix.

Age: early Eocene -middle Eocene
Locality: Wadi El Qena, sample no. 291
Environment: Open marine to shallow marine.

Figures 7,8. Foraminiferal Biomicrite (X 30). Microcrystalline calcareous matrix with foraminifera species, Nummulites sp, Operculina sp, and shell fragments in the matrix.

Age: early - middle Lutetian
Locality: Wadi El Qena, sample no. 298
Environment: Shallow marine.

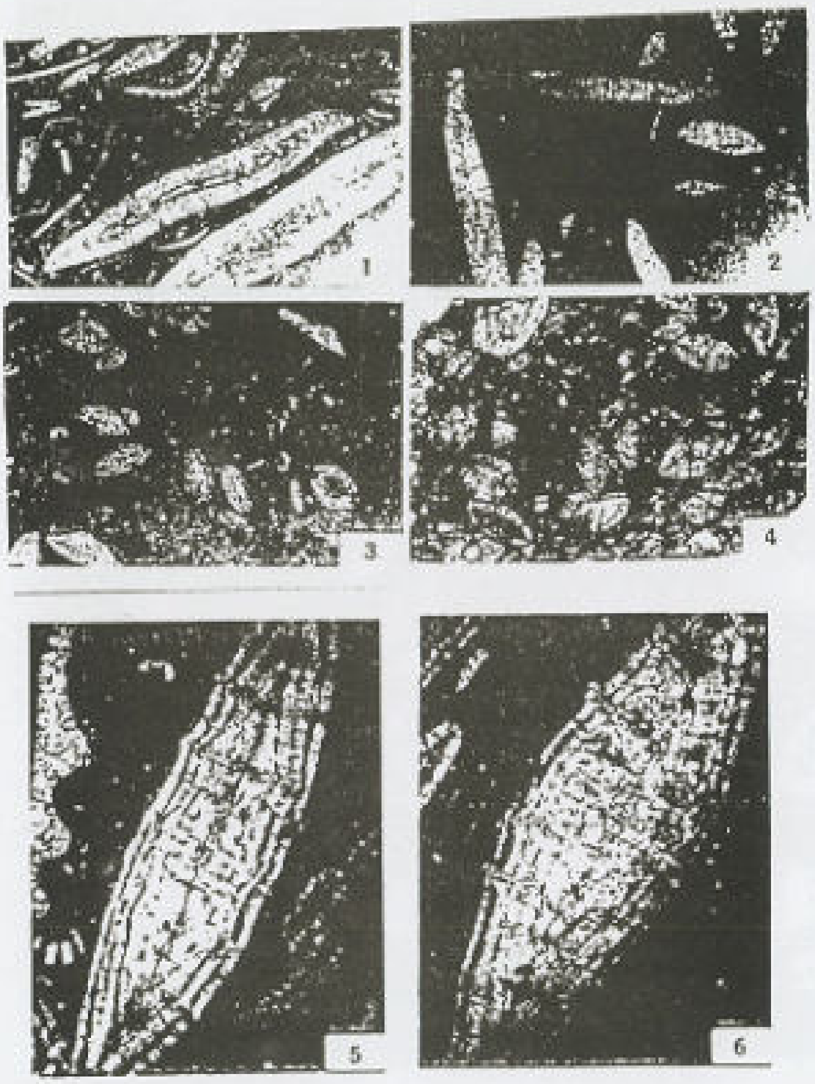

Plate 4

Figures 1,2. Nummulitic Biomicrite (X 10). Microcrystalline calcareous matrix with *Nummulites* species, *Discocyclina* sp. *Operculina* sp. and some shell fragments embeded in the matrix. The major species of *Nummulites gizehensis gizehensis* Forskal.

Age: early- middle Lutetian
Locality: Wadi El Qena, Samples no. 300, fig. 1, 299, fig. 2.
Environment: Shallow marine (Middle and outer neritic zone).

Figure 3. Nummulitic Biomicrite (X 10). Microcrystalline calcareous matrix with *Nummulites gizehensis Nummulites perforatus, Nummulites beaumonti* and some shell fragments.

Age: : early- middle Lutetian
Locality: Wadi El Agramiya, Sample no. 58
Environment: Shallow marine.

Figure 4. Nummulitic Biosparite (X 10). Microcrystalline calcareous matrix with *Nummulites* species. The Nummulites species as follows: *Nummulites beaumonti, Nummulites discorbinus,* and *Nummulites* spp.

Age: middle Lutetian
Locality: Wadi El Agramiya, Sample no. 61
Environment: Shallow marine.

Figures 5,6. Nummulitic Biomicrite (X 30). Microcrystalline calcareous matrix with *Nummulites* in the matrix with *Nummulites discorbinus, Nummulites perforatus* and some shell fragments.

Age: : early- middle Lutetian
Locality: Wadi El Qena, samples no. 300, fig. 5, 299, fig. 6
Environment: Shallow marine.

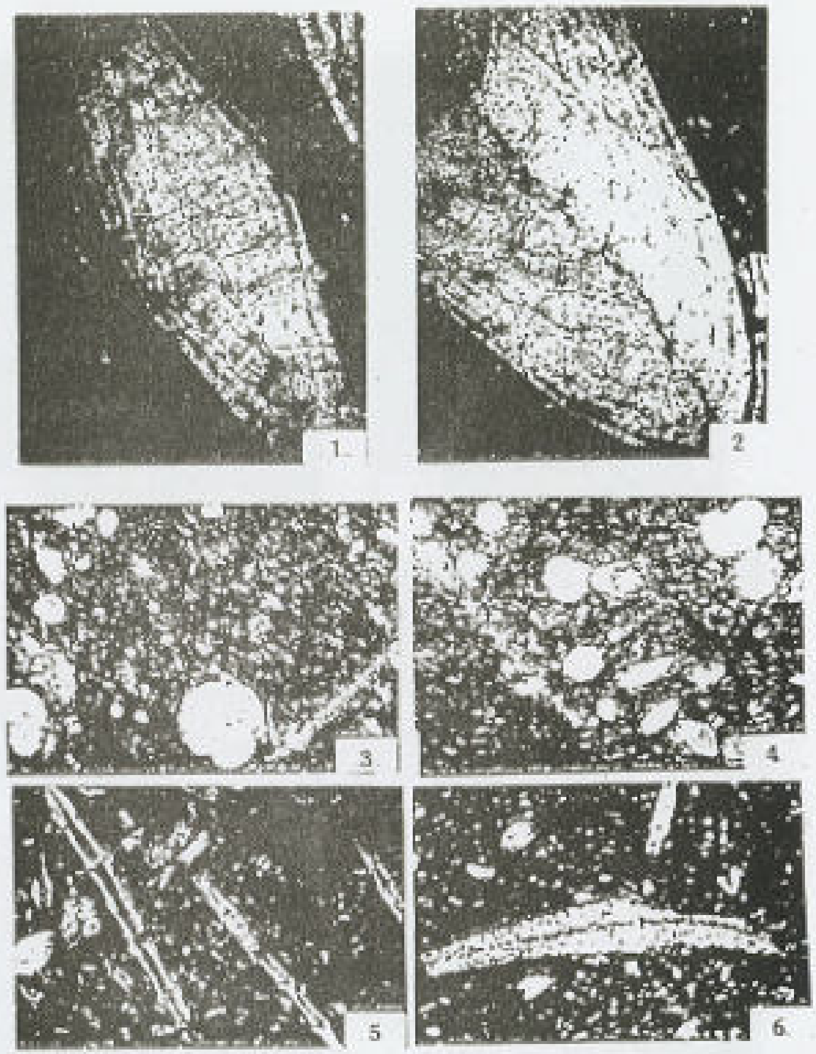

Plate 5

Figures 1,2. Nummulitic Biomicrite (X 30). Microcrystalline calcareous matrix with Nummulites species embeded in the matrix with *Nummulites subbeaumonti* (fig. 1), *Nummulites gizehensis* (fig. 2) together with some shell fragments.

Age: middle Lutetian
Locality: Wadi El Qena, sample no. 306
Environment: Shallow marine.

Figure 3. Foraminiferal Biomicrite (X 70). Microcrystalline calcareous matrix with planktonic species (*Acarinina*, *Morozovella* and *Globigerina* spp. in the matrix, some shell fragments in the matrix.

Age: early Eocene (Upper Ypresian)
Locality: Wadi El Agramiya, sample no. 1
Environment: Open marine.

Figure 4. Foraminiferal Biomicrite (X 70). Microcrystalline calcareous matrix with planktonic species (*Acarinina*, *Morozovella* and *Globigerina* spp) in the matrix.

Age: early Eocene (Upper Ypresian)
Locality: Wadi El Agramiya, sample no. 25
Environment: Open marine.

Figure 5. Operculina Biomicrite (X30). Microcrystalline calcareous matrix with *Operculina praespira* Douville and some shell fragments in the matrix.

Age: middle Eocene (Lower Lutetian)
Locality: Wadi El Agramiya, sample no. 47
Environment: Shallow marine.

Figure 6. Discocyclina Biomicrite (X 30). Microcrystalline calcareous matrix with *Operculina* sp. and *Discocyclina* sp. in the matrix.

Age: middle Eocene (Lower Lutetian)
Locality: Wadi El Agramiya, sample no. 48
Environment: Shallow marine.

PLATE 6

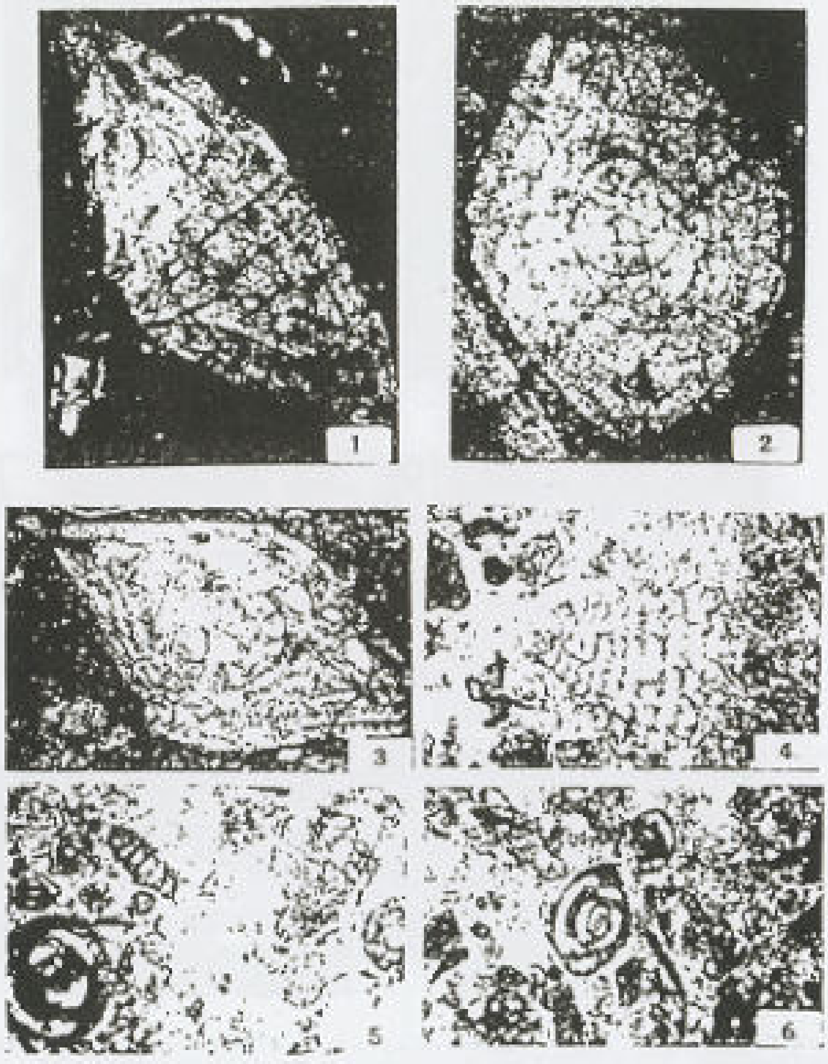

Plate 6

Figure 1. Nummulitic Biomicrite (X 30). Microcrystalline calcareous matrix with *Nummulites discorbinus* and *Nummulites* sp. in the matrix.

Age: early- middle Lutetian
Locality: Wadi El Agramiya, sample no. 57,
Environment: Shallow marine (outer neritic zone)

Figure 2. Nummulitic Biomicrite (X 30). Microcrystalline calcareous matrix with *Nummulites perforatus*, and *Nummulites beaumonti*, embedded in the matrix.

Age: early- middle Lutetian
Locality: Wadi El Agramiya, sample no. 53
Environment: Shallow marine.

Figure 3. Nummulitic Biosparite (X 30). Fine to medium grained, fossiliferous, containing *Nummulites beaumonti* together with some undifferentiated organic remains, all embedded in a homogenous, ferruginated sparry calcite.

Age: middle Lutetian
Locality: Wadi El Agramiya, sample no. 61
Environment: Shallow marine.

Figures 4,5,6. Foraminiferal Biomicrosparite (X 30). Fine grained, with *Dictyconus aegyptiensis* (fig. 4) together with some miliolides and *Fabularia* species (figs. 5, 6). Microsparite in parts impregnated by some shell fragments and iron oxides.

Age: late Lutetian
Locality: Wadi El Agramiya sample no. 68
Environment: Shallow marine (inner neritic zone).

SUMMARY AND CONCLUSIONS

The investigation of the early and middle Eocene succession of Wadi El Qena (Sec. II) and Wadi El Agramiya (Sec. I) surface sections in west El Galala El-Baharia area, north Eastern Desert, was undertaken. This lead to the classification of such succession into the following rock stratigraphic units; arranged from top to base as:

3- Observatoray Fm.)
2- G.Hof Formation) Mokattam Formation
1- Minia Formation

These rock units have a regional distribution and be used as a basis for detailed mapping.

This succession was zoned on the basis of its foraminiferal content. The proposed zones were correlated with those recognized in other parts of the world, arranged from top to base as:

3- Dictyoconus aegyptiensis Zone)
2- Nummulites gizehensis Zone) L.-U. Lutetian
1- Acarinina pentacamerata Zone U. Ypresian

The study of stratigraphic ranges of the nannofossils found contempora-neous with these planktonic and large foraminifera in such succession aided in delineating three microbiostratigraphic zones, These zones were equated with the nannobiozones through a high resolution biostratigraphy. Further-more, both biostratigraphic zonations were correlatable with corresponding successions in other parts of the world.

This sort of study results in a number of interesting conclusions:

1. This led to the identification of twenty species and subspecies of planktonic foraminifera belonging to eight genera as well as six microfacies associations were also indentified and their ranges were given (Figs. 4,5).
2. The lowest formation cropping out in the studied region is at Wadi El Qena / W. El Agramiya section. This is the Minia Formation which may be dated; on the basis of microfossils (Acarinina pentacamerata Zone) and of nannofossils, as of Upper Ypresian age.
3. The Nummulites gizehensis Zone is equated with the upper part of Discoaster sublodoensis Zone together with the overlying zone devoid of nannofossils in Gabal Hof Fm. denoting a L.-M. Lutetian age. The upper Dictyoconus aegyptiensis Zone in Observatory Fm. is of Upper Lutetian age.
4. It was possible from the litho- and biofacies studies to recognize the depositional environments of the different formations. The Late Early Eocene (Ypresian) of the studied sections (Wadi El Qena and Wadi El Agramiya) is relatively open marine sediments (deep marine) as suggested by the common occurrence of planktonic foraminifera (globorotalids and globigerinids), such as Acarinina, Morozovella, Truncorotaloides, Globigerina and Subbotina. The benthonics are relatively rare in deeper marine environment. The sediments were probably laid down in the upper bathyal bathymetric zone.
5. The Lower – Middle and Upper Lutetian ages in the studied sections were characterized by reefal environment as indicated by the presence of frequent large foraminifera of the genera Nummulites, Operculina, Discocyclina, Fabularia, Miliolidae and Dictyoconus embedded in carbonate facies.
    a- Open marine (outer bathyal zone) including planktonic foraminifera

b- Shallow marine (Middle and outer neritic zone) includes large foraminifera (Nummulites Discocyclina, Operculina)

c- Shallow marine (inner neritic zone) included in the top of section II (Dictyoconus, Fabularia, Miliolidae).

6. The detailed correlation of the lithostraigraphic units as well as the planktonic and large foraminiferal zones of the studied sections makes possible the more accurate correlation of other Early Tertiary sections in Egypt (fig. 6).

ACKNOWLEDGEMENTS

The authors wish to express their gratitude deeply grateful and especially indebted to Prof. Dr. N.M. Aboul Ela Geology Department, Faculty of Science, Cairo University for his kind supervision, valuable advice and criticizing the whole manuscript. Thanks are also due to Dr. A. Swedan, Stratigraphic Division Manager, Geological Survey of Egypt for his continuous encouragement and help.

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الاستراتيجرافيا ودراسات للسحنات الدقيقة لبعض صخور الثلاثى
فى هضبة الجلالة الشمالية – شمال الصحراء الشرقية - مصر

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اجريت الدراسة على استراتجرافية الصخور السطحية للايوسين (السفلى – المتوسط) لمنطقة وادى العجرمية "قطاع رقم I" ووادى القنا "قطاع رقم II" وذلك بالاستعانة بالمثقبات (الفورامنيفرا) الهائمة بالاضافة إلى السحنات الصخرية الدقيقة التى استخدمت لتفسير هذا التتابع الصخرى.

أمكن من الدراسة التعرف على ٣٠ نوعا من المثقبات الهائمة تنتمى إلى ٨ أجناس بالاضافة إلى عدة أنواع من الفورامنيفرا الكبيرة من ستة تجمعات للسحنات الصخرية وجد أنها تجمعت تحت ظروف مغايرة، تم التعرف على امتدادهم الاستراتجرافى.

كذا أمكن تقسيم التتابع الصخرى إلى وحدات صخرية وحيوية مميزة وتعد أقدم الصخور الحاوية للاحافير الدقيقة فى منطقة البحث تابعة لحين الايوسين السفلى early Eocene وقد امكن تمييز ثلاثة نطق حيوية لاحافير الفورامنيفرا كما أمكن ترتيبها من أسفل إلى أعلى فى التتابع الزمنى كما يلى:

٣- نطاق الـ Dictyoconus aegyptiensis ... M. Eocene (U. Lutetian)

٢- نطاق الـ Nummulites gizehensis ... M. Eocene (L. - M. Lutetian)

١ - نطاق الـ Acarinina pentacamerata ... E. Eocene (U. Ypresian)

وقد قورنت هذه النطاقات الحيوية للفورامنيفرا بمثيلاتها من النطاقات الحيوية للنانوبلانكتون بالنسبة لعلاقة هذه النطاقات الحيوية بالصفات الطبيعية للصخور المعروفة باسم الليثوستراتيجرافى، هذا إلى جانب دراسة السحنات الدقيقة للصخور عن طريق عمل وتجهيز قطاعات صخرية دقيقة لصخور متكون المنيا **Minia Formation**، متكون جبل حوف **Gabal Hof Formation**، ومتكون المرصد **Observatory Formation** وكنتيجة لهذه الدراسة فقد أمكن استنتاج البيئات الترسيبية القديمة والسائدة أثناء ترسيب كل متكون على حدة.