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MICROFACIES ANALYSIS OF THE EOCENE SEDIMENTS SOUTHWEST OF FAID, SUEZ-CANAL ZONE, EGYPT

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ABSTRACT

Microfacies analysis of the Middle and Upper Eocene sediments south west of Faid Suez-Canal Zone. Egypt revealed nine associations: seven for the carbonates which are either limestones or dolomites and two for the terrigenous. Interpretation of the identified microfacies associations has led to the conclusion that the Middle and Upper Eocene sediments were deposited under shellow marine conditions of the inner neritic zone, reefalin parts, receiving variable amounts of deterital elements with repeated oscillations of the sea level.

INTRODUCTION

Eocene sediments southwest of Faid have a nearly horizontal attitude. They are dipping to the southwest with angles ranging between 4^0 - 8^0. They are separatd from the steeply dipping Cretaceous strata that constitute the core of Gebel Shabrawet by a short wadi which drains in the wide plain which leads to the Great Bitter Lake (Fig. 1).

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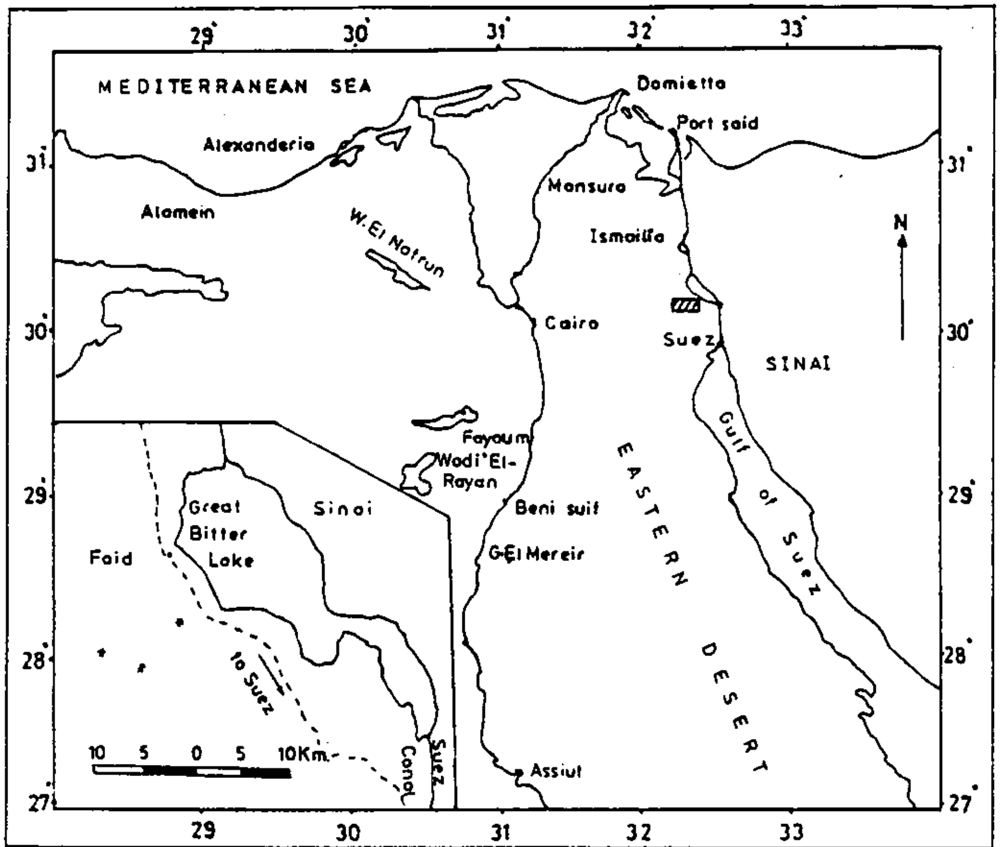

Fig(1.) Location map of the studied sections.

*1 Gebel El Gozo El Homra section.
*2 The hill southwest Gebel El Gozo El Homra.
*3 South Darbet El Houity section.
▨ Study area

20 0 40 100Km.

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The succession begins at the base by the Minia Formation (Early Lutetian; Said, 1980) followed upwards by the Mokattam Formation Middle to Late Lutetian; Zittel, 1883; Said, 1962) which is topped by Maadi Formation (Upper Eocene; Barron, 1907; Cuvillier, 1930; Said, 1962).

On the basis of the lithological and paleontological characters, each of the above mentioned Formations was subdivided into three members. Detailed Stratigraphical study of the sequence was treated in a separate work by Shamah and Helal (in press).

Three sections were measured at Gebel El-Goza El-Hamra, South Darbet El-Houity, and a hill to the Southwest of Gebel El-Goza El-Hamra (Fig. 1).

One hundred and seventy three samples were collected, the hard samples (97 samples) were thin sectioned and petrographically examined for mircofacies investigation. The study was carried out on the basis of the calssification of the carbonate rocks of Folk (1959, 1982). These terms have been comated with those introduced by Dunham (1982) in his classification of carbonate rocks according to depositional textures. Tucker (1982) suggested that dolomites can be described in terms of Folk's or Dunham's classification, preceded by the word dolomitic, or prefixed by dolo-, as in dolosparite. On this basis the dolomites are studied and grouped.

Terrigenous clastic sediments (especially sandstone) have also been studied using the terminology of the classification of sandstones (Pettijhon et al., 1973). The present microfacies study resulted in the identification of the following microfacies associations:

I. Limestones:

A. *Biomicrite:*

1. Alveolina biomicrite.
2. Ostracoda - foraminiferal biomicrite.
3. Somalina biomicrite.
4. Sandy - Miliolidae biomicrite.
5. Sandy biomicrite.
6. Miliolidae biomicrite.

B. ***Biomicrosparite:***

1. Somalina biomicrosparite.
2. Milioidae biomicrosparite.
3. Algal - Miliolidae biomicrosparite.
4. Ferruginous - foraminiferal biomicrosparite.

C. **Biosparite:**

1. Dolobiosparite.
2. Sandy dolo - biosparite.

D. **Micrite:**

1. Sandy micrite.
2. Micrite.

II. Dolomite:

1. Ferruginous dolosparite.
2. Sandy dolosparite.
3. Dolomicrite.

III. Terrigenous rocks:

1. Lithic arenite.
2. Quartz wacke.

Interperation of the recognized microfacies associations to deduce their depositional environments has been carried out on the basis of the works of wilson (1975) Flugel (1982) and Tucker (1982) beside the palaeontological implications of the identfied fauna.

I. LIMESTONES:

A. *Biomicrite:*

1. Alveolina biomicrite (Alveolina Floatstone) : pl. 1, Fig. 1.

This microfacies type is recorded from the Member I of the Minia Formation beds No. 1, 2.

It is characterized by the abundace of Alveolina frumentiformis Schwager, miliolids (Quinquloculina sp., Trilocuina sp.), Bryozoa (Nellia sp.) Echinoid remains, Ostracoda spp. and some shell fragments embeded in homogenous micritic carbonate matrix. The Alveolina shells are lined by drusy spar. The biogenic components represent about 75% of the rock. There are also some detrital quartz grains medium to fine, subhedral, monocrystalline. According to Wilson (1975) this microfacies type can be considered as a reef flank facies composed mainly of debris from organisms inhabiting reef top and flanks.

2. Ostracoda-Formainiferal biomicrite (wackestone): pl. 1. Fig. 2.

This microfacies type is reported from Member II of the Minia Formation beds No. 6, 8; Member I of the Mokattam Formation bed No. 6; and from Member II of the Maadi Formation bed No. 10. This microfacies type is characterized by the abundance of benthonic formainifers (coiled and uncoiled), ostracods (articulated and disarticulated), echinoid remains, some shell fragments scattered in a micrite matrix. The allochems represnt about 60% of the rock. This type of sediments refers to deposition in quite water below normal wave base in bays and open lagoons behind the outer platform edge (Wilson, 1975; Flugel, 1982).

3. Somalina biomicrite (Somalina wackestone): pl. 1. Fig. 3.

This microfacies type is recorded from Member I of the Mokattam Formation bed No. 20. It is also recorded from Memnber II of the Maddi Fornation bed No. 13.

It is characterized by the relative abundance of Somalina stefaninii embedded randomly in a microcrystalline carbonate matrix (micrite). Intraclasts also include widely

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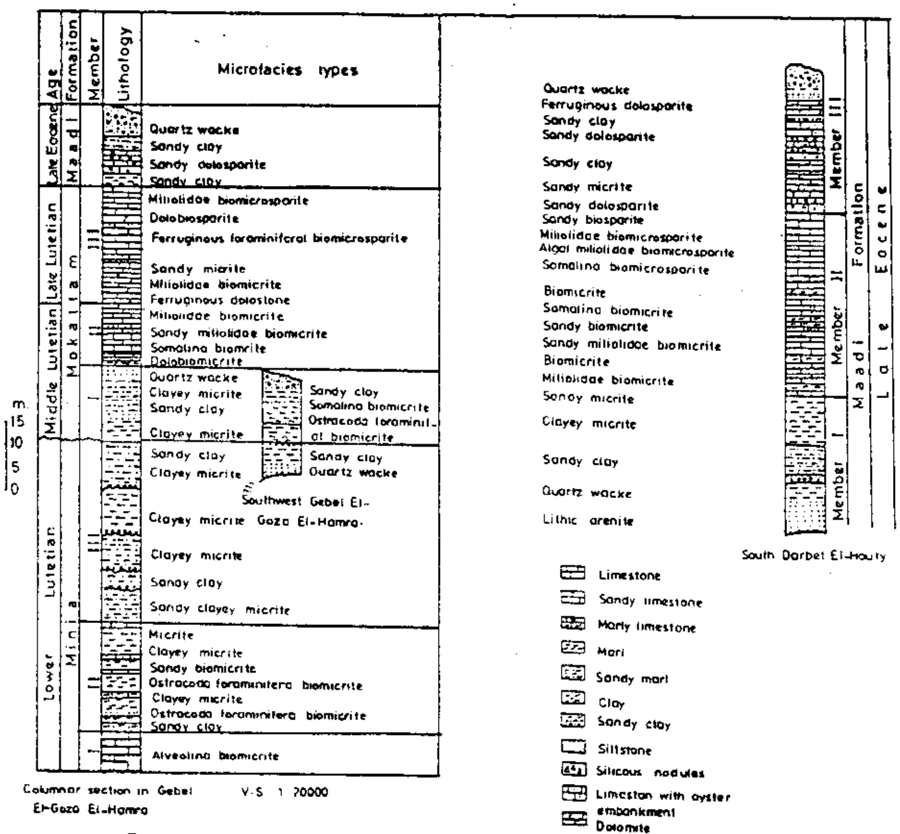

Fig (2) : Correlation chart between proposed rock units and microfacies types .

distributed miliolids (Hauerina sp.), Dictyoconus aegyptiensis and Ostrcoda spp. Some of the intraclasts (especially the articulated Ostracoda) are filled with sparry calcite. The allochems constitute about 40% of the rock. There are also some scattered quartz grains, subhedral, medium to fine. This microfacies type attributes to a quite water environment below normal wave base in a shelf lagoon with somewhat low energy water, not far from land, receiving considerable amount of detrital sand grains.

4. Sandy Miliolidae biomicrite (Wackestone): pl. 1. Fig. 4.

This microfacies type is recorded from Member II of the Mokattam Formation, beds No. 21 and 22. It is also recorded from Member II of the Maadi Foramtion, bed No. 11.

It is characterized by the abundance of quartz grains, fine, subhedral, embedded in a micritic matrix. The miliolids constitute a considerable percent of the allochems, beside are benthonic formainifera (Reussella sp. and Peneroplis sp.), rare Ostracoda and some shell fragments.

This microfacies type reflects deposition in a shallow water environment at a shelf lagoon with considerable influx of detrital sand grains in a low energy water below normal wave base.

5. Sandy biomicrite (sandy lime Mudstone/wackestone) : pl. 1. Fig. 5.

This microfacies type is recorded from Member II of

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Minia Formation bed No. 10; Member I of Mokattam Formation bed No. 5 and Member II bed No. 20. It is also recorded from Member II of Maadi Formation, bed No. 12.

This microfacies type is characterized by the presence of some benthonic formainifers, with medium to coarse subhedral monocrystalline, quartz grains. There are also some small shell fragments, the fossils and shell fragments are micritized, scattered in a microcrystalline carbonate matrix (micrite). This microfacies type reflects deposition in very restricted bays (Wilson, 1975) receiving considerable quantities of detrital sand grains. This assumption is supported by the presense of the coarse, angular, monocrystalline quartz grains.

6. Miliolidae biomicrite (Miliolidae Grainstone/packstone): pl. 2, Figl 1.

This microfacies type is recorded from Member II of Mokattam Formation, bed No. 23 and Member III, bed No. 25. It is also recorded from Member II of Maadi Formation, bed No. 8.

It is characterized by the dominance of miliolidae that constitute the majority of the biogenic components with Dictyoconus aegyptiensis, other benthonic formminifers (coiled and uncoiled), Bryozoa, Ostracoda (articulated), algal filaments and some shell fragments scattered through a microcrystalline carbonate matrix with medium, subherdral cracked quartz grains. Some of the shell fragments are recrystallized to sparry calcite.

According to Wilson (1975) this type of sediments occurs as concentration of tests with peloids commonly in bars and shoals heaped up by tidal currents in shallow lagoons and bays and is common throughout the geologic record.

B. Biomicrosparite:

1. Somalina biomicrosparite (Somalina wackestone/packstone): pl. 2, Fig. 5.

This microfacies type is recorded from Member II of Maadi Formation, bed No. 15.

It is characterized by the abundance of Somalina stefaninii (about 5-7 m m. in length) prefrentially arranged with its length parallel to each other. Miliolidae and other benthonic foraminifera, Ostracoda, echinoid remains and some shell fragments embedded in a microcrystalline carbonate matrix; vienlets and pockets of recrystallized calcite are common, most of the allochems are recystallized to spary calcite.

This microfacies type reflects deposition in shallow agitated water in open platform (shelf lagoon) with open circulation and moderatly to high energy water.

2. Miliolidae biomicrosparite (Miliolidae packstone): pl. 2, Fig. 4.

This microfacies type is recorded from Member III of

Mokattam Formation, bed No. 29, and from Member II of Madi Formation, bed No. 15.

It is characterized by the dominance of Miliolidae among the allochems, with Ostracoda, Algae, Bryozoa, some benthonic foraminifera, echinoid remains, and Dictyoconus sp. embedded in a microsparitic matrix. Veinlets and pockets of sparry calcite are frequent. Most of the allochems are recrystallized to sparitic calcite but some of them are still micritized.

According to Flugel (1982) this type of sediments reflects deposition in shelf lagoon behind the outer platform edge with open circulation and agitated, high energetic water.

3. Algal-Miliolidae biomicrosparite (Algal-Miliolidae grainstone) pl. 2, Fig. 3.

This microfacies type is recorded from Member II of Maadi Formation, bed No. 15.

It is characterized by the abundance of Miliolidae which dominates other allochems. Algal filaments, Ostracoda, coiled benthonic foraminifera, Dictyoconus sp., echinoid debries, medium to fine quartz grains embedded in a microsparite matrix, recrystallized sparry calcite veinlets and pockets are common. Most of the biogenic components, especially the articulated Ostracoda are filled with sparry calcite.

According to Wilson (1975) this type of sediments occurs as concentration of tests with peloids commonly in tidal bars and channels of lagoons.

4. Ferruginous foraminiferal biomicrosparite: pl. 2, Fig. 2.

This microfacies type is recorded from Member III of Mokattam Formation, bed No. 27.

It is characterized by the abundance of the foraminiferal fauna (coiled and uncoiled benthos, Miliolidae and Somalina sp. Ostracoda (atriculated and disarticulated), echinoid remains rare, Bryozoa and fine to medium quartz grains, subhedral embedded in a microcrystalline calcite matrix. Iron oxides stain most of the matrix and the allochems.

This microfacies type reflects deposition in a shelf lagoon with open circulation, agitated water (intertidal to subtidal) with high energy water.

C. ***Biosparite:***

1. Dolo-biosparite (Grainstone): pl. 3. Fig. 4.

This microfacies type is recorded from Member III of Mokattam Formation, bed No. 28 and from Member III of Maadi Formation, bed No. 19.

It is characterized by the dominance of dolomite rhombs of sparitic size, unzoned, with iron oxides expelled as rims on the periphery of the dolomite rhombs and in its centers. Pockets and veinlets of sparite are common although there are some micrite areas. Some of the shell fragments are filled with sparite.

This type of sediments refers to deposition in a shallow water environment, moderately agitated, warm, intertidal to subtidal, with moderatly energetic water.

2. Sandy dolo-biosparite : pl. 3. Fig. 5.

This microfacies type is recorded from Member III of Maadi Formation, beds No. 17 and 22.

It is characterized by the widely distributed dolomite rhombs, unzoned with dark centers due to the expelled iron oxide on the periphery and centers of the rhombs. Patches and veinlets of clear sparry calcite are common although some areas are still micritized. Medium to coarse, subhedral quartz grains with some carcks are common.

This microfacies type reflects deposition in warm agitated very shallow marine water intertidal to supratidal environment. This assumption is supported by the presence of coarse angular detrital quartz grains.

D. ***Micrite:***

1. Sandy micrite (sandy mudstone) : pl. 2, Fig. 6.

This microfacies type is recorded from Member III of Mokattam Formation, bed No. 26 and from Members II and III of Maadi Formation beds No. 7, 20.

It is characterized by the abundance of quartz grains, medium to fine, subhedral, monocrystalline, scattered through a microcrystalline carbonate matrix (micrite). Not any biogenic components are recorded, some veinlets of iron oxides and gypsum are present, the quartz grains constitute about 30% of the rock.

This type of sediment reflects deposition in somewhat saline or evaporative tidal ponds (Wilson, 1975) receiving considerable amounts of detrital quartz grains.

2. Micrite (mudstone) : pl. 4, Fig. 1.

This microfacies type is recorded from Member II of Minia Formation, bed No. 11. The clayey micrite is widely distributed throughout Minia, Mokattam and Maadi Formation.

The rock consists of microcrystalline carbonate matrix with some gypsum veins without any signs of biogenic components.

This microfacies type refers to deposition in very shallow water with restricted circulation in saline, shelf and tidal flates.

II. Dolomites :

1. Ferruginous dolosparite : pl. 3, Fig. 3.

This microfacies type is recorded from Member III of Mokattam Formation, bed No. 24 and from Member III of Maadi Formation, bed No. 25.

It is characterized by the dominance of dolomite rhombs, unzoned, with the iron oxide expelled on the periphery and centers of the dolomite rhombs causing dark centers of the rhombs, inequigranular, idiotopic. Sparry calcite veinlets and pockets are common. Medium to fine subhedral quartz grains, moderatly sorted are also common.

2. Sandy dolosparite : pl. 3, Fig. 2.

This microfacies type is recorded from Member III of Maadi Formation, bed No. 18.

The rock is composed of dolomite rhombs, euhedral to subhedral, unzoned, with dark centers and peripheries due to the expelled iron oxides. The dolomite rhombs constitute about 60% of the rock. The quartz grains are angular, medium to fine, monocrystalline, with some alterations, moderatly sorted.

3. Dolocmicrite : pl. 3. Fig. 1.

This microfacies type is recorded from Member II of Mokattam Formation, bed No. 20.

It is characterized by the dominance of medium to fine dolomite rhombs, unzoned, with iron oxide expelled on the periphery and centrers of the dolomite rhombs. Faint Ostracodal and foraminiferal ghosts are embedded through a microcrystalline carbonate matrix (micrite), with some fine, subhedral moderatly sorted quartz grains.

Origin of the dolomite :

Dolomite precipitates with great difficulty and in the laboratory its synthesis has often required nongeological conditions (Graf & Goldsmith, 1956; Lippmann, 1973; Chilinger et al., 1979; ibid. Tucker, 1982). In fact the majority of dolomites are formed by replacement of preexisting carbonate minerals (Tucker, 1982). The conversion of $CaCo_3$ minerals into dolomit $CaMg\ (Co_3)_2$ may take place soon after the sediments have been deposited, i.e. penecontemporaneously and during early diagensis (formerly referred to as syngenetic dolomitization) or a long time after deposition, usually after cementation, during the later stages of diagensis (epigenetic dolomitization) (Tucker, 1982). The dolostones in the studied sections are considered to be of epigenetic origin. this assumption is bassed on the following criteria :

1. Presence of some relics of micrite and microspar surrounded by dolomite rhombohedra.
2. The presence of some dolomitized ghosts of fossils with the dolomite rhombs cutting through its shells.

III. Terrigenous rocks :

1. Lithic arenite : pl. 4, Fig. 3.

This lithofacies type is recorded from the basal part of Maadi Formation (Member I), bed No. 1.

The rock consists of coarse to fine, subrounded rock fragments with coarse to medium, subhedral to unhedral quartz

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grains with alteration and inclusion of other smaller quartz grains. Most of the quartz grains are monocrystalline but there are some polycrystalline grains, moderatly sorted to illsorted, embeded in a ferruginated clay matrix.

The accessory minerals are represented by a small percentage of subangular iron oxide grains, and very rare staurolite grains.

2. Quartzwacke : pl. 4, Figs. 2, 4.

This lithofacies type is recorded from the basal part of Maadi Formation (Member I), bed No. 1 and Member III (bed No. 26).

It is also recorded from the basal part of the lateral equivalent of Member I of Mokattam Formation, bed No. 1.

The rock consists of medium to coarse quartz grains subhedral to unhedral, monocrystalline but some grains are polycrystalline, first and second order with some alterations and cracks. There are some rock fragments medium to fine angular to subangular, embeded in a dense clay matrix, iron stained. The quartz grains are moderatly to illsorted.

The accessory minerals are represented by few grains of iron oxid, staurolite, and rutile grains.

Conclusion :

The microfacies study of the Middle and Upper Eocene sediments Southwest of Faid has led to the identification of seven microfacial associations for the carbonate rocks and only two associations for the clastic constituents.

Interpretation of the identified microfacies types has led to the conclusion that the Middle and Upper Eocene Sediments were deposited under shallow marine conditions of the inner neritic zone, reefal in parts, receiving variable amounts of detrital elements. There are several regressions that resulted in the formation of the clastic deposits at the end of the Late Lutetian (between Mokattam and Maadi Formations) and at the top of Maadi Formation (Upper Eocene). These oscillations also led to the subareal weathering at the end of the Early Lutetian (Member III of the Minia Formation).

Investigating the vertical and horizontal distribution of the extracted faunal content (ostracodes, foraminifera and bryozoan species) beside the consideration of the paleecologic implication have greatly supported the results of the microfacies investigations.

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PLATE 1

Fig. 1 Alveolina biomicrite :

Thin section photomicrograph showing Alveolina frumentiformis (axial section) and Orbitolites complanatus (oblique section) embeded in a micritic matrix. Minia Formation. Ordinary light, x25.

Fig. 2 Ostracoda-foraminiferal biomicrite :
Thin section photomicrograph showing xestoleberis subglobosa, coiled and uncoiled foraminifera and rare fine grained quartz grains embeded in a microcrystalline carbonate matrix. Minia Formation, (Member II). Plane polarized light, x35.

Fig. 3 Somalina biomicrite :
Thin section photomicrograph showing Somalina stefaninii (axial section) in a micritic matrix. Mokattam Formation. Plane polarized light, x38.

Fig. 4 Sandy Miliolidae biomicrite :
Thin section photomicrograph showing Miliolidae with fine angular sand grains embeded in a microcrystalline carbonate matrix. Maadi Formation plane polarized light, x35.

Fig. 5 Sandy biomicrite :
Thin section photomicrograph showing fine, angular quartz grains with rare badly preserved fossil fragments in a micritic matrix. Minia Formation plane polarized light, x38.

Fig. 6 Foraminiferal biomicrite :
Thin section photomicrograph showing Reussela sp. with coiled and uncoiled formainiferal species with rare sand grains embeded in a micritic matrix. Minia Formation. Plane polarized light, x38.

PL 1

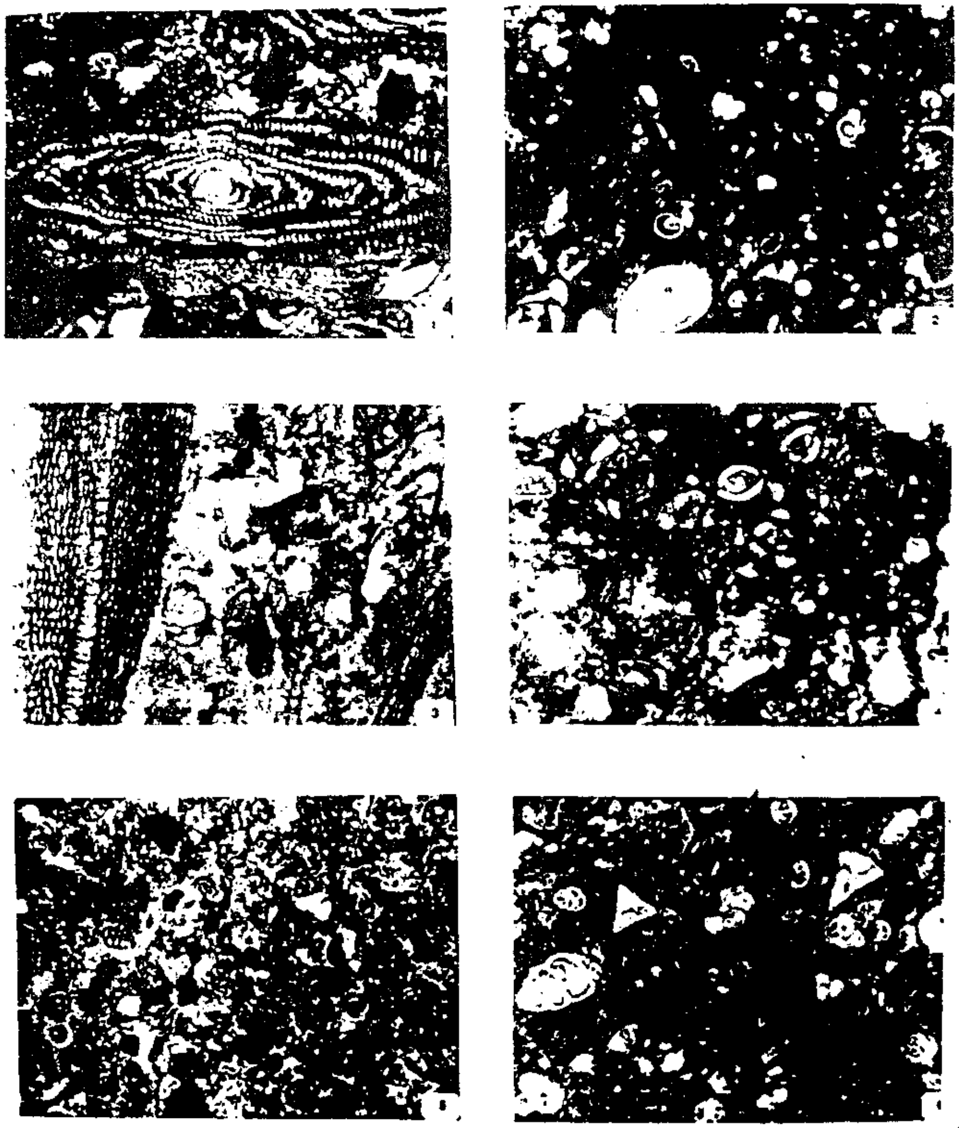

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PLATE 2

Fig. 1 Miliolidae biomicrite :

Thin section photomicrograph showing Miliolidae, intial part of Pseudoclavulina sp., Xestoleberis subglobosa in a microcrystalline carbonate matrix Mokattam Formation. Plane polarized light, x38.

Fig. 2 Ferruginous foraminiferal biomicrosparite :

Thin section photomicrograph showing Miliolidae spp. embeded in a microsparitic matrix with iron oxides Mokattam Formation. Plane polarized light, x38.

Fig. 3 Algal Miliolidae biomicrosparite :

Thin section photomicrograph showing Algae and Miliolidae packed in a microsparitic matrix with still micritized patches, Mokattam Formation. Plane polarized light, x38.

Fig. 4 Miliolidae biomicrosparite :
Thin section photomicrograph showing Miliolidae and Fabularia sp. Packed in a microsparite matrix. Maadi Formation. Plane polarized light, x38.

Fig. 5 Somalina biomicrosparite :
Thin section photomicrograph sohwing Somalina stefaninii in a microsparite matrix with fine sand grains and still micritized matrix pockets, Mokattam Formation, plane polarized light, x38.

Fig. 6 Sandy micrite :
Thin section photomicrograph showign medium to fine angular sand grains embeded in a homogenous micritic matrix with thin gypsum vein. Minia Formation. plane polarized light, x32.

PL 2

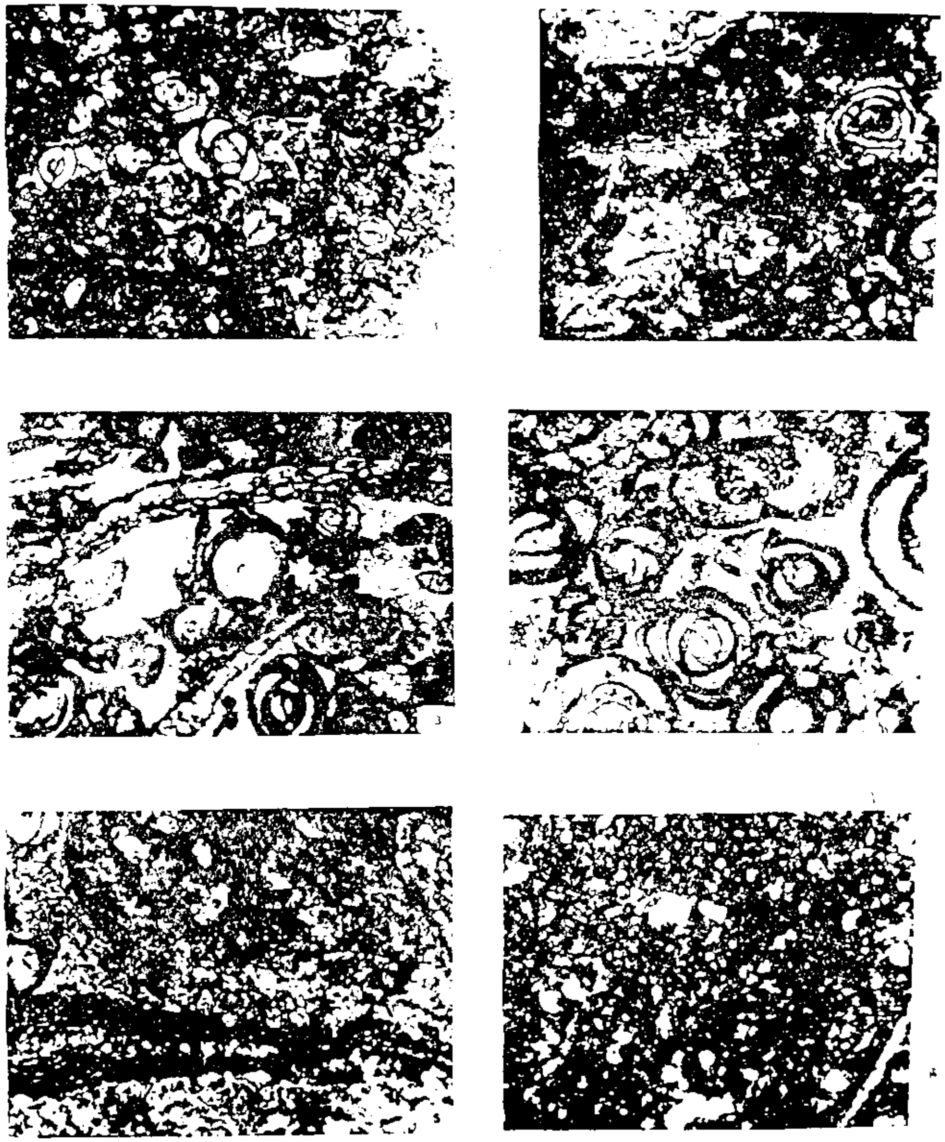

PLATE 3

Fig. 1 Dolomicrite :
Thin section photomicrograph showing fine grained unzoned dolomite rhombs embeded through a microcrystalline carbonate matrix, Mokattam Formation. Polarized light, x42.

Fig. 2 Sandy dolosparite :
Thin section photomicrograph showing zoned dolomite rhombs packed by spary calcite crystals with coarse to fine quartz grains. Maadi Formation. Plane polarized light, x42.

Fig. 3 Ferruginous dolosparite :
Thin section photomicrograph showing well developed zoned dolomite rhombs with rare angluar sand grains packed through iron oxide cement. Maadi Formation. Polarized light, x38.

Fig. 4 Dolobiosparite :
Thin section photomicrograph showing zoned dolomite rhombs with molluscan shell fragments recrystallized to sparry calcite. Maadi Formation. Polarized light, x38.

Fig. 5 Sandy dolobiosparite :
Thin section photomicrograph showing well developed medium size, zoned dolomite rhombs, angular, medium size quartz grains with shell fragments recrystatlized to sparry calcite. Maadi Formation, Polarized light, x38.

Fig. 6 Foraminiferal biosparite :
Thin section photomicrograph showing <u>Somalina stefaninii</u>, <u>Dictyoconus aegyptiensis</u>, <u>Quinqueloculina sp.</u> and <u>Fabularia sp.</u> embedded in sparite matrix. Mokattam Formation. Polarized light, x38.

PL 3

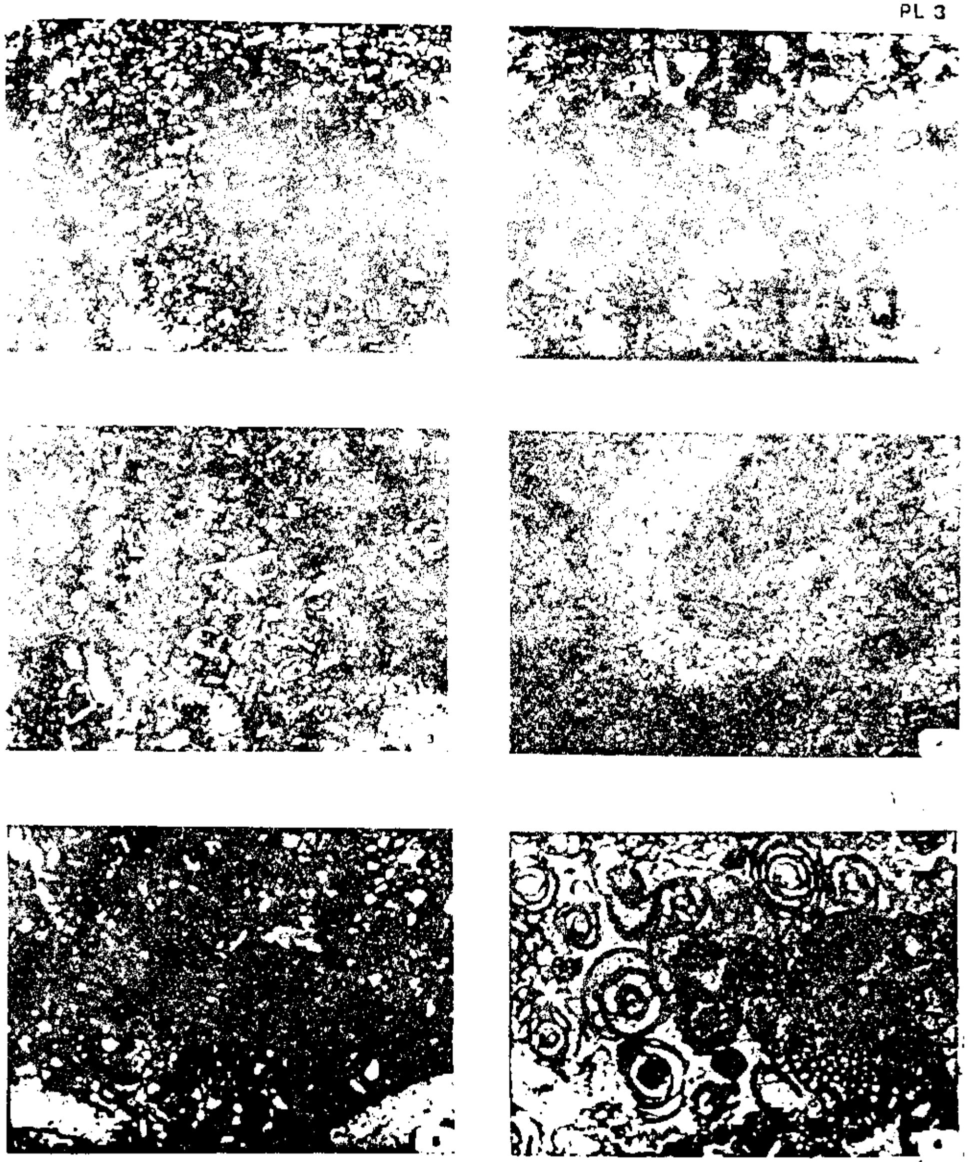

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PLATE 4

Fig. 1 Micrite :

Thin section photomicrograph showing microcystalline carbonate matrix with fine sand grains, Minia Formation Plane polarized light, x38.

Fig. 2 Quartz wacke :

Thin section photomicrograph showing medium to fine angular quartz grains in argillaceous matrix. Minia Formation, Plane polarized light, x38.

Fig. 3 Lithic arenite :

Thin section photomicrograph showing angular rocks fragments with coarse grained. Scluptured sand grains Minia Formation Plane polarized light, x38.

Fig. 4 Quartz wacke :

Thin section photomicrograph showing coarse grained scluptured quartz grains in fine siliceous matrix with iron oxide cement. Maadi formation. Polarized light. x38.

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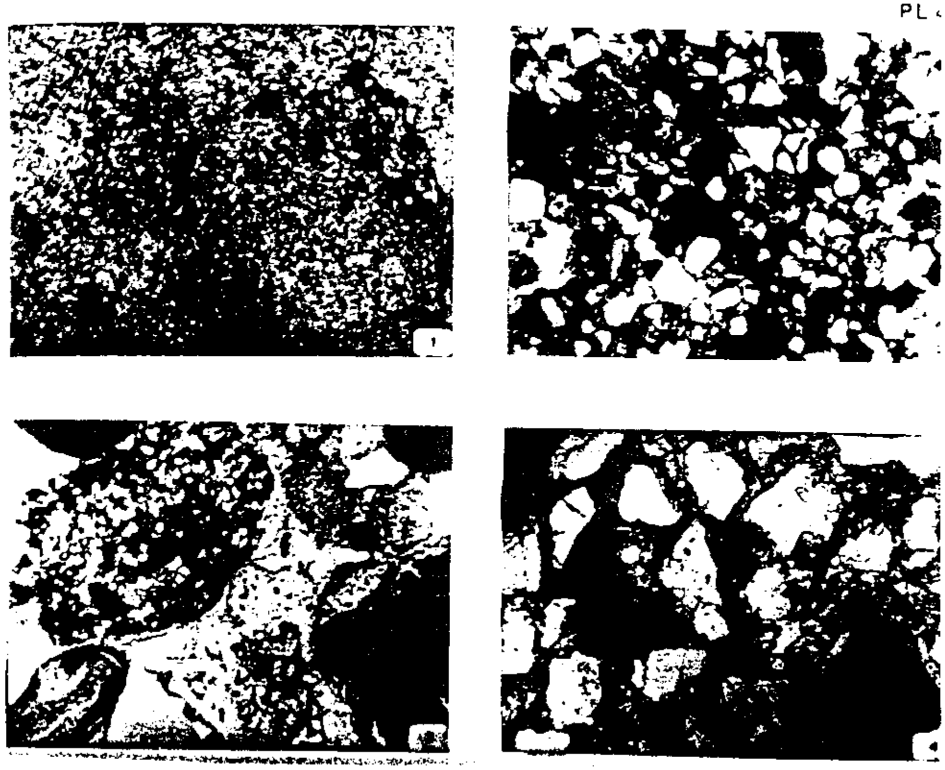

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تحليل السحنات الدقيقة لرواسب الأيوسين جنوب غرب فايد ؛ منطقة قناة السويس ؛ مصر

د. كمال شامه - د. مجدى هلال

جامعة القاهرة - كلية التربيه فرع الفيوم - قسم التاريخ الطبيعى - الفيوم

إن تحليل السحنات الدقيقة لرواسب الأيوسين الأوسط والعلوى المتواجد بجنوب غرب فايد - منطقة قناة السويس ؛ مصر تدل على تواجد سبعة تجمعات تسوبية من الكربونات سواء كانت حجر جيرى أو دلوميت وإثنين من الفتاتيات • وقد أوضحت دراسة السحن الدقيقه التى تم التعرف عليها إلى أن رواسب الأيوسين الأوسط والعلوى قد ترسبت فى ظروف بيئيه تتميز بمياه ضحله إلى قليلة العرق كتلك التى تسود فى البيئات الشعابية فى بعض الأجزاء والتى تحمل كميات متغيرة من العناصر الفتاتيه وذلك نتيجة لتكرار تذبذب مستوى سطح البحر بين التقدم والإنحصار •