

# BIOSTRATIGRAPHY OF THE SUBSURFACE OLIGOCENE SEDIMENTS IN THE NORTH WESTERN DESERT, EGYPT

By

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**Key words:** Biostratigraphy — Eocene — Oligocene — Planktonic Foraminifera — Ostracoda — Western Desert — Egypt.

## ABSTRACT

This paper deals with the study of planktonic foraminifera, larger foraminifera and ostracoda in the Oligocene sediments in four wells: Abu Tunis No. IX, East Faghur-I, Khalda No. I and North Ghazalat No. I, North Western Desert. It was possible to recognize the following foraminiferal biozones, which are from top to base: *Miogypsinoides complanatus/Lepidocyclina* spp. Zone = *Nummulites* aff. *bouillei* Zone and *Globorotalia opima opima* Zone of Chattian Age and *Globigerina ampliapertura* Zone and *Cassigerinella chipolensis* Zone of Rupelian Age. The topmost zone correlates well with that described from Tunis by Biely and Kohler (1976).

## INTRODUCTION

The stratigraphy of the Oligocene sediments attracted the attention of only a few workers, Beadnell (1905), Barron (1907), Ball (1939), Eames (1953), Drooger (1956 & 1964), Abdallah (1966), El Akkad & Dardir (1966), Norton (1967), Blow (1969), Fahmy *et al.* (1969), Marzouk (1970), Postuma (1971), Biely & Salaj (1971), Omara & Ouda (1972), Stainforth (1975), Biely & Kohler (1976), Bolli & Krasheninnikov (1977).

The present work deals with the investigation of the Oligocene sediments in the North Western Desert. Four wells are studied; they are (Khalda Well No. 1, North Ghazalat Well No. 1, Abu Tunis Well No. IX and East Faghur Well No. 1 (fig. 1).

About 200 ditch samples and 40 thin sections of larger foraminifera were studied for their microfossil content. The main aim of this study is to subdivide the Oligocene sediments of this region into different biozones with the help of planktonic foraminifera, larger benthonic foraminifera and ostracoda. Subdivision of the Oligocene sediments into a Middle (Rupelian)

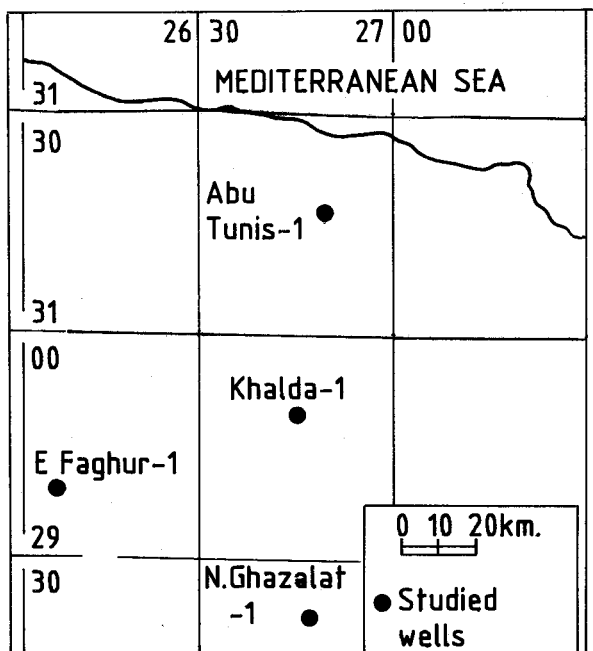
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**Fig. 1** Location map

and an Upper (Chattian) on the basis of the foraminiferal biozones is achieved. Attempt is made to define the Late Eocene-Early Oligocene boundary.

**I. Stratigraphy of the Oligocene sediments in North Western Desert**

This part deals with the stratigraphy of the Oligocene sediments of four wells (Khalda-1, Abu Tunis IX, East Faghur-1 and N. Ghazalat-1), located in the northern part of the Western Desert, Egypt, (Fig. 1).

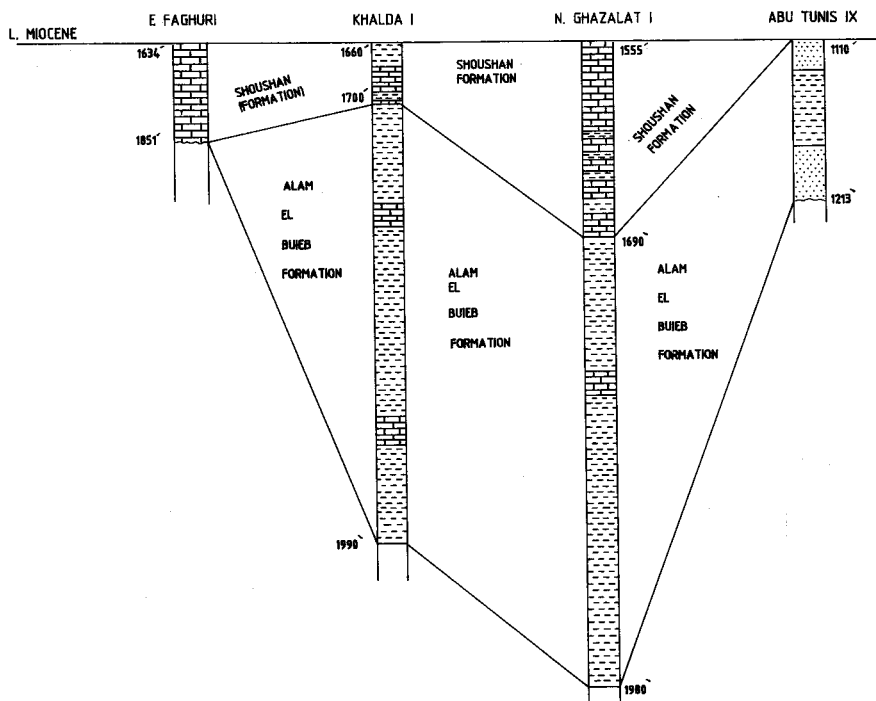
The Oligocene section in Khalda-1 and North Ghazalat-1 is represented by upper unit known as Shoushan Formation (mainly limestone) and lower unit is called Alam El Bueib Formation (calcareous shale). In Abu Tunis-IX the only represented formation is Alam El-Bueib. In East Faghur I, the Oligocene section is composed mainly of limestone (Shoushan Formation).

Figure (2) is a correlation chart of the Oligocene rock units between the studied wells in the North Western Desert, Egypt.

Table no. 1 shows a comparison between different rock stratigraphic units of the Oligocene in the Western Desert (After Omara and Ouda, 1972).

**II. Biostratigraphy**

It was possible to subdivide the Oligocene succession in the studied wells into the following foraminiferal Zones:



**Fig. 2. Correlation chart of the Oligocene rock-units between the studied wells in North Western Desert, Egypt.**

- |   |  |  |
|---|--|--|
| <p>4. <i>Miogypsinoides complanatus/Lepidocyclina</i> spp. =</p> <p><i>Nummulites bouillei</i> Zone</p> <p>3. <i>Globorotalia opima opima</i> Zone</p> <p>2. <i>Globigerina ampliapertura</i> Zone</p> <p>1. <i>Cassigerinella chipolensis</i> Zone</p> |  | <p>of<br/>Chattian<br/>Age</p><br><br><br><br><br><p>of<br/>Rupelian<br/>Age</p> |
|---|--|--|

Table no. 2 shows the distribution of these biozones in the studied wells:

**Table (1)**  
**Comparison between different rock stratigraphic units of the Oligocene in the Western Desert,**  
**Egypt**  
**After Omara and Ouda, 1972**

BEADNEL 1905	DAILE & FINDLAY 1940	BARKER 1946	AKKAD & ISSAWI 1963	NORTON 1967		MARZUK 1970				OMARA & AUDA 1972	PRESENT STUDY
BASALT	HADDADIN BASALT	BASALT		OARET SHOUSHAN		ABU ZAABAL FORMATION				SHOUSHAN FORMATION	SHOUSHAN FORMATION
FLUVIO - MARINE SERIES	KHASHAB RED BEDS FORMATION	GEBEL EL DATANIA SERIES	RADWAN FORMATION	FORMATION	MOGHRA GROUP	ALAM EL - BUEIB FORMATION	ZEBEIDA FORMATION	QATRA FORMATION	AGLA FORMATION	4 GHAZZALAI FORMATION	ALAM - EL BUEIB FORMATION
				DABAA FORM- ATION							

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**Table 2: Distribution of the Oligocene biozones in the studied wells**

Biozones	Wells		East Faghur I		Khalda I		North Ghazalat I	
	Top	Bottom	To	Bottom	Top	Bottom	Top	Bottom
<i>Miogypsinoides complanatus</i> / <i>Lepidocyclina spp</i>					1660'	1700'	1555'	1690'
=					Thickness (40')*		(135')	
<i>Nummulites</i> aff. <i>bouillei</i>			1634'	1851'				
			(217')					
<i>Globorotalia</i> <i>opima opima</i>	1110'	1176'			1700'	1870'	1690'	1910'
	(66')				(170')		(220')	
<i>Globigerina</i> 1980'					1870'	1930'	1910'	1980'
<i>ampliapertura</i>					(60')		(70')	
<i>Cassigerinella</i> <i>chipolensis</i>	1176'	1213'			1930'	1990'		
	(37')				(60')			

\* Figure in parenthesis represents the thickness of each biozone

#### A. Foraminiferal Biozones

##### 4. *Miogypsinoides complanatus*/*Lepidocyclina spp.* Zone = *Nummulites* aff. *bouillei* Zone.

This Zone is characterised by the presence of *Miogypsinoides complanatus* SCHLUMBERGER, *Lepidocyclina (Nephrolepidina) parva* OPPENOORTH, *Lepidocyclina (Nephrolepidina) sumatraensis* BRADY, *Heterostegina costata* D'ORBIGNY, *Operculina* sp., *operculina venosa* FICHTEL & MOLL and *Miogypsinina tani* DROOGER.

This zone is the reefal equivalent of the planktonic foraminiferal zone: *Globigerina ciproensis ciproensis* of Chattian Age.

The *Miogypsinoides complanatus*/*Lepidocyclina* sp. Zone is tentatively equivalent to the *Nummulites* aff. *bouillei* Zone.

The *Nummulites* aff. *bouillei* Zone is characterized by the presence of the following foraminiferal species: *Operculina* sp. *Miogypsinina tani* DROOGER, *Heterostegina costata* D'ORBIGNY together with the following planktonic foraminifers: *Globigerina ampliapertura* BOLLI, *Globigerina praebulloides praebulloides* BLOW, *Globorotalia increbescens* BANDY, and *Globigerinita unicava primitiva* BANNER & BLOW, *Globigerina ouachitaensis ciproensis* BOLLI, *Globigerina angulisuturalis* BOLLI, *Globigerina officinalis* SUBBOTINA, *Globigerina senilis* BANDY, *Globigerina venezuelana*, *Globigerina praebulloides leroyi* BANNER & BLOW.

### 3. *Globorotalia opima opima* Zone:

This zone is characterized by the occurrence of the following planktonic foraminiferal species and subspecies: *Globorotalia increbescence* BANDY, *Globigerinita unicava primitiva* BANNER & BLOW, *Catapsydrax dissimilis* CUSHMAN & BERMUDEZ, *Globigerina praebul-loides* BLOW, *Globigerina praebul-loides praebul-loides* BLOW, *Globigerina ouachitaensis gnaucki* BANNER & BLOW, *Globigerina ouachitaensis ciproensis* BOLLI, *Globigerina senilia* BANDY and *Globigerina eocaena* GUMBEL.

### 2. *Globigerina ampliapertura* Zone:

This zone was firstly recorded by Bassiouni *et al.* 1978 in the biostratigraphic zonation of the Oligocene rock units in Dabaa Well No. 1, (North Western Desert, Egypt), to comprise the interval between the extinction of *Globigerina selli* to the extinction of *Globigerina ampliapertura*.

Once the *G. selli* Zone is missed, the lower boundary of *Globigerina ampliapertura* Zone has been taken at the disappearance of *Cassigerinella chipolensis* CUSHMAN & PONTON.

This zone is characterized by the following planktonic foraminiferal species and subspecies:

*Globigerinita unicava unicava* (BOLLI, LOEBLICH & TAPPAN), *Globigerinita martini* BANNER & BLOW, *Globigerinita unicava primitiva* (BANNER & BLOW), *Globorotalia opima nana* BOLLI, *Globigerina officinalis* SUBBOTINA, *Globigerina praebul-loides oculosa* BANNER & BLOW, *Globigerina euapertura* JENKINS, *Globigerina ampliapertura* BOLLI, *Globigerina senilis* BANDY, *Globigerina eocaena* GUMBEL, *Globigerina angulisuturalis* BOLLI, *Catapsydrax stainforthi* (BOLLI, LOEBLICH and TAPPAN), *Catapsydrax dissimilis dissimilis* CUSHMAN & BERMUDEZ, *Globigerina praebul-loides leroyi* BANNER & BLOW.

### 1. *Cassigerinella chipolensis* Zone:

It has been noticed that this zone is very rich with the following planktonic foraminiferal association:

*Cassigerinella chipolensis* CUSHMAN & PONTON, *Globigerina eocaena* GUMBEL, *G. yeguaensis pseudovenzuelana* BANNER & BLOW, *Globorotalia (Turborotalia) postcretacea* (MYSTRLUCK), *Globigerinita unicava primitiva* (BOLLI, LOEBLICH & TAPPAN), *Globigerina gortanii* BORSETTI, *Catapsydrax dissimilis dissimilis* CUSHMAN & BERMUDEZ, *Globigerinita pera* TODD, *Globigerina foliata* BOLLI.

Figure (3) is a correlation chart of the Oligocene rocks between the studied wells in the North Western Desert, Egypt.

Two Ostracod assemblage zones are distinguished, they are, from top to base, as follows:

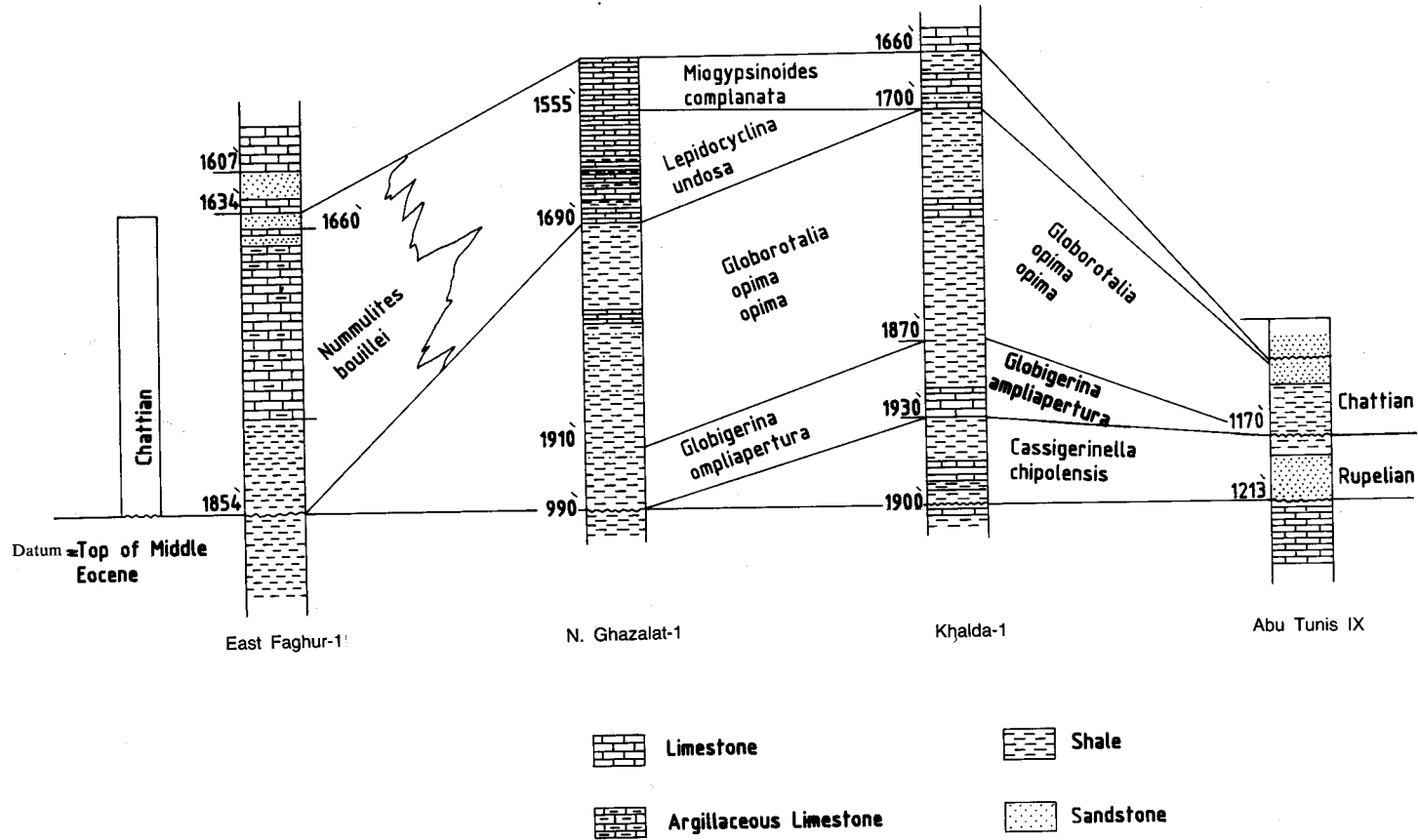
### 2. *Neocyprideis* spp. Zone.

#### 1. *Trachylebesis nodosus* Zone.

### 2. *Neocyprideis* sp. Zone:

This zone is recorded in three wells, they are, East Faghur Well no. 1, North Ghazalat Well no. 1 and Khalda Well no. 1.

In East Faghur Well no. 1, this zone consists mainly of 217 feet of limestone and is encountered



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Fig. 3: Correlation chart of the Oligocene rocks between the studied wells

between 1634 ft and 1851 ft and contains the following association: *Cytherella compressa* VON MUNSTER, *Ruggeria* sp<sub>1</sub>, *Ruggeria* sp<sub>2</sub>, *Loxoconcha* sp<sub>1</sub>, *Neocyprideis* n.sp<sub>2</sub> SALAHI, *Costa* sp<sub>1</sub>, *Costa* sp<sub>2</sub> and *Paracypris* sp<sub>1</sub>.

This zone is poor with the Ostracoda if compared with the underlying zone.

In North Ghazalat Well no. 1 this zone contains about 220 feet calcareous shale encountered between the interval from 1690' - 1910'. It coincides with the planktonic zone *Globorotalia opima opima*.

The following assemblage is recorded from this zone: *Bairdia gliberti* KEIJ, *Paracypris* sp<sub>1</sub>, *Loxoconcha* sp, *Costa* sp<sub>1</sub>, *Costa* sp<sub>2</sub>, *Ruggeria* n.sp<sub>2</sub> SALAHI, *Ruggeria* sp<sub>2</sub>, *Cytherelloidea* sp SONMEZ & GOKCEN and *Neocyprideis* n.sp<sub>2</sub> SALAHI. This assemblage is indication of open marine environment.

In Khalda Well no. 1 this zone is consisting mainly of 170 ft. thick of calcareous shale intercalated with few streaks of limestone.

This zone is characterised by the following species: *Bairdia gliberti* KEIJ, *Neocyprideis* n.sp<sub>2</sub> SALAHI, *Cytherelloides* sp. SONMEZ & GOKCEN, *Cytherella compressa* VON MUNSTER, *Ruggeria* sp<sub>1</sub>, *Ruggeria* sp<sub>2</sub>, *Ruggeria* n.sp<sub>2</sub> SALAHI, *Costa* sp<sub>1</sub>, *Costa* sp<sub>2</sub>, *Loxoconcha* sp<sub>1</sub>, and *Paracypris* sp<sub>1</sub>.

#### 1. *Trachylebesis nodosus* Zone:

The zone is only recorded from East Faghur Well no. 1. It belongs to the Middle Eocene (see Bassiouni *et al.* 1984).

This Eocene ostracod zone is characterized by the following association:

*Krithe bartonensis* JONES, *Paracypris contracta* JONES, *Loxoconcha matiensis* KHALIFA & CRONIN, *Trachylebesis nodosus nodosus* BASSIOUNI, *Novocypris eocenanus* DUCASSE, *Bradleya oertlii* DUCASSE.

This zone is coincided with the Middle Eocene *Nummulites beamounti* Zone is East Faghur Well no. 1. As a result of the above mentioned zone we concluded that there is unconformity between the Middle Eocene and the Middle Oligocene; as both Upper Eocene and a great part of the Lower Oligocene sections have been missed in the area.

These ostracoda and larger foraminiferal assemblage are reflecting shallow marine condition during that time.

### III. Conclusion

The Eocene-Oligocene boundary is traced at the disappearance of *Globigerina pseudoampliapertura*, *Hantkenina* spp and *Bulimina jacksonesis* which are characteristic of the Late Eocene, and the first appearance of *Cassigeriella chipolensis*. So, the *Cassigerinella chipolensis* Zone is related to the Middle Oligocene (Rupelian stage). The *Globorotalia opima opima* Zone and *Globigerina ampliapertura* Zone were considered by Banner & Blow (1962) to be of Aquitanian age. In the present study the *Globorotalia opima opima* Zone is overlain conformably by *Miogypsinoides complanatus* Zone which is of Chattian Age.



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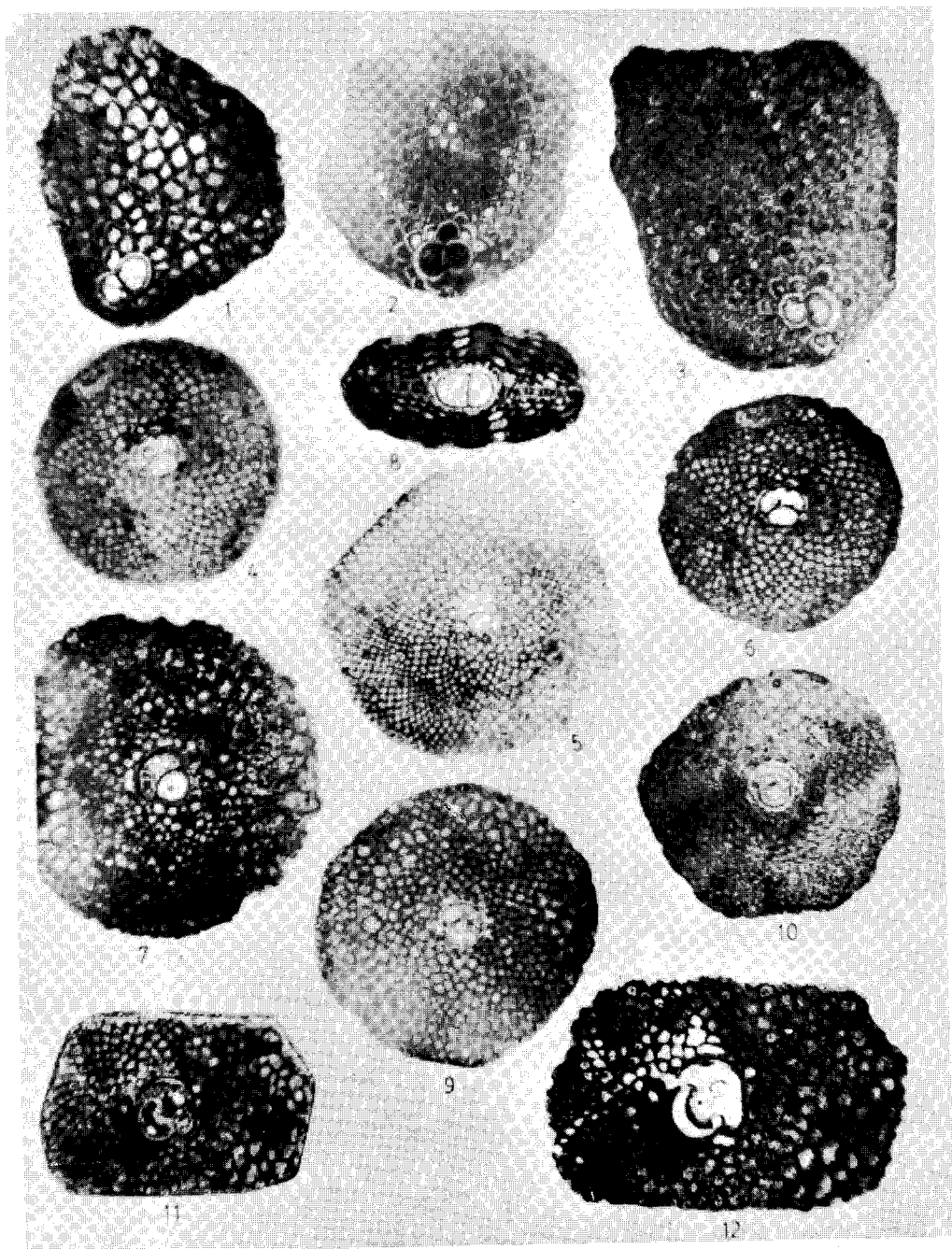
**Explanation of plates**

**Plate 1**

- Fig. 1:** *Miogypsina tani* DROOGER, X30, horizontal section, Upper Oligocene (*Lepidocyclina* spp Zone). Khalda well No. 1, ditch samples 1610-1630'.
- Fig. 2:** *Miogypsina ex. interc. tani-globulina* OUDA, X30, Upper Oligocene, East Faghur well No. I, depth 1620'.
- Fig. 3:** *Miogypsina globulina* MICHELOTI, X30, Upper Oligocene to Lower Miocene, East Faghur well No. 1, depth 1554'.
- Figs. 4,5,6,7:** *Lepidocyclina (Nephrolepidina) sumatraensis* BRADY, X42, horizontal section, Upper Oligocene (*Miogypsinooides complanatus/Lepidocyclina* spp Zone), Khalda well No. 1, (1660-1700').
- Fig. 8:** *Lepidocyclina (Nephrolepidina) sumatraensis* BRADY, X42, vertical section, Upper Oligocene (*Miogypsinooides complanatus/Lepidocyclina* spp Zone) Khalda well No. 1, (1660-1700').
- Figs. 9,10:** *Lepidocyclina (Nephrolepidina) parva* OPPENOORTH, X42, horizontal section, Upper Oligocene (*Miogypsinooides complanatus/Lepidocyclina* spp Zone), Khalda well No. 1, (1660-1700').
- Figs. 11,12:** *Lepidocyclina (Eulepidina) undosa* CUSHMAN, X42, horizontal section, Upper Oligocene (*Lepidocyclina undosa* Zone), North Ghazalat well No. 1, (1580-1600').

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PLATE 1

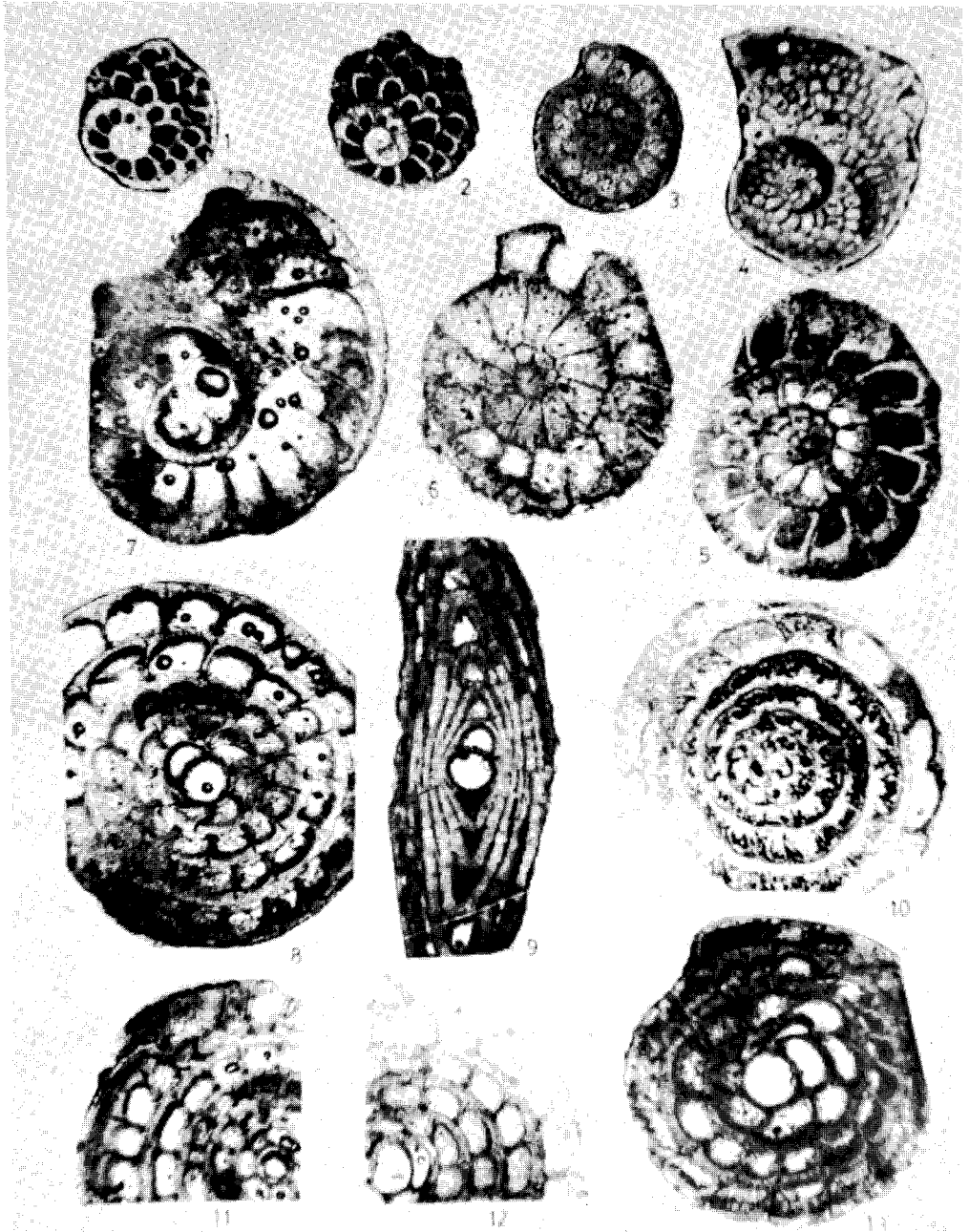


**Plate 2**

- Figs. 1,2:** *Miogypsinoides complanatus* SCHLUMBERGER, X30, horizontal section, Upper Oligocene (*Miogypsinoides complanatus/Lepidocyclina spp* Zone), Khalda well
- Figs. 3,6:** *Operculina sp.* X42, horizontal section, Upper Oligocene (*Lepidocyclina undosa* Zone), North Ghazalat well No. 1, (1580-1600').
- Fig. 4:** *Heterostegina costata* D'ORBIGNY. X42, horizontal section, Upper Oligocene (*Nummulites bouillei* Zone) East Faghur well No. 1, (1640-1660').
- Fig. 5:** *Operculina venosa* FICHTEL & MOLL, X42, horizontal section, Upper Oligocene (*Miogypsinoides complanatus/Lepidocyclina spp* Zone), Khalda well No. 1, (1660-1700').
- Fig. 7:** *Operculina complanata* DEFRANCE, X42, horizontal section, Upper Oligocene (*Miogypsinoides complanatus/Lepidocyclina spp* Zone), Khalda well No. 1.
- Figs. 8-13:** *Nummulites* aff. *bouillei* 8,10,13, horizontal sections, X42, 9 vertical section, X42 Upper Oligocene, East Faghur well No. 1, (1640-1700'), 11, 12, exhibit the number of chambers in a quarter of the shell.

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PLATE 2



**Plate 3**

- Fig. 1:** *Globigerina ampliapertura* BOLLI (a) ventral view, (b) dorsal view, *Globigerina ampliapertura* Zone, Khalda well No. 1, (1870-1880').
- Fig. 2:** *Globigerina pseudoampliapertura* BANNER & BLOW (a) ventral view, (b) dorsal view, (c) side view, *Globigerina pseudoampliapertura* Zone, Khalda well No. 1, (1980-1990').
- Figs. 3, 4:** *Globigerina angiporoides* HORNIBROOK (a) ventral view, (b) dorsal view, (c) side view *Cassigerinella chipolensis* Zone, Abu Tunis IX, ditch sample (1180-1190').
- Fig. 5:** *Globigerina angulisuturalis* BOLLI (a) ventral view, (b) dorsal view, *Nummulites bouillei* Zone, East Faghur well No. 1, (1760-1770').
- Fig. 6:** *Globigerina angustiumbilitata* BOLLI (a) ventral view (b) dorsal view, *Globorotalia opima opima* Zone, Khalda well No. 1.
- Fig. 7:** *Globigerina ciperoensis* BOLLI (a) ventral view, (b) dorsal view, (c) side view, *Globorotalia opima opima* Zone, Khalda well No. 1, (1850-1860').
- Fig. 8:** *Globigerina eocaena* GUMBEL (a) ventral view, (b) dorsal view, (c) side view, *Cassigerinella chipolensis* Zone, Khalda well No. 1, (1940-1950').
- Fig. 9:** *Globigerina euapertura* JENKINS, (a) ventral view, (b) dorsal view, (c) side view, *Globigerina ampliapertura* Zone, Khalda well No. 1, (1870-1880').
- Fig. 10:** *Globigerina gortanii* BORSETTI, (a) ventral view, (b) dorsal view, (c) side view, *Cassigerinella chipolensis* Zone, Khalda well No. 1, (1950-1960').

BIOSTRATIGRAPHY OF THE SUBSURFACE  
OLIGOCENE SEDIMENTS

PLATE 3



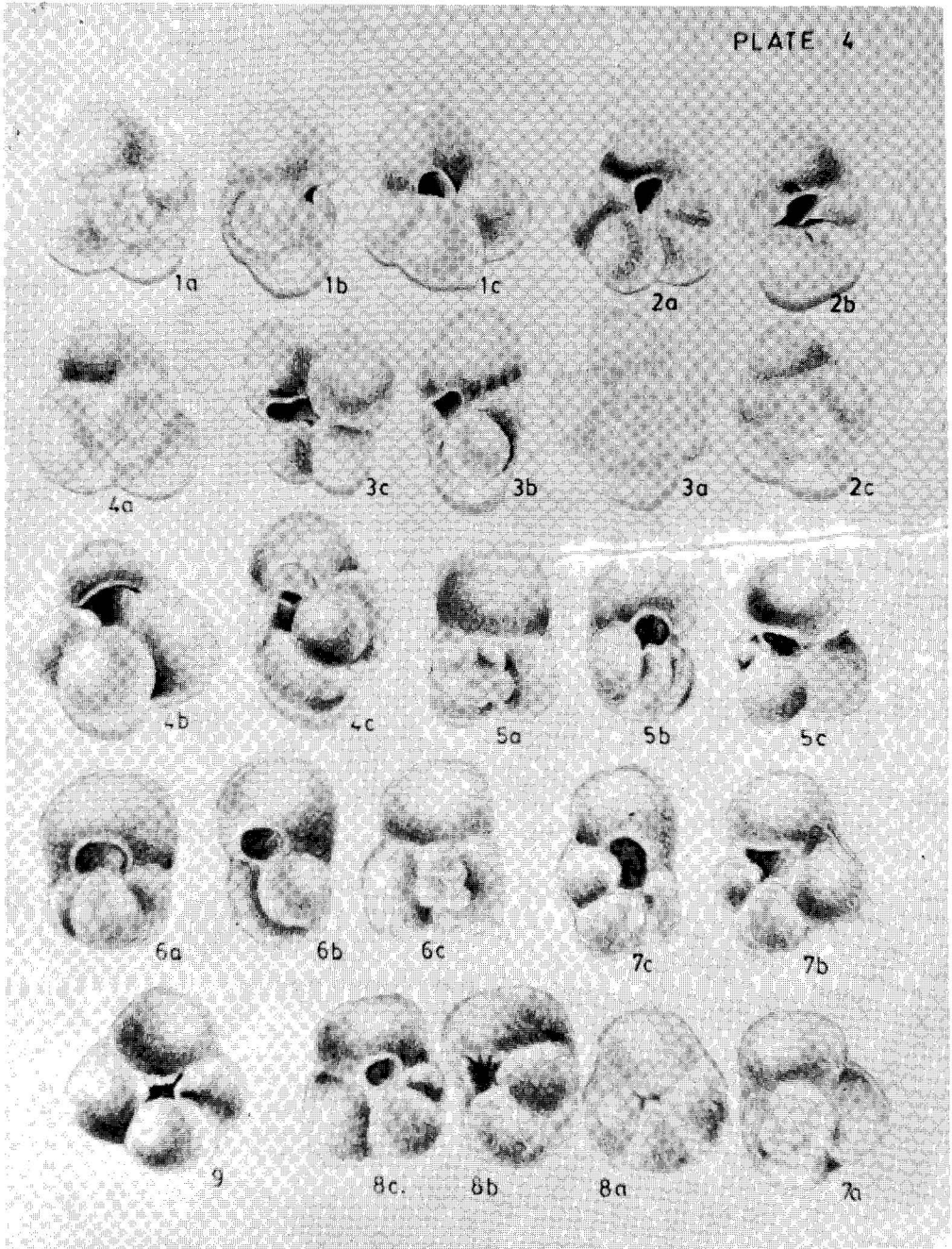


**Plate 4**

- Fig. 1:** *Globigerina officinalis* SUBBOTINA (a) ventral view, (b) side view, (c) dorsal view, *Globigerina ampliapertura* Zone, Khalda well No. 1, (1870-1880').
- Fig. 2:** *Globigerina ouachitaensis ciperoensis* BOLLI, (a) dorsal, (b) side view, (c) ventral view, *Nummulites bouillei* Zone, East Faghur well No. 1, (1680-1690').
- Fig. 3:** *Globigerina ouachitaensis gnaucki* BANNER & BLOW, (a) ventral view, (b) side view, (c) dorsal view, *Globorotalia opima opima* Zone, Khalda well No. 1, (1720-1730').
- Fig. 4:** *Globigerina ouachitaensis ouachitaensis* HOWE & WALLAC (a) ventral view, (b) dorsal view, (c) side view, *Globorotalie opima opima* Zone, Abu Tunis well No. IV, (1140-1150').
- Fig. 5:** *Globigerina praebulloides praebulloides* BLOW (a) ventral view, (b) side view, (c) dorsal view, *Globorotalia opima opima* Zone, North Ghazalat No. 1, (1700-1710').
- Fig. 6:** *Globigerina praebulloides leroyi* BANNER & BLOW, (a) dorsal view, (b) side view, (c) ventral view, *Globigerina ampliapertura* Zone, Khalda well No. 1, (1910-1920').
- Fig. 7:** *Globigerina praebulloides occulosa* BANNER & BLOW, (a) ventral view, (b) dorsal view, (c) side view, *Globigerina ampliapertura* Zone, Khalda well No. 1, (1870-1880').
- Fig. 8:** *Globigerina parasaepeis* BLOW (a) ventral view, (b) side view, (c) dorsal view, *Globigerina ampliapertura* Zone, Khalda well No. 1, (1910-1920').
- Fig. 9:** *Globigerina eamesi* BLOW, dorsal view, *Nummulites bouillei* Zone, East Faghur 1, (1800-1810').

BIOSTRATIGRAPHY OF THE SUBSURFACE  
OLIGOCENE SEDIMENTS

PLATE 4

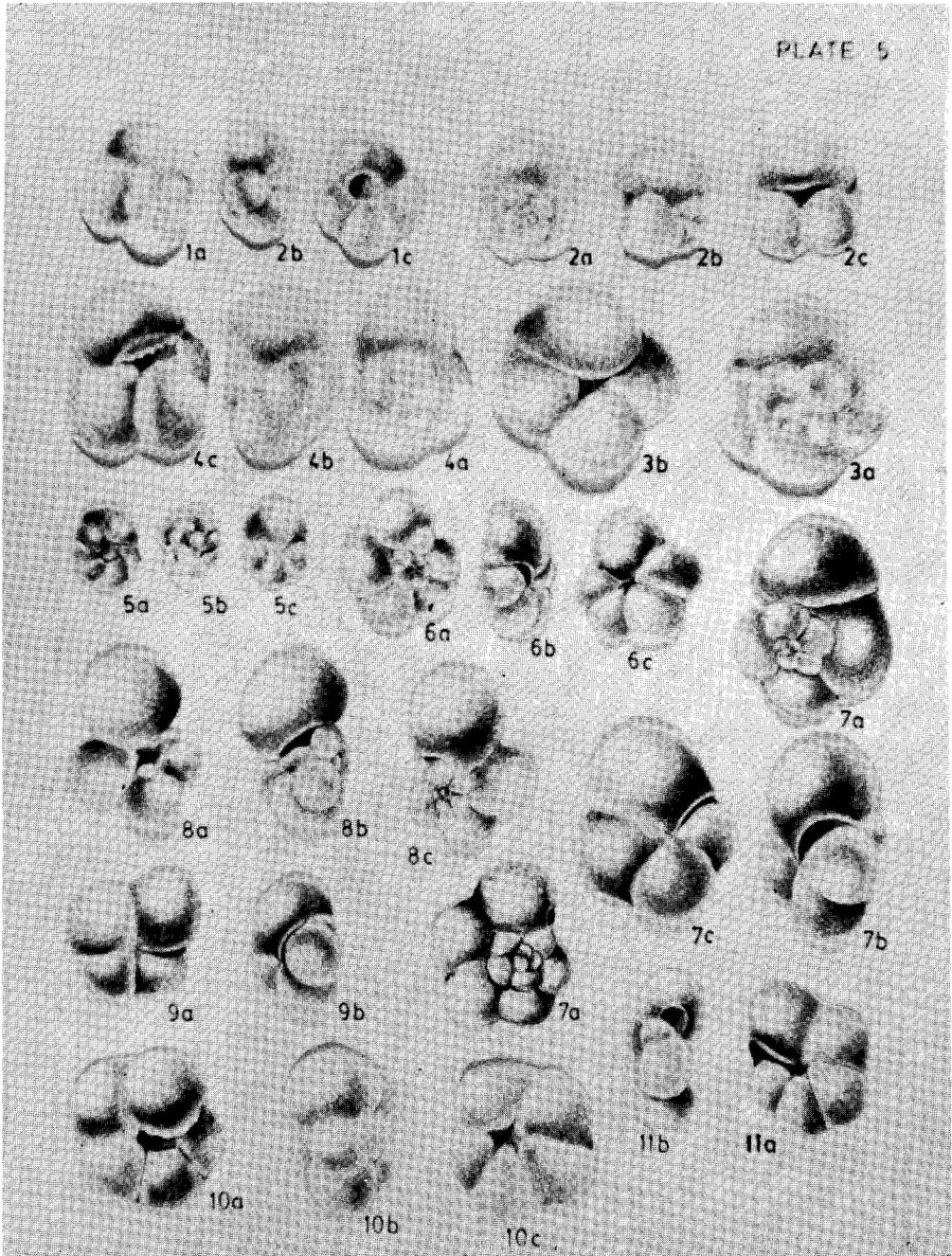


**Plate 5**

- Fig. 1:** *Globigerina senilis* BANDY, (a) ventral view, (b) side view, (c) dorsal view, *Globorotalia opima opima* Zone, Khalda well No. 1, (1790-1800').
- Fig. 2:** *Globigerina tripartita tripartita* KOCK (a) ventral view, (b) side view, (c) dorsal view, *Cassigerinella chipolensis* Zone, Abu Tunis IX, (1180-1190').
- Fig. 3:** *Globigerina venezuelana* HEDBERG (a) ventral view, (b) dorsal view, *Globorotalia opima opima* Zone, Khalda well No. 1, (1690-1700').
- Fig. 4:** *Globigerina yeguaensis pseudovenzuelana* BANNER & BLOW (a) ventral view, (b) side view, (c) dorsal view, *Cassigerinella chipolensis* Zone, Khalda well No. 1, (1960-1970').
- Fig. 5:** *Globorotalia cerroazulensis* COLE (a) ventral view, (b) side view, (c) dorsal view, *Globorotalia cerroazulensis* Zone.
- Fig. 6:** *Globorotalia gemma* JENKINS, (a) ventral view, (b) side view, (c) dorsal view, *Cassigerinella chipolensis* Zone, Abu Tunis IX, (1190-1200').
- Fig. 7:** *Globorotalia increbescens* BANDY, (a) ventral view (b) side view (c) dorsal view, *Globorotalia opima opima* Zone, Abu Tunis IX, (1130-1140').
- Fig. 8:** *Globorotalia obesa* BOLLI, (a) dorsal, (b) side view (c) ventral view, *Nummulites bouillei* Zone, east Faghur 1, (1780-1790').
- Fig. 9:** *Globorotalia opima nana* BOLLI, (a) dorsal view, (b) side view, *Globorotalia opima opima* Zone, North Ghazalat well No. 1, (1690-1700').
- Fig. 10:** *Globorotalia opima opima* BOLLI, (a) dorsal view, (b) side view, (c) ventral view, *Globorotalia opima opima* Zone, Khalda 1, (1710-1720').
- Fig. 11:** *Globorotalia postcretacea* MYATILUK, (a) dorsal view, (b) side view, *Cassigerinella chipolensis* Zone, Khalda well No. 1, (1960-1970').

BIOSTRATIGRAPHY OF THE SUBSURFACE  
OLIGOCENE SEDIMENTS

PLATE 5



**Plate 6**

- Fig. 1:** *Globorotalia scitula* BRADY (a) ventral view, (b) side view, (c) dorsal view, *Cassigerinella chipolensis* Zone, Abu Tunis IX, (1190-1200').
- Fig. 2:** *Catapsydrax dissimilis dissimilis* CUSHMAN & BERMUDEZ, (a) ventral view, (b) side view, (c) dorsal view, *Globorotalia opima opima* Zone, Khalda 1, (1720-1730').
- Fig. 3:** *Globigerinita martini* BANNER & BLOW, (a) ventral view, (b) dorsal view, (c) side view, *Globigerina ampliapertura* Zone, North Ghazalat 1, (1930-1940').
- Fig. 4:** *Globigerinita unicave primitiva* BANNER & BLOW (a) ventral view, (b) side view, (c) dorsal view, *Globigerina ampliapertura* Zone, North Ghazalat-1, (1910-1920').
- Fig. 5:** *Globigerinita unicavus unicavus*, BOLLI, LOEBLICH & TAPPAN, (a) ventral view, (b) dorsal view, (c) side view, *Cassigerinella chipolensis* Zone, North Ghazalat-1, (1930-1940').
- Fig. 6:** *Cassigerinella chipolensis* CUSHMAN & PONTON, (a) & (b) side view, *Cassigerinella chipolensis* Zone, Khalda-1, sample (1930-1940').
- Fig. 7:** *Pseudohastigerina micra* COLE (a) ventral view, (b) side view, *Cassigerinella chipolensis/Pseudohastigerina micra* Zone, Khalda-1, (1950-1960').

BIOSTRATIGRAPHY OF THE SUBSURFACE  
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PLATE 6

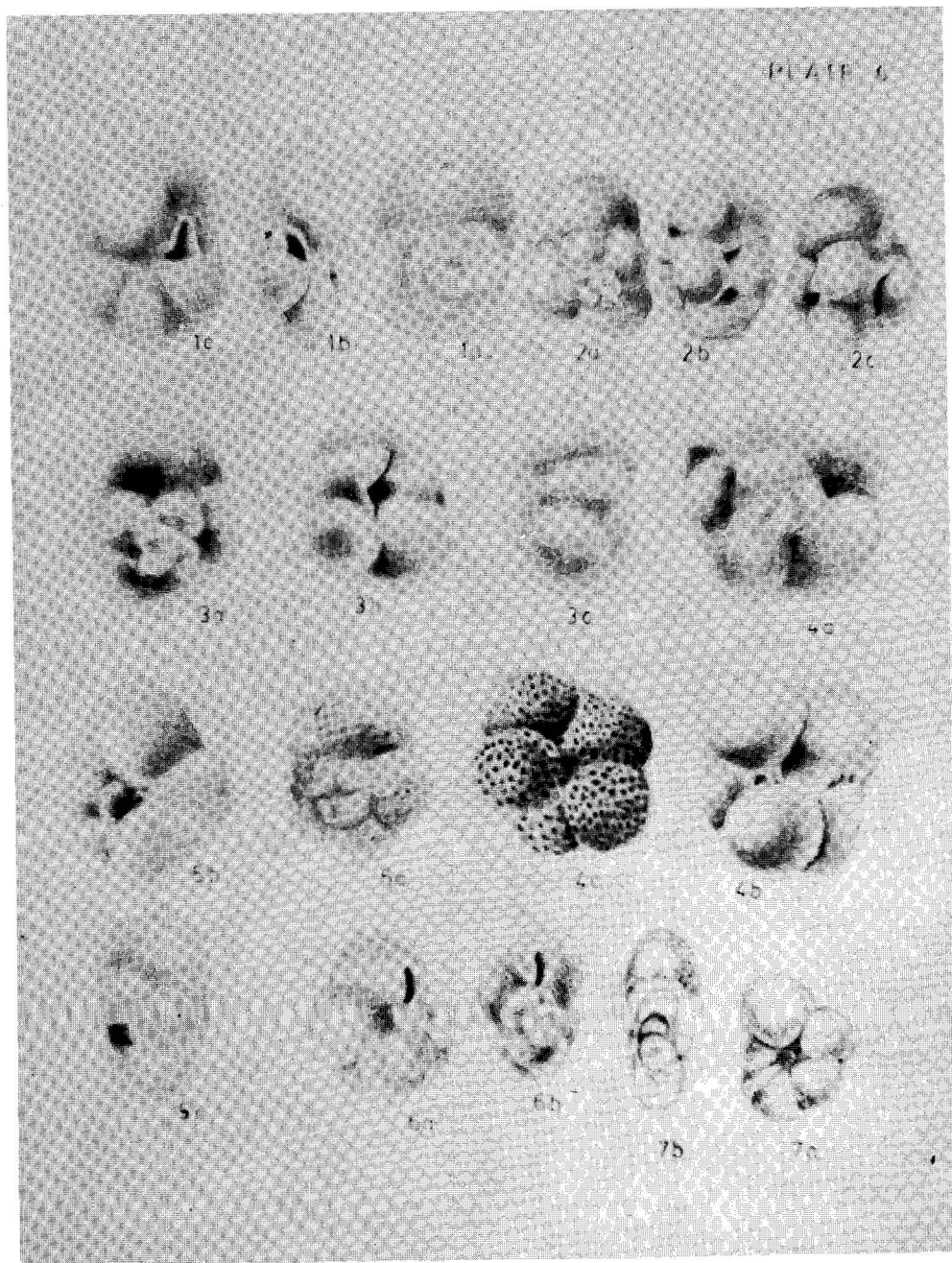
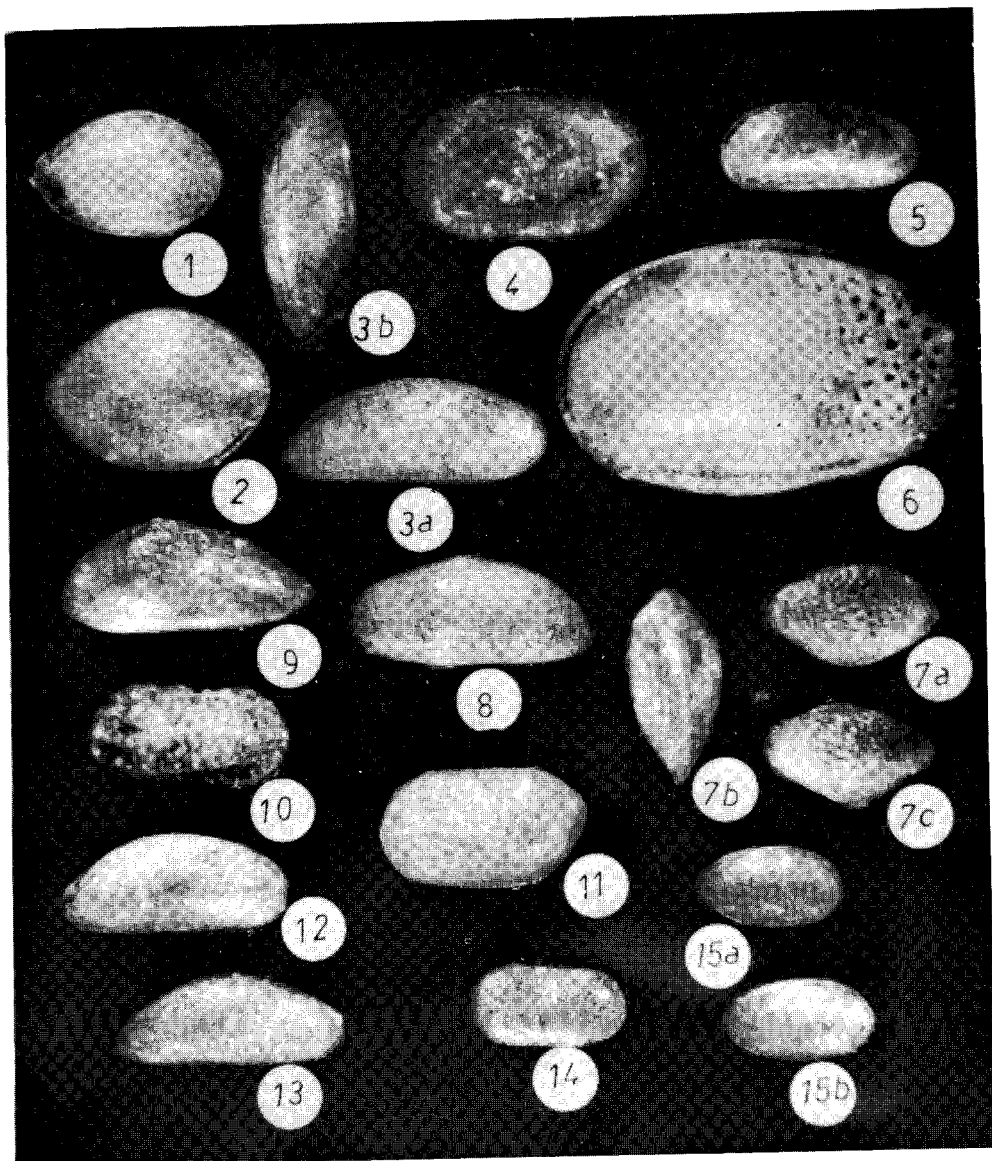


Plate 7

- Fig. 1,2:** *Bairdopillata gliberti* KEIJ, Lower to Middle Oligocene, *Globorotalia opima opima* Zone, Khalda 1, (1720-1760').
- Fig. 3a,b:** *Paracypris contracta* JONES, Middle Eocene, *Trachylebris nodosus nodosus* Zone, East Faghur well No. 1, (1851-1883').
- Fig. 4:** *Cytherelloidea* sp. SONMEZ & GOCKEN, Lower to Middle Oligocene, *Globorotalia opima opima* Zone. *Neocyprideis spp* Zone, Khalda well No. 1, (1690-1720').
- Fig. 5:** *Kriithe bartonensis* JONES, Lower to Middle Oligocene, *Globorotalia opima opima* Zone/*Neocyprideis spp* Zone, Khalda well No. 1, (1690-1720').
- Fig. 6:** *Neocyprideis* n.sp<sub>2</sub>SALAH, lower Middle Oligocene, *Globorotalia opima opima*/*Neocyprideis spp* Zone. Khalda well No. 1, (1690-1750').
- Fig. 7a,b,c:** *Loxococoncha* sp. Lower to Middle Oligocene, *Globorotalia opima opima*/*Neocyprideis spp* Zone, Khalda well No. 1, samples (1680-1720').
- Fig. 8,9:** *Novocypris eocenanus* DUCASSE, Middle Eocene, *Trachylebris nodosus nodosus* Zone, East Faghur 1, at 1851'.
- Fig. 10:** *Bradleya oertlii* DUCASSE, Middle Eocene, *Trachylebris nodosus nodosus* Zone, East Faghur-1, at 1851'.
- Fig. 11:** *Loxococoncha matiensis* KHALIFA & CRONIN, Middle Eocene *Trachylebris nodosus nodosus* Zone, East Faghur 1, at 1851'.
- Figs. 12,13:** *Paracypris* sp<sup>1</sup>, Lower to Middle Oligocene *Globorotalia opima opima*/*Neocyprideis spp* Zone, Khalda 1, (1690-1720').
- Fig. 14:** *Cytherella punctata*, Lower to Middle Oligocene *Globorotalia opima opima*/*Neocyprideis spp* Zone, Khalda 1, (1690-1720').
- Fig. 15a,b:** *Cytherella compressa* VON MUNSTER. Upper Oligocene, *Nummulites bouillei* Zone East Faghur 1, (1800-1850').

BIOSTRATIGRAPHY OF THE SUBSURFACE  
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PLATE 7



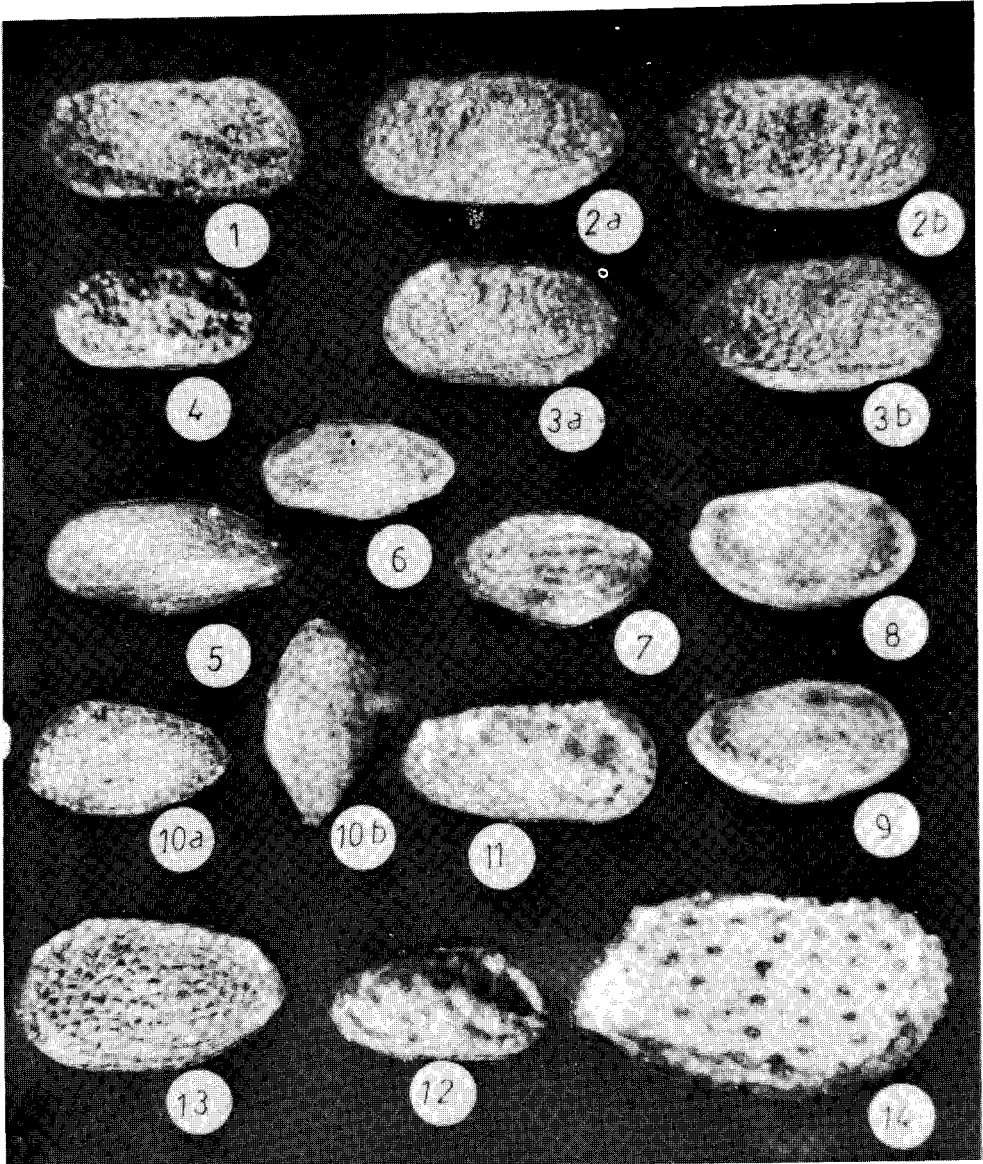


**Plate 8**

- Fig. 1:** *Costa sp*<sub>1</sub>, Upper Oligocene, *Nummulites intermedius* Zone, East Faghur-1, 1800'.
- Fig. 2,3a,b:** *Trachylebris nodosus nodosus* BASSIOUNI, Middle Eocene, zonal fossil, East Faghur-1, 1851'.
- Fig. 4:** *Costa sp*<sub>2</sub>, Upper Oligocene, *Nummulites intermedius* Zone, East Faghur-1, 1800'.
- Fig. 5,6,7:** *Ruggieria n.sp*<sub>2</sub> SALAHI, Lower to Middle Oligocene *Globorotalia opima opima/Neocyprideis spp* Zone. Khalda-1. (1690-1750').
- Fig. 8:** *Ruggieria sp*<sub>1</sub>, Lower to Middle Oligocene, *Globorotalia opima opima/Neocyprideis spp* Zone, Khalda-1, (1720-1750').
- Fig. 9:** *Ruggieria sp*<sub>2</sub>, Lower to Middle Oligocene, *Globorotalia opima opima/Neocyprideis spp* Zone, Khalda-1, (1720-1750').
- Fig. 10,11,12,13:** *Leguminocythereis sp*, Lower to Middle Oligocene *Globorotalia opima opima/Neocyprideis spp* Zone, Khalda-1, (1720-1750').
- Fig. 14:** *Cytherura sp*. Lower to Middle Oligocene, *Globorotalia opima opima/Neocyprideis spp* Zone, Khalda-1, (1720-1750').

BIOSTRATIGRAPHY OF THE SUBSURFACE  
OLIGOCENE SEDIMENTS

PLATE 8



## بيوستراتجرافية رسوبيات الأوليجوسين تحت السطحية ، شمال الصحراء الغربية

محمد يوسف حسن ، محمد البخاري ، جمال سلوم ، حسن الشيخ

يشتمل هذا البحث على دراسة للفورامنيفرا الهائمة والفورامنيفرا الكبيرة ، والواستراكودا المفصولة من رسوبيات عصر الأوليجوسين من أربعة آبارهم :  
أبوتونس رقم ٩ ، شرق فاغور رقم ١ ، خالده رقم ١ وشمالا غزلات رقم ١  
وكلها تقع في شمال الصحراء الغربية . وقد أمكن تمييز عدة نطق حيوية فورامنيفريه  
هم على التوالي ، من أعلى إلى أسفل :  
٤ - نطاق ميوجيسينيودس كومبلناتس / لبيدوسيكلينا والذي يكافيء نطاق

النيموليتس بوليلبي .

٣ - نطاق جلوپورو تاليا أوبييا أوبييا .

٢ - نطاق امبلي أبرتيورا .

١ - نطاق كاسيجيرينيليا شيبولينسيس .

والنطاقان ١ ، ٢ يتبعان العمر الروبيلي ، والنطاقان ٣ ، ٤ يتبعان العمر الكاتي . وقد تمت مضاهاه النطاق رقم ٤ بمثيله في تونس ( انظر بحث بيلي ، كولر . ( ١٩٧٦ ) .