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## RESEARCH ARTICLE

# STRATIGRAPHICAL STUDIES ON TWO CARBONATE RESERVES (KAHYLIA & OKHEIDER MOUNTAINS), NORTHWEST GULF OF SUEZ, EGYPT

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### ABSTRACT

The Lithostratigraphy of the Eocene exposures in the north Eastern Desert has been a subject of study for many authors. Two major stratigraphic sections are measured to clarify the facies characteristics of the studied sequence. The first section is sampled at the eastern scarp of Gabel Kahylia along the western bank of wadi Haugl. The second section is samples at Gabel Okheider along Cairo-Sukhna road.

Lithostratigraphically; the Middle Eocene limestone (of Lutetian age) exposures in the study area are subdivided into two rock units from base to top are:

**1- Minia Formation:** It is recorded only in the southwestern part of the studied area at Gabel Okheider (about 40m. thick), and unconformably overlain by Mokattam Formation. In the investigated area, the Minia Formation is of Middle Eocene (Lutetian) age.

**2- Mokattam Formation:** It is widely distributed in the study area at both Gabel Okheider (reaches 65m.), and Gabel Kahylia (about 120m. thick). In the study area, it is mainly composed of yellowish with, thinly to thick bedded, hard limestone rich in fossils (mostly nummulitic). In the investigated area, the Mokattam Formation is of Middle Eocene (Late Lutetian) age.

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### INTRODUCTION

The study area forms part of the great Eocene plateau of the Northern Eastern Desert of Egypt. It consists of series of elongated and widely-spaced North-West and East-West trending topographic highs and lows, which are mainly structurally controlled. It extends along the Western side of Gulf of Suez between Latitudes 29° 40' and 30° 00' N, and Longitude 32° 00' and 32° 30' E, covering an area about 800 sq km. (Fig.1). It occupies the area between the south western scarp of Gabel Ataqqa to the northeast, including Gabel Kahylia to the north and Gabel Okheider to the south.

The Lithostratigraphy of the Eocene exposures in the north Eastern Desert has been a subject of study for many authors. The most important are those carried out by Blanckhorn (1900), Cuvillier (1941), Al-Ahwani (1982), Strougo (1985 a,b), Strougo and Boukary (1987), Abd-Elshafy *et al.* (1989), Strougo and Abd-Allah (1990), Strougo *et al.* (1992); Abu El-Anain and Ismail (1995), Bignot and Strougo (1994 & 2002). However, there is not overall accepted classification regarding the Eocene stratigraphic subdivision, and different terms had been given in various parts of the north Eastern Desert. Both pre-rift and syn-rift sedimentary successions are represented in the study area. The exposed pre-rift sediments are represented by the Tertiary rock units of Middle and Late Eocene

exposures. The syn-rift sediments are represented by the Neogene rock units belonging to Oligocene and Miocene exposures. (Fig.2). The Oligocene exposures are represented by continental sands, quartzite and gravel sediments of Gabal El-Ahmer Formation, which capped the Eocene rocks at both northwestern and southeastern parts of the study area (Fig.2). A review of the lithostratigraphy of the Middle Eocene sequence in the study area (Fig.2) and the surrounding environs are summarized in following table (Fig. 3).

### Experimental Procedures

Two major stratigraphic sections are measured to clarify the facies characteristics of the studied sequence. The first section is sampled at the eastern scarp of Gabel Kahylia along the western bank of wadi Haugl (Fig.4). The second section is samples at Gabel Okheider along Cairo-Sukhna road (Fig.4). These two stratigraphic sections are particularly selected to show in details the facies characteristics and cyclic pattern of sedimentation that marks the Eocene sediments (Fig.6 & 7).

Through the discussion of the exposed Eocene rock units in the area with those suggested before by different authors (Fig.3) in the neighboring areas, the author tends to follow Said (1990) and AbuEl-Anain and Ismail (1995) classification of the exposed Eocene rock units in the investigated area.

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In the following pages, there is a detailed description of the studied Eocene rock units:

### **Minia Formation**

The Minia Formation was first introduced by Said (1960), to describe the alveolinide limestone succession (30m thick) exposed east of Sawada Village (type locality) southeast of Minia City, which directly overlies the Thebes Formation and underlies the Mokattam Formation.

The Minia Formation was recorded and studied in Nile Valley by Bishay (1961&1966), Keheila (1978&1983), Boukhary and AbdelMalik (1983), Philobos and Keheila (1991) and Abu El Ghar *et al.* (2005).

In the studied area, the Minia Formation is recorded only at Gabel Okheider section (Fig. 4), where it measures about 70m thick. It shows unconformable relationship with the overlying Mokattam Formation. The contact with Mokattam Formation is evidenced by hardground, bioturbated conglomeratic surface representing a discontinuity surface (Fig. 8 & 9).

The Minia Formation in the investigated area is composed of grayish white, bedded to massive limestone and marly limestone rich in alveolines. Thin intercalations of dolomitic and sandy limestone are also encountered (Fig. 10). Planner cross-bedded limestone is also recorded in the middle parts of this Formation (Fig. 11) very dense bioturbation horizons are also present H.S Hassan (2013).

In the present work, and in accordance with the aforementioned studies, the Minia Formation is considered here to be of the Middle Eocene (Lutetian) age (Said,1960 & 1971; Bishay,1966; Boukhary, 1970; Mansour and Philobos, 1983 and Abdel Shafy *et al.* 1989).

### **Mokattam Formation**

The formal term Mokattam Formation was introduced by Said (1962) to include the lower Mokattam unit of Zittle (1983). Said (1962) considered the Mokattam Formation to be conformably overlies the Minia Formation and underlies the Maadi Formation.

Later, Said (1971), subdivided the Mokattam Formation into Gabel Hof Member at the base, and Observatory Member at the top. However, different terms and subdivisions had been given in various parts of Nile Valley and north Eastern Desert of Egypt (e.g. Frag and Ismail, 1959; Bishay, 1960 &1962; Said and Martin, 1964; Tadros, 1968; Boukhary, 1970 & 1973; Mansour and Philobos, 1983; Abd Alla, 1993 and Strougo 1995) (Fig 3). In the study area, the Mokattam Formation is widely distributed along both sides of the Cairo-Sukhna road (Fig.2). The Mokattam Formation which, is recorded in both Gabel Okheider section is overlying unconformably the Minia Formation (Fig.4), with a thickness reaches 65m, and Gabel Kahylia section where it attains about 120m thickness, H.S Hassan (2013).

In the study area, the Mokattam Formation is mainly composed of yellowish, thinly to thick bedded, hard, fossiliferous (mostly nummulitic) limestone (Fig.12). Thin beds of dolomitic limestone, marly limestone and bioturbated horizons are also present H.S Hassan (2013).

The Mokattam Formation of the investigated area is assigned to be of Middle Eocene (Late Lutetian) age (Barakat *et al.*, 1970; Mansour and Philobos, 1983; Strougo and Boukhary, 1987; and Said, 1971 & 1990).

### **Maadi Formation**

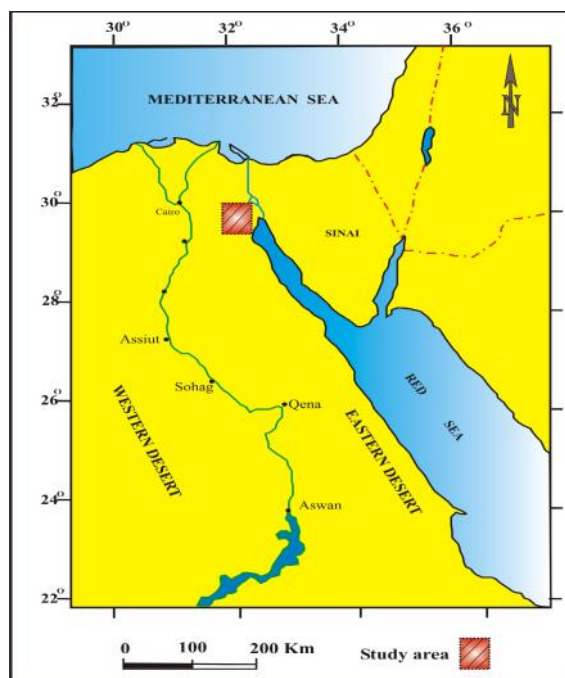
The studied Middle Eocene limestone sequence is capped in some parts of the study area by thin beds of Upper Eocene belonging to the Maadi Formation. The Maadi Formation was first introduced by Said (1962 & 1971) to describe the upper Mokattam of Zittle (1883).

In the study area, the Maadi Formation is reported from Gabel Okheider and Gabel Kahylia (Fig.2), where its base is unexposed. It is composed of sandy limestone intercalated with calcareous claystones and sandstones with some Oyster bands and Carolia beds H.S Hassan (2013).

The Maadi Formation belongs to Late Eocene (Pariabonian) age by Said, 1962 & 1971; Bishay, 1966; Strougo, 1979, and Bassiouni *et al.* 1987.

## **RESULTS AND DISCUSSION**

The study area extends on shore of the Western side of Gulf of Suez between Latitudes 29° 40' and 30° 00' N, and Longitude 32° 00' and 32° 30' E, covering an area of about 800 sq km. forming a part of the great Eocene plateau of the Northern Eastern Desert of Egypt.



**Fig.1** Location map of the study area

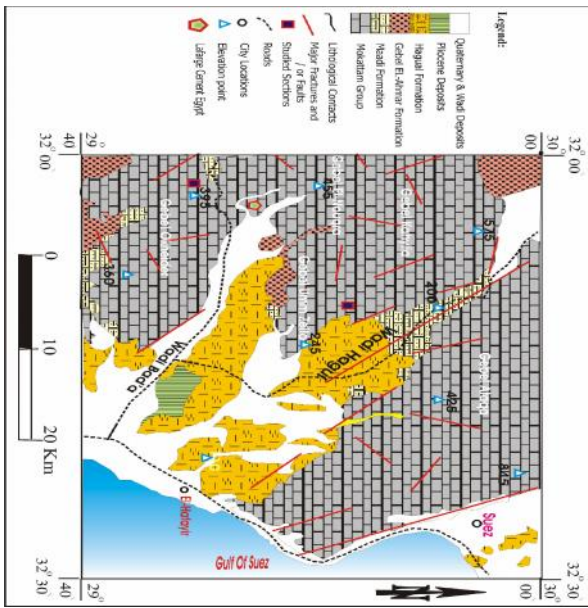


Fig2 Geological map of the study area showing the studied sections (After CONOCO, 1989)

Age		Author
Eocene		
Lutetian	Late Eocene	Said (1971), Egypt
	Early Middle Late	
Middle Eocene	Mokattam Group	Boukhary & Abdel-Malik (1983), Egypt
	Samalut Formation, Gushli Formation, Maadi Formation, Nasuri Formation	
Middle Eocene	Mokattam Group	Conoco (1989), Egypt
	Samalut Formation, El-Sheikh Formation, Beni Suf Formation, Gushli Formation, Maadi Formation	
Middle Eocene	Mokattam Group	Said (1990), Egypt
	Samalut Formation, Maghaghla Formation, Qarara Formation, Observatory Formation, Maadi Group	
Middle Eocene	Mokattam Group	Strougo, 1995, Giza Pyramids
	Samalut Formation, Mokattam Formation, Observatory Formation, Maadi Group	
Middle Eocene	Mokattam Group	El-Ayyat, 1988, Eol Minia-Beni Suf
	Samalut Formation, Mokattam Formation, Observatory Formation, Maadi Group	
Middle Eocene	Mokattam Group	Present Work, North Eastern Desert
	Samalut Formation, Mokattam Formation, Observatory Formation, Maadi Group	

Fig3 Correlation between the previous lithostratigraphic classification of the Middle Eocene in Egypt and present study.

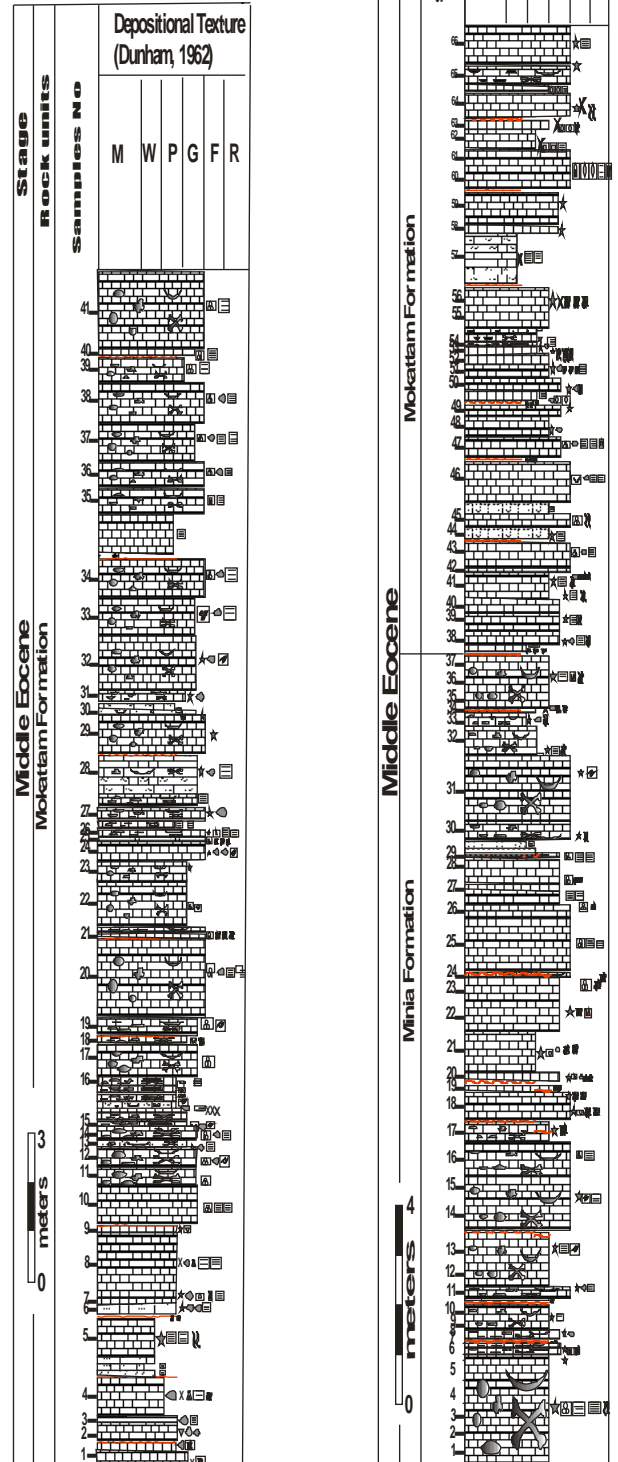


Fig 4 The measured stratigraphic sections at Kahylia(A) and Okheider(B).

It consists of a series of elongated and widely- spaced North-West and East-West trending topographic highs and lows, which are mainly structurally controlled.

Rock types	Components	Sedimentary structures
Limestone (General)	Planktonic foraminifera	Cross Bedding
Limestone Bioclastic	Bivalvia	Coarsening Upwards
Marly limestone	Nummullites	Fining upward gradation
Dolomitic limestone	Echinoderms	Channeling
Dolostone	Reef Patches	Disconformity surface
Silicrete	Plant remains	Slightly bioturbated
	Mullusca Fragments	Moderately bioturbated
	Peloids	Strongly bioturbated
	Gastropods	Thickly Bedded
	Corals Heads	Bedded
		Thinly Bedded
		Dewatering Structure

**Carbonate depositional textures**  
M = lime mudstone, W= wackestone, P= packstone, G= grainstone.

**Fig.5** Legend of symbols used in the present study



**Fig. (6).** Field view shows the interbedding Mokattam Formation at Kahylia section



**Fig. (7).** Field view shows the cyclic pattern of sedimentations, Minia Formation Okheider section.

The topographic highs, are also structural highs and mostly made up of hard Middle Eocene limestone beds, while the topographic lows, are also of structural origin and are occupied by soft rocks ranging in age from Late Eocene to Recent.

Both the pre-rift sediments (represented by the Tertiary rock units of Middle and Late Eocene) and syn-rift sediments (represented by the Oligocene and Miocene deposits) are occurred in the study area.



**Fig. (8).** Field view shows horizontal bioturbated limestone, of the Minia Formation, Okheider section.



**Fig. (9).** Field view shows a discontinuity surface in Minia Formation.



**Fig. (10).** Field view shows thin intercalations of dolomitic and sandy limestone, Minia Formation.



**Fig. (11).** Field view shows planar cross-bedding in Minia Formation, Okheider section.



Fig.(12). Field view shows thick bedding in Mokattam Formation at Okheider Section.

Lithostratigraphically; the Middle Eocene limestone (of Lutetian age) exposures in the study area are subdivided into two rock units from base to top are:

### Minia Formation

It is recorded only in the southwestern part of the studied area at Gabel Okheider (about 40m. thick), and unconformably overlain by Mokattam Formation. It is composed of grayish white, bedded to massive limestone and marly limestone, with thin intercalations of dolomitic and sandy limestone intercalations. Planar cross bedded limestone is also recorded in the middle parts of this formation. Very dense bioturbation horizons are also present. In the investigated area, the Minia Formation is of Middle Eocene (Lutetian) age.

### Mokattam Formation

It is widely distributed in the study area at both Gabel Okheider (reaches 65m.), and Gabel Kahyilia (about 120m. thick). In the study area, it is mainly composed of yellowish with, thinly to thick bedded, hard limestone rich in fossils (mostly nummulitic). Thin beds of dolomitic limestone, marly limestone and bioturbated horizons are also present. In the investigated area, the Mokattam Formation is of Middle Eocene (Late Lutetian) age.

Relationships between the studied rock units are noticed and the contact between them is recognized.

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