

**CHAPTER I:  
INTRODUCTION**

## **Chapter (1) Introduction**

### **1.1. Location and Accessibility:**

The Gabal Shabrawet area is located in the midway between Suez and Ismailia cities. The area under study is delineated by the following coordinates:-

Latitudes:        30° 10' 00"   to 30° 19' 00" N

Longitudes:     32° 08' 00"   to 32° 25' 00" E

The area is bounded to the east by the Ismailia-Suez road and to the west by the tributaries of Wadi Abu Talh and Gabal Um Kathieb (Figure 1.1). To the east, the area is bounded by the wide plain that extends from the Great Bitter Lake in the north to Gabal Ataqa in the south. Figure (1.1) is a Landsat ETM+ image giving an overview of the different rock units and the main topographic features in the area under study.

The area is well accessible as it is located at the intersection of many asphaltic roads such as Cairo-Suez, Cairo-Geneifa and Ismailia-Suez. The study area represents the extreme eastern sector on the Cairo-Suez district in the northern part of the Eastern Desert. The area is close to the northern tip of the Gulf of Suez, west of the Great Bitter Lake, which gives the area much importance and attention.

### **1.2. Topography and Drainage:**

The Gabal Shabrawet area (Figures 1.2) forms a conspicuous topographic feature, consisting of steeply dipping Cretaceous rocks surrounded by gently dipping Eocene and younger rocks, midway between Ismailia and Suez. Being a part of the Syrian Arc system, most of the topographic highs are structurally controlled. The northern Cretaceous hill (Gabal Shabrawet east) reaches an elevation of about 220m above sea level. Gabal El Goza El Hamra is 212m to the southeast, and its southward extension, Gabal Geneifa is 192m, both are covered by Eocene rocks. Northwards, the area descends gradually to a wide plain extending to the shoreline of the Great Bitter Lake. To the south, the area is bounded by the tributaries of Wadi Hessa which runs east-west. Gabal El Shehabi forms the northeastern part of the area and is composed of Miocene sediments, which are tilted mildly to the north. The area is barren of vegetation though it has a considerable number of dry wadis. The Oligocene fluvial sediments, consisting of conglomerates, cross-bedded sandstones and sands, cover a wide plain to the south and southwest of the area.

The general relief of the area is moderate; the average height is about 200m above sea level. The highest peak is at Gabal Gharra, which has an elevation of about 313m above sea level and is located in the southern part of the area (Figure 1.3). The main topographic features in the study area are Gabal Shabrawet east (220m), Gabal Shabrawet west (160m, and located some 3km west of Gabal Shabrawet east), Gabal El Goza El Hamra (212m), Gabal Geneifa (192m), and Gabal Gharra (313m). Gabal Shabrawet east is separated from Gabal El Shehabi to the northwest by Wadi Abiad, which drains the northern part of the area towards the east, into the Great Bitter Lake. Wadi Abiad separates the Miocene deposits in the north and northwest from the Cretaceous rocks, which constitute the northern slopes of the Shabrawet area. Wadi Sud El Gamouth separates Gabal Shabrawet east and Gabal El Goza El Hamra in the north from Gabal Geneifa in the south. Gabal Shabrawet east is separated from Gabal El Goza El Hamra by a small wadi, Darbet El Houity, which runs east-west.

### **1.3. Aim of the work:**

The present work is devoted to study the stratigraphy and structure of Gabal Shabrawet area and its environs. A special emphasis on the tectonic evolution of the area and on the stratigraphic succession, in relation to the regional tectonic events, is introduced.

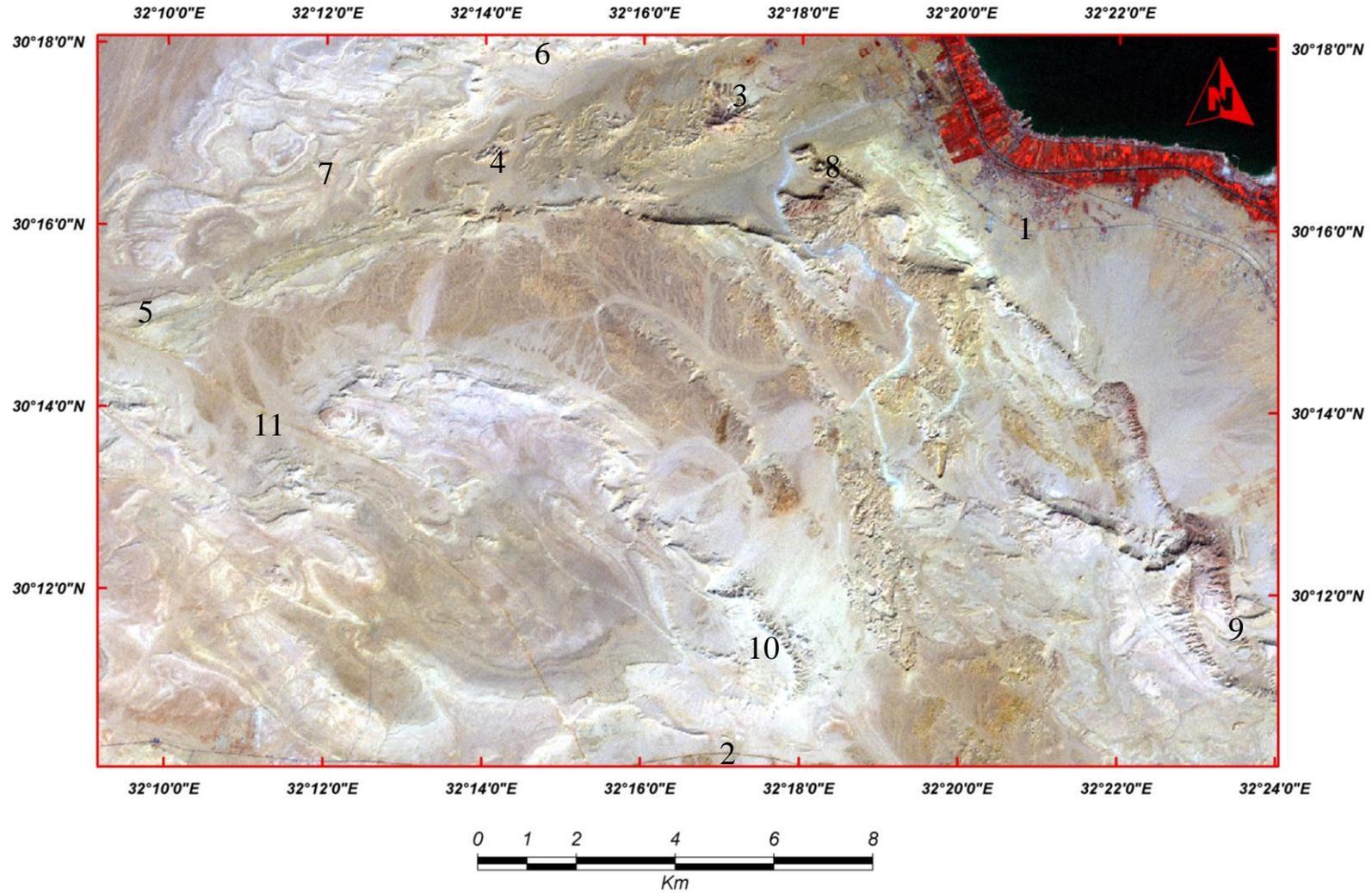
The present study is achieved through the following points:

1. Mapping the area at a scale of 1:50,000.
2. Measuring, studying and correlating the stratigraphic sections of the exposed rock units.
3. Analysing the mapped structures.
4. Interpreting the mapped structures in relation to the Late Cretaceous-Early Tertiary and the Oligo-Miocene deformations of northeastern Egypt.

### **1.4. Methodology:**

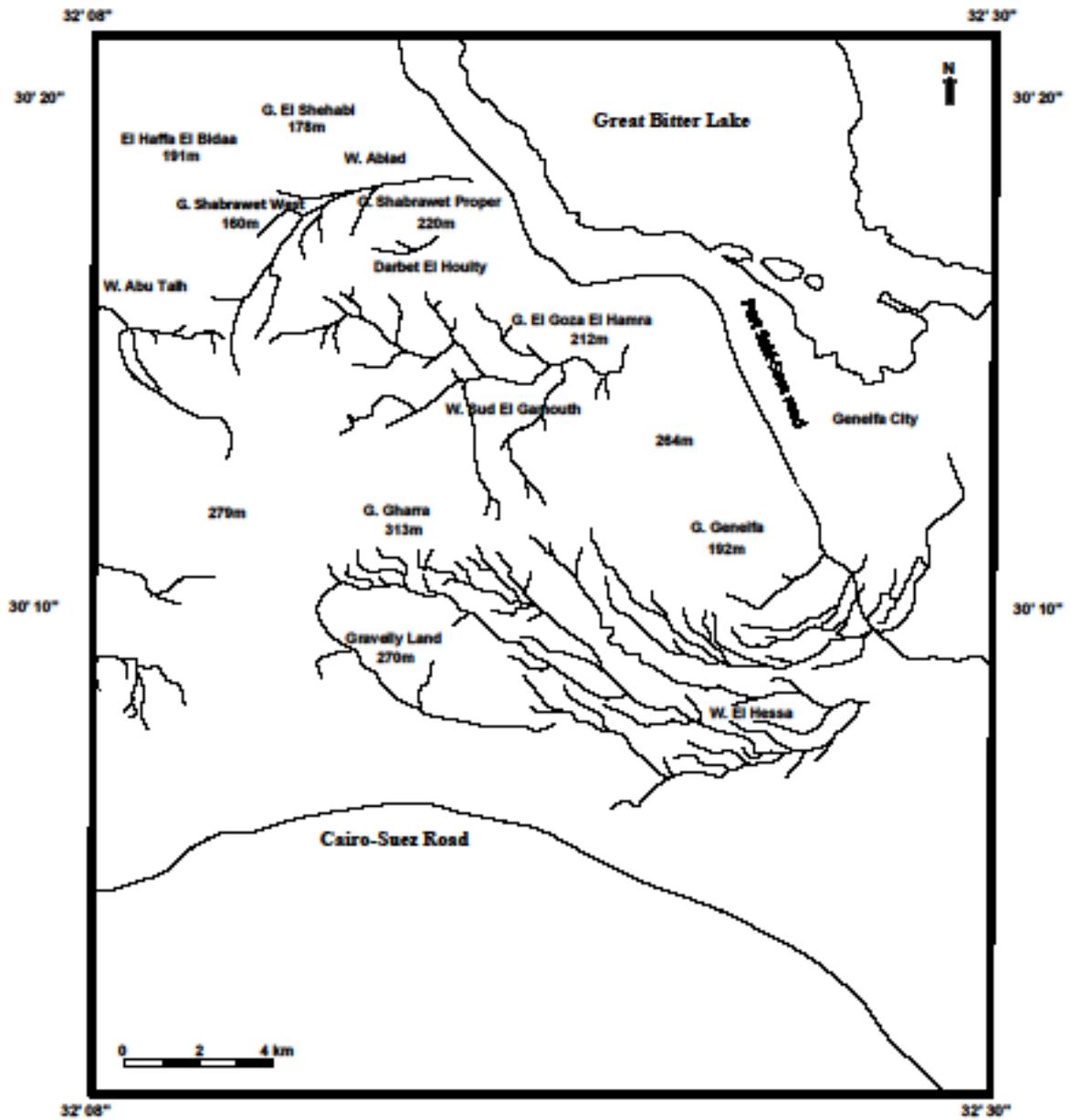
To achieve the proposed objectives, the following steps were done during the period of study:

- The previous geological studies on the area were collected and reviewed.
- Both black and white aerial photographs and Landsat of 7 Enhanced Thematic Maps plus other images mostly aerial photographs scale 1:40,000 were photogeologically studied.
- A preliminary photogeological map was prepared to be used as a base map during field work.



(1) Ismailia-Suez road, (2) Cairo-Suez road, (3) Gabal Shabrawet east, (4) Gabal Shabrawet west, (5) Gabal Um Kathieb, (6) Gabal El Shehabi, (7) El Hafa El Baida, (8) Gabal El Goza El Hamra, (9) Gabal Geneifa, (10) Gabal Gharra, (11) Wadi Abu Talh

**Figure (1.1):** Landsat TM image of the Gabal Shabrawet area and its environs.



**Figure (1.2):** Simplified topographic map of the Gabal Shabrawet area and its environs.

- Several stratigraphic sections of the exposed rock units were measured, studied and correlated.
- Detailed field mapping and structural studies of the mapped structures were performed and analyzed using stereographic projections, and rose diagrams.
- A tectonosedimentary model for the evolution of the area was established from the aforementioned steps and the data output were used to build the geological history of the study area.

### 1.5. Previous work:

The area has attracted the attention of many authors since the beginning of the 20<sup>th</sup> century. Much work was done concerning the area stratigraphically, sedimentologically, and paleontologically, but little work dealing with the structural analysis of the area was achieved. The following section summarizes and sheds some light on the previous studies in the field of structure, stratigraphy, and paleontology of the exposed rock units.

**Barron (1907)** considered Gabal Shabrawet as a broken dome, and described the Cretaceous rocks and fixed the upper limit of the Cenomanian at the top of the greenish marls, which contain *Ostrea flabellata*, *O. mermeti*, *O. olisponinsis* and *Cardium* sp.

**Blanckenhorn (1921)** referred to Gabal Shabrawet as the remains of the southern limb of an anticline. The oldest beds are found at its northern base, whereas the youngest strata occupy the summit and its southern foot. He measured a series of beds 175m thick, consisting of hard white or grey limestones alternating with soft marls.

**Barthoux (1922)** described Gabal Shabrawet as a lying fold, and stated that Gabal Shabrawet involves the Vraconian and the Cenomanian strata, describing that the hill starts at the base with the Vraconian containing *Knemiceras syriacum*, which is overlain by well developed Cenomanian rocks including *Hemiaster cubicus*.

**Fawzi (1959)** referred to Gabal Shabrawet as the remains of the southern limb of an anticline. He gave a complete section of Gabal Shabrawet defining the lower and upper limits of the Cenomanian section.

**Fawzi (1960)** contributed to the study of the Cenomanian of Egypt and correlated the Egyptian fauna with those of the neighbouring countries. He reported that the Late Cretaceous transgression which started at the beginning of Cenomanian was the longest in Egypt and Cenomanian rocks were found

outcropping in many localities. He stated that Gabal Shabrawet is the northernmost locality in the Eastern Desert where fossiliferous Cenomanian beds are found. A detailed section was made and the whole Cretaceous succession was found to be about 338m thick, of which the Cenomanian is supposed to attain only about 180m starting from above by *Knemiceras* beds or the top of the Albian. The fauna shows that the lowermost horizon of the Cenomanian contains the typical Cenomanian fossils, as well as fossils having affinity to the Albian. The fossils are characterised by their large size e.g. *Exogyra flabellate*, *Lima aff. numidica*, *Venus reynesi* and *Protocardium combei*.

**Faris and Abbas (1961)** described Gabal Shabrawet as a domal structure, and dated the basal series of the section to the Albian on the basis of the presence of *Orbitolina subconcava*. The topmost Cretaceous beds are Campanian limestone with *Ostrea vesicularis*, which are unconformably overlain by the Middle Eocene series that contains *Alveolina* and *Orbitolite* beds of Lutetian age. This section is overlain by alternating beds of Upper Eocene sands, clays and conglomerates.

**Said (1962)** described Gabal Shabrawet as a doubly plunging anticline with steeper dips toward the southwest than toward the northeast. He added that Gabal Shabrawet has the same trend and geological history as that exhibited by other structures of the Syrian Arc system. He divided the Cretaceous strata into two major rock units: a lower unit of dark coloured variegated marls and shales about 250m thick, and an upper limestone unit about 140m thick. He considered the lower unit as Cenomanian, except its lower part which contains *Knemiceras syriacum* which belongs to the Albian. The upper unit may belong to the Turonian-Santonian. He believed that the Middle Eocene rocks follow on top of the Turonian-Santonian strata of Gabal Shabrawet with an angular unconformity.

**Fawzi and Naim (1964)** considered Gabal Shabrawet as a domal structure, and studied the marine Lower Cretaceous sediments measuring a section of about 174m with *Knemiceras aff. spathi* of Albian age at the upper part. They recorded that the base of the Cenomanian conformably overlies the previous section.

**Ismail et al. (1967)** stated that the highly tilted Cretaceous rocks of Gabal Shabrawet form an inlier, overlain from every side by nearly horizontal younger strata of the Eocene, Miocene and Recent ages. They revealed the presence of eight microfacies associations throughout the Cretaceous section, and interpreted their ecology and conditions of sedimentation. They described the Lower Cretaceous sediments of Gabal Shabrawet and dated them to Albian age noting that the basal beds show Aptian affinity. They reported that the

Cenomanian strata are 182m thick and formed mostly of dolomites and dolomitic limestones, which constitute 56.6% of the section, especially near the top. At the base, shelly sandy limestones, sandy dolomites and calcareous shales constitute the main bulk. Macrofossils are represented by different species of the genera *Exogyra*, *Cardita*, *Anisocardia*, *Dosinia*, *Venus*, *Cerithium*, *Nerinea*, *Natica* and *Hemiaster*, having definite Cenomanian affinities. They found that the Turonian strata at Gabal Shabrawet area represent a series of dolomites and dolomitic limestones, shelly near the top. This series is fossiliferous with *Pycnodonta vesiculosa*, *Liostrea rouvillei*, *Exogyra conica*, *Fimbria sharpie*, *Pyramidella gaudryi*, *Nerinea cretacea*, and *Cyphosoma sp.* The lithology and enclosed fauna indicate deposition in comparatively deep marine conditions of the neritic zone far from any terrigenous material input. The original Turonian carbonates were later dolomitized by metasomatic replacement in a warm and shallow magnesium rich environment.

**Ismail and El Dakkak (1971)** presented additional information about the Cretaceous section exposed at Gabal Shabrawet by detailed microfaunal, microfacies and chemical analysis and interpreted the conditions of sedimentation and geologic history of the area during the Cretaceous.

**Barakat and Aboul Ela (1971)** studied stratigraphy and structure of the Gabal Geneifa-Gabal Gharra area. They concluded that the area was greatly influenced by faulting and to a lesser extent by folding. Faults follow two main trends, NW-SE and E-W, beside a NE-SW trend of minor importance. Folding is of subordinate importance. However, two diapiric structures are of interest (west Geneifa and south Gharra). These are local structures in the form of doubly plunging anticlines trending NE-SW. They studied a section of about 200m of Middle Eocene rocks composed of yellowish white chalk and marly limestone with few dolomitic bands. The microfossils picked are *Somalina sp.*, *Orbitelites complanatus*, and *Dictyoconus aegyptiensis*, together with the megafossils namely: *Gisortia gigantean*, *Natica longa* and *Lucina sp.* The assemblage assigned a Late Lutetian age to these sediments. The Upper Eocene section is about 61m, consisting mainly of pale yellow to yellowish brown limestones which are dolomitic, marly and sandy in some places. The section is fossiliferous with *Nummulites striatus*, *Nummulites gizehensis*, *Carolia placunoides*, *Ostrea multicostrata* and *Ostrea clot beyi*.

**Barakat and Aboul Ela (op. cit.)** classified the Miocene section into marine and non-marine Miocene. The marine Miocene is characterized by a lower series of brownish yellow calcareous sandstone followed by thin fossiliferous limestone rich in *Operculina sp.* and *Heterostegina sp.* with thin streaks of marl and shale intercalations. The uppermost beds are rich in algal limestone with *Lithothamnium* and *Lithophyllum* interbedded with yellowish white limestone rich in *Oysters*, *Clypeasters* and *Scutellas*. This Marine

Miocene section attains a thickness of about 130m. The authors gave an Early-Middle Miocene age to this marine section. The non-marine Miocene characterized by a thin veneer of grey sands, grits and gravels, not exceeding 10m of thickness. They are unfossiliferous except for a few small, silicified wood fragments. These unfossiliferous clastics are believed to be of Late Miocene age.

**Al Ahwani (1982)** considered the area under study as affected by the structural elements controlling the Cairo-Suez district (manifested in E-W faults), the movements that resulted in the development of the Gulf of Suez graben (NW-SE trends) and the Syrian Arc movements (NE-SW trends). He described the structural pattern of the area as two anticlines, Shabrawet proper and Shabrawet west (some 3km to the west of Gabal Shabrawet) with a shallow syncline in between. He studied stratigraphically and sedimentologically the complete sedimentary succession of the Gabal Shabrawet area, and assigned an age of Aptian to Late Eocene time to this succession. The following formational names were used: the Galala Formation (Cenomanian), the Maghra El Hadida Formation (Turonian-Santonian), the Maghra El Bahari Formation (Upper Cretaceous-Lower Tertiary), the Minia Formation (Lower Lutetian), the Mokattam Formation (Upper Lutetian) and the Maadi Formation (Upper Eocene). He emphasised that the Miocene deposits unconformably overlies the Oligocene fluvial clastics, and consist of yellowish white limestone interbedded with clay and sandstone at the base. Sandstone is grey and relatively hard, sometimes with nodules, especially near the base. He added that these rocks are generally rich with *Clypeasters*, *Scutellas* and crowded with fossil fragments.

**Abdel Wahab and Al Ahwani (1982)** described the paleoecology and environmental conditions of the different stratigraphic units of the Cretaceous-Eocene sediments in the Gabal Shabrawet area depending on the interpretation of the lithofacies and biofacies as well as the primary sedimentary structures. They considered that a near shore littoral to shallow marine environment was prevailing with intermittent transgressive and regressive phases.

**Helal (1990)** considered the area under study to be affected by the structural elements controlling the Cairo-Suez district (manifested in E-W faults); the movements that resulted in the development of the Gulf of Suez graben (NW-SE trends) and the Syrian Arc movements (NE-SW trends).

**Mohammad and Omran (1991)** investigated in detail the stratigraphy of the Gabal Shabrawet area and divided its sedimentary sequence into eight formations namely: the Fayid Formation (Aptian-Albian), the Galala Formation (Cenomanian), the Adabiya Formation (Turonian-Santonian), the El Goza El Hamra Formation (Middle Eocene), the Maadi Formation (Upper Eocene), the

Gabal Ahmar Formation (Oligocene), the Gharra Formation (Lower Miocene) and the Marmarica Formation (Middle Miocene). The lithostratigraphic and petrographic investigations are used to interpret the depositional history of these sediments.

**Helal (1990), Shama and Helal (1993a,b)** measured and described the Eocene succession in Gabal El-Goza El-Hamra and the Eocene escarpments to the south of Darbet El Houity in the Gabal Shabrawet area. They divided the succession into three lithostratigraphic units: the Minia Formation (Lower Lutetian), the Mokattam Formation (Middle to Upper Lutetian), and the Maadi Formation (Upper Eocene). A biostratigraphic zonation based on the ranges of the ostracode and foraminiferal fauna was established. In this study, four benthonic Foraminifera biozones equivalent to five ostracode biozones were recorded in the Middle Eocene sediments. These biozones can be summarized as follows:

1- Ostracode biozones:

*Brachycythere (Digmocythere) ismaili* zone  
*Bradleya oertlii* zone  
*Costa praetricostata* zone  
*Charophyta* zone (barren of Ostracoda)  
*Martinicythere samalutensis dorsocosta* zone  
*Hornibrookella? ainshamsiana* zone

2- Benthonic Foraminifera biozones:

*Dictyoconus aegyptiensis* zone  
*Pseudoclavulina anglica* zone  
*Charophyta* zone (barren of Foraminifera)  
*Orthoplecta clavata* zone  
*Alveolina frumentiformis* zone

They also established in this study the biostratigraphic zonation of the Upper Eocene (Maadi Formation) at Gabal El Goza El Hamra based on the ranges of the Ostracodes and Foraminiferal fauna. In this study, one benthonic Foraminifera biozone equivalent to two Ostracode biozones was recorded in the Upper Eocene sediments. These biozones can be summarized as follow:

1- Ostracode biozones:

*Carolia placunoides* zone (barren of Ostracoda)  
*Uromuellerina saidi* zone  
*Asymmetricythere hiltermanni* zone

2- Benthonic Foraminifera biozones:

*Carolia placunoides* zone (barren of Foraminifera)  
*Discorbis vesicularis* zone

**Khalil (1994)** defined the Gabal Shabrawet anticline as an asymmetric fold with overturned Cenomanian to Turonian rocks on its southeastern side. He added also that the overturned flank of this anticline lies on the upthrown side of

an ENE-WSW oriented reverse fault which dips 70° toward the north. This fault was rejuvenated by right-lateral strike-slip movement in post-Late Eocene time.

**Shama et al. (1995)** studied the Middle Eocene sediments of Gabal Shabrawet area, and measured three sections at Gabal El Goza El Hamra, east of Darbet El Houity, and the hill to the southwest of Gabal El Goza El Hamra. They divided the Middle Eocene succession into two rock units namely the Minia Formation (Lower Lutetian) and the Mokattam Formation (Middle to Upper Lutetian). They studied, described and classified the Bryozoan content of the Lutetian sediments into eight species, which are erect zoarial growth forms. They concluded that such a growth form distribution reflects that the water energy during the deposition of the Minia Formation was higher, being more agitated, than that during the deposition of the Mokattam Formation. This indicates that the Minia Formation might have been deposited under rather shallower environmental conditions than those which prevailed later during the deposition of the Mokattam Formation.

**Abu El Hassan (1997)** assessed the complex diagenetic history of the Cenomanian dolomite of the Galala Formation from Gabal Shabrawet. The petrographic and geochemical evidence explained the dolomitization mechanisms which have occurred during the diagenetic history of the study sequence near surface oxidizing conditions.

**Hegazy and Omran (1999)** studied the Shabrawet area structurally and considered it as a part of the Syrian Arc system, which resulted from a folding phase at the end of the Late Cretaceous. They revealed the presence of four distinct brittle tectonic events depending on the analysis of the fault-striae. They followed the same stratigraphic classifications and units of **Mohammad and Omran (1991)**.

**El Azabi (1999)** studied the Lower/Middle Cretaceous succession and its sequence stratigraphic applications. He stated that the Lower Cretaceous clastic/carbonate deposits of Malha and Risan Aneiza formations suggest three depositional sequences, and the Cenomanian carbonate succession of the Halal Formation holds four depositional sequences interrupted by three sedimentologic breaks.

**El Sheikh and Hewaidy (1999)** recognized two main *Orbitolina* zones from the Lower Cretaceous and the Cenomanian from Northern Egypt. The lower zone "*Orbitolina (Mesorbitolina) texana*" (Late Aptian) was recorded from Gabal Manzour in North Sinai and also from Darduma well no. 1 in the north Western Desert. The upper zone "*Orbitolina concava*" (Middle Cenomanian) was recorded in Gabal Manzour, Gabal El Minsherah and Gabal El Hamra in north and west Central Sinai, respectively. The "*Orbitolina*

*concava*" zone correlates with the same zone in Gabal Shabrawet, across the Gulf of Suez, but it has been replaced by the "*Praealveolina cretacea tenuis*" zone.

**El Safori and El Sorogy (1999)** studied the Early Miocene Bryozoa of the Gharra Formation at Gabal Gharra, and identified twenty six bryozoan species. They measured a section of about 110m thick, represented by limestones with few marl interbeds. Some localities are coralline limestones and others are rich in oysters with coral and algal reefs in parts. The basal part of the section is sandy. The paleoecological investigation of the studied bryozoans and the accompanied microfacies indicates reef to back-reef depositional environments of shallow depth (20-40m), moderate turbulence, and low rate of sedimentation.

**Abdel Ghany (2002)** determined the lithostratigraphy, biostratigraphy and facies distribution of the Miocene sediments at the Gabal Shabrawet area and placed the two units of the sequence (the Gharra and Marmarica formations) into the Gharra Formation and gave it an Early Miocene age (Burdigalian). The author reported for the first time *Miogypsina intermedia* from the Miocene sequence of the area.

**Abdel Gawad and Mekawy (2002)** studied the Cenomanian and Turonian macro-invertebrates from El-Giddi pass (NW Sinai) and Gabal Shabrawet sections. They discussed the biostratigraphic ranges and geographic distribution of the studied fauna along with their paleoecologic conditions.

**El Sorogy et al. (2005)** studied the stratigraphy, paleontology and depositional environments of some exposed Miocene sediments in the Cairo-Suez district and differentiated the transgressive-regressive Miocene succession at Gabals Geneifa, Homeira and Gharra into two rock units: the Gharra Formation (Lower Miocene) and the Geneifa Formation (Middle Miocene). They divide the Miocene succession into tidal flat and typical reef flank to shelf lagoons with open circulation environments according to microfacies associations, sedimentary structures and faunal content.