CHAPTER I
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1.1 General problem and definition

The Eocene rocks outcropping at the western part of Fayum depression are unfavorable as building ground and construction materials as well as problematic to engineering structure because of their tendency to heave and may decay and change to soil during the wet season or even the water content changes. Such change in wetting and drying out of water may cause structure damage and this process is further if the parent rock contains swelling clay minerals. Pavements are in particular susceptible to damage by swelling soil even shallow foundation in the study area. Similarly, earth structure such as embankments, road base, canal, tunneling etc built above these decayed rocks and their weathering products suffering slip and damage.

The amount of volume change is a function of type and amount of clay, initial condition and/or other factors like the depositional environment which determine both particle arrangement and overburden pressure as well as the degree of weathering (Yong and Warkentin, 1975; Nelson and Miller, 1997). The same factors influencing swelling and shrinkage are also expected by Reik and Ismail, 2003; Sridharan and Gurtung, 2004; Ismail, 2004; Ismail, 2006 and Mishra et al., 2008.

It is important in the present work to investigate the relationship between the petrological characteristics and engineering properties at Wadi El Nazla area, west of Fayum depression.

1.2 Scope and objective of the work undertaking

The aim of the entire work is to determine the geotechnical and petrographical characteristics of the middle Eocene rocks and their weathering products at Wadi El Nazla- El Roba area, western Fayum

depression. The area under study is an example of such typical sites which needs many developments and planning work in Fayum province.

Besides, it is generally found in the studied area a serious of geological problems, the foundation were built above almost vertical slope and the occurrence of soft clay materials underneath the foundation. Another factor to the foundation problem is the weathering of rock mass base materials. It is generally known that, rock weathering process increases the degree of geological complexity in rock mass materials and makes the site characterization in the most place of the area under study more difficult and unfavorable to building ground. The major problem is the occurrences of swelling clay minerals which demonstrated that the light structure are suffering from adverse effects of expansion and shrinkage of the foundation ground. As the vertical swelling causes heave of the base like structure of the foundations and lateral expansion as well as shrinkage also cause significant damage to retaining structures and basement walls. Instability of unsupported excavations in swelling/ shrinkage clayey rich materials are results of deformation characteristics of the soil when it come in contact with water or due to excessive loss of water by drying out.

Many authors studied the problems of heave and shrinkage of soil materials (e.g., Day, 1994 and Nelson and Miller, 1997).

The present work deals with the geotechnical and petrological studies on the late middle Eocene (Gehannam Formation) and Quaternary deposits occurring as foundation base of the present area. In brief, the following procedure is adopted in the research undertaken. Literature survey over previous research works on geotechnical characters of rock materials and their weathering products are summarized in this chapter. The test procedures are discussed as follow:

- Site investigation of the area under consideration.
- Preliminary tests for the collected samples, e.g. mineralogical, petrographical and chemical studies using X-ray diffraction (XRD), X-ray fluorescence (XRF), scanning electron microscope (SEM) and petrography (thin sections).
- Engineering and physical properties of rocks and soil materials including natural moisture content, grain size analysis, plasticity, swelling, shrinkage.
- Discussion of the relation between geotechnical, mineralogical, chemical, physical and engineering parameters results of the rocks and soil under study to give information about the behavior of materials in buildings tasks in the area under investigation.
- Statistical analysis of mineralogical and geo-engineering parameter results.
- Recommendation and suggestions for the future building tasks in the area under investigation.

The methods and plan of study are illustrated in flow chart (Fig. 1.1).

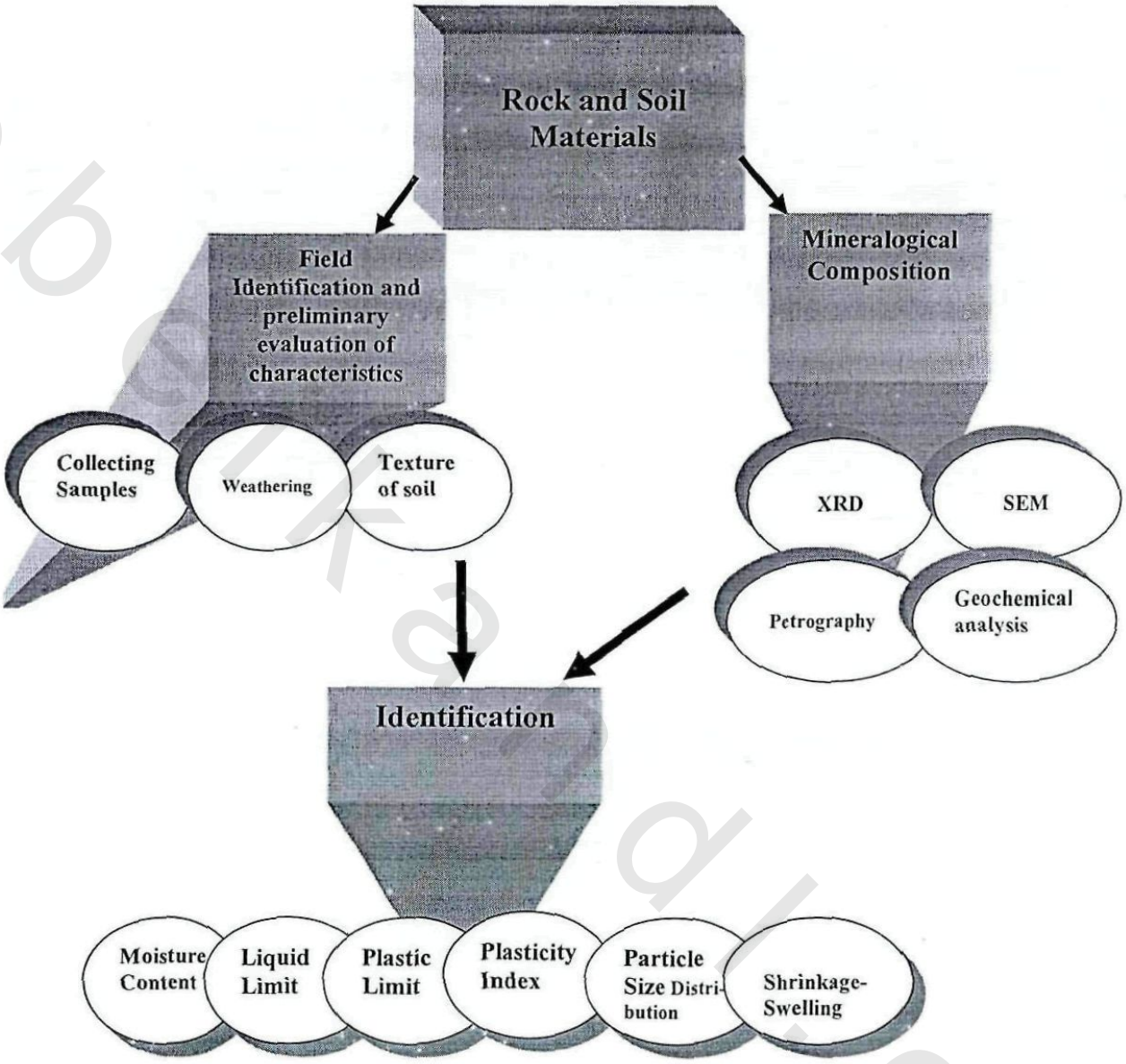

Fig.1.1: Flow chart of the field and laboratory tests on the studied rock and soil materials.

1.3. Previous study

Stratigraphical, sedimentlogical and structural studies were carried out on Fayum province and its surroundings. From these studies Fayum depression areas were geologically discussed by various authors as follows:

I) Stratigraphic sequence overview

Beadnell (1905) introduced the following classification:

Pleistocene lacustrine deposits

Pliocene

Lower Miocene Gebel Khashab red beds

Basalt

Oligocene: Qatrani Formation

Upper Eocene { Qasr El Sagha Formation / Birket Qarun Formation

Middle Eocene { Gehannam Formation (Ravine beds) / Wadi El Rayan Formation

Hume (1912) studied the middle and upper Eocene sequence in the Fayum depression and proposed the following classification:

Upper Eocene (Upper Parisian):

Qasr El Sagha "Series"

Middle Eocene (Lower Parisian):

Birket Qarun "Series"

Ravine beds

Wadi Rayan "Series"

Tromp (1951) classified the Ravine "beds" into lower Ravine "beds" of middle Eocene age and upper Ravine "beds" of upper Eocene age.

Ansary (1955) divided the upper Eocene rocks of the Fayum depression into the following:

Upper Eocene: Qarun-Sagha "Series"
Gehannam "beds"
Qalamun "beds"

El-Dakkak and Rifai (1984) mentioned that "the Wadi Rayan Formation is of upper Lutetian age at Gebel El Qalamun area and divided into four members: Muweilih, Midawara, Sath El Hadid and El Gharaq".

Samir (1986) indicated that the Gehannam Formation at Qaret Gehannam, Fayum province represents the topmost part of the middle Eocene and the upper Eocene age on the basis of planktonic foraminifera and calcareous nannoplanktonics.

Bown and Kraus (1988) mentioned that The Birket Qarun Formation and the Temple Member of the Qasr El Sagha Formation are principally nearshore marine in origin.

Abd El-Ghany (1990) studied the biostratigraphy of the middle Eocene rocks in the southern part of the Fayum depression and suggested the following three biozones: Nummulites midawarensis, N. champollioni and N. lyelli.

Said (1990) reported that the Maadi group in the Fayum desert includes the Gehannam Formation (Middle Eocene) and the Qasr El Sagha Formation (Late Eocene).

Allam et al. (1991) studied the Middle Eocene succession at Gebel Mishigeiga, Wadi Rayan, and Fayum depression and assigned the Mishigeiga Member of Wadi Rayan Formation is late Lutetian to Bartonian (Late Middle Eocene) age on the basis of microfossil content.

Abd El-Aziz (1995) studied the microfossils of the upper Eocene and Oligocene Formations north the Fayum province and proposed the

following benthonic foraminiferal and ostracods biozones: Uvigerina mediterranea – Bulimina jacksonensis, Cancris subconicus and Elphidium ancestrum. For ostracods; Asymmetricythere hiltermanni and Uromuellierina saidi were recorded.

Abd Allah et al. (1997) reported that the Qasr El Sagha Formation is of late Eocene (Priabonian) age on the basis of benthonic foraminifera and ostracods which were recorded from the Temple Member of this formation.

Elewa et al. (1998) mentioned that the middle Eocene succession of the Fayum depression includes the Gehannam and the Birket Qarun formations; while the Qasr El Sagha Formation is of late Eocene age based on the study of planktonic and benthonic foraminifers and ostracods.

Abd El-Aziz (2002) studied the stratigraphy, paleontology and paleoecology of the middle and upper Eocene rocks which exposed in the ridge area separating Fayum depression from Nile Valley (Nile-Fayum Divide). He divided the Eocene sequence at the area in six rock units starting at the base by Samalut Formation (Middle Lutetian) followed upward by the Muweilih Formation (Middle Lutetian), the Midawarw Formation (Late Lutetian), the sath El Hadid Formation (Bartonian), the Gehannam Formation (Middle/Late Eocene) and the Birket Qarun Formation (Late Eocene). He also mentioned that the Gehannam Formation was deposited in inner to middle neritic environments.

Abd El-Gaied and Abd El-Aziz (2007) and Abd El-Aziz and Abd El-Gaied (2007) studied the stratigraphy of the Eocene rocks that are exposed at wadi El Nazala, west Fayum depression. They classified the Eocene succession in the studied area into two rock units (Gehannam and Birket Qarun formations). The identified foramineferal and ostracodal contents of the recorded rock units suggested a late middle Eocene to the Gehannam Formation and a late Eocene to the Birket Qarun Formation.

II) Clay mineralogy and sedimentary petrography overview

Many authors studied the clay mineralogy, sedimentary rocks, structure and geomorphology in some areas of Fayum depression as follows:

Abd El-Salam et al. (1973) studied the mineralogy of sandy and clay fraction in relation to the different geomorphlogical units present in Fayum area. The study showed that iron oxides, amphiboles, pyroxenes and epidote are the most abundant heavy minerals followed by rutile and saussurite. The light minerals are mostly quartz with little contamination of feldspars. Montmorillonite is the most dominate clay mineral in all soils followed by illite, while Kaolinite, feldspars and quartz were only presented in small amounts.

Basta et al. (1974) studied the different clay minerals present in the fraction less than 1.4 μm from Fayum soil and neighboring soils of the Nile Valley using X-ray diffraction (XRD), Differential thermal analysis (D.T.A), cation exchange capacity (CEC) and infra-red adsorption analysis (IR). The investigation indicated that the clay minerals consist mainly of montmorillonite group minerals and kaolinite group minerals. Quartz, calcite, and feldspars were detected in minor amounts as the non-clay admixtures and the absence of any chlorite minerals, illite and other mica clay minerals.

El-Demerdash, et al. (1976) studied the mineralogy of soil aggregates from El Fayum governorate. Adjacent to Qarun Lake the study show that smectite represents the dominant clay mineral (54-75%) followed by kaolinite (5-10%), illite (never exceeds 10%) and chlorite (5-10%).

Naga et al. (1981) studied the clay minerals content of Fayum soils using XRD techniques he showed that the clay is mainly montmorillonite (50-70%), kaolinite (10-15%) whereas hydrous mica (5-10%), chlorite (0-

5%), beside a randomly interstratified smectite-illite and smectite-chlorite ranging (10-12%). Non-clay mineral present are calcite (28-78%), quartz (12-48%) and feldspars (7-27%).

Hammad et al. (1983) studied the soil types in different land forms of Fayum area. The soils could be outlined as alluvial, fluvio-lucstrine residual, regosols and litho-soils. Soil parent materials are generally of two kinds, transported or residual.

Khatter (1988) studied the relation between the water movement within some soils in Fayum area and the physical and chemical properties of these soils. The study shows that water movement under both saturated and unsaturated conditions depends on textural and structural characteristic of the soil where hydraulic conductivity values increased as drainable pores increases and the soil become coarser in texture. The opposite is true with the relatively fine textured soils due to the swelling of clays, which in turn reduce the values of drainable pores. Sharp decreases in hydraulic conductivity values occurs for alkali and saline alkali soils of some sites, these related to the degradation of soils aggregates and the swelling of Na-clay as well as the parallel decrease of the drainable pores. Finally the rate of water movement under saturated condition of the studied soils could be arranged as the following decreasing order sandy > loamy sand > sandy clay loam > clay loam > saline clayey >saline alkali clayey > alkali clayey soil.

El-Anbaawy (1989) studied the distribution and genesis of the clay minerals in some soil sediments from Fayum area. He concluded that the middle Eocene sediments along the Nile–Fayum divide represented by the Gehannam Formation (Ravine beds) is deposited in flood plain environment and the clay mineral assemblage is represented by kaolinite, illit/smectite mixed layer and smectite and are occasionally associated with gibbsite. The upper Eocene sequence represented by Birket Qarun

Formation is of shelf lagoon-shoal carbonate environment at the lower unit and the clay mineral assemblage is represented by illite and or kaolinite accompanied by illite/smectite mixed-layer. Quaternary deposits are lacustrine aeolian deposits environment and the clay mineral assemblage is smectite, smectite/illite mixed layer containing 80% expandable layers and kaolinite and or halloysite.

El-Hefnaway et al. (1994) studied mineralogy and geochemistry of smectite clays from Fayum area. The study showed that the main clay mineral present is montmorillonite followed by kaolinite and illite.

El-Younsy (1999) studied the upper Eocene-Oligocene sequence north west of Birket Qarun, he concluded that the recorded clay minerals (Kaolinite and smectite) are of detrital origin, whereas illite is diagenetically formed probably due to alteration of smectite.

III) Geotechnical overview

Many foundation problems are more crucial in developing countries due to the fact that most of their cities towns were not founded on planned bases. The following is summary of the geotechnical studies and foundation problems occurring on different cities of Egypt and Fayum areas.

Awad et al. (1953) study the rock fall occurred in Manshyte Nasser and upper plateau of Gebel El Mokattam, he stated that the buildings suffered cracking in some parts of El Mokattam area due to the poor mechanical characteristics and the presence of clayey layers.

Moustafa et al. (1991) measured the rate of retreat of the edge of the upper plateau of G. EL Mokattam and found that the rate of retreat equal to1.7 m/year. Buildings located near the limestone scarp edge suffer much more intensive damage than those located away from the escarp edge; they recommended that there must be distance at least 50m from scarp edge.

Abd El-Tawab and Ibrahim (1992) study the site of New Minia city. The field measurements indicate that presence of faulted block of rectangular shape NW oriented grabben dissected the Eocene plateau.

El-Behiry (1995) studied the proposed site of the New-Fayum city. Twenty four compressional (P-wave) seismic refraction lines, with a maximum length of about 330 meters, are carried out covering the area. The results of the study show that the bed rock of the opposite site is classified as follows:

1. South eastern part is highly fractured and porous calcareous mudstone which is of low unconfined compressive strength (UCCS) and low rock quality designation (Low RQD).
2. The western and southern parts represent intermediate zone of consolidated calcareous mudstone and it is characterized by moderate mechanical elastic parameters.
3. Its central and northern parts which are of highly consolidated non-fractured, slightly jointed, calcareous nature are characterized by higher RQD, UCCS and lower clay content.

Consequently the southern eastern, southern- western and northern central parts of the proposite of the new Fayum city may be classified as non eligible, less eligible and preferred for construction, respectively, thereby the housing area should be located at the north part of the site.

Hassan et al. (1997) studied the subsurface structural settings in west of Qarun area. The study area is found to be characterized by the presence of WNW, ENE (Syrian arc), NW (Suez) and NNE (Aqaba) fold and fault trends, a regional reverse fault of NNE (Aqaba) cuts through the whole study area.

Abd El-Meguid et al. (1998) studied the geotechnical characters of middle Eocen east of Nile Valley at El Minia city. The study showed that these rocks have heterogeneous physical and mechanical properties. The

rocks fall within the weak and very weak range of limestone based on their compressive strength values. These rocks have brittle mode of failure. The mechanical properties such compressive strength and shear strength are controlled by the physical and geological properties where they increase with density and dolomite content and decrease with porosity and calcite content. The structure studies indicate presence of major and minor normal faults and fractures trending NW and NE, the most dominate are NW faults.

Senosy et al. (1999) studied the geotechnical properties and clay minerals in El Salam Suburb area north of El Kharaga town and New Valley governorate. The results revealed that the foundation bed is mainly shale (with an average of thickness 15m) that exhibits highly swelling characters. Results also show the abundance of the kaolinite and smectite clay minerals.

Abd El-Aziz and Zahra (2002) studied the tectonics of Qarun area, the major tectonic structures and their trends were determined through the different types of gravity maps. The area is affected by fault lines taken the following five trends, N45°E, N5°E, N85°W, N65°E, and N34°W.

Refaie (2003) studied the structural framework, the geotechnical properties of the foundation bedrocks of Beni Suef El Gedida city. The structural studies indicated four predominant fault trends: NW-SE, NNW-SSE, E-W and NE-SW. The NW-SE major faults control the main drainage lines in the region and consequently constitute one of the main hazards that may affect the city location. The geotechnical studies revealed that Beni Suef El Gedida limestone bedrocks fall within the weak to medium strong range. The mode of failure is almost of brittle type, developing extension, wedge type and single shear fracture.

The present work is focused on the study of the geotechnical and petrological characteristics of late middle Eocene and Quaternary rocks

which are exposed in Wadi EL Nazla-El Roba areas located at the western part of Fayum province.