Summary of the M.Sc. Thesis

"Geological and Sedimentological Studies on the Eocene Rocks, West of the Nile Valley between Abu-Tig and Mallawi, Western Desert, Egypt"

This work deals in detail with the geological features and sedimentological characteristics of the Lower and Middle Eocene rocks exposed in the area between Abu-Tig and Mallawi, Western Desert, Egypt. It gives a clear picture and throws more light on the lithostratigraphic classification, biostratigraphic zonation, petrography and microfacies, main diagenetic processes and depositional environments of the recognized rock units.

Lithostratigraphically, the exposed carbonate rocks range in age from Early Ypresian (Early Eocene) to Lutetian (Middle Eocene). The stratigraphic sequence of the recorded rock units is tabulated as follows from top to base:

Rock units	Lithology	Age
Samalut Formation	Massive, hard limestones crowded with *Nummulites gizehensis* (Forskal)	Lutetian
Minia Formation	White limestones associated with alveolines and orbitolites.	Late Ypresian
Drunka Formation	Burrowed and algal limestones with chert bands and concretions.	Early to Late Ypresian

Biostratigraphically, the Lower and Middle Eocene carbonate sequence in the studied area can be subdivided mainly into one algal zone and three large foraminiferal zones. The algal biozone is represented here by the *Ovulites arabica / Ovulites pyriformis* zone (Early Ypresian) which is confined to the lower unit of the Drunka Formation. The foraminiferal biozones are represented by the following zones from older to younger: *Nummulites planulatus* zone (Late Ypresian, upper unit of the Drunka Formation), *Alveolina oblonga / Orbitolites complanatus* zone (Late Ypresian, Minia Formation) and *Nummulites gizehensis* zone (Lutetian, Samalut Formation). Furthermore, the *Nummulites planulatus* zone is subdivided into three algal subzones. These are (from base to top): *Niloporella subglobosa* algal subzone, *Ovulites elongata* algal subzone and *Acicularia robusta / Ovulites* spp. algal subzone.

Petrographically, each rock unit is subdivided into several microfacies associations on the basis of the carbonate depositional texture, abundance and type of fauna and flora and the binding material. Thirty-six microfacies associations are recognized representing the main depositional facies. The microfacies associations of the Drunka Formation include lime mudstone, recrystallized lime mudstone, bioclastic wackestone, echinoidal wackestone, codiacean algae wackestone, fecal peloid wackestone dasycladacean algae wackestone, nummulitic wackestone, orbitolites wackestone, peloidal wackestone, miliolidae wackestone, bioclastic packstone, codiacean algae packstone, peloidal packstone, fecal peloid packstone echinoidal packstone, dasycladacean algae packstone, nummulitic dasycladacean algae packstone, orbitolites bioclastic packstone, foraminiferal bioclastic packstone, miliolidae packstone, siliceous orbitolites green algae packstone, pelecypoda packstone, fecal peloid grainstone, siliceous oolitic grainstone, codiacean algae grainstone and bryozoa boundstone.

The following microfacies associations were recognized from the rocks of the Minia Formation: bioclastic wackestone, dasycladacean algae wackestone, alveolina bioclastic wackestone, forminiferal wackestone, peloidal packstone, orbitolites bioclastic packstone, dasycladacean algae orbitolites packstone, alveolina dasycladacean algae packstone, alveolinid packstone, orbitolites alveolinid dasycladacean algae grainstone. Five microfacies associations were recorded from the rocks of the Samalut Formation. These are the nummulitic wackestone, discocyclina nummulitic wackestone, nummulitic packstone, bioclastic packstone and bioclastic grainstone.

The most striking diagenetic processes affecting the studied rock units are discussed in detail. These are the cementation, recrystallization and silicification. Five types of carbonate cements are recorded in the studied microfacies associations. Three shallow marine types (micrite, fibrous calcite and isopachous calcite rim cements) and two meteoric water types (granular calcite and syntaxial rim cements).Both particles and matrix are affected by the recrystallization process. Matrix is subjected to aggrading neomorphism. Early recrystallization produces uniform equigranular microspars, while in further stages of aggrading neomorphism, the microspar crystals coalesced with one another to produce single coarser crystal of pseudospar which converts to blocky neomorphic calcite by further recrystalliztion. Skeletal particles are also influenced by the aggrading recrystalliztion (e.g. molluscs, foraminifera, algae and bryozoa). The aggrading neomorphism process affects the rocks of the three recognized rock units. This process is controlled by the presence of freshwater, Mg ions and clay minerals. The general mechanism of this process is depending upon the removal of Mg ions, which can be leached by the fresh meteoric water and absorbed on the surface of the clays and hence causing the enlargement of the high Mg-calcite crystals into coarser low Mg-calcite crystals. Particles represented by algae, foraminifera and echinoids have suffered from degrading recrystallization (micritization). Generally, it is found that the degree of the micritization process of the allochemical constituents of the Minia Formation is heavier than that of the allochemical constituents of the Drunka and Samalut formations. It was found that the boring of organisms is not distinct, but it seems that the particles are replaced by micrite that produced by the disintegration of algal components or that of the matrix.

The silicification process is represented here by the formation of cherts in the rocks of the Drunka Formation and the selective replacement of the limestone components in both the Drunka and Minia formations. Two modes of occurrence of chert are recorded in the rocks of the Drunka Formation, the banded chert and the chert concretions. Some skeletal particles are replaced by silica (e.g. pelecypods, foraminifera and algae). Also the non-skeletal particles are replaced by silica through the silicification process (e.g. fecal peloids and oolites). The matrix, cement and neomorphic spar are also replaced by silica. The silica is represented by cryptocrystalline quartz, microquartz, chalcedonic quartz and granular megaquratz. The source of silica in the present rocks may be the migration of the biogenic silica-rich solutions from the surrounding limestones.

The deduction of the **paleoenvironmental conditions** during which the recognized rock units were deposited is depending upon their lithologic characters, geometry, stratigraphic position, sedimentary structures, facies associations, fossil content and cyclic sequences. Detailed sedimentological analysis reflecting the deposition of the studied rock units in three major carbonate facies:

1. The restricted shelf lagoonal facies:

It is responsible for the deposition of the Drunka Formation. The main characteristics of the Drunka Formation can be summarized as follows:

Geometry: with lensoid shape within the Thebes Formation and rimmed from the north by the Nashfa Formation.

Sedimentary structures: mainly massive to thick-bedded with few ripple marks, thin laminations, wavy bedding, lenticular bedding and highly bioturbated.

Facies: mainly composed of algal, foraminiferal, echinoidal and peloidal wackestones, packstones and grainstones in addition to the lime mudstone and recrystallized lime mudstone.

Fossil abundance: low in the lower unit and higher in the upper unit.

Fossil diversity: low.

Major taxa: green algae, echinoids, nummulites and miliolids.

Depositional textures: lime mudstone, recrystallized lime mudstone, wackestone, packstone, grainstone and boundstone. The packstone texture is the most dominant texture among the previous depositional textures.

2. The alveolina-orbitolites-green algal bank facies:

This facies type builds up the carbonate succession of the Minia Formation in the present area. The main characteristics of the Minia Formation can be summarized as follows:

Geometry: sheet-like geometry.

Sedimentary structures: massive to thick-bedded.

Facies: mainly alveolinid, orbitolites and dasycladacean algae wackestones, packstones and grainstones.

Fossil abundance: high.

Fossil diversity: medium.

Major taxa: alveolines, orbitolites and dasycladacean green algae.

Depositional textures: wackestone, packstone and grainstone. The packstone texture is the most common.

3. Nummulitic carbonate buildup facies:

This facies constructs the Samalut Formation. It is characterized by the following criteria:

Geometry: mound-like.

Sedimentary structures: massive to thick-bedded.

Facies: mainly nummulitic packstones.

Fossil abundance: high.

Fossil diversity: low.

Major taxa: nummulites, discocyclines, bryozoa and red algae.

Depositional textures: wackestone, packstone and grainstone. The most predominant texture is the packstone.