CHAPTER 8

SUMMARY AND CONCLUSIONS

The present work dealt with detailed sedimentological, mineralogical, textural and chemical compositions and aspects of some surface sediments. These sediments are represented with sands, clays and carbonates which are studied from eleven localities scattering at east and west of Cairo-Alexandria desert road.

Furthermore, these investigations were carried out on representative selected surface sediments to determine their environment of deposition, transporting agent and source rock.

In addition to the previous investigations, the present study dealt with studying the possible utilization of some raw materials (carbonate and clay deposits) in building purposes through studying their technological characteristics. Moreover, some natural additives (sand and grog) were used with the studied Egyptian clay (Hagif Formation, locality V) to improve their technological properties.

Lithostratigraphical units

In the present study, five rock units are described lithologically in the field (other rock units in the area under investigation out of the present study) through studying several stratigraphic sections. The studied rock units arranged from the oldest to the youngest as follows: Hagif Formation, Muluk Formation, Qataji Formation, Diba Formation and Stabilized Sand dunes.

Hagif Formation (Middle Miocene) in the present study is divided into two members; Carbonate-Clastic at top and Clastic at base. Lithologically, the Hagif Formation is represented in locality **V** by the Carbonate-Clastic Member, which consists mainly of fossiliferous carbonate deposits intercalated with the argillaceous beds, while at locality **VII** the studied section is composed of the two members; Clastic-Member at base and intercalation of carbonates and argillaceous deposits at top (Carbonate-Clastic Member). Hagif Formation at the studied localities is unconformably overlain by the Qataji Formation.

Carbonate-Clastic Member of the Hagif Formation at the studied locality may be deposited in marine environment, while the Clastic Member may be deposited in fluvial environment.

Muluk Formation (Late Pliocene) at the studied locality is represented by Clayey Member of Abou Khadrah (1973), which consists of clay; greyish green, compact, gypseous, saliferous and unfossiliferous. The Clayey Member may be deposited in marine environment under reducing condition. However, probably this member was deposited in marine environment.

Qataji Formation (Plio-Pleistocene) at the studied localities is composed of buff to dark brown, very hard and oolitic sandy limestone. This formation may be deposited in fluvial environment under semi-arid climate.

Diba Formation (Pleistocene) in the present study is classified into two members; the upper Gravely Member and the lower Sandy Member.

Gravely Member is composed of loose to semiconsolidated gravels of metamorphic and igneous rock fragments, in addition to the quartz and chert pebbles. The occurrence of rock fragments (basement and sedimentary) may be pointed to recycling from the basement source (igneous and metamorphic) or reworking from previously deposited sedimentary rocks.

Gravely Member of the Diba Formation may be deposited from braided streams occurred at low sinuosity and steep slopes of the channel, low threshold of bank erosion (weak banks) with series of cataracts which responsible for the long transport of the heterogeneous gravels which may be either from its highland source area in the Eastern Desert along the Red Sea mountains (Mohamed, 1994) or older sediments which transported by Prenile River.

Sandy Member of the Diba Formation is composed mainly of yellowish to greyish white, loose, fine to medium grained, cross bedded, ill-sorted sands with carbonate streaks and some quartz pebbles. The sedimentological investigations indicated that the sediments of Sandy Member in locality **III** represent levee deposits due to occurrence of the vertical sequence of alternating sandy and muddy layers in addition to presence of rootless. Consequently, Diba Formation in all probability was deposited in fluviatile environment.

Stabilized Sand dunes (Pleistocene) are composed of yellow, medium to coarse grained, loose and ill-sorted sands. These sands were deposited in desert environment by winds.

Sand

Representative sand samples from the Hagif Formation, the Diba Formation and the Stabilized Sand dunes were studied mechanically and mineralogically. The size parameters (Mz, σ_1, SK_I and KG') of Folk and Ward (1957) were calculated. Scatter plotting diagrams are drawn for each pair of these size parameters. The four moments of Friedman (1961& 1967) were calculated and plotted as scatter diagrams. The relationship between the grain size and hydraulic conditions during transportation also were discussed according to Passega and Byramjee (1969). The four discriminant functions of Sahu (1964) are calculated to clarify the environment of deposition.

- Sands of the Stabilized Dunes are very coarse to medium sand sizes, poorly to very poorly, range from fine skewed to coarse skewed and from very platykurtic to leptokurtic classes.
- Sands of the Gravely Member of the Diba Formation are pebbley to medium sand sizes, vary from moderately well sorted to very poorly sorted, range from strongly fine skewed to strongly coarse skewed and range from very platykurtic to leptokurtic classes.
- Sands of the Sandy Member of the Diba Formation are medium and fine sand sizes, poorly sorted, range from fine skewed to strongly coarse skewed, and fall within mesokurtic and leptokurtic classes.
- Sands of the Carbonate Member of the Hagif Formation distinguished by their medium sand size, poorly sorted sand, coarse skewed sand and mesokurtic and leptokurtic classes.

The calculated size parameters have been plotted for the studied sediments against each other to recognize their depositional environments using the boundaries of Friedman (1961&1967) and Moiola (1968) and showed that majority of the examined sands of the studied rock units are plotted the river environment.

Plot of the C-M diagram showed that the majority of the studied sediments probably transported by rolling motion with some minor graded suspension. The discriminant functions of Sahu (1964) indicated that majority of the studied sand samples were deposited in turbidity environment.

Results of light and heavy minerals show that the light fractions are mainly composed of quartz grains and other minerals with percentage about 2% from calcite mica and clay minerals. The absence of feldspars can be attributed to their removal during transportation process because it is physically weaker than quartz grains. The heavy fractions showed relative enrichment of epidotes and amphiboles than pyroxenes in the non-opaque sand fractions.

From the mineralogical studies and according to Hubert (1971) the studied sands of the Diba Formation may be derived from high rank metamorphic (may be derived from uncovered crystalline basement complex in Sudanese-Egyptian borders or equatorial sub-Saharan Africa and transported through the Neonile River) and ash fall rocks (may be derived from volcanic rocks of the Ethiopian Plateaux and transported through the same river). The Stabilized Sand dunes may be derived from the reworked sedimentary rocks. The studied sediments of the Clastic Member of the Hagif Formation may be derived from high rank metamorphic and ash fall source rocks (may be from the Eastern Desert mountains through the Eonile River tributaries which drained on the Red Sea mountains during Miocene period, Said, 1993).

Clay

Representative clay samples representing the Muluk and Hagif Formations were studied texturally, mineralogically and chemically.

Texturally, the studied clay samples fall in well sorted silty clay, fairly sorted clayey silt and in fairly sorted sandy silt categories.

Mineralogically, majority of the studied clay samples of the Hagif Formation is composed mainly of montmorillonite, kaolinite and illite minerals (in decreasing order of abundance), while the studied clay sample of the Muluk Formation is composed of montmorillonite and lesser amount of kaolinite mineral.

Majority of the studied non-clay minerals in the samples were represented by plagioclase and quartz minerals.

There are a good agreement in the results of mineralogical analyses with these obtained from chemical analyses.

In the present study, it can be concluded that the clays of the Carbonate-Clastic Member of the Hagif Formation and Muluk Formation may be deposited in marine environment, while that of the Clastic Member of the Hagif Formation may be deposited in fluviatile environment.

In the experimental work (**part 2**), the fired clay articles of the used montmorillonitic clay without additives are cracked at all firing temperatures (800°C, 850°C and 900°C) due to the high content of montmorillonite mineral and soluble salts. Hence, sand and grog additives were used as non-plastic materials with different percentages (15, 25, 35 & 50 % by weight) with the used clay as an attempt to improve their technological properties.

The optimum physico-mechanical properties were obtained with mixes containing 15% grog fired at 900 °C and 15 % sand fired at 800° C.

Mixes of the used montmorillonitic clay with various percentages of grog additive save the workable water, modify the physical mechanical properties into reasonable ones and have much lower corrosive action on the metals of equipments than caused by the clay/sand mixture.

Finally, addition of grog as well as sand with various percentages led to improve some of technological characteristics (physico-mechanical properties) of the used clay. Moreover, this montmorillonitic clay can be used successfully in cement manufacture.

Carbonate

The studied carbonate samples representing the Carbonate-Clastic Member of the Hagif and Qataji Formations were studied petrographically, mineralogically and chemically.

Petrographically, the studied carbonate samples are divided into two main lithofacies as given below:

- The limestone lithofacies: Classified into four common microfacies types, these are: The lime-mud (recorded in Qataji Fm. and Hagif Fm.), the wackestone (recorded only in Hagif Fm. and subdivided into the algal foraminiferal wackestone sub-microfacies), the packstone (recorded only in Qataji Fm. and subdivided into sandy pisoidal packstone sub-microfacies) and the grainstone (recorded only in Qataji Fm. and subdivided into sandy foraminiferal and algal grainstone sub-microfacies)

- The dolostone lithofacies: Recorded only in the base of the Carbonate-Clastic Member of the Hagif Formation and is composed mainly of fine-grained rhombic dolomite mineral.

Algal foraminiferal wackestone microfacies of the Hagif Formation may be deposited in the shallow marine environment (subtidal zone), while the fine-grained dolostone microfacies of the same formation may be deposited in the intertidal zone.

Mineralogically, many of carbonate rock types could be recognized in the Carbonate-Clastic Member of the Hagif Formation these are: Dolomitic limestone, dolostone, limestone and sandy limestone, while in the Qataji Formation only sandy limestone rock is present.

Chemically, all of the studied carbonate rocks are characterized with presence of calcium oxide as the main oxide and high values of loss on ignition.

In the experimental work (**part 2**), the studied carbonate rocks are dolostone and sandy limestone. The dolostone is used as cubes (5 cm. side length), while sandy limestone rock is used as aggregates (sizes 1, 2 & 3). Some of chemical and physico-mechanical tests were carried out on these cubes and aggregates following ESS and ASTM specifications.

The results of chemical and physico-mechanical properties clarified the following:

1- The studied sandy limestone aggregates fall in limits of Egyptian Standard Specification 1109:1971 and American Standard Specifications C33-90. Consequently these aggregate can be used successfully in concrete in addition to their uses in road works.

2- The studied dolostone cubes generally fall out of the standards specification of building units. Moreover, they may be used as partition units of buildings, but must be protected from water.