CAIRO UINVERSITY

FACULTY OF SCIEINCE

GEOLOGY DEPARTMENT

ENVIRONMENTAL APPLICATIONS OF CLAYS OF QUSEIR FORMATION FROM KHARGA –DAKHLA LAND-STRETCH, WESTERN DESERT, EGYPT

A THESIS SUBMITTED TO FACULTY OF SCIENCE

CAIRO UNIVERSITY

In partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN GEOLOGY

.

By

MOHAMMED SAYED MABROUK ABD EL GAWAAD ATR SHAN

B.SC. (CAIRO UNIVERSITY)

Faculty of Science

Cairo University

2009

APPROVAL SHEET SUBMISSION

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NOTE

The present Thesis is submitted by Mr. Mohammed Sayed Mabrouk Abd El Gawaad Atr Shan, to the Geology Department, Faculty of Science, Cairo University, in partial fulfillment of the requirements for the degree of Master of Science in Geology.
Beside the research work materialized in the present thesis, the candidate has attended and successfully passed the following post-graduate courses for one year:

- **IGNEOUS PETROLOGY**
- **METAMORPHIC PETROLOGY**
- **ROCK FORMING MINERALS**
- **ORE MINERALOGY**
- **ORE DEPOSITS**
- **GEOCHEMISTRY**
- **X-RAY DIFFRACTION**
- **SEDIMENTARY PETROLOGY**
- **ISOTOP GEOLOGY**
- **STATISTICS**
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ACKNOWLEDGEMENTS

I am deeply thankful to ALLAH, by the grace of whom this work was possible.

The author is greatly indebted to Prof. Ahmed M. A. El-Kammar, Professor of Geochemistry, Geology Department, Faculty of Science, Cairo University, for his continuous help, direct supervision, constructive scientific discussions, guidance, and his critically reading of the manuscript and for supporting my work at the field.

The author wishes to express his deepest gratitude to Dr. Ashraf M. O. El Maghraby, Geology Department, Faculty of Science, Cairo University for his encouragement, help, direct supervision, valuable discussion, reviewing the manuscript and for supporting my work at the field.

My thanks are extended to Prof. El Sayed A. A. Youssef, Head of the Geology Department, Cairo University for his encouragement as well as for providing the official facilities.

My thanks are extended to Prof. Mohamed A. M El-Anbaawi for his corporation in the X-ray diffraction analysis. My special thanks are due to Prof. H. Hamouda, head of the Egyptian mineral resources Authority, for allowing us visiting the Area of Abu Tartur for field work. My special thanks are due to Prof. Head of the Nuclear Material Authority for supporting the field work and the chemical analyses. My special thanks to Mr. Hussein (Nuclear Materials Authority) for his accompany in the Kharga town and his corporation in the field, also thanks to geologists Hisham and Mohamed for their help in Abu Tartur Area. Special thanks to my colleagues Mr. Amir Hassan, Mr. Moataz Adel, Mr. Adham Refai and Mr. Omar Moussa, for their continuous encouragement and help during the progress of this work.

Great thanks for my parents who were encouraging and helping me though out my thesis work, I hope Allah bless them.

Warm thank to my wife, for her continuous help and encouragement during the progress of this work.

In addition, I want to thank all the other individuals who are not mentioned here but were of valuable help to me during the last years.

Abstract

The present thesis discusses the different characteristics of the Quseir Formation in the Dakhla-Kharga land-stretch and suggesting their appropriate application in the environment protection; landfill barrier, and as toxic elements adsorbent. The petrographic study revealed that the studied sediments are mainly composed of mudstone and claystone beds intercalated with sandstone, siltstone and shale especially in the Lower and Upper Members. The mineralogical study of both clay and non-clay minerals of the Quseir Formation reveals that quartz and carbonate minerals (dolomite and calcite) are the main non-clay constituents, besides some gypsum and anhydrite as secondary veinlets or streaks, with occasional plagioclase grains. The X-ray diffractograms of the clay mounts indicate the presence of illite, kaolinite, smectite and mixed layer illite-smectite (I-S). The proportions of these minerals vary from one member to the other. Illite and kaolinite are the most abundant in the lower part of the Lower Member with variable proportion of smectite while smectite and kaolinite increase at the upper part of the Lower Member relative to illite. On contrary, illite is the main clay mineral in the Middle Member except its upper part which is characterized by higher quotients of smectite and kaolinite. Finally, kaolinite and smectite are the main clay minerals of the Upper Member with some proportions of illite and mixed layer I-S.

The obtained geochemical results are generally similar to the published data on worldwide claystones. The trace elements content does not represent any risk to the environment, except limited increase in vanadium concentration. However, the geochemical results on the sediments of the Quseir Formation confirm their suitability as soils for cultivation or reclamation. Indeed, these sediments will not introduce any potentially toxic metals to the soil.

The physical properties of the sediments belonging to the Quseir Formation suggest that they have lower values of permeability, less than $1*10^{-7}$ cm/sec, and low values of porosity that may reflect their considerable compactness and high density. Also the obtained values of cation exchange capacity (CEC) are variable through out the Quseir Formation depending on the type

of the clay minerals present. High CEC values, more than 50meq/100g soil, are measured for the Lower and Upper Members that reflect dominance of smectite. While low to medium CEC values are recorded for the Middle Member that reflects the predominance of illitic composition. In addition, marked swelling character has been reported in some samples containing smectite. The values of plasticity are ranging from medium to high. These characteristics support the suitability of the sediments of the Quseir Formation in the application of the environment protection as lining barrier for landfill sites. These sediments are also suitable for cultivation, being free of toxic elements. They have the capability to be used as adsorbent, especially the sediments of the Lower and Upper Members, where the CEC values exceed 50meq/100g soil.

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The great significance of clays and clay materials can be attributed to the wide range of their physical and chemical characteristics. These characteristics made them the most important materials in the petroleum exploration and production, civil engineering, geological and environmental applications and agriculture. However, as far as the author is aware, shales in Egypt have received sufficient attention from the stratigraphical, sedimentological, geochemical and mineralogical points of view but the data on their uses are very immature.

Thick sedimentary succession of shales and clay deposits of different ages, composition and physical properties is exposed along the Kharga - Dakhla landstretch for a distance of more than 250km. This sequence belongs to the Upper Cretaceous-Lower Tertiary time interval and it extends for other several hundred kilometres in Upper Egypt. Although this giant shale succession has a regional distribution, it is not yet evaluated for the different applications. Most attention has been given to the phosphate deposits but not to their hosting clays. Nevertheless, the present study attempts to provide original data on the characterization of some of these Upper Cretaceous shales, namely the Quseir (Variegated Shale) Formation from the Kharga - Dakhla landstretch in the environmental applications. The modern technologies used in the environment protection and mitigation exploit the unique physical and chemical characteristics of clays and shales. The barrier lining, agriculture and ion-sorbent are among the widespread applications in the environment protection.

Study area

The study area extends for several hundred kilometres in the Western Desert from Kharga to Dakhla Oases including Abu Tartur plateau (Fig.1). The inhabitants in the study area depend mainly on the resources of the underground water of the Nubia Sandstone aquifers for

agriculture and municipal uses. The prosperity growth in these Oases is challenged by water crisis and harsh arid climate.

The Kharga Oases lie between latitudes 24^{o} and 26^{o} N, and longitudes 29^{o} and 31^{o} E. They occupy long depression with its longer axis (200 km) extending from north to south. On the other hand, the Dakhla Oases lie between latitudes 25^{o} and 26^{o} N, and longitudes 28^{o} $30^{\backslash}$ and 30^{o} $15^{\backslash}$ E. The distance between Dakhla town and Kharga town is about 200 km. This long landstretch is limited from the north by step escarpment (Fig. 2).

The Kharga - Dakhla Oases represent the greatest depression in the Western Desert of Egypt and according to the geomorphologic classification, it can be considered as fifth order mega depression (Embabi, 2004). The length and breadth of such depression exceeds 100 km and the depth is more than 100 m. The most conspicuous geomorphologic features in the study area are the bounding escarpments, floor depressions, outlier hills and sand dunes

In the Kharga Oases, the escarpment is made of sandstone-shale-limestone sequence ranging in age from Upper Cretaceous to Lower Eocene and forming three slope sequences. According to Embabi (2004), the depression floor represents a pediplain but it is characterized by the presence of three forms, namely; playa flats, hills of various origins, and sand dunes. The folded hills of the depression are less prominent than other hills in the depression and they are composed of small anticlines and synclines plunging in one or two directions. These hills rise between 45 m and 100 m above the surroundings ground surface. Another group of hills of different origin is the granite inliers which project from the Nubia Formation and are concentrated in the extreme south of the depression. A third group of hills is outlier hills; which concentrate in the northern part of the depression. In the Kharga - Dakhla depression, barchan is the commonest dune type and it is organized in dune belts that extend from the north to the south for more than 200 km in the eastern, central and western parts (Embabi, 2004).

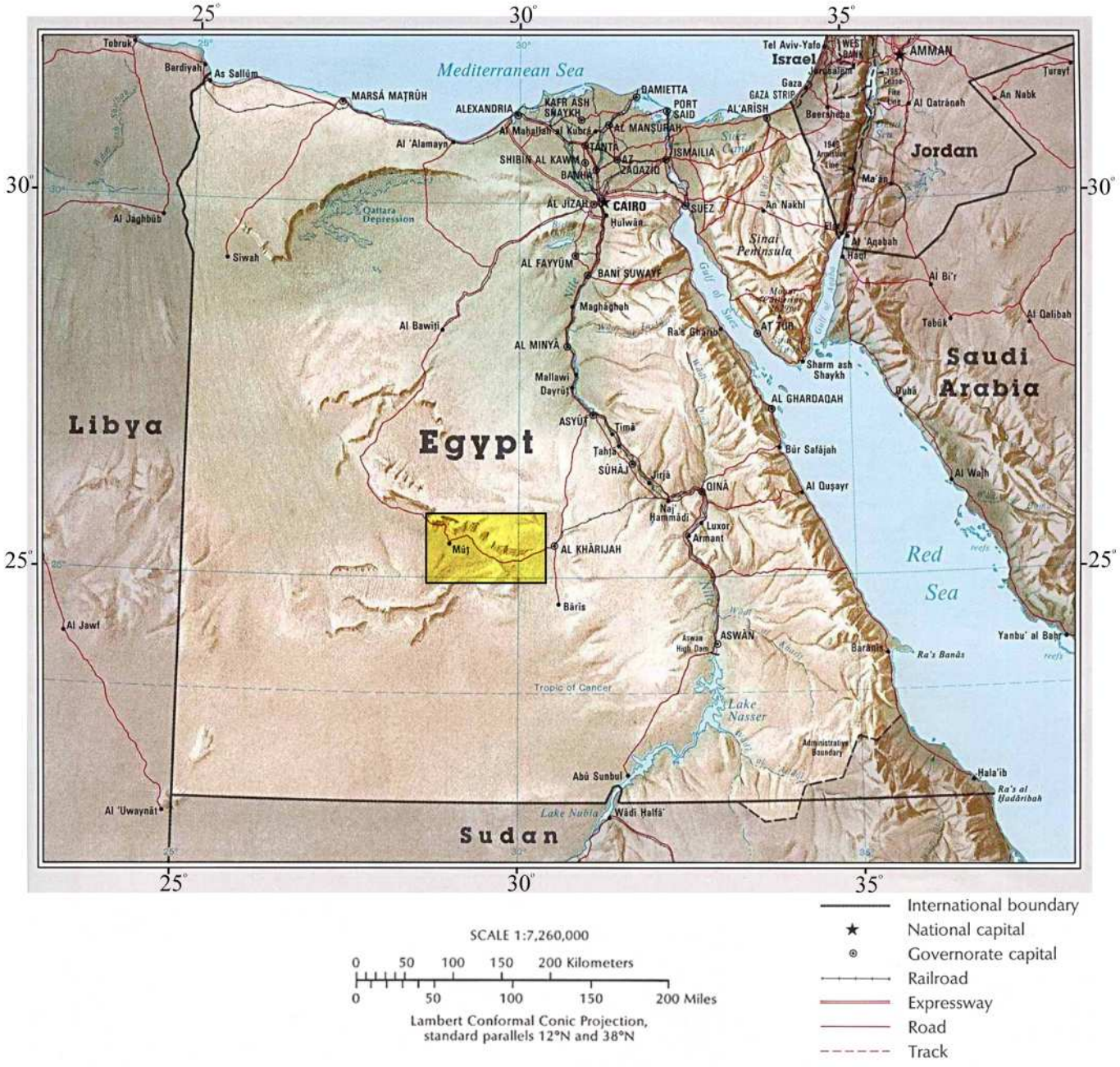

Fig.1: Location map of the study area