Geologic Origin and Physiochemical Characterizations of Tertiary Bentonitic Clays in the North Western Desert of Egypt for Some Industrial Applications

By

Mohamed Ali Mohamed Ali Agha

A Dissertation

Submitted to Fayoum University

for the degree of

Doctor of Philosophy

in

Geology

Department of Geology

Faculty of Science

Fayoum University

2014

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(M.Sc. in Mineralogy, Petrology and Ore deposits, Fayoum University, 2007)

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Acknowledgments

I owe the accomplishment of this study to many people. First and foremost, I wish to express my deepest gratefulness and heartfelt thanks to Professor **Ray E. Ferrell** for his support, encouragement, fruitful suggestions, fertile discussion, and reviewing the dissertation. It was an honor to work with him.

Special appreciations have to be directed to Professor **Ali Abdel Motelib** for suggesting the point of study, field work, and supervision. I am greatly indebted to Dr. **Mohamed Said Abu El Ghar** and Dr. **Sobhi Helal** for their wise supervision, assistance in the fieldwork and provided great support during the study.

The investigation was funded by **the Egyptian Cultural Affairs and Missions Sector**, as a joint supervision program. The author expresses his sincere greetings to Professor **Ahmed G. Shedeed** and Professor **Nabil Yassen** for making his work possible in Egypt. I should extend my thanks to Professor **Mohamed El Rabeaai,** Dr. **Amr Abel Nabi,** and Dr. **Mosaa Negm** for productive discussions.

The LSU Department of Geology & Geophysics provided support for the study. I am extremely thankful to Professor **George F. Hart** for providing appropriate statistical methods. The author expresses his sincere thanks to **Wanda LeBlanc** for her indescribable and skillful assistance during all phases of laboratory work at Louisiana State University. Many thanks for Dr. **Xiagong Xie** (SEM Lab.), Professor **Murad Abu-Farsakh** (Louisiana Transportation Research Center), Professor **Andrew K. Wojtanowicz, Fenelon Nunes** (Mud Drilling Lab.), **Andy Harrison,** and **Nchekwube Mbmalu** (former LSU graduate students) for their kind help.

Above all, many, countless and lots of thanks to my parents, my wonderful wife **"Shimaa"** and **my lovely children** for their never-ending encouragement and patience!

I dedicate this work

To

My Parents

My wife

My Children: Ali, Omar and Yussuf

Curriculum Vitae

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Professional Profile

Eager to teach college students and carry out researches about applied mineralogy, using a unique combination of twelve years' education experience coupled with mineralogy and petrology background.

- Hold Master's Degree in Mineralogy, Petrology and Ore deposits.
- Experienced in Clay Mineralogy and petrogenesis of clays.

Scientific Qualifications

PhD student, 2009-untill now: I have been awarded a full joint scholarship sponsored by the Egyptian Government for two years (Oct. 2009- Oct. 2011) to conduct PhD research studies connected to my PhD registered at the Fayoum University. These researches are carried out at Louisiana State University (LSU), Baton Rouge, Louisiana, USA under the supervision of Prof. Dr. Ray E. Ferrell.

M.Sc., 2003-2007: Thesis entitled **"Geology and Geochemistry of Gabal Agib Ring Complex, South Eastern Desert, Egypt"** Department of Geology, Faculty of Science, Fayoum University, Fayoum, Egypt.

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B.Sc., 1995-1999: Geology and Chemistry; **Grade** "very good", **Rank** "1st", Department of Geology, Faculty of Science, Cairo University, Fayoum Branch, Fayoum, Egypt.

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Training Sessions

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- Teaching Assistant, 2008.
- Quality Standards in the Education Process, 2007.
- Use of Technology in Teaching, 2006.
- How to Write Scientific Researches, 2006.
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- Superlative Assistant Lecturer Award, Cairo University, 2009.

Computer Skills

- **Software: Clays Software** (Clay++, MacDiff); Geochemical software (Newpet 2.0, Minpet); **IBM** Software (Microsoft Windows® and DOS, Microsoft Word, Microsoft Excel, Microsoft Power Point)
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Employment

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Publications from the Thesis

- **Agha, M.A.**, Ferrell, R. E., Hart, G.F. (2012): Mineralogy of Egyptian Bentonitic Clays I: Discriminant Function Analysis. *Clays and Clay Minerals*, **60**, 387-404.
- **Agha, M.A.**, Ferrell, R.E., Hart, G.F., Abu EL Ghar, M.S., and Abdel-Motelib, A. (2013) Mineralogy of Egyptian bentonitic clays II; Geologic Origin. *Clays and Clay Minerals*, **61**, 551-565.

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ABSTRACT

Sixty two side-by-side duplicates (124 total) of Paleogene and Neogene bentonitic clays were collected from 12 quarries in the North Western Desert of Egypt. Thicknesses of the bentonitic clays varied between 1m and 20m. The mineralogy, cation exchange capacity, origin, and physical properties were studied.

A discriminant function analysis (DFA) of quantitative mineralogical data provided an objective procedure for grouping the samples at three distinctly recognizable, but partially overlapping, levels of classification. These levels were province or geographic region, geologic age, and quarry. DFA was successful in identifying statistically significant differences amongst the groups.

Reconstructing the origin of bentonitic clays is a challenging and rather complicated undertaking, but the use of certain predictor clay minerals is provided an innovative, excellent method to simplify this process. The abundance changes of five X-ray diffraction (XRD) predictor minerals was used to determine the relative contributions of weathering and parent-rock changes to the origin of clay minerals in Egyptian bentonitic clays. The minerals in the Egyptian bentonitic clays formed as weathering products of basic and/or acidic parent rocks and have been transported by north-flowing streams and rivers to the sites of accumulation under variable climate regimes.

A multiple sample AgTU ion exchange method was applied to the Egyptian bentonitic clays utilizing 0.15 and 0.3 g sample weights to characterize the exchange properties (AgTU-CEC, TEB, ECEC, Na, Ca, Mg, K, and Si). The method afforded a measure of sample repeatability and the ability to assess contributions from soluble

minerals. Variability of cation exchange capacities could be used to supplement geologic history interpretations or serve as a tool to guide industrial exploitation. Cation exchange fingerprints provided clues to the pore fluid compositions in the environment of sedimentation. The presence of halite, calcite, and bischofite contributed to the overall sample fingerprint. Correlation analysis produced equations relating the independent XRD mineral variables to each dependent cation exchange variable (AgTU, ExchK, ExchNa, ExchCa, and ExchMg). Mineralogically calculated CECs for the Egyptian bentonitic clays could provide a predictive tool to estimate exchange cation contents without actual measurement.

These samples have a good potential for foundry sand and drilling mud applications as suggested by selected physical property tests. The specific surface area was greatly influenced by CEC, Exch Mg, expandable minerals, and finely crystalline kaolinite. Swelling index of raw samples showed poor relationships with mineralogy and exchangeable cations. After Na-activations, the relationships were more significant particularly with the grade of the samples. Some of the Egyptian bentonitic clays showed high compressive strengths and rheological properties that satisfied the international standards for their use.