

**Ain Shams University
Faculty of Science
Geology Department**



Geology, Petrology and Radioactive Potentiality of Um Bogma Formation in the Area West of Wadi El-Nasab, Southwestern Sinai, Egypt

By

Yasmeen Gamal Ahmed Abdel-Maksoud

B. Sc. in Geology (2013), Faculty of Science, Ain Shams University

A thesis submitted to

**The Department of Geology, Faculty of Science, Ain Shams University
In partial fulfillment of the requirements of the degree of Master of
Science (Geology)**

Supervised by

Prof. Dr. Mohamed M. Abu-zeid
Professor of Mineralogy and Sedimentary
Petrology, Faculty of Science, Ain Shams
University

Prof. Dr. Ibrahim E. El Aassy
Professor of Uranium Geology,
Nuclear Materials Authority

Prof. Dr. Ashraf R. Baghdady
Professor of Sedimentary Petrology,
Faculty of Science, Ain Shams University

Cairo (2018)

NOTE

The present thesis is submitted to the Geology Department, Faculty of Science, Ain Shams University in partial fulfillment of the requirements of the degree of Master in Science in Geology.

Beside the research work materialized in this thesis, the candidate has successfully passed the final examinations of post-graduate courses covering the following topics:

1. Field Geology.
2. Geostatistics.
3. Sedimentary Petrology.
4. Sedimentation.
5. Advanced Mineralogy.
6. Geochemistry.
7. Igneous Petrology.
8. Metamorphic Petrology.
9. Advanced Crystallography.
10. Ore Petrology.
11. Lab Techniques.
12. English Language.

Head of Geology Department

Prof. Dr. Ali Farag Sayed

.....

Dedication

To

My Parents

My Husband Kareem

&

My Lovely Daughter Farida

ACKNOWLEDGEMENTS

First of all, praise is due to almighty ALLAH for his compassion and mercifulness that allowed me to finish this work,

The author would like to express her deep appreciation to the Geology Department, Faculty of Science, Ain Shams University and the Nuclear Materials Authority (NMA) for providing facilities during the progress of this research work. Also, thanks are due to the Sinai Manganese Company for the accomodation and generous hospitality during the field work,

I am greatly indebted and deeply grateful to the supervisors of this thesis:

Prof. Mohamed M. Abu-zeid (Geology Department, Faculty of Science, Ain Shams University), Prof. Ibrahim E. El Aassy (Nuclear Materials Authority, NMA) and Prof. Ashraf R. Baghdady (Geology Department, Faculty of Science, Ain Shams University). Their immense knowledge, close supervision, sincere guidance, fruitful discussions and continuous support were essential to accomplish this research work,

My gratitude goes also to the respected staff at the Nuclear Materials Authority Prof. Gehan A. Aly, Ass. Prof. Eman M. Ibrahim, Dr. Marwa M. Abdel Azeem and Amany R. A. Saied. Special gratitude is expressed to Dr. Ahmed M. A. Al-Anweh, Dr. Ayman K. El-Safy, Dr. Samia El Wakil and Ass. Lec. Mohamed M. Abdel Fattah for their sincere help.

I am deeply grateful to Allah who made my husband Kareem M. Salama and my lovely daughter Farida the main part of my life. Their understanding, sincere help and continuous encouragement were essential for the accomplishment of this thesis which represents one of my life goals. I would like to express my hearty love and deepest gratitude to my father and my mother for their unlimited patience and sympathetic feelings and care during the progress of this research work. I would like to express my deep appreciation to all my friends who were always supportive.

Finally, I would like to say

“ If it were not for you, I would not have been here”

ABSTRACT

The exposed rocks in Talet Seleim area west of Wadi El-Nasab are represented by the Precambrian Basement Complex overlain by a succession of the Lower Carboniferous Um Bogma Formation and the unconformably overlying Abu Thora Formation. Extensive field and laboratory studies on the Um Bogma Formation indicated that it consists of a lower siltstone-dolostone member, a middle siltstone-mudstone-dolostone member and an upper dolostone member. These rock units have mainly unconformable relationships and show marked lateral variations in thickness and minor changes in lithology. The rocks display several primary sedimentary structures the most common of which are bedding, lamination and biogenic features. Also, the succession is variably affected by faulting, jointing and small-scale folding and contains gypsum veins and clastic dykes.

The argillaceous rocks in Um Bogma Formation are slightly to highly calcareous and ferruginous. They are texturally classified as siltstone, sandy siltstone, mudstone and sandy mudstone. Their clay fractions consist of kaolinite and minor proportions of illite and montmorillonite-illite. The nonclay mineral assemblage is made up of non-radioactive, radioactive and REEs- and heavy metals-bearing minerals. It contains thorite, uranothorite, fergusonite, allanite, cerite, ferricorondite, chalcophanite, cassiterite, brass (Cu, Ni, Zn) and REEs concentrates. These minerals exist in a variety of forms, habits and modes of occurrence indicative of primary and secondary as well as allogenic and authigenic origin. On the other hand, the carbonate rocks in the lower two members of Um Bogma Formation and those constituting its upper member are classified as dolosparite (dolomitized crystalline carbonate) and dolomitized intra-biosparite (dolomitized wackestone). These carbonates

consist of dolomite and lesser proportions of calcite. Dolomite crystals are micro-to macrocrystalline and of two types: idiotopic and xenotopic. The noncarbonate fractions consist of a large number of minerals including thorite, uranophane, zircon, Ni concentrates, gold and silver.

The argillaceous rocks, especially those of the middle member, are markedly enriched in Al_2O_3 , Fe_2O_3 and MnO in addition to a large number of the trace and rare earth elements (mainly LREEs) and heavy metals. The majority of these elements are concentrated in the heavy mineral fractions. Their moderate to strong positive correlations indicate genetic relationships. It is most likely that they were concentrated during weathering and diagenesis. The rocks showed moderate negative Ce and Eu anomalies when normalized to chondrites. This indicates the prevalence of reducing conditions during their deposition and / or diagenesis. Applying several discrimination diagrams revealed that the detrital components of the rocks were derived from continental source rocks having intermediate chemical composition or from mixed felsic and basic rocks. Evidently, these rocks were subjected to moderate to strong weathering under tropical conditions.

The argillaceous rocks in Um Bogma Formation, especially those of its middle member, have much higher radioactivity than that of carbonates. Also, the rocks in the eastern part of Talet Seleim area are more radioactive than those in its western part. Evidently, the majority of Um Bogma rocks were subjected to continuous and contrasting uranium mobilization processes that resulted in its addition in rocks of the middle member and a state of equilibrium for each of the lower and upper members. Assessing the time of the last uranium migration in the rocks revealed that it ranged between 20.32 and 322.5 Ka for rocks of the middle member and is 97.59 Ka for those of the upper member.

Abstract

Diagenetic compaction, cementation, alteration, replacement and dissolution greatly modified the original textural and, especially, compositional characteristics of Um Bogma rocks. The first two processes were more profound in the argillaceous rocks whereas the other three affected mainly the carbonates. Dolomitization of the original limestones occurred during both the mesogenetic phase (by the action connate waters) and epigenetic phase (in the zone of mixing of marine waters and underground freshwaters).

CONTENTS

Page No.

List of Figures	Iv
List of Tables	x

CHAPTER ONE

Introduction

1.1. Sinai.....	1
1.1.1. Geologic setting.....	3
1.1.2. Lithostratigraphy.....	4
1.2. Southwestern Sinai.....	4
1.2.1. Geologic setting.....	4
1.2.2. Paleozoic lithostratigraphy.....	5
1.2.3. The mineralizations.....	11
1.2.3.1. Radioactive mineralizations	12
1.2.3.2. Non-radioactive mineralizations.....	15
1.3. Objectives of the study.....	18

CHAPTER TWO

Materials and Methods of Study

2.1. Materials and Field Work	20
2.2. Laboratory Methods	20
2.2.1. Acid treatment.....	20
2.2.2. Grain-size analyses.....	20
2.2.3. Microscopic examination.....	21
2.2.4. Heavy mineral examination.....	21
2.2.5. X-Ray diffraction analysis.....	21
2.2.6. Chemical analyses.....	22
2.2.7. The loss on ignition.....	22
2.2.8. Radiometric measurements.....	23

CHAPTER THREE

Geology and Lithostratigraphy

3.1. Geology.....	24
3.1.1. Distribution of rock units.....	24
3.1.2. Structures.....	26
(a) Primary structures.....	26
(b) Secondary structures.....	26

3.2. Lithostratigraphy.....	29
3.2.1. Description of the stratigraphic sections.....	29
3.2.2. Lithostratigraphic correlation.....	42

CHAPTER FOUR

Petrography and Mineralogy

4.1. The Lower Member.....	44
4.1.1. Petrography.....	44
4.1.1.1. Carbonate content and grain- size distribution.....	44
4.1.1.2. Microscopic petrography.....	46
4.1.2. Mineralogy.....	49
4.1.2.1. Bulk and clay mineral composition.....	49
4.1.2.2. Heavy mineral composition.....	52
(i) Radioactive minerals.....	52
(ii) REEs- and base metals-bearing minerals.....	52
(iii) Non- radioactive minerals.....	52
4.2. The Middle Member.....	54
4.2.1. Petrography.....	54
4.2.1.1. Carbonate content and grain- size distribution.....	54
4.2.1.2. Microscopic petrography.....	54
4.2.2. Mineralogy.....	60
4.2.2.1. Bulk and clay mineral composition.....	60
4.2.2.2. Heavy mineral composition.....	66
(i) Radioactive minerals.....	66
(ii) The REEs- and base metals-bearing minerals.....	67
(iii) Non- radioactive minerals.....	70
4.3. The Upper Member.....	73
4.3.1. Petrography.....	73
4.3.1.1. Carbonate content.....	73
4.3.1.2. Microscope petrography.....	73
4.3.2. Mineralogy.....	76
4.3.2.1. Bulk mineral composition.....	76
4.3.2.2. Heavy mineral composition.....	76
(i) Radioactive minerals.....	76
(ii) The REEs- and base metals-bearing minerals.....	77
(iii) Non- radioactive minerals.....	79

CHAPTER FIVE

Geochemistry

5.1. The Major Elements.....	82
Geochemical classification of the rocks.....	84
5.2. The Trace Elements.....	87
Geochemistry of the trace elements.....	89
5.3. The Rare Earth Elements.	92
Geochemistry of the rare earth elements.....	94

CHAPTER SIX

Radioactivity

6.1. Distribution of Radioelements	97
6.2. Uranium migration	99
6.2.1. Criteria of migration.....	99
6.2.2. Type of uranium migration.....	102
6.2.3. Time of uranium migration.....	103

CHAPTER SEVEN

Summary and Conclusions	107
--------------------------------	-----

References.....	113
Appendix.....	125
Arabic Summary.....	1