

**STRATIGRAPHIC STUDIES ON THE EXPOSED EOCENE
ROCKS AT BIR GINDALY-GEBEL EL HAI AREA
EASTERN DESERT, EGYPT**

By

MAGDY OMAR MEDANY

B.Sc. (Ain Shams University)

552.5
M.O.



**A Thesis Submitted in Partial Fulfilment of
the Requirements for the Degree of Master of Science
(In Geology)**



37340

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

(1991)

Handwritten signatures and initials.

N O T E

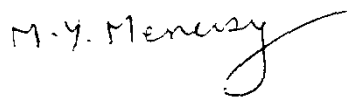
The present thesis is submitted to the Faculty of Science, Ain Shams University in partial fulfillment for the requirements of the degree of Master of Science in Geology.

Besides the research work materialized in this thesis, the candidate has attended ten one-semester, post-graduate courses in the School year 1985/1986 in the following topics:

- 1- Lithostratigraphy
- 2- Biostratigraphy
- 3- Paleoecology
- 4- Micropaleontology
- 5- Mapping and Field Geology
- 6- Geostatistics.
- 7- Advanced Structural Geology
- 8- Geotectonics
- 9- Sedimentary Petrology
- 10- Sedimentation

He successfully passed the final examinations of these courses in fulfillment of the language requirement of the degree, he also passed the final examination of a course in the English language.

Prof. Dr.



Chairman of the Department
of Geology



ACKNOWLEDGEMENTS

I am indebted to Prof. Dr. Hussein Lotfy ABBAS, Professor of Stratigraphy, Ain Shams University for supervising the thesis as well as reviewing the manuscript and his helpful discussions. I am also indebted to Dr. Fawzy H. HAMZA, Assistant Professor of Geology, Ain Shams University for proposing the point of research, supervising the thesis as well as the field and office work.

I am indebted to Prof. Dr. Amin STROUGO, Professor of Stratigraphy, Ain Shams University for his honest help in the field and assistance in the study of the stratigraphy of the study area.

I would like to thank Mr. Ali ABD ALLAH, Lecturer Assistant, Ain Shams University for his honest help in the field.

I am thankful to my colleagues Hesham Abd El Maksoud, Ahmed Ali, Abdel Mohsen and Osman for helping me during this work.

A B S T R A C T

The observatory and El-Qurn Formations (Middle Eocene) have a wide geographic extension in Helwan-Maadi-Qattamiya area. Allover the area they attain considerable thickness (177.2 m), composed of different varieties of limestones and outcrop in surrounds of one of the major complexes of cement industry in Egypt. The microfacies types of the Observatory Formation are mudstone, foraminiferal wackestone, foraminiferal grainstone and cherty dolomitic foraminiferal wackestone while El Qurn Formation includes foraminiferal Wackestone, silty wackestone and foraminiferal grainstone.

The limestones of the Observatory Formation, after stripping of the thin dolomitic beds, can be exploited for manufacturing the white cement. Other raw materials for this type of cement are kaoline and white sand (as corrective material). Kaoline quarries are 200 km to the east, at Abu El-Darag, and the white sand is available from El-Maadi Quarries to the northwest of the study area.

Geochemically, the Observatory limestones are high grade as the carbonate content is 95% with very low content of silicon oxide, aluminium oxide and iron oxide. Among the colouring elements, only the iron oxide is recorded with average content of 0.2%. These limestones are soft and have a high whiteness degree (80-85%), low

dense, highly porous, low humidity (less than 1%) and low compressive strength.

The suggested proportions of the raw mix for producing white cement are 82.44% limestone, 8.4% kaoline and 9.16% white sand.

The carbonate rocks of El-Qurn Formation have the qualifications for the production of the ordinary portland cement, especially the soft marly limestone beds in its lower part. It will require adding argillaceous material and sand, as corrective, from the upper units of the Eocene sequence in the area, i.e. Wadi Hof and El-Angabia Formations.

In these limestones, the average carbonte content is about 90%, the silicon oxide 5%, the aluminium moxide 1.41% and the iron oxide is 0.61%. Besides, they are soft, less dense, highly porous with low compressive strength.

The suggested proportions of the raw mix for producing ordinary portland cement are 77.52% limestone, 21.27% clay and 1.21% sand for the observatory formation and 82.5% limestone, 16.5% clay and 1% sand for El-Qurn Formation.

C O N T E N T S

	Page
CHAPTER I: INTRODUCTION	1
A- Location and Accessibility	1
B- Aim of study	1
C- Methods and techniques	1
D- General structure	4
E- Geomorphology	4
CHAPTER II: STRATIGRAPHY	6
Previous work	6
Measured stratigraphic sections	16
1- Measured stratigraphic section of Gebel Abu Shama	16
2- Measured stratigraphic section of Gebel Sid El Naam	22
3- Measured stratigraphic section of Gebel El Hai	29
CHAPTER III: MICROFACIES AND PALEOENVIRONMENT	37
Introduction	37
Thin section study	37
1- The microfacies study of the Observatory Formation at Gebel El Hai	40
I- Cement or/and matrix	40
a- Micrite with some neomorphic sparite	40
b- Neomorphic sparite with some micrite.....	40
c- Orthosparite cement	40
d- Cherty dolomitic micrtite	40
II- Skeletal constituents	43
a- Echinoid fragments	43
b- Small Formas	43
c- Large Formas	43
d- Bryozoa	43
e- Algae	45
f- Corals	45
g- Mollusca	45
h- Ostracoda	45
III- Non skeletal grains	45
a- Pellets	45
b- Interacclasts.....	47
IV- Terrigenous materials	47
Microfacies types and depositional environment of the Observatory Formation	47
1- Mudstone	47
2- Foraminiferal wackestone	47
3- Foraminiferal grainstone	49
4- Cherty dolomitic foraminiferal wackestone	49
2- Microfacies study of El Qurn Formation	55
I- Cement or/and matrix	55
1- Neomorphic sparite with micrite	55
2- Orthosparite cement	55
II- Skeletal constituents	55
a- Echinoid fragments	55
b- Small Formas	55

	Page
c- Large Forams	55
d- Bryozoa	58
e- Algae	58
f- Mollusca	58
g- Ostracoda	58
III- Non skeletal grains	61
- Pellets	61
IV- Terrestrial materials	61
Microfacies types and depositional environment of El Qurn Formation	61
1- Foraminiferal wackestone	61
2- Silty mudstone	61
3- Grainstone	62
CHAPTER IV: GEOCHEMISTRY AND ECONOMIC IMPORTANCE OF THE STUDIED ROCKS	64
Raw materials for cement industry	64
- Definition	64
- Stages of clinker manufacture	64
- Portland cement clinker: chemical composition	64
- Raw materials	66
- Correctives	67
- Additives	67
1- Check-list for potential cement raw material	68
- Minor elements and their influence	68
2- Physical characteristics	70
a- Density and porosity	70
b- Water absorption	71
c- Rock strength	71
d- Rock hardness	71
Evaluation of the studied rocks as potential cement raw material.	72
I- Gebel Abu Shama	72
II- Gebel Sid El-Naam	78
III- Gebel El-Hai	84
CHAPTER V: ECONOMIC EVALUATION	90
CHAPTER VI: SUMMARY AND CONCLUSIONS	99
CHAPTER VII: REFERENCES	103
ARABIC SUMMARY AND CONCLUSIONS	

LIST OF FIGURES

<u>Fig. No.</u>		<u>Page</u>
1	Location map of the study area	2
2	Map showing the locality names in the study area	14
3	Geologic map of the study area from MOUSTAFA and ABD-ALLAH (1991)	15
4	Stratigraphic section of Gebel Abu Shama (Bir Gindaly area)	17
5	Showing the topographic bench which separates the Observatory Formation from the overlying Qurn Formation at Gebel Abu Shama	19
6	Stratigraphic section of Gebel Sid El Naam (Bir Gindaly area)	23
7	Patches from cherty dolomitic limestone ledge with mottled distribution at Gebel Sid El Naam (2nd ledge)	24
8	Cherty dolomitic limestone ledge overlain by a small topographic bench which separates the Upper Building Stone Member from the overlying Giushi Member at Gebel Sid El Naam	24
9	Bioturbation in the Giushi Member at Gebel Sid El Naam	25
10	Lenticular sandwiches from chert nodules in a dolomitic ledge (marker bed) in the Observatory Formation at Gebel Sid El Naam	25
11	Stratigraphic section of Gebel El-Hai (Gebel El-Hai) area	30
12	Caverneous limestone at the base of the Observatory Formation at Gebel El-Hai	34
13	Correlation of the measured stratigraphic sections	36
14	Standard Microfacies Types 1-24 and depositional limestone types (After FLUGEL, E., 1982)	38
15	Facies scheme after WILSON (1975). Sequence of the standard microfacies types	39
16	Mudstone with well distributed silt size pellets in the lower part of the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 58	41
17	Foraminiferal wackestone. The matrix is mainly micritic with patches from neomorphic sparite in the upper part of the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 58	41
18	Large crystals from orthosparite cement with sharp boundaries with the allochems in the uppermost part of the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 35	42
19	Cherty dolomitic wackestone showing rhombohedral crystals from dolomite with chert grains in the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 35	42

<u>Fig. No.</u>		<u>Page</u>
20	Axial section of nummulites in micrite matrix with patches from neomorphic sparite in the middle part of the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 35	44
21	Bryozoa and algae in (grainstone) cemented by orthosparite cement in the lowermost part of the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 35	44
22	Coral fragments in (Foraminiferal grainstone) in the lowermost part of the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 35	46
23	Molluscan shell fragment (Gastropod) in micrite matrix with patches from micrite in the middle part of the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 35	46
24	Molluscan shell fragment in micrite matrix (mudstone) in the lower part of the Giushi Member at Gebel El-Hai. Ordinary light X 35	48
25	Oblique section of nummulites in micrite (mudstone) in the lower part of the Giushi Member at Gebel El-Hai. Ordinary light X 35	48
26	(Foraminiferal wackestone). Tangential section in Nummulites embedded in a lime mud with patches from neomorphic sparite which contains comminuted fossil debris. Ordinary light X 35	50
27	(Foraminiferal wackestone). Large forams (<i>Fabularia</i>) embedded in micrite matrix with few patches from neomorphic sparite at Gebel El-Hai. Ordinary light X 35	50
28	Axial section of Nummulites embedded in micrite matrix with few patches from neomorphic sparite (Foraminiferal wackestone) in the Giushi Member at Gebel El-Hai. Ordinary light X 35	51
29	Axial section of Nummulites embedded in micrite matrix and fossil debris in the Giushi Member at Gebel El-Hai. Ordinary light X 35	51
30	Large forams (<i>Fabularia</i>) in Foraminiferal grainstone cemented by orthosparite cement in the lower part of the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 35	52
31	Foraminiferal and algae cemented by orthosparite cement in Foraminiferal grainstone in the lower part of the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 35	52
32	Large Forams (<i>Fabularia</i>) cemented by orthosparite cement (Foraminiferal grainstone) in the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 35	53
33	Foraminifera embedded in orthosparite cement (Foraminiferal grainstone) at Gebel El-Hai. Ordinary light X 35	53

<u>Fig. No.</u>		<u>Page</u>
34	Algae, large forams and pelecypod shell fragments cemented by orthosparite cement in the lower part of the Upper Building Stone Member at Gebel El-Hai. Ordinary light X 35	54
35	Large forams and few interclasts embedded in rhombohedral dolomite, chert grains, neomorphic sparite and some micrite matrix (cherty dolomitic foraminiferal wackestone) in the lower part of Gebel El-Hai. Ordinary light X 58	54
36	Neomorphic sparite with micrite matrix in the lower part of El Qurn Formation at Gebel Sid El Naam. Ordinary light X 58	56
37	Foraminifera cemented by orthosparite cement of large calcite crystals with sharp boundaries with the allochems (Foraminiferal grainstone) in El Qurn Formation at Gebel Sid El Naam. Ordinary light X 35	56
38	Echinoid spine embedded in lime mud and fossil debris at the base of El Qurn Formation at Gebel Sid El Naam. Ordinary light X 58	57
39	Oblique section in nummulites embedded in lime mud at Gebel Sid El Naam. Ordinary light X 35	57
40	Foraminiferal wackestone in neomorphic sparite and micrite matrix at Gebel Sid El Naam. Ordinary light X 35	59
41	Bryozoa fragments embedded in lime mud, neomorphic sparite and fossil debris in El Qurn Formation at Gebel Sid El Naam. Ordinary light X 35	59
42	Algae embedded in neomorphic sparite and micrite matrix with fossil debris (Foraminiferal wackestone) in El Qurn Formation at Gebel Sid El Naam. Ordinary light X 35	60
43	Molluscan shell fragments embedded in lime mud and neomorphic sparite (Foraminiferal wackestone) in the middle part of El Qurn Formation at Gebel Sid El Naam. Ordinary light X 35	60
44	Classification of clay lime carbonate mixtures, top petrographic classification, bottom classification based on commercial use (After BARTH, CORRENS and ESKOLA, 1939)	66
45	Quantitative chemical analysis of the collected rock samples from Gebel Abu Shama as it was carried by the aid of X.R.F.	73
46	Quantitative chemical analysis of the collected rock samples from Gebel Sid El-Naam as it was carried by the aid of X.R.F.	79
47	Quantitative chemical analysis of the collected rock samples from Gebel El-Hai as it was carried by the aid of X.R.F.	85

LIST OF TABLES

<u>Table No.</u>		<u>Page</u>
1	Stratigraphic subdivisions of the Eocene section in Nasuri-Anqabiya area (SHUKRI and AKMAL, 1953)	6
2	Stratigraphic classifications of the Eocene sequence in Gebel Mokattam (SAID and MARTIN, 1964)	10
3a	Suggested correlation between Gebel Mokattam and Helwan stratigraphic sequences by STROUGO (1985a)	11
3b	Suggested correlation between local chronostratigraphic units and west European stages based on macro foraminiferal assemblages	12
4	Showing the microfacies analysis of the rock samples from the Observatory Formation at Gebel El-Hai and El Qurn Formation at Gebel Sid El Naam.	63
5	Average density and porosity values for the main raw material	70
6	Average compressive strength values for the main raw materials	71
7	The average compiled chemical analysis of the Upper Building Stone Member	74
8	The average compiled chemical analysis of the Giushi Member at Gebel Abu Shama	74
9	The average compiled chemical analysis of the Observatory Formation at Gebel Abu Shama	74
10	The average compiled chemical analysis of the limestone beds of El Qurn Formation - Gebel Abu Shama	76
11	The average compiled chemical analysis of the Observatory Formation of Gebel Sid El Naam	81
12	The average compiled chemical analysis of the limestone beds of El Qurn Formation at Gebel Sid El Naam	83
13	The average compiled chemical analysis of the lower part of the Upper Building Stone Member at Gebel Al-Hai	86
14	The average compiled chemical analysis of the upper part from the Upper Building Stone Member at Gebel El-Hai	86
15	The average compiled chemical analysis of the Observatory Formation at Gebel El-Hai excluding the dolomitic ledges	87
16	The average compiled chemical analysis of the lower part (17m) of El Qurn Formation	88
17	The average compiled chemical analysis of El Qurn Formation at Gebel Abu-Melisat	89

<u>Table No.</u>		<u>Page</u>
18	The average chemical composition of the sand from El-Maadi quarries	90
19	The suggested raw material proportions	90
20	The average compiled chemical composition of the argillaceous materials from the Upper Eocene sequence, Wadi Hof and Wadi El-Anqabiya Formations	91
21	The raw mix composition of the different areas	92
22	The average compiled chemical composition of the collected spot samples from Abu El-Darag	94
23	The average compiled chemical composition of the collected spot samples from El-Maadi quarries	94
24	The exposed raw mix composition of the clinker of white cement	95
25	The suggested raw material proportions and the average raw mix composition by using the limestone beds of El Qurn Formation	97

CHAPTER I
INTRODUCTION

INTRODUCTION

A- Location and Accessibility

The study area represents a part of the (Cairo-Suez District) North central part which extends from longitude $31^{\circ} 34' 35''\text{E}$ to longitude $31^{\circ} 47' 05''\text{E}$ and from latitude $29^{\circ} 41' 46''\text{N}$ to latitude $29^{\circ} 55' 03''\text{N}$ (Fig. 1). This area is about 520 Km².

The area is bounded from the north by two paved roads, Cairo-Suez road and Maadi-El Qattamiya road, they are connected together by Bir Gindaly (paved) road and El Qattamiya-Observatory (paved) road, while the upward Helwan-El Sheikh-Ain Sukhna road passes through the studied area and is connected to the main roads by two unpaved roads. There are several roads branch from the main roads into different parts of the study area. El Qattamiya Cement Company and its limestone and clay quarries are located in the northern part of the studied area close to the Maadi-El Qattamiya road. (Fig. 2).

B- Aim of the Study

The Eocene carbonate rocks of the area of study are considered as one of great potentialities for cement manufacture in Egypt where the carbonate rocks, argillaceous rocks, kaoline, sands, white sands and the gypsum are present in or nearby the area of study. The Eocene carbonate rocks are investigated from the geologic and the geochemical points of view to be evaluated for cement manufacture at Gebel Abu Shama, Gebel Sid El Naam (Bir Gindaly area), Gebel El-Hai, Gebel Abu Melisat (Gebel El-Hai area). The raw materials of the study area can be exploited for the manufacture of ordinary portland cement and white cement by mixing with the argillaceous material from the Upper Eocene sequence (Wadi Hof Formation and Anqabiya Formation) and the corrective sand material in case of producing O.P.C. or by adding with the kaoline from Abu El-Darag (200 Km east of the area of study) and the white sand from El-Maadi quarries (northwest of the study area) in case of producing white cement.

C- Methods and Techniques

Different available methods were utilized for the geologic and geochemical evaluation of the carbonate rocks for cement manufacturing.