AIN SHAMS UNIVERSITY
FACULTY OF SCIENCE

GEOELECTRICAL STUDIES ON GROUNDWATER OCCURRENCES IN THE AREA BETWEEN MARSA UM GHEIG AND MARSA AALM, RED SEA COAST-EGYPT

By

Helmy El-Sayed Mohamed Ahmed Habib
(B. Sc., Geology, Ain Shams University)
(M. Sc., Geophysics, Ain Shams University)

A Thesis

Submitted for the Ph.D.Degree of Geophysics

Supervisors

Prof. Dr. Mahdy Mohamed Ahmed
Prof. of geophysics, Geophysics Department, Faculty of Science, Ain-Shams University, Cairo

Prof. Dr. Talaat Ali Abdel Latif
Prof. of geophysics, Geophysical Exploration Department, Desert Research Center,Cairo

Prof. Dr. Hosny Mahmoud Ezz El Deen
Prof. of geophysics, Geophysical Exploration Department, Desert Research Center,Cairo

Dr. Ahmed Moustafa Abd El-Gawad
Assistant Prof geophysics, Geophysics Department,Faculty of Science, Ain-Shams University, Cairo

2010

ACKNOWLEDGMENTS

Thanks to God for granting me health and patience to complete this thesis.

I wish to express my deep gratitude and appreciation to ***Prof. Dr. Mahdy Mohamed Ahmed,*** Faculty of Science, Ain Shams University for supervising, continuous advising during the work and for critical reading and revising the manuscript.

I wish to express my deep gratitude and appreciation to ***Prof. Dr. Talaat Ali Abdel Latif***, Desert Research Center for suggesting the point of research, supervising and planning the work and for his continuous advising during the field work, for help during the interpretation of the data and critical reading and revising the manuscript.

Special thanks are due to ***Prof. Dr. Hosny Mahmoud Ezz El Deen.,*** Desert Research Center**,** for his continuous advising during the field work, for help during the interpretation of the data, encouragement me and revising the thesis.

Special thanks are due to ***Dr. Ahmed Moustafa Abd EL-Gawad,*** Faculty of Science, Ain Shams University**,** for his continuous advising during the field work, for help during the interpretation of the data, encouragement me and revising the thesis.

Special thanks to the staff members of the Geophysics Department, Desert Research Center, for their help during the fieldwork.

Finally, I wish to express my gratitude and appreciation to my brother ***Prof. Dr. Sanad***, my ***wife***, ***daughters*** and ***son*** for their patience and continuous encouragement

ABSTRACT

The present study located in the southern part of Red Sea coastal area between latitude 25º to 25º 45` North and longitude 34º 15` to 35º East.. It includes five wadis; Um Gheig, Mubarak, Duber, Igla and Aalm. The water resources (groundwater or surface water) are considered as essential elements for the future development of this area. To evaluate the groundwater and testing the sites of the suggested dams, intensive field work of geoelectrical studies such as Vertical Electrical Sounding (1-D), two–dimensional electrical survey(2-D) and three-dimensional profiles (3-D)as well as the total land magnetic and geoseismic measurements were carried out along the main channel, tectonic plains and deltas.

Geomorphologically, the study area exhibits surface features of high and low relief, included three geomorphologic units. These units are; mountainous area, Red Sea coastal plain and hydrographic basins.

Stratigraphically, the southern part of the eastern desert, includes the study area, is occupied by rocks belonging to Pre-Cambrian basement rocks, Miocene and Quaternary deposits.

Structurally, the area is affected by fold and faults. The fold is plunging fold and the faults follow different trends. The NW-SE faults are most common in the area. These faults are of the normal type

Generally, the main aquifers in the study area are Quaternary wadi deposits, Miocene sediments and fractured basement rocks

Qualitative and Quantitative interpretations were carried out using the software for every type of data. The results of the Geophysical data indicate that, the geoelectrical sequence along the main channel consists of three geoelectrical zones (A, B&C). The sequence of these zones from top downwards is dry wadi deposits (zone A),

zone (B) which is divided into two layers; saturated wadi deposits with brackish water (layer B1), saturated wadi deposits and Miocene sediments with saline water (layer B2) (in the eastern parts) and zone (C) is also divided into two layers; saturated fractured basement with brackish water (layer C1) and massive basement rocks (layer C2). On the other hand, the succession in the delta consists of three geoelectrical layers. These layers from top to base are, geoelectrical layer (A) which equivalent to the surface layer, geoelectrical layer (B) which equivalent to dry wadi deposits, geoelectrical layer (C) which represents the water-bearing formation in the delta. This layer is divided into two sub layers. The first one (C1) equivalents to wadi deposits saturated with brackish water and the second layer (C2) equivalents to wadi deposits and Miocene sediments saturated with saline water in the eastern parts as the results of sea water intrusion.

The present study explores two tectonic plains formed due to the effect of the structural faults. These tectonic plains along the main channels of wadi Duber and wadi Igla are promising to drill some wells.

The interpretation results of the integrated geophysical studies at the recommended sites for dam construction revealed that, the depth to the basement (bed rock) at the gate of the third tectonic plain of Wadi Um Gheig ranges from 11-13 m. Therefore, this site is suitable for constructing concrete dam that allows for storing water. On the other hand, the depth to the basement (bed rock) at the other sites is more than 25 m. Therefore, these sites are not suitable for constructing concrete dams where the bed rock has large depths, instead rock dams are recommended.

Generally, the depth to water decreases towards the east and the water level decreases towards the east i.e. the water flow toward the east.

The basement relief and the detected subsurface faults in the main wadis are confirmed from both the

constructed geoelectrical and magnetic profiles.

The geologic structures play an important role on the groundwater occurrences through their effect on the thickness of the wadi deposits aquifer (zone B) in the main wadis.

There is a sea water intrusion in the deltas of some wadis such as delta wadi um Gheig, delta wadi Mubarak and delta wadi Duber as detected from the three dimensional of the geoelectrical survey and constructed Panel diagrams.

The water bearing layers (C1 &C2) suffer from seawater intrusion coming from the northeastern part; this intrusion is evidenced by the decrease of resistivity and the subsequent increase of salinity downward.

The resistivity decreases downwards in the wadi deposits water-bearing layers (C1 &C2), this is mainly attributed to the increase in clay content and/ or the increase in water salinity.

In deltas, the thickness of the brackish water layer increases from 4 to 26 m westwards , and the safe yield of the hand dug wells in the eastern parts varies from 42.5 to 85 m^3/day.

The groundwater potentialities at the first tectonic plain of wadi Um Gheig is about 1,800,000 m^3 as an example.

LIST OF CONTENTS

Subject	Page
AKNOWLEDGMENT	i
ABSTRACT	iv
LIST OF CONTENTS	vii
LIST OF FIGURES	Xiii
LIST OF TABLES	xiv
INTRODUCTION	1
CHAPTER I	3
GEOMORPHOLOGICAL, GEOLOGICAL, HYDROGEOLOGICAL AND GEOPHYSICAL SETTING	
I.I .Geomorphological Setting	3
I.I.i. Basement Mountainous area	3
I.I.ii. Hydrographic basin	5
1-Um Gheig basin	5
2-Mubarak basin	6
3-Duber basin	7
4-Igla basin	8
5-Alam basin	9
I.I.iii Red Sea coastal plain and Deltas	9
I.II Geological Setting	10
I.II. i. Stratigraphic setting	11
I- Basement rocks	11

2-Sedimentary succession 11
a-Oligocene (Nakheel formation) 11
b-Miocene rocks 12
c-post-Miocene (Quaternary deposits) 13
1.II. ii Geologic Structure 13
1-Faults 14
2- Folds 15
1.III.Hydrogeological setting 16
I.IV. Geophysical setting 16
I-V- The aim of study and planning 17

CHAPTET II
DATA ACQUISITION AND INTERPRETATION TECHNIQUES 18
II. I. Data Acquisition 18
II.I.i. Geoelectrical survey 18
-Vertical Electrical Sounding (VES) 18
-Two-Dimensional (2-D) Electrical Imaging 19
-Three -Dimensional (3-D) Electrical survey 20
II.I.ii. Land magnetic survey 21
II.I.iii. Shallow Seismic Refraction measurements 22
II.II- Interpretation techniques 23
II.II- i- Geoelectrical Resistivity Data 23
1- Vertical Electrical Sounding (VES) (1-D) 23
a- Qualitative interpretation 23
b- Quantitative interpretation 25

2-Two- Dimensional Electrical Imaging (2-D) 25
3-Three -Dimensional Electrical survey (3-D) 26
II.II.ii – Land Magnetic Data 26
II.II.iii- Shallow Refraction Seismic 29
II-III- Topography survey 29
CHAPTER III 30
GEOPHYSICAL STUDIES IN WADI UM GHEIG
III.1 Main channel 30
III.I.I Geoelectrical Studies 30
III.I.II Magnetic Studies 36
III.II Tectonic Basins 37
III.II.i First tectonic plain 37
III.II.ii Second tectonic plain 39
III.II.iii Third tectonic plain 41
III.III- Delta Wadi Um Gheig 45
III.III.i. Geoelectrical Studies 45
III. III. ii. Panel Diagram 51
III-III-iii Hand dug wells and Safe Yield 53
III-III-iV Three-D imaging profile 55
CHAPTER IV 60
GEOPHYSICAL STUDIES IN WADI MUBARAK
IV- I- main channel 60
IV- I- I- Geoelectrical studies 60

IV -I- II- Land Magnetic studies 66
IV-I-III Two-D electrical imaging profile 68
IV- II- Tectonic Basin 69
IV- II- i- Two-D imaging profile 69
IV- II- ii- Magnetic studies 70
IV- II - iii-Seismic studies 70
IV- III- Delta wadi Mubarak 73
IV-III-i Geoelectrical studies 73
IV-III-ii Panel Diagram 79
IV-III-iii Hand dug wells and Safe Yield 82
CHAPTER V 84
GEOPHYSICAL STUDIES IN WADI DUBER
V-I- main channel of Wadi Duber 84
V-I-I- Geoelectrical studies 84
V-I-II- Land Magnetic studies 90
V-II- Tectonic Basin 91
V-II-I- Two-Dimensional (2-D) imaging profile 91
V-II-II- Magnetic studies 93
V-II-III- Seismic studies 93
V-III- Delta of Wadi Duber 94
V-III-I Geoelecrical studies 94
V-III-II- Panel Diagram of Delta Wadi Duber 102
V-III-III- Hand Dug Wells and Safe Yield 104

CHAPTER VI 107

Geophysical Studies in Wadi Igla

1-Geoelectrical studies 107

Geoelectrical cross section no

b- Magnetic studies 111

CHAPTET VII 114

Geophysical Studies in Wadi Aalm 114

a-Geoelectrical studies 114

Geoelectrical cross section 117

b- Magnetic studies 119

SUMMARY AND RECOMMENDATIONS

LIST OF TABLES

Table No.		Page
1-	**Resistivities and thicknesses of the geoelectrical layers along main channel of Wadi Um Gheig**	31
3-	**Resistivities and thicknesses of the geoelectrical layers along main channel of Wadi Mubarak**	61
5-	**Resistivities and thicknesses of the geoelectrical layers along main channel of Wadi Duber**	83
7-	**Resistivities and thicknesses of the geoelectrical layers along main channel of Wadi Igla**	102
9-	**Resistivities and thicknesses of the geoelectrical layers along main channel of Wadi Alam**	108
2	**Resistivities and thicknesses of the geoelectrical layers along delta of Wadi Um Gheig**	**47**
4	**Resistivities and thicknesses of the geoelectrical layers along delta of Wadi Mubarak**	**73**
6	**Resistivities and thicknesses of the geoelectrical layers along delta of Wadi Um duber**	**92**

LIST OF FIGURES

Fig. no.		Page
1-	**Location map of the study area**	2
2-	**Geomorphical map of the study area**	4
3-	**Watershed area of Wadi Mubarak**	6
4-	**Watershed area of Wadi Duber**	7
5-	**Watershed area of Wadi Igla**	8
6-	**Watershed area of Wadi Alam**	9
7-	**Geologic map of the study area**	12
8-	**Schlumberger Configuration**	19
9-	**Two - Dimensional (2-D) Wenner Imaging array**	20
10-	**Three Dimensional (3-D) Pole-Pole array**	21
11-	**An example of the field measurements of the magnetic intensity along the main channel of Wadi Um Gheig**	22
12-	**Normal, Reverse and Middle layout in line offset**	23
13-	**Example of the types of E.S. curves in the study area**	24
14-	**Location map of vertical electric sounding, 2-D imaging profiles, 3-D electrical survey magnetic profiles, and shallow refraction seismic profiles in Wadi Um Gheig.**	31
15-	**Geoelectrical cross section (a) and geomagnetic profile (b) along the main channel of Wadi Um Gheig**	34
16-	**Geoelectrical (A) and magnetic profile (B) in the tectonic plain 1 of Wadi Um Gheig**	38
17-	**2-D imaging profile (A), magnetic profile (B) and**	40

seismic section (C) in the tectonic plain 2 of Wadi Um Gheig

18- **2-D imaging profile (A), magnetic profile (B) and seismic section (C) in the tectonic plain 3 of Wadi Um Gheig.** 44

19 -Location map of VES stations and the geoelectrical cross sections in wadi Um Ghig 46

20- **Geoelectrical cross section AA', BB' and CC' in delta wadi Um Gheig** 49

21- **Geoelectrical cross section DD', EE' and FF' in delta Wadi Um Gheig** 50

25- **Horizontal slices of the model obtained from 3-D inversion of Pole-Pole survey in Delta Wadi Um Gheig** 56

26 Vertical slices of the model obtained from 3-D inversion of Pole-Pole survey in Delta Wadi Um

22- **Panel diagram for the distribution of the subsurface sequence of geoelectrical layers in Delta Wadi Um Gheig** 52

23- **Isopach map of brackish layer in Delta Wadi Um Gheig** 52

24- **Design of hand dug wells in Delta Wadi Um Gheig** 54

27- **Location map of vertical electric sounding, 2-D imaging profiles and shallow refraction seismic profiles in Wadi Mubarak.** 60

28- **Geoelectrical cross section (a) and geomagnetic profile (b) along the main channel of Wadi Mubarak** 63

29- **2-D electrical imaging profile along Wadi Mubarak 68**

30- **2-D imaging profile (A), magnetic profile (B) and** 69

	seismic section (C) in the tectonic plain 2 of Wadi Mubarak	
32-	**Geoelectrical cross section AA', BB' in delta wadi Mubarak**	75
34-	**Panel diagram for the distribution of the subsurface sequence of geoelectrical layers in Delta Wadi Mubarak**	78
35-	**Isopach map of brackish layer in Delta Wadi Mubarak**	78
36-	**Location map of vertical electric sounding, 2-D imaging profiles and shallow refraction seismic profiles in Wadi Duber.**	82
37-	**Geoelectrical cross section (a) and geomagnetic profile (b) along the main channel of Wadi Duber**	85
38	**2-D imaging profile (A), magnetic profile (B) and seismic section (C) in the tectonic plain 2 of Wadi Duber**	88
40-	**Geoelectrical cross section AA', BB' and CC' in delta wadi Duber**	95

جامعة عين شمس
كلية العلوم

"دراسات جيوكهربية على تواجدات المياه الجوفيه فى المنطقة بين مرسى أم غيج ومرسى علم ساحل البحر الآحمر – مصر"

رسالة مقدمة من

حلمى السيد محمد احمد حبيب

بكالوريوس علوم (جامعة عين شمس)

ماجستير علوم (جامعة عين شمس)

لكح شهك عو خذج بخ كهق طفكف ب غىطعكل

غىطجهغيإئ؟

المشرفون

ا. د. مهدى محمد أحمد
أستاذ الجيوفيزياء- كلية العلوم
جامعة عين شمس

ا. د. طلعت على عبد اللطيف
استاذ الجبوفيزياء- مركز بحوث الصحراء

ا.د حسنى محمود عز الدين
استاذ الجيوفيزياء – مركز بحوث الصحراء

د. احمد مصطفى عبد الجواد
استاذ مساعد الجيوفيزياء- كليه العلوم جامعه عين شمس

٢٠١٠