Faculty of Science

Faculty of Science
Geophysics Department

Assessment of Geothermal Resources at South East Gulf of Suez, Egypt using Geophysical, Geological and Temperature Well Data

A Thesis
Submitted for the Master Degree of Science as a Partial Fulfillment for the requirements of the Master of Science

To
Geophysics Department
Faculty of Science
Ain Shams University

By
Heba-T-allah Atef Mohamed El OkL
(B.Sc in Geophysics, 2012)

UNDER SUPERVISION OF

Dr. Ahmed M. S. Abd El-Gawad
Assoc. Prof. Geophysics Depart.
Faculty of Science
Ain Shams University
Cairo, Egypt

Dr. Karam S. I. Farag
Lecturer Geophysics Depart.
Faculty of Science
Ain Shams University
Cairo, Egypt

Dr. Mohamed Abdel Zaher Mohamed Mahmoud
Researcher
National Research Institute of Astronomy and Geophysics
Helwan, Egypt

Cairo, 2015

Faculty of Science

NOTE

The present thesis is submitted from Heba-T-allah Atef Mohamed to the faculty of science, Ain Shams University in partial fulfillment for the requirements of Master of Science in Geophysics. Besides she attended five post graduate courses for one academic year in the following topics.

Course No.	Subject
Geoph. 601	Geophysical Field Methods, Numerical Analysis and computer programming.
Geoph. 611	Potential Theory and Electrical Methods.
Geoph. 612	Gravimetric and Magnetic Methods.
Geoph. 613	The Shape of the Earth and Plate Tectonics.
Geoph. 614	Radiometric and Electromagnetic Methods.

She has successfully passed the final examination of thesis courses, and English language exam (2013).

Prof. Dr. Said Abd Elmaboud Ali

Head of Geophysics Department

Faculty of Science

Ain Shams University

ACKNOWLEDGEMENTS

Praise is to Allah for granting me well and determination to complete this thesis.

First of all, I would like to thank **Geophysics Department, Faculty of Science, Ain Shams University** headed by **Prof. Dr. Said Abd Elmaboud Ali** for the continual assistance and permanent support. I have a great honor to be graduated from this department.

Also, I have great pleasure in expressing my deep gratitude to **Dr. Ahmed Moustafa** Prof. Ass. of Geophysics, Faculty of Science, Ain Shams University for his valuable guidance, fruitful supervision in this work, as well as his critical revision of the thesis.

My sincere thanks are given to **Dr. Karam Samir** Lecturer of Geophysics, Faculty of Science, Ain Shams University for his assistance in the gravity inversion in addition to his useful revision.

My great indebtedness and deepest gratefulness are given to **Dr. Mohamed Abdel Zaher** Researcher at the National Research Institute of Astronomy and Geophysics (NRIAG) for his continuous assistance and support in geothermal work and gravity inversion as well.

Thanks are also given **to Dr. Markku Pirttijärvi**, University of Oulu, Finland for providing GRABLOX Software, **Dr. Reda Gamel** Desert Research Institute for his help in collecting the previous work in the study area and **Mr. Mohamed Abdeldayem** Faculty of Science, Ain Shams University for his assistance in gravity separation.

Finally, I would like to express my deepest gratitude to **my family** for their permanent care and patience.

LIST OF CONTENTS

LIST OF FIGURES

Fig. No.		Page No.
Fig. 35	Fault segments dissecting the subsurface section of the study area derived from regional map at 4.0 km.	71
Fig. 36	Fault segments dissecting the subsurface section of the study area derived from residual map at 1.0 km.	72
Fig. 37	Fault segments dissecting the subsurface section of the study area derived from residual map at 2.0 km.	73
Fig. 38	Fault segments dissecting the subsurface section of the study area derived from residual map at 3.0 km.	74
Fig. 39	Fault segments dissecting the subsurface section of the study area derived from residual map at 4.0 km.	75
Fig. 40	Rose diagrams derived from Bouguer, regional gravity contour maps from 1.0 to 4.0 km and residual gravity contour maps from 1.0 to 4.0 km respectively.	77
Fig.41	Three categories of techniques to interpret potential field data.	80
Fig. 42	Gravity field on arbitrary shape at point P(x, y, z) due to mass distribution ρ(x', y', z').	82
Fig. 43	Block model of size dX.dY.dZ divided into nx.ny.nz minor-blocks of size dx.dy.dz.	85

LIST OF TABLES

ABSTRACT

The Gulf-of-Suez region represents the most promising area in Egypt for geothermal exploration which is characterized by superficial thermal manifestations represented by a cluster of hot springs with varying temperatures from 35 to 72 ºC. The main purpose of the present thesis is to shed the light on the integration between gravity work and geothermal data in detecting the main subsurface structures in addition to expecting the geothermal sources in the area under consideration.

Correction was applied on the bottom hole temperature data to obtain the true formation equilibrium temperatures that can provide useful information about the subsurface thermal regime. Based on these logging data, temperature gradient and heat flow values computed at each well, it is found that the mean geothermal gradient of the study area is 32 °C/km nevertheless some local geothermal potential fields were located with more than 40 ^{o} C/km. Also, heat flow values are ranging from 45 to 115 mW/m^2.

The Bouguer gravity anomaly map of the study area was used for delineating the subsurface structures and tectonic trends that have resulted in a potential heat source. The gravity inversion revealed a good correlation between areas of high temperature gradients, high heat flow and positive gravity anomalies. The high temperature gradient and heat flow values suggested being associated with a noticeable hydrothermal source of heat anomaly located at relatively shallow depths which is expected to be due to the uplift of the basement in the area.

Moreover, a relation between temperature gradient and depth to oil window was derived to show the role of temperature gradient in the maturation of hydrocarbon. Finally, a conceptual model of the hydrothermal system in the study area was drawn and thus the geothermal reserve of the study area was calculated in order to know the availability of constructing power plant for electricity generation or any other utilization.