Ain Shams University

Faculty of Science

Applications of Integrated Geophysical Surveys in Delineating Groundwater Occurrences at Cairo-Bilbeis Region, East Nile Delta, Egypt

A Thesis submitted for the degree of Master of Science as a partial fulfillment for the requirements of Master degree of Science in Applied Geophysics

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Cairo – 2016

Note

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

Beside the research work materialized in this thesis, the candidate has attended ten postgraduate courses for one year in the following topics:

1. Geophysical field measurements
2. Numerical analysis and computer programming
3. Elastic wave theory
4. Seismic data acquisition
5. Seismic data processing
6. Seismic data interpretation
7. Seismology
8. Engineering seismology
9. Deep seismic sounding
10. Structure of the earth

He successfully passed the final examinations in these courses.

In fulfillment of the language requirement of the degree, he also passed the final examination of a course in the English language.

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Acknoledgement

After thanks to Allah, I would like to thank my direct supervisors Dr. **Ahmad Muhammad Sobhy Ahmad Helaly,** Associate Professor of Geophysics**,** Faculty of Science, Ain Shams University, for his guidance and leading comments in this work and efforts.

I'm deeply thankful to Dr. **Azza Mahmoud Abd El-Latif El-Rawy,** Lectruer of Geophysics**,** Faculty of Science, Ain Shams University, for sharing me the idea of this study, her effort and leading comments in this work and reviewing the write up.

Also I'm deeply thanks to **Prof. Dr. Said Abdel- Maaboud Aly,** Professor of Geophysics, Faculty of Science, Ain Shams University, for his help, guidance and his effort.

I would like also to thank the **Geophysics Department,** Faculty of Science, Ain Shams University, **for** providing the instruments and I'm deeply thankful to everyone that helped me to finish my work.

Finally I dedicated this work to my family and I'm actually and totally thank them for their patience, support and encouragement.

Abstract

The study area is located at Cairo-Bilbeis Desert rood, north-eastern part of Greater Cairo, the eastern part of the Nile Delta, Egypt. It is located between X-coordinates 350940 and 352171 meter easting and Y-coordinates 3349671 and 3350543 meter northing at Zone 36 UTM-coordinate system. The study area is mainly covered by Tertiary and Quaternary sediments. The exposed section varies in thickness which increases toward the Nile Delta recording more than 1000 m.

The main objective of this study is to delineate the groundwater occurrences based on the identification of the geological formations, geological structures and groundwater aquifers in the study area. The second objective is the use of modern geophysical method (seismoelectric method) which is sensitive to the presence of fluids. The third objective is the integration between the different geophysical methods which are the shallow seismic refraction tomography, geo-electric and seismoelectric for identifying how successful is; to use seismoelectric method, where it has not been used before in Egypt, by comparing the results of these geophysical methods in the study area. Finally the calculation of the near surface soil geotechnical parameters and dynamic characteristics.

Sixteen seismic refraction tomography profiles with 24 geophone with seven shot per each profile, 10 seismoelectric profiles with 24 dipole and pre-amplifier with three shots per each profile and finally three vertical electrical sounding with AB/2 500, 500 and 600 meter are the data acquired for this study.

Analysis and interpretation of the geophysical data indicates that there are two groundwater aquifers in the study area. The first aquifer consists of the Miocene sands and sandstone which is located at a depth of about 75-80 meter from the ground surface with an average thickness of about 38.3 meter and contains fresh water with low salinity. The second aquifer consists of the Oligocene sands which is located at a depth of about 195-200 meter from the ground surface but our measurements did not reach to its bottom. Finally by comparing between the seismic refraction tomography and geo-electric results with the seismoelectric method we found good matching between the results.

Keywords: groundwater aquifers, seismic refraction tomography, geo-electric, seismoelectric

Contents

List of Tables

List of Figures

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Recently, due to the difficulties and challenges which Egypt faces especially in the diminishing of fresh water resources (where the Nile River water is insufficient to meet the demand of the Egyptians); as a result of the population growth, as well as the necessity of increasing the area of farmland and land reclamation. So, we must start in reliance on other sources of waters instead of the Nile River water. One of them is underground water which is the second source of fresh water in Egypt and could help partly in providing large quantities of fresh water. Groundwater is considered as one of the main sources of water, particularly in the desert regions.

The conventional method to determine the hydrological and geological situation of a site is to drill boreholes to bedrock. Applied geophysics will reduce the number of drill-holes required and attain detailed information on the hydrological and geological system. By mapping geologic structures with geophysical surveys, major saving can be made for cost and time.

The characterization of the subsurface requires a detailed knowledge of several properties of the composing rocks and fluids. Whereas some of these properties can be measured directly (by seismic and borehole methods), other properties have to be estimated by indirect measurement methods such as resistivity, time-domain electromagnetic (TEM), and magnetic (Bery, 2012).

The tasks for the geophysical investigations were the structural exploration of the groundwater and the closing of information gaps of the geological and hydrogeological exploration. Geophysical methods can give a continuous overview about the water bearing aquifers (the thickness and the depth below the surface, the size,… etc.). Furthermore, it is possible to detect additional aquifer layers in the underground (Schicht et al., 2013).

1.2 Location of the Study Area

The study area lies within the northeastern part of Greater Cairo (Egypt) at the Eastern part of the Nile Delta. It is located between X-coordinates 350940 and 352171 meter easting and Y-coordinates 3349671 and 3350543 meter northing at Zone 36 UTM-coordinate system as shown in Figure (1-1).

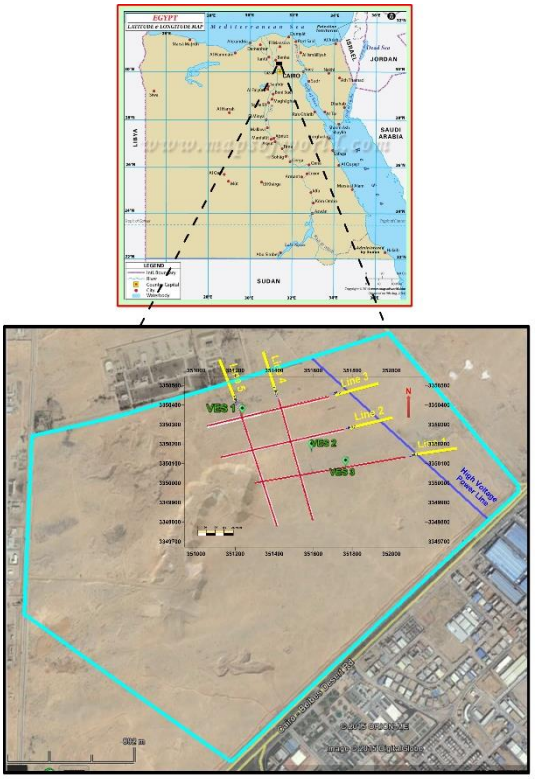

Figure (1-1): ***Location map of the study area.***

1.3 Problem of the Study

In light of the above, the study problem can be determined through the following questions:

1) What is the probability of the presence of the groundwater in the study area?
2) How successful is the use of modern geophysical method; the seismoelectric method in determining groundwater occurrence and geological structures?
3) Suitability of groundwater well design according to the near-surface soil geotechnical parameters and dynamic characteristics.

1.4 Objectives of the Study

1) Identification of the geological formations, geological structures and groundwater aquifers in the study area based on interpretation models of seismic refraction tomography, geo-electric resistivity, and seismoelectric methods.
2) Integration between different geophysical methods; seismic refraction tomography, geoelectric resistivity and new geophysical method (seismoelectric).
3) Calculation of the near-surface soil geotechnical parameters and dynamic characteristics.

1.5 Available Data

Three different geophysical methods were chosen for underground water investigation of this study.

First, the seismic refraction tomography is used to give a good overview of the structure of the brine zone. Sixteen seismic refraction tomography profiles along five seismic lines with a total 112 shot record