CONTRIBUTION OF GEOPHYSICS FOR SOLVING SOME ENGINEERING PROBLEMS AT KATTAMIYA AREA, EGYPT

A thesis

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By

Nahla Abd El Moktader Abd El Aziz

To

Geophysics Department
Faculty of Science
Ain Shams University

Supervisors

Prof. Dr.Salah El Deen A. Mousa
Prof. of Geophysics
Geophysics Department
Faculty of Science
Ain Shams University

Prof. Dr. Salah Shireef Othman
Prof. of Geophysics
Geomagnetic and Geoelectric Dept.
National Research Institute of Astronomy and Geophysics

Dr.Mohamed Abd El Aal Abd Alla
Assistant Prof. of Geophysics
Geomagnetic and Geoelectric Dept
National Research Institute of Astronomy and Geophysics

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Approval Sheet

Name: Nahla Abd El Moktader Abd El Aziz El Sayed

Title: Contribution of Geophysics for Solving Some Engineering Problems at Kattamiya Area, Egypt.

Submitted in partial fulfillment of the requirements of the degree of
Master of Science in Geophysics.

Supervised by:
Prof.Dr. Salah Abd El Wahab Moussa ……...
Prof.Dr. Salah El Sherif Othman ……...
Ass. Prof Muhammad Abd El Aal Abd Allah ……...

ABSTRACT

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The present thesis is concerned with the study of the geoelectrical and petrophysical characteristics of the geological structures in the area of "Al Amal City" in Kattamiya area.

The study area is located in the Eastern Desert in the Kattamiya area between long.31° 30` and 31° 40`E and lat.29° 45` and 30°00`N. To achieve the objectives of the study, the available geoelectric rasistivity, Petrophysics, and Ground Penetration Radar measurements have been analyzed and interpreted.

The geoelectrical resistivity survey has been applied using the Schlumberger 4-electrodes array with a maximum current electrodes spacing (AB/2) equals 200 m, thirty two soundings have been carried out in this survey .

The VES curves were analyzed and interpreted where the true resistivity and thickness of each layer were determined. The results of interpretation are represented in the form of iso-apparent resistivity contour maps, apparent resistivity sections, geoelectrical cross section, and isopach maps for the studied sequence.

The study area is divided into three main geoelectric zones .The surface zone is composed of sand, gravel and limestone with high resistivity values and thickness varies from 0.5 to 6 m. The second zone is composed of sandy clay and clay with low resistivity values, which reflect some geological variation in this zone, and thickness varies from 12.5 to 18.1 m. The third zone is considered to be the bed rock; it consists of limestone, with relatively high resistivity values. The area is found to be affected by some clay lenses.

About 20 rock samples were collected from a clear exposed section through a small valley in the study area .An attempt was made to study all the available physical properties of the collected samples. Laboratory measurements have been carried out and the relations between different physical properties have been illustrated.

The study of the measured dynamic mechanical parameters of the collected samples such as Young's modulus, rigidity and bulk modulus indicates that the bed rock under investigation is suitable for buildings and other engineering purposes, especially when the rocks are in a dry state. The water saturated rocks exhibit lower rigidity and elastic dynamic characteristics. The upper most part of the studied section is characterized by high porosity, high permeability, low rigidity and low Poisson's ratio. This may be due to the presence of caverns and a lot of fossils within the carbonate rocks. The thickness of this layer is about 1.4 m. This layer should be excavated before putting any foundations. These technical and scientific notifications must be taken into considerations by engineers and other users in order to be out of risk.

The Ground Penetration Radar technique has been applied in order to detect the subsurface layering and geological structures. The survey was conducted at 6 profiles consisting of 10 section parts which are recorded, processed and interpreted. Every part of each profile consists of two or three layers, with the presence of identified feature or anomaly like sand or clay lenses.

مساهمة الجيوفيزياء في حل بعض المشاكل الهندسية بمنطقة القطامية– مصر

رسالة مقدمة
لاستكمال متطلبات الحصول على درجة الماجستير في العلوم الجيوفيزياء

مقدمة من
نهلة عبد المقتدر عبد العزيز
(بكالوريوس علوم-جيوفيزياء 1998)

الى
قسم الجيوفيزياء – كلية العلوم
جامعة عين شمس

المشرفون

ا.د/ صلاح الدين عبد الوهاب موسى
أستاذ الجيوفيزياء
قسم الجيوفيزياء – كلية العلوم
جامعة عين شمس

ا. د/ صلاح شريف عثمان
رئيس معمل الكهربية والحرارة الأرضية
المعهد القومي للبحوث الفلكية و الجيوفيزيقية-حلوان

د/ محمد عبد العال عبد الله
أستاذ باحث مساعد
معمل الكهربية والحرارة الارضية
المعهد القومي للبحوث الفلكية و الجيوفيزيقية-حلوان

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CHAPTER 1
INTRODUCTION

1.1 General outlines:

The present study has been carried out to identify the geological structure and the lithology of the bed rock in Al Amal city in Qattamiya area using several geophysical methods. The geoelectric resistivity and petrophysical measurements in the area have been used due to their ability to provide useful information about the subsurface structure at reasonable depths using methods adopted by Dobrin, (1976) and Telfored et al, (1981).

1.2 Location and aim of study:

The area under study is located in the Eastern Desert in Qattamiya area between longitudes.31° 30` and 31° 40` E and latitudes 29°45` and 30° 00` N .This area is about 2 square kilometers (Fig.1-1) and is located at about 41 km southeast of Cairo.

The study area comprises a part of the Eastern desert, it is bounded in the south east by Gabal –Abu Shama (587 m) and by Gabal-Yahmoum Alasmar (500 m) in the north direction and crossed by Cairo-Suez road .The general purpose of this work is to study the subsurface geological structures between depth down to about 40m and then to investigate the effect of these structures on the construction of a new city in this area, while the bedrock characteristics is our additional target .

1.3 Previous works:

The study area was subjected to numerous geological and geophysical studies as the geologic and structure contour maps of Gables "El Nasuri and El Anqabiya, introduced by Shukri and Akmal (1953) on scales of 1:50,000 and 1:25,000 respectively.

The topographic map of Bir Gendali is with a scale of 1:50,000 includes the western part of the study area .Fig. (1-2). The

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

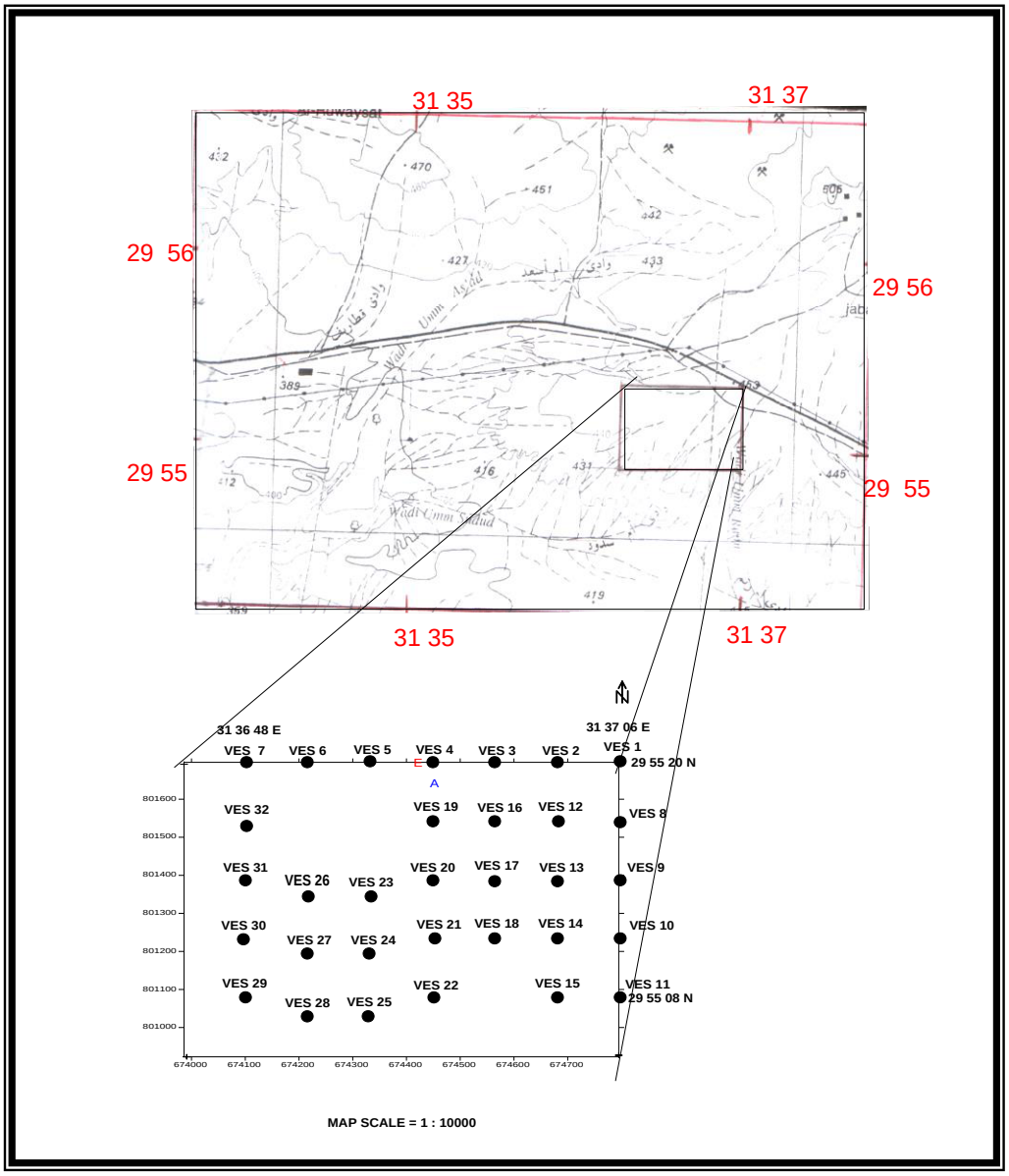

Fig.(1-2):Topographic map of the study area.

geologic map of Cairo-Suez district is compiled by Said (1962) .

The stratigraphy of the study area was included in the works done by Shukri and Akmal (1953).

The structure of Gables El Nasuri and El Anqabia were described in detail by Shukri and Akmal (1953) .A regional study of Cairo-Suez district was published by El Ghamri (1985).

The general structures of the Cairo-Suez district were studied by several workers. Egypt was divided into several regions of different structure stages and the Cairo-Suez district is considered as belonging to the Oligocene-Quaternary structural stage.

According to Said (1962), there are three fault sets in the Cairo-Suez district, these sets are east-west, northwest and northeast .The three fault sets are of the same age.

The most pronounced faults are the East-West faults which are responsible for the formation of most of the structural and topographic highs of the area. According to Said (1962) the stresses which created the structures of the area were tensional rather than compressional.

Youssef (1986) discussed the major structural elements of Egypt and the stresses that produced them. He grouped these structural elements under the following categories:

1- Gulf of Suez –Red Sea fault trend (N 35° W).
2- East West fault trend.
3- N 45° W fault trend.
4- Folds parallel with faults (as Cairo-Suez road).

Youssef (1986) considered the structural elements of the Cairo-Suez district to be belonging to the 1st, 2nd, 3rd, and 4th categories. The East-West faults may have been formed by a tangential compressive stress during the Pre-Cambrian.

The folds that are parallel with faults are believed to be the result of vertical block movement along faults in the Pre-Cambrian rocks.

According to El Ghamry (1985), the Northwest oriented faults are well exhibited in the eastern part of the Cairo-Suez district where as the East-West oriented faults are well exhibited in the Northern and Western parts of the district. The intermediate part of the district may be equally affected by both fault trends .

By studying the structure in area of east Cairo, Maadi, and Helwan indicated that, there are three fault sets which are East-West, West-Northwest and Northwest ,these fault sets form three East-West belts.

Some geophysical studies (Gravity and Magnetic) were carried out in the Cairo-Suez district. According to Nakhla (1982), Gravity and Magnetic anomalies led Bayoumi and Shenouda (1971) to identify a major syncline occupying the central part of the Cairo-Suez district .This syncline lies within a major graben. The area is also affected by NW oriented faults .The NW and E-W oriented faults extend upward from the Pre-Cambrian to the overlying sedimentary section. They concluded that the total thickness of the sedimentary section ranges from 3000 to 4500 meters.

Nakhla (1982) in his geophysical study on the Cairo-Suez district indicated the following:

1- The thickness of the sedimentary section increases from the south eastern part (300 m) to the north western part (5000 m) of the district.

2- Most of the exposed structural highs coincide with similar manifestations on the Pre-Cambrian surface, e.g: Gebels El Qattamiya, El Anqabia, Mokattam, and Shabrawet which are expressed as surface and Pre-Cambrian positive features. Also, the topographic lows coincide with forms on the Pre-Cambrian surface, such as Wadi Hof, El Anqabia, El Nasuri and Gandali.

1.4 Scope of the present study:

The present study deals with exploration of the extension and the thickness of the bedrock using the resistivity sounding technique. For this purpose, field trips, rock sampling, geoelectric and GPR survey, lab work, GPR survey, data analysis and interpretation were carried out.

1.5 Field and office work:

Several field trips have been carried out for sample collection and measuring the geoelectric parameters of the different rock layers composing the geoelectric succession along profiles covering the study area. In addition, georadar survey (GPR) has been conducted in order to confirm our results. The office work includes the collection of the previous literatures on the study area and analyses of the geoelectric ,and lab measurements as well as GPR results.

1.6 Role of Exploration in an Engineering Site.

The investigation of suitability and characteristics of sites as they affect the design and construction of civil engineering works and the security of structures should be laid out for site investigation (McLean and Gribble, 1979).

The systematic exploration and investigation of a new site should have some stages of procedure like,

-using published information and other existing data;

-using a detailed geological survey of the site;

-applied geophysical surveys to provide information about the subsurface geology;

Testing of soils and rocks to assess their suitability, their mechanical properties (soil mechanics and rock mechanics) from samples.

In the research work, each of these stages might be carried out and reported on by consultant specializing in geology, geophysics and engineering with a detailed knowledge of soil and rock mechanics.

In the present work our aim is to prove that engineering geophysics can give good information about an area if it is good for civil life or not by knowing its structures and then recognizing if we can build on it or not. For example, a site described in a geological report as being underlain by clastic sedimentary rocks might be considered by civil engineering to consist entirely of sandstones. However, in geology clastic sedimentary rocks include a variety of different rock types, such as conglomerates, sandstones and shales or

mudstones. Indeed it would not be unusual to find that the site under development contained sequences of some of this different rock types-say, intercalated beds of sandstone and shale, or sandstone with conglomerate layers. Each of these rock types has different engineering properties, which could affect the development work.

The relevance of geology to civil engineering is that most of civil engineering projects involve some excavation of soils and rocks, or involve loading the earth by building on it. In some cases, the excavated rocks may be used as constructional material, and in others, rocks may form a major part of the finished product, such as motor way cutting or the site for the reservoir. The feasibility, the planning and design, the construction and costing, and the safety of the project may depend critically on the geological conditions where the construction will take place.

For the geological exploration of an engineering site, to asses the feasibility of a project and to have a plan and design for the foundation , some information are normally required , such as:-

1-the type of rocks and soils present, including the sequence of strata , nature and thickness of the various deposits and the presence of igneous intrusions. Also how these rocks are distributed over,

2- The frequency and orientation of joints in the different rock bodies as well as the location of faults, also the presence of weathered rocks, particularly soluble rocks such as Limestone.

3- Groundwater conditions, including depth to water and presence of noxious material in solution, such as sulphates as it may affect cement in contact.

4- The presence of economic deposits which may have been extracted by mining to leave concealed voids or disturbed ground and the suitability of local rocks and soils, especially those to be excavated, as construction material

The methodology of site exploration hangs on a framework of inductive reasoning .Geological information available at the start of exploration is assessed against known patterns of rock distribution (that is, against stratigraphical and structural method).

The most elaborate exploration is needed for a large area where no systematic exploration or construction has been carried out, that is an extended green field site. Systematic exploration may involve up to some procedure stages:

First, preliminary investigation using published information and other existing data;

Second, a detailed geological survey of the site, possibly with a photography study;

Third, applied geophysical surveys as a reconnaissance of the subsurface geology;

Finally, testing of soils and rocks to assess their suitability, particularly their mechanical properties (soil mechanics and rock mechanics), either in situ or from samples.

The first stage in our investigation is to search for and study existing infotmation. about the area supposed to be the location of Al Amal city according to Ministry of Urbanization and Land Cultivation).

The area is covered by sediments of the Upper Eocene age and Maadi formation, and may have some sediments like conglomerate and sands from the Oligocene age which represente the conglomerate construction in Gabal Yahmoum Al Asmar. Also about the soil nature , we find that twelve holes done by manual drilling with small depths ,so eleven holes have been done by the rotating drilling with depth of 15m and that to give natural picture for the soil nature in the area ,and the results of these VESes told that the layers can be known from the surface as ,a-the first layer-the second layer, which be the muddy layer-the third layer, which come after the muddy layer.

The first layer, the surface layer and its contents change from place to place, and its surface consists of sand covering the conglomerate at some places. It is not consolidated, also there are fine sands at the surface which are not consolidated and affected by water. After this layer there is a layer of fossiliferous Limestone which be a solid rock even if it affected by water.