AIN SHAMS UNIVERSITY
FACULTY OF SCIENCE
GEOPHYSICS DEPARTMENT

Integration of Geophysical and Remote Sensing Techniques for Sustainable Development of Selected Areas of the Suez Canal Zone

A Thesis Submitted for Partial Fulfillment for the Requirements of the Degree of Master of Science (M.Sc.) in Geophysics

By

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(B.Sc. in Geophysics – Faculty of Science – Ain Shams University – 2012)

To

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Approval Sheet

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Note

The present thesis is submitted to the 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 post-graduate courses for one year in the following topics:

1) Geophysical field measurements.
2) Numerical analysis and computer programming.
3) Advanced Well Logging.
4) Formation Evaluation.
5) Physical properties of rocks.
6) Basin analysis.
7) Subsurface geology.
8) Geophysical exploration.
9) Reservoir evaluation.
10) Fluid dynamics.

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.

Head of Geophysics Department

Prof. Dr. Sami Hamed Abd El-Naby

﴿ وَٱللَّهُ أَنزَلَ مِنَ ٱلسَّمَآءِ مَآءً فَأَحۡيَا بِهِ ٱلۡأَرۡضَ
بَعۡدَ مَوۡتِهَآۚ إِنَّ فِي ذَٰلِكَ لَأٓيَةٗ لِّقَوۡمٖ يَسۡمَعُونَ ﴾

صدق الله العظيم

سورة النحل (الآيه 65)

DEDICATION

This thesis work is dedicated to my dear husband, Mohamed Abd El-Dayem, who has been a constant source of support and encouragement during the challenges of this work and life. I am truly thankful for having you in my life. This work is also dedicated to my dear family: Father, Mother, my son (Anas), my brother, and my sister who have always loved me unconditionally and whose good examples have taught me to work hard for the things that I aspire to achieve.

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In the name of Allah, Most Gracious, Most Merciful

First and foremost, I give **Allah** the glory that made this work to complete.

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Hadeer Ahmed Desoky Farrag

ABSTRACT

The present study deals with an Integration between different techniques which are: Remote Sensing & GIS Analysis, Petrophysical Rock Evaluation, and Electrical Resistivity Measurements to get better understanding and more details to clear the picture about the characteristics of the near surface sedimentary layers and hidden structures, and to assess the groundwater occurrences for sustainable development of a selected area of the Suez Canal zone.

The investigated area is located in the eastern part of the Cairo – Suez district, North of Gulf of Suez and Gebel Ataqa, and to the west of Suez Canal, Egypt. It is located between latitudes 30° 00' 30" N, 30° 22' 15" N, and longitudes 32° 04' 00" E, 32° 41' 15" E covering an area of some 2400 km^2.

It has a semi-flat terrain except the area to the west where topography rises defining the southern mountains as in Gebel Geniefa, which rises on average to 234 m above sea level and Gabel Shabraweet, which rises on average to 226 m above sea level.

The area's bedrock geology is made up, from the bottom (old) to top (recent) of the followings; (1) the Middle Eocene Gebel Hof and the Observatory formations, (2) the Middle/Upper Eocene El-Qurn Formation, (3) the Upper Eocene Maadi Formation, (4) the Oligocene Gebel Ahmer Formation, (5) the Miocene Sediments & Late Miocene Hagul Formation, (6) the Pliocene sediments & El-Hagif Formation, and (7) the surficial Late Quaternary Wadi deposits

In the present study, the Landsat - 8 OLI, and Sentinel-2B data were used to map the different exposed rock units. Integration of band selection, image enhancement, band rationing and Principal Component Analysis (PCA) techniques were used to clearly determine the lithological units cropping out in the study area. After that, Sentinel-2B image was compared with Landsat-8 OLI (Operational Land Imager) for lithological mapping using the maximum likelihood classification (MLC) method. The Sentinel-2B imagery yielded a classification accuracy higher than that of the Landsat-8 imagery, due to its high spectral resolution. With the help of remote sensing techniques, lineaments can be identified. The aim of this part is the comparison of Landsat-8, Sentinel-2B and Sentinel-1 data sensors in automatic lineament extraction. The comparison of the obtained results showed that the Sentinel-1 data is more efficient in restitution of lineaments.

This indicates the performance of the radar data compared to those optical in this kind of study. The results were compared with existing geologic maps and could be used to update the existing maps.

Thin section examination was applied to 13 selected rock samples representing the different formations to detect the different facies, mineral composition, textural characteristics as well as the diagenesis of the rocks.

Field sampling has been carried out to evaluate the petrophysical properties of the different collected rock samples from a selected two sections at Gebel Geniefa and Gebel Gharra areas. A total of 41 cylindrical representative rock samples collected from the exposed Miocene and Eocene rocks have been evaluated for their petrophysical parameters including: bulk density, grain density, porosity, permeability, ultra-sonic wave propagation velocity, then construct some relationships between these different measured parameters.

An attempt has been made to study the detail morphometric characteristics of some selected basins. For detailed study, SRTM data has been used for preparing digital elevation model (DEM), and geographical information system (GIS) was used in evaluation of linear, areal and relief aspects of morphometric parameters. Watershed boundary, flow accumulation, flow direction, flow length, and stream ordering have been prepared using ArcHydro Tool; and contour, slope-aspect, hill-shade have been prepared using Surface Tool in ArcGIS-10.4.1 software. Different thematic maps i.e. drainage density, slope and relief have been prepared by using ArcGIS software.

Geo-electrical resistivity measurements have been carried out to evaluate the conditions of groundwater occurrences for sustainable developments of the zones around Suez Canal region by identifying vertical and horizontal extensions of the sedimentary succession, especially water bearing formations and the structural elements such as fractures and faults which affected on water bearing formation.

Key Words:

Cairo - Suez district _ Suez Canal _ VES _ Petrophysics _ Landsat 8 OLI _ Sentinel-1 _ Sentinel-2B _ Lineaments _ Remote Sensing _ GIS _ SRTM _ Hydrology _ Morphometric Analysis.

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