Cairo University
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ENVIRONMENTAL ISOTOPIC AND GEOCHEMICAL INVESTIGATION OF THE GROUNDWATER AQUIFER OF WADI EL NATRUN AREA, EGYPT

A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (M.Sc.)

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by

Hend Saeed Taha Soliman Abu Salem

(B.Sc. in Geology-Major, 2003)

Geology Department

Faculty of Science, Cairo University

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Name of candidate:

Hend Saeed Taha Soliman Abu Salem

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Supervision Committee:

Dr. **Mohamed Mohamed Abdel Aziz El Kammar**

Associate. Prof. of Geochemistry- Cairo University – Egypt

Dr. **Mohamed Abdel Fattah El Kashouty**

Associate. Prof. of Hydrogeology- Cairo University – Egypt

Prof. Dr. **Mostafa Abdel-Hamid Sadek**

Professor of Isotope Hydrology- Atomic Energy Authority- Egypt

Prof. Dr. Adel Abdel Aziz Sehim

Head of the Geology Department

Faculty of Science, Cairo University

NOTE

The present thesis is submitted to Geology Department, Faculty of Science, Cairo University in partial fulfillment for the requirements for the degree of master of science in Geology.

The candidate has attended postgraduate course for one academic year in the following:

1- Hydrogeology
2- Hydrogeochemistry
3- Connate oil water Well logging
4- Sedimentary basins
5- Principles of petroleum geology
6- Oil reservoir
7- Geochemical prospecting for hydrocarbons
8- Structural and stratigraphic control of subsurface fluids
9- Well logging
10- Statistics
11- German language

Prof. Dr. Adel Abdel Aziz Sehim

Head of the Geology Department
Faculty of Science, Cairo University

Dedication

To my late mother who supported me wholeheartedly…..

To all of the staff, friends and colleagues who helped me…..

To my family, for their ever-present support of my personal endeavours towards learning…..

To all of them I dedicate this work...

Hend Abu Salem, 2009

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ABSTRACT

The current study deals with the geochemical investigation of the groundwater encountered in Wadi El Natrun area, northeastern corner of the Western Desert. It aims to identify the recharge sources of the Pliocene aquifer and to evaluate its water quality for different uses, as well as to evaluate the temporal changes in the groundwater situation in Wadi El Natrun area due to long term exploitation. In order to achieve the goals of the study, hydrogeochemical and isotope analyses as well as age dating were carried out.

The surface sediments in the study area are represented by Late Tertiary and Quaternary deposits. The study area comprises two fold systems: the Syrian arc and the Clysmic fold systems. Three main fault systems of normal type affect the West Delta area. These are the Clysmic, Aqaba and Tethys fault systems.

The groundwater in Wadi El Natrun area belongs mainly to the Pliocene aquifer. The water flows from the Pleistocene as well as the Miocene aquifer to the Pliocene aquifer. The latter is also recharged from the irrigation water and from El Nubaria and El Nasr canals. The groundwater salinity of the Pliocene aquifer varies from fresh in the eastern part of the study area to brackish water due west and south. Fresh water could be attributed to the influence of the fresh water of the Pleistocene aquifer due east, the recharge from the water of Miocene aquifer in the southeast of the depression and the continental origin of most of the water-bearing formations. The dominance of brackish water in the southern and western parts of the depression could be due to the effect of the presence of a great thickness of clay sediments of lagoonal and marine origin with high content of salt, upward leakage and mixing with deep saline water through faults, lateral flow of saline water of the Miocene aquifer due southwest of the study area and due to extensive pumping rates. Generally, the TDS distribution pattern increases in the direction of flow, confirming the effect of water- rock interaction. The variation of lithologic facies in the different parts of the depression plays an important role in the water quality in the study area.

Chemically, there are three water types: sodium chloride water type dominates the study area, bicarbonate water type occurs in the southeast of the study area and mixed water type in the eastern part of the depression which implies possible blending of the groundwater due east of the depression (Pleistocene aquifer water) with that of the depression (Pliocene aquifer water). Moreover, the eastern and southern parts of

the depression seem to be controlled by carbonate dissolution and/or ion exchange, while the southwestern part of the depression is controlled by evaporite dissolution and/or reverse ion exchange process.

Oxygen and deuterium stable isotopes of the groundwater of the Pliocene aquifer reveals that the main source of recharge is of meteoric origin with minor modification processes. Most of the samples lie very close to the composition of the Old Nile water (prior to High Dam construction), apart from the point of present day Nile water indicating that groundwater recharge is not so active. Some samples shift toward more depleted values in the direction of the paleowater, which may reach the aquifer from the deep aquifers under exploitation.

The results of tritium analysis conducted on a selected number of Pliocene groundwater samples in the study area reveal no measurable tritium and indicate a residence time in excess of 50 years. Three groundwater samples were selected for ^{14}C aging. Their radiocarbon age varies in the range from 2100±70 y.b.p. to 9426±145 y.b.p. and increases toward the west of the depression reflecting the progressive proportional decrease of recent recharge in the direction of flow from east to west on account of a paleorecharge component. The relationship between radiocarbon age and $\delta^{18}O$ values of the Pliocene groundwater samples shows a general trend of decreasing $\delta^{18}O$ with increasing age confirming the presence of paleowater component of depleted oxygen-18 print which can be the Nubian sandstone aquifer water. The trend line indicated in the $\delta^{18}O$ vs. Radiocarbon age relationship may put constrains on the recharge sources of the groundwater in the study area, which could come from a combination of isotopically depleted Nubian Sandstone paleowater with a mixture of present day Nile water and pre High Dam Nile water.

The groundwater of both winter and summer seasons is evaluated for drinking and irrigation. With respect to TDS, the eastern part of the depression has acceptable water for drinking, while the central part of the depression is permissible whereas the western part of the study area is unsuitable. The groundwater is excellent to very satisfactory for livestock and poultry.

Key Words: Hydrogeochemistry, isotope hydrology, water quality, groundwater, Wadi El Natrun.

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