# GROUNDWATER AQUIFER MAPPING USING VES AND TDEM DATA: A CASE STUDY, WADI EL-NATRUN AREA AND ITS VICINITIES, WEST NILE DELTA, EGYPT.

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## Abstract

The Egyptian government is working on establishing new communities to overcome the over population crisis and construct new agricultural areas. One of the targeted localities for such plan is the West Nile Delta area where it is considered as promising area for creating new settlements. The present study aims to help such national plan through the delineation of the hydrogeological regime of Wadi El-Natrun area and its vicinities. The geoelectric resistivity survey includes 93 Vertical Electric Soundings (VES) carried out using Schlumberger array with AB/2 ranging from 1.5 m to 500 m. Also, time-domain electromagnetic (TEM) survey was executed near selected VESes where 44 TEM stations with loop spreading 50x50 m were measured. The quantitative interpretation was conducted through 1D inversion IX1D software from Interpex Ltd. 10 cross-sections (from VES data) and 3 cross-sections (from TEM data) were constructed and well correlated with the available borehole. The depth to the main aquifer ranges from 6 m near El-Nubariya city to about 90 m at the southern parts where it increases to the south and south east directions. Generally the aquifer system in the area can be divided into Pleistocene and Pliocene aquifers. The Pleistocene aquifer is the shallower aquifer in the area and it is almost consist of gravelly to clayey sand deposits. The Pliocene aquifer is the main aquifer where it is composed of sand to gravelly sand deposits where in some places, it can be divided into two aquifers. Depending on the inferred structural map, it is worth to mention that Wadi El Natrun and its lakes are structurally controlled by faulting system trending NW direction.

## Location of the study area

The area under investigation (Figure 1) is located to the west of Nile Delta on both sides of the Cairo-Alexandria desert road, between latitudes 30°17′ and 30°42′ N, and longitudes 30°40′ and 30°30′ E. It covers an area of about 1250 $Km^2$ of west Nile Delta region. Wadi El-Natrun depression is nearly occupied the southwestern part of it. The main cities in the study area are El-Nubariya, Wadi El-Natrun, and El-Sadat City. It is accessible from Cairo, Alexandria, northwestern Coastal zone and central part of the Nile Delta by good roads and railway system.

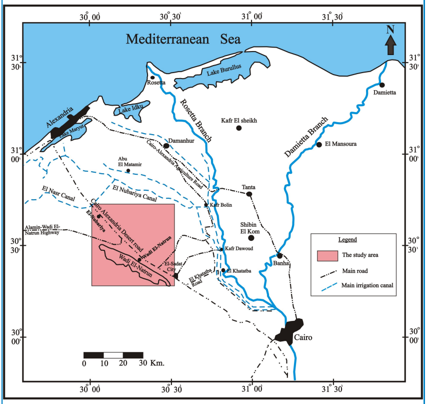

Fig (1) Location map of the study area.

## Geomorphology and Geology

The western Nile Delta fringe is generally characterized by slightly undulating topography and higher land comparing with that of cultivated part of Nile Delta. The topographic of the study area ranges between -23 m and 60 m. The exposed rocks in the area (Figure 2) belong to Cenozoic. The Oligocene outcrops composed of sand, sandstone, gravel and basalt. Neogene sediments are generally composed of sand and sandstone with clay and limestone intercalations. The Quaternary sediments are mainly clastic with essential sand facies and occasional gravel and clay intercalations. Sand sheets and sand dunes are detected towards north.

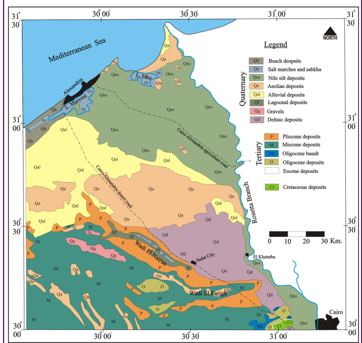

Fig (2) Geological map of the study area.

## Data acquisition

The geophysical field data used in the present work represented by a total of 93 VESes and 44 TEM stations were collected through several campaigns to investigate aspects of groundwater resources in the survey area. The VES field measurements (Figure 3) were carried out using direct current resistivity meter called McOhm manufactured by the OYO Corporation, using Schlumberger array with AB/2 ranging from 1.5 m to 500 m. TEM measurements (Figure 3) were made very close to the VES's sites where a simple coincident loop configuration, in which the same loop transmits and receives signals. The TEM instrumentation used for the survey is the SIROTEM MK-3 Conductivity meter and the conventional 50×50 TEM confirmation was applied. In all sites, the measurements were repeated up to five times. The best signal-to-noise data sets were chosen for further processing and interpretation. 1D inversion was carried out using the IX1D software from Interpex Ltd.

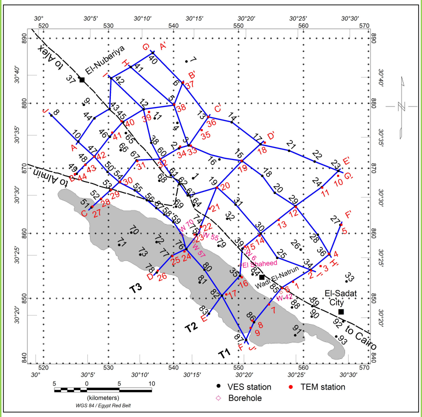

Fig (3): Location map of VES and TEM measurements

## Interpretation of VES and TEM data

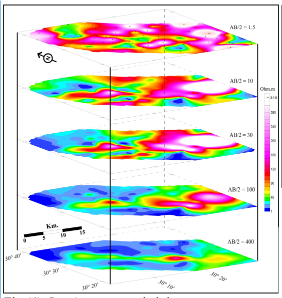

Fig (4): Iso-Apparent resistivity maps.

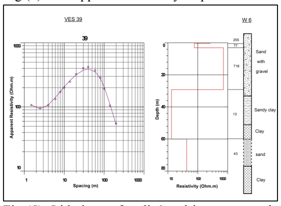

Fig (5) :Lithology of well 6 and its corresponding VES geoelectric section.

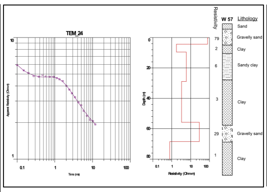

Fig (6) :Lithology of well 57 and its corresponding TEM geoelectric section.

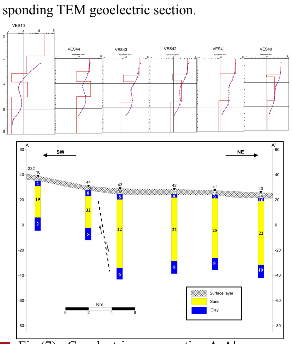

Fig (7) : Geoelectric cross section A-A'

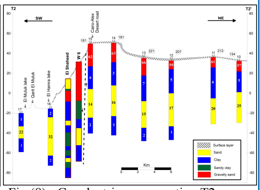

Fig (8) : Geoelectric cross-section T2.

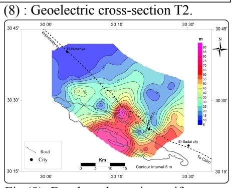

Fig (9): Depth to the main aquifer.

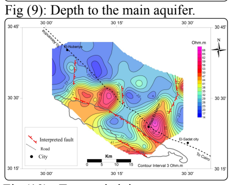

Fig (10) : True resistivity map.

## Results and Conclusions

Ten cross-sections (from VES) and three cross-sections (from TEM) were constructed and well correlated with the available boreholes. Two maps for the depth to the main aquifer (Figure 9) and its true resistivity (Figure10) are established depending on the results of the quantitative interpretation of the data. Generally the aquifer system in the area is divided into Pleistocene and Pliocene aquifers. The Pleistocene aquifer is the shallower aquifer and composed of gravelly to clayey sand deposits. The Pliocene aquifer is the main aquifer where it consists of sand to gravelly sand deposits. The main aquifer is determined at depth range varying from 6 m near to El-Nubariya city to about 90 m at the southern parts of the area where it increases to the south and southeast directions. A brackish groundwater detected at shallow depths at the northern and northeastern parts of the area whereas relatively freshwater can be determined at the southern and southeastern parts around Wadi El-Natrun city at deep depths. The inferred faults from the geoelectric sections were traced and collected to construct a structure map (Figure10). 2D inversion of VES data and joint inversion of VES and TEM data will be perform to confirm the structures inferred from 1D inversion.