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Contribution of TEM, DC and GPR to resolve the Environmental problem (Seawater intrusion) in northern coast of Egypt. .

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ABSTRACT

The study area is one of the main geographic units of Egypt. It lies in the western Mediterranean coastal zone between latitudes 31^o 06‘ and 31^o 15‘ N and longitudes 27^o 40‘ and 27^o 54‘E. The area is accessible from Matrouh city with about 70 km to the east and extends about 15 km on both sides. However, the studied area is characterized by gentle dipping (to the north) bedrock of carbonate lithology.

The northern part of the studied area is characterized by the occurrence of a series of elongated ridges oriented parallel to the coast and alternating with shallow elongated depressions.

The main purpose of the present study is to establish the applicability of the resistivity method in the form of 1-D sounding, 2-D inversion earth model, 2-D images and time domain electromagnetic (TEM) survey with ground penetrating radar (GPR) to groundwater exploration and to know the effect of seawater intrusion on the freshwater aquifer. For the groundwater exploration, a geoelectrical resistivity survey was conducted in terms of 49 VESes using Schlumberger array, of the maximum AB/2 = 500 m. The interpretation of a 1-D inversion was performed to give a layered resistivity earth using a nonlinear least squares method. From this interpretation 13 geoelectrical cross-sections, five from them parallel to the Mediterranean shoreline and

the others are perpendicular to the Mediterranean shoreline, have been constructed. Five geoelectrical zones have been established in the area. Distribution maps for the true resistivity and true thicknesses for the five units are presented. Because of some complicated geological structure, 2-D inversion based on ABIC least squares method for the same data set to the five geoelectrical cross-sections parallel to the seacoast have been carried out. The general distribution of resistivity shows a low value near to the shoreline from the north and east directions and in the depressions. However, the cross-sections derived from the 2-D inversion still show a rough spatial resistivity distribution, which corresponds to the abrupt changes of resistivity distribution between two neighboring blocks. Moreover, 150 TEM soundings at 40 stations beside the VES stations on all studied area using square loop 50m x 50m as a receiver and transmitter have been conducted to delineate the true resistivities and thicknesses for the conductive units, which are considered the aquifers in the studied area. The resistivity distribution of the main aquifer and its true thickness in a form of maps have been delineated. **A**ccording to the 1-D sounding and 1-D TEM surveys, four sites in the northern coastal depression and three sites in the southern depression were selected to study the applicability of 2-D resistivity imaging techniques, 1-D TEM sounding survey and ground penetrating radar (GPR) for mapping the saltwater intrusion in the shallow oolitic limestone aquifer. The selected four sites represent separate local hills in the northern depression, which are characterized by different hydrogeological conditions. Along the axes of the selected depression the 2-D resistivity imaging was carried out using Wenner and dipole-dipole arrays at the same lines. The survey was executed using various arrays to outline the resistivity variations in the horizontal and the vertical directions, in addition to study the reliability of these arrays for mapping the target at different depths and conditions. With Wenner and dipole-dipole arrays 13 profiles were measured using a system of 48 electrodes with spacing of 5 m between the adjacent electrodes. The inversion of the 2-D pseudo-section was carried out using RES2DINV program, to construct an image of the obtained true subsurface resistivity distribution and map the saltwater intrusion in four selected sites. Along the 2-D resistivity imaging, four 1-D TEM profiles have been measured using a square loop 25 m x 25 m and the average distance between the stations was about 50 m. and four GPR records have been measured also at same lines of the 2-D profiles. The average distance between any two sites is about 2.5 km. The compression of the 2-D models obtained from both Wenner and dipole-dipole arrays reflects that, Wenner array gives a horizontal high resolution, but the dipole-dipole array reveals the resistivity variations in the region over the target and gives a vertical high resolution. The integration of 2-D resistivity imaging , 1-D TEM profiles and GPR records can be considered as useful geophysical mapping tools for the delineation of the freshwater/ saltwater zones and intermediate zone and building a hydrogeological picture of the

fissured oolitic limestone aquifer in the investigated sites. The GPR profiles can detect the structure, fractured zones in limestone and delineate the water level in the selected sites, while the 1-D TEM soundings profiles and resistivity imaging can give more information on lithology and groundwater occurrences in the four sites selected as a compression between these profiles in different localities. The water table is presented at depths ranged between 18 m and 20 m in the two sites (Goht Nouh and Elwet El-Zitoun) and between 6 m and 8 m in Borbet area in the west, which is considered as lake marshes, and Sedi Badr well in the east.

Keywords: Tem, 2d resistivity imaging, inversion, Egypt