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Assessment of groundwater potentiality using geophysical techniques in Wadi Allaqi basin, Eastern Desert, Egypt – Case study

Ahmad Sobhy Helaly

Department of Geophysics, Faculty of Science, Ain Shams University, Egypt

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ABSTRACT

Electrical resistivity surveying has been carried out for the determination of the thickness and resistivity of layered media in Wadi Allaqi, Eastern Desert, Egypt. That is widely used geophysical tool for the purpose of assessing the groundwater potential and siting the best locations for boreholes in the unconfined Nubian Sandstone aquifers within the study area. This has been done using thirteen 1D Vertical Electrical Sounding (VES) surveys. 1D-VES surveys provide only layered model structures for the subsurface and do not provide comprehensive information for interpreting the structure and extent of subsurface hydrogeological features. The integration of two-dimensional (2D) geophysical techniques for groundwater prospecting has been done to provide a more detailed identification for the subsurface hydrogeological features from which potential sites for successful borehole locations are recognized.

In addition, five magnetic profiles were measured for basement depth determination, expected geological structures and thickness of sedimentary succession that could include some basins suitable for groundwater accumulation as groundwater aquifers.

1. Introduction

Wadi Allaqi study area lies within the longitudes 33°:08′E & 33°:21′E and Latitudes 22°:36′N & 22°:46′ N, in the Eastern Desert, Southern Egypt as shown in the location map (Fig. 1). To realize the potential of water availability, geophysical field measurements were done targeting the assessment of the groundwater availability in the Nubian Sandstone within the study area and siting the best boreholes locations for groundwater extraction.

Geophysical investigations provide a rapid and cost-effective means of developing information on subsurface hydrogeology (Kearey and Brooks, 1991). The use of geophysical methods for both groundwater resources mapping and water quality evaluation has increased dramatically over the last decades due to rapid advances in electronic technology and the development of numerical modeling solutions (Olayinka, 1991, Metwaly et al., 2009; Ndlovu et al., 2010). Although various hydro-geophysical techniques are available, electrical resistivity is a popular method because of its low cost, simple operation and efficiency in areas with high contrasting resistivity, such as between the weathered overburden and the bedrock (Telford and Sheriff, 1990). Geoelectrical methods are particularly suitable for groundwater studies because the hydrogeological properties; such as porosity and permeability; can be correlated to electrical resistivity values. Geoelectrical techniques are essentially concerned with the measurement of electrical resistivities of subsurface materials, which preferentially provides information on the different geological layers, structures and the associated occurrence of groundwater (Stewart 1982, Van Overmeeren, 1989, Dahlin et al., 1999, Nowroozi et al. 1999; Meju, 2005). Also, resistivity is related to various geological parameters such as the mineral and fluid content, porosity, and water saturation rates.

2. Geologic setting

Geomorphologically, the study area is occupied by a number of valleys and is surrounded by mountains and highlands composed of complex basement rocks. Such valleys are mostly plains covered with sands, gravels and rock fragments. These valleys are gently sloping towards the southeast. From field observations, it is found that the deposited layers are also dipping towards the southeast.

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E-mail address: ahmad.helaly@sci.asu.edu.eg

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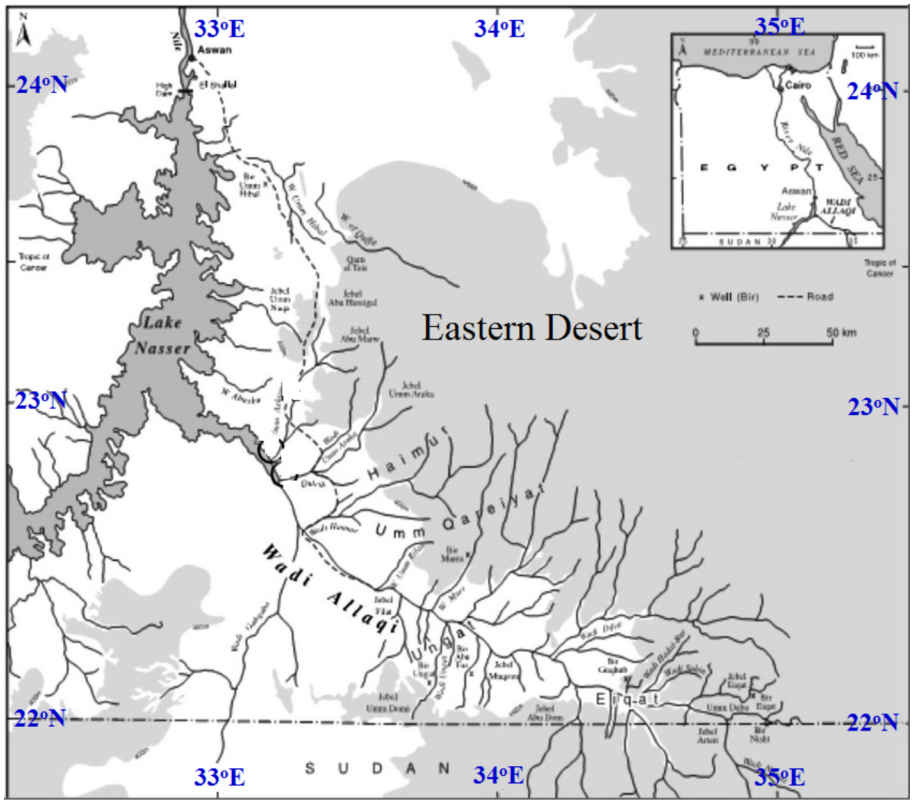

Fig. 1. General location map of the study area & surroundings (Kandal et al, 2016).

Geologically, Wadi Allaqi is one of the most important valleys in the southern part of the Eastern Desert, to the east of Naser Lake. This valley is filled with fluvial sand and silt deposits belonging to Quaternary (Pleistocene) age. Fig. 2 shows a geological map illustrating that Wadi Allaqi is bounded by igneous and metamorphic rocks from the east, while from the west, it is bounded by Nubian Sandstone.

More enlightening information about the geology of the study area and its surroundings points to that, in general, about 50% of the granitic rocks in the Eastern Desert are classified as older and younger granites. The younger granites cover about 30% of the plutonic rocks in the Arabian shield. The relative abundance of the younger granites compared to the older granites increases from 1:4 due south of the Eastern Desert to about 1:1 due north (Stern

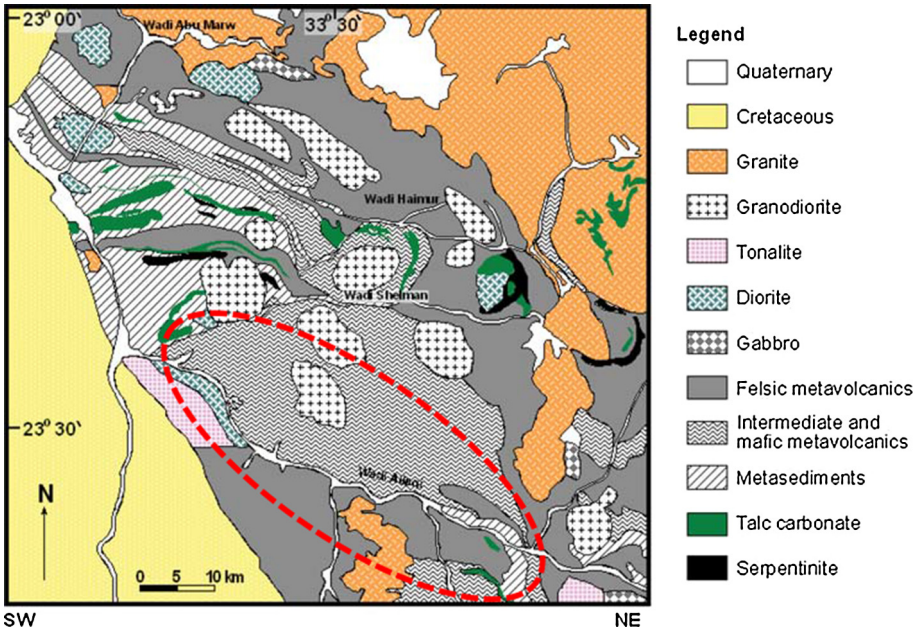

Fig. 2. Geological map of the study area (Wadi Allaqi) (Shams et al., 2012).

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