



Geophysical and hydrogeological investigation to study groundwater occurrences in the Taref Formation, south Mut area – Dakhla Oasis - Egypt



Hussein Hosni Mahmoud ^{a, *}, Saad Younes Ghouhachi ^b

^a Geophysical Exploration Department, Desert Research Center, Cairo, Egypt

^b Geological Department, Desert Research Center, Cairo, Egypt

ARTICLE INFO

Article history:

Received 2 November 2016

Received in revised form

7 January 2017

Accepted 6 February 2017

Available online 8 February 2017

Keywords:

Vertical Electrical Sounding

Petrophysics

Aquifer parameters

DZ parameters

South Mut area

Dakhla Oasis

Egypt

ABSTRACT

Integrated geophysical and hydrogeological techniques can give vital information about groundwater occurrence in the south Mut area, where groundwater is the sole source of water supply in this arid area. Quantitative interpretation of the Vertical Electric Soundings (VES) clarified the geoelectric succession in the study area. Geoelectric parameters (resistivity and thickness) of each geoelectric layer and the available data of the existing wells were used to illustrate the vertical and spatial extensions of the encountered layers, depth to the water-bearing layer, the structures affecting these layers, water level and groundwater flow of the concerned aquifer.

Groundwater in the study area occurs under confined and semi-confined conditions in the northern part and it occurs under unconfined conditions in the southern part. Dar Zarrouk (DZ) parameters were calculated to differentiate the areas of confined conditions from those of unconfined conditions. Groundwater salinity ranges between 343 and 654 ppm which is suitable for all purposes and its type is calcium sulfate and sodium sulfate.

Petrophysical analyses were carried out on the collected rock samples to evaluate their mineralogical and pore properties, which showed that this aquifer is composed of arenite sandstone with good porosity.

The results of the analysis of three constant pumping tests revealed that the hydraulic conductivity and transmissivity have high values, indicating that the aquifer has high potentiality. Combining the geoelectrical and hydrogeological results, the best sites for drilling new productive wells were recommended.

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1. Introduction

The study area is located south Mut City, southern part of the Dakhla Oasis, in the central part of the Western Desert of Egypt. It is bounded by latitudes 25° 22' 11" and 25° 28' 58" N and longitudes 28° 57' 30" and 29° 4' 20" E covering an area of about 60 km² (Fig. 1). The area under investigation is characterized by an extremely arid climatic condition having very low annual rainfall (1.6 mm). The minimum temperature (4.4 °C) was recorded during January, whereas the highest temperature (40.2 °C) was recorded during June. The minimum evaporation value was recorded in

January (5.4 mm/day) and its maximum value was recorded in June (16.9 mm/day).

The ground surface of the study area is covered by sand, silt and clay that are derived from the decomposition of pre-existing Cretaceous rocks (Mut and Taref Formations) with low relief. Its surface elevation ranges from 114 to 180 m above sea level with general slope towards the northwestern direction. Some residual hills from the Taref Formation are exposed in the central and eastern parts of the study area. This area represents the normal extension of the old cultivated lands in the Dakhla Oasis, and it is suitable for land reclamation projects.

Groundwater represents the sole source of water supply in this Oasis. New reclamation projects and development activities in the south Mut area increased the water demands. So, the main objectives of the present work is to investigate groundwater occurrence

* Corresponding author.

E-mail address: dr.husseinhosni@yahoo.com (H.H. Mahmoud).

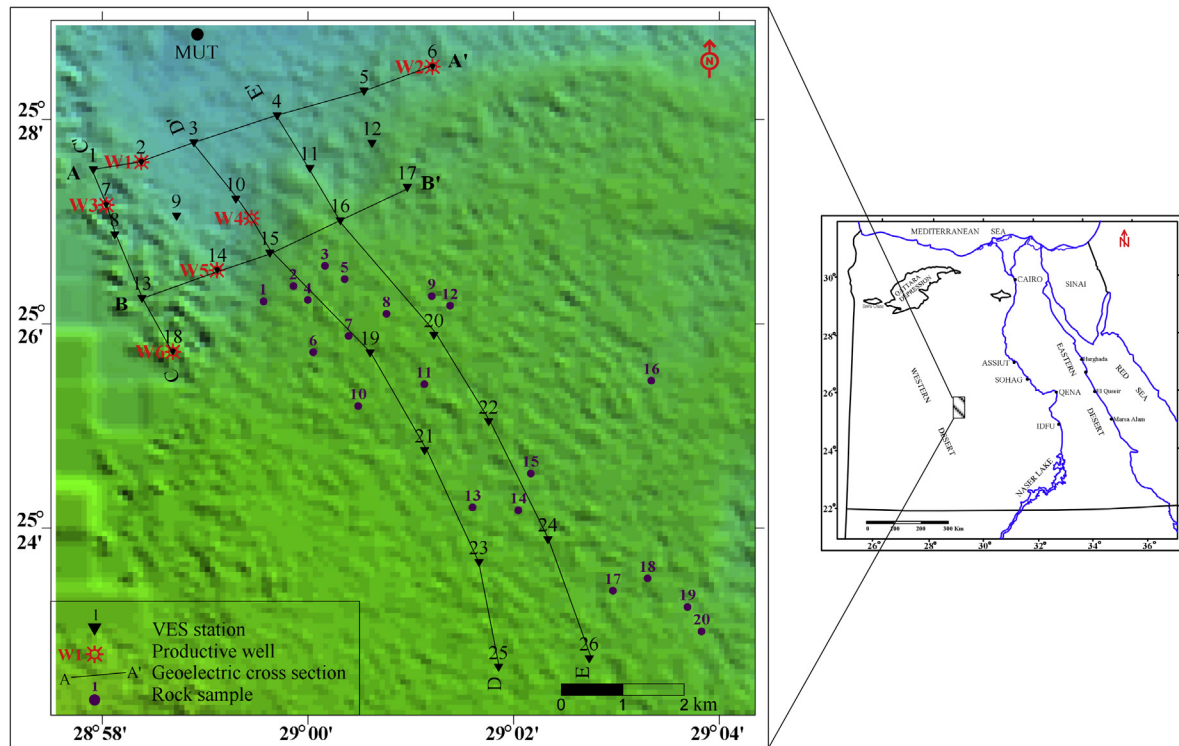


Fig. 1. Location map of the study area.

in the Taref Formation, determination of some aquifer parameters and to locate proper sites to drill new productive wells to satisfy the increasing needs of water in such an arid area. To achieve these objectives geophysical techniques including Vertical Electrical Sounding (VES) and petrophysical measurements, in addition to normal hydrogeological investigations were adopted.

2. Morphological, geological and hydrological settings

The Dakhla Oasis represents one of the famous depressions of the great sandstone-limestone plateau of the Western Desert. The tectonic action (faults and folds) followed by the weathering processes (physical and chemical) associated with the climatic changes of the Quaternary times made modifications and helped in forming the present shape of the Dakhla Oasis (Ball, 1927; Ibrahim, 1957). The investigated area exhibited three main geomorphologic units: the high plateau unit, the depression unit, and the structural plain unit (Ghouhachi, 2001). The following is a description of these units (Fig. 2):

- 1 The high plateau unit bounds the Dakhla depression on the north; it is characterized by a wide extended surface and a precipitous escarpment. Its surface is generally rough and slopes regionally in the northward direction. This unit is divided into two subunits (the plateau surface and the escarpment subunits).
- 2 The depression unit is controlled structurally and it is an erosionally low topographic area. It contains different landforms represented by the alluvial terraces, the piedmont flats, and the residual hills.
- 3 The structural plain unit resulted from the merging of the Dakhla depression gradually to the south into an extensive elevated plain sloping northward. The origin of this plain is either by weathering (Mitwally, 1953) or by erosion (Shata,

1953). This plain contains sand dune chains and isolated hills, which are affected by structures (faults and fractures).

The exposed rocks in the study area and its vicinity range in age from Upper Cretaceous to Quaternary (Attia, 1970; Mansour et al., 1982 and Said, 1990). These rocks are represented by the Taref Formation, the Mut Formation and Quaternary deposits. The following is a description of these sediments (refer also to Fig. 3):

- 1 Taref Formation: It is mainly composed of fine to medium grained and well sorted sandstone with a few shale interbeds overlying the Maghrabi Formation (shale and claystone) and underlies the Mut Formation (claystone). Its thickness is more than 100 m at its type locality at Gabal El-Taref in north El-Kharga Oasis (Awad and Ghouhachi, 1965). In the subsurface, its average thickness reaches 110 m increasing to the south of the Dakhla depression (Ghouhachi, 2001). This formation is of Turonian age (Said, 1990).
- 2 Mut Formation: it overlies the Taref Formation forming the surface of the Dakhla depression and gives the reddish color to the depression (Barthel and Herrmann-Degen, 1981). This formation is composed of moderately hard, ferruginous, reddish claystone attaining a thickness of 90 m at its type locality in the Dakhla depression. Its age is Campanian (Said, 1990). In the subsurface its thickness ranges from 2 m to 38 m (Ghouhachi, 2001) and thickness decreases towards the east and the south where the Taref Formation is exposed on the surface.
- 3 The Quaternary deposits are of continental origin (eolian sediments). These deposits include sand dune, sand sheet, and playa deposits.

From the structural point of view, Shata (1953) considered the Dakhla depression as a low area occurring between major structural highs. On the other hand, Hermina et al. (1961) stated that

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