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Geophysical characterization of the role of fault and fracture systems for recharging groundwater aquifers from surface water of Lake Nasser

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ABSTRACT

The role of the fracture system is important for enhancing the recharge or discharge of fluids in the subsurface reservoir. The Lake Nasser is consider one of the largest artificial lakes all over the world and contains huge bulk of storage water. In this study, the influence of fracture zones on subsurface fluid flow in groundwater reservoirs is investigated using geophysical techniques including seismicity, geoelectric and gravity data. These data have been utilized for exploring structural structure in south west Lake Nasser, and subsurface discontinuities (joints or faults) notwithstanding its related fracture systems. Seismicity investigation gave us the comprehension of the dynamic geological structure sets and proposing the main recharging paths for the Nubian aquifer from Lake Nasser surface water. Processing and modelling of aerogravity data show that the greater thickness of sedimentary cover (700 m) is located eastward and northward while basement outcrops occur at Umm Shaghir and Al Asr areas. Sixty-nine vertical electrical soundings (VES's) were used to delineate the subsurface geoelectric layers along eight profiles that help to realize the subsurface geological structure behind the hydrogeological conditions of the studied area.

1. Introduction

In Egypt, The population is rapidly growing now exceeding 90 million and the majority lives in less than 6% of its land area. To overcome this, the government of Egypt has been implementedmany engineering projects in southwestern Egypt for the purpose of managing its water resources and expanding its agricultural areas (Taha et al., 2009). The High Dam of Aswan was constructed in the 1960s to store the flooded water which came from The Nile upstream. The building of the Aswan High Dam caused the creation of the second largestworld artificial lake called Lake Nasser, and caused continuous recharge of the underlying Nubian aquifer either due to natural infiltration process or through the fault systems, and the fracture systems located around that Lake (Khamis et al., 2014). The study area is suitable for the conjunctive management of groundwater and Nile water for sustainable development. It is located between latitudes 22°30′ and 23°00′N and longitudes 31°25′ and 31°50′E. It covers an area of about 2567 km^2 as shown in Fig. 1.

The groundwater flow and contaminant transport, are predominantly provided through an insufficient number of dominant fractures, consequently, the precise characterization of these fractures and fault zones, as well as their connectivity is of supreme importance in prognosticating the hydraulic behaviour. In this paper, we concern mainly with the contributions of the Lake Nasser for recharging subsurface aquifers and the role of geological structure of fault systems as well as accompanied fractures in this process. Integrated geophysical data including seismicity, gravity and geoelectric measurements were used for investigating tectonic structure in south west of the Lake, and subsurface discontinuities (joints or faults) in addition to its associated fracture systems. Moreover, analysis of seismicity map helps to understand the active geological structure sets and proposing the main recharging paths for the Nubian aquifer from Lake Nasser surface water (see Table 1).

2. Geological setting

Study area is considered as a part of the stable shelf that lies to the north western edge of the Nubian Shield. The earth surface is comprised of plain sand sheet; the altitude is from 280 m to 165 m above sea level.

This sand sheet is bounded from the north by a carbonate plateau of 500 m height above sea level and is bounded from the east by the Red Sea granitic mountains series that attain a height of 1000 above sea

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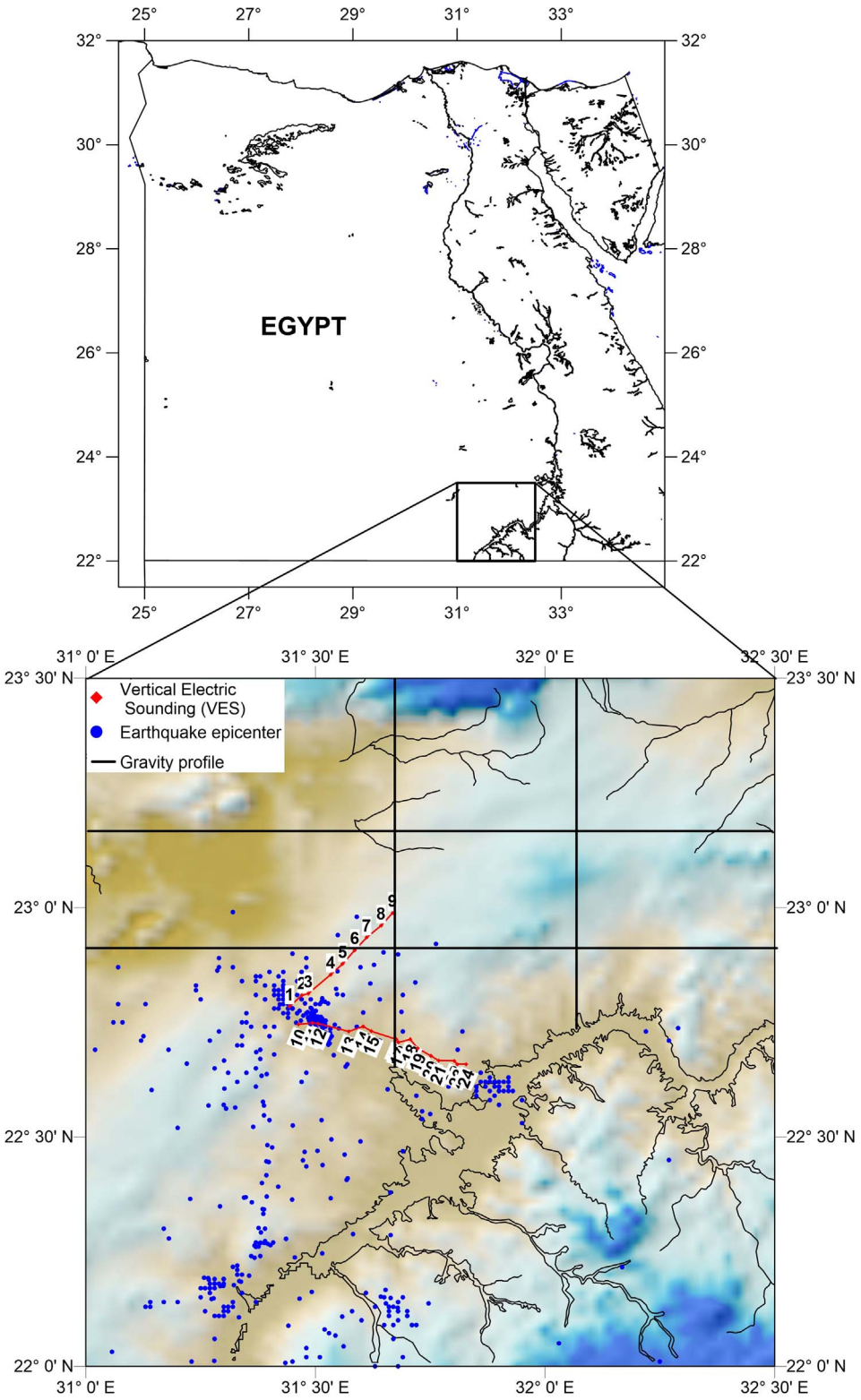

Fig. 1. Location map of Lake Nasser showing the distributions of earthquake epicentral (blue dotes), locations of VES measured stations (red squares) and gravity profiles used for 2D modeling (black lines).

level. The existence of this mountains series may explain the existence of the short wadies slope towards Toshka area from the east i.e. Wadi El Alaqi. The Naser Lake basin is bounded by a group of Khours, e.g. Toshka and Klabshakhours. There are some plains penetrate El Kharga Oasis depression and extend to the Toshka depression. From western side of these plains there is a thick belt of sand dunes about of 30 km, this belt extends to the north towards Baris Oasis, and to the north towards Salima Oasis in the north of Sudan. Fig. 2 shows the geological map of Lake Nasser area (CONOCO, 1987).

3. Seismicity around Lake Nasser

The earthquakes in the study area were collected for the period from 1982 to 2006 principally and gathered from Aswan seismic Bulletin,