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Integrated geophysical studies on the area east of Abu Gharadig basin, southern Cairo, Egypt, using potential field data

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Abstract Potential field data of the area east of Abu Gharadig basin were used to delineate the tectonic framework of probable economic interest and for future development plans for the area. To achieve this goal, the RTP and Bouguer gravity maps of the study area were subjected to several filtering and processing techniques. The regional magnetic map shows NE–SW high regional magnetic trends at the northwestern and southeastern parts as well as low magnetic trends at the central part reflecting thick non-magnetized sediments and/or deep highly magnetized basement rocks. Similarly, the regional gravity map shows NE–SW diagonal high and low gravity trends across the entire area of study as well as a distinct increase of gravity values toward the northwest corner reflecting thickening of sedimentary cover and/or deepening of denser basement rock at the central part. The residual maps reveal many anomalies of shallow sources with different polarities, amplitudes and extensions in the form of alternating high and low gravity and magnetic indicating that the basement rocks are dissected by faults forming uplifted and downthrown blocks.

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Edge detection techniques outlined effectively the boarders and extensions of the structural highs and lows through showing gravity and magnetic maxima over the edges of these tectonic features. Moreover, the River Nile course is controlled by shallow normal faults affecting the recent Nile sediments and is clearly shown by edge detection maps of gravity data.

Euler deconvolution of magnetic and gravity data reveals clustering of solution along fault trends or causative bodies centers. The Euler depth estimate to the basement surface shows a good correlation with the depth determined by the power spectrum method where its value ranges around 4 km. The interpreted basement tectonic map of the study area is dominated by ENE–WSW Syrian Arc, NW–SE Gulf of Suez and Red Sea, NE–SW Aqaba, E–W Mediterranean and N–S East Africa tectonic trends. The older tectonic trends were reactivated then intersected by younger ones.

1. Introduction

The study area is located east of Abu Gharadig basin and bounded by the Nile Valley from the east. It occupies the area southwest Cairo and situated between longitudes 30°00′ and 31°30′E and latitudes 29°00′ and 30°00′N. The study area covers an area of about 16,500 square kilometers most of them lies west of the Nile valley (Fig. 1). It consists of three main structural features: El-Faiyum depression, Qarun lake and Wadi Rayan depression (Fig. 2). El-Fayium depression is one of the spectacular depressions in the Eocene limestone plateau of the Western Desert of Egypt and represents an important basin in the Northern Western Desert. Qarun Lake is located at the northern part of El-Faiyum depression and was originated as pull-apart basin due to two parallel strike-slip faults. Wadi El-Rayan depression occupies the southwestern part of the study area and is dissected by NW–SE faults (El-baz et al., 2001; Kusky et al., 2011). Moreover, the Nile River runs through its eastern side where cultivated lands represent a narrow north–south belt. The cultivated lands are also represented by a wide area south and southeast Qarun Lake. The Nile depression is located at the eastern side and underlain by a graben structure made of two fault lines striking NW–SE.

The main goal of the current study was to integrate the gravity, magnetic and all available geological data to delineate and interpret the subsurface tectonic trends and structures dominating the study area. To accomplish this goal, the aeromagnetic map complied by the General Petroleum Company in 1986 with scale 1: 100 000 and contour interval 5 gammas and the Bouguer anomaly map complied by the Geological Survey of Egypt in 1986 with scale 1: 100 000 and contour interval 1 milligal were subjected to treatment and processing techniques by which the possible subsurface hidden features can be revealed. The results of these techniques are presented in a number of maps that can be interpreted for identifying the characteristics of the subsurface structures of the concealed inferences.

2. Geologic settings

The generalized stratigraphic column of the northern Western Desert of Egypt is thick and includes most of the sedimentary succession from Pre-Cambrian basement complex to Recent. Drilled well information indicates that, the average thickness of the comparable sedimentary cover increases northwards. The total thickness, despite some anomalies, increases progressively to the north from 1830 m in the south to 7620 m in the coastal area (Sultan and Halim, 1988). The basement rocks were encountered in just three wells of many drilled wells in the study area: Kattania-1 well at depth of 3761 m, Wadi Rayan-1 well at depth of 1265 m and Abu Roash-1 well at depth of 1890 m.

The stratigraphy of the study area has been discussed by many authors, including Beadnell (1905), Said (1962), Vondra (1974), Tamer et al. (1975), Said (1981), El-Anbaawy et al. (1988), Mohamed (1989), Brimich et al. (2011) and Kusky et al. (2011).

Generally, the Middle Eocene and Oligocene rocks form the main bulk of the sediments in the study area and thin toward the south and southwest. Pliocene and Quaternary sediments are also common. The Eocene rocks are composed of limestone with some flints, mainly blanketing most of the southwestern portion of the study area, around El-Faiyum Depression (Fig. 2) (Kusky et al. (2011). Meanwhile, the Miocene deposits mainly cover the northwestern portion of the area. The Miocene deposits are separated from the Eocene rocks by narrow belt of Oligocene rocks outcropping north of Lake Qarun and are composed of cross-bedded sandstones and gravels with interbeds of shales and limestones. To the east, the Pleistocene–Recent sediments mainly cover the narrow strip of the Nile Valley, around the cultivated lands, with local Pliocene outcrops covering the older rocks. Surficial deposits in the form of sand dunes running generally in a north

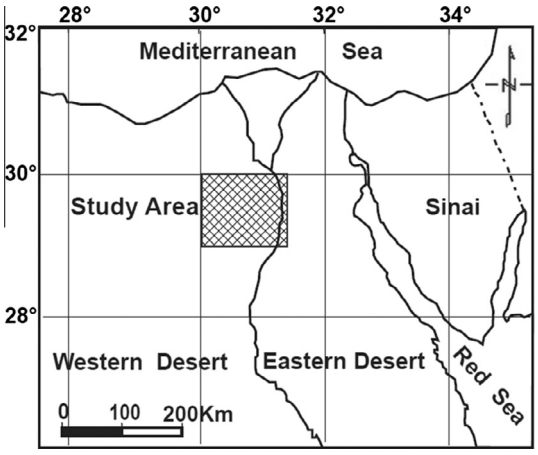

Figure 1 Location map of the study area.

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