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Implementation of magnetic and gravity methods to delineate the subsurface structural features of the basement complex in central Sinai area, Egypt

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ABSTRACT

The area of study is situated in the center of Sinai Peninsula. The current study is concerned with the analysis of magnetic and gravity data aiming to evaluate the subsurface structure of the basement rocks. The aeromagnetic and gravity methods of prospecting give an effective presentation of the subsurface structures. The aeromagnetic data was corrected and represented by total aeromagnetic intensity map then was reduced to the north magnetic pole. The corrected gravity data is represented by Bouguer anomaly map. The filtering techniques were applied to the corrected aeromagnetic and gravity maps to obtain the residual component caused by local structures and anomalies bodies. The integration of radially power spectrum was applied on both magnetic and gravity to estimate the depths of the shallow sources and the deep sources. The equivalent depths of the isolated short wavelength anomalies are 0.5 km and 0.4 km, and the depths of the long wavelength anomalies are 3.5 and 3 km for the magnetic and gravity data, respectively. The Euler deconvolution and 3-D modeling were applied to magnetic and gravity data. The 3-D Euler deconvolution is used not only to delineate major subsurface structures but also to determine the structural indices of them as well as the average depth of the magnetic and gravity sources. The calculated structural indices show that the area is mainly affected by contacts/thin sheet and the estimated depth of magnetic and gravity sources ranged between 500 m and 2000 m, also the 3-D Euler deconvolution showed that the area was affected by different fault trends such as NNE-SSW, NW-SE and E-W trends. The results of 3-D magnetic and gravity interpretation revealed that the depth of basement was ranging from 2500 m to 3000 m .The main tectonic deformations of the area of study have NNE-SSW, NW-SE and E-W trends.

1. Introduction

The area of study of Magnetic data is situated in Central Sinai between two latitudes 29°10′ and 30°40′N and two longitudes 33°00′ and 34°30′E, covering an area 24,163 km^2. The Study area of gravity data is located also in Central Sinai between latitude 29°45′N and 30°15′N. and longitudes 33°10′E and 34°10′E, covering an area 5347 km^2 (Fig. 1). Integrated geophysical tools, aeromagnetic and gravity methods, are generally used in detecting the subsurface structures, the depth of the basement and, the sedimentary cover thickness. Several authors used integrated geophysical techniques at central Sinai area. Awad et al. (2001) utilized the gravity and deep seismic data to estimate the relation between the thickness of the crust and Bouguer anomalies., Ghamry (2002) applied a geophysical study on El-Hasana area located in the northern part of central Sinai., El-Bohoty et al. (2012) conducted comparative studies between the structural and tectonic situation interpreted from magnetic, gravity, and seismic data at the southern part of Sinai and red sea area, Egypt. Mekkawi et al. (2007) used magnetic

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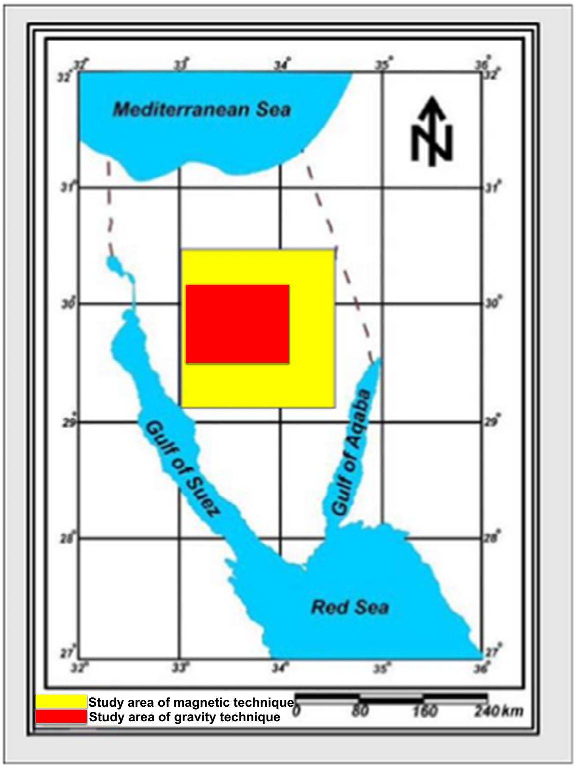

Fig. 1. Location map of the study area.

and magnetotulleric data to determine subsurface structure in the Hot Spring area, Central Sinai, Egypt. Sultan et al. (2009) applied geophysical techniques to image the subsurface and explore ground water at the central part of the Sinai Peninsula, Egypt. Rabeh (2011) designed a tectonic model of Sinai Peninsula depending on the geophysical investigations. Selim and Aboud (2012) in their geophysical study on the center of Sinai Peninsula discussed the sedimentary cover overlaying the basement and the structural trends that crossing the area through using magnetic and gravity data analysis and Araffa et al. (2015) carried out a geophysical study on the central part of Sinai by using magnetic, gravity and geoelectric methods. This research illustrates an integrated geophysical study to estimate the geologic subsurface structures and the depth of the basement complex.

2. Geologic settings

The central part of Sinai Peninsula consists of two plateaus (El-Tih and El-Egma plateaus) which occupies 40 percent of Sinai and sloping northward toward Wadi El Arish. The maximum elevation of El-Tih Plateau is about 1600 m and decreases northward direction while El-Egma plateau lies to the north and has a maximum elevation of about 1650 m towards the south and decreases to 500 m northward. The study area is covered by sediments which were deposited on predominantly shallow platform and range from Cambrian to recent in age. In general, a thick sedimentary cover in Central Sinai that overlies the Precambrian basement rocks is morphologically forms the two outstanding El-Tih and El-Egma plateaus (Said, 1962). The geological map of the area of study (Fig. 2) shows several rock units of different ages and lithology (Modified after EGSMA, 1981). The succession of the stratigraphic strata in the area illustrated in (Fig. 3). Structurally, there are three main structural provinces distinguishing the Sinai Peninsula which are all involved in the central part of Sinai Peninsula. From south to north these structural provinces are: stable shelf, transitional zone and unstable shelf, respectively. The first two provinces (stable shelf and transitional provinces) in which the study area is included occupy the plateaus of central Sinai, which are affected by NE- and NW trending faults. The last province (unstable shelf province) is affected by fold-belt of the Syrian Arc System which northly ended by the E–W trending Nile Delta Hinge zone.

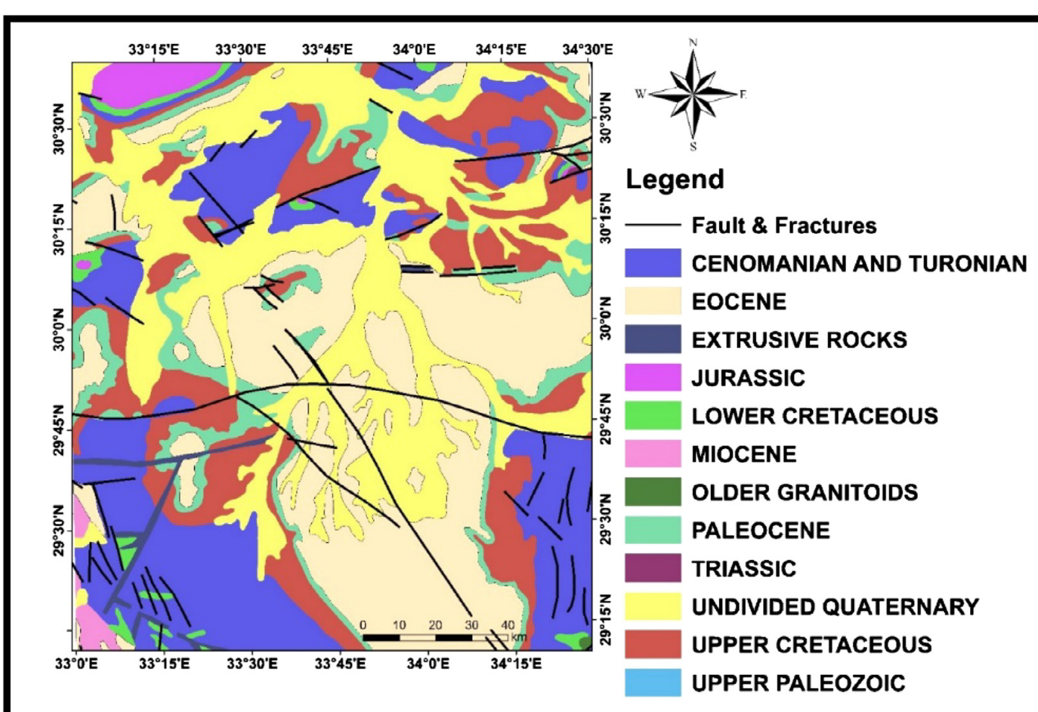

Fig. 2. Geologic map of the study area shows the main geological formations of the surface (Modified after EGSMA, 1981).

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