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FULL LENGTH ARTICLE

Agnes high, Western Desert, Egypt: A structural study in view of potential data modelling

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Abstract The spatial relationship between the gravity and magnetic maxima of Agnes horst had been studied utilizing a joint modelling technique. The process depends mainly upon combining the Bouguer and Reduced To north Pole (RTP) aeromagnetic data for constructing 2D/2.5D models of the upper crustal layers. These integrated approaches were accomplished in regional and shallow senses along two profiles, for better obtaining source parameters and finding out the structural style.

Results of the qualitative analysis show that Agnes high gravity and magnetic association is mainly caused by a near surface igneous intrusion of NW orientation. Quantitatively, regional models indicate a normal continental type of crust, which is divided into upper and lower by the Conrad surface (21.5–22 km). The crust–mantle interface lies at 32–33 km meanwhile the magnetic crust reaches a depth of 16 km. Local models reveal that the basement rocks north and south of the Agnes high were offset by some 6–8 km and 3–4.5 km, respectively. Statistically, the area was controlled by two main old trends; the most prevailing WNW to NNW (East African) and the less abundant ENE (Syrian Arc) trends. These two principal trends almost have its doubtless impact on preservation of possible accumulations.

1. Introduction

Agnes high considered as one of the most anomalous features which exist in the north Western Desert along the E–W direction. It locates to the east of the Qattara Depression, in northern Western Desert of Egypt, which represents part of the unstable shelf of northern Africa and the Mediterranean. The area under investigation is located between Latitudes 29° 00′ N & 29° 45′ N and Longitudes 28° 00′ E & 29° 15′ E (Fig. 1). It hosts two major basins; North Abu Gharadig basin where there are many of oil and gas fields (Table 1) and South Abu Gharadig basin or Miswage graben. They are separated from each other by Agnes–Rammak horst, which belongs to the Apollonia–Kattania uplift, and bounded from the north and south by Ras Qattara ridge (Sharib–Shiba) and Sitra Platform, respectively. The Kattaniya high actually limits the area to the east, and separates it from El Gindi basin.

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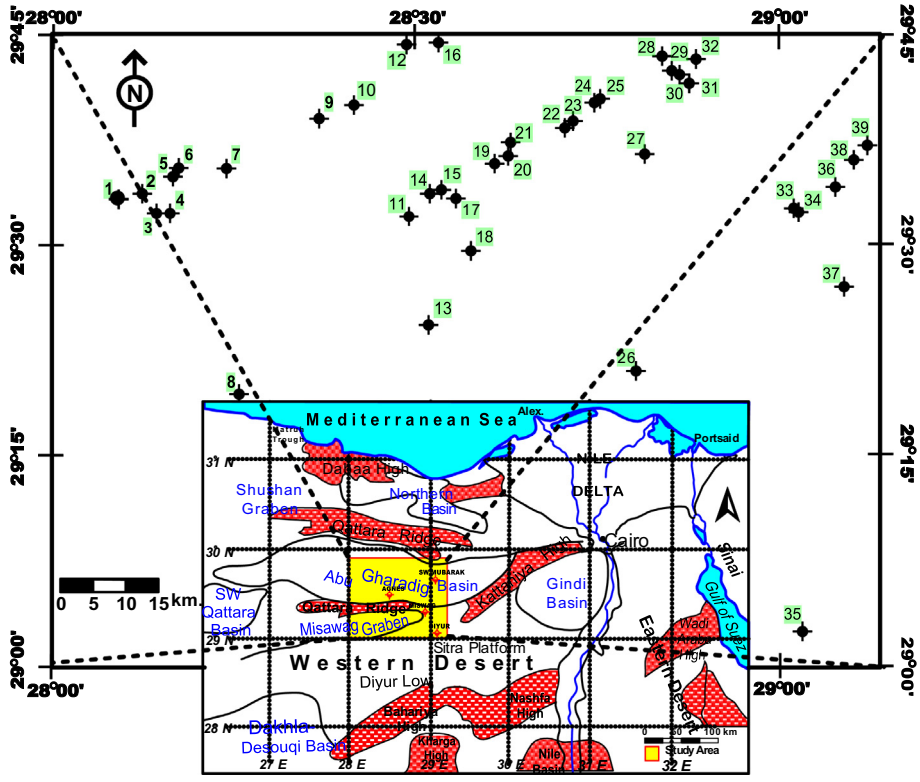

Figure 1 Location map of the study area showing locations of the drilled wells.

The purpose of this paper is to discuss the structure of Agnes area and give a demonstration for its tectonic setting in view of potential modelling. This was done through integration of the geological data and geophysical experiments to construct regional and local models for the upper crust. They ultimately aim to correlate the deep-seated and near-surface structures to improve the definition of the structural style.

The present work is based mainly on the gravity and magnetic tools as rapid methods for detecting the deeper structure. The gravity and magnetic highs of the Agnes horst, as a focal point, were focused to study their causative sources. Both of the Bouguer anomaly map with scale 1:100,000 and contour interval of one mGal measured by General Petroleum Company, 1986, and RTP aeromagnetic map provided by the General Egyptian Petroleum Corporation, 1986 with scale 1:250,000 and contour interval of 10 nT are the main source of data. Interpretation of these maps was achieved by applying several processing and filtering techniques which are important in the geophysical explanations. For instance, isolation of the residual anomalies on the expense of the regional ones was performed to clear type of anomalies and better-resolute picture. The average depths to the source bodies and major crustal interfaces were obtained from the power spectra of their gravity data. As well, the maximum depth of the magnetic crust, considering the Curie isotherm point, was estimated from the magnetic data using spectral analysis. The frequency distribution curves for the anomaly trends deduced from the Bouguer and RTP aeromagnetic maps were overlapped and used to delineate the major tectonic trends affecting the area. Two correlation charts and one geologic cross-section tying the study area in NW and NE directions have been constructed displaying the unconformities and depositional packagings across the study area.

At last, to obtain a more quantitative representation of the sub-surface situation, the Bouguer and RTP anomalies were analysed through performing a joint 2D/2.5D modelling along two long profiles covering the area in northeast and northwest directions. The significant geologic boundaries of the crust including the basement surface and the Conrad and Mohorevic discontinuities as well as the magnetic layer, were approximated through constructing two regional models. Other two local profiles were taken along the same trends on the residual gravity/magnetic maps. They were constructed concerning the uppermost 9 km of the crust, including the sedimentary layers and basement rocks. The models were built on the basis of the geological background, well logging information and seismic data. These different integrated geophysical tools are quiet valuable to produce an excellent configuration and geometry of the subsurface structures.

2. Geologic setting

The information derived from the wells drilled in the study area indicates that most of the region is characterized by a thick Palaeozoic to Recent section unconformably overlies the Precambrian granitic basement of pan African. The sedimentary succession above the basement can be subdivided into six major cycles (Fig. 2) separated by broad unconformity surfaces [1]. Major unconformity surfaces vertically separate basins of different ages with contrasting tectonic and stratigraphy. In general, it is characterized by a non-marine to marginal marine clastics at the base, while open to shallow marine fine