

INTERPRETATION OF GEOPOTENTIAL FIELD ANOMALIES IN AREA AROUND SOHAG, EGYPT

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تفسير بيانات الجهد الأرضي على المنطقة الواقعة حول سوهاج ، في مصر

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تمثل منطقة الدراسة إحدى المناطق الواقعة بمصر الوسطى (حول منطقة سوهاج) ، وتهدف الدراسة الحالية إلى إلقاء المزيد من الضوء على الظروف الجيولوجية تحت السطحية في هذه المنطقة . تركز هذه الدراسة على البيانات الثقالية المستمدة من خريطة البوجير ، وأيضاً على البيانات المستمدة من خريطة المغناطيسية الأرضية .

تتميز منطقة الدراسة بسمك غير كبير للرواسب ذات بيئات ترسيبية متنوعة . ويعتبر نهر النيل أهم الظواهر الطبوغرافية بالمنطقة . يمثل الحجر الجيري الأيوسيني أهم الوحدات الصخرية المكونة للهضبتين الشرقية والغربية لمجرى نهر النيل . بينما تغطي رواسب الرمال والحصى وغيرها من رواسب الوديان الأجزاء القريبة من هضبتي الحجر الجيري ، أما المناطق المتاخمة لمجرى النيل (الأرض الزراعية) فهي تتكون من رواسب الطين والغرين .

ومن الدراسة الحالية تم استنتاج الآتي :

- ١ - توجد زيادة ملحوظة ناحية الشمال في عمق صخور الركيزة المعقدة (٢ - ٣ كم) .
- ٢ - صخور الركيزة المعقدة تأثرت بالكثير من الفوالق التي تأخذ إتجاهات مختلفة من أهمها شمال شرق - جنوب غرب ، شمال غرب - جنوب شرق ، شرق - غرب .
- ٣ - تتميز صخور الركيزة المعقدة على طول مجرى النيل بوجود كتل صخرية هابطة لأسفل نتيجة حدوث تفلق .

٤ - يعتقد أن يكون السبب في الشذات الثقالية السالبة على خريطة البوجير والتميز أيضاً بشذات مغناطيسية في نفس المكان هو وجود أجسام داخل صخور الركيزة المعقدة علي عمق كبير من سطح الأرض ، هذا بالإضافة إلى تنوع بيئات الترسيب في هذه المنطقة .

٥ - يتراوح عمق الأجسام التي تم تفسيرها من أعداد مجموعة من النماذج الثقالية لإثنان من الشذات علي خريطة البوجير من ١,٥ - ٥ كم وذلك بإستخدام قيم متنوعة لفرق الكثافة ، ويعزى تواجد هذه الشذات الثقالية إلى وجود أجسام صخرية ذات تركيب مختلف (جرانيت) عما حولها من صخور الركيزة المعقدة أو يعزى إلى وجود أحواض ترسيب لها سحنة تختلف عما حولها .

Key Words : Geopotential field , Gravity, Magnetic, Middle Egypt

ABSTRACT

The investigated area lies in the central part of Egypt (around Sohag). The present study aims at obtaining information about the subsurface geological conditions in the area from the analysis and interpretation of both gravity and magnetic data. The results obtained suggest a general northward increase in basement depth (2-3 km). The basement rocks were influenced by major tectonic trends having NE-SW, NW-SE and E-W directions. The course of the River Nile in the examined area is characterized by small basement depth compared to the eastern and western parts. In general the course of the River Nile is characterized by subsidence in certain parts, while uplift is observed in its eastern and western parts. Origin of the major gravity anomaly low (A), at the west-central part of the area, and that of magnetic low on the aeromagnetic map at the same location may point to basement structures (of granitic type) or may suggest an increase of the sedimentary section with varying subsurface sedimentary facies at the location. The depth to the causative bodies below the gravity anomalies (A&B), on the Bouguer gravity anomaly map, varies from 1.5 to 5km. Origin of these anomalies is possibly due presence of basement bodies (e.g granitic) of different types than the surroundings of basins filled with sediments of different facies than the surroundings. Drilling data are needed to confirm this suggestion.

INTRODUCTION

The study area lies in the middle part of Egypt. It is limited by the latitudes 26° 00' to 27° 00' N; and the longitudes 31° 00' to 32° 20' E, (Fig. 1). It covers about 14520 km² including the Nile Valley from Nag Hammadi to Tima and the surrounding eastern and western plateaux (Fig. 2).

In oil exploration plans, it is common to start with gravity and/or magnetic surveys particularly in unexplored areas, as the one under investigation. Interpretation of gravity and magnetic data gives information useful for mapping sedimentary basins and defining other information pertinent to hydrocarbon exploration and thereby help to stimulate additional exploration procedures.

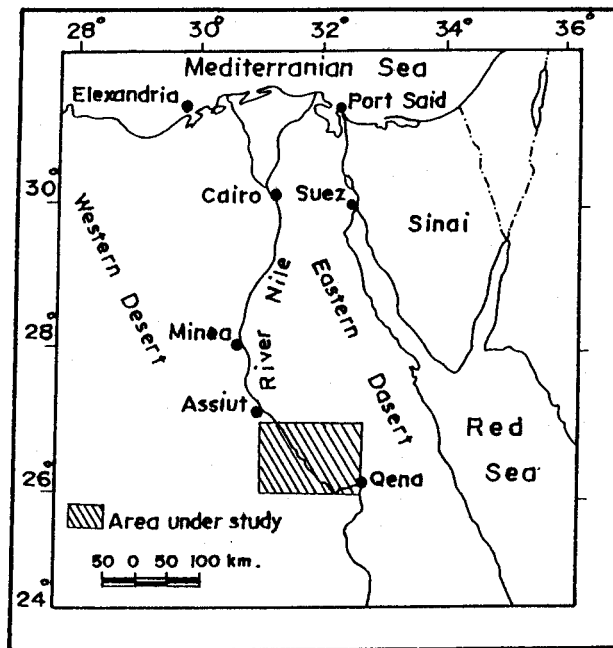


Fig. 1: Location map

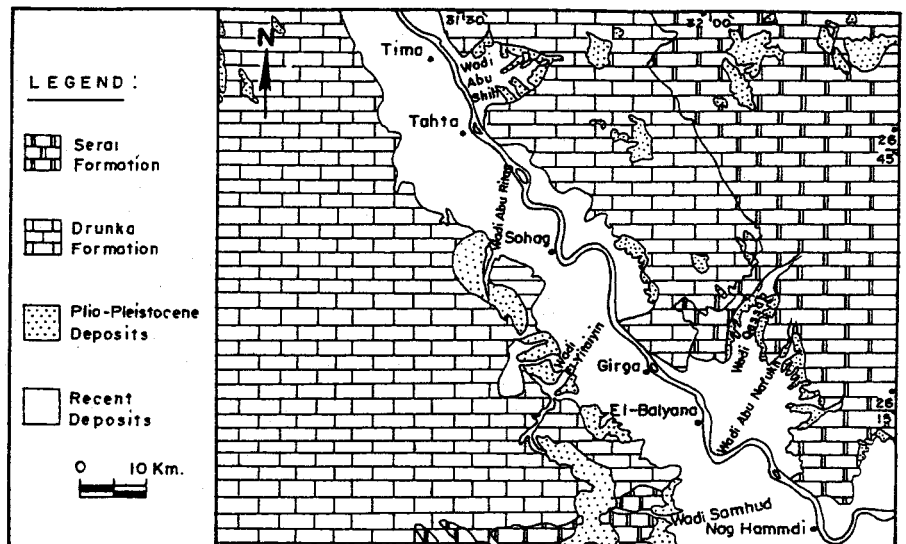


Fig. 2. Geological map of the study (after the geological map of Egypt; CO-NOCO, 1987)

The present study aims at throwing light on the sub-surface geology of the area under study through the analysis and interpretation of both gravity and magnetic data .

In the present study the Bouguer gravity anomaly map of the area under investigation (Fig. 3) was provided by the Egyptian General Petroleum Corporation (E.G.P.C.) in 1977. The aeromagnetic map (Fig. 4) represents a part from the aeromagnetic survey of Southern Egypt carried out by Compagnie General De Geophysique for CONOCO Oil Company (1976-1977). The map represents the total magnetic field measured at an altitude of 4000 feet bar-

ometric with contour interval of 10 gamma.

Before going to the geological interpretation of gravity and magnetic data it is necessary to isolate the combined gravitational and magnetic effects of different structures (i.e. extraction of residual from regional). This process of separation can be made by both graphical and/or computational techniques, using digital computers. The authors in the present work have carried out the separation process using computational techniques in the Geology Department , Assiut University.

Fig. 3. Bouguer gravity anomaly map (After E.G.P.C., 1977).

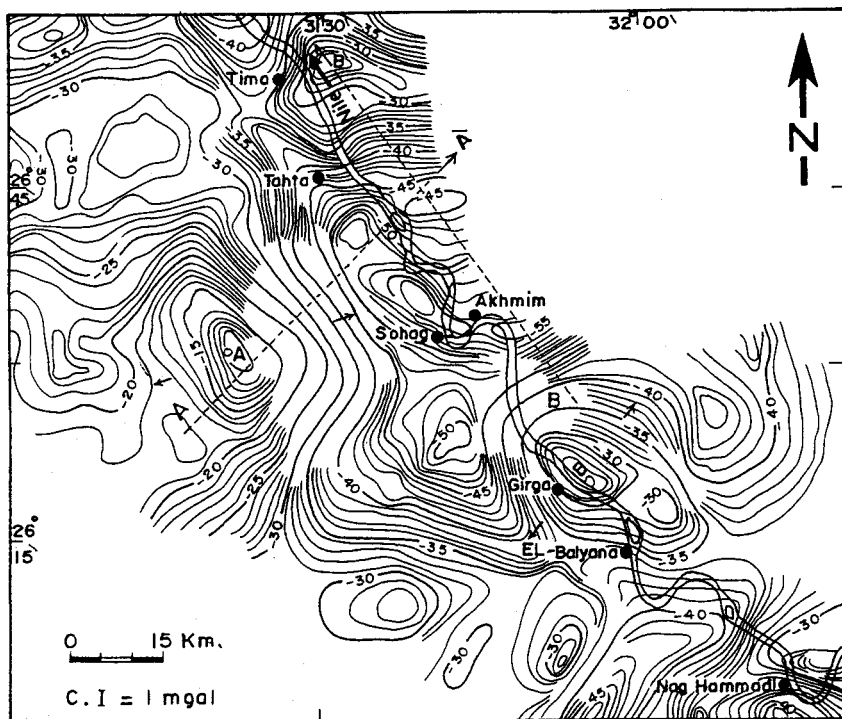
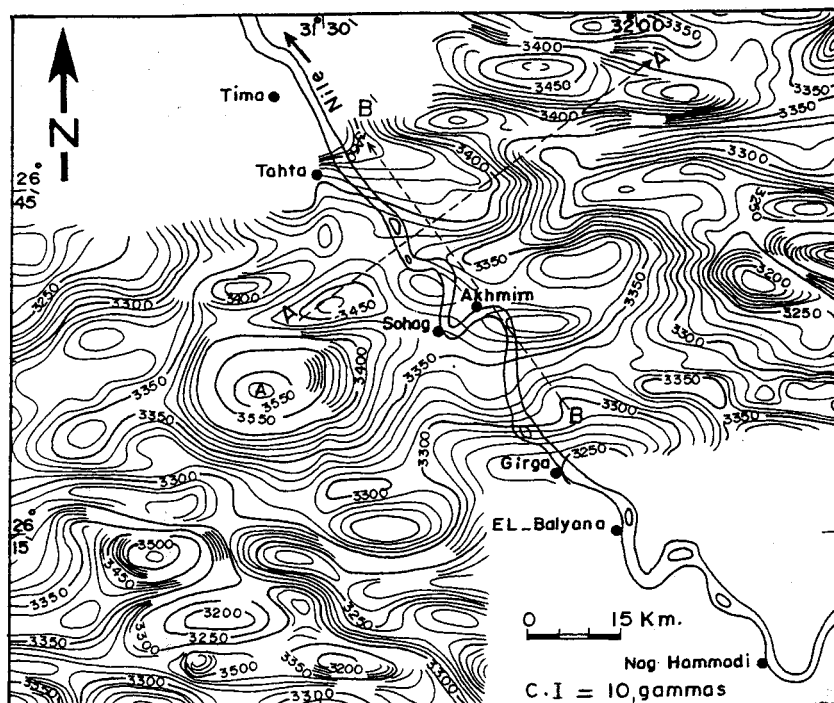


Fig. 4. Total aeromagnetic field intensity map (after CONOCO, 1977).



Although the geology of this part of Egypt has been studied by many workers, e.g. [1 - 3] there is not any sub-surface treatment due to the complete absence of deep drilling activity. Compared with several surface geological studies carried out on the area, little geophysical work has been made on it [4,5].

GENERAL GEOLOGY

The study area is characterized by low to moderate relief topography. The main topographic features present are the limestone plateaux to the east and west of the River Nile, Nile stream and its eastern and western banks (Fig. 2). The limestone plateau reaches an elevation ranging between 200 and 400 m above sea level. The Nile Valley in the study area has an average elevation between 60 and 100 m above sea level.

The floor of the Nile is covered with mud and recent deposits. The deltaic mouth of all wadis that drain into the Nile in the study area are covered with boulder, pebble, gravel and sand (Fig. 2).

A. Stratigraphy

According to Hermina et al. [6], the stratigraphy of the area can be summarized as follows:

a. Lower Eocene rocks

They are represented by two formations of the Thebes Group, namely from base to top are:

i- Seri Formation, composed of shelf and chalky limestone. It crops out mainly in the southern and eastern parts of the area.

ii- Durnka Formation, composed mainly of platform concretions and local flint bands. It covers most of the Nile banks.

b- Plio-Pleistocene deposits

They are represented by the Nile terraces located on the floor of the wadis and the foot of the main scarp. They are composed mainly of clay, gravel, sandstone and Nile silt.

B. Structure

No detailed structural studies have yet been carried out to cover all of the study area. Studies were made by many workers, e.g. [3,7]. Youssef et al. [7] believed that the NW-SE faults that affect the Eocene rocks around Assiut (north of Sohag) are of Post-Eocene movement and they are dislocated by ENE-WSW left lateral strike-slip movement. Ahmed [3] studied the surface structures in the area west and south of Sohag and observed that the faults striking N 35-45° W, N 35° E, and N 1-10° E (arranged in decreasing order of abundance) are the most predominant deformational features in the area with small drag folds.

METHODS OF ANALYSIS

The purpose of the present interpretation of gravity and magnetic data is to infer the geological character of the sub-surface structures in the study area. Furthermore, it aims at obtaining the planimetric position and aerial extent of the causative sources in the area. The methods applied include:

1. Calculation of residual gravity anomalies.
2. Determination of the second vertical derivatives of both gravity and magnetic fields.
3. Calculation of the downward continuation of both gravity and magnetic fields.
4. Basement depth determination, from both Bouguer and aeromagnetic anomalies.
5. Two-dimensional gravity modeling for some Bouguer gravity anomalies.

A. Local-Regional Separation

The observed or measured potential field (gravity and magnetic) is produced generally by the superposition of the overlapping effects of many sources, whose individual anomalies may be difficult to isolate. There are several methods to separate the potential field to its component (residual and regional). According to Nettleton [8], regional-residual separation techniques in the analysis of potential data may be grouped into graphical and analytical methods (averaging and continuation). The graphical method is slow and is controlled by interpreter's intuition.

The analytical (averaging) methods are based on different mathematical approaches on the observed field data. Such methods generally require that gravity or magnetic values be spaced in a regular array, and templates are designed. Computer programs are usually used to operate directly by the data mapped from irregularly-spaced readings. There are different methods for emphasizing the residual field and carrying the separation process, directly from a regular grid of potential field data such as those developed by many authors, [9 - 11]. Moreover, it is emphasized that the separation of the geopotential field to its components will always be a problem in geopotential, since this problem is incapable of giving an exact solution, because of inherent ambiguity.

In this study, the authors apply the method of Griffin [9] on all observed potential field data. It gives reasonable results only at the depth of separation 1 km. The residual value $g(r)$ is determined by applying the following formula:

$$g(r) = g_0 - (g_1 + g_2 + \dots + g_8)/8 \quad (1)$$

where,

g_0 is the observed field in the centre of the circle (centre of computation), g_1, g_2, \dots, g_8 are the observed values at 8 points on the periphery of the circle.

Second vertical derivative values for both gravity and magnetic fields of the study area are determined by applying the method of Rosenbach [12]. The selection is based on the suitability and simplicity of the technique. All the published second vertical derivative systems are of the form,

$$g_{zz} = \frac{C}{S^2} (w_0 g_0 + w_1 g_1 + \dots + w_{ngn}) \quad (2)$$

where,

g_{zz} is the second vertical derivative at the center of computation,

C is constant for a particular system,

S is the grid spacing,
 w_0, w_1, \dots, w_n are weighting factors,
 g_0 is the potential value at the point of calculation, and
 g_1, g_2, \dots, g_n are the average values around the successive rings selected for the computation process .

For both gravity and magnetic data suitable results of the second vertical derivative values are obtained at a depth of 1 km.

The downward continuation field for both gravity and magnetics is determined using the method of Constantinescu and Botezatu [13] . It is considered as one of the methods that utilize the Laplace equation in cylindrical form by approximation of Fourier-Bessel function . The working equation is:

$$g(s) = ag(0) + b \sum_{i=1}^4 g_i(s) + c \sum_{i=1}^4 g_i(s\sqrt{2}) \quad (3)$$

where,

$g(s)$ is the downward continuation value of the field,

$g(0)$ is the potential field at the considered point,

$g_i(s)$, $g_i(s\sqrt{2})$, are the averages on the concentric circles of radii $s, s\sqrt{2}$ respectively, and a, b, and c are constants .

The downward continuation values of both gravity and magnetic data are determined at the level 3 km, where reasonable results are obtained .

B. Basement depths

The values of the basement depths are determined from gravity using the Sazhinà and Grushinsky method [14] . The aeromagnetic map is also used for basement depth determination by applying the method of Koulomozine et al. [15] and Sharma [16] .

C. Modeling

Computer modeling in the potential field (e.g. gravity interpretation) has become a common process with the advantage of computer and geophysical software which facilitates the computation of the theoretical anomaly potential field . Several techniques were proposed by different authors, [17 - 19] to compute the potential field produced from different model sources . They involve the solution of both direct and inverse problems .

In the present study a software program, for two-dimensional modeling of gravity, given by Begg et al. [20] is used . The technique is applied only on two well-represented gravity anomalies (A & B) on the Bouguer gravity anomaly map (Fig. 3). The general steps of the technique can be summarized briefly as:

1. Choice of a geometrical model type and estimation of the initial values of the model parameters .
2. Computation of the theoretical anomaly for the model .
3. Measurement (on some mathematical bases such as least first-power or least square) of the fit between the observed and calculated anomalies .
4. Investigation (e.g. through partial derivatives) of the effect of variations of individual model parameters on the quality of the fit .
5. Estimating increments to all modeled parameters to revise the model in a way designed to approach agreement

between observed and calculated anomalies in the next iteration .

6. Stop when changes in model parameters can no longer improve the fit .

Due to the absence of available deep drilled wells in the study area, the authors refer to the density contrast values given in the literature . Youssef et al. [7] used density contrast ranges between 0.2 and 0.4 g/cm³ in the area east of Assiut city (north of the study area) . Boulos [21] and Boulos et al. [22] gave a categorization of the basement rocks in terms of magnetic susceptibility, density in the Eastern Desert of Egypt, with contrast between them and the overlying sediments . Accordingly, the density contrast in the region lying south of the study area is approximately equal to 0.35 g/cm³ . Moreover, the authors also have tried to calculate the fault parameters using different density contrasts ranging between 0.2 and 0.45 g/cm³ . By comparing the resulting depths to the basement surface (Z1), deduced from the interpretation of the aeromagnetic data and those obtained from published studies, it is found that there is a suitable agreement between the results when using density contrast equal to 0.35 g/cm³ . Accordingly, a density contrast of 0.35 g/cm³ is used for all calculations in this work.

For proper interpretation of the geomagnetic field, many points must be considered;

1. Where the basement rocks are covered with sediments, most if not all of the observed magnetic anomalies can be attributed to these rocks because their polarization is much greater than that of normal sediments [16, 23, 24].
2. Magnetic anomalies can be produced by lithologic changes within the basement, variations in thicknesses of the magnetic bodies, topographic relief, structural features such as faults and folds, and changes in magnetic susceptibilities .
3. The magnitude of a magnetic anomaly is not only a function of the vertical extent of the causative body in contrast to the case of gravity Nettleton [8]. Thus, the magnetic anomaly of a small body at shallow depth can have the same amplitude as that of a large body at a greater depth . Only the horizontal dimension of the anomaly will be different .

RESULTS AND DISCUSSION

A. Description of Gravity and Magnetic Anomalies and their Correlation with Geology

The critical characteristics of both gravity and the aeromagnetic anomaly maps (Figs.3, 4, respectively), shows:

1. The gravity and magnetic fields are generally low along the course of the River Nile (rifting valley), while the field at its eastern and western parts increases except in certain parts (e.g. west-central part).
2. The course of the Nile is generally occupied more or less by linear gravity and magnetic contours which may point to fractures (e.g. faults) crossing and more or less parallel to the Nile .

3. The regional gravity and magnetic trend mainly NE-SW NE-SE and E-W. All these directions appear on the maps of gravity and magnetic anomalies as linear contours. These linear anomalies are possibly due to fractures (e.g. faults) affecting the basement rocks as well as the sedimentary section. Generally, the direction of these linear belts shows reasonable correlation with the direction of the Nile Valley (NW-SE) and of its re-entrants, especially in the study area.
4. Closed anomalies (gravity and magnetic) of different trends, shapes and amplitudes are present. They have the same location in some parts of the study area (e.g. anomalies at Sohag, Girga and west-central part). The origin of these anomalies, especially the negative ones, may due to down faulted basement blocks. It is observed that some of these anomalies along the main stream of the Nile are present where it bends. This may emphasize that their origin is due to basement structures.
5. Steep gravity gradients flank the eastern and western parts of the Nile. They may be considered expressions of major and steep angle faults.
6. The absence of strong positive gravity anomalies with strong positive magnetic anomalies may indicate the absence of any igneous intrusion throughout the geological history of the study area.

B. Topography and Structure of the Basement Rocks

Topography and structure of the basement rocks in the study area are obtained from the interpretation of gravity and magnetic data. Based on these results, the authors prepared two basement depth maps, two tentative tectonic maps, and two subsurface sections along the study profiles.

1. Results obtained from gravity

Visual inspection of the basement depth map (Fig. 5) and basement tentative tectonic map (Fig. 6) reveals the following:

- i. The depth to the top of the basement rocks in the study area, ranges between 1.2 and 3.6 km (Fig. 5).
- ii. The basement surface is characterized by the presence of many highs and lows. Two large lows (I,II) can be recognized to the west of the Nile Valley (I to the west of Sohag city and II to the west of EL-Balyana), showing maximum depth between 3.2 and 3.6 km. A large elongated basement high (III) lies in the northwestern part of the area (west of Tima) at a depth of 1.2 km on the eastern side of the River Nile an elongated basement low (IV) (near Girga) is observed at a depth 3.6 km. The configuration of the basement at the eastern side of the area is not defined owing to the lack of the gravity data in this sector. A general increase in the basement depth can be reported from southeastern part to the northwestern part (Fig. 5).

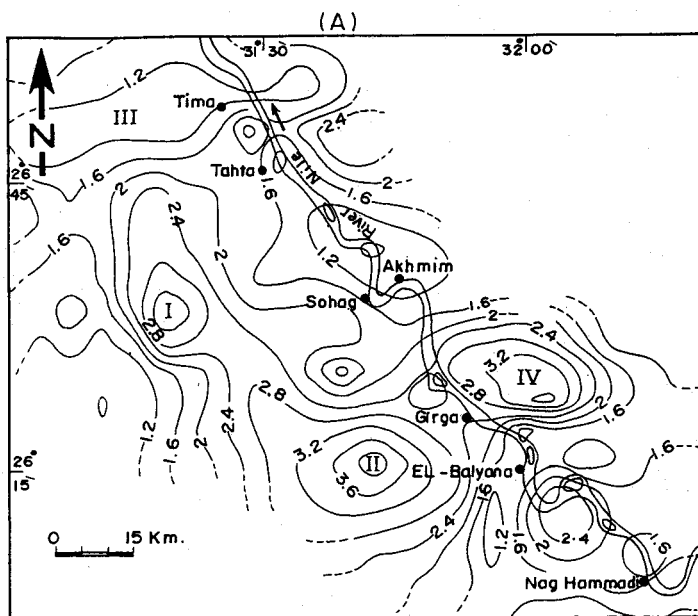


Fig. 5: Basement topographic map interpreted from the Bouguer gravity anomaly field (Depth contours with 0.2 km intervals).

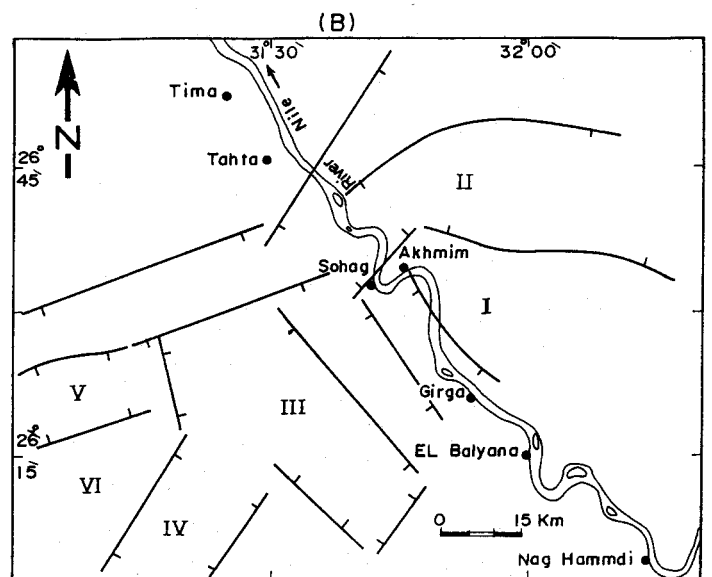


Fig. 6: Tentative tectonic map of the basement rocks as deduced from the Bouguer gravity anomalies.

iii. From the tentative tectonic map of the basement rocks (Fig. 6), it can be noticed that the basement rocks in the study area were affected by a sets of ENE-WSW, NW-SE, WNW-ESE, NE-SW and E-W major tectonic lines .

v. Major uplift (I) (At Akhmim) and two subsidences (II) (at Girga) and (III) (at the west-central part) are well observed taking nearly E-W, WNW-ESE and NW-SE directions, respectively (Fig. 6) .

vi. Two another major subsidences (IV,VI) separate a NNE-SSW major uplift (V) in the southeastern part of the study area. Another ENE-WSW major uplift is recorded in the northwestern part. Subsided and uplifted basement blocks on both sides of the Nile Valley are dissected by a NW-SE fault trend in the areas; north of Tah-ta and between Girga and Akhmim.

2. Results obtained from the aeromagnetic interpretation

Using the integrated results obtained from the previously discussed techniques on the magnetic data, a basement topographic map (Fig. 7) and basement tentative tectonic map (Fig. 8) are prepared. The careful study of them shows:

- i. The depth to the top of the basement rocks in the area under consideration ranges between 1 and 2 km (Fig. 7) .
- ii. The basement rocks are affected by a set of major tectonic lines (mainly faults) oriented predominantly in the E-W, NE-SW and NW-SE directions and they are noticed on the basement tectonic map (Fig. 8). Also, there is a major uplifted block (I) bounded by two subsidized ones (II & III) occupying the central part of the study area. This feature is also recorded previously on the basement tectonic map deduced from gravity data.

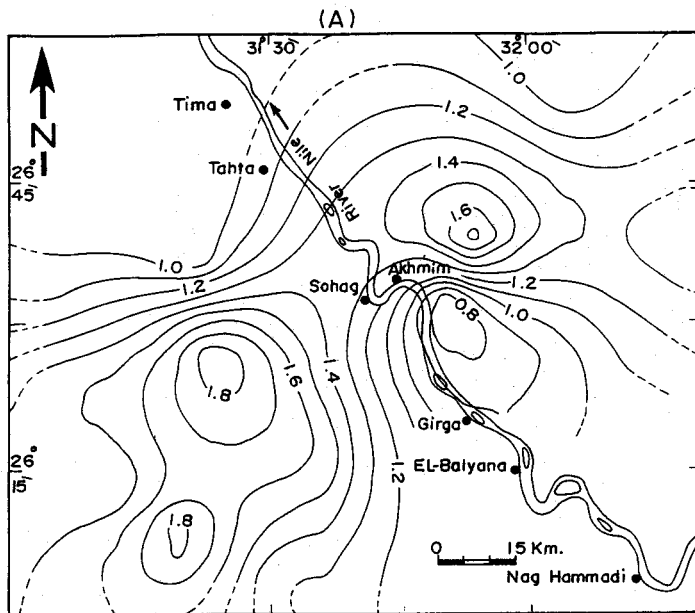


Fig. 7: Basment topographic map interpreted from the magnetic field (Depth contours with 0.1 km intervals).

iii. Faults are also observed between the uplifted block (I) and the subsident one (III) (Fig. 8).

vi. Further subsided and uplifted basement blcks (IV,V&VI) are observed . They are approximately extending from NE-SW to ENE-WSW direction (Fig. 8).

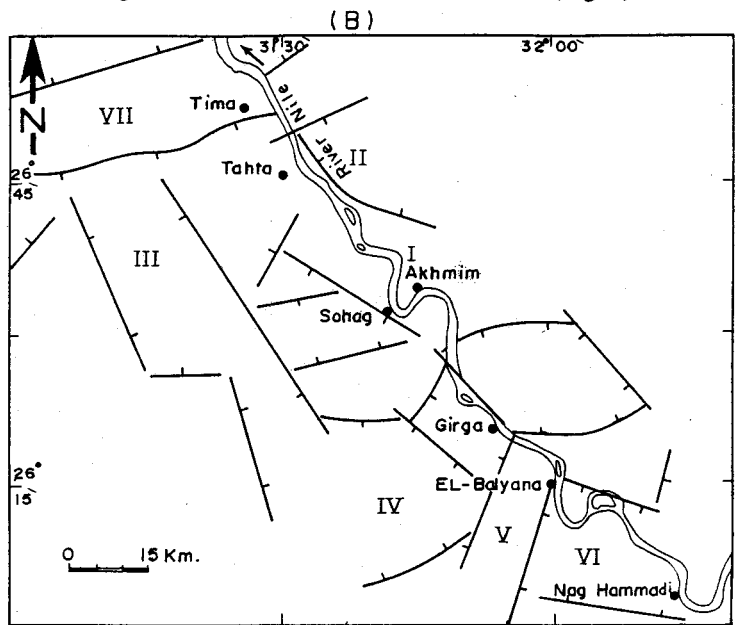


Fig. 8: Tentative tectonic map of the basement rocks as interpreted from magnetic data.

C. Interpretation of Selected Gravity and Magnetic Profiles

Two subsurface sections (Fig. 9) are constructed along the study profiles AA'&BB'. They have nearly the same directions and locations on the gravity and magnetic maps (Fig. 3&4). The information from these sections is used to recognize the general structural picture of the basement rock, and also within the sedimentary section in the study area.

The authors in these profiles used all information obtained from the Bouguer gravity anomaly and total intensity aeromagnetic maps, and their derivatives (downward continuation maps, S=3 km, the second vertical derivative map, S=1 km., and the residual gravity map, S=1 km.). Fault trends deduced from both gravity and magnetic maps with their parameters (H,Z1 and Z2) are also used to construct subsurface cross-sections along every selected direction mentioned before.

1. Subsurface sections interpreted from gravity data

Precise analysis of these sections (Fig. 9a) reveals:

- a. The depth to the top of the basement rocks in the area ranges between about 1.2 and 3.6 km.
- b. A general increase of the basement depth to the north is followed by a decrease, in contrast to the geological findings.
- c. A prominent basement subsidence lies to the east occupying the present path of the Nile River. It represents the major subsidence along the Nile stream within the study area.

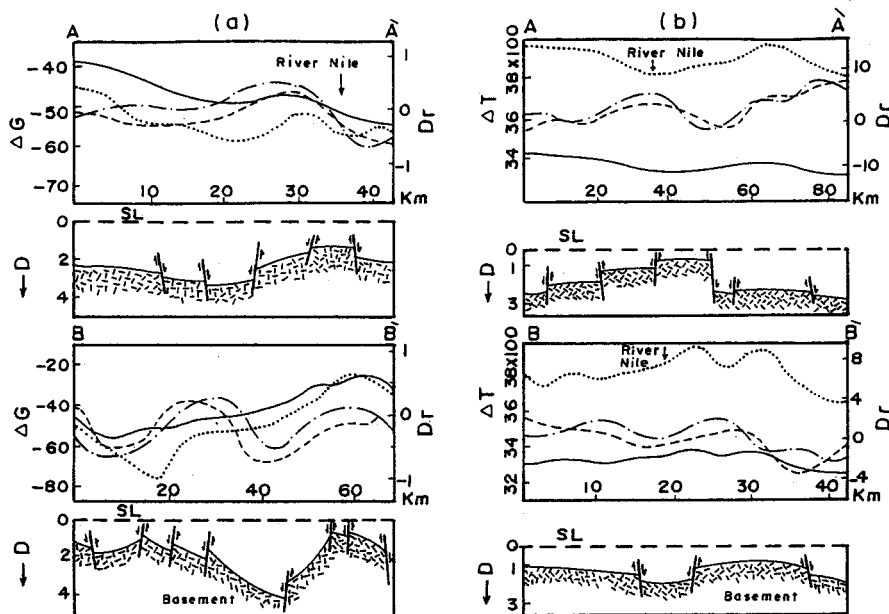


Fig. 9. Subsurface sections interpreted from gravity data (a) and magnetic data (b) [ΔG : gravity values in mgal; ΔT : Magnetic values in gamma; Dr : derivative values; D : depth in Km; SL : Sea level; — observed field; - - - Residual field, $S=1$ km; second vertical derivative field, $s=1$ km;- downward continuation field.

d. In general, basement uplift is always observed at the eastern and western sides of the River Nile.

e. Residual gravity, second derivative and the continued downward fields with varying amplitudes in the east and west suggest structures and density contrast within the basement due to differential uplift. The central and the northern parts of the gravity profiles show an alternation of anomalies with longer wavelength, implying local and widely-separated structural and lithological variations within the section of the sedimentary rocks.

2. Subsurface sections interpreted from aeromagnetic data

The study of these sections (Fig. 9b) shows:

- The depth of the basement surface as deduced from the aeromagnetic data in the area varies from about 1 to 2 km.
- A general northward increase in basement depth is also observed.
- The same feature of the prominent basement subsidence, observed from gravity interpretation is also observed here (Fig. 9b) nearly at the same location.
- The eastern and western sides of the Nile River are characterized by different uplifts (ridges).
- Alternating high and low magnetic anomalies of and longer gradients are observed.
- In certain parts the area of the Nile is characterized by a remarkable low magnetic anomaly.

D. Gravity Models

In the present study a software for two-dimensional mod-

eling of gravity, proposed by Begg et al. [20], is used. The technique is applied only on two selected gravity anomalies (A) at the west-central part and (B) around Girga on the Bouguer gravity anomaly map (Fig. 3).

Two profiles are taken perpendicular to the long axes of the selected anomalies (Fig. 3). The residual gravity values along these profiles are also taken from the residual gravity values. So, the models are constructed using the observed gravity values and their corresponding residual ones to obtain suitable models which have a possible reasonable geologic meaning.

The model parameters such as depth and density contrast of the buried causative bodies are based on the results obtained from basement depth information determined and deduced previously from the Bouguer gravity anomaly map. Inspection of the obtained models (Fig. 9) shows:

- The causative body below the gravity anomaly (A) is relatively large and lies at a depth from 2 and 3 km. Reasonable fit between the observed and calculated values is reached by assuming density contrast 0.35gm/cm^3 (Fig. 10a)
- When the residual gravity values are used in the modeling process, the large causative body detected previously is altered into four bodies a,b,c and d (Fig.10b). They lie at depth ranging between 2.4 and 4 km. A suitable fit is reached by assuming density contrasts $0.05, 0.01, 0.06$ and 0.02g/cm^3 , respectively, for the buried bodies.

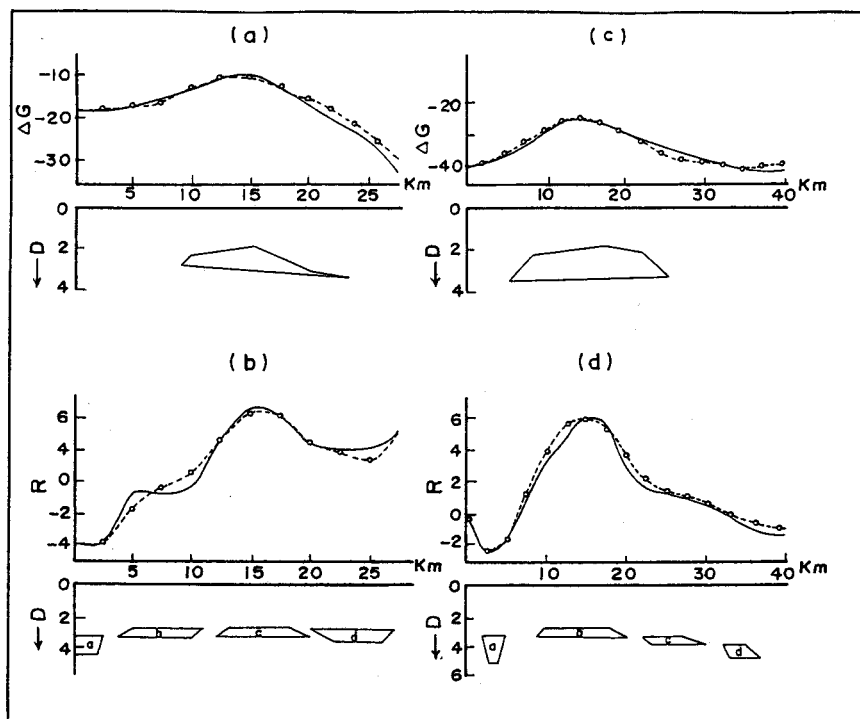


Fig. 10. Interpreted models along the Bouguer gravity anomalies A & B (ΔG : observed gravity field in magal; R: Residual gravity field in magal; D: depth in Km; ---- experimental; o.o.o. theoretical).

3. The observed gravity anomaly (B) is possibly due to a large causative body (probably sedimentary basin) located at depth varies from 1.7 to 3 km. The fit is obtained when assuming density contrast 0.35g/cm^3 (Fig. 10c).
4. When using the residual values, four separated causative bodies a,b,c and d (Fig. 10d) are recognized. Their depth vary from 2.5 to 5 km. The best fit is obtained by assuming density contrasts 0.05,0.04,-0.01 and 0.02 g/cm³ for the buried bodies, respectively.

The different subsurface geological bodies recognized here from the gravity modeling may be due to an occurrence of basement structure (of granitic type) having densities different from their surroundings or may suggest an increase of the sedimentary section with varying facies at these locations.

CONCLUSIONS

Realizing the fact that the subsurface geological information in this work in the study area are yet to be deduced by more definitive seismic methods or others than gravity and magnetic methods, below are the major tentative findings from the present work.

1. Steep gravity and magnetic gradients flank the eastern and western banks of the Nile River may considered as indications of major and steep high angle faults.
2. Low-relief gravity anomalies with low-relief magnetic anomalies along the banks of the Nile would indicate thick sediments (possibly sedimentary basins).
3. The origin of the major negative gravity anomaly and the high magnetic intensity in the west central part of the study area may be due the abnormal thickness of the sedimentary succession (possibly sedimentary basins), or presence of basement structure (of magnetic type) at that location. These anomalies are observed near the bending parts of the River Nile.
4. The basement rocks in the area were influenced by major tectonic lines (mainly faults) oriented mainly in the directions NE-SW, NW-SE and E-W.
5. The course of the River Nile is characterized by subsidence while its eastern and western parts are characterized by a series of uplifts.
6. A general basement deepening is observed along the course of the Nile comparing with the adjacent areas. The basement depth generally increases from south to north.
7. The depth and shape of the expected causative bodies below the gravity anomalies (A & B) on the Bouguer gravity anomaly map are recognized by applying gravity models using different values of density contrast. Results

obtained here need subsurface information (e.g. drilling) Probably the origin of these causative bodies is due the basement structure (of granitic type) or presence of basins filled with sediments having facies different from the surroundings.

8. The basement depth (1-2km) obtained from magnetic data seems to be accepted in an area in middle Egypt in which the expected basement depth range between 2 and 3 km. On the other hand, the depth (1.2-3.6 km) obtained from gravity is also accepted, where the rising depth values (3.6 km) is observed only at Girga which may point to presence of a sedimentary basin. The possible approach to the present difference in depth values is possibly due dependence of gravity on the assumed density values owing to absence of drilling data, the presence of highly brittle sandstones of Nubia, and the dependence of magnetic on different factors such as magnetization.

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