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INTERPRETATION OF AIRBORNE MAGNETIC SURVEY DATA OF GABAL ELURF AREA, CENTRAL EASTERN DESERT, EGYPT.

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ABSTRACT

Gabal Elurf area covers about 3000 km^2 and lies in the Central Eastern Desert of Egypt. The study area is mainly blanketed by Precambrian Basement (igneous and metamorphic) rocks overlain by Cretaceous Nubian Sandstones and Quaternary Wadi Sediments. This area shows a special importance, as it comprises large masses of granitic rocks.

The present study deals essentially with the use of and correlation between the geology and aeromagnetometry to establish the structural framework of the area under investigation. The main target of this study is to use the aeromagnetic survey data as the main source of information to determine and modify the structural framework of the study area.

Two interpreted magnetic basement structural (IMBS) maps were constructed along the two computed interfaces to show the structural setting of the study area. This includes the display of the uplifted and subsided blocks in the study area. The two interfaces were determined to the aggregated bodies at 770 m and 2.7 km depth, through the application of the two-dimensional power spectrum. Filtering combined with analytical downward continuation on the two assigned interfaces were then conducted. The shallow and deep-seated anomalies could be determined and the structural setting could be delineated through two modeled profiles across the area under investigation.

Reduced to the north magnetic pole map was divided into four different magnetic zones based on the variations in the character of magnetic anomalies (i.e., their wavelengths or frequencies, amplitudes (intensities) positive and/or negative, magnetic behaviour, groupings of anomalies and their trend patterns). Two of the identified magnetic zones are represented mainly by positive magnetic anomalies, while the other two magnetic zones are represented mainly by negative anomalies.

The calculated average depth values to 48 anomalies selected from the RTP total aeromagnetic map range between 495 m and 1332 m with an average (arithmetic mean) depth of about 788 m.

The modeled basement rocks show a wide range of magnetic susceptibility contrasts varying between - 0.0007 and 0.003 e.m.u. This wide range of variation suggest the intrusions of relatively acidic basement rocks of low magnetic susceptibilities into more basic rocks of high magnetic susceptibilities. It also indicates a great lateral variation in the lithologic composition of the crystalline basement rocks across the study area.

INTRODUCTION

Gabal Elurf area is located in the Central Eastern Desert of Egypt, between Latitudes 26° 17′ N and 26° 42′ N and Longitudes 33° 15′ E and 33° 50′ E. The area under study is connected with Qena, the nearest largest town on the Nile valley, by two desert roads. The area under study consists mainly of Precambrian basement complex, which is represented by igneous and metamorphic rocks, Cretaceous Nubian Sandstones and Quaternary Sediments in Wadis.

The present work aims essentially to use the airborne aeromagnetic survey data to determine and modify the structural framework of the study area. In order to achieve this target, the following scheme of analytical work was followed :

1- Compilation of the geological and aerogeophysical maps from the available sources.
2- Isolation of the magnetic anomalies of the Reduced to Pole (RTP) aeromagnetic map, using relevant computer programs, into two maps.
3- Conducting two-dimensional trend analysis for the magnetic lineaments as followed from the RTP, regional and residual magnetic-component maps are also interpreted and mapped.
4- Depth determination of the magnetic anomalies sources along a set of selected magnetic profiles across the magnetic map.
5- Magnetic modeling will be applied to draw the subsurface configuration and the structure of the basement that is responsible for the observed magnetic anomalies.

The study area was subjected to extensive airborne magnetic survey by Aero-Service Division, Western Geophysical Company of America, USA, in 1984, following a system of equally-spaced (1.5 km apart), NE-SW oriented flight traverses at a nominal flight altitude of 120 m ground clearance. Tie lines were flown in a NW-SE direction at 10 km intervals. The aeromagnetic data were reduced, compiled and finally presented by a set of contour maps, on a scale of 1 : 50000.

The regional and residual aeromagnetic-component maps (Figs. 4 and 5), the interpreted magnetic basement structural maps (Figs. 9 and 10) and the geological map (Fig. 1) show that the study area could be divided into four main uplifted and four main subsided blocks, beside other small ones, as a result of strong normal and strike-slip faulting in NE-SW and NW-SE directions. The uplifted parts are represented by Gabal El-Garrah, Gabal Kab-Ameri, Gabal El-Missikat, Gabal El-Gedami, Gabal Wassif, Gabal El-Aradiyyah and Gabal El-Urf. The subsided parts are mainly represented by Wadis covered by Quaternary sediments, e. g., Wadi El-Markh, Wadi Abu Had, Wadi Abu Furad and Wadi Umm Salam.

GEOLOGICAL OUTLINE

Gabal Elurf area is covered by basement rocks, which are traversed by many Wadis (dry valleys) filled with Quaternary alluvium. The igneous-metamorphic basement complex forms the main cover. The Foreland Sediments represented by Nubian sandstones of Mesozoic age cover small parts (Fig. 1).

The basement rocks are represented by metamudstones and calcareous metamudstones of Geosynclinal Sediments. Main Geosynclinal Volcanics comprise basic, intermediate and acidic volcanics, beside ultra-basic serpentinites and related rocks. Diorites and epidiorite complex, granodiotites and grey granites of Synorogenic Plutonites and Postgeosynclinal Sediments, are considered the main components of the basement complex as well as red and pink granites of the Late Orogenic Plutonites. The Foreland Sediments unconformably cover small parts in the western part of the study area (Fig. 1).

METHODS OF ANALYSIS

I. Spectral Frequency Analysis and Filtering

Several techniques were developed for the analysis of aeromagnetic maps, which led finally to their quantitative interpretation. The following are some of these quantitative techniques, which were applied to delineate the geologic structure of the area under study.

Bands of frequency were used through the band-pass filter technique to produce the regional and residual magnetic-component maps (Figs. 4 and 5).

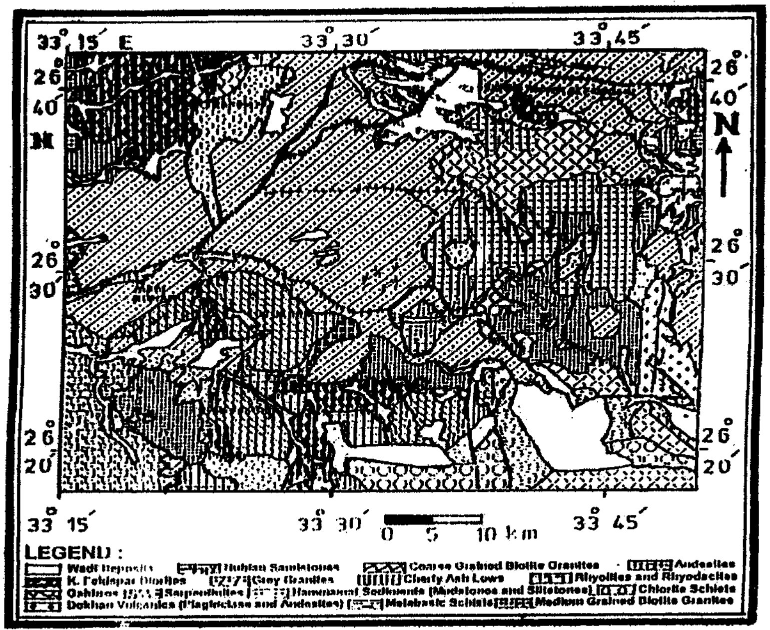


Fig. (1) : Compiled Geological Map of Gabal Elurf Area, Central Eastern Desert, Egypt.

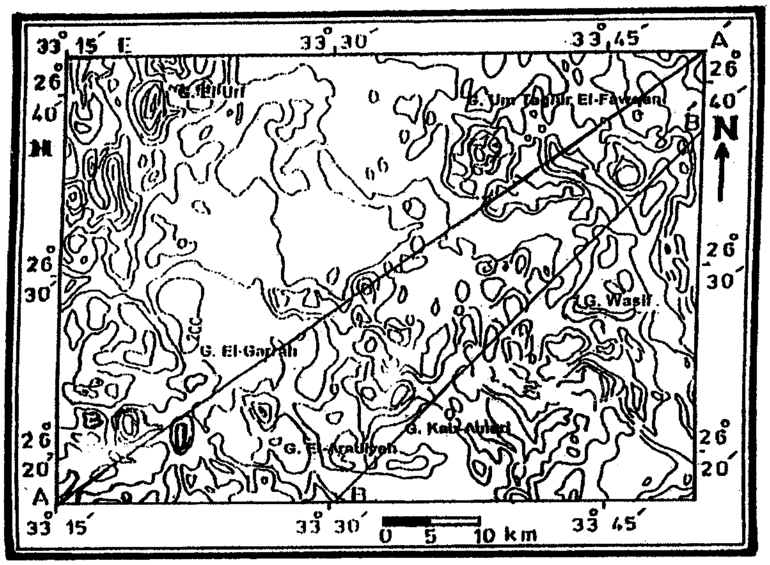


Fig. (2) : Aeromagnetic Contour Map, Reduced to the North Pole (RTP), (in nT) of Gabal Elurf Area, Central Eastern Desert, Egypt.

Based on the results of energy spectrum analysis (Fig. 3) of aeromagnetic data, the isolation of magnetic anomalies was conducted for the RTP aeromagnetic map (Fig. 2) into a deep-seated (regional) magnetic-component contour map at interface 2.7 km depth (Fig. 4) and a near-surface (residual) magnetic-component contour map at interface 770 m depth (Fig. 5), using the Spectral Frequency Analysis and Filtering Technique (Fig. 3) (Spector, 1970).

II. Depth Estimation

The application of depth determination techniques to identify the depth of causative geological bodies is one of the most important parameters that must be determined in order to interpret adequately the lithology and structure of the study area. Two methods of depth estimation were applied to 48 magnetic anomalies, selected from the total aeromagnetic map reduced to the north pole (Fig. 2). These methods are :

1 - Werner Method (1983) and

2 - Spectral frequency analysis using Filon Fourier Transform "FFT" (1987).

The results obtained from the two methods, as well as the calculated average depths are summarized in Table (1). It is to be noted that the depth estimates by the two depth determination techniques are in a fairly good agreement. Meanwhile, the differences refer to differences in the basic concepts between the two methods. The calculated depth values of these anomalies range between 495 m and 1332 m with an average (arithmetic mean) depth of about 788 m and a standard deviation of about 179 m.

Figure (7) shows the locations of the determined anomalies in addition to their serial numbers and estimated depths to the source bodies. Besides, the values of the estimated depths were contoured and presented in the form of two-dimensional contour map (Fig. 8).

III. Magnetic Modeling

The inverse problem in magnetic interpretation is to calculate the anomaly of the assumed source and then comparing this anomaly with the observed data. The inversion is called modelling. The method is to calculate the theoretical anomaly over a simple body whose geometrical dimensions are approximately estimated by the user. The program then compares the theoretical anomaly with the observed profile and proceeds to improve the fit between the two profiles by making judicious adjustments to the body parameters until the best possible fit is obtained between the observed and the calculated magnetic anomaly profiles or contours (Paterson et al., 1992).

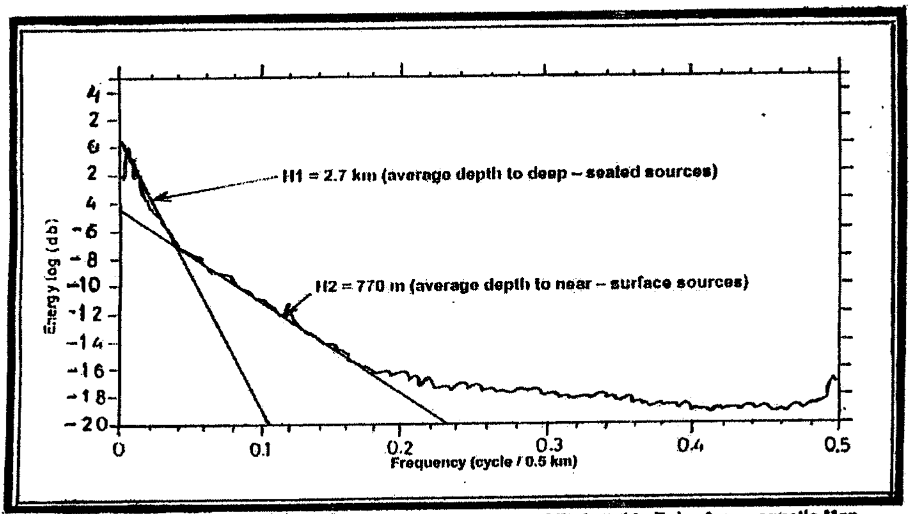


Fig. (3) : Local Power Spectrum of Interface Determination of Reduced to Pole - Aeromagnetic Map of Gabal Elurf Area, Central Eastern Desert, Egypt.

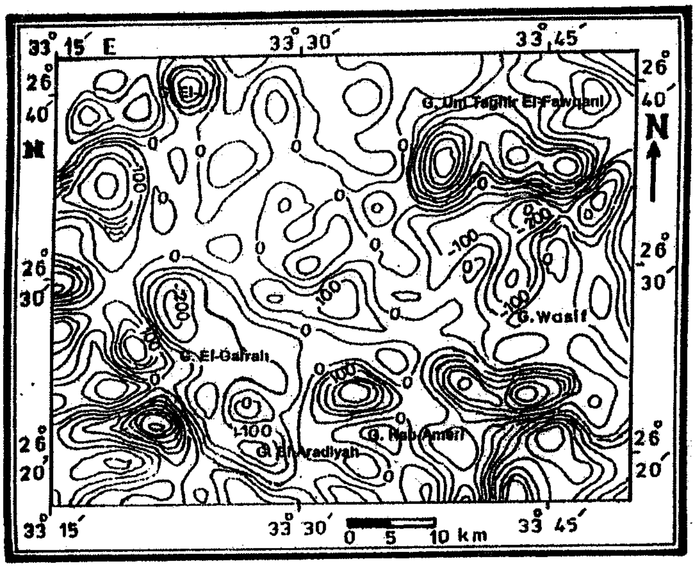


Fig. (4) : RTP Regional Aeromagnetic-Component Contour Map (In nT) at an Interface of 2.7 km of Gabal Elurf Area, Central Eastern Desert, Egypt.

Each separate part of the model (polygon) is assigned a certain susceptibility value. The anomaly along the entire profile is the sum of the contributions of each separate polygon (Abdel Rahiem, 1999).

Magnetic potential field modeling involves four separate pieces of information :

1- Top surface, 2- Bottom surface, 3- Susceptibility and 4- Anomaly.

If any three of these four pieces of information are known or assumed the fourth item may be calculated. Forward modelling specifies the first three items and calculates the anomaly. To confirm the dip of tilted fault blocks, depth of basement surface and delineate, as accurately as possible, the basement tectonic framework revealed in the studied area. Two magnetic profiles denoted as A-A′ and B-B′ (Fig. 2) were modelled using the 2-D modelling algorithm (Talwani et al., 1959).

QUALITATIVE INTERPRETATION OF AEROMAGNETIC DATA

The aim of any magnetic survey is to investigate the subsurface geology on the basis of anomalies in the earth's magnetic field resulting from the magnetic properties of the underlying rocks. Although most rock-forming minerals are effectively non-magnetic, only certain rock types contain sufficient magnetic anomalies. Similarly, man-made ferrous objects also generate magnetic anomalies. Magnetic survey, thus, has a broad range of applications, from small-scale engineering or archaeological surveys to detect buried metallic objects to large-scale surveys carried out to investigate regional geological structures (Kearey and Michael, 1994).

An interpreter experienced in magnetics can usually see structures merely by looking at a magnetic map, much as one visualizes surface features from the contours of a topographic map (Telford, 1990). Since it is known that a magnetic contour map is a reflection of the horizontal contrast in the magnetic properties of the underlying rocks, thus, the magnetic expression of various structural features depends on the existence and intensity of such magnetic horizontal contrast (Telford, 1990).

The residual magnetic anomalies can be defined as the anomalies that are economically interesting because they indicate shallow bodies and are characterized by weaker and more localized anomalies.

The regional magnetic anomalies are strong, broad, extend over large areas and usually have high amplitudes and low frequencies. These anomalies are of considerable significance in regional tectonic studies of basement complex and secondary importance in mineral and petroleum exploration (Abdel Razik, 2002).

Sedimentary rocks, excluding iron formations, are low in magnetic susceptibility and are generally considered to be non-magnetic, while igneous rocks are sufficiently magnetic to influence the earth's magnetic field and contribute to anomalous features. The magnetic relief observed over sedimentary basins (areas) is almost controlled by the lithology of basement rather than its topography. In other words, the lithologic variations within the basement, i.e., intrabasement effects are responsible for the strong and major magnetic anomalies.

Magnetic contrasts due to deeply extending contrasts are called anomalies. The anomalies of structural origin are fairly small and of limited extent; they are referred to as suprabasement anomalies. Changes in lithology, however, give rise to lateral contrasts in susceptibility, which are shown clearly in magnetic contours more than the topographic features on the basement surface.

DISCUSSION OF THE RESULTS

In the present study, the interpretation of aeromagnetic survey data is mainly concerned with the examination of the reduced-to-pole (RTP) aeromagnetic map (Fig. 2).

Close examination of the RTP aeromagnetic map shows that the studied area is characterized by the existence of numerous major and minor positive and negative anomalies of varying wave lengths, amplitudes and trends. This reflects great variations in the depth and composition of causative masses.

The calculated zero level of the RTP aeromagnetic map coincides with the 42150 nT value.

The following three maps either the original or the computed will be discussed together in an integrated manner :

1- The RTP aeromagnetic map (Fig. 2).
2- The magnetic-component map, at an interface of 2.7 km depth (Fig. 4).
3- The magnetic-component map, at an interface of 770 m depth (Fig. 5).

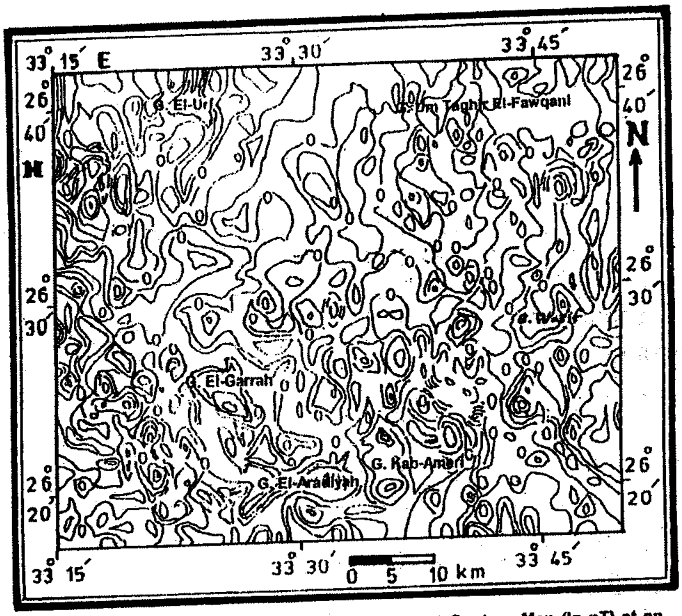


Fig. (5) : RTP Residual Aeromagnetic-Component Contour Map (In nT) at an Interface of 770 m of Gabal Elurf Area, Central Eastern Desert, Egypt.

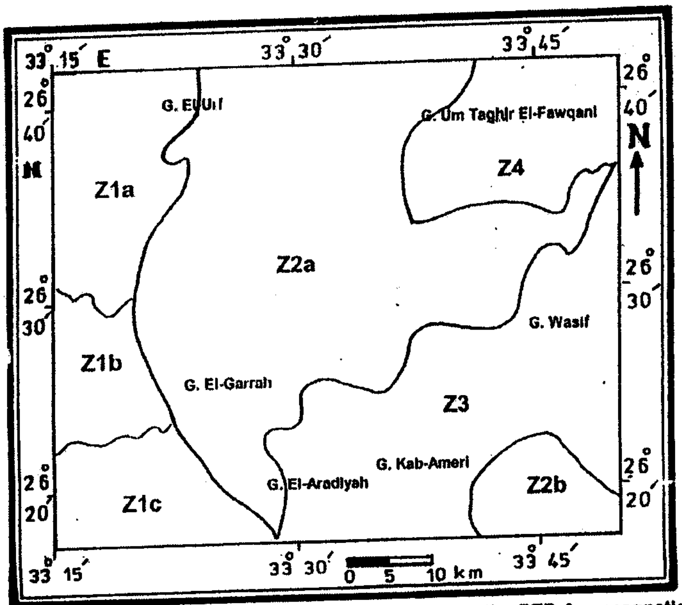


Fig. (6) : Magnetic Zonation Map, as Interpreted from the RTP Aeromagnetic Map of Gabal Elurf Area, Central Eastern Desert, Egypt.

(Z : Zone 1 : No. of zone a : No. of subzone)

The aeromagnetic maps of the study area (Figs.2, 4 and 5) indicated that they don't agree very well with surface lithologies. Therefore, the variations observed on the magnetic maps define the subsurface configuration of the magnetic basement rocks rather than those exposed on the surface.

The RTP residual magnetic-component map (Fig. 5) resembles to a great extent the RTP aeromagnetic map (Fig. 2). This similarity means that the sedimentary cover and acidic rocks possess low magnetization and hence it could be neglected. Therefore, the deep-seated structures play the major role in defining the general tectonic framework of the studied area.

The RTP aeromagnetic and regional magnetic-component maps (Figs. 2 and 4) show the same number of high magnetic anomalies. These anomalies are characterized by their high magnetic amplitudes. The shapes of some of these anomalies are somewhat rounded, while others are elongated. These anomalies acquire sharp contacts in various degrees with the surrounding magnetic features. The sources of these anomalies may be due to basic or ultra basic intrusions.

According to the visual inspection of the mentioned geological and geophysical maps; four separate and distinct magnetic anomalous zones of various magnetic characteristics (Fig. 6) could be distinguished on the basis of the differences in the characters of the magnetic anomalies. These characteristics features include, their wavelengths (or frequencies), amplitudes (peak intensities), positivity and /or negativity, groupings of anomalies as well as trend patterns. Here follows is a discussion of these different magnetic zones :

A- The First Magnetic Zone (Z1)

The first magnetic zone (Z1, Fig. 6) is located at the western part of the study area. It is composed mainly of three magnetic sub-zones denoted as : Z1a, Z1b and Z1c. They are mainly associated - on the geological map (Fig. 1) - with diorites, biotite granites, Nubian sandstones and Wadi sediments. They are characterized by high magnetic relief and positive magnetic anomalies with amplitudes reaching to 1410 nT.__They are characterized by prominent features and their boundaries could be easily traced.

The first sub-zone (Z1a) is located in the northwestern part of the area including Gabal Elurf. It is associated on the surface with andesites, biotite granites, diorites and grey granites. It is characterized by the presence of a strong positive anomaly, with a maximum amplitude of 1410 nT.

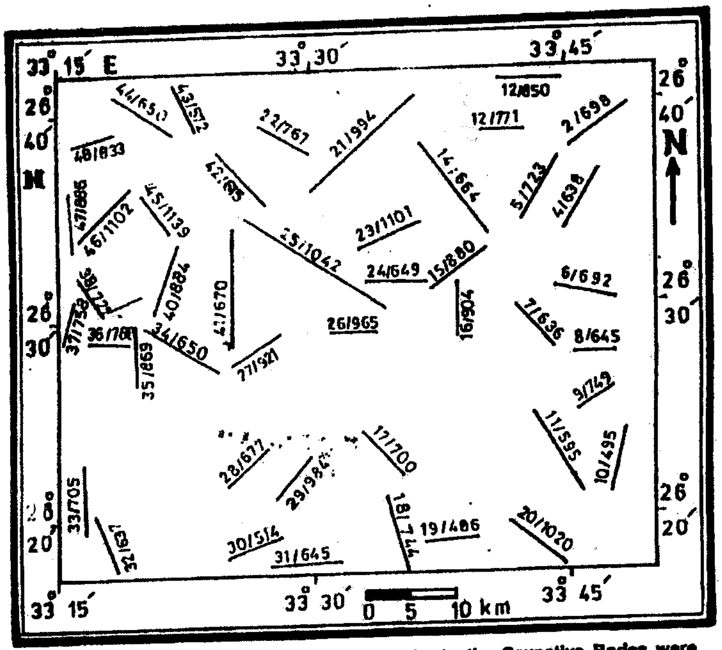


Fig. (7) : The Locations at which the Depths to the Causative Bodes were Determined using Werner and Spectral Frequency Analysis Techniques, Gabal Elurf Area, Central Eastern Desert, Egypt.

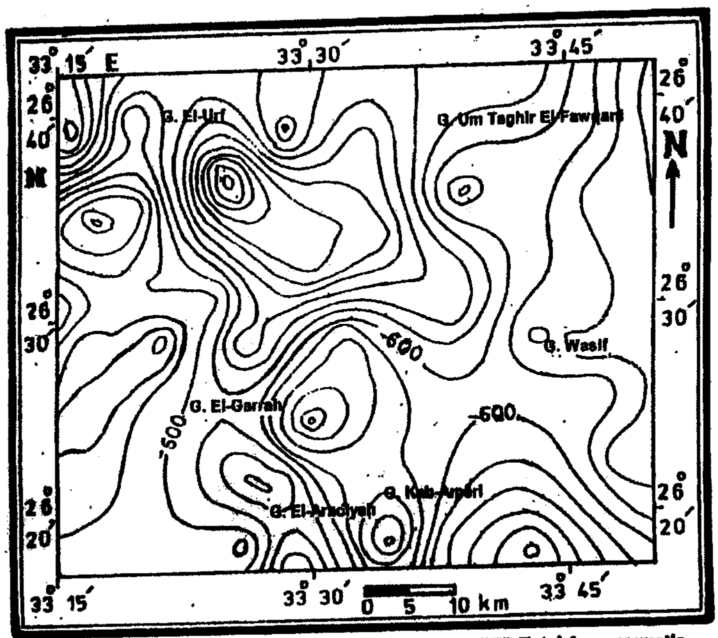


Fig. (8) : Depth Contour Map, as Calculated from the RTP Total Aeromagnetic Anomalies, Gabal Elurf Area, Central Eastern Desert, Egypt.

The second subzone (Z1b) occupies the area located in the southern part of the first subzone (Z1a) and west of Gabal El-Missikat and Gabal El-Gedami. It is associated with grey granites, biotite granites and Nubian sandstones. It is composed of a positive magnetic anomaly, with amplitude reaching 305 nT.

The third sub-zone (Z1c) is located at the southwest of the study area, west of Gabal El-Aradiyyah. It is associated mainly with andesites and Nubian sandstones. It is composed of strong positive magnetic anomalies of moderate frequency and amplitude, trending in NNW and E-W directions and ranging between -130 and 100 nT.

B- The Second Magnetic Zone (Z2)

The second magnetic zone (Z2, Fig. 6) is composed of two magnetic sub-zones (Z2a and Z2b) trending mainly in NW-SE and NE-SW directions. These sub-zones are located in the central and southeastern parts of the study area. Moderate negative magnetic relief and amplitude mainly characterize this zone.

The first sub-zone (Z2a) is associated on the surface with grey granites, biotite granites, rhyolites, rhyodacites and andesites. It is occupied by belts of positive and negative magnetic anomalies, having a NW-SE direction. The amplitudes of these anomalies range between - 180 and - 350 nT.

The second sub-zone (Z2b) is associated on the surface with chlorite schist, metabasic schist, serpentine and gabbro. It is represented by a negative magnetic magnetic anomaly of relatively big size. It trends in a NE-SW direction with amplitude reaching about 412 nT. The abrupt changes of the magnetic contours along the contact of this sub-zone may reflect its structural origin of faulting in the NE-SW and NW-SE directions.

C- The Third Magnetic Zone (Z3)

The third magnetic zone (Z3, Fig. 6) lies in the eastern and southeastern parts of the study area, including Gabal Wassif and Gabal Kab-Ameri. On the surface, this zone is associated with grey granites, sepentinites, gabbros, rhyolites, rhyodacites, Dokhan volcanics, andesites, Nubian sandstones and Wadi sediments.

It is bounded from all sides by steep gradients, which suggest that it may be due to uplifted basement blocks and some major faults bounding this zone. It is characterized by moderate to high frequencies as well as positive and negative anomalies with amplitudes ranging from 480 nT to 1410 nT in intensity.

The negative magnetic anomalies, consisting of clusters of small-scale local anomalies of low amplitudes and wavelengths, may indicate that the causative bodies are either of intermediate or acidic composition or represent down-faulted blocks.

The positive magnetic anomalies are oval in shape trending in NW-SE, NE-SW and E-W directions. This may indicate deep-rooted origin of the causative bodies producing this anomalous zone. The magnetic gradient of the contours in some localities may reflect the presence of faulting and can be easily traced, especially along the contacts separating the magnetic zones.

D- The Fourth Magnetic Zone (Z4)

The fourth and last magnetic zone (Z4, Fig. 6) is located in the most northeastern corner of the area under investigation, including Gabal Safaga and Gabal Abu-Furad. Relatively high and strong magnetic relief characterizes this zone. It is associated mainly with outcropping rocks of gabbros, biotite granites, andesites and Wadi sediments.

On the RTP aeromagnetic map (Fig. 2), the characteristic features of this zone are the presence of high frequencies and high amplitudes of five positive anomalies. These anomalies possess amplitudes ranging nearly between 400 and 600 nT. Besides, one general negative magnetic anomaly goes down to - 230 nT.

Two magnetic anomalies of the five positive anomalies combine into one anomaly of nearly circular shape, high amplitude reaching 600 nT and is associated with gabbros on the surface. The third positive magnetic anomaly is found to the east of the previous one. It appears as elongated two circles, trending in a NW direction and having a maximum amplitude reaching approximately to 400 nT.

The general negative magnetic anomaly lies to the north of the second positive anomaly, having low frequency and moderate amplitude going down to less than - 200 nT. It is characterized by its elongated shape, trending in a NW-SE direction and is associated with K-feldspar diorites on the surface.

Comparative inspection of the filtered regional and residual magnetic-component maps (Figs. 4 and 5) with the RTP aeromagnetic map (Fig. 2) has shown clearly good development of most of the magnetic characters associated with most of the anomalies. This indicates that most of the anomalies related to this zone are deep-rooted and relatively of wider subsurface areal extent.

QUANTITATIVE INTERPRETATION OF AEROMAGNETIC DATA

Depth Determination Results

Several techniques have been developed for analysis of aeromagnetic survey data, which led finally to their quantitative interpretation. The computed depths of the magnetic bodies and structures show that they are located at or near to the residual or near-surface magnetic-component level, which is very important in the structural mapping and mineral exploration. The results obtained helped greatly in interpreting the structure and relief of the basement surface, either exposed or buried. There is a close relation between both the uplifted blocks and shallow magnetic anomalies and the subsided blocks and the deep magnetic anomalies.

Table (1) : Depth values, in meters, for 48 selected major aeromagnetic anomalies as recorded on the reduced to pole aeromagnetic map, Gabal Elurf area, Central Eastern Desert, Egypt

Profile No.	Werner (1983)	Spectral Analysis (1987)	Average Depth (in m)	Profile No.	Werner (1983)	Spectral Analysis (1987)	Average Depth (in m)
1	569	521	545	25	1087	997	1042
2	728	668	698	26	1007	923	965
3	669	585	627	27	961	881	921
4	666	611	638	28	707	648	677
5	755	692	723	29	1027	942	984
6	722	662	692	30	536	492	514
7	664	608	636	31	673	617	645
8	673	617	645	32	665	609	637
9	781	716	749	33	736	674	705
10	516	473	495	34	678	622	650
11	620	569	595	35	907	832	869
12	887	813	850	36	822	754	788
13	804	737	771	37	791	725	758
14	692	635	664	38	758	695	727
15	918	842	880	39	1390	1274	1332
16	943	865	904	40	923	846	884
17	731	670	700	41	793	727	760
18	776	712	744	42	642	589	615
19	901	826	864	43	596	547	572
20	1070	981	1026	44	678	622	650
21	1037	950	994	45	1188	1089	1139
22	800	734	767	46	1150	1054	1102
23	1148	1053	1101	47	924	847	886
24	677	620	649	48	869	796	833

Magnetic Modelling Results

To confirm the dip of the tilted fault blocks, the depth of basement surface and delineate the basement tectonic framework of the study area, two aeromagnetic profiles denoted as A-A′ and B-B′ (Fig. 2) were taken in approximately NE-SW direction, in order to be almost at right angles to the NW-SE Red Sea trending structures, which is the prominent direction of faulting bounding the hill ranges of the basement rocks within the studied area. The two profiles were modeled using the 2-D modeling algorithm (Talwani et al., 1959).

The RTP aeromagnetic values along these two selected profiles were traced and used as the observed ones for modeling. Using the available geologic information and the two interpreted basement structural maps as deduced from the regional and residual magnetic-component maps, the two basement structural cross-sections were constructed along the two magnetic profiles to initiate modeling. The bottom surface of the modelled polygons was assumed to be the final sensitivity of the magnetic measurements along the profiles

Suitable magnetic susceptibility contrast values were assumed to the different basement blocks. These values were readjusted during modeling. The topographic elevations and flying heights have been subtracted to reach the calculated depths.

The observed total magnetic field (in nT) profile is shown as a dashed line with stars on the upper half of every figure, while the calculated magnetic field (in nT) profile is drawn as a solid line. The lower half of these figures represents the modeled basement structure configuration with corresponding magnetic susceptibility values and the dashed line represents the topographic elevation along the profile.

The values inside the polygon represent the magnetic susceptibility contrast. The horizontal X-axis represents the horizontal distance in kilometers along the profile. The vertical axis shows two different scales. The upper scale represents the magnetic intensity in nano Tesla (nT) and the lower half represents the depth in kilometers. The investigation of these profiles shows very reasonable best fit between the observed and computed magnetic profiles. Here follows is a discussion of the two-modeled profiles :

1- Modeled Magnetic Profile A-A′ :

The result of modeling of the magnetic profile (A-A′) is shown on Fig. (11). This profile crosses the northwestern part of Gabal Elmaghrabiya and passes through the centre of Gabal Elgarrah in a NE-SW direction (Fig. 2). Close examination of this profile shows an excellent fit between the observed and computed magnetic values.

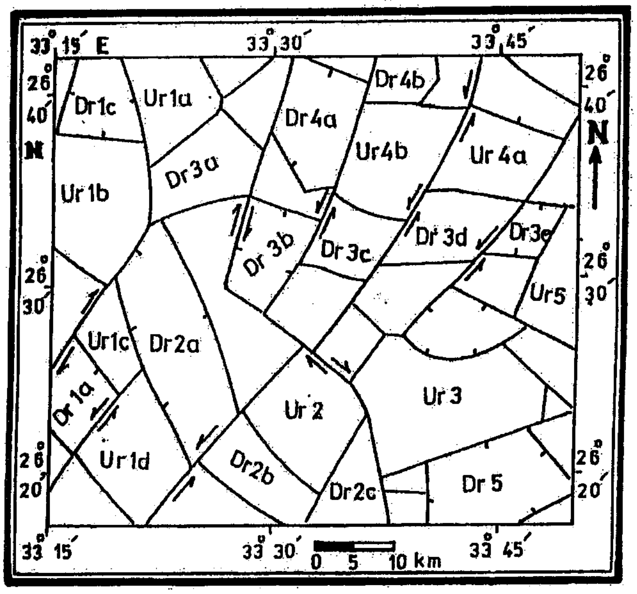


Fig. (9) : Interpreted Regional (Deep-Seated) Magnetic Basement Structural Map, as Deduced from the RTP Regional Aeromagnetic-Component Contour Map of Gabal Elurf Area, Central Eastern Desert, Egypt.

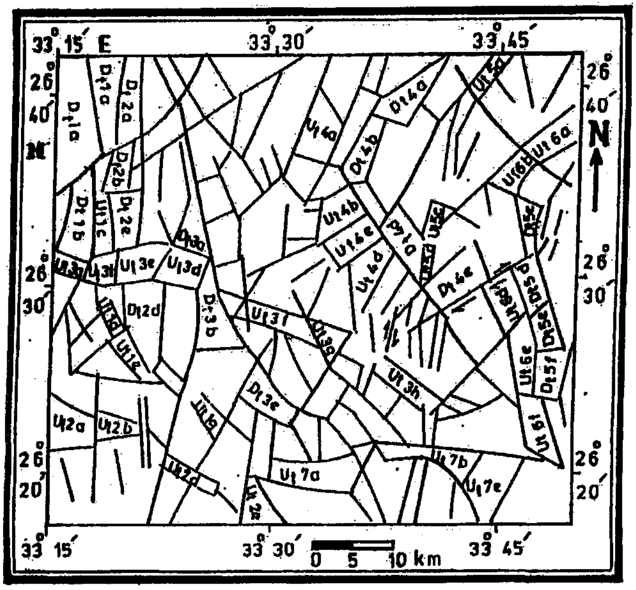
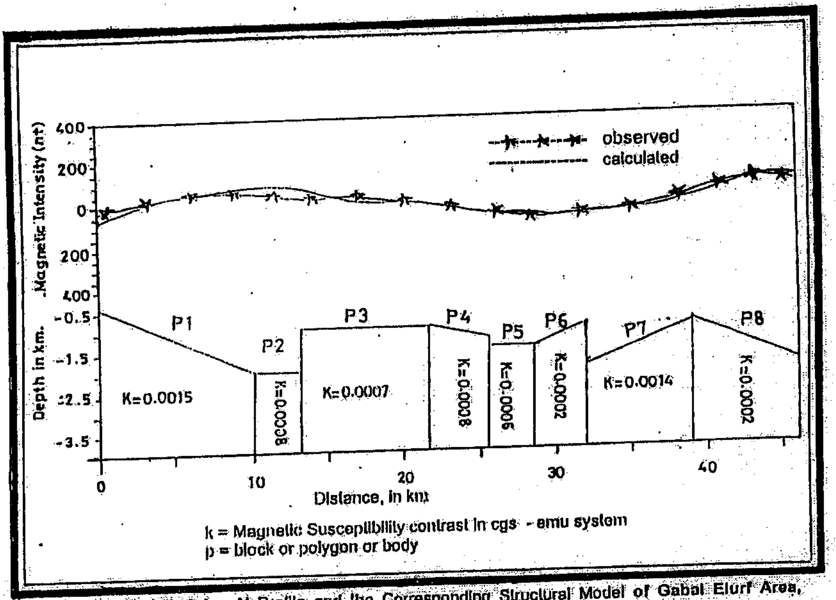
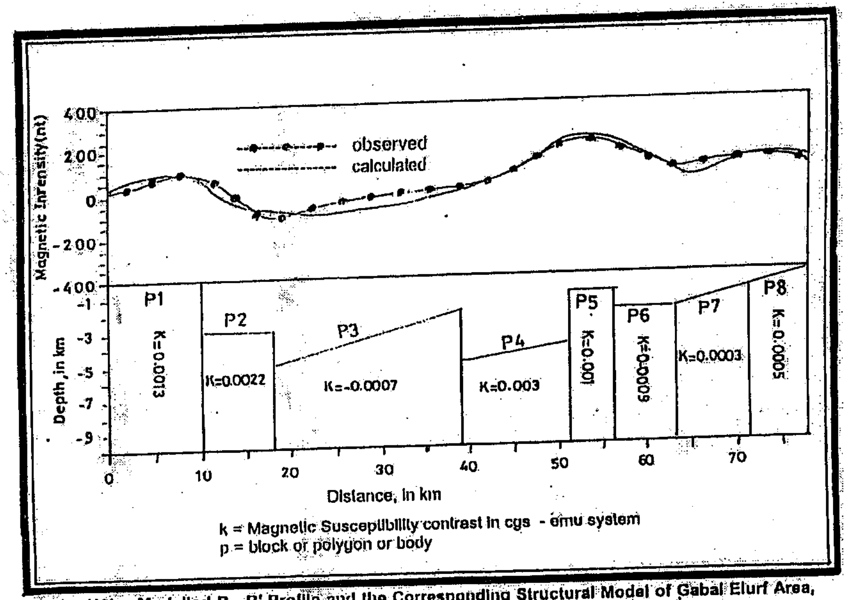


Fig. (10) : Interpreted Residual (Near-Surface) Magnetic Basement Structural Map, as Deduced from the RTP Residual Aeromagnetic-Component Contour Map of Gabal Elurf Area. Central Eastern Desert, Egypt.



k = Magnetic Susceptibility contrast in cgs - emu system
p = block or polygon or body

Fig. (11) : Modelled A - A' Profile and the Corresponding Structural Model of Gabal Elurf Area, Central Eastern Desert, Egypt.



k = Magnetic Susceptibility contrast in cgs - emu system
p = block or polygon or body

Fig. (12) : Modelled B - B' Profile and the Corresponding Structural Model of Gabal Elurf Area, Central Eastern Desert, Egypt.

This magnetic profile was modeled using eight polygons representing eight basement blocks. The contact between these polygons may represent lithologic contact (especially in the area of outcropping basement) or structural contact (e.g., major faults).

These faults are responsible for these uplifted blocks (polygons Nos. 1, 2 and 3), where polygon No. 3 represents Gabal Elgarrah Younger Granites. Meanwhile, polygon No. 4 represents the grey granites uplifted block. These faults are also responsible for the subsided blocks, which are represented by polygon No. (5) and show the most basic composition. The subsided blocks Nos. 6, 7 and 8, passing south Gabal Um-Taghir Elfawqani are represented by grey granites and smaller parts of medium-grained granites (Fig. 1). The blocks Nos. 4, 7 and 8 show the most acidic composition among the different blocks along this magnetic profile (Fig. 11). The uplifted and subsided blocks are faulted by step faults with their down-throws nearly towards the NE-SW direction, as in the case of polygons Nos. 7 and 8.

This magnetic profile shows that in the upper half, a single positive magnetic anomaly of high frequency, associated with bodies Nos. (3 and 6) and their relative smaller areal extensions reflect their shallower depth (uplifted blocks) for the basement rocks. The modeled basement blocks show magnetic susceptibility contrasts ranging between - 0.0007 and 0.003 e.m.u. This reflects variation in the composition of the basement rocks across this profile. The depths to the basement surface along this profile vary between outcropping to more than 5 km depth.

2- Modeled Magnetic Profile B-B′:

The result of modeling of the magnetic profile (B-B′) is shown on Fig. (12). this profile is passing south of Gabal El-Aradiyyah and Gabal Kab-Ameri in a NE-SW direction. Close examination of this profile shows complete coincidence between the observed and computed magnetic values.

This magnetic profile was modeled using eight polygons representing eight basement blocks. The contact between these polygons may represent lithologic contact (especially in the area of outcropping basement) or structural contact (e.g., major faults). These faults are responsible for the presence of the uplifted and the subsided blocks. There are two peaks representing the uplifted blocks, while the low areas are represented by the subsided blocks.

The uplifted and subsided blocks are separated by step faults, where their down-thrown sides are mostly towards the NW-SE direction. The first polygon has a relatively high magnetic susceptibility and is represented on the geologic map (Fig. 1) by outcropping schists and serpentinites. The polygons Nos. 2, 3 and 4 are given low values of magnetic susceptibilities and are mainly represented on the geologic map (Fig. 1) by grey granites, andesites and schists.

Serpentinites cover the subsided blocks (grabens) (polygons Nos. 5 and 7) and take the NE-SW direction. They may be of basic composition. Polygon No. 6 is represented by an uplifted block and covered geologically by grey granites and sepentinites (Fig. 12).

This magnetic profile shows that, in the upper half, two positive magnetic anomalies of varying frequencies and amplitudes reflect different depths and compositions. The modeled basement blocks show magnetic susceptibility contrasts ranging from - 0.0007 and 0.002 e.m.u. This reflects a relatively high variation in the composition of basement rocks across this profile. The depths to the basement surface along this magnetic profile vary from 0.5 km to more than 2.0 km.

CONCLUSIONS

The main results and conclusions of the qualitative and quantitative interpretations of the aeromagnetic survey data of Gabal Elurf area could be summarized in the following paragraphs.

The regional structural framework of the study area was delineated through the application and integration of some interpretative techniques on the RTP total aeromagnetic survey data.

The application of the two-dimensional power spectrum technique to determine the depths of the causative magnetic bodies within the basement, attained to a conclusion that the causative magnetic bodies in the area are aggregated at two disturbing interfaces having average depths of 770 m and 2.7 km below the measured level, for the near-surface and deep-seated magnetic effects respectively. Moreover, the frequency bands related to the regional and residual magnetic-components were used to produce the regional and residual magnetic-component maps. The residual map shows a great similarity to the RTP map. This may suggest that most of the basement rocks in the area are either outcropping or buried at deep depths. The regional magnetic-component map shows that the characteristic magnetic anomalies trending in the NE-SW and NW-SE directions are the important subsurface basement tectonic trends.

Magnetic modeling is a very powerful tool in quantifying basement parameters as depth, composition and attitude especially when coupled with geologic information.

The depth estimation was carried out on 48 RTP magnetic anomalies which range between 495 m and 1332 m, with an average (arithmetic mean) depth of about 788 m and a standard deviation of about 179 m.

The regional dip of the different blocks along the two modeled profiles is nearly vertical or gently dipping to the NE-SW.

The basement rocks in the study area show a very wide range in their composition as reflected by their magnetic susceptibility contrasts, which range between - 0.0007 and 0.003 e.m.u. This suggests the intrusion of relatively acidic basement rocks (of low susceptibilities) into very basic rocks (of high susceptibilities).

Most of the magnetic anomalies are caused by serpentinites and gabbros, some of them are related to the buried diabasic dykes, which intruded the southern part of the study area. Finally, the magnetic anomalies would be interpreted as due to basic materials intruded along the faults and contacts of these rocks.

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