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Aeromagnetic Survey for Determining Depth to Magnetic Source of Abakaliki and Ugep Areas of the Lower Benue Trough, Nigeria

[1]Ugwu, G. Z. and [2]Alasi, T. K.

[1]Department of Industrial Physcis, Enugu State University of Science and Technology, Agbani; Enugu State, Nigeria
[2]Department of Science Laboratory Technology, Federal College of Agriculture, Ishiagu; Ebonyi State, Nigeria
Correspondence author's e-mail address: balogunrb@gmail.com

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ABSTRACT

Aeromagnetic data of Abakaliki- Ugep part of the lower Benue Trough was used to calculate the depth to magnetic source of the area. The study area is on latitudes 5^{o} .30' and 6^{o} .30'N and longitudes 8^{o}.00' and 8^{o}.30'E. Qualitative and Quantitative method of interpretation were adopted using spectral analysis method to compute for depth to basement and by visual inspection of aeromagnetic map to delineate structural lineament. The NE and NW are the main trends in the studied area. The magnetic anomalies also suggest a strong folding of the basement in a direction similar to the trend of the trough. The deeper source depth ranges along the profile between 2548m to 4246m, while the shallower depth varies between 637m to 877m.The result also shows a linear depression with sedimentary accumulation trending E-W. The finding of the results indicated that application of Aeromagnetic survey combined with geological studies provide a powerful tool in estimating the depth to basement and delineating the lithological and structural setting of the terrain.

corresponding Author:

[2]Alasi, T. K.

KEYWORDS: **Abakaliki, Ugep, delineate, basement, aeromagnetic, lithological**

Introduction

Depth to magnetic source is based on the principle that a magnetic field measured at the surface can be considered an integral of magnetic signatures from all depths. The power spectrum of the surface field can be used to identify average depths of source ensembles (Spector and Grant, 1970). This is essential in order to estimate depths to basement (sedimentary thicknesses) across geological area. The Benue Trough in Nigeria possesses a geological complex that can be assessed using aeromagnetic survey to estimate the depth to magnetic source.

Aeromagnetic survey is one of the most important tools used in modern geological mapping. The principle is similar to a magnetic survey carried out with a hand-held magnetometer but allows much larger areas of the Earth's surface to be covered quickly for regional reconnaissance. This survey along a profile or grid determines the strength of the geomagnetic field at particular points by

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measuring spatial variations in the Earth's magnetic field (Onwuemesi, 1995). Ofoegbu (1988) reported that roughly about 60% of magnetic surveys are carried out for regional geological mapping and mineral exploration purposes while the remainder being mainly for petroleum exploration. Onuba *et al.,* (2008) equally pointed out that the main purpose of magnetic survey is to detect rocks or minerals possessing unusual magnetic properties that reveal themselves by causing disturbances or anomalies in the intensity of the earth magnetic field.

Aeromagnetic survey, is similar to magnetic method used to detect magnetic anomalies within the earth's magnetic field which are caused by the magnetic properties of the underlying rocks. The aim of aeromagnetic survey is to investigate the subsurface geology based on magnetic anomalies in the earth's magnetic field resulting from the magnetic properties of the underlying rocks (Onuba *et al*., 2008). Its operating physical property is the magnetic susceptibility and remanance which determine magnetizability.

Onwuemesi (1995) affirms that magnetic prospecting study the variations in the magnetic field of the earth. The magnetic field of sedimentary rocks is usually much smaller than igneous or metamorphic rocks. This allows the measurement of the thickness of the sedimentary section of the earth's crust.

Magnetic surveying investigates the subsurface geology of an area by detecting magnetic anomalies within the Earth's magnetic field, which are caused by the magnetic properties of the underlying rocks. Most rock-forming minerals are non-magnetic but a few rock types contain sufficient amounts of magnetic minerals, which can impart a magnetism to their host rocks and thus produce detectable magnetic anomalies. Rock magnetism has both magnitude and direction, the latter being determined by the host rocks position relative to the past and present magnetic poles of the Earth (Onuba *et al*., 2008).

The Benue Trough of Nigeria however is an elongated rifted depression that trends NE – SW from the South, where it merges with the Niger Delta, to the north where its sediments are part of the Chad Basin successions. The origin and evolution of the Benue Trough is now well documented (Ofoegbu, 1985). The major component units of the Lower Benue Trough include the Anambra Basin, the Abakaliki Anticlinorium and the Afikpo Syncline. The study area which covered parts of Abakaliki and Ugep is characterized by a zone of lead-zinc mineralization, pyroclastic rocks and brine. The occurrence of these mineral deposits has generated a lot of interest on the re-examination of the economic potentials of this mineral belt. Intense geological and geophysical investigations have been carried out in the Abakaliki Anticlinorium at different times in search of mineral deposits (Ofoegbu and Onuoha, 1991; Obi *et al*, 2010).

This study therefore seeks to undertake the determination of depth to magnetic source of Abakaliki/Ugep area of the lower Benue Trough using aeromagnetic survey.

MATERIALS AND METHODS

Study Area

The study area consists of sheets 303 and 314 (Abakaliki and Ugep sheets) which is delimited by latitudes 5^{o} .30' and 6^{o} .30'N and longitudes 8^{o}.00' and 8^{o}.30'E. This belong to the part of the lower Benue Trough which was formed during the formation of Benue Trough, as a result of series of tectonics and repetitive sedimentation in the Cretaceous time when South American continent separated from Africa and the opening of the South Atlantic Ocean. The separation of the continents resulted to an aborted rift (aulacogen) which have been filled with transgressive and regressive sedimentary deposits (Obi *et al*., 2010; Ugwu, and Ezema, 2012).

The Abakaliki sheet consists of the following major villages; Ochoko Okwu, Enyibichiri Izzi, Ntezi Aba, Mgbabor, Umuoghara, Okposi, Juju Hill, Ogharaugo, Acharaunuhu, Aghameghu, Nkpume Akpatakpa, Abofifia, Ezzagu, Ekperu Iyimagu, Ofe Iyiokwu, Agbaja, and Abakaliki urban (Fig. 1.1).

The Ugep sheet consists of the following major villages; Ekwerekunta, Arish, Alessi, Etara, Nko, Imabana, Obubra, Iyamlef, Yakurr, Ago Ibiam, Biase, Usumutong, Itigidi, Abi and Abanama (Fig. 1.2). The study area is accessible through the Abakaliki/Afikpo Road diversion in Abomege through Abomege/Ediba Road to Ugep, Abakaliki/Ugep Road, Ugep/Itigidi/Abakaliki highway, Akpepon Ntiefoli Road Ugep, Akpepon farm Road Ugep, Epanipaniti along park Road Ugep, Ementi along Idomi major Road, Egeiti farm Road in Ugep, Yidobiti farm Road, Ndibe beach route from afikpo, There are other footpaths and minor routes that made the accessibility into the area possible.

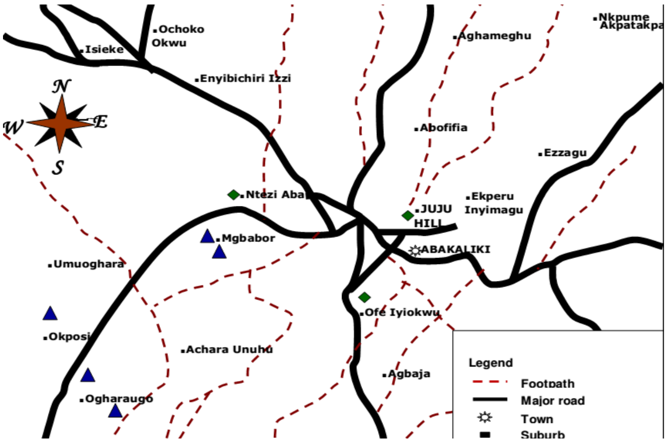

Fig. 1.1 Location map showing part of Abakaliki and its environment (Aghamelu *et al*., 2011)

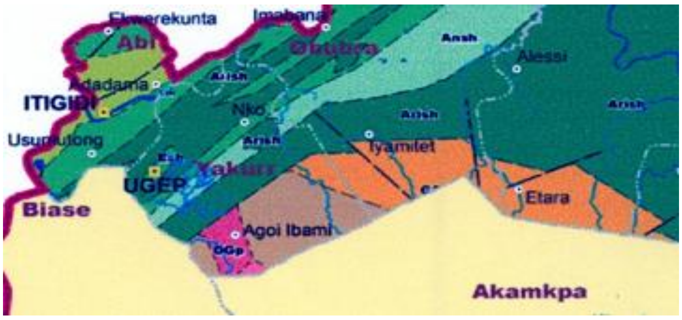

Fig. 1.2 Location map showing part of Ugep and its environment (Obianwu *et al*., 2015)

Geological Formation of the Study Area

Benue Trough is a linear (north east-south west) rift system whose development was associated with the separation of Africa from south America and the opening of the South Atlantic Basin. Its overall length is about 800km (Ofoegbu, (1985a).

It southern portion include the Anambra basin, the Abakaliki Anticlinorium, Urban massif, and the Afikpo syncline areas, which extend about 250km wide.

The lower Benue trough is underlain by a sequence of thick sedimentary deposit in the Cretaceous which have the Abakaliki Anticlinorium, towards the Anambra basin and the Afikpo syncline basin, belong to the following four geological formations:

Eze Aku Shale (Turonian)

The formation of Eze Aku consists of black shale and siltstones which sits unconformably at the Precambrian Gneiss to the north of Ugep. This unit is conformably overlain by the senonian sandstones and Upper coal beds along Ugep, (Ofoegbu and Onuoha, 1991; Obi *et al*., 2010).

Nkporo Shale (Campanian)

They are the youngest unit of cretaceous sequence and overlie the Eze Aku Shale unconformably.They are campanian-maastrich in age and are mainly marine in character, with some intercalations Sandstone members.

Awgu Shale (Campanian)

Consist of marine fossiliferous, grey bluish shales, lime stones and calcareous sandstones of Coniacian age.

Asu River Group (Albian)

The oldest sediment of all, consist of bluish black shales with very minor sandstone units. the shales are fissile and highly fractured. In the vicinity of the study areas these shales are associated with pyroclastic rocks and brine, the tectonic significance and stratigraphic dispositions of which have remained controversial. They uncomfortably overlie the Precambrian basement complex that is made up of granitic and magmatic rocks, (Ofoegbu and Onuoha, 1991; Ugwu *et al.*, 2013).

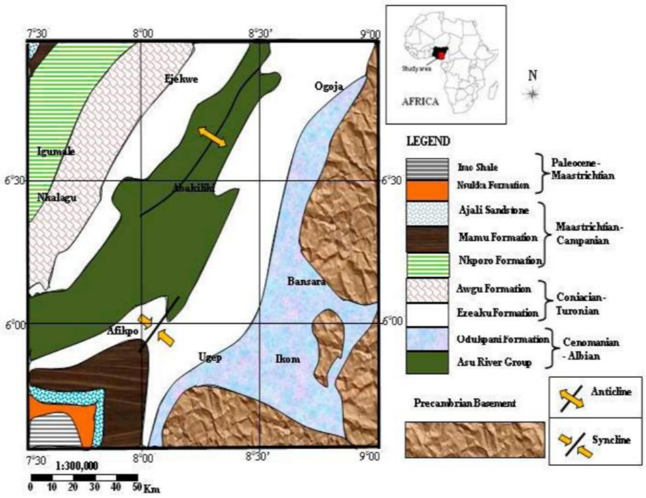

Fig.1.3 Geology map of the study area (Onuba *et al.*, 2013)

Estimates of the thickness of sedimentary rocks in the Benue Trough obtained from the interpretation of magnetic anomalies agree fairly well with those obtained through the analysis of the gravity field. Ofoegbu (1984c) working in the lower Benue Trough has found the thickness of sediments or depth basement to vary between 0.4km and 7km.

Data Collection

Digitized aeromagnetic data (sheets 303and 314) acquired from Nigerian Geological Survey Agency (NGSA) were assembled and interpreted. These data were acquired along a series of NW-SE, flight line with a spacing of 500m and flight line spacing (Infil) of about 250m while tie lines occur at about 5000m interval. The geomagnetic gradient removed from the data using the International Geomagnetic Reference Field (IGRF). The data made in form of contoured maps on a scale of 1:100,000. The area covered was about 12,100km^2.

Separation of aeromagnetic map

The contoured digitized data which is referred to as the total magnetic field intensity (TMI) contains both the regional and residual anomaly. The first step in the present study was to assemble the two maps covering the survey area. The next was to re-contour the map using WingLink integrated software and surfer 10 software in order to produce the total field aeromagnetic intensity map (Fig. 1.4) which contains both the regional and residual anomaly. Therefore for us to interpret the local field, we must remove the regional field from the TMI data. The regional gradient removed from the map by fitting a linear surface to the digitized aeromagnetic data using a multiple regression technique. The surface linear equation on the data selected according to (Ikumbur *et al.*, 2013) as:

$$T(x, y) = ax + by + c \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1a)$$

Where, a, b and c are constants; x and y are distances in x and y axis; T (x, y) is the magnetic value at x and y coordinates, where n is the maximum data point.

$$D = \sum_{i=1}^{N} [T - \{ax_i + by_i + c\}]^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1b)$$

The Least squares method of statistical analysis in 1(b) above was used to obtain the constants (a, b and c) from the linear equation system below.

Where X and Y are units of spacing, along the horizontal and vertical areas.

$$\begin{bmatrix} n & \Sigma x & \Sigma y \\ \Sigma x & \Sigma x^2 & \Sigma xy \\ \Sigma y & \Sigma xy & \Sigma y^2 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} \Sigma T \\ \Sigma Tx \\ \Sigma Ty \end{bmatrix}$$

The regional field values were subtracted from the aeromagnetic (observed) data and the resultant residual aeromagnetic anomaly data obtained and contoured. Both the digitized data and the residual data were contoured and their digital terrain models obtained using WingLink integrated software and surfer 10 software at interval of 15nT.

Data analysis (method of interpretation)

In this work qualitative and quantitative interpretation was carried out.

Qualitative interpretation of the aeromagnetic map involves the description of the aeromagnetic map and explanation of the major features revealed by the contour residual and regional data in terms of the types of likely geological formation and structures that give rise to the evident anomalies.

Some important features in qualitative interpretation, include, sharp changes in contour gradient which defines structural trend, alignment of lateral shift which off-set the main anomaly e.g. faulting, alignment close to anomalies suggest presence of magnetic bodies.

Quantitative interpretation of the aeromagnetic map involves making numerical estimates of the depth to magnetic source and the dimensions of the source of anomalies.

Spectral depth method

Spectral analysis was adopted for the interpretation of aeromagnetic anomalies (Hahn *et al*., 1976). In order to estimate depths to basement (sedimentary thicknesses) across the study area using spectral analysis methods, the spectral depth method is based on the principle that a magnetic field measured at the surface can therefore be considered the integral of magnetic signatures from all depths. The power spectrum of the surface field was use to identify average depths of source ensembles (Spector and Grant, 1970).

This same technique was used in identification of the characteristic depth of the magnetic basement, on a moving data window basis, merely by selecting the steepest and therefore deepest straight-line segment of the power spectrum, assuming that this part of the spectrum is sourced consistently by basement surface magnetic contrasts. A depth solution is calculated for the power spectrum derived from each grid sub-set, and was located at the centre of the window.

Depth results are generated for the entire dataset using different wave number ranges and window sizes. Six profiles were taken cutting across anomalous features for the interpretation of the geophysical anomalies in the area under study, the anomalies identified on these profiles subjected to the spectral analysis.

In order to carry out the spectra analysis of the aeromagnetic data, given a residual magnetic anomaly map of dimension LxL digitized at equal interval. The study area was divided into blocks containing 18 x 18 data points. In doing this, it was ensured that essential parts of each anomaly were not cut by the blocks. Care was also taken to ensure that each block contained more than one maximum, as suggested by Hahn *et al*., (1976). To achieve this, a few of the blocks were made to overlap each other. The degree of overlap was not significant. The analysis was implemented using Inequalities model developed in the course of the study. The spectra for the 18 block making up the area are shown in Table 1. Two depth models have been estimated for nearly all the blocks and these values are summarized in Table 1, which gives the computed depths for each block 18 x 18 data points.

The Discrete Fourier Transform is the mathematical tool for spectral analysis and applied to regularly spaced data such as the aeromagnetic data. The Fourier Transform represented mathematically in (Ikumbur, et al., 2013) as:

$$Y_i(x) = \sum^{N}_{n=1} [A_n \mathrm{Cos}\{2\pi n x_i /L \} + B_n \mathrm{Sin}\{2\pi n x_{i/} L\}] \ldots\ldots\ldots\ldots(3)$$

Where $Y_i(x)$ is reading at x_i position, L is length of the cross-section of the anomaly, n is harmonic number of the partial wave, N number of data points, A_n real part of the amplitude spectrum and B_n is imaginary part of the Amplitude spectrum; for Graphs of the logarithms of the FFT MAG. (spectral energies/Amplitude A_n) against FFT frequencies (frequency n) plotted and the linear segments from the low frequency portion of the spectral drawn from the graphs. The gradient of the linear segments were computed and the depths to the basement were determined using the equation according to (Ikumbur et al., 2013), given as;

$$Z = - ML/2\pi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Here Z is depth to the basement, M gradient of the linear segment and L defined as length of the cross-section of the anomaly (assuming L=1).

Results

The original aeromagnetic field map over the area was characterized by a series of local anomalies. The lines help to delineate the predominant trends of the subsurface (lineament) structures in the studied area as shown in fig 1.4. The data is processed (or transformed) such that the edge of a causative body is located beneath a maximum in the grid. The structural trends revealed from the polynomial surfaces of first degrees have a preponderance of NE-SW and NW-SW directions. The NE-NW trend is the dominant orientation as shown in the first degree regional polynomial surface. This result is similar to that of Goodhope and Luke (2013) on Structural interpretation of Abakaliki – Ugep, using Airborne Magnetic and Landsat Thematic Mapper (TM) Data with the exception of NE-SW dominant structural trend. It is equally fairly in agreement with that obtained by Obi *et al.*, (2010) on Aeromagnetic modeling of subsurface intrusive and its implication on hydrocarbon Evaluation of the lower Benue Trough, Nigeria with NW-SE dominant structural trend.

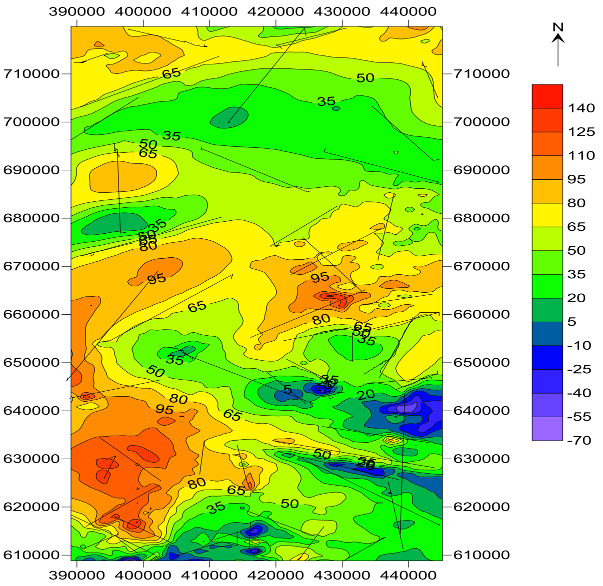

Fig. 1.4 Total Magnetic Intensity Map of the Study Area with structural trends affecting the study area (Contour interval ≈ 15nT)

3D surface map of total magnetic intensity

Figure 1.5estimate the 3D spatial location of structures and their edges. The results help to quantify the different magnetic responses of structures located in the shallow and deep sedimentary sections in the basement. The 3-D surface map also shows a linear depression with thicker sediments trending E-W direction.

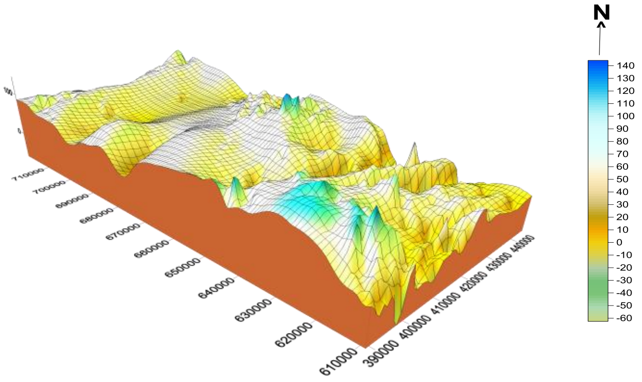

Fig 1.5 3D surface map of total magnetic intensity

Determining the depth to magnetic basement using slope method

The most important parameter in quantitative interpretation is the depth of the anomalous body. Depth to source is contained in the shape of the anomaly as represented in table 1. Because of the obvious importance of the depth to basement in mineral exploration, the depth to the magnetic source usually referred to as the depth to the basement is of great importance.

The study area was divided into eighteen blocks (18 blocks containing 18 km × 18 km). In doing this, adequate care was taken so that essential parts of each anomaly were not cut by the blocks. In order to achieve this, the blocks were made to overlap each other. Graphs of the logarithms of the FFT MAG (spectral energies/Amplitude A_n) against FFT frequencies (frequency n) obtained for various blocks are shown in Fig. 1.6a-f. From the slope of the spectrum segments, the estimated depths to magnetic basement are shown (Table 1).

For the spectral determination of depths to magnetic source, across the study area, the slope method of interpretation was deployed. Six profiles (18blocks) were taken on the residual aeromagnetic anomaly map of the study area. This profiles were taken perpendicular to the direction of the magnetic profiles, namely, A-A, B-B ,C-C, D-D, E-E, and F-F, were used for detailed interpretation (Fig. 1.6a-f) and these may serve as representatives of other as they behave almost in the same manner. The result of the interpretation is used to calculate depth to the magnetic source in table 1.

Table 1: showing depth estimate to basement

Profiles	Block	Shallow depth (m)	Deeper depth/Thickness to sediments (m)
A-Aǀ	1	811	3715
	2	780	4246
	3	732	3185
B-Bǀ	4	859	3609
	5	796	3284
	6	637	2548
C-Cǀ	7	845	3867
	8	877	3867
	9	796	3867
D-Dǀ	10	812	3609
	11	845	3715
	12	845	3715
E-Eǀ	13	796	3867
	14	732	3715
	15	732	3715
F-Fǀ	16	812	3284
	17	764	2997
	18	812	3867

Estimation of depth

The plot was used to estimate depth to basement using logarithms of magnitude and the fast Fourier Transform Frequency, which estimate the shallower depth of this profile to range between 637m to 877m and 2548m to4246m for the deeper depth using Microsoft excel (fig. 1.6a-f).

Profile A-Aǀ

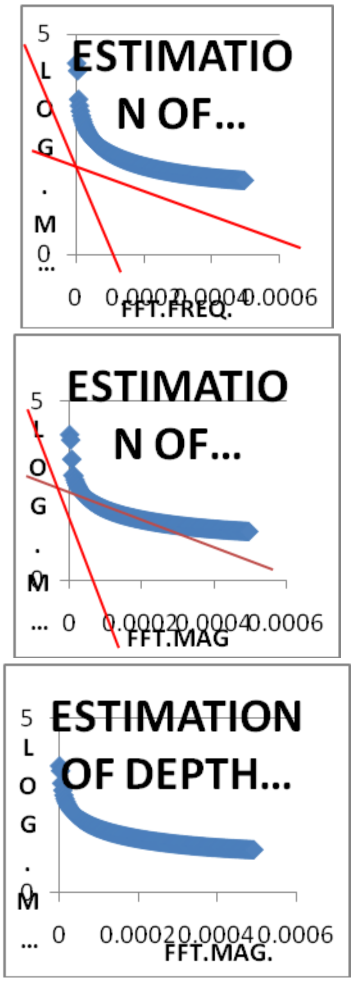

Fig. 1.6a

Profile B-Bǀ

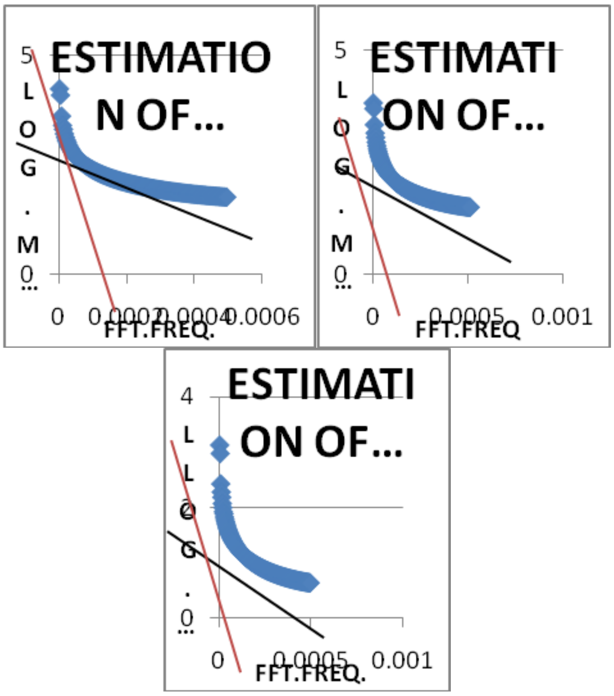

Fig. 1.6b

Profile C-C'

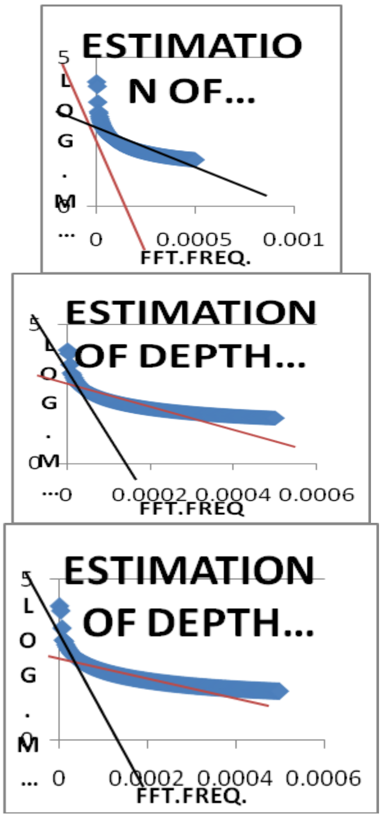

Fig. 1.6c

Profile D-D'

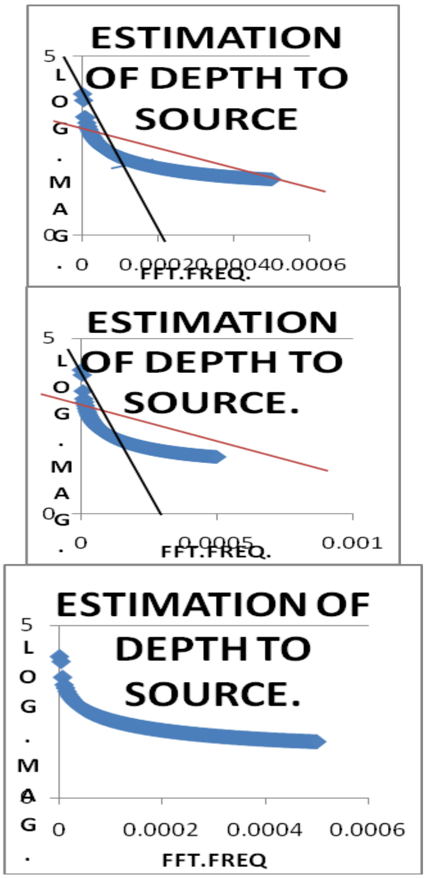

Fig. 1.6d

Profile E-E'

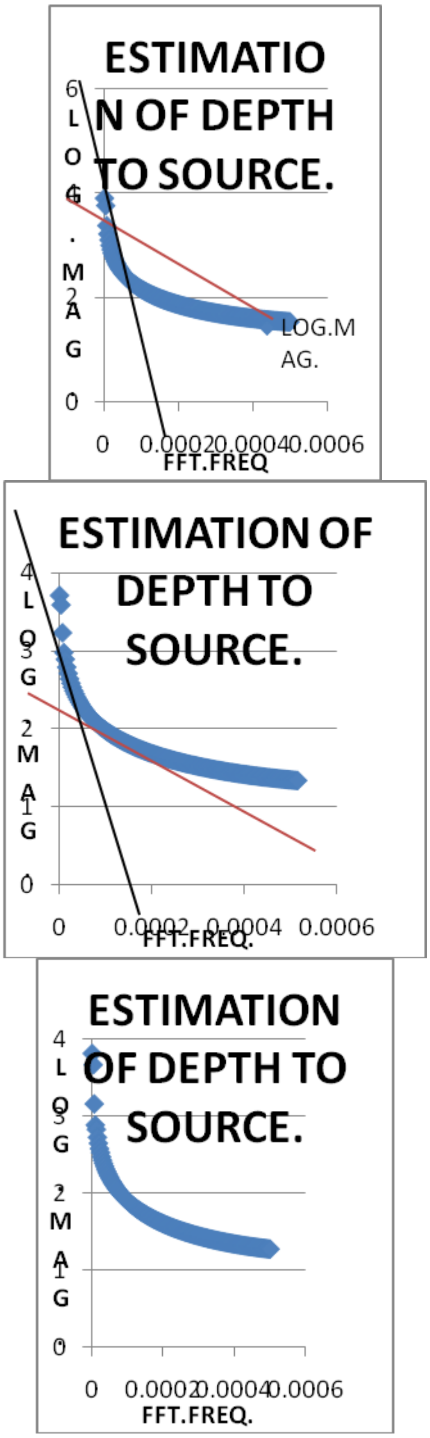

Fig. 1.6e

Profile F-F'

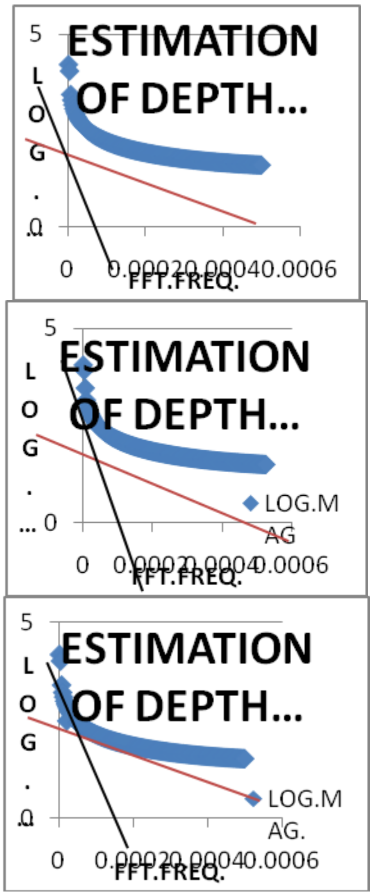

Fig. 1.6f

Discussion

Qualitative Interpretation

The qualitative interpretation of a magnetic anomaly map begins with a visual inspection of the shapes and trends of the major anomalies. This work present a qualitative approach to the geological terrain of the studied area, which clearly gives the visual inspection of the contour map, shading relief map and also the 3D surface map of the area. WingLink integrated software and surfer 10 software was deployed to produce the TMI, Regional, and residual contour map of the study area.

In sedimentary regions of the studied area, particularly where the basement depth exceeds 1.5km, the magnetic contours are normally smooth and variations are small, reflecting the basement rocks rather than the near surface features. This observation conforms to the work of Telford *et al.*, (1990). The magnetic relief observed over sedimentary basin areas is almost always controlled more by the lithology of the basement than by its topography as reported by Dobrin and Savit, (1988). Meanwhile, in regions where igneous and metamorphic rocks are predominant, they usually exhibit complex magnetic variations. Deep features are frequently camouflaged by higher frequency magnetic effects originating nearer to the surface. This observation correlates with the findings of Telford *et al*., (1990).

The density of contour lines often provides a useful criterion for indicating structures. The closer the contours, the greater the gradients, the shallower, in general, is the source. Any sudden change in the spacing over an appreciable distance suggests a discontinuity in depth, possibly a fault as studied by Dobrin (1960).

The visual inspection of the aeromagnetic map (Fig. 1.4) shows that the contour lines that are closely spaced indicated a shallow depth to basement while the widely spaced contour line indicate a deeper depth to the magnetic basement of the area. The magnetic anomalies of large area extent reflect a deeper source than small size anomalies (Vacquier *et al*., 1951).

However, a well defined boundary between zones with appreciably different degrees of magnetic relief can indicate the presence of a major basement fault. This is affirm by Dobrin and Savit, (1988).

The original aeromagnetic field map over the area was characterized by a series of local anomalies which are not apparent on the residual map. Deep bodies produce only long wavelengths. Shallow bodies produce both longer and short wavelength. Short wavelength produce at basement depth is due to magnetic dipole.

First order polynomial filter, first vertical derivatives, first horizontal derivatives and upward continuation was used to smoothen the data, so as to reduce high frequencies (noise).

The resultant magnetic field over the area as shown in Figures 1.4 as a contour map. Several processing techniques were also applied to aeromagnetic anomaly data but only the enhancement with optimal information for the intended purpose of this work was considered for interpretation.

Total intensity aeromagnetic contour map and 3D surface of the total magnetic intensity maps were constructed (Fig. 1.4 and 1.5) using WingLink integrated software and Surfer 10 software for outlining the discontinuity lines which divide the study area into characteristic structural zones. These zones represent the outlines of the local regional variations in basement structures beneath the study area. The line helps to delineate the predominant trends of the subsurface (lineament) structures in the studied area.

The structural trends revealed that the polynomial surfaces of first degrees have a preponderance of NE-SW and NW-SW directions. The NE-NW trend is the dominant orientation as shown in the first degree regional polynomial surface. Figure 1.4 gives lineament structure map of the studied area using the interpretation of the total magnetic intensity contour and residual field contour map which shows the NE and NW as the main trends in the studied area. The magnetic anomalies also suggest a strong folding of the basement in a direction similar to the trend of the trough.

Quantitative Interpretation

The most important parameter in this quantitative interpretation is the depth of the anomalous body. Depth to source is contained in the shape of the anomaly. Because of the obvious importance of the depth to basement in mineral exploration, the depth to the magnetic source usually referred to as the depth to the basement is of great importance.

The result of the spectra analysis of aeromagnetic data over the survey area, suggest the existence of both shallow and deeper source depth under the area. The deeper source depth range along the profile is from 2548m to 4246m, which agree with the analysis of Ofoegbu and Onuoha (1991) for a profile in the lower Benue Trough. These deeper sources are represented by the first segment of the spectrum of Figure 1.6a-f which reflects the Precambrian basement. While the shallower magnetic horizon which varies between 637m to 877m, represented by the second segment of the spectrum (Fig. 1.6a-f) were sources shallower than the Precambrian basement are shown. The effect of aliasing not eliminated by the filter is seen to be strongest here and therefore this shallower horizon may be unreliable. This result is in agreement to that obtained by Goodhope and Luke (2013) on Structural Interpretation of Abakiliki – Ugep, using Airborne Magnetic and Landsat Thematic Mapper (TM) Data, which estimate the deeper depth to range between 1.585km to 4.136km with a shallower depth of 0.0035km to 1.285km. However, the area is generally flat except for a few hills (Abakaliki and Ugep hills), the elevation of which above the surrounding plains hardly exceeds 200m above sea level.

Conclusion

Airborne geophysical study is utilized to delineate the subsurface structure which controls the anomalous mineralization zones of the studied area. In this study, aeromagnetic data, TMI, Residual and Regional geological map are considered as the main source of information.

According to visual inspection of the various geological and aeromagnetic maps, the subsurface basement tectonics map of studied area is constructed, the NE and NW as the main trends in the studied area. The magnetic anomalies also suggest a strong folding of the basement in a direction similar to the trend of the trough.

The result of the spectra analysis of aeromagnetic data over the survey area, suggest the existence of both shallow and deeper source depth under the area.

The deeper source depth range along the profile is from 2548m to 4246m, which agree with the analysis of Ofoegbu and Onuoha (1991) for a profile in the lower Benue Trough. These deeper sources are represented by the first segment of the spectrum of Figure 1.6a-f which reflects the Precambrian basement. While the shallower magnetic horizon which varies between 637m to 877m, represented by the second segment of the spectrum (Fig. 1.6a-f) were sources shallower than the Precambrian basement are shown. The effects of aliasing not eliminated by the filter should be strongest here and therefore this shallower horizon may be unreliable. This result agree fairly in agreement to that obtained by Goodhope and Luke (2013) on Structural Interpretation of Abakiliki – Ugep, using Airborne Magnetic and Landsat Thematic Mapper (TM) Data which estimate the deeper depth to varies between 1.585km to 4.136km with a shallower depth of 0.0035km to 1.285km. These results agree well with both topographical and geological maps of the studied area. The interpreted depth helps greatly in the interpretation basement relief.

However, the area is generally flat except for a few hills (Abakaliki and Ugep hills), the elevation of which above the surrounding plains hardly exceeds 200m above sea level.

Finally, it could be concluded that, the application of aeromagnetic survey combined with geological studies provide a powerful tool in estimating the depth and delineating the lithological and structural setting which may control the magnetic relief observed over sedimentary basin areas (Dobrin and Savit, 1988) and mineralization in the terrains.

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Highlight

This study undertakes the determination of depth to magnetic source of Abakaliki/Ugep area of the lower Benue Trough using aeromagnetic survey.

In this study, aeromagnetic data, TMI, Residual and Regional geological map are considered as the main source of information.

According to visual inspection of the various geological and aeromagnetic maps, the subsurface basement tectonics map of studied area is constructed, the NE and NW as the main trends in the studied area. The magnetic anomalies also suggest a strong folding of the basement in a direction similar to the trend of the trough.

The result of the spectra analysis of aeromagnetic data over the survey area, suggest the existence of both shallow and deeper source depth under the area.

The deeper source depth range along the profile is from 2548m to 4246m, for a profile in the lower Benue Trough. These deeper sources are represented by the first segment of the spectrum which reflects the Precambrian basement. While the shallower magnetic horizon which varies between 637m to 877m, represented by the second segment of the spectrum were sources shallower than the Precambrian basement are shown. The effects of aliasing not eliminated by the filter should be strongest here and therefore this shallower horizon may be unreliable. The interpreted depth helps greatly in the interpretation basement relief.

Finally, the application of aeromagnetic survey combined with geological studies provide a powerful tool in estimating the depth and delineating the lithological and structural setting which may control the magnetic relief observed over sedimentary basin areas and mineralization in the terrains.