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MAGNETIC BASEMENT DEPTH RE-EVALUATION OF ABAKALIKI/IKOM AND ENVIRONS SOUTHEASTERN NIGERIA, USING 3-D EULER DECONVOLUTION

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Abstract: A research on magnetic basement depth re-evaluation of Abakaliki/Ikom and environs was carried out in the study area which is located between latitude $5^{\circ}30' - 6^{\circ}30'N$ and longitude 8° . 9° E. Aeromagnetic data were used for the study. The study was carried out to determine depth to the magnetic basement, delineate basement morphology, relief, structural and tectonic features associated with the area. The aeromagnetic data were subjected to various image, data enhancement and transformation routines. Oasis montaj and ILWIS softwares were used for data analysis. Maps such as the total magnetic intensity map, 3-D surface map of the basement topography of the area ,2-D wireframe map of the study area , power spectrum plots of the aeromagnetic data of the area, standard Euler maps were produced. Results show that the area has a very complex pattern of magnetic anomalies of both short and long wavelengths. Result of the 2-D spectral analysis revealed a two layer depth model. The shallower magnetic source (D_1) has an average depth of 3.27km while the deeper magnetic source (D_2) has an average depth of 2.626km. The shallower magnetic anomalies are as a result of basement rocks which intruded into the sedimentary rocks while the deeper magnetic anomalies are associated with magnetic basement surface and intra basement discontinuities like faults, fractures and lineation. Structural analysis of these shallow anomalies using 3-D Euler deconvolution with structural index values ranging from 0-3 revealed two main structural models in the study area which include sills/pipes and horizontal cylinders/pipes. With shallow basement depth, abundance of intrusives and linear features which may have acted as conduit for mineralization, the distribution of minerals like baryte, lead/zinc, cassiterite, chalcopyrite and andersite, the ore bodies prospectivity of the area is high but the area is unfavorable for hydrocarbon generation and accumulation

Indexwords: Aeromagnetics, , anomalies, basement, structural features, sediments, tectonics,

1 INTRODUCTION

The study area is part of the Lower Benue trough. It is located between latitude $5^{\circ}30' - 6^{\circ}30N$ and longitude 8° -9° E. The trend of the basement fault and structure is frequently the main determinant of the primary fractures that develop to accommodate basin extension. In many sedimentary basins magnetic anomalies arise from secondary mineralization along fault planes, which are often revealed on aeromagnetic maps as surface linear features. The use of satellite imagery for regional mapping of geologic units and structures has long been demonstrated as a vital tool for regional geologic mapping. This is as a result of its ease of operation, speed, accuracy, low cost and coverage. Acquisition of data by remote sensing is among the technological advancement that has been realized, and in geological aspect, the technique is normally used in acquiring earth's surface geological data for instance structural features, lithologies, lithogical sequences and relative age of rocks strata Onuha et al (2011). A typical contoured aeromagnetic map present several anomalies whose sources are traceable to the basement. It now becomes imperative that depth estimation from those anomalies provide useful clues to appropriate estimation of sedimentary thickness. Aeromagnetic survey data are routinely interpreted by estimating source depth or locations. Consequently, many processing algorithms have been proposed to assist the estimation. The application of 2-D spectral inversion to the interpretation of potential field data is one method that has been used to determine the basement depth and is now sufficiently well established. Several authors have applied spectral inversion techniques in the determination of sedimentary thickness in various basins of the world. The magnetic anomaly signatures characteristics are results of one or more physical parameters such as the configuration of the anomalous zone, magnetic susceptibility contrast as well as the depth to the anomalous body. Using Euler deconvolution, source position and depth can also be interpreted.

This study therefore attempts to estimate depths to anomalous magnetic sources within the study area using 2-D spectral analysis and 3-D Euler deconvolution techniques. Structural interpretation was also carried out on the contoured aeromagnetic data with a view of locating structures that may possibly accommodate ore bodies.

2 GEOLOGY OF THE STUDY AREA.

The study area covers geological formations such as the northern part of Oban massif, Obudu massif, Ikom-Mamfe Embayment and the Lower Benue Trough. The basement part of the study area consists of banded schist, gneiss and associated with pegmatites. The schists are highly deformed and display conspicuous segregation into light and dark portions. The light band contains porphyroblasts of garnet, cyanide and sillimanite. On the other hand, the dark portion of the schist is highly foliated and consists of mafic minerals dominantly phyllosilicates (Ekuweme, 2004). The Lower Benue and the Ikom-Mamfe Embayment exhibit enormous lithologic variation, although they are fairly comparable in sedimentary thickness. 3,000m of mostly marine strata have been drilled in the Calabar Flank. Gravity estimates of sedimentary thickness in the Ikom-Mamfe Rift by Okereke et al. (1989) suggested 3,000-4,000m of predominantly non-marine beds.

At the Mamfe Embayment, there are two major Cretaceous units – the Ezeaku Group and the Asu River Group. There is also Late Turonian – Coniacian calcerous sandstone ridges which belong to the Amaseri Formation (Petters, 1995). The southern Benue Trough in the cretaceous period is stratigraphycally represented by sediments of three main marine depositional cycles; Albian – Cenomanian, Turonian – Santorin and Compano – Maastrichtian (Reyment, 1965). The first marine transgression of the trough is generally believed to have occurred in Mid – Albian times. Sediments of Asu River and Abakaliki shales were deposited during this transgressive phase. They are mostly shales with localized development of sandstones and carbonates.

The Benue Trough is marked by a lot of igneous activities. This is shown by the occurrence of intrusive and extrusive rock of all forms. The intrusive activity is reported to have gained momentum during the late and post Albian times and ceased by the end of Turanian. The intrusive rocks are more common in the Lower Benue Trough. They occur in the forms of sills and dykes (Kogbe, 1989).

In the middle Albian the first transgression took place covering up the basement complex in Lower and Middle Benue Trough with the Asu River Group sediments. Sedimentation started here in the lower Cretaceous with the deposition of the Albian shales and limestones of the Asu River Group. It consists of dark shales, siltstones and fine grained sandstones passing upwards into shales and limestones of the upper Albian sub-stage. The indications are that the sediments were deposited in shallow marine environment. The considerable compaction of the sediments and large thickness are thought to be due to a "yielding bottom condition".

The Mamfe Formation is in the Asu River Group. The type locality of the Mamfe Formation is at the bank of the Cross River at Mamfe in Cameroun Republic, where about 800m of massive arkoses sandstone with marl, sandy limestone, and shale intercalations are exposed (Reyment, 1965), the sequence on the Nigerian part of this basin comprises conglomeratic, immature, arkoses, cross-bedded, coarse to medium sandstone and mudstones (Reyment, 1965). Figure 1 shows the different units in the study area.

Eze-Aku Formation is also found in the study area which includes those rocks that were believed to have been deposited during the Turonian transgression (Reyment, 1965). These groups of sediments lie conformable over the Asu River Group. The type locality is the Eze-Aku River valley in South Eastern Nigeria. The Amasiri sandstones, as well as the shaley limestone, calcareous limestone and sandy limestone of Nkalagu are lateral equivalent of the Eze-Aku Formation. Some of the Eze-Aku sandstones are highly weathered yellow to brownish in colour. They range from fine to medium grain in texture. Eze-Aku sandstone is found along stream channels opposite the post office in Ugep town.

The Awgu Shale is a formation in the Cross River Group. This is bluish grey; bedded shale with some fine-grained carbonaceous limestone beds which is about 900m in thickness. It consists of marine fossiliferous grey blue shales associated with subordinate limestone and calcareous sandstones. Geologic map of the study area is seen in figure 1.

3 METHOLOGY

Aeromagnetic data were used in this study. In this method, four aeromagnetic sheets (303, 304, 314 and 315) were used. The aeromagnetic data were acquired during the nationwide aeromagnetic survey which was sponsored by the Geological Survey of Nigeria (GSN) in 2005. Flight lines were NNW-SSE at station spacing of 2km with flight line spacing of 20km at an altitude of about 150m. The aeromagnetic data were subjected to low pass filtering achieved through manual digitization of the map using 2cm by 2cm (equivalent to 2km by 2km) grid spacing. The nature of filtering applied in this study in the Fourier domain was chosen to eliminate certain wavelengths and to pass longer wavelengths. Regional - residual separation was carried out using polynomial fitting. This is a purely analytical method in which matching of the regional by a polynomial surface of low order exposes the residual features as random errors. For the magnetic data, the regional gradients were removed by fitting a plane surface to the data by using multi- regression least squares analysis. The expression obtained for the regional field T(R) is given as:

 $T (R) = 7612.158 + 0.371x - 0.248y \dots (1)$

In addition, 2-D spectral analysis allows an estimate of the depth of an ensemble of magnetized blocks of varying depth, width, thickness and magnetization. The digitized aeromagnetic data is transformed in Fourier domain to compute the energy (or amplitude) spectrum. This is plotted on a logarithmic scale against frequency. The slopes of the segments yield estimates of average depths to magnetic sources of anomalies.

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For the spectral determination of depth to layers of magnetization, the four sheets were divided into four different blocks containing 16 * 16 data points. In doing this, adequate care was taken so 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). In other to achieve this, the blocks were made to overlap each other. Similarly, second vertical derivative filters were used to enhance subtle anomalies while reducing regional trends. These filters are considered most useful for defining the edges of bodies and for amplifying fault trends. In mathematical terms, a vertical derivative can be shown to be a measure of the curvature of the potential field, while zero second vertical derivative contours defines the edge of the causative body. Thus, the second vertical derivative is in effect a measure of the curvature, i.e., the rate of change of nonlinear magnetic gradients. The zero magnetic contours of the second vertical derivative often coincide with the lithologic boundaries while positive and negative anomalies often match surface exposures of the mafic and felsic rocks respectively (Opara et al., 2012).

The Standard 3D Euler method is based on Euler's homogeneity equation, which relates the potential field (magnetic or gravity) and its gradient components to the location of the sources, by the degree of homogeneity' N' which can be interpreted as a structural index. The method makes use of a structural index in addition to producing depth estimates. In combination, the structural index and the depth estimates have the potential to identify and calculate depth estimates for a variety of geologic structures such as faults, magnetic contacts, dykes, sills, etc. The algorithm uses a least squares method to solve Euler's equation simultaneously for each grid position within a sub-grid (window). A square window of predefined dimensions (number of grid cells) is moved over the grid along each row. At each grid point a system of equations is solved, from which the four unknowns (x, y as location in the grid, z as depth estimation and the background value) and their uncertainties (standard deviation) are obtained for a given structural index. A solution is only recorded if the depth uncertainty of the calculated depth estimate is less than a specified threshold and the location of the solution is within a limiting distance from the center of the data window (Opara et at, 2012).

It can be shown that, the following equation, which is known as Euler's homogeneity relation can be satisfied:

$$x\frac{\delta f}{\delta x} + y\frac{\delta f}{\delta y} + z\frac{\delta f}{\delta z} = nf \quad \dots$$
(2)

In geophysics, the function f(x,y,z) can have the general functional form:

$$f(x, y, z) = \frac{G}{r^N} \tag{3}$$

Where $r^2 = (x - x_0)^2 + (y - y_0)^2 + (z - z_0)^2$, N a real number (1,2,3...) and G a constant (independent of x,y,z). Many simple point magnetic sources can be described by equation (3), with (x₀; y₀; z₀) the position of the source whose field F is measured. The parameter N is dependent on the source geometry, a measure of the fall-off rate of the field and may be interpreted as the structural index (SI). Clearly equation (3) is homogeneous and thus N is equivalent to -n in Euler's equation (2).Considering potential field data, Euler's equation can be written as:

$$(x - x_0)\frac{\delta T}{\delta x} + (y - y_0)\frac{\delta T}{\delta y} + (z - z_0)\frac{\delta T}{\delta z} = N(B - T)$$
(4)

With B the regional value of the total magnetic field and $(x_0; y_0; z_0)$ the position of the magnetic source, which produces the total field T measured at (x; y; z). Simple magnetic and gravimetric models are consistent with Euler's homogeneity equation. Thus Euler deconvolution provides an excellent tool for providing good depth estimations and locations of various sources in a given area, assuming that appropriate parameter selections are made. Applied to aeromagnetic surveys, the 3D Euler process is a fast method for obtaining depth and boundary solutions

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of magnetic sources for large areas. Though it is a general advantage of the Euler deconvolution method, that it is applicable to all geologic models and that it is insensitive to magnetic remanence and geomagnetic inclination and declination, an initial assumption of the source type has to be made. Dependent upon the potential source type, a structural index is chosen. This structural index is also a measure of the distinctive fall-off rate of the geologic feature. For example, the best results for a contact are obtained by structural indices of 0 to 0:5, while for thin two-dimensional dyke structures a structural index of 1 yields the best estimates. Table 1 summarizes the structural indices (SI) for given geologic models. The number of infinite dimensions describes the extension of the geologic model in space. A reliable tool for the limitation of results is the specification of a threshold value for depth and horizontal uncertainties. Geosoft Oasis montaj reports the depth and location uncertainties as percentage of the depth below the recording sensor position. As matter of principle, low SI values are associated with source bodies which give rise to low gradients, thus depth estimation solutions with low SI values have high uncertainties. The data quality determines the general level of uncertainty, so an examination of the recorded solutions will define the selection criteria.

The consideration of appropriate solutions should be guided by two aspects. On the one hand, the position (and depth) anomalies should be kept low to improve the accuracy of the computations, on the other hand a sufficient number of solutions must be retained in order to delineate geologic features sought and provide meaningful solutions. The results of the Euler method are displayed in ordinary maps as point solutions combining the location (position of solution) and the depth (colour range). Given the choice of an appropriate structural index, 3-D Euler deconvolution will lead to a clustering of solutions, which can be interpreted. A vertical pipe structure will for example be shown as a cluster of solutions around a specific point, whereas an elongated dyke structure will be recognized as a linear trend of solutions.

4 RESULTS AND DISCUSSION

Several analytical results of the study area are presented in this section for the purpose of inferring the relationship between magnetic depth in the study area with intrusive bodies, linear features, ring dykes and other geological features. The influence of these structures in mineral bearing potential of the area was also considered

The total magnetic field over the study area was obtained by digitizing four sheets of aeromagnetic map supplied by Geological Survey of Nigeria. The resultant magnetic field over the area obtained by digitizing four sheets of aeromagnetic map was contoured. The contoured and other enhanced maps are discussed below.

4.1 Total Magnetic Field Intensity.

The resultant total magnetic field map gotten after digitization along flight lines at spacing of 2km is presented in figure 2. The total field of the aeromagnetic data revealed that the underlying basement within Ikom has an estimated magnetic range of 7780 to 7860 gammas. Within this area, there are places with magnetic intensity as low as 7720 to 7760 gammas. Northwest of Ugep and south of Bansara, are places with magnetic intensity as high as 7950 gammas and surrounded by fairly high intensity area. The 3-D map revealed two distinctive relief patterns; low and high relief. Areas with low relief are observed around Ikom, Bansara and east of Ugep. The high relief areas are believed to be more tectonically active than the low relief areas (Opara 2011).

The total field map of the area shows a very complex pattern of magnetic anomalies of both short and long wavelengths. This is seen in figure 2 These wavelengths are represented as magnetic low and high anomalous bodies. The area is characterized by many closed contours with major anomalies striking northeast – southwest. Areas of highly magnetic values could be as a result of magnetic eruption or igneous intrusion to the earth surface. The isolated high magnetic structure represented by circular contours of 8100y to 8150y in figure 2 could be an

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intrusion. Intrusions are described on the aeromagnetic maps by elliptical or circular contours (Akanbi and Udensi, 2006). These intrusions may have been from basement which contains aggregate economic mineral deposits. Major faults may be recognized as a region of closed low exhibiting a linear trend on the aeromagnetic field map (Reynold et al 1990). Therefore it is logical to note that this area is not only sedimentary but has fault zones.

Major faults may be recognized as a series of closed lows exhibiting a linear trend on the map (Opara, 2011) as seen in figure 2. In the same vein large contrasting tectonic units such as faulted igneous blocks produce broader and larger lows (Alligham, 1996). Therefore, these magnetic lows maybe interpreted as major fault zones predominantly as seen in Ugep. The major magnetic highs which covered predominantly the areas of Abakaliki and lkom may be interpreted as lineaments as a result of tectonic event. This tectonism is believed to have been initiated during the separation of the African and South American land masses. This major fact distinguishes the study area between the cretaceous and the sedimentary zones.

Both the 3-D surface and 2-D maps (figures 3 and 4 respectively) of the basement are observed as made up of uplifts and depressions. The tectonism responsible for the folding is believed to have been initiated during Mesozoic time due to the separation of African and South American land masses which causes folding on the basement surfaces. However the lineament trending E-W direction around Ugep in figure 3 is a major erosional escarpment believed to be tectonic. This feature demarcates the Lower Benue trough from the Niger Delta and Calabar Flank. The area exhibits high tectonic events on them. This confirms the Abakaliki Anticlinorium an active centre of igneous activity during the Aptian – Albian period (Uzuakpunwa, 1974) and its sub basin an early Cretaceous transtensional. The high relief area is therefore more tectonically active than the low relief area owing to the presence of many intrusive bodies present in the area. These intrusives harbor solid minerals.

The second vertical derivative contour map of the study area is presented in figure 37. The zero contour of the second vertical derivative map indicated the lithologic boundaries between the different lithologies. Using second vertical derivative anomally map, mafic rock forming minerals have positive values and felsic rock forming minerals have negative values (Opara et al. 2012). The felsic minerals are abundant in Ugep area with some mafic minerals. There are mafic minerals in Abakaliki while Obudu area is made up of more mafic minerals than felsic minerals. The second vertical derivative was done to enhance anomalies of possible structural origin. Since high amplitude anomalies are associated with shallower sourced bodies, structural detail is more sharply focused, and magnetic lineament directions are better delineated. A second vertical derivative is applied in situations where for some reason the regional – residual separation is difficult to apply. Example is where two or more sources with their centres of mass are closer together than their depths. The anomalies overlap that it becomes difficult to discern the source that is causing a more serious anomally. It enhances near surface effects at the expense of the deeper sources. It is used to delineate the contacts of lithologies with contrasting magnetic properties. This map is important because of its ability to show shallower structural anomalies which harbor ore bodies. The zero contours of the second vertical derivative map indicated the lithologic boundaries between the different lithologies.

4.2 Spectral Depth Analysis

2-D spectral analysis allows an estimate of the depth of an ensemble of magnetized blocks of varying depth, width, thickness and magnetization. The digitized aeromagnetic data is transformed in Fourier domain to compute the energy (or amplitude) spectrum. This is plotted on a logarithmic scale against frequency. The slopes of the segments yield estimates of average depths to magnetic sources of anomalies. Graphs of logarithms of the spectral energies against frequencies obtained for various blocks are shown in figures 5, 6, 7 and 8. Each of these plots present two clear linear segments (the first few points which represent contribution from much deeper sources have been ignored because of the reduced dimensions of the areas covered by these sections). The gradients of the linear segments were evaluated and depths to causative b oldies were calculated. These depths are shown as D_1 and D_2 in table 3

Spectral analyses revealed a two layer (D_1 and D_2) depth model. These depths were established from the slope of the log-power spectrum at the lower end of the total wave number of frequency domain. The estimated depths to magnetic basement are shown as D_1 and D_2 respectively in table 2. The first layer depth (D_1) is the depth to the shallower source represented by the second segment of the spectrum as seen in figures 6-9 This layer (D_1) varies from 0.285km to 0.985km with an average of 3.27km. The second layer depth (D_2) varies from 2.236km to 3.016km, with an average of 2.626km. This layer may be attributed to magnetic rocks intruded onto the basement surface. Another probable origin of the magnetic anomalies contributing to this layer is the lateral variations in basement susceptibilities, and intra-basement features like faults and fractures (Ofoegbu and Onuoha, 1991 Kangkolo, 1997). It can therefore be deduced that the D_2 values obtained from the spectral plots, represent the average depths to the basement complex (sedimentary thickness) in the blocks considered.

5 LIST OF FIGURES AND TABLES



Fig. 1 Geologic map of the study area. (Taken from Nigerian Air Space Development Agency, 2016)

Fig. 2



Colour coded contour map of the total field magnetic intensity of the study area

Figures 3 and 4 show the basement topography of the area as highs and lows.



Fig 3



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Fig. 5. Second vertical derivative contour map of the magnetic field of the study area



Power spectrum plots of aeromagnetic data of blocks A- D(Abakaliki)



Power spectrum plots of aeromagnetic data of blocks E- H(Ugep)

Fig. 7:



Power spectrum plots of aeromagnetic data of blocks I- L(lkom)

Fig. 8:



Power spectrum plots of aeromagnetic data of blocks M- P(Bansara)

Table 1: Structura	al Indices for	Simple	Magnetic	Models	Used F	For Depth	Estimation	by
3-D Euler Deconv	olution							

Geologic Model	Number of Infinite Dimensions	Magnetic Structural Index
Sphere	0	3
Pipe	1 (z)	2
Horizontal cylinder	1 (x-y)	2
Dyke	2 (z and x-y)	1
Sill	2 (x and y)	1
Contact	3 (x, ,y, z)	0

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Table 2:	Location	and Magnitud	e of First a	and Second	Layer	Spectral D	epth
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TOWN	SPECTRA L BLOCKS	LONGITUDE (E)		LATITUDE (N)		DEPTH (KM)	
		X ₁	X ₂	Y ₁	Y ₂	D ₁	D_2
ABAKALIKI	А	8	8.25	6.25	6.50	0.723	2.964
	В	8.25	8.50	6.25	6.50	-1.008	2.79
	С	8.00	8.25	6	6.25	-1.048	2.461
	D	8.25	8.5	6.00	6.25	0.843	3.009
BANSARA	E	8.5	8.75	6.25	6.50	-1.035	2.236
	F	8.75	9.00	6.25	6.50	0.985	3.016
	G	8.50	8.75	6.0	6.25	0.535	2.585
	Η().	8.75	9.00	6.0	6.25	0.329	2.995
UGEP	C	8	8.25	5.75	6.00	-1.235	2.236
	J	8.25	8.50	5.75	6.00	0.285	3.016
	К	8.00	8.25	5.50	5.75	0.435	2.585
	L	8.25	8.5	5.50	5.75	0.629	2.995
IKOM	Μ	8.50	8.75	5.75	6.00	-1.035	2.236
	N	8.75	9.00	5.75	6.00	0.285	3.016
	0	8.50	8.75	5.5	5.75	-1.002	2.585
	Ρ	8.75	9.00	5.50	5.75	0.329	2.995

6 CONCLUSION

A detailed magnetic depth re-evaluation of Abakaliki/Ikom and environs was carried out using aeromagnetic data. The presence of intrusive bodies and faults in some areas shows that these areas are more tectonically active than others. The tectonism is believed to have been initiated during the separation of African and South American land masses (Akanbi and Udensi, 2006). Structural analysis of the interpreted anomalies using 3-D Standard Euler deconvolution with structural index values ranging from 0 -3 revealed the dominant presence of two geological structural features which include sills/dykes and horizontal cylinders/pipes. This confirms the presence of intrusives in the area (Kogbe, 1989).

Result of the 2-D spectral analysis revealed a two layer depth source model. The depth of the first layer varies from 0.285km to 0.985km while that of the second layer varies from 2.236km to 3.016km. This depth is in agreement with depth estimates from Peter's rule which revealed a depth estimate of 3125m and Onyedim et al. (2006) of 2.5km to 3.0km. Opara et al. (2012) using 3-D Euler deconvolution estimated sedimentary thickness of 3.3km in the Benue Trough. Depth to source interpretation of aeromagnetic field data provides important information on basin architecture for mapping areas where the basement is shallow enough for mineral exploration Magnetic basement is an assemblage of rocks that underlies sedimentary basins and may also outcrop in places. If the magnetic units in the basement occur at the basement surface, then depth determinations for these will map the basin floor morphology, relief and structure (Onyedim & Awoyemi, 2006).

The second vertical derivative map of the area shows that there is abundance of mafic and felsic minerals in the area. They are formed by hydrothermal processes. According to Whitten, 1978 Pb –Zn mineralization is farther away in the zoning of minerals around an igneous intrusion while tin and copper are closer. The occurrence of Pb – Zn, copper and tin related minerals shows the presence of intrusions in which the minerals are of hydrothermal processes. This is in agreement with the result of investigations carried out by Ekwueme (2004) of various rock samples in Oban and Obudu massifs.

Economically, the area has low petroleum potential because the average sedimentary thickness of 2.626km is very thin for entrapment of crude oil. Also high magnetic anomalies may be associated with igneous and/or metamorphic rocks which have high susceptibility than sedimentary rocks. This implies that the temperature accompanying tectonic activity in the area must have cooked the source rock, if any beyond the oil window phase of maturation(Opara et al 2012). However, the area is viable for ore deposits exploration.

The interpretation of aeromagnetic and land sat data of the study area reveals that the area has a dominant N-S trend which reflects the basin. The high magnetic intensity observed around Ikom and Obubra suggest the existence of a relatively deep-seated basement structure. The presence of this structure confirms that the area has been subjected to both regional stress and strain fields. The abundance of intrusive and shallow basement depth is conducive for solid minerals exploration.

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