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EVALUATION OF AEROMAGNETIC ANOMALIES OVER SOUTHERN PART OF BIDA BASIN, WEST- CENTRAL NIGERIA

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Abstract

The qualitative interpretation of aeromagnetic anomalies over parts of Bida basin, west - central Nigeria was performed. Three magnetic data enhancement procedures were employed to determine their effectiveness in characterizing the studying area. The upward continuation technique significantly improves the interpretation of magnetic data regarding discriminating between shallow and deep magnetic source anomalies within the studying area. The residual map showed improved correspondence with known geology map of the studying area. The aeromagnetic anomaly map together with reducing to equator identified the areas of high amplitude positive magnetic intensity and low negative amplitude magnetic intensity. The positive magnetic field anomalies range from (+20 to +160nT), and negative magnetic field anomalies range from (-20 to -200nT). The areas of highest values were obtained in the northern and southern parts of the study area and the lowest located in the central area. Aeromagnetic anomaly map reveals that the most predominant trend in this part of the Basin is the northeast-southwest direction. The second predominant trend discovered at the east-west direction in the western/central area of the basin. The least predominant trend is discovered at the northeast and southeast directions. Further examination also reveals that; the high and low magnetic anomaly is bounded by high gradient zones trending in the east-west, northeast-southwest, and northwest-southeast directions. The areas of wide magnetic anomalies are situated at Baro, Galu and Katakwa part of the area under consideration are bound from two sides (north and south) by the relatively steep magnetic gradient.

Keywords: Aeromagnetic Anomalies; Fault; Bida basin; Basement topography; Qualitative interpretation; Nigeria

1. Introduction

The Bida basin is located in the west central Nigeria. It's among the least investigated sedimentary basins in the country. It is a linear intracratonic sedimentary basin situated in Niger State, Nigeria. The basin is about 350km long and 75km to 150km wide trending northwest-southeast and starting from Kontagora (in the north) to just south of Lokoja (in the south) and is aligned closely orthogonal to the Benue Trough. It is detached from the basal continental beds of the Sokoto basin by a narrow outcrop of the crystalline basement rocks in the west, and it is sharing a common border with the Anambra basin in the east. Because of its vast area covered, the basin has been divided into two parts, i.e., northern and southern Bida basins, almost certainly due to great rate facies changes across the sub-basins. A very wide range of verification has been done in the Bida basins. Most of the verification was concentrate on the sedimentology, depositional environments, spectral analysis and structural analysis in the southern Bida basin with few has been carrying out in the northern part of the basin. Therefore, this present study involves the description of aeromagnetic anomalies over part of the southern Bida basin, west-central Nigeria. The procedure is imperative in geophysics; because it gives information about the earth's subsurface, by carrying out a qualitative investigation of the grid of magnetic values and magnetic anomalies obtained in the study area. The method involved in this study which incorporative the production of magnetic anomaly map; reduce to equator map and upward continuation maps at a different height. The description of aeromagnetic maps which incorporative the explanation of basement structures and full examination of assemblies and lithologic variations in the sedimentary section. Magnetic basement is the collections of rocks that underlie sedimentary basins and may also outcrop in areas (N.G Obaje et al. 2011). Therefore in almost sedimentary basins, a magnetic anomaly comes from secondary mineralization along fault planes, which are all the times revealed on aeromagnetic maps as linear surface features. The aeromagnetic data indicates changes in the magnetic field of the earth, which are contributed the variation within the magnetic susceptibility of near-surface rocks.

2. **The Geology of the Study Area**

The study area is mostly consists of cretaceous rocks covering the basement. The area composed of Precambrian to lower Paleozoic schist and basement gneisses which is covered by alternating claystone, siltstones, shale and sandstones (Obaje, 2009). The sanstones composed of siltstones and tiny bonded fine to coarse-grained sandstones with interbeded light beds of carbonaceous shale and clays. Southern Bida basin composed of the Lokoja basal formation, concealed by the Agbaja formation and Patti formation. The Lokoja basal formation is a progression of matrix aided conglomerates and sandstone covering the Pre-cambrian to lower Paleozoic basement. Furthermore, depositional territory is mostly inside fluvial arrangement of a continental position. Patti formation made up of inky grey carbonaceous shale, siltstones and mudstones designated to an area of low-

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lying ground adjacent to a river, formed mainly of river sediments and subjected to flooding plains of little depth seawater sediments with probable organic rich intervals. Agbaja formation composed of kaolinitic mudstones and ferruginised oolitic of a small territory (Akinde et, al, 2005). The enclosing Pre-cambrian rock basement consists of an outfit of Pre-cambrian gneisses, migmatites and metasedimentary schist crosscut by granitoids (shekwolo, 1992). The basements of Precambrian rocks encounter serious disfigure throughout late Pan-Africa phase, and grow mega shears which bring back in the late Campanian-Maastrichtian (Braide, 1990). While gneisses and metasedimentary schists are form generally as level lying outcrops (Shekwolo, 1992). Figure 1 and 2 below shown the geology of the studied area.

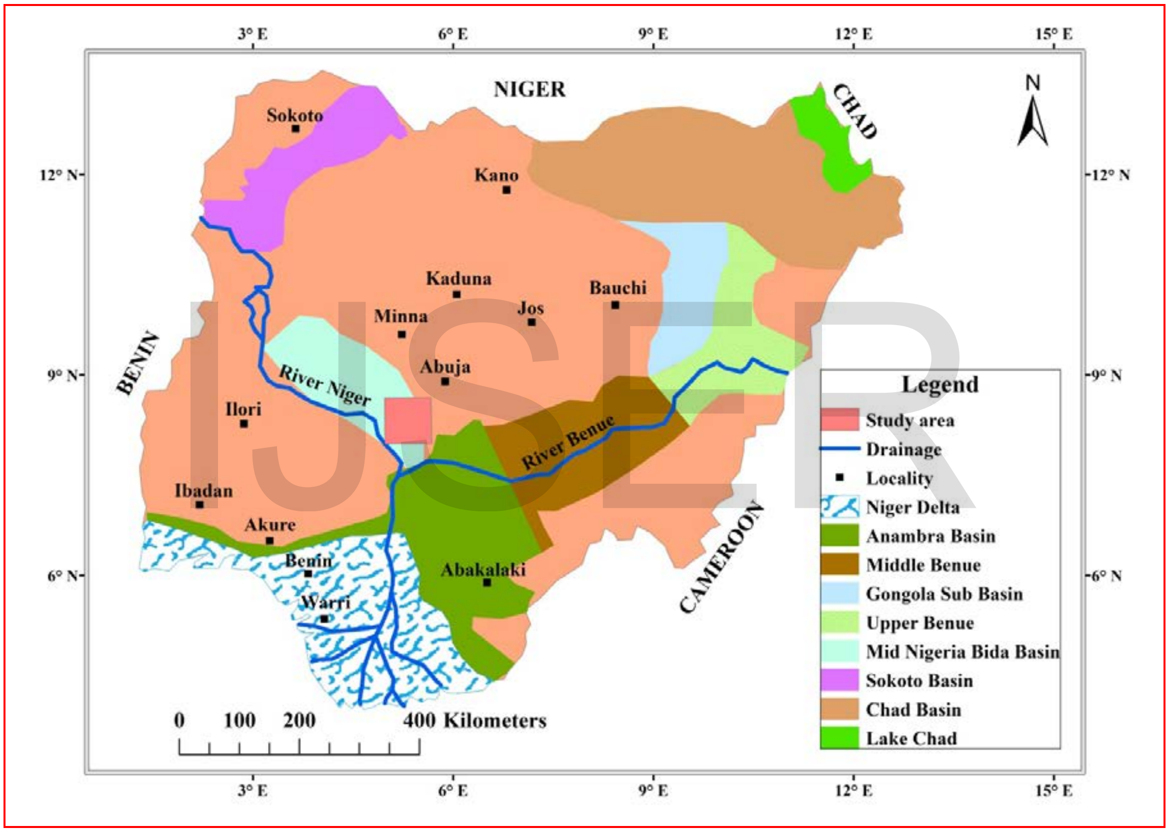

Figure 1: Map of Nigeria's Sedimentary Basins Showing the Study Area (Modified after Obaje et al., 2006).

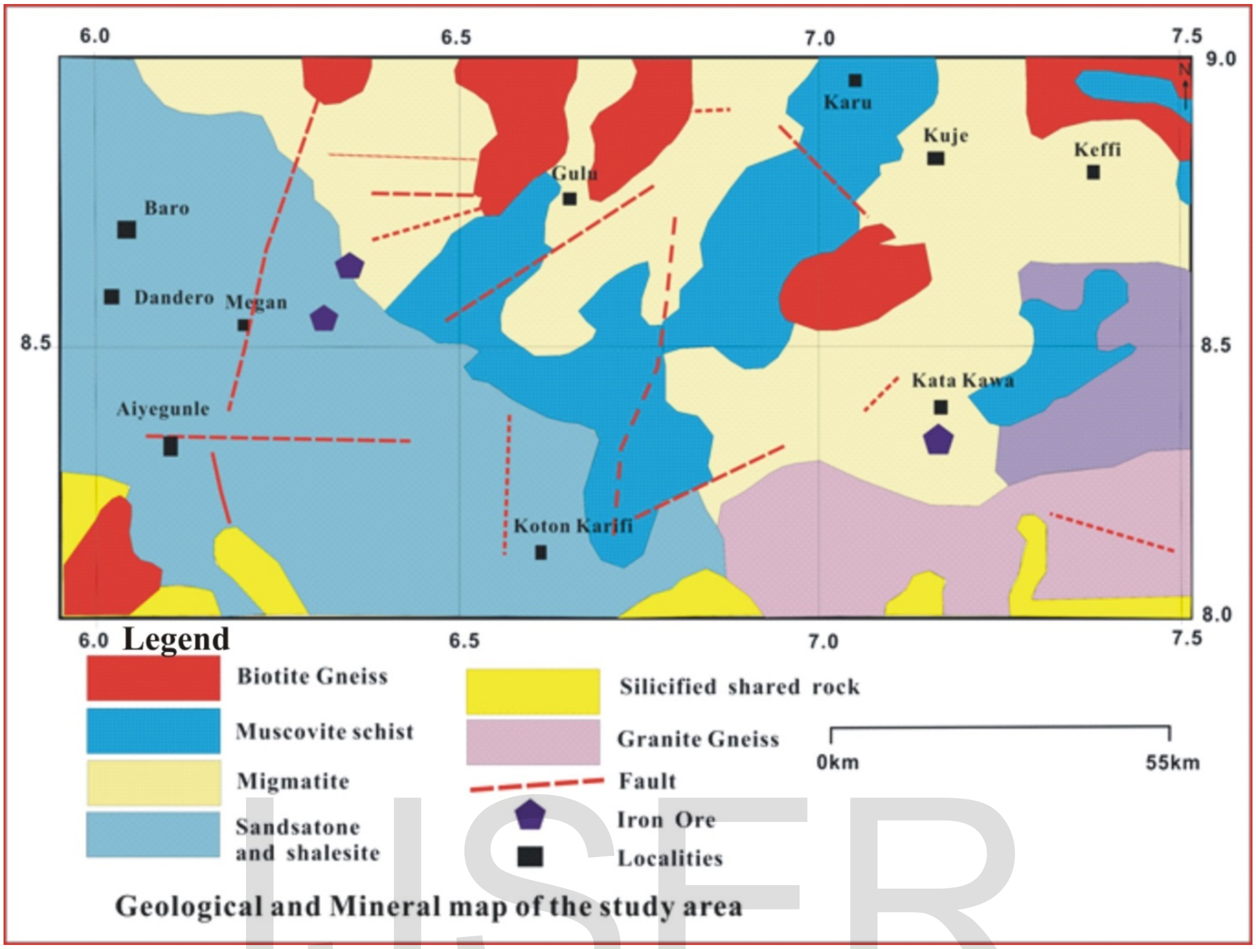

Figure 2; Geological Map of the study area, (2009 Nigerian Geological Survey Agency)

2.1 The Bida Sedimentary Basin

The Bida sedimentary basin is a northwest-southeast trending intracratonic basin starting from Kontagora in the northern parts to the southern parts of lokoja. It spreads from the confluence of Niger and Benue Rivers to the dam lake of Kainji, where basement rocks detached it from the Sokoto Basin. Therefore three (3) physiographic units are discovered in the basin. The following physiographic units are The Niger River with its floodplain and distributaries, a belt of mesas and the plains. The Niger River moved from east-south-east to the southern marginal area of the basin. Its floodplains are vast and marked in most areas by a series of elongated ponds flowing parallel to the river. The belt of mesas is not continuous. It flows from an area about 16km east of Mokwa to Lokoja and south-west of Dekina covering about 30% of the basin. The upper lies between 260m and 500m around the Niger / Benue confluence areas. Flat-lying to gently rolling plains covers about 80% of the basin. The plains lie between 19 and 65m in the Lokoja area. The sediment thickness in the Middle of Niger Basin is calculated to be between 3,000 and 3,500m (Ofor. N.P, Adam. K.D et al. 2014), this referred to as the

Lokoja Sandstone. However, the Sandstone is only partially same as Nupe Sandstone (Levi.I. Nwankwo et al., 2017) and is overlain by the Patti formation.

2.2 The Complex Basement

The basement multifarious is one of the three (3) important litho- petrological components that made up the geology of Nigeria. Inside basement complex of Nigeria, four significant petrol lithological units are differentiable namely: the migmatite – Gneiss complex, the schist belt, the older Granite and the undefined Acid and Basic dykes. Therefore, the migmatite-Gneiss complex is taken as the basement complex that is most widely spread of the component units in the Nigeria basement. It has a heterogeneous collection comprising migmatites, orthogenesis, paragneisses, and a series of basic and ultrabasic metamorphosed rocks. The Migmatite-gneiss complex has ages ranging from Pan-African to Eburnean. It makes up about 70% of the surface area of the Nigerian basement (Akhirevbulu O.E et al. 2010). Furthermore, the surrounding Pre–Cambrian basement rocks of the studied area consist of an appropriate Pre–Cambrian gneisses, migmatites and metasedimentary schist crosscut by intrusive granitoids.

2.3 Tectonic Setting of the Bida Basin

The Bida basin occupies a moderately down bent trough. The epeirogenesis responsible for the basin genesis seems nearly attached with the santonian tectonic crustal movements which mainly affected the Benue Basin and south-east of Nigeria. The buried basement complex surely has a highest relief (Ejueyitsi O.E et al., 2015). The sedimentary foundations have been shown to be about 3,000m thick by gravity survey (Solomon Ojo Olabode, 2016). Therefore the sediments were constituted by post-tectonic molasses facies and slim marine strata, which are all, spread out. A comprehensive analysis of the facies shows great rate basin-wide variations from different alluvial fan facies through flood-basin and deltaic facies to lacustrine facies (Akhirevbulu O.E et al. 2010). Consequently, an easy subsides and rift origin earlier suggested may not consider for the basin's evolution. According to Dahiru Dahuwa et al. (2016), paleogeographic re-construction suggests lacustrine environments were widely dispersed and elongate. Lacustrine environments happened at the basin's axis and close to the margins. This suggests the depocenter must transfer during the basin's depositional history and subsided abruptly to accommodate the 3.5km thick sedimentary fill.

3. Data and Methodology

The total field aeromagnetic data were collected by Nigerian Geological Survey Agency (NGSA). The data were captured for NGSA in 1975 by Earth Science Limited as part of the nationwide airborne geophysical survey. The IGRF correction of the data was based on 1974 IGRF epoch on January 1. The production of total magnetic maps was completed in 1976 on a scale of 1:100,000 in half degree sheets and was contoured at interval of 10nT for the study area. Therefore, for this study, maps covering an area of 18,150 km^2 bounded by latitudes 8^0N to 9^0N and longitudes 6^0E to $7^0.30^1$E were utilized. Magnetic anomalies map or the combine map, Reduction to Equator (RTE) map, Residual map of the study area was generated using the Model Vision geophysical software. The residual map was analysed qualitatively by comparing it with geological map of the survey area, and magnetic lineaments that delineated the sedimentary basin and influenced minerals and hydrocarbon accumulation in this place were thus located. Magnetic closures and discontinuity were also analysed. These were achieved by applying data processing approach such as Upward Continuation, Residual from Upward Continued Data at 5km, on the gridded data. The layout of the map is shown in (figure 3) below,

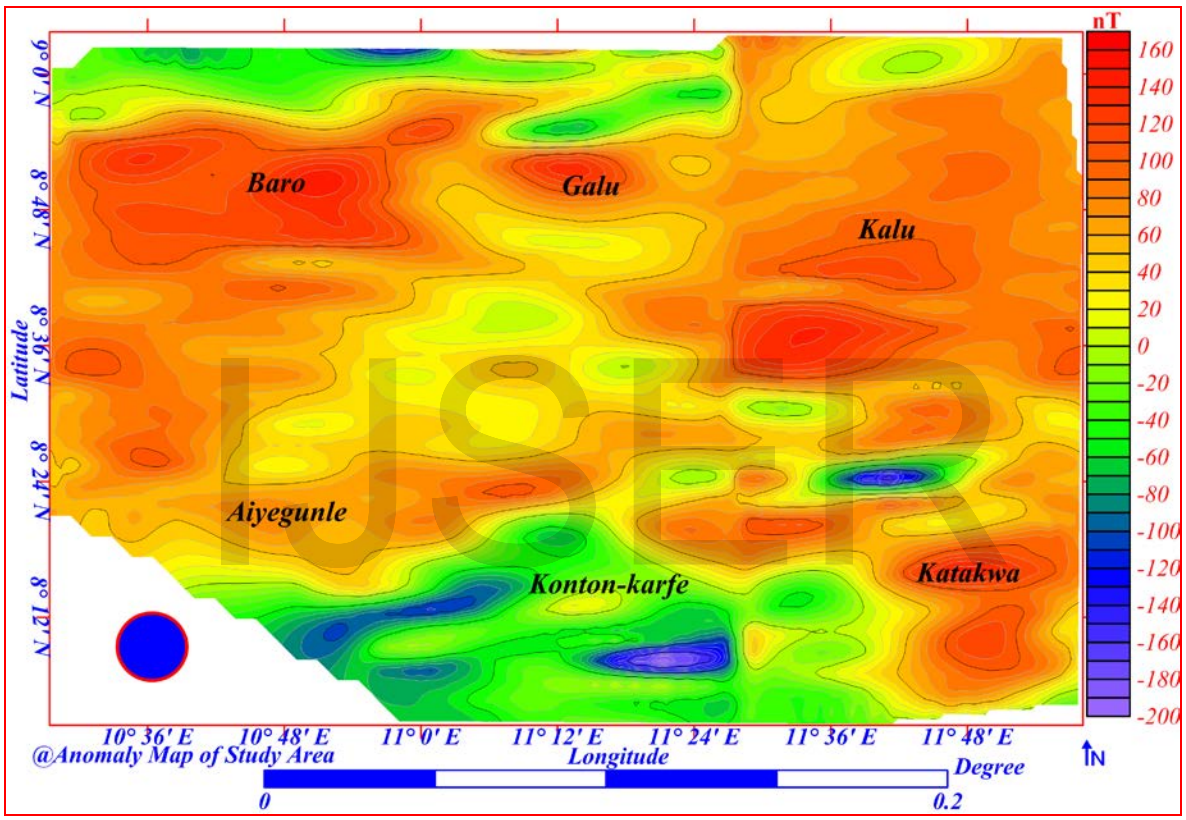

Figure 3: The Map of the Magnetic Field Anomalies of the Study Area (Contour interval=10nT).

which shows the aeromagnetic field anomaly map for this study area. Acquisition and reduction parameters of the data are stated as legend on each of the original map. From this legend, the data consists of a system of equally spaced (2km apart), North-South oriented flight traverses at a nominal flight altitude of 152.4m above the ground level. The average magnetic inclination across the survey area was from 9^0 in the north to 0^0 in the south.

3.1 Result and Discussion

3.1.1 Result

The qualitative analysis has been executed by visual investigation of magnetic anomaly map. The positive total magnetic field anomaly ranges from (+20 to +160nT). Negative magnetic field anomalies range from (-20 to -200nT). The highest values found in the northern and southern parts, and lowest values in the central area (fig.3) above. The closely spaced linear sub-parallel alignment of contours in the northern and southern parts of the study area shows that faults or local fractured zones may conceivably infiltrate through these areas (fig.3) above. Therefore most of the anomalous features trend in the East-West direction, while minor ones trend Northeast-Southwest. (Ikumbur Emmanuel Bemesn et al., 2013) generally believed there would be a magnetic susceptibility difference across a fracture zone due to oxidation of magnetite to hematite, and infilling of fracture planes by dike-like bodies whose magnetic susceptibilities are not the same from those of their host rocks. Furthermore, such geologic feature may become openly visible as thin oval closures or nosing on an aeromagnetic map. The ovoid contour closures observed in the study area suggest the presence of magnetic bodies. The most important trend of the lineaments is east-west, while little trend Northeast-Southwest. Also, the aeromagnetic map of the study area shows that the contour lines are widely spaced in the middle part which significantly appeared as bulky sediments in the region showing that the depth to basement is much higher compared to the closely spaced contours in the northern and southern parts which appeared as shallow sedimentary thickness). In the south-eastern part of the study area (Koton-Karfi), there is the existence of a dome-shaped linear feature. Its indicate that this linear feature is of intermediate depth and seems too hosted in the basement structure and is thought to be a significant divide (fault or fracture) making a boundary (Ofor. N.P et al.2014). Many contour closures obtained in the south of this lineament, which signifies shallow basement.

3.1.2 Discussion

An important qualitative technique is analyses of trends and lineaments. Trends can be analysed qualitatively and quantitatively. Trends were analysed using profiles or gridded data and generally consist of drawing lines on a map that may correspond to edges of structures, faults, or partitions of the data character. Trends are the general direction in which the contour lines tend to have in a particular area of the magnetic contour map. Lineation in the magnetic contours may reflect the strike line of elongated intrusive features or the surface of a large fault reflected in the basement topography or lithology (Dobrin and Savit, 1988). The picture that emerges from a magnetic contour map such as Figure 3 is one that shows the superposition of disturbances of notably different order of sizes. Larger features produce magnetic anomalies that are smooth over considerable distances and are caused by the deeper heterogeneity of the earth’s crust. These smooth trends are referred to as regional trends, regional field (Akanbi and Mangset, 2011) or simply regionals. Smaller, more local sources account for sharper anomaly shapes of more restricted areal extent. These are superimposed on the regional fields but frequently camouflaged by them. Though they are smaller local disturbances which are secondary in size, they are of primary importance. These are the residual anomalies, residual field or simply residuals which may provide evidence of the existence of mineral ore bodies or reservoir-type structures. For total magnetic intensity map to be interpreted and or used for further analysis, the residual anomalies were separated from the regional background field. The 3-D map represent of total magnetic field intensity (Figure 4) below, of the study area described blow

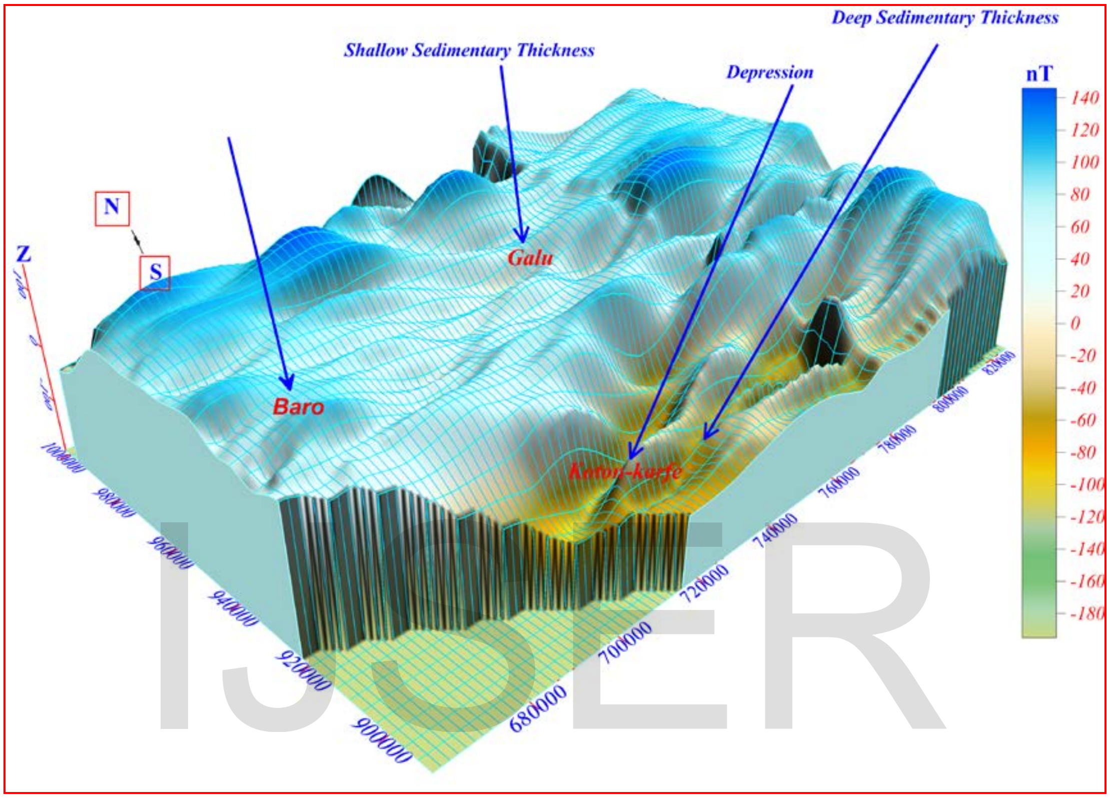

Figure 4: 3D Surface Plot for the Basement Topography of the Study Area.

and high relief patterns. A basin is characterized by smooth contours and low magnetic contours while the surrounding basement area shows steep gradients and high relief in the magnetic contour. The map shows anomalies of high and low magnetic intensity value with predominant E-W, NE- SW and NW-SE trends and steep gradients which are distributed throughout the area. The dominant long wavelength anomalies with spatial scales of several kilometres are certainly due to deep seated basement under the basin. The magnetic high and low are usually paired together, with the highest usually on the north side of low (Figure 3). The anomalies in the magnetic field of the earth may be considered to arise from three principal sources (Bird, 1997). These are lithologic variation, basement structures and sedimentary sources. Magnetic anomalies over a broad sedimentary area can also arise from a number of different sources. These sources may include the underlying basement rocks, variations in the primary syngenetic magnetic mineral content and composition of the sediments, igneous bodies that have intruded the sedimentary section, localized epigenetic concentrations of newly formed magnetic minerals produced by interaction between the sediments and some fluid Phase, topographic and terrain – related to near surface changes in magnetic mineral content, and cultural anomalies produced by man – made concentrations of magnetic minerals.

3.2 Comparison between the RTE and Total Magnetic Field Anomalies Map of the Study Area

Figure 5 below indicates some of the prominent anomalies feature in the study area. The locations of these features on the reduced to the equator and aeromagnetic anomaly map were deduced an improved correspondence to each other.

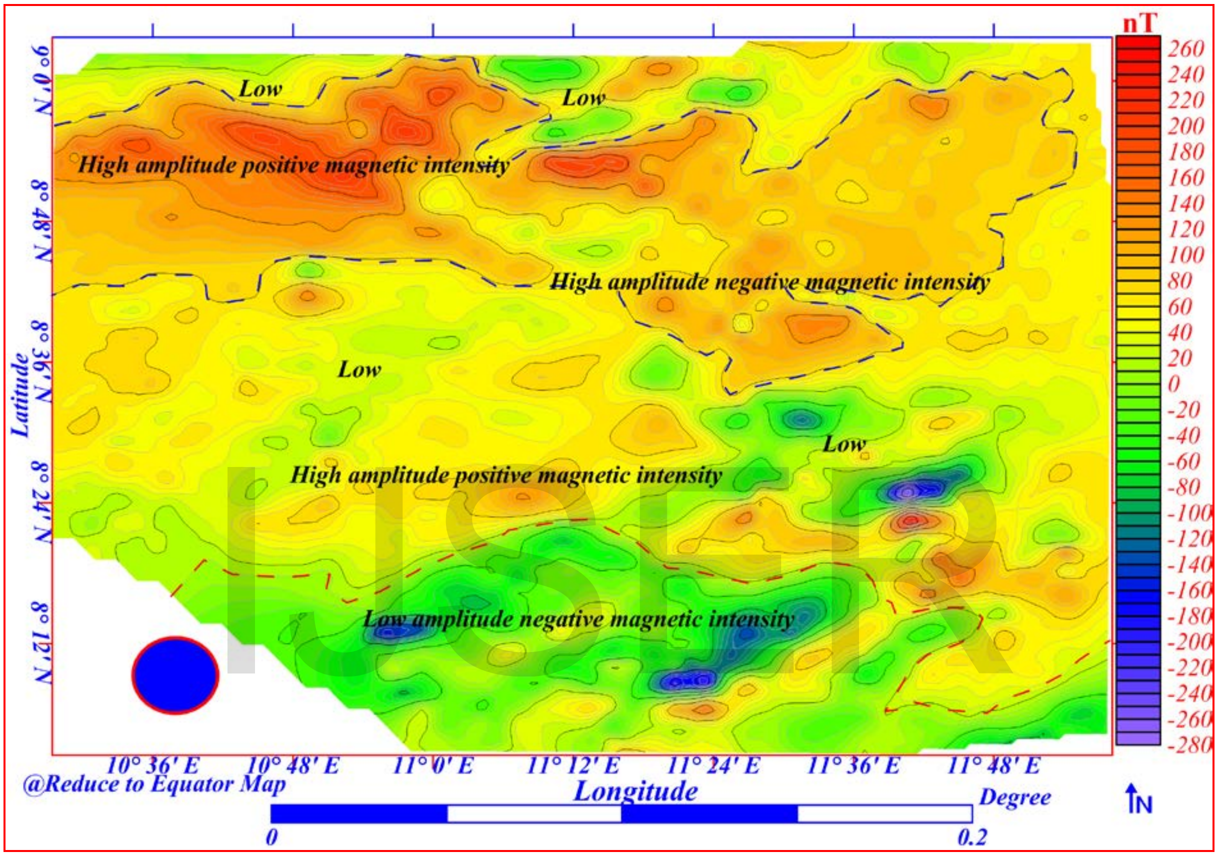

Fig. 5: reduced to the equator map of the total intensity map of the study area.

The magnetic high and low are usually matched together with the high usually on the north-western and eastern part of low. The features on the map are not straight that is we have closures on the map which shows the anomalous conditions in the subsurface. The aeromagnetic anomaly map in (fig. 3) revealed that the most predominant trend in this area of the Bida Basin is the northeast-southwest direction. The second predominant trend appeared in the east-west direction in the western/central area of the map. The least predominant trend is found to be the northwest-southwest direction in the west area. According to Obi D.A (2015), these trends sometimes coincide with litho - tectonic regions and rely on the scale of investigation. Cole J.A (1958) discovered three (3) critical tectonic directions in the Bida basin namely; northeast-southwest trend covered the northern part, the east-west trend in the central and ENE-WSW trend in the southern part. A detailed inspection of the map also shows that the magnetic high and low are bounded by high gradient zones trending in the east-west, northeast-southwest, and northwest-southeast directions. Therefore the areas of wide magnetic anomalies are at Baro, Galu and Katakwa parts (fig. 3) of the area under consideration are bounded from two sides (north and south) by relatively steep magnetic gradients. These recommend the occurrence of significant deep-seated faults/fracture zones bounding these areas in the stated directions. The great gradient zones are described by a range of equidistant contour directions of same amplitudes. These high gradient zones are the manifestation of deep-seated shear zones (Braide, 1992). The comparisons of this map with reducing to the equator map of the Bida Basin revealed a common correlation to each other.

3.3 Correlation of Residual Map with the Geology Map of the Study Area

Figure 2 and 6, shows some prominent geologic features of the study area. These maps show improved correspondence between the residual anomalies and known geology map. Major fault zones (F1 to F5), as illustrated by the dash lines in (figure 2 and 6). The most predominant trend in this part of the Bida Basin is the northeast-southwest direction (C, D, E and G) figure 6. The others trends are observed in the western and northeastern part of the map which is east-west (F) direction and northeast-southwest A and B direction respectively. The minerals occurrences are observed to be systematically associated with the flanks of the high gradient zones F1 to F7 and coincident with locally very low magnetic gradient zones. The sandstones are ob

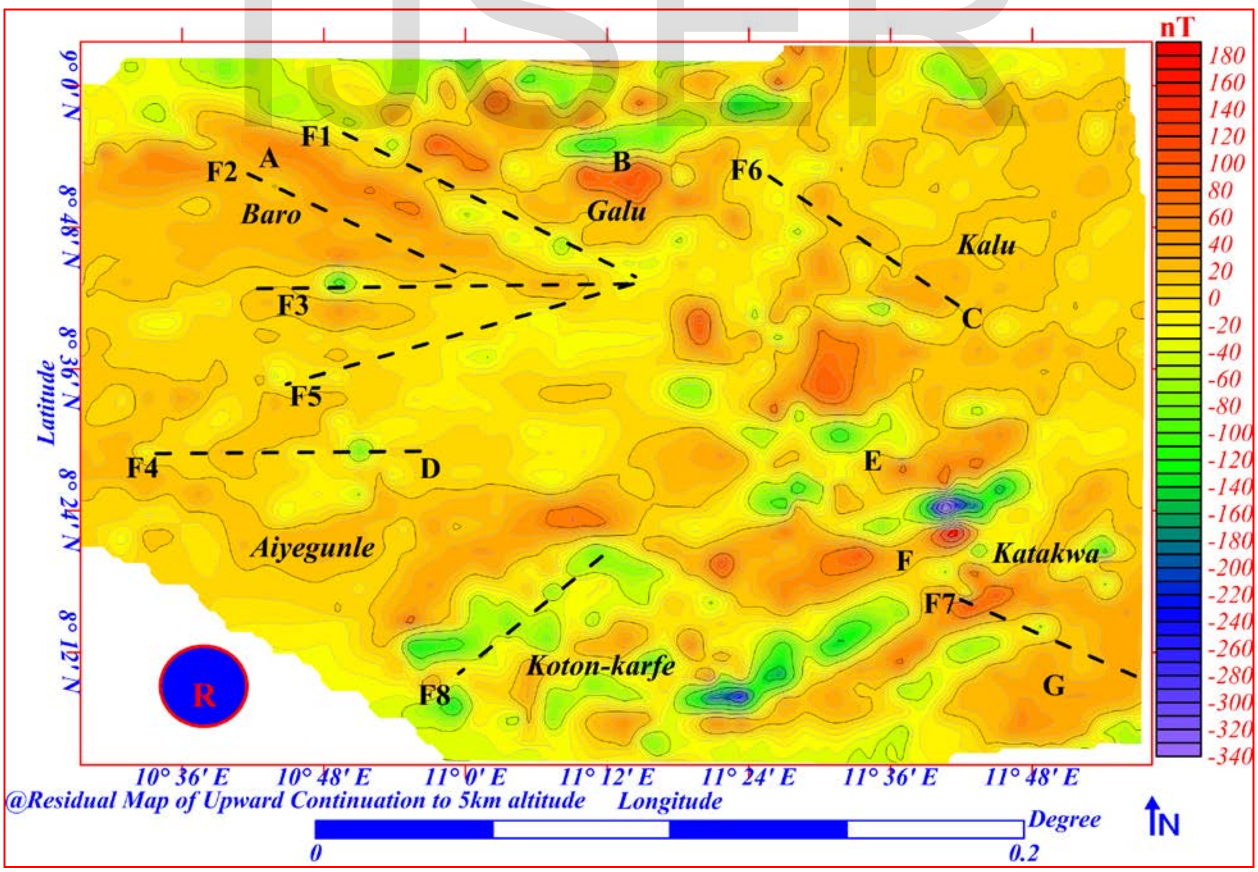

Figure 6: Residual Map of Upward Continuation to 5km altitude

served to align on a trending imaginary straight line define by the high gradient zone F6 and F7 trending approximately northeast-southwest in the eastern region of the study area covered by migmatite-gneiss.

A linear pattern in the map has been commonly reflecting linear distribution of minerals. Muscovite and Iron ore are located on the southwest and northwest along the high and low gradient zone and associated with the fracture F6 on migmatite rock. Biotite gneiss is located on the northern half of the area and is associated adjacent fracture zone F5 and is trending northeast-southwest on migmatite rock. The Iron ores are located on the west, south, and southeast of (F3, F5, and F7) found to align in a northeast-southwest direction corresponding to associate with migmatite and sandstone/shale. The alignments of the minerals locations along or near high gradient zones suggest that these high gradient zones are major fracture/shear zones which influence mineral/hydrocarbon accumulations. Furthermore, many magnetic lineaments are associated with basement faults, which sometime control productive reservoir trends in the sedimentary cover. The continuation of such potential-field lineaments into undrilled areas often points to new exploration opportunities (Lyatstsky et al., 2004). On the major contour lines in these areas, they are short wavelengths, low amplitude riders. The observation suggests that a possible genetic association of these anomalies with mineral and/ or hydrocarbon accumulation at depth and many therefore to be diagnostic of mineral and/ or hydrocarbon accumulation at depth. Such factors incorporative structure of strata in which the magnetic minerals might accumulate the hydrology of the setting, the topographic location, time span of alteration, and post-alteration deformation (Reynolds et al., 1991).

4. Computation of Regional and Residual.

After removal of International GeomagneticReference Field (i.e., IGRF), the flight line profiles again have anomalies with an amplitude of the order of tens of nanoteslas and with predominant wavelengths of so many kilometers (km). The long wavelength features are certainly as a result of very deep basement sources and which referred to as regional. The regional applied in this method was chosen by comparing upward continuation to 5km, 10km 15km, and 20km altitude respectively (figure 7a-d) below. This was performed by applying Fast Fourier Transform FFT, (S.A. Ganiyu et al. 2013) and upward continuation to 20km was selected as the excellent regional because of the smoothness of the anomaly. Furthermore, in this study, the data reduced to the equator and residualized (i.e. removal of regional) by removing upward continued data to 5km from the reduced to the equator data so as to get a magnetic response from the top-crust of the earth comprising of the basement and the sedimentary unit (fig. 6 above). The residual map indicates magnetic anomalies little bit change from that of the reduced to equator (RTE) map in (Fig. 5, above). The prominent trend is in the northeast-southwest direction, which is related to the Pan African trend. The other trend appears in the north-western region of the map which is in the northwest-southeast direction. A thorough examination of the map shows that the magnetic high and low are remained bounded by great gradient zones. In the western part of the study area, there are so many high-frequency anomalies that may be associated with shallow sources. There are also clear descriptions of long wavelength anomalies trending southeast-northwest and east-west, which are correlated to deeper sources like regional large fault zones and contacts between rock complexes described from the difference in magnetic susceptibilities.

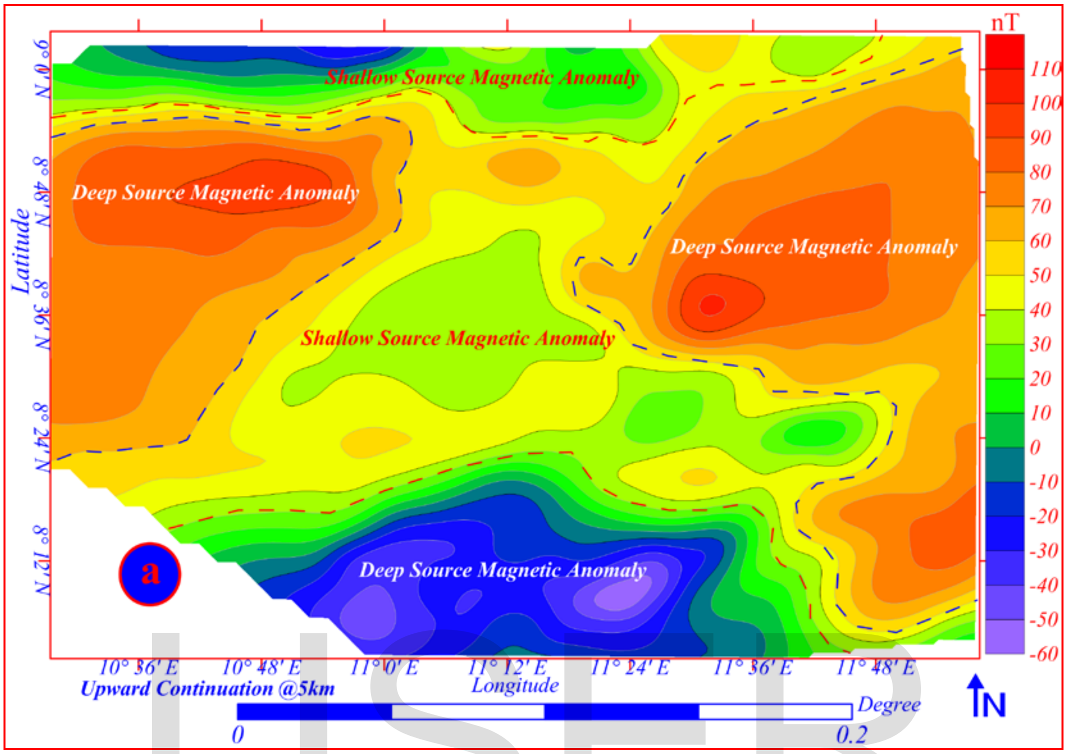

Figure 7a Upward continuation at 5km.

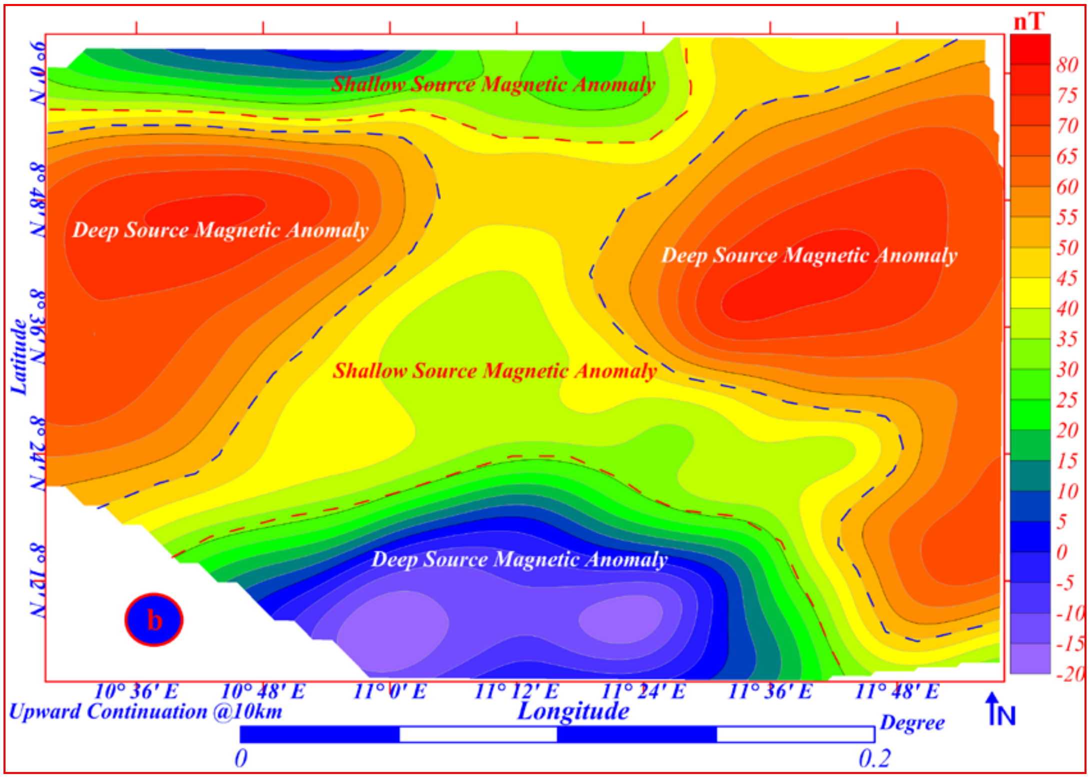

Figure 7b: Upward continuation at 10km.

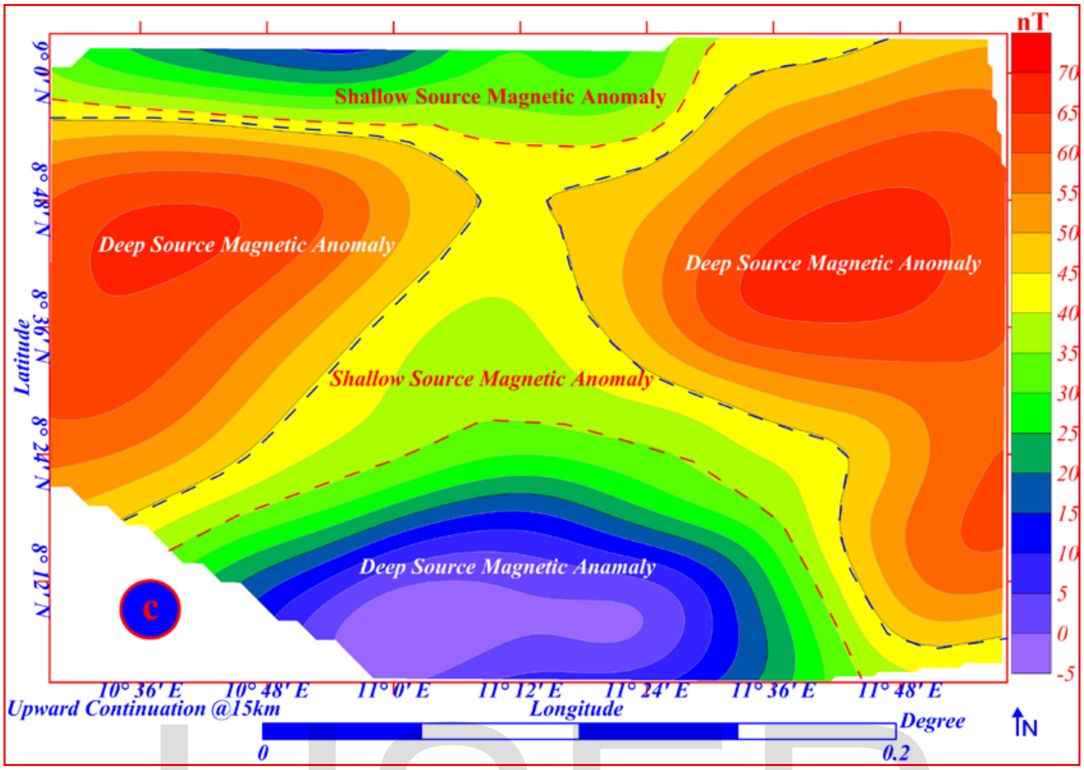

Figure 7c: Upward continuation at 15km.

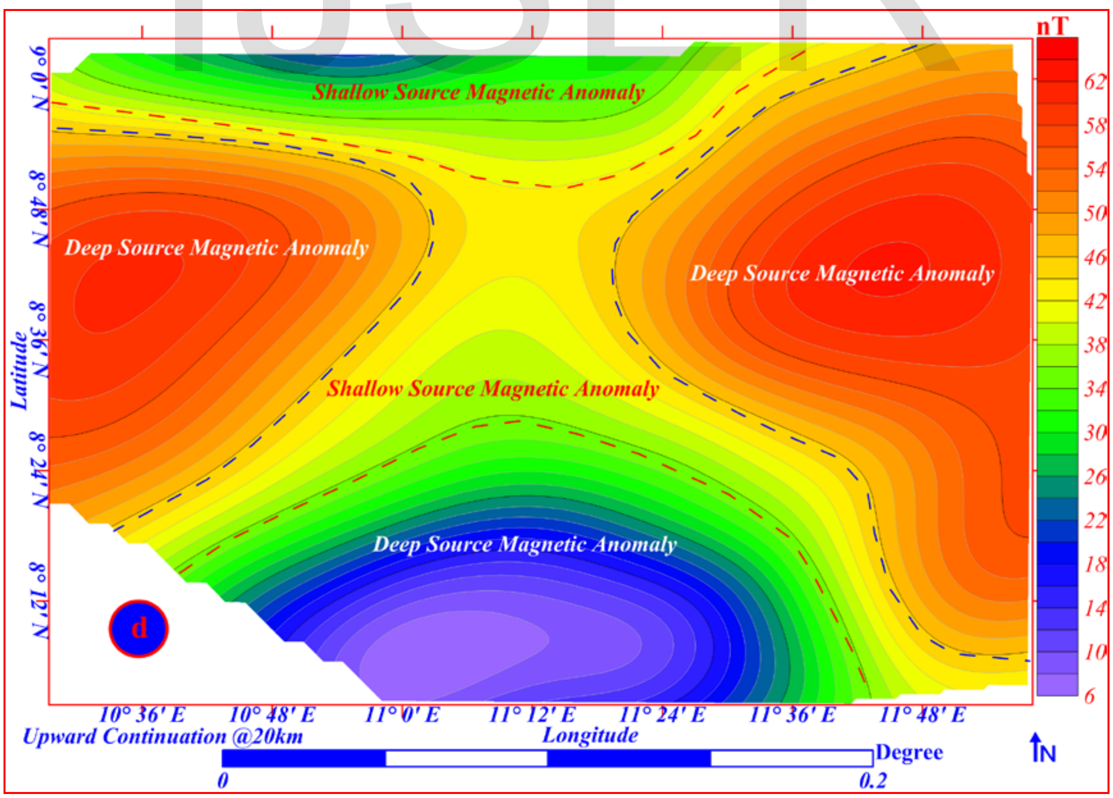

Figure 7d: Upward continuation at 20km.

Upward continuation is a method used in geophysics to calculate the values of the magnetic field by using measurements at a lower height and extrapolating upward, assuming continuity. This is a mathematical method that project data carried at an elevation to a higher elevation. This method is commonly used to combine different dimension to a common level to lower disperse and allow for convenient, detailed examination. Therefore upward continuation reduces the shallow feature (near surface) anomalies and relatively make anomalies of the deeper seated sources more noticeable. The application is that those short wavelengths features are removed out because one is moving away from the anomaly. Upward continuation is a technique of making big scale (usually deep) features to become prominent in the survey area. It reduces anomalies concerning wavelength; the shorter the wavelength, the greater the attenuation. Also, upward continuation tends to accentuate anomalies caused by deep sources at the expense of anomalies caused by shallow sources (Zhentao Wang et al., 2015).

5. Conclusion

The analysis of aeromagnetic data over southern Bida basin has been performed. Four structural trends were identified in the research area; they are the east-west, north-south, northeast-southwest and northwest-southeast directions. There is an excellent correlation in trend, location between basement structures, and overlying sedimentary fault systems. These excellent correlations strongly show that the sedimentary section has been influenced by the underlying basement architecture. These results are in consistent with those from foregoing geophysical and geological inspection in the area.

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References

Akhirevbulu O.E. (2010), (P.3), The Geology and Mineralogy of Clay Occurrences Around Kutigi Central Bida Basin, vol.3 Nigeria

Alagbe, O. A. (2015), (P. 37-52), Depth Estimation from Aeromagnetic Data of Kam Vol. 2, Nigeria.

Henry, Yand Madukwe, (2013), (P. 2409-2150), Granulometric Study of the lokoja Sandstone, Mid Niger basin, Vol.2, Niger, Nigeria.

Ali Moumouni1, and Suleiman Chaanda, (2016), (P.83-92), Geological Exploration of Marble Deposits in Toto Area, Vol.7 Nasarawa State, Nigeria.

Adeleye D, R. (1971), (P.222-235), Stratigraphy and Sedimentation of Upper Cretaceous Strata around Bida, Nigeria. Ph.D. Thesis, University of Ibadan, Nigeria.

Adeleye D, R. (1973), (P.709-727), Origin Of ironstones, An example from Middle Niger Valley, Nigeria. Journal of Sedimentary Petrology, Vol. 43, Niger, Nigeria.

Adeleye D, R. (1974), (P. 1-24), Sedimentology of the fluvial Bida Sandstones (Cretaceous): Journal of Sedimentary Geology, Vol. 12, Niger, Nigeria.

Agarwal B, N, P and Shaw, R, K. (1996), (P.911-914), Comment on an analytic signal approach to the interpretation of total magnetic anomalies by Shuang Qin. Geophysical Prospecting, Vol. 44.

Agocs W, B. (1951), (P.686-696), Least squares residual anomaly determination: Geophysics, Vol.16,

Ananaba S, E and Ajakaiye D, E. (1987), (P.531-537), Evidence of tectonic control of mineralization Nigeria from lineament density analysis: A Landsat study, Geology of Nigeria, Lagos, Elizabethan Publishers, Vol.5, Lagos, Nigeria.

Braide S, P. (1992), (P.33-44), Geological development, origin, and energy mineral resources potential of the Lokoja Formation in the Southern Bida Basin. Journal of Mining and Geology, Vol. 28, Niger, Nigeria.

Cole, J, A. (1958), (P.16), Memorandum on Resistivity Surveys in the Ihima District, near Okene, Kabba Province for Water Supplies Geological Survey of Nigeria Report, Vol.12, Nigeria.

Dahiru, Y and Abubakar S. (2016), (57-66), The Analysis of Aeromagnetic Data over Wase and It Adjoining Area, Vol. 8, Plateau, Nigeria.

Ejueyitsi O,E. and Opara, A.I. (2015). Aeromagnetic Interpretation of Kabba Kogi state Nigeria.

Ema Michael, A. and Kolawole Muideen, (2012), (P.3), Spectral analysis of aeromagnetic data for geothermal energy investigation of Ikogosi Warm Spring - Ekiti State, southwestern Vol.4, Ekiti, Nigeria,

Ganiyu S, A. (2012). Upward Continuation and Reduction to Pole Process on Aeromagnetic Data of Ibadan Area, South-Western Nigeria. Earth Science Research, Vol. 2, Ibadan Nigeria.

G. Chen1, Q. and Cheng T, Liu, Y. (2013). (P.12), Mapping local singularities using magnetic data to investigate the Discussions volcanic rocks of the Qikou depression, Dagang oilfield, Vol.4,China.

Goodluck, K and Anudu, R. (2014), (P.141-160), Using high-resolution aeromagnetic data to recognize and map intra-sedimentary volcanic rocks and geological structures across the Cretaceous middle Vol.35, Benue Trough, Nigeria.

Gerald M and David, W. (1999), (P.391-411), Basement reactivation in the Alberta Basin, Observational constraints and mechanical rationale, Vol. 47.

Henry Y and Madukwe, (2013), (P.215-2450), Granulometric Study of the lokoja Sandstone, Mid Niger basin, Vol. 2, Niger, Nigria.

Ikumbur Emmanuel, B and Onwuemesi Ajana, (2000), (P.27-31), Spectral Analysis of Aeromagnetic Data over Part of the Southern Bida basin, West-Central Nigeria, Vol. 3, Nigeria.

John, U and Lawal, (2013), (P.125-139), Geothermal and Radioactive heat studies of parts of southern Bida basin, Nigeria, and the surrounding basement rocks, Vol. 2, Niger, Nigeria.

J. S. Kayode1, P. (2010), (P.122-131), A Ground magnetic study of Ilesa east, south western Nigeria, Vol.4, Nigeria.

J.S. Kayode, and Adelusi, (2010), (2040-7467), Ground Magnetic Data Interpretation of Ijebu-Jesa Area, Southwestern Nigeria, Using Total Component, Vol.2, Nigeria.

José A., B. (2017) (9-16), 3D inversion of aeromagnetic Data on Las Tablas District, Panama, Vol. 138.

Levi I and Nwankwo, (2015), (P.76-81), Estimation of depths to the bottom of magnetic sources and ensuing geothermal parameters from aeromagnetic data of Upper Sokoto Basin,Vol.54. Sokoto Nigeria.

Levi I. Nwankwo, and Abayomi, J. (2017), Regional estimation of Curie point depths and succeeding geothermal parameters from recently acquired high-resolution aeromagnetic data of the entire Bida basin, north-central Nigeria.

Liqing Zhao and Xioumei Li, (2012), (P.45-56), Structural Control to the Genesis of Sediment-hosted Disseminated Jinlongshan Gold Orebelt, China, Vol. 5, China.

Mohammed-Raza Azadi, and Mohammad, (2000), (P.113-120), Comparison of factorial kriging analysis method and upward continuation filter to recognize subsurface structures- A case study: Gravity data from a hydrocarbon field in the southeast sedimentary basins of the east Vietnam Sea, Vol. 35, Vietnam.

Ofor N, P. Adam. K.D., and Udensi E, E. (2014), (P.9), Spectral Analysis of the residual magnetic anomalies over patent and Egbako area of the middle Niger basin, Vol.4, Nigeria .

Obi D, A. and Abua J, U. (2015), (P.50-56), Interpretation of aeromagnetic data over the Bida basin, north-central, Vol.6, Nigeria.

Oghuma A, (2010), (2157-7617) http: 2-D Spectral Analysis of Aeromagnetic Anomalies over Parts of Monguno and Environs, Northeastern Nigeria http://dx.doi.org/10.4172/2157-7617.1000303D, Nigeria.

Olakunle Olawale and Olayinka, (2013), (P.451-470), Aeromagnetic mapping of basement topography around the Ijebu-Ode geological transition zone, Southwestern Nigeria, Vol. 48, Nigeria.

Onyewuchi R, A. (2012), (P.4), Geological Interpretations Inferred From Airborne Magnetic and Landsat Data: Case Study of Nkalagu Area, Southeastern Nigeria Vol. 2, Nigeria

ISSN 2229-5518

Solomon, O. (2016), (P.410-438), Soft Sediment Deformation Structures in the Maastrichtian Patti formation, southern Bida basin Nigeria: Implications for the assessment of endogenic triggers in the Maastrichtian sedimentary record, Vol. 6, Niger, Nigeria.

W. E. Glenn, (2015), (P.35), Aeromagnetic Depth Solutions Indicate Numerous Magnetic Sources within the Sedimentary Section of the Western Canada Sedimentary Basin, Vol. 4, Canada.

Zhentao Wang, H. (2015), (P.465-475), Characteristics of crystalline basement beneath the Ordos Basin, Constraint from aeromagnetic data Vol.6, China.