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Aeromagnetic Anomalies, Limited Ground Magnetic and Gravity Survey of NE Kogi State / NW Benue, Nigeria

Madu Anthony Joseph Chinenyeze[1], Onuoha K. Mosto[2]

[1]Department of Geology, College of Physical and Applied Sciences, Michael Okpara University of Agriculture Umudike (Mouau), Abia State, Nigeria

2Professor, Holder PTDF Chair, Dept of Geology, Faculty of Physical Sciences, University of Nigeria Nsukka (UNN), Enugu State, Nigeria

Abstract: ***The study area has had a good coverage of aeromagnetic survey sponsored by the Geological Survey of Nigeria. A combination of ground surface gravity and magnetic survey was conducted to tie to the aeromagnetic profiles. The terrain is made up Basement Complex rocks bounded at the west by the River Niger, and sedimentary rock type in the east. The Basement Complex comprises schists and meta-igneous rocks. Evidence of igneous activities within the Basement includes igneous intrusions of granites, pegmatites and gabbro. Density measurements of various rock types were taken. Magnetic susceptibility is highest in the igneous intrusive, with the magnitude of 0.00095 emu. The metamorphic rock of high susceptibility (0.00015 emu) is the Cordierite-Tourmaline Schist. Aeromagnetic interpretation of the study area yielded a range of total magnetic field intensity 8000 gammas to 8030 gammas, with mean maximum horizontal gradient of 30gammas/km in the sedimentary terrain, and about 35 gammas/km over the Basement rocks. The ground magnetic survey indicated an average vertical field intensity of about 3140 gammas for the area. An integrated interpretation of geophysical results revealed the existence of a fracture at Gboloko NE-SW axis, a synclinal fold axis at about 5.5km west of Gboloko (between the Staurolite Schist and Cordierite-Tourmaline schist). The Basement-Sedimentary boundary is characterized by a drop in residual Bouguer anomaly from positive to negative at about 6km east of Gboloko, and a decline in magnetic horizontal gradient 20.40 gammas/km. The thickness of the sediments is about 0.90km at the northern part of the Basement-Sedimentary boundary, and about 2.0km in the south, thus suggesting a progressive increase in sedimentary thickness at the western edge of the Benue trough. The magnetic 'highs' correspond to a combination effect of topographic irregularities and some bands of weathered, lateritized sediments. The olivine gabbro covers a diameter of about 1.5km in the subsurface, extending to Emi-Adama area indicative of significant iron-content for the magnetic anomaly and density contrasts in the Bouguer anomalies.***

Keywords: Aeromagnetic anomalies, Bouguer anomaly, magnetic susceptibility, Basement complex rocks, gravity measurements

1. Introduction

The aeromagnetic anomalies, ground magnetic and gravity anomaly investigation was conducted based on Nigeria Geological Survey Sheet 247 (Lokoja). The area is characteristic of Lower Benue Trough structures with the Quaternary Alluvium that adjoined the River Benue, and ridge of sediments which flanked the Basement Complex in the East. The area is associated with topographic irregularities or escarpment features and some bands of weathered, lateritized sediments. The laterization of these sediments induces concomitant ferruginization of non-silicic streaks which produce gently sloping magnetic contours. This magnetic character is attributed to the geologically mapped Coal Measures (Ekwueme, 1981) of the sedimentary terrain.

2. Study Area & Location

The study area lies between latitudes 7deg 35min N and 7deg 48min N, and longitudes 6deg 45min E and 7deg 00min E. The area is bounded in the North by the River Benue and in the west by the River Niger. The area falls within the Southeast quadrant of the Topographical Map-Sheet 247 of the Nigeria Ministry of Lands and Surveys. The major access traversed from Ankpa to Shintaku which are all now in Kogi State. The long sedimentary ridge marks the eastern boundary of the Basement rocks, constitutes the main watershed, or source of prolific dendritic drainage system. The latter enhances the weathering of both the metamorphosed rocks and sedimentary rocks intensely affected by laterization.

Figure 1: Location of Survey area - East-to-Northeast BLOCK of Kogi State (Southeast of River Niger & River Benue Confluence), former NW Benue State

3. Geology of the Area

The heterogeneity of rocks in the study area introduces three divisions of rock-types comprising sedimentary rocks, the Basement Complex rocks and igneous intrusive. The sedimentary terrain comprised medium-grained to boulders of sandstone and weathered and lateritized sediments, sometimes with bands of ferruginized sandstone (Artsybashev and Kogbe, 1974). Outcrops were at Nyankpo and Emi-Eronu in the NE of the study area. Density and magnetic susceptibility measurements were taken of samples collected from the area. Prominent escarpment in the topographic map constitutes the easterly boundary of the Basement Complex.

The degree of weathering and ferruginization of the sediments in the area was indicative of considerable similarity to the Upper coal Measures (Ekwueme, 1981). The age Campanian-Maaestrichtian has been assigned the Coal Measures by previous workers (Adeleye 1976). The Northern fringe of the study area is delimited by Quaternary Alluvium which adjoins the southern bank of the River Benue. This portion bears little or no good outcrops, but constitutes favourable soil for agriculture.

The Basement Complex rocks in the area consist of a variety of schists ranging from quartz-bearing mica-schists with preferred alignment of quartz and biotite-muscovite minerals, to quartz-free schist (Ekwueme, 1981). Other types of schists include staurolite schist and Cordierite-Tourmaline schist which have been affected by the intrusion of olivine gabbro and granite bodies. A discrete exposure of the gabbro outcrop approximates to 15m x 20m contiguous to the staurolite schist. The western portion is covered with granite gneiss and migmatite which have been subjected to intense granitic and pegmatitic intrusions.

4. Literature Review

With no detailed previous geophysical investigations conducted in the area, the geological mapping became the significant foundational reference. Hockey et al (1965) published a regional map of Lokoja area in the scale of 1:250,000, showing the study area as expanse of Biotite-Andalusite-Staurolite schist. Rahaman (1976) described the Basement geology of the entire area as slightly migmatized to unmigmatized paraschists and meta-igneous rocks which consists of pelitic schists. The age was identified at Pre-Cambrian.

Adeleye (1976) reported on his work in the Middle Niger Basin of occurrence of spread of the Mamu Formation and thickly occurring laterites. The ferruginization process in the area that developed to laterites is considered as the source of ironstone formations. Ojo and Ajakaiye, (1976) in their regional gravity survey of the Middle Niger Basin reported positive Bouguer anomalies which were attributed to the occurrence of basic igneous intrusive within the Basement rocks. Adighije (1981) produced a Bouguer anomaly map of the Benue Trough, which showed an axial positive anomaly attributed to Moho uplift. But a negative anomaly over the Lower Benue at Ankpa Basin was ascribed to maximal thickness of sediments of about 5000m.

Ekwueme (1981) identified the metamorphic members of the Basement Complex comprising schist, migmatites, and gneisses as products of polymetamorphism and polyphase deformation, associated with faulting and subsidence of the crust. The index minerals include garnet, staurolite and cordierite. The suite of schist rocks showed a related phase of metamorphic progradation: Biotite – Almandine garnet – Staurolite.

The effect of migmatitic activities in the area is typified by intrusions of pegmatites, granites and olivine gabbro. The geometry of the bodies varied widely, from narrow rectangular dykes of pegmatites, to near-oval to oblong patterns of granites. The sedimentary rock type bordering the metamorphic rock in the east, were identified as the Cretaceous Coal Measures.

Figure 2: Aeromagnetic Map of Lokoja SE, (Acquired by Nigerian Geological Survey)

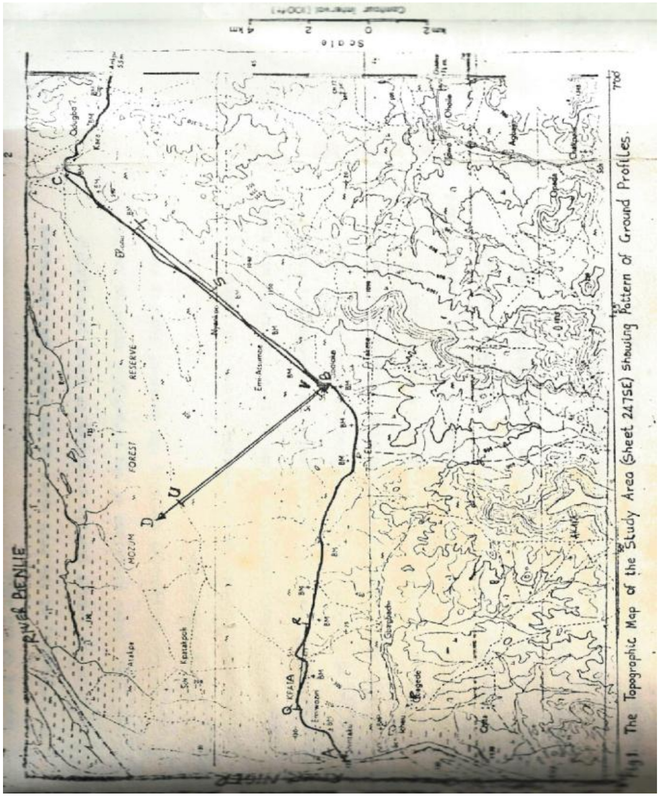

Figure 3: Location of different Profiles, used in Ground Magnetic and Gravity surveys for comparison with Aeromagnetic data

5. Objective of Study

The research was aimed at using geophysical methods (gravity and magnetic) to investigate,

1) Boundaries between different rock formations delineated by geological mapping.
2) Using interpretations of Aeromagnetic map of the area (in total magnetic intensity) to confirm results from ground geophysical measurements.

6. Methodology

A reconnaissance survey was carried out in the area during which surface geology was mapped. This was followed by detailed geophysical survey a month after. Three gravity profiles or traverses were conducted with respective lengths of 8km, 15km, and 16km with the observation intervals of about 0.50km. The Canadian Scintrex Gravimeter Model CG-2 was used for the survey, while elevation for each gravity station was measured using the American Paulin System Altimeter, with accuracy level of 0.0304m (0.1ft). Ground magnetic measurements were taken along selected profiles, at intervals of about 150m using Flux-gate Magnetometer. The total of 63 gravity stations and 168 magnetic observation points were measured.

The gravimeter has a sensitive instrumental balance which measures the attraction of the earth on a small mass inside the instrument, to an accuracy level of 0.01milligal. One base station was used for all the gravity profiles and it was reoccupied every two hours during each day's operation. The number of repeated readings at the base station measured at two-hour intervals was used for plotting the drift curve for that day. The base station coincided with the location of a bench mark with an altitude of 121.6m (400ft) above sea level. This was located opposite the Gboloko Primary School, Gboloko, Abassa Nge Local Government Area. The scale readings which were expressed in scale divisions were converted to milligals by multiplication with the calibration constant of the instrument. The calibration constant of the gravimeter was 0.10378 milligal/division.

The Paulin System Altimeter used in the survey was a pressure-controlled instrument. Changes in altitude affected the barometric pressure level. The instrument is also influenced by the temperature of the air column at the location of observation. The height measuring instrument operated at an accuracy level of 0.0325m.

7. Results and Analysis of Data

The gravity measurements in the area were taken along three profiles, comprising Profile A-B, Profile B-C, and Profile B-D. The profiles are shown in figure 3, and a comparison with the variation of rock types along the profiles to highlight rock density contacts. Generally the Bouguer anomaly in the area ranged from about -1.75mgals to +26mgals.with the average anomaly value of +12.5mgals. The regional anomaly trend of each profile was worked out based on the Bouguer gravity pattern. The Profile A-B revealed residual positive and negative anomalies. Profile A-B has a linear regional anomaly trend with associated residual positive and negative anomalies. The Profile runs East-West, from Gboloko in the east (as well as the Base Station) to Shintaku in the west (see figures 2 - 4).

In Profile B-D, the regional gravity field decreases from a maximum of about +22mgals to a minimum of -2.5mgals NW.

Profile B-C conforms to a regional anomaly of Cratchley and Jones (1965) consideration of topographic compensation, and topographic and sediment compensation combined. Some 2-D models were calculated for anomalous "highs" and "lows" in the residual profiles.

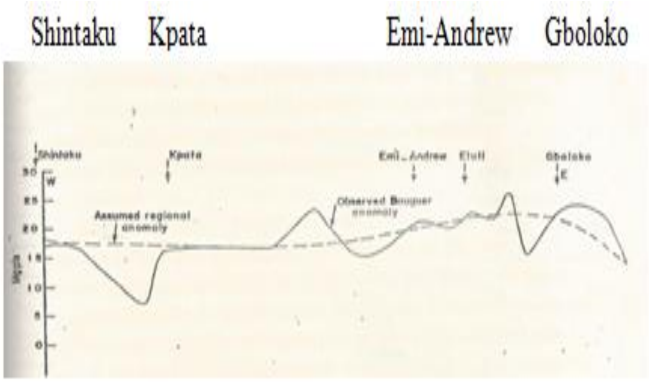

Figure 4: Gravity Profile A-B showing observed Bouguer anomaly and regional trend.

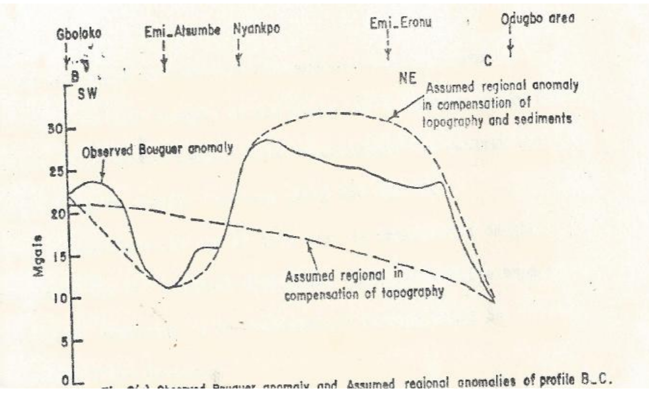

Figure 5: Gravity Profile B-C showing observed Bouguer anomaly and regional trend.

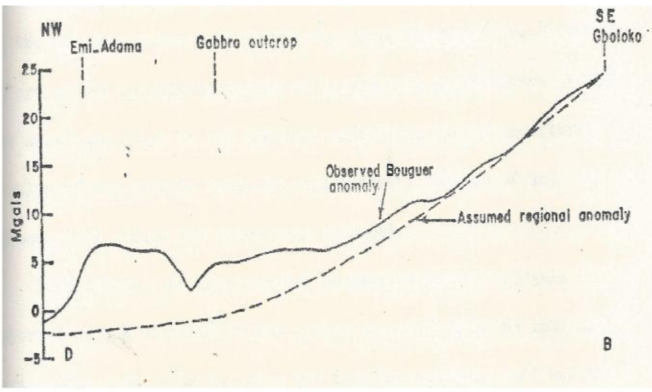

Figure 6: Gravity Profile B-D showing observed Bouguer anomaly and regional trend.

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8. Comparison of Results: Gravity and Aeromagnetic Data

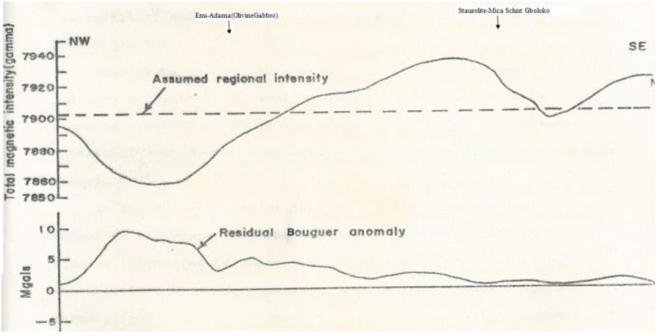

Figure 7: Correlation of aeromagnetic data in total magnetic intensity and residual Bouguer anomaly along Emi-Adama – Gboloko Profile

9. Interpretation of Results of Aeromagnetic Profiles

The survey involved the measurement of the total magnetic Field Intensity of the area, from Sheet 247 LOKOJA SE, (Airborne Magnetometer Survey Map). The magnitudes of the field intensity (in gammas) at various locations, obtained by the airborne measurement have been contoured at intervals of 1000 gammas, 100 gammas, 10.5 and 2.5 gammas Figure 2.

The aeromagnetic data underwent a regional correction. The effects of latitudes and orientation of the magnetic source with respect to the magnetic meridian have been reduced by the correction (Telford, et al, 1976). There does not seem to exist any false magnification of amplitude of the anomalies due to high magnetic latitudes, since the area (Lat. 7° 45' N) is at proximity to the magnetic equator. It could therefore be deducted that the apparent anomalies are due to some effects of rocks of magnetic properties and topography.

The magnetic contour map broadly revealed three distinct magnetic features, which are located in the north-western portion of the northeast-southwest axis of the map, and the south-eastern portion.

South-Eastern Portion: It is characterized by a gentle magnetic relief. The magnetic levels show gradual rise and fall along selected profiles. There exist prominent magnetic lows of magnitude 7795 to 7800 gammas, trending NE-SW axis in the direction of the River Emiji floodplain to the south. The magnetic gradient in this portion of the map is gentle and more consistent over the whole area than in any of the other two portions. On the average, the horizontal magnetic gradient is about 34 gammas/Km. There are two notable bands of magnetic maxima with levels of about 7900 gammas. They are aligned in the NW-SE direction, and orthogonally disposed to the NE-SW trending minima with magnetic levels of 7795 – 7800 gammas. This gives the magnetic amplitude of the south-eastern portion of the map area as approximately 105 gammas.

The magnetic signature of this portion is mostly characteristic of a sedimentary terrain with no igneous intrusive bodies of high magnetic susceptibility. The 'highs' and 'lows' in the magnetic profiles are peculiar reflections of the topographic pattern of the area and depth to the Basement. The magnetic 'highs' correspond to a combination effect of topographic irregularities and some bands of weathered, lateritized sediments. The laterization of these sediments induced concomitant ferruginization of non-silicic streaks which produced gently sloping magnetic contours. This magnetic character is attributed to the members of the geologically mapped Coal Measures (Ekwueme, 1981) of the sedimentary terrain.

The magnetic 'low' observed along the flood plains of River Emiji could be attributed to comparatively Basement and absence of ferruginized sedimentary 'covers'.

The Northeast-Southwest axis of the magnetic map runs linearly with a very steep signature. The magnetic map shows some topographic trends and bearing with rock-type. The NE-SW lineation of magnetic contours follows the trend of the range of hills in the area (Figs. 2 and 3). There exists a central low magnetic intensity, descending from the high magnetic levels of 8000 gammas. The magnetic signatures in some profiles suggest existence of faults.

The Northwestern portion is characterized by high magnetic levels, ranging from approximate minima of 7870 gammas to about 8030 gammas maxima. The magnetic contours largely show a correlation to some major structures. Some parts which appear to have suffered tectonic disturbances exhibit complex magnetic contours, and their profiles are reflective of probable tectonic activities. This lends support to the faults mapped by Ekwueme (1981) in Akabe vicinity. Some magnetic 'deeps' as contained in Shintaku-Gboloko profiles correspond to structural deeps, suggestive of disturbed environment.

The magnetic gradient varies all over the area. But sharper variations of magnetic gradients are observed over areas of topographic complexity. Magnetic gradients in Emi-Andrew locality in the metamorphic rock terrain of the Basement Complex range from 10 gammas/Km to 32 gammas/Km. The magnetic gradient in this area increases westwards; corresponding to Staurolite Schist and Cordierite Tourmaline Schist boundary (Bean, 1966) with susceptibility contrast of 0.0005 emu. There exists a magnetic low at about 0.75 Km west of Emi-Andrew. Its gradient is as low as 10 gammas/Km and the low coincides with an existing structural syncline.

This suggests that in nearly uniform lithologic conditions and magnetization, magnetic 'lows' correspond to aeromagnetic lows or deeps. The boundaries of some of the extensive basement rock units have been delineated by the trend of magnetic intensity data.

10. Quantitative Interpretation

The quantitative interpretation of the aeromagnetic map of the study area has been treated for each of the character subdivisions of the area, the southeastern portion, the northeast-southwest axial portion, and the northwestern portion.

Northeast-Southwest Axis

This part of the map has very complex magnetic contours. The profiles along this area produce very irregular and sinusoidal trends replete with sharp rises and falls. There is no regional magnetic character exhibited in any of the profiles. But magnetic levels and amplitudes throughout this axis display extreme degree of heterogeneity. This is typical of variety of basement complex rocks in the area. The magnetic signature of this Profile B-B has two peaks and a prominent 'low'. The maximum magnetic level over the profile is 8000 gammas with a very narrow width. The other profile C- C' shows a very high degree of complexity. The amplitude of anomalies in the profiles range from about 90 gammas to 400 gammas. But the magnetic levels are of high magnitudes from 7800 to 8200 gammas. The magnetic character of these profile indicates partly the geomorphologic inhomogeneity, variable degree of laterization and laterite-cover development, and contribution made by probable igneous activities within the underlying sediments which effected the deformation of the sediments. The complexity of the magnetic profiles in this domain can be attributed to lithologic contact between the Basement Complex and the sedimentary terrain. It is likely that the near-surface contact between the basement rocks (with some intrusive bodies within) and the overlying sandstone of the Cretaceous Coal Measures can stimulate such complex magnetic signals as observed.

The Northwestern Section

This portion of the Total Magnetic field intensity (T) map is interpreted on the basis of profiles taken along the already measured gravity profile along the already measured gravity profiles. The profiles running East-West (DD), Southwest-Northwest (D'D') and Northwest-Southeast Emi-Adama axis (G-G"). The profiles reveal a declining magnetic level from Shintaku, (by the bank of the River Niger), with a maximum horizontal gradient of 33 gammas/Km for about 2km eastwards. It is followed by a drop in horizontal gradient which remained uniformly, low though, associated with random rises and falls. There are sharp oscillations of the magnetic level. With amplitude ranging from 10 gammas to 20 gammas. The average maximum horizontal gradient at this portion of magnetic wavy character is 20 gammas/km.

The part of the profile that is characterised by consistently low magnetic anomaly is over the pegmatite to granite intrusives. A high range of horizontal gradient, 30 to 40 gammas/km which declines to a region of uniform low magnetic anomaly is suggestive of a change in lithology from the basement (migmatite) rocks to the intrusive bodies of pegmatite and granite. The oscillating magnetic levels at the east might by indicative of a structural setting which displays an existing syncline, characterized by a broad smoothed magnetic low. A magnetic rise trending over Gboloko area.

This rise is attributable to a possible emplacement of an igneous instrusive, or due to a near-surface basement.

The 52 gamma amplitude-"low" might be due to pile of sediments of low magnetic susceptibility. Possibly, a significant susceptibility contrast (0.00002 emu) between the fresh sandstone sediment and its lateritized and partly ferruginized "cap" or "cover" might be responsible for the magnetic "rise "east of the "low".

The higher level of the total magnetic field at the SW could be ascribed to the metamorphic basement rocks (Quartz-Muscovite-Biotite Schist) which are of higher susceptibility (0.00015 emu) than the adjacent sediments (0.00012 emu) of the coal measures.

Possibly, the susceptibility contrast between the basement meta-rocks and the overlying Cretaceous Coal Measures could be the cause of the amplitude "high".

The NW-SE profile (G-G") extends from Emi-Adama area to Gboloko. This displays a prominent magnetic anomaly low in Emi-Adama Area. The magnetic anomaly low over this area is possibly caused by a high magnetic susceptibility contrast (0.00095 emu) between an igneous body and alluvium deposit. The magnetic "low" corresponds to the location of a gabbro instrusive. The minor "high" existing east of the anomalous low could be attributed to the moderate susceptibility contrast between the evident gabbro body and Staurolite Schist member of the host basement complex.

11. Comparison of Results

Results obtained from both gravity and magnetic surveys are hereby composited to enable the extraction and correlation of consistent interpretations. The trend of the gravity profile is similar to that of short ground magnetic profiles (fig. 3). Besides, cross-sections of selected profiles across the aeromagnetic contour map of the study area were made to provide both quantitative and qualitative information about the magnetic character of the place. Its measurements are in terms of total magnetic intensity (T or ΔT in gammas).

The ground magnetic profiles were taken to produce contrasting magnetic signature across lithologic boundaries or structures.

Shintaku-Gboloko Profiles

The gravity profile (A-B), is matched with two aeromagnetic profiles (M_1 and M_2) to generate the correlation profiles in (figure 9). Geologic features are displayed on the composited profiles thus, establishing a correlation of some features. The residual gravity low, adjacent to Gboloko (Gravity base station), has been interpreted as a signature of an existing fracture. This signature is correlated to magnetic "deeps" of identical configuration, and trend. The stacked profiles reveal the existence of an anti-clinical axis or structure, which also give credence to a suggested syncline occurrence. Furthermore, the supposed anticline is underlain by Cordierite-Tourmaline Schist which has a magnetic susceptibility of 0.00015 emu.

A section of the profile which shows little or no deviation from the regional trend of the respective profiles except for profile M_2, is conceived to be underlain by a uniform lithology, possibly the granite gneiss. From the extreme west, down to the "low" manifest, a sharp decline in both gravity and magnetic horizontal gradients (33 gammas/Km). This is

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attributed to the change in lithology from the Basement (magmatite to an emplaced granitic body).

Gboloko-Odugbo Profiles

The residual Bouguer anomaly profiles of this place in comparison with the aeromagnetic profile of the same trend (fig. 8) reveals a prominent anomaly low at the middle of the profiles. The "low" has been interpreted as resulting from a pile of sediments (Green, 1976), 0.90km thick near the Basement complex-sedimentary rock-type boundary. An apparent magnitude rise in both gravity and magnetic profiles, which follows the "low" could be suggestive of:

1) Proximity of the basement of the surface
2) Presence of igneous intrusive within the sediment capped basement.
3) The expanse of the lateritized and ferruginized "cover" of the Cretaceous Coal Measures. The comparatives analyses of the profiles point towards a similar

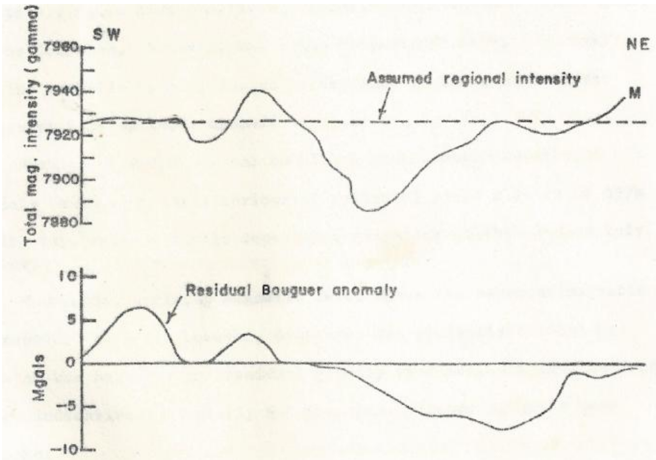

Figure 8: Correlation of Aeromagnetic data in Total Intensity and Residual Bouguer Anomaly along Gboloko – Odugbo Profile

Emi-Adama-Gboloko Profiles

The residual gravity (G) and the aeromgnetic profile of Emi-Gboloko (fig. 7) tend to point out a contrasting magnetic low (or a residual negative) and a high positive residual Bouguer anomaly at the gabbro intrution area. However, the conformity of the gravity anomaly and the magnetic anomaly-low gives credence to the quantitative interpretation of these anomalies.

Result of 2-dimensional modelling of the source of the anomaly (assumed to be a horizontal cylinder) yielded a depth of 157m to its top, while magnetic depth interpretation of the same anomaly (magnetic low) gives a depth of 170m to the surface of the anomaly source.

Eastwards, a rising magnetic level shows the basement magnetic signatures. A low is however, displayed (at proximity to Gboloko) to be indicative of a nearly N-S trending fracture of joint near Gboloko.

The gravity and magnetic profiles, to a high degree shows a correlatable signature configuration.

12. Significant Geologic Features and Geophysical Results

There is a fracture in the vicinity of Gboloko trending NE-SW which has been revealed by residual negative anomaly and a magnetic low. This fracture is conceived to have necessitated the infill of sediments for the aquifer of Gboloko borehole. This study has established the existence of a syncline at the boundary between the Staurolite Schist and the Cordierite-Tourmaline Schist at about 5.5km West of Gboloko.

At the Western Part of the Shintaku-Gboloko profile, a change in rock-type from the basement (granite gneiss) to the igneous instrusives (granite and pegmatite) is observed to be characterised by a corresponding decline in residual Bouguer anomaly from positive to negative at the granitic and pegmatitic rock terrain. This reveals a contiguous location of the igneous intrusives (granite and pegmatitie), but not separated by an intrusive-free-basement-rock. The Basement-Sedimentary boundary is about 6Km east of Gboloko, along the Gboloko-Odugbo profile. The boundary is characterized by a fall in Bouguer gravity, from positive Bouguer anomaly to negative Bouguer anomaly, coupled with a decline in magnetic horizontal gradient to 20.40 gammas/km approximately.

The thickness of the sediments is about 0.90km and Emi-Eronu area, near the Basement-Sedimentary boundary, and about 2.0km near Elikah, at the south of the map area (fig.2). Thus, a progressive increase in sedimentary thickness is suggestive at the western edge of the Benue trough.

The olivine gabbro reported by Ekwueme (1981) as having a superficial extent of 12m x 10m, amidst host basement rock and also an assumed greater extent, has been geophysically determined to extend up to Emi-Adama, where alluvium deposit constitutes the host rock. At Emi-Adama area the (gabbro) body has a diameter of about 1.5km in the subsurface and is conceived to be related to the olivine gabbro outcrop along the Emi-Adama-Gboloko profile.

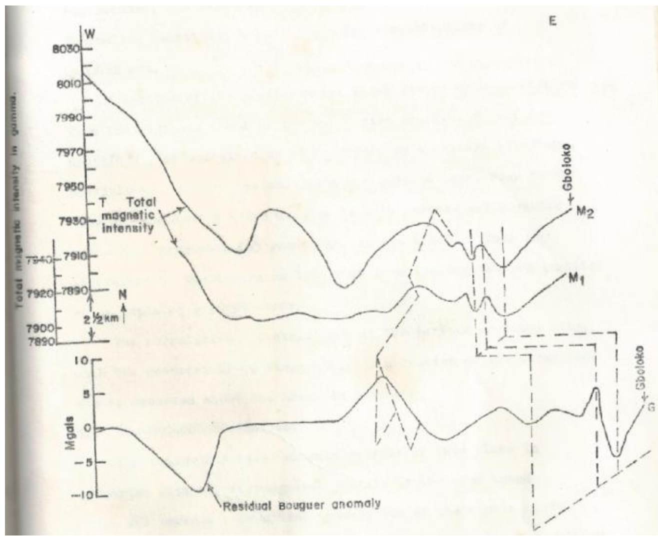

Figure 9: Correlation trend of Aeromagnetic Profiles M1/M2 and Gravity Profile from Shintaku by the Riv. Niger to Gboloko Base Station

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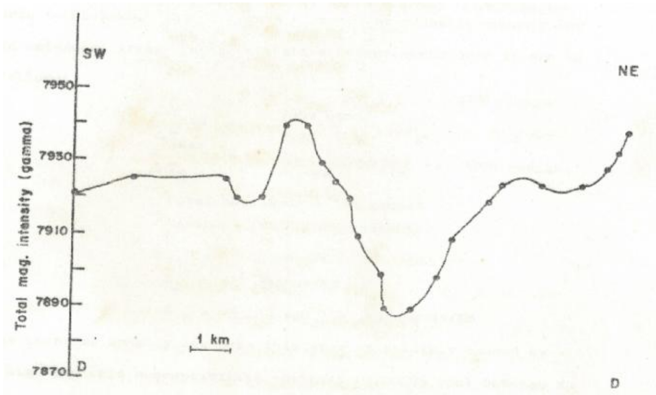

Figure 10: Aeromagnetic field Profile along D-D, (SW-NE)

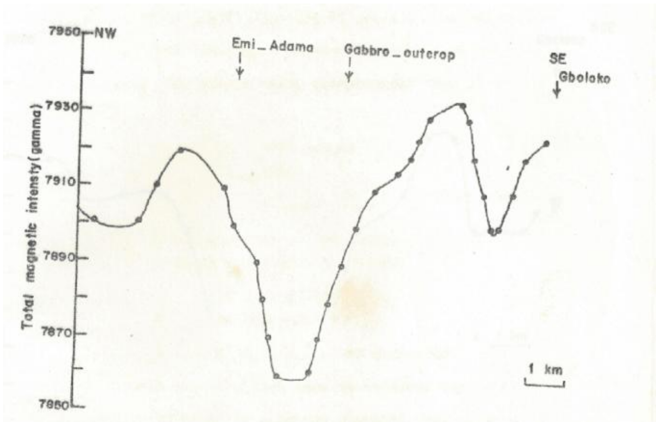

Figure 11: Aeromagnetic Field Profile over the Gabbro intrusive

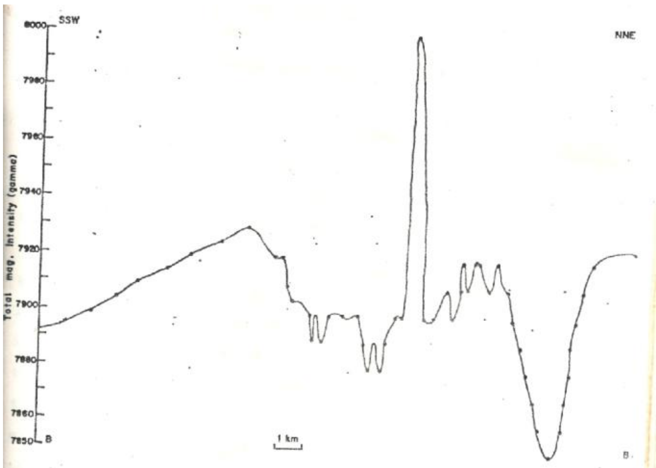

Figure 12: Aeromagnetic Anomaly Profile across the range of hills B-B'(S to N near Odugbo)

13. Conclusion

The study area characterized by Basement Complex spread between the River Niger border and the hilly ranges at about 6km east of Gboloko, which borders with the sedimentary rock type in the east. The Basement Complex consists of a variety of Schists and meta-igneous rocks. Evidence of igneous activities within the basement are the igneous intrusions of granites, pregmatites and gabbro.

Magnetic susceptibility was highest in the igneous instrusive (Olivine gabbro) with the magnitude of 0.00095 emu. The metamorphic rock of highest susceptibility (0.00015 emu) is the Cordierite-Tourmaline Schist. Results of the geophysical survey show that the study area has a mean Bouguer anomaly of +12.15 mgals and a mean free air anomaly of +22.0 mgals. The ground magnetic survey indicates an average vertical field intensity of about 3140 gammas for the area. Interpretation of aeromagnetic map reveals a mean maximum horizontal gradient of 30 gammas/km in the sedimentary terrain, and about 35 gammas/km over the Basement rocks.

An integrated interpretation of geophysical results has revealed the existence of a fracture at Gboloko vicinity, a synclinal fold axis at about 5.5km West of Gboloko (between the Staurolite Schist and Cordierite-Tourmaline Schist). The Basement-Sedimentary boundary is characterized by a fall in residual Bouguer anomaly from positive to negative at about 6km East of Gboloko, and a decline in magnetic horizontal gradient to 20.40 gammas/km. The thickness of the sediments is about 0.90km at the northern part of the Basement-sedimentary boundary, and about 2.0km at the south, thus, suggesting a progressive increase in sedimentary thickness at the Western edge of the Benue trough. The Olivine gabbro covers a diameter of about 1.5km in the subsurface, extending up to Emi-Adama area.

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