ZIBELINE INTERNATIONAL™ PUBLISHING

*ISSN: 2521-5035 (Print)*
*ISSN: 2521-5043 (Online)*
*CODEN: ESMACU*

**Earth Sciences Malaysia (ESMY)**

*DOI: http://doi.org/10.26480/esmy.01.2023.43.46*


CrossMark

*RESEARCH ARTICLE*

# RECONNAISSANCE IMPLEMENTATION OF GROUND MAGNETIC METHOD TO DELINEATE THE SUBSURFACE IN GIDAN-DOYA BASEMENT AREA, NORTH CENTRAL NIGERIA

**Ohakwere-Eze, M.C., Nwankwo, L.I**

***Geophysics Research Group, Department of Physics, Federal University of Kashere, Gombe State.***
****Corresponding author email: michael.ohakwereze@gmail.com***



**ARTICLE DETAILS**

***Article History:***

Received 25 November 2022
Revised 10 December 2022
Accepted 12 January 2023
Available online 14 January 2023

**ABSTRACT**

A 3 Axis MCL6 Magnetometer was used to gather the magnetic data. The information was gathered from a 1 km by 500 m area along eight profile lines with a length of roughly 1000 m each. Each profile is spaced roughly 250m apart from the other. The magnetic investigation was created in a way that provided clear definition of the depth to phenomena in the region. Measurements of the magnetic strengths at discrete spots along traverses spaced consistently throughout the area of interest were required by the data collecting approach in order to sufficiently cover the segment utilized to ascertain the structure and deformation analysis of the study area. The geological conditions in the shallow subsurface provide the highest frequency events of interest, whereas magnetic property contrasts at or beneath the basement surface produce the lowest frequency occurrences. Significant lateral variations and contrasts in the shallow formations' magnetic characteristics are produced either singly or as a result of a particular combination of faulting, deposition, and mineralization linked to displacement and deformation of the structural system.

**KEYWORDS**

Magnetic Survey, Magnetometer, Magnetic Intensities, Anomalies, Basement Complex.

## 1. INTRODUCTION

The earth's magnetism origin is commonly believed to be the outer liquid core which cools at the outside as a result of which the material becomes denser and sinks towards the inside of the outer core, and new warm liquid matter rises to the outside; thus, convection currents are generated by metallic liquid matter which move through a weak cosmic magnetic field which subsequently produces induction currents (Kayode, et al., 2010). It is this induction current that generate the earth's magnetic field (Telford et al., 1976). Some geophysicists have developed a mathematical model for the earth's magnetic to study and understand the magnetic intensity across the surface of the earth. In a field survey involving a magnetometer, there are many unexpected variations in such model indicated as "magnetic anomalies". When there is a high magnetic anomaly, the measured field strength is higher than the value predicted by the global model, and when there is a low magnetic anomaly, the measured field strength is lower than the value predicted by the global model (Mariita, 2013).

Variations or otherwise called anomalies in the earth's magnetic field are caused by induced or remanent magnetism. Remanent magnetic anomalies are the result of secondary magnetization induced in a ferrous body by the earth's magnetic field. A likely cause for magnetic highs includes the presence of magnetically charged rocks in the subsurface. The objective during magnetic prospecting is to look for variations in the magnetic field of the earth which are caused by changes in the subsurface geologic structure or by differences in the magnetic properties of near-surface rocks (Mariita, 2013). The magnetic susceptibility which refers to a rocks' innate magnetism are important for the quantitative interpretation of magnetic data and can be used to differentiate rock types. Where the rock materials have high magnetic susceptibility, the local magnetic field will be strong, whereas for low magnetic susceptibility rocks, it will be weaker.

It then implies that rock units with higher susceptibility will show up as areas of high magnetic field strength. Sedimentary rocks generally have a very little magnetic susceptibility when compared with igneous or metamorphic rocks, which tend to have much higher magnetite (a common magnetic mineral) content. The aim of this research is to investigate subsurface geology on the basis of the anomalies in the earth's magnetic field resulting from the magnetic properties of the underlying rocks and to map the basement faults and fractures as well as the basement depth.

## 2. MATERIALS AND METHODS

### 2.1 Field Procedures

The magnetic survey was designed in such a way that deep insight into the depth to magnetic sources in the area was delineated (Igboekwe et al., 2018). The technique of the data acquisition adopted requires measurements of the magnetic intensities at discrete points along traverses regularly distributed within the area of interest so as to cover large segment used to determine the structure and the structural history of the study area.

### 2.2 Data Acquisition

Ground magnetic measurements were made with portable 3 Axis MCL6 Magnetometer at a regular interval of 50m along each profile. A total of 20 sampling points were obtained on each of the profile while a total of

| Quick Response Code | Access this article online | |
|---|---|---|
| | **Website:**<br>www.earthsciencesmalaysia.com | **DOI:**<br>10.26480/esmy.01.2023.43.46 |

Cite The Article: Ohakwere-Eze, M.C., Nwankwo, L.I (2023). Reconnaissance Implementation of Ground Magnetic Method to Delineate the Subsurface in Gidan-Doya Basement Area, North Central Nigeria. *Earth Sciences Malaysia, 7(1): 43-46.*

eight profile separated by 100m respectively were covered. Anomalies from intense fields arising from man-made electromagnetic sources were avoided. The compass was more than 3 m away from the magnetometer during the field measurement. The magnetometer was immobilized to ensure that it has attained stability after base station readings were collected over a period of 24 hours. The reading from the base station tends to show stability in the morning than in the afternoon hence the acquisition of magnetic data was done in the morning. Total field magnetic readings were recorded using the magnetometer. A Garmin GPS model was used for the survey direction and to establish the station positions. In the UTM zone 31N, coordinates were logged using the WGS84 datum. The direction of the survey line was roughly parallel to the local geological strike.

### 2.3 Data Processing

In order to produce accurate magnetic anomaly maps, temporal changes in the earth's field during the period of the survey was considered. The correction for diurnal drift was made by repeat measurements of a base station at frequent intervals. The measurements at field stations was then corrected for temporal variations by assuming a linear change of the field between repeat base station readings. After correcting for drift variation, the total magnetic fields were then filtered to remove excess noise using the first order polynomial analysis and then plotted as contour (Figure 1).

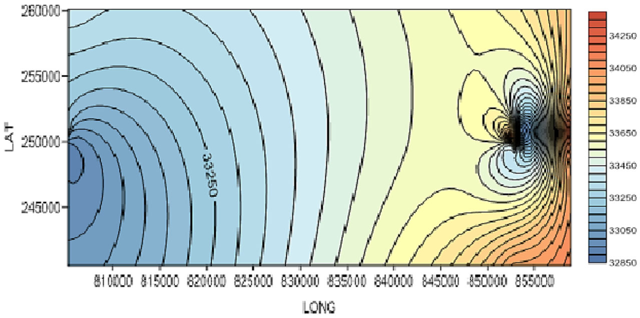



**Figure 1:** Total magnetic field collected directly from the field.

### 2.4 Data Enhancement

The total magnetic field is seen to be distorted towards the right-hand end of the map. This indicated that a magnetic anomaly exit. The presence of this causes the earth magnetic field to behave unregularly. However, after the application of minimum curvature techniques on the total field (Figure 2), the total field is seen trending towards NE-SW, which agrees with the geology of the area. Also, as observed from Figure 2, there is enhancement of the structure that distorted the earth magnetic field towards the end of the right-hand side.

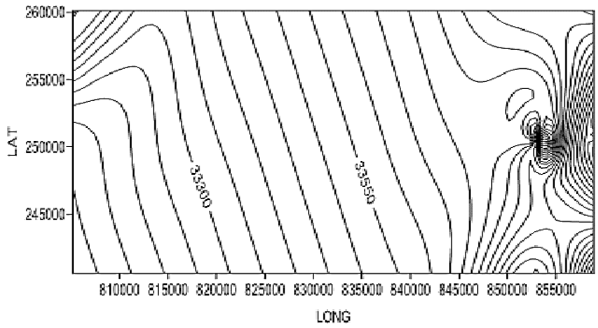



**Figure 2:** Total magnetic field trend after Second Derivative filtering.

## 3. Results and Discussion

In this study, we adopted the two most convenient methods of interpreting residual magnetic field data. These are profile lines and contour maps.

### 3.1 Profile Lines Interpretation

Residual magnetic field are plotted against distance for profile lines interpretation. The variation in the field is presented as both positive and negative. As a rule of thumb, for a well-defined peak, the depth of the corresponding source is approximately equal to the width of the peak at half of its amplitude.

***Profile 1:*** From profile 1 (Figure 3), magnetic data were collected from 20 sampling point at a distance of 50 m each. Magnetic low were observe from the beginning of the profile to a distance of about 620.0 m. This indicate a reasonable thickness of the over burden within the section. However, between 620-700 m, magnetic high was observed indicating an intrusive body of high magnetic susceptibility. Towards the end of the profile the drop in magnetic field may be likely due to the presence of fault.

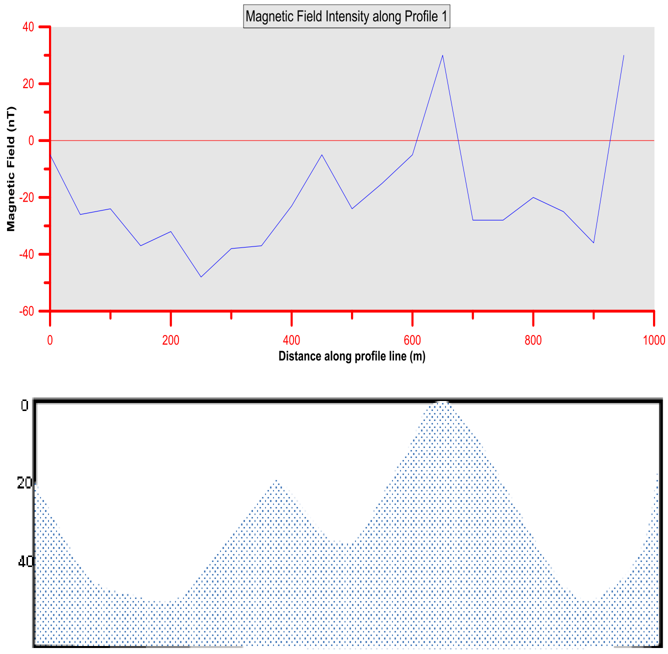



**Figure 3:** Magnetic profile along profile 1 with the corresponding geomagnetic section

***Profile 2:*** From profile 2 (Figure 4), magnetic data were collected from 20 sampling points at a distance of 50 m each. Magnetic low observed of about -30 nT indicated a magnetically quiet zone, however the sharp decrease at about 760 m is an indication of a magnetic anomaly within the section.

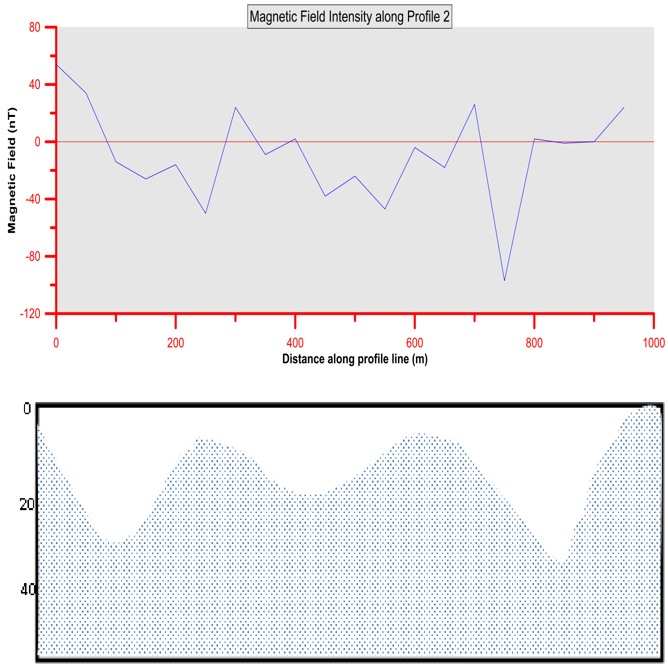



**Figure 4:** Magnetic profile along profile 2 with the corresponding geomagnetic section

***Profile 3:*** From profile 3 (Figure 5), magnetic data were collected from 20 sampling point at a distance of 50 m each. The variation indicates that the basement is undulating. At a distance of about 650.0 m, the sudden rise and fall in the magnetic signal may be as a result of a fault within the basement. Also the over burden is thin towards the beginning of the profile.

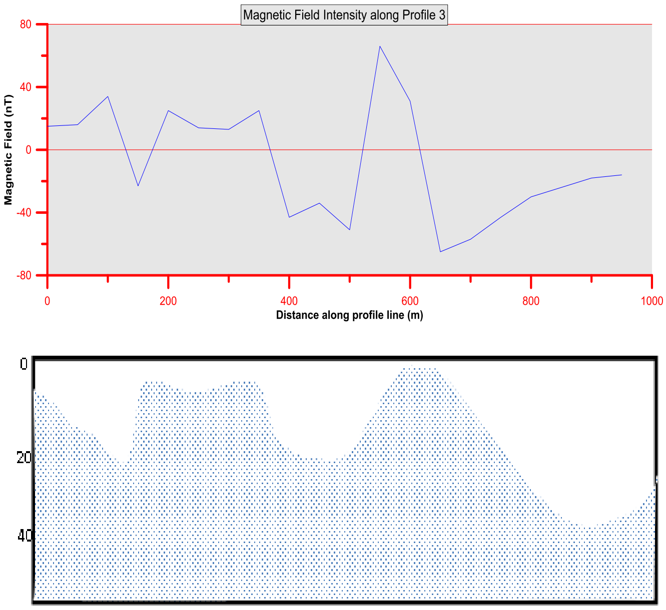



**Figure 5:** Magnetic profile along profile 3 with the corresponding geomagnetic section

***Profile 4:*** From profile 4 (Figure 6), magnetic data were collected from 20 sampling point at a distance of 50 m each. The variation indicates that the basement is undulating. At a distance of about 750.0 m, sharp fall in the magnetic signal may be as a result of a fault within the basement. Also the over burden has an average thickness of about 15 m.

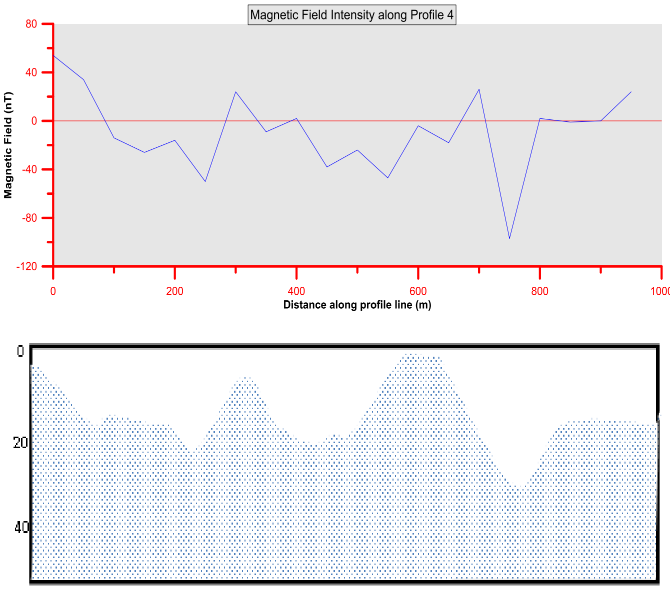
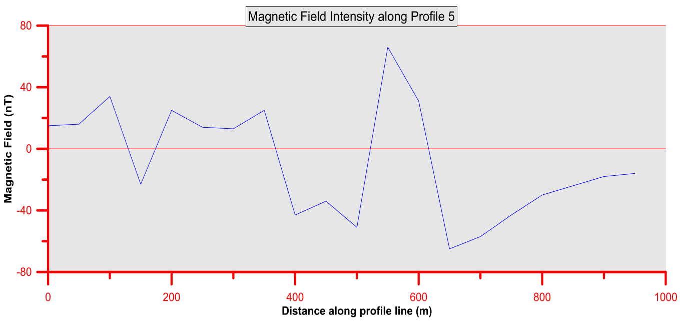



**Figure 6:** Magnetic profile along profile 4 with the corresponding geomagnetic section

***Profile 5:*** From profile 5 (Figure 7), magnetic data were collected from 20 sampling point at a distance of 50 m each. The sudden rise and fall in the magnetic signal at about 650.0 m may indicate the presence of a fault within that section. From the geomagnetic section, the overburden is generally thin from the beginning of the profile, however, towards the end the basement show evidence of weathering.



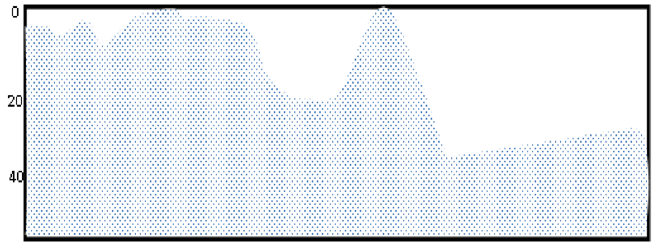



**Figure 7:** Magnetic profile along profile 5 with the corresponding geomagnetic section

***Profile 6:*** From profile 6 (Figure 8), 20 sampling points were collected along the 100 m profile. From the profile it is observed that there is a magnetically quiet subsurface till about a distance of 600 m. The sudden rise in magnetic signal at about 650 m may indicate a fault within the section of the profile. The geomagnetic section shows that the overburden is thick with an average thickness of about 30 m at the beginning of the profile.

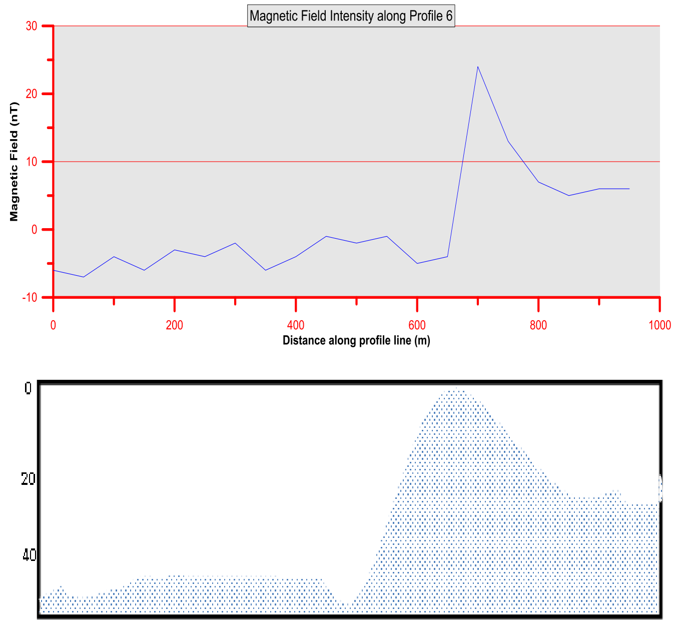



**Figure 8:** Magnetic Field along profile 6 with the corresponding geomagnetic section

***Profile 7:*** From profile 7 (Figure 9), 20 sampling points were collected along the 100 m profile. From the profile it is observed that the basement is undulating. Also, at about 650 m there is an indication of fault within the basement.

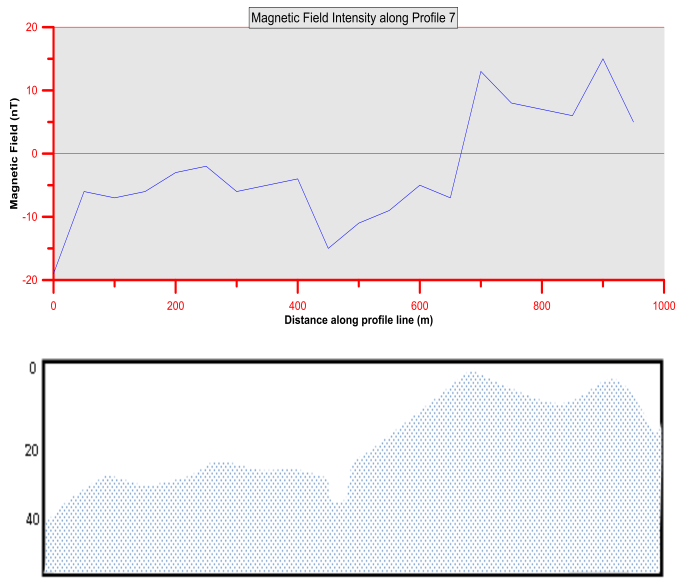



**Figure 9:** Magnetic Field along profile 7 with the corresponding geomagnetic section

***Profile 8:*** From profile 8 (Figure 10), 20 sampling points were collected along the 100m profile. From the profile it is observed that the basement is undulating. Also, at about 100m and 850m respectively, there is an indication of fault within the basement.

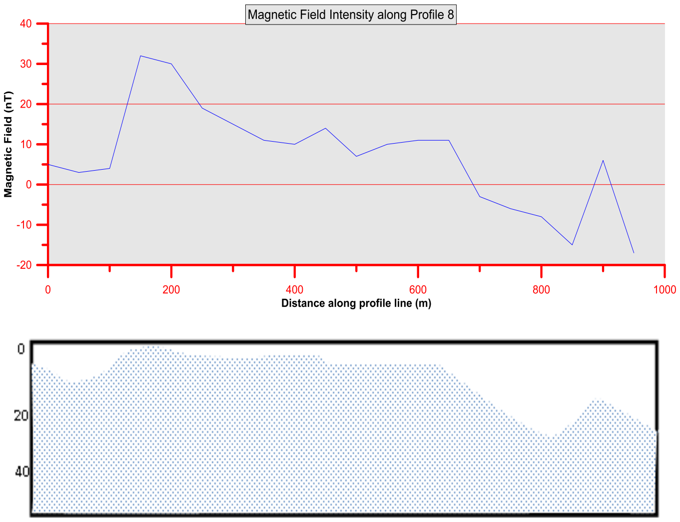



**Figure 10:** Magnetic Field along profile 8 with the corresponding geomagnetic section

### 3.2 Contour Map Interpretation

The presentation of the magnetic data for this research region uses a contour map of the residual magnetic flux. (Figure 11). From the contour map, four anomalies were delineated. The first is a magnetically low anomaly sited at a depth of about 25 m, and with average length of 300 m (Figure 11). The second anomaly is a magnetically low anomaly at the beginning of the profile. The may be as a result of a major fault line. The third and the fourth are magnetically high anomalies; this may be as a result of the outcrops within the study area.

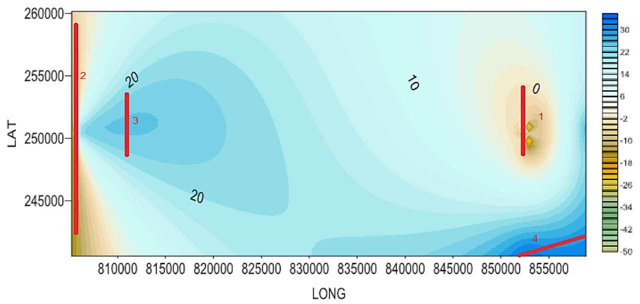



**Figure 11:** Residual magnetic field within the study area (red lines showing major anomalies)

## 4. Conclusion

The Earth's magnetic field is a conglomerate of anomalies of varying frequencies. The geological conditions in the shallow subsurface provide the highest frequency events of interest, whereas magnetic property contrasts at or beneath the basement surface produce the lowest frequency occurrences. Within the sedimentary section, occurrences of intermediate frequency are observed. Significant lateral variations and contrasts in the shallow formations' magnetic characteristics are produced either singly or as a result of a particular combination of faulting, deposition, and mineralization linked to displacement and deformation of the structural system.

It is observed that the basement is within an average depth of 25 m, in some cases above that. However, the magnetic signal was able to show that the basement is undulating with a series of depressions. Also, towards the end of the profile's lines, at an average distance of about 650 m, a major strike is observed which indicates the present of major fault zones, brittle fractures or any other geological features that exhibit low values. From the contour map, there is evidence of magnetic low concentric body with an average length of about 300 m at a depth of about 25 m. This may be a depression field over time with sediments.

## Acknowledgement

The author is grateful to the Centre for Atmospheric Research, National Space Research and Development Agency, CAR-NASRDA, Anyigba, Kogi State, Nigeria for providing the magnetometer used for the study.

## Declaration of Interest Statement

The author reports that there is no competing interest to declare.

## References

Igboekwe, M.U., Ohakwere-Eze, M.C., Anyadiegwu, F.C., Ahamefule, C.Y., and Eme, U.K., 2018. Preliminary interpretation of magnetic survey undertaken in Michael Okpara University of Agriculture (MOUAU), Umudike, Abia State. Journal of the Nigerian Assoication of Mathematical Physics, 48, Pp. 233-238.

Kayode, J.S., Nyabese, P.K., and Adelusi, A.O., 2010. Ground magnetic study of Ilesa East, Southwestern Nigeria. African Journal of Environmental Science and Technology, 4 (3), Pp. 122-131.

Mariita, N.O., 2013. Short Course VIII on Exploration for Geothermal Resources Strengths and Weaknesses of Gravity and Magnetics as Exploration tools for Geothermal Energy. Organized by UNN-GTP, GDC and KenGen.

Reijers, T.J.A., 1996. Selected Chapters in geology. Shell Petroleum Development Company, Warri, Nigeria, Pp. 87 – 90.

Telford, W.M., Geldart, L.P., Sheriff, R.E., and Keys, D.A., 1976. Applied Geophysics. Cambridge University Press, Pp. 770.