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Research Paper

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The Interpretation of Magnetic Data over the North-Southern Part of a Gold Mining Site in IBODI, ILESA, OSUN-State, Nigeria

A.B. Ekundayo[1*], A.O. Samuel[2]

[1,2]Physics Department, Faculty of Science, University of Lagos, Lagos, Nigeria

**Corresponding Author: azeezekundayo82@gmail.com, Tel: +2348036476205*

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Abstract—The geophysical method that was used for this field work is the ground magnetic survey technique. This method was used to give facts about the subsurface structure of the Earth, which focuses on the geological structure of the site based on the qualitative and quantitative interpretation of the ground magnetic data collected during the field work of this study. Two magnetic traverses were considered in this study. The magnetic anomalies along the two profiles show both minimum and maximum peaks indicating the presence of different rock types which include the Schist/Epidorite complex and Gneiss/migmatite undifferentiated.

The profile of magnetic traverse 1 cut across the North-Southern part of the gold mining site and it is 350m long. Two rock types were observed along this traverse, these are: Schist/Epidorite complex and Gneiss/migmatite undifferentiated characterized by magnetic high and lows. The magnetic signature obtained for the magnetic anomaly along this traverse shows both maximum and minimum peaks. The Schist/Epidorite complex is observed to be at a station of about 10m from the base station, the Gneiss/Migmatite undifferentiated is at a distance between 10m to 306m, while the Schist/Epidiorite is observed at a distance of 310m to the final station on the geological section.

The profile of magnetic traverse two cut across the West-Eastern part of the gold mining site and it is 270m long. Two rock types were observed, these are: Schist/Epidorite complex and Gneiss/Migmatite undifferentiated. The profile is characterized by magnetic high and lows. The Schist/Epidorite complex was observed to be at a station of about 10m and the Gneiss/Migmatite undifferentiated is observed at a distance between 11m to 270m.

Keywords— Magnetic, Rock, Traverse, Anomaly, Delineate, Gold, Mineralization

I. INTRODUCTION

Geophysics as its name indicates has to do with the physics of the earth and its surrounding atmosphere. Geophysics deals with earth's properties by applying physical theories and using instruments for measurement [1]. It deals with all the aspect of the physics of the earth, its atmosphere and space. Geophysical dimensions were made by men who visited the moon and the atmosphere. Magnetic field and other properties of the planet are studied using geophysical data obtained by unmanned spacecraft.

The knowledge of the earth has been developed by combining the information gotten from these entire fields. This holds also for investigation in applied geophysics as well. The combination of several parameters may help us to determine the location of a structure or deposit. The choice of technique to locating a mineral deposit or rock type depends on the deposit at that particular location. All these are used in the location of deposit by a geophysicist.

The importance of geophysical exploration as a means of deriving subsurface geological information is so great that the basic principles and scope of the methods and their main fields of application should be appreciated by any practicing Earth Scientist [2].

II. RELATED WORK

A lot of work has been carried out on the Ilesha schist belt, owing to the existence of economic minerals. All the previous work carried out in the Ilesha schist belt have provided adequate information on the subsurface, depth to the basement, geologic structures, and so on but none has majorly worked on the study of gold mineralization in Ibodi Town.

A lot of work has been carried out on the Ilesha schist belt, because of the presence of economic minerals. The earlier works on geological and geophysical study on the structure of the rocks in the area include the pioneering studies [3, 4].

Adetoyinbo et al. [5] investigated the geological and geochemical characteristics of soil around Itagunmodi gold deposit. He found that the mobility of the trace in altered host rocks and the distribution in host rocks and ores may

provide constraints regarding the physio-chemical characteristics of the ore bearing fluids.

Ariyibi E.A [6] made the geological investigation for the delineation of potential mineralized zone in southern part of Ilesha Area, Nigeria and investigated the subsurface geology with different geophysical techniques.

Kayode et al [7] worked on the ground magnetic survey of Ilesha east using high resolution proton precession magnetometer, which measures the total component of the ground magnetic anomaly data running through 15 traverses.

The magnetic survey method geophysical research used for this study was used to provide accurate information on depth to basement, geological structure of the subsurface and the presence of gold mineralization on the study area.

The geology of Nigeria is composed mainly of crystalline and sedimentary rocks both appearing roughly in equal proportions [8]. The Nigerian basement is believed to have had structural complexity due to folding igneous and metamorphic activities with five major rock units known within the basement complex [9]. The study area is a gold mining site located in Ibodi, Ilesa, Osun State (Southwestern Nigeria). The gold mining site lies within geographic coordinates of Latitude 7º 35'N, 7º 41'N and longitude 4º 40'E, 4º 50'E respectively. The road leading to the gold mining site is moderately tarred. The main rock types found in Ibodi area are: pegmatite, Gneiss/Migmatite undifferentiated, Schist/Epidiorite complex and Talc (Figure 2.1). The study area is underlain mainly by the Schist and Epidiorite rocks

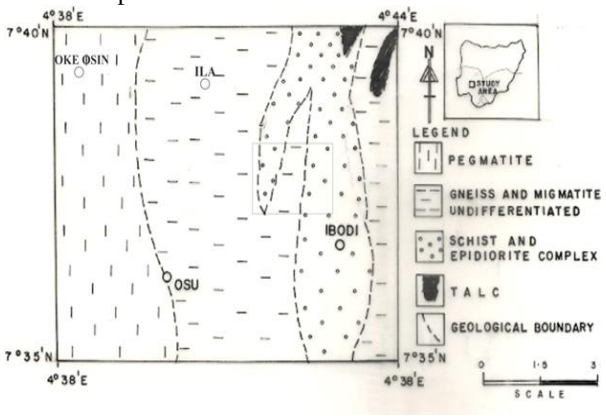


Figure 2.1: Geological map of the study area, shown in rectangle is the study area in Ibodi.

III. Materials and Methods

3.1. Ground Magnetic Survey Procedures and Processing

The ground magnetic measurement was taken by using proton magnetometer that involves three components which are vertical, horizontal and total magnetic intensities, with a Garmin Global Positioning System (GPS). Observations were made along two traverses of lengths 350 meters, and 270 meters, all with equal spacing of about 6 meters. Magnetic traverse over the delineated area are shown in Figure 3.2. In the survey the total magnetic profile was measured. The necessary precautions were taken in the course of the survey, these include:

- The day and time of the field was carefully chosen to avoid the effect of geomagnetic storm on the data, which was collected on the field.
- Metallic objects such as belts, cutlasses, wrist watches were removed during the time of the magnetic survey.
- The base readings were taken periodically to avoid drift.
- Repeated reading was taken to avoid random error.

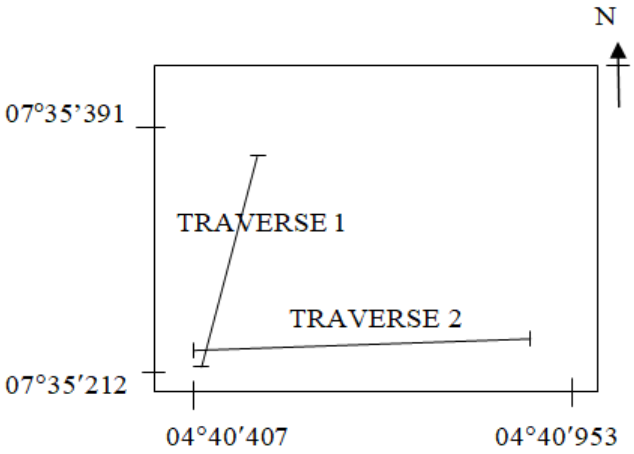


Figure 3.1: The layout of the Magnetic Traverse on the Gold Mining Site

3.2. Reduction of Magnetic Data

The reduction of magnetic data is necessary to remove all causes of magnetic variation from the data other than those arising from the magnetic effect of the subsurface structure. The magnetic survey method requires less correction when compared to the reduction of gravity data. One outcome that must be balanced is the change in intensity of the geomagnetic field at the earth's surface while taking readings during the day. Three major types of correction used in this study are diurnal; geomagnetic; and topography.

3.3. Modeling

In this study, magnetic modeling was done by using Oasis Montaj software. After, opening the software program and selecting the GMSYS.OMN icon on the screen the gm-sys icon shows at the top of the screen the tool bar. The map to be modeled was open, clicking the gm-sys. Magnetic grid was selected; cross hair appears which was used to pick any two points. The value for the earth's magnetic field is 32000nT. The inclination and declination for this study was gotten from the international geomagnetic reference field (IGRF) calculator on the internet. ClickingOK, the modeling window shows, which comprises of five compartment; plan view, magnetic anomaly, gravity window, depth window, and time window. The time and gravity window was close. The magnetic data was then computed using the plan view. The anomalies were

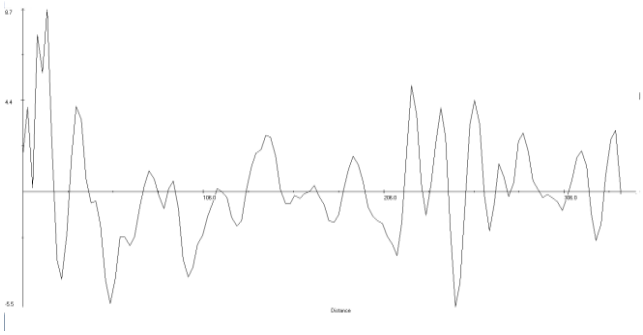
modeled using the fore knowledge of the geology of the study area and the depth to the basement was interactively modified to reduce the error and achieve the best fit. The sediments were assigned the susceptibility of zero in this modeling exercise.

IV. RESULTS AND DISCUSSION

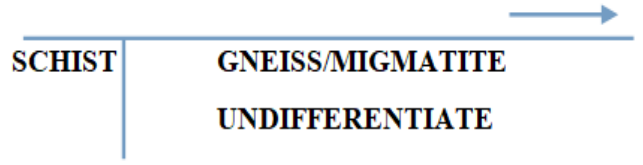
In this section, the result of the magnetic data obtained on the field along the three traverses were plotted using Signproc software, window version 1.6 design by Professor G.R.J Cooper [10] after the removal of the regional geomagnetic field which is of magnitude 32500nT and interpreted quantitatively using the peter half slope method. Oasis Montaj software was used for the modeling of the acquired field data.

4.1 Magnetic traverse 1

The magnetic profile for traverse one is revealed in Figure 4.1(A) and the corresponding geological section is revealed in Figure 4.1(B). The magnetic profile is about 350m long and cut across the North-Southern part of the gold mining site; it is characterized by magnetic highs and lows. It show an equal maxima and minima magnetic values of about ±0.1nT at stations 80m, 86m from the initial station position, and ±0.3nT at stations 312m, 318m, from the initial station position and ±0.4nT at stations 10m, 16m respectively, all of these occur in the gneiss/migmatite undifferentiated. In the delineation of the geological section two rock types was observed the Schist/Epidorite complex and the Gneiss/Migmatite undifferentiated. The Schist/Epidorite complex is observed to be at a station of about 10m from the base station, the Gneiss/Migmatite undifferentiated is at a distance between 10m to 306m, while the Schist/Epidiorite is observed at a distance of 310m to the final station on the geological section.

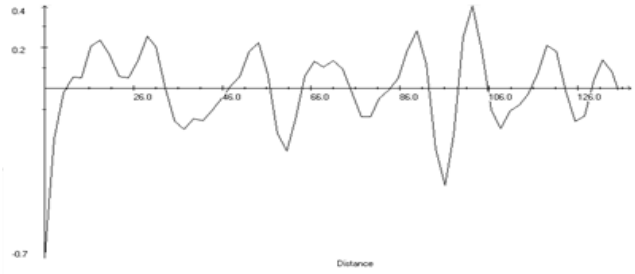


(A)

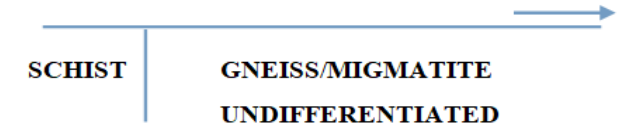


(B)

Figure 4.1(A) Showing the magnetic profile for traverse 1
(B) Showing the geologic section for traverse 1



(A)



(B)

Figure 4.2(A) Showing the magnetic profile for traverse 2
(B) Showing the geologic section for traverse 2.

4.2 Magnetic traverse 2

The magnetic profile for traverse two is revealed in Figure 4.2 (A) and the corresponding geological section is revealed in Figure 4.2 (B). The magnetic profile is about 270m long and cut across the mining site. The profile is characterized by magnetic highs and lows. It shows an equal maximal and minimal in magnetic values of ±0.2nT at stations 33m, 51m and 118m, 126m. Also a maximal and minimal magnetic anomaly value of about ±0.4nT at stations 96m, 100m respectively indicating gold deposit characteristics at those station positions.

These occur in the Gneiss/Migmatite undifferentiated rock. In the delineation of the geological section two rock types were observed namely Gneiss/Migmatite and Schist/Epidiorite complex. The Schist/Epidorite complex was observed to be at a station position of 10m and the Gneiss/Migmatite undifferentiated is observed at a station distance between 11m to 270m.

4.3 Magnetic Model for Traverse 1

Traverse 1 cut across the mining site and it has a length of about 350m, the magnetic model and the computed magnetic profile is revealed in Figure 4.3. It shows almost a perfect fit between the model structure and the computed magnetic profile. The profile was modeled as a six basement blocks. The contact between the rocks may be because of lithology or structural contacts. Movement along this contact may be responsible for the uplifted blocks and down faulted blocks giving rise to the undulation of the basement topography. From the model the sediment has a maximum depth of 153m at station 31m along the profile and minimum depth of 132m at station 62m along the profile. The bedrock is shallow at station 120m and gradually slopes down to a depth of 100m at station 190m and rises again to a depth of 10m at station 220m along the profile, there is an outcrop of the basement rock at a station 208m.The susceptibility of the basement rock is in the range of 0 to 0.007.

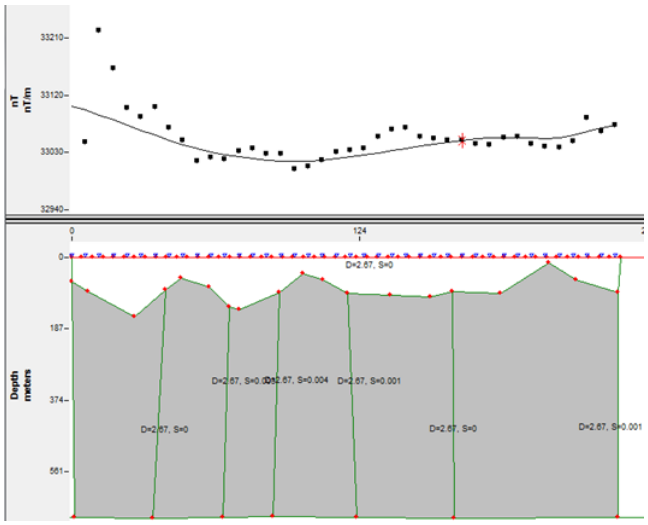


Figure 4.3: The model structure and the computed magnetic profile along traverse 1.

4.4 Magnetic Model for Traverse 2

Traverse two run across the mining site and has a length of 270m, the modeled structure and the computed magnetic profile is revealed in Figure 4.4. It shows a good fit between the computed magnetic profile and the modeled structure. The profile was modeled as a three basement blocks, the contact between the rock types may be because of lithology or structural contact. Movement along this contact may be responsible for the uplifted blocks and down faulted blocks giving rise to undulation of the basement topography. The rock types have a susceptibility ranging from about 0.003 to 0.009. From the model the sediment has a maximum depth of 93.5m to the basement at station 43m along the profile and a minimum depth of 78.3m at station 188m along the profile. The bedrock is shallow at stations between 60m and 66m and gradually slopes down to a depth of 52m at a station 98m along the profile. The pits that were dug by the illegal miners for gold mineralization range between these values.

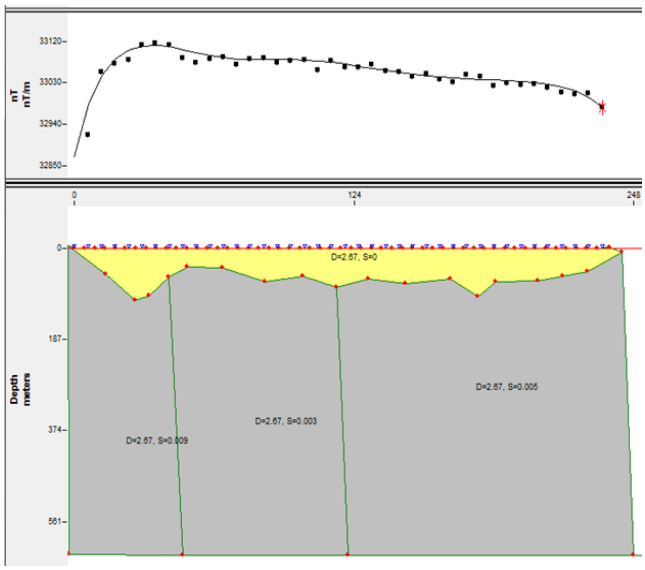


Figure 4.4: The model structure and the computed magnetic profile along traverse 2.

V. CONCLUSION AND FUTURE SCOPE

5.1. CONCLUSION

In this field work, proton precession magnetometer was used to obtain magnetic data, on a gold mining site at Ibodi, Ilesha. The data obtained on the field was analyzed both quantitatively and qualitatively using the signproc for window version 1.56 software designed by Professor G.R.J COOPER and Oasis montaj software respectively.

The profile of magnetic traverse 1 runs in the North-South direction and cut across the gold mining site, it is 350m long. From its geological section, two rock types, Schist/Epidorite and Gnesis/migmatite undifferentiated are observed. The magnetic profile attained for the magnetic anomaly along this traverse shows both maximum and minimum peaks. It shows an equal maximal and minimal magnetic anomaly values of ±0.2nT at stations 33m, 51m, and 118m, 126m. Also a maximal and minimal magnetic anomaly value of about ±0.4nT at station 96m, 100m respectively indicating gold deposit characteristics at those station positions.

The profile of the magnetic traverse 2 along the West-East direction cut across the gold mining site, it is 270m long. Two rock types are observed, these are Schist/Epidorite and Gnesis/migmatite undifferentiated. The profile is characterized by magnetic high and lows. The magnetic profile obtained for the magnetic anomaly along this traverse shows a the lowest negative peak magnetic anomaly of -0.4nT at a distance of 96m in the Gneiss/Migmatite geologic section and a maximum peak magnetic anomaly value of 0.4nT at a station distance 102m.

From the magnetic model of traverse 1, the sediment has a maximum pit depth of 93.5m to the basement at station 43m and a minimum pit depth of 78.3m at station 188m to the basement along the profile. The bedrock is shallow at station between 60m and 66m and gradually slopes down to a depth of 52m at a station 98m along the profile.

From the magnetic model of traverse 2, the sediment has a maximum pit depth of 153m at station 31m and minimum pit depth of 132m at station 62m along the profile. The bedrock is shallow at station 120m and gradually slopes down to a depth of 100m at station 190m and rises again to a depth of 10m at station 220malong the profile. There is an outcrop of the basement rock at station 196m.

Gold mineralization is possible in the folding of the schist/Epidorite complex. The gold mineral present in this area are mostly alluvial gold which are explored along stream course. The pits that were dug by the illegal gold miners range between these values.

5.2 FUTURE SCOPE

Magnetic measurements are more easily and cheaply deployed than the most geophysical methods and correction is practically unnecessary. Other methods would

have been more suitable for this project such as Polarization, Electrical Resistivity Method, and Electromagnetic Method.

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AUTHORS PROFILE

Mr A.B Ekundayo pursued Bachelor of Science in Physics, 2012, at Department of Physics, and Engineering Physics, Faculty of Science, Obafemi Awolowo University, Ile Ife, Osun- State, Nigeria and Master of Science in Physics, 2020, at the Department of Physics, Faculty of Science University of Lagos, Akoka, Lagos-State Nigeria. He is currently working as Head of Science Department at Sophem High School, Water Bus-Stop, Ipaja Lagos.

Mr A.O. Samuel pursued Bachelor of Science in Physics, 2012, at Department of Physics, and Engineering Physics, Faculty of Science, Obafemi Awolowo University, Ile Ife, Osun- State, Nigeria and Master of Science in Physics, 2020, at the Department of Physics, Faculty of Science University of Lagos, Akoka, Lagos-State Nigeria. He is currently working as a Teacher in Elias international School, Ile-Epo Bus Stop, Oke Odo, Lagos-State.

