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GROUND MAGNETIC SURVEY FOR THE INVESTIGATION OF MAGNETIC MINERALS AT IBORO VILLAGE, ABEOKUTA, SOUTH-WESTERN NIGERIA.

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ABSTRACT

The geological map of the old western region of Nigeria indicates the presence of iron ore deposit at Iboro village Ogun state (7.9983^o - 7.99933^o N, 3.5790^o - 3.5890^o E). Hence a ground magnetic survey was carried out at a location at Iboro village so as to delineate the subsurface magnetic anomalies and to know whether the anomalies favour accumulation of magnetic minerals. The survey was carried out using high resolution proton precession magnetometer model G-856X. Eight traverses were run at 5m separations and earth magnetic intensity values were measured at 10m intervals along each traverse; the acquired data were corrected for drift. The residual anomalies obtained by removal of regional gradient from observed data using trend analysis were presented as profiles and maps. The treated data were qualitatively and quantitatively interpreted and the results gave values for the total ground magnetic anomalies that varied between a minimum and maximum peak values of about -33.0 and 30.6nT respectively. Depth to the basement rock was estimated using Peter's half slope method which gave a maximum depth of about 13m. The contour maps and the total relative graphs present the subsurface picture of the geological structure that is assumed to harbour the metallic minerals through the action of the field towards the concentration of anomalies. It was suspected that the overburden was relatively thin in the study area and the minerals were at a shallow depth.

Keywords: Magnetic minerals, residual anomaly, Iboro village.

INTRODUCTION

Magnetic method involves the measurements of localised variations in the Earth's magnetic field intensity. It sets out to investigate subsurface geology on the basis of anomalies in the Earth's magnetic field resulting from magnetic properties of the underlying rocks (Philips, 1979). Anomalies in the earth's magnetic field are caused by the magnetism of naturally occurring materials and buried objects. Naturally occurring materials acquire their magnetism from the Earth's magnetic field, initially, at the time of their formation (remanent magnetism) and later due to secondary magnetization induced by the same field after its magnitude and direction has changed (induced magnetism). These phenomena cause the materials to act as magnet (Nettleton, 1976; Ross, 2002). The presence of this induced magnetism yields a local anomaly in the natural Earth's magnetic field. The field caused by such a material is directly proportional to the intensity of the ambient field and to the ability of the material to enhance the local field, a property called magnetic susceptibility. The induced magnetization is equal to the product of the volume magnetic susceptibility and the inducing field of the earth.

$$I = kF$$

Where k = volume magnetic susceptibility (unit less)

I = induced magnetization per unit volume

F = field intensity in telsa (T) (Reijers, 1996).

The shape, dimension, and amplitude of an induced magnetic anomaly is a function of the orientation, geometry, size, depth and magnetic susceptibility of the body as well as the earth's magnetic field strength in the survey area (Maritta, 2007). The magnetic method has a wide range of applications in geophysical study. It is used to locate abandoned steel well casings, buried tanks, pipes and metallic debris, also to investigate archaeological sites, map basement faults and basic igneous intrusive (Reynolds, 1997).

In magnetic prospecting we attempt to investigate subsurface geology on the basis of anomaly in the earth magnetic field resulting from magnetic properties of the underlying rocks (Philips, 1979). A magnetic high (positive) anomaly is where the measured field strength is higher than the computed value for the global model; low (negative) anomaly is where measured value is less than the computed value. Hence, the ground magnetic survey is used for detailed mapping in order to understand the subsurface geology of an area. The technique requires measurements of the amplitudes of **magnetic** components at discrete points along traverses distributed regularly throughout the survey area of interest.

The only minerals that normally cause observable magnetic effects in the context of magnetic surveys related to mineral deposits are: - magnetite, the most magnetic mineral, which generally does not have significance remanent; pyrrhotite, of which only the monoclinic form is magnetic and which frequently has remanent magnetisation an order of magnitude greater than its induced magnetisa tion-the susceptibility of pyrrhotite is approximately one-tenth the susceptibility of magnetite; hematite, which can exhibit weak magnetic responses due to induced magnetisation and which sometimes has strong remanence; - ilmenite/titanohematite, which can give weak but ob servable magnetic responses: - maghemite, a weathering product, which can have strong magnetic responses (Clark et al., 1997; Gunn and Dentith, 1997)

Exploration for iron ore based on its magnetic effects is one of the earliest use of geophysics in mineral exploration. According to Espersen (1967), magnetic surveys to locate iron ore were carried out in Sweden as early as the middle of the seventeenth century.

The magnetic signature of iron deposits fundamentally depends on whether the mineralisation is in the form of magnetite or hematite. The majority of the world's iron production comes from ores in banded iron formation (BIF). The interpretation of data collected from such areas is complicated by the magnitude of the anomalies (which may be significant relative to the geomagnetic field where significant magnetite is present), the presence of strong remanent magnetisation, demagnetisation, and the markedly

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anisotropic nature of the magnetic properties of the BIFs (Clark & Schmidt 1994; Obot et. al., 1981).

Some ground magnetic surveys carried out in Nigeria recently include ground magnetic survey of Ilesa East, Southwestern Nigeria (Kayode et al., 2010). In their work, the geomagnetic sections of the study area were used to delineate different rock contacts and geological boundaries that are very useful in mapping the basement structures of the area. Odunaike et al. (2009) also carried out ground magnetic survey of Ijebu-Imushin using proton precession magnetometer to delineate major subsurface structures that include Amphibolite, quartz and quartz, schist and oil sands deposit in the study area.

Geological setting of the study area:

The basement complex of South Western Nigeria lays to the west of the West African craton in the region of late Precambrian to early orogenesis. Runcorn (1956) has recognized six major groups of rocks as basement complex of Nigeria.

i. Migmatite-gneiss quartzite complex.
ii. Slightly migmatised to un-migmatised meta–sedimentary and meta-igneous rocks.
iii. Charnockitic gabbroic and dioritic rocks.
iv Older granites, which comprise rocks varying in composition from granodiorite to true granites and potassic syenite
v. Metamorphosed to un-metamorphosed calc-alkaline volcanic and hyperbyssal rocks.
vi. Un-metamorphosed dolerite dykes, basic dykes and syenite dykes e.t.c

Also, the study area (Iboro village) is located in Yewa north local government area of Ogun State, Southwestern Nigeria. The geological map of western Nigeria (1964) indicates the presence of iron compounds somewhere around Iboro village. (Fig. 1).

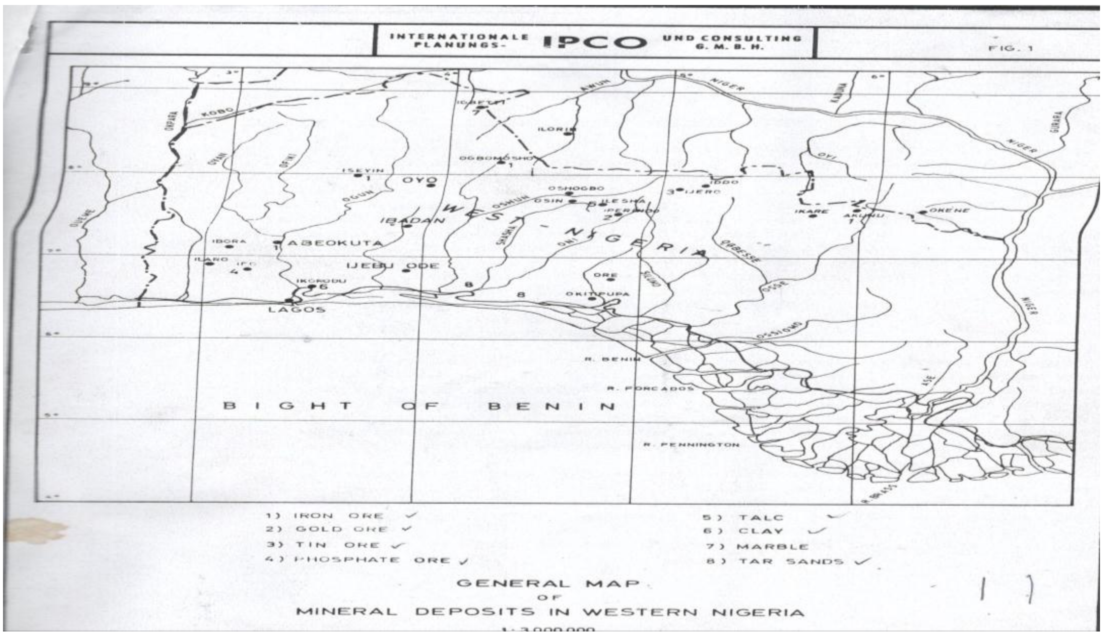

Figure 1. Geological map of old Western Region of Nigeria showing mineral deposits (IPCO, 1964)

METHODOLOGY

This study focused on the subsurface geological structures based on the qualitative and **quantitative interpretations of the ground magnetic data collected during a field work that was carried out Iboro village**. The magnetic survey was designed in such a way that deep insight into the depth to the magnetic sources in the area was delineated. The data acquisition technique **required m**easuring the magnetic intensities at discrete points along traverses regularly distributed within the area of interest so as to cover enough segment used to determine the structure and the history of the study area.

Data acquisition

The magnetic measurements were taken using a proton precession magnetometer. Observations were made along series of traverses at equal spacing of 10meters and the spacing between two adjacent traverse lines was 5meters. A location in the vicinity of the study area was chosen as the base station where measurements were taken at regular intervals for the whole duration of the survey.

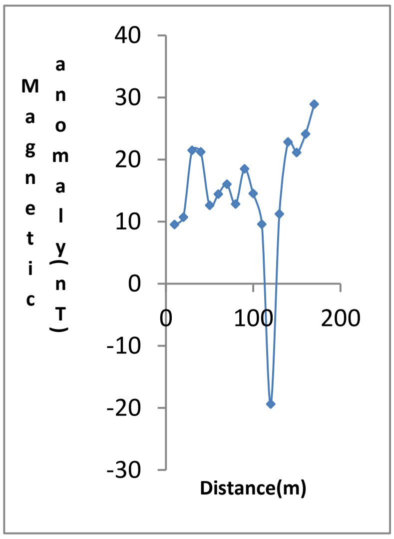

Figure 2: Corrected magnetic anomaly of traverse 1

Data processing

The field values obtained at the base station were used as the references for correcting the anomalies at points of measurements, taking into consideration the time of the day each measurement was taken. Magnetic profiles were plotted for each of the traverse line and the best fit was drawn to obtain the residual using Microsoft Excel 2010. The average value of the best fit plot was used to separate the **anomalies to obtain positive and** negative values. The positive and negative anomaly were plotted to obtain the contour maps and relative magnetic profiles. Peter's half slope method was used to estimate the depth to the source of the magnetic body responsible for the anomaly.

RESULTS AND DISCUSSION

The magnetic anomaly profiles, the 2-Dimensional and 3-Dimensional contour maps for sample traverses are presented in figures 2 to 11 below.

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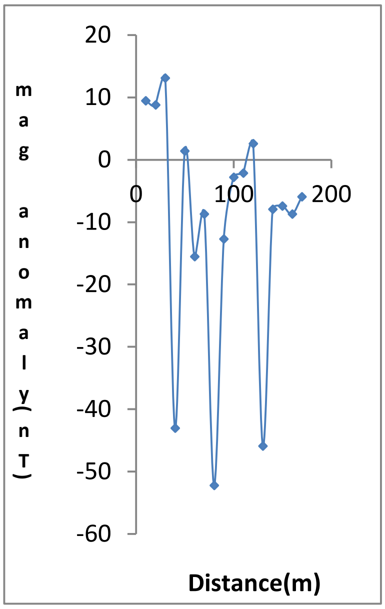

Figure 3: Corrected magnetic anomaly of traverse 2

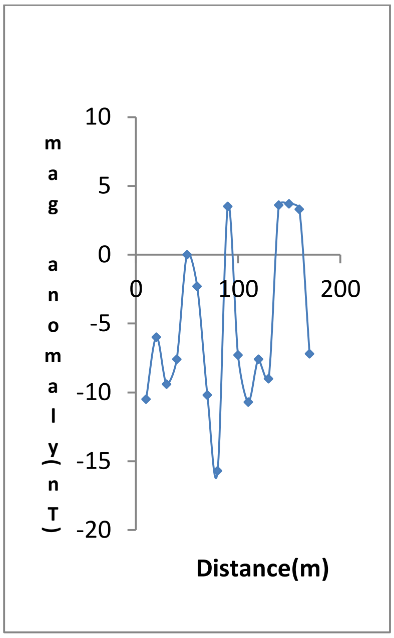

Figure 4: Corrected magnetic anomaly of traverse 3

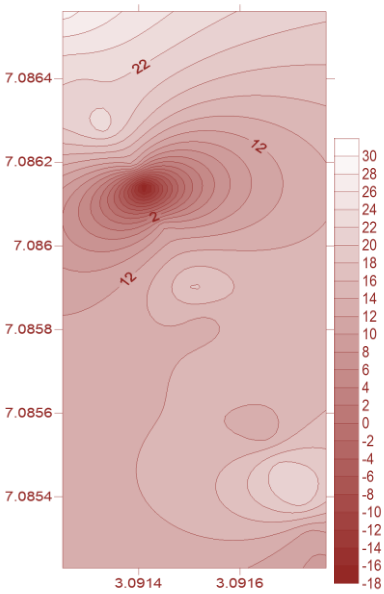

Figure 5: 2D Contour map of traverse 1

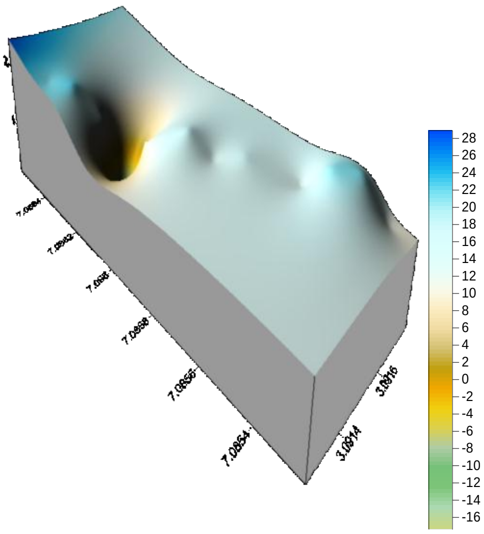

Figure 6: 3D Contour map of traverse 1

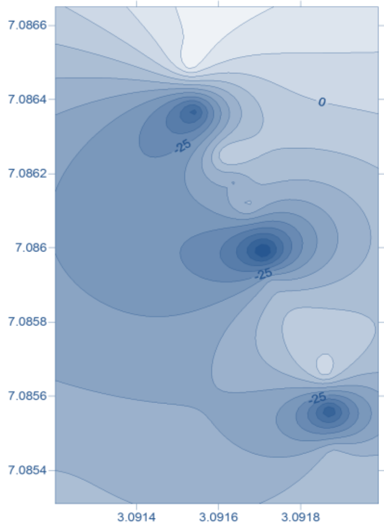

Figure 7:2D Contour map of traverse 2

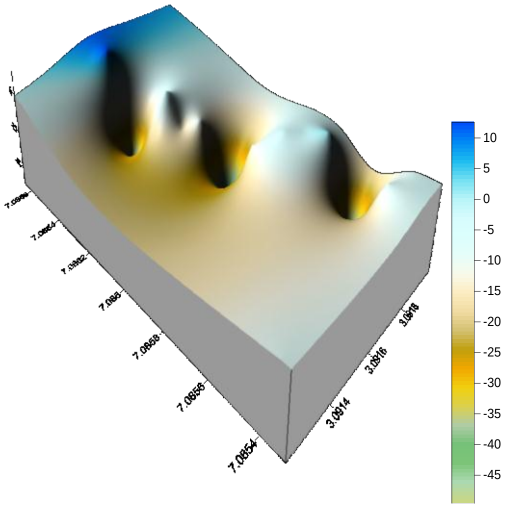

Figure 8:3D Contour map of traverse 2

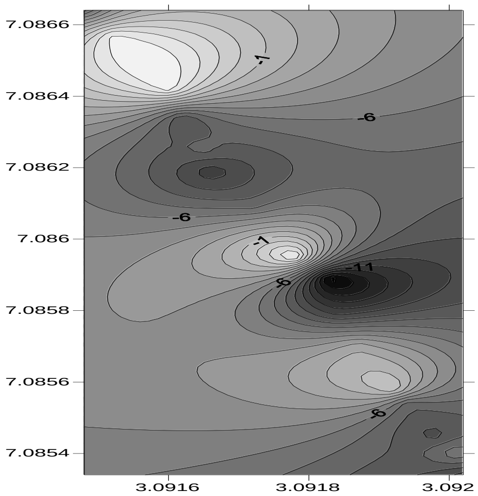

Figure 8:2D Contour map of traverse 3

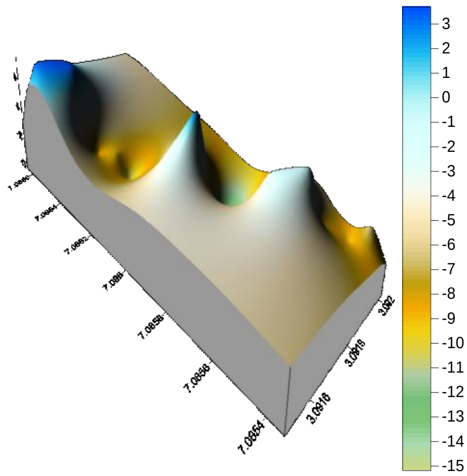

Figure 9:3D Contour map of traverse 3

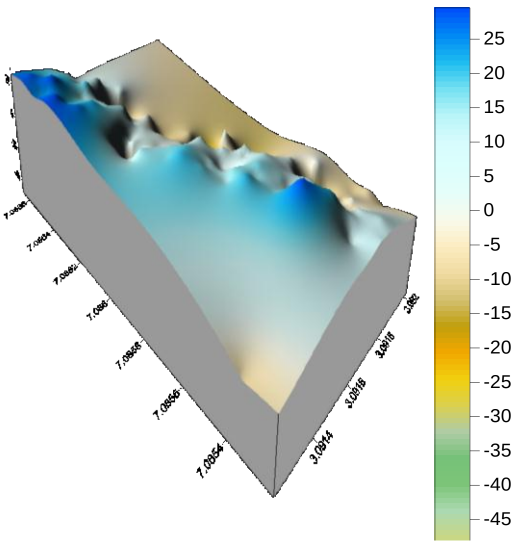

Figure 10:3D Contour map of the whole study area

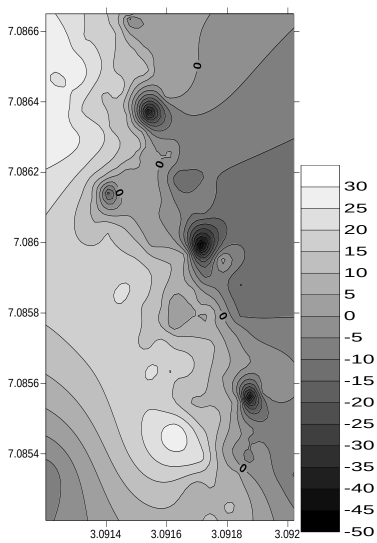

Figure 11:2D Contour map of the whole study area

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Table 1: Estimated Basement Depths

Profile line				
	1	2	3	4
1	6.25m	12.5m	-	-
2	6.25m	7.5m	12.5m	-
3	12.5m	11.25m	-	-
4	2.5m	1.88m	3.75m	5.0m
5	6.25m	12.5m	9.4m	-
6	18.75m	12.5m	13.75m	-
7	6.25m	6.25m	-	-
8	8.75m	3.75m	9.4m	-

The magnetic signatures obtained for total relative magnetic intensity plot along traverses exhibited positive and negative anomalies with notable peaks. For instance, traverse 1 had a positive peak of 22.8 nT at a distance of about 140 m and a minimum negative peak of -19.4 nT at a distance of 129m from the initial position **(Figure 2), traverse** 2 had peak values of 20.6 nT and -8.2 nT. The dense contour lines of field strength are indicative of subsurface materials of high susceptibility which is a feature of iron ore deposit since magnetization which determines field response is a function of susceptibility. This feature is equally depicted by the peaks and troughs of the 3-Dimensional maps. Application of Peter's half slope method revealed that the magnetic bodies in the study area were all located within shallow depth (Table 1).

CONCLUSION

The site located at Latitude 7.9983ºN - 7.99933ºN, Longitude 3.5790ºE - 3.5890ºE at Iboro village had been investigated using high resolution proton precession geometric magnetometer. It was deduced from our results that the site is most likely one the locations depicted as having iron ore deposit in the 1964 map of the old Western Nigeria. This is evident by the notable magnetic anomalies obtained from the analysed magnetic data. The magnetic ore bodies at the site are suspected to exist at shallow depth of about 3 to 13 m. This conclusion is based on an assumption that the site is not an old dumpsite in which steel wastes and other iron materials had been buried.

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