EARTH SCIENCES

DELINEATION OF MINERAL POTENTIAL ZONES OVER KEFFI – ABUJA AREA IN NORTH-CENTRAL, NIGERIA USING AEROMAGNETIC DATA.

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ABSTRACT
Aeromagnetic data over Keffi-Abuja,North-central Nigeria bounded by latitudes N08°50′, N10°00′ and longitudes E07°00′ and E08°00′ were obtained with the aim of delineating the mineral potentialzones and structural lineaments in the area. The data was subjected to series of processing to enhance the interpretation. First and second vertical derivatives filters were applied to the data to enhance shallow features. The result obtained revealed a NE-SW trend as the dominant trend of the structures of the shallow anomalies with a less dominant E-W and NW-SE trends and also the central to Western part around the Kagarko, Kafin and Abuja area are particularly promising for mineral prospecting.

Key words: *Aeromagnetic Data, Mineral potential Zones, Lineaments, Basement Complex*

INTRODUCTION

Aeromagnetic survey is a rapid and cost effective technique for locating both hidden ores and structures associated with mineral deposits. Roughly about 60% of magnetic surveys are carried out for regional geological mapping and mineral exploration purposes while the remainder being mainly for petroleum exploration (Sharma, 1987).

Mineral potential zones are areas with high concentration of minerals. These minerals are found in rocks. Most rocks are made up of aggregates of various minerals; however, some rocks are made up of entirely one mineral type. When these minerals occur in anomalous concentration within a rock, they become of interest to the exploration geophysicist.

Lineaments are mappable linear or curvilinear structures such as faults, joints, and folds of a surface whose parts align in straight or nearly straight relationships. These structures can be mapped on different scales, from regional (continental), local (outcrop) to microscopic (thin section), (Onyewuchi *et al.*, 2012).

The process of extracting these structures from an aeromagnetic map involves several enhancement techniques or manual interpretations with the scope of analysing the density, orientation and intersection for mineral exploration.

Several articles have been published on the Nigerian Basement Complex's structural and tectonic framework, based on analyzing aeromagnetic data, (Ajakaiye *et al.*, 1986; Olasehinde et al., 1990). Ajakaiye *et al.*, (1986) studied the Benue Trough's tectonic framework and parts of the adjoining Nigerian Basement Complex using aeromagnetic maps, delineating NE-SW and ENE-WSW directions as being the dominant aeromagnetic lineament trends. They stated that these aeromagnetic lineaments depicted a possible continental continuation of the four Atlantic fracture zones (St Paul's, Romanche, Chain and Charcot) abutting the West African coast into the Nigerian Basement Complex.

However, the present study is concerned with the delineation of mineral potential zones Over Keffi – Abuja Area in North-Central, Nigeria using aeromagnetic data. The study area is an elongated N-S trending block situated within the north central part of Nigeria. It covers an area of about110 km x 165 km. The objectives of the study include: identification of prominent structural lineaments and their trends in the study area through the application of first and second vertical derivative filters. Aeromagnetic (data) method was used for the study because it has the ability of mapping magnetic mineral deposit (such as iron ore) and in delineating structural lineaments.

The study area lies entirely within the Basement Complex of North-central Nigeria. It comprises rocks of the migmatite-gneiss and schist and generally intruded by the Pan African Older Granite rocks. The rocks of the study area have undergone various episodes of deformation and have ages ranging from Precambrian to Pan African. Fig. 1 shows the geology of the study area.

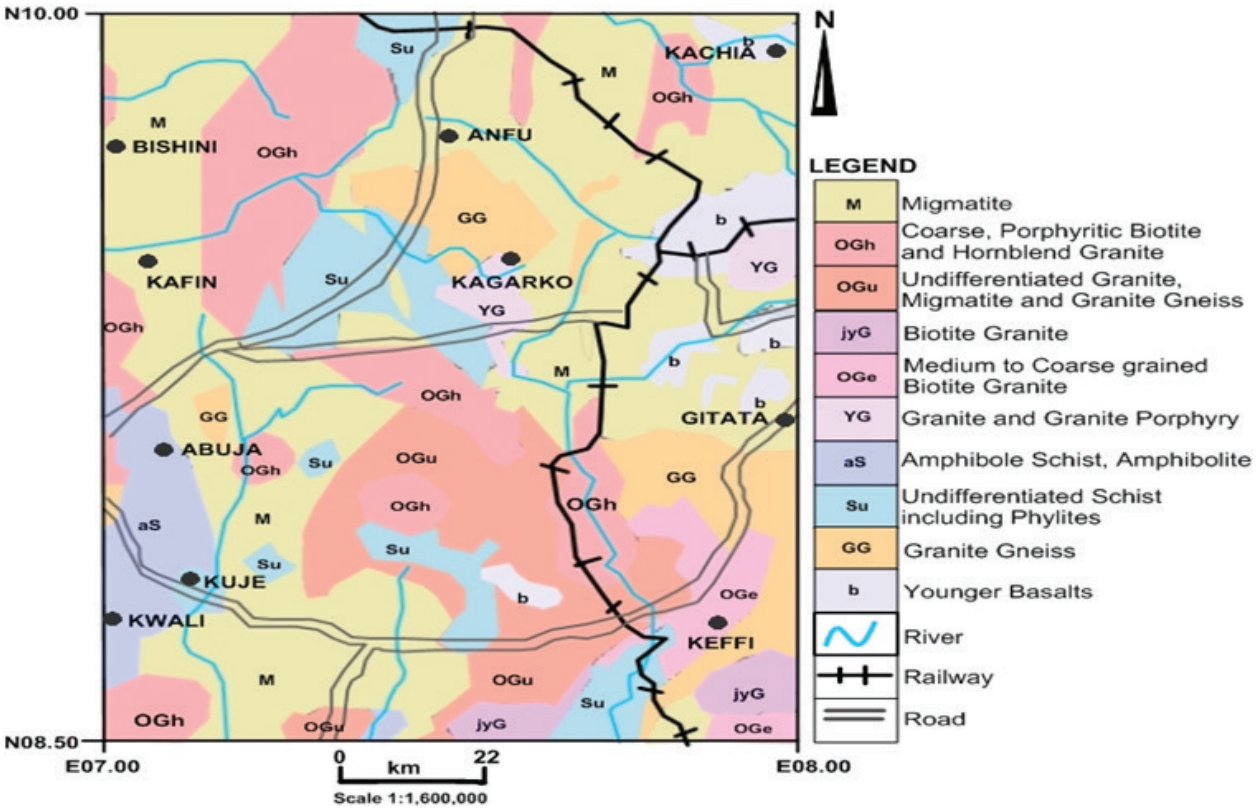

Fig.1: Geological Map of the Study Area, Modified from NGSA (2006)

MATERIALS AND METHODS

For the purpose of this study, aeromagnetic data comprising of six (6) maps sheet (Bishini-165, Kachia-166, Abuja-186, Gitata-187, Kuje-207 and Keffi-208) covering the study area within the north central part of Nigeria were used. The digitized data were obtained from the Nigeria Geological Survey Agency (NGSA). The data from the six (6) maps were then combined into a single data from which the composite Total Magnetic Intensity (TMI) contour map was produced.The TMI map was analysed qualitatively to interpret closures and trends of magnetic anomaly over the area.

Several other filters were applied to the magnetic data including derivatives (horizontal and vertical derivatives) in order to further interpret and delineate the mineral potential and structural boundaries in the study area.

RESULTS AND DISCUSSION

The Total Magnetic Intensity (TMI) contour map (Fig. 2) shows variations in magnetic intensity across the area in contours. The map has been contoured at 10 nT interval using Surfer version 10 software. High contour values indicate areas of high magnetic intensities while low contour values indicate low magnetic intensities. Where the contours become rounded or elliptical in shape, we have magnetic closures and these closures could be high or low and often indicate anomalies. Where a set of contours appear in parallel or near parallel orientation indicates a fracture or fault zone often referred to as discontinuity. This map has also been aided with colour aggregates. Here, the portions with brownish colourations show areas with high magnetic intensities while bluish colourations indicate low magnetic intensities.

The map reveals magnetic high values around Bishini and Kafin in the north-western portion and around Kuje, Keffi and Gitata in the south-eastern portion. Magnetic lows on the other hand dominate the areas around Abuja, Kagarko and Kachia to the central and north-eastern part. The variation in magnetic intensity across the area is an evidence of the polycyclic nature of the Nigerian Basement Complex, comprising rocks of different types with different magnetic intensities.

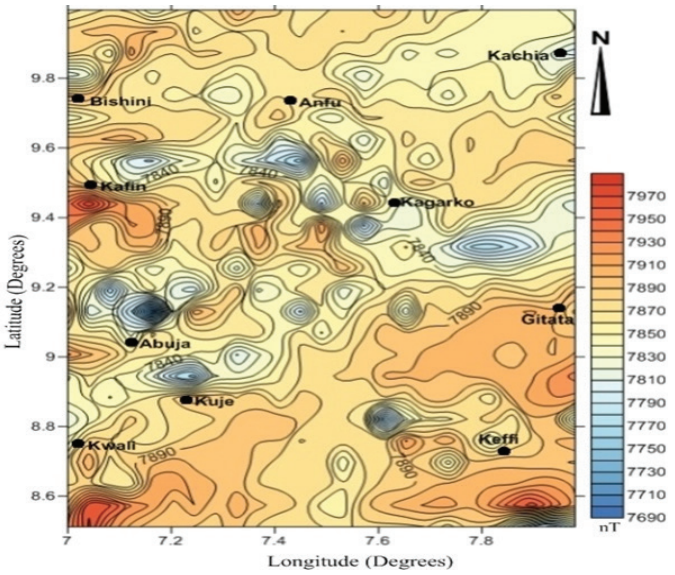

Fig.2: Total Magnetic Intensity Contour Map of the Area Contoured at 10 nT interval, after 25,000 nT have been Removed.

Magnetic Trends and Closures

Magnetic trend refers to the orientation of the magnetic structures such as closures and discontinuities or lineaments in the area. Observation of the TMI contour map (Fig. 2) reveals a dominant NE-SW trend, however, E-W trends are observed around Bishini and Kafin area in the NW portion and around Keffi in the SE portion. Also, NW-SW trend is observed around Kagarko in the central portion of the area. These trends of E-W NW-SE and NE-SW correspond with the lineament trends of the Basement Complex of Nigeria as reported by (Ajekaiye *et al.*, 1986) and (Olasheyinde *et al.*,1990).

Numerous magnetic closures dot the entire survey area. Both magnetic highs and lows closures were observed and are elliptical in shape. The magnetic high closures are marked H while the magnetic low closures are marked L (Fig. 3). The magnetic high closures dominate the area around Bishini and Kafin in the north-western part and around Kuje, Keffi and Gitata area in southern and south-eastern parts. On the other hand, the magnetic low closures dominate the central portion around Kagargo and the north-eastern portion around Kachia.

The magnetic low closure actually represents high magnetic anomalies intruding into the surrounding pre existing basement rocks. This is because at lower latitudes, due to the dipolar nature of the geomagnetic field, high magnetic anomalies appear as low magnetic anomalies.

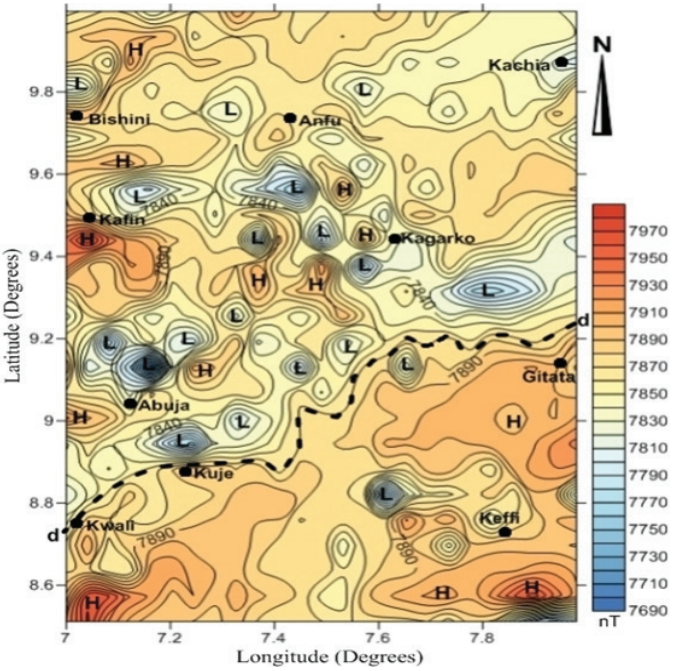

Fig. 3: Magnetic Closures and Discontinuity within the Study Area

H = Magnetic high, L = Magnetic low, dd = Discontinuity

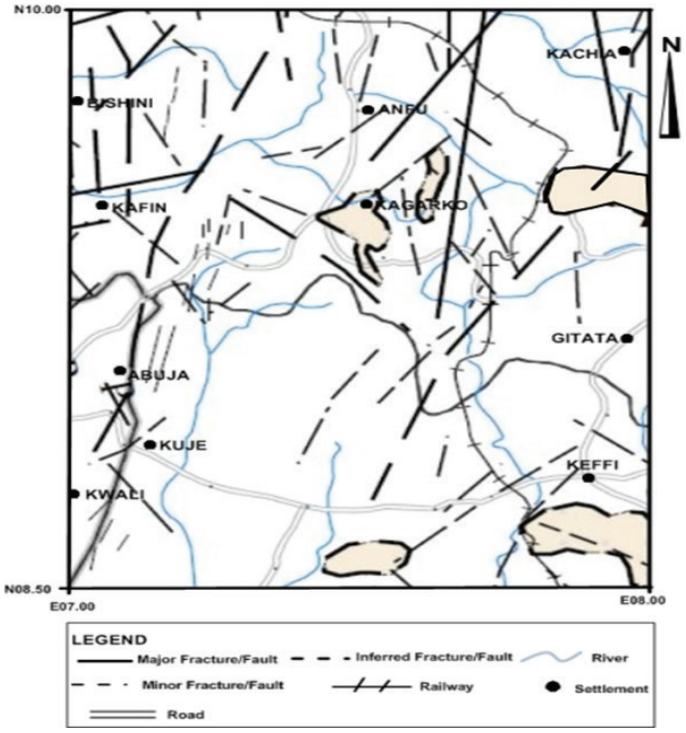

Fig. 5: Geological Lineament Map of the Study Area, NGSA (2006)

First Order Derivatives

The first order derivative enhances magnetic anomalies associated with faults and other structural discontinuities (Dobrin and Savit, 1988; Telford *et al*., 1990). It can be either vertical or horizontal. It was used to infer reasonably to the orientation of the lineament in the area. The lineament on first vertical derivative map produced showed a dominant NE-SW orientation and a less dominant E-W and NW-SE orientations. These lineament trends correspond with that of the geological lineament map of the area from NGSA in terms of orientation. (Fig. 5).

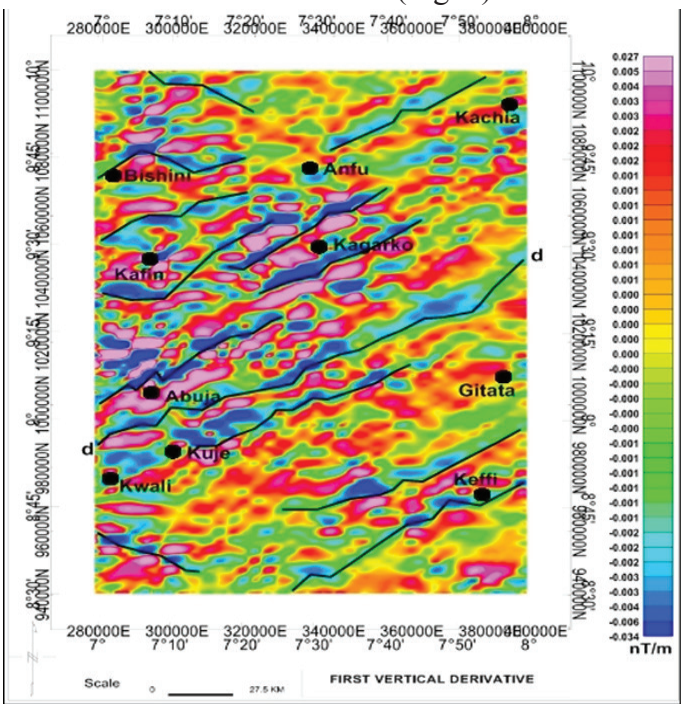

Fig. 4: Lineaments on First Vertical Derivative Map of the Area

Second Vertical Derivative (SVD)

Second vertical derivative filter was used to enhance subtle anomalies while reducing regional trends. This filter is considered most useful for defining the boundaries of anomalies and for amplifying fault trends. The SVD map (Fig. 6) reveals the boundaries of those shallow anomalies clearly. This made it possible to delineate the various mineral potential zones (A,B,C and D). The map shows that the central to western portions around the Kagarko, Kafin and Abuja are particularly promising for mineralisation. There are also smaller mineral potential zones to the NW around Bishini, SW around Kwali and Keffi in the SE region.

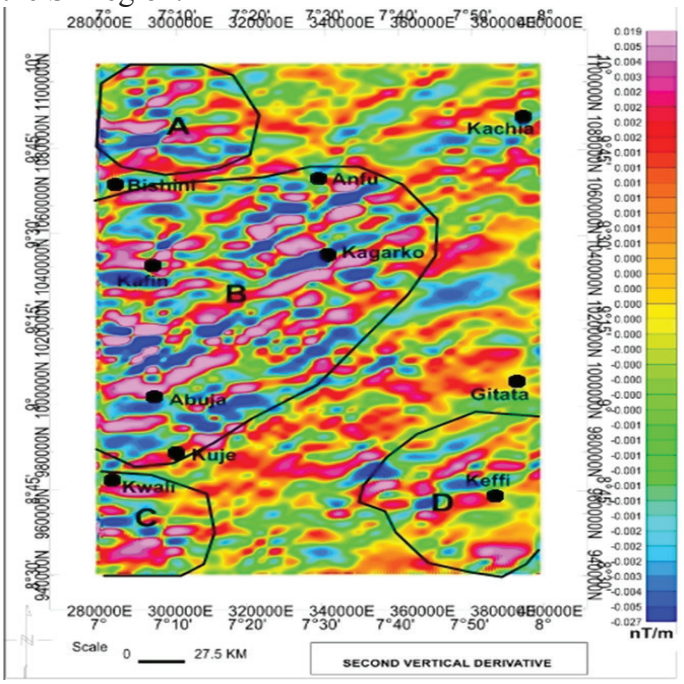

Fig. 6:Mineralisation Zones on Second Vertical Derivative Map of the Area

CONCLUSION

The interpretation of the aeromagnetic data over the Keffi-Abuja area using various filters indicates that the area has good potential for high magnetic mineral, possibly iron ore.

The TMI map produced show variation in magnetic intensity across the study area which is attributed to the occurrence of various rock types with different magnetic susceptibilities. The magnetic intensity values across the study area range from 7690 nT to 7990 nT (after 25,000 nT has been removed). High magnetic intensities dominate the southern to south-eastern region around Kuje, Keffi and Gitata while low magnetic intensities dominate the central to north-eastern portion around Kagarko and Kachia. The lineament map orientation showed a dominant NE-SW trend and a less dominant E-W and NW-SE trend within the study area.

The possible mineral potential zones observed have been isolated and labelled A-D on the Second Vertical Derivatives (SVD) map. These zones show good prospects for high magnetic mineralisation.

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