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Ground Magnetic Data Interpretation of Ijebu-Jesa Area, Southwestern Nigeria, Using Total Component

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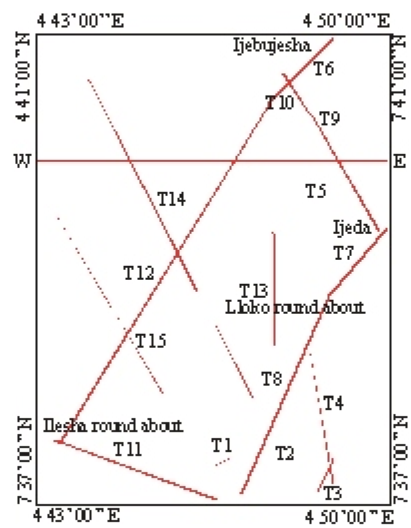
Abstract: The ground magnetic studies of Ijebu-jesa town in Oriade local government area of Osun State Southwestern Nigeria were carried out to study the subsurface geology of the area. The Total Component Magnetic Intensities data was interpreted. The qualitative interpretation of the ground magnetic data showed varying magnetic intensities over the different rock types in this area from the approximation of the geologic boundaries were delineated. Also the quantitative interpretation resulted in generation of geomagnetic section using linear trends gives magnetic intensity values that vary between about -250 nT to about 300 nT. Depth to the basement rock was estimated using slope techniques this allows the Lateral and Depth estimates of different rock types to be determined. Also basement structures such as bedrock topography; bedrock depression; rock boundaries, contact zone, fractures/faults were delineated which serve as deposits centers' for mineral resources. The trend analysis was used to produce a residual magnetic map which allows better mapping of Iwaraja fault as seen on Amphibolites schist.

Key words: Magnetic intensity, residual ground magnetic, geomagnetic sections, rock boundaries, Ijebu-jesa

INTRODUCTION

The study area is located in the northeastern part of the Ilesa schist belt southwestern Nigeria. The area is bounded by Latitudes 7º37′000″ N and 7º41′100″ N and Longitudes 4º43′500″ E and 4º50′700″ E. Fifteen traverses were established in the study area however, traverses 5, 6 and 10 cut across the area being reported in this research work. Traverse 5 starts from Iloko roundabout to Ijebu-jesa town, while traverse 6 starts from Esaoke road to Ilesa road and traverse 10 from Ijeda junction in Ijebu-jesa town to link Ilesa road all within Ijebu-Jesa town as presented in this write up Fig. 1 (Kayode, 2006; Kayode, 2009). Humid tropical climate is prevalent in the area, marked by the alternating wet and dry seasons. The temperature is moderately high during the day and also varies from season to season (Kayode, 2006). Two periods of high temperatures are recorded annually due to the passage of the sun on its way to and from the tropic of cancer. The first period occur in March-April and the second period in November - December. The average daily temperature varies between about 20ºC (for a very cold day) and about 35ºC (for a very hot day). The coolest period is in the middle of the raining season i.e., July - August (Kayode, 2006; Kayode, 2009).



Fig; 1: Base map of the study area showing geophysical layout

Previous study has shown that this area is underlain by Precambrian rocks typical of the basement Complex of Nigeria (Fig. 2) (Rahaman, 1976). The main rock types found in this area are amphibolites complex and schist occupies most part of the area with quartzite and quartz

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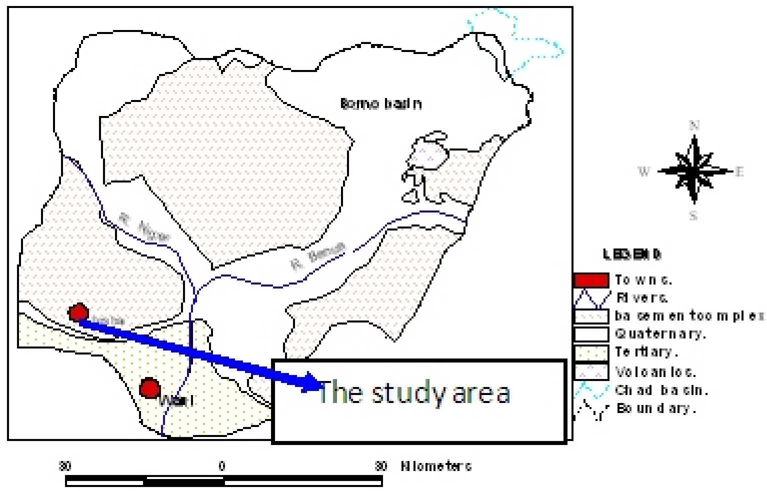

Fig. 2: Map of Nigeria showing the study area

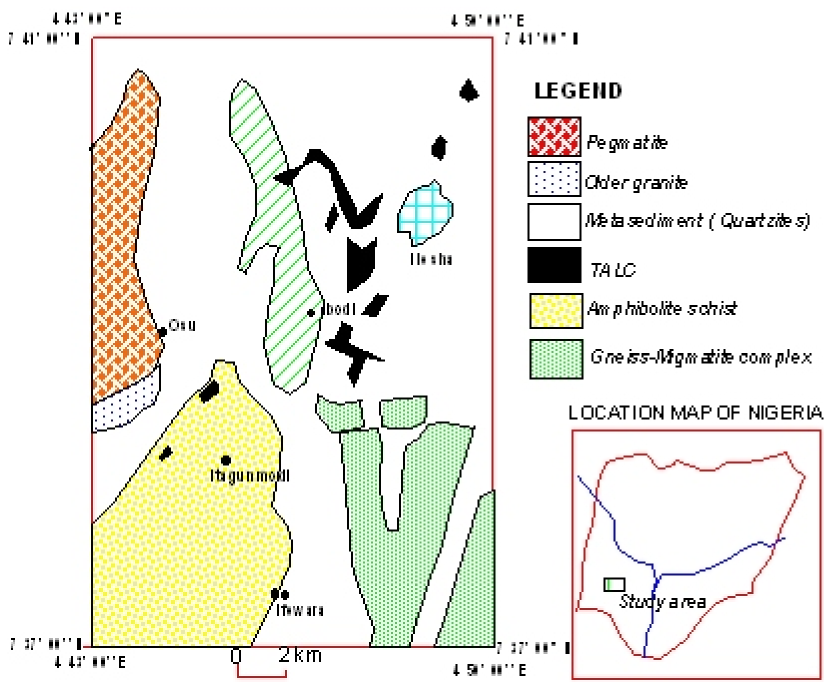

Fig. 3: Map of the schist belt of Ilesa area after Elueze (1986)

schist also form part of the rock units (Kayode, 2006; Ajayi and Ogedengbe, 2003; Folami, 1992; Ajayi, 1981; Elueze, 1986; Kayode, 2009). The topography is gentle with few local outcrops in the northeastern and northwestern part of the surveyed area (Rahaman, 1976).

Local geological setting: The rocks of the Ilesa district may be broadly grouped into gneiss-migmatite complex, mafic-ultramafic suite (or amphibolites complex), meta-sedimentary assemblages and intrusive suite of granitic rocks. A variety of minor rock types are also related to these units. The gneiss-migmatite complex comprises migmatitic and granitic, calcereous and granulitic rocks. The mafic-ultramafic suite is composed mainly of amphibolites and amphibole schist and minor meta-ultramafites, made up of anthophillite-tremolitechlorite and talc schist (Rahaman, 1976). The meta-sedimentary assemblages, chiefly meta-pelites and psammitic units are found as quartzites and quartz schist. The intrusive suite consists essentially of Pan African (c.600 Ma) Granitic units. The minor rocks include garnetquartz- chlorite bodies, biotite-garnet rock, syenitic bodies, and dolerites (Olusegun *et al.*, 1995; Folami, 1992; Rahaman, 1976).

Rocks in the Ilesa schist belt are structurally divided into two main segments as by two major fracture zones often called the Iwaraja faults in the eastern part and the Ifewara faults in the western part (Fig. 3) (Kayode, 2006; Kayode, 2009; Folami, 1992; Elueze, 1986). However, this study focuses on part of the former faults zone. The area north of the fault comprises mostly amphibolites, amphibole schist, meta-ultramafites, and meta-pelites. Extensive psammitic units with minor meta-pelite constitute the eastern segment (Rahaman, 1976). These are found as quartzites and quartz schist. All these assemblages are associated with migmatitic gneisses and are cut by a variety of granitic bodies (Olusegun *et al.*, 1995; Ajayi and Ogedengbe, 2003; Rahaman, 1976).

MATERIALS AND METHODS

The ground magnetic profiles were conducted on foot using Geometrics 856 Proton Precision Magnetometer and Garmin Global Positioning System (GPS) navigational Equipment for real-time measurements (Kayode, 2006). A base station was carefully selected and established near the study area where the magnetometer was been continuously returned to correct for diurnal variations of earth magnetic field and other sources of external interferences (Kayode, 2006). Though the data was collected during the dry season, some "noise" was observed in some points due to high tension cables and other metallic objects. However, the magnetic signal due to the geologic formations was stronger than the cultural noise hence it was easy to separate (Kayode, 2006, 2009).

Qualitative interpretation relies on the spatial patterns, which can be recognized by the geoscientists. The total component magnetic anomalies are highly variable in shape and amplitude. However, faults, lineaments, dykes, and folds are usually easily identified than features given by some number of sources, which can produce an anomaly that may result in complexities in the interpretations (Folami, 1992; Ross, 2002; Cui *et al.*, 2003; Green, 2004). A plot of the field data corrected for diurnal variations relative to the base station against distance along each profile is as shown in

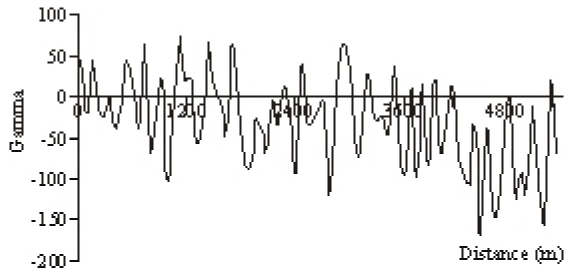

Fig. 4a: Total relative magnetic intensity along traverse 5(S-N) of the study area

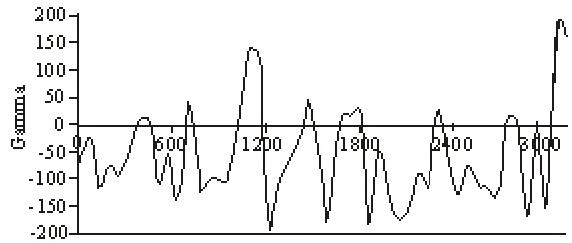

Fig. 4b: Total relative magnetic intensity along traverse 6(E-W) of the study area

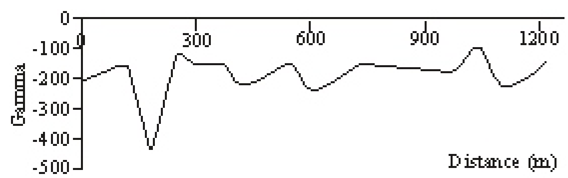

Fig. 4c: Total relative magnetic intensity along traverse 10(SE-NW) of the study area

Table 1: Depth estimate of total component relative magnetic intensity

Profile	Anomaly number	
	1	2
5	41 m	142 m
6	112 m	213 m
10	52 m	61 m

Fig. 4a-c. The plots show a magnetic anomaly signature, which varies over the different rock types. The differences in the magnetic properties present in each rock unit results in the contrast between the magnetic anomalies signatures.

However, rock contacts, intrusions and the effect of fissures also contribute to the magnetic anomaly (Kayode, 2006; Reijers, 1996; Folami and Ojo, 1991).

Depth to basement calculations: The depth estimation of the basement in the area and identification of the rock boundaries was carried out using half slope method for depth estimate (Peters, 1949). Table 1 shows the depth

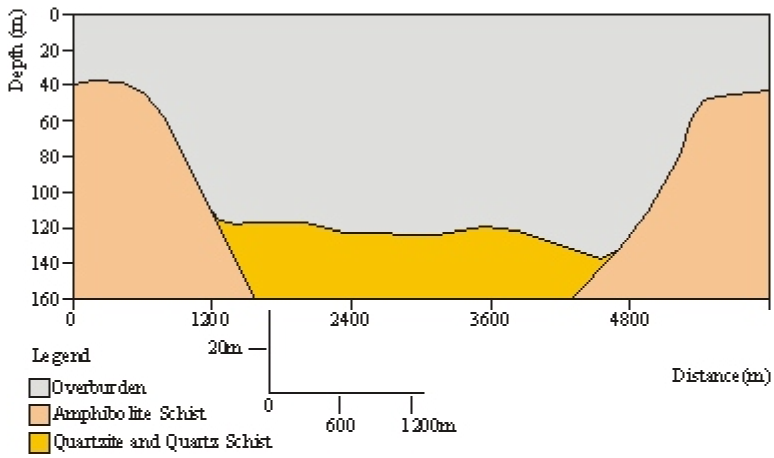

Fig. 5a: Geomagnetic section along traverse 5(S-N) of the study area

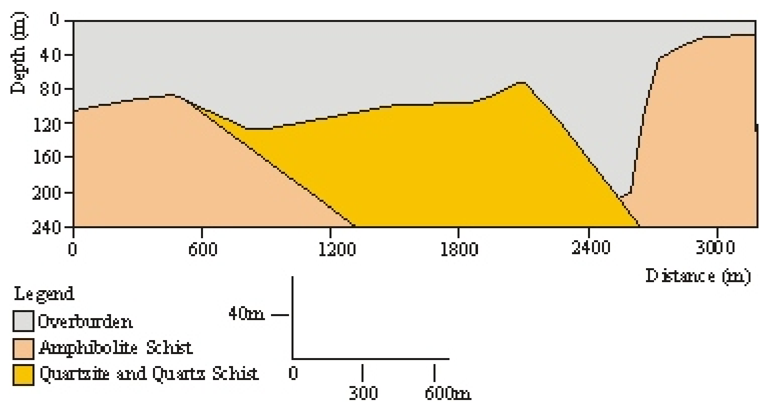

Fig. 5b: Geomagnetic section along traverse 6(E-W) of the study area

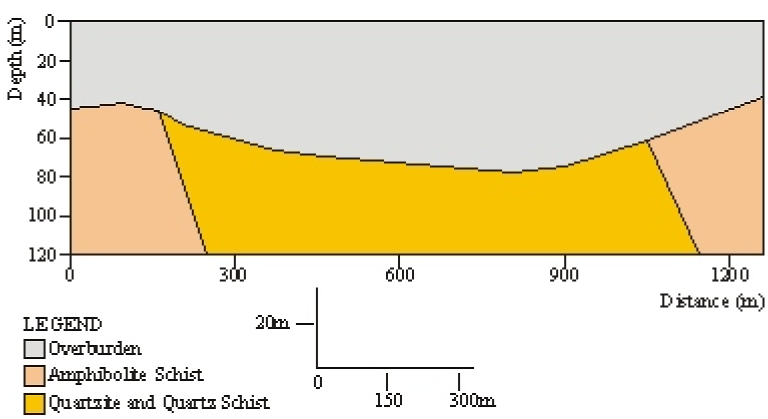

Fig. 5c: Geomagnetic section along traverse 10(SE-NW) of the study area

estimate from the ground magnetic data. The location of inflection points which is an indicative of rock contacts couple with the pre-knowledge of the geology of the study area during the fieldwork, enables the geomagnetic sections of the area to be drawn Fig. 5a-c.

RESULTS AND DISCUSSION

Traverse 5 (S-N): The magnetic signature obtained for the total component relative magnetic intensity plot along this traverse shows considerable varying amplitude from a minimum negative peak value of about -160 gammas at a distance of about 4000 m from the initial station position and a maximum positive peak value of about 60 gammas at a distance of about 1200 m Fig. 4a. Two rock units were delineated from the corresponding geomagnetic section shown in Fig. 5a.

Quartzite and Quartz schist: The first rock type delineated at the earlier and later part of this profile based on the geological information is called quartzite and quartz schist. The rock unit covers about 1300 m from the initial station position and from about 4000 m to the end of the profile. The depth to the magnetic basement for this rock unit varies between about 50 m at the end of the profile and about 38 m at the initial station position.

Amphibolites complex: This rock unit covers larger part of the central portion of the profile. Amphibolites schist was delineated between about 1300 m from the starting point and extended beyond 4000 m along the profile. The depth to the magnetic basement varies between about 115 m to about 135 m.

Traverse 6 (E-W): The magnetic signature obtained for the total component relative magnetic intensity plot along this profile shows a considerable varying amplitude from a minimum peak value of about -180 gammas at a distance of about 1200 m from the initial station position and a maximum positive value of about 180 gammas at a distance of about 3200 m see Fig. 4b. Two rock units were delineated from the corresponding geomagnetic section shown in Fig. 5b.

Quartzite and quartz schist: This rock type covers the earlier and later segment of the profile. The first segment extended from the initial station position to about 1300 m while the second segment starts from about 2500 m to the end of the profile. The depth to the magnetic basement varies between about 90 and 100 m at the first part and between 40 and 80 m towards the end of the profile.

The amphibolites complex: Amphibolites schist covers the central segment of this traverse, which extended from about 1300 m to about 2500 m with depth to the magnetic basement which varies between about 80 m and about 200 m.

Traverse 10 (SE - NW): The magnetic signature obtained for the total component relative magnetic intensity plot along this traverse is very similar to those obtained in previous profiles except for the depth of probing which differs. The profile shows complete varying negative amplitude from a very low peak value of about -430 gammas at a distance of about 240 m from the initial station position and a maximum peak value of about -100 gammas at a distance of about 1000 m Fig. 4c. Two rock units were delineated from the corresponding geomagnetic section as shown in Fig. 5c.

Quartzite and quartz schist: occupies the first and last segment of the profile covering about 240 m from the starting point for the first segment and about 1100 m to the end of the profile for the last segment with depth to the magnetic basement that varies between 35 m to about 45 m in the first and last segment respectively.

The amphibolites schist: This rock type occupies about 90% of the profile and covers about 240 m to about 1000 m at the central part of the profile with depth to the magnetic basement that varies between 40 m to a maximum of about 60 m.

Linear trend analysis: The linear trend analysis for total component of the magnetic intensity was obtained using Eq. (1) to (3) from Microsoft Excel package for the interpretations of the three traverses (i.e., traverse 5, 6 and 10) in the study area.

$$y = -1.1121x + 13.605 \quad (1)$$

$$y = -1.0428x - 54.422 \quad (2)$$

$$y = 3.7501x - 229.05 \quad (3)$$

$$\Delta r \text{ (residual)} = \Delta T \text{ (corrected field data)} - \Delta R \text{ (regional)} \quad (4)$$

These Equations (i.e., Eq. 1-3), were used to obtain the regional ΔR values for the total component of the magnetic intensity where x is the station position. The residual Δr values were obtained using Eq. (4) by subtracting the regional ΔR values from the corrected field data ΔT. The results obtained were used to construct the residual ground magnetic map of the area.

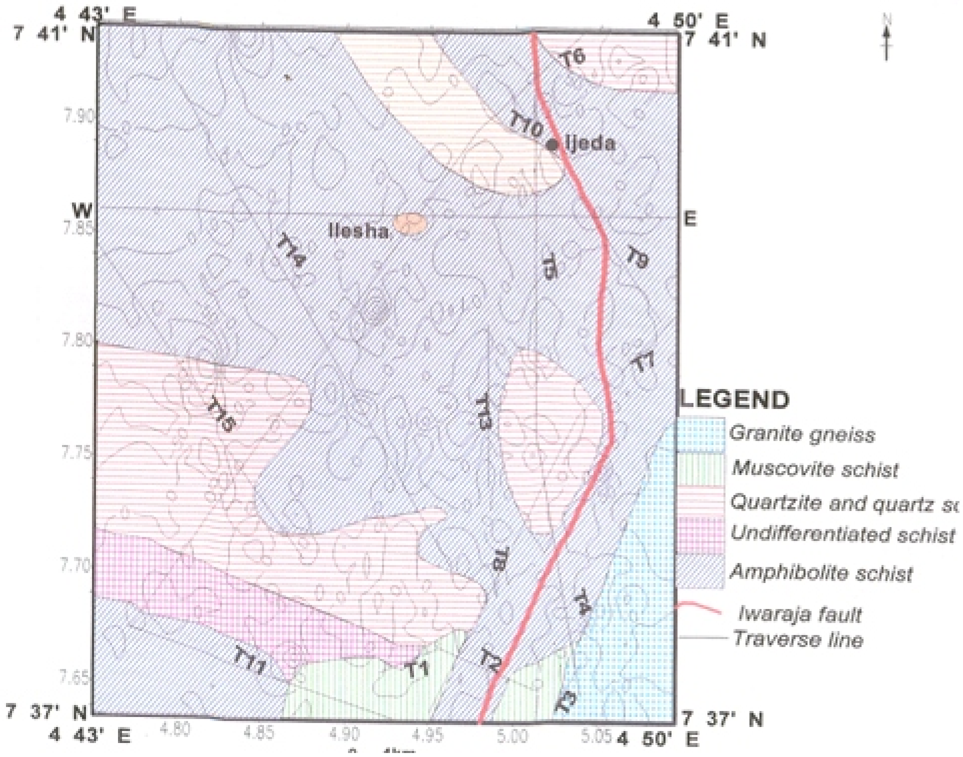

Fig. 6: Residual magnetic map of the study area using linear trend for total component

Total component residual ground magnetic map: The residual ground magnetic map of the study area using linear trend analysis for total component is as shown in Fig. 6. The area was divided into two regions: Positive magnetic anomaly region with highest value of about ($\Delta T \leq 0 \leq 300nT$) was recorded in the central portion of the study area. The negative anomaly region with the lowest value of about ($\Delta T \geq 0 \geq -250nT$) was recorded around the western part. The map further reveals the major and minor rock contacts in the area. The highest magnetic value of about 300 n T recorded in the central part further confirms the earlier submissions (Kayode, 2006, 2009). This is an indicative of shallow subsurface geologic structure. The different rock types were indicated by the colours. The northeastern part through the eastern area towards the southern part of the area supports the previous reports on the existence of faults in this zone.

CONCLUSION

The ground magnetic study of this area has helped in the delineation of the geologic structures such as bedrock topography; bedrock depression; rock boundaries, contact zone and fractures/faults which serve as deposits centers' for mineral resources. Secondly, the trend analysis was used to produce a residual magnetic map which allows better mapping of Iwaraja fault as seen on meta sedimentary rock which comprises of Amphibolites, Quartz and Quartz Schist. Lastly, the depth to the magnetic basement in each rock unit was obtained using slope method gives the overburden thickness that varies between about 40 m to about 200 m these values might have been exaggerated as a result of the method used. The linear nature of the anomalies in this part of the schist belt support the report that these rocks are bounded and offset by fractures/faults which serve as deposits centers' for mineral resources. These results presented from this research are very useful for the ministry of solid minerals to assist in the future mineral exploration.

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