



Application of Geophysics and Geology as Complimentary Veritable Tools to Investigate the Subsurface Lithological Content and its Mineralization Potential

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Abstract Both geological and geophysical campaign was carried out in Ado-Awaiye and its environs part of Iseyin in Oyo State, southwestern Nigeria. The work was focused on the geological mapping, study of the different rock units and geomagnetic investigation of the subsurface in order to determine the structural elements and mineral resources of the area. Information such as strike, dip alongside with total magnetic intensity etc acquired on the field were used to establish field relations and geological boundaries which aided in the deduction of origin and evolution of the different rock units and the geological history of the area. Field traversing, rock sample collections and petrographic investigations revealed migmatite-gneiss and hornblende granite-gneiss with some associated minor rock units such as amphibolite and pegmatite characterized by minerals: biotite, muscovite, k-feldspar, Plagioclase feldspar, quartz, hornblende and microcline. The rocks are also characterized by structures such as pygmatic folds, joints, fault, foliation, mineral lineation, veins and also bears the imprints of Pan African orogeny.

Magnetic traverses were also designed to deduce the character of buried subsurface rock and the depth to their top aimed at revealing the subsurface basement lithology and its mineralization. Total magnetic field intensity ranging from 30446.47nT to 33536.10nT (nanotesla) characterized the area. Regional-residual separation and half - width methods were applied and results presented as magnetic map and profiles. Qualitative and quantitative interpretations were made based on the maps and profiles. Differences in the magnetic data reveals variation in the lithological and mineralogical content of the basement with the higher value corresponding probably to the amphibolite (basic) component and the lower value corresponding to the granitic or gneissic component of the migmatite-gneiss being higher at the west and lower at the east with basement depth ranging from 2.5m to 15.5m with few basement lineament, suprabasement and intrabasement block.

Keywords Geological mapping, Total magnetic intensity, Magnetic basement, Pygmatic fold, Suprabasement, Intrabasement.

Introduction

The Study area Ado-Awaiye and its environs is part of Iseyin Local Government Area of Oyo State and falls within Latitudes 07°48'00"N and 07°54'00"N and on the Longitudes 003°18'00"E and 003°30'00"E with an approximate area of about 220sq Km. It falls within the Basement Complex of Southwestern Nigeria which are characterized by rocks of mainly Precambrian age. Several authors had written on the general geology of this region with no specific account on the geology of this studied area and hence the justification for the present detailed work aimed at reviewing the past work in order to shed more light on recent geological occurrences as they unfold over time in the area.

Basement Complex of southwestern Nigeria

The generalized geology of Nigeria and the Basement Complex of south-western Nigeria is shown in figure 1. Field evidences and radiometric dating have shown that the Nigerian basement complex bears the imprints of the major orogenies in the earth history dating back to 3000 Ma and it undergone its most pervasive deformation and remobilization during the Pan African (< 600 Ma) [1].



The basement complex is believed to be polycyclic (where rocks are found in the same environment with different age and mode of occurrence) and has responded totally to tectonic episodes with differing relics from Achaean to Late Proterozoic (Pan African).

The review of basement geology of southwestern Nigeria was carried out by [2] and the result shows that there are five major rock groups which have been recognized. These include:

- Migmatite-Gneiss Complex which comprises of biotite-hornblende gneiss, quartzite and quartz schist and lenses of calc-silicate rocks.
- Slightly migmatized paragneisses and metaigneous rocks, which consist of pelitic schist, quartzite talcose rock, metaconglomerate and calc-silicate rocks. The belts are among the best-studied groups of rocks in Nigeria [3], because of the associated mineralization of gold, banded iron formation (BIF), marble, manganese, talc, anthophyllitic asbestos etc.
- Charnockitic rocks.
- Older Granite, which comprises of rocks varying in composition from granodiorite to granite and potassicsyenite.
- Unmetamorphosed dolerite dykes believed to be the youngest.

The Migmatite-Gneiss Complex was also described by [4] as the most widespread rock unit in the basement complex of Nigeria and further stated that it is a heterogeneous assemblage including migmatites, orthogneisses, paragneisses and a series of basic and ultrabasic metamorphosed rocks. Petrographic evidence indicates that the Pan African reworking has led to recrystallization of many of its constituent minerals by partial melting, with most displaying medium to upper amphibolite facies metamorphism.

The term "Older Granites" was introduced by [5] who on the basis of morphology and texture distinguished the Pan-African granitoids from the Carboniferous-Cretaceous high level anorogenic volcanic, hypabyssal, peralkaline, "Younger Granites" of the Jos Plateau Region. The granitoids include biotite and biotite-muscovite granites, syenites, charnockites, diorites, monzonites, serpentinites, anorthosites etc. In many places, the coarse-grained biotite-hornblende granites have concordant foliation with the host schists.

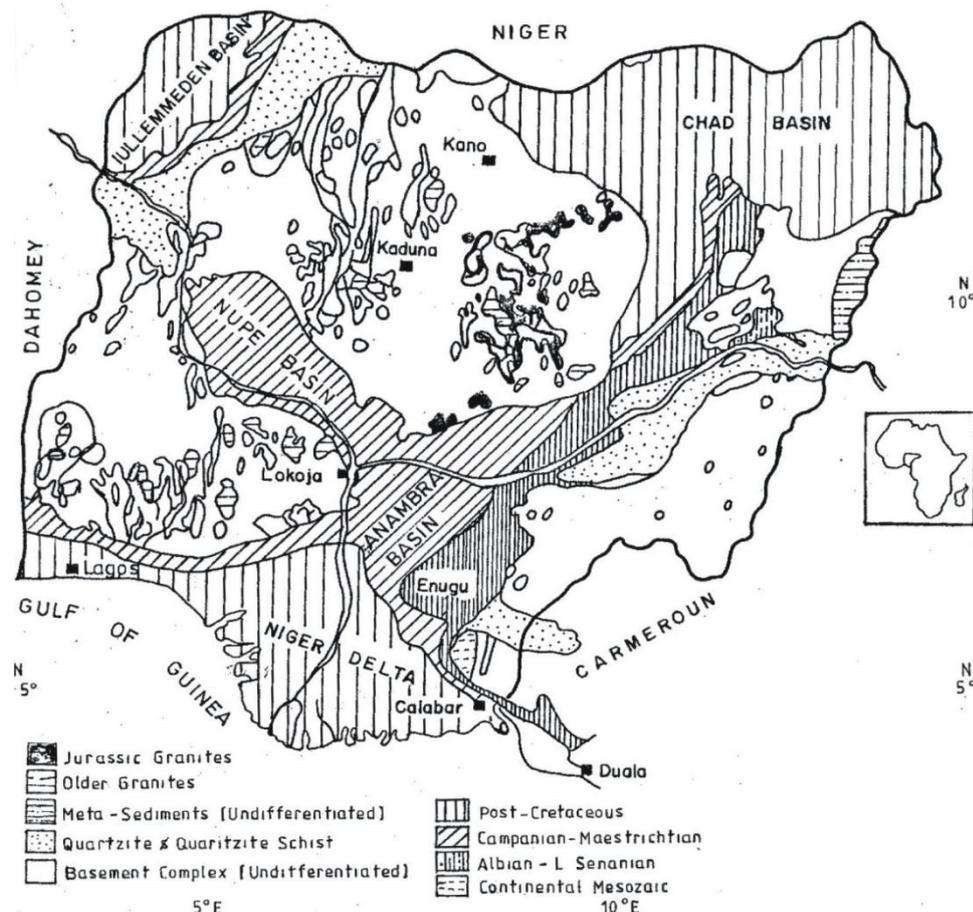


Figure 1: Generalised geological map of Nigeria [6]



The aeromagnetic survey has been applied in mapping the magnetic anomalies in the earth's magnetic field and correlated with the underground geological structure [7]. The main purpose of the magnetic survey is to detect minerals or rocks that have unusual magnetic properties which reveal themselves by causing anomalies in the intensity of the earth's magnetic field [8]. There would always be a magnetic susceptibility contrast across a fracture zone due to oxidation of magnetite to hematite and/or infilling of fracture planes by dyke-like bodies whose magnetic susceptibilities are different from those of their host rocks [9]. Such geological features may appear as thin elliptical closures or nosings on magnetic map. Faults usually show up by abrupt changes or close spacing in orientation of the contours as revealed by the magnetic anomalies. Modern high-resolution magnetometers are able to collect data with an accuracy of 0.001nT [10]. Removal of the regional from total field anomaly result into residual anomaly compose of positive and negative magnetic anomalies. A positive magnetic anomaly is a reading of magnetic field strength that is higher than the regional average which can indicate hidden ore and geologic structures, while a negative magnetic anomaly is a reading of magnetic field strength that is lower than the regional average [11]. Basement rock is much more magnetic than the sedimentary rock [12] and in the geophysical literature there are number of tables of magnetic susceptibility of rocks ([13-16]). Again, among the basement rock, basic igneous rocks are usually more magnetic due to their relatively high magnetite and mafic content. All rocks contain some magnetite from very small fractions of a percent up to several percent, and even several tens of percent in the case of magnetic iron ore deposits.

Materials and Methods

The topographic map used was on a scale of 1: 25000 but reduced by eight (8) to scale of 1:200000 during digitization in order to be contained on a page.

The field work was carried out with the use of topographic map, Global Positioning System (GPS), compass clinometer, geological hammer, field notebook, and G856AX MagTM proton-precision magnetometer. The mapping was carried out systematically through traversing while the magnetic profile lines were designed with Station interval of 10m and inter-profile interval of 10m and hence a grid coverage of 10m by 10m was maintained throughout the magnetic survey. Each station was occupied and the total magnetic field intensity in nanotesla was taken and recorded manually and it was subjected to computer processing. Magnetic maps were produced and profiles drawn. Line of best fit representing the regional field was superimposed on each of the profile in order to obtain the residual fields. After necessary data processing, the result was presented in form of magnetic map and profiles.

During the mapping exercise strike and dip value were also measured and helped to determine the geological boundary. Laboratory work includes thin section preparation and observations under a petrological microscope for mineral identifications and microstructures study.

Results and Discussions

Observed Lithology, Field Relationship and Petrographic Study

The mapped area, a metamorphic terrain characterized by defined and clear orientation consists of two main rock types of slightly contrasting characteristics. They include migmatite-gneiss and hornblende granite-gneiss with some minor rock occurrences of amphibolite schist, pegmatitic intrusions, and quartz of eldspathic veins which occur mostly as near linear intrusions. Some of the rocks exhibit jointing and show strong mineral lineation and foliation. The megascopic minerals observed on these outcrops include feldspar, quartz and biotite. From the field relation, the migmatite-gneiss appears to be the oldest rock unit.

Petrographic analysis on thin sections prepared from different rock samples observed under petrographic microscope were carried out and identification of minerals were accomplished using their diagnostics optical characteristics. The following alphabet(s) were used to represent each mineral on the photomicrograph: **H** = Hornblende, **B** = Biotite, **P** = Plagioclase, **Or** = Orthoclase, **Q** = Quartz, **A** = Augite, and **O** = Opaque Mineral.

Migmatite-Gneiss

About 60% of the outcrops in the study area is migmatite – gneiss; a mixed rock containing igneous and metamorphic portions. This is a metamorphic rock of highest grade. It outcrops from the center to the eastern part of the map especially in Ado-Awaiye, Oha, Adepoju, etc. Several pegmatitic intrusions, quartz veins, fractures and faults characterized the migmatite-gneiss. Foliation, lineation and migmatitic structures which include folds of various kinds were also observed on the outcrop (figure 2). The folds occur as normal fold, tight fold and pygmatic fold i.e the initial parallel bands appear to be contorted due to compressive stress that existed during its formation.

The general orientation of the rocks is NE-SW with moderate dip. The minerals are separated into light and dark bands, i.e. gneissosity. The rock consists of palaeosome and the neosome. The neosome divided into lighter bands (leucosome) consist of feldspars and quartz and muscovite while the darker bands (melanosome) contain biotite mica and hornblende.



Thin section observation revealed that the rock is composed of orthoclase, plagioclase, quartz, hornblende and biotite. Accessory minerals are also present (figure 3). Plagioclase constitutes about 40%, subhedral to euhedral, colourless with quartz inclusion and cleavage. Quartz is about 20% and is colourless, clear and some show conchoidal fracture and undulose extinction with no pleochroism and alteration. Orthoclase is about 15%, colourless and cloudy in plane polarized light (PPL) and show Carlsbad twinning in cross polarized light (CPL). Biotite is about 15%, brown to green with strong pleochroism and pleochroic haloes, and also characterized by cleavage and moderate relief. Hornblende (about 10%) is green in colour and it is characterized by cleavage intersection of approximately $56^{\circ}/124^{\circ}$. Opaque mineral constitutes about 5% and it is black in both Plane Polarised Light and Cross Polarised Light.

Hornblende-Granite Gneiss

This is a crystalline metamorphic rock in which the rock is unusually rich in hornblende. It occupies about 40% of the mapped area outcropping on the western part of the area. They trend from nearly North-South to North-East / South-West. It shows some jointing and faulting with few being healed (filled) with the newer material (figure 4). It is light in colour except where it is dominated by mafic alternations.

Thin section study indicates the presence of the following minerals. Quartz is about 30%, orthoclase is about 15%, hornblende is about 15%, biotite is about 5%, plagioclase is about 35%, and opaque mineral (probably iron oxide) constitute 10%. Orthoclase undergoes extinction, show Carlsbad twinning and characterized by pethitic structure with clear define cleavage plane. Biotite is greenish to brown with strong pleochroism and characterized by jagged edges. Hornblende is characterized by cleavage intersection. It is light yellow to green and interference colour of second order. Opaque mineral is dark in both plane and cross polarized light (figure 5).



Figure 2: Migmatite-Gneiss with characteristic different folds.

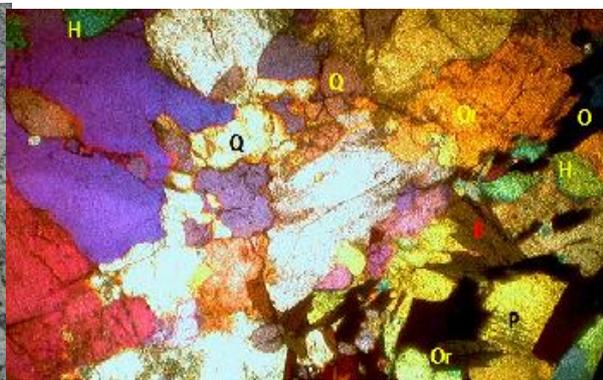


Figure 3: Photomicrograph of thin section of Migmatite-Gneiss (Cross Polarized Light)



Figure 4: Faulted Hornblende Granite-Gneiss

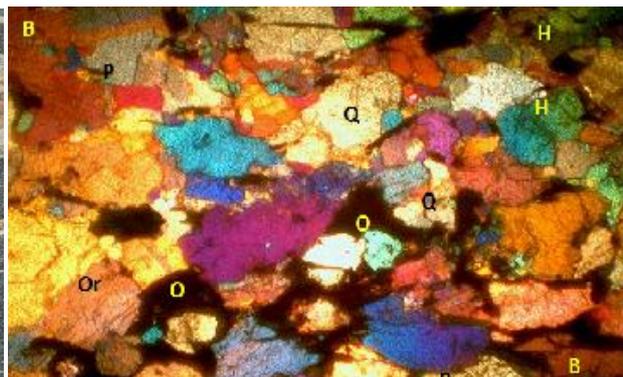


Figure 5: Photomicrograph of thin section of Hornblende-Granite-Gneiss (Cross Polarized Light)

Amphibolite

It occurs as a dyke-like structure within the migmatite-gneiss and granite-gneiss. It has a medium grain size because of the effect of metamorphism. It appears to be schistose and either as a continuous vein parallel to the regional trend of the rock or it shows discordant relationship with the host rock. It is predominantly characterized by mafic mineral (figure 6).



From the thin section observation, the rock is dominantly composed of hornblende (about 35%), plagioclase (albite about 20%) and quartz (about 20%). Other minerals include biotite (about 18%), augite (about 3%), and opaque mineral is about 4%. Hornblende is greenish-brown to brown characterized by cleavage plane intersecting at nearly $56^{\circ}/124^{\circ}$. Plagioclase is colourless to light grey and lacks pleochroism but characterized by albite (polysynthetic) and pericline twinning. Quartz is colourless to light yellow and shows no cleavage. Biotite occurs as an elongated crystal and in form of lath. Augite is green and has cleavage intersection of nearly perpendicular to one another (figure 7).

Pegmatite

It is a very coarse grain rock with large crystal of feldspar and quartz with some micas (figure 8). It is a light-coloured rock because of the dominance of felsic materials and it is hosted by banded gneiss. It crystallizes from residual melt during the later stage of crystallization. This pegmatite lacks economic minerals and hence it is barren.

Petrographic study reveals the following minerals; orthoclase (about 25%), quartz (about 20%), Plagioclase (about 30%), biotite mica (about 10%), hornblende (about 10%) and opaque mineral (about 5%). Plagioclase is colourless but characterized by albite twinning and cleavage. Quartz is colourless with no cleavage and alteration along the fractured plane. Biotite is characterized by pleochroic haloes and jagged edge. It is mostly brown but some are also green in colour. Hornblende is green and opaque mineral is black in both plane and cross polarized light (figure 9).



Figure 6: Amphibolite rock hosted by medium grain gneiss.

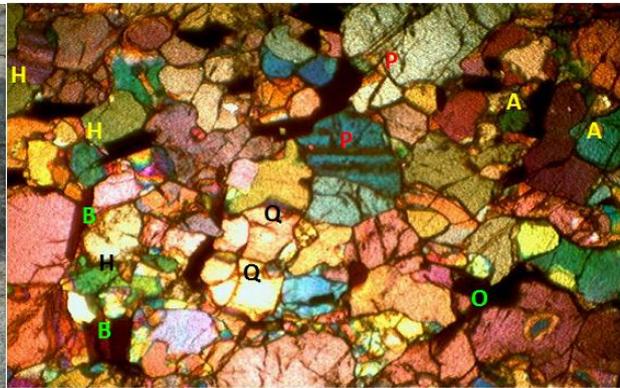


Figure 7: Photomicrograph of thin section of Amphibolite (Cross Polarized Light).



Figure 8: Pegmatite hosted by Gneissic rock.

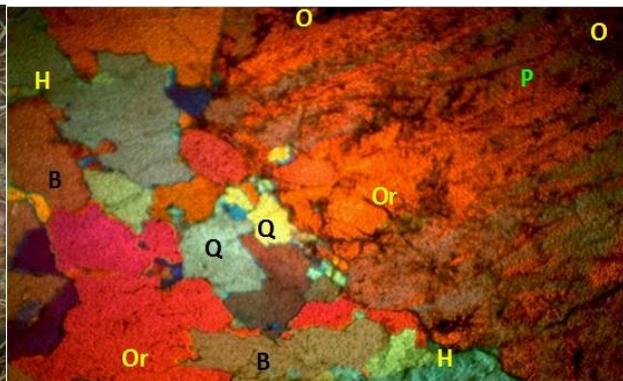


Figure 9: Photomicrograph of thin section of Pegmatite (Cross Polarized Light).

Structural Features and its Interpretation

Structures are the principal sources of information on the nature of the deformational episodes as it affects the earth and it relates to chronological sequence. It reveals the processes that produced the observed structures, the temperature-pressure condition operating at the time of the deformation, the stress distribution at the time of formation, the nature of the rock and as well as the environment. Geological structures are strains resulting from the application of stress. The following structures were observed and these provided information about the geological history of the area.

Folds



These are bend-like structures resulting from compressional forces acting from opposite sides of a rock. It usually leads to shortening of initially horizontal straight parallel layers and finally become contorted following plastic / ductile deformation. Several fold types were observed on the outcrops particularly the migmatites. The fold types observed includes simple folds, ptygmatic folds, tight folds, and open folds. Many of the quartz veins observed have been intensely folded and were suspected to be of different ages. Ptygmatic fold (figure 10) differs from others because it has uniform thickness at both crest, limb and trough while the other types of fold has different thickness (figure 2).

Faults

Some of the rocks have been heavily fractured and displacement of the outcrop has been indicated by the discontinuity in the lithology on the opposite side of the fault plane (figure 11). A few localized fault were seen on the outcrop at some locations. It is a dextral strike-slip fault with the fault plane filled with felsic material. It strikes at an angle of 120° . Other micro faults strikes at various angle.



Figure 10: Migmatite-Gneiss Showing faulted ptygmatic fold



Figure 11: Dextral strike-slip fault with quartz vein as the fault plane.

Joint

This is an opening or crack within the rock with no appreciable displacement. This was found in most of the outcrop. In some outcrop it was healed to form vein (dilation healed joint) while in some it was an open joint (barren joint). No relative displacement between the adjacent block. Several parallel joints were observed in all the outcrops. The migmatite-gneiss exhibits different degrees of jointing. The joints show concordant to discordant relationship to the regional strike of the outcrop. They are oriented in different directions as shown by the Rose diagram in which the dominant joint direction is almost NE – SW (figure 12). This is the direction of failure mainly resulting from the Pan – African event. While those of E – W orientation, although minor may indicate the effect of earlier orogenic episode probably that of Eburnean.

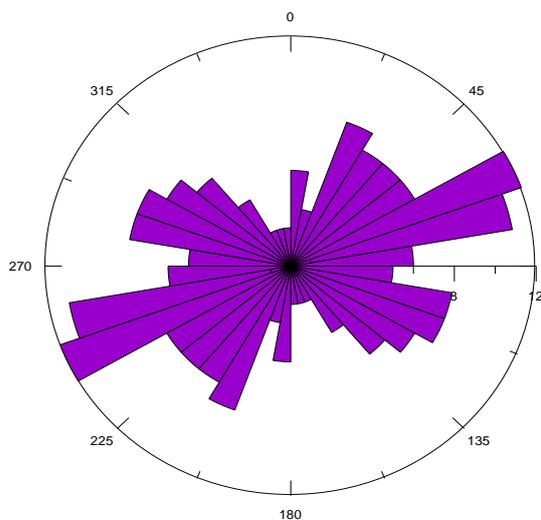


Figure 12: Rose diagram for strike of joints on outcrop.

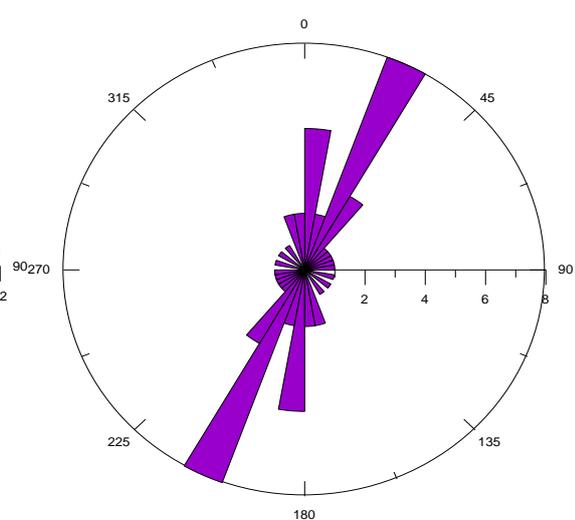


Figure 13: Rose Diagram for Foliation and Mineral Mineral Lineation

Foliation and Lineation

Several planar and linear structures occur repeatedly on the outcrops. Minerals with similar physical and chemical properties are aligned in the same directions i.e parallel to sub-parallel alignment of inequant mineral grains such as micas or amphiboles and the intersection of their planes. These alignments of minerals are induced by the directional stress that characterizes the formation of many metamorphic rocks. These structures mainly characterized both migmatite-gneiss and granite-gneiss. They are mostly N – S to NE – SW but in some outcrop they are NW – SE to E – W. This also reveals the resultant orientation impacted by combine effect of Pan-Africa and Eburnean orogeny. The Rose plot reveals their dominant direction. It is oriented in a NNE – SSW (figure 13) which is an imprint of Pan – African orogeny on the basement rock being the recent orogenic episode that affected Nigerian basement rock.

From the structural analysis of lineation, foliation, joints, fault and the rock outcrop e t c, they have orientation aligned in the direction associated with many of these major tectonic episodes indicating that the rocks had undergone polyphase metamorphism and series of deformation processes.

Geological, Lithological and Chronological Relations of the area

From all the lithological, petrographical and structural studies using strikes, dips and dip directions, the mapped area is made up of two major rock unit; the migmatite-gneiss and the hornblende granite-gneiss including amphibolite and pegmatite as shown in the figure 14 below. Both amphibolite and pegmatite were not mappable and hence do not appear on the geological map. The migmatite-gneiss is the oldest rock unit in the area while pegmatite hosted by the gneiss is the youngest. Migmatite-gneiss is a composite rock consisting both metamorphic and igneous units. It is believed to be formed under the granulite facie condition when there is partial melting. During anatexis the light coloured minerals melt away and this corresponds to the granitic component (the newly formed portion) of the migmatite. The remaining material is devoid of granitic component (degranitization) and rich in granodioritecomposition (granodioritization) and this correspond to the older parent material in metamorphic stage.

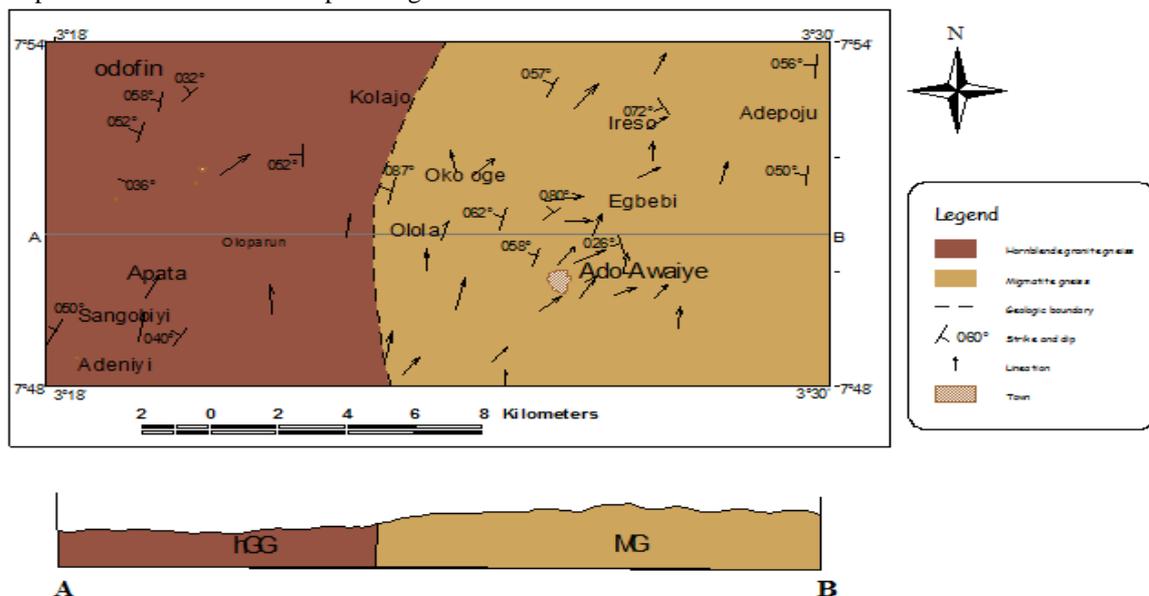


Figure 14: Geological map and cross-section of Ado-Awaiye and its environs, Part of Igangan Sheet 240, Southwestern Nigeria[17].

Geophysical Data Presentation and Analysis

The total magnetic intensity were recorded and processed into contour maps of total intensity map (figure 15) and residual anomaly map (figure 16) using computer software. A regional surface was superimposed on the total field to obtain the residual upon which analysis and interpretation were made.



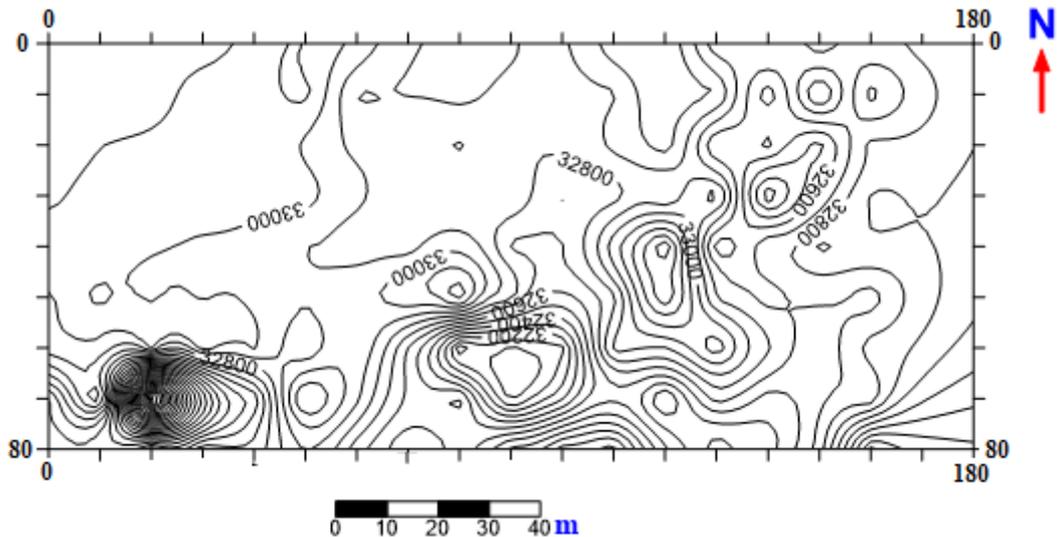


Figure 15: Total Magnetic Field Intensity Contour Map of the Study Area (Part of Iseyin, Ado-Awaiye).

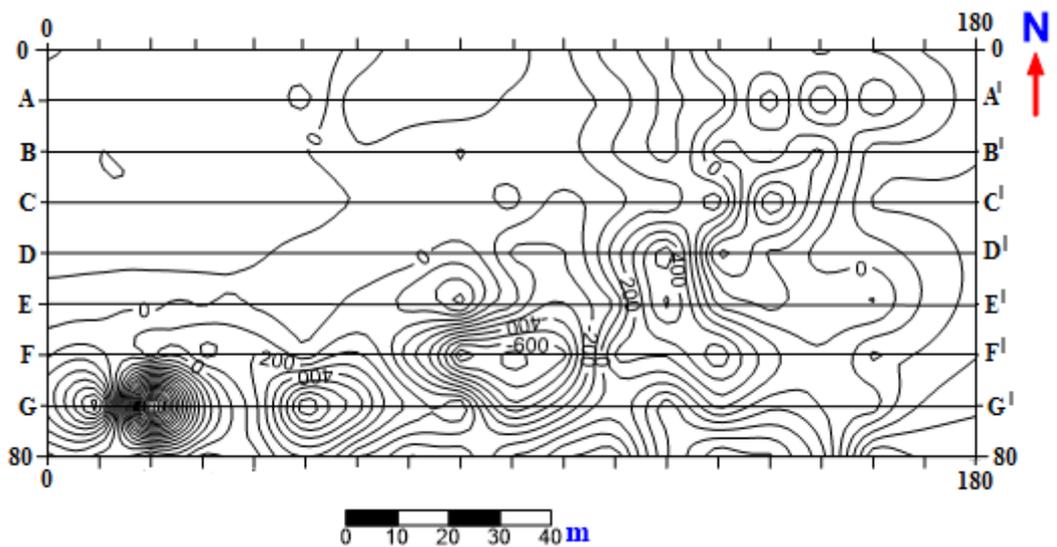


Figure 16: Residual Magnetic Field Intensity Map of the Study Area with Traverse Lines (Part of Iseyin, Ado-Awaiye).

Interpretation

The interpretation of the magnetic data is always done in two ways: one involving judgment from the nature of the map and the other one involving mathematical manipulations and resolutions. This interpretation is termed Qualitative and Quantitative Interpretation respectively.

Qualitative Interpretation

This interpretation is based on visual inspection of the magnetic contour map and the variation in the magnitude of the intensity field. The magnetic contour is widely spaced at the north, an indication of relatively great depth to magnetic basement. But at the southern part of the map the magnetic contours are closely spaced indicating a shallow magnetic basement depth (figure 15 and 16). The variation in total magnetic field intensity from 30446.47 nT to 33536.10 nT is a function of variation in lithology of the basement with the highest value corresponding to high magnetite or mafic content which may represent amphibolite schist and the intermediate to low magnetic intensity may correspond to granitic component of the migmatite-gneiss of the basement. The inward increase in magnetic contour is an indication of presence of suprabasement block (basement knoll) and this occur from central to eastern part of the map while those with magnetic contours that increases outward (intra-basement block) may be termed as a basement depression filled by materials of low magnetic susceptibility (mainly weathered material such as clay, clayey sand and sandy horizons).



Also, the residual field intensity is characterized by both negative and positive anomaly with negative anomaly indicating weathered material filling the basement depression.

Again, at the southern end of the map, the contours are characterized by presence of elliptical closure and nosing which are closely spaced, linear and sub-parallel in both total magnetic intensity and residual map and this represent geologic lineament such as fault, dyke or local fractured zones. Magnetic susceptibility contrast across a fracture zone may be probably due to oxidation of magnetite to hematite or infilling of fracture zone by dyke-like bodies (such as amphibolite) whose magnetic susceptibilities differ from those of their host rocks. The data also reveals that the area is characterized by zero to low mineralization as earlier revealed from geological mapping.

Quantitative Interpretation

The depth estimate constitutes the quantitative interpretation of magnetic data and it involves simple to complex mathematical calculation as the case may be. The interpretation of geophysical anomalies is often based on the analysis of data observed along traverse lines. Data having geological meaning are usually extracted and interpreted in terms of geology.

Anomaly Depth calculation and Half-Width Method

Much is written on the variety and relative merit of methods for estimating the depth to the source of anomalies. Knowledge of the depth of a particular formation or source may have considerable geological significance as it determines the nature or configuration of a formation, the slope of its surface and its discontinuities.

Half-width method is the most common method of depth estimation and it makes use of the shape of the anomaly. The basis for depth determination from anomaly width is that variation in depth affects the shape of an anomaly (figure 17).

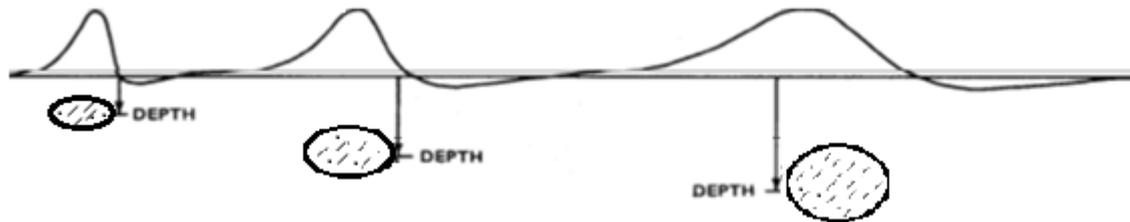


Figure 17: Effect of Depth on Anomaly Shape and Amplitude([modified from 18]).

For simple forms of anomaly sources, the depth to their centers is related to the half-width of the anomaly (figure 18). Half-width can be defined as half the horizontal distance between the principal maximum (or minimum) of the anomaly (assumed to be over the center of the source) and the point where the value is exactly half the maximum. This rule is valid for various simple shaped forms including gently sloping surfaces such as topography on basement bedrock which is assumed and modelled by an infinite slab.

For an infinite slab, the half-width $X_{1/2}$ equals depth to the basement Z .

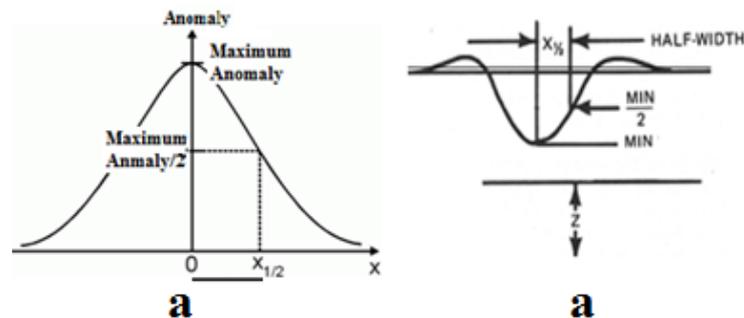
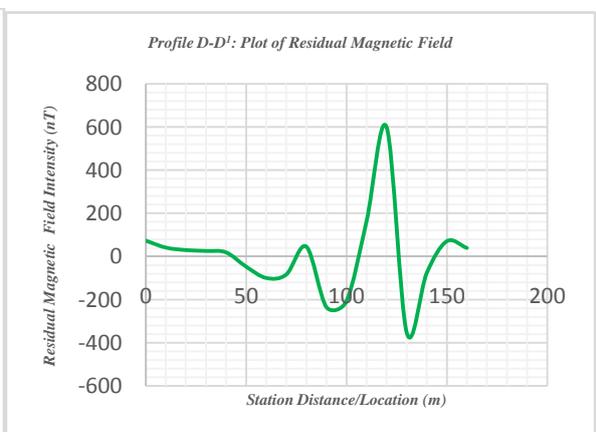
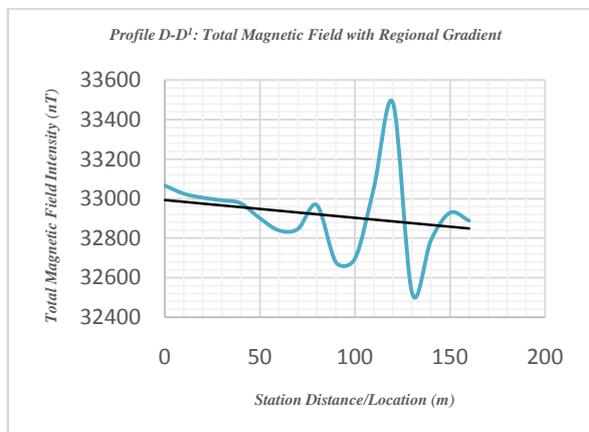
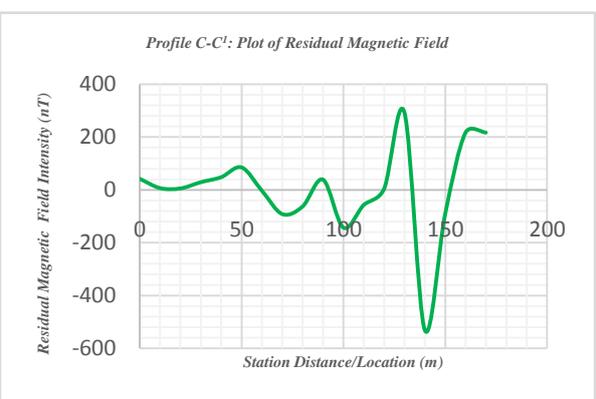
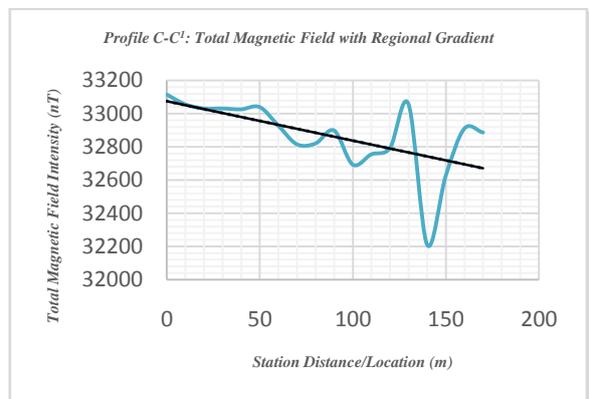
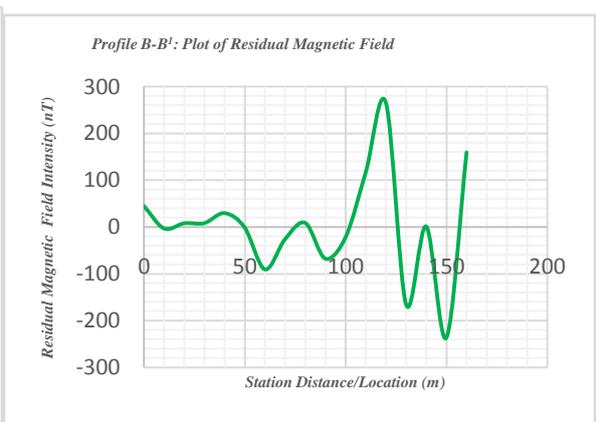
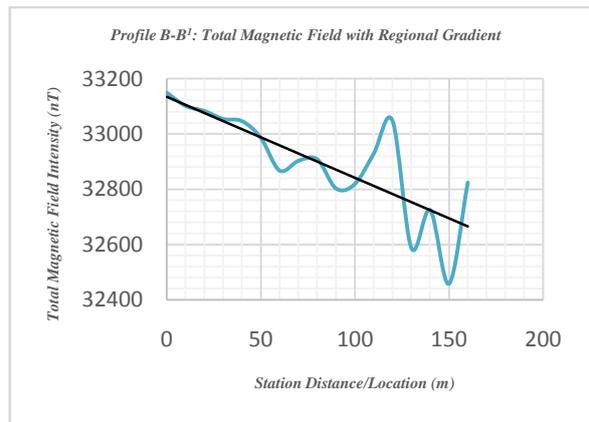
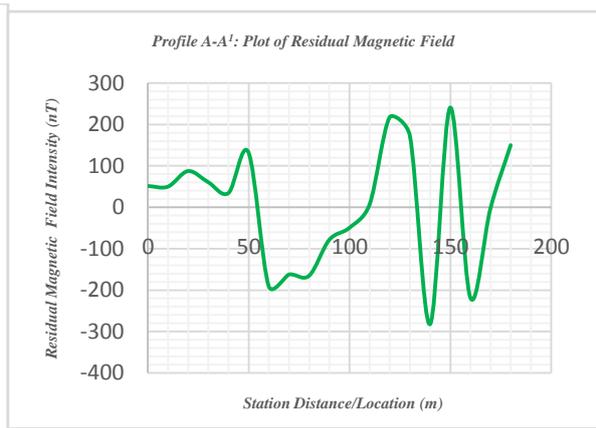
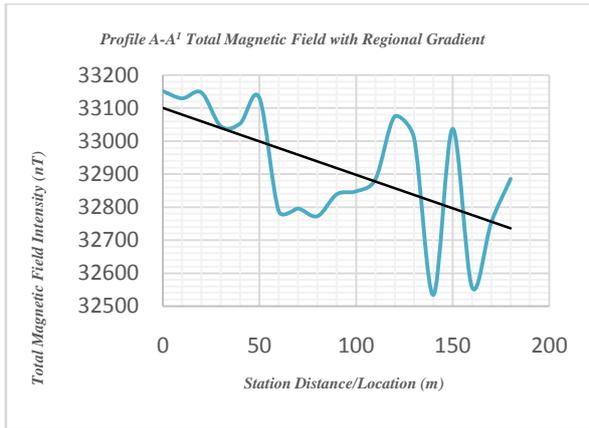


Figure 18: The method of calculating half-width from anomaly shape for depth estimate (modified from [18]).

The depth to various points on the surface of crystalline rock or magnetic basement allows one to map the surface and its topography.

Below are the profiles taken mainly from west to east along each traverse line for detail qualitative interpretation.







Each of the profile was subjected to regional – residual anomaly separation by fitting a regional gradient surface to the total field (left) in order to obtain the residual field (right) after necessary subtraction. This was followed by half-width calculation which the result is summarized and presented in table 1.

Table 1: Basement Depth Estimated from Half-width.

PROFILE	GROUND DISTANCE (m)	BASEMENT DEPTH (m)	ANOMALY TYPE & AMPLITUDE (nT)
A-A ¹	0 to 40	7.5	+87.7
	40 to 53	4.5	+132.2
	54 to 110	15.5	-190.6
	110 to 134	9.0	+195.7

	134 to 146	3.5	-282.5
	146 to 156	3.5	+241.1
	156 to 170	5.0	-281.1
	28 to 50	6.5	+29.9
	50 to 75	6.0	-90.5
B-B¹	82 to 102	6.0	-67.6
	102 to 126	6.0	+265.4
	126 to 140	3.5	-165.3
	140 to 156	5.5	236.2
	20 to 60	7.0	+85.2
	60 to 85	8.0	-91.5
C - C¹	85 to 93	2.5	+39.1
	93 to 120	6.0	-142.9
	120 to 134	4.0	+292.7
	134 to 152	5.0	-530.7
	44 to 75	10.0	-100.0
D-D¹	83 to 106	9.0	-206.9
	106 to 126	5.5	+599.0
	126 to 144	4.5	-353.3
	40 to 57	5.0	-67.8
	57 to 89	6.5	+368.7
E - E¹	89 to 111	7.5	-306.6
	111 to 129	5.0	+539.9
	129 to 148	4.0	-141.0
	0 to 45	11.5	+244.4
F - F¹	50 to 67	4.5	216.8
	67 to 107	14.0	-815.0
	107 to 152	13.0	+501.3
	0 to 13	4.5	+837.1
	13 to 36	5.0	-2022.5
G - G¹	36 to 84	9.0	+940.1
	84 to 106	6.3	-491.9
	112 to 126	3.8	-286.6
	126 to 137	3.5	+153.9

Three profiles have been selected for detailed analysis and explanation. These serve as representatives of the others.

Profile B - B¹

Along this profile line, the depth to magnetic basement is 6.5m between 28m to 50m ground distance, it is 6.0m between 50m to 75m, 82m to 102m and 102m to 126m. It is also 3.5m between distance of 126m to 140m and 5.5m between 140m to 156m. Therefore, the minimum depth is 3.5m and maximum depth to basement is 6.5m with a mean depth of about 5.6m. In addition to depth variation, this profile is also characterized by minimum anomaly of -236.2nT and peak value of +265.4nT indicating intrabasement and suprabasement respectively.

Profile D-D¹

From the anomaly width of the residual field, the depth to magnetic basement along this profile varies. Between 44m to 75m ground distance, the magnetic basement depth is approximately 10.0m, between 83m to 106m, it is approximately 9.0m, between 106m to 126m, it is approximately 5.5m and between 126m to 144m it is approximately 4.5m. Therefore the minimum depth is 4.5m and maximum depth is 10.0m with an average of approximately 7.3m. The anomaly amplitude also ranges from -353.3nT to +599.0nT also indicating basement depression and basement knoll respectively.

Profile F-F¹

The basement depth along this traverse line varies extensively. Between 0m to 45m, the depth estimate from the anomaly width is 11.5m, between 50m to 67m, it is 4.5 m, between 67m to 107m, it is about 14.0m and between 107m to 152m, it is 13.0m. Minimum and maximum depth is 4.5m and 14.0m respectively with an average of approximately 10.8m. Also minimum anomaly amplitude of -815.0nT and maximum value of +501.3nT characterize this profile signifying basement valley and basement high respectively.



Conclusion

The study area lies within the basement complex of southwestern Nigeria. Rocks encountered include migmatite-gneiss, hornblende granite-gneiss and some pegmatite and amphibolite. The mineralogical compositions of the rocks include: biotite mica, k-feldspar, Plagioclase feldspar, quartz, hornblende, augite, opaque minerals (probably magnetite or ilmenite) etc. Also, the variation in total field ranging from 30446.50 nanotesla to 33536.10 nanotesla indicates that the magnetic basement is not uniform in composition. The magnetic basement constitute migmatite-gneiss with associated amphibolite which is rich in opaque mineral such as magnetite and/or ilmenite etc. This most certainly responsible for the relative high magnetic values recorded. The basement is relatively shallow at the southern end of the map and relatively deep at the north. The overburden thickness ranges from 2.5m to 15.5m (table 1) and hence the basement topography is relatively undulating characterized by few basement structures such as fracture, intrabasement and suprabasement blocks which were inferred from the magnetic map. Both geological mapping and the ground magnetic data reveals that the area is not mineralized and hence zero to low mineralization potential.

The rocks are also characterized by structures such as folds, joints, fault, foliation, mineral lineation, veins, etc as observed from the outcrop. Few barren pegmatite were encountered and hence the study area is not mineralized but is fairly good for quarry activities.

Therefore, from this study, it is very clear that both geology and geophysics can supply veritable important complimentary information about the lithological content and mineralization potential of an area.

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