Geological Mapping, Petrographic and Structural Attributes of Basement Rocks at Eiyenkorin Area, Southwestern Nigeria

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Abstract- The study area Eiyenkorin and its environs fall within the Precambrian Basement Complex of Southwestern Nigeria. This research was aimed at geological mapping and studying of the different rock units in the area to decipher their structural relationships and established their lithologic boundaries. Geological field mapping and identification of associated structural elements such as strikes of foliations and dips, azimuths of folds and joints and orientations of dykes were measured using a compass. Ten (10) representative rock samples were collected, subjected to thin-section analysis for petrographic studies. Field observation shows the area is characterized by rocks of the migmatite complex; migmatite-gneiss, granite-gneiss and banded-gneiss with minor rocks such as pegmatites and quartzo-feldspathic veins running discordantly across the rocks as dykes. The rocks are medium-coarse grained texture, varied felsic and mafic bands, characterized by migmatite structures like strike-slip fault, folds (ptygmatic, concentric and isoclinal). The variable thicknesses and associated fold types especially on the migmatite-gneiss are a function of the variability in metamorphic factors and conditions with distance from source area. Macroscopic observation revealed quartz, feldspars, biotite and green hexagonal shaped tourmaline crystal (associated with granite-gneiss) with the micaceous minerals displaying a lustrous shiny surface. On the average, the order of mineral abundance in these rocks are quartz (55), feldspars (19), biotites (12), accessory minerals (6.5), hornblende (5) and muscovite (2.5). Structural interpretations shows fold axis are mostly E-W with minor trends in NNW-SSW direction and average plunge angle of 27°, joints were mostly NE-SW with minor trends in the NW-SE directions. Orientation diagram revealed NNW-SSE general orientation with minor trends in NE-SW direction and dipping SW of foliations. This is in agreement with the general trends of the Pan-African structures in the NE-SW orientations. It is obvious from this study that structural attributes/orientation of rocks from Eiyenkorin area conforms in direction associated many tectonic episodes reflecting polycyclic deformation processes and metamorphism in the area.

Index Terms- Eiyenkorin, Geology, Petrography, Migmatite structures, Basement Complex

I. Introduction

The importance of geological mapping exercise is next to the interpretation and understanding of pre-historic, modification events or processes and reconstruction of geological history of any environment and as such cannot be over emphasized. Geological maps is an indispensable tool normally employed due to its uniqueness in displaying physical and landforms features of a wide range of area on scales that could possibly help in the field mapping exercise. Basically, it usually consist of relevant information about the topography and elevation data of the earth's surface which in most cases are shaded, or coloured to show where different rock units occur at or just below the ground surface (Adetayo *et al.*, 2013). These shaded or coloured features aid in making proper distinctions by creating litho-boundaries of several rock units spread within an area of interest to gain a full knowledge of the area's geological endowment.

The study area Eiyenkorin and its environs situated between latitude N 08°23' to N08°27' and longitudes E 04°27' to E 04°30' with 41.44 km^2 estimated land area belongs to the Precambrian Basement Complex (PBC) of Southwestern Nigeria occurring east of the west African Craton. Various studies (Jones and Hockey, 1964 and Rahaman, 1976) have described the geology and characterized the rock units of the Basement Complex setting in South-western Nigeria to include five major rock units as;

1) *Migmatite–gneiss complex* is the oldest basement and consists of gneisses/biotite gneiss and banded gneiss.
2) *Migmatized meta-igneous units* consist of pelitic schist, quartzite/quartz-schist, amphibolites, talcose rocks, meta-conglomerates as well as marbles and calc-silicate rocks in places.
3) *Charnockitic rocks* occur as dyke-like bodies and circular intrusions emplaced within the migmatite-gneiss terrain and are composed of quartz, alkali-feldspars, plagioclase, pyroxene, hornblende, and biotite and accessory minerals.
4) *The Older granites* occur as plutons and batholiths and include rocks varying in composition from granodiorites to granite and potash syenites.
5) *Un-metamorphosed dolerite dykes and Pegmatite veins* occur as tubular, un-metamorphosed bodies cutting across foliations in the host rocks and are widespread as quartz veins

These Basement Complex of the south-western Nigeria and indeed the Nigeria Basement Complex has been affected by a number of orogenic tectonic episodes (Odeyemi, 1981 and Annor, 1985) giving rise to the major structural trends in the N-S orientation. Garba (2002) also reported that the last stage of the Pan-African orogeny is represented by conjugate fracture system of strike-slip faults. The study area is underlain by the migmatite-gneiss complex rocks comprising banded-gneiss, granite-gneiss, migmatite-gneiss and intrusions of quartzo-feldspathic veins (pegmatites) cutting across the host rocks as dykes in the area. These rocks are also characterized by faults, fold and foliations (Ekeleme et *al.*, 2017). Some of them are not deformational but are secondary structures developed during metamorphism of the rocks (Rahaman, 1988). In literature, the study area and its environs lack any geological map/records to locally distinguish the rock units and their lithologic boundaries in the area where commercial mining activities are practiced. However, the readily available information about the area is contained in the regional geological maps of Nigeria (Ojo, 1994 and Malomo, 2004) with no detail description of the local rocks and their associated attributes. Thus, this has necessitated a more localized mapping exercise to meaningfully map, give an accurate description/ representation of rock units within the area relative to the regional scale perspective thereby adding to the knowledge of the local geology of the area.

II. STUDY AREA AND METHODOLOGY

The study area Eiyenkorin and its environs is accessed through series of interconnecting footpaths, minor roads with few major roads (paved and unpaved), and dry stream/river channels. The road trends on NNE-SSW with Ilorin in the north and Ogbomoso to the south (Okunola, *et al.*, 2015). The topography of the study area is slightly undulating with rounded low hills, occasional often elongated ridges indicating a characteristics residue setting of a typical basement terrain with an average height ranging between less than 100-1150m above sea level (Fig.1) and average annual temperature of 30-33°c (Ilorin Atlas, 1982). The settlements (Eyenkorin, Apata, Aiyengun, Araromi, Ogele, Alagbado, Idi-iya and Idiya) are connected by series of major road, minor roads and footpaths traversing the area.

Field geological and structural mapping of Eiyenkorin and environs were carried out on a topographic map of 1:100, 000 scale. At each outcrop location, the rock was carefully observed, described, identified for their petrology, mineralogy, structures, relationships and determined/ recorded their co-ordinate on the field map and in the notebook. However, some of these outcrops are obscured in places by thick vegetation and products of chemical weathering of the basement rocks (lateritic hard pans). Structural features like foliation, fractures (joint and faults), folds and dykes were identified and their attitudes such as strikes and dips patterns, and orientation were measured using geological compass. The data collected from the field was used to produce the geological map of the area and also structurally analyzed using Rosette diagram to determine the orientations. Mineralogical composition of the various rocks domicile in the area were carried out based on the results of the thin-section analysis conducted on the ten (10) representative rock samples (2-Banded gneiss, 5-Migmatite-gneiss, 1-Pegmatite and 2- Granite gneiss) at the department of Geology, University of Ibadan, Ibadan, Nigeria. Identification of minerals was done using their diagnostics optical characteristics under plane polarized and cross polar media. This analysis allowed the modal composition to be determined and aided in the proper naming of the rock (Ibrahim *et al.*, 2015).

III. RESULTS AND DISCUSSION

The litho-petrological units characterizing the study area are migmatite-gneiss, granite-gneiss, and banded-gneiss while other felsic rocks such as pegmatites dykes/quartzo-feldspathic veins occurring as intrusions with a discordant relationship to the country rocks in the area. The megascopic minerals (visual observation) observed on these outcrops include feldspar, quartz and biotite.

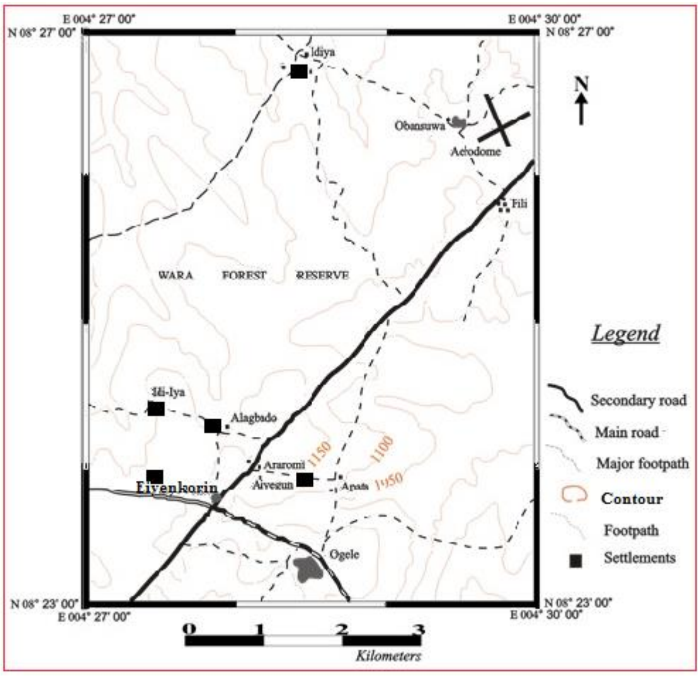


Figure 1: Accessibility and Topographic map of the study area

Field Observations

Important information about the study area was acquired through field geological mapping exercise. The area is underlain principally by three main metamorphic rocks such as migmatite-gneiss; granite-gneiss and banded-gneiss with minor rock types such as pegmatites define by discordant mineralized veins of quartz and feldspars. The granite-gneiss forms the dominant unit in the area occupying a lands mass spanning from the NE through NS to the S most parts of the area, characterized by low-lying, pegmatitic intrusions, jointed in places, rugged topography and hills, migmatite-gneiss occupies the central portion of the area, and are low-lying, well veined, strongly folded, characterized by pegmatitic intrusions, and development of pinch and swell structures. The banded-gneiss outcrops occur as a low-lying with gentle slope to the level ground surface, extensive with moderately folded mineralized felsic/mafic veins, presence of solution cavities, discordant pegmatitic intrusions with the general foliation trend and capped by lateritic units especially at Ologun village. These rock units are mined at localities where they occur, however, there are also network of dry-semi stream channels using the weaker zones and poorly consolidated materials.

Observed Lithology and Field Relationship

Migmatite-Gneiss

It is of a highest grade metamorphism consisting of mixtures of igneous and metamorphic portions covering about 20% of the study area. It outcrops at the central portion of the map especially at villages such as Araromi, Apata, Alagbado and Aiyegun. It is low-lying in a NS-SW direction and dipping moderately west and average elevation as 340m, with felsic and mafic bands, slightly folded veins and foliation, characterized by several pegmatitic, quartzo-feldspathic intrusions, and development of pinch and swell structures. These bands vary in coloured density and width of individual bands as either the dark or light band may be locally dominant in a particular outcrop and/or section of an outcrop. The Migmatite-gneiss is medium-coarse grained, hard with mafic and felsic bands defined by biotite, hornblende and other ferromagnesian minerals. At locations such Ogele quarry, these rocks were observed to be intruded by quartz veins, pegmatitic veins and quartzo-felspathic veins of varying dimensions ranging from 1.5-11cm in width and mostly over 300cm in length. The pegmatite veins or dyke trend about 68˚NE, and some migmatitic structures such as strike slip fault, ptygmatic fold (Fig.2) and joints were also visible on the outcrop.

It is worthy to point out here, that the rock consists of palaeosome which is the unaltered parent rock in metamorphic stage and the neosome which is the newly formed rock portion. The lighter bands which are the leucosome consist of feldspars and quartz while the darker bands which are the melanosome contain biotite mica, muscovite mica and hornblende by mere field observation. The micaceous minerals produce a lustrous shiny surface on the hand specimen visual observation.

Petrographically, it exhibit variable mineral grains closely packed with preferred orientation. The dominant mineral observed include quartz, feldspar and biotite as hornblende and muscovite occurrences were minute and absent in some samples (Table 1). Some of the quartz exhibit conchoidal fracture, colorless, clear with undulose extinction indicative of deformation or straining. However, quartz shows no pleochroism and alteration. The biotite displays weak to strongly brownish pleochroism with cleavage. Opaque mineral both in plane polarized light and cross polarized light are black and the least abundant constituting about 5% of each sample mineral composition (Fig.3).

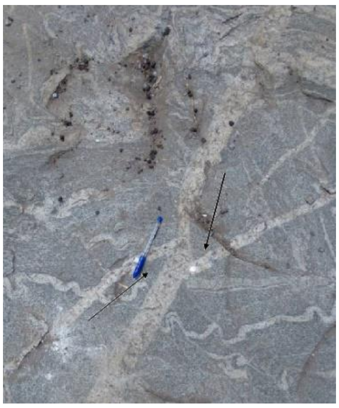
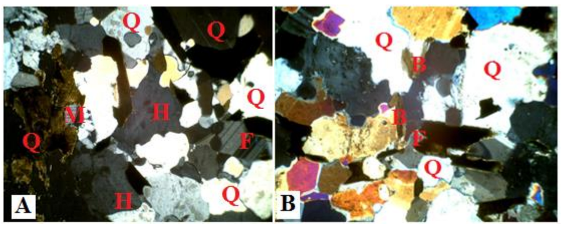


Figure 2: Strike-Slip fault and ptygmatic fold of mineral veins on Migmatite gneiss



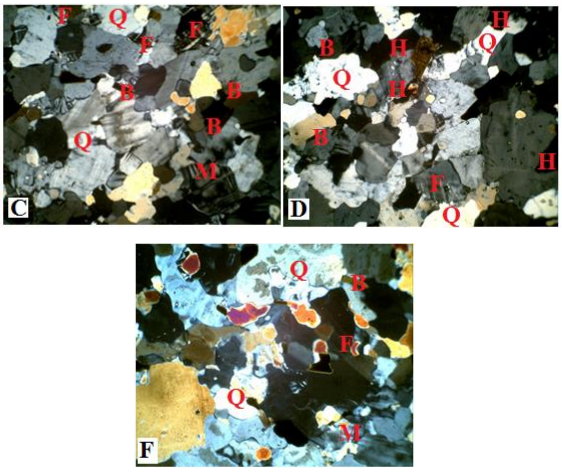


Figure 3: Photomicrograph of Quartz (Q), Feldspar (F), Biotite (B), Hornblende (H), and Muscovite (M) in Migmatite gneiss

Granite Gneiss

Granite-gneiss forms the dominant metamorphic unit at Eiyenkorin area covering about 50% of the area. Its appearance displayed a characteristic semi-circular morphology/ridge trending NE through the NW axis to the SW, outcropping at villages such as Idi-Iya, Eiyenkorin and Ogele. It shows some pegmatite dykes and quartzo-feldspathic veins as intrusions cutting across the granite gneiss rock as a result of later metamorphism. It is slightly foliated with two phases of foliation revealing the obvious alignment of light coloured minerals separated approximately 1.4cm and indistinguishable sets of foliation. It is of medium-coarse grained texture consisting of moderately thick mineralogical bands scattered in places with a characteristic alternations of felsic (quartz) and mafic (biotite and hornblende) mineral grains. There is constituent quartz and few mica grains in the quartz veins (quartzo-feldspathic) which are believed to be recrystallized with interlocking mosaic textures. Structural features like folds, strike-slip faults on mineral bands, joints and foliations are evident on the outcrop especially under the bridge at Eiyenkorin along Kaduna-Jebba road. These joints and fractures are mostly enhanced by agents of biological weathering (plant roots) acting on the outcrop, weakening and exposing the rocks to denudational agents (Fig.4). **A**zimuths of foliations and dip directions measured were dominantly in NNW-SSE with minor trends in an NE-SW direction. Some of the pegmatite dykes on the outcrops visited has lengths and widths (thickness) in the range of 5-10 cm and 15-30cm with mean values of 7.6cm and 21cm respectively.

In thin section, it contains majorly quartz and feldspar and other accessory minerals (Table 1). The quartz is colorless with euhedral shape. Quartz is colorless, reddish to black with conchoidal fracture in cross polarized light. It also shows pleochroism. Opaque mineral is dark in both plane and cross polarized light (Fig.5a) and remained invisible for fig. 5b.

Banded Gneiss

It is about 30% of the rock unit in the study area trending NE-E-SS making it the second most abundant unit typified by outcrops in settlements such as Ologun and Ogele. They are low-lying and extensive, moderately folded mineralized quartz veins with pegmatitic intrusions discordant with the general foliation trend. The mineral bands are aligned in series of repetitive alternation of felsic and mafic bands.

Figure 4: Granite Gneiss outcrop with insert showing effects of weathering agents

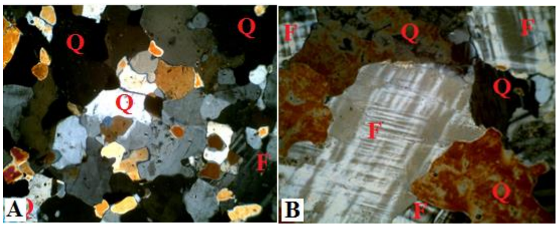


Figure 5: Photomicrograph of Quartz (Q), Feldspar (F) in Granite gneiss samples.

Further observation indicates the rocks are capped by extensive laterite overburden, leucocratic (light) to mesocratic (dark) in coloured, medium grained texture, foliated, jointed, faulted mineralized veins, solution cavities/sinkholes (Fig.6) and exfoliation especially at Ologun quarry about 1/2km east Ogele village. The quartzo-feldspathic intrusions on the banded gneiss outcrop trends 254˚W with thicknesses in the range of 2.4-7.0 cm averaging 4.0 cm. However, attitudes of foliations and their dips measured and plotted on a Rosette diagram are trending NNW-SSE.

From the thin-section photomicrograph, quartz and biotite is the dominant mineral with feldspar and hornblende been the less abundant (Fig.7). Here, quartz appears to be colorless, clear and euhedral to sub-euhedral with little pleochroism and no cleavage. Biotite is brownish with well-defined crystal faces. Hornblende is greenish brown. It is characterized by cleavage plane and shows strong pleochroism and interference color of second order.

Pegmatite Intrusion

Pegmatites are very coarse grain rock crystallized from melt during the later stage of metamorphism with giant/large crystals of dominantly quartz and feldspars and some micas (Fig.8). It is light-coloured rock due to the dominance of felsic constituents (quartz and feldspars) and it is hosted majorly by the migmatite gneiss and banded gneiss outcrops in the study area. In the thin-section photomicrograph (Fig.9), pegmatite shows enrichment in quartz and feldspar with traces of other minerals at minute amount (Table 1). Quartz is colorless with no cleavage and alteration along the fractured plane. Feldspar (K-Feldspar) is also colorless but characterized by albite twinning and cleavage. Opaque mineral is black in both plane and cross polarized light.

Figure 6: Solution cavities on a Banded Gneiss outcrop

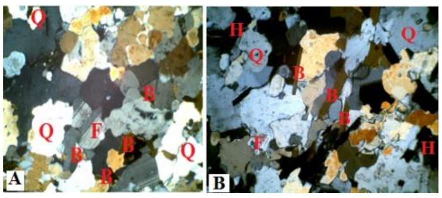


Figure 7: Photomicrograph of Quartz (Q), Feldspar (F), Biotite (B) and Hornblende in Banded gneiss samples

Structural Features and Significance

Geological structures are direct reflection of geological processes which gives information on the formation and deformation of rocks. It also reveals the processes that produced the observed structures, the temperature-pressure condition operating at the time of the deformation and the stress distribution at the time of formation (Ibrahim *et al.*, 2015). Geological structures are strains resulting from the manifestation of the type of stress, nature of the rock as well as the environment.

Figure 8: Pegmatite Dyke on Migmatite-Gneiss outcrop

However, their presence in this study area reveals the type and series of deformational episodes that may have affected rocks units in the area. Common structural features identified in the Precambrian basement complex area of Eiyenkorin include folds, faults, joints, foliation and lineation.

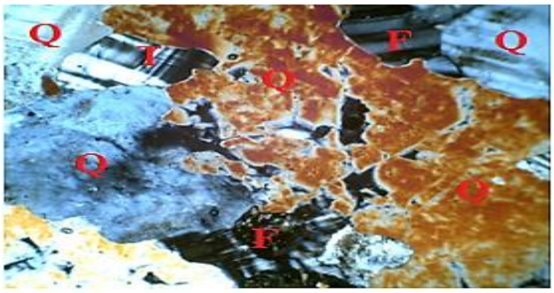


Figure 9: Photomicrograph of Quartzo-feldspathic vein (Q) and Feldspar (F)

Table 1: Mineralogical Composition of the Analyzed Rock samples

Minerals	Migmatite Gneiss					Pegmatite	Granite Gneiss		Banded Gneiss	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Quartz	60	50	40	50	60	70	60	60	50	50
Feldspar	10	5	45	5	20	20	30	30	20	5
Muscovite	10	-	10	-	-	-	-	5	-	-
Biotite	5	40	-	10	10	-	-	-	25	30
Hornblende	10	-	-	30	-	-	-	-	-	10
Acc. minerals	5	5	5	5	10	10	10	5	5	5

Fold

These are curved shaped structures with a crest, limb and trough resulting from compressional forces acting from opposite sides of a rock leading to crustal shortening. Several types of folds such as ptygmatic, concentric and isoclinal folds were observed on top of the outcrops (migmatite gneiss, granite gneiss and banded gneiss) representing plastic deformation (Fig.10). These types of folds may have taken place when the rock was buried at depth under confining high pressures favoring plastic strain. Series of mineralized quartz veins observed have been intensely folded and were suspected to be of different ages (Ibrahim et al., 2015). Ptygmatic fold differs from others because it has uniform thickness at crest, limb and trough while the other type of fold has different thickness. However, isoclinal fold have same angle; that's symmetrical and aligned in a parallel fashion (Fig.10b).

In the study area, the dominant axial trends of the folds are in E-W with few trending NNW-SSW direction along the southern segment of the granite-gneiss outcrop with an average plunge angle measured as 27°.

Figure 10: Concentric and Isoclinal folds on Migmatite Gneiss (a) and Banded Gneiss (b) outcrops

Fault

Field observation indicates that some of the rocks have been intensely fractured and displacement of the outcrop has been revealed by the lithological discontinuity on the opposite side of the fault plane. A few localized strike-slip faults with the fault plane filled with felsic material were seen on outcrops (Fig.11a).

Joint

Joints are abundant in Eiyenkorin area particularly on the migmatite gneiss and granite gneiss (Fig.11b). Field studies shows that most joints trend NE-SW with minor trends in the NW-SE directions.

Foliation

This is a planar structure characteristic of metamorphic rocks. It results primarily from the parallel to sub-parallel alignment of inequant mineral grains such as micas or amphiboles. These alignments of minerals are induced by the directional stress that characterizes the formation of many metamorphic rocks (Ibrahim *et al.*, 2015). All the strike readings (Table 2) were taken with respect to mineral alignment of the rock and its foliation plane. The plot of rose diagram shows the general orientation of the outcrops as NW-SW with minor orientation in a NE-SW (Fig. 12). This confirms the results of earlier works that most of the rock in the basement complex trends in the NE-SW direction. From Figure 13, it is obvious from the structural interpretation and analysis that the folds, faults, joints and foliations have orientation conforming in direction associated with many of the major tectonic episodes implying that the rocks had undergone polycyclic deformation processes and series modification.

Table 2: Strike readings of foliation trend of the outcrop

S/N	AZIMUTHAL RANGE	Frequency	Percent Frequency (%)
1	100-130	5	50
2	131-160	9	90
3	161-190	9	90
4	191-220	0	0
5	221- 250	1	10
6	251-280	1	10
7	281-310	1	10
8	311-340	8	80
	TOTAL	34	340

Geological Relation of the area

Eiyenkorin and its environs is primarily made up of three major rock units namely; the migmatite-gneiss, granite-gneiss and the banded-gneiss including pegmatite as indicated in the map (Fig.14). Though, the pegmatites bodies occurred as non-mappable discordant intrusive bodies, hence does not appear on the geological map.

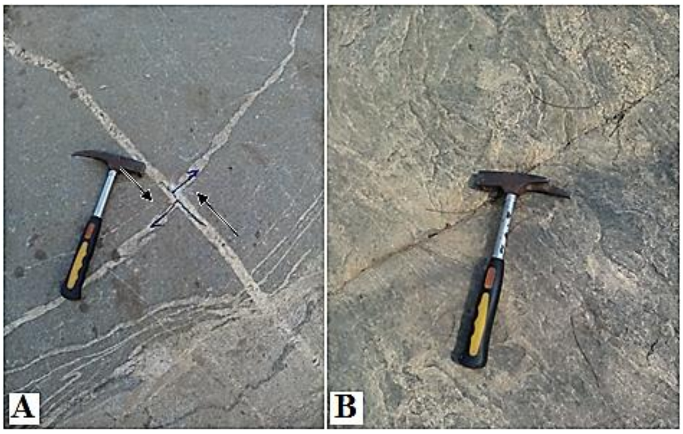


Figure 11: Strike-slip fault on migmatite Gneiss and fracture on Banded Gneiss

IV. CONCLUSION

The study area of Eiyenkorin and its environs lie within the Precambrian mobile belt of south-western Basement Complex of Nigeria. Field observations revealed the area is characterized by rocks of the migmatite complex typified by three main lithologic units; migmatite-gneiss, granite-gneiss and banded-gneiss with non-mappable pegmatites dykes discordantly cutting the different rock units in the area.

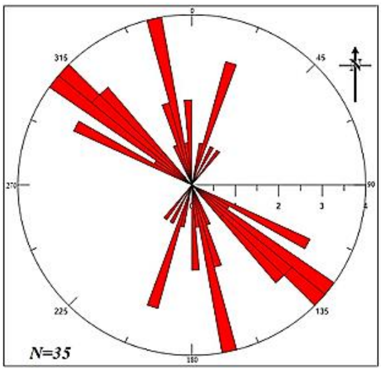


Figure 12: Rosette diagram for strikes of foliation orientation

The presence and occurrence of mineral veins in light (felsic) and dark (mafic) bands with variable thicknesses and associated fold types especially on the migmatite-gneiss is a function of the variability in metamorphic factors with distance from source area. Thin-section analysis of the rocks mineralogical compositions revealed on the average the

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dominance of quartz (55) followed by feldspars (19), biotites (12) while others are minutely and sparingly distributed with accessory minerals (6.5), hornblende (5) and muscovite (2.5). Also, in the study area, the dominant axial trends of the folds are in E-W with few trending NNW-SSW direction along the

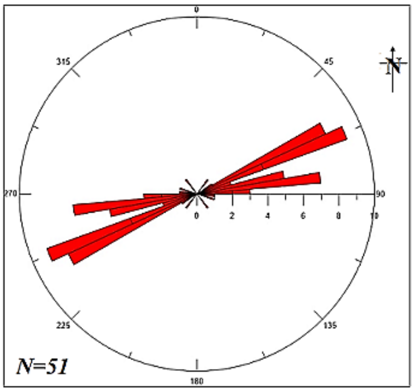

Figure 13: Rosette diagram showing a polycyclic deformation of rocks in the area

southern segment of the granite-gneiss outcrop with an average plunge angle as 27°.

By and large, the Rosette diagram for the strikes of the foliations on the rocks revealed the general orientation of the outcrops as NNW-SSE with minor trends in NE-SW direction and dipping SW.

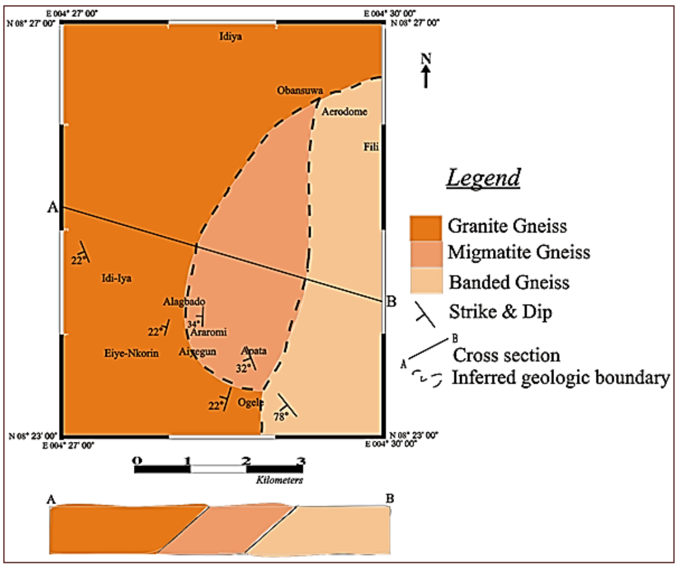

Figure 14: Geological map of the study area

This is in consonance with earlier works that have opined that most rock in the basement complex trends in the NE-SW direction. It is obvious from the structural interpretation and analysis that the folds, faults, joints and foliations have orientation conforming in direction associated with many of the major tectonic episodes implying that the rocks had undergone polycyclic deformation processes and series modification (metamorphism).

References

[1] E. Annor and P.I. Olasehinde, "Vegetational Niche as a Remote sensor for subsurface aquifer: A geological-geophysical study in Jere Area, Central Nigeria". Water Resources, Journal of Nigerian Association of Hydrogeologists, 7(1 and 2), 1996, pp. 26-30.

[2] A. I. Ekeleme, M.U. Uzoegbu, I.E. Abalaka, and A. E. Olorunyomi, "Petrographical Evaluation of rocks around Arikya and its environs, North Central Nigeria". International Journal Geology and Mining, Vol. 3(1), 2017, pp. 103-109.

[3] I. Garba, "Nigeria Journal of Mining and Geology" Vol.38, No.1. 2002.

[4] Ibrhim, A., Toyin, and Z. J. Sanni, "Geological Characteristics and Petrographical Analysis of Rocks of Ado-Awaiye and its Environs, Southwestern Nigeria". International Journal of Applied Science and Mathematics Theory, Vol. 1 No.4, 2015, pp.1-20.

[5] Ilorin Atlas, Geography Department University Press, Ilorin, Nigeria. 1992.

[6] H. A. Jones and R.D. Hockey, "The Geology of part of Southwestern Nigeria" Geological Survey of Nigeria Bulletin, 31: 1964, 101-104.

[7] Malomo, "Geological Map of Nigeria. Geological Survey of Nigeria". 2004.

[8] B. I. Odeyemi, "A review of the Orogenic events in the Precambrian Basement of Nigeria". Geol. Rundesheu, Vol. 70, No 3, 1981, pp. 897-090.

[9] M. Ojo, " Geological Map of Nigeria". Geological Survey of Nigeria.1994.

[10] I. Okunlola, A. N. Amadi, A. O. Dinde, and L. L. Kolawole L. L. "Geotechnical and Geochemical Properties of Lateritic Profile on Migmatite-Gneiss along Ogbomosho-Ilorin Highway, Southwestern Nigeria". Civil and Environmental Research, Vol.7, No.4, 2015, pp.79-85.

[11] M.A. Rahaman, "Review of the Basement Geology of Southwestern Nigeria." In: Kogbe C.A. (ed.): Geology of Nigeria, Elizabethan Publishers Co. Lagos, 1975, pp. 41-58.

[12] M.A. Rahaman, "Recent Advances in the Study of the Basement Complex of Nigeria". In: Oluyide, P.O., Mbonu, W.C., Ogezi, A.E.O., Egbuniwe, I.G., Ajibade, A.C. and Umeji, A.C. (eds.) Precambrian Geology of Nigeria. Geological Survey of Nigeria, Kaduna, 1988, pp. 11-43.

[13] E. Annor and P.I. Olasehinde, "Vegetational Niche as a Remote sensor for subsurface aquifer: A geological-geophysical study in Jere Area, Central Nigeria". Water Resources, Journal of Nigerian Association of Hydrogeologists, 7(1 and 2), 1996, pp. 26-30.

[14] A. I. Ekeleme, M.U. Uzoegbu, I.E. Abalaka, and A. E. Olorunyomi, "Petrographical Evaluation of rocks around Arikya and its environs,

North Central Nigeria". International Journal Geology and Mining, Vol. 3(1), 2017, pp. 103-109.

[15] I. Garba, "Nigeria Journal of Mining and Geology" Vol.38, No.1. 2002.

[16] Ibrhim, A., Toyin, and Z. J. Sanni, "Geological Characteristics and Petrographical Analysis of Rocks of Ado-Awaiye and its Environs, Southwestern Nigeria". International Journal of Applied Science and Mathematics Theory, Vol. 1 No.4, 2015, pp.1-20.

[17] Ilorin Atlas, Geography Department University Press, Ilorin, Nigeria. 1992.

[18] H. A. Jones and R.D. Hockey, "The Geology of part of Southwestern Nigeria" Geological Survey of Nigeria Bulletin, 31: 1964, 101-104.

[19] Malomo, "Geological Map of Nigeria. Geological Survey of Nigeria". 2004.

[20] B. I. Odeyemi, "A review of the Orogenic events in the Precambrian Basement of Nigeria". Geol. Rundesheu, Vol. 70, No 3, 1981, pp. 897-090.

[21] M. Ojo, " Geological Map of Nigeria". Geological Survey of Nigeria.1994.

[22] I. Okunlola, A. N. Amadi, A. O. Dinde, and L. L. Kolawole L. L. "Geotechnical and Geochemical Properties of Lateritic Profile on Migmatite-Gneiss along Ogbomosho-Ilorin Highway, Southwestern Nigeria". Civil and Environmental Research, Vol.7, No.4, 2015, pp.79-85.

[23] M.A. Rahaman, "Review of the Basement Geology of Southwestern Nigeria." In: Kogbe C.A. (ed.): Geology of Nigeria, Elizabethan Publishers Co. Lagos, 1975, pp. 41-58.

[24] M.A. Rahaman, "Recent Advances in the Study of the Basement Complex of Nigeria". In: Oluyide, P.O., Mbonu, W.C., Ogezi, A.E.O., Egbuniwe, I.G., Ajibade, A.C. and Umeji, A.C. (eds.) Precambrian Geology of Nigeria. Geological Survey of Nigeria, Kaduna, 1988, pp. 11-43.

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