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Research Article

PETROLOGY AND STRUCTURAL GEOLOGY OF IKPESHI AND IT'S ENVIRON OF IGARRA SCHIST BELT SOUTHWESTERN NIGERIA

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ABSTRACT

Ikpeshi and its environ lies within latitudes $7^0$08'N to $7^0$10'N and longitudes $6^0$10'E to $6^0$15'E and is part of Igarra schist belt, southwestern Nigeria. It comprises of metasedimentary rocks which include schist, amphibolite, calc-silicate and marble which have been subjected to polyphase deformation and have subsequently been intruded by post-tectonic granitic rocks of Pan-African (600±150Ma) age. Minerologically, average modal composition shows that the rocks in the area consist of quartz, k-feldspar, plagioclase, mica, muscovite and calcite as the major minerals while opaque are accessory minerals. More than three phases of deformational episode have been recognized in the rocks of this area. The first phase was associated with the development of the regional foliation with open, close, tight to isoclinal folds. Followed by the heterogeneous deformation which gave rise to ductile shear zones, in an extensional tectonics environment. The third phase produces the dominant major folding on an approximately NW-SE axis and the last phase is associated with open folds added to the earlier formed structures. The structural element in the study area shows multidirectional orientations. Rocks in the study area have a general and consistent trend as revealed by rose diagrams and stereographic projection in NNW–SSE, and a few N-S to NE-SW direction which is an indicative of Pre-Pan-African orogeny. The other trends as revealed by the plots which is not prominent, is in E-W and ENE-WSW direction are relicts associated with Pre-Pan African orogenic events.

Keywords: Rocks types, Deformation, Structural features, Tectonic trends ,Igarra SW, Nigeria

INTRODUCTION

The study area, Ikpeshi and its environs in Igarra lies within the Southwestern Basement Complex of Nigeria Fig.1. This is a part of the major lithology component that makes up the geology of Nigeria. The Basement Complex of Nigeria lies within the Pan African mobile belt to the east of West Africa Craton (WAC) and northwest of the Gabon Congo Craton (GCC). The Complex is broadly classified into two provinces; the western province comprises mainly narrow metasediment (schist) which trend N-S, the schist in this province form schist belt which also includes other rocks mainly migmatite, gneiss, marble and all were intruded by Pan-African granitic plutons. While the Eastern province is migmatite-gneiss complex which is being intruded by larger volumes of Pan-African granite with the Mesozoic ring complexes of central Nigeria (Ajibade and Wright, 1988).

Evidence from the eastern and northern margins of West Africa Craton shows that Pan African belt is as a result of plate tectonic processes (Ukaegbu, 2003). The Basement Complex of southwestern and northwestern parts of Nigeria has suffered more than two episodes of deformation with the Pan-African episode being the most pervasive (Grant, 1978).

The deformation patterns of the Nigerian Basement Complex have been reported to be very complex Ogezi, (1977). So it is imperative to constantly evaluate the petrology and structural geology of the study area. Hence, this study will also add knowledge to the works already done by Oyawoye (1967),Rahaman, 1976, 1988, and Egbuniwe et al (1978). To update the previous works by mapping, collecting and analyzing geological data to produce more information in the study area, for the better understanding of the geology of the Basement Complex.

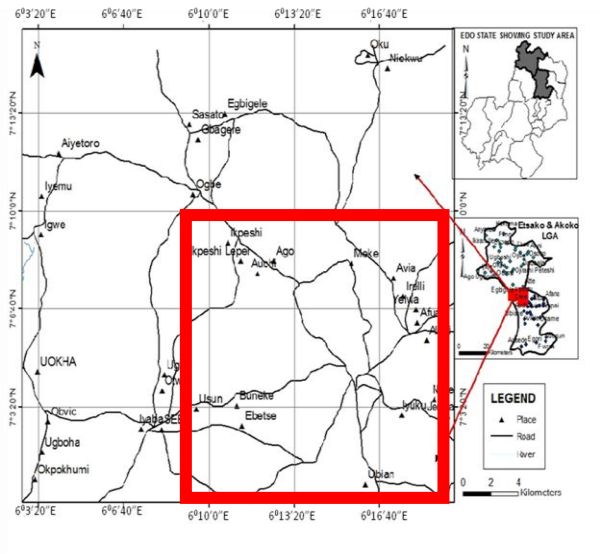


Figure 1: Location map showing the study area.

Local geology of the study area:

The study area, Ikpeshi and its environ lies within the Pre-cambrian Basement Complex of Southwestern Nigeria. The schist in the study area is foliated in NW-SE direction and some others N-S, there is also occurrences of quartz veins, joints and fractures in the granite body. The Igarra granites intruded the most easterly schist belts in southwestern Nigeria (Turner, 1983).

The Igarra region is underlain by rocks of the Precambrian Base-ment Complex and about four major groups have been observed within this area. These are the migmatite-gneiss complex, the metasediments (schists, calc-silicate rock, quartzites, marble, metaconglomerates) and the porphyritic older granite whi-ch are discordant, non metamorphosed syenite dyke (Odeyemi, 1976). Figure 2 is the geological map of the area showing large deposits of granite plutons to eastern parts of the study area Iyuku.

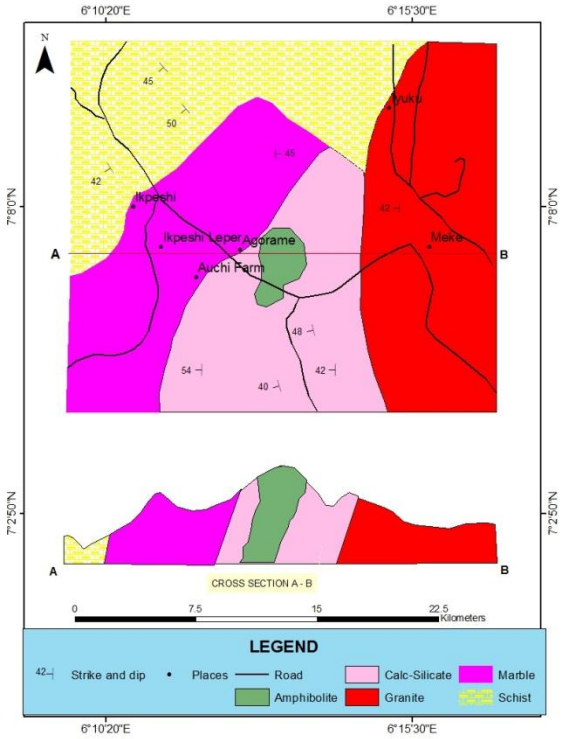


Figure 2: Geological map of Ikpeshi and its environs.

Petrology:

Rocks around Ikpeshi and its environs in the Igarra schist belt consist of a highly deformed metamorphic suite, which have been intruded by igneous plutons of Pan-African age. The major rocks in the study area include schist, amphibolite, marble, calc-gneiss and granite (Fig. 2). The granite in the area has dome-shaped range with white colouredphenocrysts. The rocks are fairly well exposed with the level of exposure approaching sixty percent in some places. These like the Igarra plutons are dome-shaped and

contain small whitish phenocrysts intruding basically schist and rarely metaconglomerate and calc-silicate rocks.

Metamorphic petrology:

Schist that occur in the study area and are highly deformed. The schist in the study area are foliated. They occur as homogeneous massive rock unit. This schist has shown to have been affected by cycles of metamorphism and granitization. They have varieties, trend depend on the degree of metamorphism and deformation. Typically, they are melanocratic, fine grained with dark and grey bands. The thickness of individual grain varies between few millimeters, the darker band contain more biotite than the lighter variety. The leucocratic minerals are quartz and feldspar, this quartz gives rise to granular texture while the biotite and hornblende is responsible for the foliation Plate 1.

Plate 1a: Field photograph showing quartzite in schist alongAuchi - Ikpeshi road.

X25 (XPL)

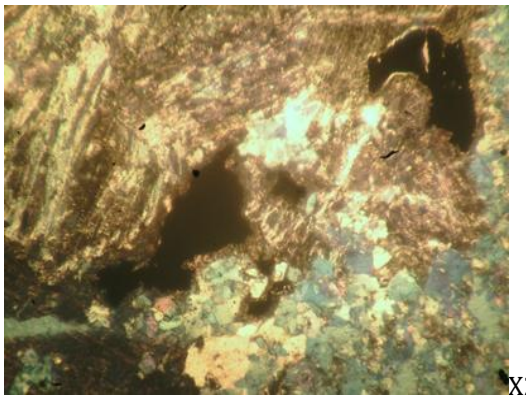
Plate 1b: Photomicrograph of schist showing biotite, quartz,and K-feldspar at Ikpeshi

Amphibolite:

Amphibolite occurs as a fine-medium grained metamorphic rock composed mainly of hornblende. It was formed by the regional metamorphism of basic igneous rocks and is banded type of amphibolite. The banded variety has thin layers of quartzo-feldspathic materials, alternating with thick dark bands consisting of mainly hornblende and minor phyllosilicate minerals in the study area, it constitutes less than 15% of the total area underlain by rocks.

Amphibolites are associated with dolerite stocks, which are chemically related, but the amphib-olites are probably older because they have been deformed and metamorphosed Plate 2.

Plate 2a: Field photograph showing amphibolite at the boundary between Iyuku and Ikpeshi along Igarra road.



X25 (XPL)

Plate 2b: Photomicrograph of foliated amphibolite showing prefered allignment of minerals, solution

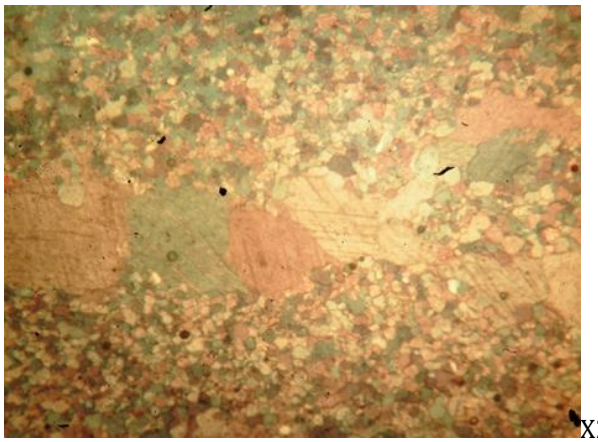
carvities, quartz, biotite and hornblende

Marble and Calc-silicate rock:

Marble deposits are present in many areas. They are being mined by small scale miners for industrial minerals and rocks Plate 3. The calc-silicate rocks are similar to marble, medium to coarse-grained with porphyroblasts Plate 4. In photomicrograph, marble contains high amount of calcite, (56%), (calcium carbonate), some amount of quartz (19%), wallastonite (20%), and opaque minerals (4%) Table 1.

Dolomitic marbles usually contain brucite crystals, while the schistose variety may contain tremolite and diopside. The minerology of carbonate rocks are chiefly a dependant of the type and amount of impurities present and this also determines their colour Plate 3. While calc-silicate contain quartz (15%), calcite (63%), wallastonite (16%), and opaque minerals (3%) (Plate 4a and b).

Plate 3a. Field photograph showing a white coloured marble at Freedom Quarry in Ikpeshi.



X25 (XPL)

Plate 3b: Photomicrograph of marble at Freedom Quarry showing allignment of minerals in their preffered orientation with calcite having the higher modal percentage.

Plate 4a: Field photograph showing a calc-silicate rock with joints and folded structures in Ikpeshi.

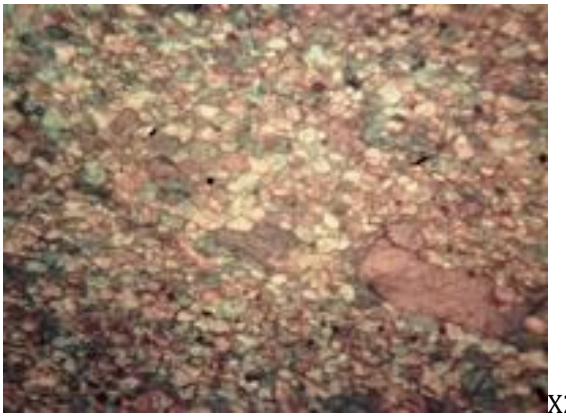
 X25(XPL)

Plate 4b: Photomicrograph of calc-silicate in Ikpeshi showing serpentine, quartz and calcite with twining and perfect cleavage

Igneous Petrology – Granite:

There are grey, pink and white types of granite in the area. They dorminant in the eastern part, also small unmappable exposure are present in the western part of the study area. Plates 5 and 6.

Plate 5a: Field photograph showing porphyritic Biotite granite,quartz andfeldspar phenocrysts are pronounced at Iyuku.

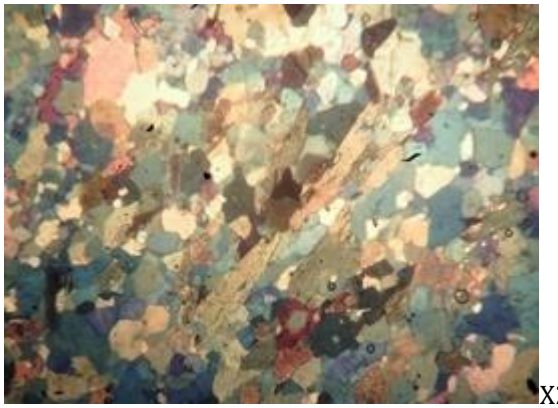

X25(XPL)

Plate 5b: Photomicrograph showing biotite, quartz and plagioclase at Iyuku porphyritic Biotite granite.

Plate 6a: Field photograph showingporphyritic biotite granite with exfoliation weathering exposing fresh surface for weathering in Iyuku.

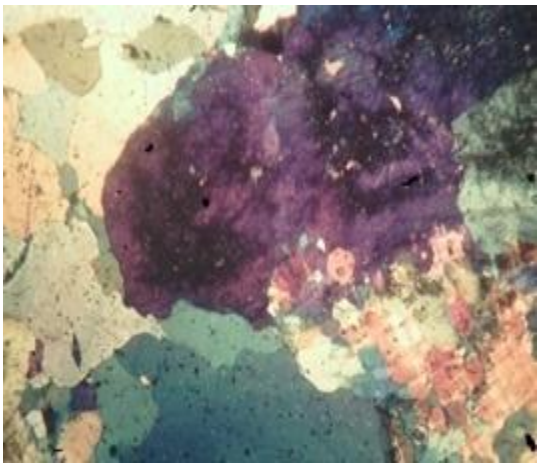


Plate 6b: Photomicrograph of granite showing quartz , microclne, biotite and plagioclase in Iyuku.(X25 XPL)

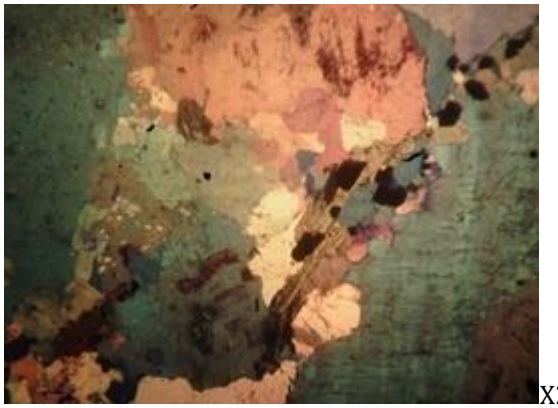

X25(XPL)

Plate 6c: Photomicrograph of granite in Iyuku showing quartz, K-feldspar, opaque minerals and biotite.

Minerals	Rock Samples				
	Schist	**Amphibolite**	**Calc-silicate**	**Marble**	**Granite**
Quartz	20	22	12	19	36
K-feldspar	12	—	—	—	40
Plagioclase	22	—	—	—	10
Biotite	8	—	—	—	7
Muscovite	20		—	—	4
Hornblende	4	60	—	—	—
Garnet	8	10	—		—
Calcite	—	—	63	56	—
Wollastonite	—	—	10	20	—
Serpentine	—	—	12	-	—
Accessory minerals	2	—	—	—	—
Opaque minerals	4	8	3	4	2

Table 1: Average modal composition of the rocksample

Structural geology:

A study of the structural features and trend of rocks in the study area was carried out, in microscopic, mesoscopic and megascopic scales both in the field and laboratory. Rocks in Ikpeshi and its environs have

varieties of structural profile, with the granites hosting the least of these structures when compared to the schists and other metamorphic rock types. The metamorphic rocks have suffered polyphase deformation to various degrees as shown by the presence of multiple trending deformational features such as foliations, fractures and fold axes.

The general structural trend of rocks in the study area varies, but the dominant trend is in NNW trending flat lying superacrustal cover of metasediments in which the fracture-controlled Pan-African granitoids have intruded, which give rise to migmatization and granitization of country rocks in many parts of the area. There are varieties of folds in the study area due to the extensive deformation of rocks in Ikpeshi and its environ (Plates 7 - 9). Folds (F1) are associated with tight to isoclinals folds, and show a consistent dip in the northern direction.

Plate 7: Field photograph showing recumbent fold at Oyami river at Ikpeshi

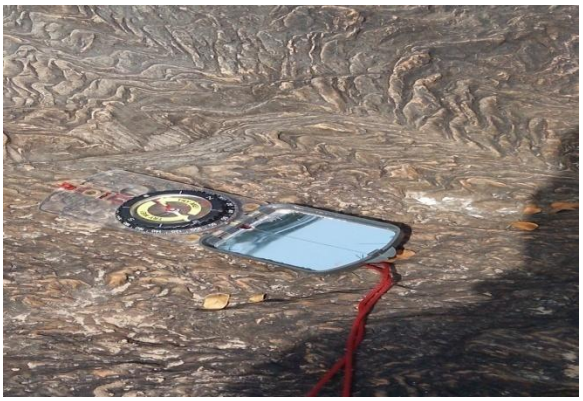


Plate 8: Field photograph showing syn-forms type of fold At Oyami river in Ikpeshi

Plate 9: Field photograph showing chevron folds at Oyamiriver in Ikpeshi.

Linear Structures:

Lineation is the preferred alignment and orientation of mineral grains in a rock. It is non-dimensional features in a rock and it is so common in schist. The fracture trend shows high peak in N-S, NE-SW and NNW-SSE direction but the general orientation of the structures varies. Due to complex deformation of the rocks, sub-areas of structural homogeneity have been identified. The re-orientations of the earlier structures are good indicators of multiple deformations. Mineral lineation resulting from stretching and preferred alignment of quartz, feldspar and mica is the common form of lineation in the study area (Plate 10).

Plate 10: Field photograph showing stretching and preferred alignment of quartz, feldspar and mica on schist at Ikpeshi.

Measurements of planar and linear features were plotted on rose diagrams and stereonets as shown on Figs 3 – 6 and Figs 7 – 9.

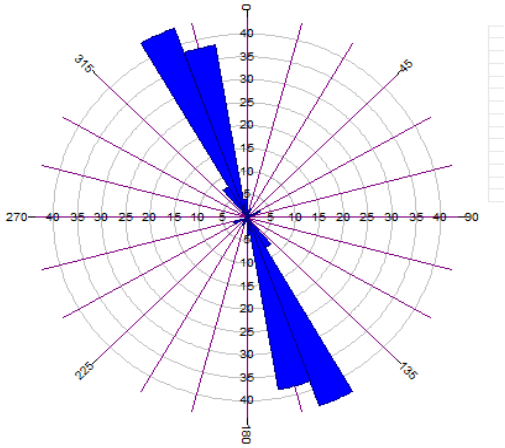


Figure 3: Rose diagram of mineral lineation in Ikpeshi area indicating high peak in NNW and SSE direction and this confirm with Pre-Pan-African.

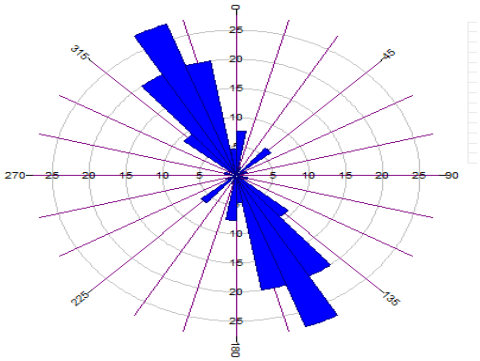


Figure 4: Rose diagram of mineral lineation at Oyami river in Ikpeshi area indicating high peak in NNW, SSE and minor NE-SW direction and this confirm with Pre-Pan-African.

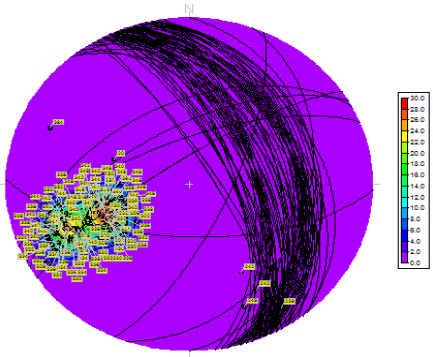


Figure 5: Stereonet of mineral lineation trends in Ikpeshi area showing clusters towards NW and SE direction.

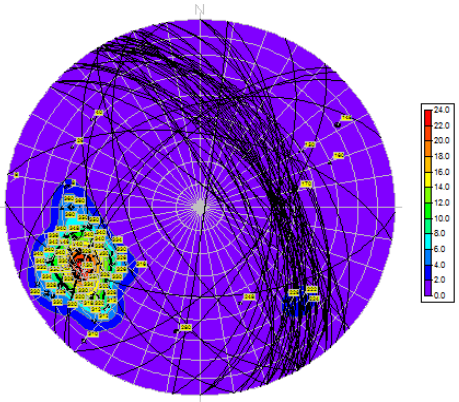


Figure 6: Stereonet of mineral lineation trends at Oyamiriver in Ikpeshi area showing clustered trend in SW and a few in NE direction which is an indication of Pre-Pan African.

The fold measurement were taken and rose diagram was plotted on fold left limb (LL), fold axis (FA), and fold right limb (RL), (Figs. 7-9) respectively.

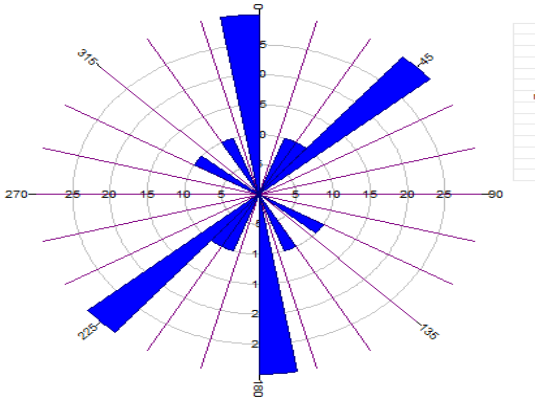


Figure 7:A rose diagram of fold left limb (LL) at Oyami river showing preferred trend in the NNW-SSE and NE-SW direction

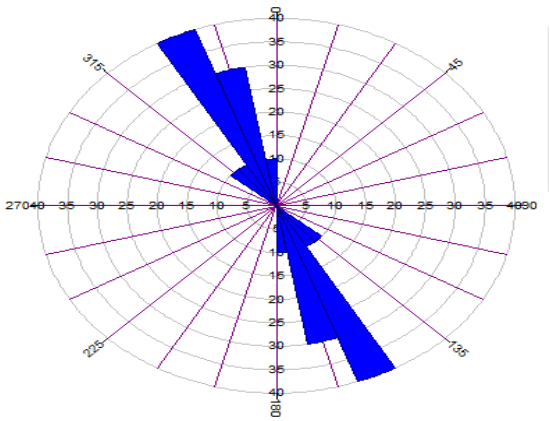


Figure 8: A rose diagram of fold axis (FA) at Oyami river showing preferred trend in the NNW-SSE direction.

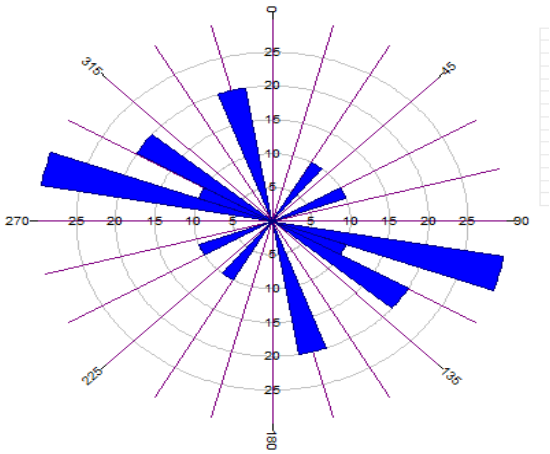


Figure 9: A rose diagram of fold right limb (RL) at Oyami river showing preferred trend in the NNW-SSE and minor NE-SW direction

DISCUSSION

An attempt was made to infer on structural characteristics of the rocks in the absence of geochemical data, based on the information from cross section, petrography and field relations rose diagrams and stereonets. Against this background certain inferences can be drawn from the available facts. Regionally, the Basement Complex rocks have been affected by a number of metamorphic and orogenic events as seen by the presence of dyke and drag folds. Studies have shown that schist bodies immediately adjacent to the granite intrusion have fine to medium grains and poor foliation compared to other schist bodies Rahaman and Ocan 1978. While the granite bodies nearer the schist and metaconglomerate are fine grain and tend to coarse as you move up towards the plutons pointing to the fact that the temperature and presuure were probably

similar. Quartz veins of varying sizes form concordant and discordant structural features which reflect the presence of zone of weakness in the country rocks which resulted during the emplacement of granite. These structural features are important in engineering of good pavements Egesi and Tse (2012).

The metasediments constitute the oldest rock suites as they form the foundation upon which other rocks were emplaced and into which some have intruded. These rocks are products of repeated cycles of deformation and metamorphism of ancient sediments and igneous bodies. The close association of these rocks implies that they were originally deposited in a littoral setting.

CONCLUSION

The study area has two distinct rock types, metamorphic at Ikpeshi area and Igneous at Iyuku area. Metamorphic rocks of Igarra North-West are distributed in the Basement Complex. They are mostly metasediments, schists, marbles, amphibolites and calc-silicate rocks . This is as a result of multiple periods of regional metamorphism that affected the ancient sedimentary series that covered the study area. This deformation, metamorphism and magmatism produced schists, quartzites and calc-silicates. Probably, produced the multiple structural features that were observed. The granite in the study area range from medium to coarse grained, the coarse grained forms the porphyritic granite of Iyuku and it is as a result of the long time that it took for the magma to cool, while the fine grained feature at the contact point, is as a result of fast cooling and it forms the non-porphyritic granite in the study area.

The structural analysis of linear structures, displacement indicators, planar structures and fractures of the rocks in the study area shows that the area has at least undergone three stages of tectonometamorphic events in the NW – SE direction and minor NE – SW trend. The structural element in the study area shows multidirectional orientations.

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