Petrography, Structural characteristics and Mineral resources of Igue Oke Igarra area Southwestern Nigeria.

ABSTRACT
Igue Oke area and its environs is part of Igarra schist belt, southwestern Nigeria. The rocks consists of metasedimentary rocks which include marble, schist, meta-coglomerates, amphibolites, calc-silicate rocks which have been subjected to polyphase deformation and have subsequently been intruded by syn-tectonic granitic rocks of Pan-African age which lasted for about 300 million years. Minerologically, the rocks in the area consists of quartz, k-feldspar, biotite, plagioclase, mica, muscovite and calcite as the major minerals while opaque are major accessory minerals. Two phases of deformational episodes 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 second deformation which gave rise to ductile shear zones, in an extensional tectonics environment. The second 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 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 directions. 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 orogeny. Exploitation of granites has been going with established quarrying firms for granites, while mining of marble by small-scale miners has been going on without proper design or plan causing badland topography, a three bench mine design with reclamation procedures will be appropriate for the area.

K**eywords:** Rocks types, Structural characteristics, Mineral resources, Igue Oke area, Igarra Southwestern, Nigeria

1. Introduction

Igue Oke and its environs in Igarra area, lies within the southwestern Basement Complex of Nigeria Fig.1. The study area are parts of Agor, Ikpeshi, Ojukutu and Igue Oke. 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)[1], [2]. The complex is broadly classified into two terranes; the western terrane comprises mainly narrow metasediment (schist) which trend N-S, the schist in this area form schist belt which also includes other rocks mainly migmatite, gneiss, marble and schist, calc-silicate hornfels and calc-silicate rocks which were intruded by Pan-African granitic plutons. While the northern parts are mainly migmatite complex which has been intruded by larger volumes of Pan-African granite in places with the Mesozoic ring complexes of central Nigeria [3].

Field evidence from the eastern and northern margins of WAC shows that Pan African belt is as a result of plate tectonic processes which gave the similarities and differences in the geology of the eastern Nigerian and western Cameroon basement and western Nigerian basement [4]. 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 longest for about 300 million years is most pervasive.

The deformation and structural patterns of the Nigerian Basement Complex have been reported to be very complex [5]. [6] using satellite imagery concluded that NE-SW and NW-SE diagonal lineaments are preponderant over other fractures reflected on the Nigerian basement and they increase from west to east that is, towards the Bamenda massif of the Cameroon. The extractive industry in Nigeria need to know, where did we go wrong? [7] to enable Nigeria enhance its minerals exploration and production. Therefore, there is need to update and evaluate the rocks and mineral resources of the area as more information are obtained from recent exploration and mining activities in Igarra mineral district.

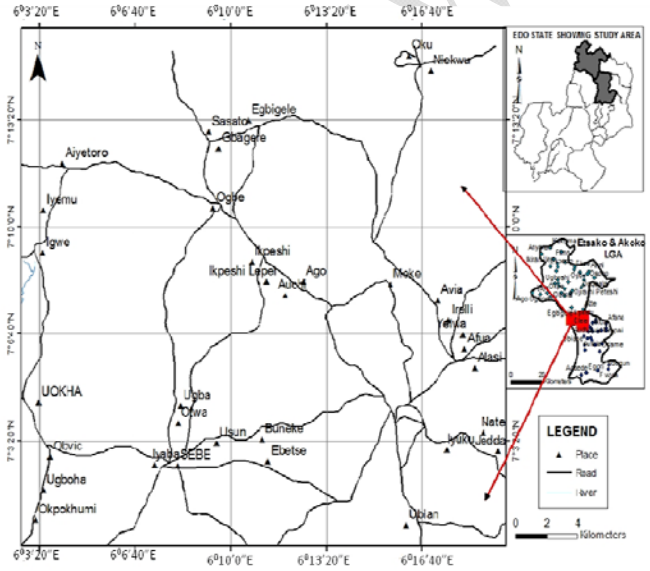


Figure1. Location map showing Igue Oke, Agor (Sebe Ogbe), Ojukutu, Ikpeshi and its environs.

2. Geology of the study area

Igue Oke, Agor, Ikpeshi and Ojukutu lies within the Pre-Cambrian Basement Complex of southwestern Nigeria. The rock types includes meta-conglomerates, quartzites, amphibolites, schists, calc silicate rocks, marbles, meta-sediments and granites. The schist in the area is foliated in NW-SE direction and some others N-S, there is also occurrences of quartzite veins, joints and fractures

in the granite body. The Igarra granites intruded the most easterly parts of schist belts in southwestern Nigeria [1]. Petrology and structural geology of the area have received attention workers such as [8].

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, metaconglo merates;and the porphyritic older gr anite which are discordant, non metamorphosed syenite dyke. Figure 2 is the geological map of the area showing large deposits of granite plutons to the western parts of Ikpeshi, which traverses northwards to Ojukutu area.

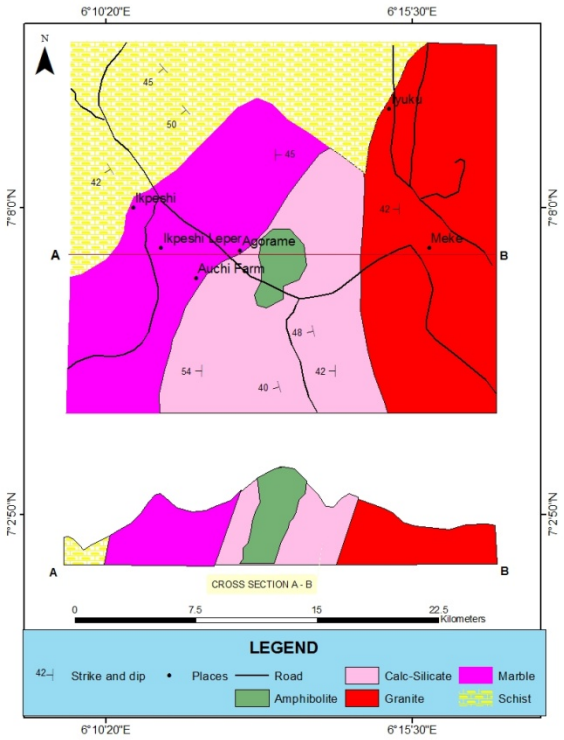


Figure 2. Geological map of Igue Oke area [9].

3. Petrography

The rocks at Igue Oke area are marbles, calc silicate rocks and amphibolites; Agor market area are meta-conglomerates, quartzites and schists; at Ojukutu is porphyritic biotite granite while the Ikpeshi rocks are marble, amphibolites, dolerite and granite. The major rocks in the study area include schist, amphibolite, marble, calc-schist and granite (Fig. 2). The granite in the area has dome-shaped structures with colourless, white and flesh pink coloured phenocrysts of quartz, plagioclase and orthoclase. The rocks are well exposed with the level of exposure approaching seventy five percent in some places. These like the Igarra town granite plutons are dome-shaped and contain small whitish phenocrysts intruding basically schist and rarely meta-conglomerate, marble and calc-silicate rocks. Unlike the Igarra granite which are dark-coloured and over 526m high they are about 168m high and light-coloured with large phenocrysts of quartz and feldspar.

3.1 Metamorphic Rocks

The schist are dark coloured highly deformed and foliated. They occur as homogeneous massive rock unit with veins of quartzite particularly at the boundary between sedimentary and basement contact. The schist at Agor market area were metamorphosed with meta-conglomerate and quartzite. The pebbles of in the meta-

conglomerate are stretch in N-S direction. They have varieties, trend depends on the degree of deformation, metamorphism and magmatism. 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 and hornblende than the lighter varieties. 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 is a field photograph showing a vein of quartzite in schist near the sedimentary/basement contact.

Plate 1a.Field photograph showing quartzite in schist along Auchi - Ikpeshi road.

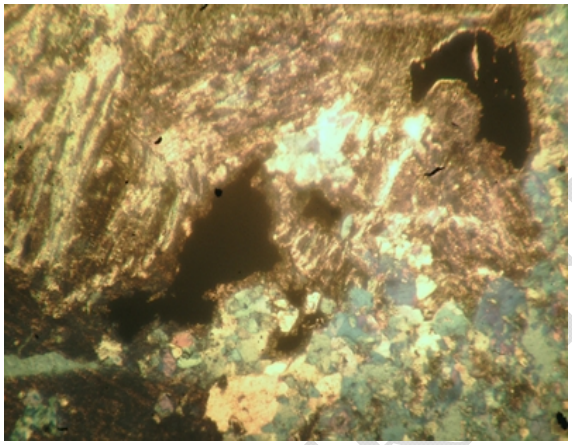
X25 (XPL)
Plate 1b. Photomicrograph of schist showing biotite, quartz ,
and K-feldspar at Ikpeshi

3.2 Amphibolites

Amphibolites are present at Ikpeshi and Igue Oke areas and 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 a banded type of amphibolites. The banded variety has thin layers of quartzo-feldspathic materials, alternating with thick dark bands consisting of mainly hornblende and minor accessory minerals in the study area, it constitutes less than 10% of the total area underlain by rocks.

Amphibolites are associated with dolerite dyke, 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 amphibolites at the boundary between Ikpeshi and Agor along Igarra road.



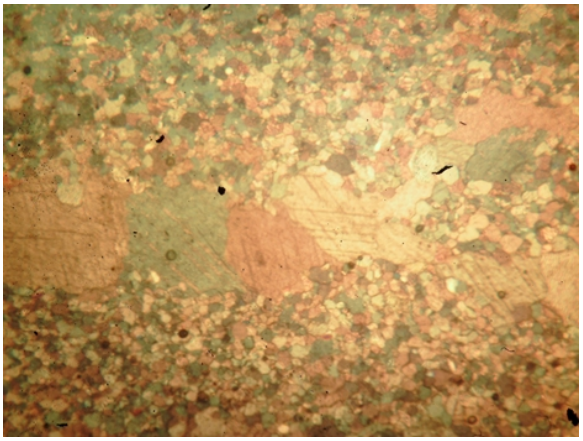
X25 (XPL)
Plate 2b: Photomicrograph of foliated amphibolite showing prefered allignment of minerals, solution carvities, quartz, biotite and hornblende.

3.3 Marble and Calc-silicate rocks.

Marble deposits are present at eastern and western parts of Igue Oke and several locations around Ikpeshi. They are being mined by everal 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, (calcium carbonate), some amount of quartz, accessories and opaque minerals 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 , calcite,
accessories, and opaque minerals (3%) (Plate 4a and b).

Plate 3a. Field photograph of marble mining pit at Igue Oke

Plate 3b. 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.

X25(XPL)

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

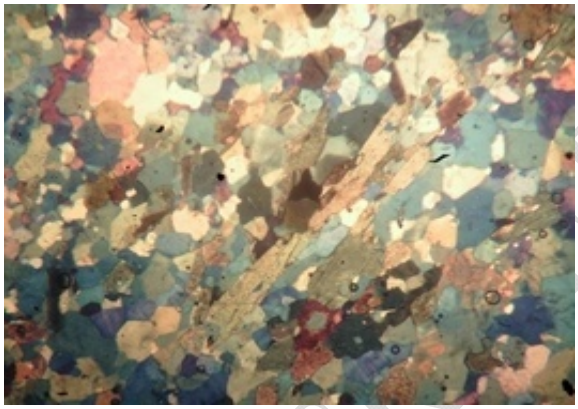
3.4 Igneous Rocks

The granites are grey, pink and white types of granite in the area. They dorminant in the extreme eastern part, and also reasonable exposure are present in the western part of the study area. Plates 5 and 6.

Plate 4. Field Photograph marble and calc-silicate truncated with a fault in NE-SW at Igue Oke

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

Plate 5b: Field photograph showing Porphyritic
biotite granite with exfoliation weathering exposing fresh surface for weathering in Iyuku.



X25(XPL)

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

Plate 6a. Field Photograph of Ojukutu porphyritic granite.

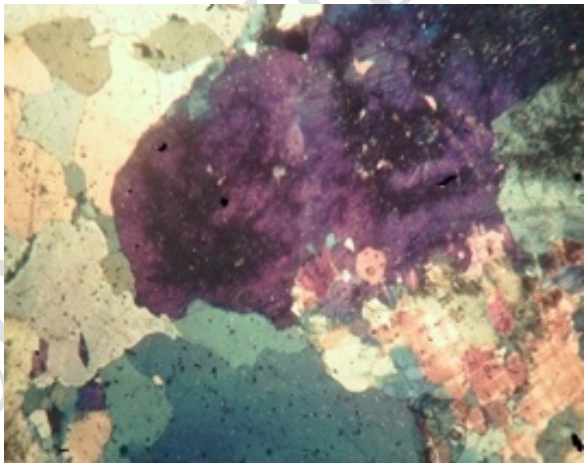
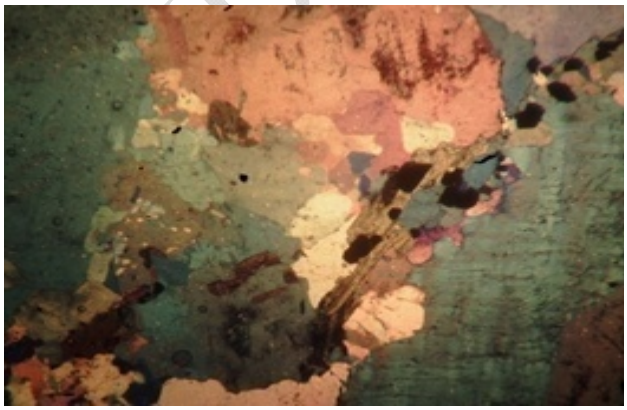


Plate 6b: Photomicrograph of granite showing quartz , microcline, biotite and plagioclase in Iyuku.(X25 XPL)

Table 1. Average modal composition of minerals from the rocks from the area

Minerals	Rock Samples						
	Schist Ikpeshi	Amphibolites Ikpeshi	Calc-silicate Igue Oke	Marble Ikpeshi	Marble Igue Oke	Granite Iyuku	Granite Ojukutu

Quartz	23	22	12	2	5	36	38
K-feldspar	15	-	-	-	-	30	25
Plagioclase	20	-	-	-	-	10	15
Biotite	8	-	-	-	-	7	10
Muscovite	10	-	-	-	-	4	-
Hornblende	4	60	-	-	-	-	-
Alumina	8	10	-		-	-	-
Calcite	-	-	63	65	75	-	-
Dolomite	-	-		9	5	-	-
Serpentine	-	-	12	-	-	-	-
Garnet	-	-		-	-	-	-
Pyroxene	-	-		-	-	-	trace
Accessory minerals	7	-	10	20	9	8	9
Opaque minerals	6	8	3	4	6	4	3



X25(XPL)

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

4. 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 like amphibolites at Ikpeshi area 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 deformational episodes 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

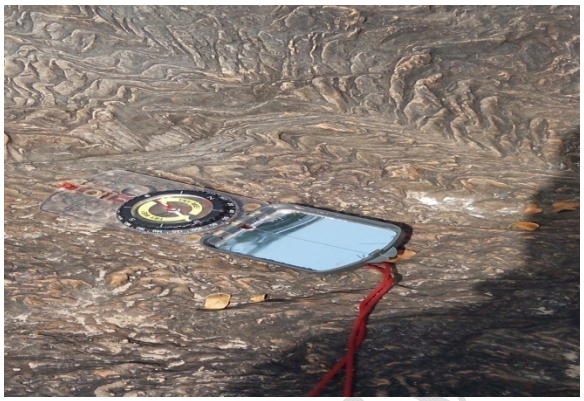


Plate 8: Field photograph showing syn-forms type of fold At Oyami river in Ikpeshi

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

5. 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 – 7 and Figs 8 – 9 respectively.

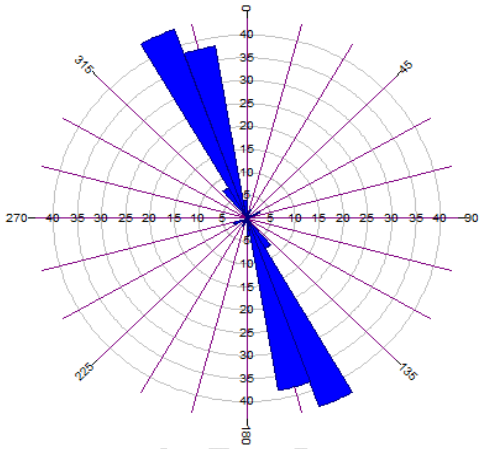


Figure 3: Rose diagram of mineral lineation in Ikpeshi area indicating high peak in NNW and SSE direction and this confirm with Pre-Pan-African.

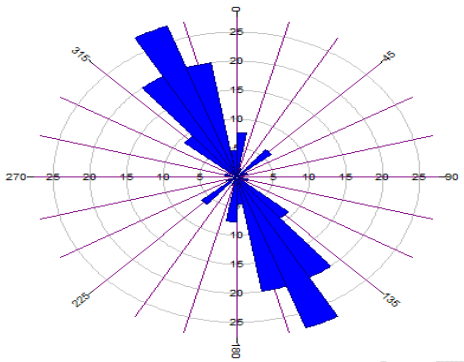


Figure 4: Rose diagram of mineral lineation at Oyami river in Ikpeshi area indicating high peak in NNW, SSE and minor NE-SW direction and this confirm with Pre-Pan-African.

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.

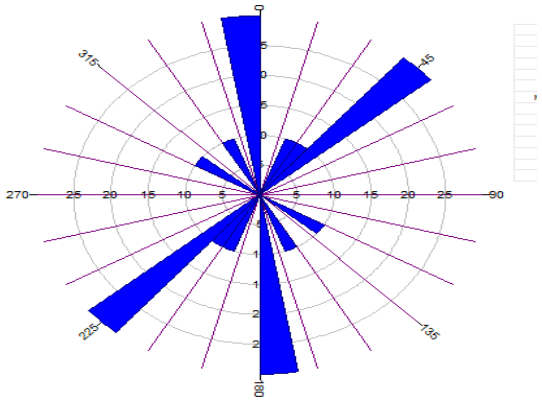


Figure 5. A rose diagram of fold left limb (LL) at Oyami river showing preferred trend in the NNW-SSE and NE-SW direction

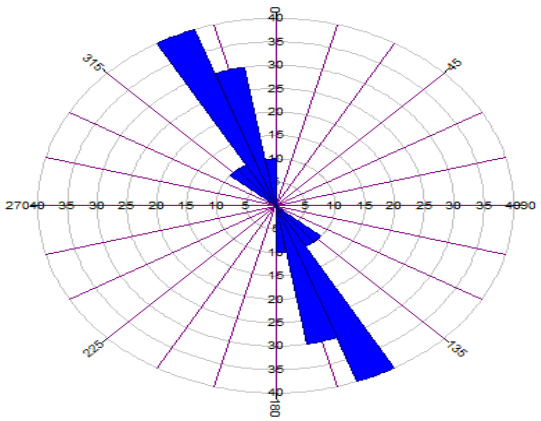


Figure 6: A rose diagram of fold axis (FA) at Oyami river showing preferred trend in the NNW-SSE direction.

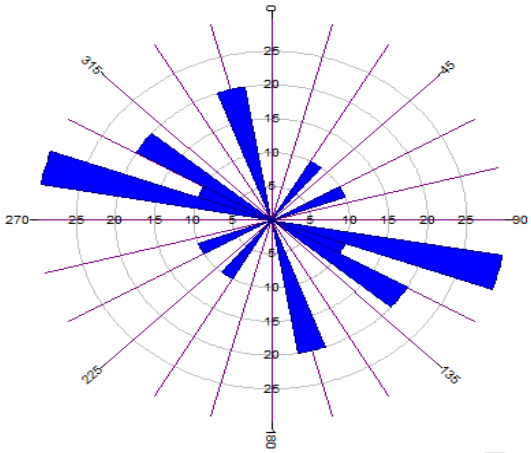


Figure 7: A rose diagram of fold right limb (RL) at Oyami river showing preferred trend in the NNW-SSE and minor NE-SW direction

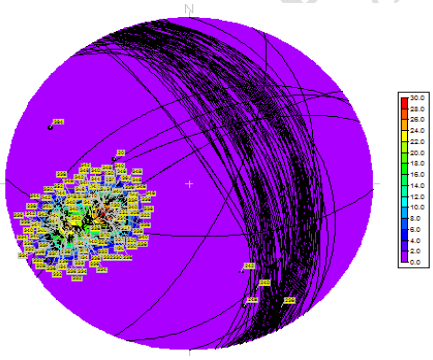


Figure 8: Stereonet of mineral lineation trends in Ikpeshi area showing clusters towards NW and SE direction.

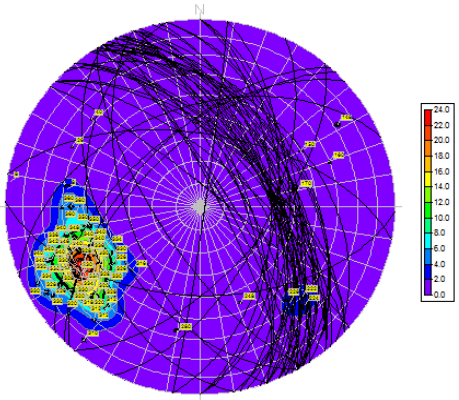


Figure 9: Stereonet of mineral lineation trends at Oyami river in Ikpeshi area showing clustered trend in SW and a few in NE direction which is an indication of Pre-Pan African.

6. Discussion

An attempt was made to infer on structural characteristics of the rocks, based on the information from petrography, field relationships, rose diagrams and stereonets. The structural element in the study area shows multidirectional orientations [10]. 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. While the granite bodies nearer the schist and metaconglomerate are fine grained and tend to coarse as you move up towards the plutons pointing to the fact that the temperature and presssure 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

exploration and exploitation of the rocks for engineering of good pavements [11].

The production of dimension stone which are stone cut or quarried accordance with specific dimensions has huge potentials in the area [12]; [13] observed that a typical semi-mechanized marble quarry site at Igue Oke produces 300 metric tons of high quality un processed dimension stone at N 2, 500 per ton. It will equally generate huge employment opportunities if fully mechanized.

7. Conclusion

The rock types of more economic importance in the area are, marble which are being quarried on small-scale and semi large-scale at Igue Oke and Ikpeshi areas while granite at Ojukutu and Iyuku areas. The structures observed are 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 rocks. It also produced the multiple structural features that were observed with the intrusion of granite plutons. The granite in the study area range from medium to coarse grained, the coarse grained forms the porphyritic granite of Ojukutu and Iyuku areas.

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 and N-S direction and minor NE-SW trends. The huge potentials for dimension stone production in the area should not be truncated by interests in importation of finished and synthetic products from Asia, Europe and America.

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