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# GEOLOGY AND PETROGRAPHY OF ILUKE, NORTH CENTRAL BASEMENT COMPLEX, KIRI SHEET 226, (SW OF NIGERIA)

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**ABSTRACT**

A systematic geological mapping of Iluke, Kiri sheet 226 SW, (Nigeria) was carried out on a scale of 1:50,000.The study shows Migmatite-gneiss complex, Schist, Quartzite and the granitoids, as the major rocks, the minor rocks observed are the amphibolite, pegmatite dykes and veins, while the superficial deposits mapped include laterite and alluvial sands. The schist and amphibolite were subjected to thin section where the petrography of Schist and amphibolite was carried out under Plane Polarized Light (PPL) and Cross Polarized Light (XPL) which revealed mineral assemblages which correspond to the metamorphic facies of the upper greeenschist (Quartz, Chlorite, Sericite, muscovite and plagioclase) and the lower amphibolite facies (Hornblende or amphibole, plagioclase, Quartz, Biotite) that indicates a regional metamorphism. An ultramylonites with less than 10% porhyroblast was observed in the studied area which indicates a dislocation metamorphism. These was done to understand the occurrence of rocks and to determine the metamorphic grade of the study area.

**Keywords**: Assemblages, Metamorphic Facies, Dislocation, Metamorphism, Porphyroblast, Ultramylonite, Petrogenetic, Metamorphic grade

## INTRODUCTION

The studied area is part of the North Central basement complex of Nigerian and also a northern extension of Igarra Schist belt. This is the part of the major lithology that makes up the Geology of Nigeria. The Nigerian Basement complex lies within the mobile belt that separates the West African and Congo Cratons. The West African Craton is to the west while the Congo Craton is to the Southeast of Nigeria.

Evidence from the eastern and northern margins of the West African cratons shows that Pan-African belt Originate from plate tectonics (Ajibade 1987)

Previous work From Kolawole M.S, Onimisi M and Olobaniyi S.B (2017) studied the field occurrence and structural characteristic of basement However, Kolawole M.S Idakwo S.O, Ameh E.G (2021) studied Sn-Ta-Nb mineralization potential of pegmatitic bodies in Bunu ,Na Ta and Sn these are enriched in pegmatite in Otafun and Okutose. Furthermore, Kolawole M.S, Chukwu E.C Agibe A.N (2022) studied the Geochemistry and Petrogenetic evolution of metasedimentary rocks.

Kolawole *etal* (2023*)* carried out a geochemical study on the metavolcanic rock around Bunu. The indication and simplistic three-fold grouping of basement rocks based on lithology and inferred age may not fully capture the complex relationships within the Migmatite-gneiss Complex and the rocks of the Schist belts. Many Pan-African granites exhibit foliation and elongation parallel to the country rocks, further complicating the differentiation between rocks formed during the Pan-African event and those formed during earlier events. Thus, it is challenging to make generalizations or correlations between different areas without sufficient geological data. Establishing the contact relationships between the metasediments and the intrusives or granitoids can be quite cumbersome, due to migmatization. Despite the aforementioned limitations, this work tends to map rock types and boundaries, the field relationships between the various rock types in the area of study, to also determine the metamorphic grade of the study area and produce a geological map of the study area

### The Geology of the study area

The study area is underlain by igneous and metamorphic rocks, which form the basement. There are three broad lithological groups usually distinguished within the Basement Complex, namely; The Migmatite-gneiss complex:is a polymetamorphic geologic body that is composed largely of migmatites and gneisses of various composition and amphibolites. Relict's metasedimentary rocks represented by medium to high grade calcareous, pelitic and quartzitic rocks occur within the migmatites and gneisses, and they have been described as "Ancient Metasediments" (Oyawoye, 1972).The Schist belts are low grade Sediment dominated schist that forms narrow belts mainly in the western half of the country. These have been described as "Younger Metasediments" (McCurry, 1976), and unmigmatised to slightly migmatised schists" (Rahaman, 1976) and " Newer Metasediments" (Oyawoye, 1972). The schist belts are believed to be relicts of supacrustal cover which was infolded into the migmatite-gneiss complex (Russ, 1957; McCurry, 1973). The schist belts are intruded by Pan-African granitoids.While the Older Granites ranges from granite to tonalite and charnockite, intrude both the migmatite-gneiss complex and the schist belts, exhibiting syntectonic to late tectonic characteristics. Additionally, smaller bodies of syenite and gabbro are present within these granitoids. Radiometric dating places the age of these Pan-African granitoids in the range of 750-500 Ma, falling within the Pan-African age spectrum. In Nigeria, these Pan-African granitoids.

## MATERIALS AND METHODS

This Study involved a systematic geological field mapping of the area on a scale of 1:50,000. Detailed geological field mapping involved the use of relevant tools such as Global positioning station, compass, clinometer, Geological hammer for measurements of structural features and sampling of representative rock respectively. Samples were obtained through systematic sampling for petrographic analysis. Identification of the various rock types was based on their lithological properties, major folds were observed on the field. Megascopic and microscopic petrographic descriptions of the rocks were done in the field and the laboratory under petrographic microscope respectively.

Thin Section and Microscopic Studies was done in the laboratory: A total of two sample were selected for thin section. These samples were prepared in the Department of Geology, Ahmadu Bello University, Zaria. Petrographic studies and photomicrography were carried out for all the thin section with the help of a petrographic microscope in the Department of Geology, Ahmadu Bello University, Zaria. The process of Preparation of the thin section involves slicing of the rock types, in which the epoxy or araldite is rub on the slide then place the rock on it and then later cut, the slide from the rock sample this is then kept on an oven to dry for some hours. The slide after oven drying, it is ready to be viewed under petrographic microscope.

## RESULTS AND DISCUSSION

### Geology of Study Area

The study area is part of the North central Basement complex and is located in the south-western segment of the Precambrian Basement Complex of Nigeria and also a northward extension of Igarra Schist belt. The study area (about 770 sq. km) is delimited by latitudes 08° 00' to 08° 15' N and longitudes 06° 00' to 06° 15'E (Figure 1). The Intrusive suite or Granitoids are well exposed in scenic hills, while the metasediments occur as ridge, rubbles, boulders, plains and low lying areas especially stream channels such as river and road cuts. Structural features such as fractures and folds are often ubiquitous.

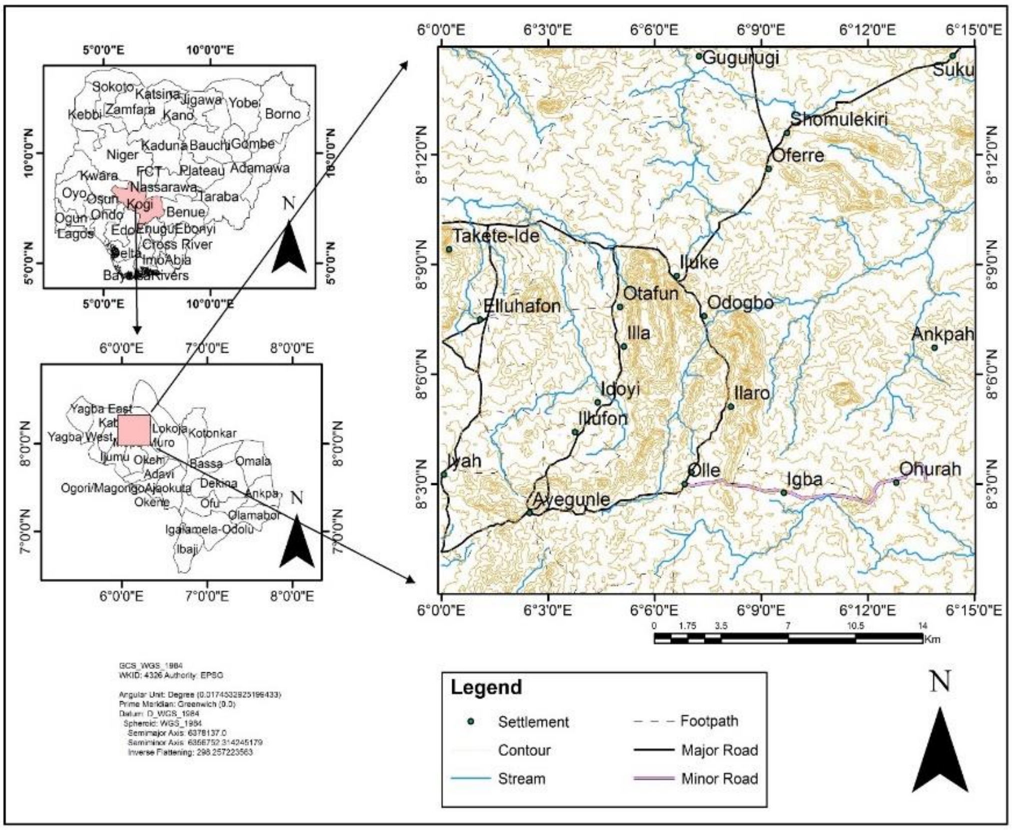


Figure 1: The location map of study area covering sheet 226 Kiri SW

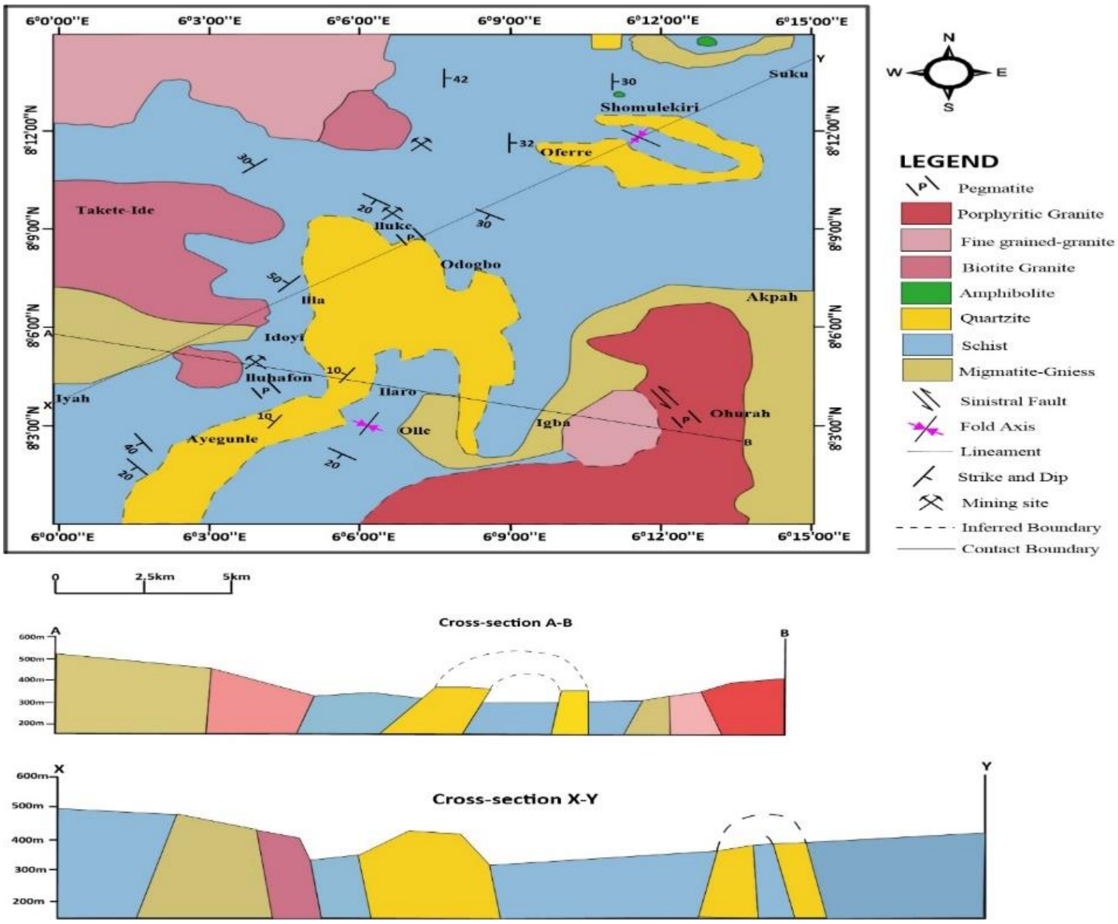

Figure 2: Geological map and Cross-section of the Study area

**Petrography**

***Field description***

The area study consists of two main suites of rocks: the host metasedimentary suite made up of Migmatite-gneiss complex and Schist, Quartzite and Amphibolite and the intrusive suite comprise of Porphyritic Biotite granite, Fine grained granite, Biotite granite, and Pegmatite and Quartz vein.

**Migmatite-Gneiss**

***Field Relationships***

The migmatite gneiss covers about 15% of the study area (Fig.1).It is heterogeneous, consisting of metamorphic and igneous portions with varying textural characteristics (Plate I). The migmatite-gneiss within the study area has undergone significant weathering,the texture is medium to fine-grained texture which speaks of the high rate of cooling. It exhibits alternating light and dark-colored mineral grains aligned in a NW-SE direction this is know as Neosome, the dark coloured allignment is the melanosome characterized by micaceous mineral observed to be biotite,while the light coloured is the leucosome which is characterized by the granitic rock observed to be orthoclase feldspar due to it pink colour, these alignment of platy minerals indicates foliation. Partial migmatization occurred due to the intrusion of acidic magma, resulting in distinct felsic and mafic bands ranging from a few millimeters to tens of centimeters, hence the designation migmatite-gneiss. The intense metamorphism experienced by the rock has led to mineralogical alterations in both the mafic and felsic minerals.

Plate 1: Ptygmatic folding on migmatite-gneiss with heterogeneous composition at location $8^0$ 2′ 49.2″N and $6^0$ 9′ 34.6″E

Mapped structures include foliation, lineation, folds, joints, and locally banded regions, demonstrating evidence of intense deformation (see Plate 1). Fractures, veins, and pegmatites are prevalent, indicating multiple deformation episodes. While these structures are predominantly obliterated, some fresh imprints are discernible at certain points. The rock occurs in undulating bodies and, in some instances, as boulders within colonies.

**Schist**

***Field Relationships***

Schist formations are evident as low-lying outcrops along river channels and road cut exposures (refer to Plate III). These formations constitute approximately 40 percent of the study area, primarily occurring in the lowland regions. Notable locations include the vicinity of River Bobi and the southwestern parts encompassing Iyah, Illah, Ayegunle, and Olle. Similarly, areas around Iluke and Oferre exhibit schist outcrops (see Plate III). The schist trends predominantly in an NNW-SSE direction, slightly deviating from the general N-S trends. In hand sample observation, based on mineral composition, schist formations are classified into two categories: Quartz-mica schist and Mica Schist.

The quartz-mica schist predominates in the study area, characterized by a high proportion of mica minerals, particularly Muscovite, which is abundant along the Iluke-Oferre road, Iyah-Ayegunle road. In hand specimen, Quartz-mica schist presents a silky, shiny appearance due to the abundance and reflective properties of muscovite mica, along with the presence of quartz. These distinctive features facilitate macroscopic identification. The texture of Quartz-mica schist is generally fine to medium-grained, with a dark grey coloration. Conversely, Mica Schist exhibits a darker grey coloration, with prominent, dark-colored mica visible along the the Illah-Offerre road.

Plate: 2: Quartz- Mica Schist around Iyah- Ayegunle Road at Latitude 8º 1' 59.5'' N and Longitude 6º 2' 14.2'' E

Plate 3: Mica schist showing Schistosity around Illah-Oferre road latitude 8º 6' 12.4"N and Longitude 6º 4' 2.5" E

**Microscopic Description**

In plane polarized light, quartz is colourless, has a low relief and not pleochroic while muscovite display colourless to pale yellow hue, weak pleochroism, moderately positive relief and has a perfect cleavage in one direction (Plate IV). In cross polarized light, quartz shows low interference colour of first order grey and undergoes undulose extinction while muscovite undergoes parallel extinction. Chlorite is pale green with low relief, Sericite is yellow with moderate pleiochroism (Plate IV)

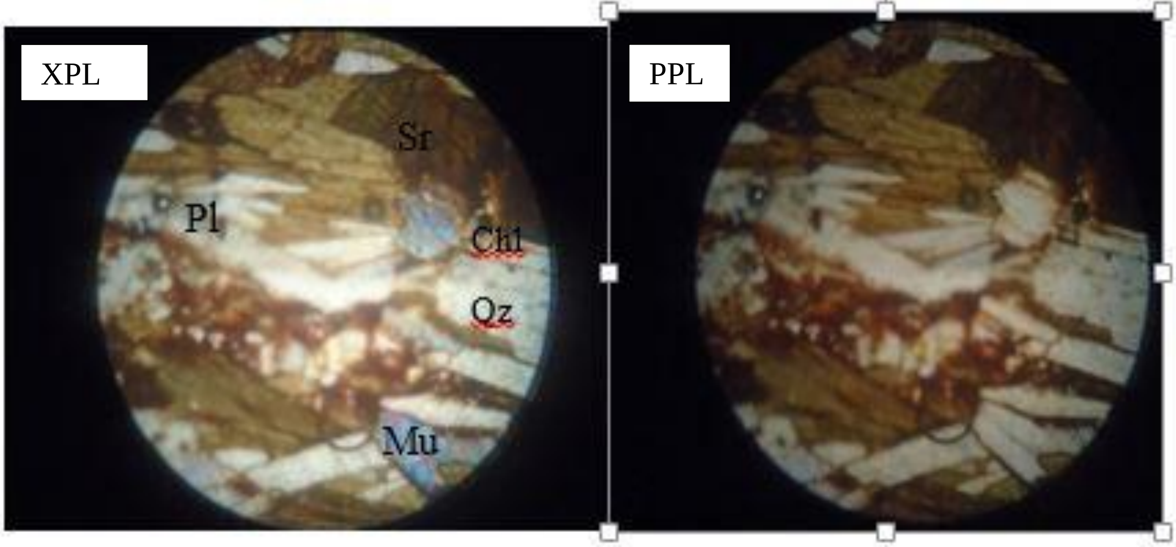


Plate 4: Photomicrograph of schist on XPL and PPL Mgx20
Qz=Quartz, Mus=Muscovite, Sr =Sericite, Pl= plagioclase feldspar and Chl=Chlorite

**Quartzite**

***Field Relationships***

Quartzite are predominantly observed as ridges and rubbles with scattered rock fragments within the study area, these Quartzite are folded and extends kilometers.These formations constitute approximately 20% of the rock types present. Two distinct varieties of quartzite are identified, differentiated by textural characteristics and mica composition:

*Grey Variety*: This variety contains a significant proportion of micaceous minerals and is prevalent in areas around Ayegunle.

*Brownish White Variety:* This variant, poor in micaceous minerals, trends in the N-S direction of the study area, extending to areas around Ayegunle (Plate V). In some parts of the study area, quartzite is intercalated with schists, exhibiting various styles of joints, while in other localities, it displays pronounced folding. Weathering has obscured clear contacts between quartzite and other rock types. In hand specimen, quartzite appears massive, medium-grained, and displays interlocking crystals of quartz. Mineralogically, quartzite is primarily composed of quartz with minor occurrences of muscovite.

Plate 5: Ridge and rubbles of Quartzite around Iluke, location 8º 7' 59.8"N and 6º 7' 6.4" E

**Granite**

***Field Relationships***

Granite formations cover approximately 25% of the study area. They are classified into three categories based on texture and mineralogical composition: porphyritic granite, medium to fine-grained granite, and medium to coarse-grained biotite granite. The outcrop shapes range from dome to whaleback.

*Porphyritic Granite:* This type is predominantly composed of quartz, feldspars (mostly orthoclase), and dark mica (biotite). The rock appears pink due to the abundance of orthoclase feldspar, while quartz remains colourless. Orthoclase feldspar forms phenocrysts, with quartz and mica comprising the fine-grained ground mass. This indicates a slow rate of cooling. Porphyritic granite is characterized by complex patterns of intergrowth between quartz and feldspar crystals as shown in Plate VI.

*Medium to Fine-grained Granite:* Composed of quartz, orthoclase feldspars, plagioclase, mica (biotite), and garnet in Plate VII.

*Medium to Coarse-grained Biotite Granite:* This variant contains more biotite and orthoclase feldspar, with less plagioclase and quartz. It is commonly observed in the southeastern to northwestern portion of the study area.

The presence of intergrown quartz and feldspar crystals contributes to the unique appearance and composition of granite formations within the study area.

Plate 6: Phenocryst on Porphyritic Biotite Granite outcrop at location 8º 5' 5.4"N and 6º 11' 27.1" E

Plate 7: Fine to medium Grained Granite outcrop with Garnet occurring as pods around Igba, location 8º 2' 34.3" N and 6º 11' 11.5"E

**Minor Rocks**

***Field Relationships***

Minor lithologies comprise approximately 8% of the rocks in the study area, including amphibolite, pegmatites, and quartz veins. The amphibolite is found in the extreme northeastern part of the study area, amphibolite is primarily composed of hornblende, amphibole, and plagioclase feldspar. The quartz veins exhibit a glassy texture and vary in width and length. The

pegmatites are characterized by extensive grain size variation, appearing white and pink. They are present in all major lithologies in the area and often show cross-cutting relationships with at least two structural generations.

**Amphibolite**

This mappable and unmappable unit mostly occurs as boulders on the schist and at the base of the quartzite ridges at Ayegunle. However, at the right and left side of the road from Shomulekiri to suku, these outcrop are trending East-West fairly outcrops of amphibolite characterized by felsic veins and banding stringers of quartz were mapped. (Plate VIII) The amphibolite lies conformably with the schist in an E-W direction. It's brown to dirty brown in colour due to weathering. Fresh field samples appear green in colour with abruptly weak foliation.

Plate 8:Outcrop of Amphibolite trending E-W around Shomulekiri-Suku road Location 8º 13' 4.3"N and 6º 10' 29.9"E

**Pegmatite Dykes**

Pegmatite dykes are prevalent throughout the study area, cutting across various lithologies as shown in (plate IX). Composed mainly of feldspars, with quartz and micas present in some instances, they display extensive grain size and color variation. Pegmatite dykes exhibit cross-cutting relationships with the older structures (Plate X) are often faulted and folded. The composition of the pegmatite dykes is predominantly felsic in nature, containing light-colored minerals such as feldspars, quartz, and muscovite, with tourmaline as an accessory mineral.

Plate 9: Pegmatite dyke of a schist at location $8^0$ 9' 2.7"N and $6^0$ 7' 2.9"E


Plate 10: Crosscutting relationship on a vein on porphyritic granite at location 80 5' 5.5"N and 60 11' 27.1"E Ohura with O older pegmatite dyke, Y: younger Quartz vein

**Quartz Veins**

Quartz veins are prevalent as fracture infillings across all major lithologies in various sizes and ages. Ranging from 10 to 3000mm wide, they exhibit considerable variation in length. Grain size is medium to coarse grained, with many showing significant weathering, leaving behind only quartz due to its resistance to chemical weathering. The quartz veins are oriented in NNW-SSE, NE-SW, and E-W directions, with a predominant trend in the NW-SE direction, influenced by the orientation of the host rock, particularly Migmatite-gneiss (see Plate XI and Plate XII).

Plate 11: Quartz vein at location $8^0$ 11' 49.6"N and $6^0$ 7' 16.4" E trending NW-SE around Oferre

Plate 12: Alternating Quartz veins on Quartz-Mica schist around Iyah gbede –Ayegunle road location 8º 1' 59.5N and 6º 2' 3.8"

**Discussion**

Metamorphism arises from the adjustment of rocks to physical conditions distinct from those under which they originated. These conditions encompass pressure, temperature, chemically active fluids, and geological time, resulting in changes in mineral composition, texture, and microstructure. The mineral assemblages in the metasediments were used to define the intensity of metamorphism in the study area.

According to Rahaman (1976), metamorphic grades within the southwestern Nigeria Basement complex span from greenschist to amphibolite facies.

In the study area, two types of metamorphism have been identified based on field observations, and petrographic mineral assemblages. The primary and prevalent type of metamorphism is the regional metamorphism. The metamorphic facies observed are the upper greenschist and the lower amphibolite facies, the upper greeenschist mineral facies (Quartz, Chlorite, Sericite, muscovite and plagioclase) and the lower amphibolite facies(Hornblende or amphibole, plagioclase, Quartz, Biotite*)*( See plate IV and Plate XIV) .

The secondary type of metamorphism is dislocation metamorphism, often confined to specific zones of shearing and cataclasis. Evidence of dislocation metamorphism is found in the Migmatite-gneiss, where ultramylonite with less than 10% porphyroblasts exhibits fine-grained, partially recrystallized rock with pronounced foliation due to intense shearing (Plate XVII).Ajibade (1982) verified that mylonite in the gneiss and concluded that it is a product of dislocation metamorphism within the Basement Complex. Mineral assemblages in metasediments aid in defining the intensity of metamorphism. Regional metamorphism is also observed, where upper greenschists exhibit higher grades, potentially due to greenish coloration indicating the presence of minerals such as actinolite, epidote, and chlorite in hand specimens and under microscope.

Petrographically, the mineral assemblage observed under the microscope aligns with the Amphibolite facies, characterized by amphibole or hornblende, biotite, plagioclase, and quartz.(Plate XIV)

The green schist facies is defined by the presence of Sericite+chlorite + quartz + plagioclase+muscovite in schist (Plate IV).

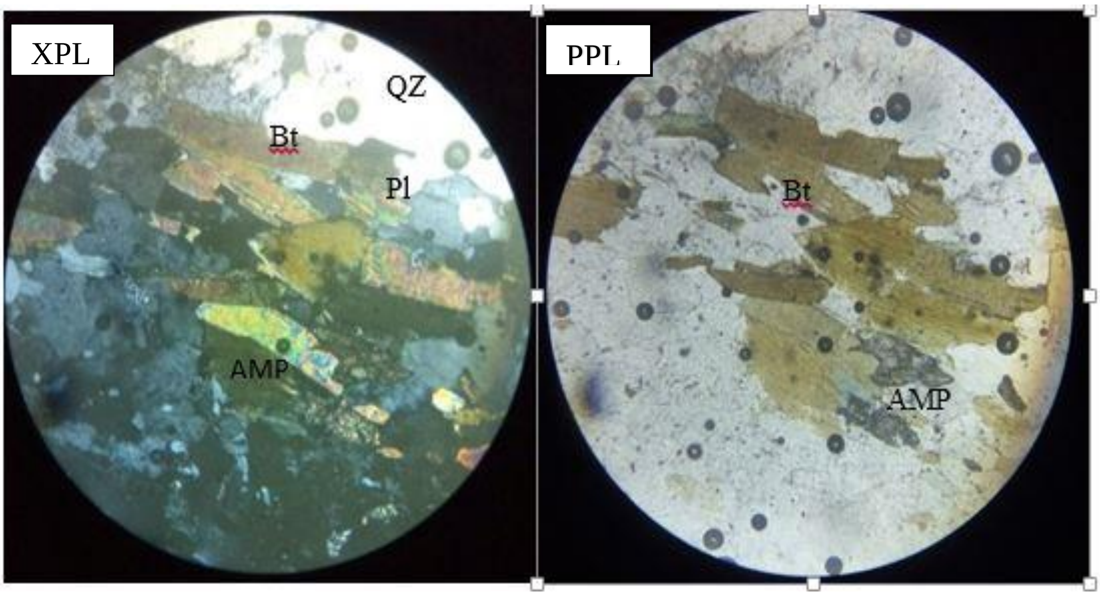


Plate 13: Photomicrograph of Amphibolite on XPL and on PPL showing the Mineral assemblage on Amphibolite Facies where Qz=quart, Bt=Biotite, Pl= Plagioclase, Amp=Amphibole/ Hornblende.

Garba (1985) mentioned a mineral assemblage such as talc, tremolite- actinolite, hornblende, biotite, muscovite, sericite, quartz and garnet as typical characteristic mineral assemblages of the study area. This is a typical character of the upper greenschist and lower amphibolite facies.

The migmatite-gneisis complex is of higher grade of metamorphism than the metasediment aspect of the amphibolite

Plate 14: Ultramylonite occurring around Olle on Migmatite-gneiss location 8º 2' 44.9"N and 6º 10' 12.11"E

**CONCLUSION**

The exposed rock types of the North central basement complex are classified into two suites of rocks, namely the metasediments and the intrusive igneous rocks. The metasediment comprises of Migmatite-gneiss complex, Schist, Quartzite and Amphibolite. The intrusive comprises of the Porphyritic-granite, Fine grained granite, Biotite granite, Pegmatite and Veins. The major structures in this area are

Major folds which extends kilometres was observed on field and shown on Geological map, these folds are recumbent and M or asymmetric folds, with predominantly NW-SE (nearly E-W) and NNE-SSE (nearly N-S) axial plane respectively. The metamorphic facies of the Schist belt ranges from upper green schist while that observed on the amphibolite ranges from the lower amphibolite facies which indicate a regional metamorphism and the presence of ultramylonite indicates a dislocation metamorphism**.**

**REFERENCES**


Abaa S. I. (1983).The structure and petrography of alkaline rocks of the Mada Younger granite Complex of Nigeria. Journal of African Earth Science 3:107-113.

Ajibade, A. C. (1988). : Structural and tectonic evolution of the Nigerian basement with special reference to NW Nigeria. *In* International Conference on Proterozoic Geology Tectonics High-Grade Terrains (Ife, Nigeria), pp. 42-129

Ajibade. A. C, Woakes, M., and Rahaman M.A. (1987): Proterozoic Crustal Development in the Pan-African Regime of Nigeria. In: C. A. Kogbe (edition) "Geology of Nigeria" 2nd revised edition *Rock View Nigeria limited, jos,* pp. 57-69.

Danbatta U.A. (2002). Rb-Sr isochron dating of Granitoids from Kazaure Schist belt NW. Nigeria.Global journal of pure and applied sciences 8(3) pp319-322

Ekwueme, B.N. (1995). Petrogenesis of Schist in Southeast Lokoja, Central Nigeria. Decford, Journal of Pure and Applied. Science. Vol 1. . pp70 – 83.

Garba, I. (1985).Geological and geochemical investigation of the Gold occurrence north of Isanlu pp 49-51

McCurry, P. (1973). Geology of Degree Sheet 21, Zaria, Nigeria. Overseas Geol. Mineral Res., 10 McCurry, P. (1976). The geology of the Precamrian to Lower Palaeozoic rocks of northern Nigeria-a review. In: C.A.Kogbe (Editor), Geology of Nigeria. Elizabeth Publishing Cooperation. Lagos, pp. 15-3

McCurry, P. (1976).Pan-African Orogeny in Northern Nigeria. *Geological Society of America Bulletin* 82*:* pp. 3251-3263. (45): 1-45.

Kolawole M.S, Onimisi M and Olobaniyi SB (2017) studied the field occurrence and structural characteristic of basement rocks around Kabba-Lokoja-Igarra Schist Belt, Southwestern, Nigeria. Global journal of pure and applied sciences Vol 23, 2017:263-274

Kolawole M.S, Idakwo SO, Ameh EG (2021) Sn-Ta-Nb mineralization potential of pegmatitic bodies in Bunu Area, part of Kabba –Lokoja-Igarra Schist Belt, SW Litho 400 106426 2021

Kolawole M.S Onimisi M and Olobaniyi SB (2017) studied the field occurrence and structural characteristic of basement rocks around Kabba-Lokoja-Igarra Schist Belt, Southwestern, Nigeria

Kolawole M.S, Oyelami C.A, Alabi A.A Olabaniyi S.B (2023)Geochemical study of Precambrian Metavolcanic rock around Bunu Area, Part of Kabba-Lokoja-Igarra Schist Belt, Sw Fuoye journal of pure and applied science(FJPAS) 8(2) 21-44 2023

Kolawole M.S, Chukwu E.C, Agibe A.N (2022) Geochemistry and Petrogenetic evolution of metasedimentary rocks in Bunu Area, part of Kabba-Igarra-Lokoja Schist Belt Sw Acta Geochemica 41(5) 765-788, 2022

Obaje .N (2009). Geology and Mineral resources of Nigeria pp 15-35

Odeyemi, I. B., (1976). Preliminary report in the relationships of the Basement complex rocks around Igarra, Mid-west. In: Geology of Nigeria, edited by C.A Kogbe. Elizabethan Publ. Lagos.59-63.

Odeyemi, I.B., (1988). Lithostratigraphic and structural relationships of the upper Precambrian metasediments in Igarra area, Western Nigeria. In: Oluyide, P.O., Mbonu, W.C., Ogezi, A.E., Egbnike, I.G., Ajibade, A.C., Ana-Umeji, A.C., (Eds), Precambrian geology of Nigeria, Geological Survey of Nigeria Publication, Kaduna, 111-123.

Oyawoye, M. O. (1972). The basement complex of Nigeria. *In* Dessauvagie, T. F., and Whiteman, A. J., eds. African geology. Ibadan, Geology Department, University of Ibadan, pp. 42-98.

Rahaman, M. A. (1976). Progressive polyphase metamorphism in pelitic schists around Aiyetoro, Oyo State, Nigeria. *Journal of Mineralogy and Geology*. 13: pp.33-44

Rahaman, M. A. (1988). Recent Advances in the Study of the Basement Complex of Nigeria in: Geological Survey of Nigeria (ed.) *Precambrian Geology* of Nigeria, pp. 11-41.

Rahaman, M.A. (1988). Trace Element Geochemistry and Geotectonic setting of Ile-Ife Schist Belt. In Precambrian Geology of Nigeria. Geology Survey of Nigeria, Kaduna. Pp. 241-256.

Russ W. (1957).The geology of part of Niger, Zaria and Sokoto provinces with special references to occurrence of Gold. Geological survey. Nigeria Bull No.79