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The Geology and Petrographic Studies of Rocks Around Ogale, I. Jumu Local Government Area Kogi State

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CERTIFICATION

This thesis "the geological and petrographic studies of rocks around OGALE, Ijumu Local Government Area of Kogi state Nigeria" by AKINWUMI FRANCIS BODUNWA Matric number 12GL1007 has been examined and found to meet the Kogi State University requirements for the Award of the Degree of Bachelor of Science (Hons.) in Geology.

……………………………… 28/9/2016 ………………………………

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DEDICATION

This work is dedicated first to the Trinity, God the Father, the Son and the Holy Spirit;the one who gives wisdom; out of his mouth comes knowledge and understanding "The Alpha and the Omega". Also, to my beloved parents Mr and Mrs Akinwumi who believe that the best legacy they could hand over to me is education and they actuallydid.

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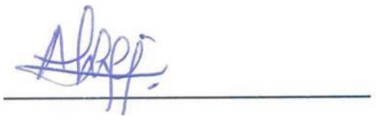
DECLARATION

1, AKINWUMI FRANCIS BODUNWA, hereby declare that this project has been written by me and that it is a record of my own research work. It has not been presentedin any previous application for the award of degree. All sources of information are specifically acknowledged by means of references.



28-09-2016

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ABSTRACT

The study area is located around OGALE town, in Ijumu Local Government Area, Kogi state. Il forms part of topographic sheet 24 southwestern Basement Complex of Nigeria mapped on a scale of 1:25, 000. Geological mapping was carried out in the area through traversing from one outcrop to another and was moved with macroscopicobservation of the rock samples in the field. The rocks of the study area comprise of granite gneisses gneisses, and biotite granite, while pegmatites occur as intrusive. The gneisses were characterized by joints, fractures, folds, and foliations. The foliation shows a dominant trend ofNE — SW. From the petrographic studies, the Granite gneisses consists of different minerals such as plagioclase, biotite, quartz, hornblende etc. However, most of their grains were subhedral in nature. Base on the presence ofjoint and fracture on the outcrop it can be deduced that the rock have hydrogeological potential.

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CHAPTER ONE

GENERAL INTRODUCTION

Geological field mapping is an indispensable exercise in Geology because geology is a field-oriented discipline. It is on the basis of this, that the project was carried out anda report presented on the geology of sheet 246, Ogale, Ijumu S W.

This report contains all the activities carried out in the course of the field mapping exercise which were traversing the major and minor roads into the interior outcrops, measurement of the trends of the strike and dips of various outcrops found, taking noteof and measuring the structures on the outcrops and finally taking fresh rock samples. The field equipment used during the field exercise include; A topographic map for making fact map and used to produce a geological map, geological hammer which is used to break rocks in order to collect a samples, compass and clinometers formeasuring a strike and dip direction of rocks, field note book for recording data and observations, GPS (global positioning system), makers and masking tape for labeling samples, etc.

A. Location and Extent of Study Area

The study area is located around Ogale in Ijumu Local Government Area of Kogi State.The mapped portion (plot 27) is located between Latitude 7 ^{0} 35'N and 7 ^{0} 37' 15NS" of the Equator and Longitude 6 ^{0} 07' E and 6 ^{0} 03 '30"E of the Greenwich Meridian, ona scale of It covers an area of 16km^{2}

B. Accessibility

The area is accessible through a tarred road which runs from Ehima through Arima to Okuma in Kabba Kogi State. The plot study area is accessible through cattle tracks anddried up stream channels.

C. Climate and Vegetation

The area usually experiences two climatic seasons, the dry and the wet seasons. The wet season begins from the end of March to October, while the dry season commences in early November till late March. December and January experience cold dry wind of the Harmattan. The average rainfall in this area ranges from 100cm — 150cm per annum during the rainy season, while temperature on the average is about 78 ^{0}F, 46^{0}Cdaily, (Balogun, 2000).

The vegetation of the area is Guinea Savannah (Southern) which is the most widespread vegetation belt in Nigeria, with averagely tall trees, shrubs and scattered trees as well as tall grasses, (Falconer, 1911).

D. Geomorphology and Drainage

The area is a segment of the basement complex of Nigeria and it is characterized by anundulating sequence of high and low lands, i.e. alternating high and low areas with thehighest elevation of 524m above sea level and the lowest of 451m above sea level. Some portions of the area are flat enough for settlement.

The area has a good network of drainage system. It is characterized by many tributariesand small seasonal streams which flow or empty its water into River (River Ikakumu- Ogale). The area is thus drained by streams, tributaries.

E. Aims and Objective of study

- Mapping of different or diverse rock in other to update previous works that havebeen done in the area
- To produce a geologic map of the study area
- To map geological structure and features e.g. faults, dykes, foliation etc. in thestudy area
- Determination of the economic / hydrogeological potential of the study area inorder to give way to possible future exploration.

F. Scope of Work

This work is aimed at establishing in details the relationship between rocks types in the area, petrographic analysis of representative rock samples collected from the field.

The observation of outcrops, rock samples, structures and the evolution of the rocktypes in the area and the economic significance of the rocks.

CHAPTER TWO

GEOLOGY OF THE SOUTHWESTERN BASEMENT COMPLEX

The study area is part of the Basement Complex of South-Western Nigeria. It lies within the Benin Nigeria shield situated in the mobile zone extending between the West Africa and Congo craron.

Intensive work has been done within the South Western Nigeria Basement Complex; the first of such works was carried out when mineral survey of Southern Nigeria. Rahaman (1970)

Annor,A.(1995). Notable works were done on the following viz:

- An early phase comprises granodiorites and even diorite
- A main phase that comprises course porphyritic hornblende, granite and syenite.
- c. A phase that consists homogenous granite, dykes, pegmatite and aplite.
- Oyawoye (1970), in his work classified the rock of the South-Western Nigeria basement complex into four major groups. This classification was based on petrological evidence viz.
- The migmatite-gneiss complex
- The met-sediment series
- The Older Granite
- The minor rock types which include biotites, diorite etc. Rahaman (1989)classified the rock type into five groups viz:
- Migmatite — gneiss — quartzite complex
- Schist belts
- Charnockitic, gabbroic and diorite rocks
- Older granites
- Metamorphosed to unmetamorphosed calc- alkaline and hypabyssal rocks
- Unmetamorphosed dolerite, basic, and syenite dykes e.tc.

McCurry (1976) changed this terminology and introduced the term "Older Metasediments" to describe metasedimentary rocks deposited some 2,500Ma age, surviving the gneisses and Migmatite. McCurry (1976), also introduced the termed "Younger Metasediments" to refer to all low grade metasedimentary belts considered to have been deposited some 1000 — 800 Ma ago.

The Nigeria basement complex is divided into three provinces namely: (Rahaman 1988) The North-central province The Southwestern province The southeastern province. The study area is located in the eastern end of south western provinces of the Nigeria basement.

A. Geology of the Southwestern Basement Complex of Nigeria

In Nigeria, the rocks of the Precambrian are collectively known as the Basement Complex (Oyawoye,1976). The southwestern Basement Complex of Nigeria which encompasses the study area lies in the east of the West African craton in the region of late Precambrian to early Paleozoic orogenesis. Various authors (McCurry, 1976, Rahaman, 1976) who worked in the region have proposed different models for the Basement Complex rocks. Majority of them agreed on the following points:

That the rocks of this area are largely made up of metasedimentary series with associated minor metaigneous rocks which have been variably changed to migmatite gneiss and the rocks of Older Granite suites of both intrusive and replacement origin (.0yawoye, 1972). The unmetamorphosed crosscutting dolerite and syenitic dykes are the youngest focused in the Basement Complex. (Jones and Hockey 1964, Rahaman, 1973)

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The age determination carried out by Rb/Sr and K/Ar methods on rocks of the Older Granites indicates age ranges of 600-500 Ma. The Basement Complex of the Older Granites is frequently referred to as Precambrian. (Rahaman, 1976)

a) Structures:
The structural features in the South Western Basement Complex of Nigeria include: Foliation, lineation, microfolds, joints and fractures and faults.

b) Foliation:
Foliation is dominant throughout the South western basement. In the schist, the foliation is a well-developed schistocity defined by parallel alignment of mica and amphiboles and compositional banding. The regional strike of foliation is roughly constant in North — South direction with variation between Northwest — Southeast and Northeast Southwest directions.

c) Lineation:
Mineral lineation due to the preferred alignment and orientation of minerals such as biotite, amphiboles, quartz is very common in gneisses and quartzite.

d) Minor Folds:
These features are variable from open to isoclinal folds and the fold axes appear to maintain a constant NNE — SSW to N-S direction. Over most of South-WesternNigerian basement region plunges are to the North and are rarely more than 25 ^{0}.

e) Faulting:
Major faults are not easily evident. Most of those recognized can be traced on aerialphotographs. A post Older granite tectonic activity is thought by Jones and Hockey (1964) to be responsible for the well-developed ENE-NE trends of joints andsubsidiary faults.

f) Fractures:
Fractures are evident on some rocks because they are subjected to high degree of thermotectonic events brought about by intense regional metamorphism, crystallization, migmatization and granitization.

g) Metamorphism:
Jones and Hockey (1964), Winkler, (1979), have recognized amphibolite facies grademetamorphism in the area and the metamorphic activity in the area can be related with the Older Granite (Pan — African) activity. Rahaman (1973) concluded that in thisregional metamorphism reached green schist to amphibolite facies and that the metamorphic grade decreases rapidly from the amphibolites in the Southeast to the green— schist in the North West.

Types of metamorphism recognized include; the Barrovian type recognized in themetapellites and a zonation of metamorphic index minerals recognized in some area.

B. Geochronology and Evolution:

The basement complex of Nigeria is believed to have undergone at least two phases ofdeformation (Grantl 970, Ajibade 1976). Geochronology of Precambrian Basement rocks from Ibadan south western Nigeria. Four thermotectonic events have been recorded in the Nigerian basement complex (Grant 1970, Ajibade 1976). These are;

Liberian Orogeny	2800±200 ma
Eburnean Orogeny	2000±200 ma
Kiberian Orogeny	1100±200 ma
Pan - African Orogeny	600±150 ma

(Grant 1969,Grant 1970, Ajibade 1976).

The youngest of the polyphase deformation episode occurred during the Pan African Orogeny. Post Pan — African times was a period of crustal adjustment and the basement may have responded to stresses as a rigid platform. Thus, the only structures imposed during this time were joints, fractures and microfolds.

Due to the polyphase nature of the Nigerian basement complex, structures which display different orientation in response to the deformational episode that produce them were observed.

Ekwueme (1982) observed that abundant pre Pan — African structures exist in parts of the basement complex, these structures are characterized by orientation which are often different from the North — South structures produced by the Pan — African Orogeny.

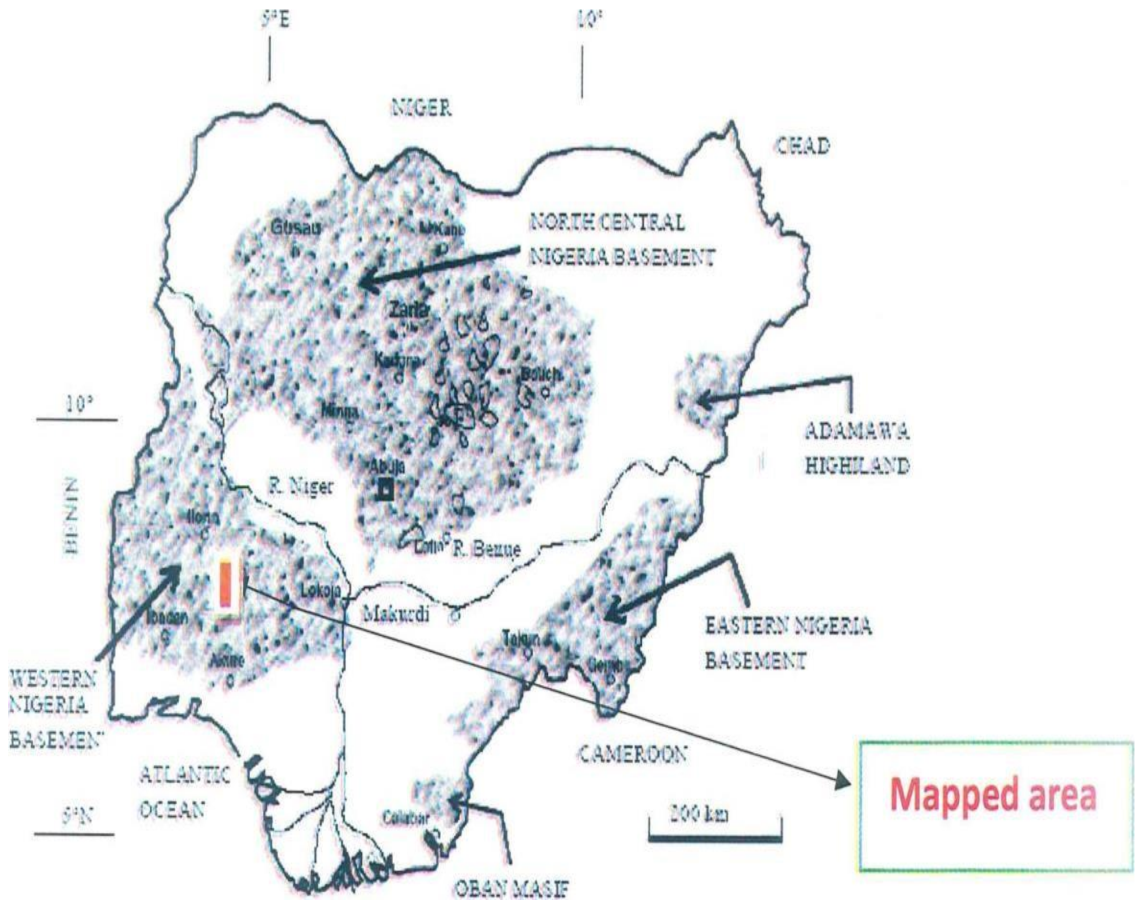

Fig. 1: Basement geological map of Nigeria (Obaje, 2009).

C. Previous Work

As early discussed, the area is part of the south-western basement complex of Nigeria.Five major groups of rocks have been recognized in this area namely;

- Migmatite —gneiss complex which comprises of biotite and hornblende, gneisses, quartzite, schist and small lenses of calcium silicate rocks.
- Slightly migmatized to unmigmatizedparaschist and metaigneous rocks which consist of politic schists, quartzites. Amphibolites, talcosee rocks metaconglomerates, marble and calsilicate rocks.
- Charnockitic rocks.
- Older granites which comprise rocks of varying composition from granodiorite to true granites and potassicsyenite.
- Unmetamorphosed dolerite dyke believed to be the youngest.

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Age determination of the south western basement complex suggests that themigmatite gneiss complex could have evolved over three or four tectonic cycles of deformation, metamorphism and reactivation. However, some of the rocks in kabba are believed to have not been affected by migmatization (Odigi, 2002). There is yet noconsensus as to the origin of banded - gneisses. Some author believed that they were believed that they were metasediments derived from greywackes and shales (Odigi 2002, Ezepue and Odigil 993, Elueze and Okunlola 2003), whereas, other interruptedthem as orthogenesis.

However, most workers agree at migmatization was a result of regional metamorphismwhich resulted into an upper amphibolite facies. The schistose rocks are associated with the upper basement complex rocks such as gneisses and granitic intrusive. It is characterized by vertical to nearly vertical joint trending in a NE - NW direction.

The Older Granites are igneous plutonic bodies which occur as small, circular to oval outcrops, sporadically distributed in the basement in the complex rocks between kabba, okene, and lokoja area (Ezepue and Odigi 1993]. They have believed to have been emplaced during the pan African thermotectonic event [550±100ma]. These igneous rocks were identified as monozodiorites, granodiorites, and granites. They are however not cogenetic. The monzodiorites are mostly probably derived from upper mantle magma,thegranodiorite were formed from magma generated by fusion of the crustal arenaceous sediments, while granites were formed from magma produced by limited partial melting of crustal rocks (Ezepue and Odigi, 1993), Oyawoye, (1972) described the most abundant and typical member of older granites suites which is a coarse porphyritic granite. Jones and Hockey, (1964) have recgonised that the mineral assemblages of the basement complex of south western Nigeria indicates amphibolitesfacies grade metamorphism and that this metamorphic activity can be equated with the older granites (Pan African) activity

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CHAPTER THREE

METHODOLOGY OF STUDY

A. Field Methods

The method used in carrying out the field work is the traverse method. That involves moving from one outcrop to another was embarked upon with macroscopic observation of rock samples which is the physical observation of rocks in the field andplotting features and structures observed on the outcrop on the base map.

B. Field geologic mapping/sampling method

Reconnaissance mapping was initially carried out at the camp. This involved the location of the study area, access roads, drainage channels, types of settlements and locating the outcrops. This was then followed by a detailed geological field mapping and was carried out in the field for the sole purpose of collecting data i.e. observation of outcrops, collection of rock samples from outcrops, road cuts, river channels and the recognition of the contact relationship between them and representing each of the rock units on a base map.

Each sample collected was labeled using the masking tape and a tentative name was given to it, taking note of the locations, and the structures strikes, dips, joints, folds, veins, foliation etc

The samples collected were studied macroscopically on the field.

C. Tools and Equipment Used in Geological Field Mapping

- Location Map: - For locating the area, outcrops and some features such as relief, road, physical topography, vegetation, quarry sites, etc.
- Global positioning system (GPS): This was used to get the exact coordinate ofwhere measurements / outcrops and samples were collected.

Fig. 2: Global Positioning System (GPS) for taking coordinates of a point.

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- **Geological hammer**- For breaking and collection of samples from outcrops.

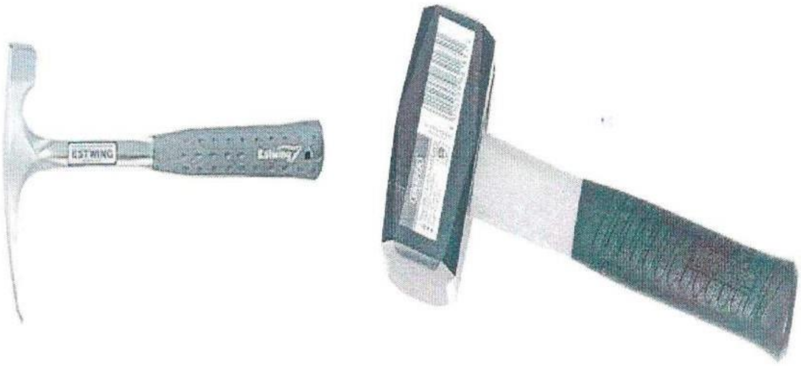

Fig. 3: Chisel head and crack geological hammers

- **Compass clinometers-** which was used to determine direction with respect to the magnetic north and the bearing or strike of rocks. The clinometers was usedin taking dips of rocks in the field.

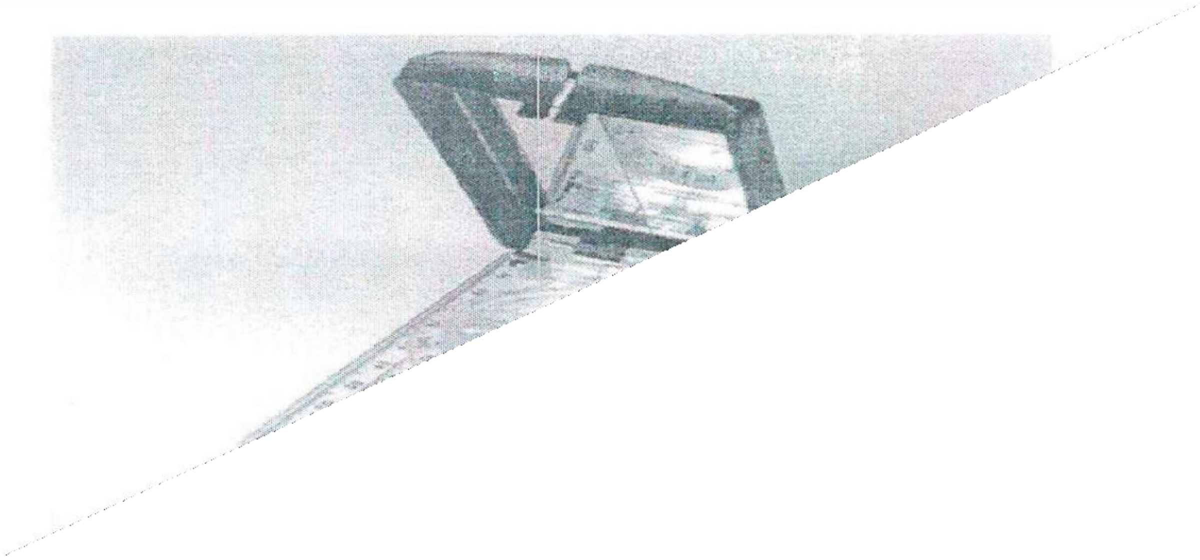

Fig. 4: The Swedish Silva Ranger 15 TDCL Geologist's compass

- **Hand lens**- Was used to help make the first observation of rock samples in thefield before further analysis is performed in the laboratories. It was also used todetermine micro folds and fractures on the outcrops.

Fig. 5: Hand lens

- **Measuring tape-** for taking actual measurements of lithologies and structures. For instance, in lithologies that exhibit layering, it is used to measure the thickness of each layer precisely.
- **Sample Bag-** Used for the preservation of samples against destruction i.e. moisture and impurities and also for keeping them.
- **Field notebook-** masking tape, marker, pens — These were used to write downall important observations in a concise, orderly and legible manner. Masking tape and marker pens were used for labeling samples before they were put intothe sample bags.
- **Field camera** - It is very important to take photographs of all interesting features. Photographs are important for descriptive purposes especially during report writing.
- **Safety clothing**: These include solid shoes, clothes that are tough in fabric preferably jeans or khaki, hat and sun glasses to protect one from the sun, a bagpack,safety glasses and gloves are important especially when hammering rock samples.

D. LABORATORY METHOD

The various rock samples collected were subjected to petrographic analysis. The mainobjectives of these analyses were to properly identify the various rock types, ascertaining there mineralogical composition, textural and micro structural characters.

E. Petrographic Analysis

The petrographic analysis involves both megascopic and microscopic analyses.

Megascopic Analysis

This involves the description of the rock samples in hand specimen with the aid of a hand lens.

Microscopic Analysis (thin section)

Instrument used: Hillquist Thin Section Machine, Model 1005 and 1010, U.S.A.Apparatus/Reagents

- Hot plate
- Epoxy A,B,C and D, (various types of adhesives)
- Epoxy syringe
- Cover slip
- Carbonrundum
- Aluminum foil

F. Procedure:

a) Initial cutting of specimen
Rock samples were reduced with the saw arm of Hillquist machine into a slice along a marked orientation that is not less than 8mm thick and trimmed to dimensions that areless than length and width of the glass slides to be used.

b) Initial grinding of specimen
With the aid of a 45 micron full coated diamond lap on the Hillquist thin section grinder, each specimen was grinded on the surface to be cemented until all disturbed structures and saw marks were removed and absolutely flat. Checks for flatness were made by reflecting light ofT the prepared surface.

c) Frosting and heating of glass slide and specimen
For each of the specimen, a glass slide was frosted to brush off the oily surface and to make the thickness of the glass slide uniform. This was done with fine mesh silicon carbide (800grit) on a glass plate. After frosting, a heat controllable hot plate set to 175^{0}F and covered with aluminum foil was used to heat each specimen until it was warmand free of moisture. The frosted glass slide were also

heated.

d) Cementing Specimen and Slide
With the use of epoxy syringes, 7ml of epoxy A and 3ml of epoxy B were measured and mixed thoroughly in a small disc container. The mixed epoxy was spread generously on the prepared surface of each sample. Then, each specimen was cemented against the glass slide firmly. The specimens were allowed to cool naturally for at least24 hours.

e) Final Cutting of Specimen
The saw arm of the Hillquist machine was then used to reduce the thickness of the cemented specimens to about 1.5mm thickness. Then, each specimen was then grindedusing the lap arm and dial gauge indicator as control by sweeping the specimen back and forth across the wheel cup to a thickness of between +0.06 and +0.07mm. This will leave the specimen between 40 and 50 microns thick.

G. Finishing Of Specimen to 30 Microns

The 30 micron plate was installed as the grinder to remove scratches which then brought each specimen's thin section to transparent thickness of 30 microns (0.03mm)if need be, cover slip were installed on the thin section for permanent protection using4ml of epoxy C and Iml of epoxy D at 173 ^{0}F on a hot plate.

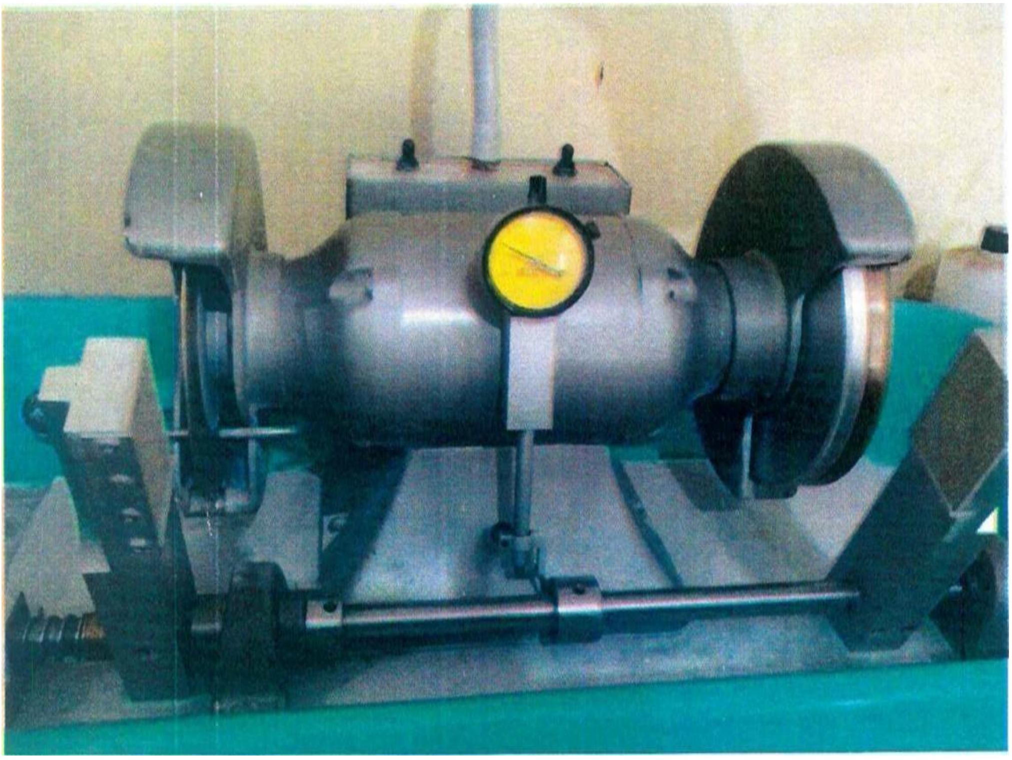

Fig. 6: Hillquist machine used in the cutting of rock

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CHAPTER FOUR

RESULTS, INTERPRETATION AND DISCUSSION

A. Field Lithological Occurrence and Petrography

The exposed major rocks in the study area include, biotite Granite and Granite Gneiss,while the minor rocks in the study area are pegmatite and quartz vein.

B. Major Rock

- **Biotite Granite Rock**

  The granite rocks in the study area are highly emplaced outcrop intruding the low lying gneiss of the area biotite granite rock occupies the central part of the study area, they are found in location 1,5, and 8. They appear characteristically as undeformed rock; biotite granite showed sharped discordant contact with the rock surrounding it. It range from fine to medium grain, it generally range from medium to coarse grain in texture and contain light colored minerals such as quartz, feldspar, biotite and little joint and fracture also observed in the outcrop.

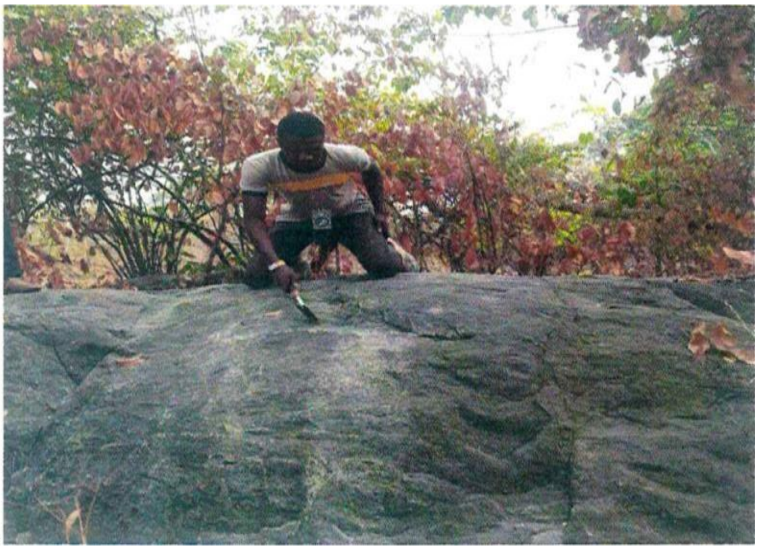


Plate l: Showing biotite granite at location l .

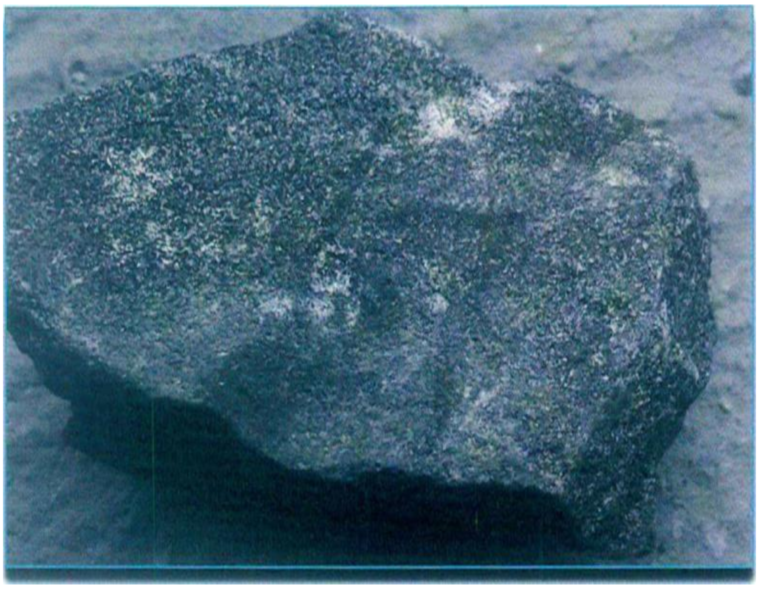


Plate 2: A hand lens specimen of biotite granite collected at location 8

b: PETROGRAPHIC DESCRIPTION BIOTITE GRANITE

MINERALS	PERCENTAGE COMPOSITION
Quartz	28
Hornblende	
Biotite	44
Plagioclase	
Opaque	
Muscovite	10

Table 2: Show the minerals and percentage composition of biotite granite.

a : PETROGRAPHIC DESCRIPTION OF B ITITES GRANITE

Plate 3: Photomicrograph of biotite granite under plane polarized light (^{x} 10) 0= Opaque, B= Biotite

Plate 4: Photomicrograph of biotite granite under cross polarized light (^{x} 10)M=Muscovite, P= Plagioclase, Q= Quartz, B=Biotite, H=Hornblende

a: PETROGRAPHIC DESCRIPTION OF BITITES GRANITE

Plate 3: Photomicrograph of biotite granite under plane polarized light (x 10)O = Opague, B = Biotite

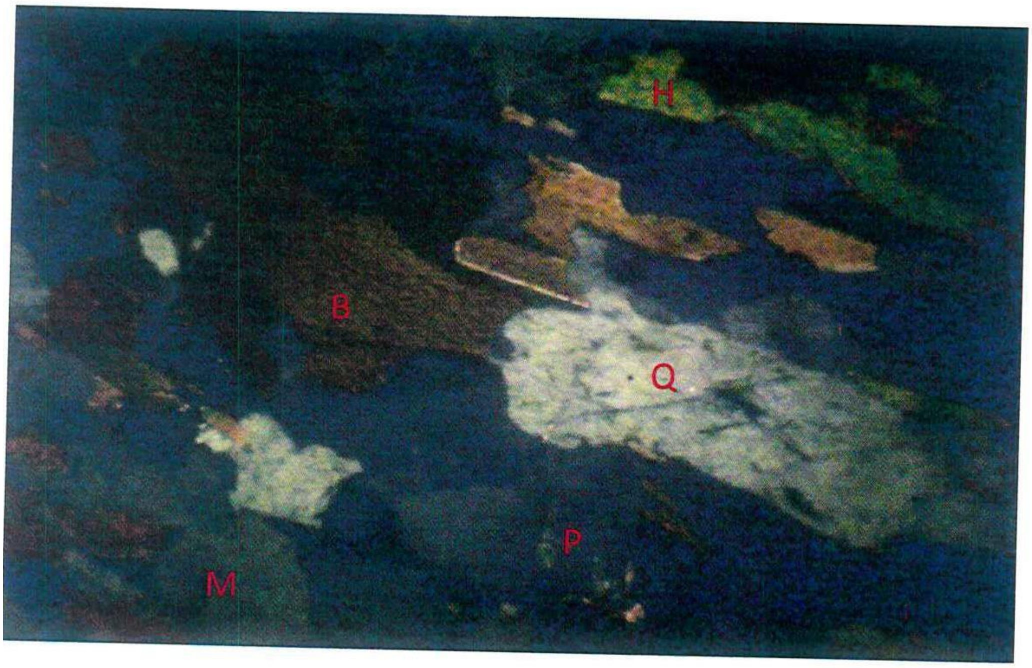


Plate 4: Photomicrograph of biotite granite under cross polarized light (x 10)M = Muscovite. P = Plagioclase, Q = Quartz, B = Biotite, H = Hornblende

C. Petrography

The description of biotitegranite as observed under petrological microscope is as follow:

Quartz: The quartz is colourless under plane polarized light and under cross polarizedlight, it is white to grey. Quartz constitutes average of 28% of the biotite granite.

Hornblende: The colour is variable, may be light brown or green, iron rich varieties are darker in colour. Pleochroic usually elongated and prismatic. Cleavage at moderateto high relief, extinction angle. Hornblende constitutes average of 8% of the biotite granite .

Biotite: The biotite present in this sample is brown to black under plane polarized lightand dark brown under cross polarized light. It is highly pleochroic since the colour changes from light to dark brown as the stage is rotated. The biotite exhibits parallel extinction due to its pleochroic properties and it lacks twinning. It has high birefringence and moderate relief. Biotite mineral constitutes average of 44% of the biotite granite.

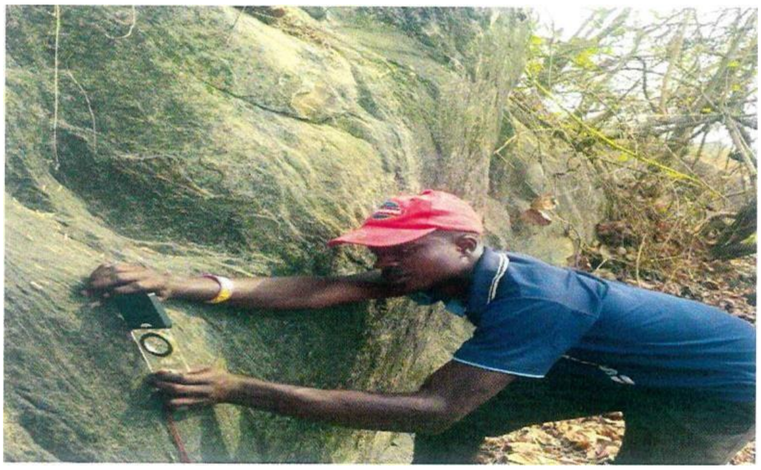
Plagioclase: The plagioclase in the sample appear gray in colour. It has a low relief, colourless, cleavage in three directions and has low multiple twinning. Plagioclase averagely constitutes 7% of the biotite granite.

Muscovite: Is colourless under plane polarized light, and pale pink colour in cross polar. No cleavage is displayed, it has a high relief. Having contact with biotite crystaland been align in similar direction as biotite.

Opaque: it occur as accessory mineral. They appear black in colour in plane polarize light and cross polarized light. On averagely, they consist of 3% of granite gneiss.

D. Granite Gneiss

The granite gneiss cover about 70% of the study area. Granite gneiss are slightly metamorphic rock in which weak foliation result from layer of different mineral group. It occurs as a very massive ridge in the study area. The granite gneiss is dark to light in colour as seen megascopically. The granite gneiss have two textural types: coarse- grained texture containing plagioclase feldspar, quartz, biotite and muscovite and the fine-grained type have similar mineralogy, slightly foliated with large phenocrysts of feldspars present, other minerals were quartz and micas. The texture observed range from fine-grained at the top of the rock to coarsegrained texture at the base of the rock. The granite gneiss was mostly composed of quartz, feldspar, biotite, and hornblende.



Pate 5: A very massive Granite Gneiss at location 2

MINERALS	PERCENTAGE COMPOSITION
Biotite	31
Plagioclase	13
Hornblende	
Muscovite	
Quartz	49
Opaque	
Orthoclase	

Table 3: Showing the minerals and percentage composition in granite gneiss

b: PETROGRAPHIC DESCRIPTION OF GRANITE GNEISS

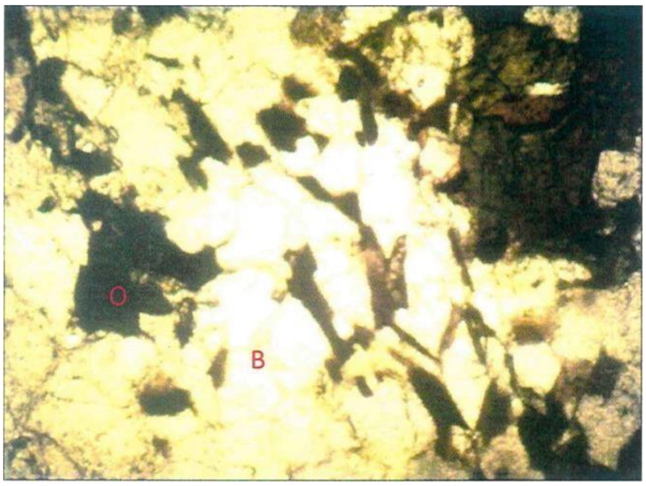


Plate 6: Photomicrograph of granite gneiss under plane polarized light (x 10)0= Opaque, B= biotite

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Plate 7: Photomicrograph of granite gneiss under cross polarized light (x 10) B=Biotite, H=Hornblende, 0= Opaque, Or= Orthoclase, M= Muscovite, Q= Quartz,P= Plagioclase.

E. Petrography

The description of granite gneiss as observed under petrological microscope is as follow:

- Biotite: It is yellowish brown to reddish brown; it is more pleochroic than other micas. Cleavage in one direction, cleavage lines are more closely packed than in hornblende. Straight extinction but angle may be about 3 0 unlike hornblende which has oblique extinction. Birefringence is strong and yields maximum interference colors. It consists of 31% of the minerals in the granite gneiss.
- Plagioclase: This mineral is identified by its distinctive polysynthetic twinning. It is colourless under plane polarized light and grey under cross polarized light. The mineral shows good cleavage and extinction as the stage is rotated, it has very low relief and low birefringence. On the average, it consists of 13% of the minerals in the granite gneiss.
- Hornblende: The colour is variable, may be light brown or green, iron rich varieties are darker in colour. Pleochroic usually elongated and prismatic. Cleavage at moderate to high relief, extinction angle. Hornblende constitutes average of 2% of the granite gneiss.
- Muscovite: The mineral is colourless under plane polarized light and appears pinkish under cross polarized light. Muscovite also displays a high birefringence. It consist of 3% of the minerals in the granite gneiss.
- Quartz: Colourless under plane polarized light and under cross polar. It ranged from white to grey, and has a low relief. It has a low interference colour. Quartz shows wavy extinction at certain oblique angles as the stage is rotated. Cleavage and twinning were distinctly absent in this mineral. It averagely consists of 49% of minerals in the granite gneiss.
- Orthoclase: The orthoclase appears white in colour with lamellae present in some sample. It average consists of 3% of minerals in the granite gneiss.
- Opaque: it occurs as accessory mineral. They appear black in colour in plane polarize light and cross polarized light. It averagely consists of 2% of the minerals in the granite gneiss.

F. Minor Rock type

- **Pegmatite Veins:**

  Pegmatite veins occur in all the major rocks type in the area. They are small, varying in thickness from few mm to many cm. They show great irregularities in their forms.

  The pegmatite veins cross-cut all rock types except in the fault zones, implying that the tectonic activity was later than the emplacement of the pegmatites.


Plate 8: Showing pegmatite on granite at location 3

- **QUARTZ VEIN**

The study area is predominantly composed of quartz of fine to medium grained texture.They are small and varied in thickness from a few millimeters to about a meter. The quartz observed in the study area occur whitish in colour with a glassy luster. Some ofthe veins lies conformably within the host rock and may have been involved in tectonics affecting the host rock whilst most were structure less and discordant with respect to the host rocks..


Plate 9: Showing quartz vein on gneiss at location 4.

G. *STRUCTURAL GEOLOY*

Structural geology is the study of feature of the earth crust formed as a result of the deformation resulting from tectonic processes within the earth crust.

Structural features observed in the study area includes,

H. *FOLIATION*

Foliation are continuous or discontinuous layered structure in metamorphic rock, formby the segregation of different minerals or by the alternation of bands of different textures.

In most of the rock units in the study area, the foliation was defined by parallel orientation of light and dark coloured minerals as seen on gneisses. Foliation was usually developed during metamorphism due to direct stress which causes differentialmovement of recrystallization.

The preferred orientation of the foliation in the NW-SE directions were are indicativeof the Pan-African Orogeny, which no doubt affected rocks in the Basement Complex(Rahaman, 1976).

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Plate 10: Showing foliations of dark and light minerals at location 2

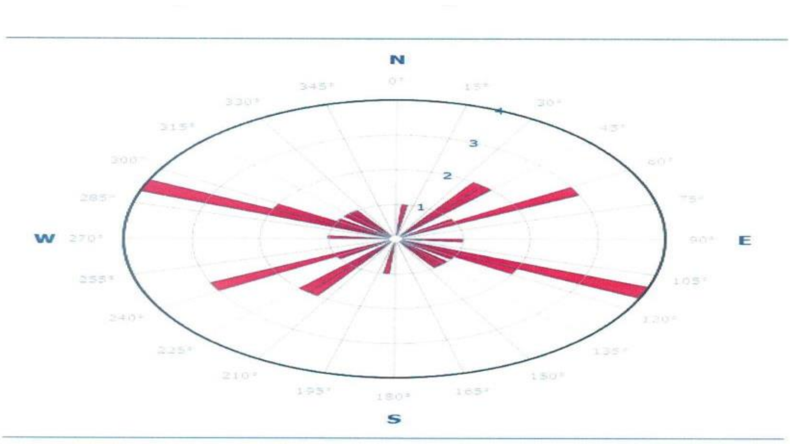

Fig. 7: Rose diagram showing foliation trend of all foliated rock in the study area (NE-SW).

I. JOINT

Joints are divisional plane or planes of parting rocks along which there has been no observable relative movement. Joints involve neither displacement nor filling i.e. they are dry fractures. The joints generally cross cut the rocks and some of them have been widen by erosion. Also the joint in some rocks in the mapped area occur as family fracture which are irregular in shapes. Joint help in interpreting rocks history in the study area. Sets of minor joint can be observed with some cross cutting one another in both horizontal and vertical fashion but with discontinuities. The joints observed in the study area are cross cutting and are mostly on the granite gneiss.

Plate 11: Showing joint structure granite gneiss at location 8

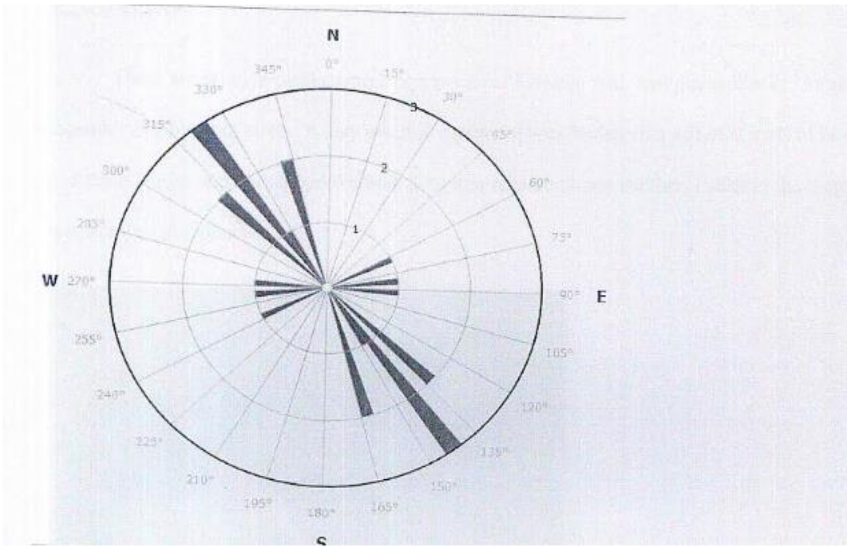

Fig. 8: Rose diagram showing fracture and joint of all rocks types in the study area(NW—SE and NE-WS)

J. FRACTURES

Are used to describe any break or disruptions in a rock. Fractures on the other hand describe the appearance of the surface of rocks when broken or chipped. Most of the rocks in the study area, especially the granite gneiss were highly jointed and fractured. This is an evidence of high tectonic activity within the area under study.

K. FAULTS

These are relative displacement or movement between two contiguous blocks (formerly together) as a result of stress. It may result in rupture of rock bodies into different parts of blocks and these blocks may move over various distances relative toone another. Faults in the mapped area are well pronounced.

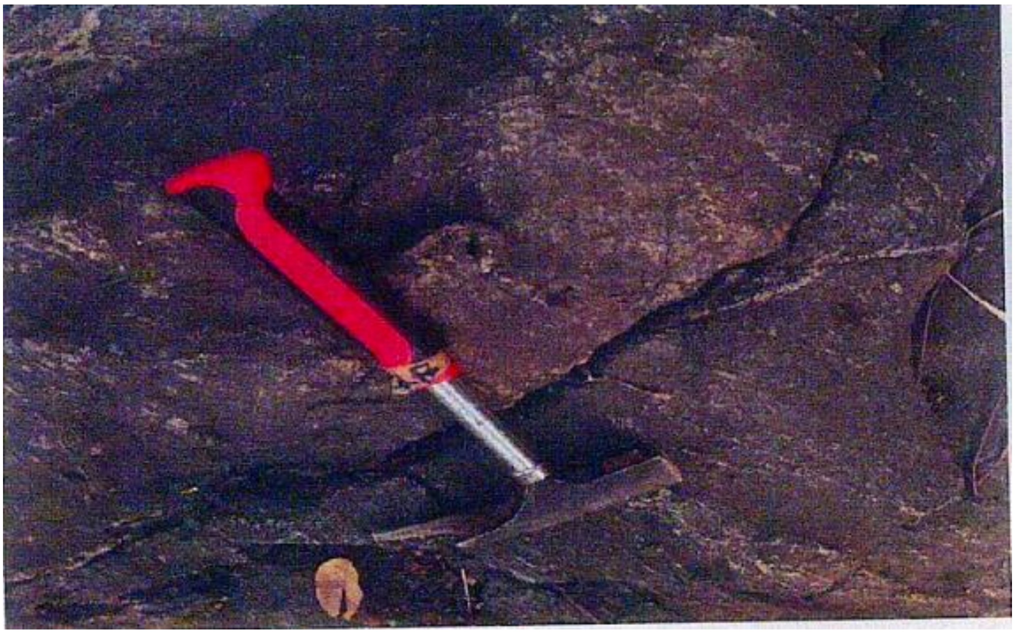

Plate 12: Showing a fault structure at location 4.

L. FOLDS

Are bends in rock that is the response to compression forces. The pattern of folds observed in the granite gneiss complex in the study area is the tight to isoclinals folds. The limbs of these folds dip in the same direction and they close sideways with the strike of the fold axis.

The types of fold found in the study area are recumbent fold

M. Recumbent fold

In this type of fold, the wrapping is so gentle that the inclination of the strata is barelyperceptible, or the warping may be so pronounced that the strata of the two flanks maybe essentially parallel or lie nearly flat. Some of these folds are products of highly ductile deformation with valid axial planes. The overtune fold identified is found on granite-gneiss outcrop at location 2. Field studies of this fold revealed that it has been displaced from its original position by earth movements.

Plate 13: Showing recumbent type of folds on a quartz vein in granite rock at location

N. METAMORPHISM OF THE ROCK TYPES.

The metamorphism in the study area resulted from large scale thermotectonic event as seen from the deformation of the rocks over an extensive area.

Metamorphism is the process of mineralogical and structural changes of rocks in their solid state in response to physical and chemical condition (pressure, temperature).

The types of metamorphism observe represent a period of progressive metamorphism to lower amphibolites facies and is consider to be syntectonic progressive phase of metamorphism to amphibolitesfacies, and mineralogical banding, (Bosses and Ocan 19880).

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CHAPTER FIVE

GEOLOGICAL HISTORY OF TIIE STUDY AREA

Field observation around Ogale reveals that a typical Basement Complex is not uniform in composition and texture, also most Basement Complex terrain often consist of variety of different metamorphic and igneous rocks in the area have related origin that is there is a common parent magma from which the rocks were derived. Another possibility is that the variation in rocks type in the study area is due to the interaction of magma with the surrounding wall rock are unrelated in origin being derived from melting sources rocks in crust and in the mantle.

According to Jones and Hockey,(1964) , McCury,(1976) ;Rahaman(1976) believed that the Pan African orogeny being the last deformation episode obliterated earlier, theStructures in the Nigeria Basement rocks ,Onyeagocha and Ekwueme 1982 observed that abundant preAfrican structures exist in part of Basement complex. These structures are characterized by their orientation which are are often different from theNorth-South structures produced by the Pan African orogeny

A. Economic mineral potential

Economic geology is the study of the mineral potential of the mapped area speculating on a possible extraction and exploitation of the mineral for the purpose of making profit. The mineral potential available in the mapped area may be associated with the gneiss and some minor intrusive rocks containing pegmatite and quartz veins etc. Biotite granite and Gneisses were the most common rock types in the study area whichcan be useful in the following areas.

These rocks maybe used for road construction and as building stones when crushed to desired sizes. These are also used for foundation of most engineering structures like dams, bridges, pavement, monuments, and several other exterior projects. Polished granite slabs adorn stair cases, and floors, due to the resistance and strength of the rocks.

Feldspars (in pegmatite) are used for manufacturing of ceramics and paints. Also the quartz found in the pegmatite is likewise used in the production of glass, sand, paper and, cement. Due to their piezoelectric property. They are used in clocks and wristwatches. Quartz is a hard mineral/rock (designated as 7 on Mohs' hardness scale)and is thus used as an abrasive.

Micas (Biotite and muscovite) also contained in pegmatite and gneisses can be used for the production of roofing materials, manufacturing of lubricants, wall finishes, and mostly used as insulators in electrical companies and rubber industries.

B. Hydrogeological potential

Most stream channels in the area maintain little or no surface water during the dry season. This is due to high rate of evaporation which is as a result of high temperature. In the rainy season, the streams were filled with water and this serves as a source of water supply for communities living around the area. While in the dry season, the communities employ measures like digging holes into the river beds to get water.

They also use hand dug wells.

The Basement rock units are weathered, jointed and fractured and these provide secondary porosity and permeability for groundwater accumulation. These structures could be good prospects for ground water sourcing.

Adekoya et al. (2003), observed that the deep weathering and fractures encountered inrecent studies of some Basement areas have given high yield between 6819 liters/hr to 18,184 liter/hr, with acceptable drawdowns. Thus the Basement Complex rocks appearto present relatively good groundwater potentials and are increasingly providingreliable aquifer for water supply.

C. RIVER

River is located toward the out sketch of the community with coordinate NOT 35' 30.4" and E006 ^{0} 02' 16.0" along the major road which is the boundary between Kogi State and Ondo State which fall within the mapped area. The river serve as a source of revenue to the community in term of fishing, domestic and it can be used for irrigationduring the dry season for agricultural purposes.

Fig. 9: showing ogale and Ikakunmo river.

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CHAPTER SIX

CONCLUSION AND RECOMMENDATION

A. CONCLUSION

In general, the association of rock types described in this study area are typically of the south-western Basement Complex of Nigeria. The rocks in the area are gneisses (banded gneiss, granite gneiss, Porphyroblastic gneiss and granite-biotite gneiss) and pegmatites. The rocks are of Pan-Africa Orogeny which resulted in structural deformation and development of numerous fractures and joints that serves as a pathway for the late phaseof pegmatitic fluids. The study of the rocks under thin section reveals that the rocks contain the following minerals: Quartz, Plagioclase, Biotite, hornblende and some accessories minerals.

The Basement rocks appear to have good groundwater potentials for supply of water to the communities around the area.

B. RECOMMENDATION

- There should be periodic mapping of the area because some rocks in the area host economically valuable minerals such as feldspar, quartz, muscovite, and biotite.
- A more detailed exploration work should be carried out especially in the highlymineralized intermediate zone of the pegmatite vein, to ascertain the potential of this zone for new discoveries and to further access the quality and quantity of industrial minerals present.

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APENDDIX

Strike and dip Showing foliation of rocks in the study area.

224SW	20W
35NW	45 W
60NW	45W
112SE	54E
292NW	32W
122NW	38W
324sw	68W
188	68W
188SW	70W
142SW	60wss

Strike of fracture and joint

162	132
342	310
148	320
328	273
144	328