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Geology, Petrology and Petrographic Analysis of Ruwan Tabo Area, Northwestern Nigeria

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ABSTRACT

The study area overlies the Nigerian basement complex that is made up of Liberian to Pan African rock units, falling within latitudes 110 17' 00" N and 110 21'20.27" N and longitudes 080 18' 43.33" E and 080 21' 33.33" E, in the northern part of the country, covering an area of 40km2, mapped at a scale of 1:25,000. The area was mapped using compass clinometer and GPS, rock samples were collected using hammer and chisel and then taken to the laboratory for thin sectioning. Structures were measured and recorded. Petrologically, the rock units mapped in the area are gneiss, covering about 50% of the total area, coarse-grained granite which covers about 40% of the total area of study, while the remaining 10% constitutes the minor rocks. Gneisses and granites from the major rock types in the area, while migmatite, pegmatites and laterites form the minor components of the rock units in the area. Pertographically, the gneiss consists of biotite (10%), plagioclase (25%), quartz (20%), orthoclase (7%), microcline (30%) and muscovite (11%), while the coarse-grained granite consists of biotite (10%), plagioclase (15%), quartz (15%), orthoclase (8%) and microcline (45%) as essential minerals. Structurally, faults, foliations, joints, and veins are the main structures observed in the study area and are mostly attributed to the effects of Pan-African Orogeny which resulted in the N-S trending pattern of the structures in the associated lithologies.

Keywords: *Petrology, Petrography, Gneiss, Granite, Migmatites, Ruwan Tabo.*

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1. INTRODUCTION

The study area falls within the basement complex of Nigeria. The rock types found in the basement complex of Nigeria include migmatites, gneisses, schists, quartzites, marble, and a series of basic, intermediate plutonic rocks, charnockitic suites, gabbros, diorites, granites, granodiorites and syenites [1]. The basement complex in northern Nigeria is underlain by migmatite, gneiss and metasediments of Precambrian Age, which have been intruded by series of granitic rocks of late Precambrian to lower Paleozoic. The plutonic rocks are known as older granites and have been dated to about 500 to 600 million years, representing the Pan-African Orogeny in Nigeria. The granite bodies are widespread in the north and range in size from the smaller elliptical plutons to masses of batholithis with dimensions over 100km in length. The contacts with the gneisses are gradational passing from granite into metasomatic gneiss with marginal migmatites. The contacts between granites and metasediments are sharp with no marginal migmatite [2]. These rocks have been variably metamorphosed and granitised through at least two tectono-metamorphic cycles so that they have been largely converted to migmatites and granite-gneiss [3]. Therefore in order to understand the geology of the study area which is located in the northwestern Nigeria, the knowledge of the general geology of the basement complex of Nigeria has to be well understood.

The study area falls within Tudun Wada local government of Kano State, northern part of Nigeria, consisting of Proterozoic to lower Paleozoic rocks of the basement complex. It lies between latitudes $11^0 17' 00''$N and $11^0 21'20.27''$N and longitudes $08^0 18'43.33''$E and $08^0 21'33.33''$E. The area is underlain by gneisses and migmatites which were metamorphosed by the intrusion of older granites associated with Pan African Orogeny, causing the north-south trending of most of the structures associated with the lithologic units. It is accessible with tarred road from western to the eastern part of the map. Accessibility is also through a network of footpaths that connect most of the villages and also serves as routes for motorcycles and bicycles.

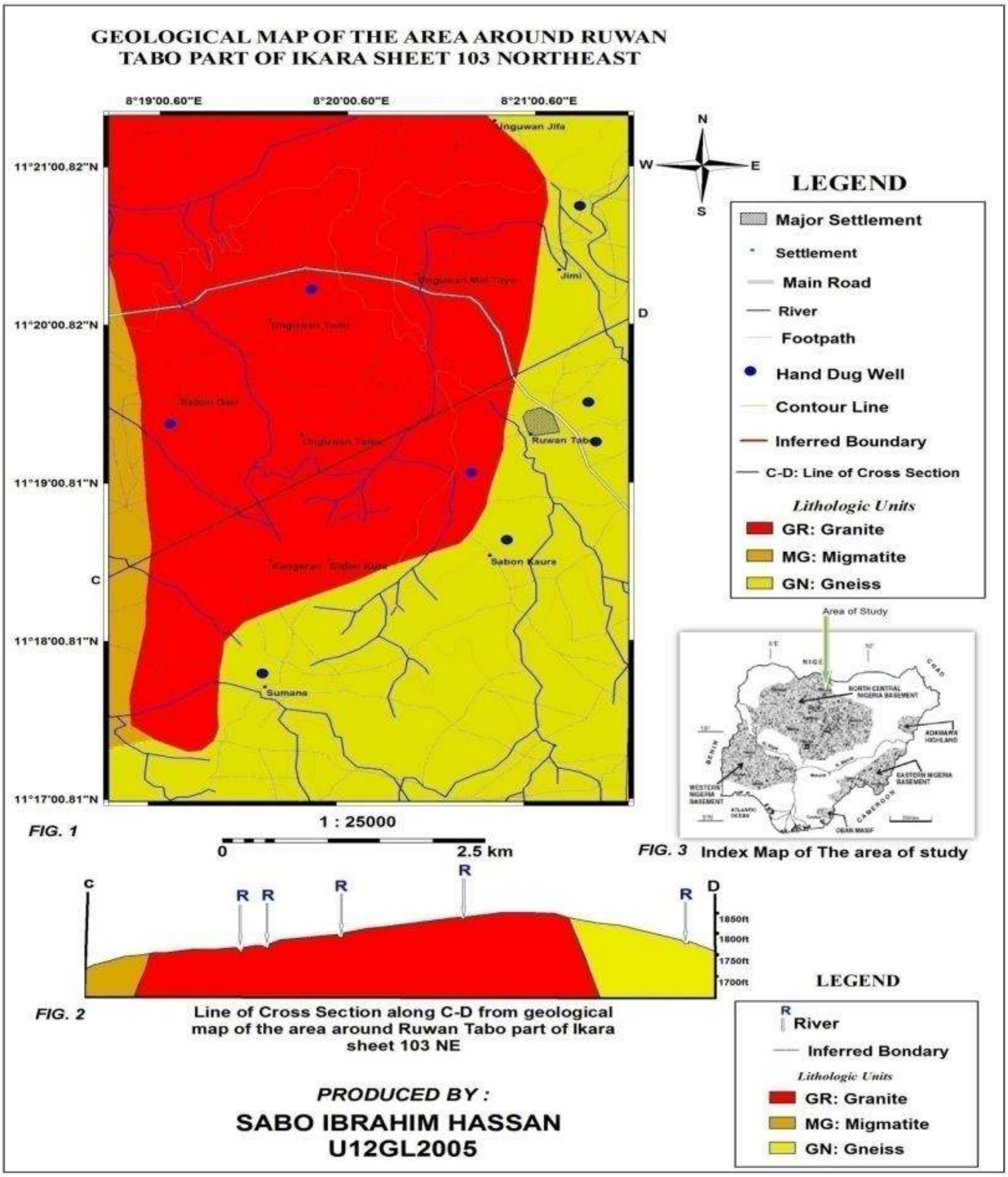

Figure 1: Geological Map of the Study Area and its Cross Section

2. GEOLOGICAL SETTING

Outstanding works have been conducted by [4], [5], [6] and [7] regarding the Nigerian basement complex (within which the study area falls). The basement complex of Nigeria has been classified by various works using different schemes. Reference [4] concluded that northern Nigeria is underlain by gneisses, migmatites and metasediments of Precambrian age which were later intruded by a series of granitic rock of late Precambrian to lower Paleozoic age, during the Pan African Orogeny. In 1976, [8] classified the basement rocks, and subdivided them into; Older Granites, Schist Belts and Migmatite-Gneiss Complexes. In addition to the three lithologies, [9] and [10] also recognized volcanic and hypabyssal rocks as part of the lithologic units.

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3. SCOPE AND METHODOLOGY

The work entails all geological aspect necessary for the understanding of a detailed geological mapping. It involves description of individual rock unit, observation and study of geological boundaries, structures, and petrology including sampling of different rock types for petrographic analysis so as to accurately update geological information of the area of study. Transverse were carried out along major roads, minor roads, river channels and footpaths to different outcrops observed in the area. Compass clinometer for measuring strike, dip dirction and angle, Global Positioning System (GPS) for taking coordinates, measuring tape for measuring exposure dimension, hammer and chisel for sampling and hand lenses for simple mineral identification in the field, were all used for the provision of adequate information of the geology of the area in question. Fresh rock samples were taken in the field from different outcrops encountered and the best five were used for thin sectioning.

4. RESULTS AND DISCUSSION

4.1 MAJOR ROCKS

The area under study is dominantly composed of two rock types; coarse grained granite and gneiss. There are occurrences of minor rocks in the area such as migmatites, pegmatite, and laterite. The rocks are described below. The description is systematically done in three ways; the first part of the description entails the field description of the rocks, the second part shows the megascopic description and the third part of the description contains the microscopic description of the rocks in terms of mineralogical composition and optical properties as observed under plane polarized (PPL) and cross-polarized (XPL) lights.

4.1.1 Gneiss

4.1.1.1 Field Description

The gneiss occupies about 50% of the study area; it occurs as a whale back, low lying ridges, with a penetrative structure (foliation). It usually occurs along river channels. The gneiss is easily distinguished from granite by its foliation (gneissosity), the gneissosity dips at an average angle of 45^0 (Plate 1). Most of the exposures of gneiss are found along river and stream channels occurring as whalebacks. Evidence of chemical weathering is visible in the gneiss exposures where epidote is formed as a result of chemical alteration of feldspars giving green colour clay. Lit-par-lit structures are formed in the gneiss outcrops where quartz utilizes foliation plane to form these structures. Gneiss also occurs as xenoliths in the granites of the study area. Some of the gneisses occur with granite, forming a sharp contact.

4.1.1.2 Megascopic Description

In hand specimen, gneiss is fine- medium grained in size, the rock is grey in colour, with equigranular grains sizes. Visible minerals are mainly biotite, quartz and feldspars (orthoclase, microcline or plagioclase). Foliation is observed in the gneiss where platy minerals are aligned, as a result of metamorphism of the rock (Plate 1).

Plate 1: Weathered Gneiss Showing Dipping and its Direction.

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4.1.1.3 Microscopic Description

Minerals observed under Plane Polarized Light (PPL) and Cross Polarized Light (XPL) are plagioclase, quartz, orthoclase, microcline, biotite and muscovite.

Biotite: this appears dark under plane polarized light (PPL) and dark brown under cross polarized light (XPL), it is strongly pleochroic upon rotating on the stage of the microscope, it shows preferred orientation with needle-like alignment, it exhibits perfect basal cleavage. The percentage composition of biotite is about 10%.

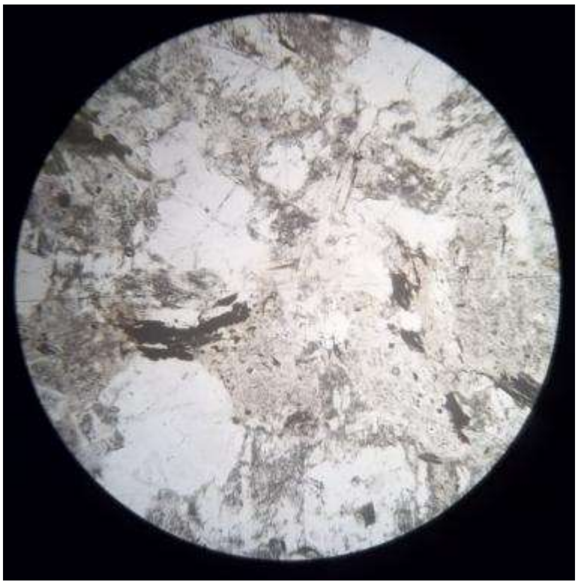
Plagioclase: this is colourless under plane polarized light (PPL) and appears greyish under cross polarized light (XPL) and exhibits albite twining, this twinning and low birefringence helps to differentiate it from quartz, the crystals are anhedral in shape, it has a low relief, the percentage composition of plagioclase is about 25%.

Quartz: Quartz crystal appears colourless in plane polarized light (PPL) and cross polarized light (XPL), the shape of the crystals is anhedral. The mineral has a low relief and exhibits undulous extinction, the percentage composition of quartz is about 20%

Orthoclase: it appears cloudy under both plane polarized light (PPL) and cross polarized light (XPL), the crystals of orthoclase are anhedral in shape and has a low relief, the percentage composition of orthoclase in the rock is about 7%.

Microcline: this mineral is colourless under plane polarized light (PPL) and appears milky white under cross polarized light (XPL) with 2 sets of cleavage. The crystals of the mineral are anhedral to subhedral in shape, pleochroic with mottled extinction. It has a higher relief relative to Quartz and Orthoclase, the percentage composition is about 30%.

Muscovite: this appears colourless under plane polarized light (PPL) and has a pale green appearance under cross polarized light (XPL), hence pleochroic. It has a high relief and exhibits parallel extinction. The percentage composition is about 11%.



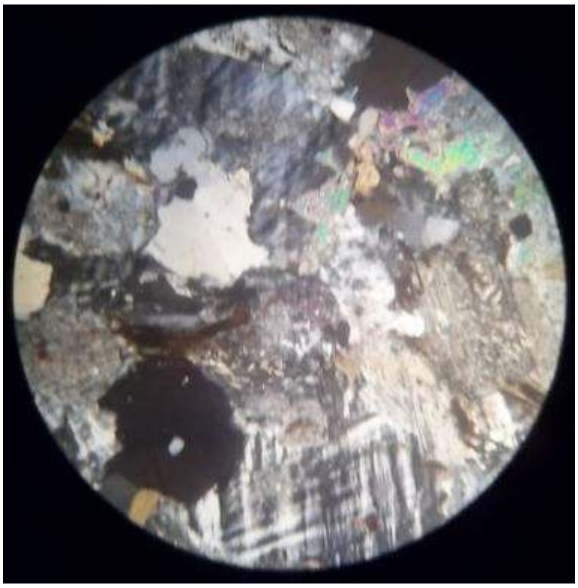


Plate 2: Photomicrograph of Gneiss under PPL and XPL dominantly composed of M- Microcline, P- Plagioclase, O- Orthoclase, Q- Quartz, B- Biotite, Mu- Muscovite

4.1.2 Coarse Grained Granite

4.1.2.1 Field Description

This lithologic type is widely spread and scattered, covering the central and northern part of the study area in form of whale backs, low lying ridges, and also as elevated ridges with height of about 3-6m above sea level. It occupies about 40% of the study area and occurs mainly at the boundaries of the study area.

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Plate 3: A photograph of coarse grained granite.

4.1.2.2 Megascopic Description

A fresh sample of the granite in hand specimen is usually coarse grained in texture. The minerals present are feldspars (plagioclase and orthoclase, microcline), quartz, and biotite. Sometimes the granite appears pinkish because of the dominance of microcline feldspar (Plate 3).

4.1.2.3 Microscopic Description

The rock has a light appearance due to the abundance of felsic minerals. In terms of its mineral content it is certainly granite. The rock was viewed under the microscope under a plane polarized (PPL) and cross polarized light (XPL) and the following minerals were observed; microcline, quartz, biotite, orthoclase and Plagioclase.

Microcline: colourless under the plane polarized light and non pleochroic. It has low relief with weak birefringence. It exhibits cross hatch twinning under the cross polarized light. Some part of the microcline contains quartz, found as an intergrowth in the microcline. It constitutes about 45% of the entire mineral composition of the rock.

Quartz: this is present in the rock with anhedral large crystal. It is colourless in both plane polarized light (PPL) and cross polarized light (XPL). There is no alteration or twinning. It has a low relief and shows undulous extinction. It constitutes about15% of the rock.

Biotite: it appears dark under plane polarized light (PPL) and dark brown under cross polarized light. This constitutes 10% of the rock. Biotite has well-developed large crystals. It is anhedral-subhedral in form. The mineral is highly pleochroic and has moderate relief. Is has a perfectbasal cleavage.

Plagioclase: it occurs as colourless under plane polarized light, cloudy, anhedral in form and of low relief with good cleavage under cross polarized light. It has low birefringence (first order grey colour) in cross polarized light. It constitutes about 15% of the entire mineralogy observed in the slide.

Orthoclase: it is as anhedral to subhedral crystal, colourless with low relief in plane polarized light. It occurs as dark gray, and shows simple Carlsbad twinning in cross polarized light. It constitutes about 8% of the entire mineralogy observed in the slide.

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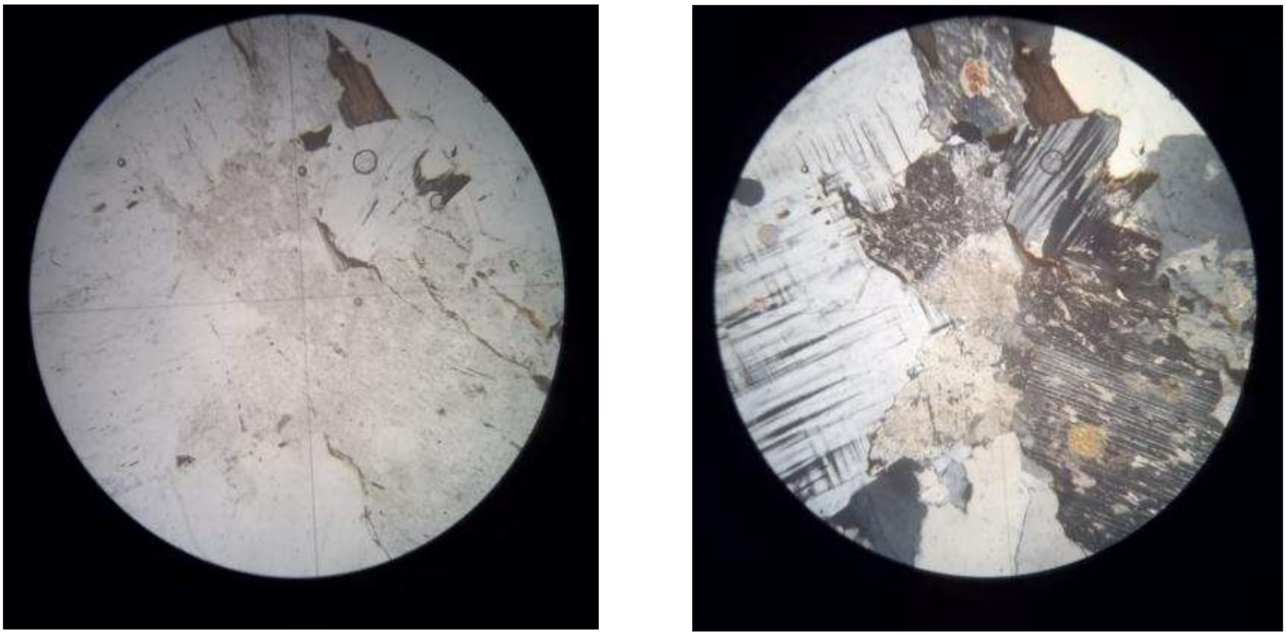

Plate 4: Photomicrograph of Coarse grain granite under PPL and XPL dominantly composed of M- Microcline, P- Plagioclase, O- Orthoclase, Q- Quartz, and B- Biotite

4.2 MINOR ROCKS

4.2.1 Migmatite

Migmatite occurs only at the western part of the area of study constituting about 10% of the study area. They are banded with two distinct layers namely; Leucosome layers: which are largely composed of feldspar and quartz, which make them light in colour, Melanosome layers: which are made up of mafic minerals mainly biotite, which makes them dark in colour. The migmatite occurs along the river channels around Sabon Gari village with coordinates of latitude 11^0 19’ 34. 1”N and longitude 8^0 18’ 50.5”E. Structures associated with the lithology are fault, joint, intrinsic fold and normal fold.

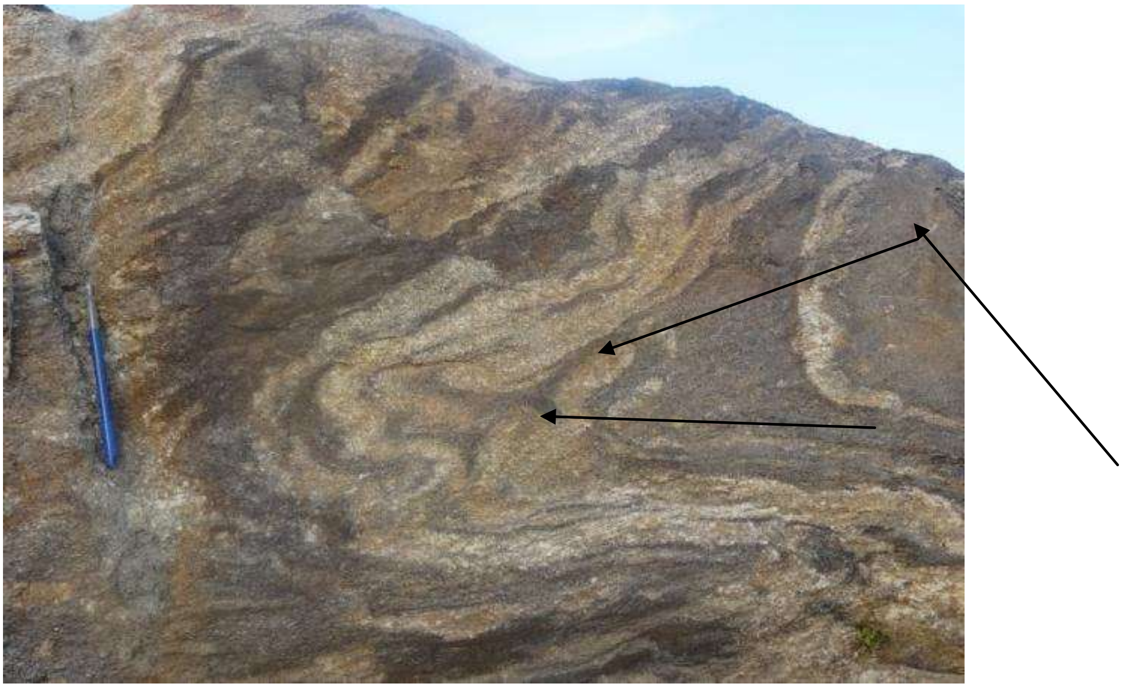

Plate 5: Migmatite Showing Leucosomes and Melanosomes

4.2.2 Pegmatite

Pegmatites occur in almost all rock types within the study area, they were formed during the last stage of crystallization, they occur mainly as dykes and veins with very coarse grains of quartz, feldspar and very little biotite, they are found to be dominant in

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granites. They have a width of about 30cm to 70cm, cutting across the host rocks. They show a dominant trend of N-S direction. Most of the pegmatites are discordant, because they intrude vertically into the older rock, the average width of the pegmatite is about 55cm, a pegmatite was observed at latitude 11^0 20'17.0"N and longitude 08^0 19' 6.3"E cutting across a gneiss.

Plate 6: A Pegmatite Cutting across Gneiss.

4.3 STRUCTURES

The area of study is characterized by structural features which are considered to have been formed as a result of different tectonic processes that had affected the rocks in response to different stress and strain conditions. Having genetic variation, the rocks respond to stress and strain application in variable ways. Structures associated with the rocks in the study are; faults, joints, dykes and veins. The regional trends of most of these structures are generally NE-SW direction (Fig 2). Structures may form either during or after the formation of the rock.

4.3.1 Fold

The main fold observed in the study area is found in migmatite (Plate 7). Fold is the bending or buckling in of a pre-existing rock as a result of deformation through the application of compressional forces.

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Plate 7: A Photograph of Migmatite Showing Folding

4.3.2 Foliation

This refers to the parallel to sub-parallel alignment of platy minerals, formed due to the effect of shearing forces or differential pressures. Most foliations are caused by the preferred orientation of phyllosilicate minerals, such as micas and chlorite. The structure is common in the study area and occurs from microscopic to megascopic in size in the gneisses within the study area. Most of the foliations observed trend in N-S direction (Plate 8).

Plate 8: A Photograph of Gneiss Showing Foliation

4.3.3 Faults

Faults are brittle fractures within crustal rocks along which relative movement or displacement has taken place on either side of the plane. They are observed in the study area consisting of dextral strike-slip and sinistral strike slip fault. The major faults mapped are strike slip-faults.

Plate 9: A Photograph of Sinistral Strike-Slip Fault in a Granite Exposure.

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4.3.4 Joints

Joints are fractures or cracks found in rocks along which there has been no displacement. The granite and gneiss exposures in the study area are characterized by several joints, majority of the joints identified have their trend in NNE-SSW direction, with gneiss showing a lot of different joint sets (Table 1 and Fig 2).

Plate 10: A Photograph of Joint Sets Occurring in Gneiss

Table 1: Readings of Joints Trends

119^0	125^0	110^0	302^0	130^0	280^0	282^0	250^0	018^0	020^0
038^0	188^0	186^0	310^0	334^0	352^0	272^0	136^0	128^0	1360
058^0	130^0	092^0	138^0	112^0	248^0	254^0	068^0	226^0	248^0
228^0	052^0	090^0	258^0	282^0	292^0	092^0	088^0	294^0	224^0
266^0	220^0	280^0	236^0	076^0	272^0	270^0	112^0	184^0	246^0
280^0	276^0	280^0	248^0	078^0	094^0	078^0	060^0	132^0	228^0
336^0	210^0	170^0	322^0	184^0	104^0	070^0	078^0	244^0	130^0
122^0	109^0	140^0	326^0	276^0	332^0	324^0	002^0	266^0	076^0
220^0	280^0	294^0	052^0	228^0	236^0	324^0	218^0	008^0	

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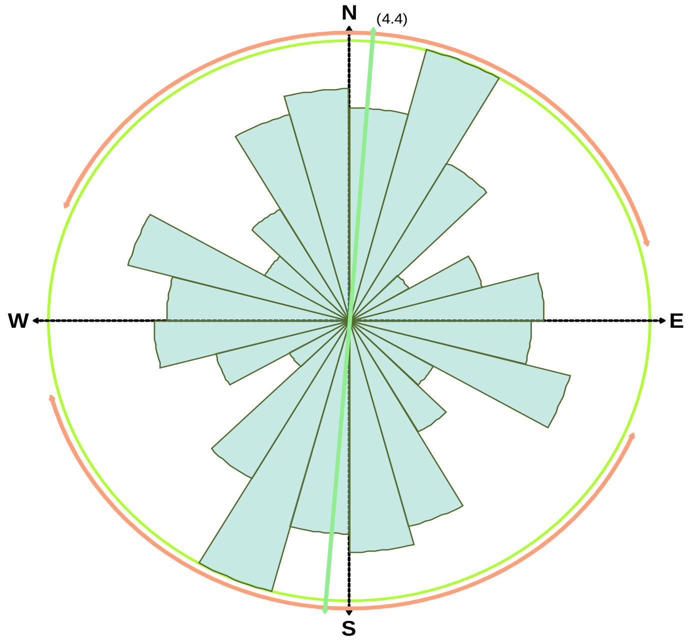

Fig 2: Rose Diagram of Joints Trending Dominantly NE-SW.

5. CONCLUSION

Geological, petrological and petrographic studies show that the mapped area is underlain by rocks of the basement complex including gneisses and granites as the major rocks and migmatites, pegmatites and laterites as the minor rocks. The evolution of the rocks as well as that of most of the geological structures has been linked to at least three past tectonic events ranging from Archaean to Pan African. The rocks and structures in the area are therefore products of tectonic events. Structural features like folds, faults, joints and foliations were observed dominantly trending N-S are evidence that confirms the E-W dominant stress direction of the Pan-African Orogeny. Weathering and erosion has led to the formation of superficial deposits of the area (laterite). The topography of the area is low, drained with few river and stream channels. The rocks as well as the superficial deposits are mainly used for engineering constructions.

REFERENCES

1. Rahaman, M.A. (1988): Pre-Cambrian Geology of Nigeria. Paper presented at the Benin, Nigerian Geol-traverse International Meeting on Proterozoic Geology and Tectonic of high grade terrain programme and lecture series 28-30.
2. Oyawoye, M. O. (1964). The Geology of the Nigerian Basement Complex.Journal of Nigerian Mineral Geology and Mell.soc. Vol. 1.
3. Mc Curry, P. (1971): Pan-African Orogeny of Northern Nigeria. Bulletin Geology. Soc. American, 82, pp. 35 1-362.
4. Wright, J.B and McCurry (1970).The Geology of Zaria sheet 102 SW and its region in M.J Mortimore (Ed).Department.
5. Oyawoye, M.O. (1972). The Basement Complex of Nigeria. In: Dessauvagie T.F.J. and Whiteman, A. J. (Eds) African Geology, University of Ibadan, pp. 66-82.
6. Rahaman, M.A. (1976). Review of the Basement of South-Western Nigeria.In Kogbe C.A. (Ed) Geology of Nigeria.Elizabethan publishing Company Limited Lagos, pp.41-56.
7. Grant, N.K. (1971): A Compilation of Radiometric Ages. Nigeria Journal. Mm. Geology., 6, 37-84.
8. Mc Curry, P. (1976): The Geology of the Pre-Cambrian to Lower Paleozoic Rocks in Northern Nigeria- a review in Kogbe.
9. Rahaman, M.A. 1981. Recent Advances in the Study of the Basement Complex of Nigeria. First symposium on the Precambrian Geology of Nigeria.
10. Ajibade, A.C and Fitches W.R. (1988): The Nigerian Precambrian and the Pan –African Orogeny, Precambrian Geology of Nigeria, pp. 45-53.

DOI: 10.31695/IJASRE.2019.33097