Earth Sciences
2025, Vol. 14, No. 2, pp. 57–71
https://doi.org/10.11648/j.earth.20251402.12

Research Article

Geology and Petrography of Rawayya and Its Environs Part of Sheet 54SE, Bungudu Local Government Area of Zamfara State, Nigeria

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Abstract

The area of study is Rawayya and its environs, North Eastern Bungudu. An area of 15km ²bounded by latitude 12 °14'17" to 12 °13'19" N and longitude 06 °42'7" to 06 °42'32" E was mapped on a scale of 1: 25,000. The area is accessed through major roads, footpaths, and river channels. The study area was mapped using the traverse method done with the aid of a topographical map, G. P. S (Global Positioning System), Hand lenses, Tape, compass clinometers, sack bags, and hammers to locate position, collect samples, take structural readings and store samples. Two major rock types were identified in the area. The rocks within the area comprise biotite-granite and granodiorite. The minerals identified through hand specimen field description of these rocks include: quartz, feldspar (plagioclase), biotite, and muscovite. Structures within the study area manifest an imprint of Pan-African orogeny (NNE-SSW). There was the presence of monomineral quartz veins. Other structures observed were faults, folds, joints (open and closed fractures), veins, xenoliths, and pegmatite veins. The predominant trend of the joints and veins is in the NE-SW direction. These structural features have been interpreted to be related to the Pan-African orogeny. The Petrographical analysis of the rock sample was carried out at Abubakar Tafawa Balewa University Bauchi. Using a Petrographic microscope (Thin section) identified major elements such as quartz, feldspars (plagioclase), biotite mica, muscovite, and accessory minerals such as Hornblende.

Keywords

Petrographic Microscope, Global Positioning System, Topographical Map, Compass Clinometers

1. Introduction

Geological mapping is the process of gathering data in the field and adding that to a topographic map in order to create a geological map of that particular region. According to [1, 4, 7], a geological map will depict the various rock types of the region, the geological formation, structures, age relationships, geothermal manifestations, distribution of mineral ore deposits and fossils, etc. All these features may be superimposed over a topographic map or a base map. On this basis, this work was carried out and a report was presented on the geology of Gusau.

Geological mapping exercise was carried out in Rawayya and its environments, to determine and understand the geology of the area, this includes; surface and subsurface features. The study area falls within the northwestern part of Nigeria

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Received: DD MM 2025; **Accepted:** DD MM 2025; **Published:** DD MM 2025

and is underlain by crystalline rocks of the basement complex.

The primary goals of this research concern the study of different rock types, their petrography, petrogenesis, structural relationship, and mineralogy including geochemistry, economic geology, and hydrogeology of the area. This study involves mapping rock exposures and their limits, traverses taken along roads, footpaths, and along stream channels. [5]

1.1. Location of the Study Area

The study area is located in Bungudu Local Government area of Zamfara State and forms part of the Federal Survey map of Nigeria sheet 54 SW, Zamfara State which falls within the Nigerian Basement Complex. It lies within the coordinates; Latitude 12°12'00"N to 12°14'00"N and Longitude 6°39'00"E to 6°42'00"E covering an area of about 30. 8025 km². The prominent settlements in the study area: include Rawayya, Unguwan Sarkin Noma, G. yammatawa, Nasarawa Rashi, Gidan Zalla, and Unguwar Kwama. The study area is accessible by a network of footpaths, and minor and major roads which include; TasharRawayya to Rawayya Road.

Table 1. *Locations.*

S/N	Settlement	Location
1.	RAWAYYA	1214’ 11.2”N, 06°41' 0.30”E
2.	UNGUWAN SARKIN NOMA	1213’ 2.70”N, 0642’ 3.66”E
3.	G YAMMATAWA	1212’39.1”N, 0643’24.3”E
4.	NASARAWA RASHI	1212’ 77.1”N, 0643’14.4’E’
5.	GIDAN ZALLA	1212 040”N, 0643’ 250”E
6.	UNGUWAN KWAMA	1214’ 9.33”N, 0640’ 15.2”E

1.2. Climate, Vegetation and Drainage

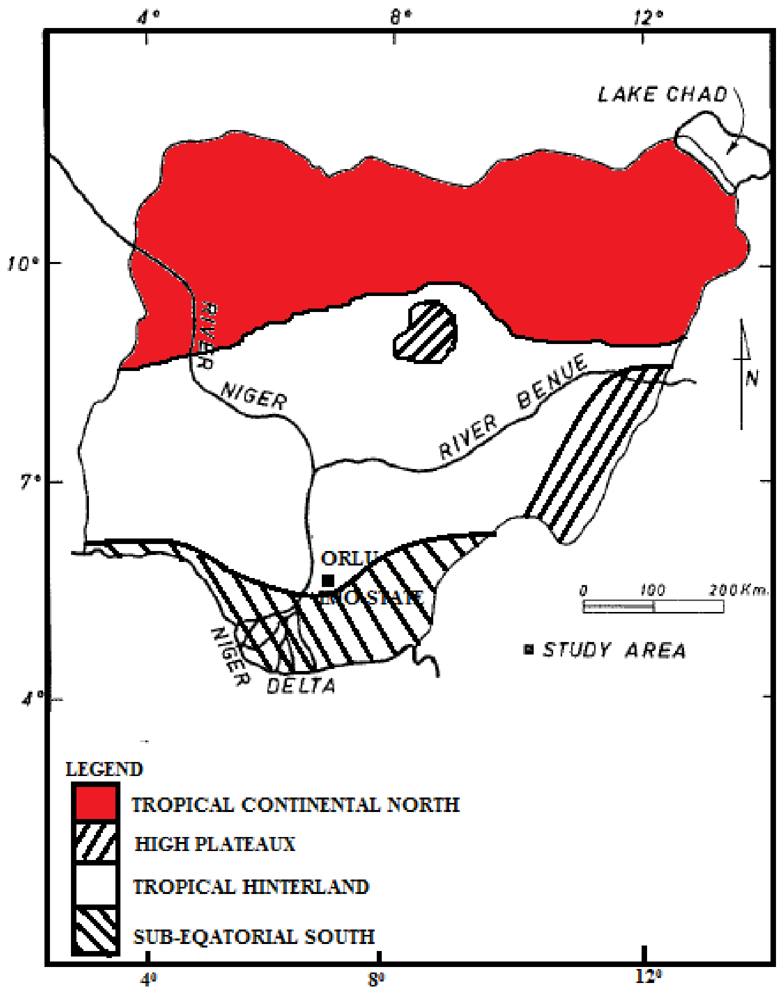

Figure 1. *Map of Nigeria Showing the climatic regions (After, Iloeje, 1981).*

The climate of an area plays a significant role in relation to its effect on the character of vegetation as well as the people's way of life and their pattern of economic activities. The study area belongs to the tropical continental climate and it is characterized by distinct wet and dry seasons. The wet season occurs between April and October, while the dry season occurs between November and April. These two seasons are brought about by the two predominant winds that rule the area: the southwestern monsoon winds from the Atlantic Ocean and the Northeastern dry winds from across the Sahara Desert. It is also good to note that during the dry season period, the harmattan period (a particularly dry and dusty period that occurs for about two weeks within the dry season usually between November and February) does occur. The zone moves upwards to the north. This is followed by the maritime air mass from the south high-pressure zone which carries moisture from the Atlantic Ocean and surges up northwards.

In addition, the temperature condition of the study area falls within the Zamfara State temperature region with temperature rising up to 38 ℃ (100.4 ℉) and above between March to May.

1.2.1. Vegetation

The vegetation of the study area is that of the Northern Guinea Savannah with a variety of short grasses, thorny shrubs, and a few trees scattered. The grasses in the study area have durable roots that remain underground after the stalks are burnt away or wilted in the dry season enabling them to germinate after the first rain, while the trees possess long tap roots and thick bark that make it possible for them to withstand the long dry season and bush fire.

However, in Rawayya and the surrounding area, the varieties of trees and grasses seen include; Baobab (*Adansonia digitata)* indicating the existence of settlement in the past, Shea butter *(Butyraspemum)*, locust beans (*Parkia Piglobosa*), Neem *(Azadirachta indica)*, Dalp palms common along river valley, and numerous thorny and short shrubs including Acacia species.

1.2.2. Drainage

The major passage for water bodies in the area of study is Rawayya, several tributaries that are supposed to empty into this river channel are dried up and hence, the major sources of water for this river downstream are groundwater and seepages/releases from the different rivers, making it a perennial river. The drainage pattern is dendritic. The study area is well drained such that most of the streams and Rivers are seasonal and only flow during the rainy season.

2. General Geology of Nigerian Basement Complex

The study area constitutes part of the Basement Complex of Nigeria. The Basement Complex in Northern Nigeria is underlain by gneiss, migmatites, and metasediments of the Precambrian Age, which have been intruded by a series of granitic rocks of late Precambrian to lower Palaeozoic. The plutonic rocks are known as Older Granite 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 the masses of batholithic dimensions over 100 km 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 migmatites [2, 3, 6, 9].

Therefore, a general overview of the Basement Complex of Nigeria constituting the preamble of this project seems justified, since the study area is located within the Basement Complex of Nigeria.

2.1. Regional Geology of the Nigerian Basement Complex

The Nigerian Basement Complex lies within the Pan-African mobile belt. It is bordered on the west and east by West African and Congo cratons respectively, and lies south of the Tuareg Shield [10, 11, 15]. Rocks of the basement complex of Nigeria are composed predominantly of migmatitic and granitic gneisses, quartzite and schist, and meta-igneous rocks which are Precambrian to Lower Paleozoic in age [12-14]. In addition to the three lithologies, [17] and [18] also recognized volcanic and hypabyssal rocks. The Nigerian Basement Complex can thus be grouped into four main lithologic units; The Basement Complex comprises the poly-metamorphic migmatite-gneiss complex. Younger Metasediments comprise the low-grade Meta-sediment that dominated the schist belts. Older Granites which cut both the migmatite-gneiss-quartzite complex and schist belt. Volcanic and hypabyssal rocks which belong to a post Older Granite episode of high-level magmatic activity [8]

The Basement Complex rock structures are N-S trending foliations, joints, folds and faults having evolved between 2000Ma to 873±44Ma [18, 20].

2.2. Migmatite - Gneiss Complex

This is also referred to as older Metasediments of Birimian to Eburnean age [20]. The conversion of large areas of a basement into migmatites and granite gneisses has led to changes in many features of the original gneisses. Sediments have been metamorphosed and granitised to form gneisses which incorporate the rocks that resisted granitisation, basically schist, quartzite, and calcareous rocks. These provide evidence of early sedimentary deposition [14]. These relics are widely distributed thus suggesting their belonging to extensive supracrustal coves which have been modified into migmatite-gneiss complex [23].

2.3. Schist Belt (Metasedimentary Series)

The younger metasediments make up the schist belt and they occur in north-western and south-western Nigeria. The schist belt of north-western Nigeria occupies N-S trending synformal troughs with smaller bodies occurring in the migmatites and gneisses of the basement complex but due to erosion, they are only restricted to synformal troughs. The schist is composed of low-medium grade metasediments and Meta igneous rocks which are composed of the following rock types; muscovite-biotite schist, quartz schist, ferruginous quartzite, and kyanite schist. It is generally believed that the schist belts of Nigeria make up extensive super crustal cover on the migmatite-gneiss basement complex but it has been removed by the intrusion of the older granites that are found in the synclinal remains of the basement complex [19, 21].

2.4. Older Granites

The Older Granites are accepted as the only undisputed products of Pan-African events in Nigeria. They cut both the migmatite-gneiss complex and the schist belt. They include rocks of granitic to charnokitic composition with smaller bodies of syenites and gabbros and range in age from 750-450 ma [16] This shows that the older granites are high-level intrusions emplaced by stooping and diapiric processes. The foliation in some granite is a result of post-emplacement deformation.

The batholiths are dominated by the porphyritic biotite granite which forms the main rock type of the area so far investigated. In this rock, the crystallization history is closed with the appearance of the feldspar megacrysts and the assimilation of xenoliths [22]

Described and grouped Older Granites into three types according to their petrographic affinities, porphyritic granites which are the most typical, and coarse-grained to very coarse-grained with white or pink prismatic phenocryst of microcline [17].

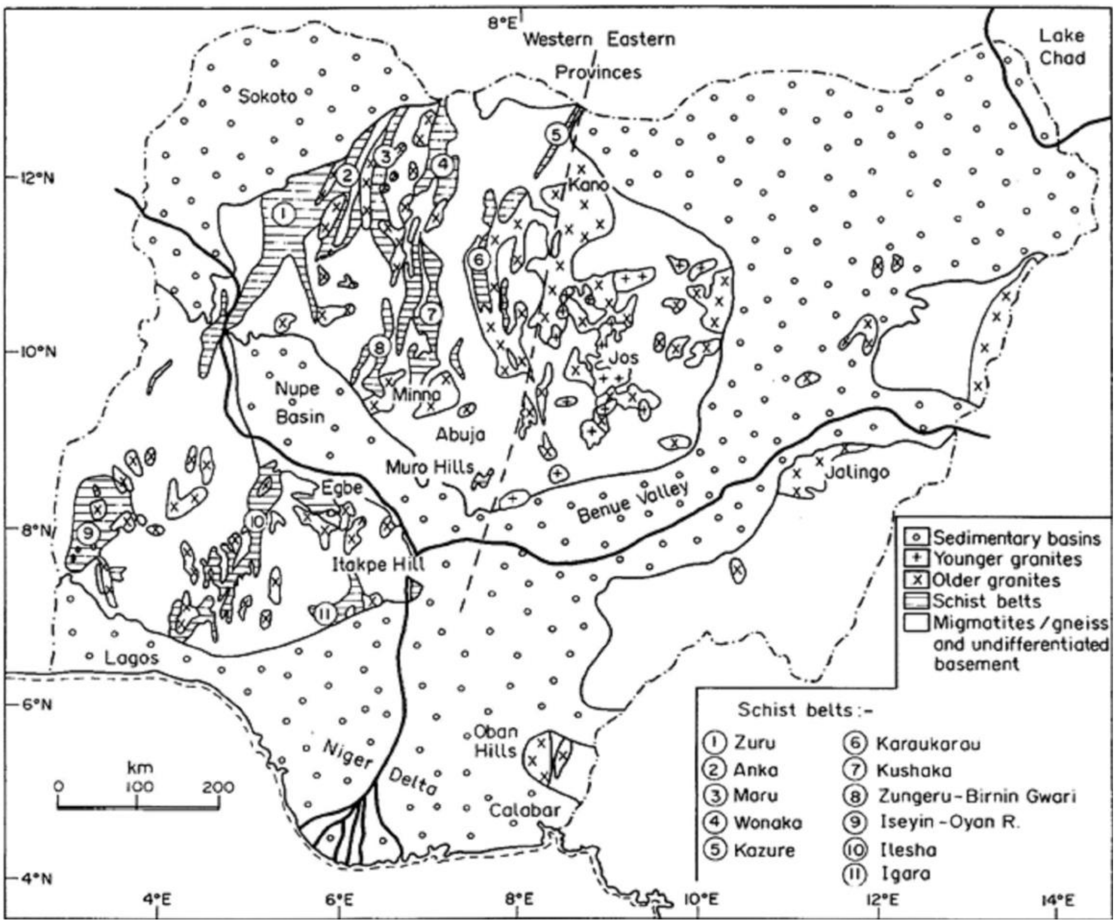

Figure 2. *Schist belt localities within the context of the Geology of Nigeria (After Woakes et al., 1983).*

Fine to medium-grained granites, granodiorites which are fine-medium-grained. They are generally unfoliated and rich in xenoliths with lenses of light material and magmatic segregation [17] Syenites, which are of minor occurrence but they are uniformly textured. They are fine to medium-grained and vary in color from pale gray-pink to dark grey.

2.5. Volcanic and Hypabyssal Rocks (Younger Granite Series)

They are either partly or wholly intrusive in older granite bodies. They occur in many places in north-western and north-eastern parts of Nigeria. These rocks are believed to have been emplaced during epi-orogenic uplift and regional cooling. Rocks belonging to these groups include; Andesites, Basalts, and Granite porphyries.

2.6. Regional Setting of the Nigerian Basement Complex

The Pan Africa Shield consists of two sectors; Tuareg and Togo-Benin Nigerian belts. The belts are believed to occur in north-eastern Brazil where it is referred to as the Brazilian belt [16] The Nigerian basement complex witnessed at least two cycles of orogenesis [23]. This has been supported by geo-chronological studies of the Nigerian basement. The first tectonic metamorphic cycle took place between the Birimian and Eburnean ages, with orogenesis resulting in the folding, and intrusion of Eburnean granites. The metamorphism of sediments deposited on the pre-Cambrian crystalline complex or gneiss and migmatites correspond to Eburnean orogeny [20]. The second tectonic metamorphic cycle is known as the Pan-African orogeny; this is characterized by pre-existing rocks. In general, these orogenic episodes have resulted in; metamorphism, migmatisation, folding, and remobilization of pre-existing basements to produce suites of granitic rocks [19].

The basement complex has been divided into two zones; A western zone in which N-S trending elongated schist belts are separated from one another by migmatite-gneisses and gneissic-granites. An eastern zone in which schist are poorly developed and comprises mostly of migmatites and gneisses. North-western Nigeria has been regarded as the most interesting area of basement geology in Nigeria since major rocks are present and relatively better developed [23, 24]. In general, the Nigerian basement complex can be classified into four lithologic units; migmatite-gneiss complex, schist belt, Older Granites, and volcanic hypabyssal rocks.

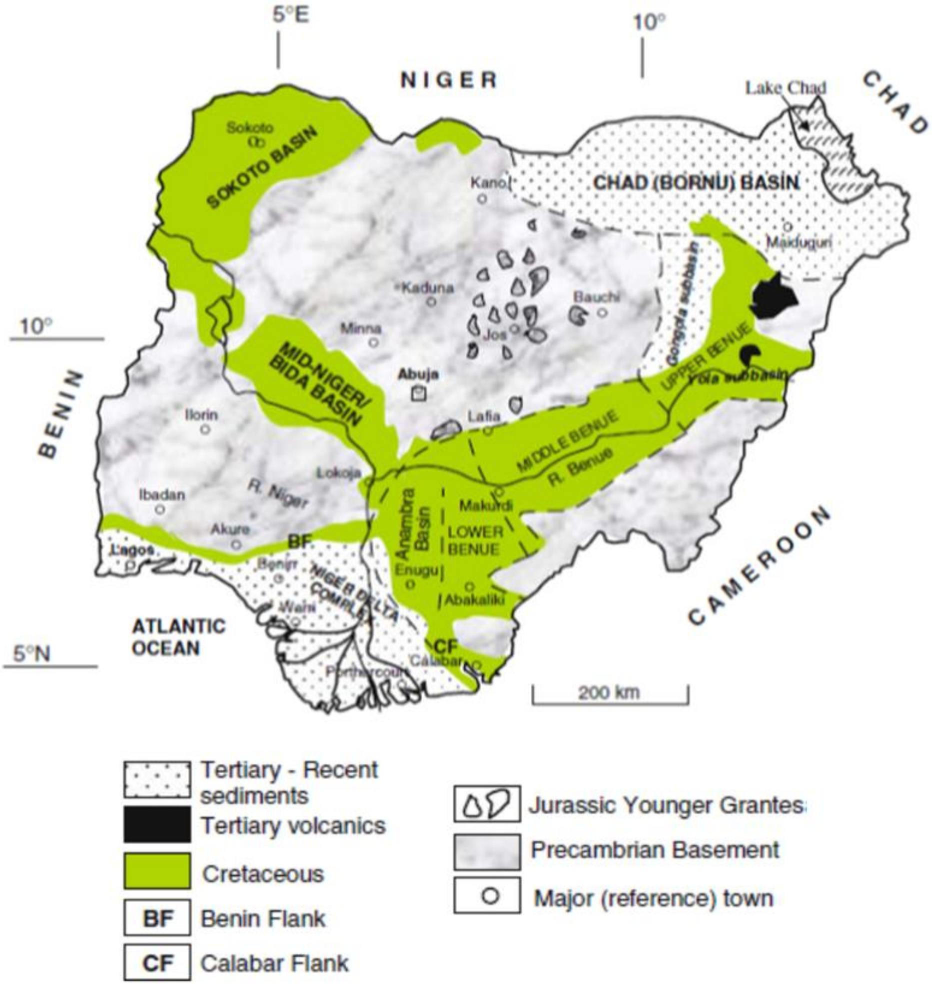

Figure 3. Geological sketch map of Nigeria showing the major geological components; Basement, Younger Granites, and Sedimentary Basins (After Obaje, 2006).

2.7. Geochronology

The Nigerian Basement Complex is polycyclic in nature. Pieces of evidence from other parts of Nigeria show that the migmatite-gneiss complex may be as old as Archean [21] and correlated the migmatite-gneiss complex as Liberian and Dahomeyan (2,800Ma). Geochronology of schist belts gives the idea that schist belts were laid down on the older basement and later folded into the basement rocks (Trustwell and Cope 1987; Ajibade, 1972, and Mc Curry, 1970). [20] suggested that the low-grade Metasediments in Zaria Sheet 21 were equivalent to the Katangan sediments of central Africa. [12] and [16] agreed that the Nigerian schist belts belong to two different age groups; one in Kibaran and the other Pan African. [19] and [13] later considered Kibaran ages earlier given to the schist belts, thus upper Proterozoic was suggested for most of the schist belt.

The Older Granites are generally believed to have been emplaced during the Pan- African orogenesis. The rocks comprising the Older Granite suites range in age from 750-450Ma (Ajibade, 1987). The emplacement of the Older Granites occurred due to the closure of the ocean at the cratonic margin about 1000Ma ago and the crustal thickening in the Dahomeyan with subsequent deformation of sediments. The general geochronologies of the Nigerian Basement Complex rock in Nigeria are shown in below.

Table 2. General Geochronology of the Basement Complex Rocks in Nigeria. (After Kogbe, 1976).

AGE (ma)	PERIOD	CHARACTERISTIC SEQUENCE OF ACTIVITIES	ROCK TYPES
540±40Ma	Mid-Cambrian	Uplift, down warping, cooling, fracturing, high-level magmatic activity.	
540-650Ma	Lower Cambrian	Granite intrusion, pegmatite, and aplite development	Older Granites
650-850Ma	Pan-African	Orogenesis, deformation, metamorphism, migmatisation, reactivation of the pre-existing rocks	Older Granites
800-1000Ma	Katangan	Geosynclinals deposition, intrusion of hypersthene-bearing rocks	Katangan Metasediments
1900±150Ma	Eburnean	Granite intrusion, orogenesis, folding, metamorphism, and reactivation	Eburnean granites
2500Ma	Birimian	Geosynclinals deposition	Birrimian Metasediments
2500±200Ma	Liberian cycle	Probable formation of banded gneisses	Migmatite gneisses
2800Ma	Dahomeyan	Crystalline basement	Granulitic gneisses

3. Methodological Overview: Data Acquisition, Field Techniques, and Petrographic Preparation

This section explains the methodology used to study the geology and petrography of the Rawayya area. It contains the data sources used at the beginning of this work, such as providing early-stage regional topography and geological maps, followed by field techniques and instruments used in geological mapping. In addition, the laboratory sections summarize the processes involved in preparing rock samples for thorough petrographic study, thus allowing a better overview of the research process from data acquisition to laboratory analysis.

3.1. Data Availability and Description

The data set available for this research work includes regional topography and geologic maps. Thus, the necessary instruments used during the mapping periods are clinometers-compass, a geological hammer, a Global positioning system (GPS), a field notebook, a base map, and sample bags. The workflow approach used in this present study is illustrated. The study involves 3 stages namely:

1) Desk study
2) Geological fieldwork
3) Office work

The execution of these steps was done in accordance with the geological principle.

The basic data available in the process of making a geological map of the study area was a topographic map which was used to plot geological observation in the field. However, a second base map was also used on which the clear interpretation of the geology of the study area was also plotted again as a fair copy map submitted to the supervisor after the mapping was done.

3.2. Material

Geological mapping of the study area involved the recognition, identification, and measurement of different rock types, structures, and their mineral composition various techniques were employed during this exercise. These include.

1) Field Notebook: was used during the mopping exercise to record the available.
2) Compass traversing pacing: To measure the dimension of outcrops, usage of compass clinometers to determine strike and dip.
3) Global positioning system (GPS) device: To coordinate and evaluate outcrops, wells, and settlements.
4) Measuring tapes: To measure distances and depth of the water table.
5) A Geological Hammer: This was used to collect samples of rocks which were used for thin sections analysis to determine the minerals content of the rocks.
6) A hand lens: was used to undertake a preliminary field mineral identification before rock thin sections were made.
7) Maker and Masking Tape: The fresh samples collected from the field were labeled with a marker and masking tape kept in a sample bag and transported to the laboratory for further analysis.
8) Enlarge base map: The use of a topographic map in other to update the new geological map of the study area by inserting different lithologies. The base map used during the exercise has a scale of 1:25,000 produced from enlargement of 1: 50,000 sheet 54 (Gusau)SE.
9) Camera: Used for making photographs of outcrops, structures, fractures, etc.

Safety: the field requires safety the mapping tools should be prepared including safety equipment, it's very important because we need to know anything that may happen outside. Many dangerous things like reptiles or insects bite the rebound of rock particles while sampling, or hitting by a hammer, it has the probability to happen so, we should be well prepared. The standards suit to use are:

1) Safety Shoes
2) Safety Glasses
3) Glores
4) Field Cap
5) Safety Helmet (Important if we go down to the hole or come)

3.3. Procedure for the Section Preparation

1) Using a rock-cutting machine, cut the side of interest from the rock sample.
2) Using carborundum powder (an abrasive containing silicon and carbon) thin the rock chip and also the face of the glass side.
3) Mark the glass side using a diamond pen
4) Place the thinned rock and glass ride on the source of head chat plates for 2-5 minutes.
5) Using a glass rod mix Araldite to equilibrium
6) Rick chip and glass –slide using the Araldite
7) Ensure the removal of air bubbles by gently heating the slide of ten pressing cut air bubbles with forceps.
8) Dry four for about 3-5 minutes
9) Allow to cool for about 5-10 minutes
10) Clamp slide and rock chip on the grinding machine and grind gradually.
11) Then with carbonranclu powder, after grinding, while observing, the petrology microscope
12) Take the trained glass slide to the hot plate to be scrapped to the size of the giver slip
13) The glass slide to the giver slip wing Canada babam
14) Eliminate air bubbles by germ-rubbing the surface using a mounting pin
15) Keep to dry for two days.
16) Scrop gum debris off the edges of the glass slides.
17) Wash the slide using detergents and methylated spirit and allow it to dry
18) Label slides ready for further studies

4. Results and Interpretation

Below are the results from field mapping and laboratory tests, including petrographic study of rocks. The two major rock types that dominate the study area are Biotite granite and granodiorite, felspar(plagioclase); with a trend in quartz minerals found to be highly dominating in the area, and follow-up minerals include biotite and muscovite minerals which were recognized in the course of field description.

4.1. Result

There are different rock types in the study area. These can be broadly grouped into two on the basis of their abundance; the major and minor rocks. The major rock includes Granite, Biotite-granite, grono-diorite, xenolith, quartz vein, aplite dykes, and pegmatite vein. Constitute the minor rocks. While Alluvium, laterite, and soil occur as superficial deposits.

The intense regional tectonics that proceeded and accompanied the emplacement of the granitoid during the Pan-African orogeny produced a well-defined and extensive N-W trend in North Central Nigeria including the Zaria area. (Russ 1957), Trustwell and Cope, 1963: Grant (1969).

A number of structural elements were observed in the study area which is considered to have been formed as a result of different processes that affected the rocks. The rocks in the study area have a geological history that has resulted in the formation of variable structural elements, based on the difference in the genetic properties of the various rocks and due to the different stress and strain conditions that prevailed during tectonic events.

The structures associated with the different rocks can be grouped into two types:

1) syn- tectonic (primary) structures

2) post- tectonic (secondary) structures

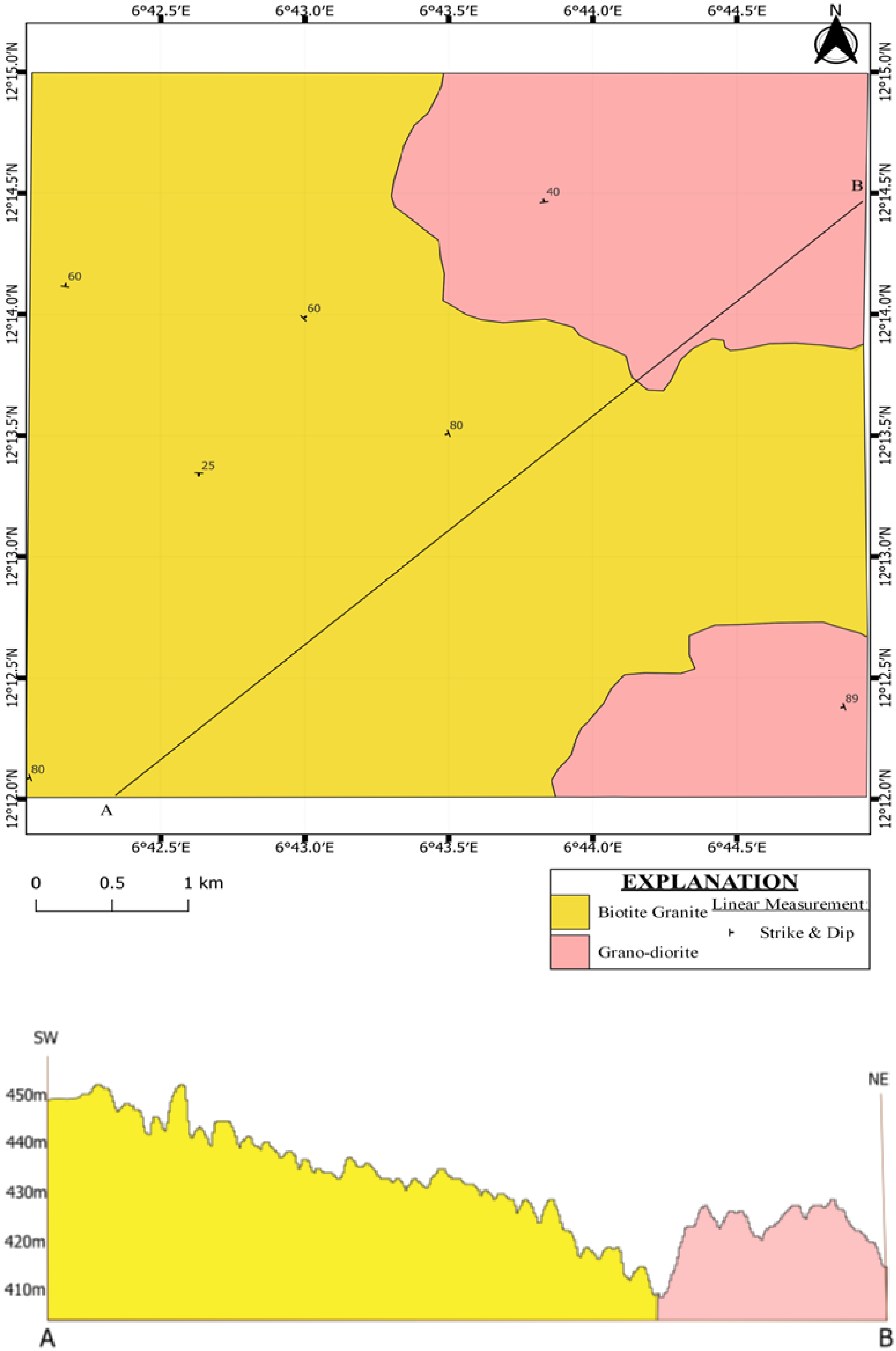

Figure 4. Geological map of the study area.

Table 3. *Summary of the geological field mapping of the study area.*

Location	Coordinates	Measurement	Outcrops description	Economic activities	Geology
1- Rawayya 1	Lat N12 °14'7" Long: E 06 °47'7" Elevation: 460m	Strike: 280 °NW Dip dir: 90 °NS	A Biotite-granite contains many different types of faults, fractures, and veins, the width of the vein is 3cm, and the length is 7m.	None	A medium to coarse-grained Biotite-granite rock.
2- Rawayya 2	Lat: N12 °13'59" Long: 06 °42'59" Elevation 460m.	Strike: 360 °NE Dip dir: 60 °SW	A Biotite-granite contains many different types of faults, fractures, and veins the width of the vein is 4cm and the length is 6m. Thickness is 25m.	None	A fine-grained Biotite-granitic rock
3- Gidan yammatawa	Lat: 12 °14'28"N Long: 6 °43'51"E Elevation: 430m	Strike: 260 °NE Dip dir: 40SW	Biotite-granite with many types of fold, faults, veins, and xenolith the vein width is 2.5cm and length is 5m the thickness of the outcrop is 50m.	None	Medium to fine-grained Biotite-granitic rock
4- Nassarawa Rashi 1	Lat: N 12 °12'44" Log: E 06 °42'49" Elevation: 460	Strike; 160 °SW Dip for: 80 °SW	A Biotite-granite with many folds, faults vein, and xenolith.	None	Medium to coarse-grained Biotite-granitic rock
5- Gidan Zalla	Lat: 12 °12'22" N Long: 6 °44'56"E Elevation: 437m	Strike: 163 °NE Dip for:80 °	A granodioritic rock with many fractures, faults, and vein	None	Medium to fine grained granodioritic rock
7-Nassarawar Rashi 2	Lat N12 °14'7" Long E6 °41'7" Elevation 460m	Strike 160 °SW Dip dir 80 °SE.	A Biotite-granite with different types of faults, fractures, and veins.	None	Medium to coarse-grained Biotite-granitic rock.

4.1.1. Syn-Tectonic (Primary) Structures

These are structures formed during the time of emplacement of the rock body they form concurrently with the emplacement of the rocks. The primary structures include; foliation, lineation, etc.

4.1.2. Post-Tectonic (Secondary) Structures

These are structures formed after the rock has already been formed, and then the rock is incorporated or emplaced. The secondary structures observed in the study area include faults, joints, veins, pegmatite, and dykes.

4.1.3. Fault

Faults are brittle fractures within the crustal rocks, along which relative movement or displacement has taken place on either side of the plane. They are, therefore, planes of shear failure as a result of brittle fractures. When a rock mass is subjected to rapid stress, permanent ruptures, and cracks are developed. Faults may have displacements of a few (cm) centimeters up to many tens of km on the field, these structures are recognized by displacement of matching structures, on either side of the plane of displacement (fault plane).

However, during the fieldwork, a fault was encountered in the study area, at unguwar kwama. with the coordinates N 12 °13'19.9"/ E6 °42'36".

Figure 5. *Photography of quartz vein in the study area.*

4.1.4. Joints

Joints are fractures or cracks found in rocks along which there has been no noticeable displacement. They are fractured surfaces along which separation without any movement had occurred. Joints form in several ways such as from compressional, tensional, and shear stress. They can range from microscopic sizes to kilometers in measurements. The Biotite-granite and granodiorite exposures in the study area are characterized by several joints majority of the joints identified were striking in N-E and NNS-SSW directions. Some of the joints in the study area are filled with crystals of minerals such as quartz, feldspar, and biotite sometimes even the combination of the various minerals forming pegmatite and veins.

4.1.5. Vein

A vein in geology can be defined as a fissure or fracture containing minerals. The veins observed in the study area include: quartz veins and pegmatite veins, which define the history of the late stage of magma crystallization (peneumatolite stage). The veins occur in various sizes (width) which depends on the intensity of the stress that acted on the fractures on the exposures rock outcrops.

Figure 6. *Photography of joints in the study area.*

4.1.6. Quartz Vein

Quartz veins are widely distributed in the study area; they occur mostly in the granites. As the name implies, the quartz vein contains a single (mono minerolic) mineral, quartz. the quartz occurs along fractures or cracks on the granite exposures. The quartz vein is well visible occurring in the exposures and is highly resistant to weathering activities. They are small varying in thickness from a few millimeters to some centimeters in width, but can go up to a distance of kilometers in length.

Figure 7. *Photography of pegmatites vein in the study area.*

4.1.7. Pegmatite Vein

Pegmatite veins were also observed in the study area. The pegmatite veins have a coarser texture than quartz veins and also constitute a variety of minerals, which makes them more distinct from the quartz veins that contain a single mineral, quartz. The pegmatite vein contains the mineral quartz, feldspar, and micas. The PEGMATITE observed has an average width of 7cm.

4.1.8. Dyke

Dikes or dykes are discordant tabular or sheet-like bodies of magma that cut vertically through older rocks at the time of intrusion. Outcrops of dikes can range from a few meters to many kilometers in length. Because dikes intrude relatively cool country rocks they frequently display a chilled margin, with grain size becoming coarser towards the center, where the rate of cooling has been slower in the mapped area one category of dykes observed is: aplite dykes.

(i). Aplite Dyke

These are commonly found in the granitic bodies, formed from the ultimate residual melt after most of the crystallization of the granitoid is completed, aplites are light in color, fine to medium-grained in size, and composed of mainly quartz and alkali feldspar. They are discordant structures and have an average thickness of about 6 to 8cm in width.

Figure 8. Photography of an aplite dyke in the Study area.

(ii). Xenolith

A xenolith is sometimes referred to as 'strange rock' it is an inclusion of pre-existing rock in a rock body. Or a fragment of rock that has been derived from the pre-existing country rock or maybe a fragment of an earlier solidified portion of the igneous rock having a slightly different composition. In the study area, a number of xenoliths were identified occurring within the exposure rocks.

Figure 9. Photography of xenolith in the Study area.

4.2. Field Occurrence and Relationship

In the study area, the oldest rock is amphibolite which occurs as xenolith, followed by granite and then the intrusion of the granodiorite. The pegmatites occur as inclusion mostly affected by tectonic processes during the Pan-African events resulting in structures such as faults joints etc.

Below is the list of the rock types within the study area with field descriptions in order of their age relationship as follows.

1) Pegmatites' youngest
2) Xenolith
3) Granites
4) Biotite-granite
5) Grano-diorite. Oldest

4.2.1. Biotite-Granite

This is a coarse-grained intrusive igneous rock of felsic chemistry, as the name and chemistry suggest, this variant of granite is composed mainly of the mineral's quartz, feldspar with biotite mica. The quartz present in the rock is a white color due to the presence of fluids as gas inclusion during the time the rock formed.

4.2.2. Field Description for Biotite-Granite

The biotite granite in the study area occurs as low lying most have been partially weathered, they are mostly medium to coarse-grained rocks in texture they are usually dark color rock due to the high percentage of biotite maca present in the rock. they have different types of structures and features such as fractures, faults quartz veins, aplite dykes, and xenoliths.

4.2.3. Hand Specimen Description for Biotite-Granite

The fresh sample of the biotite-granite obtained shows dark to light coloration and phaneritic in texture. The minerals observed are feldspars, biotite, quartz, and Hornblende. However visual estimate of the minerals in the fresh sample using a hand lens indicates that feldspar is the dominant mineral constituting about 45% of the volume of the rock, followed by the micas (dark minerals) about 35% of the volume of the rock, and then glassy (quartz) that is 25% by volume of the rock.

4.2.4. Grano-Diorite

Grano diorite is an intrusive igneous rock similar to granite, but containing more plagioclase than orthoclase-type feldspar it can be generally defined as a phaneritic igneous rock with greater than 20% quartz by volume where at least 65% of the feldspar is plagioclase. it usually contains abundant biotite mica and hornblende, giving it a darker appearance than true granite.

4.2.5. Field Description for Grano-Diorite

The granodiorite in the study area occurs as low- lying most have been partially weathered they are mostly medium to coarse-grained in texture the rock is usually dark due to the high percentage of plagioclase feldspar and contains abundant biotite mica and Hornblende the rock has different types of structures and features such: fractures, faults, pegmatite vein, quartz vein, and xenoliths.

4.2.6. Hand Specimen Description for Grano-Diorite

The fresh sample of the granodiorite obtained shows dark to light coloration and phaneritic in texture. The minerals observed are feldspars, biotite, quartz, and Hornblende. However visual estimate of the minerals in the fresh sample using a hand lens indicates that feldspar is the dominant mineral constituting about 65% by volume of the rock, which is plagioclase feldspar and contains biotite mica and then glassy (quartz) which is greater than 20% by volume of the rock.

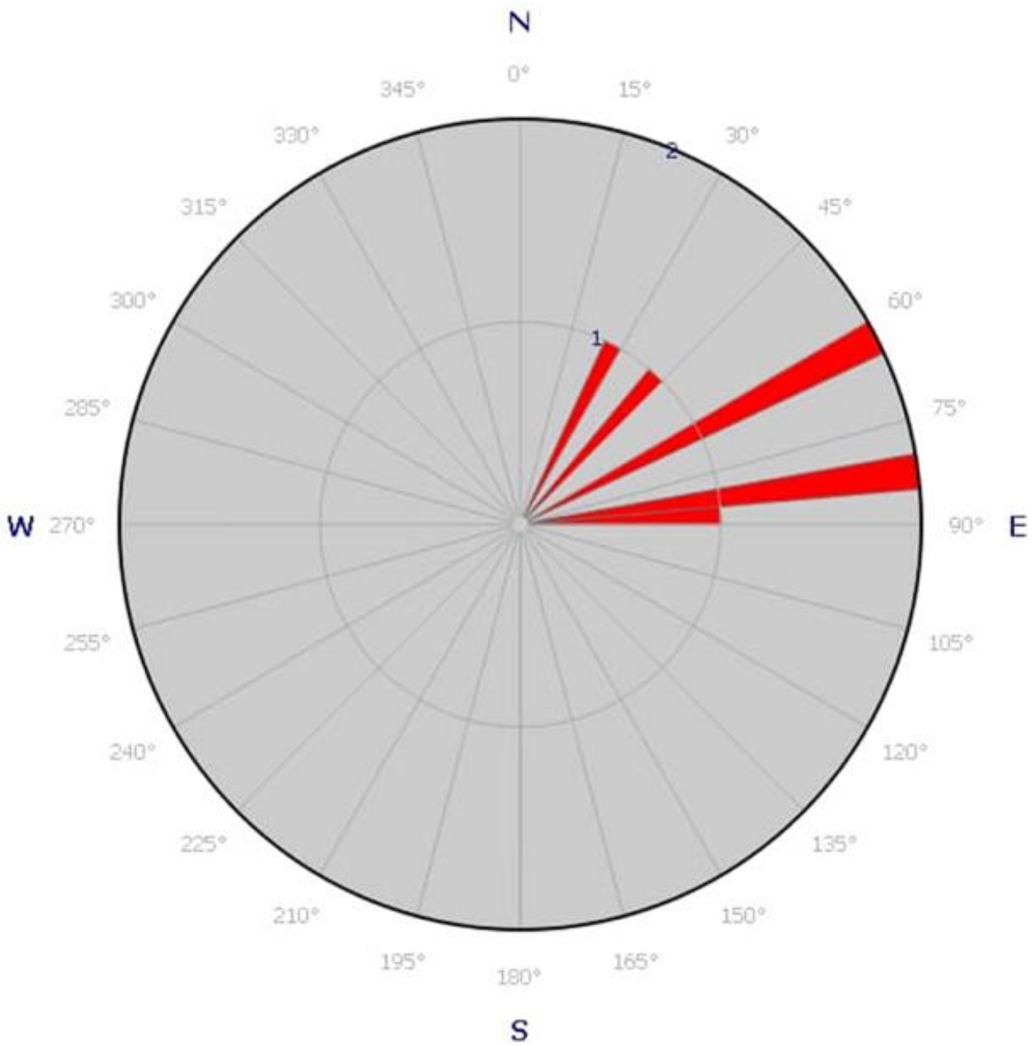

Figure 10. Petrographic analysis.

Table 4. Linear measurement of the study area.

Location	Strike	Dip direction
Location 1	280 °	60 °
Location 2	320 °	60 °
Location 3	260 °	40 °
Location 4	160 °	80 °
Location 5	163 °	80 °
Location 6	160 °	80 °

Petrographic analysis indicates that the rock is coarse-grained in texture with individual mineral grains being well-developed. The minerals present include Quartz (40%), Orthoclase (10%) and Biotite (15%). The plate below shows the minerals observed both in PPL and XPL.

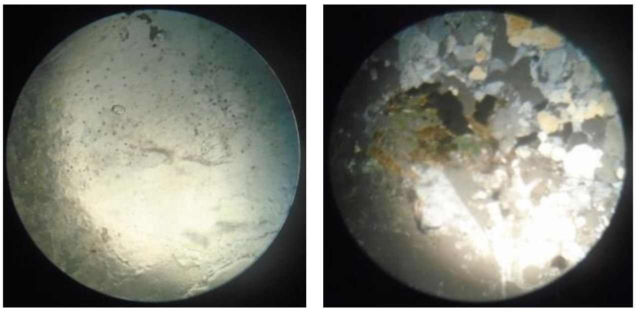

Figure 11. *Photomicrograph of biotite granite showing its mineralogical composition (B = Biotite, Q = Quartz and ORT= Orthoclase) in XPL (A) and PPL (B). Diameter of view=4.0mm. Mag. X40.*

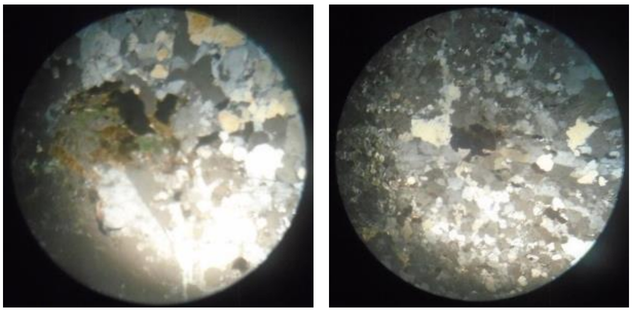

Figure 12. *Photomicrographic of biotite-granite sample 1.*

Table 5. *Petrography Analysis of Sample 1.*

Minerals	PPL	XPL
Quartz	20%	30%
Biotite	25%	15%
Plagioclase feldspar	10%	10%
Muscovite	35%	40%
Accessory minerals	10%	5%
Total	100%	100%

Table 6. *Petrographic analysis of sample 2.*

Minerals	PPL	XPL
Quartz	50%	10%
Biotite	15%	35%
Orthoclase	5%	20%
Muscovite	20%	30%
Accessory mineral	10%	5%
Total	100%	100%

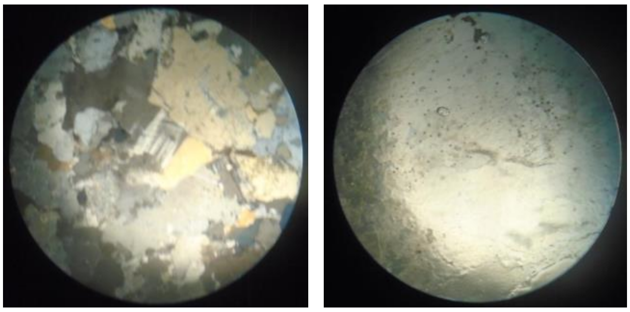

Figure 13. *Photomicrographic of biotite-granite sample 2.*

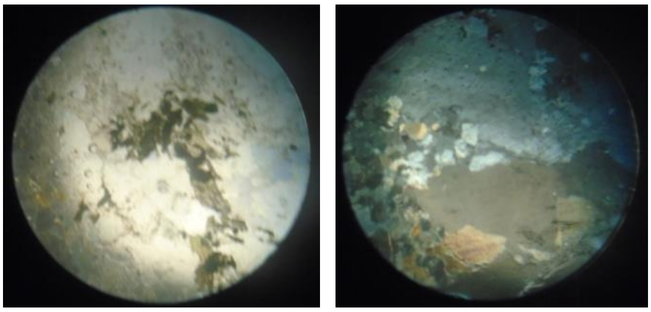

Figure 14. *Photomicrographic of biotite-granite sample 3.*

Table 7. *Petrographic analysis of sample 3.*

Minerals	PPL	XPL
Quartz	20%	20%
Biotite	10%	40%
Orthoclase	15%	10%
Muscovite	50%	20%
Accessory mineral	5%	10%
Total	100%	100%

Table 8. *Petrographic analysis of sample 4.*

Minerals	PPL	XPL
Quartz	20%	30%
Biotite	35%	10%
Plagioclase feldspar	10%	35%
Muscovite	30%	20%
Accessory mineral	5%	5%
Total	100%	100%

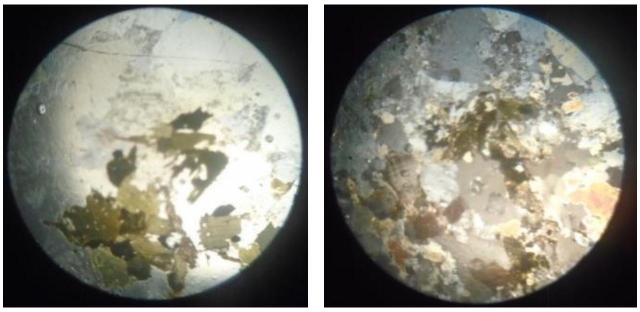

Figure 15. Photomicrographic of biotite-granite sample 4.

Table 9. Petrographic Analysis of sample 5.

Minerals	PPL	XPL
Quartz	30%	25%
Biotite	40%	50%
K- feldspar	25%	13%
Accessory mineral	5%	7%
Total	100%	97%

Table 10. Petrographic analysis of sample 6.

Minerals	PPL(%)	XPL (%)
Quartz	20%	25%
Biotite	50%	45%
Orthoclase feldspar	5%	15%
Muscovite	25%	10%
Accessory minerals	5%	5%
Total	100%	100%

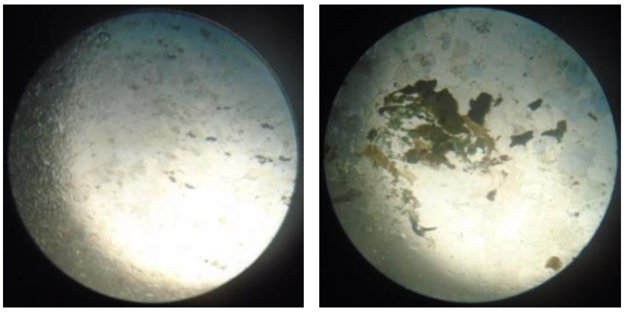

Figure 16. Photomicrographic of biotite-granite sample 6.

5. Conclusion

The study area is located in Rawayya, Gusau Local government area of Zamfara State, and forms part of sheet 54, Gusau SE in the Nigeria Basement Complex. Covering an area of about 15km and was mapped on a scale of 1:25,000. The outcrops in the study area occurred in different types of exposure such as low-lying ridges, whalebacks, and boulders. This research project is aimed at providing general geology with more emphasis on petrographic details of the rock units that underlain the study area, from the samples collected which involve rock thin-section preparation for microscopic view.

The petrographic description of the rocks from the study is systematically described in three ways. The first part of the description contains the field relations of the rock. This showed the characteristics of the rock. This is followed by a megascopic description; here the samples were collected from the field and analyzed. The third part of the description involved the petrographic description of the rock. It showed that the mineralogical composition of the rocks and their optical properties. As observed under the polarizing and cross-polarizing microscope. The general knowledge of the geology of the Nigeria Basement Complex aided in the study geology of Rawayya and it environments. Granite and biotite granite of the Older Granite of Northern Nigeria Basement Complex. Various types of geological field equipment were used to carry out effective mapping in the study area. Different geologic structures ranging from fractures, joints, veins pegmatite, etc were encountered and studied in the exposed outcrops within the study area.

Abbreviations

GPS	Global Positioning System

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Ajibade, A. C., (1976) Provisional classification and correlation of the schist belts in north western Nigeria. In Geology of Nigeria, pp. 85-90, ed. Kogbe, C. A., Elizabethan publishing Co., Ibadan.

[2] Ajibade, A. C and Fitches W. R. (1988): The Nigerian Precambrian and the Pan –African Orogeny, Precambrian Geology of Nigeria, pp. 45-53.

[3] Ajibade, A. C., Woakes, M., and Rahaman, M. A. (1987): Proterozoic crustal development in Pan-African regime of Nigeria: In A. Croner (ed.) Proterozoic Lithospheric Evolution Geodynamics Vol. 17, pp. 259-231.

[4] Farghar, M. N. (1961). The Precambrian geology of the 1:100,000 sheet no. 52 (Anka) Sokoto province Geol. Surv. Nigeria.

[5] Falconer, J. D. (1911) The geology and geography of Northern Nigeria. MacMillan, London.

[6] Grant, N. K. (1970): Geochronology of Pre-Cambrian Basement Rocks. Earth and Planet Sci. Lett. 10. 29-38.

[7] Grant, N. K. (1971): A Compilation of Radiometric Ages of from Nigeria Journal. Mm. Geol., 6, 37-84.

[8] Harper, C. I.; Shearer, G.; McCurry, P. and Wright, Y. B., (1973): K-Ar Retention Ages from the Pan-African of Northern Nigeria. Geol. Soc. American. Bull. Vol. 34, No. 3, 9, 9s19-926.

[9] Ike, E. C. (1974). The Structure, Petrology, and Economy Geology of the Zaria Batholith. Unpublished B. Sc. project. Ahmadu Bello University, Zaria.

[10] McCurry, P. (1970). Geology of degree sheet 21 (Zaria). M. Sc. Thesis, Ahmadu Bello University (unpublished).

[11] McCurry, P. (1971): Pan-African Orogeny of Northern Nigeria. Bulletin Geol. Soc. American, 82, pp. 35 1-362.

[12] McCurry, P. (1973). Geology of degree sheet 21, Zaria and its region, Nigeria. Overseas Geol. Mineral Res., vol. 10.

[13] McCurry, P. (1976): The Geology of the Pre-Cambrian to Lower Palaeozoic Rocks in Northern Nigeria- a review in Kogbe.

[14] Oyavoye, M. O. (1964). The Geology of the Nigerian Basement Complex. Journal of Nigerian Min. Geol. and Mell. soc. Vol. 1.

[15] Oyawoye, M. O. (1965) “Nigerian Basement Geology”. In: Aspect of Nigerian Geology. Reyment R. A. (ed.). University of Ibadan press: Ibadan, Nigeria.

[16] 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.

[17] Rahaman, M. A. (1976). Review of the Basement of south-western Nigeria. In Kogbe C. A. (Ed) Geology of Nigeria. Elizabethan Publishing Company Ltd. Lagos, pp. 41-56.

[18] Rahaman, M. A. (1981) Recent advances in the study of the Basement Complex of Nigeria. First symposium on the Precambrian Geology of Nigeria.

[19] Rahaman, M. A. (1988): Pre-Cambrian Geology of Nigeria. Paper presented at Benin, Nigerian Geol-traverse International Meeting on Proterozoic Geology and Tectonic of high-grade terrain program and lecture series 28-30.

[20] Russ, W. (1957): The Geology of Parts of Niger, Zaria, and Sokoto Provinces of Nigeria. G. S. N. Bulletin No 27.

[21] Turner, D. C. (1983): Upper Proterozoic Schist Belts in the Nigerian Sector of the Pan-African Province of West Africa. Precambrian Research, 21.

[22] Trustwell, J. F (1962). Report on the geology of crystalline Basement of 1:100,000. Geol. Surv. Nigeria, Rept. No. 1319.

[23] Truswell, J. F. and Cope. R. N. (1963): The geology of part of the Niger and Zaria Provinces, Northern Nigeria. Geol. Surv. Nigeria Bull. 29, 54p.

[24] Wright, J. B and McCurry (1970). The geology of Zaria sheet 102 SW and its region in M. J Mortimore (Ed). Department of Geography, occasional paper 4, Ahmadu Bello University, Zaria.