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Geology and Economic Potential of Umme Mai Gwanjo and Its Environs, Part of Wamba Sheet 210, North Central Nigeria

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ABSTRACT

The research focused on the geology and economic potentials of Umme Mai Gwanjo and its environs, part of Wamba sheet 210NE, North Central Nigeria. So as to ascertain the areas of economic potentials. Field result shows that the study area is characterized by four morphological unit of rocks, Migmatite (Mesocratic diatexite, Leucocratic diatexite, Biotite Granite and Rhyolite, based on provenance and field relation which shows variation in textural and composition. Petrographically, rock forming minerals such as feldspars, biotite, plagioclase, muscovite and quartz were identified with other minor accessory minerals such as Hematite, Pyrite, fluorite copper and Ilmenite. Geochemical results revealed that, the major oxide MgO, FeO, CaO, TiO₂ shows negative linear trends. SiO₂ and K₂O, Na₂O and Al₂O₃ shows positive linear trends. Even though some SiO₂ shows erratic distribution which indicate the feature of silicate melt. Rocks in the study area are hosts to numerous geological structures such as joints, faults, dykes, foliations and quartz veins. Rose plot indicate that the general structural trend in the study area are NE-SW, NNE-SSW and N-S direction indicating impact of the Pan African orogeny, and conforming with those of structures in the Basement Complex of North central Nigeria. The study area is enriched with economic mineral resources such as fluorite, tin, hematite, Lead/Zinc, copper and iron ore, and the rocks are mostly quarried for engineering purposes.

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I. Introduction

The study area, Umme Mai Gwanjo and environs falls within Nassarawa Eggon Local Government Area part of Wamba sheet 210NE, Nasarawa State, North Central Nigeria. The area is bounded by latitude N8 ° 42' 00" to N8 ° 46' 00" and longitude E8 ° 32' 30" to E8 ° 36' 00" covering a total area of 40Km² and on a scale of 1:25,000 and rise to the height of approximately 400m above mean sea level in some areas. The study area consists of the Nigerian basement complex

rocks which are well exposed in the central part of the study area, occurring as a chain of granitic hills stretching from the east to the west (fig. 1 and 2). The study area is mainly accessible through Nassarawa Eggon – Akwanga highway, the Arikya road and other minor roads and footpath within the area of research. This study will provide an insight on the geology, petrography, geochemistry and understanding the areas of possible source for economic minerals within the rock unit in the research area.

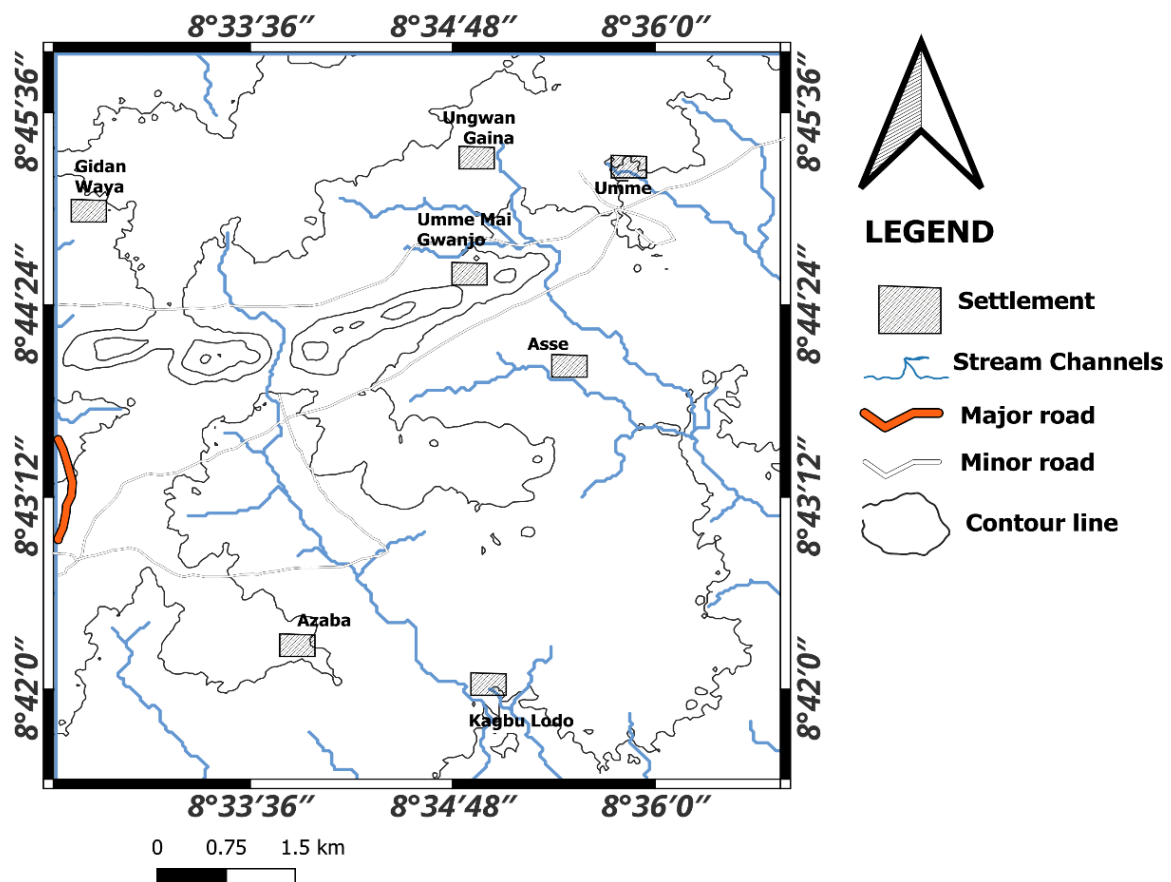


Figure 1: Location of the Study Area (Source: Google earth)

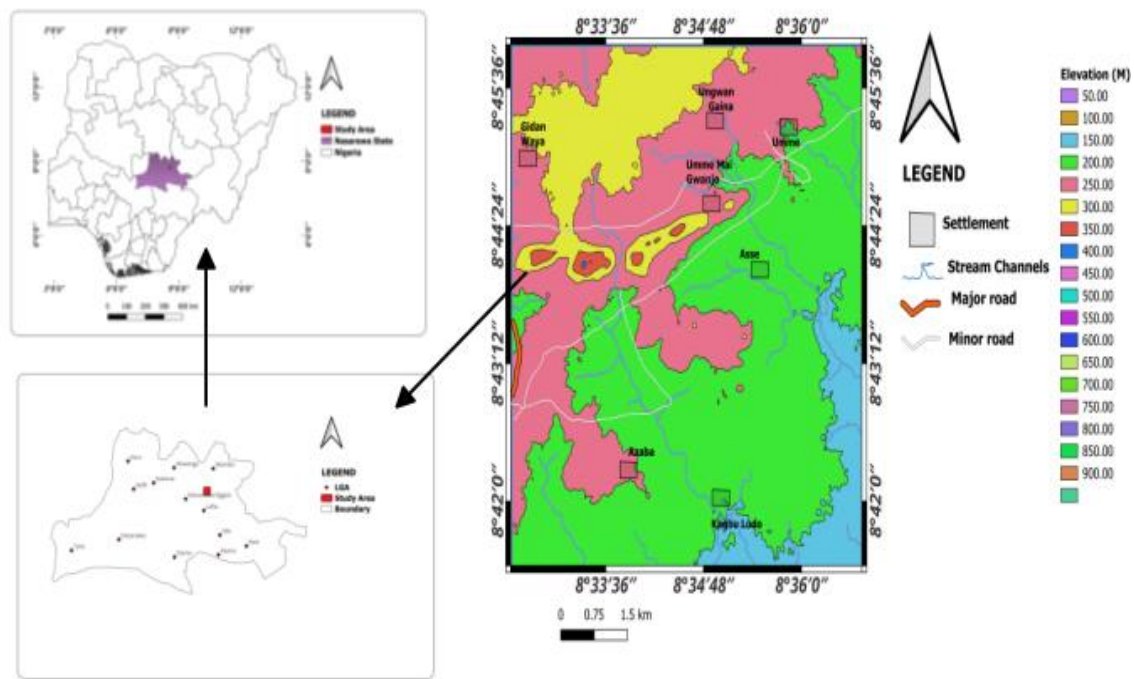


Figure 2: Digital Elevation Model of the Study Area Source: (Google earth)

II. Geological Background

The study area consists of the Nigerian basement complex rocks which are well exposed in the central part of the study area, occurring as a chain of granitic hills stretching from the east to the west. These basement rocks have been affected by at least four major orogenic cycles; the Liberian (2,700 Ma), the Eburnean (2,000 Ma), the Kibaran (1,100 Ma), and the Pan-African (600 Ma) orogenic cycles [25]. These orogenies were characterized by intense deformation, isoclinal folding, regional metamorphism, migmatization, extensive granitization and gneissification, producing syn-tectonic granites and homogeneous gneisses [1]. The final stage of the last deformational cycle was characterized by the late tectonic emplacement of granites and granodiorites, and associated contact metamorphism [10]. These orogenic cycles were concluded by faulting and fracturing [7, 17] whose azimuths are depicted to trend in the NE-SW and NWSE direction [3].

III. Methodology

For the purpose of this study, geological fieldwork, rock sampling, petrographic studies,

geochemical analysis and interpretation were employed. For the petrographic studies, the rock samples were cut into chips with a micro-cutting machine and subsequently polished on glass ground plate using carborundum powder to obtain required thickness and a perfectly smooth surface; the cut rock samples were, thereafter, mounted on a clean glass slide with adhesive 18 (Rollison, 1992). The prepared slides were examined under the petrological microscope to identify mineralogical features of the rock samples on a microscopic scale. Furthermore, the geochemical analyses were carried out using XRF method. The samples were broken down to aggregates, then pulverized, homogenized and pressed into pellet. For the emission—transmission method usually a 150 or 200 mg pellet is prepared (25 mm diameter) with or without a binder (chromatographic cellulose, boric acid or starch are used as a binder in a proportion 1:10 by weight and in some cases a liquid binder might be used). The samples for this work were analyzed at the National Steel Raw Material Exploration Agency Research Laboratories (NSREA) Kaduna. The results were

then used to generate geochemical plots using software (GCDkit and Petrograph).

IV Result

Field Relationships

The area mapped shows four broad morphological rock types, Migmatite (mesocratic diatexite and leucocratic diatexite), biotite granite and rhyolite which occur as mappable

units. The boundaries between the rock units are gradational, so the contacts shown in the map (figure3) were inferred. The mesocratic diatexite generally occur as pocket within the leucocratic diatexite unit. The leucocratic diatexite occur mostly as low laying outcrop, the biotite granite occurs as chain of granitic hills together with the rhyolite stretching from east to west.

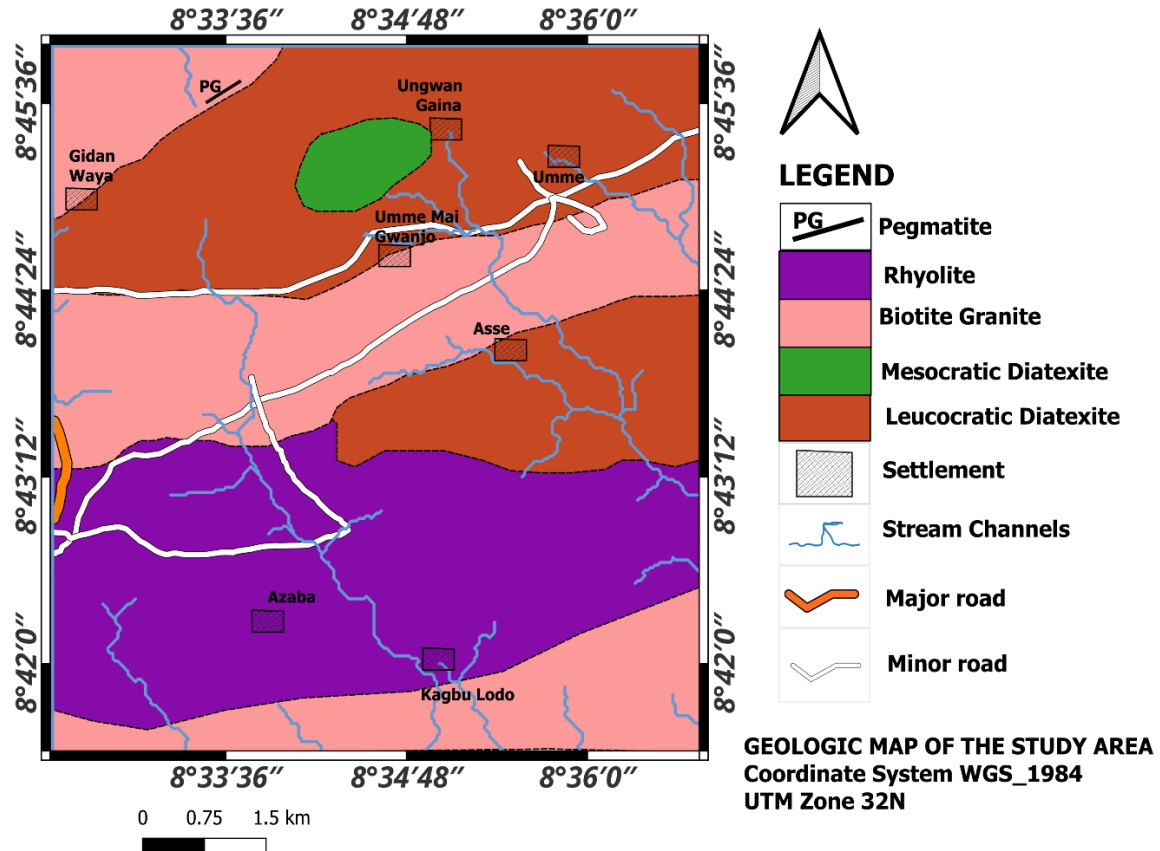


Figure 3: Geological map of the study area

Lithological Mapping

A lithological map for the study area was developed using a detailed field survey and observations. Four distinct lithological types including pegmatites, Rhyolite, biotite granite, Mesocratic migmatite, and leucocratic migmatite were observed to underlay the entire study location.

- Leucocratic migmatite occur as brown pixels and predominate the North eastern part of the study area (Figure 3).

- Biotite granite rocks predominates the entire study location and occur along an NNE-SSW trend within the study area and is displayed in pink (Figure 3).
- Rhyolite represented in purple predominate the Southern part of the study area (Figure 3).
- The contact existing between the biotite granites and the leucocratic migmatites and rhyolites is undulating and irregular.
- Pegmatites veins displayed as a black stripe line occurs as intrusions within the

biotite granite leucocratic migmatite lithologies. The pegmatites occurrences within leucocratic migmatite appear to be more extensive compared to the biotite granite types.

- Figure 3 illustrates a detailed lithological map of the study area.

New Approach on Migmatite in the study area

A migmatite is a rock found in medium- and high-grade metamorphic areas that can be heterogeneous at the microscopic to macroscopic scale and consists of two, or more, petrographically different parts, which are petrogenetically related to each other, and to their protolith, through partial melting or segregation of the melt from the solid fraction (Sawyer 2008a)[13,14].

Diatexite

A diatexite is a migmatite dominated by pervasive neosome. Pre-partial-melting structures are absent from the neosome, and commonly

replaced by syn-anatectic flow structures or isotropic neosome. The neosome is variable in appearance as it typically includes leucosome and melanosome in varying proportions. The palaeosome can occur as rafts or schollen, or it may be absent (Sawyer 2008a) [13,14].

The diatexite is divided into three (3) subgroups depending on the number of mafic components:

- i. Melanocratic
- ii. Mesocratic and
- iii. Leucocratic diatexite

All have the pre-existing structures (e.g., bedding and foliation) destroyed, having undergone a textural homogenization. In general, diatexite migmatite is characterized by increased grain size (0.5–5 mm), relative to the metatexite. The mesocratic and leucocratic diatexite occurs together and differ mostly in the number of mafic components, they both are characterized by lack of patches of stromatic migmatite or foliation but may they contain centimetre-scale layering or few schlieren and parallel oriented felsic leucosomes.

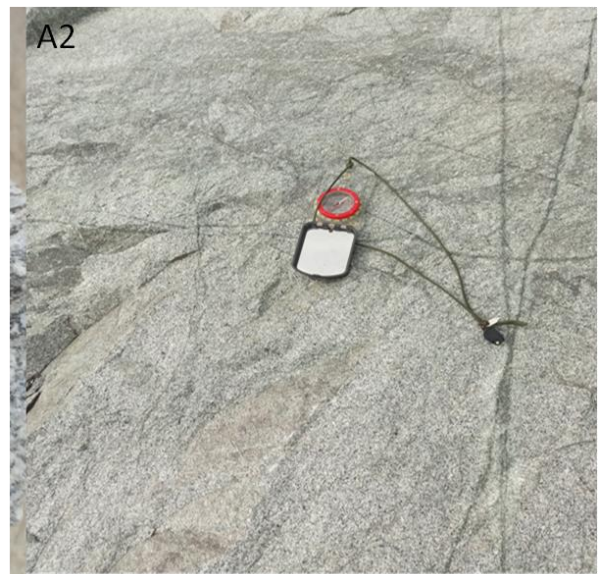


Plate I: (A1) An outcrop of mesocratic diatexite
(A2) An outcrop leucocratic diatexite

Biotite granite

The Biotite granites occur in different textural variations, fine to medium grain, although more of them are coarse grained. They are generally pale pink to pinkish orange in color and are highly

indurated. Numerous fractures and joints occur within the biotite granites with many filled with quartz to quartzo-feldspathic veins. Petrography analysis revealed that the rock contained; quartz, biotite, plagioclase, opaque minerals.

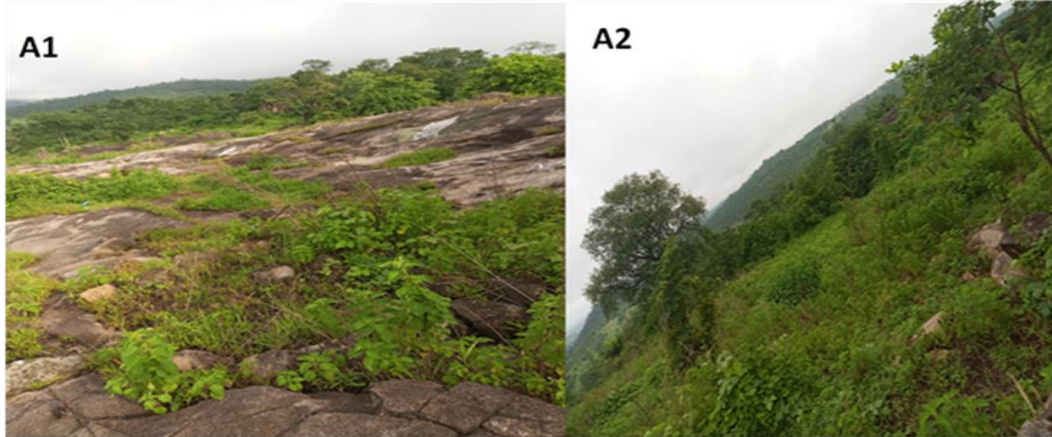


Plate II: Field occurrence of biotite granite

Rhyolite

Rhyolite is an extrusive rock commonly showing flow texture, and typically porphyritic, with phenocrysts of quartz and feldspar in a glassy to microcrystalline groundmass. It is the extrusive equivalent of granite. Its colour index is

leucocratic to mesocratic. It is devoid of foliation. Although most of the rock's mineral grains are unidentifiable megascopically due to its fine-grained texture, they appeared to be composed of mostly quartz and feldspar (felsic minerals).



Plate III: Field occurrence of Rhyolite

Petrographic Study

Representative samples were collected from the different rock units in the study area and studied petrographically. The rocks contain the mineral assemblage quartz-plagioclase-biotite \pm Kfeldspar \pm muscovite, and the varying textural relationships between fine grained crystals in the biotite granite. The proportion of the minerals in samples of the Leucocratic diatexite, mesocratic diatexite is similar (Plates 1 and 2). However, on a photomicrograph scale, there may be substantial differences in modal compositions in the rocks.

Mesocratic Diatexite

The mesocratic diatexite in hand specimen, generally has a medium to coarse grain size with relatively uniform texture. Petrographic studies revealed that the rock contains quartz, plagioclase, biotite, and exhibits a granoblastic texture. The biotite is dark brown. It generally exists along the outlines of the plagioclase porphyroblast. The plagioclase shows albite twinning and some shows sign of deformation or strain (Plate 1(d)), while Quartz grains show strain and exhibits undulose extinction.

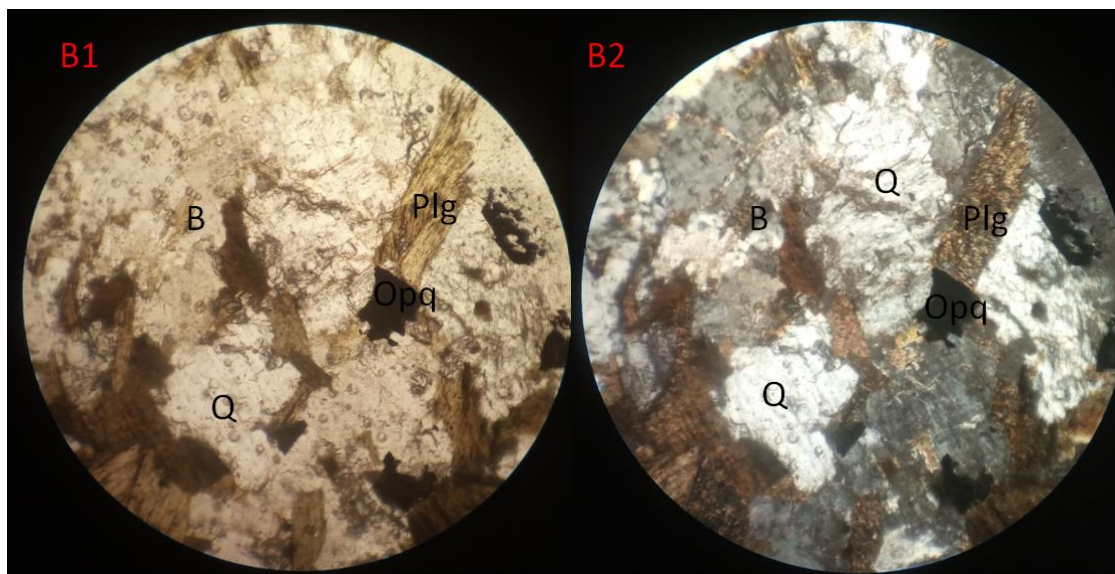


Plate IV: Photomicrograph of Mesocratic diatexite sample under PPL (B1) and XPL (B2)
Q- Quartz, B-biotite, Plg- plagioclase and Opq- Opaque

Leucocratic Diatexite

Leucocratic diatexite contains more k-feldspar than the other types of diatexite, forming small cross-cutting dykes as well as much large concordant and subcordant sheets. It is leucocratic (pink), in equigranular in texture on outcrops scale. The leucocratic diatexite has the highest K-feldspar/plagioclase ratio and the lowest biotite content and represent the most

evolved types of diatexite. Petrographic analysis shows that the rock has a granoblastic texture and is composed predominantly of microcline, biotite, and quartz. (Plate 2b). The microcline exhibits cross-hatched twinning, biotite exhibits strong pleochroic halos, though very scanty and it sometimes occurs as interstitial grains, while few grains of silimanite exhibits high relief and parallel extinction.

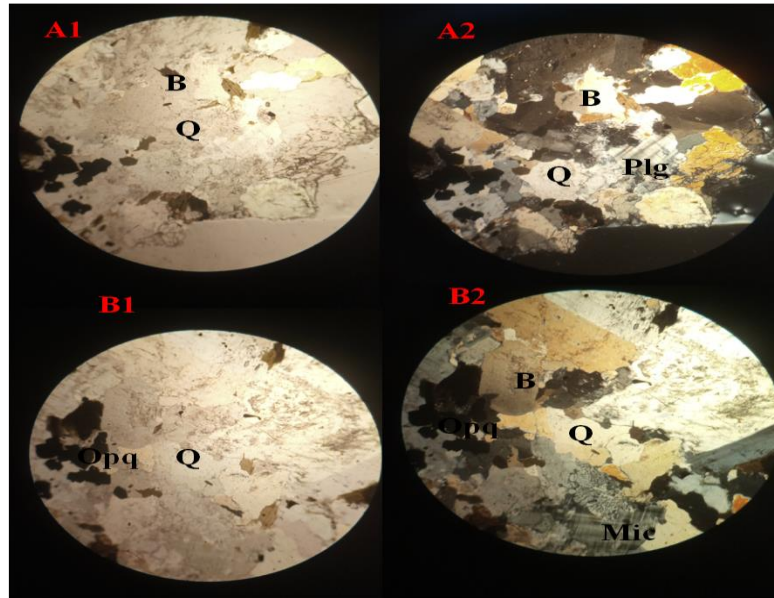


Plate. V: Photomicrograph of Leucocratic Diatexite under PPL(A1and B1) and XPL (A2and b2)
Q- quartz, B- biotite, Plg- plagioclase, Opq-opaque and Mic-microcline

Biotite granite

The Biotite granites occur in different textural variations, fine to medium grain, although more of them are coarse grained. They are generally pale pink to pinkish orange in color and are highly indurated. Numerous fractures and joints occur within the biotite granites with many filled with quartz to quartzo-feldspathic veins. Petrography analysis revealed that the rock contained; quartz,

biotite, plagioclase, opaque minerals. The biotite appears brown and is strongly pleochroic from brown to pale green in PPL. In XPL, the extinction is parallel and there display of dark blue-green interference colors. Quartz is characterized by absence of color and pleochroism, subhedral to anhedral grains, and low relief. In XPL. It shows first order greys as its highest interference color and wavy extinction.

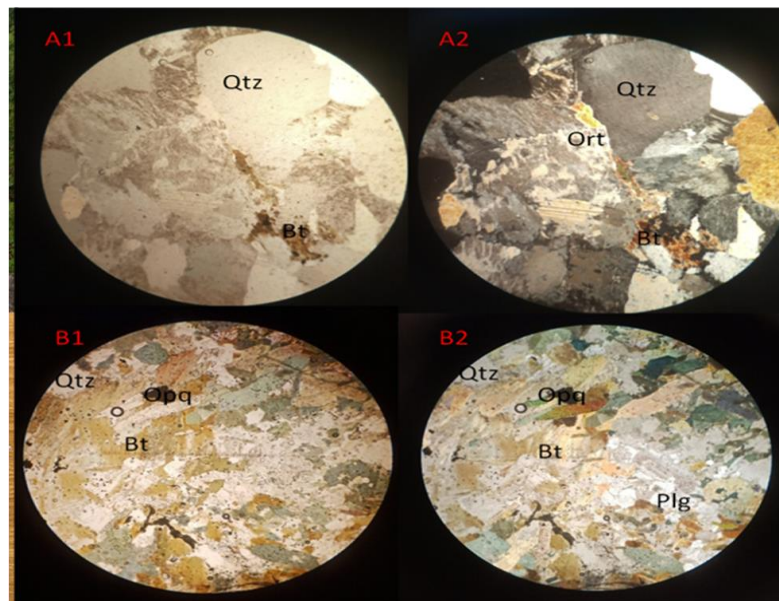


Plate. VI: Photomicrograph of Biotite Granite under PPL (A1 and B1) and XPL (A2andB2). Q-quartz, B-biotite, Plg-plagioclase and Opq-opaque minerals

Rhyolite

Rhyolite is an extrusive rock commonly showing flow texture, and typically porphyritic, with phenocrysts of quartz and feldspar in a glassy to microcrystalline groundmass. It is the extrusive equivalent of granite. Its colour index is

leucocratic to mesocratic. It is devoid foliation. Although most of the rock's mineral grains are unidentifiable megascopically due to its fine-grained texture, they appeared to be composed of mostly quartz and feldspar (felsic minerals).

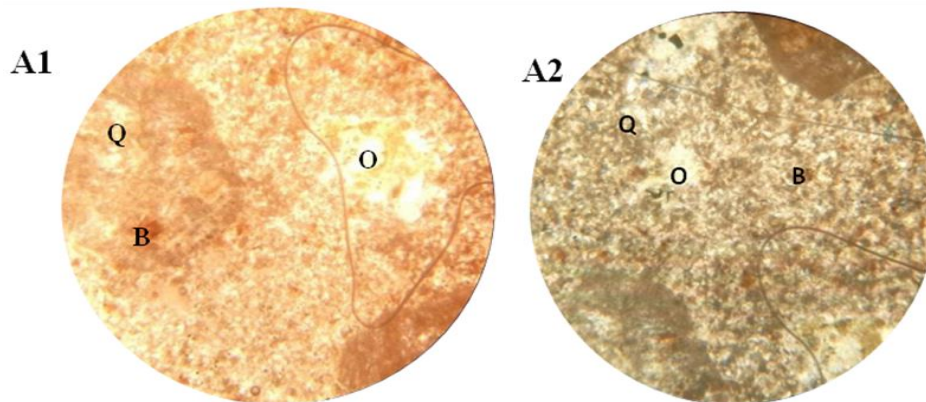


Plate VII: Photomicrograph of Rhyolite under PPL(A1) and XPL (A2)
Q-quartz, B-biotite and O-orthoclase

Geochemistry

The geochemical data for twelve representative rock samples from the study area were presented and analyzed to conclude on the different lithological rock unit in the research area and to understand their tectonic discrimination.

Characteristic of Major oxides

The Harker plots (Fig. 4) shows the geochemical variations in the behaviours of the major oxides

which in turn gives idea about their mobility during partial melting and their compositional differentiation within the rocks. E.g., CaO (0.184-10.416 wt %), MgO (0.052-2.093wt %), Fe₂O₃ (0.519-10.809 wt %), TiO₂(0.033-1.194wt %), Na₂O (17.343-32.180wt %), K₂O (3.845.-13.761wt %), Al₂O₂ (11.182-15.761wt %).2

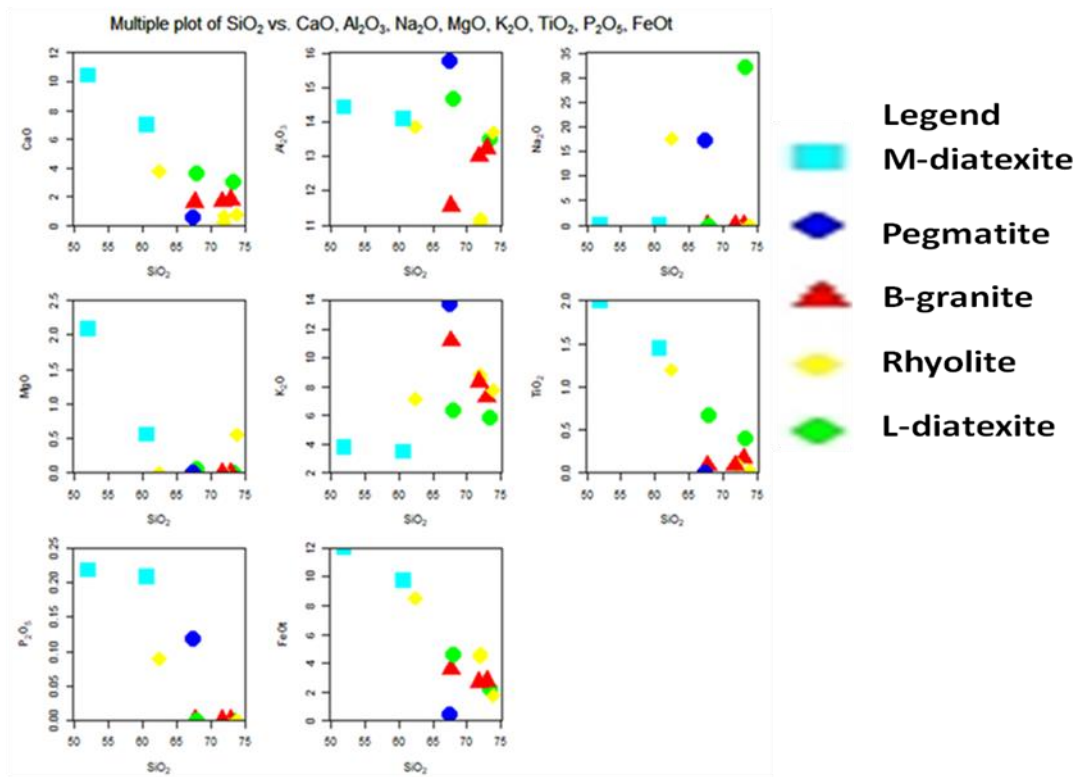
Table 1: Major element oxide data of whole rock samples from the study area (wt %)

Major Oxide	RKS2	RKS4	RKS5	RKS6	RKS9	RKS10	RKS11	RKS12	RKS15	RKS16	RKS21	RKS23
SiO ₂	67.65	67.861	73.27	72.94	71.93	73.84	72.03	62.47	51.986	60.653	71.721	67.325
CaO	1.564	3.619	3.061	1.786	0.184	0.762	0.613	3.774	10.416	6.983	1.639	0.536
Al ₂ O ₃	11.544	14.654	13.515	13.22	11.05	13.696	11.182	13.854	14.421	14.090	12.995	15.761
P ₂ O ₅	ND	ND	ND	ND	ND	ND	ND	ND	0.218	0.208	ND	0.118
Fe ₂ O ₃	3.946	5.130	2.452	3.059	4.940	1.926	5.153	9.471	13.332	10.809	2.952	0.519
MgO	ND	0.052	ND	ND	ND	0.551	ND	ND	2.093	0.559	ND	ND
K ₂ O	11.165	6.393	5.822	7.272	8.814	7.757	8.445	7.161	3.753	3.485	8.342	13.761
Na ₂ O	ND	ND	32.180	ND	ND	ND	ND	17.571	ND	ND	ND	17.343
TiO ₂	0.082	0.667	0.405	0.168	0.087	0.033	0.106	1.194	1.987	1.444	0.082	0.000
MnO	0.076	0.082	0.067	0.124	0.071	0.056	0.034	0.154	0.451	0.303	0.075	0.114

Table2: Trace element data of whole rock samples (PPM)

Trace Elements	RKS2	RKS4	RKS5	RKS6	RKS9	RKS10	RKS11	RKS12	RKS15	RKS16	RKS21	RKS23
Cr	0.108	0.048	0.050	0.075	0.083	0.056	0.073	0.042	0.030	0.053	0.067	0.050
Mg	ND	0.032	ND	ND	ND	ND	ND	ND	1.261	0.337	ND	ND
Al	6.110	7.756	7.153	7.000	5.849	7.249	5.918	7.332	7.632	7.457	6.877	8.342
Sr	0.002	0.069	0.044	0.033	0.007	0.008	0.003	0.033	0.095	0.087	0.009	0.008
Zr	0.051	0.026	0.042	0.044	0.404	0.031	0.186	0.077	0.040	0.064	0.038	0.002
P	ND	0.008	ND	ND	ND	ND	ND	0.108	0.192	0.185	0.244	0.098
K	9.269	5.307	4.833	6.037	7.317	6.440	7.011	5.945	3.116	2.893	6.925	10.939
Ca	1.118	2.586	2.188	1.276	0.131	0.523	0.438	2.697	7.445	4.991	1.171	0.383
Ti	0.049	0.400	0.243	0.101	0.052	0.020	0.064	0.716	1.191	0.866	0.049	ND
V	0.005	0.025	0.012	0.009	0.008	0.005	0.006	0.038	0.065	0.043	ND	0.008
Na	ND	ND	23.837	ND	ND	ND	ND	13.036	ND	ND	ND	12.866
Mn	0.059	0.063	0.052	0.096	0.055	0.043	0.026	0.119	0.350	0.235	0.058	0.088
Fe	2.760	3.588	1.715	2.139	3.456	1.347	3.604	6.624	9.325	7.560	2.064	0.363
Co	0.024	0.018	0.004	0.009	0.013	0.006	0.021	0.037	0.044	0.039	0.010	0.002
Ni	0.003	0.001	ND	ND	0.001	ND	ND	0.001	0.002	ND	ND	ND
Cu	0.074	0.036	0.034	0.029	0.046	0.031	0.051	0.032	0.031	0.035	0.057	0.034
Zn	0.021	0.014	0.004	0.028	0.099	0.021	0.053	0.021	0.027	0.024	0.031	0.014
Rb	0.231	0.014	0.073	0.043	0.106	0.147	0.158	0.077	0.044	0.043	0.197	0.495
Nb	0.053	0.007	0.007	0.021	0.144	0.025	0.105	0.029	0.007	0.011	0.035	0.021
Ag	0.030	0.025	0.008	0.011	0.032	0.020	0.019	0.009	0.027	0.031	0.020	0.013
Sn	1.093	0.016	0.003	0.100	0.278	0.187	0.226	0.236	ND	ND	0.111	0.433

ND-Not detected

Figure 4: Major oxides (wt %)/SiO₂ variation plots (after Harker et al., 1996)

The mesocratic diatexite sample has the lowest content of SiO_2 constituting about 51wt% and shows a more varied appearance as compared to Leucocratic diatexite samples having the range of 67-861wt% SiO_2 (Table 1) and further cluster as a group occupying certain portions of the plots (Figure 4), the biotite granite has the highest contents of SiO_2 range from (62.473wt%-73.844wt%). The main chemical variation seems to be SiO_2 . Plots of major elements versus SiO_2 shows varying trends in ferromagnesian elements with Plots of TiO_2 , Fe_2O_3 , MgO , CaO showing decrease alongside increase in SiO_2 , an indication of melt depletion in the analyzed samples even though some erratic and scattered distribution were also observed. Na_2O , K_2O and Al_2O_3 increases with increasing SiO_2 in the analyzed samples indicating melt enrichment attributable to their mobility during

metamorphism in such rocks. There linear trend in most samples may indicate that the concentrations of most element are significantly changed from their primary abundance.

Tectonic discrimination

Tectonic discrimination diagrams (Figure. 4) are used to distinguish magma that are produces in different tectonic environment based on their chemical composition (Bachelor & Bowden 1985, and Pearce et al., 1984). The essence of this chemical data is to distinguish the geodynamic content of granitic rock emplacement. In particular, anatectic granite is usually a function of protolith rock composition and of melt crystallization history being the tectonic environment (Rollinson 1993 and Forest et al., 2001).

Granite tectonic discrimination – Maniar and Piccoli (1989)

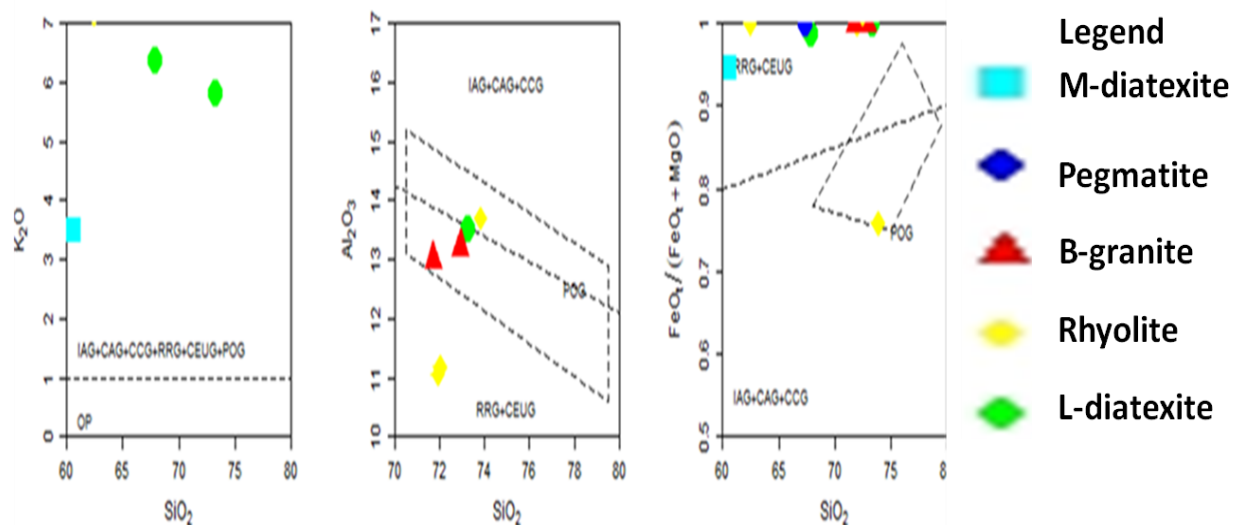


Figure 5: Geotectonic Discrimination Diagram Source: Maniar & Piccoli (1989)

Structural Geology

Structures recorded in the area generally conform to the NE-SW trend of structural elements of the Basement Complex of Nigeria and can be grouped based on those resulting from ductile deformation and from brittle deformation. The ductile deformation occurs where the rocks have been subjected to stress

that exceeds their elastic limit but still within their bearing capacity. Such structures include planar and linear features like foliations, lineation, and folding. Brittle deformation in the rocks occur where the tension on them has exceeded their total bearing capacity (yield point) resulting in structures like fractures, joints, and faults. The

major structures mapped during the fieldwork are joints, quartz veins, and mafic dykes.

Joints

Majority of the rocks in the area were jointed to different degrees, depending on rock strength. However, the joints occur more frequently and scattered in the biotite granites than in other

rocks. The joints were of different patterns from opened to closed, parallel, horizontal, vertical and wavy. The streams, and pathways are greatly influenced by joints from those few millimeters long, to those 10s to 100s of meters long. (Plate VIII) Some joints were filled with quartz-rich veins, due to the action of silica-rich hydrothermal fluids.



Plate VIII: Joints in the study area

Quartz and Quartzo-feldspathic veins

The quartz veins were generally found within joints and trended in the NE-SW direction. Their composition ranges from nearly pure quartz to pegmatitic, and are defined by large quartz crystals usually the only visible mineral in hand

specimen, or combined with plagioclases defined by milky color and earthy luster. (Plate IX). The pegmatites and other quartz veins in the area range from a few mm to 10s of meters in width.



Plate IX: Major Quartz vein in the study area

Mafic dyke

The mafic dykes encountered in the field discordantly intrude the Basement, and have also been observed cutting across Rhyolite dykes. and

show no preferable trend. They range from centimeters in some areas to few meters in width in other areas. They are the least jointed rocks in the area with no visible faults detected. (Plate X).



Plate X: Mafic dyke

Table 3: Strike values for joints and quartz veins

Joints	Quartz veins	Joints	Quartz veins
23	37	39	140
43	40	67	47
130	50	15	30
137	22	17	33
102	20	120	41
19	130	122	47
78	49	35	25
30	122	15	31
45	150	120	155

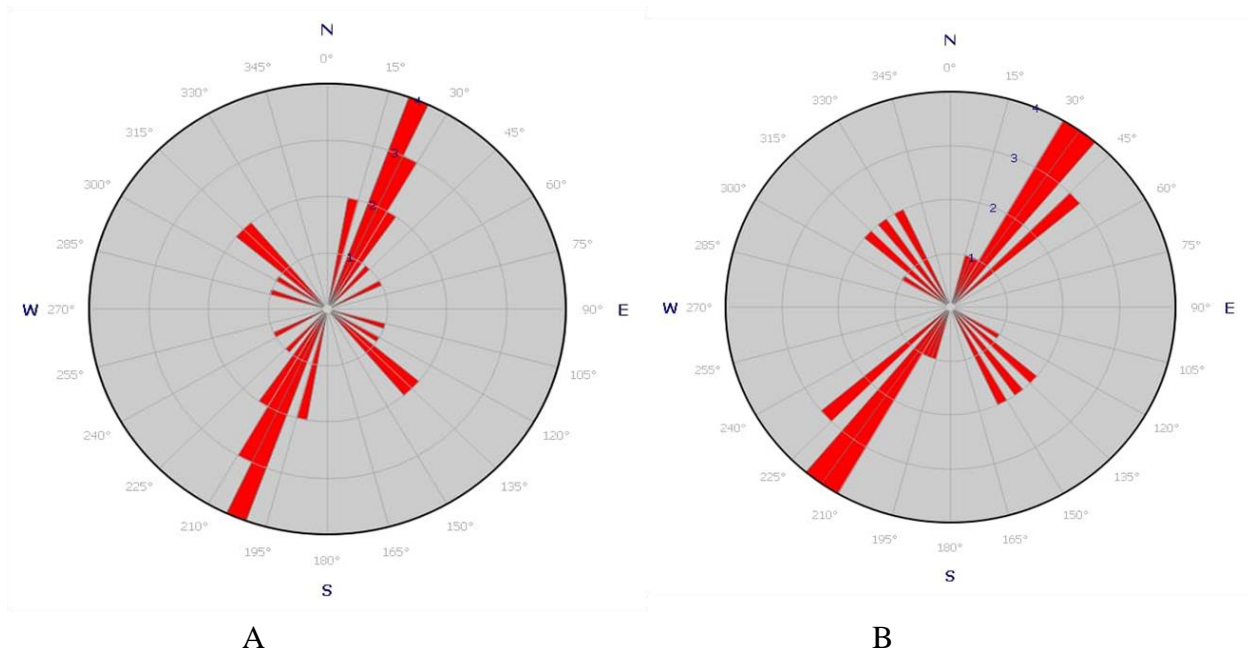


Figure 6: Rose diagrams showing strike directions for joints (A) and quartz veins (B) (Generated with GeoRose Software).

Economics Potential within the Study Area

Mineral resource is a word used to describe the concentration of naturally existing solid, liquid, and gaseous minerals in or on the Earth's crust such that commercial extraction of the commodity is viewed as viable today or later.

Within the study area, quartz veins and joints, pegmatitic veins/dykes, and other potential commercial mineral-bearing structures were seen. Economic mineral deposits can be classified on the basis of their means of concentration;

Magmatic ore deposits

Through magmatic processes such as partial melting, crystal fractionation, and settling in a magma chamber, economically valuable materials are concentrated within igneous rock. When elements previously extensively spread in low concentrations in the magma were concentrated and removed from the magma, they became the mineral ores that are concentrated in igneous rocks. Pegmatite is an illustration of a magmatic ore deposit seen in nature in the study area. A silica-rich residue called pegmatite is formed when magma fractionally crystallizes in the late stages of its

evolution. It is also abundant in water and rare earth elements including gold, uranium, niobium, boron, and lithium, all of which have high economic worth when concentrated. This residue is often injected into rock fracture and crystallizes as a rock called a pegmatite that characteristically consists of large crystals. The pegmatite observed occurred as veins and dyke, though veins were most common. Also, quartz veins observed in the study area were found in different locations occurring mostly on biotite granite. These quartz veins had varying dimensions. These pegmatitic veins and dykes may be either mineralised or barren.



Plate XI: Pegmatite Vein in the study area

Sedimentary Ore Deposits

Sedimentary ore deposits are secondary mineral deposits that have been formed as a result of the concentration of ore minerals that have weathered from mineralized rocks. Laterite and placer ore deposits are a couple of examples of these deposits. Placer Ore Deposits - Iron ore, Surface waters that are flowing, like river channels, concentrate deposits. The method and distance by which these minerals are transported out from the primary mineral deposit depend on the speed of flowing water. Despite being the same size, lower-density minerals like quartz are deposited at a faster rate than heavier minerals like gold, diamond, and magnetite. As a result, locations with slow water currents are where heavy minerals are concentrated. Due to a few stream channels that can be seen crossing over the

research area and potentially leaching mineralized rocks, placer deposits may be present there.

Laterite (found in the south of the investigated area) is a source of secondary oxides of iron and aluminium. These oxides are insoluble deposits of iron and aluminium, during chemical and physical weathering of mineralized rocks.

Mining Activity in the Study Area

Artisanal mining

Mining activities in the area are a source of income for many. In this method, the search for economic minerals is typically for fluvial deposits. Minerals are transported to the banks of streams, where they are exploited by the miners. Two artisanal mining sites both exploiting tin,

were observed in the area. The typical mineral processing method here is panning. It involves washing the extracted mineral from the riverside. Abandoned mining pits were seen on some hills

at the central part of the mapped area, where artisanal miners had exploited for copper, zinc, lead, fluorite and tourmaline.



Plate XII: An Artisanal Mining Site in the Study Area

Quarrying

This involves the extraction of durable non-mineralized or non-metallic rock or sand from the earth for economic purposes. It is a very common practice in almost every area people dwell.

Whether a sedimentary or basement terrain, rocks and sands are both quarried for local and industrial uses. In the research area, quarrying is performed more often on the biotite granites and rhyolite



Plate XIII: Photograph of Quarrying Site in the Study Area

V. Discussion

The field investigation reveals that, the study area is composed of four distinguishable rock units. The migmatite (mesocratic and leucocratic diatexite), biotite granite and rhyolite. The outcrops have ranges of elevation from low level, medium to high. Areas where biotite granite were exposed have higher elevations. The migmatite occur at the shallowest elevations in the area. Its composition from thin section petrography suggests a granitic protolith. Presence of pronounce foliations in some portion of the rock, suggests it has been subjected to a compressional phase of regional metamorphism/deformation. These foliations are very evident in the northwestern portion of the area and trend NE-SW. Their trend is perpendicular to the stress, implying the deformation occurred along a NW-SE axis which follows the trend of the Pan African deformation. The Migmatite range in texture from fine to coarse in grain size. The mesocratic diatexite occur as patch within the leucocratic diatexite. They are residuum rich rocks which are dominated by the paleosome (characteristic of the incipient stages of partial melting). They are associated with large phenocryst of feldspar that are aligned or stretch (characteristics of shearing in rocks). There is an inhomogeneity in the lithologies and direct relationship between the rocks in the study area, which is a typical characteristic of a migmatitic rocks (Brown, 2008: Sawyer, 2008). A genetic relationship between the morphological type was supported by Sawyer (1998), Solar and Brown (2000) and Milord *et al* (2001) who demonstrated that some migmatites are transitional to granites. The intrusion of the biotite granite cut across the migmatite and form the hilly region. The intrusion is characterized by finer grains on the far western end and coarse grain on the eastwards with an outline of very fine quartz-felspar granite porphyry at the Northern part of the ridge. The biotite granite appeared more as sheet structures dipping gently to the south. The rhyolite is the volcanic equivalent of the granite. The general structural trend of joints, veins, and faults is NE-SW, indicating impact of the Pan African orogeny, and

conforming with those of structures in the Basement Complex of North central Nigeria.

Conclusion

The study area is underlain mainly by the Nigerian Basement Complex rocks, The rock in the study area exhibits varying texture, composition and are group base on their morphological description; the Migmatite are classified as mesocratic diatexite and leucocratic diatexite (Brown, 2008: Sawyer, 2008) and occur in field as low-lying outcrop. The Granite occurs as a chain of granitic hills stretching from the east to the west. The geology of the study area is completely composed of granoblastic rocks, it is economically viable. The abundant quartz vein and pegmatite vein's structure occurring in the area is an indication for significant economic mineral deposits in the area. Petrographic studies revealed that quartz; microcline, plagioclase and biotite constitute the major minerals present in the rocks, while hematite, fluorite, sphene, ilmenite, copper, magnetite and zircon are the most dominant accessory minerals present in the rocks. The major structures encountered in the field are joints, quartz veins, and mafic dykes. The general structural trends are in (NNE-SSW and NE-SW directions) are characteristic of the last known major orogenic activity within Africa, the Pan African Orogeny (600Mya).

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