



## General Geology and Geochemistry Studies of Basement Rock Types of Zagun Area, North Central Nigeria

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### Abstract

*The mapped area is part of the Basement Complex of Jos Plateau, Central Nigeria and is made up of rock types that include migmatite gneiss, porphyritic biotite granites, microgranite, basalt and dolerite. Field relations revealed the occurrence of structures such as foliations, joints, quartz veins, aplitic dykes, pegmatite dyke, basic dykes, enclaves, shear zones and mylonites, trending dominantly in a NE-SW, N-S, NNE-SSW and NW-SE, respectively. These suggested that the rocks were affected dominantly by the Pan-African Orogeny (600±150). Microscopic studies revealed that the rocks contain varying percentages of quartz, K-feldspar, plagioclase, biotite, hornblende, pyroxene and augite as the major minerals. Geochemical studies showed that the rocks have limited variation in their major element compositions and give a decrease in CaO wt. %, and increasing Ba/Sr, Zr/Y ratios, K<sub>2</sub>O wt. % with increasing silica. The rocks are distinctly calc-alkaline as they plot in the sub-alkaline and cal-alkaline, syn-collision-post-collision fields on various discrimination diagrams. The above characteristics suggest that the Basement rocks of the study area were formed from the fractional crystallization of a calc-alkaline magma in a syn-post collision tectonic terrain.*

**Keywords:** Petrography; Geochemistry; Structural Orientations; Economic Geology; Basement complex.

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### 1.0 INTRODUCTION

The study area lies within the Zagun Pan-African Granite Complex located in Bassa local Government Area of Naraguta sheet 164NW, Jos Plateau, which is part of the Basement Complex of the Jos Plateau in north central Nigeria. The Igwara, Buhit and Zagun are the

areas encountered in the study area and they form part of the Basement Complex. The general geology and petrography of the area was first carried out by Buchanan *et al.*, (1971), Macleod *et al.*, (1971), Turner (1983) and Ogezi (1988). According to them the area is underlain

by the basement rocks of the Precambrian age ( $600\pm 25\text{Ma}$ ) and part of Pan -African Granites of the Jos plateau, and was intruded by the Younger Granites which are Jurassic in age ( $165\pm 25\text{Ma}$ ) and later the Cenozoic volcanic rocks which are now lateralized. The rock units found in the study area are porphyritic biotite/hornblende granite, diorite and to some little extent basalts and medium coarse granites. Porphyritic biotite/hornblende granite occupies the greatest percentage of the north western to western, central and southwestern part of the area and referred to as the Zagun Granite (Ogezi, 1988). It is a large well exposed mass forming rugged groups of hills on the western side of the Plateau edge which is over 300m high dropping down to Kafanchan plains. The rock is largely homogenous foliated granite with large crystal of feldspar (feldspar phenocryst) ranging between 2 to 5cm long. The dark minerals include both biotite and hornblende. Inclusions of migmatites are abundant particularly near

## 2.0 MATERIALS AND METHODS

### 2.1 The Study Area

The area of study is located in Bassa Local Government Area of Plateau state. The villages contained include Igwara, Zagun and Buhit. The area is part of Naraguta sheet 168NW, on a scale of 1:50,000. The topographical map covering the study area was extracted from the above mention sheet and enlarged to a scale of 1:12,500 and it lies between latitude  $9^{\circ}57'50''\text{N}$  and  $10^{\circ}00'00''\text{N}$  and longitudes  $8^{\circ}41'32''\text{E}$  and  $8^{\circ}43'40''\text{E}$ . It covers  $30\text{km}^2$  (Figure 1).

marginal granites including those adjusted to rocks foliation is marked in the Zagun Granites particularly near the margin. There are granite dykes which are sheared along contacts. Diorites dykes are probably younger than the migmatite and porphyritic biotite/hornblende biotite granite. This is evidenced by the law of crosscutting relationship. In the study area, the dyke is found cross cutting the migmatites and the porphyritic biotite granites in a NE-SW direction and is highly fractured due to intense weathering. Basalts are also found at the north western and north eastern include central part of the study area on the porphyritic biotite/hornblende biotite granite. The amount is very small and occurring as scattered boulders. They are dark in color having phenocryst of olivine (Wright, 1985).

The primary goal of this research work targets the preliminary study of different rock types, their petrography, petrogenesis, structural relationship, mineralogy and geochemistry.

The villages are accessible by one motorable road that runs from Bassa town to Binchi village and Zagun village which is part of the area of study. This study area is poorly accessible due to rugged topography. The secondary roads include footpaths, cattle tracks and stream channels which served as access to rock exposures during the field mapping exercise. School and primary health care centre are available in Zagun.

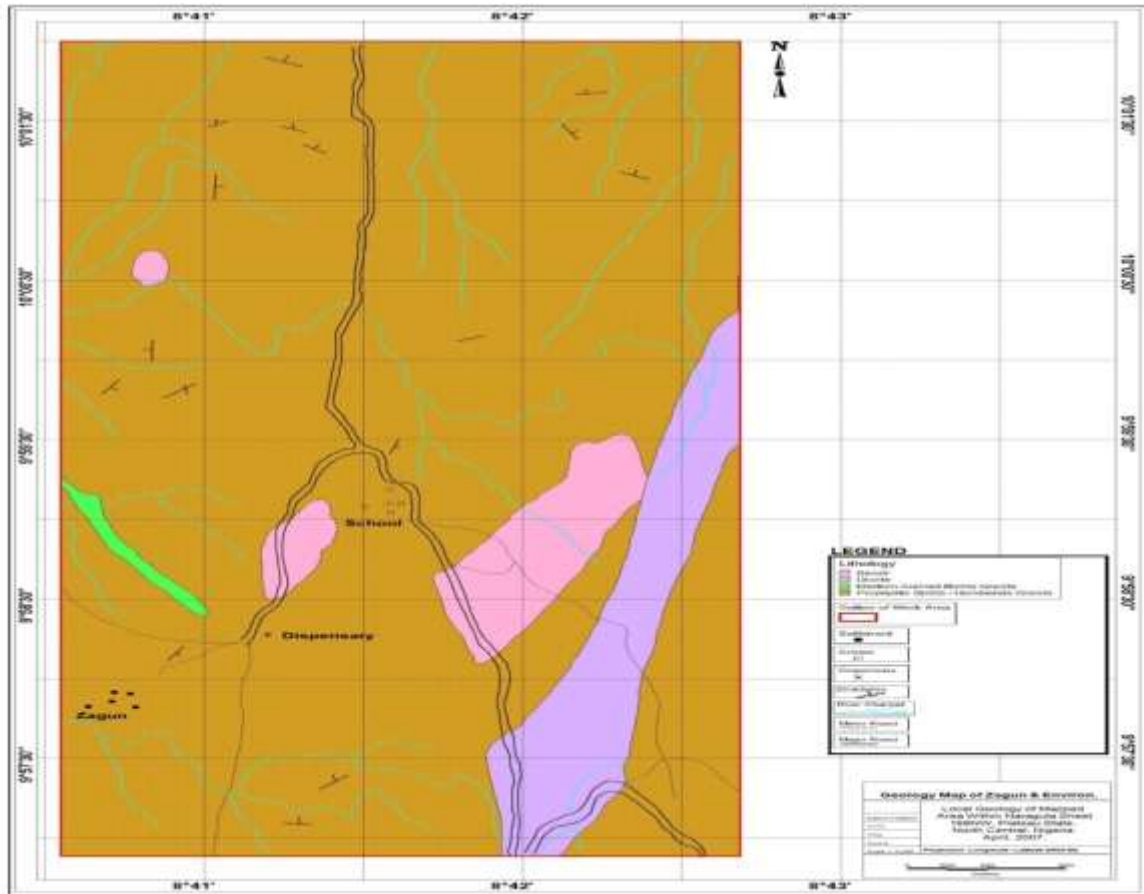


Figure 1: Geological sketch of Zagun Area.

## 2.2 General Geology of the Area

The Igwara, Buhit and Zangun are the areas encountered in the area and they form part of the Basement complex on the Jos Plateau. The Basement complex of older granulitic gneiss which is mainly psammitic and semi-pelitic gneiss intermediate rocks which has diorites commonly occurring with hypersthene succeeded by a series of migmatite forming a heterogeneous group which include granulitic gneiss, veined and banded gneiss, porphyroblastic gneisses, amphibolites, calc-silicate rocks and schists, Macleod *et al.* (1971), Rahman and Fitches, (1988). This sequence continues with granites gneiss and migmatite granite gneisses which was derived from older gneisses by granitization “*insitu*” which show

variable relicts structures of original gneiss and enclosing scattered basic inclusions and are predominantly granodioritic in composition (Ogezi, 1988). The Pan-Africa granites complete the sequence and include varieties of transitional granite gneiss and intrusive granites. These are characteristically coarse-grained types containing biotite and / or hornblende (Figure 1). The dominant foliation is in the N-S direction which is parallel to the trend in the Basement areas further to the west (Wright, 1985).

## 2.3 Data Collection and Interpretation

The mapping exercise was carried out during the dry season which enhanced a maximum exposure of geological features for detail observation. A topographical map of the study area, Naraguta sheet 168NW with a scale of

1:50,000 were used as a based map. The field work was done by investigating the exposed sections of the rocks and their relative features. Fresh samples were collected at each location with the help of geological hammer. Representative samples totaling twelve (four porphyritic biotite granite, three Diorites, two micro-granites, two basalt and one Dolerites) were cut into thin sections and were petrographically studied under the microscope

for their mineral compositions. The twin part of the representative samples were crushed pulverized and package in sealed polythene bag for geochemical analysis. The packaged and pulverized samples were sent to Activation Laboratory Canada for major, trace and rare-earth element analysis using the combined X-ray florescence and inductively coupled plasma atomic mass spectrometry method.

### 3.0 RESULTS AND DISCUSSION

**Migmatite Gneiss:** occurs as a foreign rock inclusion in porphyritic biotite granite in the area. Here the migmatite gneiss has undergone severe deformation, weathering and fracturing. They mostly occur as “Xenoliths” resulting to few exposure. In hand specimen, it has metamorphic and magmatic components typically segregated into bands, porphyroblastic augen gneiss and large crystals quartz are present. It is holocrystalline, the grain size is medium to coarse grained. Thin section of this rock reveals the following minerals; plagioclase feldspar, alkali feldspar, quartz and biotite (Plates 1 and 2), potassium feldspar observed was microcline. It shows granular and medium grained crystals of microcline that are subhedral to anhedral in form, with low interference colour

and a weak birefringence. The plagioclase feldspar was in form of granular, medium-grained crystals of mostly albite with extinction angles form 5° to 14°. They are of low relief and they are weakly fractured. Quartz is colorless to white depending on the interference color. They are usually clustered together in aggregates. The crystal forms are granular subhedral sub-angular and subrounded quartz. Biotite crystals appear in granular subhedral, sub-angular and sub-rounded quartz crystals, plagioclase and k-feldspar under plane polarization light. They show little or no deformation. There are inclusions of opaque minerals zircon and stains of magnetite including apatite. The description goes in accordance to the work of Buchanan *et al.*, (1971).



Plate 1: Granular and Prismatic medium grained crystals of quartz, Plagioclase, and alkali feldspar with large biotite flakes which shows alignment along a preferred direction. PPL.

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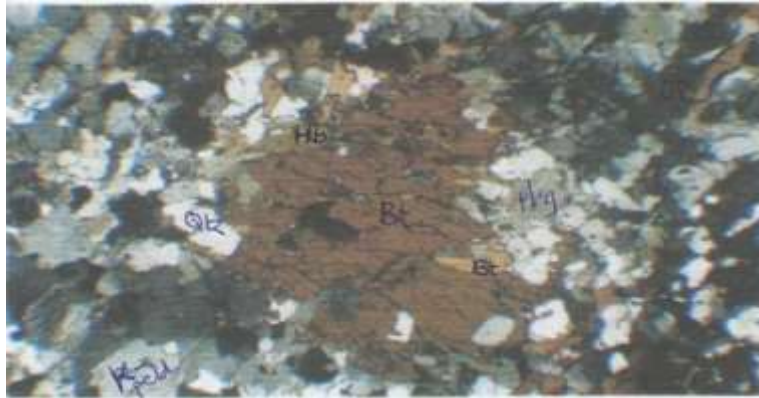


Plate 2: Xenolith of biotite in granular subhedral, sub angular to angular and sub rounded quartz crystals, Plagioclase and K-feldspars. XPL.

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**Porphyritic biotite granite:** dominated most of the outstanding topographic features of the mapped area. It is homogenous granite with simple mineralogy and major lithologic units in the area, minor lithologic units are basalt, dolerite, diorite, microgranite and dolerite. In hand specimen biotite granite is homogenous unit with tabular or ovoid potassium feldspar phenocryst, some of which are up to 4 cm in length and 1.5-2 cm in diameter. These are set in a medium grained granular matrix of quartz and feldspar with biotite and hornblende as the dark minerals. Feldspar and quartz are the dominant felsic minerals which constitute about 60% while biotite and hornblende are the dominant mafic minerals and constitute the remaining 30-35% and the rock were foliated. Thin section studies of biotite granite through microscope revealed plagioclase, quartz, biotite and hornblende as the major minerals while apatite, zircon, pyroxene and opaque minerals occur as accessories (Plates 3 and 4). K-feldspar grains are microcline shows cross-hatched twinning and with inclusion of quartz. The crystals are subhedral to anhedral in shape, cracks and fractures are characteristic of some crystals. Plagioclase has low relief under plane polarized light and as colorless laths. It typically shows

polysynthetic twinning and often clouded due to the alteration probably to clay minerals. The color range from white to light grey, the extinction angle is from 5° to 14° indicating a variety of plagioclase ranging from albite to oligoclase. Quartz is colorless-white and has a turbid appearance, which may have resulted from intense weathering. Mymerkitic intergrowth between quartz and plagioclase occurs in some parts of the section. The crystal forms are subhedral to anhedral under cross polar. Biotite shows a perfect cleavage in one direction and it occurs generally as brown to dark flakes. Alteration to green mineral is most probably chlorite. They show high relief and are subhedral to tabular forms through some aggregates of irregular forms were observed, it revealed pleochroism of yellowish brown to dark brown by Buchanan *et al.*, (1971). Hornblende revealed high relief and subhedral to anhedral forms, it is generally yellowish-green to dark brown, opaque crystals were observed around the hornblende and cloud due to magnetite formation by oxidation of iron. The accessory minerals are zircon and apatite, most of the opaque minerals are mainly magnetite and ilmenite enclose in feldspars.



Plate 3: Intergrowth of microcline and alkali feldspar at the center of view, highly altered plagioclase feldspar toward the right with quartz and biotite are seen to the far right (PPL).



Plate 4: Intergrowth of quartz and alkali feldspar (granophyritic texture), XPL.

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**Microgranite:** this occurs as small intrusions without any traces of foliation, at the southwestern part of the mapped area within the porphyritic biotite granite. In hand specimen, it is medium grained with long crystals of feldspar and quartz. The color index of the rock is mesocratic, revealing dark flakes of biotite

grains and probably other mafic minerals make up the melanocratic aspect while the feldspar and quartz grains make up the leucocratic portion. Microscopic studies of it revealed quartz, biotite, microcline and plagioclase; accessories are iron oxide, apatite and zircon (Plate 5).



Plate 5: Large microcline showing X-hatch twinning biotite flakes, quartz with intergrown boundaries and alkali feldspars being altered to clay mineral.

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**Diorite:** this forms a unique and distinctive topographic feature which crosscut the porphyritic biotite granite of the mapped area. It occurs as a prominent and extensive dyke forming a direction, about N70°. It has a length of about 2km from southwest of Igwara to the northern part and with a width that ranges between 100-250m. The dyke occurs as boulders and such has few joints. The boulders vary in width and length from between 10-100cm and 10-500cm respectively. In hand specimen, the rock is melanocratic in color, medium to coarse-grained. Some of the rock have been highly weathered and marked by exfoliation. Thin section of the rock revealed under microscopic studies plagioclase, quartz, hornblende, biotite, pyroxene and opaque minerals (Plates 6 and 7). Plagioclase show grayish to dark polarization colors with fractures cutting across the twinning, the crystals are elongated and have a low relief. They appeared aligned in a particular direction. Some of the crystals are fractured and inclusions are found along these fractures. Those inclusions are mainly biotite and opaque minerals such as olivine. Extinction angle of about 9° was measured indicating that the plagioclase is andesine.

Quartz appeared colorless with no cleavage and twinning. The form is mainly anhedral, interference color is low and extinction may in most crystals and parallel in few. The relief is low and biotite inclusions are seen. The hornblende has elongated crystals with few of them being prismatic. The pleochroic colors are green to dark brown. It has an extinction angle of 23°. The relief is high and only one cleavage plane is visible. Biotite is seen as light brown to dark brown with high relief. The crystals have a perfect cleavage in one direction. They are disseminated or are found in close association with hornblende. Under plane polar they show a characteristic mottled appearance when close to extinction. Pyroxene revealed anhedral crystal with plagioclase feldspar in between their space. Augite occurs showing pleochroism from dark brown to violet. Two cleavage plane perpendiculars to each other are visible in some crystals which anhedral to subhedral in shape many occurring as prism. The opaque minerals observed are mostly products of biotite alteration.



Plate 6: Prismatic and elongated crystals of plagioclase feldspar much are undergoing alteration into sericite. Some of the feldspar is zoned. PPL.

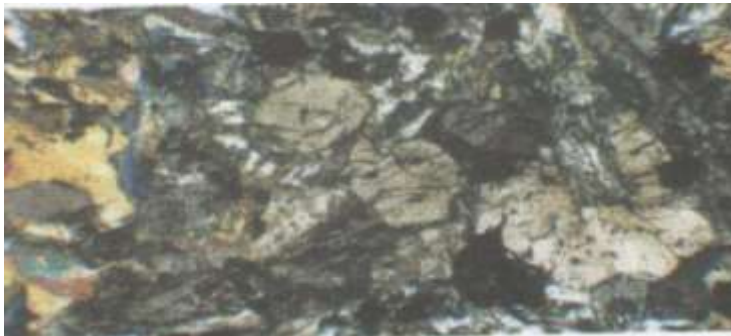


Plate 7: Olivine crystals at the center of view with plagioclase crystals (slide is slightly thick hence the features are not well visible (XPL).

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**Basalts:** they occupy almost 5% of the mapped area and exposed as boulders remnants on porphyritic biotite granite with no pronounced volcanic focus. It is located at Buhit at the north and south-eastern part of the mapped area. In

hand specimen the rock is melanocratic (dark color) fine grained, vesicles filled with olivine crystals. Thin section of this rock reveals plagioclase, feldspar, pyroxene and opaque minerals (Plate 8).

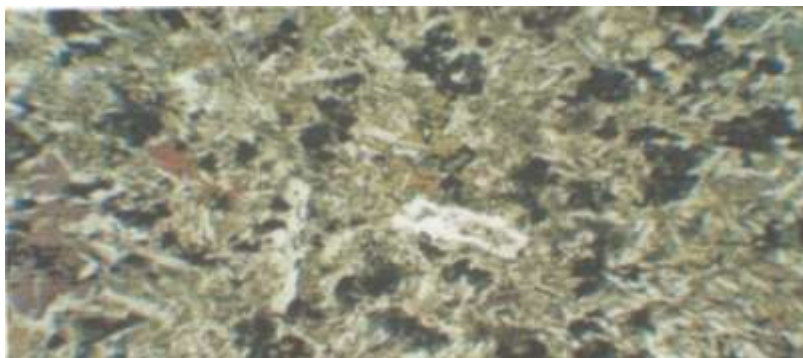


Plate 8: Microphenocryst of plagioclase feldspar at the center of view, anhedral crystal of pyroxene enclosing laths of plagioclase and opaque minerals. PPL.

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**Dolerite:** occurs as minor dykes within the country rock, in hand specimen it is fine grain dark colored mineral. The main mineral components of the dolerite dyke are K-feldspar, plagioclase, quartz, biotite and hypersthene (Plate 6). K-feldspar, orthoclase is the most abundant k-feldspar is fractured and it is filled with biotite. Simple twinning is commonly developed in the crystals. The extinction angle is generally oblique. Plagioclase occurs as colorless crystals with an inclusion of sericite. The plagioclase exhibits lamella twinning, low relief and the crystals are anhedral to subhedral. Quartz is not abundant here, no cleavage or twinning was observed but they exhibit a shadowy extinction. The quartz occurs in a large amount than the plagioclase. Biotite occurs as the major ferromagnesian minerals in this rock type. It shows pleochroism from light brown to dark brown. It has one cleavage direction and exhibits a perfect cleavage. The extinction is parallel to the long axis of the crystals green to pink. This research work agreed with the finding of Ogezi, (1988).

### 3.1 Structural Geology of the Area

The structural features observed in the area are restricted mainly to Pan-African Granites. The structure may be as a result of tectonic stresses the rocks were subjected to; it could probably be due to the effect of widespread Pan-African

Orogeny which has affected the entire Nigerian Basement Complex (Nyikwagh, 1990). This initiated some major structural reformative processes on the various rock units. The structural features encountered in the area include foliation, joints, dykes, veins, shear-zones and mylonite. Foliation in the porphyritic granites is marked by preferred orientations and elongation of pink feldspar phenocryst which measured up to 4cm in length, parallel arrangement of biotite layers aligned with K-feldspar megacrysts. The major trend is N-S. Joints are very common features in porphyritic granites (Figure 2). The major trend is NNE-SSW with minor trends of N-S and E-W. Quartz vein formed sharp contact with the host rock, ranging between 2-10cm in thickness, it were found in variable orientation with major trend being E-W and minor trends is NE-SW (Figure 3). The pegmatite dykes are common in porphyritic granites of the area. They have variable thickness ranging from 4cm to 2m, showing exceptional coarse grained in texture which normally incorporate the same material as the host rock. They are composed of quartz, feldspars and micas (muscovite or biotite). The pegmatite dykes could be as a result of gradual crystallization from a volatile rich melt with which they are often associated. The major trend is NW-SE, minor trends are NNE-SSW, NE-SW and sometimes vertical.

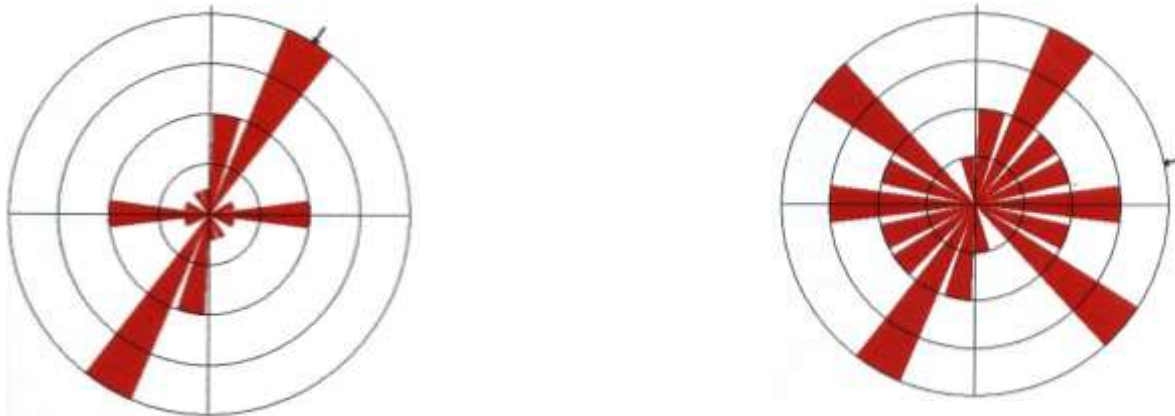


Figure 2: Plot of Joint directions in the Granites of the Area. Figure 3: Trend of Quartz Vein in Granites of the Area

### 3.2 Geochemistry of the Area

The major element (wt %) and trace elements (ppm) geochemical results are presented in table 1 and 2 below. The results showed that SiO<sub>2</sub> wt% ranges between (63.87 and 70.96wt%), with the Porphyritic biotite granite and microgranite having the highest silica content while dolerite and basalts is having the least value of silica, and diorite being intermediate

rock with silica value ranging between (45.4 to 51.32wt%) (See Tables 1 and 2).

There is a systematic increase in K<sub>2</sub>O as SiO<sub>2</sub> wt% increases while CaO decrease as SiO<sub>2</sub> increases. Na<sub>2</sub>O wt% does not display any significant changes.

Table 1: Elemental distributions of Felsic Rock Units of the area.

Rock Name/Elements Weight %	Biotite Granite 1	Biotite Granite 2	Biotite Granite 3	Biotite Granite 4	Micro-Granite 1	Micro-Granite 2
SiO <sub>2</sub>	67.16	70.96	67.69	63.87	71.36	70.52
Al <sub>2</sub> O <sub>3</sub>	14.73	14	13.91	15.56	14.33	13.99
Fe <sub>2</sub> O <sub>3</sub>	4.64	3.47	5.07	6.22	2.37	2.87
MnO	0.054	0.041	0.081	0.086	0.02	0.034
MgO	0.69	0.45	0.9	0.91	0.53	0.66
CaO	2.79	1.89	2.69	3.62	1.19	1.04
Na <sub>2</sub> O	3.19	2.98	3.11	3.44	2.98	2.74
K <sub>2</sub> O	4.92	5	4.51	4.23	6.2	6.61
TiO <sub>2</sub>	0.751	0.517	0.903	0.949	0.358	0.511

P <sub>2</sub> O <sub>5</sub>	0.27	0.25	0.37	0.37	0.18	0.33
LOI	0.82	0.87	0.52	0.45	0.53	0.53
Total	99.8	100.4	100.4	99.71	100.1	99.83
Element (PPM)						
Ba	1527	1340	1220	1477	701	700
Sr	245	221	213	273	139	118
Y	49	32	44	52	13	21
Sc	11	5	10	11	2	4
Zr	599	454	747	815	224	359
Be	3	2	3	3	<1	1
V	36	19	43	40	<5	22
Ba/Sr	6.232	6.063	5.727	5.410	5.043	5.932
Zr/Y	12.224	14.18	16.977	15.673	17.23	17.095

Table 2: Elemental distributions of Mafic Rock Units of the area.

Rock Name/Elements Weight %	Diorite 1	Diorite 2	Diorite 3	Dolerite	Basalt 1	Basalt 2
SiO <sub>2</sub>	51.32	46.1	45.4	44.87	45.36	45.64
Al <sub>2</sub> O <sub>3</sub>	15.61	14.51	15.46	15.47	13.5	14.49
Fe <sub>2</sub> O <sub>3</sub>	11.08	14.1	12.79	12.12	17.49	12.05
MnO	0.168	0.175	0.218	0.183	0.217	0.172
MgO	6.36	6.08	4.24	5.79	4.92	8.83
CaO	9.61	7.75	8.93	10.44	7.72	8.92
Na <sub>2</sub> O	2.66	3.04	3.97	2.74	3.23	3.89
K <sub>2</sub> O	0.72	1.76	1.83	1.91	1.33	1.77
TiO <sub>2</sub>	1.385	3.578	3.497	3.046	4.478	2.543
P <sub>2</sub> O <sub>5</sub>	0.17	0.63	0.99	0.86	1.36	0.72
LOI	1.08	2.24	2.84	2.95	0.46	0.42
Total	100.2	99.97	100.2	100.4	100.1	99.43
Element (PPM)						
Ba	170	359	711	711	571	569
Sr	246	541	633	633	447	788
Y	19	35	37	37	47	25
Sc	23	26	16	16	25	19
Zr	103	244	296	296	428	227
Be	1	2	2	3	2	2
V	166	275	201	201	244	163
Ba/Sr	0.691	0.663	0.567	1.123	1.277	0.722
Zr/Y	5.421	6.971	8.457	8	17.23	9.08

On SiO<sub>2</sub> wt% against NaO + K<sub>2</sub>O (wt%) plot, the porphyritic granites and microgranite samples were plotted in the rhyolite field their by gives an indication that the rocks most have crystallize at depth with high temperature, fractional crystallization may be the case that result to the variation of their silica content. While the basalt were plotted in the basalt field with one of diorite samples (Diorite 1) plotted towards the basalt-andesite field. The similarity in the chemistry of basalt and dioritic rocks gives credence that, the magma that which gives rise to the formation of diorites rock may be of basaltic origin.

On the AFM diagram the basalt and diorites plot in the tholeiitic field while the microgranite and porphyritic biotite granites plot in the calc-alkaline fields. This gives an indication of crystal settling during magmatic crystallization which fractionates the rock types and lastly they are of the same parental origin, though slight variation in the chemistry may be due to time of difference in order of crystallinity. Basalts shows purely theoleiitic magma type (non porphyritic

#### **4.0 ECONOMIC GEOLOGY OF THE AREA**

The major mineral resources and materials observed in the area of study that may be of good economic value include quartz and feldspar. Constructional materials include crystalline rocks such as biotite granites, diorite and material derived from dykes, and laterite. Granites rocks have high crushing strengths, low polishing coefficient, and high ability to withstand abrasion and resist impact. These qualities make granites suitable for aggregate and road surface material. The variation in color

#### **5.0 CONCLUSIONS**

The polycyclic nature for the Nigerian Basement Complex indicated initial sedimentary rocks which have been subjected to multiple tectonism probably the Liberian, Eburnean, Kibaran and Pan-African events (Ajibade and Fitches, 1988). The rocks during this period are believed to have been metamorphosed and reactivated. This is

central types of mull), characterized in part by pigeonite (estantite-augite), siliceous residue that is often glassy and rarely olivine, this goes to suggest that during extrusion of basaltic magma it may have contaminated the diorite rocks which tends to change their chemistry.

On the tectonic discrimination diagrams the diorites and basalts plot outside the field but more toward the post-collisional uplift, microgranites plot on late Orogenic field, the porphyritic biotite granites plot on syn-collision uplift field. This research goes in accordance with the work of Bowden *et al.* (1984), Robert and Clemens (1993), McCurry and Wright (1997) which concluded that tectonism under rising temperature gives rise to various degree of partial melting of the crust and older meta-igneous rocks. Subduction and the consequent collision at the eastern margin of the West African craton produced extensive melting of the older rock solutions resulting to the emplacement of the mainly calc-alkaline and basaltic intrusion.

of the granitic rocks makes it possible for them to be used as floor tiles when properly polished. When fractured properly it can act as good source of groundwater supply in crystalline basement aquifer. The basalts and diorites have an added advantage of being fairly uniform, they may break into more or less equi-dimensional fragment. Their close packing and high compressive strength of their constituents makes them difficult to wear off easily and from effects of impact and abrasion. Hence when cut to desired size and shapes, it is used for construction of drainage systems which also help in erosion control.

evidenced by the presence of structures such as foliations, joints, veins, dykes, and shear zones. The principal structural trends include N-S, NNE-SSW. At the scale of crystals, the deformation is brittle and is evident in porphyritic biotite granite and to some extent in the diorite. This resulted in the general of fractures in the crystals, and alignment of biotite and plagioclase minerals. The basalts are fine-

grained and the absence of foliation and other directional structures on it suggested that they are younger than the basement. Petrography studies showed that the Quartz, Microcline, Orthoclase and Biotite are the dominant minerals in the Migmatite Gneiss, Porphyritic Biotite Granite and the Microgranite while the Diorite has hornblende, calcic plagioclase (andesine), biotite and the Basalt is made up of Augite, calcic plagioclase (bytownite, labradorite).

The rock units of the study area were formed at different temperatures especially the granite and basaltic rocks. The high percentage of the silica in the rock unit suggests a later stage of magma

crystallization except the porphyritic granite which has low silica representing the basement that probably formed earlier. The magma resulting to the formation of diorite, porphyritic biotite granite, diorite and microgranite were calc-alkaline magma which fractionated to give different rock types. The porphyritic biotite granite formed under a syn-collision uplift regime while the basalt and diorite were formed in a post-collision uplift geologic terrain.

The anomalous concentration of the Ba, Sr, Y, Sc, Zr, Be and V in the rock unit implies that there is possibility of mineralization in the project area, because the elements are associated with late phase of magmatic crystallization.

## 6.0 REFERENCES

- Ajibade, A.C., & Fitches, W.R. (1988). The Nigeria Precambrian Geology of Nigeria: a Geochronological Summary. In *Precambrian Geology of Nigeria* (pp. 45-53). Geological Survey of Nigeria Publication.
- Buchanan, M.S, Macleod, W.N, Turner, D.C and Wright E.P (1971). The Geology of Jos Plateau. The Younger Granite Complexes of Nigeria Geological survey Bull 32. Vol 2:160pp.
- Bowden, P., Batchelor, R. A., Chappel, B.W., Didier, J., Lameyre, J., 1984: Petrological, geochemical and source criteria for the classification of granitic rocks: a discussion. *Physics of the Earth and Planetary Interiors*, 35: 1 –11.
- Macleod, W.N, Turner, D.C and Wright, E.P (1971). The Geology of the Jos Plateau Geological survey of Nigeria Bull.32, vol.1:166.
- McCurry, P., and Wright, J. B., 1977. Geochemistry of Calc-alkaline volcanic in northwestern Nigeria, and a possible Pan-African suture zone. *Earth and planetary Sc. Lett*, 37: 90 – 96.
- Nyikwagh, D. M. 1990. Geology of Pegmatites in Ube-Wulko Area, Akwanga. Unpublished M.Sc. Dissertation, University of Jos, 168p.
- Ogezi, A.E. (1988). Origin and Evolution of the Basement Complex of Nigeria in Light of New Geochronological and Geochemical Data. In *Precambrian Geology of Nigeria* (Ed.), (pp. 301-312). Nigeria Geological Survey Publication.
- Rahaman, M. A., 1976. Review of Basement of southwestern Nigeria. In: Kogbe, C. (Ed.), *Geology of Nigeria*, Elizabethan Press, Lagos. 41-58p.
- Roberts, M. P. and Clemens, J. D., 1993. Origin of high potassium calc-alkaline, I-type granitoids. *Geology*. Vol. 21. 825-828p.
- Turner, D.C. (1983). Upper Proterozoic Schists Belts in the Northern Sector of Pan African. *Precambrian Research*, 21, 55-72.
- Wright, J.B. (1985). Geology and Mineral Resources of West Africa. Discussion, *Bulletin Geology Society America*, 81, 3491 - 3492.