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Geology and Petrographic Analysis of *Porphyritic Biotite Granite* Rocks in Funtua Sheet 78, Ne, Northwestern Nigeria

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Abstract

The aim of petrographic analysis is to find the ratio and percentages of certain elements in a rock. Petrographic work of twenty (20) samples of granite rocks was done with primary aim of attempting to understand the mineralogy, texture and modal composition of all the rock samples. The Petrographic analyses were undertaken using Olympus model polarizing microscope at Ahmadu Bello University, Zaria in the year 2011.The study reveals that Quartz in granite rocks Quartz is very stable and even if fluid enters in it, it does tolerate it. The microscopic study revealed the presence of basically the same mineralogical assemblages in all the rock samples namely; Quartz, feldspars (orthoclase and plagioclase) There are also another group of minerals such as zircon, biotite, muscovite, and others like, microcline, myrmekite and apatite. The lithologic types display variations in mineralogy and texture and they are related to the color variations. Based on the thin section study, granites truly exist. The names assigned on each rock were based on the identification of mineral assemblages or paragenesis.

Keywords*:* *Geology, Granites, Petrography, Mineralogy, Funtua NE, NW Nigeria*

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Background to the Study

This is an older granite formed during Pan African orogenic (570 +_ 160 Ma) event and which frequently outcrops in the western portion of Funtua NE. It has a very visible crystalline formation and texture (Kankara, 2014). Granite is usually whitish or gray with a speckled appearance caused by the darker crystals. Granite is an acid igneous rock that crystallizes from magma-chamber that cools slowly. Granite, along with other crystalline rocks, constitutes the foundation of the continental masses, and it is the most common intrusive rock. The specific gravity of granite ranges from 3.00 to 2.84 (Ezepue, 1992) its crushing strength is from 1,000 to 13,000 kg per sq cm ((Ezepue, 1992; Cox *et al*, 1979). It is heavier than sedimentary rocks which are naturally softer, such as the sandstone, phyllites in the study area, often becoming difficult to quarry. Its economic applications are in constructions or building, the best grades (those of younger granites) being extremely resistant to weathering. It consists principally of K-feldspar and plagioclase feldspar (usually potash feldspar or oligoclase), quartz and mica (Biotite) with low amount of muscovite, plagioclase feldspar, with minor accessories like muscovite, Apatite, microcline, myrmekite, Alkali feldspar and zircon.

Study Area

Many researchers have shown that NW Nigeria in which Funtua NE is part are covered by Lower palaeozoic terrain of NW Nigeria (Dada, 2006)Geographically, the area cut across Kankara, Bakori, Malumfashi and Faskari Local Government areas in Katsina State and covers a total land area of approximately 745.29km$^{2.}$ The study area of Funtua north east (FTNE) falls within longitudes and latitudes 7^0 15',7^0, and 11^0 45', 12^0 00' (Kankara, 2014; Figure 1) The area is characterized by series of discontinuous ridge of inselbergs (gneiss and granite) in the western side which made it a slightly rugged landscape. Some areas around far western and eastern parts are inaccessible due to intense flooding especially in the rainy seasons.

Climate, Relief and Drainage

The natural vegetation of the mapped area is largely Sudan savanna type, that is tropical climate zone of Nigeria and is characterized by two main seasons; rainy season which is from April to October and dry seasons (or Hamattan) for the remaining periods which is typical of northern Nigeria, and which is characterized by sharp regional variances depending on rainfall (Babsal and Co.,1998).Generally, the seasons are moved by the movement of the Inter Tropical Air Mass or Inter Tropical Convergence zone (ITCZ) a zone where dry and often dust-carrying air from the northern Hemisphere, known locally as hammattan collide with moist air from the southern Hemisphere or Atlantic. The study area receives an average precipitation of 1,200 mm in the south per year to 650 mm down in northern Nigeria (Kankara, 2002) Dry season is marked by low humidity and has Harmattan wind that blows from Sahara.

The area is a gently undulating peneplained surface, consisting of an extensive superficial cover which rises to an altitude of between 570m and 600 m above mean sea level. This prevailing low relief is attributed to the predominance of metasediments and to the absence of intrusives. It also consists of a series of residues of ridges (of metasediments) and prominent inselbergs (of gneisses and granites) which makes the terrain to appear rugged. The highest points are Dutsen Wawa, Dutse Mai Zuma, Dutse Mai Amarya, Baka-Zari, Dutsen Mashi, Dutsen Mununu, Duwatsun Zango, Yan Ajera and Mai Dorayi inserlbergs form the Bakkai complexes (see Table 1) Na-Doshe inserlberg is located at the western border of the area. The lowest points in the project area are found at the areas close to Kwakwaren-Nabadau, around river valleys, with a gradual decrease in slope towards southeast.

Methodology

Twenty (20) major lithological units were identified and sampled during the mapping (reconnaissance survey and actual field investigation), using a 1:50,000 scales and this covered a total land area of approximately 153km^2. The Funtua NE is part of Nigerian Basement. Each lithological unit has been described in accordance with reference to their locations in the map provided. For the geological mapping, granitic lithological units were identified and as well, their structures, field and contact relationships. Laboratory analysis was carried out to ascertain the various percentages of minerals, by the use of AAS, XRF and FP.

Results and Discussion

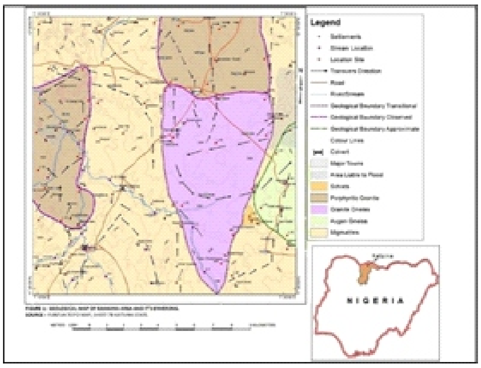

Fig. 1: Geological map of the study area showing the Older granites; Plate i: Multiple Pegmatites at the extreme western portion, near *Bakarya* village

Plate i: Biotite granite along *Tudun-Sha-Tambaya-Guga* road, extreme western portion of Funtua NE

Table1: Geochronometric Samples Description, Locality and Co-Ordinates of Granites

Sample No.	Description/ Lithological Name	Nature of Outcrop	Locality	Co-ordinates	
				Elvtn.	Long/Lat.
FTNE 56	Porphyritic Granite	Bouldery Inserlberg	Zari Tudu, 1km SW of Kakumi	1885ft	$11^0$48.547′N $7^0$16.929′E
FTNE 81	Porphyritic Granite	Bouldery Inserlberg	Dutse mai Zuma	1930ft	$11^0$49.467′N $7^0$16.818′E
FTNE 82	Porphyritic Granite	Bouldery Inserlberg	Near River Fetsa, at Mununu Site	1860ft	$11^0$50.230′N $7^0$16.580′E
FTNE 108	Porphyritic Granite	Bouldery Outerop	Dutse Mai Amarya Site	1826ft	$11^0$50.474′N $7^0$16.200′E
FTNE 137	Porphyritic Granite	Bouldery Outcrop	Near Na-Kadaddaba River	1812ft	$11^0$50.664′N $7^0$15.965′E
FTNE 128	Porphyritic Granite	Whaleback (occasional)	Baka-Zari Inselberg	1819ft	11^0 50.587′N 7^0 15.894′E
FTNE 111	Porphyritic Granite	Whaleback	1.5 km West of Dunfui Village	1849ft	$11^0$50.646′N 7^0 17.189′E
FTNE 141	Porphyritic Granite	Bouldery Outcrop	Granite close to Mabai	1897ft	11^0 50/290′N $7^0$17.680′E
FTNE 120	Porphyritic Granite	Bouldry Outcrop	Sheme Road, close to Kakumi	1886ft	11^0 50/313′N $7^0$18.357′E
FTNE 125	Porphyritic Granite	Bouldery Inserlberg	Along Kankara -Zango Road	1993ft	11^0 57.049′N 7^0 16.018′E
FTNE 2	Porphyritic Granite	Whaleback	1km after Zango Town	1889 ft	$11^0$54.92′N 7^0 16.34′E
FTNE 109	Porphyritic Granites		NW of Kankara Town	1831ft	$11^0$56.19′N$7^0$24.50
FTNE 136	Porphyritic Granites		At Malali Village	1828ft	$11^0$56.50′N $7^0$19.00′E
FTNE 149	Porphyritic Granites		500m NE of Malali	1836ft	$11^0$58.01′N $7^0$20.00′E
FTNE 47	Porphyritic Granites		Gidan Kare, 15k from Sheme	1889ft	$11^0$46.72′N $7^0$16.92′E
FTNE 35	Porphyritic Granites		At Gambo Karfi Village	1818ft	$11^0$47.50′N $7^0$29.52′E
FTNE 134	Porphyritic Granites		1km West of Unguwan-Nagunda	1830ft	$11^0$51.28′N $7^0$20.45′E
FTNE 65	Porphyritic Granites		Pauwa outcrop	1939ft	$11^0$58.20′N $7^0$18.10′E
FTNE 3	Porphyritic Granites		An Outcrop at Marake	1822ft	$11^0$59.10′N $7^0$23.50′E
FTNE 1	Porphyritic Granites		At Danmarabu	1821ft	$11^0$57.82′N $7^0$25.00′E

Geology of the study Area
Lithology, distribution and field relationship have shown that part of the Funtua north east is underlain by grey to pink colored granitoids, which occur as inselbergs and low lying whale-backs. The granitoids occur as massive fractured plutons irregular shapes, roughly occupying two belts in the NW-SW parts of the map area. The granites sharply intrude the metasediments and migmatite-gneiss unit, with the sharp contacts suggesting their younger age. There is a closecontact between the granites and the gneiss (Bowden & Kinnaird, 19 84; Kankara, 2014).

Physical relations (example, sharp contacts) show clearly that porphyritic biotite granites in the study area were emplaced as liquid melts, and that the fine-medium grained varieties are older than the porphyritic varieties. In addition to that, structural grain that dip in north-southdirection in the eastern neighbouring sheets has influenced the surfacing of phorphiritic granites.

Medium grained granites and coarse granites are found to occur, but due to their limited exposure they do not constitute mappable units (mostly in a locality west of Dunfui inselberg). Biotite granites outcrop the SW parts of Funtua NE, bounded by migmatite-gniesses (FTNE 107, 137, 128, 141, 111, 125, 2, 109, 136, 149) They extend to the upper northern end, at the northern part of Kankara town. They occupy about 25% of the total area. The outcrops form low ridges in some places, and are aligned in NE-SW and probably have gradational boundaries with the strongly lineated, pink-grey rocks with an even-grained texture coarser than in the other gneisses. It consists principally of quartz, biotite and feldspar minerals with minor accessories.

Thin Section
Plagioclase: The Plagioclases exhibit good polysynthetic normal Albite twinning with twin lamellae parallel to the elongated crystal dimension. Plate xxxiv shows an Albite twinning of Plagioclase feldspar.It is colorless, cloudy and the most abundant mineral in the Porphyritic Granite gneiss rocks in the study area. Potash feldspar is red colored. The plagioclase feldspars comprise of a series of minerals from sodium alumino-silicate to calcium alumino-silicate. The former is called albite, and oligoclase, andesine, labradorite, bytownite, and anorthite are minerals with increasing percentages of calcium. Anorthite is calcium alumino-silicate with the formula $5CaAl_2Si_2O_8$.

Feldspars are broad, dorminant variety of minerals which are composed of alumino-silicates of potassium, sodium, calcium,and sometimes or occasionally barium. In the rock, they occur as single crystals or as masses of crystals and form an important constituent of the porphyritic granites. They dorminate the other minerals. They belong to both the triclinic and monoclinic systems. They do not resemble each other in twining and crystal habit and by having cleavage surfaces inclined to each other at an angle of 90°. The clay and cleavage alterations can in most of the cases affect feldspar distribution in a rock. Polycrystallinequartz are therefore seen in this arrangement.

Orthoclase feldspar*:* This type of feldspar has a chemical formula: $10KAlSi_3O_8$. It is monoclinic and it is the most common of all minerals. It has acloudy or colorless appearance. It is often colorless crystal, and as grey, or reddish. The weathered feldspar represents the darker portion of the thin section. In plate number xxiii the dark portion represent an area where there is no cleavage, meaning that the thin section did not cut along or across. If it cut perpendicular to the mineral, it would have been light brown colored, as one other portion of the feldspar shows. This suggests that one mineral can exhibit more than one or two different colors (see plate ii).

Microcline: Microcline crystallizes in the triclinic system. It is identical with orthoclase-feldsparboth in chemical composition and in physical properties. It sometimes exists as an enormous single crystal mineral. Thin section examination shows large subhedral microperthitic microcline with good polysynthetic cross hatched twining. This is evident in (Plate iii). This Alkali feldspar occurs as turbid crystal with elongate crystals that exhibit sub-hedral habit. It is non-pleochroic with low relief and parallel extinction. It is characterized by interlocking merging especially when in contact with quartz (Plate iii).

Quartz: Quartz is very stable and even if fluid enters in it, it does tolerate it. Some stable minerals such as quartz cannot be used to monitor alteration. In most of the cases quartz occurs as polycrystalline quartz, meaning that the rock has suffered stress. Quartz is not distinguished from feldspar in plate Platev under plane polars, they both occur as colorless, cloudy but when they were viewed under cross polars quartz is very visible as capability (Plate iii**)** was added to the microscope because it is a modified view. Quartz normally occurs as groundmass in feldspar. In some localities, like microphotographs of plate xxvii coarse grained quartz occur at extinction position. It also occurs as whitish coarse grained mineral with twinning characteristic. Quartz occurs as colorless crystal with mostly anhedral habit. Crystals of quartz exhibit low relief and sometimes exhibiting undulose extinction. Most of the crystals are polycrystalline exhibiting evidence of the effect of stress during the formation of the rock. The quartz crystals show no evidence of alteration and is mostly found interlocked with feldspars. The whitish area of granites under cross polarize indicates either quartz or feldspar.

Biotite: The more wider and brownish mica here is Biotite and has one directional cleavage. Pleochroic tabular Biotite plates from brown to reddish-brown can define the foliation trend of the rock. Plate xxiv shows Biotite exhibit different pleochroic orientations. In some thin sections they can occur as linear aggregates with alteration to chlorites. Iron oxides taking place along the perfect cleavage plates forming green ragged flakes often associated with disoriented needle-like inclusions probably of unaltered biotite. For example, biotite and Hornblende are both brown colored. Biotite is specifically brown colored under cross polarize. Biotite is not necessary in granites but may be there. All amphiboles have two directional cleavages. Extreme weathering leads to alteration. Incipient (hidden) alteration means you can't see it unless under microscope. In fact all rocks have their monitors.

Zircon is generally rounded in shape and occurs as minute patches of mineral. Zircon is radioactive, and in the thin section of plate number Plate xxvii act as pleochroic halloe. It therefore destroys the crystalline structures of the Biotite and feldspars in plate xxvii**.** It however occurs as a trace element.

Myrmekite: There is an intergrowth of myrmekite mineral in between quartz and feldspar (Platei**)** with a vermicular texture which is clearly seen in this cross polars. Because the quartz and feldspar have the same refractive index, the intergrowth is not visible. The alkali feldspar has a microperthitic texture with some oriented inclusions.

Apatite: Another element of traceability is Apatite that occurs as colorless, small hexagonal cloudy mineral at extinction position stand out in high relief. In Plate iv it can be shown that the birefringence of Apatite is almost the same with that of plagioclase that exhibit a twinning habit.

Muscovite: Muscovite minerals are trace elements in Porphyritic granite gneiss. They are medium grained and occur at extinction position with high relief. Many of the crystals show twinning and those near to the extinction position show the mottled appearance which is characteristics of all micas. Muscovite is yellowish under cross polars and exhibit parallel extinction and perfect cleavage in one direction.

Textures: As indicated by Hanson (1978) and Kankara (2014) porphyritic granites are characterized by superimposed textures. The feldspars forms larger penocrysts. Quartz forms porphyritic polygonal texture. Muscovite forms a plannar foliation on the feldspar groundmass while Biotite is foliated in bands with pleochroism. Feldsparsusually has a hardness of 6.5 to 7.0 and a specific gravity ranging from 2.8 to 3.3. Vitreous luster is their common physical feature. They vary in color from colorless to pinkish, yellowish orish green. Feldspars weather or degrade readily to form kaolin.

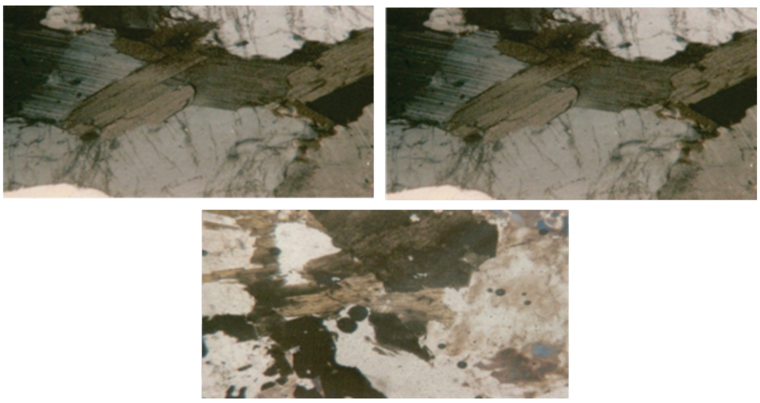

Plate ii: Microphotograph of porphyritic granite under plane polars showing biotite exhibiting different pleochroic orientations, and plate Plate ii: Microphotograph of porphyritic granite showing highly weathered feldspar almost turning into clay. Magnificent=30x

Plate iii: Microphotograph of porphyritic granite showing the whitish area as the quartz (Q), the Biotite in the dark brown portion and a minor portion of Alkali feldspar (AF) under plane polars.

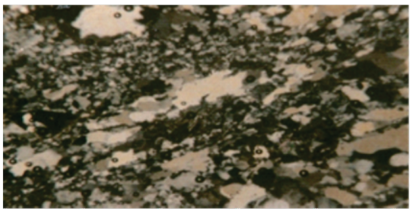 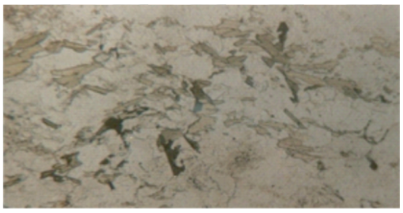

Plate iv: Microphotograph of porphyritic granite showing feldspar that has been weathered into clay. There are also apatite, microcline or Alkali feldspar and a lot of air bubbles under cross polars. Magnificent=30x Plate v: Microphotograph of granite showing parallel alignment of muscovite minerals. Most of them tend to be intestitials. The most abundant mineral present is feldspar. Magnificent=30x

Conclusion

Feldspar in plate **i** here has clay alterations and cleavages. Quartz is absent, although in most of the cases cannot be distinguished from feldspar. Quartz is therefore not polychrystalline. Zircon which is radioactive act as pleochroic haloe that also destroys the chrystalline structure of the biotite. The dark portion in plate iii represent an area where there is no cleavage, the thin section did not cut along or across. Magnificent= 30xThere are a lot of air bubbles in plate **xxviii** and the greener portion of the feldspar suggests that it is thicker than the usual 0.03mm or 30 microns and this makes it to appear with interference colors. As can be identified, albite and potassium feldspar are independent.

References

Bowden, P. & Kinnaird J. A. (1984). Petrologic and geochemical criteria for the identification of (potential) ore-bearing Nigerian granitoids proc. *International Geological Congress Moscow.*

Cox, K. G., Bell, J. D. & Punkhurst, R. J. (1979). *The Interpretation of Igneous Rocks*. London: George Allen and Unwin.

Dada, S. (2006). Proterozoic evolution of Nigeria. In: Oshi O (ed) *The Basement complex of Nigeria and its mineral resources* (A tribute to Prof. M. O. A. Rahman). Ibadan: Akin Jinad & Co.

Ezepue, M. C. (1992). Petrology and petrochemistry of igneous sill in Ishiagu Lead-Zinc Sulphide District, Eastern Nigeria. Journal of Min. Geol., *28*(2), 45-351.

Hanson, G. N. (1978). The application of trace elements to the petrogenesis of igneous rocks of granitic composition. *Earth Planet. Science Lett, 38*, 26-43.

Kankara, I. A. (2014). *Geochemical characterization of rocks in funtua NE, sheet 78, scale 1:50,000 NW Nigeria*. An Unpublished PhD Thesis, Dept. of Geology, Federal University of Technology, Minna.

Kankara, I. A. (2002). *Solid minerals development In Katsina State: Prospects and Constraints.* An Unpublished M.Sc Thesis BUK, Kano, 36-41.