

GEOLOGY AND ENVIRONMENTAL IMPACT ASSESSMENT AND BENEFIT OF GRANITIC ROCKS OF MINNA AREA, NORTHWESTERN NIGERIA.

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DOI: <http://dx.doi.org/10.4314/ejesm.v4i4.5>

Received November 23rd 2011; accepted December 5th 2011

Abstract

Nigeria basement complex has shown that the older granites are high level intrusions emplaced by stoping and diapiric process and include spectrum of rocks varying in composition from tonalite through granodiorite to granite. The intense regional deformation which accompanied and preceded the emplacement of the older granite result in it pronounced and wide spread northeast trend. The granites termed older granites in Nigeria have been dated severally at 500-750 million years. Minna is situated in the central part of the Nigeria basement complex surrounded by rugged terrain of granitic rocks, this necessitates the geological and impact assessment of the granitic rock in Minna. Field study reveals eight granitic masses which occur as Paiko and Minna batholiths and as continuous ridge in north-south direction of about 18 kms and average height of 350 meters above sea level. In hand specimen, the granitic rocks vary from medium, porphyritic to coarse variety from light colored to medium dark colored.

Key Words: *Geology, Environmental impact, Assessment, Benefit and Granitic Rocks.*

Introduction

The Older Granite of Nigeria includes a wide spectrum of rocks varying in composition from tonalite through granodiorite to granite, syenite and charnockite rocks (Trustwell *et. al*, 1963). The granitoids have been emplaced into both the migmatite-gneiss complex and the schist belts, and they occur in all parts of Nigeria (Ajibade, 1982). Recent work in different parts of the Nigerian basement complex has shown that the older granites are high level intrusions emplaced by stoping and diapiric process (Fitches *et. al*, 1985). The marked generally north-south linear aggregation of many of the large batholiths of the basement suggests that they may be related to deep-seated pre-existing plutonic episode controlled by major deep mantle structure (Ogezi, 1977a). The intense regional deformation which accompanied and preceded the emplacement of the older granite resulted in the pronounced and wide spread of N-S trend. The granites termed the older granites in Nigeria have been dated severally at 500-750 ma (Van Breem *et. al* 1977, Rahaman *et. al*, 1983 and Kroner 1998).

Granitic magma is commonly associated with several tectonic stages during evolution, and their structure, texture, and mineralogy composition can be of benefit and environmental impact (Pearce *et.al*. 1984, Pitcher 1983, 1989, Whalen *et al* 1987, Frost *et. al*, 1999).

Minna is situated in the central part of Nigeria basement complex, surrounded by rugged terrain of granitic rocks. There is need to examine the origin, attributes and benefits of these rocks in the area.

Methodology

Study Area

Minna is located between longitude 6^o25'E and 6^o45'E and latitude 9^o24'N and 9^o48'N, it occupy the central portion of the Nigerian basement complex. The Minna area comprises of metasedimentary and meta-igneous rocks which have undergone polyphase deformation and metamorphism. These rocks have been intruded by granitic rocks of Pan-African age.

Five lithostratigraphic units have been recognized in Minna area (Fig. 1). The schist which occur as a flat laying narrow southwest-northeast belt at the central part of Minna with small quartzite ridge parallel to it, the gneiss occur as a small suites at the northern and southern part of the area forming a contact with the granite. Feldspathic rich pegmatite is bounded to the east, with average width of 65meters and 100 meters long, the pegmatite host tourmaline. Granitic rocks dominate the rock types in the area and vary in texture and composition. Detailed geological mapping of the area was carried out on a map scale 1: 25,000 using geological compass clinometers, hammer and GPS. The mapping exercise involved description,

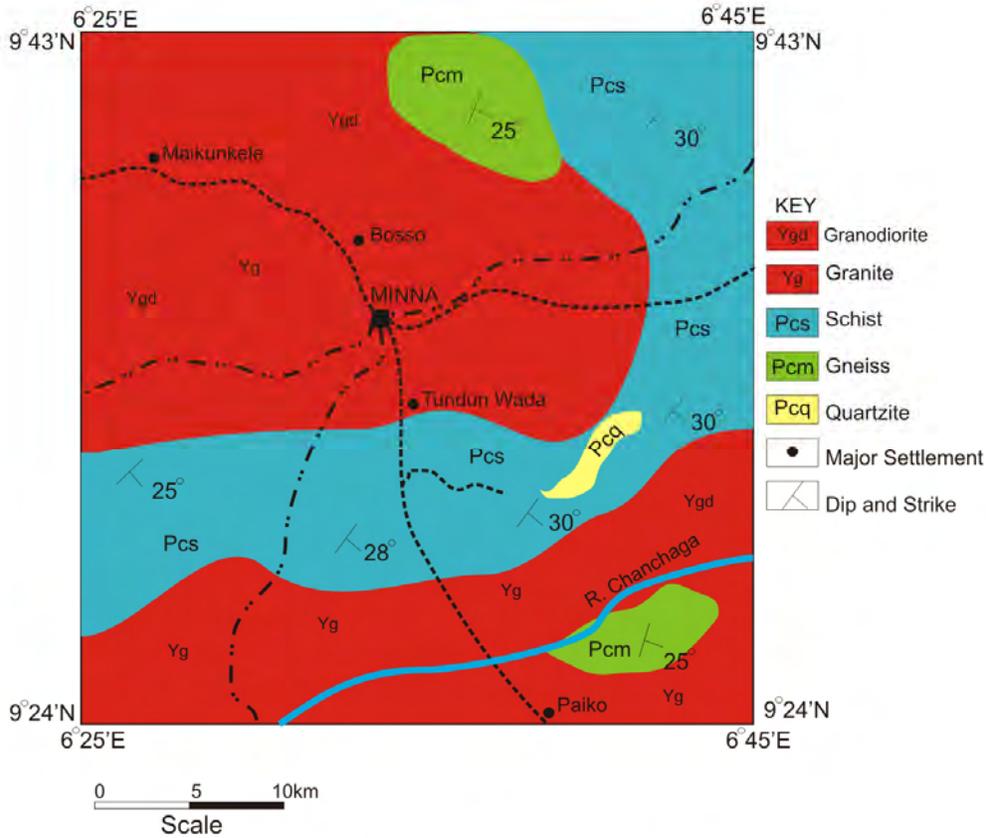


FIG 1: GEOLOGICAL MAP OF MINNA AREA

measurement and sampling of the outcrops. Fresh samples of outcrops were collected from different locations and were studied in hand specimen. Meso-structures and the attributes of the outcrops were measured and described in the field.

The rock thin sections were prepared in the Geology Department Federal University of Technology, Minna. Four fresh rock samples were cut into thin section using rock cutting and lapping machine. The thin sections were studied under plane and cross polarized light microscope and photomicrographs of the samples were produced. The optical properties of the minerals present in the thin section of each sample were used to determine the relative abundance of major, minor and accessory minerals.

Results

In the field eight large granitic masses occur as batholiths and continuous uninterrupted ridge in north-east direction of about 18km long, average width of 1.5km and an average height of 35 meters above sea level. Five striking features of the older granite occur as batholiths, that is prominent rising sharply above their surrounding plains, such

granitic batholiths occur as Paiko and Minna batholiths. The Paiko batholith is almost circular with a maximum diameter of 2000m and 430m high. Other outcrops are flat lying. In the field, meso-structures of non-penetrating cross joints and faults of which most are quartz filled was examined in most of the outcrops, the quartz vein is usually between 1cm – 35cm wide.

Foliation is present near the top of the north granitic ridge. Exfoliation is common on the outcrops. In hand specimen, the granitic rocks vary from medium, porphyritic to coarse variety and ranges from light colored to medium dark colored.

The porphyritic granite contains phenocryst of plagioclase in ground mass of quartz, muscovite, orthoclase and minor hornblend. Muscovite acquired elongated structure probably as a result of shearing. Plagioclase granular structure is as a result of slow cooling during the formation of the rock. Under plane polarize light, quartz, plagioclase, orthoclase and muscovite are colorless, while under cross polar quartz color vary from grey to cream, plagioclase yellow, hornblend blue, orthoclase white and muscovite green. These colors

are at extinct at rotation angles of 45° , 30° , 15° and 90° respectively (Figure 1a,1b. 2a,2b.3a,3b). The microcline and biotite composition in granodiorite is responsible for the dark color. In all the granites, twinning axis is normal to the compositional plane in plagioclase and inversion twinning in plagioclase.

Visual relative proportions of the minerals present in the thin section show considerable variation (plate 1, 2 & 3). Thus quartz varies between 23 and 30 percent, orthoclase between 17 and 24 percent, plagioclase between 37-52 percent, biotite between 04-13 percent, muscovite and hornblende are about 2 percent. Accessory minerals are present in small amount (Table 1, 2 & 3)

Discussion

Mineralogical composition of analyzed granitic rock samples, indicate variation grading from granodiorite to granite which represents separate intrusions. It seems that the granite was intruded as a granodiorite and latter metasomatism of which the bulk composition of the rock was transformed to granite. The diapiric nature of the magma that crystallized to form granite, results in the high level rugged batholiths and ridges in the study area. Mineralogy composition comparison of Minna granite and granodiorite with adjacent Madaka granite and Tegina granodiorite show similarity in mineralogical composition(Table 4 and 5). This indicates similarity in their mode of formation.

The granitic ridge is elongated parallel to the regional structural trend, the ridge and the batholiths are poorly vegetated and hence expose their area surface. The inhabitant of Minna area take advantage of the thin overburden which ranges from few meters to about 3 meters (Unuevho, 2009) for foundation construction, most of the houses are built on and along the ridge and the heat radiation from the ridge and batholiths are responsible for the local increase in temperature of the area, the steep nature of the ridge and batholiths promote run-off that causes flooding during the rainy season. The striking features of these outcrops occupy about 35 percent of the northeast, therefore restricts land use and urban development to the southwest. The non-penetrating cross joints and fairly weathered nature of the flat lying outcrop make it a poor aquifer and hence there is 85 percent failed boreholes in the area. Due to the availability and properties of the granitic outcrops, there are quarries in north and

northeast which is the source of rock aggregates and powder for constructions.

The dominant rock types in the area are of monotonous pattern of medium to coarse grained granodiorite and granite. Their orogenic evolution is of two generations, the early formed granodiorite and late formed high level granite. The striking features of the Minna granitic rocks and its geological structure is of less benefit but rather of great impact to the inhabitant of the area.

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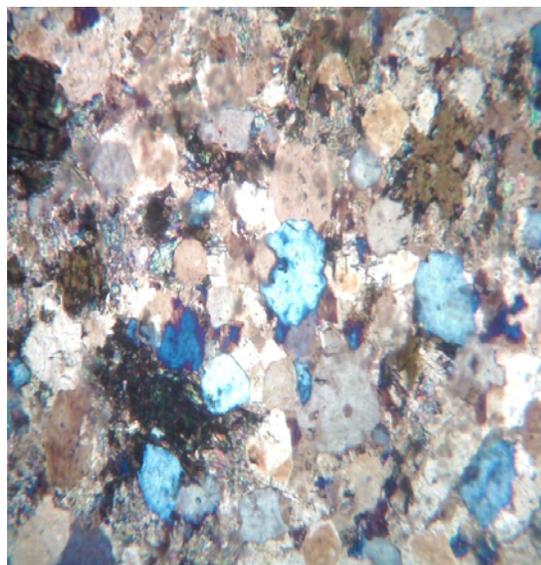
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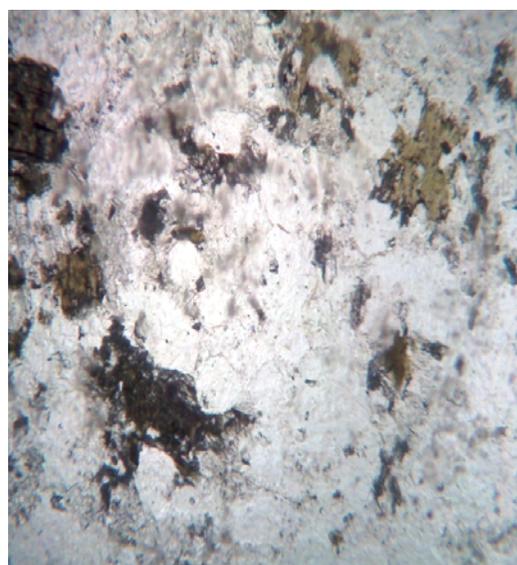
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Plate 1 Photomicrograph of granite (a) under crossed polar and (b) under plane polar (Mg.10X)



(a)

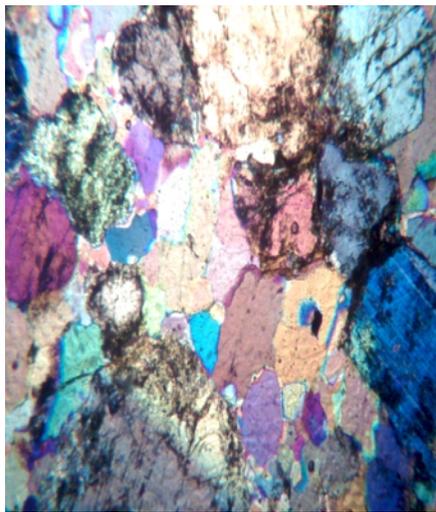


(b)

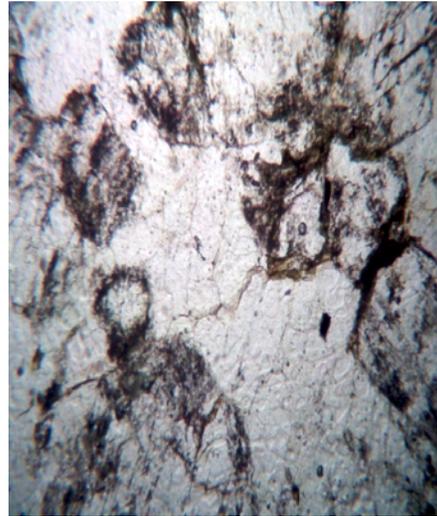
Table 1: Mineral optical properties and visual estimation in percentage of Plates 1a and 1b

Mineral	Colour in PPL	Colour in XP	Extinction angle	Diagnostic feature	Twinning	% in Thin Section	Rock name
Quartz (SiO ₂)	Colourless	grey to cream	Parallel	Irregular with no cleavage	Absent	30%	Porphyritic Granite
Plagioclase (NaAlSi ₃ O ₈ – CaAl ₂ Si ₂ O ₈)	Colourless	yellow	About 45 ⁰	Granulose structure	Multiple	15%	
Hornblende	Brown	Blue	30 ⁰	Show pleochroism	Simple	5%	
Orthoclase (KNaAlSi ₃ O ₈)	Colourless	White	About 15 ⁰	Interlocking	Cross – Hatch	40%	
Muscovite	Colourless	Green	Parallel	Elongated structure with wavy colour	Absent	10%	

Plate 2 Photomicrograph of granodiorite (a) under crossed polar and (b) under plane polar (Mg.10X)



(a)



(b)

Table 2: Mineral optical properties and visual estimation in percentage of Plate 2 a and 2b

Mineral	Colour in PPL	Colour in XP	Extinction angle	Diagnostic feature	Twinning	% in Thin Section	Rock name
Quartz (SiO ₂)	Colourless	First order white to grey to cream	Parallel	Lack of cleavage and alteration, irregular grains	None	25%	Granodiorite.
Plagioclase (NaAlSi ₃ O ₈ – CaAl ₂ Si ₂ O ₈)	Colourless	light yellow	40 ⁰ – 45 ⁰	Multiple twinning	Multiple twins	35%	
Hornblende	Green – blue	Ink blue – black	30 ⁰ to long cleavage	Poikilitic plates rather than euhedral crystals	Simple	20%	
K – Feldspar (Microcline)	Colourless	Light blue	Oblique	Cross-Hatch twinning	Cross - Hatch	10%	
Muscovite	Colourless	High second order bright pink & green	Parallel	Perfect cleavage high polarization colours	None	5%	
Biotite	Brown	High second order bright pink	Straight to 0 (parallel)	Perfect cleavage high polarization colours	None	5%	

Plate 3 Photomicrograph of granite (a) under crossed polar and (b) under plane polar (Mg.10X)

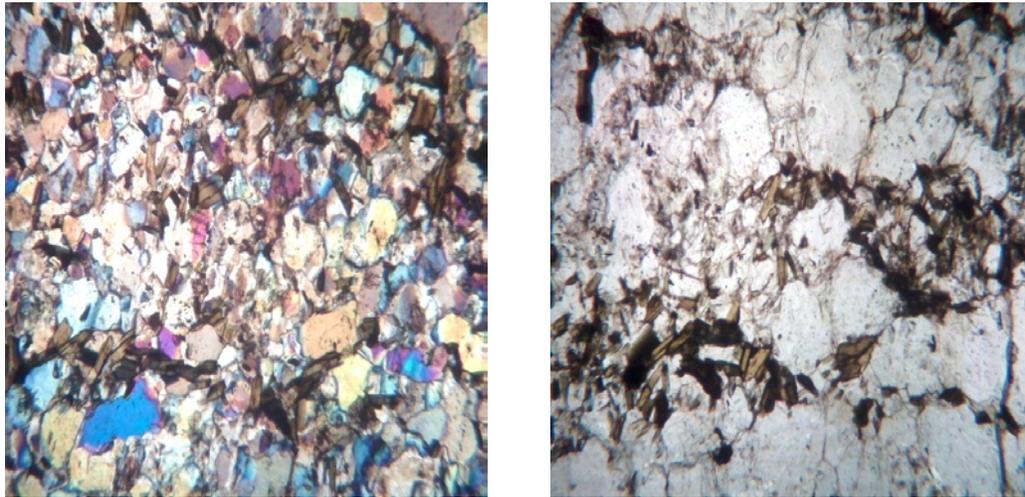


Table 3 : Mineral optical properties and visual estimation in percentage of Plate 3a and 3b

Mineral	Colour in PPL	Colour in XP	Extinction angle	Diagnostic feature	Twinning	% in Thin Section	Rock name
Quartz (SiO ₂)	Colourless	grey to cream	Parallel	Irregular with no cleavage	Absent	30%	Medium Grained Granite
Plagioclase (NaAlSi ₃ O ₈ – CaAl ₂ Si ₂ O ₈)	Colourless	yellow	About 45 ⁰	Granulose structure	Multiple	15%	
Hornblende	Brown	Blue	30 ⁰	Show pleochroism	Simple	5%	
Microcline	Colourless	White	About 15 ⁰	Interlocking	Cross - Hatch	40%	
Biotite	Brown	Red	Parallel	Elongated structure with wavy colour	Absent	10%	

Table 4: Mineralogical comparison of the Tegna granite with Minna granite

Mineral	×Madaka %	Minna %
Quartz	33	25
Plagioclase	43	35
Microcline	07	10
Biotite	11	8
Muscovite	-	2

×Madaka granite(Trsuwell *et. al*, 1963).

Table 5: Mineralogical comparison of the Tegna granodiorite with Minna granodiorite

Mineral	×Tegna %	Minna %
Quartz	28	30
Plagioclase	25	15
Microcline	36	40
Biotite	6	10
Hornblend	-	5

×Tegna granodiorite (Trsuwell *et. al*, 1963).