Research Article

ISSN 2766-2624

Advances in Earth and Environmental Science

Lithologic Relationship and Petrographic Features of Crystalline Rocks in Babanla Area, Egbe-Isanlu Schist Belt, Southwestern Nigeria

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Submitted : 25 Apr 2025 ; Published : 14 Jun 2025

Citation: OlaOlorun, A. O. et al. (2025). Lithologic Relationship and Petrographic Features of Crystalline Rocks in Babanla Area, Egbe-Isanlu Schist Belt, Southwestern Nigeria. *Adv Earth & Env Sci; 6*(3):1-11. DOI : https://doi.org/10.47485/2766-2624.1070

Abstract

Crystalline rocks form a major part of the basement complex of Nigeria, and Babanla area in Egbe-Isanlu schist belt is not an exception. These rock units are investigated for lithological characteristics and petrographic features that may be related to geodynamic setting of the area. Systematic geological mapping reveals the area is underlain by banded gneiss, granite gneiss, quartzite (quartz schist), marble, talcose rock (talc schist), epidiorite, coarse-grained granite and pegmatite. Field investigation also reveals the gneissic units are low-lying and Babanla area sits on Precambrian pegmatite occurring as dykes, veins and discordant bodies within the host gneissic rocks. The structural framework of Babanla area is dominated by discontinuities including faults, joints and fractures with widespread deformations characterized by mesmerizing folds and veining. Petrographic analysis of the crystalline rocks indicates the units contain varying amounts of common rock-forming minerals which include quartz, orthoclase, plagioclase, muscovite, biotite, hornblende and subordinate opaque minerals. The percentage mineralogical composition as revealed in thin section based on visual estimation and point counting indicates the rocks are mineralogically similar to those in other areas of the basement complex. These lithologies, which are mainly metamorphic and igneous are common and have predictable mineralogy but are unique in their respective localities as contributing to the understanding of the geodynamic evolution of the basement complex of south western Nigeria.

Keywords: Babanla, Egbe-Isanlu schist belt, lithological characteristics, petrographic, discontinuities, geodynamic evolution.

Introduction

The schist belts in Nigeria have been fascinating for reasons ranging from their controversial origin, variable lithologic associations, heterogenous structural features, tectonic implications, petrogenetic affiliations, and gold mineralization. However, despite these belts being popular, research on Babanla and its adjourning localities in Egbe-Isanlu schist belt has scanty representation in literature. Thus, this work is precipitated by scantiness of geological information about the area, it emphasizes the petrology, lithologic relationship and mineralogical composition of the Babanla area. The study area is underlain by basement complex rocks and such include lithologic units that is common to other basement complex terrains in Nigeria and by extension, those in other parts of the world. Insufficient geological information about the area and the relevance of its lithology on geodynamic setting and tectonic interpretation of the terrain, and to a larger extent, the basement complex of Nigeria is among reasons for undertaking this research.

The Study Area

Babanla, which is about 50 km from Ilorin, the State Capital, is located on Lafiagi Sheet 224 NW and falls within the Ifelodun Local Government Area of Kwara State. The area is delineated by Longitude 4° 36′ 00″ E to 4° 39′ 00″ E and Latitude 7° 30′ 00 ″ N to 7° 34′ 00″ N and covers an area of approximately 215km^2. Accessibility to the study area is provided by numerous tarred and untarred roads, foot paths and cattle routes. The study area lies in a transition zone between tropical rain forest characterized by lush vegetal signature with few emergent tall trees and extensive open Guinea savannah-type vegetation dominated by tall grasses. The area is unique for its exceptional geomorphological attributes having gently rolled hills with fast-flowing rivers that punctuated the landscape.

Geological Setting

Regional Geology

Nigeria is situated within the Pan-African mobile belt; specifically, it lies on eastern side of the West-African Craton, southern segment of the Tuareg shield and northwestern part of the Congo craton (Fig. 1). Nigeria landmass is almost equally shared by crystalline rocks and sedimentary sequences. The former (popularly called the basement complex or the Nigerian shield) is dominantly Precambrian. The basement complex is extensive in north-central and southwestern Nigeria with only a small area of the basement exposed in southeast Nigeria. In north-central area around Jos Plateau, the basement complex is intruded by anorogenic granite of Jurassic age, and in northeastern part by Tertiary volcanic rocks. Generally, the basement complex is polycyclic and bear imprints of Liberian (2700 ± 200 Ma), Eburnean (2000 ± 200 Ma), Kibaran (1100 ± 200 Ma), and Pan-African (600 ± 150 Ma) orogeny. Authors Ajibade et al. (1979); Garba, (2003) believed the basement complex was formed by continental collision of two massive blocks (the passive continental margin of West African Craton and the active margin of Pharusian belt (Tuareg shield) around 600 Ma. Odeyemi et al. (1999) believed all structural features of crystalline rocks in southwestern Nigeria are tectonic in origin stressing that pre-existing primary structures are grossly overprinted by-subsequent deformations. The basement is divided into two contrasting provinces viz: the Western and the Eastern Province (Ferré et al., 1998). The Western Province is characterized by an Archean basement comprising tonalite-trondhjemite-granodiorite (TTG) type orthogneisses and amphibolite (Rahaman, 1988) with gold metallogeny (Woakes et al., 1987). The amphibolite display greenstone affinities and encapsulated within schist belts with greenschist to amphibolite facies metamorphism. The Eastern Province is a high-grade metamorphic domain (Onyeagocha & Ekwueme, 1990; Ferré et al., 1998) with pervasive migmatisation and granite plutonism (Ferré et al., 1996) and a tin metallogeny. The boundary between these two provinces is marked by a major lineament recognized only on Landsat image (Ferré et al., 1998). The Nigerian basement consists of five major rock types, these are migmatite-gneiss-quartzite complex, the Schists belts, Pan-African granites, calc-alkaline volcanics (exemplified by tuffs, rhyolite and rhyodacite), and hypabyssal rocks (dolerite, basic and syenite dykes). The Cretaceous-Resent sediments which occur within the major Nigeria sedimentary basins overly the basement with pronounced unconformity.

Local Geology

Babanla area is located within the basement complex of southwestern Nigeria, the major rock units as revealed during systematic geological mapping include assortment of gneisses (banded gneiss, granite gneiss), quartzite, marble, talc schist, epidiorite, coarse-grained granite and pegmatite (Fig. 2). In many parts of the study area, the lithologic contacts are obscured in critical places by soil and the boundaries are inferred.

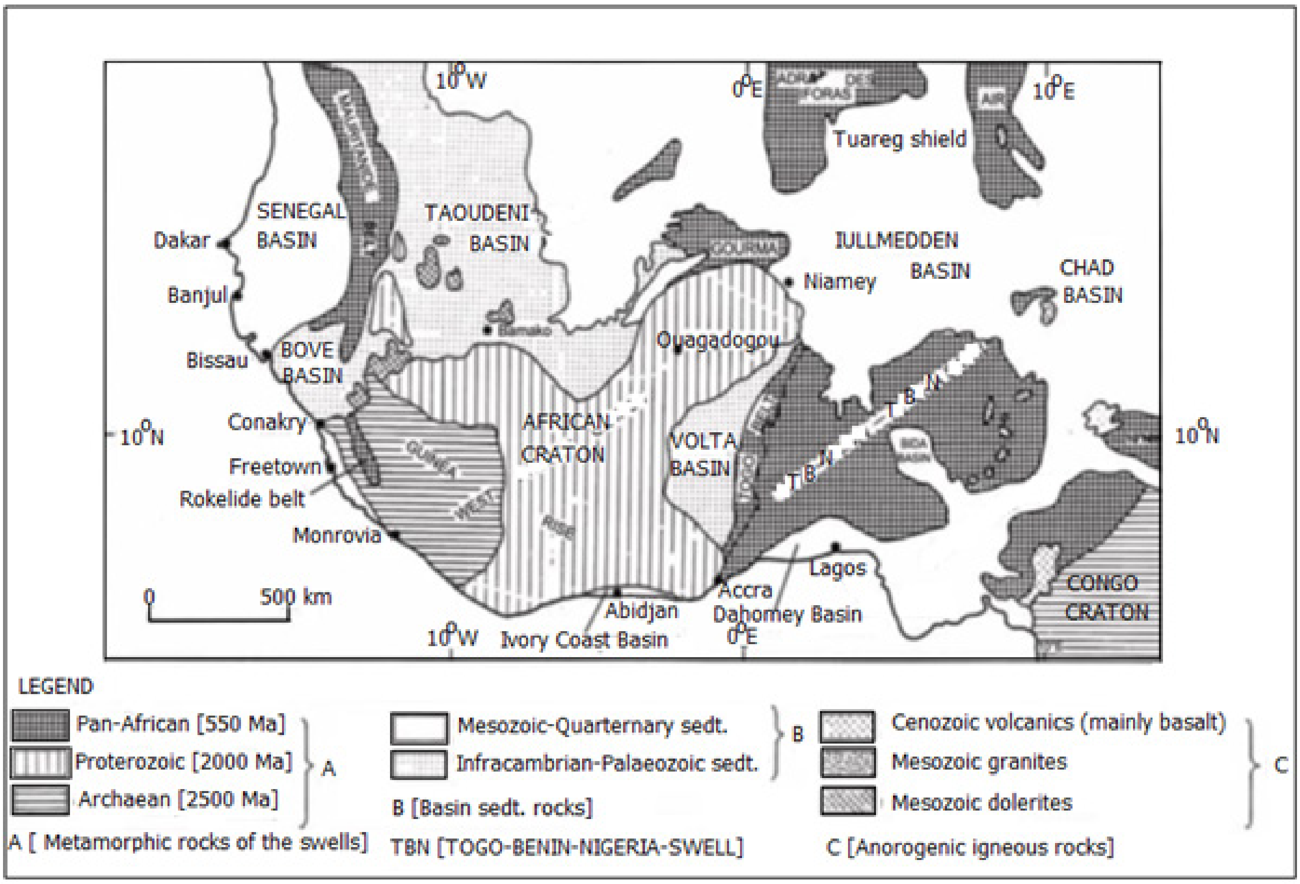

Figure 1: Generalized Geological map of Nigeria within the framework of the geology of West –Africa. (Modified after Wright, 1985).

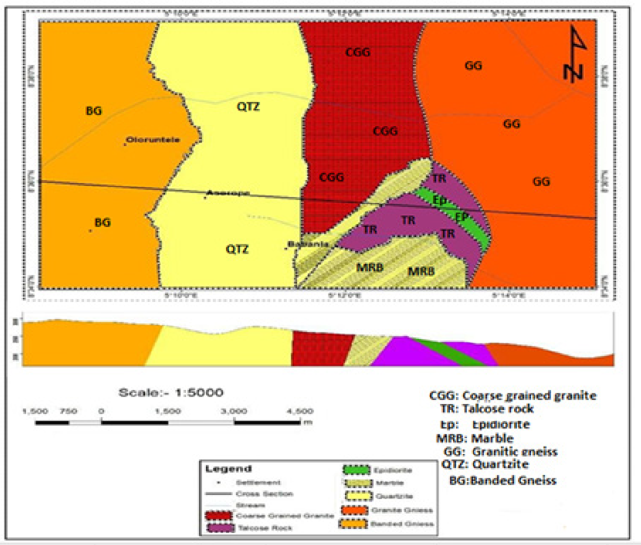

Figure 2: Geological map of the Babanla area.

Materials and Methods

Two methodological approaches were adopted in the research, these are

1. Field techniques,
2. Laboratory techniques.

Field Techniques

Reconnaissance and detailed field studies were carried out at the site. These include observing the field relationship of rock units and giving close attention to observable structures, mineralogy and textures. After observing outcropping exposures, hand specimen samples from quarry pit provided a good basis for sample selection using their mineral constituent, texture, and structures. Fresh samples were collected for thin section and geochemical analysis. Rock sampling was done randomly. Various geological tools were utilized in the field mapping, these include field notebook, sample bags, sledgehammer, chisel, a pair of boots, masking tape, pencil, compass clinometer, and global positioning system (GPS).

Sledge Hammer: was used to break rock samples to achieve an average size of the fresh part. Masking tape and a marker were used for labelling rock samples, to prevent any mix-up.

Compass Clinometer: The compass-clinometer was used for taking measurements of strike and dip, bearing of a target or an object, amount of plunge and azimuth of folds on different outcrops. It was also used for measuring the direction at which an outcrop or the lineation of an outcrop trends.

Topographic Map: Different topographic maps were used during the course of the field exercise, depending on the area to be visited, tracing paper was placed on the topographic map in other locate and plot the precise point of the outcrop's strike and dip of the foliation plane, fault plane or fault lines, dyke (xenolithic dyke) were plotted on the tracing paper, the major roads, newly constructed roads, footpaths, river channels, name of localities etc. were also indicated in other to produce a geological map of the study area.

G.P.S (Global positioning system): The G.P.S was used during the field mapping exercise to determine precisely the coordinates of outcrops with respect to their latitude and longitude, it is often used to determine elevation above the mean sea level.

Hand Lens: it was used for close observation of the minerals within the rock specimen, this is particularly useful when dealing with very fine-grained rock.

Measuring Tape: This was used to measure to a certain degree of accuracy the distance between points, or thickness and length of quartz veins.

Field Note: It is used for recording every important observation from one outcrop to another.

Field Vehicle: It was used as means of transportation, also, to convey rock samples over a long-distance traverse to its final laboratory destination.

Sample Bag: It was used for carrying the collected rock specimen from the field to where they will be subjected to further analytical procedures.

Digital Camera: It was used for taking photographs of important structural features on the outcrop.

Cutlass: it was used for cutting and clearing of bushes that are obstructing the free access to outcrop. It is useful for creating traverses to outcrops.

Laboratory Techniques

Laboratory work involves the preparation of thin section from the rock samples that were taken during the field sampling. Thin section was examined with the help of petrological microscope by deciphering them in photomicrographs to ascertain mineral compositions of the different rock samples. Thin sections are important because they provide sectional samples of the rock that are not only effective for rapid identification of the common minerals present but are also particularly adapted for the study of their spatial relations between grain size, texture and microscopic structures. The laboratory equipment used includes: Petrological microscope, Logitec cutting machine,

Petrological Microscope: It is used for identifying minerals in the rock slides (thin sections).

Logitech Cutting and Lapping Machine: It is used for cutting the rock samples perpendicular to the orientation or alignment of a mineral.

Abrasive Powder (Carborundum): This is used as abrasive during lapping of the samples, it ensures a smooth surface during slide grinding.

Glass Slides: it is used for mounting the sample on the petrographic microscope for observation

Laboratory Thermostat: It is used for heating the fresh slides till it dries up, it ensures no water is trapped within the slide.

Results and Interpretation

Lithological Relationship

Banded gneiss

The rock occupies western part of the study area and account for about one-fifth of the landmass. It occurs as low-lying outcrops which is common among the major river channel. The gneiss contains two main components, the first is leucocratic, which is rich in quartzo-feldspartic aggregates (quartz and feldspar) which represents the leucosome, the other part is rich in mafic minerals (hornblende and biotite) which represents the melanosome. The compositional banding develops from interlayering of felsic and mafic components. This distinctive lit-par-lit structure is diagnostic. The texture is fine to medium. The field photograph (Fig. 3) of the rock reveals that apart from the texture which appears unique, the structures in the rock include veining where several quartz veins are haphazardly oriented in the rock. Other secondary structures including joints, folds and fracture are prevalent.

Figure 3: Field photograph of Banded gneiss in Babanla area taken in its in-situ.

Granite Gneiss

Granite gneiss is a metamorphic rock that is presumably formed from granite under intense heat and pressure. The unit occupies eastern part of the study area (Fig. 4). The low-lying outcrops occupy the lowland and vegetated part of the study area. The rock unit makes a contact with coarse-grained granite in the west and talc schist in the study area. Even though, granite gneiss is quite distinctive (for not showing conspicuous segregation of the felsic and mafic components into bands); yet it is morphologically similar to banded gneiss in the outlook of the major outcrops particularly on their sizes and altitude.

In hand specimen, the mineralogy of the unit is mainly quartz, feldspar, and mica (biotite and muscovite). The rock is remarkably fine-grained. Several quartz veins crisscross the numerous outcrops. Few massive outcrops are impressive as some reach 120 m above mean sea level. The spectacular attribute of the unit is that granite gneiss in Babanla area is felsic with a diagnostic grey colour with scanty biotite. In places, the K-feldspar appear porphyroblastic showing remnant feldspar phenocrysts of the precursor granitic rock. Granite gneiss in Babanla area show intense folding in places indicating polycyclic metamorphic history like the migmatite-gneiss complex they are closely associated with. One of the several outcrops show quartz vein intrusions that has suffered different deformation episodes (Fig. 4).

Figure 4: A low-lying outcrop of Granite gneiss in Babanla area showing deformed quartz veins.

Quartzite

Environment characterized by abundance of quartz rubbles and platforms that stands out above its surroundings is indicative of quartzite. In the study area, quartzite occurs mostly as ridges, a specific example occurs where mine workings and human activities has exposed the unit around Aseropa town around the middle of the study area. Here, the center occupies a north-south trending segment bounded in the west by banded gneiss and in the east by coarse-grained granite. Babanla town is situated on extensive quartzite ridge which is massive and fractured. The unit makes contact with marble deposit located towards the east. A segment of the unit grades into quartz schist with muscovite forming subordinate mineral. Quartzite existing in north eastern part of the study area have sharp contacts with granitic gneiss. Babanla quartzite is strongly folded and forms a complex topographic entity. Quartzite is a competent rock unit that is often folded. This rock defines the magnitude of deformation, the history and direction of shear. The fold and foliation are N-S trending with prominent axial plane surfaces that dips towards the west. Quartzite in the study area is of two types – massive and schistose quartzites (Fig. 5). The schistose quartzite in Babanla area occurs predominantly as quartz grains with intercalations of muscovite forming quartz schists in the west. The intercalation is more frequent in the eastern part of the area. The composition of the quartzite is essentially almost interlocking quartz with grains ranging from coarse to fine.

Figure 5: Schistose quartzite from the study area exhibiting numerous joints.

Marble

The marble deposit in the study area is a low-lying hummocky physiographic entity. It is overlain by thin layer of gritty sand (Fig. 6). The marble is white to grey in colour and the texture is medium to fine-grained. Part of the marble deposit is exposed in a mine working located in the vicinity of Babanla town. Detailed information about the marble has not been ascertained, however, the physico-chemical and industrial application of the marble been investigated in a recent work (Ogunleye, 2023). Marble is universally known to be a metamorphic product of limestone. The marble deposit occurs at a shallow depth ranging between 1 to 3 m and was covered by a thin veneer of top soil. Marginal facies in the marble contain evidence of deformation. The marble deposit occurs towards south-eastern quadrant of Osi Sheet 224. The white marble is medium-grained and more extensive while the grey variety occurs in the central segment of the study area. Further south, the marble is exposed (Fig. 7) in an open mine working where the marble is covered by deep-brown gritty ferruginous tropical soil.

Figure 6: An outcrop of Babanla marble deposit exposed beneath a gritty tropical soil.

Figure 7: An open pit mining site where the Babanla marble is exposed beneath ferruginous gritty tropical soil.

Talc Schist

Talc is formed when basic and ultrabasic rocks are altered by hydrothermal process (Hess, 1993; Hailey, 1974). These authors believed it is essentially a hydrous magnesium silicate with chemical formula $Mg_3Si_4O_{10}(OH)_2$. Talc belongs to a subclass of phyllosilicate in a larger group called clays. Usually, talc-bearing rocks are exclusively confined to the schist belts. In south western Nigeria. Four compositional varieties have been reported in Nigeria, namely: talc, tremolite, anthophyllite and chlorite types (Elueze & Akin-Ojo, 1993). Within these areas, talc occurs in notable localities like Iseyin area Durotoye and Ige (1991); Obaluru-Araromi Akin-Ojo (1992) Baba-Ode area Okunlola et al. (2012); Erin-Omu (Okunlola and Anikulapo, 2006); Oke-Ila Bolarinwa (2001) and Ijero-Ekiti Okunlola et al. (2011). The present occurrence (Babanla talc) reported first in this work is an addition to the list of talc occurrences within the south western Nigeria schist belts. Field mapping shows the rock occur towards southern part of Oreke town along Babanla-Olayinka Road where it is exposed. The marble is restricted to a narrow N-S trending lensoid strip. The talc displays radiating acicular striations typical of tremolite crystals having dull to pearly lustre. Its softness, characteristic soapy feel are its distinguishing features on the field. Being a soft mineral, it can be scratched with the fingernails and it leaves a white powdery flake when robbed within the palm. The talc is white in colour, the fibrous appearance is attributable to dominance of long, thin, acicular mineral grains. The talc schist is sheet-like (Fig. 8) and concordant with surrounding rocks (marble, quartzite and epidiorite). The talc is composed of aggregates of tremolite crystals with characteristic soapy feel.

Figure 8: Field photograph of Talc schist (talcose rock) from Babanla area.

Epidiorite

The rock outcrop is of restricted occurrence, the unit cut through talc schist in eastern segment of the study area. The unit is dark-coloured, fine-grained and extremely hard. Hand specimen sample of the rock is characteristically fine grained and dense. Ferromagnesian minerals including pyroxene, olivine and hornblende form dominant part of the rock. The epidiorite unit is poorly exposed and dark in appearance (Fig. 9). The dark colour has strong compositional layering marked by alteration of narrow to streak-like layers of hornblende. Essentially, hand specimen sample of the rock contains hornblende (39%), plagioclase (30%), epidote (20%) quartz (10%) (approximate values) as essential mineral constituents while magnetite (1%) forms the main accessory mineral. Some of the crystals of hornblende have been partially altered to chlorite or replaced by epidote.

Figure 9: Field occurrence of Epidiorite as exposed in a mine in Babanla area.

Coarse-grained Granite

Coarse-grained granite occupies central portion of the study area forming a strip aligned in a north-south direction. Outcrops of coarse-grained granite have rounded outlook (Fig. 10) while few have whaleback appearance. Due to the coarseness of the grains, individual minerals are unmistakable. Quartz crystals appear colourless and irregular; feldspars are bulky pinkish to whitish mineral with striations and micas having silvery and flaky nature with resinous lustre. Granite occurs in north-eastern part of the study area having contact with quartzite and the talc bodies.

Figure 10: Field photograph of a fractured coarse-grained granite in the study area.

Pegmatite

Pegmatite from the study area is well exposed, it exists in form of large dykes and massive bodies that occupies southern section of the coarse-grained granite. The dykes are of variable sizes, this type is characterized by extremely coarse texture with granite mineralogy. The massive pegmatite contains essentially quartz, feldspar, muscovite and tourmaline (Fig.11). Some sections of the pegmatite which appears weathered is dominated by quartz and large black tourmaline aggregate (Fig. 12). The feldspar has been converted to clay in areas of intense weathering and ferrugenization.

Figure 11: A fresh outcrop of pegmatite from Babanla area showing quartz, feldspar, muscovite mica and small black tourmaline crystals.

Figure 12: Field photograph of a weathered pegmatite sample from Babanla area showing black tourmaline and quartz, (the central part of the photograph contains feldspar and some reflective muscovite mica almost turning to clay by ferruginization.

Petrography

Petrographic analysis undertaken on the rocks from the study area reveals that the different lithologies comprises of different minerals in varying proportions. On the basis of the petrographic investigation, the rocks in the study area are described below:

Banded Gneiss

Banded gneiss in Babanla area comprise essentially of quartz, muscovite, biotite, and microcline (Fig. 13). Quartz occurs as clear angular to subangular crystals without alterations. The grains are of variable sizes and are scattered randomly across the field of view. All the grains have clear margins. Biotite occurs as laths arranged such that the long axis of the plates is aligned in same direction. It is acicular with low relief and bird view signatures. Muscovite like biotite has bird view appearance forming subordinate aggregates associated with quartz. Muscovite has low birefringence and are scattered in the interstices of other minerals. Microcline though very scantily distributed has characteristic grid twinning. Some appear sericitized probably due to metamorphic alteration. Even though, the foliation exhibited by the rock unit in thin section is determined by preferred orientation of the mica, hand specimen samples reveal inconspicuous foliation. Modal analysis indicates the rock contains approximately quartz (28%), biotite (15%), muscovite (12%), microcline (5%), plag + Orthoclase (26%) and others (13%).

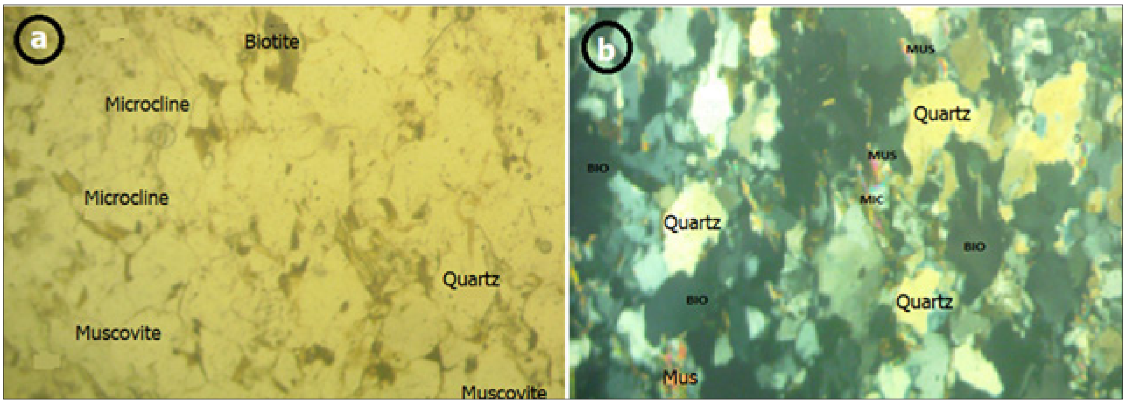

Figure 13: Photomicrograph of banded gneiss in transmitted light (a) ppl (b) cpl showing the constituent minerals

Granite Gneiss

Granite gneiss in Babanla area comprises of quartz, feldspar, biotite and hornblende (Fig. 14). Quartz occurs in different sizes forming irregular grains with white colour. Quartz is well-distributed across the field of view in most samples and rarely occur in clusters. The quartz grains lack any form of structural defects, inclusion or alteration, each grain occurs as distinct entity with well-defined margins. The feldspars are mainly plagioclase and microcline. Plagioclase is mostly albite with characteristic Carlsbad twins. Biotite forms stretched lepidoblastic aggregates with acicular habits and colour which ranges from pink to deep brown and straw-green. Hornblende forms supporting mineral with diagnostic golden-brown colour, prominent cleavages and irregular shapes.

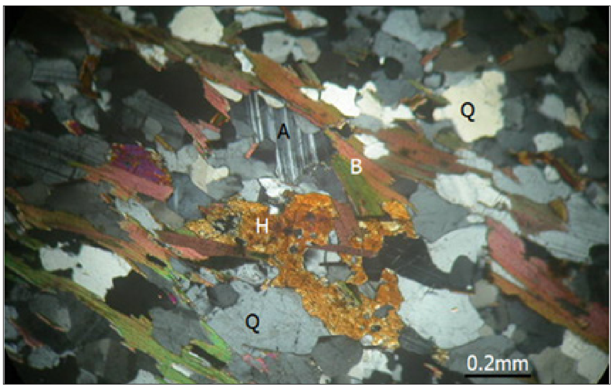

Figure 14: Photomicrograph of Granite gneiss from Babanla area in transmitted light under cross polarized light (cpl) showing the constituent minerals quartz (Q), biotite (B), hornblende (H) and feldspar which is in the form of albite (A).

Quartzite

Quartzite from Babanla area is predominantly composed of quartz grains of irregular shapes. The rock exhibits some translational fabrics which indicate they are product of metamorphic recrystallization. This decussate type of texture is evidence of mineral growth during metamorphism (Fig. 15). The seemingly large grains are similar to growth rings in igneous minerals. Under the microscope, the quartzites shows predominance of quartz, accessory muscovite, biotite and opaque minerals. Quartz is the most abundant mineral and is easily distinguishable from other minerals as it occurs as a milky sometimes colorless mineral usually cloudy and exhibits weak birefringence, low relief with wavy extinction. It has no cleavage but shows traces of fractures that are interconnected. Quartz and muscovite constitute up to volume fractions 86 % of the rock in thin section (Fig. 15).

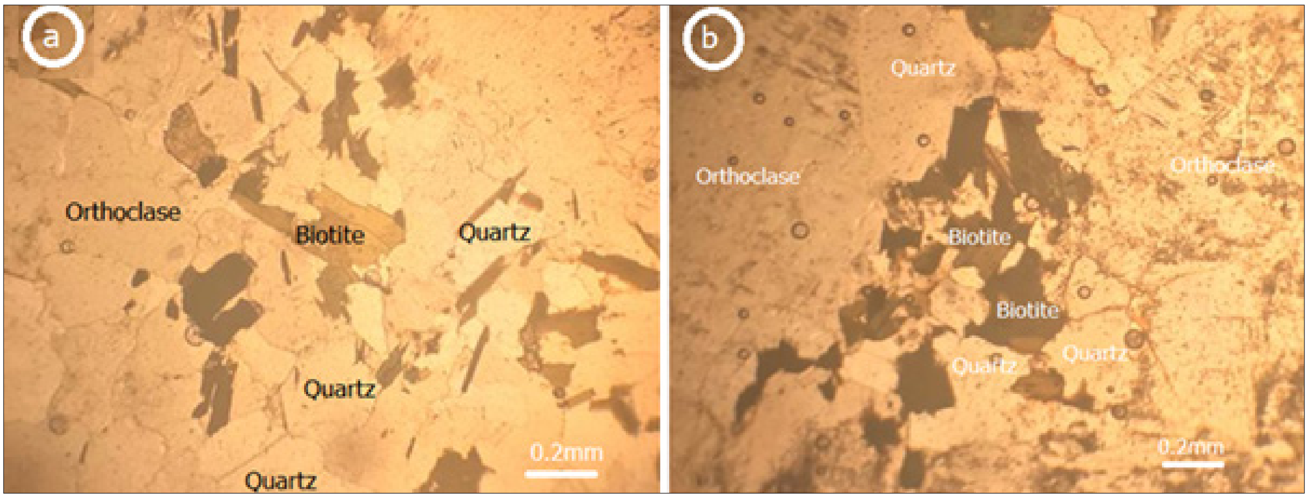

Figure 15: Photomicrograph of Quartzite from Babanla area in transmitted light (a) plane polarized light (ppl), (b) cross polarized light showing the rocks constituent is dominantly quartz and accessory biotite.

Marble

The Babanla marble comprise of two major minerals, these are calcite and dolomite (Fig. 16). Under plane polarized light the dolomite appears pale yellow in color. Under cross polarized light, the dolomite appears colorless with low relief. However, a zoning is recognizable within the portion of red calcite crystals characterized by bands of pale red color and also recognizable within the portion thin bands of bright to moderate yellow dolomitic crystals. Calcite is also present in close association with dolomite, it ranges between 1cm to 4cm and are clearly distinguishable in cross polarized light. Calcite occupies spaces among irregularly shaped dolomite crystals, the sizes of the crystals vary from few tens of microns to some millimeter. large and shows the same zoning observed in veins. In the thin section (Fig.15a and b), the dominant minerals in the marble rock are calcite (42%), dolomite (31%), quartz (13%), plagioclase (7%), muscovite (5%), biotite (7%) and opaque mineral 3.1%. Microscopic examination reveals the quartz occurs as euhedral crystals exhibiting a characteristic whitish to light greyish color. However, some are cloudy under crossed polarized light with low interference yellow colors. Quartz grains are of variable sizes and are angular to sub-angular and some near being rounded. The crystals of plagioclase with characteristic albite twins are scattered.

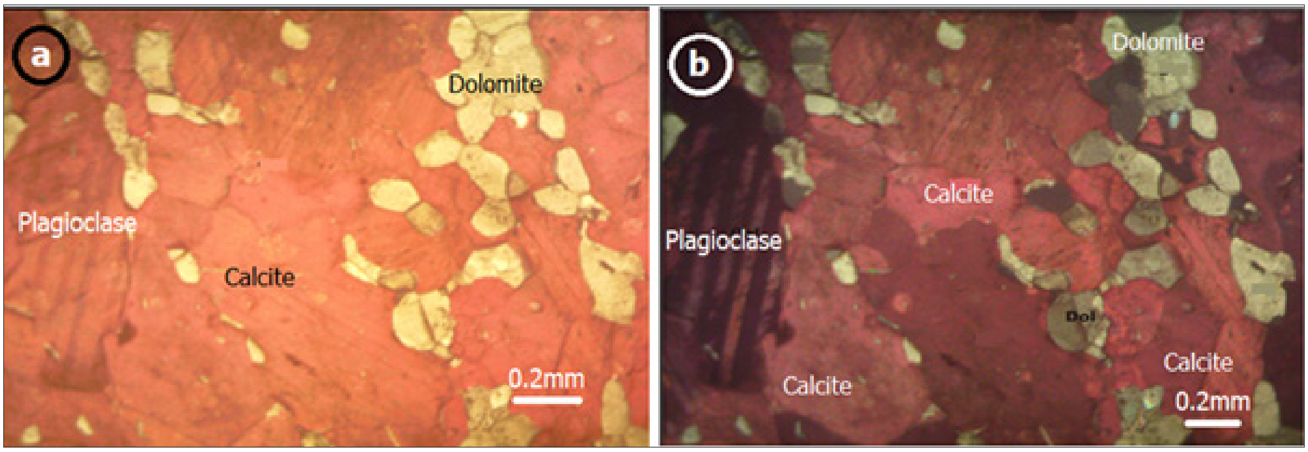

Figure 16: Photomicrograph of white marble from Babanla area in transmitted light (a) plane polarized light (ppl) and (b) cross polarized light (cpl) showing the mineral aggregates dominated by calcite and dolomite, while plagioclase occurs in subordinate amount.

Talc Schist

The talc rock contains talc, tremolite, actinolite, chlorite and other trace minerals. The talc mineral occurs as acicular mineral with fibrous habits (Fig. 17a). The Babanla talc rock has similar physical appearance with other talcose rocks in Iseyin, Oke-Ila, and Erin-Omu areas of southwestern Nigeria. However, the Igbo-Agbon talcose rock has a comparable talc content. The talc content of the tremolite talc around Baba-Ode area (Okunlola, et al., 2002) and Ijero talcose rock (Okunlola et al., 2011) are similar. The talc in the study area looks like those in Baba-Ode Tremolite Talc (Okunlola, et al., 2002), Erin-Omu area (Okunlola & Anikulapo, 2006), and Igbo-Agbon talcose rock (Ayemo, 2003).

Epidiorite

The rock is fine-grained and appears seemingly as ferromagnesian-rich based on the colour (Fig. 17b) index. Among minerals that are conspicuous in the thin section are quartz which occurs as irregular mineral with well-defined edges. It appears as white colour minerals that are randomly distributed within the stage. Orthoclase is also irregular in shape but with diagnostic grey colour. Pyroxene occurs as reddish to bluish in colour while hornblende is straw-green in colour. The minerals in the plate cannot be labelled as usual because the mineral aggregates are too small such that labelling them will encroach into adjourning minerals.

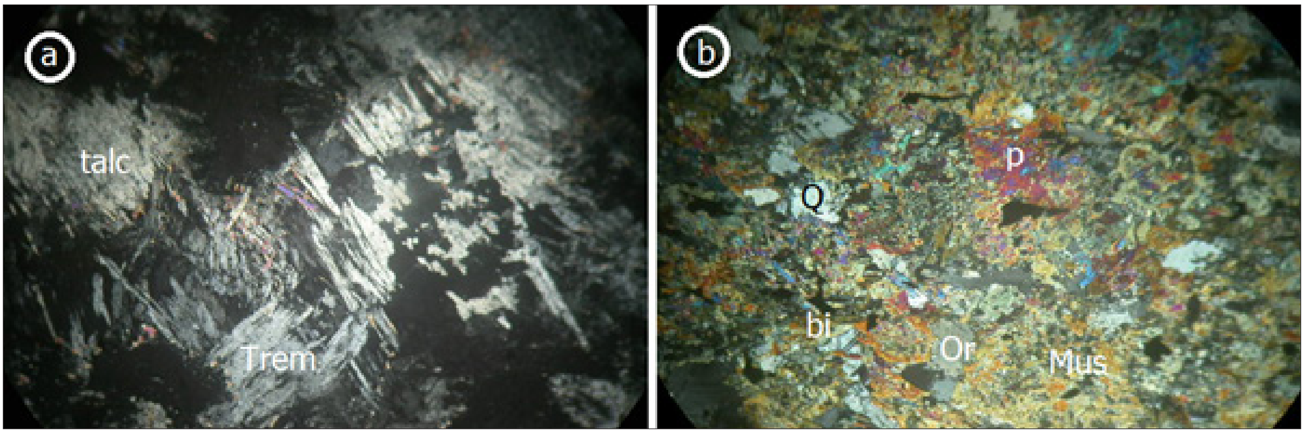

Figure 17: Photomicrograph of (a) Babanla talc schist in transmitted light (plane polarized light) showing the major mineral aggregates; (b) Babanla epidiorite in transmitted light (cross polarized light) showing the mineral aggregates.

Coarse-grained Granite

Petrographic study on Babanla coarse-grained granite sample shows that it consists mainly of plagioclase and quartz with appreciable amounts of biotite (Fig. 18). Quartz occurs as anhedral crystals of medium grains. It sometimes occupies the interstitial spaces between other subordinate minerals. Microcline though of insignificant importance is present as small crystals characterized by cross-hatch twining. Biotite is dark brown to brownish-green subhedral crystals characterized by highly pleochroic feature and parallel extinction.

Figure 18: Photomicrograph of Coarse-grained granite in Babanla area in transmitted light (plane polarized light) (ppl) showing the mineral aggregates.

Pegmatite

Essentially, pegmatite in Babanla area is of granitic composition, it is made up of minerals quartz, feldspars (orthoclase and plagioclase), and micas (biotite and muscovite) (Fig. 19a). In hand specimen, the rock is medium – grained, the light greyish to whitish in colour is largely due to abundance of quartz and felsic minerals. These rocks are foliated with strong planar preferred orientation of the constituent minerals especially, quartz (30%), microcline (28%), plagioclase (14%), and hornblende (6%), and opaque minerals (1%). Quartz forms colorless anhedral crystals and exhibits non-uniform extinction. Pegmatite in Babanla varies extensively in character, it is heterogeneous in respect to grain size (pegmatitic vein) and mineralization. Pegmatite in the study area occurs as veins (less than 6 m thick) around the mine. It occurs as near-horizontal dykes around Babanla (3-2 m thick) and randomly oriented. Field observations have indicated that Babanla pegmatite complexes are invariably found in areas in which parallel systems of Sn/W-bearing sheeted pneumatolytic greisen and quartz-tourmaline lodes are well-developed. Such relationships are well-exposed in the central part of the Babanla pluton, the pits at Asookore where Babanla pegmatites marks the contact of the hornblende biotite granite, emplaced within the megacrystic biotite granite. Microcline crystals are so bogus that it almost covers half of the stage (Fig. 19b).

Figure 19: Photomicrograph of Babanla pegmatite in transmitted light (cross polarized light) (a) showing the mineral aggregates quartz, plagioclase, biotite and hornblende; (b) another slides of the pegmatite in transmitted light (cross polarized) showing large phenocrysts of microcline and other supporting minerals. The mineral aggregates are quartz, plagioclase, biotite and hornblende.

Table 1: Mineralogic composition of the crystalline rocks in Babanla area (values in %) (average of 3 samples).

Minerals	Q	P	O	M	H	Ms	B	C	D	Px	T	Tr	Op	Ot	Total
Banded Gneiss	28	16	10	5	8	12	15	-	-	-	-	-	3	3	100
Granite Gneiss	35	15	13	7	10	9	11	-	-				4	-	100
Quartzite	72	4	-	-	-	14	6	-	-				1	3	100
Marble	13	7	-	-	-	5	7	-	-	-	-	-	-	-	100
Talc Schist	12	-	-	3	8	2	7	42	31		51	17	-	-	100
Epidiorite	17	6	4	-	38	-	13	-	-	14	-	-	3	5	100
C-grained granite	34	18	13	8	7	5	12	-	-	-	-	-	2	1	100
Pegmatite	30	14	8	28	6	4	9	-	-	-	-	-	1	-	100

Summary and Conclusion

The polycyclic basement of Nigeria which forms regional extension of the study area is a Pan-African orogenic belt which contains migmatite-gneiss complex, schistose assemblages and granite. The lithologic units in Babanla area are banded gneiss, granite gneiss, quartzite, marble, talc schist, epidiorite, coarse-grained granite and pegmatite. Field investigations show the gneisses are basal to other units and forms the country rock.

Field investigations revealed the gneisses are low-lying with distinct melanosomes, mesosomes and leucosome and are intensely crisscrossed by veining. Banded-gneiss shows lit-par-lit structure (alternating bands of mafic and felsic minerals). Field evidences show the gneisses have gradational contacts. The simultaneous occurrence of metamorphic (gneisses, quartzite, talc schist) and igneous units most especially, granite and pegmatite with quartzo-feldspartic veins possibly suggests the geodynamic activities that affected Babanla area probably resulted in partial melting.

Quartz, feldspar (plagioclase, orthoclase and microcline) and mica (biotite, muscovite) are prominent mineral components in the crystalline basement rocks but each contain slightly varying amounts of these minerals. While Babanla marble is dominated by calcite, dolomite and quartz; the talc schist contains significant amount of talc and tremolite; epidiorite is fine-grained and contains hornblende, pyroxene and quartz.

Quartzite and marble in Babanla area possibly formed when heat and pressure acted on quartz sand and limestone while talc schist may have been sourced from thermal alteration of pellite of basic to ultrabasic compositions. Epidepride is formed from basic rock enriched in ferromagnesian components. Coarse-grained granite and pegmatite are igneous, both forms from silicic magma while pegmatite represents late phase fluid-rich component formed during terminal stage of Pan-African magmatism.

Acknowledgements

The authors wish to acknowledge Mr. Mafoluku of the Department of Geology, University of Ibadan for preparation of the thin sections for petrographic analysis. The authors are also grateful to the postgraduate students that assisted during the geological mapping.

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