The Geology and Petrographic characterization of rocks in part of Tegina Sheet 142 SE and Alawa Sheet 143SW North-Central Nigeria

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Abstract
The geology of Kawo, Maigiro and environs was study with the aim of characterizing rock types based on their petrography. The area is part of Tegina Sheet 142 SE and Alawa Sheet 143 SW underlain by rocks belonging to Zungeru- Birnin Gwari Schist Belt of Nigeria and mapped on a scale of 1:50,000. From the geological mapping, four lithological units were observed namely; granite, gneiss, schist and amphibolite. These rocks were intruded with quartz veins at the eastern part which host gold mineralization. Each outcrop location was determined with handheld GPS. Specimen of the rock samples were studied based on their colour, mineralogy and texture on the field. Fifteen (15) out of thirty (30) collected rock samples were selected and sent to petrological laboratory for thin section analysis to determine mineral composition under binocular polarizing microscope with X10 magnification. The result of petrographic analysis showed that gneiss consists of quartz, plagioclase, biotite, hornblende, and epidote. Visible grains of biotite, plagioclase, hornblende, quartz and opaque minerals were observed in schist. Plagioclase occurs in amphibolite as elongated prismatic crystal, greenish and pleochroic. Granite consists of quartz, plagioclase biotite and hornblende. Fracture, foliation, folds, faults, lineation and veins were the observed structures which serve as a zone of mineralization in the eastern corner of the study area.

Keywords: Petrographic; Geology; Tegina sheet 142SE; North central Nigeria.

1. Introduction

The study area lies between Latitudes 10°00'N to 10°15'N and Longitudes 6°15'E to 6°33'E. The area straddles two topographic sheets, namely Tegina 142SE and Alawa 143SW (Figure 1). It is accessible through Minna-Zungeru-Tegina-Kaduna highway through Kagara. Footpaths' leading to various villages like Kawo, Sabon Gida, Gida Kafinta, Madagwa, Maikomo, Gidan Gwari and hamlets further enhances access to different parts of the study area (Figure 1).

2. Literature Review

The Precambrian Basement Complex rocks of Nigeria are categorized into three sub-divisions and include ancient Migmatite-Gneiss-Quartzite Complex, the Schist Belts and Pan African (600 my) Granitic Series commonly called Older Granite Suites (Ako, 2014). The Migmatite-Gneiss Complex rocks are believed to be basement rocks in real sense. These rocks consist of gneisses, schists, granites and amphibolites which was systematically mapped by Truswell and Cope (1963) but later reclassified by Ajibade (1976). Falconer (1911), Jones and Hockey (1964), Grant (1969), McCurry (1976) and Ajibade (1982) studied the basement rocks in the north-western part of Nigeria and suggested that the pelitic and semi-pelitic younger meta-sediments in Nigeria were deposited between 800 and 1000 million years ago. According to Ako (2014), Schist Belts consist of north-south trending rocks which occur prominently in the western part of Nigeria.

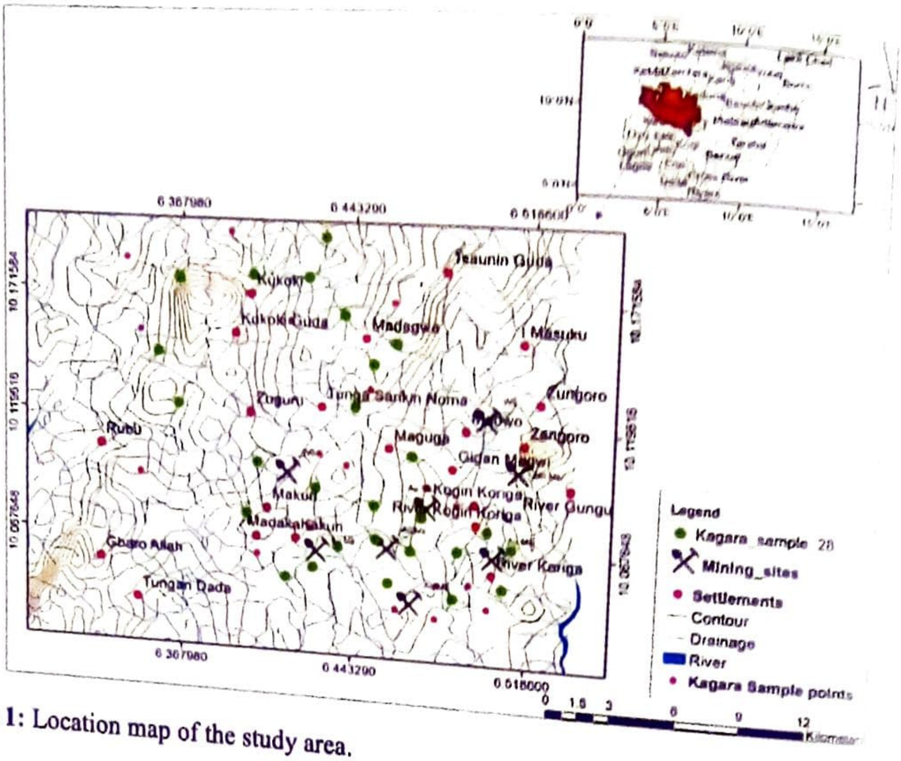


Figure 1: Location map of the study area.

The Schist Belt rocks show good distinctive structural features such as transcurrent fault and isoclinal fold structure trending in NNE direction. These structures give rise to strong foliation parallel to axial plane of fold (Truswell and Cope, 1963). The Schist Belt of north-western Nigeria is notable for gold and other rare earth metals mineralization (Abubakar, 2012). According to Garba (2002), the local and regional control of mineralization within the north-western Schist Belt is primarily structures. Other Schist Belt with similar petrological and structural features are in the northwest and south-west including Iseyin, Igarra-Okene and Egbe -Isanlu schist belts. Granites in the area are termed older granite by previous researchers so as to differentiate them from younger granite; that is high level orogenic Jurassic granites of Jos Plateau in Northern Nigeria.

3. Materials and Methods

3.1 Fieldwork

Mosaic map of Alawa Sheet 143 and Tegina Sheet 142 formed the topographic base map of the study. Geological mapping was carried out on a scale of 1:50,000. Each outcrop location was determined with the aid of Global Positioning System (GPS) device to know geographic coordinate of the area on the base map and to measure elevation of the sampled area. Representative rock samples were collected from different part of the study area with the use of a geological hammer and labelled base on the abbreviation of localities where samples were taken to avoid mix up. Hand specimens of the rock samples were study based on their colour, mineralogy and texture. Other micro structures and mineral constituents of the rocks were observed with hand held magnifying lens. Careful observation of rock boundaries was made by observing changes in rock lithology. Compass clinometer was used to measure strike and dip of structural features which were measured and plotted on Rosette diagram. At the end of the mapping exercise, fifteen (15) fresh and well labelled representative samples were thoroughly selected out of collected thirty (30) samples for petrological and geochemical analysis. Well labelled fresh samples collected from the study are sent to the petrological laboratory in Prague Czech Republic for petrological analysis.

3.2 Laboratory Analysis

Samples were cut according to desire sizes and then lapped on the lapping machine with silicon carbide to the lapping glass. The glass slide was put on the lapping table with water and lapped until a smooth surface was achieved. A thermoplate was used to heat the lapped specimen at temperature of about 103°C for one hour. The essence of heating is to remove excessive water from prepared specimen and this process is often referred to as baking. After baking, the specimen is allowed to cool to a temperature of 60°C, at this temperature, araldite was used to mount the prepared specimen with the glass slide and allow to cool at room temperature. Cutting machine was then used to reduce the size of the specimen to a sizeable fraction before final lapping by lapping jig to get a thin section of 0.03mm. After achieving 0.03mm specification, the specimen then thoroughly washed to remove any slurry and allowed to dry and covered [illegible] Methylated spirit was used to wash the prepared specimen and rinsed [illegible] allowed to dry at room temperature and then labelled appropriately [illegible] analysis helped to know mineral and modal composition under [illegible] with x10 magnification.

4. Results and Discussion

4.1. Geological mapping

The geological mapping of Kawo and Maigiro shows four lithological units, namely, gneiss, schist, amphibolite and granite with distinctive mineralogical, petrological, structural, and textural characteristics which have effect on the geology of the study area. Gneiss occurs in the eastern half and occupies about 40% of the study area; schists occur in the middle portion of the study area. Amphibolite covers the north-western part of the area with gradational contacts with the schist at western side. Large scale intrusions of medium to coarse grained granite also outcropped within south-eastern end of the area (Figure 2).

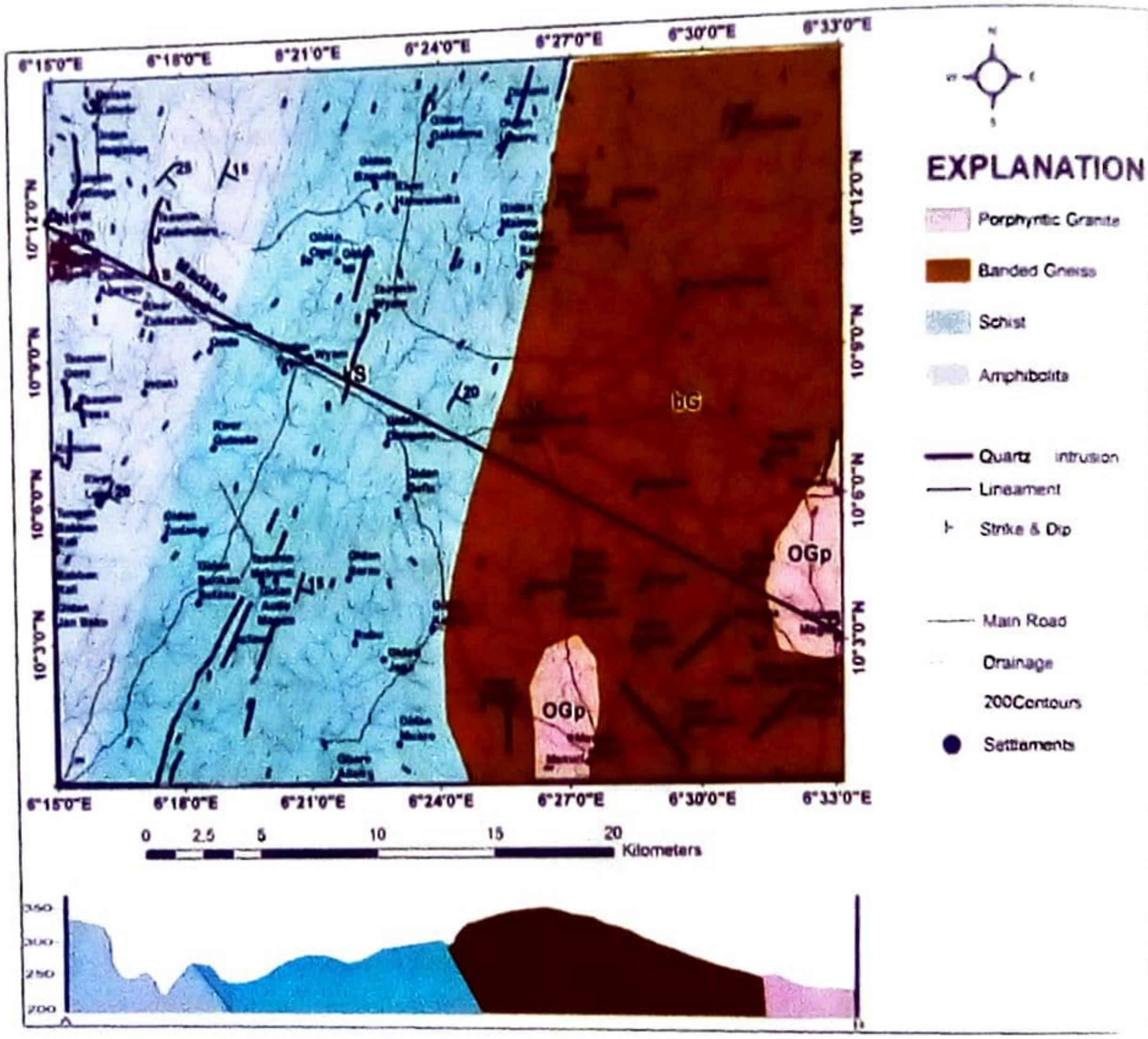


Figure 2: Geological map of the study area.

Gneiss was observed mainly around mine sites and is intruded by quartzite and granites. In some area the outcrops have been greatly weathered but traces of alteration and alignment of minerals are still preserved. In area where the rocks have not been weathered, it appears grey in colour and have medium to coarse grained texture. Mineralogically, gneiss consists of quartz, feldspar, mica and foliations are defined by parallel arrangement of ferromagnesian and quartzo-feldspathic layers (Plate I).

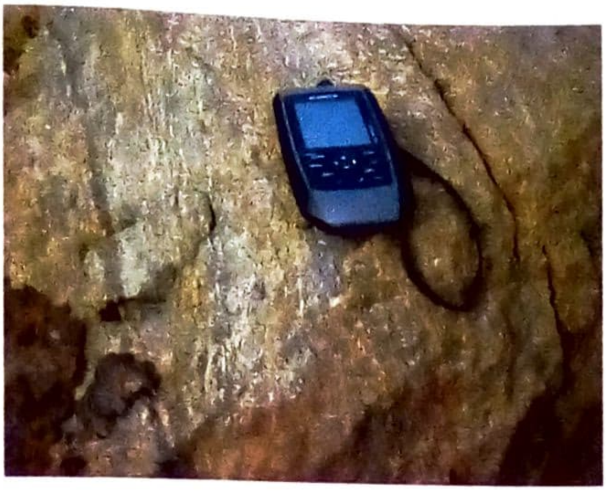
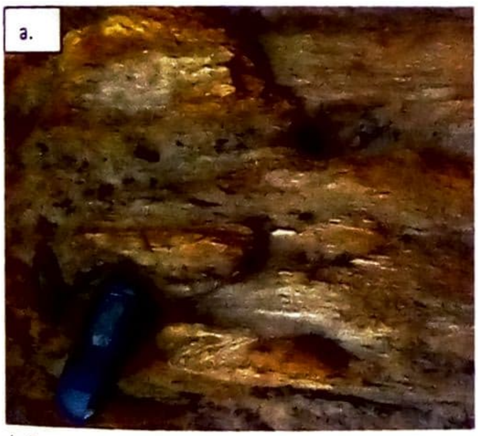


Plate I: Outcrop of gneiss around Maigiro showing preferred orientation of minerals (10°00'53.1" N, 6°28'59.8" E)

Schist appears as NNE-SSW bodies forming gradational contacts with the gneiss on the eastern side of the area and with amphibolites on the western portion. The schist has been highly weathered and occurs as small low-lying exposures. It is reddish brown in colour which may be as a result of oxidation of iron bearing minerals. Though they are weathered, foliation planes in them are still visible. It shows medium to coarse grained texture (Plate IIa). Talc schist with micro fold showing sign of exfoliation was also observed towards the northern end of the study area along Madagwa and Kukoki (Plate IIb).

a.



b.

(a.) (10° 09'13.2"N, 6° 24' 25"E), (b) (10°06'44.6"N, 6°27'28.5"E)

Plate II: Outcrop of schist from the study area

Amphibolite was observed around Wyam and Nasira area, the exposure is prominent ... exposed along river Wyam with a shining greasy surface and exhibit fine grained texture ... III). Most of the exposures are intensively weathered. Micro folds, joints, fracture and faults were observed.

(10° 06'00.4"N, 6° 23' 20"E)

Plate III: Exposed amphibolite along River Wyam.

Granite covers the southern part of the study area around Madaka. The outcrop is massive (Plate IV), characterised by felsic minerals (quarts, feldspar and biotite). The Madaka outcrop ... texturally phaneritic but varies from medium to fine grain texture along Kampani Madaka ... grained granite with lots of K-feldspar exposed along the river course very close to gold ... site (Plate IVb). Boulders of various sizes with joints and fractures were also observed at the ... of the Madaka outcrop (Plate Vc). Other observed feature like exfoliation is shown in plate ... The observed rock colour is greyish ash in Madaka but dark ash along Kampani Madaka.

10° 00' 43.8"N, 6° 27' 47"E

Massive Madaka granitic outcrop undergoing chemical and biological weathering.

10° 05' 56.9"N, 6° 23' 25"E

Granite outcrop with lots of K-feldspar along Kampani.

10° 00' 42.6"N, 6° 27' 43"E

Granite with lots of boulders at the base of Madaka outcrop undergoing exfoliation.

10° 00' 43.8"N, 6° 27' 47"E

Massive granitic outcrop at Madaka

.**Plate IV (a-d):** Observed granitic structures from the study area.

Minor intrusive such as quartz veins were observed in gneiss at the eastern corner of the study area around Maigiro mine sites which serve as host for gold ore mineralization. The vein is trending in N-S direction (Plate Va). Quartzite in the area varies in colour, ranging from brownish to orange yellow in nature due to mineral impurities. It texture varies from equigranular, medium to coarse grained (Plate Vb).

10° 00' 33.6"N, 6° 31' 14"E

Gold rich quartz from Maigiro mine site

10° 01' 16.9"N, 6° 30' 42.5"E

Mining site showing trending pattern of quartz vein

Plate V (a and b): Field observation of quartz with the trending pattern

4.2 Petrography

The petrographic study was conducted under the cross polarized light on the thin section of the collected rock samples as follows:

(i) **Gneiss**

Gneiss consists of quartz, plagioclase, biotite, hornblende and epidote when observed under cross polar (Plate VI). These crystals are elongated in one direction and most of them occur as porphyroblasts. These porphyroblasts are numerous and fairly large and measuring up to 2-3cm in length, the rock displays various colours and this is as a result of the presence of different minerals. Texturally, it is medium to coarse grained.

Quartz occurs as a colourless mineral with granoblastic grains. It shows very low relief compared to the other constituent minerals in the rock. It shows undulose extinction which is evidence of some degree of deformation. In some sections, it forms interlocking pattern with the surrounding minerals (Plate VI).

Plagioclase occurs as light-coloured minerals with a tabular habit. It shows two directions of cleavage and does not display twinning which is characteristic of plagioclase. The absence of twinning may be attributed to poor development of property or direction in which the thin section was cut. Some sections of the crystals show various degree of cloudiness implying different rate of alteration of the mineral (Plate VI).

Hornblende occurs as prismatic crystals with a greenish-black colour. It shows pleochroism from yellowish-green to dark green. Its characteristic two directions of cleavage were displayed and it shows a moderate relief. Portion that have been altered have been changed to epidote which is an alteration product of hornblende (Plate VI).
Biotite occurs as a brownish coloured mineral, it shows a high relief and is pleochroic with one direction of perfect cleavage (Plate VI).
Epidote shows shades of light blue, yellow to deep blue and show pleochroism from greenish yellow to blue to yellow. It occurs in the fractured zone of hornblende where alteration has taken place. The accessory and opaque minerals occur as tiny anhedral grains scattered all over the thin section (Plate VI).

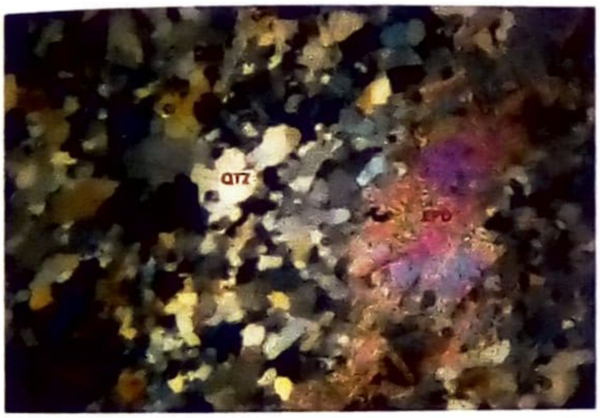


Plate VI: Photomicrograph of gneiss (Mag.X10)

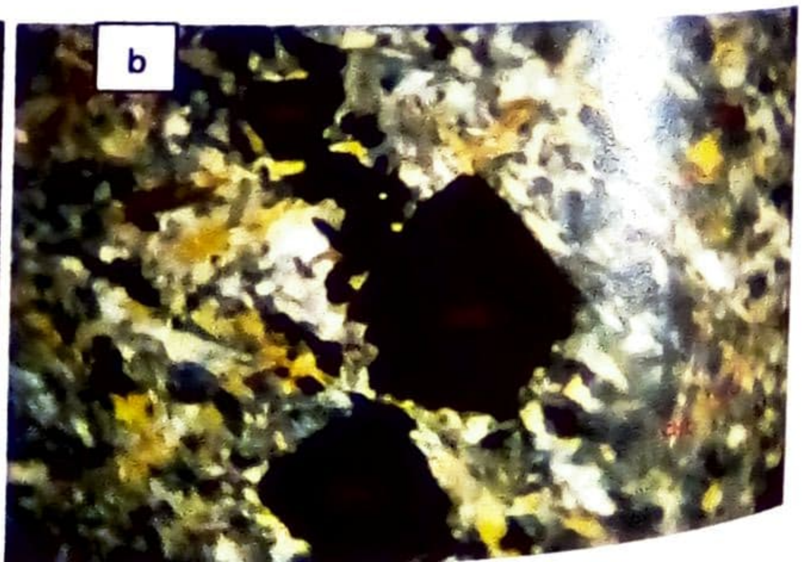
(ii) Schist

The schist in the study area consists of visible grains of biotite, plagioclase, hornblende, quartz and some opaque minerals (Plate VII). Under the microscope the rock shows various colours due to the presence of these minerals. It shows a fine to medium grained texture.
Hornblende occurs as short prismatic minerals, black in colour and shows a moderate relief. It is pleochroic and shows two directions of cleavage. It forms interlocking grain boundaries with other minerals presence in the rock (Plate VII).
Biotite occurs as a brown mineral with characteristic basal cleavage. It shows pleochroism and in some areas it has been slightly altered to epidote. Some crystals of biotite occur in the fracture surfaces of other minerals (Plate VII).
Plagioclase occurs as a tabular mineral, grey in colour and shows two directions of cleavage. It shows a moderate relief and does not exhibit its characteristics twining (Plate VII).
Quartz occurs as a light colour mineral with a very low relief. It occurs as a coarse granoblastic grains with undulose extinction. The opaque minerals occur as accessory mineral within the rock. In the rock they occur as tiny anhedral to euhedral grains scattered all over the rock with corroded edges which show reddish brown tinge at the edge (Plate VII).

Plate VII: Photomicrograph of schist (Mag.X10)

ii) Amphibolite

Amphibolite occurs as lenses and sometimes as oval shapes in N – S direction trend with the ... rocks of the study area. They form gradational contact with schist and are mostly schistose ... The schistose amphibolite is green in colour, very fissile and shows some degree of weather... In thin section, the rock contains hornblende, biotite, plagioclase and chlorite as presented in Pl... VIII (a - c). Hornblende shows elongated prismatic crystals and greenish in colour and pleochr... from pale green to dark green as shown in Plate VIII (a). In some areas, hornblende has be... altered to tremolite (Plate VIIIc). Plagioclase occurs as small subhedral crystals, often corroded... some samples (Plate VIIIa). Biotite occurs as greenish short and tabular crystals with extensi... alteration to chlorite (Plate VIIIb).



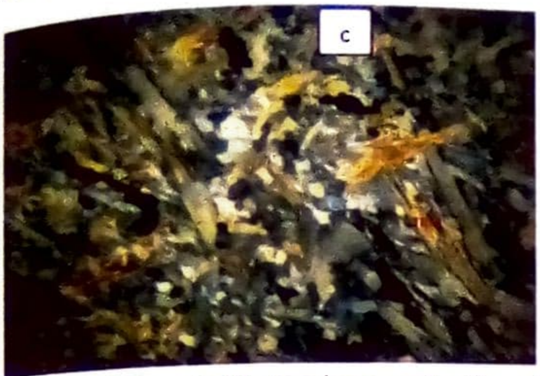


Plate VIII (a - c): Photomicrograph of amphibolite (Mag.X10)

(iv) Granite

Granite which occurs as an intrusion within the gneiss consists of quartz, plagioclase, biotite and hornblende (Plate IX). Quartz occurs as colourless and irregular grains without any cleavage. Under crossed polar, it occurs as a blue crystal and generally looks twining (Plate IX). It also shows a low relief. Plagioclase appears as colourless minerals with two directions of cleavage. The crystals occur as large crystals which are set of a fine grain matrix giving it a porphyritic texture which forms interlocking grains with other minerals within the section. Twining is not well developed. Along the fracture section of the minerals, alteration to sericite has started taking place (Plate IX).

Biotite occurs as brown minerals with a platy habit. It displays pleochroism and one direction of basal cleavage (Plate IX). Hornblende occurs as greenish prismatic minerals with two distinct planes of cleavage, it is highly pleochroic with the change in colour from green to greenish black. It has a very high relief and shows straight and undulose extinction.

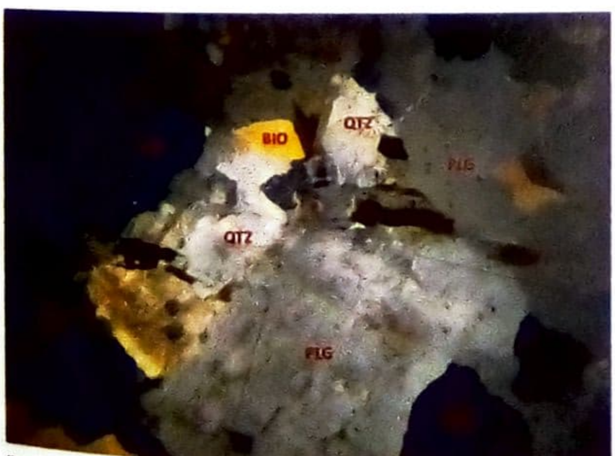


Plate IX: Photomicrograph of granite (Mag.X10)

5. Conclusion

Geology and petrographic study of rocks around Kawo, Maigiro and environ shows that the ... is made up of granite, gneiss, schist and amphibolite. The area is largely occupied by gneiss ... eastern part and is intruded by the granite and quartzite; schist which occupies the central ... of the study area is the second most abundant lithology. Amphibolite occupies the western part ... the study area. Plagioclase, quartz, biotite, and hornblende are common to all rock types ... microscope but in addition to these minerals, gneiss shows epidote, amphibolite show tremol... and chlorite while schist show the presence of opaque minerals. High deformation of minerals ... a result of metamorphic activities gives both planar and linear structures to the mine... assemblages. Chlorite, epidote and biotite occurrence based on petrological examination in a... mentioned rock types showed that the area is a metamorphic environment formed by intrusion ... acidic magma. The presence of joint and fracture will be good tools to groundwater prospecting ... the area and a good zone for mineral formation.

References

Abubakar, Y. I. (2012). An integrated technique in delineating structures: A case study of Kushak... schist belt north-western Nigeria. *International Journal of Applied Science and Technolog...* 2(5), 164-173.

Ajibade, A. C. (1982). The origin of Older Granites of Nigeria, some evidence from Zunge... Region. *Journal of Mining and Geology,* 19, 223-230.

Ako, T. A. (2014). Geology and Geochemistry of Zungeru Amphibolites, North Central Niger... *Universal Journal of Geoscience,* 2(4): 116-122, DOI: 10.13189/ujg.2014.020402.

Jones, H. A and Hockey R. D. (1964). The Geology of part of South-Western N...eria. Explanati... of 1:250,000 sheet 59-65, *Geological Survey of Nigeria*, Bull. 31, 87pp.

Falconer, J.D. (1911). The Geology and Geography of Northern Nigeria. M...millian, Londo... 295p. 1911.

Garba, I. (2002). Late Pan-African Tectonic origin of gold mineralization and r... metal pegmati... in Kushaka schist belt, north-western Nigeria. *Journal of Mining and G...gy*, 38 (1), 1-1...

Grant, N. K. (1969). The Late Precambrian to early Palaeozoic Pan-African ...ogeny in Gha... Togo, Dahomey and Nigeria, *Geological Society of America* Bulletin. 8... ...5-56.

McCurry, P. (1976). *The Geology of the Precambrian to Lower Palaeozoi... ...cks of northe... Nigeria:* a review. In Kogbe, C. A.(Ed.), Geology of Nigeria. Elizabeth... Pub. Co. Lago...

pp. 15-39, 1976.

Rahaman, M. A. (1976). *Review of the Basement Geology of South Western Nigeria Geology ... Nigeria*. In Kogbe, C. A. (Ed.). Geology of Nigeria. Elizabethan Publishing Company, Lag... pp. 41-58.

Truswell, J.F., and Cope, R.N. (1963). The geology of parts of Niger and Zaria Provinces, Norther... Nigeria. *Geological Survey Nigeria Bulletin,* 29, 1–104.