

Petrographic Investigation of Oke-Awun Rocks Southwestern Nigeria

Folorunso, I.O.

1Department of Geophysics,
University of Ilorin, Ilorin, Nigeria
Ismail.folorunso@gmail.com

Okonkwo, C.T.

Department of Geology,
Federal University of Technology
Akure, Nigeria

ABSTRACT

The Oke-Awun area is underlain by older units of Migmatitic gneisses, Augen gneisses, Quartz-biotite-muscovite schists, Quartzites and Amphibolites which have been intruded by Granites, Granodiorites and Pegmatites of probable Pan African (ca 600 Ma) age. The Gneisses are medium grained rocks with mineral constituent which include quartz, plagioclase, biotite, hornblende, microcline with accessory minerals such as chlorite, sericite, sphene, epidote and ore minerals. Amphibolites are medium-fine grained and are characterised mainly by hornblende and plagioclase with minor quartz while the metasediments are characterized by quartz, plagioclase, biotite, muscovite, microcline and epidote. The granites are made of quartz, biotite, plagioclase, microcline, chlorite, epidote, sericite and muscovite. The metamorphic rocks of Oke-Awun have been subjected to Amphibolite facies regional metamorphism which has been locally overprinted by greenschist facies retrogression.

Keywords: Metamorphism, Retrogression, Greenschist facies, Amphibolite facies.

1. INTRODUCTION

The present study investigates the minerals present in rocks from Oke-Awun using the petrographic microscope with the aim of determining their metamorphic mineral assemblages. The Basement Complex of Oke-Awun area forms part of the northern sector of Nigeria Basement complex (Fig. 1). The Nigeria Basement complex is part of the Early Paleozoic to late Proterozoic Pan Africa mobile belt situated east of the West Africa craton. Recent studies in Jebba area have shown that the Basement Rocks comprises of both metasediments and metaigneous rocks, which were subjected to polyphase deformation (Okonkwo, 1992) and then intruded by post-tectonic granitic rocks probably Pan Africa age. The late Proterozoic (Pan-Africa) events are marked by high-grade metamorphism, folding, widespread granite plutonism and late transcurrent faults (Ekwueme and Kroner, 1998).

METHODOLOGY

The field work part of this project commenced in November 2001 to November, 2002. During the field work, exposed rocks in Oke-Awun area were mapped with the aid of a Global Positioning System samples taken and labelled and structural data collected. Laboratory Work for Some of the rock samples collected from the area were selected and cut into thin sections in the workshop the Department of Geology, University of Ife. Production of photomicrographs of the thin sections was carried out in the laboratory of the Department of Geology, Olabisi Onabanjo University, Ago Iwoye Ogun State. Petrographic studies of the thin section were carried out using the transmitted light microscope.

GEOLOGY OF THE AREA

Oke-Awun area lies between longitude $4^{\circ} 38' 30''$ E and $4^{\circ} 45'$ and latitude $9^{\circ} 00' N$ and $9^{\circ} 13' N$ (Fig. 2) of the Federal survey of Nigeria sheet 181 Jebba southwest. The area comprises of metaigneous and metasediment rocks which have been intruded by granitic rocks of probably Pan Africa age.

Three major lithological units have been recognised in Oke-Awun area; Granitic, metasediments and Gneisses. In the northwest is a belt of granitic rocks dominantly biotite-muscovite granite with pocket of Granodiorite, Mylonite granites and Biotite granite in the north eastern part of the area. The granite is bounded on the Southwest by augen gneiss, in the south by migmatitic gneiss and southwest by quartz- biotite - muscovite schist. There is a discontinuous exposure of quartzite ridge northwest of Oke-Awun. South of the migmatite gneiss are granite gneiss and porphyritic granites.

The quartzites are highly fractured and form high structure (hill) exhibiting horizontal and vertical fractures in some places. Outcrops of amphibolite are found along the river Awun channel Southwest of Oke-Awun and also in the northeastern part of the area. There are two textural types of amphibolites in the area. In the north, Amphibolite occurs as lenticular bodies which are foliated while in the south; foliation in the Amphibolite is not distinct. Pegmatitic rocks cut across the Migmatitic rocks and trend in the north-south direction.

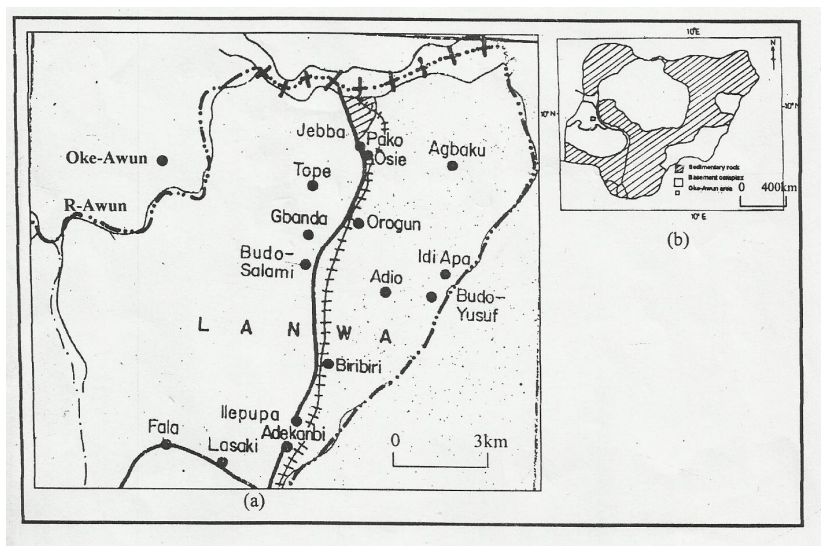


Fig. 1(a) Location map of Oke-Awun. (b) Location of mapped area on map of Nigeria.

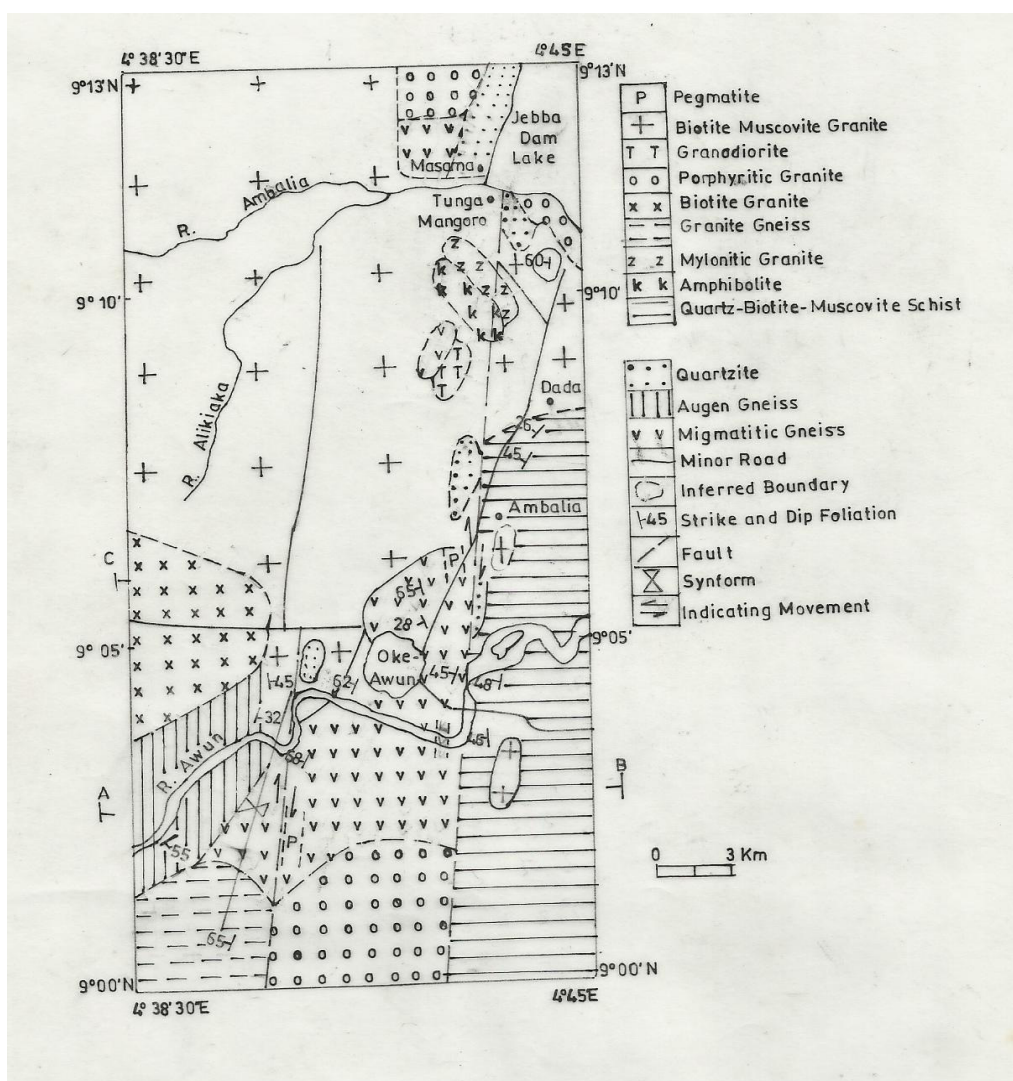


Fig 2: Location and geological map of Oke-Awun area

PETROGRAPHY

A petrographic description of lithologies in the study area is given. The study involves the examination of thin sections of many samples of different rock types, using the transmitted light microscope. The texture and mineralogy of the rocks are determined.

GNEISSES

Migmatitic Gneiss

The migmatitic gneiss is a medium-grained rock. The major mineral constituents include quartz, plagioclase, biotite and hornblende (Fig. 3a and Fig. 3b). Microclines occur as minor minerals, the accessory minerals are chlorite, sericite, epidote and ore. Chloride might have been formed as a result of retrograde reaction of biotite. Sericite and epidote were formed from late stage alteration of plagioclase. The dark bands are made up mainly of biotite and hornblende while the light bands constitute mainly quartz and plagioclase feldspars. Biotite grains show strong alignment. microcline. Biotite defines the foliation (Fig. 4b). Epidote occurs as an accessory constituent.

Quartzite

The normal quartzite is fine grained. The mineral constituent is mainly quartz. The Cataclastic quartzite is a fine to medium-grained rock. The Cataclastic quartzite contains quartz and muscovite. Cataclastic texture is observable in thin section with angular medium- grain quartz in very fine-grained groundmass of quartz grains. Locally, these may be cut by later medium-grained quartz - veins (Fig. 4c).

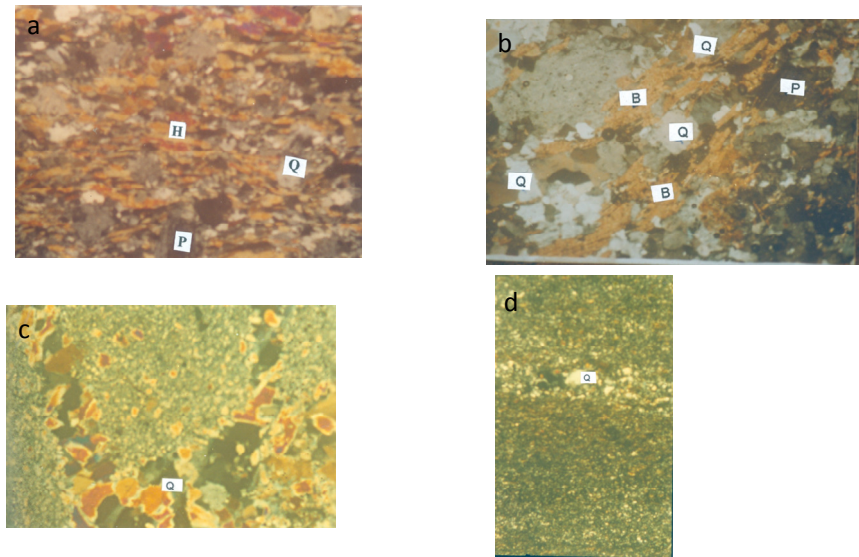


Figure 4. (a) Photomicrograph of mylonitic amphibolites. Crossed Nicols, magnification X40. (H- Hornblende, Q-quartz, P-Plagioclase); (b) Photomicrograph showing mineral alignment of biotite (B) and quartz (Q) in quartz-biotite-muscovite schist. Crossed Nicols, magnification X40; (c) Photomicrograph of Cataclastic quartzite with later quartz-vein (Q) cutting very fine-grained groundmass of quartz grains (Anomalous interference colours of quartz are due to thick section). Crossed Nicols, magnification X40; (d) Photomicrograph of mylonitized granite. Crossed Nicols, magnification X40. (Q - Quartz).

GRANITES

Mylonitic Granite

Mylonitic granites outcrop south of Tunga Mangoro in the northeastern part of the area mapped (Fig. 2). It is a very fine-grained rock. The main mineral constituents of the rock are quartz, biotite, plagioclase and microcline. Also very fine-grained chlorite, ore and epidote are present. Quartz grains broken down in groundmass of other minerals define foliation (Fig. 4d).

Porphyritic Granite

Thin section reveals phenocryst of microcline in a finer-grained matrix of quartz, plagioclase and other minerals. The mineral constituents are quartz, microcline, biotite and plagioclase. Accessory minerals are sericite, chlorite and sphene. The microcline crystals are subhedral showing the characteristic cross-hatched twinning. Anhedral crystals of quartz occupy interstitial positions between microcline and plagioclase (Fig. 5a).

Biotite Granite

The biotite granite is medium grained. The mineral constituents include biotite, plagioclase, microcline and quartz. Accessory mineral is sericite. Biotite is brown in color. It exhibits prismatic laths (Fig. 5b). Crystals of plagioclase exhibit albite twinning. Anhedral crystals of quartz occupy interstitial spaces between biotite and plagioclase.

Augen Gneiss

The Augen gneiss is a medium-grained rock, and consists mainly of Quartz, Plagioclase, Biotite, Hornblende and Microcline. Chlorite, Sericite and ore occur as accessory minerals. The Biotite has been partially Chloritized while the Plagioclase has been sericitized as a result of retrograde reaction. Biotite and Hornblende define the foliation along with elongate porphyroblasts of Plagioclase (Fig 3c).

Granitic Gneiss

The rock is medium-grained and contains Quartz, Microcline, Plagioclase and minor Biotite. Accessory minerals include Epidote, Sphene and Chlorite. Crystals of Quartz are xenoblastic. Aligned crystals of Biotite define the foliation.

AMPHIBOLITE

The decussate textured Amphibolite is fine-grained and the major mineral constituents are Hornblende and Plagioclase which formed decussate texture of subhedral laths and prisms (Fig 3d). Mylonitic Amphibolite exhibits Hornblende and Plagioclase where Hornblende grains define a strong foliation (Fig 4a). Minor Quartz occurs in thin section.

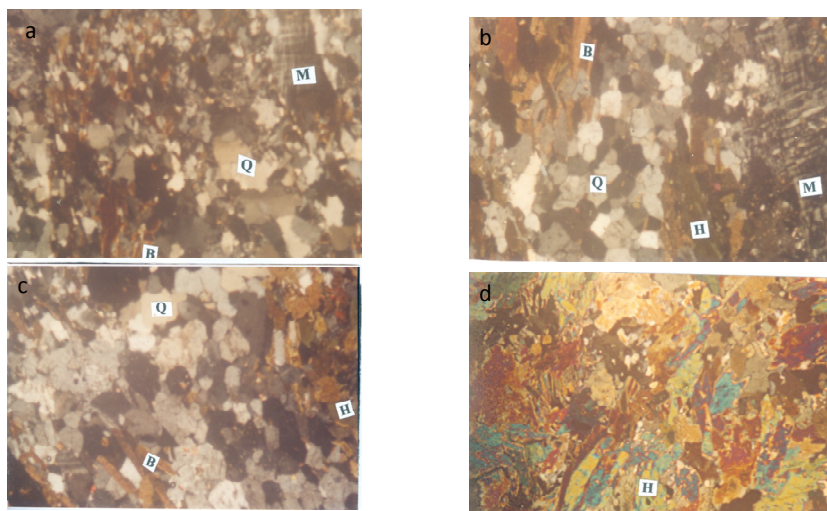


Figure 3. (a) Photomicrograph of migmatitic gneiss showing elongate microcline (M) biotite (B) defining the foliation. Crossed Nicols, magnification X40; (b) Photomicrograph of migmatitic gneiss showing elongate microcline (M) biotite (B) and hornblende (H) defining the foliation. Crossed Nicols, magnification X40; (c) Photomicrograph of augen gneiss. Crossed Nicols, magnification X40 (Q – Quartz, B – Biotite, H – Hornblende); (d) Photomicrograph of amphibolites showing a decussate texture. Crossed Nicols, magnification X40 (H - Hornblende).

METASEDIMENTS

Quartz-biotite-muscovite schist

The rock is medium-grained and the major mineral constituents are quartz, Plagioclase, biotite, muscovite and

Granodiorite

This rock type is medium-grained. It consists of quartz, plagioclase and biotite as major constituents. Microcline occurs as minor constituent. Accessory minerals presents include sericite, epidote and ore. Quartz constitutes about 30% of the slide. It is colourless and occupies the interstitial spaces between plagioclase and microcline. Crystals of plagioclase are anhedral (Fig. 5c). Phenocrysts of muscovite can be seen in some sections. There is extensive sericitization of the plagioclase.

Biotite-muscovite granite

This rock type is medium-grained. It consists of quartz, microcline, plagioclase, biotite and muscovite. Chlorite and ore occur as accessory minerals. The biotites have been partially chloritized. Plagioclase exhibits albite twinning.

Pegmatite

The rock is coarsed-grained. Mineral constituents include quartz and microcline. Microcline exhibits ovoid to lensoid grains which are occasionally fractured in a groundmass of quartz and microcline (Fig. 5d). Anhedral crystals of equigranular quartz form the groundmass.

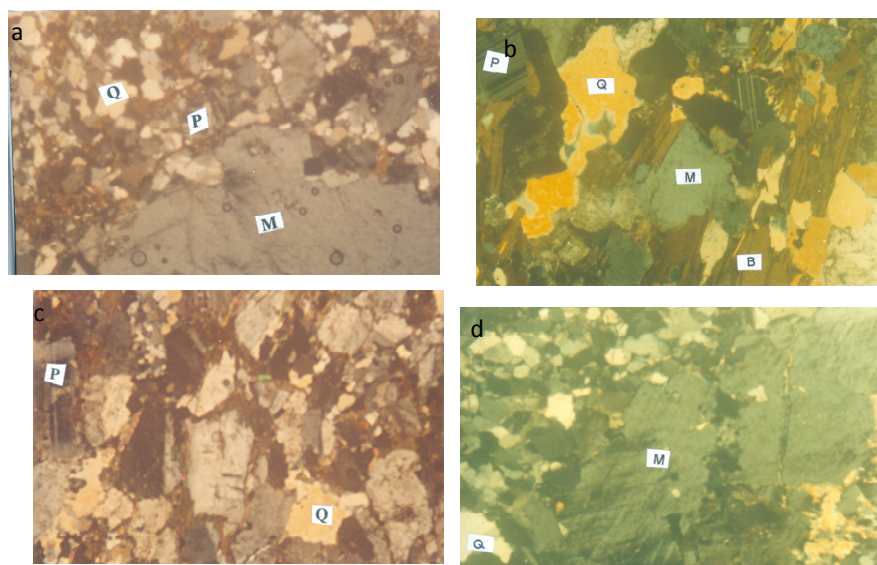


Figure 5. (a) Photomicrograph showing phenocryst of microcline (M) in porphyritic granite. Crossed Nicols, magnification X40 (Q - Quartz, P- plagioclase); (b) Photomicrograph of Biotite granite showing abundant biotite (B). Crossed Nicols, magnification X40 (Q - Quartz, P- plagioclase); (c) Photomicrograph of granodiorite. Crossed Nicols, magnification X40 (Q - Quartz, P- plagioclase); (d) Photomicrograph of Pegmatite showing lensoid microcline (M). Crossed Nicols, magnification X40 (Q-Quartz).

DISCUSSION

The metamorphic mineral assemblages of the lithologies in the study area are examined. Miyashiro (1973) approach to characterization of assemblages which recognizes only the set of stable minerals in mutual contact with each other as constituting a metamorphic assemblage is adopted. The description of metamorphism of the rocks of Oke-Awun area will be done based on the gneisses, amphibolites, and quartz-biotite-muscovite schists. Mineral assemblages identified are used in characterization of the metamorphic facies attained in the area, based on the comparison with the equilibrium mineral assemblages as given in Miyashiro (1973).

The migmatitic gneiss exhibit the following primary mineral assemblage; quartz plagioclase-hornblende-microcline-biotite. This assemblage indicates middle Amphibolite facies. The partial retrogression of some primary minerals such as plagioclase being altered to sericite and epidote, and biotite being partially chloritized gave rise to a secondary mineral assemblage. The secondary assemblage; quartz-chlorite-sericite-epidote, indicates greenschists facies. The Augen-gneiss exhibits the following mineral assemblage; quartz-plagioclase-hornblende-microcline-biotite. This mineral assemblage is indicative of middle amphibolite facies. Also partial retrogression of biotite to chlorite and plagioclase to sericite gave rise to a secondary mineral assemblage of quartz-chlorite-sericite, which characterizes the greenschist facies.

The amphibolite has a mineral assemblage of quartz-plagioclase-hornblende. This mineral assemblage characterizes the Amphibolite facies. The quartz-biotite-muscovite schist exhibit the mineral assemblage; quartz-plagioclase-biotite-muscovite which is characteristic of the middle amphibolite facies.

From the above discussion, it is evident that two episodes of metamorphism affected the rocks of Oke-Awun area. These are the amphibolite facies (M_1) event which was later over-printed by a retrograde facies (M_2) episode.

CONCLUSIONS

The Oke-Awun area is underlain by migmatitic-gneisses, augen gneisses, quartz-biotite-muscovite schists, quartzites, amphibolites, granites and pegmatites. The gneisses are medium grained rocks with mineral constituent which include quartz, plagioclase, biotite, hornblende, microcline and accessory minerals such as chlorite, sericite, sphene, epidote and ore minerals. The amphibolite are medium-fine grained and are characterised mainly by hornblende and plagioclase with minor quartz while the metasediments are characterized by quartz, plagioclase, biotite, muscovite, microcline and epidote. The granites are made of quartz, biotite, plagioclase, microcline, chlorite, epidote, sericite and muscovite. The metamorphic rocks have been subjected to regional metamorphism up to the amphibolite facies and later overprinted by a retrograde greenschist facies episode.

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ABOUT THE AUTHORS

Ismail O. Folorunso

Ismail holds a Masters degree in Geology from the University of Ilorin and presently lecturing with the department. His research interest is in the area of Economic Geology. He is currently working on the characterization of Copper mineralization in middle Benue Trough for his Ph.D. research programme.

C.T. Okonkwo

Dr Okonkwo holds a doctorate degree in Geology from Keele University, United Kingdom and is currently an Associate Professor of Geology with Federal University of Technology, Akure, Nigeria. His research interest is in the area of petrology, geochemistry and structural geology.