

STRUCTURAL GEOLOGY OF OKE-AWUN ROCKS, SOUTHWESTERN NIGERIA

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Abstract

Rocks found in Oke-Awun area include older units of gneisses; migmatitic gneisses, augen gneisses, metasediment; quartz-biotite-muscovite schists, and quartzites and amphibolites which have been intruded by granites, granodiorites and pegmatites of probable Pan African (ca 600 Ma) age. Three episodes of deformation have been recognized in the area. The first deformation (D_1) was associated with the development of penetrative foliation in the metamorphic rocks. The second deformation (D_2) gave rise to asymmetric folds in the migmatitic gneisses and quartz-biotite-muscovite schists which locally deformed D_1 . The third deformation (D_3) involved the formation of transcurrent faults which cuts all the rocks in the area. The metamorphic rocks have been deformed into a NNE-SSW trending synform and cut by two major approximately N-S trending sub-parallel dextral transcurrent faults.

Keywords: Transcurrent fault, Synform, Dextral, Asymmetric fold

Introduction

Studies in the northern part of the southwest Basement complex town of Jebba 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). The present study however intends to assess the distribution, field characteristics and relationships of the basement rocks of Oke-Awun area, produce a detailed geological map of the area and to elucidate the type and style of structures.

Methodology

The field work of this project commenced in November 2001 to November, 2002. During the field work, exposed rocks in Oke-Awun area were mapped and small chunks of rock samples were broken with the aid of a sledge hammer labeled and locations identified with the aid of a Global Positioning System. Structures were mapped and structural data collected with the aid of compass clinometer.

Field relationship

The Biotite - muscovite granite are discordant bodies intruding the country rocks. A synform was observed Southwest of Oke-Awun trending across the augen gneiss, granite gneiss and migmatitic gneiss. Two major transcurrent faults run across the Oke-Awun area and mimicked by the Oke-Awun River.

Geology of Oke-Awun area

The Oke-Awun area is underlain by rocks of the Nigerian Basement Complex. In the area, four major rock units have been recognized namely gneisses, metasediments, amphibolites and granites. The gneissic rocks occupy about 20% of the area. It comprises migmatitic gneiss, augen gneiss, and granitic gneiss. Migmatitic-gneiss is the dominant of these rock types.

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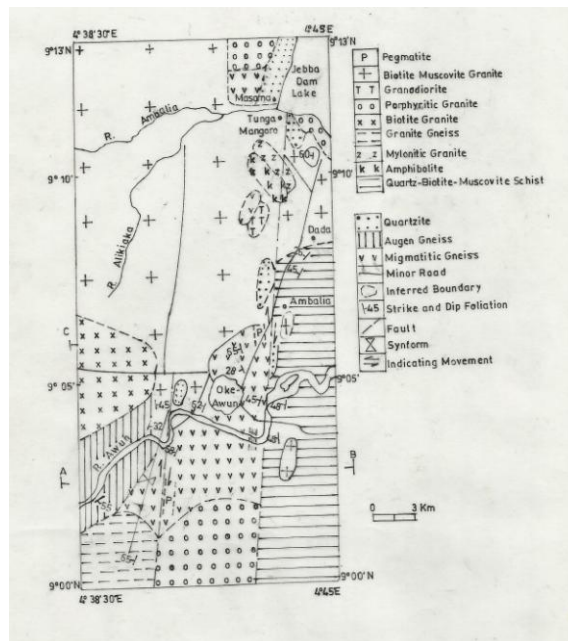


Fig. 1: Location and geological map of Oke-Awun area

Migmatitic gneiss outcrops in and around Oke-Awun and in areas southwest, southsouth, southeast and north of Oke-Awun (Fig. 1). The gneiss is generally dark-grey in colour. It is medium grained and shows a dominantly north-south foliation trend. It outcrops as low-lying rock bodies. The outcrop in the area is a sequence of variably migmatitic-gneisses with concordant quartzo-feldspathic segregations and bands (Fig. 2a). Banding in the gneiss varies in thickness and persistence. The thickness of individual bands may vary from fraction of a centimeter to several centimeters.

In places, the bands may be continuous while elsewhere, a single band may split into smaller units. The dark bands are rich in biotite and hornblende while the light bands are made up of quartz and feldspar (plagioclase). Minor folds, joints and minor shears are structures seen on the migmatitic gneiss. The gneiss is intruded by pegmatites. Augen gneiss outcrops in the area southwest of Oke-Awun (Fig. 1) are bounded in the east by the granitic gneiss and migmatitic gneiss. It is characterized by feldspathic augens enclosed by the foliation, which is defined by the alignment of mafic minerals and quartz (Fig. 2b).

Granitic gneiss unit is only exposed in an area southwest of Oke-Awun (Fig. 1). The Granitic gneiss is generally a medium grained rock, showing weak foliations. It is light in colour, and contains quartz, biotite and microcline.

Amphibolite outcrops in the southern and northern part of the area (Fig. 1). The outcrops are found in river valleys. 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. Mylonitic amphibolite occurs in the northeastern part of the area. It occurs within the shear zone and is bounded by the mylonitic granite. The outcrop is typically dark in colour and fine-grained. Foliation is defined by strong alignment of hornblende (Fig. 2c). The metasedimentary rocks comprise quartz-biotite –muscovite schist and quartzite. They occupy about fifteen percent of the area. These rock types occur mainly in the eastern part of the area (Fig. 1). The quartz-biotite-muscovite schist occurs mainly in the southeastern and also in the northeastern part of Oke-Awun area (Fig. 1). It is a medium grained rock (Fig. 2d) and contains quartz, biotite and muscovite. This rock type are exposed in river valleys and also found outcropping in places southeast of Oke-Awun and south of Dada. Locally they contain siliceous bands possibly representing more psammitic layers and reflecting original sedimentary grading. Quartzite is exposed as discontinuous north-south trending outcrops, forming impressive topographic features northeast of Oke-Awun (Fig. 1). Also Quartzite outcrops as a hill west of Oke-Awun. The Quartzite bodies are bounded by granites. The quartzites have been locally fractured and faulted (Fig. 2e).

Granitic rocks occupy more than fifty-five percent of the area. These are represented in the area by varieties of Granites such as Mylonitic Granites, Porphyritic Granite, Biotite Granite, Biotite-muscovite granite, Granodiorite and Pegmatite. Mylonitic Granites outcrop south of Tunga-Mangoro in the northeastern part of the area mapped (Fig. 1). It is a fine-grained rock formed from originally coarse-grained Porphyritic Granite. It exhibits a foliation defined by aligned felsic and mafic minerals. The minerals present are Quartz, Biotite Microcline and Plagioclase. Porphyritic Granites occur north of Masama village, and south of Oke-Awun.

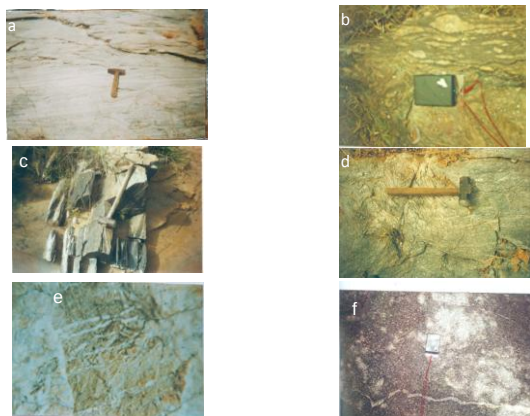


Figure 2. (a) Banding in Migmatitic gneiss; (b) Augen gneiss; (c) Mylonitic Amphibolite; (d) Quartz-biotite-muscovite schist, exhibiting crenulation cleavage; (e) Cataclastic Quartzite cut by a network of later Quartz-veins; (f) Porphyritic Granite.

Generally, they are pinkish in colour and are coarsely grained with Microcline phenocrysts set in a matrix of Plagioclase, Quartz and Biotite (Fig. 2f). Biotite-granite occurs West of Oke-Awun. It occurs as hilly outcrops and also as scattered sub-elliptical bodies. It is generally dark grey in colour and contains minerals such as Quartz, Plagioclase, and Biotite. The rock is highly jointed. Granodiorite is exposed mainly in the area north of Oke-Awun. It is generally light coloured. It outcrops as scattered boulders in the northern portion of the area. It is generally medium-grained and contains Quartz, Plagioclase and Biotite. Biotite-muscovite granite is the dominant of the Granites. It occupies a large portion of the northern part of the map. (Fig. 1) It is generally light in colour. It is coarsely-grained and occurs as scattered boulders and elliptical bodies. They contain relicts of older rocks (Fig. 3a). Pegmatite occurs southwest and northeast of Oke-Awun as an intrusion in the Migmatitic gneiss (Fig. 3b). It is medium-grained. It trends in a north south direction and about a meter wide.

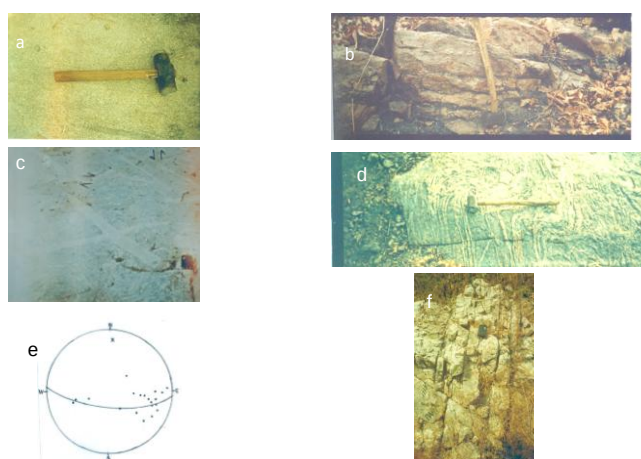


Figure 3 (a) Biotite-muscovite granite; (b) Pegmatite; (c) Migmatitic gneiss with cross-cutting pegmatite vein which have been faulted. The pegmatite vein exhibits conjugate faulting in some places; (d) Minor folds in migmatitic gneiss; (e) Equal area stereographic plots of poles to foliation (solid dots) from Oke-Awun area. X- Represents the major fold axis; (f) Joints in quartzite.

Structural geology

Oke-Awun area has undergone some tectono-metamorphic events, resulting in the deformation of the rocks. Structural elements resulting from the deformation are ductile and brittle features. The ductile structures include foliations and folds while the brittle features include fractures (joints and faults).

Foliations

The earliest penetrative structure of the area is the planar metamorphic fabric of the migmatitic gneiss and quartz-biotite-muscovite schist. The first deformation D_1 , produced the penetrative foliation S_1 , and the development of concordant quartzo-feldspathic segregations (Fig. 2a) in both the migmatitic gneiss and quartz-biotite-muscovite schist (Fig. 2d). Foliation is well developed in most of the rock types, but is indistinct in some. One foliation trend is dominant throughout the area and this is consistent with the regional strike of foliation, which is essentially north-south with some variations.

Foliation is strong in the migmatitic gneiss, and is marked by alternating bands of dark and light minerals (Fig. 2a). The schistosity of the Quartz-biotite-muscovite schist is well-developed, due to parallel orientation of the micas. Foliation in the mylonitic amphibolite is strong, marked by impersistent quartzo-feldspathic layers and aligned amphibole prisms (Fig. 2c). The alignment of microcline porphyroblast and quartz ribbon imparts a strong foliation in the mylonitic granites. Foliation is weak in the granitic gneiss of the area.

Minor Folds

Minor folds are common in the migmatitic gneiss and to a lesser extent in the quartz-biotite-muscovite schist. The minor folds occur as asymmetric folds of the compositional banding (S_1) in the migmatitic gneiss and the schistosity (S_1) in the quartz-biotite muscovite schist (Fig. 3d and Fig. 2d). They are a series of open to close asymmetric folds with vertical axial planes, trending northwest-southeast. In some places in the quartz-biotite-muscovite schist, there is corrugation of the foliation by minor folds which resulted into the formation of crenulation cleavage (Fig. 2d).

Only a fold type can be identified on the migmatitic gneiss and quartz-biotite muscovite schist in contrast to the report from Jebba area (Okonkwo, 1992 and Annor, 1998), where more than one fold types were recognized in these areas, in the southwestern sector of the Nigerian Basement Complex. This may be due to the poor exposure of the rocks in Oke-Awun area. The minor folds are results of the second deformation (D_2) in the area.

Minor Faults and Joints

Minor faults are seen in the migmatitic gneiss of the area. The sense of displacement of these faults is dextral. In some locations, conjugate minor fault system is observable (Fig. 2c). Joints characterize most outcrops in the area. Joints are frequently seen in quartzites (Fig. 2f) and gneisses and to lesser extent in the granites.

Result and Discussion

One major fold, the Oke-Awun synform has been established in the area, from the orientation of the foliation and dip directions and also from the vergence of minor folds. This fold is cored by gneisses (migmatitic and augen gneiss) in the south (Fig. 1). Equal area stereographic analyses of poles to foliation (Fig. 2e) indicate that the fold axis trend almost north-south (003°) and its axis plunges 18° to the north.

The third deformation D_3 involved the formation of faults, which affected most of the rocks of the area. The dominant north-south structural trend associated with folding on steep axial planes has been reported from many parts of the Nigerian Basement Complex (Truswell and Cope 1963, Rahaman 1976, McCurry 1976, Holt et. al., 1978, Grant 1978, Fitches et. al., 1985, Annor, 1986, Okonkwo, 1992). This structural orientation is generally regarded as Pan- African imprint.

Major Faults

Two major lineaments which are indicated on the map of the area by rectilinear drainage pattern suggest the presence of two sub-parallel faults trending approximately north-south in the area. The faults have been confirmed by ground geological mapping by the presence of cataclasites along these lineaments. The sense of displacement along the faults as suggested by minor faults in the area is dextral. The cataclastic quartzites which principally defined the fault zones confirm that the faults are dextral transcurrent faults. This fault type has been reported in the north western part of Nigeria (McCurry, 1976). These faults cut all the rocks in the area and are therefore late-tectonic.

Conclusions

The Oke-Awun area is underlain by Migmatitic-gneisses, augen gneisses, quartz-biotite-muscovite schists, quartzites, amphibolites, granites and pegmatites. Generally N-S structural trends characterise the basement rocks of Oke-Awun area. The area has undergone deformational events, resulting in the development of penetrative planar metamorphic fabric and major folding. A synform trending approximately NNE-SSW has been recognised. Two major sub-parallel N-S trending dextral transcurrent faults have been mapped in the area. The rocks of the area are similar to those of the Central Hoggar and the faults systems are probably a continuation of the Central Hoggar fault system into the Nigerian province.

Acknowledgment

This paper forms part of a M.Sc. dissertation that was undertaken at the University of Ilorin under the supervision of Dr C.T. Okonkwo. Many thanks to Mr. Odediran for his assistance during the field work. Special thank is extended to Dr. O.A. Adekeye for his contribution during the course of the research.

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