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Petrography and Mineralogy of Part of the Gold Schist Belt around Esa-Oke and Environs, Southwestern Nigeria

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Abstract

Esa-Oke, situated within the Ilesha Schist Belt of southwestern Nigeria, was the focus of this study aimed at conducting detailed geological mapping to identify geological structures, analyze the petrography of various rock types, determine the metamorphic facies, and evaluate the industrial potential of the rocks in the area. Field mapping facilitated the delineation of lithological units, textures, structural features, mineralogy, and modes of occurrence. Rock samples of granitic gneiss and quartzite were collected and analyzed petrographically through thin section preparation and examination under a petrographic microscope. Modal analysis of the granitic gneiss revealed the following mineral composition: Quartz (22.5%), Plagioclase (25.3%), Biotite (15.9%), Hornblende (8.4%), Microcline (15.2%), Sericite (0.6%), and Epidote (0.2%). The quartzite sample consisted predominantly of Quartz (90%), with Muscovite (6%) and Fibrolite (4%). Structural features such as foliation, joints, and folds were observed in both lithologies. Strike directions ranged from 02° to 71° (average: 32°), with dip trends of 45°E to 62°E (average: 46°E) and 22°W to 62°W (average: 40°W). Joint orientations ranged between 168° and 175°, with an average of 172°. The primary mineral assemblage in the granitic gneiss includes

Quartz + Biotite + Microcline + Plagioclase + Hornblende, while secondary minerals include Sericite and Epidote. Quartzite is characterized by a mineral assemblage of Quartz + Muscovite + Fibrolite. These assemblages are indicative of amphibolite facies metamorphism. The petrographic and structural characteristics confirm that the area forms part of the Migmatite-Gneiss-Quartzite Complex of Nigeria. Both granitic gneiss and quartzite in the study area are suitable for use as construction aggregates, particularly in road construction.

Keywords: Petrography; Metamorphic Facies; Modal Composition; Mineral Assemblage; Aggregate

Introduction

Nigeria lies approximately between latitudes 4° 30'N to 14° 30'N and Longitudes 2° 45'E to 14° 30'E. The Basement complex of Nigeria is part of the mobile belt that separates the West African and Congo Cratons (Kroner *et al*., 2001). Almost half of the land space in Nigeria takes up the basement complex and the other half is occupied by the sedimentary basin (Woakes et al 1987). The Basement complex of southwestern Nigeria is segregated into Migmatite-gneiss complex, Migmatized meta-igneous units, Charnockitic rocks, The Older granites, and Un-metamorphosed dolerite dykes and pegmatite (Rahaman, 1976). Geological field mapping and petrographic studies play a major role in the depiction and identification of various rock types and mineralogy which supply beneficial knowledge in the exploration and exploitation of any associated economic mineralization (Omanayin et al, 2023). Geological mapping exercise is important in the interpretation and reconstruction of geologic events in any environment (Obini and Omietimi, 2020).

The rocks of Ilesha area have undergone multiple cycles of metamorphism which is most likely prevalent in Eburnean and Pan-African tectonothermal events. Oyinloye (2011). Rahaman (1988), submitted that the southwestern Basement of Nigeria is within the zone of Pan-African reactivation 600±150 Ma. Rahaman and Ocan (1978), concluded that the migmatite-gneiss-quartzite complex occupies about 60% of the surface area of the Nigerian basement. Rahaman (1988) noted that the quartzite sequence within Ilesha area is referred to as part of Effon Psammite Formation and form a N-S trending ridge in the northern part of the study area. Bamisaye and Ajala (2021) worked on Pan African Nappe system at the Okemesi and stated that the fold in quartzite at Effon Psammite which extends to part of

Ilesha schist belt resulted from the interaction of shear zones and penetrative foliation planes.

Location and Accessibility

The study area of Esa-Oke, Esa-Odo, Iloko, Ijebu-Ijesha and their environs lies within the Ilesha schist belt in southwestern Nigeria. The study area is situated between Longitude E 4°44' 00"– E4°54'55" and Latitude N7°38'00" – N7°47' 15" and covers approximately 350km^2. It is part of topographical sheet 243 (Ilesha) produced by Nigeria Geological Survey Agency (Fig. 1). The area is made up of relatively of high ridge of quartzite in the northeastern part and granitic gneiss on the eastern part, while the central and southwestern part is of low land composed of quartzite.

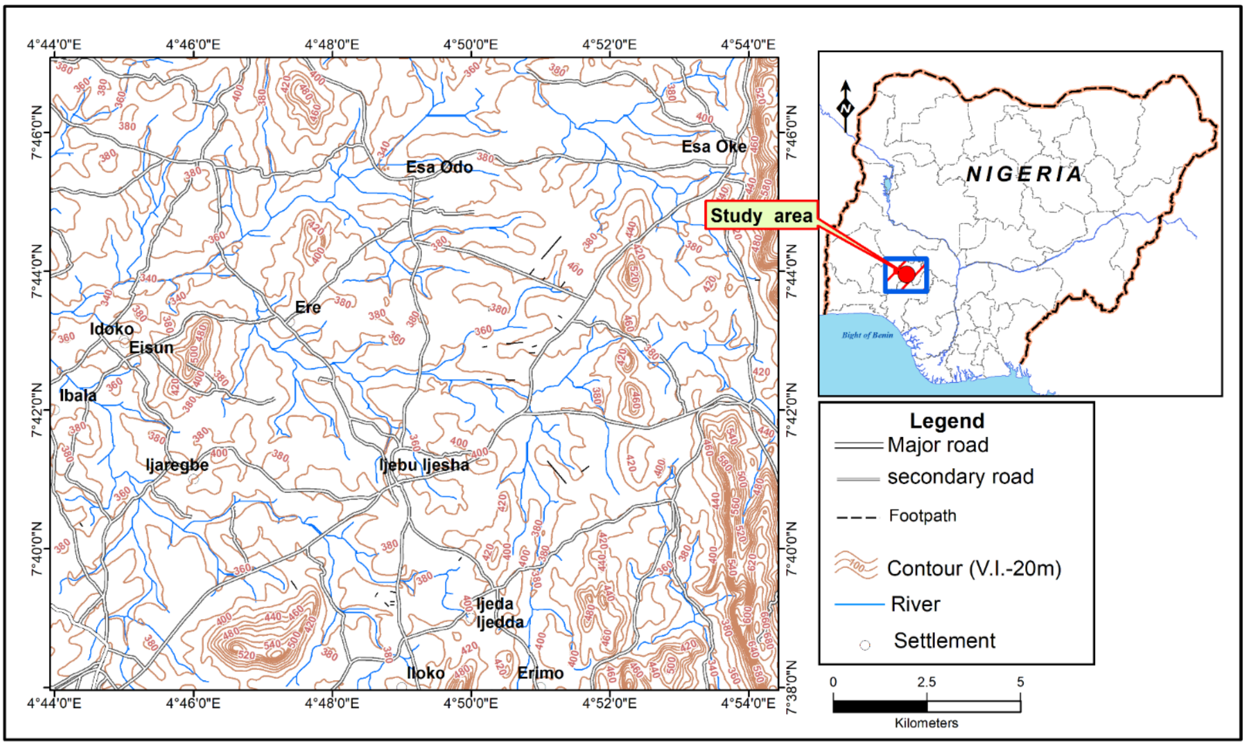

Figure 1: Topographical map of the study area

Geological Setting

The study area is located within the basement complex of Nigeria, a part of the Pan-African mobile belt east of the West African craton consisting of granitic gneiss and quartzite. Rahaman (1988) grouped the basement complex rock into six major groups namely; Migmatite-gneiss quartzite complex; Younger metasediments also called the schist belts, Charnockitic, gabbroic and dioritic rocks; Older granite; Volcanic and hypabyssal rocks; Unmetamorphosed doleritic dyke, basic and syenite dykes. The migmatite-gneisses-quartzite complex occupies about 60% of the surface area of the Nigerian basement (Rahaman and Ocan, 1978). These rocks record three major geological events (Rahaman and Lancelot, 1984). The earliest at 2500 Ma, involved commencement of crust forming processes and crustal growth by sedimentation and orogeny, followed by the Eburnean, 2000 ± 200 Ma, marked by Ibadan type granitic gneisses. This followed by ages in the range from 900 – 450 Ma which represent the indentation of the Pan African event. This structurally reset many geochronological clocks in the older rocks and also generate the granitic gneisses, migmatites and other similar rocks.

The Older Granite suite represents a diverse and long lasting (750 – 450 Ma) magmatic cycle associated with the Pan-African orogeny. The rock inn this group varied in composition consisting tonalite, diorites, granodiorite, granites and syenites. The Older Granite suite is prominent for its general lack of associated mineralization, although the thermal effects play a role in the remobilization of mineralizing fluids.

Field Geology and Petrography

Attention were given to the mode of occurrence, field relations, identification of geological structures present in the studied area, determination of distribution and petrography of various rock types present, delineation of the lithology, texture, mineralogy and mode of occurrence of various rock types. A simple random sampling method was employed. Samples of the studied outcrops were collected using sledge hammer and the locations were recorded with the aid of Global Positioning System (GPS), careful observations of landform and road cuts were done during the mapping exercise. Rocks were studied and described adequately noting their field relationship, mineralogy, structures and mode of occurrence. Strike and dips of foliations were measured using Silvia ranger compass/clinometers. Photographs of features on the outcrop were taken with camera. Representative outcrop samples were collected, labeled for laboratory studies (petrographic analysis). Careful observations were made on the geologic structures.

Granitic gneiss

The granitic gneiss underlies the northwestern part and southeastern part of the study area and occur as hilly, extensive outcrops. Outcrops of granitic gneiss are dominant in northwestern part especially at Oke-Ogun at Ere town. In other parts such as Ijeda, Oke-Ila, Orisi and Orita-Ijeda, it is poorly exposed. In some of the localities, the outcrops are weathered but the textural features are still preserved. The rock has a well developed planar preferred orientation of minerals with average 13^{o}strike, 53^{o}E dip, 39^{o} strike and 35^{o}dip. Texturally, the rock is medium – coarse grained. In some areas, the granitic gneiss contains concordant quartz veins as seen in Figure 2.

It has a well-developed planar orientation of minerals. It consists of quartz, plagioclase, microcline, biotite, hornblende and opaque mineral.

The granitic gneiss consists of minerals like quartz, plagioclase, microcline, biotite, hornblende and opaque (Table 1). Quartz is colorless under plane polarized light and has grey or white interference color under crossed nicols. It makes up about 22.5% of the rock. Plagioclase shows albite twinning (polysynthetic twinning) under crossed nicols. It has low relief and makes up about 25.3% of the rock. Biotite is brown under polarized light and exhibits pleochroism from brown to yellowish brown, having its maximum absorption when the trace of the cleavage is parallel to the vibration direction of the lower polars. It makes up about 15.9% of the rock. Hornblende is brownish green under plane polarized light and its pleochroic. It has two directional cleavages and shows moderate birefringence. It makes up about 8.4% of the rock. Microcline is colorless under plane polarized light and shows cross hatching twinning under crossed nicols. It makes up aboiut 15.2%. sericite is colorless in thin section and has a birefringence and a moderate relief. It makes up about 0.6%. epidote is 0.2% and opaque is 11.9%(Figure 3).

Table 1: Percentage modal composition of Granitic gneiss

S/N	Minerals	Percentage Modal Composition
1.	Quartz	22.5
2.	Plagioclase	25.3
3.	Biotite	15.9
4.	Hornbende	8.4
5.	Microcline	15.2
6.	Sericite	0.6
7.	Epidote	0.2
8	Opaque	11

Figure 2: Granitic gneiss in the studied area

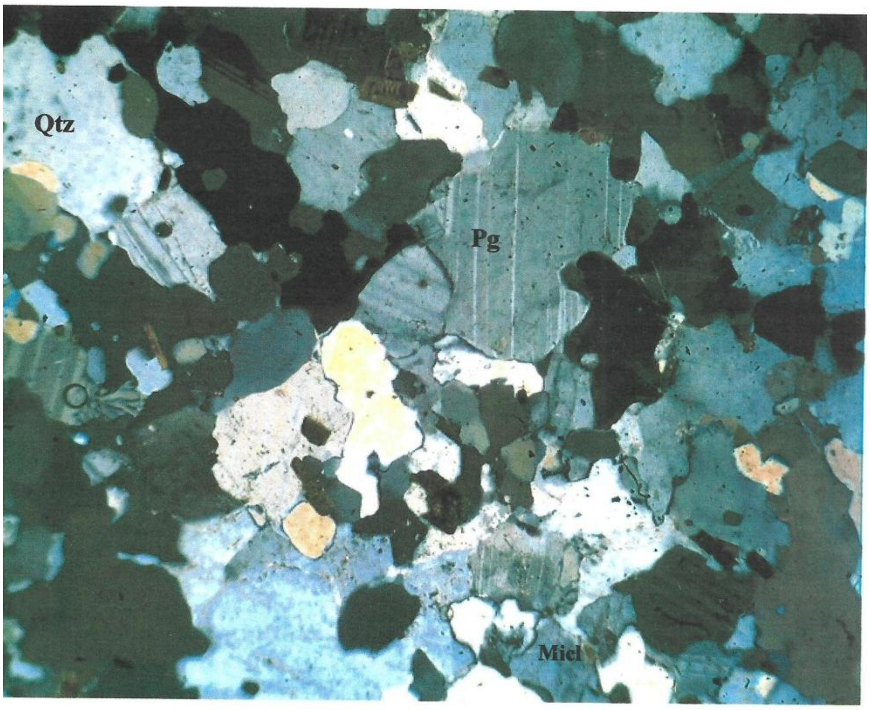

Figure 3: Photomicrograph of granitic gneiss under crossed nicols (X40)

Pg – Plagioclase

Qtz – Quartz

Mic - Microcline

Quartzite

The quartzite forms impressive high topographic outlook which rise about 250m above the surrounding terrain. In general, the quartzite ridges occur in Esa-Oke town. It occupies the northern part and the southwestern part of the map area. Although the quartzites form a good topographic feature, they seldom form good outcrops, the ridges being marked with rubbles. Most of the quartzites are uniformly grayish but in parts, they are milky white (Fig 4). Outcrop of quartzite occupy a wider portion of the entire studied area, most of the outcrops encountered are slightly weathered.

This rock is light grey in hand specimen. It is medium to coarse grained. The mineral observed in thin section are shown in Table 2.

Quartz is colorless under plane polarized light and it is light grey or has white interference color under crossed nicols. It makes up about 90% of the rock. Muscovite is colorless under plane polarized light, it has moderate relief. It makes up about 6% of the rock. Fibrolite occurs as acicular crystals and fibrous masses. Its cleavage is not normally conspicuous and has high positive relief. It makes up about 4% of the rock. Figure 5 shows the photomicrograph of quartzite under crossed nicols.

Table 2: Percentage modal composition of Quartzite

S/N	Minerals	Percentage composition
1.	Quartz	90
2.	Muscovite	6
3.	Fibrolite	4

Figure 4: Quartzite in the study area

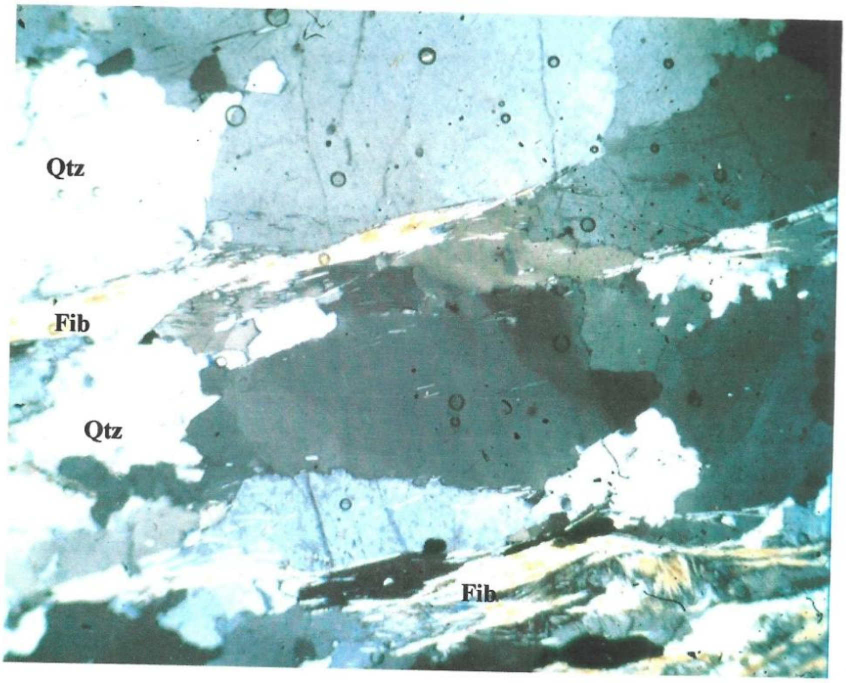

Figure 5: Photomicrograph of quartzite under crossed nicols (X40)

Qtz= Quartzite, Fib= Fibrolite

Structural Geology

There are some structural features observed in the granitic gneiss and quartzite in the study area. The structures include foliations, joints and folds.

Foliations

The foliation observed in the Esa-Oke area is caused by preferred orientation of phyllosilicates. The rock has preferred orientation developed as a result of differential stress on the rock. The granitic gneiss displays preferred orientation of mineral due to the deformation and recrystallization. Also, foliation in quartzite is as a result of differential stress during metamorphism resulting in layering. It has profound effect on the texture of quartzite. The following are the strike and dip of foliations that were obtained in the studied area: 002°/45°E, 024°/52°E, 015°/62°E, 040°/26°W, 024°/46°W, 021°/44°W, 071°/22°W, 39°/35°W, 13°/53°E and 28°/49°E. They are presented in the Rose diagram below (Figure 6). The foliation is generally trending in northeast to southwestern direction.

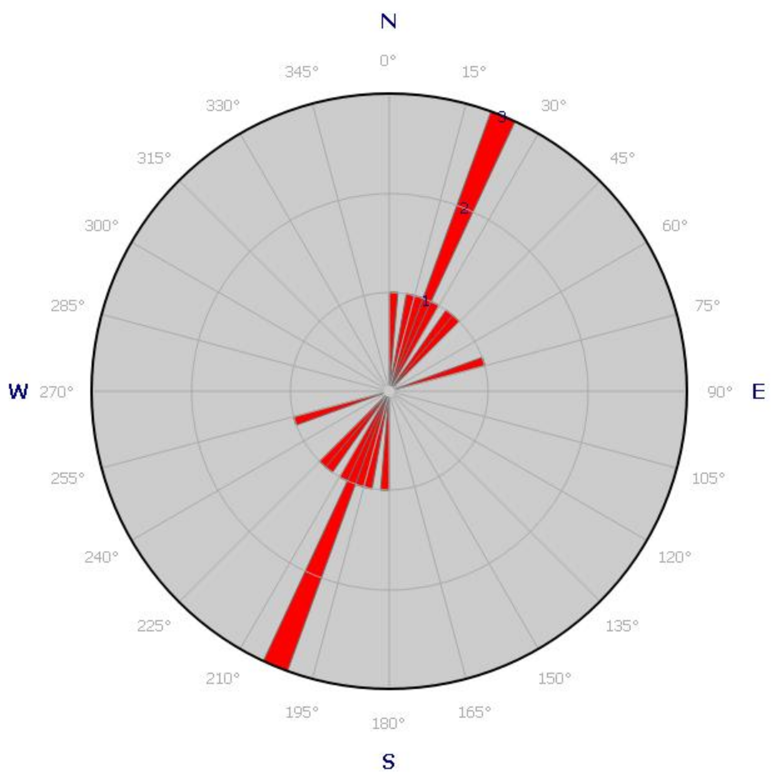

Figure 6: Rose diagram showing Northeast - southwest trend of foliation in the study area

Jointing

Joints occur in granitic gneiss and quartzite in the study area. They are features along which there has been no significant movement parallel to the plane of the structure. In metamorphic rocks, joints commonly occur in sets that have been filled by veins. Joints commonly develop from primary or secondary tensional stresses resulting from stored stress in the rock, but may also develop from active shear or tensional stresses. The orientations of the joints are 168°, 174°, 170°, 175°, 173°(Figure 7).

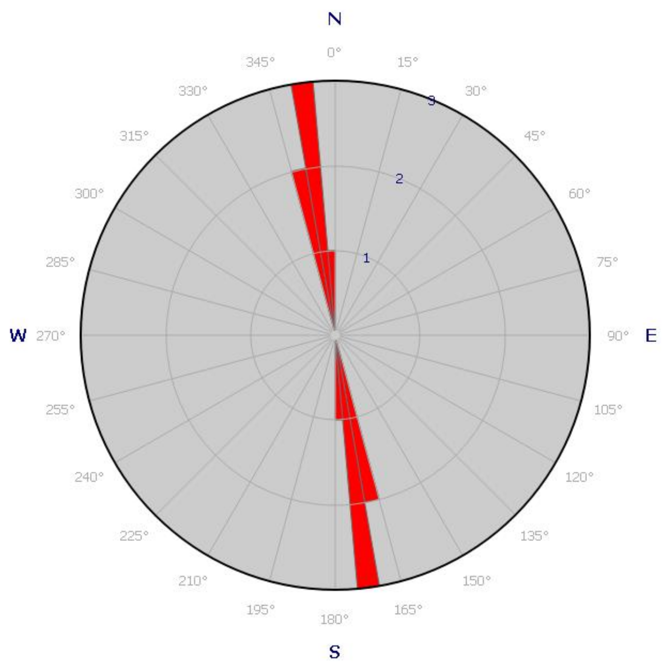

Figure 7: Rose diagram of the predominant joint direction.

Fold

Fold occur in granitic gneiss forming an antiform and synform. This can be seen from the interpretation of the cross-section.

Metamorphism

The resulting mineral assemblage developed in granitic gneiss is quartz + biotite + microcline + plagioclase + hornblende and the secondary mineral assemblage is sericite + epidote. The mineral assemblage in quartzite is quartz + muscovite + fibrolite. The mineral assemblages are indicative of amphibolite facies of metamorphism. The metamorphic mineral assemblage observed in the study area as in part of the basement complex of south-western Nigeria suggest that regional metamorphism in granitic gneiss and quartzite is indicative of amphibolites facies of metamorphism.

Discussion

The quartzite is a metasediment which was formed from sandstone. The sandstone was deposited, lithified and metamorphosed to quartzite. The granitic gneiss was formed from a granitic rock which was metamorphosed, deformed and folded forming an antiform and synform (Fig. 8). The quartzite can be used in making crystal glass if subjected to advance technology, this is as a result of the purity of the quartz. The granitic gneiss can be considered to be good for aggregate and for building construction, considering the low percentage of feldspar content (about 25.3%).

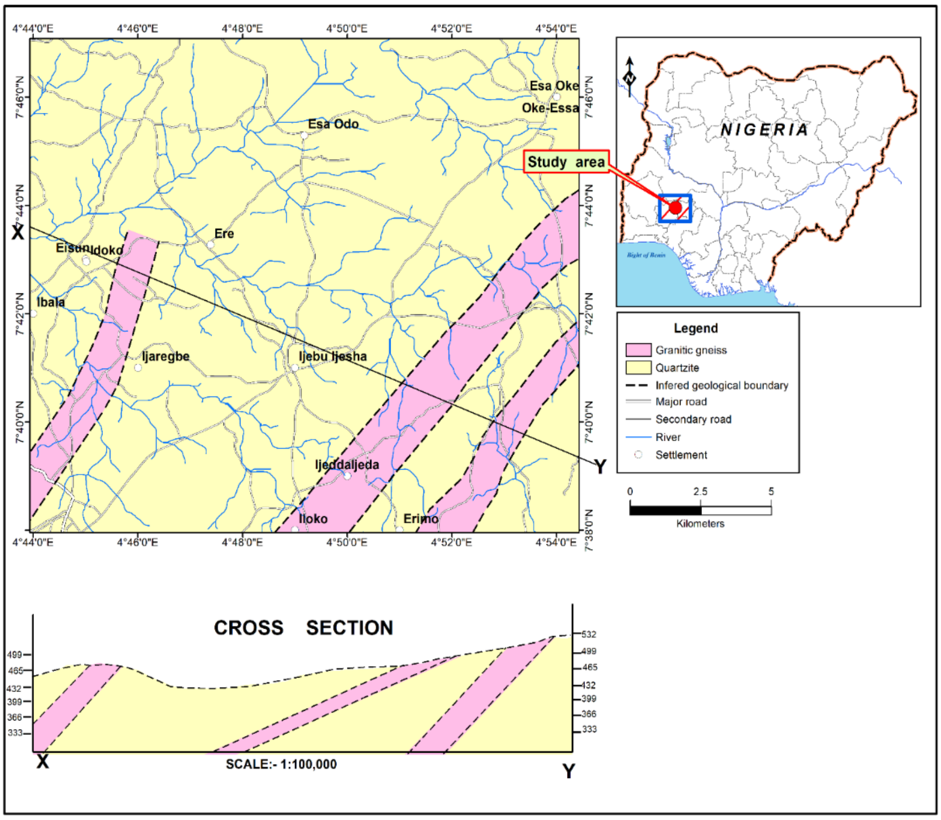

Figure 8: Geological map of the studied area

Conclusion

Esa-Oke and environ is underlain by granitic gneiss and quartzite. The mineral composition of granitic gneiss includes quartz, biotite, microcline, plagioclase, hornblende, sericite, epidote. The mineral composition of the quartzite is quartz, muscovite and fibrolite. The petrographic analysis of granitic gneiss and quartzite reveal that the mineral assemblages developed are indicative of amphibolite facies of metamorphism. From the field observation and petrographic studies, it could be concluded that the studied area is part of the migmatite gneiss quartzite complex of Nigeria. This is supported with the previous work carried out by Rahaman (1988), Oyinloye and Odeyemi (2001), Oyinloye (2011) and Bamisaye (2021).

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