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# Lithogeochemical and petrographic studies of the precambrian rocks around okemesi area, southwestern Nigeria

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**ABSTRACT**

Twenty one (21) rock samples were systematically collected during geological mapping of the study area, while 10 representative samples were selected for geochemical and petrography studies. Six lithologies including Quartzite, Quartz-biotite schist, Banded gneiss, pegmatite, biotite gneiss and biotite schist with well defined boundaries were recognized and mapped in the study area. Thin sections were prepared from the rock, and were studied under the research Petrological Microscope. The results of the petrographic analysis of the thin sections revealed that minerals such as quartz, biotite, muscovite and feldspar (plagioclase, orthoclase and microcline) of variable composition were present in the slides. The presence of these minerals could be as a result of the type and nature of magma responsible for the emplacement of these rocks. However, quartz is the most resistant and dominant mineral in all the slides analyzed. Geochemical analysis was also carried out on the rock samples to determine the trace and rare earth elements in them. The results of the trace elements detected in (ppm) includes; Ba (338), Cd (0.054), Ce (42.19), Rb (129.99), S (0.036), Sr (42.7), Th (4.94), Y (4.97), Zn (29.39), Co (39.18), Cs (1.97), Cu (3.86), Li (5.02) Ni (18.05) and W (179.05). The rare earth elements include; Dy (1.68), Eu (0.58), Ga (9.89), Gd (2.70), Hf(1.07), La (20.69), Nd (18.05), Pr (4.92) and Sm (3.40). The results above revealed that Ba, W, Rb, Ce are extremely high in the rocks of the study area which indicate that the rocks are highly radioactive in nature. The concentration of radioactive elements such as Ba, Rb, Ce are useful in energy provision and modern warfare business. Nevertheless, radioactive elements may produce X-ray which can affect the skin and causes skin cancer and other related diseases. Therefore, detailed exploration program to discover hidden natural resources is hereby recommended for the study area.



## Introduction

The Precambrian rocks around Okemesi and its environs, southwestern Nigeria is one of the three major litho-petrological components that make up the geology of Nigeria. The Nigerian Basement Complex forms a part of the Pan-African mobile belt and lies between the West African and Congo Craton and south of Tuareg shield (Black, 1980). The Nigerian Basement Complex was affected by the 600Ma Pan African Orogeny and occupies the reactivated region which resulted from plate collision between the passive continental margin of the West African Craton and the active Pharusian continental margin (Burke and Dewey 1972, Dada, 2006). The study area covers about half the landmass of the entire Nigerian landscape, and basement rocks studied include Quartzite, Quartz-biotite schist, Banded gneiss, pegmatite, Biotite gneiss and Biotite schist, all of which occupies strategic positions within the study area with well delineated boundaries. The rocks in the study area had undergone polycyclic deformation, thereby causing the formation of both micro and macro structures in them such as foliations, folds of different magnitudes and styles, micro-faults, joints, quartz veins, pegmatitic dykes, fractures, solution holes, veins, veinlets and so on. These structures are observed to be the main factor controlling the drainage pattern in the area. However, the major fold, situated a few kilometres north of Okemesi township, is a NNE-SSW trending antiformal structure, which was formed during the deformational phase of the Pan-African-orogeny (Odeyemi, 1993). Generally, these structures are obviously the product of Pan African orogeny that obliterated most of the earlier structures. Ayodele (2010) carried out a remote sensing and geological evaluation of the Okemesi fold belt southwestern Nigeria, He interpreted the Landsat™ imagery of the area followed by minimum ground truth, the result revealed the presence of overturned antiformal and asymmetric fold in the area and the series of folds and faults observed both on imagery and ground are products of geotectonic activities. Anifowose and Borode (2007) carried out a photogeological study of the fold structure in Okemesi, Southwestern Nigeria and discovered the existence of a series of faults that offset the fold trend. Also, the schists and schistose quartzite display strong foliation and shearing which are indicated by sub-parallel planes. Okunlola and Okorojafor (2009) studied the schistose rocks around the Okemesi fold belt, Ife-Ilesha schist belt with a view to evaluate their compositional feature and petrogenetic affinities and to contribute further to the understanding of the geodynamic evolution of Nigerian's schist belts. Odeyemi et al, (1999) suggested that almost all the foliations exhibited by rocks of southwestern Nigeria excluding the intrusions are tectonic in origin because pre-existing primary structures have been obliterated by subsequent deformations; the general north-south trend of major fractures and foliations within the basement complex is as a result of deformation.

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However, the aim of this work is to carry out geologic, petrography and geochemical studies of the various lithologies in the study area in order to know the associated structures and minerals present.

**Location and accessibility to the study area**

The study area can be located within the latitudes $7^{0}$ $50^{'}$ $10^{''}$ and $8^{0}$ 00"N and longitudes of $4^{0}$ $56^{'}$ $30^{''}$E and $5^{0}$ $01^{''}$ E, covering a total area of 138.45km$^{2}$ (Fig. 1).

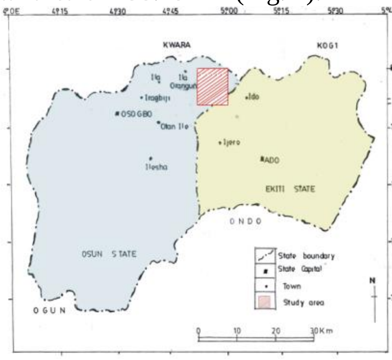


**Fig. 1: Location Map of the Study Area**

It also covers part of the half degree topographical map sheet No 243 (Ilesha NE sheet, scale 1:50,000). The study area shares boundary with Ekiti and Osun states respectively. Major towns within Ekiti state include Ajindo, Kajola, Arapate/Erigbe, Aworo(soso), Makanju etc, while those outside Ekiti State includes Oke-ila, Oba-sinkin and Aiyegunle. The study area can be rated moderately motorable due to the road network systems which include the major and minor roads and also the footpaths which are inter-linked with one another.

The area is generally accessible through a good network of all seasonal roads and motorable tracks which links it with other part of the country. Also villages and towns are interconnected with footpaths. The study area is generally poorly exposed because of the thick vegetation and soil cover and that most of the outcrops have been weathered to clay, a good example is the Quartzite observed at Ajindo which resulted from the metamorphism of sandstone, this makes the rock crumbles into powder when hammered. The few exposures seen in these areas are usually along stream channel and roadcuts. However, the hilly parts are underlain by quartzites which form an extensive ridge system.

**Topography and Drainage**

The topography of the study area is the undulating type, dotted with different outcrops in several places. Most of the rocks in the study area are well exposed and are as high as 250m above sea level, there is prevalence of erosion gullies along hill slopes and valleys.

The drainage system over the area consisting of the basement rocks are usually marked with the proliferation of many smaller river channels.

The channels of these smaller streams are dry for many months especially from November to May. There is a major river in the study area called River Oyi and Owawa in Aiyegunle village. Also, a tourism centre was seen in Oke-Ila called Ayikunugba waterfalls. The drainage pattern in the south-eastern part of the area where topography is dominated by series of ridges is the trellis type which suggests that the drainage here is structurally controlled whereas, the drainage pattern in other parts of the study area is dendritic, due to homogeneity of the rocks and absence of structures. (Fig.2).

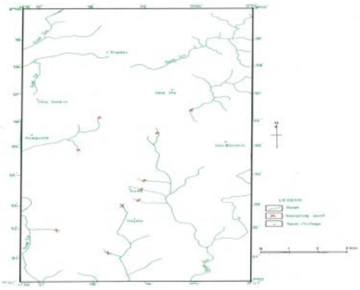

**Fig.2. Drainage Map of the Study Area**

**Regional geologic setting of the study area**

The study area is underlain by crystalline rocks of Precambrian Basement Complex of southwestern Nigeria, which is also part of the Basement Complex rocks of Nigeria. The study area is also part of the regional Dahomeyide fold belt defined by Affaton et al. (1991), and so it is not an exception to the structural and deformational episodes that pervaded Nigeria's Precambrian Basement Complex. Within the basement complex, tectonic deformation has completely obliterated primary structures (Oluyide, 1988) except in a few places where they survived deformation (Okonkwo, 1992). The study area is also an extension of the Ife-Ilesha schist belt, which is made up of different lithologic units. The major rock units within the belt are the amphibolite complex, the schists and the quartzitic sequence (Elueze, 1988). The Ifewara fracture zone separates the rock of Ilesha schist belt into two structural units of contrasting lithologies (Hubbard, 1975; Ako et al., 1978, Folami, 1992; Odeyemi, 1993). Other workers (Klemm et al., 1984; Wright et al., 1985; Oyinloye and Odeyemi, 2001; Anifowose, 2004) have provided evidences in support of the existence of the structure as well as its significance in terms of tectonic movements.

The basement complex is one of the three major litho-petrological components that make up the geology of Nigeria. The Nigerian basement complex forms a part of the Pan – African mobile belt and lies between the West African and Congo cratons and south of the Tuareg shield (Black, 1980). It is intruded by the Mesozoic Calc-alkaline ring complexes (Younger granites) of the Jos plateau and is unconformably overlain by Cretaceous and younger sediments. The Nigerian basement complex was affected by the 600Ma Pan African orogeny and it occupies the reactivated region which resulted from plate collision between the passive continental margin of the West African craton and the active Pharusian continental margin (Burke and Dewey, 1972; Dada, 2006). The Basement rocks are believed to be the results of at least four major orogenic cycles of deformation, metamorphism and remobilization corresponding to the Liberian (2,700Ma), the Eburnean (2500Ma), the kibaran (1,100Ma), and the Pan-African cycles (600Ma). The first three cycles were characterized by intense deformation and isoclinals folding accompanied by regional metamorphism, which was further followed by extensive migmatization. The Pan-African deformation was accompanied by a regional meta-induced syntectonic granites and homogenous gneisses. Late tectonic emplacement of granites and granodiorites and associated contact metamorphism accompanied the end stages of this last deformation. The end of the orogeny was marked by faulting and fracturing (Gandu et al 1986). Anifowose (2004) was of the opinion that the granitic emplacement was probably controlled by fractures within the basement, and also showed outcrop pattern indicating that the older granite cut across all other structures with sharp and chilled contact. Within the basement complex of Nigeria, four major petro-lithological units are distinguishable (Dada 2006), namely;

- The Migmatite – Gneiss-Quartzite Complex
- The schist belts
- The Pan African granitoids
- Under formed acid and basis dykes.

**Local Geology of the Study Area**

The study area belongs to the Precambrian Basement complex of Southwestern Nigeria. The Basement rocks comprises of migmatite gneisses and a metasupracrustal sequence. The western side is underlain by biotite gneiss, biotite schists, quartzites and associated pegmatites and gneisses, while the eastern side of the rock consists mainly of quartzites (Fig.3). The quartzitic sequence, commonly referred to as the Effon Psammite Formation occur mostly as massive quartzites, schistose quartzites and quartz schists which mostly make up the ridges of high relief typical of the study area. Varieties of quartzites were observed in the study area, such as milky quartzite, which was observed at Ajindo area and possesses equigranular texture. The structure common on the lithology is microjoint. Also, smoky quartzite was mapped at Olokuta (Soso), it has equigranular crystal arrangement and foliations as the inherent structure on the rock and similarly, at Aworo, Arapate Erigbe, Makanju, Ayegunle and Ayegbaju. The smoky quartzites in these areas have experienced compressive deformation leading to folding of the rocks. The type of folded structure is an overturned asymmetric fold as shown in the cross-section map of the study area. (Fig.3), one limb of the fold dips at a steeper angle and the other limb dips at a shallower angle. The schistose quartzite was mapped at Oke-Jewoese; it is pinkish in colour, has medium-grained texture and well foliated. Other schistose types were seen at Olutoki (Okemesi road) and Oko Ajindo, They are pinkish in colour, medium grained and foliated. The structures mapped on the Ajindo schistose quartzites include joints and fractures, with same textural characteristics and colour. The smoky and the schistose types occur within the same locality, while the massive quartzites were observed at Okokoro in Ekiti state. They have gritty texture with light grey colouration. Solution holes are common on them with pegmatite intrusions. Other massive quartzites were also mapped at Ilupeju in Osun state. They are coarse grained with no structures on them, but are whitish in colour. Quartzites were also discovered in Oke-Ila 2, with granular texture and fractures, they have sugary white colour similar to those mapped at Ayikunugba water falls. The structures found on them include joint sets, solution holes; texture is granuloblastic with sugary white colouration. The Quartz-biotite schists are group of rocks that had undergone several phases of deformation with the adjacent migmatite-gneiss-quartzite complex. It was observed at Oko-Esinkin2 in Ekiti state, a metamorphic rock having coarse-grained texture, greyish to dark in colour, and commonly display fracture sets. Other lithologies include banded gneiss with alternation of mafic and felsic mineral components which was mapped at Aba Orita in Ikoro-Ekiti. It is medium grained rock with mineralogical banding as the major structure, and having grayish colour. Pegmatites were another set of rocks encountered at Aba Francis in Ikoro, They have simple mineralogy and no structures on them. The biotite gneiss is also a metamorphic rock in which the dominant mineral present is biotite, it is marked by the alternation of mafic and felsic minerals, found in Aworo, having medium grained texture. The biotite schists in the study area were discovered to have experienced similar deformational episodes like the biotite gneiss and occur within the migmatite-gneiss-quartazite complex in the study area. The lithology was located in Arapate/Soso area in Ekiti-state, have medium grained texture and dark grey colour. The structures found on it are foliations and microfolds while dominant mineral present is biotite. Systematic field descriptions of the various lithologies encountered during the geologic mapping exercise for this work are presented in table.1.

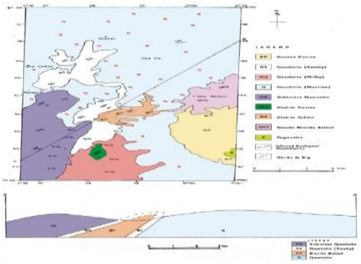

**Fig.3: Geologic and Cross-sectional Map of the Area**

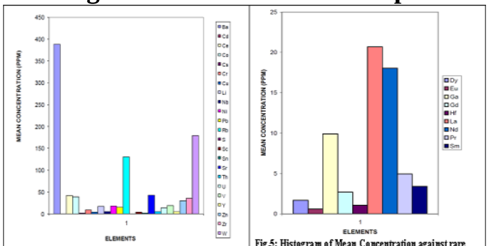

Fig.4: Histogram of mean concentration against trace elements

Fig.5: Histogram of Mean Concentration against rare earth elements

**Materials and Methods**

Various materials were used for the different aspect of this work, which ranges from the base map of the area for geologic mapping at a scale of 1:50,000, compass clinometer, geologic hammer, global positioning systems to digital camera and field note book for recording and presentation of geological information on the field. The method employed in this mapping exercise is the grid-controlled type which involves picking a rock sample per square unit. Topographical map sheet of the study was used as a base map to provide necessary geographical information. These map provided detailed information about the diversity of landforms, vegetation, drainage pattern and the relief of the mapped area. Also, Global Positioning System (GPS) was employed in locating accurately the geographical positions of outcrops. Twenty one (21) rock samples were systematically picked from the study area, but Ten (10) fresh representative rock samples were selected for both geochemical and petrographic studies. The samples were collected by moving from one location to another and put in a sample bag, after they have been properly labeled. After the samples were collected, the samples were prepared in readiness for the analysis proper. The samples were prepared mainly for two types of studies namely; mineralogical and petrographic studies in order to determine and know the mineralogical composition of the rocks and geochemical analysis was carried out to know the trace and rare earth elements present. In carrying out the petrographic study of the rock samples, thin sections of rock samples were prepared. The thin sections were later studied under petrological microscope. However, in preparing the rock samples for geochemical analyses, the jaw crusher was used to crush the samples to tiny bits until it became very fine. Methylated spirit was used to cleaning the milling machine after each crushing to avoid contamination, the samples were later digested using the lithium borate method and placed in a sample container which was properly labeled. The samples were transferred to the laboratory for trace and rare earth elements determination. The geochemical analyses were carried out in Petroc Laboratory, Ibadan in collaboration with at ACME Laboratories East Vancouver, Canada. The analysis involves the use of Multi-collector High Resolution inductively coupled Plasma-Mass Spectrometry (ICP-MS) for the trace and rare earth elements determination.

**Photomicrograph of Thin Sections**

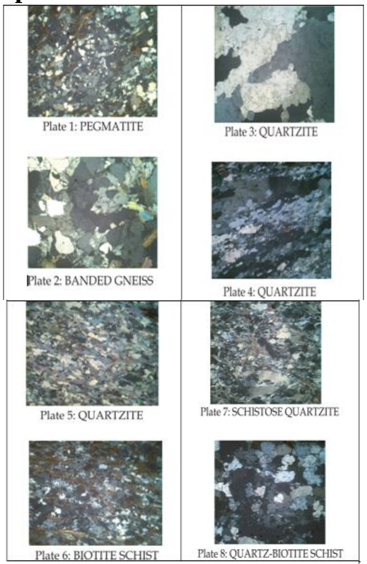


Plate 9: QUARTZITE

Plate 10: QUARTZITE

The result of field description of the various lithologic units in the study area is presented in Table.1. while those of geochemical analyses for trace and rare earth elements are presented in Tables 2 and 3 respectively. The results of modal composition of minerals in each slides analyzed are presented in table 4-5, Slide 1-10, while the photomicrographs of the thin-section slides are shown in Plates 1 -10. From the tables.4-5, Slides 1-10 above, it can be observed that quartz occur with the highest percentage in all the thin sections. Its crystal can be described as subhedral and sometimes euhedral with well developed crystal faces. The extinction angle is symmetrical with respect to crystal angle, the most conspicuous optical properties of quartz when observed under petrological microscope are its colour (it is colourless under plane polarised light and appear light yellow under crossed nicols and it has high refractive index than orthoclase and microcline. Biotite belongs to the black mica which are described as ferromagnesian minerals. They give monocline (pseudotexagonal) crystals with optically negative character when observed in the thin sections. They are usually overprinted or super imposed on the muscovite minerals with yellowish brown to black colour when viewed under polarized light. Biotite has some inclusions of some accessory minerals like Apatite, Zircon, Rutile and magnetite. When muscovite is observed under petrological microscope between crossed nicols, the interference colours are pure also, second and third order tints and red crystal of muscovite were seen. They belong to the white mica which is grouped with the felsic minerals. The muscovite crystals are porphyroblastic in nature, the extinction angles of the crystals are parallel to the cleavage direction. Feldspars are generally distinguished from the other feldspars by higher refraction and presence of polysynthetic twinning. The plagioclase crystals are strongly pleochroic. The more prevalent twinning in the plagioclase is the albite with an extinction angle of about $16^{0.}$ The petrographic analysis carried out showed mineral distribution in quality with respect to quartz, boitite, muscovite and feldspar (microcline, plagioclase and orthoclase), also these analyses revealed the concentration of quartz in all the rocks as evidenced from the modal analyses of the minerals present in the slides (Table 4-5, slide 1-10). It is also evident from the microscopic studies that the different minerals making up the rocks in the study area are randomly distributed without any preferred alignments.

From the result of the geochemical analysis carried out on the samples, the trace elements observed were Ba, Cd, Co, Cs, Cr, Cu, Li, Ni, Nb, Pb, Rb, S, Sc, Sn, Sr, Th, U, V, Y, Zn, and Zr (Table 2 and 3). The results showed that Barium (Ba) is extremely high and considered as the dominant trace element found in the rock samples having a wide range value of 8.0-928.0ppm with an average value of 388ppm. The high concentration value of Ba is found in the banded-gneisses Aba-ori apata (Okemesi Road) and Oko-Esinkin2 having values of (928.0 and 618.0)ppm respectively. The lowest value of Ba occurred in the quartzites found at Ajindo. Ba content is also high in the biotite schist at Arapate (Soso), the schistose quartzites in Oke-Jewoese (Aworo) and massive quartzites in Ilupeju having a range value of (556.0, 514.0 and 409)ppm respectively. The results confirmed that rocks in the area mentioned above are radioactive. W is also very high, having a range value of (127.0-203.0)ppm with an average value of 179.05ppm. W is very high in Ilupeju, Arapate Erigbe, Olokuta (soso) and Ajindo having values of (203.0, 202.0, 201.0 and 201.0)ppm respectively, moderately high in Oke-Jewoese, Aba-Francis, Arapate(soso) and Aba-ori-apata having values of (173.6, 163.0, 160.4 and 158.5)ppm respectively. W is low in Oko-Esinkin 1 having a value of 127.0ppm. Rb is very high in Oke-Ila 1 and Aba-Francis (Ikoro-Okemesi Road) having values of (290.3 and 246.7)ppm respectively. Rb is extremely low in Olokuta (Soso) and Ajindo having a values of (29.1 and 2.9) ppm respectively. Rb proportion may indicate that the rock samples may contain porphyry copper due to the fact that Rb is a pathfinder element for porphyry copper. It has an average value of 129.99 ppm. Ce has a range value of (1.45-95.5)ppm with an average value of 42.19ppm. Ce is high in Arapate (Soso), Arapate Erigbe, Oke-Jewoese and Aba-Ori Apata, having values of (95.5, 72.85, 65.04 and 60.72)ppm respectively. Ce is extremely low in Ajindo having a value of 1.45ppm. Cu range from (0.02-13.31)ppm with an average value of 3.86. Cu is high in Aba-ori-apata and Arapate (Soso) having a range values of (13.31 and 12.68)ppm respectively. Cu is extremely low in Ajindo with a value of 0.02ppm. Pb ranges from (0.27-39.81)ppm having an average value of 15.0ppm. Pb is high in Aba-Francis and Oko-Esinkin2 having values of (39.81 and 23.0) ppm respectively. Pb is very low in Ajindo having a value of 0.27ppm. Pb is one of the most important decay products of U, and Th, and Pb content indicate that the samples have the tendency to be radioactive.

Lithium (Li) values ranges from (0.7-52.3)ppm having an average value of 15.49pmm. Li is high in Arapate-Erigbe and Arapate (Soso) having values of (52.3 and 32.7)ppm respectively, moderately high in Aba-ori apata, Oko-Esinkin2 and Oke-Ila 1 having values of (17.6, 16.9, and 16.9)ppm respectively. Li is very low in Ajindo with a value of 0.7ppm. Cd and S values are extremely low compared with other trace elements having a close values of (0.02-0.09) and (0.03-0.04)ppm respectively with average values of (0.054 and 0.036)ppm respectively. Zinc(Zn) value ranges from (2.0-76.5)ppm with an average value of 29.39 ppm, zinc is high in Arapte Erigbe and Arapate/Soso, having values of (76.50 and 76.10)ppm respectively, moderately high in Aba-ori-apata with a value of 51.9ppm. Zn has a lower value in Ajindo, Ilupeju and Oke-Jewoese having values of (2.0, 2.3 and 9.0)ppm respectively. Zircon(Zr) has a very wide value ranging from (1.0-141.6)ppm with an average value of 36.28ppm. Zircon(Zr) is very high in Arapate Erigbe and Oke-Jewoese having values of (141.6 and 86.7)ppm respectively. Zr is extremely low in Ajindo with a value of 1.0ppm. (Fig.5).

The rare-earth elements analyzed are Dy, Eu, Ga, Gd, Hf, La, Nd, Pr, Sm and W. La and Nd have a range values of (0.7-45.6) and (0.7-44.8)ppm respectively, having average values of (20.69 and 18.05)ppm respectively. La is moderately high in Arapate-Erigbe, Oke-Jewoese, and Aba-ori-apata having values of (36.2, 33.3, 30.69)ppm respectively. La is very low in Ajindo and Aba-Francis with values of (0.7 and 1.3)ppm respectively. Nd is high in Arapate(soso) with a value of 44.8ppm, moderately high in Arapate Erigbe and Aba ori apata having values of (31.0 and 27.18)ppm respectively and very low in Ajindo and Aba Francis with values of (0.7 and 1.2)ppm respectively. Dy and Hf have an extremely low average values of (1.68 and 1.07)ppm respectively with a range values of (0.1-3.6) and (0.03-4.02)ppm respectively. Dy is high in Arapate soso, Aba ori apata and Arapate Erigbe, having values of (3.6, 3.1 and 2.9)ppm respectively. Eu has the lowest average value of 0.58ppm, having a range value of (0.1-1.0)ppm. Eu is extremel;y low in Aba francis, ajindo and Oke-ila 1, having values of (0.1, 0.1 and 0.1)ppm respectively. Eu has the highest value of 1.0ppm in Arapate Erigbe. (Fig.6).

The petrographic investigation showed that a distinct boundary can be drawn between Banded Gneiss, pegmatite, Quartzite, Biotite schist, Biotite Gneiss and Quartz-biotite schist in the study area based on the texture and mineralogical composition. The texture of the pegmatite is coarse grained, which is indicative of plutonism, It cooled very slowly close to the earth surface which resulted in its texture. Also, the petrographic studies of thin sections revealed that quartz is the dominant mineral and occur distinctively in all the slides analyzed under the petrological microscope. The rocks are characterized by the assemblages of quartz, biotite, muscovite, plagioclase, orthoclase, microcline and opaque minerals. Also, from the result of the geochemical analyses, it is confirmed observed that (Ba) is extremely high and considered as the dominant element compared to all other trace elements. Other traces elements whose values are also very high include: W, Nb, Co, Sr, V, Rb, Zn, and Zr which indicate that the rock in the study area is radioactive in nature. Rubidium(Rb), been very high in the rocks indicate that fluorspar and porphyry copper may be present. Zr is moderately high which according to Taylor (1965) confirmed that rock with abundance of Zr indicate a product of extreme fractionation. And the closeness values of Pb and V shows that the moderate concentration of Zr indicated that some of the rocks are crystallized which give rise to the enrichment of the rock sample in Zr. La and Nd are very high in the rocks of the study area.

However, it is not an understatement that the rocks in the study area are of great economic importance. (Quartzite, quartz-biotite-schist, banded gneiss, pegmatite, biotite schist and biotite gneiss). Quartz-biotie schist and biotite schist are not commonly used as building stones, because they are incompetent but their glittering colours, are often put to other decorative non-weight bearing purposes. Banded gneiss & Pegmatite are often used for road construction; they are good aggregate materials for road surfacing. Biotite gneiss is a common dimensional stone used in construction, paving, facing of building etc especially because of its attractive texture, dark colour, hardness and polishabiltiy and its ready availability. Crushed quartzite is often used as railway ballast, quartzite as a decorative stone may be used to cover walls, as roofing tiles, as flooring and stair steps. Crushed quartzite is sometimes used in road construction. Highly purified quartzite is used to produce ferrosilicon, industrial silica sand, silicon and silicon carbide.

**Conclusion**

The petrographic and geochemical analysis of the Precambrian rocks around Okemesi and its environs, southwestern Nigeria have been carried out. The petrographic studies revealed that banded Gneiss consists of mineral assemblages like quartz, biotite and Microcline feldspar, pegmatite consists of minerals like quartz, biotite, Microcline and plagioclase, milky quartzite contains 100% of quartz, biotite schist consist of minerals like quartz, biotite, orthoclase, plagioclase and opaque and massive quartzite consists of mineral assemblages like quartz , muscovite and so on. It can be deduced that both the texture and mineralogical composition of the Precambrian rocks vary from one rock to another. It also shows that the rocks found in the study area are thermo-tectonic in nature based on the nature of magma, mode of emplacement and their structural styles. Considering the geochemical properties of the rocks in the study area, we can deduce that Pb, Co and Ni are indicator elements for copper-zinc mineralization. Pb, Zn and Cu may be suggestive of hydrothermal uranium deposits. Pb, Ba and U content have the tendency to be radioactive in nature. Analytical studies revealed that quartz is the most resistant and dominant mineral present in the study area and other different lithologies observed can be used for various economic and industrial purposes. The rocks around Okemesi which are mostly schistose and massive quartzites can be quarried for making glass, building and construction purposes.

The high concentration of radioactive elements in the rocks of the study area serves as a good source of nuclear energy generation sites. However, radioactive materials may produce X-ray which can affect sensitive skin and causes skin cancer, mutations etc. Radioactive substances can also affect the organs like gonads in human beings; proper care should be taken by workers when working in such area and should coat them very well to avoid this effect. The anomalously high Barium (Ba) content in the rocks of the study area could be attributed to the wide spread Basement rejuvenation, reactivation and remobilization during the Pan African event (Oyawoye, 1972),

**Recommendation**

Having established the petrographic and geochemical properties of the Precambrian rocks around Okemesi and its environs, it is recommend that individual and government should establish a large scale quarry sites for the exploration of quartzite, biotite schist and biotite gneiss as dimension stones, this will help to reduce the cost and over reliance on marble for interior and exterior decorations for the economic and technological development of Ekiti and Osun state and Nigeria at large. It is also recommend that a detailed geological mapping should be carried out in the study area to evaluate the reserves of these lithologic units. This will help in determining the quantity and quality of the rocks in the study area. The Federal Ministry of Solid Minerals should provide more logistics for geological exploration for the eventual exploitation of the abundant mineral resources available in the area. To avoid future health disaster, if industries or factories are sited, it is recommend that the industries should not dump their wastes in the streams around the place because the presence of swine of this element are hazardous to human health, these elements include cadmium, which causes degenerative acute bone diseases and finally leads to death after a long term of consumption. Hence, waste should be properly managed and dumping must be in reclamation centers.

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## DISCUSSION OF RESULTS

### TABLE .1: FIELD DESCRIPTION OF ROCK SAMPLES

| S/N | LOCATION | LATITUDE/ LONGITUDE | ROCK TYPE | TEXTURE | STRUCTURE | COLOUR | MINERALOGY | LITHOLOGY | STRIKE/ DIP | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Aba Ori-Apata (Okemesi Road) | 07$^0$51’49.1N 005$^0$01’04.1”E | Metamorphic | Medium grained | Banding | Grey | Quartz, biotite. Feldspar | Banded Gneiss | _____ | Alternation of felsic and mafic minerals. |
| 2 | Aba Francis (Ikoro-Okemesi road) | 07$^0$51’49.9’N 005$^0$01’05.1”E | Igneous | Very Coarse | _________ | Impure white | Quartz, Muscovite & feldspar | Pegmatite | _____ | Extremely coarsed grained due to low cooling rate. |
| 3 | Ajindo | 07$^0$52.193N 004$^0$58.240’E | Metamorphic | Equigranular | Microjoint | Milky | Quartz | Quartzite (milky) | ______ | ______ |
| 4 | Aworo | 07$^0$51.527’N 004$^0$58.007’E | Metamorphic | Medium | _________ | Dark to black | Biotite, Quartz | Biotite Gneiss | ____ | Weathered outcrop |
| 5 | Makanju | 07$^0$52.579’N 004$^0$57.698’E | Metamorphic | Medium | Joints | Slivery grey | Quartz, Mica | Quartzite | _____ | Joints and controls stream level |
| 6 | Olutoki IOkemesi road) | 07$^0$52.335’N 004$^0$57.468’E | Metamorphic | Medium | Foliation | Pink | Quartz mica & feldspar | Schistose Quartzite | 024$^0$ 80$^0$W | Tiny species of micaceous minerals |
| 7 | Oko Ajindo | 07$^0$52.912’N 004$^0$57.561’E | Metamorphic | Medium | Joints, Fracture. | Pink | Quartz, mica, feldspar | Schistose Quartzite | 034$^0$ 40$^0$W | Tiny species of micaceous minerals |
| 8 | Aworo (soso) | 07$^0$54.380’N 004$^0$58.380’E | Metamorphic | Equigranular | _________ | Smoky | Quartz | Quartzite | _____ | Exposed by a stream |
| 9 | Olokuta (Soso) | 07$^0$54.519’N 004$^0$58.135’E | Metamorphic | Equigranular | Foliation-Foliation | Smoky | Quartz | Quartzite | 028$^0$ 40$^0$ | Exposed by a stream |
| 10 | Arapate (Erugbe) | 07$^0$54.474’N 004$^0$58.064’E | Metamorphic | Coarse grained | _________ | Smoky | Quartz, mica | Quartzite | 042$^0$ 80$^0$ | Shinny surface due to the presence of mica |
| 11 | Arapate/Soso | 07$^0$54.380’N 004$^0$58.087’E | Metamorphic | Medium | Foliation, Microfold | Dark grey | Quartz, Biotite. | Biotite Schist | 032$^0$ 48$^0$W | Presence of microfold |
| 12 | Oke Jewo Ese | 07$^0$54’.474’N 004$^0$57.931’E | Metamorphic | Medium | Foliation | Pink | Quartz, mica, feldspar | Schistose Quartzite | 046$^0$ 66$^0$W | An isolated hill |
| 13 | Okokoro | 07$^0$55’28.3’N 005$^0$00’10.6”E | Metamorphic | Coarse | Fracture | Light grey | Quartz, mica | Inassive Quartzite | 046$^0$ 66$^0$W | Shinny surface due to micaceous flakes. |
| 14 | Oko-Esinkin (1) | 07$^0$55’14.6’N 005$^0$00’42.4E | Metamorphic | Medium | Banding | Light grey | Quartz, Biotite | Banded Gneiss | 046$^0$ 66$^0$W | ________ |
| 15 | Oko-Esinkin (2) | 07$^0$54’48.5’N 005$^0$01’22.3”E | Metamorphic | Coarse | Fracture Foliation | Grey to Dark | Quartz, biotite & muscovite | Quartzite, biotite Schist | 046$^0$ 66$^0$W | Well foliated outcrop with distinct mineralogy |
| 16 | Oke-Ila (1) | 07$^0$56’89.4’N 004$^0$58’59.9”E | Metamorphic | Medium | Solution hole | Light grey | Quartz, feldspar & muscovite | Massive Quartzite | 046$^0$ 66$^0$W | Part of the outcrop have pegmatitic intrusion |
| 17 | Oke-Ila (2) | 07$^0$57’53.8’N 004$^0$57’45.2”E | Metamorphic | Granular | Fracture | Sugary white | Quartz, muscovite | Quartzite | 046$^0$ 66$^0$W | Muscovite specks sandwiched in the quartzite |
| 18 | Ayegbaju | 07$^0$55’08.4’N 005$^0$00’06.3E | Metamorphic | Coarse | _____ | Smoky | Quartz | Quartzite | 046$^0$ 66$^0$W | ________ |
| 19 | Ayegunle | 07$^0$55’14.6’N 004$^0$57’02.0E | Metamorphic | Coarse | Joint | Smoky | Quartz | Quartzite | 046$^0$ 66$^0$W | ________ |
| 20 | Ayikunnu gba water fall | 07$^0$55’40.2’N 004$^0$57’55.7E | Metamorphic | Granular | Joint set, caver, solution hole | Sugary white | Quartz, muscovite | Quartzite | 046$^0$ 66$^0$W | Muscovite speck, sandwiched in the quartzite |
| 21 | Ilupaju | 07$^0$58’54.2’N 004$^0$58’31.0”E | Metamorphic | Coarse | ______ | Impure white | Impure white | Quartzite | 046$^0$ 66$^0$W | _______ |

### TABLE 2. TRACE ELEMENTS IN THE STUDY AREA (PPM)

| Location | | Aba-Oripapta | Aba Francis | Ajindo | Olokuta (Soso) | Arapate Erigbe | Arapate/ Soso | Oke-Jewo ese | Oke-Esinkin (2) | Okenla 1 | Ilupeju | MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element | Sample No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| Ba | | 928.00 | 88.00 | 8.00 | 283.00 | 390.00 | 556.00 | 514.00 | 618.0 | 86.00 | 409.00 | 388.000 |
| Cd | | 0.08 | 0.05 | 0.02 | 0.03 | 0.09 | 0.070 | 0.06 | 0.04 | 0.08 | 0.02 | 0.054 |
| Ce | | 60.72 | 2.87 | 1.45 | 32.46 | 72.85 | 95.50 | 65.04 | 40.2 | 22.79 | 28.01 | 42.190 |
| Co | | 27.10 | 17.20 | 73.70 | 31.50 | 104.40 | 28.20 | 19.30 | 25.9 | 16.00 | 48.50 | 39.180 |
| Cs | | 0.50 | 3.70 | 0.10 | 0.30 | 1.50 | 9.80 | 1.10 | 0.6 | 0.70 | 1.40 | 1.970 |
| Cr | | 22.00 | 1.00 | 1.00 | 6.00 | 15.00 | 33.00 | 7.00 | 6.0 | 1.00 | 1.00 | 9.300 |
| Cu | | 13.31 | 1.02 | 0.02 | 0.83 | 1.09 | 12.68 | 2.47 | 5.76 | 0.33 | 1.06 | 3.860 |
| Li | | 17.60 | 14.90 | 0.70 | 4.40 | 52.30 | 32.70 | 10.10 | 16.9 | 16.90 | 5.30 | 17.180 |
| Nb | | 13.70 | 0.20 | 0.70 | 1.10 | 7.70 | 15.30 | 4.60 | 4.3 | 1.00 | 1.60 | 5.020 |
| Ni | | 27.80 | 1.20 | 0.70 | 13.00 | 31.00 | 44.80 | 22.40 | 18.9 | 10.30 | 10.40 | 18.050 |
| Pb | | 21.54 | 39.81 | 0.27 | 5.83 | 4.72 | 20.73 | 11.87 | 23.0 | 16.17 | 6.06 | 15.000 |
| Rb | | 148.70 | 246.70 | 2.90 | 29.10 | 66.10 | 203.50 | 57.60 | 206.2 | 290.30 | 48.80 | 129.990 |
| S | | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.0360 |
| Sc | | 5.70 | 0.50 | 0.10 | 0.80 | 4.20 | 12.40 | 3.00 | 3.8 | 3.30 | 0.70 | 3.750 |
| Sn | | 1.00 | 3.90 | 0.10 | 0.50 | 1.40 | 5.40 | 0.90 | 0.7 | 3.80 | 0.80 | 1.850 |
| Sr | | 100.00 | 15.00 | 2.00 | 12.00 | 22.00 | 115.00 | 34.00 | 73.0 | 25.00 | 29.00 | 42.700 |
| Th | | 3.70 | 0.40 | 0.30 | 3.50 | 13.30 | 19.00 | 5.70 | 0.3 | 0.80 | 2.40 | 4.940 |
| U | | 0.30 | 6.20 | 0.10 | 0.40 | 1.80 | 3.90 | 0.70 | 0.2 | 0.50 | 0.60 | 14.200 |
| V | | 53.00 | 1.00 | 1.00 | 4.00 | 15.00 | 74.00 | 8.00 | 20.0 | 15.00 | 3.00 | 19.400 |
| Y | | 7.90 | 1.30 | 0.20 | 2.20 | 9.40 | 10.10 | 5.00 | 5.8 | 5.10 | 2.70 | 4.970 |
| Zn | | 51.90 | 4.70 | 2.00 | 7.50 | 76.50 | 76.10 | 9.00 | 32.4 | 31.50 | 2.30 | 29.390 |
| Zr | | 8.40 | 10.80 | 1.00 | 30.10 | 141.60 | 32.00 | 86.70 | 10.0 | 22.20 | 20.00 | 36.280 |
| W | | 158.50 | 163.00 | 201.00 | 201.00 | 202.00 | 160.40 | 173.60 | 201.0 | 127.00 | 203.00 | 179.050 |

### TABLE 3. RARE EARTH ELEMENTS IN THE STUDY AREA (PPM)

| Location | | Aba-Oriapata | Aba Francis | Ajindo | Olokuta (Soso) | Arapate Erigbe | Arapate/ Soso | Oke-Jewo Ese | Oke-Esinkin (2) | Okenla 1 | Ilupeju | MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element | Sample No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| Dy | | 3.10 | 0.40 | 0.10 | 0.80 | 2.90 | 3.60 | 1.80 | 1.90 | 1.40 | 0.80 | 1.68 |
| Eu | | 0.90 | 0.10 | 0.10 | 0.40 | 1.00 | 1.10 | 0.90 | 0.80 | 0.10 | 0.40 | 0.58 |
| Ga | | 14.37 | 13.58 | 0.24 | 2.84 | 8.50 | 19.23 | 8.31 | 14.38 | 13.80 | 3.60 | 9.89 |
| Gd | | 4.80 | 0.30 | 0.10 | 1.60 | 4.30 | 6.10 | 3.30 | 3.20 | 1.90 | 1.40 | 2.70 |
| Hf | | 0.31 | 0.51 | 0.03 | 0.79 | 4.02 | 0.90 | 2.31 | 0.35 | 0.91 | 0.55 | 1.07 |
| La | | 30.60 | 1.30 | 0.70 | 14.40 | 36.20 | 45.60 | 33.30 | 21.40 | 9.60 | 13.60 | 20.69 |
| Nd | | 27.18 | 1.20 | 0.70 | 13.00 | 31.00 | 44.80 | 22.40 | 18.90 | 10.30 | 10.40 | 18.05 |
| Pr | | 7.70 | 0.30 | 0.20 | 3.20 | 8.40 | 11.60 | 6.80 | 5.10 | 2.90 | 3.00 | 4.92 |
| Sm | | 5.90 | 0.40 | 0.10 | 2.30 | 5.30 | 8.10 | 3.90 | 3.70 | 2.60 | 1.70 | 3.40 |

**MODAL ANALYSIS OF THE ROCK SAMPLES**

**BANDED GNEISS , TABLE 4.1 SLIDE 1**

| MINERALS | MODAL COMPOSITION (%) |
|---|---|
| Quartz | 59.58% |
| Biotite | 38.84% |
| Microcline | 1.65% |

**PEGMATITE, TABLE 4.2 SLIDE 2**

| MINERALS | MODAL COMPOSITION (%) |
|---|---|
| Quartz | 23.36% |
| Biotite | 4.67% |
| Microcline | 42.99% |
| Plagioclase | 28.97% |

**QUARTZITE TABLE. 4.3 SLIDE 3**

| MINERALS | MODAL COMPOSITION (%) |
|---|---|
| Quartz | 100% |

**QUARTZITE, TABLE. 4.4 SLIDE 4**

| MINERALS | MODAL COMPOSITION (%) |
|---|---|
| Quartz | 80.77% |
| Biotite | 18.27% |
| Opaque | 0.96% |

**QUARTZITE, TABLE 4.5 SLIDE 5**

| MINERALS | MODAL COMPOSITION (%) |
|---|---|
| Quartz | 60.78% |
| Biotite | 32.29% |
| Orthoclase | 0.98% |
| Opaque | 2.94% |

**BIOTITE SCHIST, TABLE.4.6 SLIDE 6**

| MINERALS | MODAL COMPOSITION (%) |
|---|---|
| Quartz | 56.49% |
| Biotite | 35.71% |
| Orthoclase | 3.25% |
| Plagioclase | 3.90% |
| Opaque | 0.65% |

**SCHISTOSE QUARTZITE, TABLE 4.7 SLIDE 7**

| MINERALS | MODAL COMPOSITION (%) |
|---|---|
| Quartz | 72.67% |
| Biotite | 26.16% |
| Opaque | 1.16% |

**BIOTITE GNEISS, TABLE. 4.8 SLIDE 8**

| MINERALS | MODAL COMPOSITION (%) |
|---|---|
| Quartz | 83.33% |
| Biotite | 16.67% |

**Massivequartzite,Table.4.9slide 9**

| MINERALS | MODAL COMPOSITION (%) |
|---|---|
| Quartz | 54.93% |
| Biotite | 21.13% |
| Plagioclase | 9.85% |
| Microcline | 14.09% |

**MASSIVE QUARTZITE, TABLE.5.0 SLIDE 10**

| MINERALS | MODAL COMPOSITION (%) |
|---|---|
| Quartz | 74.60% |
| Muscovite | 25.40% |

**Source Field work, 2011**