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Akinola Oluwatoyin O
Department of Geology, Faculty of Science, Ekiti State University, Ado-Ekiti, Nigeria

OlaOlorun Olusola A
Department of Geology, Faculty of Science, Ekiti State University, Ado-Ekiti, Nigeria

Corresponding Author:
Akinola Oluwatoyin O
Department of Geology, Faculty of Science, Ekiti State University, Ado-Ekiti, Nigeria

Morphological attributes, petro chemistry and origin of quartzite units in Ekiti, South-Western Nigeria

Akinola Oluwatoyin O, and OlaOlorun Olusola A

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Abstract
This study presents lithologic and petrogenetic investigation of bedded quartzite from Okemesi and massive quartzites from Ado-Ekiti in southwestern Nigeria. Okemesi quartzite is extensive, thickly bedded and steeply dipping while quartzite from Ado-Ekiti is hummocky, ferruginous, fractured, and non-bedded. Analytical results reveal average SiO_2 Okemesi (94.74 %) and Ado-Ekiti quartzite (93.88%). Similarly, average Rb/Sr are 0.74 and 1.22 while Sr/Ba are 0.89 and 0.69, respectively. These parameters portray them as supracrustal rocks of continental origin. Implying quartzites in Ekiti are non-schistose pelitic metasediments. Na_2O/Al_2O_3 versus K_2O/Al_2O_3 diagram revealed the quartzite units are sedimentary in origin and are compositionally similar to the Scottish metapelite and Igarra quartz mica-schist. Chemical Index of Alteration (CIA) of Okemesi quartzite (88 %) and Ado-Ekiti quartzite (91 %) which are relatively high signifies intense chemical weathering of their source rocks. Index of compositional variability (ICV) of Okemesi quartzite (0.83) and Ado-Ekiti quartzite (0.74) indicate the quartzites are immature pelite.

Keywords: Nigeria, bedded quartzite, massive quartzite, pelite, supracrustal

Introduction

Apart from granitoids which form towering bodies throughout the study area, quartzite outcrops contribute to the ruggedness of the Ekiti topography. Quartzite exposures around Ekiti occur in two forms: as extensive ridges, and as ferruginous residual hills that are dissected by erosion. The quartzite ridge extends from Ipetu-Ijesha area of neighbouring Oshun State into Effon-Alaaye and Okemesi areas of Ekiti. A section of this quartzite ridge is exposed by roadcut between Itawure and Ita-Ido Junctions. The roadcut reveals the rock unit is steeply dipping, thickly bedded and with a pronounced N-S structural trend. The second, which is mostly confined within Ado-Ekiti metropolis is typically non-bedded, non-dipping and hummocky. These distinct quartzite types form raised platforms above the surrounding pediments. The prominence of quartzite is consequent on its resistance to erosion. Quartzite is a metamorphic equivalence of sandstone or quartz sand. It is formed when quartz sand or sandstone is subjected to elevated temperatures and increasing pressures within the earth.

Previously, geochemical studies of quartzite (metasediments and schists) in the basement complex of Nigeria were undertaken by several authors (e. g., Ajibade, 1976; Elueze, 1981; Eneh *et al*., 1989; Okonkwo and Winchester, 1996; Annor *et al*., 1996; Elueze and Okunlola, 2003; Okunlola *et al*., 2003; Olobaniyi, 2003; Olobaniyi and Annor, 2003; Okunlola *et al*., 2011; Akinola *et al*., 2014) [2, 12, 13, 21, 5, 11, 22 26, 27, 23, 4]. The petrology and petrogenesis of these rocks are contained in Okeke and Meju, (1985) [18]; Okunlola, *et al*. (2003, 2009) [22, 24, 25]; Okonkwo, (2006) [20]; Okunlola and Okoroafor, (2009) [24]; Akinola and Okunlola, (2014) [3]. The general geology of Ekiti is contained in Oyinloye and Obasi, (2006) [29] and Talabi, (2013) [32] among others. However, only scanty publications are available on the lithologic framework and petrogenetic study of quartzite bodies in Ekiti. In the current study, we investigate lithologic and compositional features of these quartzite units in relate it to origin. The result of this investigation is expected to provide additional information on geological significance and evolution of these rocks.

Geological setting

Nigeria is located within southern segment of the Pan-African orogenic belt, it lies on eastern side of West African craton and directly south of Pharusian belt of Central Hoggar (Fig. 1).Ekiti is underlain by migmatite-gneiss, quartzite, schists, granite, charnockite and pegmatite (Fig. 2). Migmatite-gneiss accounts for approximately 65% of the landmass of Ekiti and occurs as low-lying outcrops of fine-grained texture and complex folds. The schistose units are biotite schist and amphibole schist that occur towards west of Ijero. Granite-charnockite association stretches northwards from Ikere-Ekiti in the south towards Iworoko. However, other massive outcrops are located around Ilupeju and Ayede. Massive pegmatite is restricted to Aramoko-Ijero and their neighbouring towns. On regional petrological scale, quartzite is a subunit of the Migmatite-gneiss quartzite complex and a prominent lithologic unit in Ekiti. Quartzite forms the Okemesi Fold belt and had been previously referred to as Effon psammite (De Swardt, 1953; Hubbard, 1975) [9, 16]. The thickly bedded, and steeply inclined quartzite have dip values between 45ºE to 84ºE (Figs. 3a, and 3b). This type trends N-S and restricted to western part of Ekiti. The characteristically hummocky and ferruginous type (Figs. 3c and 3d) occurs mainly in Ado-Ekiti metropolis. Despite the bold topographic expression, sufficiently good exposure for sampling is rare. Okemesi quartzite is intensely weathered while those around Ado-Ekiti is ferruginous in appearance. Quartzite outcropping within the metropolis have profuse joints and quartz rubbles with angular fragments. The well aerated top soils that serves as overburden supports luxuriant vegetation. De Swardt (1953) [9] believed Nigeria quartzite generally originate by silicification of shear zones. However, Oluyide *et al*., (1998) [28] were of the opinion that the two variants represent products of metamorphism under varying conditions. The later believed most Nigeria quartzite originate from high-grade metamorphism of sandstones, felspathic sandstone or arkoses.

Materials and Methods

An existing geological map of Okemesi Fold Belt (Adeoti and Okonkwo, 2016) [1], and the Geological Survey (GSN, 1974) map of Ekiti State served as guide for sampling. The Geological Survey map was adopted for the study and random sampling was undertaken. Twenty-six (26) carefully selected fresh outcrop samples were used in the study. Six samples were cut into thin sections for mineralogical investigation. The remaining twenty samples (ten (10) each from Okemesi and Ado-Ekiti areas) were pulverized and analysed for geochemical composition. Approximately 0.5 kg of each sample was dried at temperature of 105ºC for 2 hrs before allowing it to cool to room temperature and then crushed in a Jaw crusher. Thereafter, the samples are pulverized in a Tema mill. Major element determination was conducted using XRF facility at the laboratory of Geology Department, University of Malaya, Malaysia. The rock powder (0.2 g) passing through -80 mesh was accurately weighed into a graphite crucible and mixed with 2 g of lithium tetraborate $LiBO_2/LiB_4O_7$ and heated in a muffle furnace at 980ºC for 30 mins and prepared into beads. Each was allowed to cool and the beads are dissolved in 100 ml of 5% HNO_3 (ACS grade nitric acid diluted in distilled water). An aliquot of the solution was poured into a test tube. Calibration standards and verification standards are included in the sample sequence. Sample solutions were aspirated into the XRF spectrometer to determine major elements (SiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, TiO_2 and Cr_2O_3). For the trace and Rare Earths (REE) composition, powdered rock samples were packaged in plastic tubes and dispatched to Bureau Veritas, Vancouver, Canada for ICP-MS analytical method.

Results

Petrographic results (Table 1) and analytical results (Table 2 and Table 3) are presented.

Lithologic description and petrography

Quartzite from Okemesi is whitish to grey in colour (Figs. 3a and 3b). However, some parts exhibit purple and pinkish colour. Foliation is well-preserved, in the bedded and steeply inclined quartzite, joint directions are parallel. Quartzite from Ado-Ekiti apart from been massive and non-foliated, is ferruginous with conspicuous brown to reddish-brown colour (Figs. 3c, and 3d). A set of joints are perpendicular to the strike direction, while few show haphazard and randomly oriented joint sets in Ado quartzite. The dip values range from 45ºE to 84ºE in the Okemesi quartzite, whereas outcrops from Ajebamidele area of Ado-Ekiti show dip values ranging between 12º-21ºE. Quartzite from NTA road is non-dipping and are thus hummocky and massive. In thin section, quartzite from the two areas generally comprises of recrystallized interlock of aggregates quartz grains. However, muscovite, orthoclase feldspar, microcline and few opaque minerals occur as minor constituents in varying proportions in the rock. Thin section of Okemesi quartzite contains quartz grains that appear colourless to grey in transmitted light. It is a fine to medium–grained rock with weak schistosity imparted by quartz granoblasts having preferred orientation. Few quartz grains are distorted, some have cracked edges while others exhibit translational fabrics arising from stretching and strain. Syn-kinematic recrystallization is observed in some deformed grains as they divide and recrystallize as neoblasts. Larger quartz grains exhibit wavy extinction while tiny ones occur as localized groundmass aggregates with uniform extinction. Petrographic examination by visual estimate reveals the quartzite as quartz dominated in which quartz alone accounts for over 80% of Okemesi quartzite and 75% of quartzite from Ado-Ekiti (Table 1). Other minerals altogether constitute less than 18% and 25% respectively in the two quartzite types. The dominance of quartz in the mineralogy is expected in this kind of rock and may be attributed to quartzite being a monomineralic rock. Other minor components are impurities contributed by silicate minerals that are metamorphosed together or are grown *in-situ* during metamorphic recrystallization. Quartz granules are sub-rounded and of different textures. Ado-Ekiti quartzites are texturally finer than Okemesi quartzites. Biotite lathes may have been responsible for the schistosity in the rock. Under higher magnification, the Okemesi quartzites exhibit micro fractures while accessory zircon crystals with high relief, dark colour are arranged in interstitial positions around large quartz grains (Figs. 4a and 4b).

Geochemistry

Analytical results (Table 2) reflect dominance of silica over other oxides in Okemesi quartzite. The overall average contribution of silica is 94.74% of the bulk chemical composition. Dominance of silica may reflect monomineralic nature of quartzite, being a rock primarily composed of quartz grains (silica) and conspicuous absence of ferromagnesian minerals. On the other hand, quartzites from Ado-Ekiti (Table 3) contain between 91.78-94.72% (ca. 93.38%) silica. Even though, this quartzite contains marginally lower average silica value, this difference may have arisen from petrogenetic differences or variation in source material (protoliths). Apart from silica which forms the most vital component, alumina and iron ($Al_2O_3 + Fe_2O_3$) contributed 4.04% in Okemesi quartzites and 4.66% in Ado-Ekiti quartzites. Apart from Lost on Ignition (L.O.I.) values, all other oxides constitute insignificant values which range between 0.32% in Okemesi and 0.45% in Ado-Ekiti quartzites respectively. Trace elements composition of the Okemesi quartzite also show that the contribution of Sc, Be, Sn, Cs and Nb record low values. However, Ba, Sr, Y and Zr have higher values and thus play dominant role in the trace elements geochemistry. High abundance of the latter is attributable to being lithophile elements which forms principal component of rock forming minerals. Quartzites as metamorphosed quartz grains is expected to have lower concentration of certain trace elements (e.g., Sc, Be, Sn etc). The higher concentration of (Ba, Sr, Zr etc) reflects accessory minerals like zircon which often survive rock recycling or are minor silicate rock constituents that are transported with surviving quartz grains from the source area. The low alkali (Na, K) and Alkali-Earths (Mg, Ca) may have resulted from increasing instability of soluble cationic components during metamorphic transformation. However, these values are still within acceptable limits for metasediments (Weaver, 1989) [35]. Based on elemental abundances, trace elements geochemistry reflects two main groups in Ado-Ekiti quartzites, those with concentrations less than 10 ppm (e.g., Sc, Be, Sn and Cs) altogether add up to 11.7 ppm of the bulk trace element's composition. The second group are trace elements with abundances between 10-200 ppm (Ba, Sr, Y, Zr, Rb and Nb) these contributes a total of 335.3 ppm of the bulk composition. Comparing the two rocks, trace elements distribution pattern follows similar trends. For instance, the average concentration of trace element (Sc, Be, Sn, and Cs) in Okemesi quartzite is 8.53 ppm while Ba, Sr, Y, Zr, Rb and Nb account for a total of 299.6 ppm.

Discussion

Generally, compositional features of quartzite from Ekiti compares well to those in other parts of basement complex of southwestern Nigeria. Their geochemical features are similar to those of Jebba quartzite and micaceous quartzite in central Nigeria (Okonkwo, 2006) [20]. Pronounced depletion of MnO, Na_2O may connote dearth of passage of metamorphic remobilized fluids during the Pan-African tectono-thermal or earlier events. Some of Nigeria's shear zones have auriferous quartz enrichment that originated from metamorphic dewatering of the country rocks during orogenesis (Olobaniyi, 2003) [26, 27]. The study area falls within non-mineralized auriferous domain of the Ife-Ilesha schist belt when compared to the eastern segment of Nigeria as suggested by Elueze, (1992) [10]. However, geochemical features are comparable to rocks of metasedimentary origin (Brown *et al*., 1979) [6], Scottish metapelites (Okonkwo, 1992) [19] and Igarra quartz mica-schist (Okeke and Meju, 1985) [18]. High Zr, Sr, Ba and Nb suggests the quartzites are supracrustal rocks (Brown *et al*., 1979; Babcock *et al*., 1979) [6, 7]. High Zr content may symbolize presence of detrital zircons in the rock units. Average Sr/Ba content in Okemesi quartzites (0.89) and Ado-Ekiti quartzites (0.69) which are >0.4 probably indicate they are not schistose rocks (Van de Kamp, 1968). Average Rb/Sr for Okemesi quartzites (0.74) and Ado-Ekiti quartzites (1.22) are significantly higher than 0.4 which indicate the rocks are pellitic metasediments (Van de Kamp, 1968). Petrogenetic features as presented by Na_2O/Al_2O_3 *versus* K_2O/Al_2O_3 diagram (Garrels and Mackenzie, 1971) [15] (Fig. 5) shows that Okemesi and Ado-Ekiti quartzites are derived from rocks whose antecedents are sedimentary. Similarly, Na_2O *versus* K_2O binary diagram (Pettijohn, 1975) [31] (Fig. 6) shows that even though the two rocks have sedimentary origin, quartzites from Ado-Ekiti plots within greywacke field while the Okemesi quartzites plots within field of arkoses. Trace element geochemistry of the rock units particularly Zr *versus* TiO_2 binary plot (Fig. 7) reveals an inverse relationship exists between Zr and TiO_2. Similarly, Zr *versus* Nb (Fig. 8) portray inverse relationship for the two rocks implying derivation from a probable alkaline granitic source. Ternary plot of TiO_2-K_2O-P_2O_5 (Pearce, 1975) [30] (Fig. 9) revealed the metamorphosed quartz sediments are of continental source. Al_2O_3-CN-K_2O ternary plot (Fig. 10) shows that Okemesi quartzites and Ado-Ekiti quartzites both plot on the apical part of the triangular diagram close to Al_2O_3 corner and kaolinite field suggesting the rocks have high intensity of weathering. Chemical Index of Alteration (CIA) [Al_2O_3+CaO+Na_2O) +K_2O] x100 (Nesbitt and Young, 1982) [17] for Okemesi quartzites (88%) and Ado-Ekiti quartzites (91%) are relatively high which points to intense chemical weathering conditions in the source rocks. Index of Compositional Variability (ICV) [Fe_2O_3 + K_2O + Na_2O + CaO + MgO + TiO_2) / Al_2O_3] (Cox and Lowe, 1995) which compare the abundance of alumina relative to other constituents except silica, the Okemesi quartzites (0.83) and Ado-Ekiti quartzites (0.74) have relatively high ICV values. Previous studies show that high ICV values are characteristics of compositionally immature pelitic sediments, whereas mature pelitic rocks with very little non-silicates or those rich in kaolinite group possess low values (<0.6) Elueze and Okunlola, (2003) [11]. The ICV values show immature nature of the sedimentary protolith prior to metamorphism. High concentration of Ba relative to other trace elements like Rb and Sr as indicated by Rb/Sr and Sr/Ba ratios imply significant contribution of silicic source rocks because Ba is a lithophile element that is often mobilized towards the surface from deeper regions of the earth by siliceous rocks like granite (Vigneresse, 2005) [34].

Table 1: Mineralogical composition of Okemesi and Ado-Ekiti quartzite's

Mineral	Okemesi Quartzites (KM)					Ado-Ekiti Quartzites (AD)				
	1	2	3	4	Average	1	2	3	4	Average
Quartz	87	81	79	84	82.75	73	69	81	77	75
Muscovite	-	2	-	1	0.75	3	5	4	2	3.5
Biotite	3	3	9	5	5	15	11	10	12	12
zircon	7	10	8	6	7.75	-	6	1	-	1.75
Opaque	2	4	3	4	3.25	5	3	3	8	4.75
Others	1	-	1	-	0.5	4	6	1	1	2
Total	100	100	100	100	100	100	100	100	100	99

Table 2: Analytical result of Okemesi quartzites

Oxides	KM1	KM2	KM3	KM4	KM5	KM6	KM7	KM8	KM9	KM10	Average
SiO_2	95.87	94.25	95.18	94.92	94.51	94.36	93.89	95.14	94.22	95.07	94.74
Al_2O_3	2.15	2.57	2.23	1.95	2.04	2.38	2.47	2.16	2.16	2.21	2.33
Fe_2O_3	1.79	1.54	1.07	1.69	2.01	1.83	1.92	1.41	2.15	1.66	1.71
MnO	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
MgO	0.08	0.05	0.07	0.07	0.07	0.06	0.08	0.05	0.09	0.07	0.07
CaO	0.16	0.13	0.13	0.10	0.17	0.20	0.15	0.14	0.14	0.12	0.15
Na_2O	0.04	0.04	0.02	0.02	0.03	0.04	0.07	0.05	0.07	0.01	0.04
K_2O	0.07	0.04	0.03	0.05	0.05	0.07	0.04	0.08	0.03	0.1	0.05
P_2O_5	0.04	0.04	0.04	0.04	0.04	0.03	0.05	0.03	0.04	0.02	0.04
TiO_2	0.03	0.03	0.01	0.05	0.02	0.10	0.12	0.08	0.08	0.07	0.06
Cr_2O_3	0.01	0.02	0.04	0.04	0.04	0.03	0.02	0.01	0.01	0.05	0.03
LOI	0.8	1.0	1.0	1.0	0.7	0.8	1.0	0.8	1.0	0.7	0.88
Total	99.9	99.73	99.9	99.95	99.99	99.9	99.8	99.95	100	100	100.11
Trace Elements (ppm)											
Sc	1	1	1	1	2	2	1	1	1	1	1.02
Be	2	1	4	1	1	3	3	3	5	4	2.7
Sn	1	1	1	1	1	1	1	2	1	1	1.01
Cs	5	2	2	6	8	2	3	3	3	4	3.8
Ba	43	51	86	30	27	38	49	18	56	73	47.1
Sr	39	47	32	65	24	29	21	15	43	61	37.6
Y	12	9	31	48	26	52	21	28	7	36	27.0
Zr	115	78	246	207	109	94	184	230	211	85	155.9
Rb	27	35	21	49	17	25	16	11	34	42	27.7
Nb	2	2	5	1	8	7	7	2	5	4	4.3
Rb/Sr	0.69	0.74	0.67	0.75	0.71	0.86	0.76	0.73	0.79	0.69	0.74
Sr/Ba	0.91	0.92	0.37	2.17	0.89	0.76	0.43	0.83	0.77	0.84	0.89

Table 3: Analytical result of Ado-Ekiti quartzites

Oxides	AD1	AD2	AD3	AD4	AD5	AD6	AD7	AD8	AD9	AD10	Average
SiO_2	94.56	94.49	94.68	93.83	93.09	94.72	93.37	91.78	93.56	94.67	93.88
Al_2O_3	2.42	2.19	2.41	3.23	3.55	2.88	2.88	3.43	2.37	2.30	2.77
Fe_2O_3	1.68	2.71	1.52	1.58	2.06	1.89	2.33	1.53	1.76	1.81	1.89
MnO	0.01	0.01	0.01	0.01	0.03	0.01	0.02	0.01	0.01	0.01	0.01
MgO	0.06	0.09	0.05	0.05	0.05	0.04	0.08	0.05	0.09	0.03	0.06
CaO	0.11	0.14	0.19	0.16	0.11	0.12	0.13	0.15	0.17	0.19	0.15
Na_2O	0.02	0.02	0.01	0.01	0.03	0.02	0.04	0.04	0.04	0.03	0.03
K_2O	0.03	0.01	0.04	0.04	0.02	0.07	0.02	0.05	0.01	0.03	0.03
P_2O_5	0.07	0.03	0.02	0.02	0.02	0.04	0.02	0.03	0.04	0.04	0.03
TiO_2	0.02	0.05	0.05	0.03	0.02	0.07	0.03	0.03	0.02	0.03	0.04
Cr_2O_3	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI	1.0	0.8	1.0	1.0	1.0	0.9	1.0	1.0	1.0	0.8	0.93
Total	99.99	99.83	100.0	99.97	99,99	99.96	99.93	100.0	99.98	99.95	99.83
Trace Elements (ppm)											
Sc	1	1	1	1	1	1	1	1	2	1	1
Be	4	5	5	5	5	2	4	3	3	1	3.7
Sn	2	1	1	1	1	2	2	1	1	1	1.3
Cs	8	8	4	2	9	2	6	5	5	7	5.6
Ba	75	61	48	36	64	59	27	80	73	22	54.5
Sr	58	43	29	25	46	37	18	62	49	15	38.2
Y	24	26	4	17	9	21	30	14	7	2	15.4
Zr	210	304	157	192	256	82	71	114	218	95	169.9
Rb	64	51	37	31	58	46	24	74	52	18	45.5
Nb	6	6	13	2	11	9	15	28	12	16	11.8
Rb/Sr	1.1	1.2	1.3	1.2	1.3	1.2	1.3	1.2	1.1	1.2	1.22
Sr/Ba	0.77	0.70	0.60	0.69	0.71	0.63	0.67	0.78	0.67	0.68	0.69

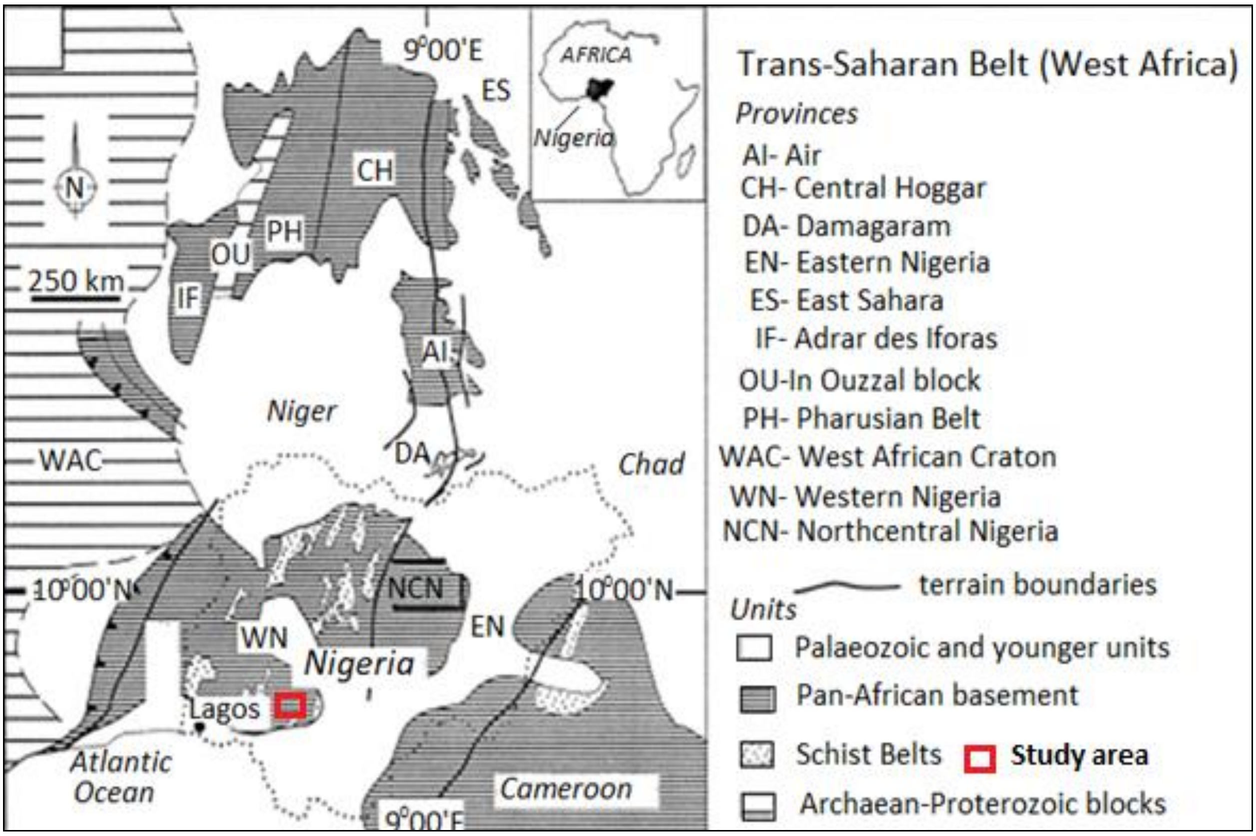

Fig 1: Geological map of Trans-Saharan fold belt located east of West African craton (Adapted from Ferré *et al*., 1998) [14]

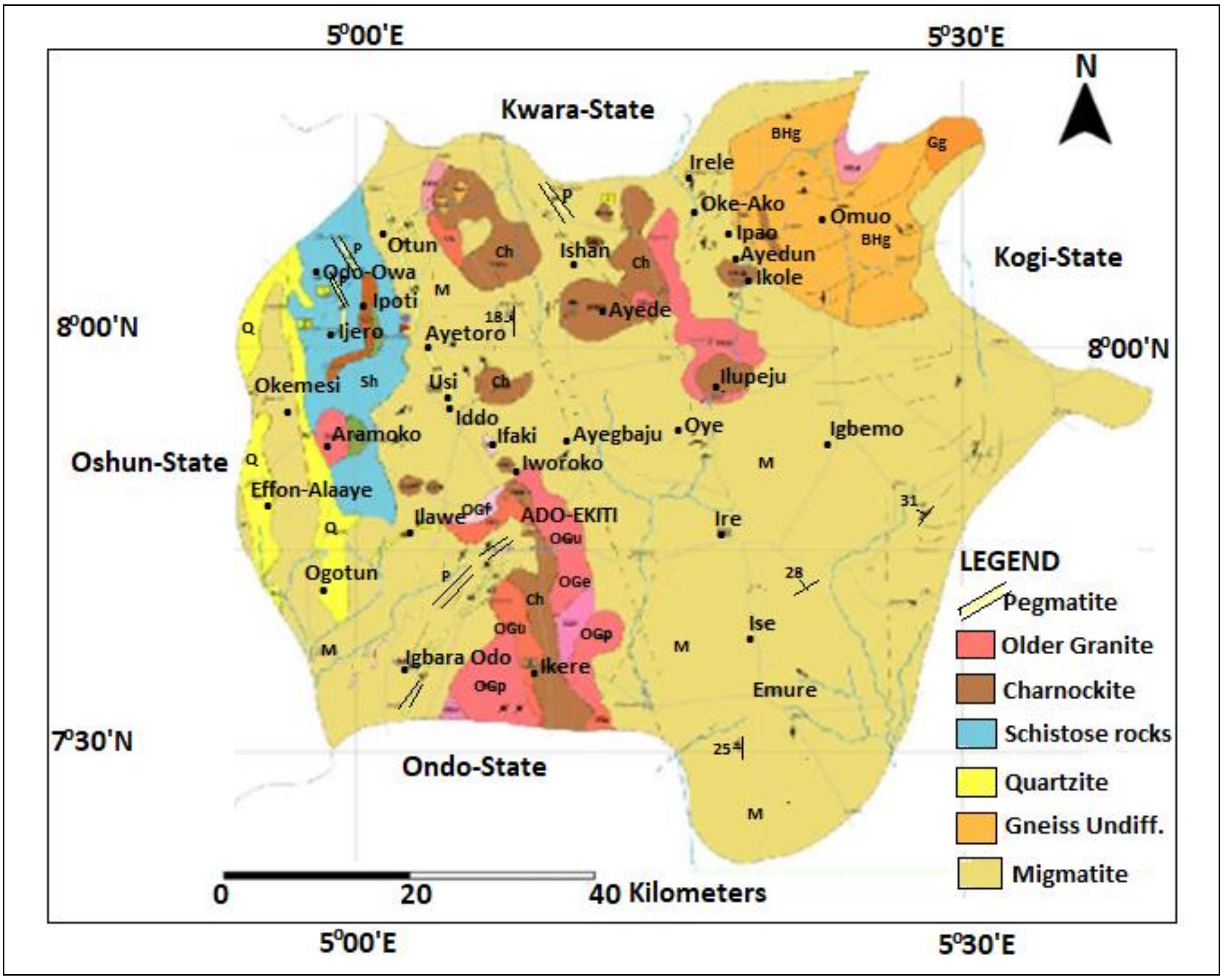

Fig 2: Geological map of Ekiti State.

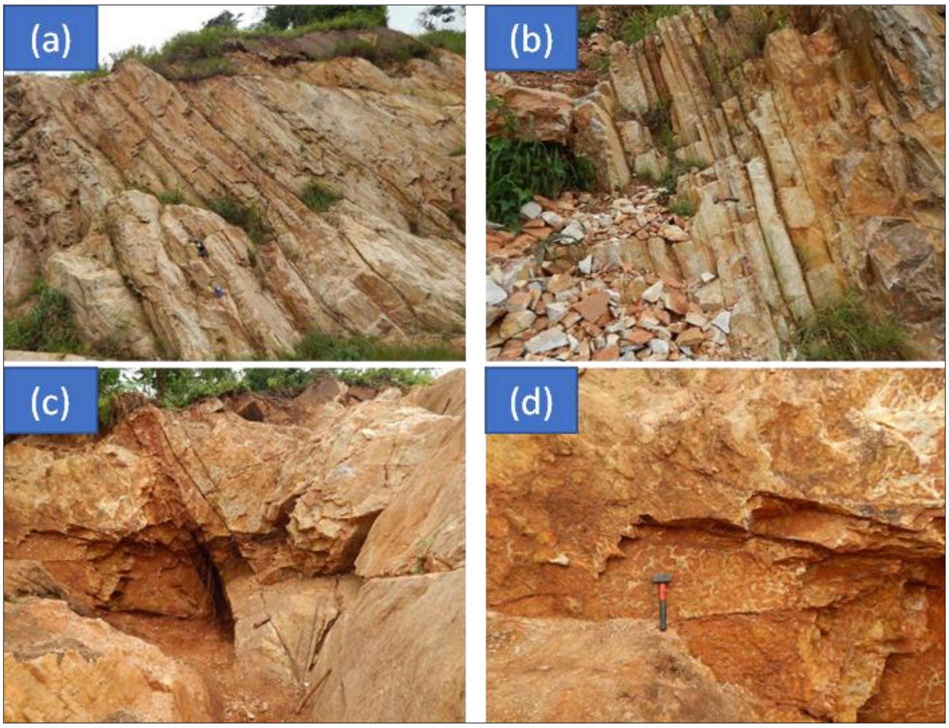

Fig 3: Field exposure of (a) a section of the thickly bedded and steeply inclined Okemesi quartzite at a road cut between Itawure and Ita-Ido junctions. (b) a nearly vertical (steep dip) section of the Okemesi quartzite, (c) ferruginous massive quartzite behind WAEC Office, Ajebandele, Ado-Ekiti, (d) massive ferruginous quartzite along NTA Road, Ado-Ekiti.

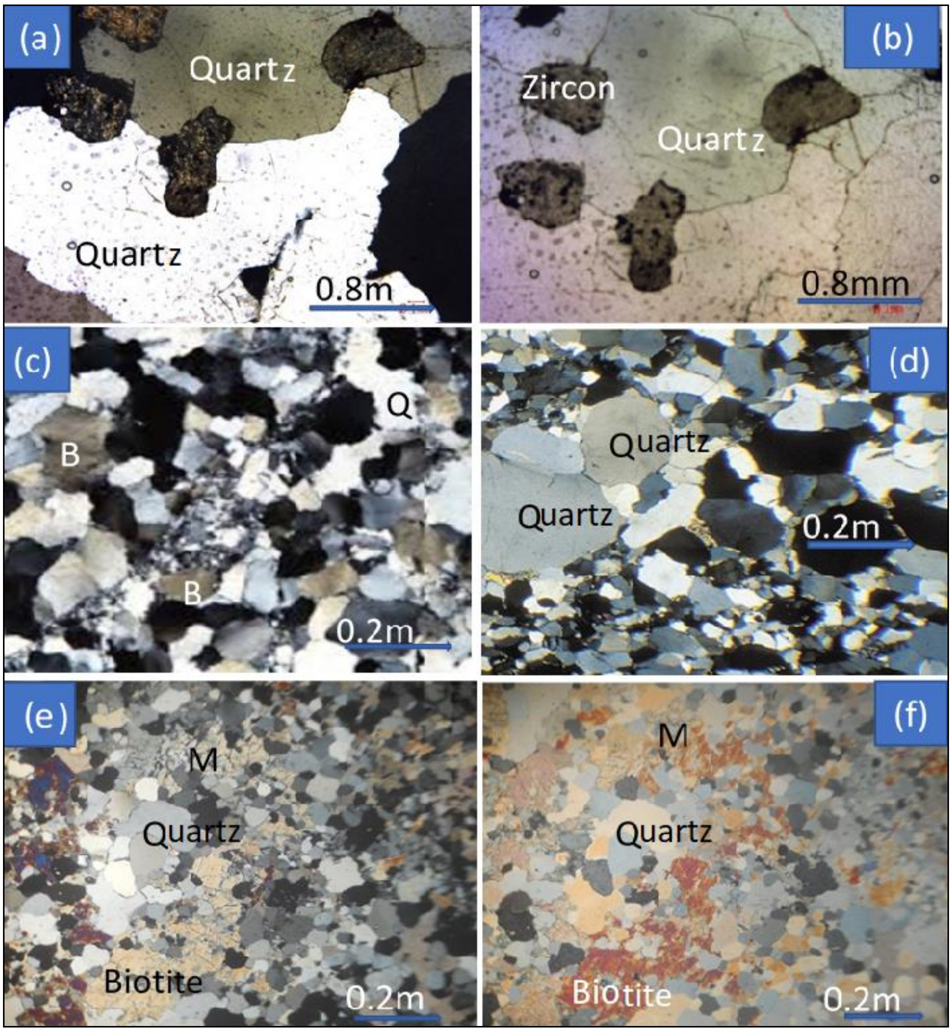

Fig 4: Photo micrograph of quartzites from the study area (a) Okemesi quartzites under cross polarized light (b) Okemesi quartzites under plane polarized light (c) Okemesi quartzites under lower magnification (d) Okemesi quartzites with few rounded quartz grains (e) Ado-Ekiti quartzites under cross polarized light (f) Ado-Ekiti quartzites under plane polarized light. B- (biotite), M (muscovite), Q (quartz),

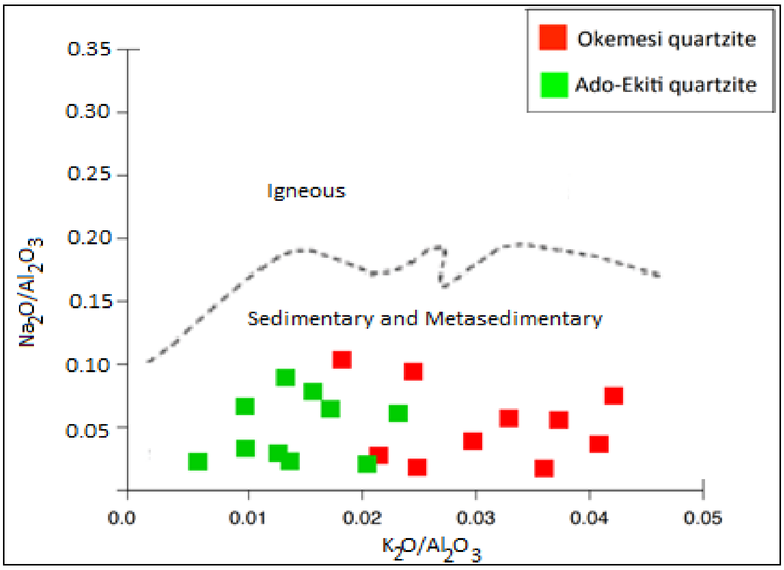

Fig 5: Na_2O/Al_2O_3 versus K_2O/Al_2O_3 for the quartzite

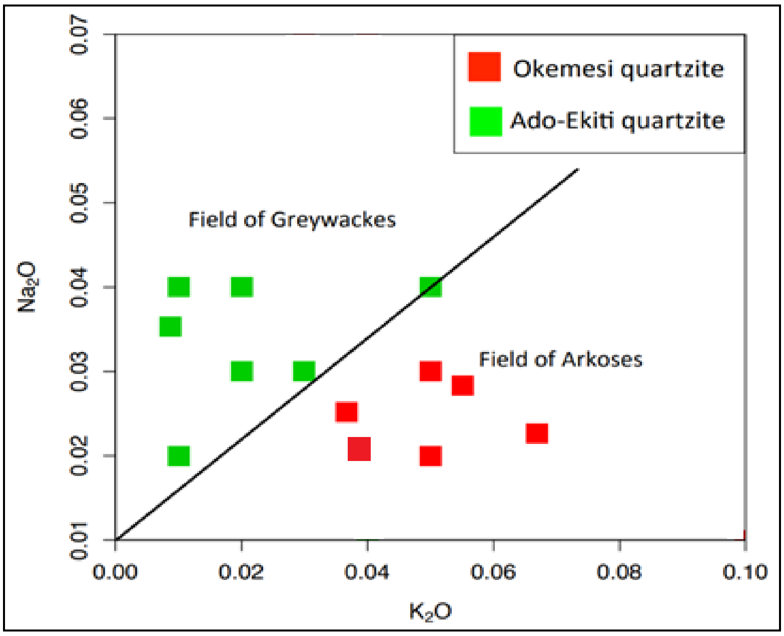

Fig 6: Na_2O versus K_2O plot of the quartzite

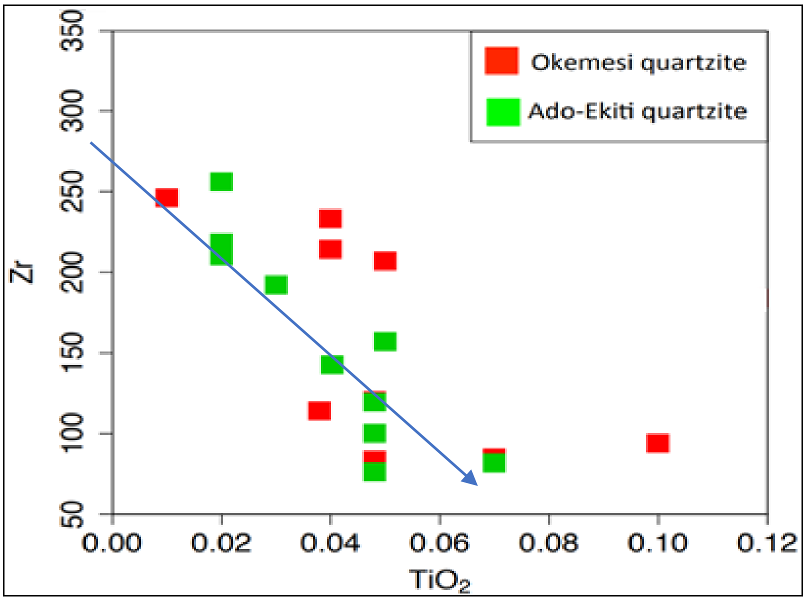

Fig. 7: Zr versus TiO_2 diagram of the quartzite

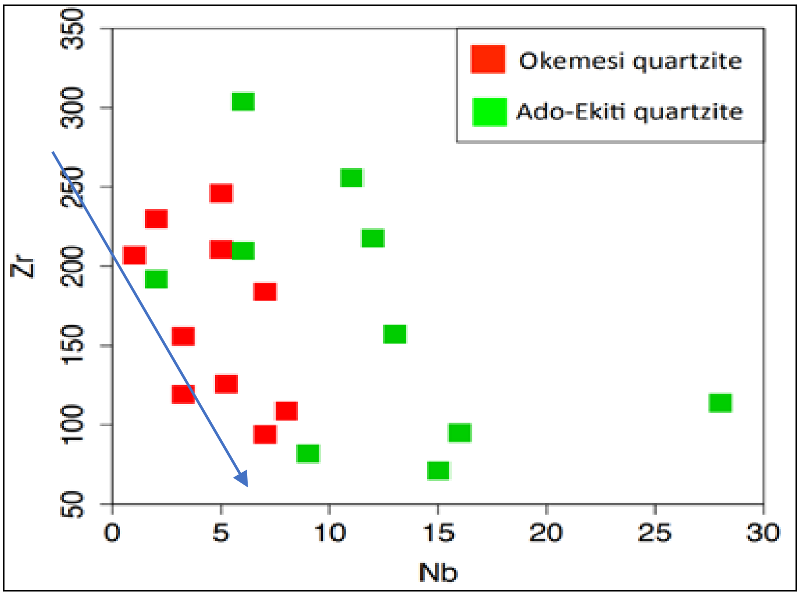

Fig 8: Zr versus Nb diagram of the Ekiti quartzite

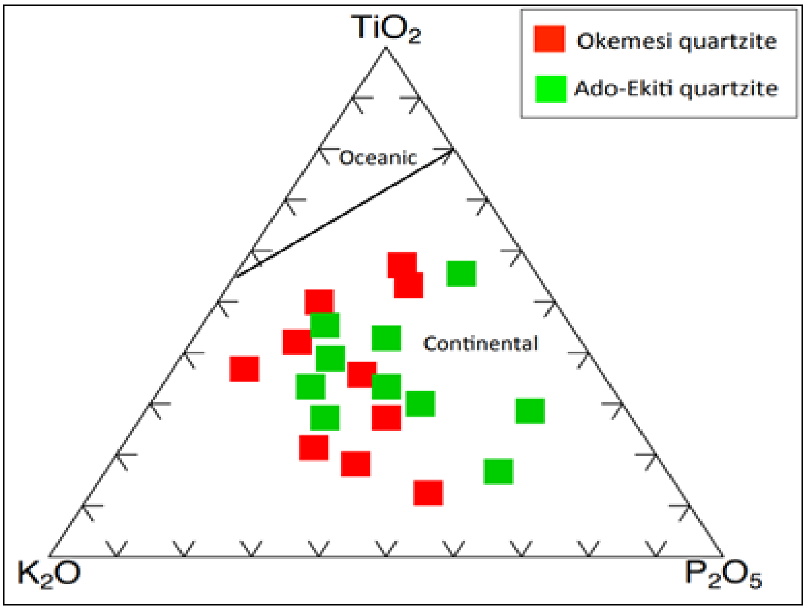

Fig 9: TiO_2-K_2O-P_2O_5 ternary diagram of Ekiti Quartzite (After Pearce, 1975) [30]

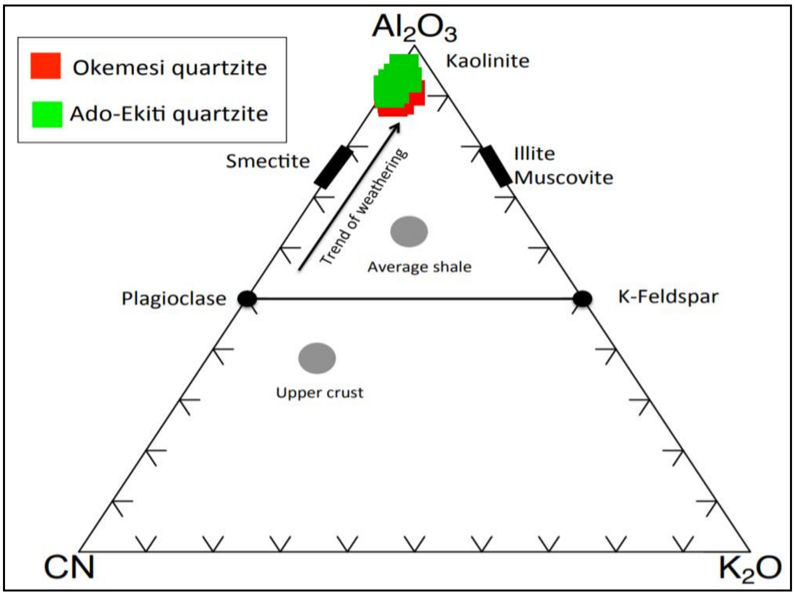

Fig 10: Al_2O_3-CN-K_2O ternary diagram of Ekiti quartzite

Conclusions
From the study, the following conclusions are made

1. Morphologically, quartzites in the basement complex of Ekiti occur as raised platforms higher than their surroundings. Okemesi type occurs as thickly bedded and steeply inclined while those in Ado-Ekiti are massive, hummocky and ferruginous.
2. Mineralogical investigation reveals dominance of quartz grains with variable sizes, while subordinate biotite and accessory zircon form supporting minerals.
3. Geochemical feature indicates the rocks are dominated by silica while other major oxides accounts for less than 8% of the bulk chemistry.
4. Petrogenetic evaluation of the rocks reveals the Okemesi quartzites have protolith of essentially continental sedimentary arkose while Ado-Ekiti quartzites have greywacke antecedents and both are subjected to relatively high intensity of weathering.
5. Index of compositional variability (ICV) of the Okemesi quartzites (0.83) and Ado-Ekiti quartzites (0.74) indicate they are immature pelites.

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References
1. Adeoti B, Okonkwo CT. Structural geology of the basement complex rocks in Iwaraja area, South Western Nigeria. International letters of Natural Science. 2016;58:16-28.
2. Ajibade AC. Provisional Classification and Correlation of the schist belt of North-western Nigeria. *Geology of Nigeria*; Kogbe CA, (Ed). Elizabethan Pub. Co., Lagos, 1976, 85–90.
3. Akinola OO, Okunlola OA. Compositional characteristics and petrogenetic features of metasediments of Ijero-Ekiti area, Southwestern Nigeria. RMZ M & G. 2014;61:221-230.
4. Akinola OO, Bolarinwa AT, Ademilua OL. Lithologic features and petrochemical characteristics of metasedimentary rocks of Igbetti area, Southwestern Nigeria. Industrial Journal of Science Research and Technology. 2014;2(4):82-89.
5. Annor AE, Olobaniyi SB, Mucke A. A note on the geology of the Isanlu area, in the Egbe-Isanlu schist belt, SW Nigeria. Journal of Mining Geology. 1996;32:47-52.
6. Brown EH, Babcock RS, Clark MD. Geology of Precambrian rocks of Grand Canyon in Petrology and structure of Vishu Complex. Prec. Res. 1979;8:219–241.
7. Babcock RS, Brown EH, Clark MD, Livingston DE. Geology of the older Precambrian rocks of the Grand Canyon Part II. The Zoroaster Plutonic Complex and related rocks. Precambrian Research. 1979;8(3-4):243-275.
8. Cox R, Lowe DR. Controls on sediment composition on a regional scale. Conceptual view; Journal of Sedimentary Research A. 1995;65:1-12.
9. De Swardt AMJ. The geology of the area around Ilesha. Geological survey of nig. Bulletin; c1953. p. 23.
10. Elueze AA. Rift System for Proterozoic schist belt in Nigeria. Tectonophysics. 1992;209(1-4):167-169.
11. Elueze AA, Okunlola OA. Petrochemical and Petrogenetic characteristics of metasedimentary rocks of Lokoja-Jakura schist belt, Central Nigeria. Journal of Mining and Geol. 2003;39(1):21-27.
12. Elueze AA. Geochemistry and petrotectonic setting of metasedimentary rocks of the schist belt of Ilesha area, SW Nigeria. Journal of Mining and Geology. 1981;18(1):194-197.
13. Eneh KE, Mbonu WC, Ajibade AC. The Nigerian metasedimentary belts. Facts, fallacies, and New Frontiers. In: Oluyide PO (Ed.) Precambrian geology of Nigeria. Geology Survey of Nigeria; c1989. p. 201.
14. Ferré EC, Caby R, Peucat JJ, Capdevila R, Monie P. Pan-African, post-collisional, ferro-potassic granite and quartz-monzonite plutons of Eastern Nigeria, Lithos. 1998;45(1-4):225-279.
15. Garrels RM, Mackenzie FF. Evolution of Sedimentary Rocks. WM Norton and CO., New York; c1971. p. 394.
16. Hubbard FH. Precambrian crustal development in Western Nigeria: Indications from the Iwo region. Geology Society of America Bulletin. 1975;86(4):548-55.
17. Nesbitt H, Young GM. Early Proterozoic climates and plate motions inferred from major element chemistry of lutites. Nature. 1982;299(5885):715-717.
18. Okeke PO, Meju MA. Chemical evidence for the sedimentary origin of Igarra Supracrustal rocks SW Nigeria. Journal of Mining and Geology. 1985;22(1):97-104.
19. Okonkwo CT. Structural geology of basement rocks of Jebba area, Nigeria. Journal of Mining and Geology. 1992;28(2):203–209.
20. Okonkwo CT. Chemical Evidence for the Sedimentary Origin of Igarra Supracrustal Rocks SW Nigeria. Journal of Mining and Geology. 2006;22:97-104.
21. Okonkwo CT, Winchester JA. Geochemistry and geotectonic setting of Precambrian amphibolite and granitic gneisses in the Jebba Area, Southwestern Nigeria. Journal of Mining and Geology. 1996;32(1):72-79.
22. Okunlola OA, Ogedengbe O, Ojutalayo A. Composition features and industrial appraisal of the Baba-Ode talc occurrence, Southwestern Nigeria. Global Journal of Geological Sciences. 2003;1(1):63-72.
23. Okunlola AO, Akinola OO, Olorunfemi AO. Petrochemical Characteristics and Industrial Features of Talcose Rock in Ijero-Ekiti Area, Southwestern Nigeria. Ife Journal of Science. 2011;13(2):317-326.
24. Okunlola OA, Okoroafor RE. Geochemical and petrogenetic features of schistose rocks of the Okemesi fold belt, Southwestern Nigeria. RMZ–Materials and Geoenvironment. 2009;56(2):148-162.
25. Okunlola OA, Adeigbe OC, Oluwatoke OO. Compositional and petrogenetic features of schistose rocks of Ibadan Area, southwestern Nigeria. Earth Sciences Research Journal. 2009;13(2):119-133.
26. Olobaniyi SO. Geochemistry of semi pelitic schist of Isanlu area, Southwestern Nigeria: Implication for the geodynamic evolution of the Egbe-Isanlu Schist belt. Global Journal of Geological Sciences. 2003;1(2):113-

127.
27. Olobaniyi SB, Annor AE. Petrology and age implication of ultramafic schist in the Isanlu area of the Egbe-Isanlu schist belt, southwestern, Nigeria. Journal of Mining and Geology. 2003;39:1.
28. Oluyide PO, Nwajide CS, Oni AO. The geology of the Ilorin area. Explanation of the 1:250000 sheet 50 (Ilorin). Ministry of solid mineral development, Geological Survey of Nigeria, Bull. 1998;42:38-97.
29. Oyinloye AO, Obasi RA. Geology, geochemistry, and geotectonic setting of the Pan-African Granites and Charnockite around Ado-Ekiti, SW Nigeria, Pakistan Journal of Industrial Research. 2006;40(5):200-208.
30. Pearce JA. Basalt geochemistry used to investigate past tectonic environments on Cyprus. *Tectonophysics*. 1975 Jan 1;25(1-2):41-67.
31. Pettijohn TJ. Sedimentary Rocks. Harper and brothers, New York. 1975;718:259.
32. Talabi AO. Mineralogical and chemical characterization of major basement rocks in Ekiti State, SW-Nigeria. RMZ-M & G. 2013;60:73-86.
33. Van de Kamp PC. Geochemistry and origin of metasediments in the Haliburton–Madoc area, southeastern Ontario. Canadian Journal of Earth Sciences. 1968;5(6):1337-1372.
34. Vigneresse JL. A new paradigm for granite generation. Transactions of the Royal Society of Edinburgh. Earth Sciences. 2005;95(1-2):11-22.
35. Weaver CE. Clays, muds, and shales. *Elsevier*; Amsterdam, 1989, 820.