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COMPOSITIONAL AND PETROGENETIC FEATURES OF SCHISTOSE ROCKS OF IBADAN AREA, SOUTHWESTERN NIGERIA

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ABSTRACT

Amphibole and quartz schist which occur in association with migmatite gneiss, granitic gneiss and Pan African Older Granite bodies around Ibadan area, southwestern Nigeria, were studied with a view to elucidate their compositional characteristics and their evolution.

Mineralogical determinations from optical studies show a high proportion of granular quartz and accessory muscovite in the quartz schist. The amphibole schist on the other hand comprises mainly dark colored bands of hornblende with subordinate tremolite, chlorite and minor amounts of plagioclase and quartz.

Chemical analysis of the samples obtained by Inductively Coupled Plasma Mass Spectrometry (ICPMS) instrumentation method, involving major and trace elements reveal the silicieous nature of the quartz schist and and the amphibole .samples of both rock units are also marked by relatively elevated contents of Ba, Zr, Rb, La and Ce and Zr. In addition, variation plots using Na_2O, Al_2O, K_2O suggests arenaceous sedimentary ancestry for the quartz schist and an igneous ancestry most probably mafic extrusive volcanics for the amphibole schist. Provenance indicators, such as Ba, in the quartz schists suggest derivation of this sedimentary protolith from the weathering of largely granitic rocks. Similarity of the amphibole schist progenitors with subalkaline basaltic andesite is also implied by the Na_2O+K_2O versus SiO_2 bivariate plot, while the $Na_2O+K_2O-Fe_2O_{3\ (t)}-MgO$ ternary plot reveal their calc-alkaline affinity. Tectonically, the quartz schists evolved within the passive margin environment, whereas the $MgO-Fe_2O_3-Al_2O_3$ ternary plots reveal an Ocean island basalt tectonic evolution for the amphibole schist.

Key words: Amphibole, Quartz, Schist, Schistose rocks, Ibadan-Nigeria, Petrogenetic

RESUMEN

Anfíboles y esquistos de cuarzo que ocurren en asociación con gneiss migmatiticas, gneiss de granito y cuerpos antiguos de granito Pan Africano alrededor del área de Ibadan, a sudoeste de Nigeria, fueron estudiados con el fin de aclarar las características composicionales y su evolución.

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Determinaciones mineralógicas a partir de estudios ópticos muestran una alta proporción de cuarzo granular y moscovita accesorios en el esquistos de cuarzo. Por otro lado, los esquistos anfíboliticos incluyen bandas de color oscuro principalmente de hornblenda con tremolita, clorito y de pequeñas cantidades de plagioclasa y cuarzo.

El análisis químico de las muestras obtenidas por el método acoplamiento inductivo de Espectrometría de Masas (ICPMS), revela la naturaleza de silicieous de los esquistos de cuarzo y los anfíboliticos. Muestras de ambas unidades de rocas también están marcados por el contenido relativamente elevado de Ba, Zr, Rb, La y Ce y Zr. Además, la variación de las gráficas Na_2O, Al_2O, K_2O sugiere arenas sedimentarias antiguas para el esquisto de cuarzo y una ígnea antigua muy probablemente mafica para los esquistos anfíboliticos. Los indicadores de procedencia, tales como Ba, en los esquistos de cuarzo sugieren derivación de protolito sedimentario desde la erosión de las rocas graníticas en gran medida. La similaridad entre los progenitores de esquisto anfíboliticos con andesita basáltica subalkaline también implican $Na_2O + K_2O$ versus SiO_2, por la variación de la gráfica $Na_2O + K_2O$-$Fe_2O_{3\ (t)}$- MgO revelan su afinidad calco-alcalinas. Tectónicamente, los esquistos de cuarzo evolucionaron en un ambiente de margen pasivo, mientras que el gráfico MgO-Fe_2O_3-Al_2O_3 parcela ternario revelan una evolución tectónica basalto en la isla de Océano para los esquistos anfíboliticos.

Palabras clave: Anfíboles**,** Cuarzo, Esquistos, Schistose rocks, Ibadan-Nigeria, Petrogenetic.

Introduction

The Nigerian Basement Complex which occurs within the Neoproterozoic to Early Paleozoic, Pan-African (ca 0.6 Ga.) province east of the West African Craton is loosely classified into three principal subdivisions. These are the ancient migmatite-gneiss–quartzite complex, the schist belts and the Pan-African (ca 600 Ma.) granitic series (Elueze and Okunlola, 2003).

The migmatite gneiss suites are mainly ca 2.8 to 2.0 Ga. ages. Most authors on the Nigerian Basement Complex subscribe to the view that the rocks of these suites comprise largely a sedimentary series with associated minor igneous rocks which has been variably altered by metamorphic, migmatic and granitic processes (Oyawoye, 1972; Rahaman, 1988; Okunlola, 2005).

A number of north-south trending Proterozoic schist belts occur conspicuously within the western part of Nigeria with few in the eastern parts and show distinctive petrological and structural features. Fourteen of such belts have been delineated (Rahaman, 1976; Odeyemi, 1977; Ekwueme and Shing1987; Elueze, 1991; Okunlola, 2001; Elueze and Okunlola, 2003). Belts in the southwest include Iseyin, Igarra, Egbe ,Isanlu, Ife-Ilesha,, lokoja -Jakura, and Toto-Gadabuike. As at now however, there is no complete agreement on location, delimitation, geological nomenclature and geodynamic setting of the Nigerian schist belt.

These schistose rocks occurrences around Ibadan constitute the southern extension of the N-S trending Iseyin Oyan belt. This study hence aims at elucidating the compositional features and hence petrogenetic affinity of these schistose rocks of Ibadan area. This is expected to further lead to the understanding of the geodynamic evolution of the schist belts and the Precambrian of Nigeria.

Lithological association and petrography

In the study area, the schistose rocks are associated with an almost north~ south trending unit of the migmatite gneiss complex. The contacts are tectonic in places with prominent slickenside features and cataclastites. These units were later intruded by Pan-African granitic rocks of adammellitic and pegmatitic varieties. These schistose rocks are mainly quartz schist and amphibole schist. The quartz schist form prominent features especially west of Ajibode and Sango area (Fig. 1). Their outcrop pattern indicates possibly a refolded fold (Fig. 1). They are usually fine grained and form extensive north -south trending bodies. In places, they are characterized by preponderance of quartz rubbles and usually whitish grey in color. But in areas of prominent iron staining as a result of thick overlying lateritic regolith they are usually brownish gray in color. They are the most extensive of the schistose rocks studied.

Under the microscope, the rock unit is composed mainly of quartz and muscovite (Fig. 3) Quartz occurs as cloudy anhedral grains with characteristic weak birefringence, prominent undulose extinction and low relief while muscovite occurs as tiny elongate plates with poikilitic crystals of quartz. The amphibole schists on the other hand occur in places as greenish, fissile bodies sometimes weathered or as lenticular and sometimes ovoid shaped bodies comprising of indistinct dark colored bands of greenish black amphibole, light colored bands of plagioclase and minor quartz. Thin section study reveals that the amphiboles are mainly hornblende, tremolite and chlorite.

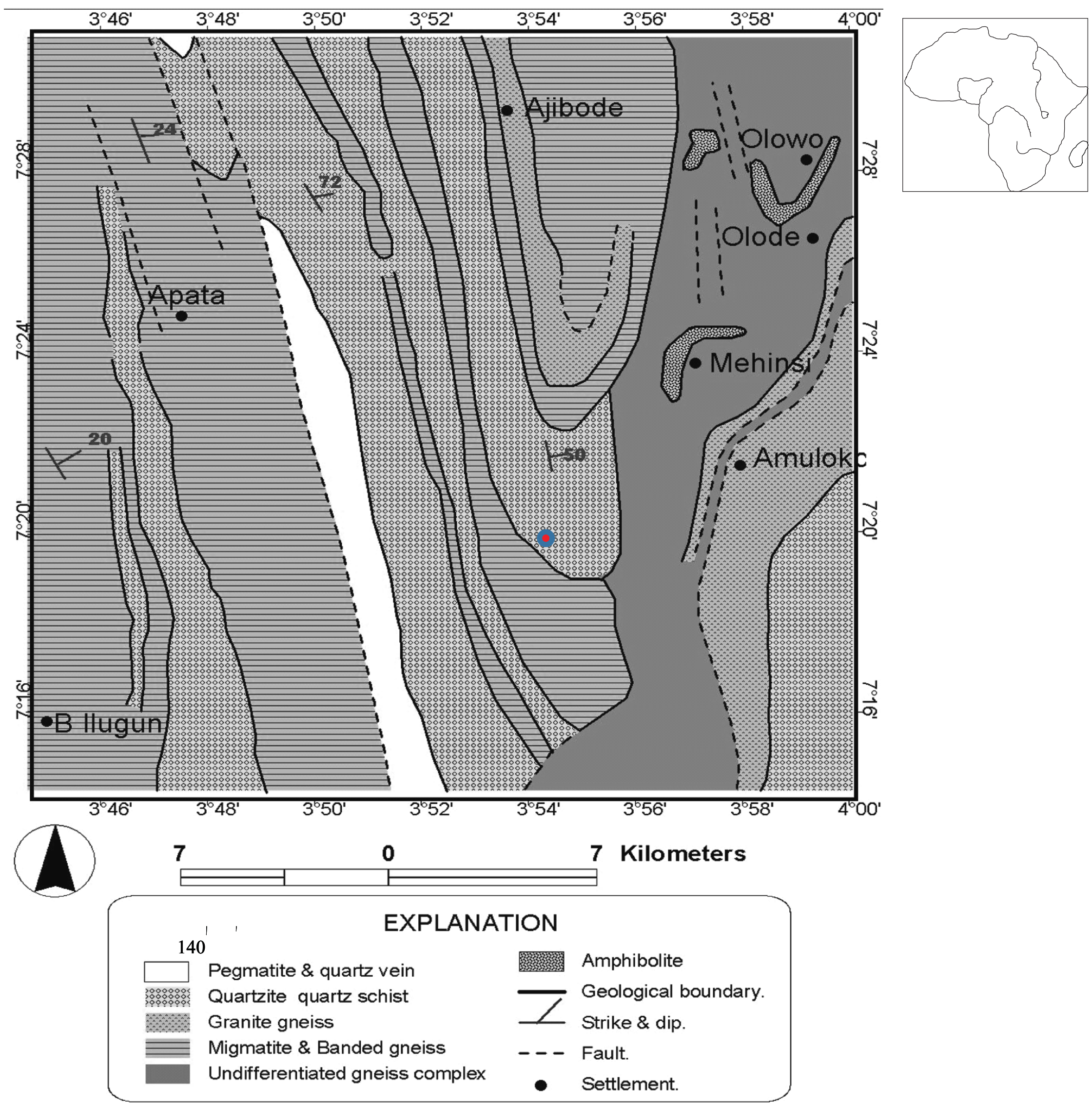

Figure 1. Geological map of study area.

Table 1. Modal composition of the Quartz Schist

	1	2	3	4	5	6	7
Quartz (%)	92	94	93	90	89.5	91	92
Muscovite(%)	7	3	5	8	8	8	5
Microcline (%	1	2	2	1	1	1	2
Magnetite(%)		0.3		0.1			
Zircon	trace	trace	trace	trace	trace	trace	trace
Rutile	trace	trace	trace	trace	trace	trace	trace

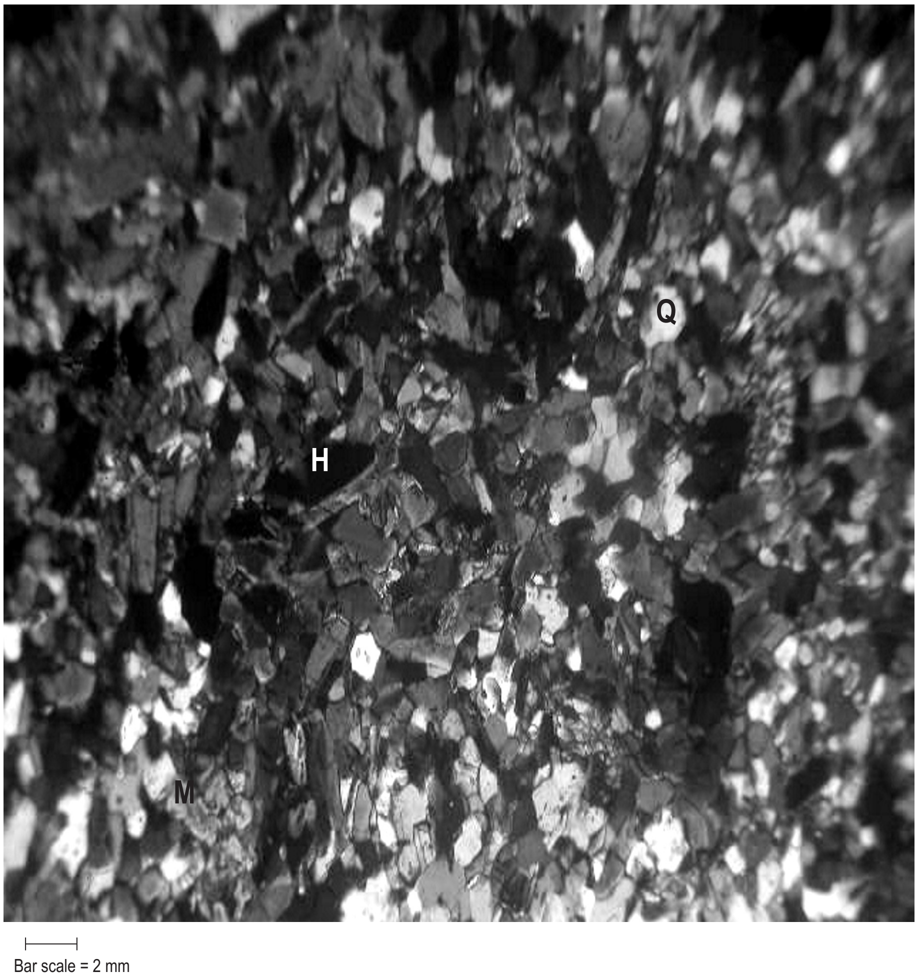

Figure 2. Photomicrograph of amphibole schist of Ibadan area in transmitted light showing. Fine grained anhedral quartz (Q), irregularly oriented hornblende (H) and interstitial mica M)

Table 2. Modal composition of the Amphibole Schist. (%).

	1	2	3	4	5	6	7
Hornblende	69	67	66	66	67	69	67
Plagioclase	10	9	12	14	9	10	10
Biotite	7	6	6	5.5	5	5	7
Quartz	8	9	8.5	9	10	9	9
Chlorite	0.6	0.5	0.5	0.5	0.5	0.5	0.5
Pyroxene	5	5	5	4	3.5	4	6
Tremolite	_	3	_	_	3.5	2.5	_
Total	99.6	99.5	98	99	98.5	100	99.5

Figure 3. Photomicrograph of quartz schist of Ibadan area in transmitted light showing coarse anhedral grains of quartz (Q)and tiny interstitial muscovite. (M)

(Fig. 2) Quartz and plagioclase occur in minor proportions with accessory biotite and zircon. Hornblende occurs as small xenoblastic crystals, greenish in color while tremolite grains tend to be long, prismatic and usually pleichroic from pale green to dark green. Quartz occurs as small anhedral grains with wavy extinction. The Modal composition of the quartz schist and amphibole schist are shown in tables 1and 2.

Geochemical Features

Samples and Analytical Techniques

Seven unaltered and fresh samples each of quartz schist and amphibole schist were analyzed for both major oxide and trace element concentrations at the Activation Laboratories, Canada, using the inductively coupled plasma analytical technique. Analytical results are presented in tables 3 and 4.

Discussion of Results

Average SiO_2 value in the quartz schist is high (95%). This is comparable to values obtained for most quartz schist samples of the Nigerian metasedimentary belt (Okonkwo, 1992; Elueze and Okunlola, 2003; Okunlola, et.al., 2006). Conversely, the average SiO_2 values in the amphibole schist (53.5%) is expectedly much lower and also lower than those of the average values of schistose amphibolites of Nigeria (Ajayi, 1980; Elueze, 1985; Elueze and Okunlola, 2003b). Fe_2O_3 values in the samples of the quartz schist range from 0.33%- 0.62% with a mean of 0.42% while in the amphibole schists they range from 9.63%-9.76% with a mean concentration of 9.7%. The comparatively lower Fe_2O_3 values in the quartz schist are due to the almost total absence of melanocratic minerals. The values for the amphibole schist are comparable to those of the schistose amphibolite varieties of Burum metabasalts while it is lower than those of the

Table 3. Major element (%) and trace element (ppm) compositions of samples of Quartz Schist from Ibadan area.

	R1	R2	R3	R4	R5	R6	R7
SiO_2	94.46	94.07	95.95	95.7	96.01	94.72	94.41
Al_2O_3	1.47	2.24	1.32	1.13	1.52	1.38	1.72
Fe_2O_3(T)	0.33	0.38	0.35	0.62	0.41	0.39	0.46
MnO	0.006	0.004	0.005	0.004	0.005	0.004	0.005
MgO	0.06	0.05	0.05	0.04	0.05	0.04	0.06
CaO	0.91	0.24	0.95	0.73	0.88	0.74	0.5
Na_2O	0.11	0.11	0.13	0.08	0.15	0.09	0.083
K_2O	0.36	0.35	0.3	0.26	0.35	0.302	0.3
TiO_2	0.067	0.224	0.105	0.123	0.23	0.09	0.07
P_2O_5	0.04	0.04	0.04	0.04	0.04	0.04	0.04
LOI	1.268	0.875	1.191	0.963	0.566	0.906	1.364
Total	99.09	98.59	100.4	99.7	100.211	98.702	99.012
Ba	84	131	98	53	94	79	102
Ce	13.2	67.8	15.6	104	50.15	22.7	77.6
Co	1	1	1	1	1	1	1
Cr	20	20	60	20	20	20	20
Cu	10	30	10	10	10	10	10
Ga	2	2	2	2	2	2	2
La	9.1	23.8	8.8	40.4	20.53	15.93	25.12
Nb	2	4	2	2	2	2	4
Nd	5.1	27.3	6.3	46.2	21.23	12.72	29.73
Ni	20	20	20	20	20	20	20
Pb	13	14	9	9	12	9	13
Rb	12	15	10	7	15	9	12
Sn	2	1	1	1	2	1	1
Sr	19	31	20	14	21	18	24
Th	2.3	8.7	2.3	9.4	5.7	8.3	3.01
V	8	9	7	9	9	8	9
Y	3	24	3	23	22	23	20
Zn	320	160	280	310	270	310	220
Zr	122	710	182	184	300	145	454

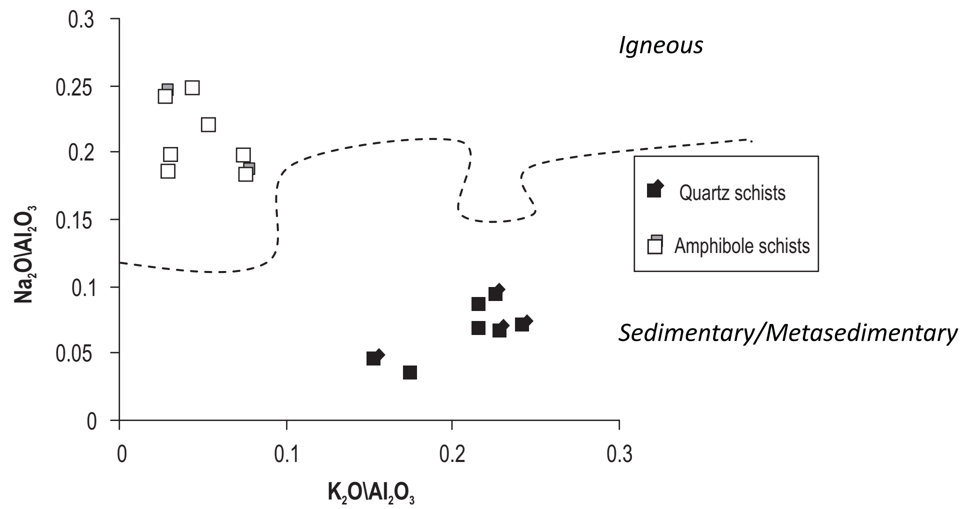

Figure 4. Na_2O/Al_2O_3 vs. K_2O/Al_2O_3 plot for quartz schist and amphibole schist of Ibadan (after Garrels and McKenzie, 1971).

banded and massive varieties of the same area (Elueze and Okunlola, 2003).

The average K_2O, Na_2O and CaO values are greater in the amphibole schist (0.62%, 2.67% and 13.0% respectively) compared to those of the quartz schists (0.32%, 0.11% and 0.71% respectively). These K_2O and Na_2O values for the amphibole schist are higher compared with most of the schistose amphibolite samples of Nigeria which are of tholeiitic affinity. However, for the quartz schist they are within limits for metasedimentary rocks (Okonkwo and Winchester, 1992.)

The average values of MgO and TiO_2 for the quartz schist are low (both less than 0.06%)

Similarly, the average value for these oxides for amphibole schist at 7.17% and 0.29% respectively are also lower than those of tholeiitic basalts of Nigeria and those of the average values for Holleindain Archean metabasalts (Jahn *et.al,* 1974).

Average value for the quartz schist is 0.13% while that of the amphibole schist is 0.28%.

Provenance of the protolith and tectonic Setting

The Na_2O/Al_2O_3 against K_2O/Al_2O_3 plot (Fig. 4) (Garrels and McKenzie, 1971) shows the entire quartz schist samples plot in the sedimentary/metasedimentary field while the amphibole schists plot in the igneous /metaigneous field. This

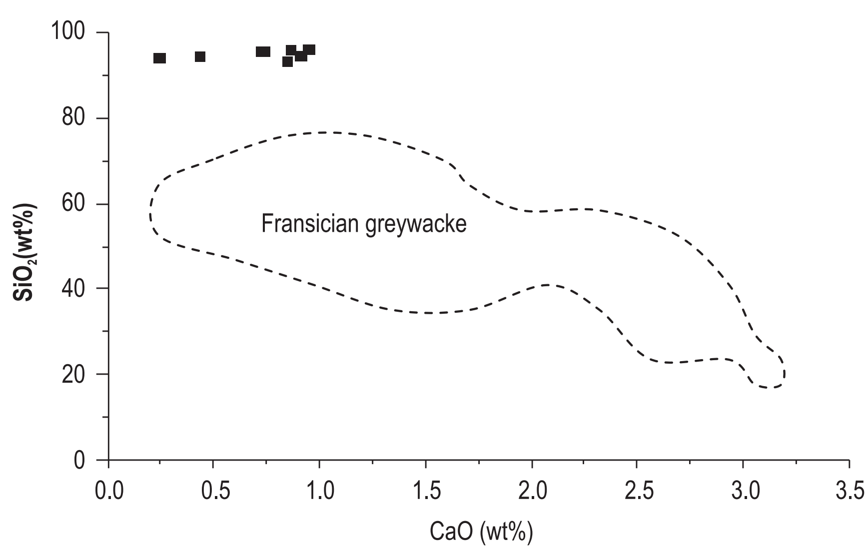

Figure 5. SiO_2-CaO plot for quartz schists of Ibadan. (Field of Fransician greywacke after Brown et al., 1979). Symbols as in figure 2.

Table 4. Major element (%) and trace element (ppm) compositions of samples of Amphibole Schist from Ibadan area.

	R8	R9	R10	R11	R12	R13	R14
SiO_2	53.2	53.81	53.29	52.98	53.75	53.53	53.99
Al_2O_3	10.89	13.44	12.11	12.39	11.02	12.09	12.22
Fe_2O_3(T)	9.76	9.63	9.75	9.66	9.71	9.62	9.74
MnO	0.179	0.168	0.169	0.174	0.177	0.169	0.179
MgO	7.07	7.26	7.3	7.11	7.17	7.22	7.03
CaO	14.74	11.29	12.98	14.57	13.29	11.36	12.89
Na2O	2.04	3.3	3.1	2.54	2.53	3.06	2.16
K2O	0.85	0.39	0.62	0.44	0.79	0.83	0.42
TiO2	0.262	0.305	0.283	0.307	0.287	0.278	0.263
P2O5	0.06	0.06	0.06	0.06	0.06	0.06	0.06
LOI	1.314	0.778	0.636	0.199	1.046	0.649	1.283
Total	100.4	100.4	100.298	100.43	99.83	98.866	100.235
Ba	93	27	60	56	87	33	64
Ce	24.2	10.8	18	25	10.5	22	12
co	53	50	52	49	50	59	48
Cr	860	710	790	850	700	860	730
Cu	40	50	50	40	40	60	50
Ga	10	11	10	10	12	11	10
La	9	4	7	6	9	5	5
Nb	1	1	1	1	1	1	1
Nd	10	6	8	10	6	8	7
Ni	250	180	220	195	230	198	232
Pb	13	5	6	9	12	8	10
Rb	13	4	9	4	11	10	8
Sn	2	1	1	1	1	2	1
Sr	111	91	101	95	106	103	100
Th	4.4	0.7	2.8	4.0	0.9	3.1	1.9
V	144	207	189	203	158	177	150
Y	9	11	13	9	13	9	7
Zn	310	110	110	205	302	253	180
Zr	105	33	81	45	101	39	79

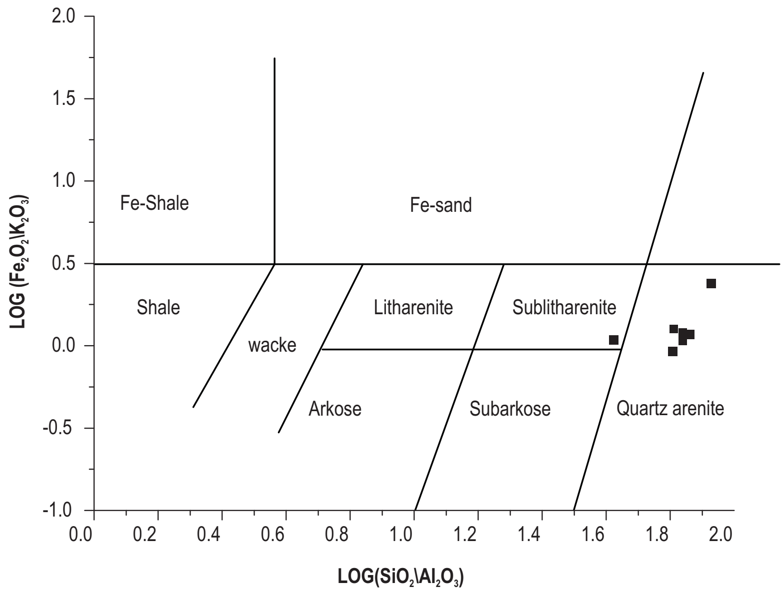

Figure 6. Log (Fe_2O_3/K_2O) vs. Log (SiO_2/Al_2O_3) for the quartz schist of Ibadan (after Herron, 1988). Symbols as in Figure 2.

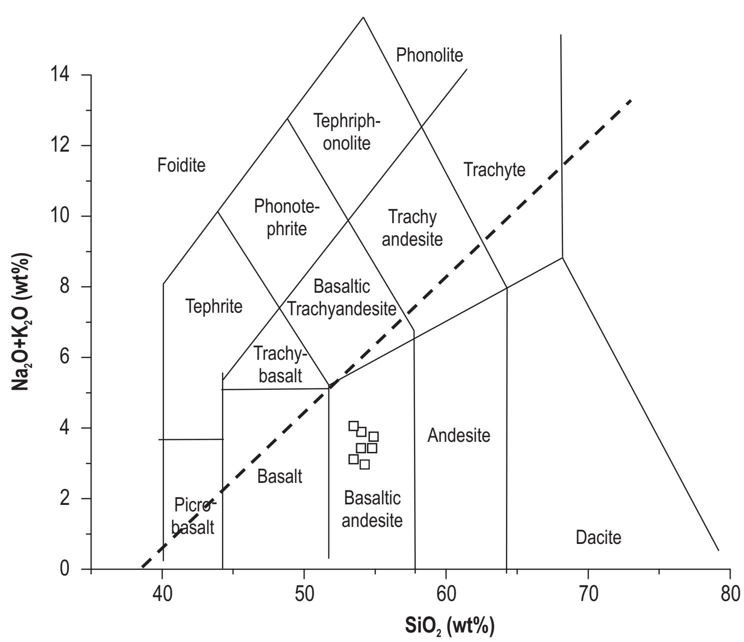

Figure 7. Na_2O+K_2O vs. SiO_2 (Total Alkali vs. Silica,) plot for the amphibole schist of Ibadan (after Le Maitre et al., 1989). Symbols as in Figure 2.

suggests clear distinct genesis for the protoliths for these rock units. The provenance of sedimentary rocks is usually inferred from the framework constituents of the rocks (Pettijohn, 1975; Potter, 1978; Dickinson and Vallani, 1980; Okonkwo, 2005) From the relatively low content of Ba, Rb and Sr in samples of the quartz schist (Table 3) there is a strong possibility of a sedimentary source depleted in arkosic composition, although the contribution on of a felsic source is not ruled out (Van de Kamp and Leake, 1986; Okonkwo and Winchester, 1996; Okonkwo, 2005). This is further supported by the plot of samples outside and above the field of Franscisian greywacke on the SiO_2 *versus* CaO diagram of Brown *et al*, 1979. (Fig. 5). This shows that the protolith is not of a greywacke type. The plot of log (Fe_2O_3/K_2O) versus log (SiO_2/Al_2O_3) diagram (Herron, 1988) (Fig. 6), shows most of the quartz schist plot in the

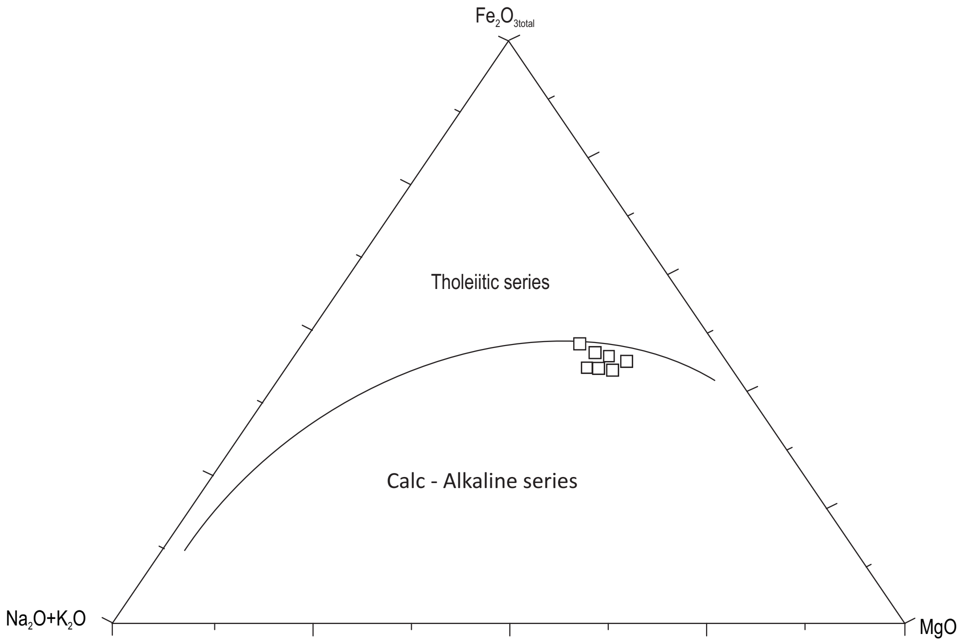

Figure 8. Ternary plot of molecular proportions Na_2O+K_2O-Fe_2O_{3total}-MgO for the amphibole schist (after Kuno, 1968). Symbols as in Figure 4.8.

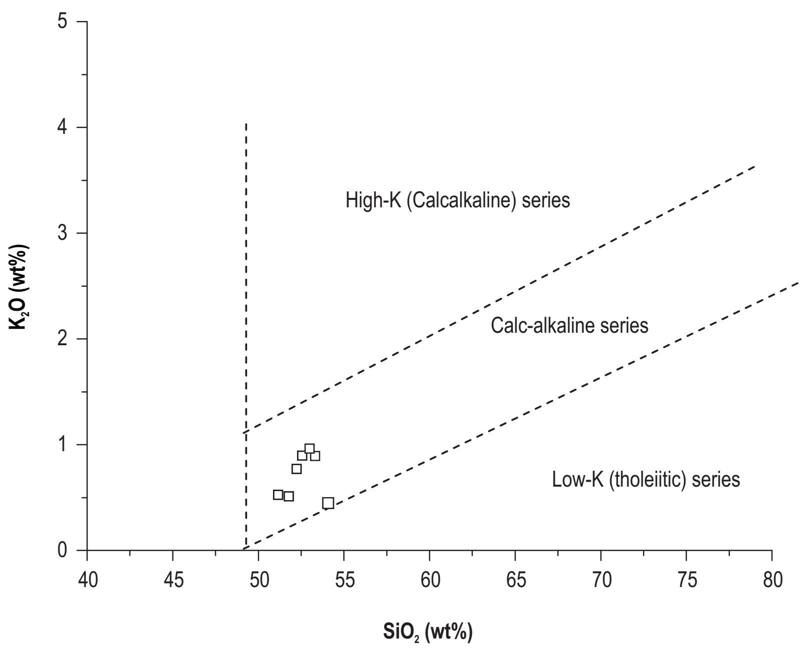

Figure 9. Plot of K_2O vs. SiO_2 for the amphibole schist (after Le Maitre *et al*., 1989) Symbols as in Figure 4.8.

quartz sandstone field thus defining a quartz sandstone protolith for the samples.

For the amphibole schist, the total alkali versus silica plot of Le Maitre *et.al*. (1989) (Fig. 7) reveal samples plotting in the basaltic andesite field indicating a protolith intermediate between basalt and andesite in composition. The bold dash lines in figure 7 shows that the amphibole schist all plots in the subalkaline series (Macdonald, 1968). The Na_2O+K_2O-$Fe_2O_{3(t)}$-MgO ternary plot (Fig. 8) after Kuno (1968) further discriminates the samples as having a calc alkaline affinity, This is further confirmed by the K_2O versus

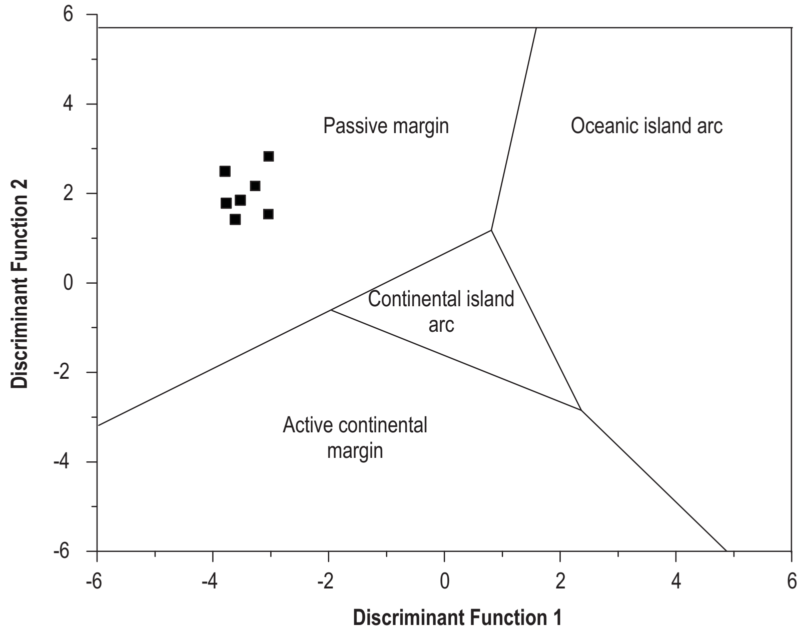

Figure 10. A discriminant functional plot for the quartz schist, showing the tectonic fields, (after, Bhatia, 1983). Symbols as in Figure 4.8.
Discriminant function 1= -0.0447 SiO_2 – 0.972 TiO_2 + 0.008 Al_2O_3 – 0.267 Fe_2O_3 + 0.208 FeO – 3.082MnO + 0.140MgO + 0.195 CaO + 0.719 Na_2O – 0.032K_2O + 7.510 P_2O_5 + 0.303
Discriminant function 2= -0.421 SiO_2 + 1.988 TiO_2 – O.526 Al_2O_3 – 0.551 Fe_2O_3 – 1.610 FeO + 2.720 MnO+ 0.881 MgO -0.907 CaO – 0.177 Na_2O – 1.840 K_2O + 7.244 P_2O_5 + 43.57

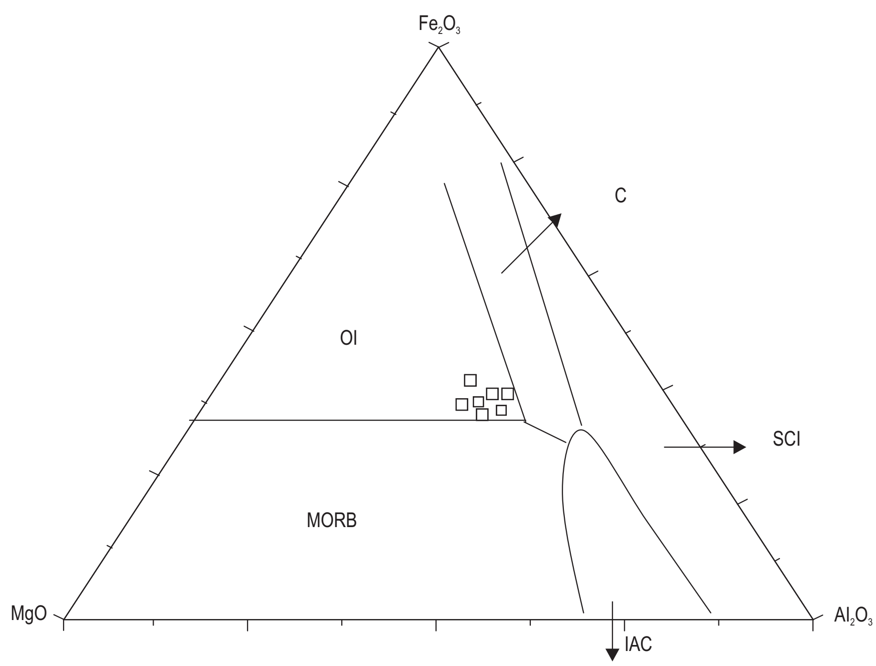

Figure 11. Ternary plot of Al_2O_3-MgO-Fe_2O_3 molecular proportions of the amphibole schist. Diagram is after Pearce *et al*., 1977. Symbols as in Figure 4.8.

C → Continental
IAC → Island arc and active continental margin
MORB → Mid-Oceanic Ridge basalt
OI → Ocean Island
SCI → Spreading centre Island

Table 5. Chemical index of alteration (CIA) % of Quartz Schist and Amphibole Schist.

Sample number	CIA (%)	Rock Name
R1	52	Quartz Schist
R2	76	Quartz Schist
R3	49	Quartz Schist
R4	51	Quartz Schist
R5	52	Quartz Schist
R6	55	Quartz Schist
R7	66	Quartz Schist
Average	57	

Sample	CIA (%)	Rock Name
R8	38	Amphibole Schist
R9	47	Amphibole Schist
R10	42	Amphibole Schist
R11	41	Amphibole Schist
R12	40	Amphibole Schist
R13	44	Amphibole Schist
R14	44	Amphibole Schist
Average	42	

Table 6. Index of compositional variability ICV % of Quartz schist and amphibole schist of Ibadan area.

Sample Designation	ICV	Rock Name
R1	1.25	Quartz Schist
R2	0.60	Quartz Schist
R3	1.42	Quartz Schist
R4	1.64	Quartz Schist
R5	1.36	Quartz Schist
R6	1.20	Quartz Schist
R7	0.86	Quartz Schist
Average	1.20	

Sample Designation	ICV	Rock Name
R8	3.19	Amphibole Schist
R9	2.39	Amphibole Schist
R10	2.81	Amphibole Schist
R11	2.79	Amphibole Schist
R12	3.07	Amphibole Schist
R13	2.68	Amphibole Schist
R14	2.66	Amphibole Schist
Average	2.80	

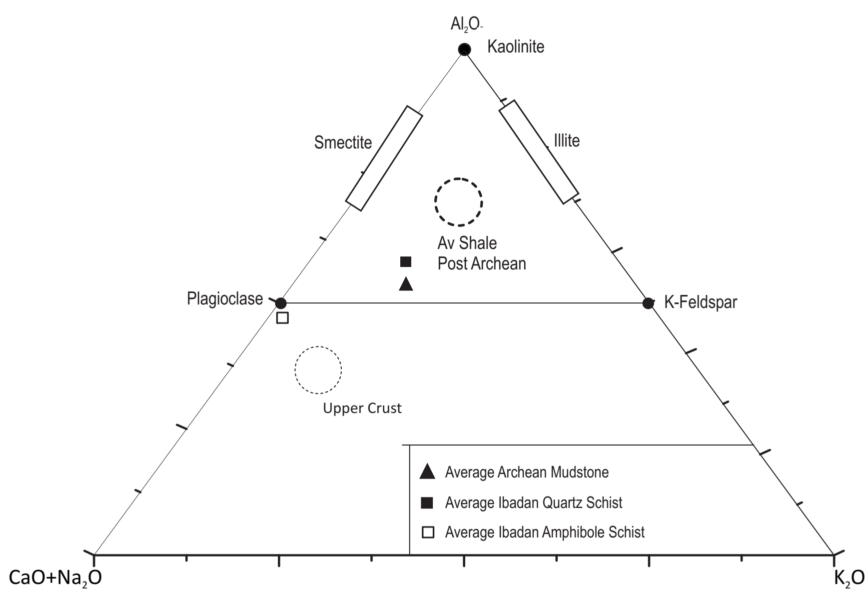

Figure 12. Ternary plot of molecular proportions Al_2O_3-(A)-CaO+Na_2O(CN)-K_2O(K) for the rocks (after McLennan *et al.,* 1995). Upper crust composition and average Post Archaean Shale from Taylor and McLennan, 1985.

SiO_2 plot (Fig. 9) after Le Maitre et al (1989).This shows that the amphibole schist of Ibadan area have a distinct petrogenetic character from most of the amphibolitic rocks of the basement complex of Nigeria which are mostly tholeiitic with Archean metabasalt affinity (Ajayi *et.al.*, 1980; Elueze, 1980; Okonkwo, 1992; Okunlola and Elueze, 2003; Okunlola *et.al.*, 2006)

Tectonically, the quartz schist samples plots as passive margin rocks on a discriminant function diagram after Bhatia (1983). (Fig. 10) The amphibole schists samples on the other hand, plot in the ocean island field on the MgO-Fe_2O_3 $_{(t)}$-Al_2O_3 ternary plot after Pearce *et al* (1977) (Fig. 11).

Source Rock Weathering and Sediment Maturity of the Protolith

The chemical index of alteration (CIA) (Nesbitt and Young 1982) defined as CIA= $[Al_2O_3/(Al_2O_3 + CaO + Na_2O + K_2O)]$ *100 has been used to determine the degree of weathering of the protolith of the rocks in the study area. The quartz schist samples have an average CIA value of 57% (Table 5) whereas those of the amphibole schist record an average value of 42%. This indicates a relatively moderate weathering of the source rocks. In comparison, quartz schists from Igarra area have an average CIA value of 53.9% (Okeke and Meju, 1985) and those of Jakura area (Elueze and Okunlola, 2003) have an average value of 62.1%. Therefore the protoliths of the Ibadan quartz schists show fairly higher degree of weathering than those of the Igarra schist and conversely a lower degree than those of the Jakura schists. The differential weathering degree is further confirmed by the ternary plot of molecular proportions: Al_2O_3 (A) - CaO + Na_2O (CN) - K_2O (K) (Fig. 10) after McLennan *et al.* (1985), the quartz schists plot between the Post-Achaean Shale and the Upper crust compositions but very close to the average Archaean Mudstone (above the plagioclase – K-feldspar mid-line) indicating still a moderately strong weathering of the rocks. The amphibole schists on the contrary plot below the plagioclase – K-feldspar mid-line, indicating a lower degree of weathering relative to the quartz schists.

From the index of compositional variability (ICV) = $(Fe_2O_3 + K_2O + Na_2O + CaO + MgO + TiO_2)/ Al_2O_3$ (wt %) (Cox and Lowe, 1995) which measures the abundance of alumina relative to other major constituents of the rock except SiO_2, average values of 1.20 and 2.80 for the quartz schists and for the amphibole schists respectively were calculated (Table 6). Normally, compositionally immature pelitic rocks will have high ICV, whereas mature pelitic rocks with very little non-silicate clay minerals will possess low values (<0.6) (Elueze and Okunlola, 2003). The value for the quartz schist show moderate to high compositional maturity which is a reflection of the moderate intensity of weathering of the source rocks for the sediments prior to metamorphism. Mature to moderately mature pelitic metasediments (such as quartz schist) are characteristics of relatively stable cratonic environments (Weaver, 1989; Elueze and Okunlola, 2003).

Conclusions

Petrographic and chemical data earlier described strongly indicates a sedimentary protolith, probably quartz sandstone, for the quartz schists. The quartz sandstone was derived from the moderate to fairly intense weathering of granitic rocks. Quartz sandstones are generally regarded as formed from recycled sediments or from materials derived from weathering under low relief conditions as well as under low rates of sedimentation. Such conditions are obtained in stable cratonic environment like the passive margin. It has been shown that first cycle quartz schists can be formed under a unique combination of tectonic and climatic conditions. These include prolonged transport involving slow rate of sedimentation or prolonged alluvial storage with low relief and severe tropical weathering conditions (Weaver, 1989).

Mature pelitic rocks may also be produced by very strong chemical weathering of first cycle materials. The quartz schist of Ibadan area are believed to be metamorphosed products of moderate to slightly intensive weathered felsic source rocks, subjected to prolonged transport, sorting and deposition under stable cratonic environment.

On the other hand, an igneous protolith, viz basaltic andesite is indicated for the amphibole schists. These metasedimentary rock is a metamorphosed extrusive mafic volcanic of calc alkaline affinity distinct from what has been deduced for amphibolitic rocks of other parts of the Schist belt of Nigeria .They may have evolved from a deep crustal source and emplaced in a domain of active sedimentation.

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