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Nature and Origin of the Amphibolites in the Precambrian Basement Complex of Iseyin and Ilesha Schist Belts, Southwestern Nigeria

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Abstract

Petrographic and geochemical studies of amphibolites from Wonu-Apomu area in Iseyin-Oyan schist belt and Ife-Ilesa area in Ilesha schist belt, southwestern Nigeria, were carried out with a view to unravel their nature and petrogenesis. The amphibolites in Wonu-Apomu are associated with quartzite, quartz schist, talc-schist, granite and pegmatites, while those of Ife-Ilesha area are associated with anthophyllite schist, talc tremolite and talc chlorite schists.

Chemical data of the amphibolites showed high Al_2O_3 (>14%), Fe_2O_3 (>12.40%), CaO (>8.10), Na_2O (>3.10%) and K_2O (>5.0%) contents. Trace element data showed that the amphibolites are enriched in Ba (>137ppm), Sr (>122ppm), Rb (>33ppm), Zr (55pm) and Y (>37ppm), but impoverished in Cr (<62ppm), Ni (<57ppm) and Zn (<83ppm). Petrogenetic indices and discriminant plots of $Na_2O + K_2O$ vs SiO_2, Ga vs Y, Zr/Y vs Zr, Cr vs Ni, Fe_2O_3 –Na_2O + K_2O – MgO, indicated tholeiitic basalt affinity of the amphibolites and emplacements of the precursor basaltic rocks within continental crust.

Keywords:amphibolites, petrogenesis, tholeiites, Iseyin schist belt, Ilesa schist belt

1. Introduction

A number of investigations have been carried out by various workers on the amphibolites within the schist belts of the Nigerian basement complex. The Proterozoic Ilesa schist belt of southwestern Nigeria has been mapped in various degrees of details by workers, such as, Deswardt (1953), Hubbard (1966, 1975), Elueze (1980), Klemm *et al.,* (1984) and Kehinde-Phillips (1991). This was largely due to the discovery of gold in the Ilesa area in 1940, as the Ilesa amphibolites Complex was suspected to be the source of the alluvial gold.

On the basis of field relationships and petrological features, the rocks of Wonu-Apomu area have been recognized to comprise the quartzite and quartz schist, amphibolites and related rocks, Older granite and pegmatites, talc and talc schist (Ige, 1985); while the rock of Ilesa area have been grouped into gneiss-migmatite complex, mafic-ultramafic suite (or amphibolites complex), metasedimentary assemblages and intrusive suite of granitic rocks (Elueze, 1980).

Elueze (1986) has indicated that the rocks of the Ilesa schist belt are structurally divided into two main segments by a major fracture zone, often referred to as the Iwaraja fault. Olade and Elueze (1979) has also identified and described four textural varieties of the Ilesa amphibolites; which are massive, banded, schistose and strongly gneissic textural types. Moreover, Elueze (1982) identified various ore minerals in the Ilesa amphibolites and described their metallographic features. Based on geochemical characteristics, Elueze (1980) and Olade and Elueze (1979) have suggested a tholeiitic basalt precursor and emplacement within the continental crust for the Ilesa amphibolites, although Ajayi (1980) proposed a dual parentage for these amphibolites.

Most of these investigations on the amphibolites occurrences within the Precambrian basement complex of southwestern Nigeria tend to emphasize their field relations, petrological descriptions, mineralogical attributes and chemical compositions. Various efforts to unravel the petrogenetic affinity have been dogged with controversy. Therefore, this present investigation largely seeks to generate chemical data to unravel the nature and origin of the amphibolites around Wonu-Apomu in the Iseyin-Oyan schist belt and those of Ilesa in the Ife-Ilesa schist belt, southwestern Nigeria.

2. Location and Geographical Features of the Study Areas

The areas of investigation lie within the Precambrian Basement Complex of southwestern Nigeria (Figure1). The main study area around Wonu-Apomu include towns and villages like Wonu, Apomu, Pagbo, Gbangba, Adigun, Laduntan, Ojewumi, Adetonwa and Elepo (Figure 2); while the area around Ilesa include Ita Osan, Aba Risawe, Isaobi, Ileki, Imosan and Agbao (Figure 3). The area around Wonu-Apomu is delineated by latitude 7º 15′ and 7º 19′ N and longitude 4º 3′ and 4º 6′ E; while the Ilesa area is defined by latitude 7º 31′and 7º 38′ N and longitude 4º 38′ and 4º 45′ E.

The study areas are characterized by rugged topography with elevations ranging from about 800m to about 1200m. The relatively lowland areas are underlain by quartz schist and pegmatites while the higher areas are underlain by amphibolite and anthophyllite-talc schist. The lowland areas are transected by streams and rivers.

3. Geology and Petrography

The Wonu-Apomu and Ilesa areas lie within the NE-SW trending schist belts of the basement complex of southwestern Nigeria. The two areas are characterized by granitic gneiss, low to medium grade metasedimentary and metavolcanics rocks, notably quartzite and quartz schists, amphibolites and talc schist. Others are porphyritic granite and pegmatites (Figures 2 and 3). The gneisses are finely foliated and contained quartz, plagioclase feldspar, microcline, biotite and hornblende (Adeleye, 2009). Quartzite commonly grade into quartz schist with increasing mica content. The massive amphibolites are predominant in the Wonu-Apomu area though they are deeply weathered in most parts (Adeleye, 2009). Essential minerals in the massive amphibolites include hornblende, plagioclase feldspar, quartz, chlorite, biotite, pyroxene, anthophyllite and opaque minerals.

In Ilesa area, N-S trending lenticular, massive, banded, schistose or strongly foliated amphibolites and amphibole schist varieties occur within an essentially gneissic terrain (Adeleye, 2009). The dominant minerals in the amphibolites are hornblende and plagioclase. Other subordinate minerals are quartz, chlorite, biotite, pyroxene anthophyllite and opaque that is generally less the 5% of the modal composition (Adeleye, 2009). The gneissic varieties contain plagioclase and hornblende bands. Some samples contain sphene, epidote, apatite and ore minerals, notably chalcopyrite, pyrrhotite, pentlandite and magnetite. Pyroxenes are present in some while epidote and microcline are well developed in the felsic variety (Olade & Elueze, 1979; Ajayi, 1980). The amphibolites in Ilesa area vary in texture, mineralogy and mode of occurrence. They may be massive, like the type predominating in Wonu-Apomu area or banded with foliation defined by felsic and amphibole rich bands. Essential mineral constituents are hornblende, quartz and plagioclase. Accessory minerals include epidote, garnet, titanite, rutile and ilmenite (Adeleye, 2009).

Rocks of the Older granite series are exposed mostly as low whale backs and pavements in both areas. Microcline constitutes over 30% of the modal composition with other principal minerals like quartz, plagioclase feldspar and mica. Pegmatite veins are intruded into the amphibolites and amphibole schists (Adeleye, 2009).

4. Materials and Methods

Twenty samples of amphibolites were collected from outcrops in Wonu-Apomu and Ilesa areas. The samples were selected for thin sectioning and chemical analysis. Thin section of the amphibolite samples were prepared and examined under the transmitted light of petrological microscope in the Department of Geology, University of Ibadan, Ibadan, Nigeria. Duplicate amphibolite samples were pulverized into fine powder of about 20 mesh size and analysed at the Activation Laboratory in Ontario, Canada. The Inductively Coupled Plasma (ICP) was used to determine the major oxides while Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) was used for the simultaneous multi-element determination of the trace and rare earth elements after total digestion. Pressed powdered pellets were prepared from 3-5g of the samples. This was digested with a mixture of 0.2g aliquot and 1.5g $LiBO_2/LiB_4O_7$ flux in graphite crucible. The crucibles were heated at 980ºC for 30 minutes in an oven. The bead formed was cooled and dissolved in 5% HNO_3 (ACS grade nitric acid diluted in demineralised water) Calibration standards and blank solutions were used in the sequence of analyses to determine the precision which was less than 5%. The major elements determined are SiO_2, Al_2O_3, $Fe_2O_{3(t)}$, MnO, CaO, Na_2O, K_2O, TiO_2, and P_2O_5, while the trace elements include Be, Ba, Sr, Y, Zr, Zn, Cs, Rb, Nb, Sn, Co, Cu, V, Ga, Cr, La, Ce, Hf, Ta, Nd, Th and U. Loss on ignition (LOI) was determined by measuring the weight loss after heating a 1g split sample at 95ºC for 90 minutes.

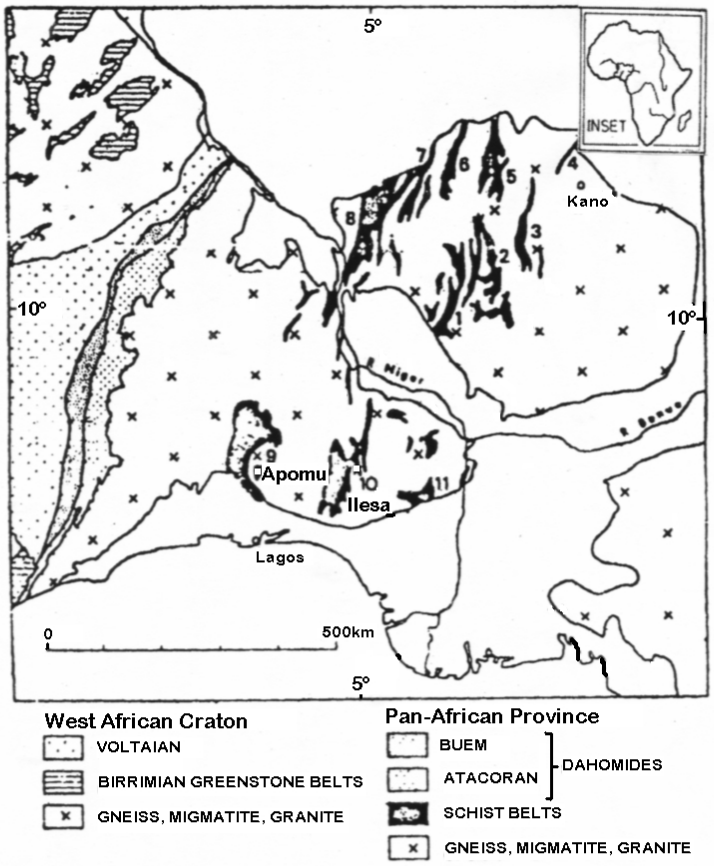

Figure 1. Location of Apomu (9-Iseyin schist belt) and Ilesa (10-Ilesa schist belt) within the Nigerian sector of the Pan-African Province of West Africa (Modified after Turner, 1989)

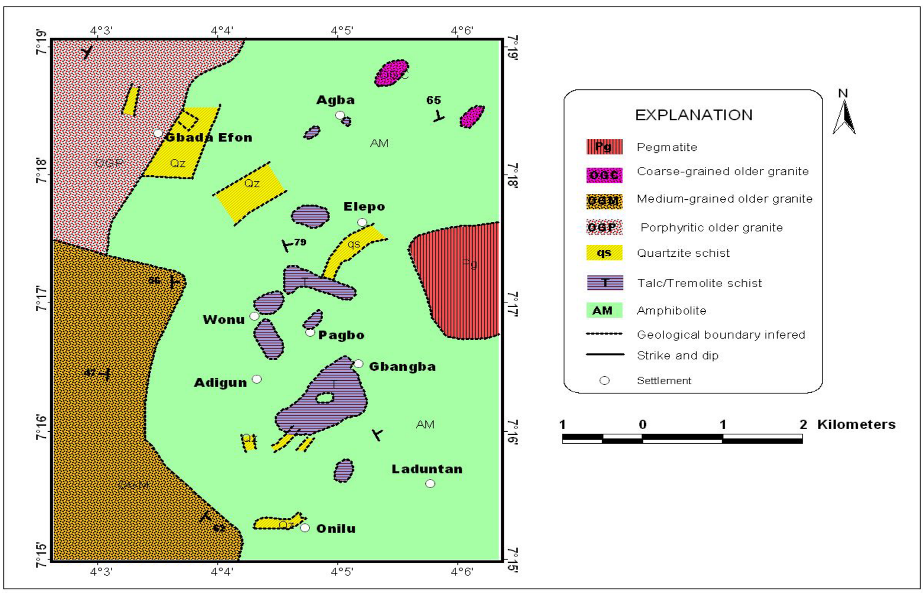

Figure 2. Geological map of Wonu-Apomu area (modified after Akin-Ojo, 1992)

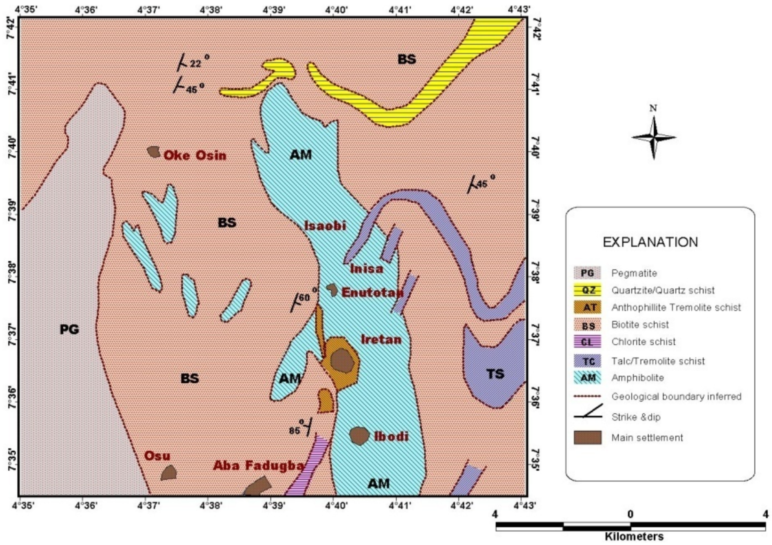

Figure 3. Geological map of Ilesa area (modified after Kehinde-Phillips, 1991)

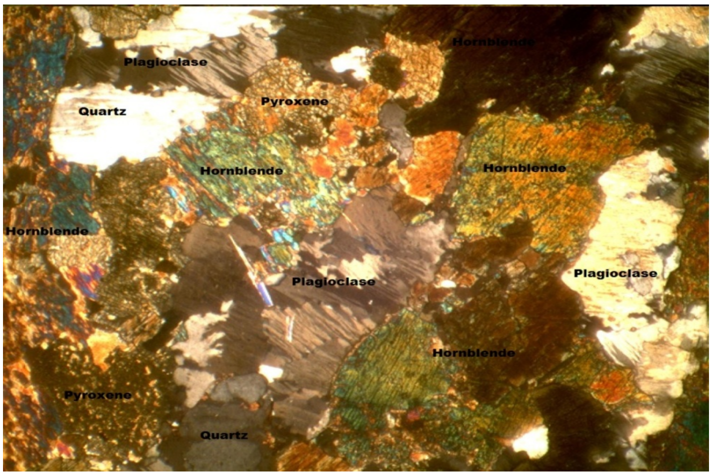

Figure 4. Photomicrograph of massive amphibolite of Wonu-Apomu area showing plagioclase, hornblende, pyroxene and quartz

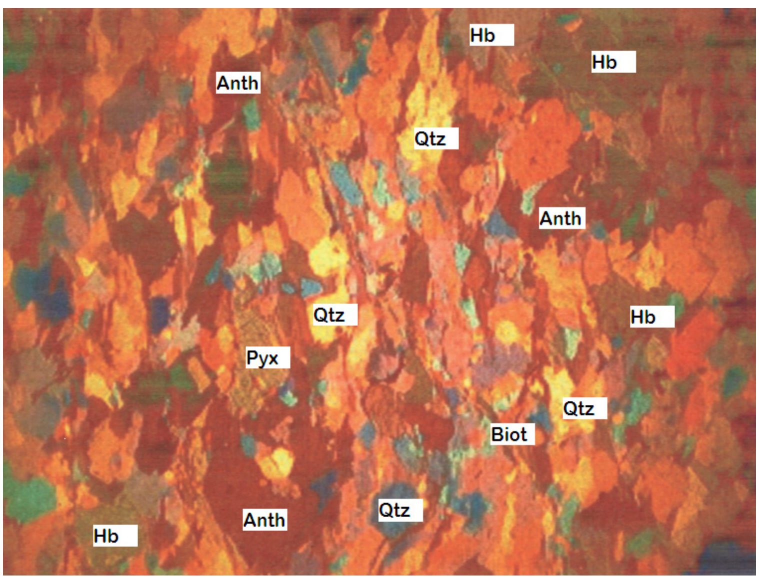

Figure 5. Photomicrograph of foliated and sheared amphibolite of Ilesa area showing hornblende (Hb), pyroxene (Pyx), chlorite (the green specs), anthophyllite (Anth), quartz (Qtz) and biotite (Biot)

5. Results and discussion

Outcrops of the amphibolites occur as smooth small ovoid lenses. They are dark grey to black, aphanitic to microporphyritic in texture. Petrographic study of the amphibolites (Figures 4 and 5) showed the dominance of hornblende (64-71%), plagioclase feldspar (10-12%), anthophyllite (3-6%) and chlorite (3-5%). Other minerals present are biotite, quartz, clinopyroxene (augite) and orthopyroxene (hypersthene) and opaque minerals, which are generally less than 5% each (Table 1). Green hornblende, chlorite and epidote are some of the alteration minerals in the samples. The light brown augite is clearly distinguishable from the amphiboles by its characteristic cleavage of 87º/93º. The brown amphiboles are classified as calcic amphiboles, notably hornblende (Adeleye, 2009). Plagioclase is the calcium rich types with bold multiple twining characteristic of andesine to labradorite composition as observed under the transmitted microscope. Anthophyllite appear 'sack-like,' light brown and yielded straight extinction.

Major and trace element compositions of the amphibolites are presented in Table 2 while the average concentrations as compared with other amphibolites elsewhere are given in Table 3. As shown in Table 2, the amphibolites of Wonu-Apomu have silica concentrations ranging from 44.78-50.62 wt% while Ilesha amphibolites ranged 44.86-49.10 wt% and average composition of 48.91 and 47.27% for Wonu Apomu and Ilesa amphibolites, respectively. This indicated that the SiO_2 contents are not markedly varied within samples, showing typical mafic silica composition. The alumina contents vary slightly, with higher values for samples from Ilesa (17.29 wt%) compared to the Wonu-Apomu samples (15.11 wt%). These values compare favourably well with amphibolites elsewhere in Nigeria (Elueze, 1985; Elueze and Okunlola, 2003; Okunlola *et al*, 2007) (Table 3). There are, however, significant variations in MgO, TiO_2, MnO and P_2O_5 contents of the amphibolites. Wonu-Apomu samples have MgO concentrations ranging from 8.08-12.5%, while Ilesa samples contained 7.85-11.10%. Similarly, TiO_2, MnO and P_2O_5 contents were 0.25-0.88%, 0.07-0.23% and 0.01-0.05% for the Wonu-Apomu samples, while Ilesa samples have 0.39-0.86%, 0.08-0.14% and 0.02-0.05% for the TiO_2, MnO and P_2O_5 respectively (Table 3).

Table 1. Average modal composition of amphibolites in Wonu-Apomu and Ilesa areas

Minerals	1	2	3	4	5	6	7	8	9	10
Hornblende	64	69	66	71	70	69	67	67	66	68
Plagioclase	12	11	11	11	12	12	11	12	10	12
Biotite	4	4	4	4	4	2	4	3	4	4
Quartz	4	3	4	3	3	4	4	4	4	4
Chlorite	5	5	5	3	3	3	3	4	4	3
Anthophyllite	5	3	4	4	4	5	6	5	6	4
Pyroxene	4	4	4	2	2	3	3	3	4	4
Opaque	2	1	2	2	2	2	2	2	2	1
Total	100	100	100	100	100	100	100	100	100	100

1 - 5:Wonu-Apomu samples

6 - 10:Ilesa samples

Table 2. Major (wt%) and trace element (ppm) composition of amphibolites of Wonu-Apomu and Ilesa areas

	1	2	3	4	5	6	7	8	9	10
SiO_2	50.60	50.03	50.62	48.50	44.78	46.38	48.72	44.86	47.29	49.10
Al_2O_3	15.05	14.81	15.26	16.41	14.01	16.55	15.80	15.20	18.67	20.22
$Fe_2O_{3(t)}$	12.52	14.10	13.03	12.27	14.62	12.67	12.15	13.34	12.48	11.56
MnO	0.09	0.12	0.15	0.07	0.23	0.11	0.09	0.12	0.14	0.08
MgO	9.65	8.11	8.08	11.20	12.15	10.18	9.44	11.16	8.96	7.85
CaO	8.72	9.45	9.22	9.25	10.00	9.23	10.28	10.55	9.32	8.11
Na_2O	1.25	1.78	1.56	1.13	1.88	2.05	1.96	2.72	1.28	1.34
K_2O	0.99	0.82	0.75	0.46	0.65	0.64	0.55	0.81	0.81	0.85
TiO_2	0.46	0.25	0.51	0.32	0.88	0.76	0.61	0.85	0.46	0.39
P_2O_5	0.02	0.05	0.01	0.03	0.02	0.03	0.02	0.05	0.02	0.03
LOI	0.35	0.32	0.25	0.34	0.28	0.26	0.33	0.24	0.35	0.28
Total	99.70	99.84	99.44	99.98	99.50	99.86	99.95	99.90	99.78	99.81

Ba	350	99	86	250	135	231	88	96	126	144
Co	85	76	68	85	40	56	48	82	69	53
Cr	92	58	65	92	88	78	65	94	45	51
Cu	40	35	48	51	66	25	72	98	66	45
Ga	25	28	26	27	29	32	46	38	23	66
Ni	46	68	24	85	98	74	25	85	46	23
Rb	38	26	32	29	40	27	36	32	28	46
Sr	125	132	143	106	110	145	124	106	116	120
V	53	56	72	94	68	77	92	98	56	62
Y	38	44	26	32	45	45	32	39	42	25
Zr	62	48	57	49	59	64	46	56	48	66
Zn	98	120	96	96	80	90	82	94	85	62
K/Rb	216.2	261.7	194.5	131.6	134.9	194.7	126.8	210.0	241.8	153.3
Rb/Sr	0.304	0.197	0.224	0.274	0.364	0.186	0.290	0.301	0.241	0.383
K/Ba	23.5	68.7	72.4	15.30	40.01	22.99	51.86	70.01	53.74	48.98
Ga/Y	0.658	0.636	1.00	0.843	0.644	0.711	1.438	0.974	0.548	1.56
Rb/Y	1.00	0.590	1.231	0.906	0.888	0.6	1.125	0.820	0.667	1.84
Na/K	1.129	1.941	1.860	2.196	2.586	2.864	3.186	0.300	1.413	1.409
Ba/Rb	9.21	3.808	2.688	8.62	3.375	8.55	2.44	3.00	4.50	3.130
Ni/Co	0.541	0.885	0.353	1.00	2.45	1.32	0.521	1.037	0.667	1.00
CaO/Al_2O_3	0.579	0.638	0.604	0.564	0.714	0.558	0.651	0.694	0.499	0.40

1 - 5:Wonu-Apomu samples

6 - 10:Ilesa samples

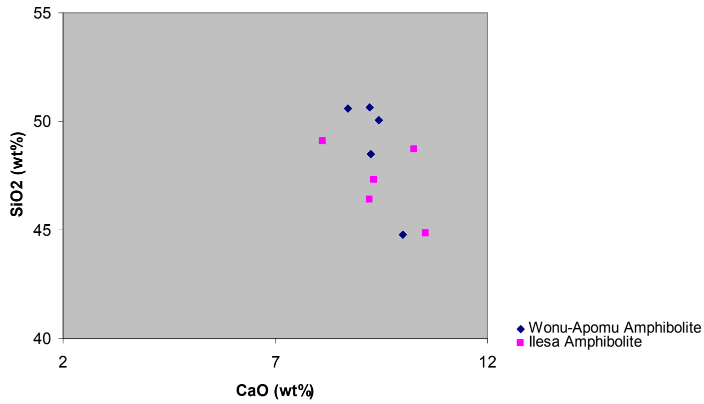

Figure 6. Plot of SiO_2 vs CaO for Wonu-Apomu and Ilesa amphibolites (Brown et al., 1979)

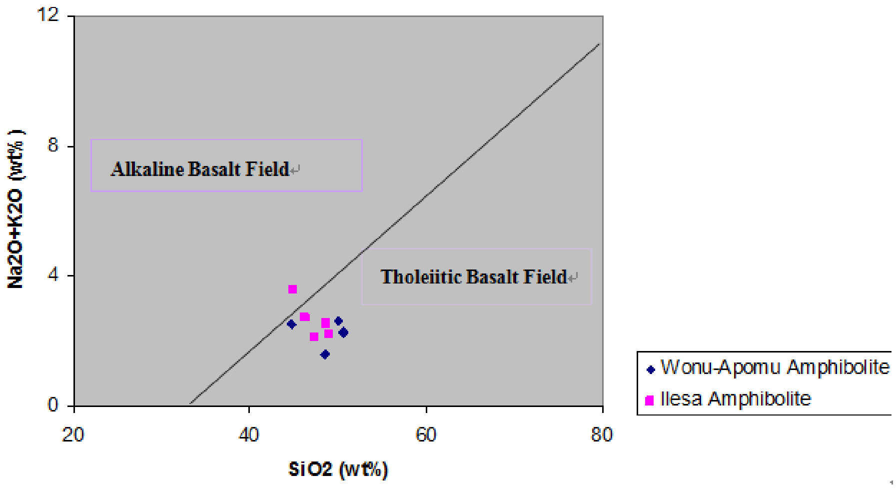

Figure 7. Plot of Na_2O+K_2O vs $SiO_2$for Wonu-Apomu and Ilesa amphibolites (Irvine and Baragar, 1971)

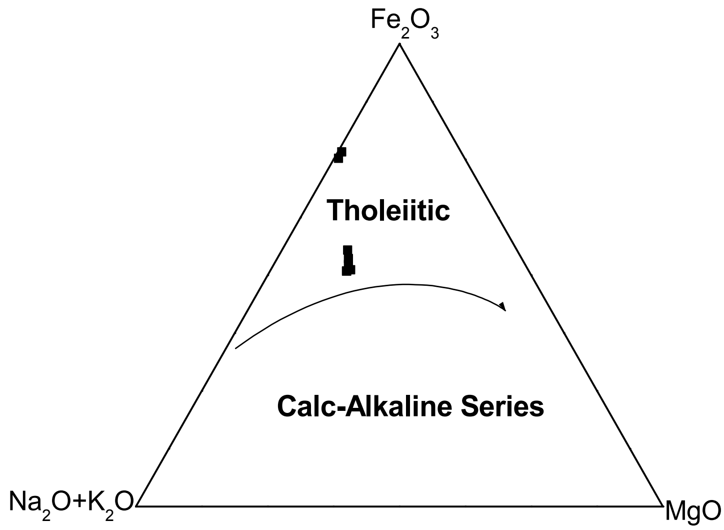

Figure 8. Fe_2O_3-Na_2O+K_2O-MgO ternary plot for Wonu-Apomu and Ilesa amphibolites

The $Fe_2O_{3(t)}$ contents are high for both amphibolites of Wonu-Apomu (13.31%) and Ilesa (12.44%) areas. The CaO concentrations 8.72-10.55% for Wonu Apomu and Ilesa samples reflected the high Ca-plagioclase contents observed in the amphibolites. The high magnesia (>9.5%) and lime contents of the amphibolites reflected the basic nature of the amphibolites. MgO and $Fe_2O_{3(t)}$ contents of the Wonu Apomu and Ilesa amphibolites are enhanced relative to other amphibolites elsewhere in Nigeria (Table 3). On the whole, major element composition of the Wonu Apomu and Ilesa areas are quite similar. However, the amphibolite samples do not compare favourably with other amphibolites elsewhere in Nigeria (Table 3). The differences could possibly be linked to the protolith or subsequent crustal contamination.

Variation diagrams were plotted to characterize the amphibolites. The relative enhancement in lime and silica concentrations of the amphibolites is portrayed on SiO_2 vs CaO discriminate plot (Figure 6). Samples from both areas plot within the field of basalts of the Vishu complex (Brown *et al.,* 1979). The tholeiitic chemical character of the amphibolites was revealed on the Na_2O + K_2O vs SiO_2 discriminant plot (Figure 7). The samples plot within the tholeiitic basalt Field. The Fe_2O_3 – N_aO + K_2O – MgO ternary plot (Figure 8) of Irvine and Barager (1971) showed the tholeiitic affinity of the magmatic precursor of the amphibolites. The tholeiitic affinity of the amphibolites is equally supported by the trend observed on the Ga vs Y bivariate plot (Figure 9), as majority of the samples plot around the 1.0 ratio (Elueze, 1985; Honkamo, 1987).

The Zr/Y vs Zr discrimination diagram (Figure 10) of Pearce *et al.* (1979) for the amphibolites indicated Mid Oceanic Ridge Basalt (MORB), though with slight overlap in the Island Arc Tholeiitic Basalt (IAT) field. The TiO_2 (<0.9) and P_2O_5 (<0.05) contents are consistent with the theoleiitic character of the metabasalts (Floyd and Winchester, 1978). The TiO_2 and SiO_2 discrimination plot (Figure 11) of the amphibolites indicated a negative correlation, which is consistent with an early fractionation of Ti-rich minerals. Also V exhibited a sympathetic relationship with TiO_2 (Figure 12). The geochemical association of Ti and V in magmatic suites is mainly controlled by the crystallization of ilmenite and titanomagnetite (Graham, 1976). Low CaO/Al_2O_3 ratio (< 0.72) for the amphibolites of the study areas suggested igneous ancestry. The strong positive correlation between Cr and Ni (Figure 13) also confirms their igneous origin.

Major oxides within the investigated amphibolites showed minor variation in compositions. Major oxides are seldom used, with care, in petrogenetic and geotectonic discriminations. The trace elements, on the other hand, showed wide range in concentrations, and are therefore essentially employed as important petrogenetic discrimination tools (Pearce and Cann, 1973). The trace element compositions of amphibolites from both areas are similar. The Sr (123ppm), Ba (184ppm), Co (71ppm), Cr (79ppm) and Ni (64ppm) contents are slightly higher in Wonu-Apomu samples than the Ilesa samples with 122ppm, 137ppm, 62ppm, 63ppm and 57ppm, correspondingly. The Ilesa samples however showed relative enrichment in Cu (61ppm), Ga (36ppm) and Rb (34ppm). The Ilesa amphibolite samples have Y, Zr and Zn contents of 37, 56 and 83ppm, while the corresponding values for Wonu-Apomu samples are 37ppm, 55ppm, 96ppm respectively. The observed trends in trace element compositions are so small that significant variation patterns are quite difficult to establish.

Considering the overall trends of the trace element composition, Ba (>137ppm) and Sr 106-145ppm) are comparably lower to other amphibolites elsewhere in Nigeria (Table 3) and fairly exceeded those of the oceanic tholeiites (Clark, 1979). The high Ba value may either reflect plagioclase fractionation, crustal contamination (Olade and Elueze, 1979) or metasomatised source (Stern *et al.,* 1990). Concentration of Co, Cr, Cu, Ga, Ni, V, Y, Zr and Zn are observed to be least variable within samples. In comparison to other trace elements, they are relatively immobile during deformation (Floyd and Winchester, 1978), thus showing their significance in petrogenetic and tectonic setting discriminations in altered mafic rocks.

The petrochemical affinity of the amphibolites: SiO_2 (>47.2%), Al_2O_3 (>15.10%), and K_2O (>0.73%) compare favourably with that of the Burum amphibolite (Elueze and Okunlola, 2003) and Daldrian metabasalts (Graham, 1976). Other chemical parameters, such as, low CaO/Al_2O_3 (<0.7%) and Rb/Sr (<0.30) also confirm the igneous origin of the amphibolites. The bivariate plots of Na_2O+K_2O vs SiO_2, Ga vsY, Zr/Y vs Zr, with the ternary discrimination diagrams of Fe_2O_3-Na_2O+K_2O-MgO, TiO_2-K_2O-P_2O_5 and Fe+Ti-Al-Mg, all confirmed the tholeiitic basalt precursor for the amphibolites.

Table 3. Average major (wt%) and trace elements (ppm) composition of Wonu-Apomu and Ilesa amphibolites, compared with other amphibolites elsewhere in Nigeria

	Wonu-Apomu		Ilesa		3	4	5	6
	Mean	Range	Mean	Range	Mean	Mean	Mean	Mean
SiO_2	48.91	44.78-50.62	47.27	44.86-49.10	60.44	50.20	50.11	53.92
Al_2O_3	15.11	14.01-16.41	17.29	15.20-20.22	13.76	14.37	14.75	13.21
$Fe_2O_{3(t)}$	13.31	12.27-14.62	12.44	11.56-13.34	6.54	10.83	14.75	9.06
MnO	0.132	0.07-0.23	0.11	0.08-0.14	0.24	0.24	0.21	0.01
MgO	9.84	8.08-12.15	9.52	7.85-11.16	2.99	5.45	8.56	9.14
CaO	9.33	8.72-10.00	9.50	8.11-10.55	9.24	15.26	10.34	10.78
Na_2O	1.52	1.13-1.88	1.87	1.28-2.72	0.01	0.19	0.63	2.0
K_2O	0.73	0.46-0.99	0.732	0.55-0.85	3.06	0.48	0.20	0.26
TiO_2	0.048	0.25-0.88	0.61	0.39-0.86	0.70	1.32	0.55	0.089
P_2O_5	0.026	0.01-0.05	0.03	0.02-0.05	0.66	0.15	0.07	1.6
LOI	0.308	0.25-0.35	1.46	0.02-0.05	0.96	0.92	0.35	0.3
Total	99.69		99.86	0.24-0.35	98.6	99.41	99.99	100.07
Ba	184	86-350	137	88-231	970	560	520	301
Co	71	40-85	62	48-82	17	34	28	149
Cr	79	58-92	63	45-94	130	125	370	117
Cu	48	35-66	61	23-98	315	310	185	-
Ga	27	25-29	36	23-85	21	15	22	-
Ni	64	24-98	57	25-85	56	81	85	62
Rb	33	26-40	34	27-46	67	5	3	21
Sr	123	106-143	122	106-145	210	260	45	167
V	71	56-94	77	56-98	130	270	133	-
Y	37	26-45	37	25-45	32	21	17	144
Zr	55	48-62	56	46-66	120	38	5	78
Zn	96	80-120	83	62-94	106	96	-	-

1: Wonu-Apomu amphibolite

2: Ilesa amphibolite

3: Bako amphibolite (Elueze, 1985)

4: Tegina amphibolite (Elueze, 1985)

5: Burum amphibolite (Elueze and Okunlola, 2003)

6: Lema-Ndeji amphibolite (Okunlola *et al*, 2007)

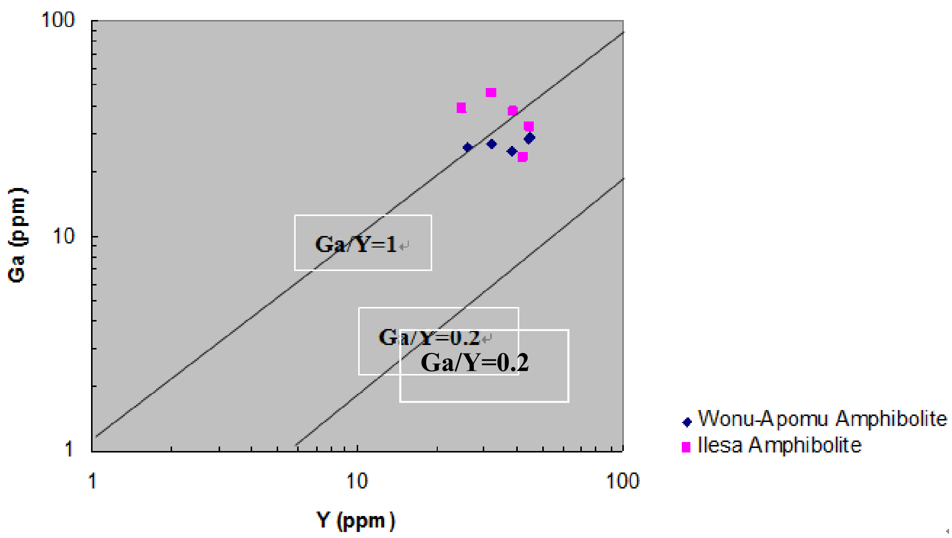

Figure 9. Plot of Ga vs Y for Wonu-Apomu and Ilesa amphibolites

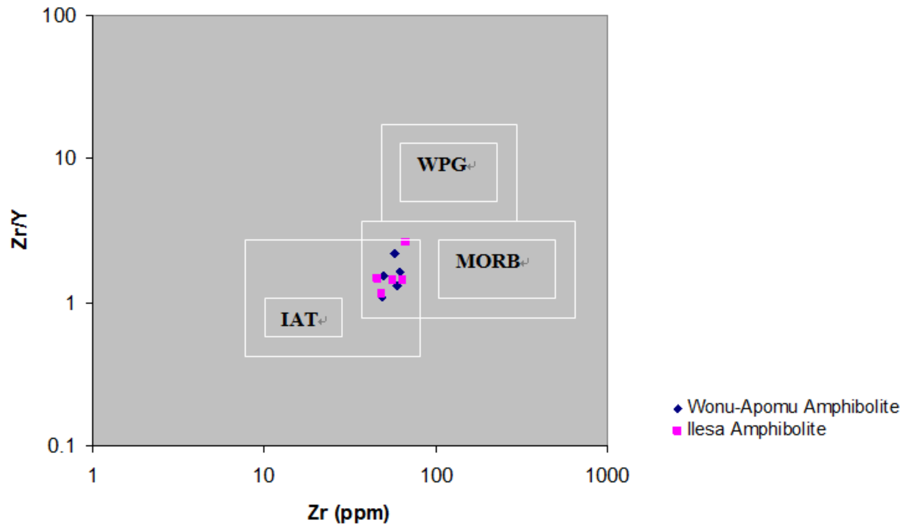

Figure 10. Plot of Zr/Y vs Zr for Wonu-Apomu and Ilesa amphibolites (Pearce *et al.*, 1979; Pearce, 1980). WPG, within plate granitoids or lava; MORB, mid-ocean ridge basalts; IAT, island arc tholeites

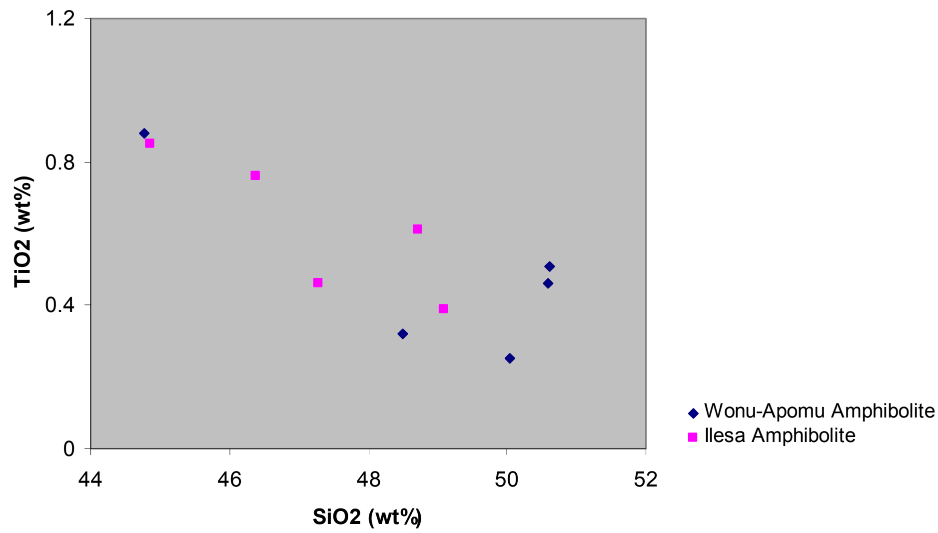

Figure 11. Plot of TiO_2 vs SiO_2 for Wonu-Apomu and Ilesa amphibolites

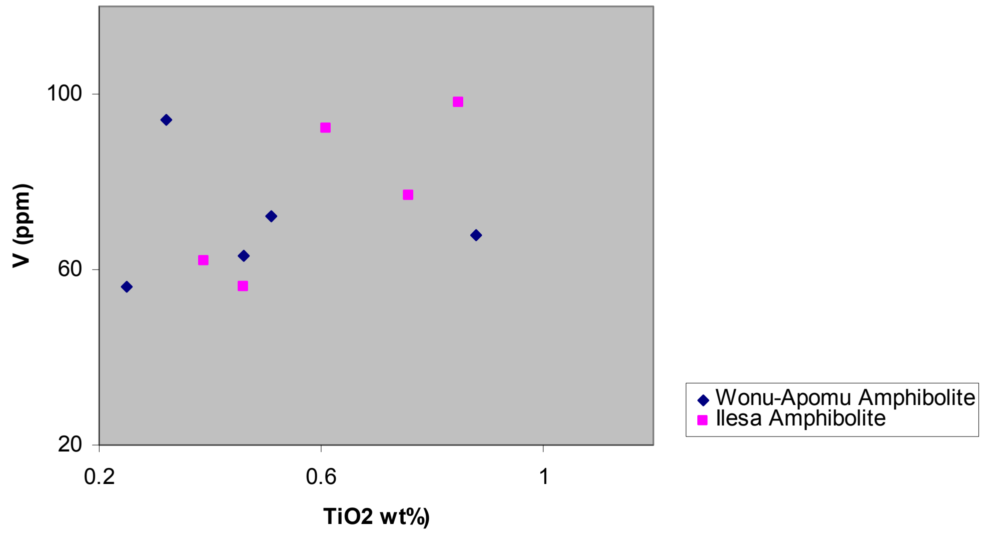

Figure 12. Plot of V vs TiO_2 for Wonu-Apomu and Ilesa amphibolites

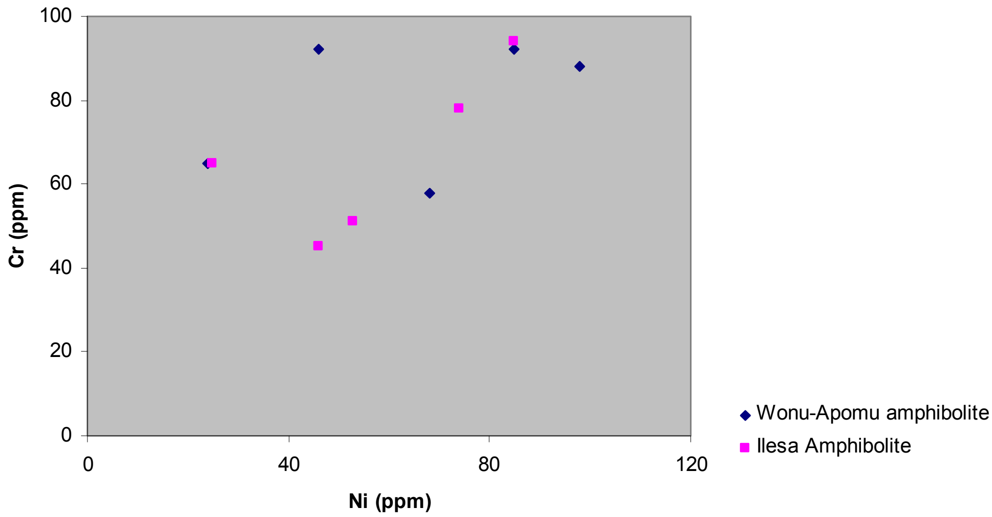

Figure 13. Plot of Cr vs Ni for Wonu-Apomu and Ilesa amphibolites

6. Conclusions

Petrographic study of the Wonu-Apomu and Ilesa areas amphibolites showed the dominance of hornblende, plagioclase feldspar, anthophyllite and chlorite. Other minerals present are biotite, quartz, pyroxene and opaques minerals. Chemical data showed subtle resemblance to other amphibolites elsewhere in Nigeria. The tholeiitic nature and the basaltic igneous precursor of the amphibolites were confirmed via the petrochemical indices and discrimination plots.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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