

Research Article

## An appraisal of the geochemistry and geotectonic settings of the pan african rocks around akure and are-ekiti and environments, Southwestern, Nigeria

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### Abstract

The geochemical characteristics of the Pan-African rocks from Akure and Are –Ekiti and Environs show a minor variations in the contents of silica ( $\text{SiO}_2$  50.18-98.92 wt%), alumina,  $\text{Al}_2\text{O}_3$  (0.26-17.26wt%), potash ( $\text{K}_2\text{O}$ , 0.07-5.98wt%), and iron  $\text{F}_2\text{O}_3$  (0.52-10.77wt%) respectively. The rocks suites from both areas are also characterized by high alumina, high silica, and presence of biotite, microcline, monzogranite, syenogranites, diorite, granodiorite as well as granites. The rocks from both studied areas plotted into the S-Type and I-Type granites suggestive of their derivation from mixed sources. The presence of shoshonitic series suggests rock association characterized by k-rich, high  $\text{Na}_2\text{O} + \text{K}_2\text{O}$  and low  $\text{TiO}_2$ . The granites from b Akure and Are Ekiti and environs are characteristically potassic with metaluminous I-Type and peraluminous S-Type affinity and elong to high-K calcalkaline to shoshonitic series. The rocks are strongly enriched in Ba-Sr with pronounced negative Eu anomaly, belonging to syn-to post collisional tectonic setting. However, the plots of Rb versus Y+Nb, Rb versus Ta + Yb, Ta versus Yb, Nb versus Y, as well as Ta versus Yb respectively showed that the granitic rocks of Akure and Are Ekiti and environs were formed in the tectonic environments of volcanic arcs, syn-collisional and post collisional as well as within plate settings, suggesting their derivation from fractional crystallization and partial melting.

**Keywords:** Appraisal, Geochemistry, Characteristics, Geotectonic Setting

### Introduction

The study areas are located between latitudes  $\text{N}7^\circ 15'$  and  $\text{N}7^\circ 20'$  and longitudes  $\text{E } 50^\circ 7' 0''$  and  $\text{E } 50^\circ 14' 17''$  for Akure) and Latitudes  $\text{N}7^\circ 36' 16''$  and  $\text{N}7^\circ 44' 44''$  and, Longitudes  $\text{E } 5^\circ 15' 16''$  and  $\text{E } 5^\circ 24'$  for the Are-Ekiti & environs) respectively. Twenty rock samples (20) ten each were collected from Akure areas and Are-Ekiti and environments respectively. Fig. 1 and 2 are the topographical maps showing the sample locations.

The geology of the study areas has been variously studied by Oversby (1975), Rahaman (1988), Annor, (1995), Dada (1998), Oyinloye, and Obasi (2006), among others as part of the Southwestern Nigerian basement complex. The local geology of the sampled areas of Akure covers three lithologic units of coarse porphyritic biotite hornblende granite, medium to coarse-grained biotite granite, and charnockite meta-

intrusives (Fig. 3). In the same way, the local geology of Are – Ekiti, and environs shows that the samples were collected from the migmatite units of the entire geologic fields of the area covering Are Ekiti, Afro Ekiti, Iworoko Ekiti, Iran Ekiti, and Igbemo Ekiti (Fig.4).

The Neoproterozoic (Pan-African) orogenic imprints in the Nigerian Basement Complex were characterized by high-grade metamorphism, folding, faulting, and widespread granite plutonism. Granite magmatism is commonly associated with several tectonic settings and various stages during orogenic evolution have been studied by Pearce, Harris, & Tindle, 1984; Whalen, Currie, & Chappell, 1987; Maniar & Piccoli, 1989; and Frost, & Frost, 1999.

Are-Ekiti, Afao-Ekiti, Igbemo-Ekiti, Iworoko-Ekiti, and Ijan-Ekiti areas represented by Are-Ekiti & environs are studied in this present work. Olusiji (2015) suggested a sedimentary protolith, for migmatite gneiss, gneiss, and banded gneiss in

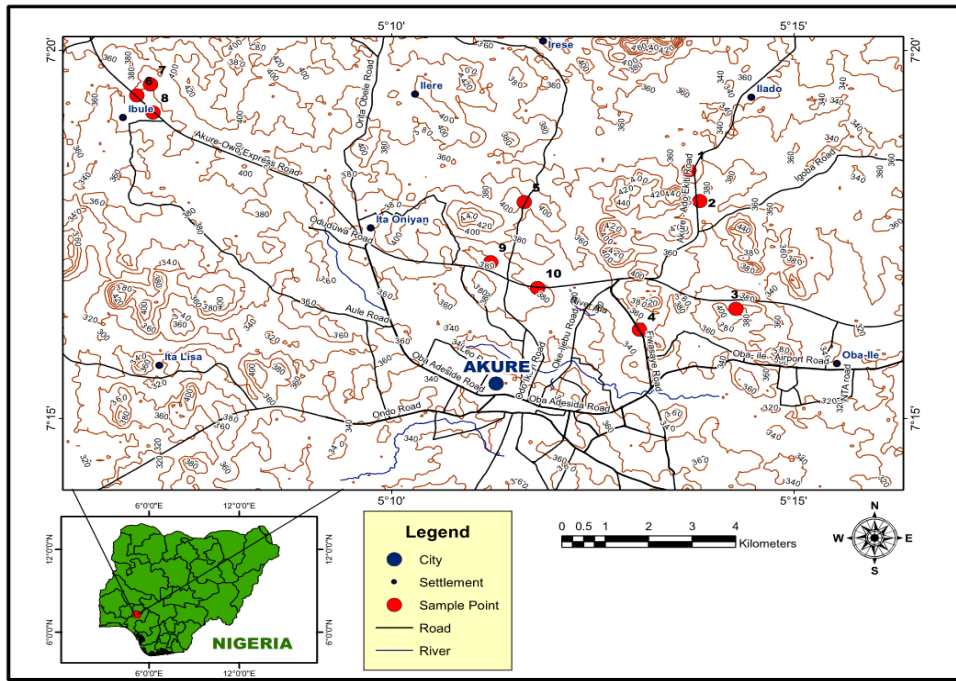


Fig. 1 Topographic Map of Akure (Present work)

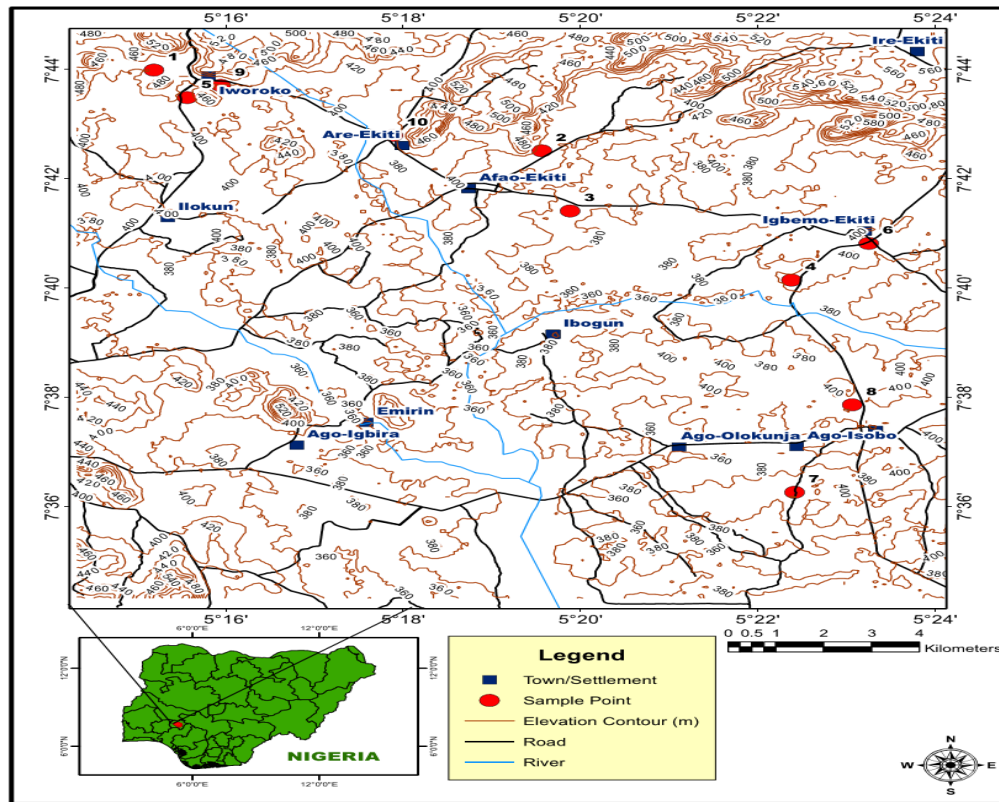


Fig. 2 Topographic map of Are-Ekiti & environments (Present work)

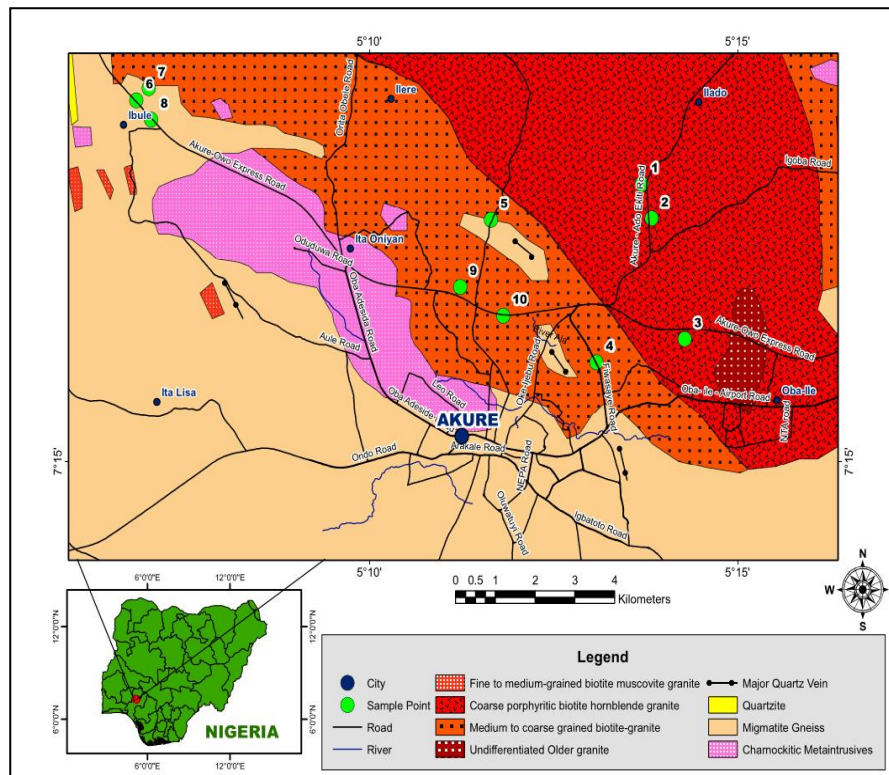


Fig. 3 Local geology of Akure rocks. (Present work)

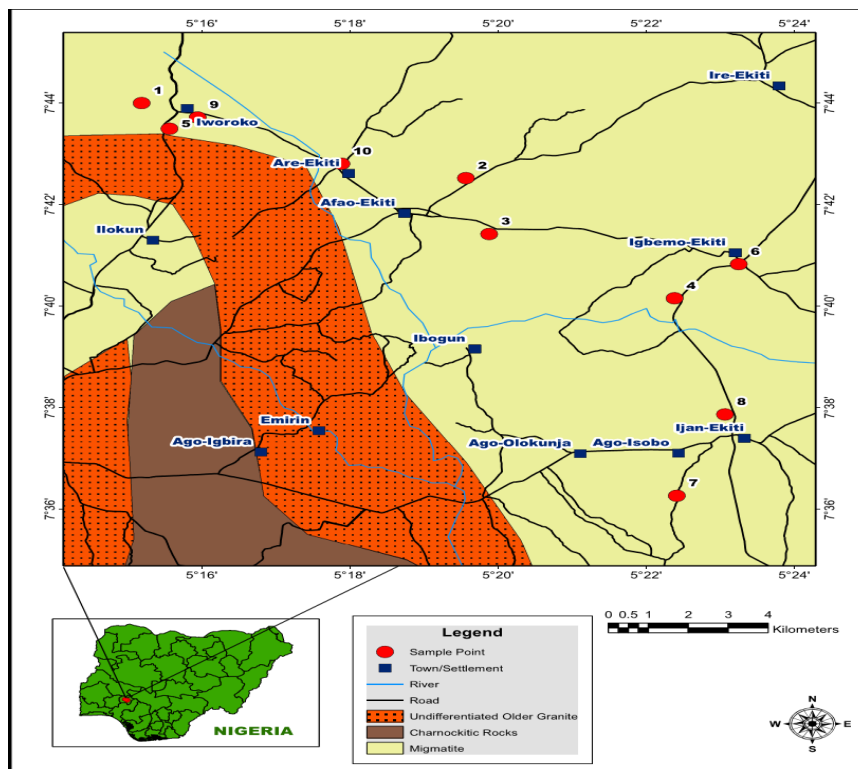


Fig. 4 Local geology of Are-Ekiti and environments rocks (Present work)

the Iworoko-Ekiti area that was derived from a continental environment. [Oyinloye and Obasi \(2006\)](#) suggested that the charnockites and the Older granites in Ado-Ekiti formed from molten magma collision. The rocks contain monzonite in their mineralogical composition, indicating crustal input into their original magma [Obasi, et al., 2021](#) studied the granitic rocks of Akure and showed that they were involved in the active magmatic and tectonic activities with post-

collision uplift and late orogeny that were in conformity with the tectonic scenario of Pan-African granite. These geodynamic activities resulted in the emplacement of granitic rock suites such as granite, granodiorite, tonalite, and adamellite into the host rock. The granitic rocks are of calc-alkaline affinity due to their significant amounts of potassium, and often contain traces of normative corundum ([Rahaman, 1988](#)).

**Table 1. Field work for Akure rocks**

Location	Name of Location	GPS Reading	Rock description
1	Ori Oke Gbogunmi Oloruntedo	N 7 <sup>o</sup> 18' 22'' E 5 <sup>o</sup> 13' 42''	Coarse to porphyritic biotite, hornblende granite
2	Mission on Earth Igobi	N 7 <sup>o</sup> 17' 57'' E 5 <sup>o</sup> 13' 50''	Coarse to porphyritic biotite, hornblende granite
3	Stone works Quarry	N 7 <sup>o</sup> 16' 29'' E 5 <sup>o</sup> 14' 17''	Coarse to porphyritic biotite, hornblende granite
4	Fiwasaye road opp ijapo	N 7 <sup>o</sup> 16' 12'' E 5 <sup>o</sup> 13' 5''	Medium to coarsed grained biotite granite
5	Shagari Village	N 7 <sup>o</sup> 16' 46'' E 5 <sup>o</sup> 11' 49''	Migmatite Gniess
6	Christ Apostolic Shagari, Irese road	N 7 <sup>o</sup> 17' 56'' E 5 <sup>o</sup> 11' 39''	Migmatite Gniess
7	FUTA road, Beside Sibasab	N 7 <sup>o</sup> 19' 23'' E 5 <sup>o</sup> 6' 50''	Migmatite Gniess
8	Adaba FM, Ibule soro	N 7 <sup>o</sup> 19' 32'' E 5 <sup>o</sup> 7' 0''	Migmatite Gniess
9	FUTA road, beside folly team work	N 7 <sup>o</sup> 19' 9'' E 5 <sup>o</sup> 7' 2''	Medium to coarsed grained biotite granite
10	Opposite automat FUTA road	N 7 <sup>o</sup> 17' 7'' E 5 <sup>o</sup> 11' 14''	Medium to coarsed grained biotite granite

**Table 2. Fieldwork for Are-Ekiti and Environments**

Location	Name of location	GPS reading	Rock description
1	Iworoko Ekiti	N7 <sup>o</sup> 43' 44" E5 <sup>o</sup> 15' 16"	Migmatite
2	Afao Ekiti	N7 <sup>o</sup> 43' 36" E5 <sup>o</sup> 15' 24"	Migmatite
3	Afao Ekiti	N7 <sup>o</sup> 43' 55" E5 <sup>o</sup> 15' 49"	Migmatite
4	Igbemo Ekiti	N7 <sup>o</sup> 42' 49" E5 <sup>o</sup> 18' 01"	Migmatite
5	Iworoko Ekiti	N7 <sup>o</sup> 42' 31" E5 <sup>o</sup> 19' 34"	Migmatite
6	Igbemo Ekiti	N7 <sup>o</sup> 41' 25" E5 <sup>o</sup> 19' 53"	Migmatite
7	Ijan Ekiti	N7 <sup>o</sup> 40' 09" E5 <sup>o</sup> 22' 23"	Migmatite
8	Ijan Ekiti	N7 <sup>o</sup> 40' 56" E5 <sup>o</sup> 23' 14"	Migmatite
9	Iworoko, Ado – Ekiti	N7 <sup>o</sup> 36' 16" E5 <sup>o</sup> 22' 25"	Migmatite
10	Are Ekiti	N7 <sup>o</sup> 37' 52" E5 <sup>o</sup> 23' 04"	Migmatite



**Materials and Methods**

**Fieldwork**

Field mapping was carried out across the study areas where fresh rock samples were collected. Care was taken against contamination. Sample locations and field descriptions of the rocks are shown in [Tables 1 and 2](#).

**Geochemical Analysis**

A total of twenty rock samples were collected ten each from Akure and Are Ekiti and environs. The pulverized samples were chemically analyzed for their major, trace, and rare earth elements using the X-ray fluorescence Spectrometry (XRF) and Laser ablation Inductively Coupled Plasma-Mass Spectrometer (ICP-MS) respectively, (Perkin-Elmer Sciex ELAN DRC 6000) at the Central Laboratory of the University of Stellenbosch, South Africa. Routine methods for sample digestion and preparation of solutions for ICP-MS were carried out in accordance with the methods of [Balaram et al. \(1996\)](#). The international rock standards (USGS) for SDC-1, GS-N Granite and BE-NBasalts were used to compare the results. Details of ICP-MS and laser operating

methods and conditions have also been published by [Norman et al. \(1998\)](#). Precision for ICP-MS is  $\pm 10\%$ . The GCDKIT software has been used significantly in the drawings related to the classifications and geotectonic settings of the rocks.

**Geochemical Characteristics of the Rocks**

The results of the geochemical analysis of Pan-African granitic rocks from Akure and Are-Ekiti and environs are presented in [Tables 3 and 4](#) respectively. The granitic rocks in Akure areas show wide variations in the oxides with silica, SiO<sub>2</sub> ranging between 50.18 and 98.92, TiO<sub>2</sub> (0.11-1.62), Al<sub>2</sub>O<sub>3</sub> (0.26-17.26), Fe<sub>2</sub>O<sub>3</sub> (0.52-10.77), MnO (0.02- 0.15), MgO (0.01-7.99), CaO (0.04-9.87), Na<sub>2</sub>O (0.02-4.27), K<sub>2</sub>O (0.07-5.98) and LOI (-0.24-0.33). The rocks from Are-Ekiti and its environs show minor variations in the oxides with SiO<sub>2</sub> ranging from 60.5 to 70.46, TiO<sub>2</sub> (0.22-0.94), Al<sub>2</sub>O<sub>3</sub> (15.16-16.77), Fe<sub>2</sub>O<sub>3</sub> (2.00-7.23), MnO (0.03-0.11), MgO (0.36-2.27), CaO (3.02- 6.50), Na<sub>2</sub>O (3.3-3.76), K<sub>2</sub>O (2.67-4.34) and LOI being less than unity. The silica in both rocks is siliceous.

**Table 3. Geochemistry of some rocks from Akure areas (wt%) with some ratios**

Oxides	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Al <sub>2</sub> O <sub>3</sub>	13.64	15.09	13.47	15.26	0.26	15.57	12.27	15.65	17.29	17.29
CaO	1.35	1.35	4.85	1.57	2.97	0.04	5.48	1.25	9.87	3.87
Fe <sub>2</sub> O <sub>3</sub>	2.83	3.50	8.03	3.91	6.51	0.52	9.00	3.82	10.77	4.76
K <sub>2</sub> O	5.98	4.57	4.22	5.69	5.49	0.07	3.53	5.17	1.16	1.16
MgO	0.09	0.21	1.55	0.31	0.71	Bdl	2.39	0.01	7.99	1.10
MnO	0.03	0.04	0.10	0.05	0.10	0.02	0.11	0.05	0.15	0.08
Na <sub>2</sub> O	3.28	3.49	3.22	3.00	3.22	0.02	3.20	2.57	2.63	4.27
P <sub>2</sub> O <sub>5</sub>	0.05	0.01	0.61	0.13	0.25	0.01	0.69	0.03	0.32	0.13
SiO <sub>2</sub>	71.65	73.12	59.84	71.40	64.73	98.92	57.85	74.32	50.18	64.43
TiO <sub>2</sub>	0.20	0.29	1.62	0.45	0.86	0.11	0.80	0.35	1.59	0.53
L.O.I	-0.25	0.09	0.33	0.26	-0.24	-0.10	0.13	-0.04	0.24	0.00
Total	99.86	100.38	99.46	100.24	99.86	99.87	99.84	99.80	100.64	100.12
Na <sub>2</sub> O+K <sub>2</sub> O	9.26	8.06	7.44	8.69	8.71	0.09	6.82	7.74	3.79	7.93
Na <sub>2</sub> O/Al <sub>2</sub> O <sub>3</sub>	0.22	0.26	0.21	0.22	0.21	0.08	0.21	0.21	0.17	0.25
K <sub>2</sub> O/Al <sub>2</sub> O <sub>3</sub>	0.41	0.34	0.28	0.42	0.36	0.27	0.23	0.42	0.07	0.21
CaO+Na <sub>2</sub> O+K <sub>2</sub> O	10.61	9.41	12.29	10.26	11.68	0.13	12.3	8.99	13.66	11.8
Al <sub>2</sub> O <sub>3</sub> /(CaO+Na <sub>2</sub> O+K <sub>2</sub> O)	1.38	1.45	1.23	1.31	1.31	2	1.27	1.36	1.15	1.47
Al <sub>2</sub> O <sub>3</sub> /(Na <sub>2</sub> O+K <sub>2</sub> O)	1.58	1.45	2.03	1.55	1.75	2.89	2.28	1.59	4.13	2.18
Na <sub>2</sub> O/K <sub>2</sub> O	0.55	0.76	0.76	0.52	0.59	0.29	0.93	0.5	2.27	1.17
K <sub>2</sub> O/ Na <sub>2</sub> O	1.8	1.3	1.3	1.9	1.7	3.5	1.1	2.0	0.4	0.27

The values of the alumina contents in the Akure rocks Al<sub>2</sub>O<sub>3</sub> (0.26-17.26) and that in the Are rocks Al<sub>2</sub>O<sub>3</sub> (15.16-16.77) are high like those of calc-alkaline rock series. The values of potash, K<sub>2</sub>O in the Akure rocks are higher than that in the Are-Ekiti rocks. TiO<sub>2</sub> contents in both areas are less than unity which means that they are within the range that are acceptable in calc-alkaline lava (Irvine et al; 1971; Pearce and Cann, 1973). Interestingly, CaO values in both rocks

under study vary. Example six (6) of the Akure rock samples have CaO values that are less than 3% while four (4) of the samples have values that are higher than 3% implying the presence of epidote and non-intensiveness of metamorphism in the areas of sample collection (Jakes and White1971). However, the CaO contents in the rocks of Are Ekiti areas have values that are higher than 3% in all the samples.

**Table 4. Geochemistry of rocks from Are –Ekiti, and Environments (wt %) with some ratios**

Oxides	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Al <sub>2</sub> O <sub>3</sub>	15.38	16.36	16.72	15.99	16.43	15.27	16.12	16.21	16.77	15.16
CaO	3.02	4.06	4.94	6.25	4.1	4.42	3.79	3.9	5.32	6.5
Fe <sub>2</sub> O <sub>3</sub>	2.25	3.78	3.6	7.23	4.41	4.16	2	3.87	3.57	6.06
K <sub>2</sub> O	3.68	3.12	2.67	2.93	3.37	2.94	4.34	3.31	3.2	2.94
MgO	0.36	0.69	0.78	2.17	0.75	0.8	0.36	0.65	0.64	2.27
MnO	0.03	0.06	0.06	0.11	0.06	0.05	0.03	0.06	0.05	0.1
Na <sub>2</sub> O	3.5	3.65	3.69	3.3	3.52	3.43	3.44	3.49	3.76	3.08
P <sub>2</sub> O <sub>5</sub>	0.35	0.31	0.44	0.61	0.32	0.38	0.21	0.3	0.32	0.57
SiO <sub>2</sub>	70.46	67.1	66.5	60.05	66.16	67.67	68.97	67.33	65.07	61.93
TiO <sub>2</sub>	0.28	0.35	0.34	0.71	0.34	0.53	0.22	0.35	0.45	0.94
L.O.I	0.48	0.53	0.61	0.73	0.47	0.45	0.67	0.78	0.93	0.64
Total	99.78	100.01	100.36	100.08	99.93	100.11	100.16	100.25	100.08	100.21
Na <sub>2</sub> O+K <sub>2</sub> O	7.18	6.77	6.36	6.23	6.89	6.37	7.78	6.8	6.96	6.02
Na <sub>2</sub> O/Al <sub>2</sub> O <sub>3</sub>	0.23	0.22	0.22	0.21	0.21	0.23	0.21	0.22	0.22	0.2
K <sub>2</sub> O/Al <sub>2</sub> O <sub>3</sub>	0.24	0.19	0.16	0.18	0.21	0.19	0.27	0.2	0.19	0.19
CaO+Na <sub>2</sub> O+K <sub>2</sub> O	10.2	10.83	11.3	12.48	10.99	10.79	11.57	10.7	12.28	12.52
Al <sub>2</sub> O <sub>3</sub> /(Na <sub>2</sub> O+K <sub>2</sub> O)	2.14	2.42	2.63	2.57	2.39	2.4	2.07	2.38	2.41	2.52
Na <sub>2</sub> O/K <sub>2</sub> O	0.95	1.17	1.38	1.13	1.04	1.17	0.79	1.05	1.18	1.05
Al <sub>2</sub> O <sub>3</sub> /(CaO+Na <sub>2</sub> O+K <sub>2</sub> O)	0.75	0.69	1.48	1.28	1.49	1.42	1.39	1.52	1.37	1.21
K <sub>2</sub> O/Na <sub>2</sub> O	1.05	0.85	0.72	0.89	0.95	0.86	1.26	0.95	0.85	0.95

The analysis of the silica in the two areas under study shows that the rocks in Akure areas have higher silica content (50.18-98.92) than those from Are and environs (60.5-70.46). The alumina, Al<sub>2</sub>O<sub>3</sub> in the rocks of Akure is slightly higher (0.26-17.26) than those from Are areas Al<sub>2</sub>O<sub>3</sub> (15.16-16.77). Similarly, the other oxides like Fe<sub>2</sub>O<sub>3</sub>, MgO, Na<sub>2</sub>O and CaO are slightly higher in the Akure rocks than in the Are Ekiti rocks.

**Geochemical classification of the rocks from Akure and Are areas**

The different ratios displayed in Tables 3 and 4 were used to classify the rocks, decipher their geochemical nature and show their tectonic settings in both areas of study. The ratio

of K<sub>2</sub>O/ Na<sub>2</sub>O in the Akure rocks ranges from 0.4 to 2.0 while that of Are Ekiti ranges between 0.72 and 1.26. When the ratio of K<sub>2</sub>O/ Na<sub>2</sub>O > 1 and K<sub>2</sub>O > Na<sub>2</sub>O, it means that the rocks do not have the characteristics of a sedimentary origin but that the K-bearing minerals in those rocks are more than the Na –plagioclase (albite) minerals. However, the ratio of eight (8) of the Akure samples have values that are more than one (1) and the rest two samples have values that are less than one. (Table 3). In the case of Are Ekiti rocks, the reverse is the case, the ratios of eight (8) samples are less than one (K<sub>2</sub>O/ Na<sub>2</sub>O < 1), while two samples have ratios that are more than one (Table 4).

When the value of Al<sub>2</sub>O<sub>3</sub> > Na<sub>2</sub>O + K<sub>2</sub>O + CaO, the rock falls in the S-Type field and when Na<sub>2</sub>O+K<sub>2</sub>O < Al<sub>2</sub>O<sub>3</sub> <

Na<sub>2</sub>O + K<sub>2</sub>O + CaO, the rock is referred to as an I-Type. The rocks in both the Akure and Are Ekiti areas fall within the two fields. To collaborate with these formula, different authors have designed different diagrams. Using the alumina saturation index (ASI) of Shand, (1943) as defined by the molecular ratio of Al<sub>2</sub>O<sub>3</sub> / CaO + Na<sub>2</sub>O + K<sub>2</sub>O (A/CNK > 1.1) to plot and the plot of Al<sub>2</sub>O<sub>3</sub> / Na<sub>2</sub>O + K<sub>2</sub>O (A/NK) versus Al<sub>2</sub>O<sub>3</sub> / CaO + Na<sub>2</sub>O + K<sub>2</sub>O (A/CNK) of (Maniar and Piccoli, 1989), the granitic rocks of Akure area plotted within the fields of metaluminous and peraluminous Fig. 5a.

The peraluminous to metaluminous nature of these rock units reflects an evolution involving the contamination of mantle-derived magma by the continental crust. The granitic rocks of Are-Ekiti and environs plotted within the fields of metaluminous to weakly peraluminous (Fig.5b). The prominent metaluminous feature of the rock from Akure reflects rocks derived by partial melting of a mafic mantle-derived igneous source material (probably of a sub-crustal underplated lithospheric material). The granites from the Akure area are strongly S and I- types suggesting their

derivations from a mixed source of origin (Fig.5a) while those from Are – Ekiti and environs are majorly of I- type and weak S-type. The modifications made by authors such as Villaseca et al., (1998) using the plot of A/NK against ASI and Frost et al., (2001) using the plot of A/NK against ASI (Figs. 6a&b &7a &b) also are in agreement with the Shand, (1943) and Maniar and Piccoli 1989) discrimination diagrams. Granites of peraluminous magma (Al<sub>2</sub>O<sub>3</sub> > NaO + K<sub>2</sub>O + CaO) S-Type, contain crustal or sedimentary materials in their original magma and they occur in regional metamorphic terranes (Wilson, 1991). They are characterized by high Al<sub>2</sub>O<sub>3</sub>, moderate silica, presence of biotite, microcline, plagioclase and mica minerals. The I-Type metaluminous granite are of igneous origin derived from the crystallization of magma generated by anatexis or partial melting of crustal rocks (Whalen et al., 1987; Frost et al., 1999). Magma type is usually meta-aluminous magma (Na<sub>2</sub>O+K<sub>2</sub>O<Al<sub>2</sub>O<sub>3</sub><Na<sub>2</sub>O+K<sub>2</sub>O+CaO) characterized by hornblende mineral, monzogranite and syenogranit.

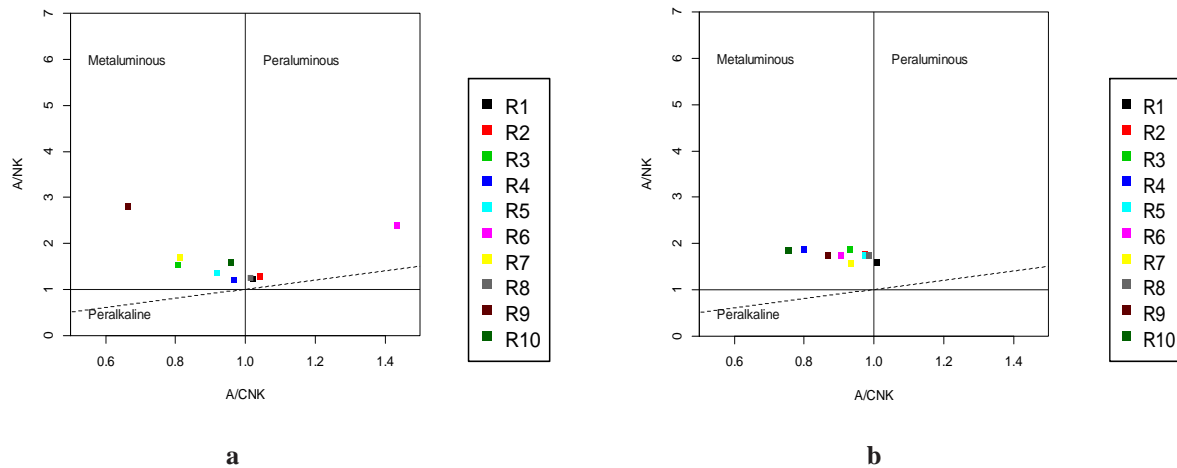


Fig. 5a & b A/CNK-A/NK plot of the granitic rocks of Akure & Are Ekiti and environments (after Shand 1943; Maniar & Piccoli, 1989)

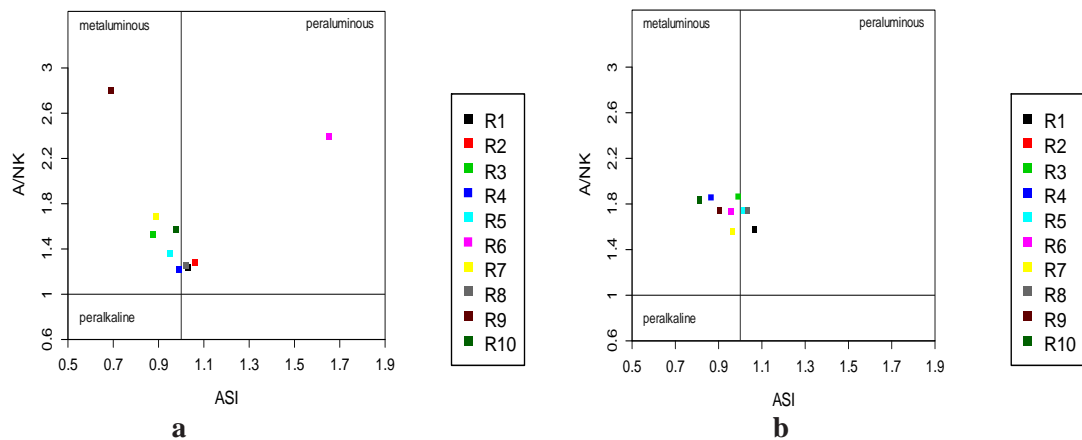


Fig. 6a & b A/NK against ASI plots of granitic rocks around Akure and Are –Ekiti and environs (Frost et al., 2001)

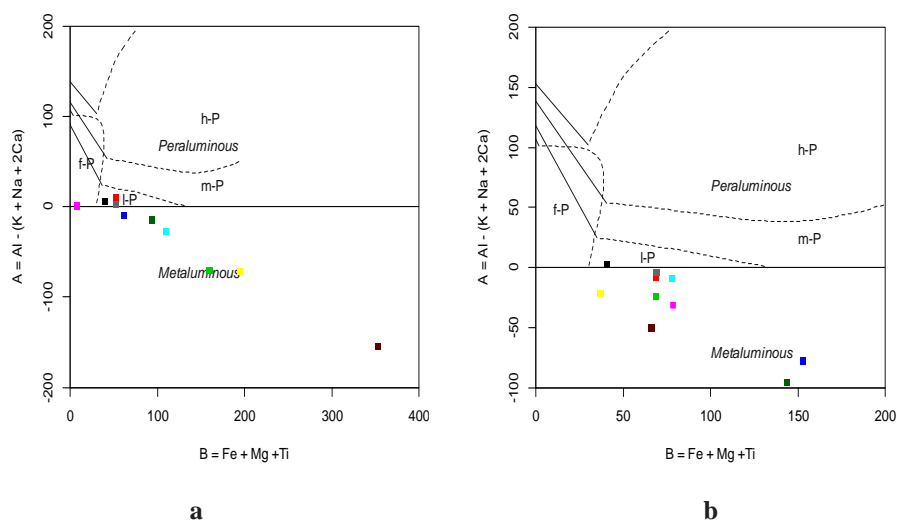


Fig. 7a & b B-A plots of granitic rocks of Akure and Are Ekiti areas (modified by Villaseca et al. 1998)

**Results and Discussions**

Table 5. shows the various major element compositions of rocks from Iworoko-Ekiti, Are-Ekiti, Afao-Ekiti, Igbemo-Ekiti, and Ijan-Ekiti jointly represented by Are Ekiti and environs. Their compositions vary with silica, SiO<sub>2</sub> ranging from 60.05 to 70.46, Al<sub>2</sub>O<sub>3</sub> (15.16-16.77), Fe<sub>2</sub>O<sub>3</sub> (2.00-7.23), Na<sub>2</sub>O (3.08-3.76), K<sub>2</sub>O (2.67-4.34) while TiO<sub>2</sub>, P<sub>2</sub>O<sub>5</sub>, MnO and LOI have values that are less than one (1) respectively. The rock samples from Iworoko show high concentrations of silica (66.50-70.46) while that from Are Ekiti has the least value of 60.05. The alumina, Al<sub>2</sub>O<sub>3</sub> tends to be uniform in all the locations while Fe<sub>2</sub>O<sub>3</sub> shows the highest value in Are Ekiti than the other locations (Table 5). Al<sub>2</sub>O<sub>3</sub>, Na<sub>2</sub>O, and K<sub>2</sub>O contents are higher than those of the crustal values, and coupled with SiO<sub>2</sub> they all reflect the abundance of alkaline minerals, alumina and silicate minerals.

The immobile oxides, alumina (Al<sub>2</sub>O<sub>3</sub>, 16.04 average) and ferric iron (Fe<sub>2</sub>O<sub>3</sub>, 4.09) have enriched concentrations than the mobile oxides of K<sub>2</sub>O, Na<sub>2</sub>O, CaO and MgO (Table 5) implying that chemical alteration of some minerals in the rocks occurred resulting in the formation of hydroxyl group and subsequent removal of soluble cations of K<sup>+</sup>, Na<sup>+</sup>, Ca<sup>+</sup> and Mg<sup>2+</sup> (Sayyed, 2014). However, CaO, Na<sub>2</sub>O and K<sub>2</sub>O have average values of 4.63, 3.49 and 3.25 respectively showing that metamorphism may not have been intensive. CaO has values that are higher than 3.00% in all the samples and locations indicating relatively the presence of epidote and mild metamorphism in the study areas (Jakes and White 1971). TiO<sub>2</sub> has values that are less than one (< 1%) suggesting that it is within the range acceptable in calc-alkaline lavas of Irvine and Barager, (1971); Pearce and Cann (1973). The ratio of Fe<sub>2</sub>O<sub>3</sub>/ MgO ranges between 2.67 and 6.25 suggesting relatively the presence of secondary opaque phase (magnetite). K<sub>2</sub>O (2.67-4.34) reflects the relative presence of feldspar in the rocks across the locations. The average values of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Na<sub>2</sub>O, and K<sub>2</sub>O are higher

than the crustal values while the crustal values are higher than Fe<sub>2</sub>O<sub>3</sub>, MgO, and TiO<sub>2</sub> respectively (Taylor, 1964). The ratio of Na<sub>2</sub>O / K<sub>2</sub>O (0.79-1.38) is low when related to the typical values of Jakes and White (1971) for calc-alkaline rocks and a reflection of a decrease during alteration and metamorphism.

**Classification Characteristics of the studied rocks**

Rocks of the basement complex can be classified using some oxides such as SiO<sub>2</sub>, Na<sub>2</sub>O and K<sub>2</sub>O into different alkaline series. Peccerillo and Taylor, (1976); Le Maitre et al., (1989) plots of SiO<sub>2</sub> against K<sub>2</sub>O classified the granitic rocks into low potassium (tholeiitic), calc-alkaline series and high potassium (calc-alkaline) series. The samples from all the sampled areas of Iworoko, Are, Afao, Igbemo and Ijan areas (represented in short form as Are-Ekiti and environs) plotted into the high -K calcic alkali series (Fig.8) implying a similar geological derivation and source.

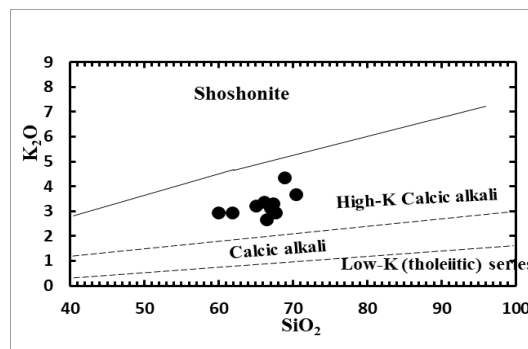


Fig. 8 Plot of SiO<sub>2</sub> against K<sub>2</sub>O (Le Maitre et al. (1989)

The plots of K<sub>2</sub>O versus SiO<sub>2</sub> (Peccerillo and Taylor, 1976) of rocks from Akure and Are- Ekiti areas indicate that the rock samples plotted on the shoshonite series, high K-calc-alkaline



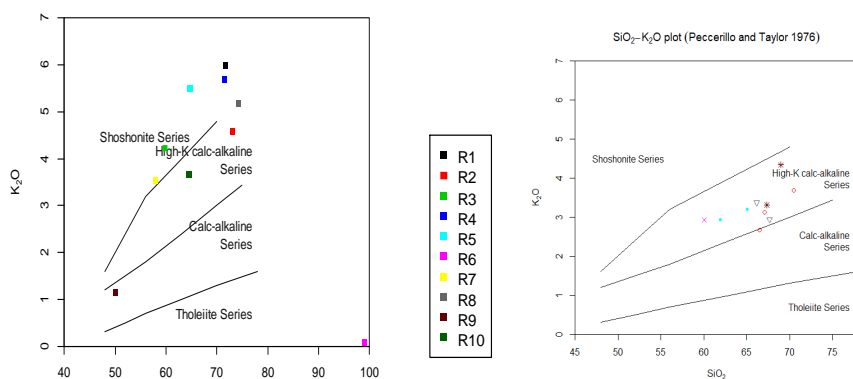
series and one on the calc-alkaline series respectively in the Akure rocks (Fig. 9a) while the samples in the Are Ekiti and environs rocks plotted on the high K-calc-alkaline series (Fig. 9b). Granites with high K-calc-alkaline series are metaluminous to weakly peraluminous with A/CNK ratio

lying within 0.69-1.52 range in the case of Are-Ekiti and environs rocks. The Akure rocks displayed the characteristics of calc-alkaline and shoshonitic igneous rocks indicative of an active continental margin setting.

**Table 5. Major Element Composition of the rocks from Iworoko, Are, Afao, Igbemo, and Ijan areas**

Oxides	Iworoko Ekiti			Are Ekiti	Afao Ekiti		Igbemo Ekiti		Ijan		Av	CA
	1	2	3	4	5	6	7	8	9	10	Average	CA
SiO <sub>2</sub>	70.46	67.10	66.50	60.05	66.16	67.67	68.97	67.33	65.07	61.93	66.12	60.3
Al <sub>2</sub> O <sub>3</sub>	15.38	16.36	16.72	15.99	16.43	15.27	16.12	16.21	16.77	15.16	16.04	15.6
Fe <sub>2</sub> O <sub>3</sub>	2.25	3.78	3.60	7.23	4.41	4.16	2.00	3.87	3.57	6.06	4.09	7.2
MgO	0.36	0.69	0.78	2.17	0.75	0.80	0.36	0.65	0.64	2.27	0.95	3.9
CaO	3.02	4.06	4.94	6.25	4.10	4.42	3.79	3.90	5.32	6.50	4.63	5.8
Na <sub>2</sub> O	3.50	3.65	3.69	3.30	3.52	3.43	3.44	3.49	3.76	3.08	3.49	3.2
K <sub>2</sub> O	3.68	3.12	2.67	2.93	3.37	2.94	4.34	3.31	3.20	2.94	3.25	2.5
TiO <sub>2</sub>	0.28	0.35	0.34	0.71	0.34	0.53	0.22	0.35	0.45	0.94	0.45	1.0
P <sub>2</sub> O <sub>5</sub>	0.34	0.31	0.44	0.61	0.32	0.38	0.21	0.30	0.32	0.57	0.38	0.11
MnO	0.03	0.06	0.06	0.11	0.06	0.05	0.03	0.06	0.05	0.10	0.06	0.10
LOI	0.48	0.53	0.61	0.73	0.47	0.45	0.67	0.78	0.93	0.64	0.63	-
Na <sub>2</sub> O + K <sub>2</sub> O	7.18	6.77	6.36	6.23	6.89	6.37	7.78	6.80	6.96	6.02		
Na <sub>2</sub> O/ Al <sub>2</sub> O <sub>3</sub>	0.23	0.22	0.22	0.21	0.21	0.23	0.21	0.22	0.22	0.20	-	
Na <sub>2</sub> O / K <sub>2</sub> O	0.95	1.17	1.38	1.13	1.04	1.17	0.79	1.05	1.18	1.05		
K <sub>2</sub> O/ Al <sub>2</sub> O <sub>3</sub>	0.24	0.19	0.16	0.18	0.21	0.19	0.27	0.20	0.19	0.19	-	
Fe <sub>2</sub> O <sub>3</sub> / MgO	6.25	5.48	4.62	3.33	5.88	5.2	5.56	5.95	5.58	2.67	-	

CA= Crustal average (Taylor, 1964).



**Fig. 9a & b K<sub>2</sub>O versus SiO<sub>2</sub> plot of Akure and of Are and its Environs rock (after Peccerillo and Taylor 1976)**

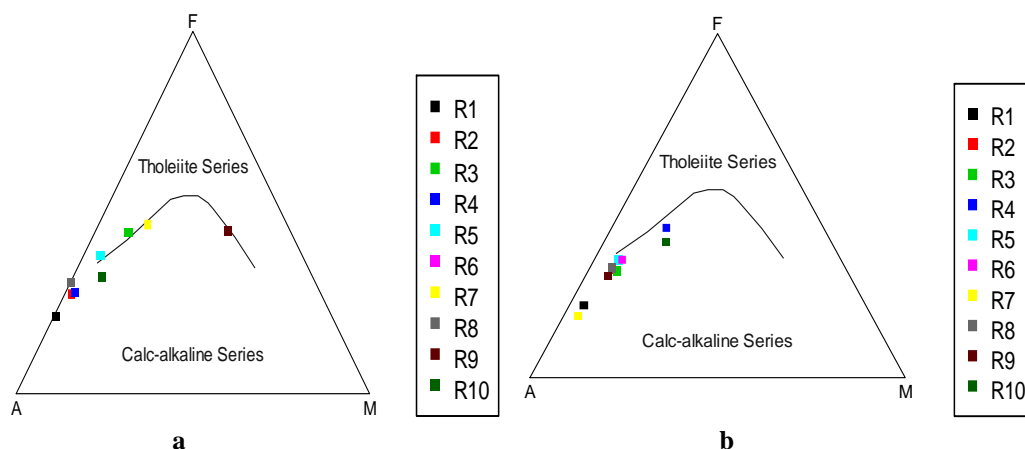


Fig. 10a & b AFM plot of the rocks from Akure and Are Ekiti areas (after Irvine and Baragar 1971)

Fig.10a is the AFM diagram of rocks from Akure areas showing samples plotted in both the tholeiitic and calc-alkaline fields, while samples plotted in the Calc-alkaline field (Fig.10b) for the Are Ekiti and environs.

Calc-alkaline magmas usually have higher alumina,  $Al_2O_3$  content, and lower incompatible trace element (Rb, U, Ba, and La) concentrations than the tholeiitic magmas. The incompatible trace elements are enriched in the continental crust.

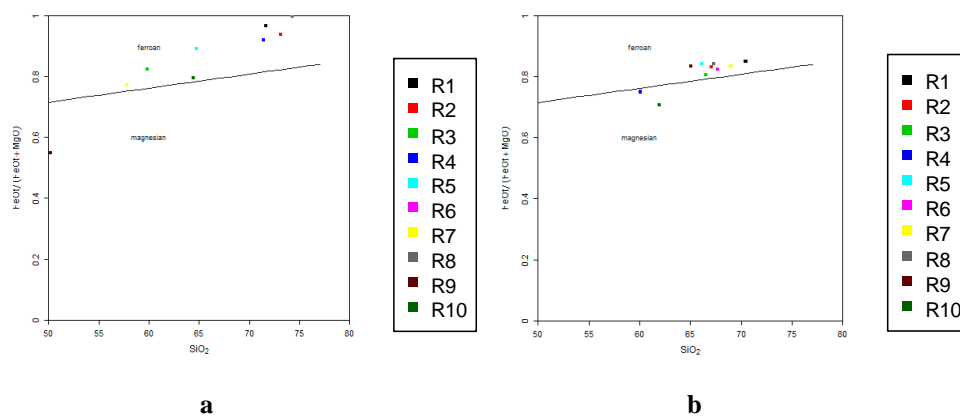


Fig. 11a & b Plots of FeOt+MgO Vs  $SiO_2$  of rocks from Akure and Are-Ekiti (Frost et al., 2001)

The Plots of FeOt+MgO Vs  $SiO_2$  (Frost et al., 2001) of rocks from Akure and Are-Ekiti and environs are shown in Figs 11a & b. The samples fell in the ferroan column (Fig.11a) for the rocks from Akure areas in conformity with Fe- enrichment of the tholeiitic series (Fig.10a), while the samples fell in both the ferroan and magnesian columns in the case of the Are-Ekiti and environs rocks. (Fig.11b). The rocks that are magnesian are related to the cordillerian types of granitic rocks (Shahabpour, 2007). Ferroan granitic rocks are associated with low oxygen fugacity during melting. Frost and Frost, (1997): Loiselle and Wones, (1979) stated that most Fe-rich rocks form by differentiation or partial melting of basaltic parents. Fig.12a shows a plot of  $Na_2O + K_2O - CaO$  against  $SiO_2$  where the majority of the samples clustered in the calcic and partly in the calc- alkali fields respectively in line with the modified alkali-lime index (MALI). The MALI is used to

classify volcanic suites into four areas namely: calcic, calc-alkalic, alkali calcic, and alkali. When the alkaline,  $Na_2O + K_2O$  index to lime (CaO) is greater than 61, the rock suites are calcic, when they are between 56 and 61, they are calc-alkalic, when it ranges between 51 and 56, it is alkali-calcic and those that are below 51 (i.e < 51) belong to alkali. The plot of  $SiO_2$  against  $Na_2O + K_2O - CaO$  in the Are Ekiti showed that the majority of the samples fell into the calcic field with few samples falling in calc- alkali (Fig.12b) an indication that the alkaline,  $Na_2O + K_2O$  index to lime (CaO) is greater than 61. However, Frost et al. (2001) suggested that the MALI could be as a result of either differentiation history or source rock region of the magma that formed the rocks. In the case of the Akure rocks, the samples fell in both the calc-alkalic and alkali calcic (Fig.12a).

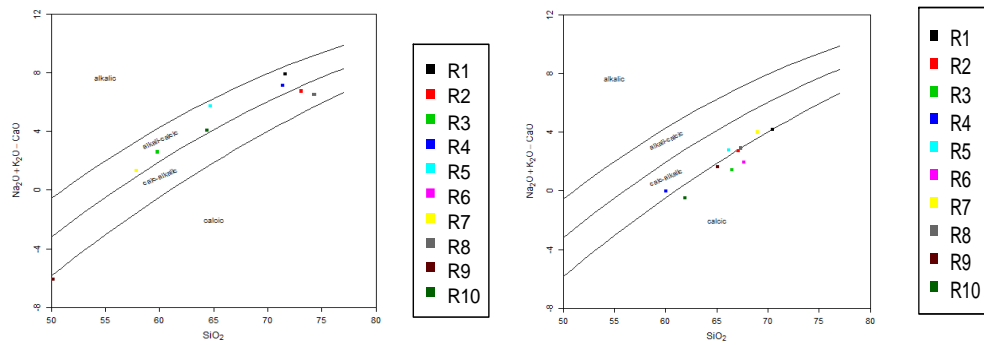


Fig. 12a & b A plot of  $\text{SiO}_2$  against  $\text{Na}_2\text{O} + \text{K}_2\text{O} - \text{CaO}$  for rocks from Akure and Are-Ekiti and environments (Frost et al., 2001)

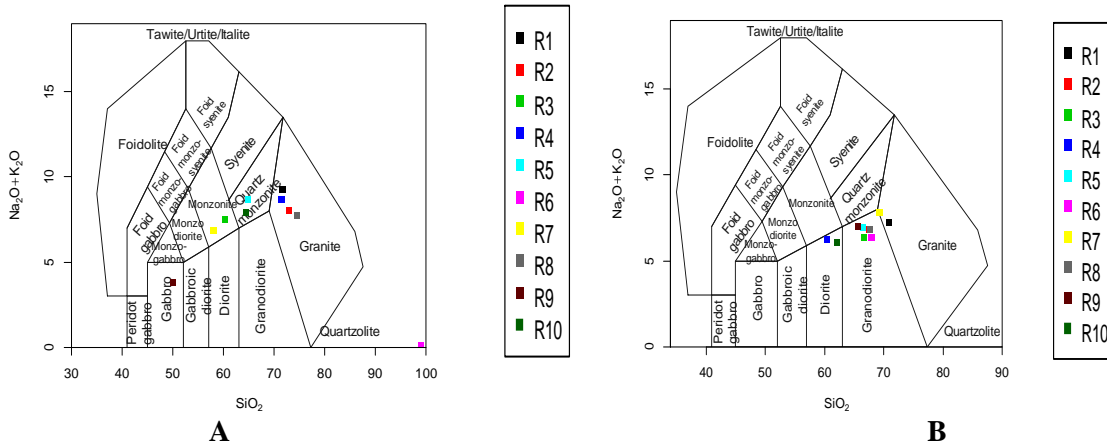


Fig. 13a & b Total alkali- silica (TAS) diagram to classify the rocks from Akure & Are-Ekiti and its environments (after Middlemost, 1994)

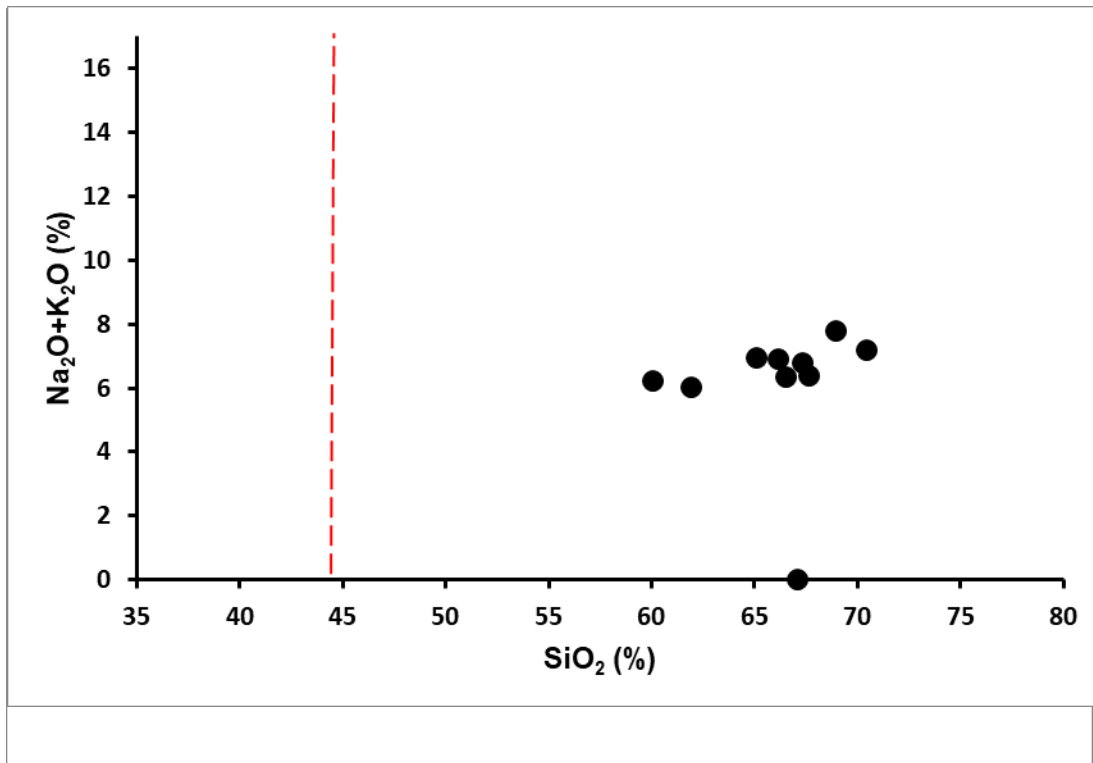


Fig. 14a plot of  $\text{Na}_2\text{O} + \text{K}_2\text{O}$  against  $\text{SiO}_2$  (LeBas and Streckeisen, 1991)

The plots of  $\text{Na}_2\text{O}+\text{K}_2\text{O}$  versus silica (TAS) (Middlemost, 1994) in Figs 13a & b show that the samples plotted on granite, quartz monzonite, monzonite, and gabbro for the Akure rock suite while the Are Ekiti samples plotted in granite, granodiorite, and diorite featuring the plutonic nature of the rocks. Le Bas and Streckeisen, (1991) classified the plutonic rocks, into ultrabasic, basic, intermediate, and acidic, and based on this, the Are Ekiti and environs rocks are intermediate (diorite) to acidic (quartz granite and granite) (Fig.14).

The resulting rocks of diorite, quartz diorite, and granite in the Akure rocks essentially define the intrusive characteristics of igneous rocks. Granite, diorite, and quartz diorite are all plutonic rocks consisting essentially of quartz, alkaline

feldspar, and plagioclase minerals. Diorite is an intermediate intrusive rock whose composition is between granite and basalt while quartz diorite is also plutonic of felsic composition and plagioclase.

### Tectonic Discrimination

The granites from the Akure areas plotted in the volcanic arc field (VAG), within plate field (WPG) of Rb-(Y+Nb), Rb-(Ta + Yb), (Ta-Yb) and majorly in VAG + Syn-collision of Nb-Y discrimination diagrams of Pearce et al. 1984; Fig.15a. When the plot of R1 against R2 of Batchelor and Bowden (1985) is used for comparison, the Akure rocks plotted in the syn-collisional and post-collision fields (Fig.16a).

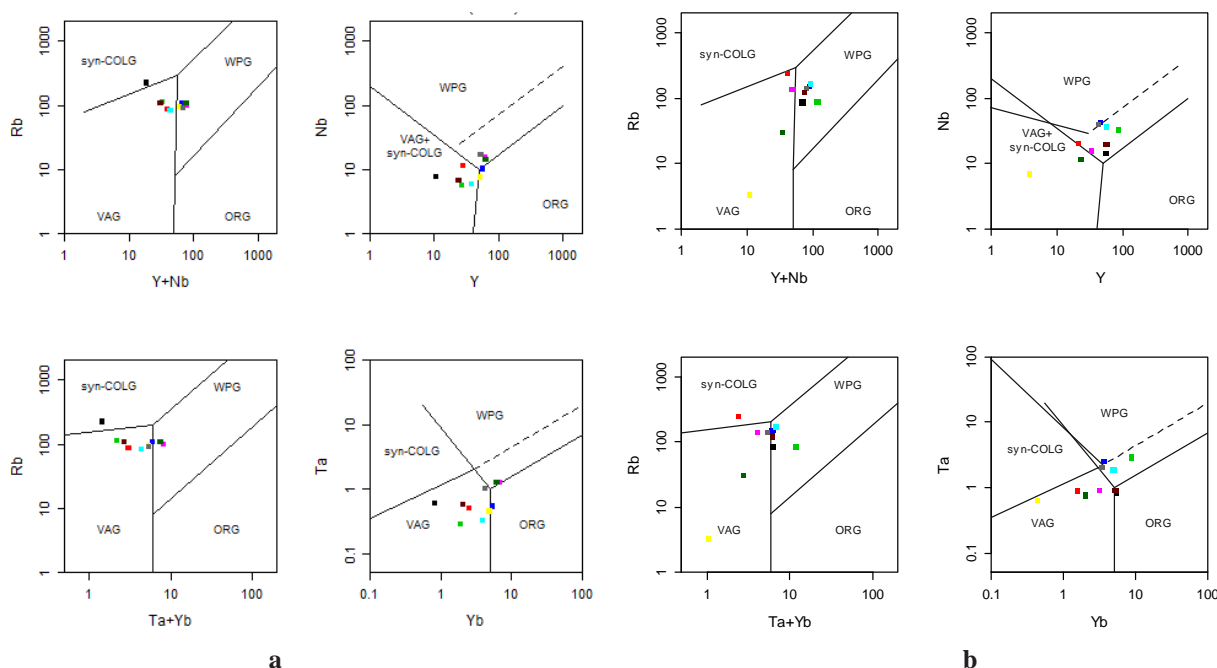


Fig. 15a & b Tectonic discrimination diagram of rocks from Are-Ekiti and its environments (Pearce et al., 1984)

Syn-COLG=Syn-collision granites; WPG= Within plate granites

VAG = Volcanic arc granites; ORG= Ocean ridge granites. (Samples 1-10 each of A and B)

Similarly, the granites from Are Ekiti and environs plotted in the within plate, and volcanic arc (WPG; VAG) of Rb- (Y + Nb); Nb-Y and Rb-(Ta Yb) as well as Ta-Yb tectonic discrimination diagrams of Pearce et al. 1984, Fig. 15b).

The plot of R<sub>1</sub> against R<sub>2</sub> of Batchelor + Bowden (1985) for the Are Ekiti rocks showed that all the rocks plotted in the pre-plate collisions environment Fig.16b; Pearce et al. 1984 stated that granites are formed in a variety of tectonic settings either at plate margins or intraplate and that these settings are subdivided according to their tectonic environments into four main groups ocean ridge granites (ORG), volcanic arc granites (VAG), within plate granites (WPG) and collision granites

(COLG) using trace elements Y-Nb, Yb-Ta, Rb-(Y + Nb) and Rb- (Yb + Ta) respectively.

The rocks from Akure area are characterized by high silica (50.18-98.92 wt %), high alumina (0.26-17.26), and iron-rich (Fe –rich). The A/CNK ratios of the rocks are also high. The rocks belong to the S-type and I-Type peraluminous and metaluminous granite groups. The S- and -Types are characteristic of rocks derived from anatexis of metasedimentary rocks with inputs from mantle-derived materials suggestive of rocks that were emplaced in a syn-collisional-setting environment. Wilson, (1991) stated that granites of peraluminous magma with A > CNK, S-Type

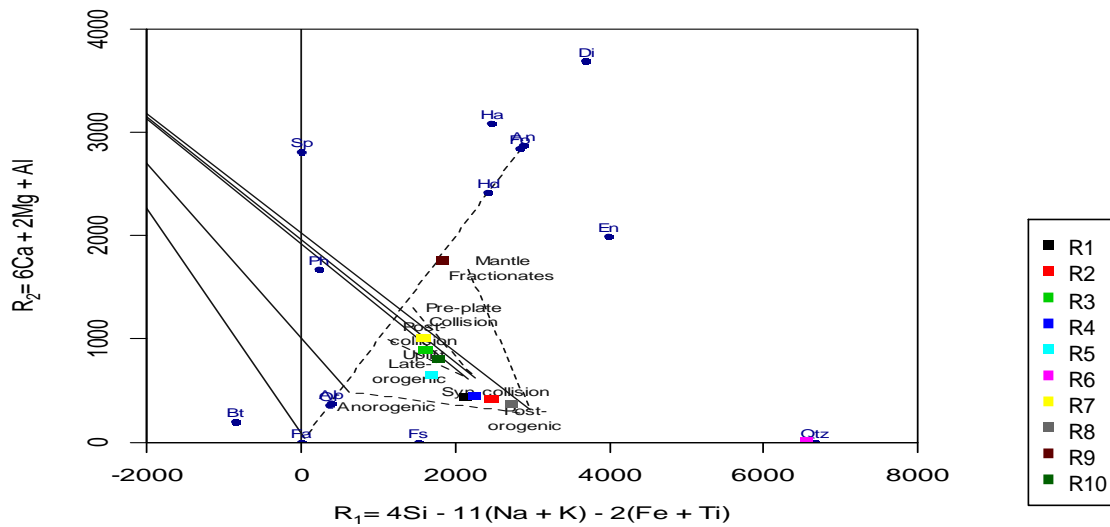


Fig. 16a R1-R2 plot of the rocks of Akure area (Batchelor and Bowden, 1985)

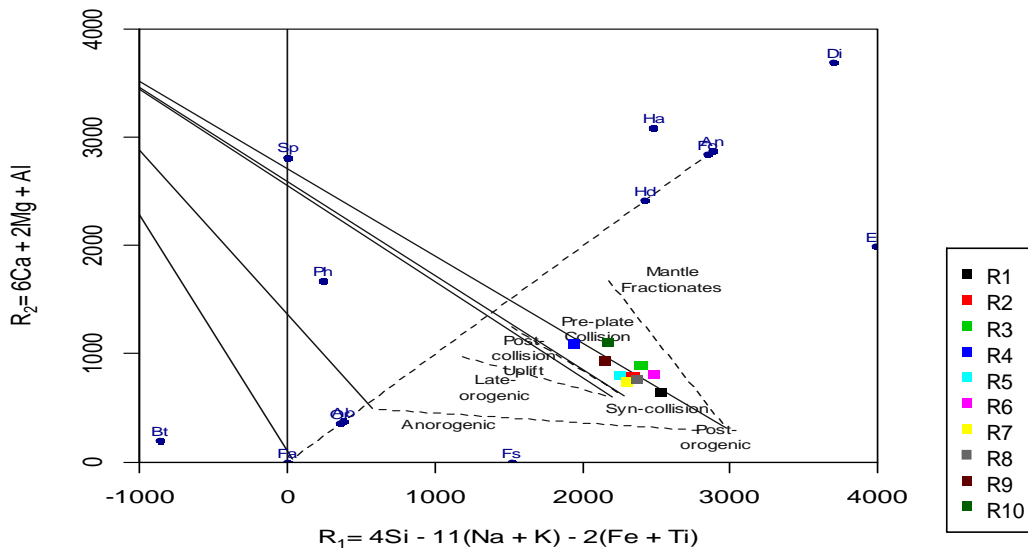


Fig. 16b R1-R2 plot of the rocks of Are-Ekiti and its environs (Batchelor and Bowden, 1985)

contain crustal or sedimentary materials in their original magma and they occur in regional terrane. The prominence of metaluminous, I-Type rocks from Akure is a reflection of rocks derived by partial melting of the mafic mantle-derived igneous source material. I-Type granites occur in the collision-syn-collision tectonic setting environment usually between continents. The occurrence of peraluminous to metaluminous rocks suggests contamination of mantle-derived magma by the continental crust. The plot of Th/Hf versus Ta/Hf of Schandl and Gorton, (2002) shows that the rock samples fell in the active continental margin (Fig. 17) in tandem with shoshonitic and calc-alkaline igneous rocks.

In furtherance to tectonic discrimination, Harris et al. (1986) suggested four groups of collisional zones viz:

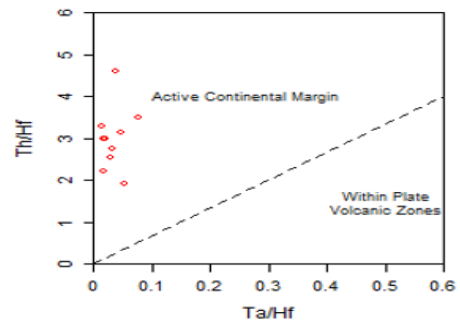


Fig. 17 Plot of Th/Hf versus Ta/Hf (Schandl and Gorton, 2002)



pre-collision calc-alkaline (volcanic-arc) intrusions which are mostly derived from mantle modified by a subduction component; (ii) Syn-collision peraluminous intrusions (leucogranites) which may be derived from the hydrated bases

of continental thrust sheets; and (iii) Late or post-collision calc-alkaline intrusions which may be derived from a mantle source but undergo extensive crustal contamination

**Table 6. Trace and Rare earth elements (ppm) Geochemistry of Rocks from Akure**

	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Pb	35.10	33.32	31.85	27.67	31.74	23.62	28.14	29.87	28.20	28.70
Sc	3.86	11.52	6.16	12.99	16.37	21.06	13.84	14.11	8.61	14.66
V	18.94	46.67	23.50	38.16	45.76	96.74	39.78	45.83	23.96	37.79
Cr	74.45	46.90	84.80	63.75	69.30	78.05	66.95	85.55	98.45	66.25
Co	3.17	7.98	4.03	5.87	6.56	14.87	6.55	7.17	3.27	5.80
Ni	15.70	15.02	7.95	7.40	7.43	15.33	8.86	8.06	7.55	5.76
Cu	88.95	60.14	23.65	18.91	19.08	43.16	27.08	26.49	62.90	20.50
Zn	22.95	60.35	38.35	52.25	67.90	79.55	54.10	55.85	25.50	49.40
Rb	220.60	84.95	110.85	106.15	81.20	97.60	93.75	90.90	106.20	105.65
Sr	165.50	575.10	283.35	425.85	364.75	330.35	433.00	315.80	377.65	406.25
Y	10.73	28.04	26.93	57.44	37.94	62.31	52.70	53.57	24.19	63.43
Zr	163.60	330.20	856.50	997.30	721.95	897.05	925.20	947.95	672.35	1016.75
Nb	7.70	11.52	5.56	10.26	5.82	15.56	7.50	17.06	6.78	14.13
Mo	8.76	3.19	0.85	0.67	0.48	2.09	0.88	2.83	0.75	0.67
Cs	1.24	0.12	0.94	3.13	1.74	2.15	0.80	0.92	1.69	2.70
Ba	621.50	1529.50	746.00	1180.50	820.50	712.00	1212.00	761.65	1086.50	1157.50
REE										
La	61.80	58.56	132.70	243.45	102.60	116.80	213.80	181.10	121.40	217.15
Ce	116.05	106.42	219.20	390.90	196.65	219.30	384.75	342.75	216.35	379.30
Pr	11.57	11.67	24.53	43.99	21.47	23.58	39.97	36.27	21.45	41.16
Nd	38.35	42.25	82.90	149.40	76.40	82.65	134.80	126.55	72.30	140.15
Sm	5.74	7.38	12.75	22.81	12.55	14.01	20.53	21.07	9.86	22.49
Eu	1.04	1.86	1.47	2.67	2.42	3.03	3.05	3.02	2.29	2.70
Gd	3.55	6.10	9.48	16.24	9.30	12.46	15.65	15.79	7.69	16.63
Tb	0.40	0.91	1.10	2.11	1.26	1.78	1.93	2.07	0.84	2.22
Dy	2.29	5.17	5.78	11.18	7.10	10.92	10.51	10.74	4.48	12.39
Ho	0.40	1.03	0.91	2.04	1.37	2.16	1.93	2.03	0.87	2.40
Er	1.23	2.98	2.47	5.80	4.08	6.59	5.67	5.49	2.62	6.70
Tm	0.15	0.41	0.26	0.79	0.58	0.96	0.76	0.70	0.34	0.95
Yb	0.84	2.54	1.92	5.40	4.00	6.77	4.93	4.32	2.11	6.25
Lu	0.15	0.36	0.00	0.79	0.63	1.05	0.75	0.62	0.35	0.92
Hf	5.09	8.56	23.90	26.56	19.58	23.82	24.63	25.58	18.82	26.94
Ta	0.59	0.49	0.28	0.54	0.32	1.28	0.45	1.01	0.58	1.24
Th	31.30	13.24	76.65	78.05	43.62	46.13	73.70	118.45	47.32	84.29
U	2.50	0.79	4.04	4.28	2.58	9.13	4.98	6.06	5.67	12.81

**Table 7. Trace and Rare elements (ppm) of rocks from Are-Ekiti and Environs (ppm)**

	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10
Sc	14.67	4.94	24.76	16.34	9.11	14.05	4.68	17.21	7.97	29.68
V	37.76	19.34	95.90	91.86	22.25	40.52	11.58	121.90	10.21	200.85
Cr	76.35	72.90	151.25	35.20	40.55	26.95	31.25	37.90	27.40	565.80
Co	5.39	3.69	12.80	14.15	3.73	7.83	0.75	19.57	1.74	38.77
Ni	8.26	15.75	17.26	12.36	10.90	9.58	8.15	21.18	7.58	153.75
Cu	19.19	30.70	31.02	64.96	108.70	28.41	25.75	29.34	25.37	167.05
Zn	43.55	42.75	62.90	97.95	65.60	104.30	4.79	113.35	57.30	84.80
Rb	84.65	241.05	85.46	152.70	169.50	135.60	3.33	138.50	123.30	30.84
Sr	405.25	119.25	336.25	389.00	127.25	328.60	4.55	458.10	221.85	410.35
Y	55.54	20.83	84.79	46.15	58.31	33.89	3.85	42.68	56.23	23.04
Zr	995.50	296.45	1399.50	995.55	510.75	594.95	201.50	687.90	630.55	130.50
Nb	14.61	20.39	33.67	43.30	36.12	15.52	6.94	39.20	19.25	11.52
Mo	0.88	8.69	1.68	5.90	4.97	5.46	3.06	3.81	5.48	3.66
Cs	0.87	0.53	1.41	0.59	0.75	0.24	0.07	0.38	0.07	0.24
Ba	1019.50	396.55	791.50	1476.50	680.80	2392.00	32.55	1310.50	1612.50	443.00
REE										
La	143.25	102.45	211.30	133.15	111.06	89.13	11.50	140.90	207.75	26.89
Ce	268.35	183.35	378.85	264.60	215.80	165.40	24.75	278.45	399.40	55.23
Pr	28.47	19.13	40.51	29.82	23.68	18.17	2.56	31.03	43.07	6.76
Nd	98.80	62.20	138.25	109.20	86.40	66.70	9.14	112.10	151.25	27.42
Sm	16.52	9.54	22.47	18.59	16.66	11.04	1.52	18.15	23.03	5.73
Eu	3.21	0.96	4.23	3.36	1.60	3.74	0.23	3.42	2.54	1.73
Gd	13.15	7.07	17.75	13.76	14.31	8.95	1.20	13.35	16.56	5.56
Tb	1.86	0.86	2.51	1.72	2.07	1.19	0.17	1.67	2.19	0.77
Dy	10.44	4.44	15.46	9.63	12.04	7.01	0.88	9.09	12.48	4.70
Ho	2.03	0.77	3.07	1.70	2.26	1.29	0.15	1.60	2.29	0.89
Er	5.77	2.07	9.04	4.67	6.13	3.53	0.41	4.24	6.40	2.45
Tm	0.80	0.27	1.31	0.59	0.82	0.50	0.06	0.54	0.83	0.33
Yb	5.56	1.55	8.96	3.73	4.98	3.15	0.42	3.37	5.17	2.00
Lu	0.76	0.23	1.36	0.52	0.65	0.47	0.08	0.46	0.71	0.30
Hf	25.94	9.03	37.60	23.92	14.19	14.46	6.15	16.33	17.88	3.40
Ta	0.85	0.87	2.94	2.50	1.86	0.93	0.64	1.99	0.90	0.75
Pb	25.88	29.81	28.73	25.87	38.42	31.77	5.06	22.95	33.67	17.76
Th	72.71	69.80	132.15	25.05	21.90	7.99	3.09	24.62	42.28	2.81
U	5.35	8.41	9.44	2.22	2.61	1.05	0.96	1.59	2.12	0.36

and (iv) one proposed by Sylvester, (1989), consists of Alkaline granites in post-orogenic continental settings and fall within the A-type or anorogenic category of granitoids. Based on the peraluminous and metaluminous characteristics of the rocks from Akure and Are Ekiti and environs coupled with their calc-alkaline nature make their rocks fit into the first three groups of Harris et al. (1986) collision zones.

### Trace and Rare Earth Elements Geochemistry

The results of the trace and rare earth elements from the Akure rocks are presented in Table 6. The results show high Ba content (621.50-1529.50), an appreciable amount of Rb (1.20-220.60), Pb (23-62-35.10), Y (3.85-84.79), Nb (6.94-43.30), and Zr (163.60-1016.75) The variations in the concentrations of the trace elements are characteristics of the S- and I-types granites. The presence of Y and Nb in relatively low concentration is an indication of their relevance in the arc or subduction-related magmatism in the genetic history of the rock (Mohammed and Hassanen, 1997; White, 2004). Rb is a pathfinder element for porphyritic copper and it indicates the presence of copper. Zr, a high field strength element (HFSE) has an average content of 752.89, Ni (9.90), Sc (12.32), V (41.71), and Zn (50.62). The light rare earth elements (LREE) like La (144.94), Ce (257.17), and Nd (94.58) have high contents in contrast to the heavy rare earth element (HREE)

whose contents are Tm (0.59), Yb (3.91), Lu (0.56) and Er (4.36). The rare elements are characterized by the abundance of Ba 621.50-1529.50), Zn (25.50-79.55), Zr (163.60-1016.75), Cu (8.91-88.95), Sr (283.35-575.10) and LREE. The results of the trace and rare earth elements from the Are Ekiti and environs rocks are presented in Table 7 the results show that Ba is very high (32.55-2392) as well as Sr (4.55-458.10) Rb (116.49), Pb (25.99) and Y (42.53) while Sc (14.34), V (64.22), and Zn (67.73) have low contents. The variations in these values suggest an involvement of more than one source of origin. Zr, a high field strength element (HFSE) has an average of 644.3 ppm. The light rare earth elements (LREE) of La (117.74), Ce (223.42) and Nd (86.15) are generally high while the heavy rare earth element (HREE) of Tm (0.61), Yb (3.89), Lu (0.56) and Er (4.47) are low in contents. The Are Ekiti and environs trace and rare earth elements in the rocks are characterized by high concentrations of Ba (32.55-2392.00), Cu (19.19-167.05), Zn (4.79-113.35), Zr (130.50-1399.50) and LREE. Figs.18a&b show the spider diagrams of the rocks from Akure and Are- Ekiti and environs (normalized; Nakamura, 1974) indicating a negative Eu anomalies. The two figures (18a and 18b) show a significant enrichment of the light rare earth elements (LREE) and depletion of the heavy rare earth elements HREE. The display of negative Eu anomalies indicate their separation during fractionation (Singh and Vallinayagam, 2012).

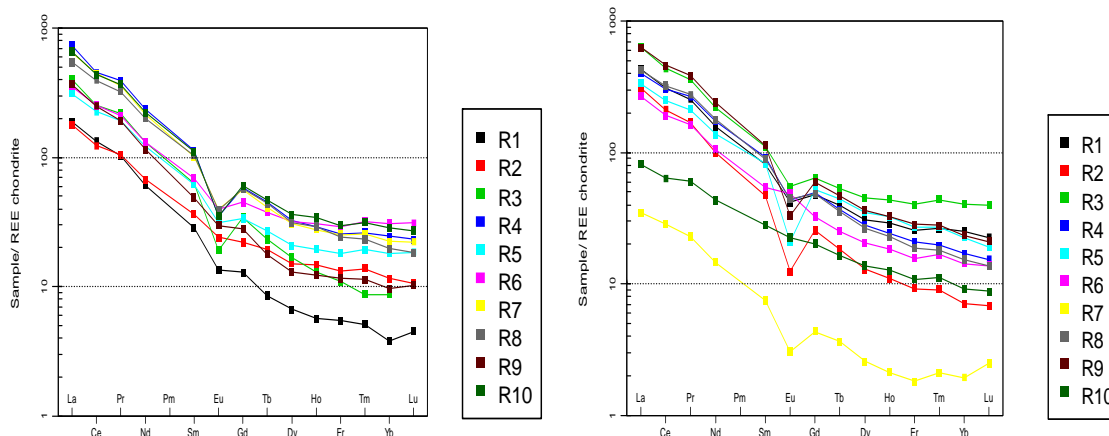


Fig. 18a & b Spider plot - REE chondrite of rock samples of Akure and Are Ekiti & environments (Nakamura, 1974)

### Conclusion

The geochemistry of the Pan-african rocks from Akure and Are –Ekiti and Environs showed a minor variation in the contents of silica (SiO<sub>2</sub>), alumina (Al<sub>2</sub>O<sub>3</sub>), potash (K<sub>2</sub>O), and iron (F<sub>2</sub>O<sub>3</sub>) respectively. Rocks from both areas are siliceous but their contents of Al<sub>2</sub>O<sub>3</sub>, F<sub>2</sub>O<sub>3</sub>, MgO, Na<sub>2</sub>O, and CaO are slightly higher in the Akure rocks than in the Are Ekiti and environs rocks. The use of alumina saturation index (ASI) of Shand, (1943), and Piccoli, (1989) placed the rocks from both areas as S-Type and I-Type granites suggestive of their derivations from mixed sources. The rocks from both areas are characterized by high alumina, moderate to high silica,

presence of biotite, microcline, monzogranite, syenogranites, diorite, and granodiorite as well as granites. The presence of shoshonitic series suggests rock association characterized by k-rich, high alkaline (Na<sub>2</sub>O + K<sub>2</sub>O) and low TiO<sub>2</sub>. The rocks of Akure and Are-Ekiti and environs showed high- K calc-alkaline to shoshonite affinity and strongly metaluminous I-Type and peraluminous S-Type affinity. The rocks are characterized by an enriched Ba, Sr and a well pronounced negative Eu anomaly, belonging to syn-to post collisional tectonic setting. The rocks are Fe-rich (Ferroan) and formed by differentiation or partial melting of basaltic materials (Loiselle and Wones 1979; Frost and Frost, 1997). The geochemical characteristics of rocks from Akure and Are–

Ekiti and environs were emplaced in the active continental arc with subsequent pre-collision, syn-collision, and post-collisional calc-alkaline intrusions derivable from a mantle source. These arc and collision characteristics are in tandem with the tectonic scenarios for Pan-African granitic rocks (Fithes et al., 1985).

### Conflict of Interest

The author hereby declares no conflict of interest.

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