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Petrogeochemical Assessment of the Erelu-Oyo Dolerite Dyke and Associated Older Granites, Southwestern Nigeria

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Abstract - **The petrochemical studies of the medium- to fine-grained discordant dolerite dyke of Erelu, located within latitude 07°52′N to 07°54′N and longitude 003°52′E to 003°57′E, were carried out to characterize the rock, infer the petrogenesis in relation to the host rocks in the area, and advance the present knowledge on the dolerite dykes of the basement complex of southwestern Nigeria. The study involved fieldwork and random sample collection, where four dolerite, four granite, and six banded gneiss samples were collected and labeled. Thin sections of representative samples of the rocks were prepared following standard procedures, while the remaining rock samples were pulverized for major oxides and trace element determination using the Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) method at Activation Laboratory, Ontario, Canada. The modal analysis results show that the dolerite is composed of olivine (40%), pyroxene (30%), plagioclase (10%), biotite (5%), and quartz (15%). Geochemical results revealed the average major elemental composition (%) as SiO_2 (48.62), Al_2O_3 (15.27), Fe_2O_3 (11.48), MgO (8.00), CaO (8.28), Na_2O (3.11), K_2O (0.82), TiO_2 (1.51), P_2O_5 (0.24), MnO (0.16), Cr_2O_3 (0.03), and LOI (1.85). The average trace element concentrations (ppm) are Ba (285.75), Ce (10), Co (51), Cu (54.5), Nb (7.75), Ni (162.25), Sc (19.75), Sr (436.75), Y (15.25), Zn (98), and Zr (111.25). The occurrence of pyroxene and olivine classifies the rock as olivine-dolerite and pyroxene-dolerite, while geochemical evidence suggests a tholeiitic origin for the dolerite. The petrochemistry of the rocks shows that the dolerite dyke is peraluminous with moderately high Al, Fe, Mg, and Ca contents compared to other rocks in the same area.**
Keywords: **Dolerite Dyke, Petrochemistry, Geochemical Analysis, Tholeiitic Origin, Basement Complex (Southwestern Nigeria)**

I. INTRODUCTION

Erelu is a small village in Oyo Alafia, located along the Oyo-Iselin Road towards the northwestern axis of the town. This area lies between 07°52′N to 07°54′N and 003°52′E to 003°57′E in the Southwestern Basement Complex of Nigeria. Dolerite is a mafic hypabyssal intrusive rock with granitic signatures. The Erelu dolerite dyke is among the many dolerite dyke occurrences reported as confined to the Oyo and Ibadan quarter sheet in [7]. This dolerite dyke occurs discordantly within the gneissic-rock complex in the area and trends in a NW-SE direction. Many authors [6], [7], [10], [11] have reported on the Precambrian Basement Complex of Southwestern Nigeria.

Dolerite dykes are associated with the older granites and the migmatite regime. In [9], it was reported that the relationship between granites and migmatite is not clearly understood. This author considered dolerite dykes as derived from passive permeation of older granite or regional gneisses by basic magmas, making them younger than both the older granite and the gneisses. The migmatite phase in the area is tightly and incoherently folded (ptygmatic folds) with dike-like veins and segregation of light-colored granitic material (leucosome) within dark-colored amphibole- and biotite-rich material (melanosome). Numerous xenolithic lenses within the granitic gneisses represent structural imprints of the Pan-African Orogeny (600 ± 150 Ma), trending in a N-S direction, which is typical of major structural features of the basement complex terrains.

Elueze [2] described the occurrence of low-grade metasedimentary rocks on the western half of Nigeria as a northerly trending reactivated gneiss-migmatite complex, a component of the schist within the basement complex regime. Amphibolite and meta-ultramafites have been defined as rocks that underwent regional metamorphism and now occur as lenticular to ovoid-shaped bodies within the metasediments [2], [13].

The Basement Complex rocks of Nigeria comprise migmatite and granitic gneisses, quartzite, slightly migmatized to unmigmatized metasedimentary rocks, schists, and meta-igneous rocks. The Pan-African older granite rocks include charnockites, gabbroic and dolerite rocks, granites, granodiorites, and syenites.

Southwestern Nigeria lies within the reactivated belt of Pan-African age (650 ± 50 Ma). In [15], a single episode of polycyclic migmatization and granitization was proposed for the Precambrian Basement Complex of the region, inferred to have occurred during the Older Granite Orogeny. In [1], four petrological groups were suggested: undeformed acid and basic dykes, Pan-African granitoids, metasedimentary and metavolcanic rocks (schist belts), and the migmatite-gneiss complex.

The migmatite-gneiss complex belongs to the oldest rock units in the basement complex, whereas the undeformed acid and basic dykes represent the youngest petrologic units.

II. GEOLOGICAL SETTING

The four major orogenic events that influenced the Precambrian history of the African basement complex are the Liberian Orogeny (2700 ± 200 Ma), the Eburnean Orogeny (2000 ± 200 Ma), the Kibaran Orogeny (1100 ± 200 Ma), and the Pan-African Orogeny (600 ± 150 Ma). The wide age range of these events reflects the widespread nature of Pan-African tectonics. The emplacement of granitoids into the metamorphic basement complex of Nigeria occurred during the 600 ± 150 Ma Pan-African event [12], [16]. The Pan-African Orogeny is the most recent and is characterized by mobile schist belts, including the Nigerian Basement Complex.

The Pan-African granitoids occur mostly as fine- to medium-grained 1-5 km bodies generally referred to as “Older Granites” [5], [8], [15], [17]. The granite, granite-gneiss, biotite-gneiss, and banded gneiss constitute the Older Granite suite.

Nigeria is located between latitudes 4°N and 14°N and longitudes 3°E and 15°E, covering a surface area of 923,768.57 km² with nearly equal proportions of crystalline and sedimentary rocks. The Nigerian Basement Complex lies within the Pan-African Belt separating the West African Craton and the Congo Craton. The migmatite-gneiss, metasediments, metavolcanics, Pan-African granitoids, charnockitic, dioritic, and gabbroic rocks constitute major lithologic units of the Nigerian Basement Complex. The Pan-African granitoids are collectively referred to as the Older Granites, which include gabbroic rocks, charnockites, diorites, granites, pegmatites, aplites, and syenites.

The migmatite-gneiss complex bears imprints of the Liberian (ca. 2500 Ma), Eburnean (ca. 2000 Ma), and Pan-African (ca. 600 Ma) tectonic events [14]. The Proterozoic migmatite-gneiss complex was reported to have been intruded by various granitoids resulting from oceanic closure, subduction, oblique collision between the West African Craton and the Hoggar-Nigeria Shields, and crustal thickening during the Pan-African episode [19].

The Nigerian Basement Complex comprises highly deformed metamorphic rocks and granitic intrusions. Its lithologic units include the gneissic complex, quartzite, slightly migmatized to unmigmatized metasedimentary rocks, schists, and meta-igneous rocks. The charnockites, gabbroic and dolerite rocks, granites, granodiorites, and syenites are also major components. The schists include fine-grained clastics, pelitic schists, phyllites, banded iron formations, marble, and amphibolite of Upper Proterozoic assemblages, which host most of the economic minerals in the Basement Complex [18].

III. SAMPLING AND FIELD OBSERVATIONS

The study area lies between latitudes 07°52′N and 07°54′N and longitudes 003°52′E and 003°57′E within the Basement Complex of Southwestern Nigeria (Fig. 1). Fieldwork began with a literature review of published materials on the geology of the area, followed by a reconnaissance survey to assess accessibility and security. Materials used included a 1:50,000-scale topographical map (for base map preparation), a Global Positioning System (GPS) for location identification, and field equipment such as a sledgehammer, 100 m nylon tape, hand lens, compass-clinometer, sample bags, and a field notebook.

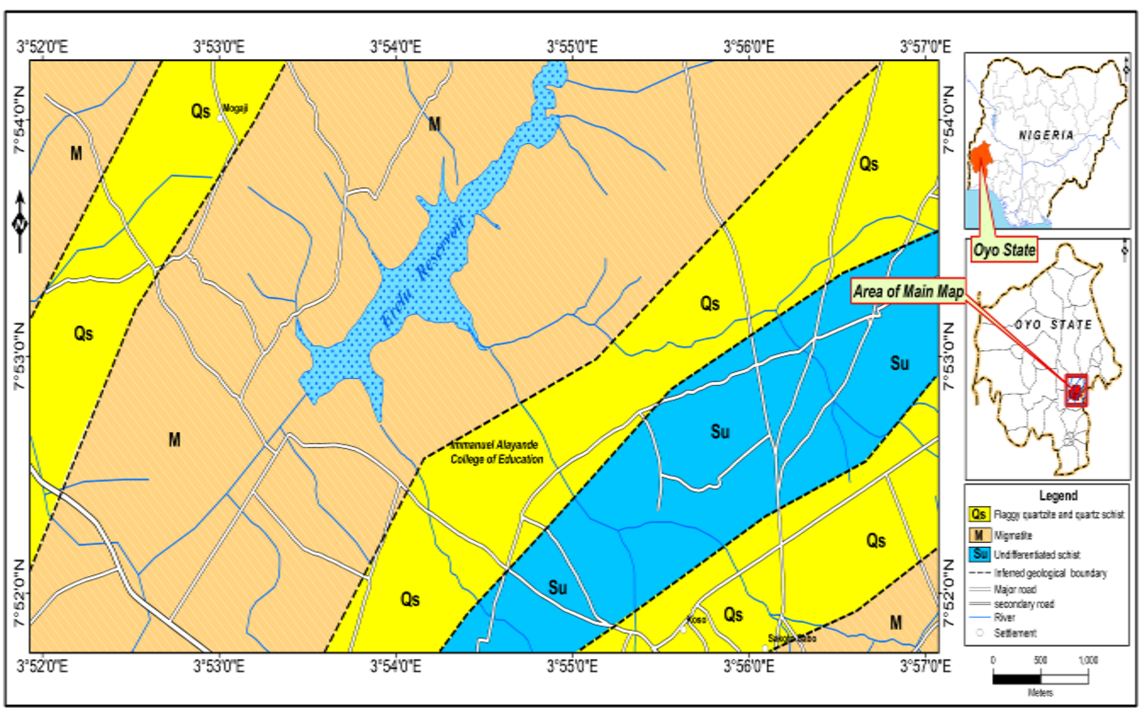


Fig. 1 Geology map of study area

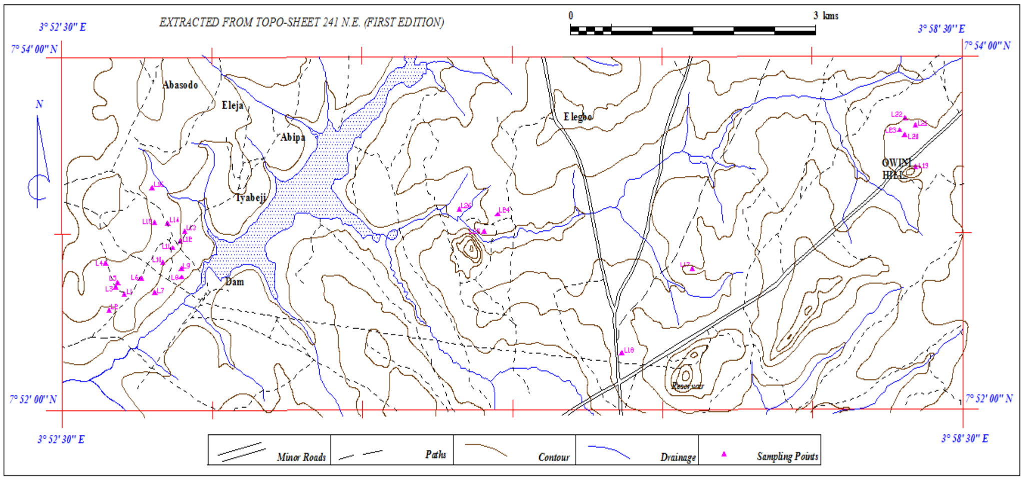


Fig. 2 Topography Map of the study area showing sample points

A systematic sampling of the dyke and associated host rocks was collected in the order of the gridded base map (Fig. 2). The rocks were examined with a hand lens to observe the variation in grain sizes between the dolerite and the gneissic host rocks and to examine the mineral assemblages megascopically. The rocks were sampled for petrographic assessment and geochemical analysis to study the likely variation in the geochemical character of the rocks. The samples for petrographic and geochemical analysis were taken from fresh surfaces, and weathered rock samples were avoided. Reasonable precautions were exercised to ensure that good representative samples that could be cut into sections were collected from the gneissic outcrops.

A total of twenty-five (25) samples were collected, out of which four dolerites, five granites, six granite gneisses, one pegmatite, and one quartzite rock sample were chosen for petrography and geochemical analysis. The dolerite dyke in the study area occurs as an extremely dark-colored rock enclosed by leucocratic host rocks.

Field observations of the outcrop show a sharp, straight-line contact of the dolerite dyke with the host rocks, often displaying a brownish to whitish surficial appearance that disguises the inner dark-colored dolerite. Xenolithic material was not observed within the dolerite wall rock, but irregular jointing is common in the dolerite. The way the dolerite is enclosed may make economic quarrying of the rock difficult.

From Plates A, B, C, D, E, and F below, the different rock types present in the study area are shown (Fig. 3). The migmatite gneiss and banded gneiss are the predominant rocks in the area. Quartzofeldspathic veins of varying lengths and sizes are widespread in the gneissic outcrops. Symmetric anticlinal folds, wavy in some areas, can be observed in the migmatite gneiss. The dolerite dyke intrusion, about a meter wide, spans a long distance in the gneissic host rocks. Randomly located xenolithic material exists in the banded gneiss, with the mafic and felsic materials trending in an N-S orientation.

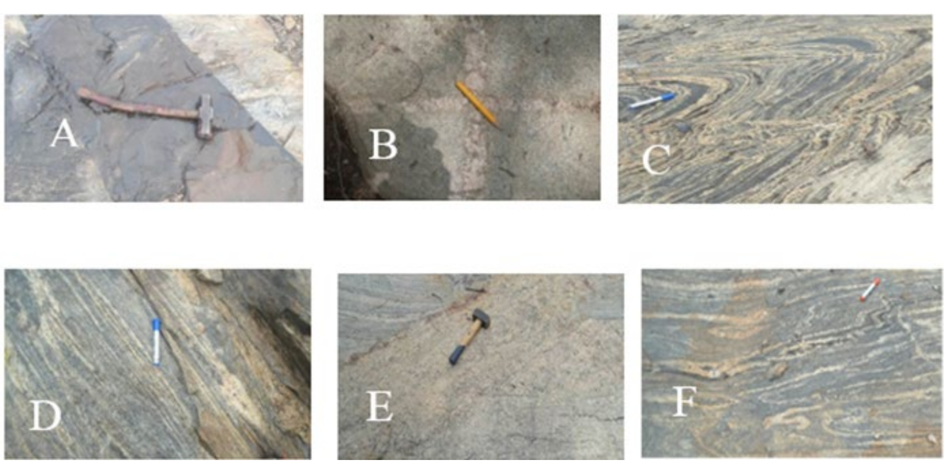


Fig.3 (A) Dolerite dyke intrusion in the gneissic hot rocks, (B) a cross like quartzo-feldspathic vein in granite-geneiss from the study area, (C) an anticlinal wavy fold in migmatite-geneiss, (D) banded gneiss showing a N-S trending of the mafic and felsic material, (E) a pegmatitic intrusion into banded gneiss, (F) irregularly-shaped quartzo-feldspathic venis in granite gneiss.

IV. PETROGRAPHY

The sampled dolerite from the study area is composed of coarse-grained plagioclase feldspar, olivine, and pyroxene minerals. Pyroxene is a high-temperature and high-pressure dark-colored rock-forming mineral in igneous and metamorphic rocks. Anhedral quartz occurs as an accessory mineral in the rock. The texture ranges from poikilitic to ophitic. The plagioclase laths are randomly oriented, while olivine is rimmed by pyroxene, suggesting a disequilibrium condition during magma crystallization. The modal analysis of the dolerite dyke shows the mineral composition as olivine (40%), pyroxene (30%), plagioclase (10%), biotite (5%), and quartz (15%). The occurrence of pyroxene and olivine classifies the rock as olivine-dolerite and pyroxene-dolerite (Fig. 4).

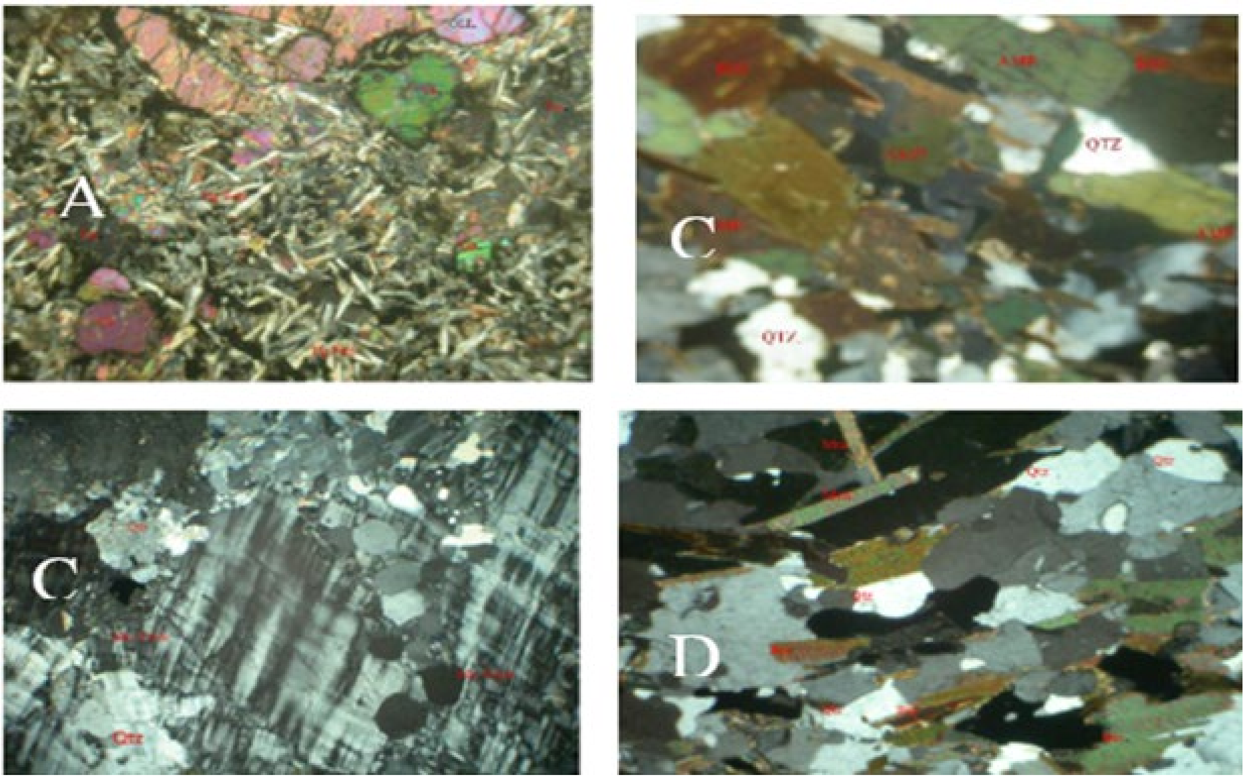


Fig. 4. (A) Photomicrograph of dolerite dyke showing olivine, pyroxene, and plagioclase under cross-polarized light. (B) Photomicrograph of banded gneiss showing quartz, muscovite, amphibole, and biotite under cross-polarized light. (C) Photomicrograph of pegmatite showing quartz and microcline under cross-polarized light. (D) Photomicrograph of granite showing quartz, muscovite, and biotite under cross-polarized light.

V. GEOCHEMISTRY

The major oxides of Erelu dolerite dyke, and the granite and banded gneiss host rocks as shown in tables Table 1 and the average and range of values in tables 2 and 3 show the basic nature of the dolerite and the acidic content of the host rocks.

The average and rages of values of the major oxides in Erelu dolerite dyke in percentages (%) are characterized by SiO_2 (48.41; 49.2 - 48.23), Al_2O_3 (15.27; 15.48 - 15.14), Fe_2O_3 (11.48; 11.45 - 11.9), MgO (8.00; 8.31 - 7.74), CaO (8.28; 8.39 - 8.12), Na_2O (3.11; 3.12 - 3.1), K_2O (0.82; 0.88 - 0.68), TiO_2 (1.51; 1.69 - 1.33), P_2O_3 (0.238; 0.26 - 0.2), MnO (0.155; 0.17 - 0.15), Cr_2O_3 (0.037; 0.039 - <0.002) and LOI (2.18; 2.6-2.7).

The alumina content is > 15wt% in the three rock types, magnesium in dolerite and banded gneiss are relatively high but low in granite MgO (0.68 - 0.03) wt.%. Sodium is moderately high in dolerite and the host rocks while P_2O_5, MnO and Cr_2O are each < 1.0 wt.% and values of TiO_2 ranges between (1.69 - 1.33) wt.% in dolerite, (2.62 - 0.42) wt.% in the banded gneiss and (0.34 - 0.03) wt.% in granite.

The trace elements analyzed in the rocks are Ba, Ce, Co, Cu, Nb, Ni, Sc, Sr, Y, Zn and Zr. Barium is fairly high in the three rock samples with average values as dolerite (285.75) ppm, granite (968.75) ppm and banded gneiss (974.29) ppm. Ni (162.25) ppm, Sr (436.75) and Zr (111.25) ppm are the average values in the dolerite dyke. Trace elements in igneous rocks are grouped as compatible and incompatible elements.

The incompatible elements are further grouped geochemically as large-ion lithophile elements (LILE) or potassium, rubidium, caesium, strontium, and barium and the high-field-strength elements (HFSE) are the zirconium, niobium, hafnium, thorium, uranium, and tantalum. The compatible elements are rubidium, uranium, lanthanum, nickel and titanium.

Barium, strontium and zirconium in th*e* dolerite samples are incompatible elements with moderately high values (ppm). Nickel, a compatible element in the dolerite has a fairly high value. Compatible elements are depleted in the crust but enriched in the mantle.

Geochemical ratios and fractionation indexes used for tracing the behavior of the trace elements during magmatic differentiation indicated that the Erelu dolerite dyke has Sr/Y (28,632), Zr/Y (6.292), Nb/Y (0.553), Y/Nb (2.495), Ba/Nb (45.341) and Zr/Nb (17.184) as shown in Table 6.

The values of these ratios vary widely in granite and the banded gneiss sample.

TABLE I MAJOR OXIDES (WT.%) IN DOLERITE (1-4), GRANITE (5-8), BANDED-GNEISS (9-15)

S.No.	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K2O	TiO_2	P_2O_5	MnO	Cr_2O_3	LOI	Total
1	48.46	15.18	11.45	8.06	8.12	3.1	0.88	1.63	0.25	0.15	0.038	2.4	99.72
2	49.2	15.14	11.32	7.88	8.39	3.11	0.9	1.61	0.26	0.15	0.04	1.7	99.7
3	48.59	15.48	11.25	7.74	8.23	3.12	0.82	1.48	0.24	0.15	0.035	2.6	99.74
4	48.23	15.29	11.9	8.31	8.39	3.12	0.68	1.33	0.2	0.17	0.002	0.7	98.32
5	69.49	15.53	2.83	0.68	2.08	3.56	4.66	0.34	0.09	0.04	0.002	0.4	99.7
6	68.76	15.86	1.82	0.47	1.55	3.15	6.86	0.24	0.12	0.02	0.003	0.8	99.65
7	71.89	16.64	0.46	0.03	1.55	4.61	3.85	0.03	0.01	0.01	0.002	0.8	99.88
8	65.46	20.44	0.84	0.04	2.56	6.22	3.61	0.04	0.02	0.01	0.002	0.7	99.94
9	64.5	16.43	5.18	1.67	3.34	4.3	2.64	0.8	0.17	0.07	0.002	0.7	99.8
10	62.14	17.44	5.25	2.02	5.03	4.7	1.85	0.58	0.14	0.09	0.005	0.6	99.85
11	48.63	14.94	11.64	8.38	8.09	3.1	0.81	1.55	0.23	0.15	0.036	2.1	99.66
12	69.45	14.22	3.66	1.3	1.62	2.93	5.19	0.45	0.08	0.05	0.002	0.8	99.75
13	54.67	12.94	15.38	2.88	2.83	2.74	3.61	2.62	0.71	0.2	0.003	0.9	99.48
14	70.89	14.5	2.49	0.61	2.13	3.06	5.11	0.42	0.09	0.03	0.002	0.3	99.63
15	72.41	16.47	0.57	0.14	3.08	4.74	2.31	0.08	0.01	0.01	0.002	0.1	99.92

TABLE II RANGE AND AVERAGE VALUES FOR MAJOR OXIDES IN ALL THE ROCK UNITS (WT. %)

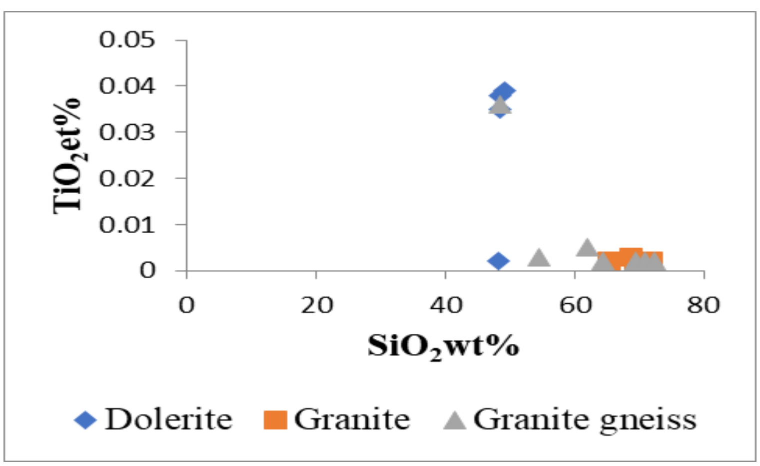
Elements	Dolerite dyke		Banded gneiss		Granite	
	Range	Aver	Range	Aver	Range	Aver
SiO_2	49.2 - 48.23	48.62	72.41 - 48.63	63.241	71.89 - 65. 46	68.9
Al_2O_3	15.48 - 15.14	15.2725	17.44- 12.94	15.277	20.44 - 15.53	17.117
Fe_2O_3	11.45 - 11.9	11.48	15.38 - 0.57	6.31	2.83 - 0.46	1.487
MgO	8.31 - 7.74	7.9975	8.38 - 0.14	2.429	0.68 - 0.03	0.305
CaO	8.39 - 8.12	8.282	8.09 - 1.62	3.731	2.56 - 1.55	1.935
Na_2O	3.12 - 3.1	3.113	4.74 - 2.74	3.653	6.22 - 3.15	4.385
K_2O	0.88 - 0.68	0.82	5.19 - 0.81	3.074	6.86 - 3.61	4.745
TiO_2	1.69 - 1.33	1.513	2.62 - 0.42	0.928	0.34 - 0.03	0.163
P_2O_5	0.26 - 0.2	0.238	0.71 - <0.01	0.204	0.12 - <0.01	0.06
MnO	0.17 - 0.15	0.155	0.2 - <0.01	0.085	0.04 - <0.01	0.03
Cr_2O_3	0.039 - <0.002	0.037	0.036 - <0.002	0.0074	0.003 - <0.002	0.002
LOI	2.6 - 0.7	2.175	2.1 - 0.1	0.786	0.8 - 0.4	0.675

TABLE III TRACE ELEMENTS (PPM) IN DOLERITE (1-4), GRANITE (5-8), BANDED-GNEISS (9-15)

S.No.	Ba	Ce	Co	Cu	Nb	Ni	Sc	Sr	Y	Zn	Zr
1	297	< 30	52	53	12	168	19	481	15	101	125
2	294	< 30	50	52	13	162	20	465	16	100	119
3	300	40	48	50	6	154	19	439	15	93	107
4	252	< 30	54	63	< 5	165	21	362	15	98	94
5	1454	145	< 20	14	< 5	< 20	3	401	9	62	336
6	1325	298	< 20	7	< 5	< 20	3	300	19	41	533
7	570	< 30	< 20	18	< 5	< 20	< 1	303	< 3	5	39
8	526	< 30	< 20	7	< 5	< 20	<1	379	< 3	9	120
9	839	110	< 20	7	8	<20	8	465	13	103	324
10	519	55	< 20	13	9	22	16	515	22	96	90
11	271	< 30	54	55	8	164	19	439	15	101	108
12	1503	< 30	< 20	75	9	< 20	3	350	4	80	128
13	832	321	50	446	44	25	15	264	52	270	966
14	2271	137	< 20	12	< 5	20	4	465	13	44	215
15	585	< 30	< 20	12	< 5	< 20	< 1	378	< 3	11	< 5

TABLE IV AVERAGE VALUES OF TRACE ELEMENTS (PPM) IN DOLERITE, GRANITE AND GRANITE-GNEISS FROM THE STUDY AREA

Trace elements(ppm)	Dolerite	Granite	Banded-gneiss
Ba	285.75	968.75	974.286
Ce	40.00	221.5	155.75
Co	51.00	ND	52.00
Cu	54.5	11.5	88.571
Nb	10.33	ND	15.6
Ni	162.25	ND	57.75
Sc	19.75	3	10.83
Sr	436.75	345.75	410.85
Y	15.25	14	19.83
Zn	98.00	29.25	100.71
Zr	111.25	257	305.167



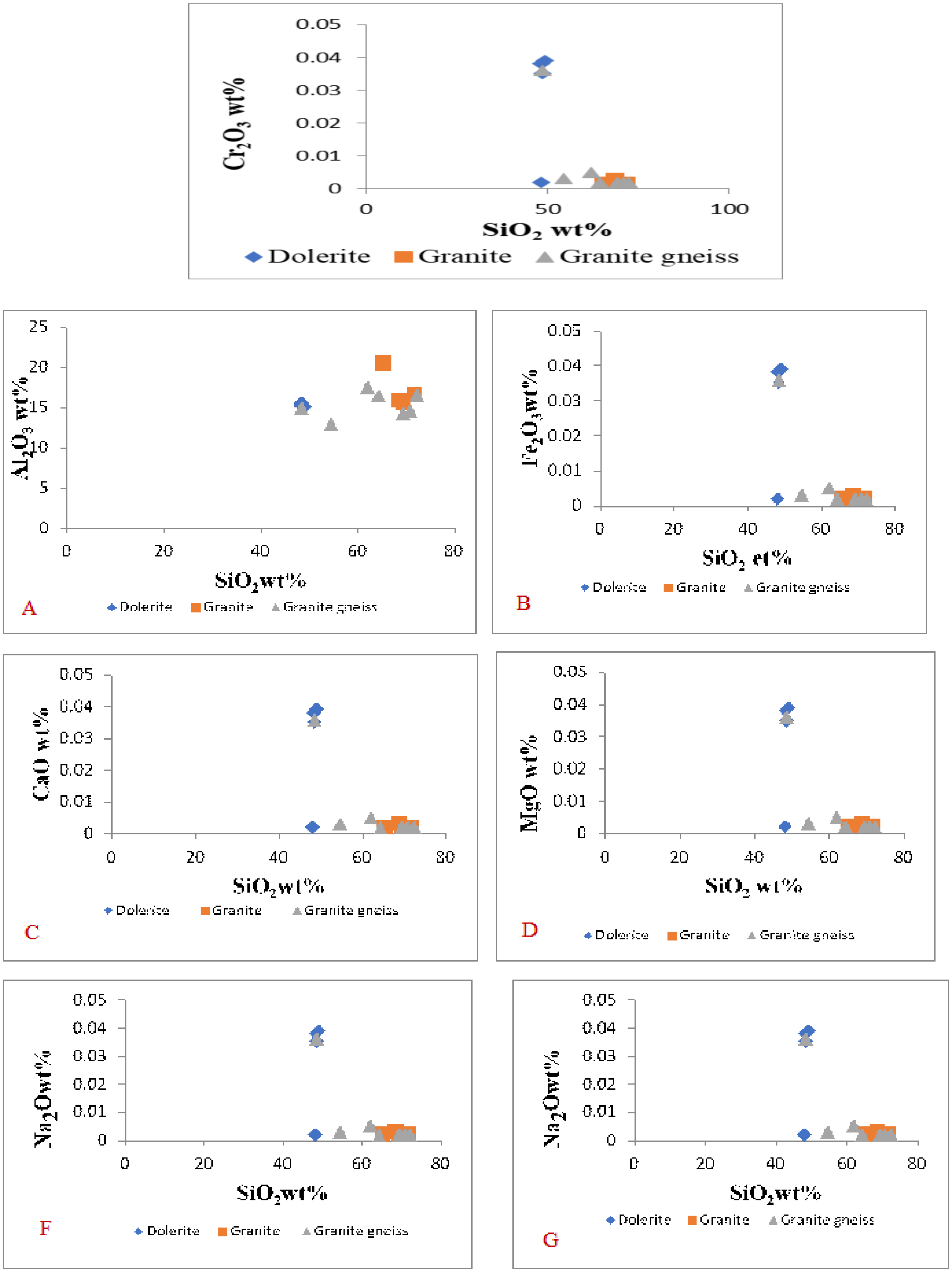


Fig. 5 Major oxide variation plots of Al_2O_3 vs SiO_2, MgO vs SiO_2, CaO vs SiO_2, MgO vs SiO_2, Na_2O vs SiO_2, K_2O vs SiO_2, TiO_2 vs SiO_2, Cr_2O_3 vs SiO_2 and Na_2O +K_2O vs SiO_2

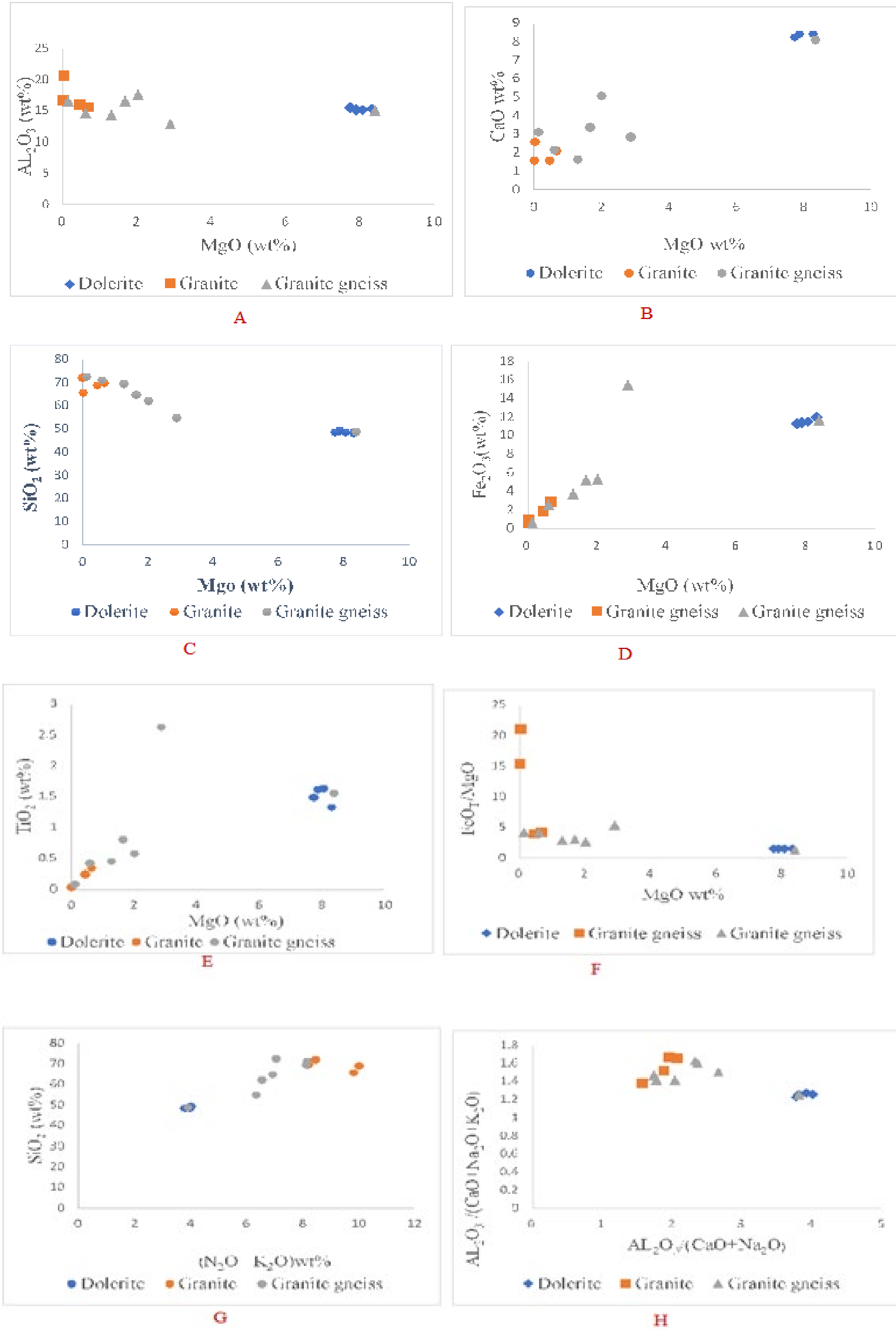


Fig. 6 Variation plots of selected major oxides against MgO (wt.%)

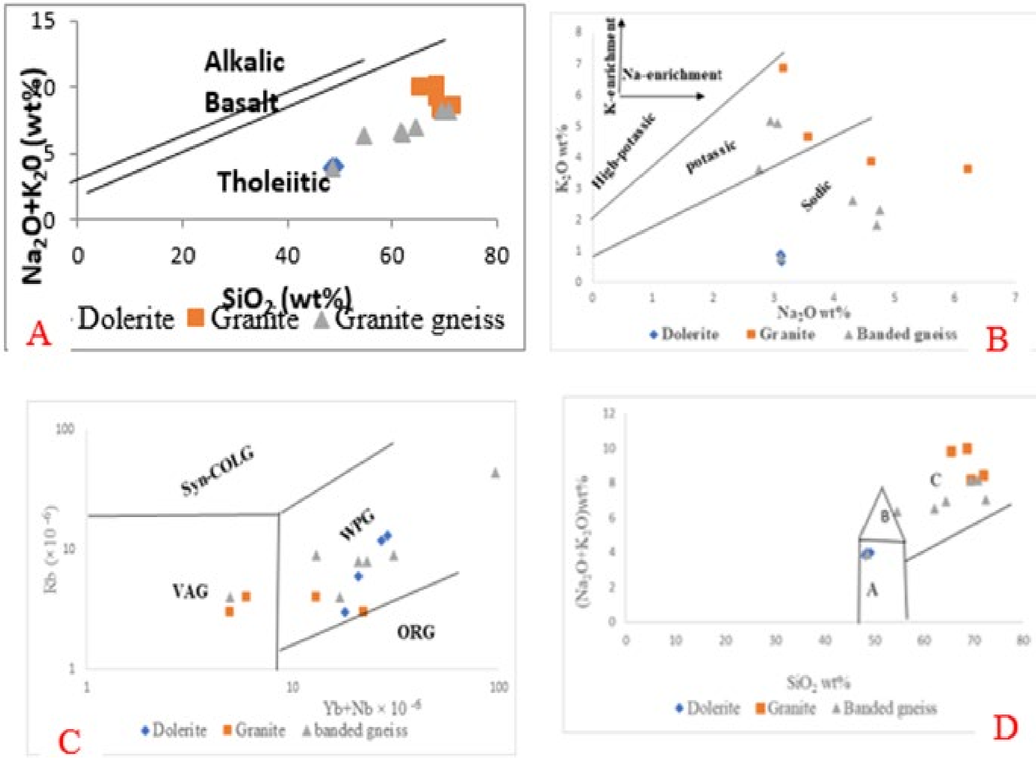


Fig. 7 (A) Plot of $Na_2O + K_2O$ vs. SiO_2 after Le Maitre (2002). (B) Variation diagram of K_2O vs. Na_2O showing the distribution of samples in the potassic and sodic fields. (C) Plot of Rb vs. Yb + Nb after Pearce et al. (1984), classifying the dolerite samples within the plate tectonic environment. (D) Total alkali diagram (TAS) after Le Maitre (2002).

VI. DISCUSSIONS AND CONCLUSION

The representative dolerite dyke samples analyzed are characterized by an average SiO_2 value of 48.62 wt.% (range: 49.20-48.23 wt.%), higher Al_2O_3 (15.27; 15.48-15.14 wt.%) and Fe_2O_3 (11.48; 11.45-11.90 wt.%) compared to MgO (8.00; 8.31-7.74 wt.%) and CaO (8.28; 8.39-8.12 wt.%). The samples are deficient in K_2O (0.82; 0.88-0.68 wt.%) but moderately high in Na_2O (3.11; 3.12-3.10 wt.%). The variation in SiO_2 in the dolerite dyke of this area suggests a basic rock, and the values plot the samples in the tholeiitic and calc-alkaline fields (I).

The major oxides in basic rocks generally have a strong correlation with silica content. When silica content is low, the rock is enriched in magnesium oxide (MgO) and iron oxides (FeO, Fe_2O_3, and Fe_3O_4), with relatively moderate sodium (Na_2O) and potassium (K_2O). The opposite relationship occurs when silica content is high: the rock is depleted in magnesium oxide and iron oxides and relatively enriched in sodium and potassium. When silica content in a rock is about 45 wt.%, both calcium oxide (CaO) and alumina (Al_2O_3) are depleted; when it is above 45 wt.%, CaO may reach as high as 10 wt.% but decreases gradually with increasing silica. Alumina in rocks containing more than 45 wt.% silica is generally above ~14 wt.%, with the greatest abundance occurring at an intermediate silica content of about 56 wt.%. This geochemical trend in igneous rocks is clearly demonstrated by the dolerite dyke from the study area, where the major oxide variation plots (Figs. A-J) show that the dolerite follows the same trend as the host rocks, indicating a cogenetic character.

The solidification index (SI = 100MgO/(MgO + FeO + Fe_2O_3 + Na_2O + K_2O)) falls within the range for basic rocks, and a CaO/Al_2O_3 ratio < 1 suggests that the protolith contains clinopyroxene, with the possibility that coexisting garnet is either deficient or refractory.

Declaration of Conflicting Interests

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Use of Artificial Intelligence (AI) - Assisted Technology for Manuscript Preparation

The authors confirm that no AI-assisted technologies were used in the preparation or writing of the manuscript, and no images were altered using AI.

REFERENCES

[1] S. S. Dada, "Proterozoic evolution of Nigeria," in *The Basement Complex of Nigeria and its Mineral Resources*, O. O. Oshin, Ed. Ibadan, Nigeria: 2006, pp. 29-44.

[2] A. A. Elueze, "Geochemistry and petrotectonic setting of metasedimentary rock of the schist belt of Ilesha area, SW Nigeria," *J. Min. Geol.*, vol. 18, no. 1, pp. 194-197, 1981.

[3] A. A. Elueze, "Metallographic studies of ore minerals in the amphibolites of Ilesha schist belt, south-western Nigeria," *J. Min. Geol.*, vol. 18, no. 2, pp. 53-58, 1982.

[4] A. A. Elueze, "Mineralogy and chemical nature of metaultramafites in Nigerian schist belts," *J. Min. Geol.*, vol. 19, no. 2, pp. 21-29, 1982.

[5] J. D. Falconer, *The Geology and Geography of Northern Nigeria*. London, U.K.: Macmillan, 1911, p. 295.

[6] R. Jacobson, "The pegmatite of central Nigeria," *Bull. Geol. Surv. Nigeria*, no. 17, p. 62, 1958.

[7] H. A. Jones and R. D. Hockey, *The Geology of Part of Southwestern Nigeria*. Nigeria Geol. Surv., Bull. 31, p. 101, 1964.

[8] S. Orajaka, "Geology of the Obudu area, Ogoja Province, Eastern Nigeria," *Le Naturaliste Canadien*, vol. 91, no. 3, pp. 73-98, 1964.

[9] M. O. Oyawoye, "The geology of the Nigerian Basement Complex," *J. Nigerian Min. Geol. Soc.*, vol. 1, pp. 87-102, 1972.

[10] M. A. Rahaman, "Geochemistry of some gneiss from Southern Nigeria," *J. Min. Geol.*, vol. 15, no. 1, pp. 36-38, 1976.

[11] A. C. Ajibade, "The geology of the Zungeru sheet," M.Sc. thesis, Univ. Ibadan, Nigeria, 1972 (unpublished).

[12] D. G. Turner, "Proterozoic schist belts in the Nigerian sector of the Pan-African Province of West Africa," *Precambrian Res.*, vol. 21, pp. 55-79, 1983.

[13] A. E. O. Ogezi, "Geochemistry and geochronology of basement rocks from Northwestern Nigeria," Ph.D. dissertation, Univ. Leeds, U.K., 1977.

[14] Y. N. Oversby, "Lead isotope study of aplites in the Precambrian basement rock near Ibadan, southwestern Nigeria," *Earth Planet. Sci. Lett.*, vol. 27, pp. 177-180, 1975.

[15] M. O. Oyawoye, "The contact relationship of the charnockite and biotite gneiss at Bauchi, Northern Nigeria," *Geol. Mag.*, vol. 101, no. 2, pp. 138-144, 1964.

[16] V. M. Oversby, "Lead isotopic study of aplites from the Precambrian basement rocks near Ibadan," *Earth Planet. Sci. Lett.*, vol. 27, pp. 177-180, 1975.

[17] P. G. Cooray, "A note on the charnockites of the Ado-Ekiti Area, Western State of Nigeria," in *Geology of Africa*, T. F. J. Dessauvagie and A. J. Whiteman, Eds. Ibadan, Nigeria: Univ. of Ibadan, 1972, pp. 45-54.

[18] D. C. Turner, "Upper Proterozoic schist belt in the Nigerian sector of the Pan-African Province of West Africa," *Precambrian Res.*, vol. 21, pp. 55-79, 1983.

[19] R. Black, R. Caby, A. Moussine-Pouchkine, J. M. Bertrand, J. Boullier, J. Fabre, and R. Lesquer, "Evidence for late Precambrian plate tectonics in West Africa," *Nature*, vol. 278, no. 5701, pp. 223-227, 1979.