

Dispersion of Trace Elements as Consequence of *in-situ* Weathering in granite-derived Tropical Soils in Southwestern Nigeria

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Abstract: Trace elements composition of granite and tropical soils formed by *in-situ* weathering over the basement complex of Ikere-Ekiti, Ado-Ekiti and Igrara-Odo areas of SW Nigeria is evaluated and reported. The granitoids exhibit chemical features such as is common to other granite bodies across the basement areas. The soil profiles typically have four different horizons with contrasting physical characteristics. Analytical result from ICP-MS technique revealed compositional variation along vertical direction within depth of the profiles. Trace element as average for the granite reveals low Tm (0.5 ppm), Eu (2.1 ppm), Co (5.1 ppm), Sc (7.2 ppm), Hf (7.6 ppm), Sm (12.6 ppm), and Th (30.5 ppm) values, while La (110 ppm), Ce (216 ppm), Cr (235.5 ppm), and Ba (963 ppm) show enrichments. All the soils have Sm, Eu, Th, Hf and Co contents below 10 ppm; Sc, La and Ce values fall between 10-100 ppm, while Cr and Ba contents fall between 200-1500 ppm. Variation between trace contents in granite and the derived soils as revealed along depths of the profile indicates greater mobility of Th, Sc and Ba during chemical weathering while Eu and Tm are least mobile. Pronounced compositional variation occur at relatively shallow (0-1m) depth in near surface area all the profiles.

Keywords: In-situ weathering, tropical soils, Nigeria, mobility, soil profile, trace elements

I. INTRODUCTION

More than 70% of elements in the periodic table occur naturally in rocks, these elements ultimately become incorporated into soils through weathering. Hence, through mobilization and dispersion of elements, soils have chemistries that are much different from the parent rocks (Nesbitt, 1979; Nesbitt et al. 1980; Topp et al., 1984; Subramanian et al., 1980). However, the abundances of these elements vary significantly from one place to another as their distribution is influenced by cosmic abundances, geochemical behaviour, and environmental factors. Trace elements content of rocks are expressed in parts per million (ppm) or parts per billion (ppb) because they have abundances less than can be expressed in percentages (1% equals 10,000 ppm), as they are present only in minute amounts in any geological sample or environment. Trace element composition of tropical soils could vary in arid, semi arid and tropical domains, while average chemical composition of such soils are dependent on combination of factors ranging from parent materials, degree of weathering and climatic conditions. On the other hand, the chemistry of granite is mostly dictated by its tectonic setting, evolution and the

degree of fractionation. The role of trace element in rocks or soils far outweighs its abundances. In rocks, it could serve as useful indicators of magma source, fractional crystallization, partial melting, or magmatic evolution. In soils, it could reflect the redistribution of mobile elements during chemical weathering. A special group of trace elements are called rare earths (REEs) not because they are scarce but because they are often not concentrated in easily workable deposits. Among trace elements that are of petrogenetic significance are Ni, Co, Cr, V, Ti, Nb, Zr, Hf, P, Ba, Rb and REEs. Relatively immobile oxides such as Al₂O₃, Fe₂O₃, TiO₂, V, Co, and Cr, decrease with increasing SiO₂. Hence, a rock sample with elevated content of TiO₂ and FeO may possibly suggest the presence of titanomagnetite. According to previous research on the behaviour of immobile elements in rocks altered by hydrothermal processes in submarine volcanic ore deposits, Finlow-Bates and Stumpfl, (1981) pointed that Zr and TiO₂ proved reliable to identifying the degree of magmatic differentiation during hydrothermal alteration. Floyd and Winchester, (1978) believed some elements (Zr, TiO₂, Y, Sc, Ce and Nb) are largely immobile during alteration of volcanic rocks owing to metamorphism, hydrothermal events, and weathering. Morrison, (1978) also applied immobile trace elements to differentiate palaeotectonic affinities of basalts of Mull and Skye, in northwest Scotland. Pearce et al. (1984) equally relied on trace elements (Nb, Y, and Rb) to validate tectonic setting of basalts and has been subsequently adopted to determine tectonic setting of granites by others. In this study, trace elements content of granite suites in Ikere, Ado and Igrara-Odo Ekiti areas and the geochemical trends in their *in-situ* weathered products are investigated for compositional disparities. The study is also designed to elucidate the dynamics of chemical weathering processes in tropical environment.

II. GEOLOGICAL SETTING

Nigeria basement comprises of a complex aggregate of Archean-Early Proterozoic migmatitic-gneisses, low-grade supracrustal assemblages of Paleoproterozoic-Mesoproterozoic ages (Rahaman et al., 1983; Dada, 1998; Ekwueme and Kroner, 1993; Ferre et al., 1998) and Neoproterozoic (600 ± 150 Ma) granitoids (Fig. 1). The orogenic activities which resulted in addition of granite batholiths and plutons into the basement produced widespread

structural readjustment in older basement rocks causing folding and faulting, some equally obliterated earlier tectonic signatures. These granitoids are popularly called Older Granites to distinguish them from the Jurassic granite of ring dyke complexes in Jos Plateau area in northcentral Nigeria. Several isotopic measurements revealed 750-500 Ma (e. g., van Breemen et al. 1977; Fitches et al., 1985) age across the granite terrains in various parts of Nigeria basement. However, geochemical studies have been conducted by several authors on granite from southwestern Nigeria (e.g., Okonkwo and Folorunso, 2013), north central Nigeria (e.g., Goodenough et al., 2014), north-eastern Nigeria (e.g., Haruna, 2014), Obudu area, south-eastern Nigeria (e.g., Ephraim, 2005) among others. Ekiti area is underlain by migmatite-gneiss, schistose rocks, quartzite, granite, charnockite and pegmatite. The rocky terrain of Ekiti is made of magnificent granite outcrops stretching in a north-south direction. The topography reflects lithologic variation, the hills are granite while the low-lying areas are underlain by migmatite basement.

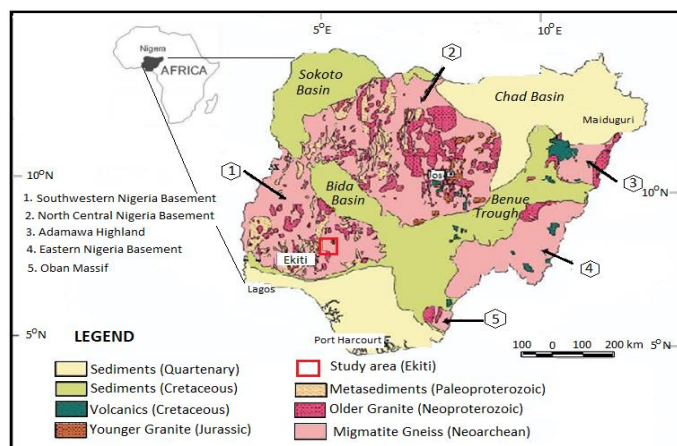


Fig. 1: Geological map of Nigeria and location of the study area (Modified after Obaje, 2009).

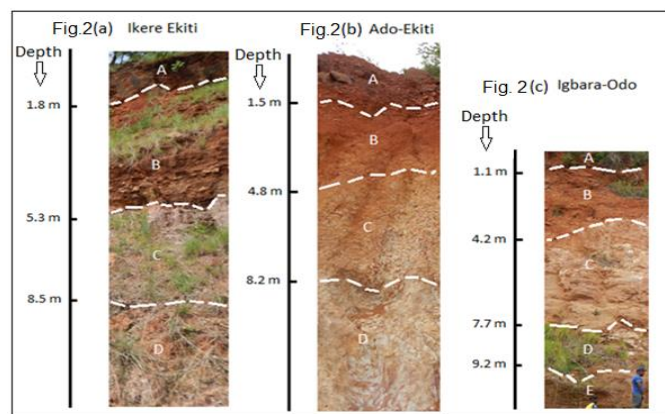


Figure 2: Variation in physical characteristics of soil profiles with depth in the study area.

III. GEOMORPHOLOGY AND DESCRIPTION OF THE SOIL PROFILES

Nigeria is located within sub-Saharan Africa; it has tropical type of climate and rocks in this domain are constantly exposed

to alternating dry and wet weather conditions. This seasonal climate change coupled with relatively high humidity produce serious effects on chemical composition of rocks. The rugged topography of the study area occasioned by several residual hills with steep slopes enhances widespread erosion, weathering, and leaching. Prolonged exposure of these masses to denudation results in low-lying areas being constantly fed with weathered rock debris while low-lying granite masses are weathered in-situ. The porous, permeable, and gritty overburden encourages infiltration of percolating fluids and leaching of some elements into basal parts of the soil profile while others are retained within surficial levels. Chamley, (1989) had earlier indicated that climate and morphology are the most significant factors affecting rate of physical and chemical weathering. Elueze and Kehinde-Phillips, (1993) believed water is a catalyst for weathering in tropical environments since chemical decomposition rarely occur without water. Chemical weathering result in formation of new set of minerals which remain stable under surficial conditions. A typical example of chemical weathering in tropical setting is the conversion of K-feldspar into clay in the presence of water. Some authors (e.g., Park and MacDiarmid, 1964; Chesworth, 1973) have noted that weathering activities in any geological environment largely depends on climate, continentality, bedrock composition and crustal stability. Soil profile in Ikere-Ekiti contains four horizons. Horizon A consists of deep-brown lateritic cap, horizon B is made of brown friable, faintly laminated layer with intercalations of cobbly particles. Horizon C contains loose whitish weathered aggregates, and horizon D is made of brownish and whitish clay rich materials (Fig. 2a). The soil profiles in Ado-Ekiti equally contain four horizons (A-D), horizon A consists of deep brown gravelly, ferruginous, and bulbous laterite. Horizon B is made of light-brown sand-sized friable gritty particles intercalated with clay materials. Horizon C has whitish brown colour with sticky and clayey aggregates. Horizon D consist of coarse-grained mixture of whitish and firm brown soil (Fig. 2b). Soil profile in Igbara-Odo Ekiti consists of five horizons, (A, B, C, D and E). Horizons A, B, and D have similar characteristics with other areas, but C horizon consists of strongly leached whitish-grey soil; horizon E consists of fractured basement making it the only location where the basement was intersected (Fig. 2c).

IV. MATERIALS AND METHOD

Twenty-nine (30) samples (ten from Ikere-Ekiti, ten from Ado-Ekiti and ten from Igbara-Odo) of weathered granite products forming soil cover over the fresh basement are collected at 1 metre vertical interval from the three soil profiles. Another thirty-one (31) samples of granites in these locations were also collected. The rock and soil samples were subjected to trace elements geochemical analysis using ICP-MS facility at the Department of Chemistry, University of Malaya, Malaysia. Samples of soil were collected by point sampling method using a hand trowel and a measuring tape. Samples were labelled appropriately and put in sample bags. Thereafter, the soil samples were kneaded using the hands to disaggregate them.

Table 1: Trace elements distribution (ppm) by depth in granite-derived soil profiles in the study area.

Ikere-Ekiti soil profile											
Depth	Sc	La	Ce	Sm	Eu	Th	Tm	Hf	Cr	Co	Ba
1.0 m	18	18	68	5.3	1.8	1.4	0.4	3.1	240	6.5	1226
2.0 m	14	19	61	5.1	1.8	1.3	0.4	2.6	315	5.1	1071
3.0 m	11	19	54	4.1	1.5	1.0	0.4	2.1	306	4.9	994
4.0 m	20	27	38	3.7	1.9	1.2	0.2	1.9	287	5.2	875
5.0 m	15	32	46	2.9	1.5	0.9	0.6	1.8	253	5.3	683
6.0 m	13	41	85	4.5	1.4	1.6	0.5	1.4	221	5.0	744
7.0 m	17	36	93	4.3	1.6	1.6	0.5	1.4	295	4.9	689
8.0 m	10	28	71	3.9	1.5	1.4	0.2	1.3	280	4.7	702
9.0 m	16	32	40	2.8	1.5	1.2	0.3	1.2	239	3.6	655
10.0m	15	28	61.9	4.0	1.5	1.3	0.4	1.8	269	4.9	850
Average	14.9	28	62	4.1	1.5	1.3	0.4	1.9	271	5.0	848.8
Ado-Ekiti soil profile											
Depth	Sc	La	Ce	Sm	Eu	Th	Tm	Hf	Cr	Co	Ba
1.0 m	15	25	61	5.4	1.7	1.2	0.3	3.8	261	6.5	1104
2.0 m	12	23	57	4.8	1.8	1.0	0.3	3.1	278	6.1	1096
3.0 m	9	35	82	5.9	1.8	0.8	0.2	2.7	300	5.9	945
4.0 m	16	31	69	3.5	1.9	0.7	0.4	2.4	324	5.2	804
5.0 m	14	44	103	6.3	1.5	1.4	0.2	2.1	279	4.8	782
6.0 m	17	56	113	4.6	1.2	1.7	0.5	1.9	250	5.0	811
7.0 m	18	48	95	5.1	1.3	1.2	0.5	1.9	208	4.3	569
8.0m	11	69	64	4.5	1.5	1.3	0.6	1.5	265	3.4	498
9.0 m	8	34	50	2.5	1.2	0.9	0.4	1.4	244	3.7	725
10 m	14	51	37	3.2	1.2	0.6	0.2	0.9	215	3.7	590
Average	13.4	41.6	73.1	4.6	1.5	1.1	0.4	2.2	225	4.9	792.4
Igbara-Odo soil profile											
Depth	Sc	La	Ce	Sm	Eu	Th	Tm	Hf	Cr	Co	Ba
1.0 m	19	20	53	7.2	1.3	1.5	0.3	4.2	247	7.1	1084
2.0 m	11	17	49	4.7	2.0	1.2	0.5	3.7	234	4.7	1049
3.0 m	10	21	87	6.5	1.7	1.3	0.5	3.1	221	4.5	1073
4.0 m	14	13	74	5.2	1.8	1.8	0.3	2.7	250	5.1	825
5.0 m	19	18	108	6.6	1.7	1.5	0.2	2.6	263	5.8	943
6.0 m	15	19	59	6.2	1.2	1.9	0.2	2.6	235	4.3	910
7.0 m	13	48	63	7.1	1.5	1.4	0.3	1.8	234	3.7	906
8.0 m	9	35	80	5.8	1.1	1.2	0.3	2.0	200	3.6	851
9.0 m	10	34	41	5.2	1.3	1.5	0.5	1.7	215	3.1	668
10 m	8	22	44	3.9	1.2	0.8	0.1	1.5	206	3.2	651
Average	12.8	25	66	5.3	1.3	1.4	0.3	2.6	231	4.5	896
Total A	13.7	31.5	67.0	4.6	1.5	1.3	0.4	2.2	242	4.8	845.7

Table 2: Trace elements distribution (ppm) in granite from the study area

Ikere-Ekiti granite												
S/No	Sc	La	Ce	Sm	Eu	Th	Tm	Hf	Cr	Co	Ba	
K1	15	75	132.3	8.1	1.9	11.3	0.3	5	231	6.8	821	
K2	10	123.8	235	22	1.4	31.4	0.3	10.8	251	6.2	478	
K3	7	92	145.7	8.84	1.8	19.3	0.4	8.2	260	5.7	1458	
K4	6	83	132.6	5.23	1.9	12.9	0.2	4.7	264	5.2	1005	
K5	7	75	387.6	16.24	2.1	51.3	0.5	12.1	265	5.2	849	
K6	3	202.4	355.2	13.7	1.1	110.1	0.3	6.9	249	5.1	392	
K7	4	109	201.8	9.26	1.6	30.7	0.3	8.9	257	4.8	948	
K8	8	125	222.3	18.18	2.2	65.8	0.6	14.1	226	4.8	818	
K9	9	185	206	21.5	3.3	31.3	0.7	16.4	242	4.3	1454	
K10	6	103	189	11.8	1.8	29.7	0.3	10.6	218	4.5	853	
Average	7	115.3	216.5	13.3	2.0	37.3	0.36	9.4	242.9	5.1	939.3	

Ado-Ekiti granite												
S/No	Sc	La	Ce	Sm	Eu	Th	Tm	Hf	Cr	Co	Ba	
D1	17	68	105	7.2	2.1	9.5	0.7	4.2	238	7.1	1584	
D2	11	127	293	17	2.5	23	0.7	7.1	245	5.9	1242	
D3	10	101	187	9.5	1.7	21.4	0.5	4.1	251	5.1	1255	
D4	4	130	240	9.2	1.8	24.8	0.3	8.7	257	5.1	816	
D5	9	65	108	6.6	2.0	10.5	0.2	4.6	263	5.1	983	
D6	3	149	259	9.2	1.7	42	0.2	7.6	239	4.7	913	
D7	3	148	263	10.1	1.5	46	0.3	9.8	234	4.2	901	
D8	3	106	280	10.8	2.1	26	0.3	8.0	192	4.6	897	
D9	4	134	221	25.2	2.3	53	0.5	11.7	221	3.5	708	
D10	8	122	264	16	3.2	24	0.5	7.5	211	3.2	651	
Average	7.2	115	220	12.1	2.1	28	0.42	7.3	235.1	4.9	995	

Igbara-Odo granite												
S/No	Sc	La	Ce	Sm	Eu	Th	Tm	Hf	Cr	Co	Ba	
G1	11	38	100	8.4	1.8	8.5	0.7	6.2	205	9.4	1457	
G2	11	106	245	17	1.9	19	0.7	5.7	233	5.6	1208	
G3	9	95	188	8.6	1.5	20.8	0.7	4.5	247	6.1	1311	
G4	6	113	236	10.0	1.8	21.2	0.7	6.8	261	6.4	841	
G5	6	71	104	9.1	2.3	16.4	0.9	4.6	227	6.4	885	
G6	4	130	256	10.5	1.7	38	0.6	5.4	259	5.7	870	
G7	5	111	271	12.9	1.7	41	0.4	8.3	230	5.8	833	
G8	3	129	254	11.4	2.4	30	0.4	8.0	186	4.1	869	
G9	5	124	230	19.8	2.1	48	0.5	10.4	209	4.2	712	
G10	13	97	249	17.2	3.5	27	0.6	8.5	222	4.4	590	
Average	7.3	101.4	213.3	12.5	2.1	27	0.62	6.8	227.9	5.2	957.6	

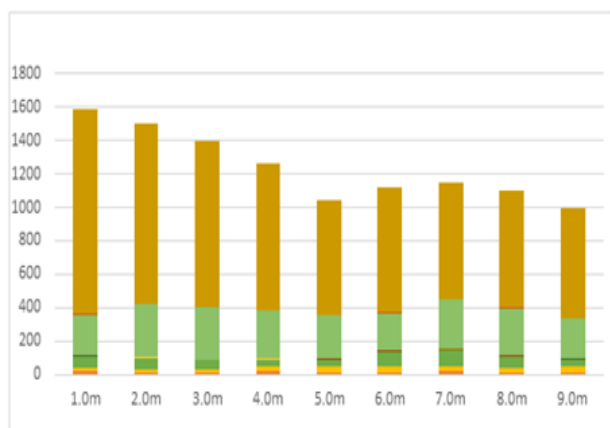


Fig. 3a: Trace element composition of soils in Ikere-Ekiti (Vertical axis (ppm))

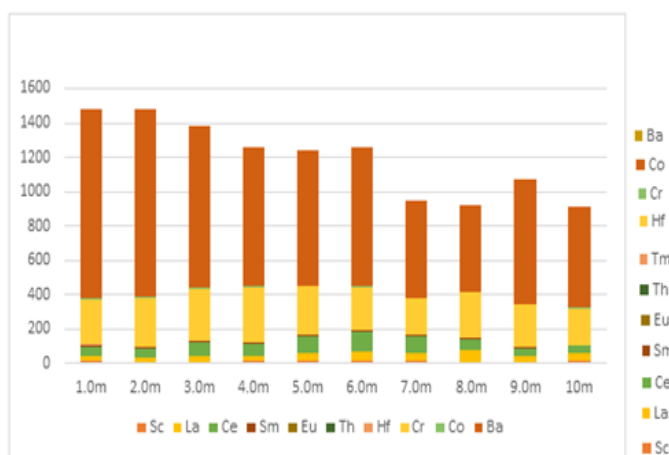


Fig. 3b: Trace element composition of soils in Ado-Ekiti (Vertical axis (ppm))

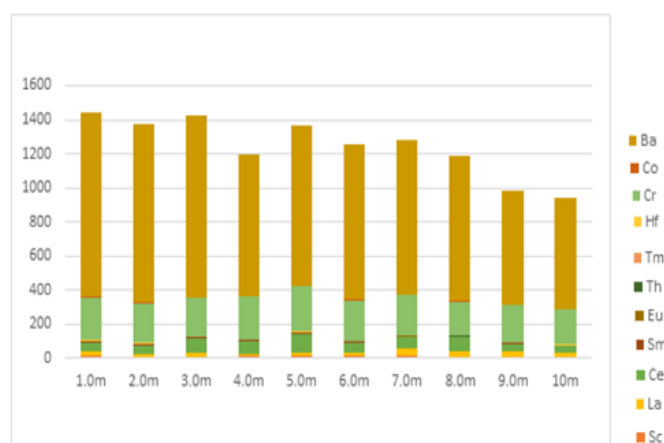


Fig. 3c: Trace element composition of soils in Igbara-Odo-Ekiti (Vertical axis ppm)

The samples were allowed to dry for two weeks at room temperature in the laboratory before they were pulverized. The rock samples were reduced by sample splitter using a jaw crusher before they were pulverized in a Tema Mill. The powdered rock and weathered samples were digested and then introduced to the torch of ICP-MS machine for trace element composition.

V. RESULTS

Analytical results of soil profiles derived from *in-situ* weathering of granite in the study area is presented (Table 1) while the source granitic rocks are presented in Table 2.

VI. INTERPRETATION OF RESULTS

6.1 Geochemical Trends in the soil profiles

The composition of residual soils in tropical regions as depicted by the three profiles in different localities within the study area reflect some similarities. Despite the resemblances, there are marked variations in thicknesses, colour, and other physical parameters. The distribution of trace elements varies considerably with depth in all the localities. Nevertheless, a consistent but systematic variation exists in trace element components between the chemistries of the precursor granite units and their respective soil profiles. In the soil profiles, Sc content ranges between 10-20 ppm in Ikere-Ekiti soils, while the profile in Ado-Ekiti records values which range between 8-18 ppm and Igbara-Odo records 8-19 ppm. The concentration of Sc in the soil profiles from the study area falls within the value (16 ppm) quoted for the crust (Taylor, 1962). Similarly, the range of values for La (18~41 ppm), Ce (38~93 ppm) and Sm (2.9~5.3 ppm) in Ikere-Ekiti soil are distributed like La (23~69 ppm), Ce (37~113 ppm) and Sm (2.5~6.3 ppm) in Ado-Ekiti soils and 13~48 ppm, 41~108 ppm and 3.9~7.2 ppm respectively in Igbara-Odo soil. All these values and their averages La (30 ppm), Ce (60 ppm) Sm (6 ppm) are within acceptable limits for the crust (Table 4). Similarity exists in the range and spread of these abundances for instance while La and Ce values vary within wide range, Sm vary within close range in all the areas (Table 1). Eu contents in the three soil profiles

show higher concentration in upper part of the profile while lower Eu values are recorded at greater depths (Table 1). Th (0.9~1.9 ppm), Tm (0.2~0.6 ppm) and Hf (1.2~3.1 ppm) in Ikere-Ekiti soil is marginally different from Th (0.6~1.7 ppm), Tm (0.2~0.6 ppm) and Hf (0.9~3.8 ppm) recorded for Ado-Ekiti soil, and 0.8~1.9 ppm, 0.1~0.5 ppm and 1.5~4.2 ppm respectively in Igbara-Odo soil. Even though, average Th contents in all the soil profiles in the study area is lower than the average crust (10 ppm), Tm and Hf concentrations are within average (Tm, 0.48 ppm and Hf, 3.0 ppm) for the crust. Co contents of Ikere-Ekiti soil (3.6~6.5 ppm) which have higher values concentrated near the surface is like Co content which range between 3.7~6.5 ppm in Ado-Ekiti soil; this is equally reflected in Co contents of Igbara-Odo soil. However, both Cr (221~315 ppm) and Ba (655~1226 ppm) in Ikere-Ekiti soil are comparable to Cr (215~324 ppm) and Ba (509~1104 ppm) in Ado-Ekiti; It is equally comparable to Cr (199~263 ppm), and Ba (651~1084 ppm) contents in Igbara-Odo soil (Fig. 3a-c). The similarity in these soils also extend to Ba contents being the highest among trace elements considered for all the areas. The similar trends depict a downward reduction in values. The distribution of these trace elements reflects those tropical soils in the study area exhibits similar dispersion for certain elements. This implies the soil horizons are likely lateral equivalents in these areas. This agrees with Ronov et al. (1967) who suggested that certain trace elements despite similarity in their dispersion patterns, their distribution still exercise slight variation in sedimentary circles.

6.2 Geochemistry of the granite

Even though granites are generally siliceous and leucocratic in nature; however, granite composition could vary within certain acceptable limits. Major elements composition (especially SiO₂) could depend on protolith, style of evolution, degree of fractionation or tectonic setting. Similarly, their trace element composition depends on several factors ranging from magmatic evolution and geochemical environment. Trace elements composition of granite from Ikere-Ekiti, Ado-Ekiti and Igbara-Odo also show many significant attributes that suggest they are geologically similar (Fig. 4a-c), (Table 2). Like most granites in the basement

complex of Nigeria, Ba contents are higher than other trace elements. In Ikere-Ekiti granite, Ba contents (651~1584 ppm) are marginally higher than Ado-Ekiti granite (478~1458 ppm) and Igbara-Odo granite (651~1084 ppm). The anomalously high Ba values reflects its lithophilic properties and are thus expected to be high in rocks of the earth's crust, especially granite. Chromium, Ce and La have abundances of 192~263 ppm, 105~293 ppm and 65~149 ppm respectively in Ikere-Ekiti granite. Similarly, these three elements have abundances of 209~265 ppm, 132.3~387 ppm and 75~202 ppm respectively in Ado-Ekiti granite. Equally, Igbara-Odo granite have 186~261 ppm, 100~271 ppm and 38~130 ppm, respectively. Generally, average La contents in granites from the study area (110.6ppm) is lower than Idanre Granite Complex (161.5 ppm) but higher than average granite (25 ppm) and crust (30 ppm) (Taylor, 1962). The disparity between trace elements

composition of granite from the study area and the Idanre Granite Complex (Akinola, 2020) is indicative of elemental redistribution. Compositionally, high Cr contents (up to 25%) are usually associated with chromite deposit, the presence of trace of Cr in rocks containing non-chromite deposits may have resulted from substitution of element having similar ionic radii and valence as Cr^{+3} such as U^{+3} . Ce (Z = 58) has similar electronic property with Th (Z = 90), and Th being radioactive is more abundant in silicic rocks like granite than in basic rocks like basalt. Thus, a high Ce content in the granite may have resulted from replacement of Th. La (Z = 57) in ionic form exists as La^{+3} , it belongs to same group as Sc, Y and Ac and can thus replace other elements with similar ionic radii and valence. Eu, Tm and Hf contents of the granites are lower than other trace elements (Table 2). The average of these elements in Ikere-Ekiti granite are Eu 2.0 ppm, Tm 0.36 ppm, and Hf 9.4 ppm, respectively. In the same order, these elements have average abundances of 2.1 ppm, 0.42 ppm and 7.3 ppm in Ado-Ekiti granite, and 2.1 ppm, 0.62 ppm and 6.8 ppm respectively in Igbara-Odo-granite. The similarities in the abundance of the first two elements may be related to their inclusion in REE group, while Hf belongs to the group having large ionic valences (or high charges) such as Zr, and Nb. Hf and Zr always behave in a similar way in most magmatic system.

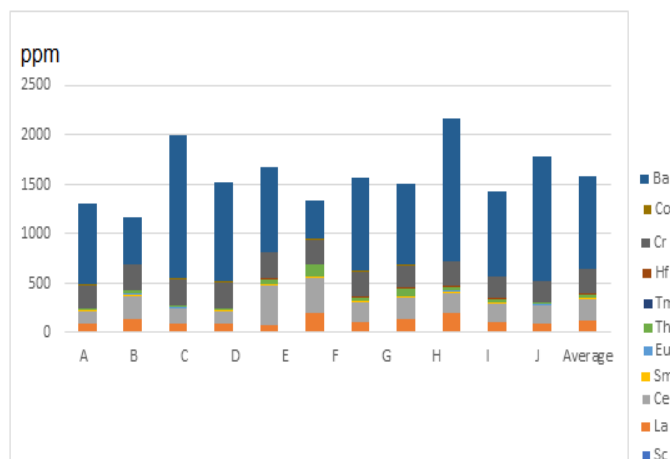


Fig. 4a: Trace element composition of the granite in Ikere-Ekiti.

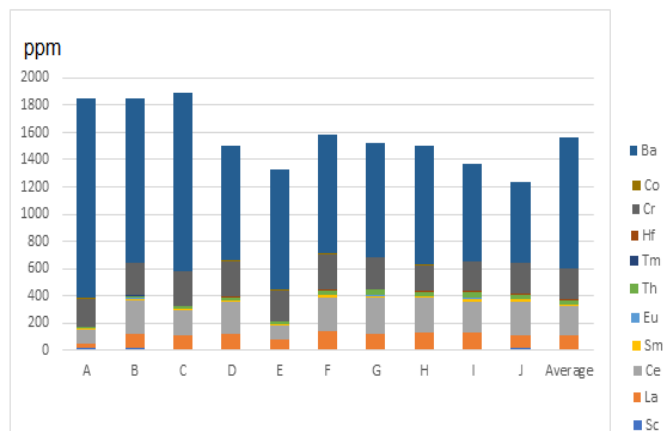


Fig. 4b: Trace element composition of the granite in Ado-Ekiti

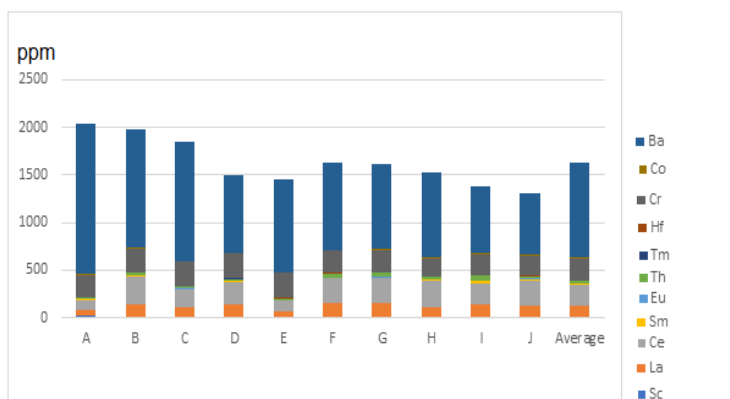


Fig. 4c: Trace element composition of the granite in Igbara-Odo

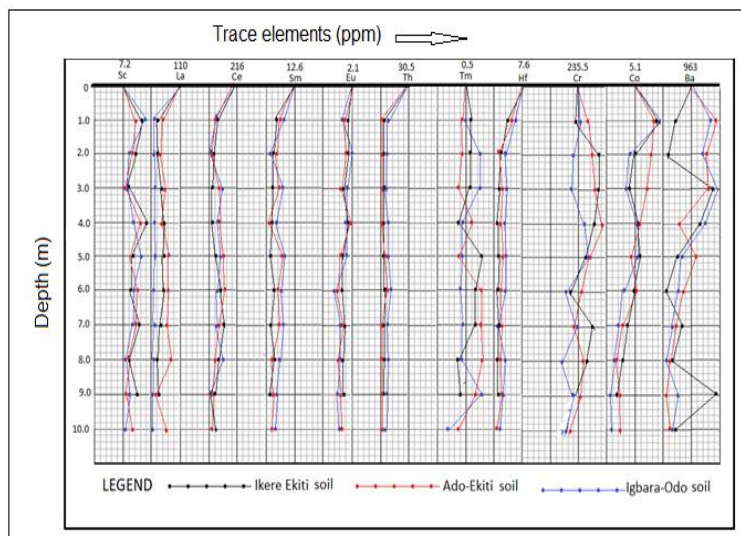


Fig. 5: Variation in average trace composition of the granite and soil profiles at various depths

6.3 Relationship between granite chemistry and their soil profiles

The trace elements composition of granite units from the study area clearly points them as lateral equivalents. However, granite chemistries were based on analysis of outcrop samples while soil samples chemistries are tied to specific depths within each profile (Fig. 5). Average trace composition in each soil profile is compared to average granite chemistries of the study area to determine trace elements that show enrichment and those that are depleted during chemical weathering. Overall average of each trace element in the granite is put as a number on horizontal axis at the top of vertical lines, a deflection to the left of the vertical line indicates a reduction in value, while a deflection to the right of it represents enhancement in trace element values. Dispersion is depicted as the degree of swing to the left or right of the central vertical line. Maximum scattering of points occurs in Ba, followed by Cr, Co, Tm and Sc, while the anomaly is less pronounced in Eu, Ce, and Th. Dispersion of elements as depicted in the different depths of the soil profiles reveals that the mobility of Hf, Th, Eu, and Ce varies along narrow limits. All of which indicates that the

values in soil profile are conspicuously less than those of the source granite because these elements go into solution during chemical decomposition. The pattern of dispersion in Sc and Tm looks alike. However, substantial part of the profile depth contains soil elements that are characteristically higher than those for average granite in the area. According to the scatter diagram (Fig. 5), Ba, Co, and Cr deflects

marginally from the average granite compositions around the middle of the soil profiles. This means the dispersion pattern of the elements in the soil profiles is closer to the precursor granite rocks near surficial areas.

VII. CONCLUSION

This study reveals that the granite show low Tm, Eu, Co, Sc, Hf, Sm, and Th contents, while La, Ce, Cr, and Ba have higher contents. All the soils have Sm, Eu, Th, Hf and Co contents below 10 ppm. Sc, La and Ce values fall between 10-100 ppm while Cr and Ba content falls between 200-1500 ppm. Variation between trace contents in granite and the overlying soils which resulted from insitu weathering show systematic patterns of distribution along depths of the profile. Th, Sc and Ba during chemical weathering of these granitoids show greater dispersion, while Eu and Tm are less mobile. Pronounced compositional variation occur at relatively shallow depth (0-1m) in all the profiles while some consistencies occurs between 1-2m and 7-8m depth.

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