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Slope-soil relationships on an Aberrant Toposequence in Ife area of South Western Nigeria: Variabilities in soil properties

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Abstract

Soils located on the upper-slope segment of a toposequence were studied to observe their properites and evaluate the slope-soil variabilities thereof. In addition, the soils were classified. This toposequence has no middle-slope soils that normally occupy physiographic units between those soils formed in upper slope in-situ materials and Gambari series (Smyth and Montgomery, 1962). The soils studied occupy summit but crestal position (FBl), the lower crestal position (FB2), and the physiographically slightly sloping lower upper-slope segment (FB3, FB4 and FB6) of the landscape. They are located on 2%, 5%, 3%, 2.5% and 3% slopes respectively.

All the soils belong to Iwo series with the greatest soil morphological variabilities expressed in the BC, and in C horizons. Typically, the surface horizons (0-30cm) range from dark yellowish brown (10 YR 3/4 .or 4/4 to dark brown (7.5 YR 5/8). A typical B horizon is strong brown (7.5 YR 5/8) with a depath range of 35–95cm. Soil physical and chemical properties mostly show statistically insignificant differences between soils located on different physiographic/slope positions. However, there are significant differences in chroma between FB3, FB4 profiles and others. Significant differences exist between some of the soil profiles for their silt content. Soils are mostly in the strongly acid to extremely acid range. Exchangeable Mg is the least variable (C.V. of 9.1%) of the exchangeable cations. These soils are classified as Paleustults in the USDA system with an equivalent of Ferric Acrisols and Ferric Lixisols in the FAO-Unesco system.

Introduction

Slope-soil relationship on a landscape has been the cornerstone of pedological investigations into soil types of any geographic area. In South Western Nigeria, particularly on soils formed in the basement complex (Precambrian) materials, different soil types have been associated with different parts of the landscape (Nye, 1954; Smyth and Montgomery, 1962).

Iwo series is the focus of this study and is one of the major soil series in central western Nigeria (Smyth and Montgomery, 1962). It is the most dominant series within Iwo Associaton soils. Iwo series is defined as formed from granitic rock materials. According to Smyth and Montgomery, Iwo series as a mapping unit may be confused with either Olorunda and/or Ondo series. Distinguishing characteristics for Iwo series as enumerated by these authors consist of the following: In shallow pits (i.e. < 4 feet or 121cm), it has (a) coarse sand fractions, (b) greyer colours and (c) common feldspar fragments; in deep pits (i.e. > 4 feet or 121cm), Iwo series has (a) absence or poor development of mottled clay and (b) presence of weathered or even fresh rock within 8 feet (i.e. 244cm). The difficulty in practical applications of the series description of Smyth and Montgomery (1962) has been described by many field workers. Ojanuga (1975) attributed this difficulty to the subjectivity of the profile descriptions as given by Smyth and Montgomery. He enumerated some morphological criteria that could help in field identification of the different series. These are –

(a) the kind and arrangement of soil horizons
(b) soil colour below 25cm depth designated by standard Munsell notation
(c) soil texture below 25cm depth but within 100cm from the soil surface.
(d) soil structure
(e) depth of solum and depth to bedrock.

Based on the above criteria, Ojanuga (1975) described Iwo series as comprising of well-structured, strong brown (7.5 YR 5/6) to reddish brown (5 YR 3/4 – 4/6) soils possessing gravelly sand clay loam to sandy clay texture within the upper horizons and having visible feldspar and /or unaltered muscovite flakes within a depth of 150cm

The problem with the latter description is the inability to be able to identify individual soil series on a routine soil survey work without having to expend energy going to greater depth of 125 cm or 150 cm. This is more important in developing countries such as Nigeria where power probes are currently not used for routine pedological investigations.

The objective of this study is to present soils perceived and identified as Iwo series and thereby bring out the qualitative and quantitative variations possible within this series found on a very short segment but different aspects of the landscape. Classification according to both USDA (Soil Survey Staff, 1975) and FAO/UNESCO (1985) systems are given.

Materials and Methods

Site Selection and Environmental Factors: The study site (Fig. 1) was a selected landscape on the Teaching and Research Farm of the University of Ife and Ife is on 7.33N, 4.3E. The toposequence is considered unusual because it does not contain the midslope or hill-wash soils (e.g. Oba, Iregun and/or Apomu) typical of all ideal toposequence or Association soils of central western Nigeria (Smyth and Montgomery, 1962; Ojanuga 1975; and Ojanuga et al. 1976). Climate is humid tropical with bimodal rainfall extending from March to October. Average annual rainfall is about 1400mm with annual average temperature of 27° C. Five profile pits were escavated, studiesd and sampled (Fig. 1).

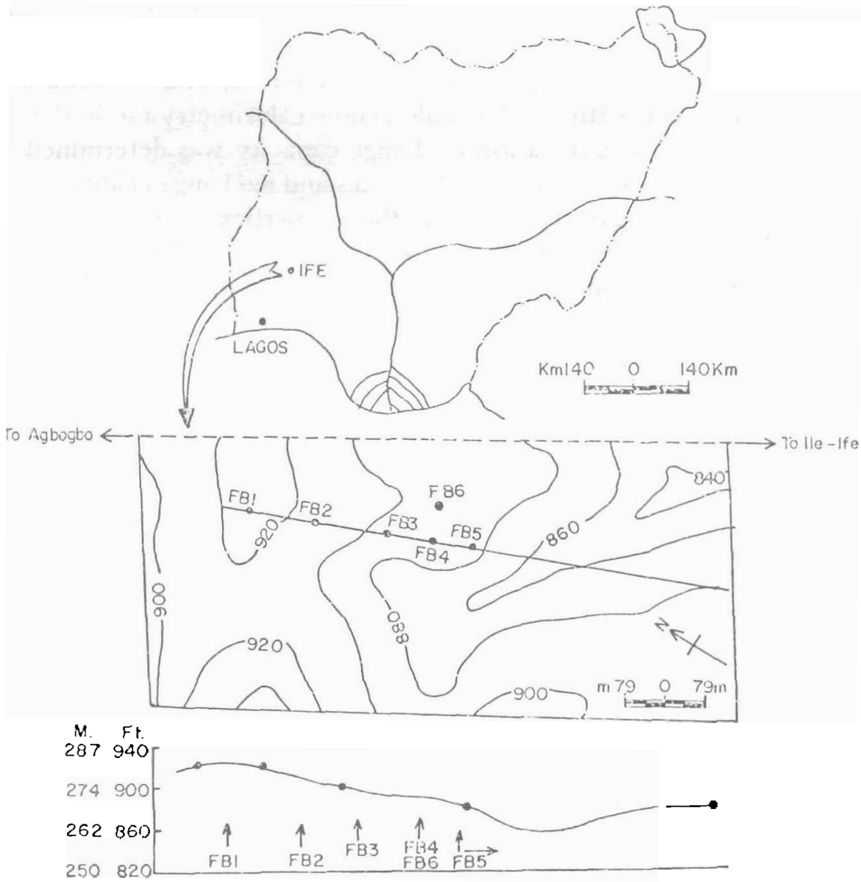

Fig. 1: Diagrams indicating sample sites and site-landscape relationship.

The pits will be referred to as FB1, FB2, FB3, FB4 and FB6. They were located on 2%, 5%, 3%, 2.5% and 3% slopes respectively all formed in granitic rocks. FB1 and FB2 were under bush regrowth and grass alley respectively while FB3, FB4 and FB6 were under citrus trees of about seventeen years old. FB6 was located some 80 metres away from FB4 where the influence of water-table would have been deeper. Their profile morphologies are described (Table 1) using the horizon nomenclature of Guthrie and Witty (1982).

Laboratory analyses: The soil samples taken were air-dried, crushed and passed trough a 2mm sieve. All laboratory analyses were on less than 2mm soil fraction. Particle size analysis was according to the hydrometer method of Bouyoucos (1962). Soil pH was determined in both water and in KC1 at 1:1 soil: solution ratio using a glass electrode pH meter (Kent 7020). Exchange acidity was determined by the fluoride titration method (Yuan, 1959). Exchangeable bases, viz: Ca, Na and K were determined with flame photometer whereas exchangeable Mg was determined with the Thiazole yellow calorimetry method using spectronic 20. Effective cation exchange capacity was determined by adding the components, exchangeable bases and exchange acidity.

To be able to quantify some of the properties, certain statistical summary measures such as the mean, range, standard deviation and coefficient of variation were computed. In addition a few hypotheses were tested using t test. This is a preliminary study to support conclusions derived from both the field and laboratory analyses.

TABLE 1: MORPHOLOGY OF SOIL PROFILES STUDIED

Depth	Horizon	COLOUR Matrix	COLOUR Others	Texture	Structure	Consistence	Inclusions	Roots	Boundary	Others
					FB1					
0–17	A	10 YR 4/4	–	sligrsl	2 f cr	m fr		ma m	c s	
17–31	AB	10 YR 4/6	–	grscl	2 m(co) sbk	m fr	sph conc	ma m f	ds	–
31–64	Bw	7.5 YR 5/8	–	grscl	2 m s b k	m fr	occ ang conc	occ f	cs	–
64–110	BC	10 YR 5/8	5 YR 3/6	grsc	2 m s b k	m fr	„ „	occ f	cs	common musc.
110–159	CI	10 YR 6/8	5YR 3/6	grc	massive	m fr	abt conc nod	occ f	cs	common musc.
159–180	Cr	10 YR 3/6	10 YR 5/6	grscl	massive	–	–	none	–	many musc.
					FB2					
0–22	A	7.5 YR 4/3	–	sligrsc	2 m(f) cr	m fr			dw	
22–40	BA	7.5 YR 5/8	–	grsc	2 m(f) sbk	m fr	occ ang ro nod	ma f m	cs	–
40–66	Bw	5 YR 5/8	–	grc	2 m(f) sbk	m fr	–	ma f m	–	common musc.
66–88	BC	5 YR 4/8	–	grc	1 m sbk	m fr	–	occ f	cs	–
88–156	C	10 YR 6/8	2.5 YR 3/6	grscl	2 m sbk	–	–	none	–	–
					FB3					
0–15	Ap	7.5 YR 4/2	-	grsl	2 f(m)cr	m fr	–	ma f m	s	–
15–26	E	7.5 YR 5/4	–	sligrscl	2 f(m)cr	m fr	–	ma m	cw	–
26–49	BE	7.5 YR 4/3		v gr sc	2 m(f)sbk	mfr	abt nod	occ f m	ds	–
49–92	Bt	7.5 YR 4/3	–	grc	2 m(f) sbk	m fr	abt nod	occ f m	ds	–
92–120	BCt	7.5 YR 6/8	7.5 YR 5/4	grc	2 m sbk	m fr	nod black	occ f	ds	few musc.
120–200	C	7.5 YR 6/8	7.5 YR 5/4	grc	massive	m fr		–		–
					FB4					
0–15	A	5 YR 3/3	-	sligrsl	2 f(m)cr	m fr	–	c f m	gs	
15–26	E	10 YR 5/3	-	grsl	2 f sbk	m fr	–	occ f m	cs	
26–35	BEt	7.5 YR 4/3	-	v grc	2 m sbk	m fr	abt ro nod	occ f m	cs	
35–95	BCt	7.5 YR 6/6	-	grsl	3 m sbk	m v fr	–	occ f	cs	common cutans
95–140	C1	7.5 YR 6/6	-	grc	2 m sbk	m fi	–	–	ds	–
140–180	C2	7.5 YR 6/8	7.5 YR 5/4	grc	2 m sbk	m fr	occ ro nod			common musc.
					FB6					
0–13	A	10 YR 3/4	–	sligrsl	2 m(f)cr	m fr		ma f m co	cw	
13–25	E	10 YR 4/6	-	grsl	3 m(f) cr	m fr		c f m	cs	
25–59	B	7.5 YR 5/8	-	v grc	3 m(f) sbk	m fr	occ conc	occ f	cs	
59–99	Bt	7.5 YR 5/8	–	grc	3 m sbk	m fr		occ f	ds	common cutans
99–136	BC	5 YR 5/8	2.5 YR 4/8	grc	3 m(f) sbk	m fi		occ f	cs	few cutans
136–175	C	5 YR 5/8	2.5 YR 4/8 10 YR 7/8	grc	1 m(f) sbk	m fi		occ f		common musc.

Abbreviations Texture. sli = slightly, v = very, gr = gravelly, s = sand c = clay, l = loam; *Structure:* 1 = weak, 2 = moderate, 3 = strong, f = fine, m = medium, co = corase, cr = crumb, sbk = subangular blocky; *Consistence:* m = moist, fr = friable, fi = firm; *Other Symbols.* sph = spherical, conc = concretion, nod = nodule, ang = angular, occ = occasional, abt = abundance, ro = round ma = many, c = clear, s = smooth, d = diffuse, g = gradual, w = wavy, musc = muscovite.

Results and Discussion

Soil Morphology: Profile features of profile .FB5 is not included in this report. It belongs to Gambari series (Lithic Dystropepts, Ojanuga *et al.* (1976), the soil with shallow petrophlinthite at 50 cm to the soil surface. This series is the cut-off point between soils of the upper/ midslope areas and those of valley bottom.

All the soil's have well-developed horizons (A–B-C-) (Table 1) even though this developent is relative. Profiles FB1 and FB2 had saprolites with a stronger expression of the parent rock structure than other profiles studied. These two profiles occupy the summit (crest) and lower summit positions respectively. Profiles FB3, FB4 and FB6 are on a lower position even though these sites may be considered as a lower upper-slope sites, because they are all formed in-situ and different from those formed in hill wash materials (middle-slope soils).

The toposequence under study is considered unique in that there are no middle-slope soils (i.e. Apomu, Iregun and Oba series) between these soils formed in the upper slope segment and Gambari series. Gambari series terminates the series of well-drained tc moderately well-drained soils before descending into valley-bottom of the landscape that co-pletes the toposequence series of soils. The sequence under study is adjacent to a "dry" basin-like (about half hectare) depression. The valley system can presently be described as dry.

For all soils the surface horizons (average of 0-30cm) range in colour from dark yellowish brown (10 YR 3/4 or 4/4) to dark brown (typically 7.5 YR 4/2 – 4/3). The soil profile with 5 YR 3/3 colour could be due to low organic matter content or be an eroded phase. The latter condition can be observed in a cultivated field.

B horizons exhibit more variability than observed in A and E horizons (or surface horizons). A typical B horizon will be strong brown (7.5 YR 5/8). This is exhibited in the profile descriptions of FB1, FB6 and to some extent by FB3. The yellowish red (5 YR 5/8) of FB2 is probably due to parent rock influence. Profiles FB3 and FB4 show some evidence of past wet environment. Their lower B horizons, i.e. BCt horizons have reddish yellow (7.5 YR 6/6 – 6/8) colours at a depth rang of about 35–95cm (Table 1). Reddish yellow colour is shallower for FB4 because it is slightly lower on the landscape and therefore must have come under stronger influence of a higher water-table which in the past occupied the now "dry" basin described earlier.

The variability described for the lower B horizons (transitional BC horizons) is even more marked in the C horizons. Profiles FB3 and FB4 demonstrate brighter mottled C horizons than observed for other soil profiles that are far removed from the historically wet depression either because of the topographically higher elevations (FB1 and FB2) or distance factor (FB6). Observations made are that typical colours for the C horizons will include brownish yellow (10 YR 6/8) in the upper slope crestal positions and yellowish red in lower positions (5 YR 4/8 5/8) probably because of its almost level physiographic position and the poor internal drainage at the time of peak recharge of soil water. These colours can be considered as relict features of a wetter past. This hypothesis is strengthened by the presence of Gambari series that occupy a slightly lower position that is synonymous to the edge of a wet valley-bottom where water-table once fluctuated highly in the soil profile. The petroplinthite is as a result of iron accumulation through years of fluctuating groundwater table. It has hardened into an iron-pan since the valley went dry because of a regional drop in ground-water table.

The colours observed are at variance with the diagnostic colours as put out by Smyth and Montgomery (1962). Major colour differences are the absence of greyish colour of surface horizons and the presence of yellowness of the subsoil horizons in these soils compared to those described by Smyth and Montgomery.

Observations from profiles described here correlate well with those made by Ojanuga (1975) except that this study discounted feldspars because of their advanced weathering stage. But more importantly the parent rock materials as deduced from the saprolite and the common occurence of muscovite mica have been the diagnostic properties of Iwo series of this study.

Statistical inferences (Table 3) tend to support the differences and formation history postulated above. The hues and values are not significantly different at all plausible probability levels. There are significant differences in chroma between FB1 vs FB3 and FB4; FB2 vs FB3 and FB4; FB3 vs Fb6; and FB4 vs FB6 (Table 3). This supports the earlier hypotheses on the genetic formation of FB3 and FB4 as having been strongly influenced for long period by high groundwater table.

TABLE 3. STATISTICAL TEST ON SOIL COLOUR AND PARTICLE SIZE DISTRIBUTION OF STUDIED PROFILES

		HUE	VALUE	CHROMA	>2mm	SAND	SILT	CLAY
		FB1		**VS**	**OTHERS**			
FB2	T	0.46	0.52	0.29	0.03	0.36	1.82[a]	0.76
	DF	9	9	9	9	9	9	9
	P	0.657	0.618	0.781	0.974	0.725	0.102	0.464
FB3	T	0.25	0.57	1.57[a]	0.74	0.59	1.50[a]	0.86
	DF	10	10	10	10	10	10	10
	P	0.804	0.583	0.147	0.474	0.568	0.166	0.409
FB4	T	0.24	0.75	1.67[a]	0.13	0.22	0.34	0.21
	DF	10	10	10	10	10	10	10
	PF	0.817	0.473	0.126	0.898	0.830	0.739	0.840
FB6	T	0.22	0.31	0.35	0.02	0.52	1.00	0.25
	DF	10	10	10	10	10	10	10
	P	0.828	0.765	0.734	0.982	0.613	0.341	0.805
		FB2		**VS**	**OTHERS**			
FB3	T	0.59	0.06	1.55[a]	0.58	0.25	0.54	0.18
	DF	9	9	9	9	9	9	9
	P	0.568	0.954	0.155	0.579	0.807	0.602	0.860
FB4	T	0.45	0.30	1.64[a]	0.08	0.50	2.71[d]	0.82
	DF	9	9	9	9	9	9	9
	P	0.662	0.770	0.135	0.937	0.629	0.024	0.431
FB6	T	0.38	0.93	0.0	0.05	0.17	3.32[d]	0.43
	DF	9	9	9	9	9	9	9
	P	0.713	0.375	1.000	0.964	0.869	0.009	0.676
		FB3		**VS**	**OTHERS**			
FB4	T	0.0	0.25	0.12	0.49	0.71	1.78[a]	0.94
	DF	10	10	10	10	10	10	10
	P	1.000	0.804	0.907	0.632	0.496	0.105	0.371
FB6	T	0.0	0.96	1.82[b]	0.65	0.09	2.90[d]	0.57
	DF	10	10	10	10	10	10	10
	P	1.000	0.360	0.099	0.531	0.928	0.016	0.578
		FB4		**VS**	**FB6**			
FB6	T	0.0	1.08	1.96[b]	0.13	0.65	1.69[a]	0.41
	DF	10	10	10	10	10	10	10
	P	1.000	0.304	0.079	0.898	0.531	0.121	0.693

Level of Significance: a = at 10%; b = at 5%; c = at 2.5%;
d = at 1%

T = sample t value; DF = Degrees of Freedom; P = Probability

Particle Size Distrubtion: There is no significant variablility in soil texture between the five profiles studied indicating lack of lateral movement dowslope. Surface horizons are mostly gravelly sandy loam, whereas subsoil horizons are gravelly sandy clay or gravelly clay. Sesquioxidic concretions and quartz materials are dominant in the gravelly horizons. This is unique for all Iwo series soils studied. A biogenetic process, has been hypothesized to be responsible for the gravelly horizons of those soils fromed in residual Pre-Cambrian rock materials (Harpstead 1974; Nye 1954; Ollier 1959; Smyth and Montgomery 1962). Muscovite mica flakes occur mostly in the transitional horizons (i.e. BC horizons). Materials that are greater than 2mm size fraction exhibit a large C.V. similar to that shown by the clay fractions

Clay skins are dominating in the three profiles occupying the lower upper slope position (i.e. FB3, FB4 and FB6) whereas they are not easily observable in those of profiles FB1 and FB2. The latter profiles probably show greater resistance to deeper profile maturation than hitherto observed for profiles FB3, FB4 and FB6 because of the quartz vein content, especially in FB1. It is however going to be accepted that profiles FB1 and FB2 also have illuvial (Bt) horizons based on evidence contained in particle size distribution data (Table 2). The clay fraction distribution suggests argillic horizons for all profiles under consideration.

Significant differences are observed in the amount of silt fractions of FB1 vs FB2 and FB3; FB2 vs FB4 and FB6; FB3 vs FB4 and FB6. Silt fractions in soils of the tropical region formed in Pre-Cambrian materials have usually been low and so these significant differences may conveniently be ignored for practical purposes.

TABLE 2: PHYSICAL AND CHEMICAL PROPERTIES OF PROFILES STUDIED

Depth (cm)	Hue*	Colour Matrix Value	Chroma	% >2mm	Sand	Silt	Clay	pH (1:1) H_2O	Ca	Mg	Na	Meq/100g Soil K	Al	H	ECEC	ECEC Meq/100g Clay	Base Satn (ECEC)	% Al Satn (ECEC)	O.C.
										FB1									
0–17	10	4	4	16.4	73	9	18	5.1	6.8	.35	.21	.59	.113	.055	8.12	45.11	97.9	1.4	1.29
17–31	10	4	6	30.7	71	7	22	4.9	6.9	.34	.19	.46	.170	.166	8.23	37.41	95.9	2.1	1.09
31–64	7.5	5	8	45.1	49	7	44	4.5	1.9	.28	.07	.44	.400	.389	3.48	7.90	75.6	11.5	.59
64–110	10	5	8	35.6	49	5	46	4.4	1.9	.34	.10	.45	.339	.309	3.44	7.47	79.3	9.8	.98
110–159	10	6	8	26.8	41	7	52	4.4	0.6	.32	.02	.38	.678	.050	2.25	4.33	64.5	33.1	.78
159–180	10	3	6	23.9	53	17	30	4.9	0.6	.34	.02	.34	.509	.443	2.25	7.50	57.7	22.6	.59
MEAN	9.6	4.5	7	31.4	56	9	35	4.7	3.1	.33	.10	.44	.37	.235	4.63	ND	78.5	13.4	.89
ST. DEV.	1.0	1.05	2	9.6	13	4	14	0.3	3.0	.03	.08	.09	.21	.170	2.80	ND	16.2	12.3	.28
C. V. (%)	10.9	23.29	24	30.5	23	49	39	6.5	94.6	7.93	80.39	19.19	57.34	72.34	60.50	ND	20.1	92.0	31.91
										FB2									
0–22	7.5	4	3	10.6	75	5	20	5.4	5.2	.33	.14	.54	.113	.083	6.41	32.05	96.7	1.8	1.37
22–40	7.5	5	8	45.0	55	5	40	4.7	4.1	.29	.12	.42	.367	.329	5.63	14.08	87.6	6.5	1.09
40–66	5	5	8	45.5	41	3	56	4.7	1.5	.27	.04	.46	.678	.638	3.59	6.41	63.3	18.9	.90
66–88	5	4	8	31.7	39	5	56	4.9	1.1	.30	.03	.40	.622	610	3.21	5.73	61.6	19.1	.90
88 – 156	10	6	8	25.5	55	7	38	5.0	4.0	.30	.10	.42	.452	.400	5.73	15,08	85.0	7.9	.86
MEAN	7.0	4.8	7.00	31.7	53	5	42	4.8	3.2	.30	.10	.45	.446	412	4.91	ND	78.8	10.8	1.02
ST. DEV.	2.1	.84	2.24	14.6	14	1	15	0.3	1.8	.02	.06	.06	.225	.227	1.42	ND	15.6	7.8	.21
C. V. (%)	29.9	17.44	31.94	46.1	27	28	36	5.8	56.1	7.38	60.20	12.5	50.45	55.10	28.92	ND	19.8	71.8	20.80
										FB3									
0–15	7.5	4	2	23.4	77	7	16	5.4	1.6	.34	.05	.56	.079	.005	.63	0.19	96.8	3.0	1.37
15–26	7.5	5	4	16.9	71	7	22	5.2	3.7	.28	.10	.56	.102	.100	4.75	21.59	97.6	2.1	1.52
26–49	7.5	4	3	56.2	49	5	46	5.2	5.7	.31	.14	.40	40	.026	6.75	14.67	97.1	2.5	1.17
49–92	7.5	4	3	48.3	41	3	56	5.0	1.2	.28	.05	.40	.367	.049	2.55	4.55	75.8	14.4	.98
92–120	7.5	6	8	42.9	35	3	62	5.0	6.0	.30	.19	.45	.339	.317	7.60	12.26	91.3	4.4	1.17
120–200	7.5	6	8	33.3	29	9	62	5.0	0.5	.28	.03	.59	.509	.509	2.44	3.94	58.4	20.9	.90
MEAN	7.5	4.8	5	36.8	50	6	44	5.1	3.1	.30	.09	.49	.261	.186	4.12	ND	86.2	7.9	1.19
ST. DEV.	0.0	.98	3	15.1	20	2	20	.16	2.4	.02	.06	.09	.171	.207	2.72	ND	15.9	7.9	.23
C. V. (%)	0.0	20.34	57	40.9	39	43	47	3.18	76.1	8.05	66.67	17.65	65.52	111.29	65.92	ND	18.5	99.9	19.58
										FB4									
0–15	5	3	3	15.6	71	11	18	5.4	2.2	.30	.13	.60	.073	.011	3.31	18.39	97.5	1.2	2.26
15–26	10	5	3	19.2	77	5	14	5.7	2.2	.29	47	.057	.055	3.13	56.5	96.4	1.8	1.17	
26–35	7.5	4	3	58.0	41	7	52	4.9	6.5	.29	.42	.283	.233	7.91	15.21	93.5	3.5		
35–95	7.5	6	6	43.9	75	9	16	5.8	1.4	.29	.04	.47	.085	.027	2.31	14.44	95.1	3.6	.78
95–140	7.5	6	6	29.8	41	7	52	4.7	0.7	.27	.03	.44	.509	.483	2.43	4.67	53.1	21.0	.90
140–180	7.5	6	8	28.1	43	9	48	4.6	7.0	.30	.17	.59	.678	.678	9.42	19.63	85.6	7.2	.90
MEAN	7.5	5.0	5	32.4	58	8	33	5.2	3.3	.29	.10	.50	.281	.248	4.75	ND	87.9	6.6	18
ST.DEV.	1.6	1.27	2	15.9	18	2	19	0.5	2.7	.01	.06	.08	.261	.277	3.09	ND	14.71	7.3	0.55
C.V. (%)	21.1	25.3	44	49.2	31	26	57	10.0	81.3	3.79	62.89	15.46	92.88	111.69	65.09	ND	16.74	111.9	46.15

TABLE 2: PHYSICAL AND CHEMICAL PROPERTIES OF PROFILES STUDIED

Depth (cm)	Hue*	Colour Matrix Value	Chroma	% >2mm	Sand	Silt	Clay	pH (1:1) H_2O	Ca	Mg	Na	Meq/100g Soil K	Al	H	ECEC	ECEC Meq/100g Clay	% Base Satn (ECEC)	Al Satn (ECEC)	O.C.
FB6																			
0–13	10	3	4	11.8	73	13	14	6.0	6.3	.31	.20	.55	.085	0.027	7.47	53.36	98.5	1.1	2.03
13–25	10	4	6	18.9	75	9	16	5.7	2.3	.27	.13	.47	.085	0.227	3.28	20.50	96.6	2.6	1.21
25–59	7.5	5	8	51.4	41	7	52	5.7	4.7	.28	.13	.52	.113	.010	5.76	11.08	97.8	2.0	.86
59–99	7.5	5	8	41.8	39	15	46	5.6	1.4	.27	.05	.42	.113	.010	2.26	4.91	94.6	5.0	1.10
99–136	5	5	8	36.4	41	7	52	5.5	1.3	.27	.04	.35	170	.026	2.16	4.16	90.9	7.9	.98
136–175	5	5	8	27.2	39	15	46	5.1	1.2	.25	.03	.35	.114	.166	2.11	4.59	86.7	5.4	.78
MEAN	7.5	4	7	31.3	51	11	38	5.6	2.87	.28	.10	.44	.113	.044	3.84	ND	94.2	4.0	1.16
ST. DEV.	2.2	.82	2	14.8	18	24	18	.30	2.14	.02	.07	.09	.031	.060	2.26	ND	4.6	2.6	.45
C.V. (%)	29.8	18.83	24	47.3	34	35	47	5.30	74.57	7.27	69.07	19.19	27.43	136.36	58.80	ND	4.9	63.8	39.14
ALL SAMPLES																			
MEAN	7.5	4.5	6	32.8	54	8	38	5.1	3.12	0.30	0.10	0.47	0.289	0.219	4.44	ND	85.3	8.5	1.09
ST. DEV.	2.2	0.97	2	13.3	16	4	17	0.4	2.27	0.027	0.06	0.08	0.213	0.219	2.41	ND	14.3	8.3	0.37
C.V. (%)	29.5	20.6	37	40.5	29	46	44	8.5	72.8	9.1	63.9	16.7	73.7	100.0	52.3	ND	16.8	98.3	33.7

*All in the YR range; ND = Not Determined

Chemical Properties: Soil reaction (pH) of the soils indicate that they are mostly in the strongly acid to extremely acid range (i.e. pH of 5.5 to 4.4), this is evidence of strong chemical weathering irrespecctive of the shallow depth of the solum. The coefficient of variation (C.V.) is very low (8.5%, Table 2) for all samples which again is a pointer to common weathering environment and status of the different soils. Significant differences (Table 4) occur between FB1 vs FB3 and FB4; FB2 vs FB3 and FB4 and FB3 vs FB6. The only plausible explanation here is that FB3 and FB4 are not as acid as others because of previously less intense hydrolytic weathering reactions probably because of the higher groundwater table which mitigated intense leaching.

Effective Cation Exchange Capacity (ECEC) is another possible index of chemical weatheirng in soils of the humid tropics. It is very low (overall mean (all samples) of 4.4, Table S: S.D. of 2.41, Table 4) with a large C.V. (Table 2). This is a summation of the variabilities exhibited within individual soil profiles in Table 2. A cursory look at the latter Table points to the large C.V. shown by exchangeable Ca^{2+}, Na^{+}, Al^{3+} and H^{+}. These four elements are responsible for the large variability in the ECEC observed either on an individual soil profile basis or when all profiles are considered together. Variability observed in exchangeable Mg values on an individual or overall average basis makes Mg^{2+} a more reliable index of the intensity of soil chemical weathering. This contention is supported with significant values obtained in Table 4. FB1 occupies the crest and contains quartz veins with a shallower saprolite that shows stronger expression of the parent rock structures than expressed in other soil profiles. Hence it is significantly different from other soil profiles. This trend is also shown slightly in exchangeable Al and H, and of course in Base saturation and Al saturation values but only mostly between FB1 vs FB6 and FB2 vs FB6.

Classiffication: All the soil profiles meet the requirement for argillic horizons. Clay skins are present in profiles FB3, FB4 and FB6; and FB1 and FB2 meet the requirement that the ratio between clay fractions of the argillic horizon (accumulation zone) to that of elluvial horizon be 1.2 or higher (Soil Survey Staff, 1975). In addition, these soils exhibit low cation exchange capacities especially as observed in the Bt or Bw horizons. The ECEC values estimated on clay base show that these soils have low clay activity (Table 2). They are all therefore classified as Ultisols. The soils also have ustic moisture regime because dry season actively occurs between November and March which is equivalent to about 150 days of dryness within soil types like Iwo series. Average annual temperature is 27°C in the area of study. No significant temperature fluctuation beyond 27 ±2°C is expected at 50cm depth from the surface because there is no wide fluctuation in aerial temperature in the humid tropics. These soils therefore classify as Ustult. Typically, Iwo series has been reported (Juo 1980) to have some weatherable primary minerals principally muscovite mica, quartz and feldspars (most probably orthoclase). At the great group level, they therefore become Paleustult. In the humid tropics of Nigeria, Iwo series is derived from granitic igneous and metamorphic rocks, thus it is not naturally endowed with the mafic primary minerals which could possibly be the source of greater fine soil materials and perhaps higher mineral nutrients. We therefore belief that these profiles can be tentatively classified as Typic Paleustult because it reflects its parent rock materials.

The FAO/Unesco (1985) equivalent is Ferric Acrisols for FB1, FB2, FB3 and FB4 because they have Bt or Bw horizons within 1.25m with a considered low base saturation or low ECEC; and Ferric Lixisols for FB6 because of its relatively high base saturation despite its low ECEC. They are ferric because of the presene of concretions and nodules that constitute significant proportions of the gravelly B horizons.

Conclusion

The statistical hypotheses tested in this study have supported that no significant differences exist between soil profiles formed in similar parent material occupying different aspects of physiographic units of the landscape. Also differences seen between FB3, FB4 and others show that groundwater table exerted a strong influence on relict features of soil profiles but this may not be sufficient to delineate different series. Chemical variabilities as observed through pH and ECEC also have shown that irrespective of physiographic characteristics, these soils that are exposed to identicial climatic parameters weather identically.

TABLE 4: STATISTICAL TEST ON CHEMICAL PROPERTIES OF STUDIED PROFILES

		$p^{H}H20$	Ca	Mg	Na	K	A1	H	ECEC	Base Sat	A1. Sat	O.C
						FB1	**VS**	**OTHERS**				
FB2	T	1.34	0.04	2.09^{b}	0.08	0.10	0.60	1.48	0.21	0.04	0.40	0.89
	DF	9	9	9	9	9	9	9	9	9	9	9
	P	.214	.968	.066	.936	.919	.566	.173	.842	.971	.696	.396
FB3	T	3.08^{d}	0.0	2.09^{b}	0.20	1.01	.97	.45	.32	.83	.93	2.00^{b}
	DF	10	10	10	10	10	10	10	10	10	10	10
	P	.012	1.000	.063	.847	.338	.356	.661	.756	.427	.376	.074
FB4	T	1.97^{b}	.13	3.37^{d}	.12	1.17	.64	.09	.07	1.05	1.17	1.18
	DF	10	10	10	10	10	10	10	10	10	10	10
	P	.077	.987	.007	.907	.270	.538	.927	.944	.319	.268	.265
FB6	T	5.20	.17	4.04^{d}	.12	0.0	2.93^{d}	2.60^{d}	0.54	2.28^{d}	1.83^{b}	1.25
	DF	10	10	10	10	10	10	10	10	10	10	10
	P	.000	.870	.002	.911	1.000	0.15	.027	.603	.046	.097	.239
						FB2	**VS**	**OTHERS**				
FB3	T	1.40^{a}	0.05	0.02	0.13	1.00	1.56^{a}	1.73^{a}	.59	.77	.62	1.19
	DF	9	9	9	9	9	9	9	9	9	9	9
	P	.194	.962	.981	.902	.341	.154	.118	.572	.463	.549	.266
FB4	T	.93	.11	.80	.04	1.21	1.11	1.06	.11	.99	.94	.61
	DF	9	9	9	9	9	9	9	9	9	9	9
	P	.377	.916	.447	.972	.257	.295	.317	.917	.350	.372	.557
FB6	T	3.72^{d}	.26	1.84^{a}	.03	.11	3.63^{d}	3.85^{d}	.92	2.32^{c}	2.04^{b}	.61
	DF	9	9	9	9	9	9	9	9	9	9	9
	P	.005	.801	.099	.973	.919	.005	.004	.382	.046	.071	.556
						FB3	**VS**	**OTHERS**				
FB4	T	.22	.15	.77	.09	.11	.16	.44	38	.19	.30	.01
	DF	10	10	10	10	10	10	10	10	10	10	10
	P	.827	.886	.457	.927	.981	.879	.671	.715	.852	.768	.995
FB6	T	3.37^{d}	.19	1.84^{b}	.09	1.01	2.09^{b}	1.61	.19	1.19	1.15	.12
	DF	10	10	10	10	10	10	10	10	10	10	10
	P	.007	.852	.096	.931	.336	.064	.139	.850	.263	.277	.907

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