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VARIATION OF SOIL MORPHOLOGICAL PROPERTIES ALONG A LITHOSEQUENCE ON BASEMENT COMPLEX GEOLOGY OF NIGERIA

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ABSTRACT
Morphological properties are inherent properties that expressed the nature and properties of the parent material from which soils are formed. The variation of morphological properties of soils was evaluated along a lithosequence of soils formed from schists and older granite in the basement complex geology of Nigeria. The soils were mapped and the morphological properties were described on the field following the standard procedure. The colour of soils on schists ranged from 5YR, 7.5YR to 10YR (moist) while on older granite it ranged from 2.5YR, 5YR, 7.5YR to 10YR (moist), all the soils on older granite have sandy loam texture at the surface and there is increase in cohesion down the depth of the profiles of soils studied. There were variations in colour, texture and structure between the parent materials and horizons ($p \leq 0.05$). The pedogenic processes observed are: plinthization, humification, melanization, braunification, ferritization, ferralitic weathering, elluviation and illuviation (argilluviation), insitu weathering and faunal pedoturbation. The following soil management options were recommended: construction of contour ridges along with the maintenance of plant cover, utilization of wetland areas for fisheries and dry season farming, maintenance of plant cover, incorporation of crop residues and soil crusting.

Keywords: *colour, texture, structure, pedogenesis, variation*

INTRODUCTION

The basement complex area of Nigeria is made up of the migmatite gneiss, schist, older granite and underformed acid dykes (Obaje, 2009). They constitute igneous and metamorphic rocks and occupy 50% of Nigeria surface area (Ogezi, 1977). The parent rock which gives the parent material is one of the major factors of soil development. It influences the nature and properties of soil (Esu, 1999), as a result of this, specific soils have been associated with specific lithology giving rise to sequence of soils across different rocks (Ukeagbu and Akamigbo, 2006; Usul and Dengiz, 2010; Maniyunda, 2012).

The morphological properties of soils are inherent properties that influence to a large extent the behavior of soils and are best evaluated insitu (Esu, 1999). They are properties that cannot be easily influenced by management and their detailed information is required in soil mapping, characterization and classification (Ojo-Atere *et al.,* 2011). The knowledge of morphological properties serves as a guide to better understanding of the nature of the soils and the determination of best use to which it can be put. Colour, mottles, texture, structure and consistence exerts strong influence in delineation of soil boundaries and horizons. They are used in studying the pedogenesis of soils (Soil Survey Division Staff, 1993). In addition, they are important in classifying soils at the series level (Smyth and Montgomery, 1962; Aruleba, 2011; Soil Survey Staff, 2014) the lowest category in soil classification system and localized.

An understanding of variation in morphological properties along lithosequence will reveal the inherent differences in soils and the relationship between soils formed on basement complex geology. The objectives of this study are to:

1. evaluate the variation of morphological properties in soils formed on schist and older granite of the basement complex geology of Nigeria;
2. identify pedogenetic processes in the study areas with the use of morphological evidence.

MATERIALS AND METHODS

Description of the study areas: Ado-Ekiti: The soils of the study site at Ado-Ekiti are formed from older granite. It lies between latitude 7.710802N and 7.71380^{0}N and longitude 5.24323^{0}E and 5.24647^{0}E. The area belongs to upland Tropical Rain Forest zone. Kabba: The soils of the study site at Kabba are formed from schist. It lies between latitude 7.860376N and 7.862225N and longitude 6.069576E and 6.074468E within the southern guinea savanna zone of Nigeria. The study areas have distinct wet and dry seasons with a typical humid tropics climate.

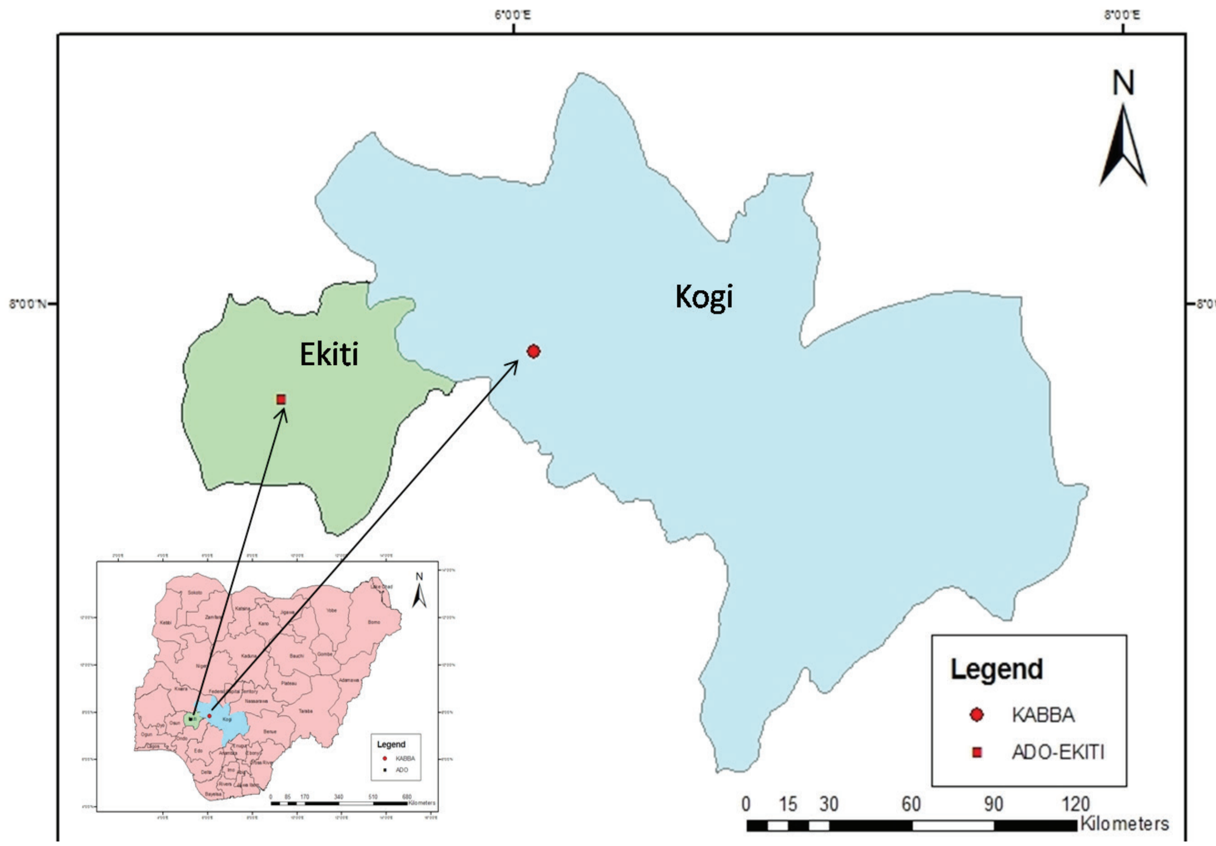

Figure 1: Map of Nigeria Showing the Location of the Two Sites

Soil Survey and Sampling

The conventional method of soil survey involving rigid grid procedure was used to map each of the study sites. Observations were made along traverses of 50 m apart with soil auger. The Global Positioning System (GPS) was used for locating points. Augering was made to a depth of 125 cm or to an impenetrable layer whichever is deeper. At each observation point, the local relief, soil erosion or deposition hazard, rock outcrops, surface characteristics, vegetation and land use were recorded. Soil morphological properties were described in the field following the procedure described in the USDA Soil Survey manual (Soil Survey Staff, 2014). The following features were observed and described; soil depth, colour, mottling, structure, texture, consistence, horizon boundary, roots, concretions and pores.

Areas with same soil type were mapped together and plotted on a base map. An area of 12.4395 and 12.1841 hectares of land were mapped in Ado Ekiti and Kabba respectively. Soil boundary lines were drawn to delineate soil mapping units.

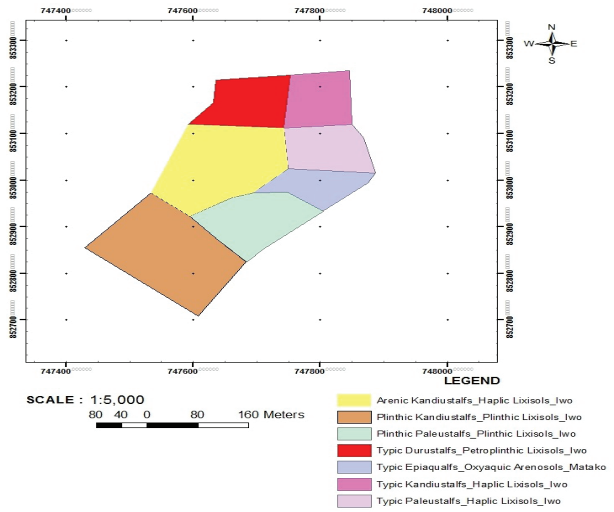

Figure 1: Soil map of Ado-Ekiti study site

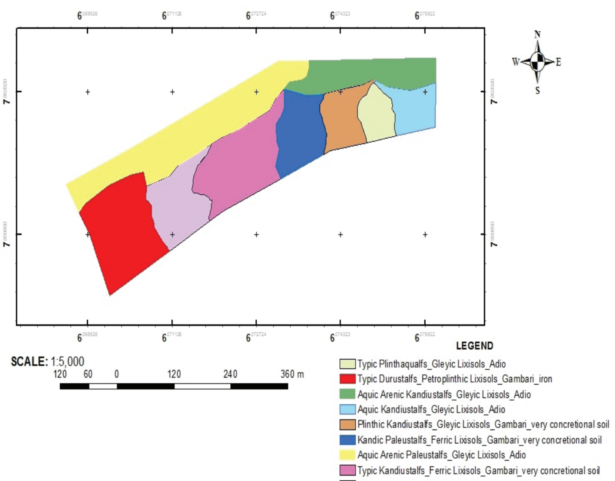

Figure 2: Soil map of Kabba study site

Coding method

The texture (by feel), structure, consistence (dry) and Colour (hue) were coded following the method developed by the soil survey of England and Wales (Avery and Bascomb, 1974) (Table 1a and 1b).

Table 1a: Codes used for Soil Morphological Properties

Colour Hue	Code Number	Texture Particle Size Classes	Code Number	Consistence Moisture State	Code Number
10R	0	Sand	1	Dry	
2.5YR	1	Coarse sand	2	Loose	0
5YR	2	Medium sand	3	Soft	1
7.5YR	3	Fine sand	4	Slightly hard	2
10YR	4	Loamy sand	5	Very hard	3
2.5Y	5	Loamy coarse sand	6	Extremely hard	4
5Y	6	Loamy medium sand	7	Moist	
5G	7	Loamy fine sand	8	Loose	0
5GY	8	Sandy loam	9	Very friable	1
5BG	9	Coarse sandy loam	10	Firm	2
N	0	Medium sandy loam	11	Very firm	3
		Fine sandy loam	12	Extremely firm	4
		Sandy silt loam	13	Wet	
		Coarse sandy silt loam	14	Moist	0
		Medium sandy silt loam	15	Slightly sticky	1
		Fine sandy silt loam	16	Moderately sticky	2
		Silty loam	17	Non-plastic	3
		Slitly clay loam	18	Slightly plastic	4
		Clay loam	19	Moderately plastic	5
		Sandy clay loam	20	Very plastic	6
		Sandy clay	21		
		Silty clay	22		
		Clay	23		

Source: Soil Survey of England and Wales (Avery and Bascomb, 1974)

Table 1b: Codes used for size and shape or type of peds and fragments

Size	Type/shape and arrangement of peds and fragments					
	Platy*1	**Prismatic*2**	**Angular blocky*3**	**Subangular blocky*4**	**Granular*5`**	**Crumb*6**
Fine*1	Fine platy 11	Fine Prismatic 12	Fine angular blocky 13	Fine subangular blocky 14	Fine granular 15	Fine crumb 16
Medium*2	Medium platy 21	Medium prismatic 22	Medium angular blocky 23	Medium subangular blocky 24	Medium Granular 25	Medium Crumb 26
Coarse*3	Coarse platy 31	Coarse prismatic 32	Coarse angular blocky 33	Coarse subangular blocky 34	Coarse Granular 35	Coarse Crumb 36
Very Coarse*4	Very coarse platy 41	Very coarse prismatic 42	Very coarse angular blocky 43	Very coarse sub angular blocky 44	Very coarse granular 45	Very coarse crumb 46

Source: Soil Survey of England and Wales (Avery and Bascomb, 1974)

Statistical analysis

T-test was used to compare differences between the morphological properties of soils formed on schist and older granite and between surface and subsurface horizons. Linear correlation analysis was used to determine the relationship between the soil properties. All the statistical analyses were carried out at 95% confidence level. Analysis was carried out using statistical package for social science (SPSS IBM Statistics 19.0).

RESULTS AND DISCUSSION

Soil morphological characteristics studied include soil depth, soil colour, mottles texture, structure, consistence, concretions and roots. The results of morphological characteristics of the soils of both sites are presented in tables 2 to 6

The soils depth was generally shallow to very deep (40cm to 200cm). Deepest soil depth observed on older granite is 130cm at profile AA while on schists it is 200cm at profile KB and KC. Generally the soils on schists are deeper than older granites, major restriction to depth in soils on the two parent materials are high water table around the lowland areas at profile AA (60cm), plinthites and concretions at profile KA and AA (40cm). In soils on both parent materials, topography seems to be a major determinant of soil depth. Soils at the upper and middle slope are restricted by plinthites and concretions, the valley bottom soils are restricted by water drained from the upper and middle slope. Earlier studies (Raji, 1995; Idoga *et al.,* 1995; Ezenwa and Esu, 1999; Idoga *et al.,* 2005) revealed that soil depth is determined by parent material, erosion and topography of an area. Soil depth restriction due to plinthites observed in this study could be managed by construction of contour ridges and bunds to improve the soils to quality seedbed and increase rooting depth (Odunze, 2006; Senjobi and Ogunkunle, 2011; Maniyunda, 2012). Construction of contour ridges along with the maintenance of plant cover will conserve the soils against surface runoff by erosion that might expose the plinthite horizons to harden irreversibly and render the soil unsuitable for crop production (Fasina *et al.,* 2007a, 2007b; Senjobi and Ogunkunle, 2011). The wetland area can be utilized for fisheries and dry season farming in other to optimize production and land use in the soils (Babalola *et al.,* 2011).

Variation in colour was observed between horizons and soils on different parent materials ($P \leq 0.05$). Surface horizons were dominantly black, dark brown, yellowish brown and reddish brown. In soils on schists it ranged from 5YR, 7.5YR to 10YR (moist) while on older granite it ranged from 2.5YR, 5YR, 7.5YR to 10YR (moist). Soils with black and dark brown colouration have been attributed to humification resulting from melanization (Raji, 1995). 7.5YR (moist) dominated the Bt horizons of the soils on older granite indicating braunification as a pedogenic process occurring in these soils. This result is similar to the reports of Ande (2010) and Maniyunda (2012) for soils formed on basement complex rocks in the humid tropical zone of Nigeria. The subsurface horizons of soils on the parent materials were observed to vary between 10YR, 7.5YR, 5YR and 2.5YR and this was clearly observed in profile KC, KD and KG of the schists and profile AA and AG of the older granites this indicates ferritization process (Raji, 1995 and Maniyunda, 2012). The morphological features exhibited in range of hues 10YR through 7.5 – 2.5YR in most layers depicts a residual accumulation of Fe-Al with a dominant pedogenic process of ferralitic weathering (Tessens and Shamshuddin, 1982). Also the variations in soil colour such as reddish brown, strong brown, dark brown, brownish yellow, dark yellowish brown and red have been attributed to the presence of minerals such as goethite (α-FeOOH), maghemite (β-Fe_2O_3), hematite (α-Fe_2O_3) and gibbsite ($Al(OH_3)$) (Akpan-diok *et al.,* 2013). Differences in soils colour of profiles from surface to lowest horizons have been reported by many workers in different parts of Nigeria (Babalola *et al.,* 2007; Ogunkunle, 2009; Ande 2010; Maniyunda, 2012).

There was significant difference (P≤0.05) in texture between parent materials and horizons. At the surface horizon; profile KA, KB, KC, KD, KE, KF and KH have sandy loam texture, KG is clay loam while KI is loamy sand in soils on schists. In Soils on the older granite, the profiles have sandy loam texture. The coarse textured surface characteristics predominant in soils on schists and older granite is typical of the surface horizon of soils derived from the basement complex geology (Jones and wild, 1975, Murdoch *et al.,* 1976; Ezenwa and Esu, 1999; Maniyunda, 1999) and has been attributed to erosion of fine particles by surface runoff down the slope from the upper slope and their illuviation into the sub soils (Esu *et al.,* 1987).

The subsurface horizons soils are dominantly sandy clay loam, sandy clay and clay. The texture changes with increase in depth is probably as a result of parent material, physiographic unit locations, in-situ weathering, sorting of soils materials by biological and/or agricultural activities, clay migration (Illuviation of clay as a result of fluctuating ground water table forming zone of maximum clay accumulation i.e argilluviation) and age of soils (Malgwi *et al.,* 2000; Idoga and Azagaku, 2008; Geetha and Naidu, 2013). These soils can be maintained by ridging, maintenance of plant cover, incorporation of crop residues with farm yard manure to control erosion, crusting to improve the quality of soil condition (Tarawali *et al.,* 2001; Odunze, 2006; Maniyunda, 2012). The comparative analysis of the morphological properties showed that texture is significantly correlated with consistence (P≤0.05) and structure (P≤0.01). This implies that texture contributes to structure and consistence in the soils studied.

All the soils on schists are mottled while only profile AF is not mottled on older granite soils. The mottles are few, common, many, fine, medium, faint, distinct and prominent down the profile for the soils studied. Mottles are indication of poor drainage condition. The poor drainage condition can be attributed to the low level of topography in some of the soils in the case of profiles KB, KC, KD and KF and high clay content in the case of profiles KG, KH, KI, AA, AB, AC, AD and AE. The high clay content contributes to impeded drainage (Idoga and Azagaku, 2008) therefore the soils are liable to flooding or over saturation with water in years of heavy rainfall and insufficient soil moisture in years of scanty rainfall, both conditions can affect yield of cultivated crops negatively.

There was significant difference (P≤0.05) in structure between parent materials and horizons. All soils in the older granite site have moderate, medium to fine crumbs structure at the surface horizon while on the schists the structure ranged from moderate to strong, medium to fine crumbs and granular. This can be attributed to the high percentage of sand and the texture of the soils which is predominantly sandy loam, loamy sand and loam. Result of correlation analysis showed that there is correlation (P≤0.05) between texture and structure.

The subsurface horizons have well developed structures being moderate to strong, medium to coarse subangular blocky to angular blocky. Also profiles KC, KD, KF, KH, AA, AB and AF have massive structures probably due to the weight of overlying horizons or due to the influence of underground water tables (Idoga *et al.,* 2005). Structural development of soils is higher in soils of the schists than soils on the older granite.

There is no significant difference (P>0.05) in consistence between the parent materials while significant differences (P≤0.05) were observed between horizons. The consistence of the surface horizons was generally slightly sticky to non-sticky (wet) and non-plastic (wet) in all the profiles expect for KG that is slightly plastic (wet).

Increase in cohesion and adhesion is a common feature in all the soils studied down the profiles with consistence ranging from slightly sticky to very sticky (wet) and slightly plastic to very plastic (wet). This can be related to increase in illuviation (Maniyunda, 2012). Profiles KE, AE and AG have loose (moist) consistence while all other soils have soft (moist) consistence at the surface horizons. Also under dry condition the consistence of the soils ranged from loose to soft at the surface. This can be attributed to high content of sand at the surface of the soils studied. Hard to very hard (dry) consistence was encountered within sub horizons of all the soils studied. This is an indication of the presence of argillic horizons in the soils and in agreement with the findings of Raji (1995), Maniyunda (1999) and Maniyunda (2012) for basement complex soils. The subsurface horizons soils are dominantly sandy clay loamy, sandy clay and clay indicating an increase in clay content down the profile. There is correlation between texture and consistence in this study.

Surface soils at the study sites have horizon boundary ranging from clearly wavy to gradually smooth and wavy, this has been attributed to melanization from humification of organic matter in the AP horizons (Maniyunda, 2012). Horizon differentiations in the subsoil are predominantly gradually wavy. The wavy boundary that is predominant in all the soils studied could be attributed to cultivated ridges and activities in all the sites studied.

Common to many, fine to coarse roots were observed at the Ap horizons and immediate horizons of all the soils studied; this is an indication that these zones are zones of root activities.

There is presence of Iron-Manganese (Fe-Mn) concretions and plinthites in the subsurface of almost all the soils studied expect for AB, AC, AF and AG in soils on older granite. This indicates plinthization has occurred in the soils. The presence is more pronounced in soils on the schists and can be attributed to pedogenic exposure resulting in increased Fe-Illuviation.

The presence and activities of termites, ants and earthworms were observed within profile KB, KH, AA, AB, AC and AE, this indicates that there is some degree of faunal pedoturbation within these soils (Buol *et al.,* 1980; Fanning and Fanning, 1989). Gleyic conditions was observed at the subsurface horizon of profiles KB, KC, KE, KF, KG and KH all of which are found in the low lying areas of schists site. This condition is peculiar to wetland areas.

At the Kabba site, there is presence of partly weathered rock within the profile at KF and several hill of schists with exposed parent material indicating that the soils are formed from schists (Turner, 1983) while the presence of several exposed inselbergs of older granite rock in Ado-Ekiti area indicates that the soils are developed from older granite parent material (Rahaman, 1981).

Table 2: Morphological characteristics of the soils studied in Kabba

Horizon	Depth	Colour	Mottles	Texture	Structure	Consistence			Boundary	Other Features
	(cm)	Moist		(field)		Wet	Moist	Dry		
Profile KA 7.859302N 6.069769E										
Ap	0 – 9	7.5YR 4/8 (Strong brown)	-	SL	1,f,cr	ns,np	vfr	l	cw	common fine roots, few iron-manganese concretions
Bv	9 – 20	7.5YR ¾ (Dark brown)	fe,fi,fa	SL	1,f,cr	ns,np	vfr	l	cw	Common fine roots, few gravels, few iron-manganese concretions
Bx	20 – 40	5YR 5/8 (Red)	c,co,pr	GSL	3,c,sbk	ss,sp	fi	h	ds	Hard pan materials at 40cm
Profile KB 7.859440N 6.070209N										
Ap	0 – 18	10YR 5/3 (Brown)	fe,fi,fa	SL	2,m,gr	ss,np	vfr	s	gs	Many fine roots, termites and ants activities
Bc	18– 39	10YR 6/3 (Pale brown)	fe,m,ds	SL	2,m,gr	ss,np	vfr	s	gs	Common medium roots, few gravel, few iron-manganese concretions, Termites and ant activities
Bcg1	39– 69	10YR 7/3 (Very pale brown)	m,co,pr	S	1,m,cr	ns,np	lo	l	-	Many gravel and stones, many iron-manganese concretions, Gleyic, termites and ants activities
Bcg2	69 – 130	10YR 7/8 (Yellow)	m,co,pr	SC	2,c,sbk	vs,np	fi	h	-	Many gravel and stones, many iron-manganese concretions, Gleyic
Bgx	130–200	2.5YR N5/0 (Gleyic)	c,fi,ds	C	3,f,abk	vs,vp	vfi	vh	cs	Pan material at 200cm, cutans and gleyic
Profile KC 7.860822N 6.069576E										
Ap	0 – 20	10YR 5/4 (Yellowish brown)	c,co,ds	SL	2,m,gr	ns,np	vfr	s	gw	Many fine roots, few stones, ants activities
Bt	20 – 46	7.5YR 5/6 (strong brown)	c,co,pr	SC	3,m,sbk	vs,sp	fi	h	gw	Many fine roots, few stones
Btcg1	46 – 70	10YR 5/6 (Brown yellow)	m,co,pr	SC	2,m,sbk	vs,sp	fi	h	-	Few stones, many iron-manganese concretions, gleyic
Btcg2	70 – 110	10YR 4/4 (Dark yellowish brown)	m,fi,pr	C	3,m,abk	vs,vp	vfi	h	gw	Few stones, many iron-manganese concretions, cutans, gleyic
Btg	110–200	2.5YR 4/2 (Dark gleyic brown)	m,fi,pr	SC	3,m,abk	ss,sp	fi	h	-	Gleyic
Profile KD 7.860376N 6.072108E										
Ap	0 – 20	7.5YR 4/3 (Dark brown)	-	SL	1,m,gr	Ss	vfr	s	gs	Many roots and gravels

Btcg1	20 – 74	5YR 4/4 (Reddish brown)	c,m,pr	C	3,m,sbk	vs,vp	vfi	vh	gw	Few roots and gravel
Btcg2	74 – 102	10YR 4/6 (Dark yellowish brown)	m,m,pr	C	3,m,abk	vs,vp	vfi	vh	-	Many iron-manganese concretions
Btcg3	102–145	10YR 5/8 (Yellowish brown)	m,m,pr	C	3,m,abk	vs,vp	vfi	vh	-	Many iron-manganese concretions, cutans and gleyic
Profile KE 7.860811N 6.072108E										
Ap	0 – 24	10YR 3/3 (Dark brown)	fe,fi,fa	SL	1,f,cr	ns,np	Lo	l	cw	Common medium roots, few stones
Btc1	24- 47	10YR 3/6 (Dark yellowish brown	m,fi,pr	SCL	3,m,sbk	vs,vp	Fi	h	-	Common medium roots, few iron-manganese concretions
Btc2	47 – 67	7.5YR 6/8 (Reddish yellowish)	m,co,pr	SC	3,c,sbk	vs,vp	Fi	h	cw	Very few roots, many iron-manganese concretions
Btc3	67 – 99	10YR 5/8 (Yellowish brown)	m,co,ds	SC	3,c,sbk	vs,vp	Fi	h	cw	many iron-manganese concretions, gleyic
Btgx	99 – 150	10YR 4/1 (Dark grey)	-	C	3,f,abk	vs,vp	Vfi	vh	gw	Few iron-manganese concretions, cutans, gleyic, hard pan at 150cm
Profile KF 7.861024N 6.073063E										
Ap	0 – 21	7.5YR 5/6 (Dark brown)	-	SL	1,m,cr	ns,np	Vfr	s	-	Common fine roots, few stones
Bv	21 – 41	7.5YR 5/6 (Brown)	-	LS	1,m,cr	ns,np	Vfr	l	-	Common fine roots, few stones, Plinthites.
Bcg	41 – 70	7.5YR 7/8 (Reddish brown)	f,co,ds	SC	2,m,sbk	ss,np	Fi	h	dw	Few fine roots, gravel and stone, gleyic, many iron-manganese concretions.
C1	70 – 86	10YR 7/8 (Yellow)	c,co,fa	GSC	2,co,abk	ns,np	Fi	h	-	Many gravel, stone and many iron-manganese concretions, presence of partly weathered rock.
Cg	86 – 120	10YR 6/8 (Brownish yellow)	c,fi,ds	SC	3,m,abk	vs,vp	Fi	h	gw	Gravel, many iron-manganese concretions, gleyic, bedrock at 120cm
Profile KG 7.861874N 6.073964E										
Ap	0 – 24	7.5YR 4/3 (Dark brown)	-	CL	2,f,gr	ss,sp	Fi	s	cw	Many medium roots, cutans
Btcg1	24 – 62	5YR 4/3 (Reddish brown)	fe,fi,fa	SCL	2,co,gr	ss,sp	Fi	s	gw	Many fine roots, many iron-manganese concretions, gleyic
Btcg2	62 – 99	2.5Y 5/6 (Light olive brown)	c,m,ds	SC	2,m,sbk	vs,vp	Vfr	h	gw	many iron-manganese concretions, gleyic
Btv	99 – 126	2.5Y 5/2 (Grayish brown)	c,co,ds	SC	2,co,sbk	ss,sp	Vfr	h	gw	Many stone, plinthites
Btx	126 – 150	2.5Y 7/6 (Yellow)	fe,fi,fa	SC	2,co,sbk	ss,sp	Vfr	h	-	Many stone, iron-manganese concretions, hard pan at 150cm
Profile KH 7.862225N 6.074468E										
Ap	0 – 27	7.5YR 3/2 (Dark brown)	fe,fi,fa	L	1,f,gr	ns,np	vfr	s	-	Many medium roots
Btc1	27 – 52	10YR ¾ (Dark yellowish brown)	fe,fi,fa	SL	2,m,gr	ns,np	fi	h	gs	Few medium roots, few iron-manganese concretions, earthworm activities
Btc2	52 – 94	5YR 5/6 (Yellowish red)	c,fi,ds	SC	3,csbk	ss,sp	fi	h	gw	Stones, many iron-manganese concretions, ant and termite activities

Btc3	94 – 120	2.5YR 4/3 (Reddish brown)	fe,fi,fa	SC	2,msbk	ss,sp	fi	h	-	Stones, many iron-manganese concretions, gleyic
Btg	120 – 150	7.5YR 3/3 (Dark brown)	fe,fi,ds	C	2,msbk	vs,vp	fi	h	-	many iron-manganese concretions, gleyic
Profile KI 7.862129N 6.072258E										
Ap	0 – 33	5YR 4/4 (Reddish brown)	-	LS	1,m,cr	ns,np	vfr	s	cw	few medium roots
Btc1	33 – 65	7.5YR 4/6 (Strong brown)	-	SC	2,m,sbk	ss,np	fi	h	dw	Common medium roots, few iron-manganese concretions
Btc2	65 – 112	10YR 6/6 (Brownish yellow)	fe,m,fa	SC	2,c,sbk	ss,np	fi	h	-	Many iron-manganese concretions, gleyic
Bt	112 – 150	2.5YR 6/6 (Olive yellow)	c,fi,ds	C	3,f,sbk	ss,sp	fi	h	cs	Few stones, gleyic, water table at 150cm

Key: *Mottles: fe= few, c= common, ma= many, fi= fine, m= medium, fa= faint, ds= distinct, pr= prominent*
Texture: G= gravelly, S= sand, LS= loamy sand, SL= sandy loam, L= loam, SCL= sandy clay loam, CL= clay loam, SC= sandy clay, C= clay
Structure: 1= weak, 2= moderate, 3= strong, f= fine, m= medium, c= coarse, cr= crumb, gr= granular, sbk= sub angular block, abk= angular blocky
Consistence: ns= non sticky, np= non plastic, ss= slightly sticky, sp= slightly plastic, vs= very sticky, vp= very plastic, lo= loose, vfr= very friable, fi= firm, vfi= very firm, l= loose, s= soft, h= hard, vh= very hard
Boundary: cw = clearly wavy, gs = gradually smooth, gw = gradually wavy, cs = clearly smooth

Table 3: Morphological characteristics of the soils studied in Ado Ekiti

Horizon	**Depth (cm)**	**Colour Moist**	**Mottles**	**Texture (field)**	**Structure**	**Consistence**			**Boundary**	**Other Features**
						Wet	**Moist**	**Dry**		
Profile AA 7.711121N 5.243230E										
Ap	0 – 13	10YR 3/3 (Dark brown)	-	SL	1,m,cr	ns,np	vfr	S	cw	Many coarse roots, termites, ants and earthworms activities
Bt	13 – 36	5YR 6/8 (Reddish yellow)	-	SCL	2,m,gr	vs,sp	fi	H	cw	Common medium roots, termites and ants activities
Btv1	36 – 84	2.5YR 5/8 (Red)	fe,fi,fa	C	2,m,sbk	vs,vp	fi	H	gs	Few fine roots, plinthites and stones
Btv2	84 – 118	7.5YR 7/8 (Reddish yellow)	c,m,ds	C	3,m,sbk	vs,vp	vfi	Vh	gs	Many stones and plinthites
Btcx	118–130	7.5YR 5/8 (Strong brown)	m,co,pr	C	3,m,sbk	vs,vp	vfi	H	Gs	Many stones, iron manganese concretions and hard pan at 130cm
Profile AB 7.710876N 5.245183E										
Ap	0 – 15	7.5YR 3/2 (Dark brown)	fe,fi,fa	SL	1,f,cr	ns,np	vfr	s	Cw	Many fine roots, termites activities
Bt1	15 – 38	7.5YR 5/6 (Strong brown)	fe,fi,fa	SL	1,m,cr	ss,np	fi	s	Cw	Common medium roots, Termites activities
Bt2	38 – 69	10YR 5/6 (Yellow brown)	fe,fi,fa	SCL	2,m,sbk	vs,sp	fi	h	-	Common medium roots, termites activities
Btc	69 – 100	5YR 5/8 (Yellowish red)	fe,fi,fa	C	2,m,sbk	vs,vp	fi	h	Gw	Plinthites
Btx	100–114	7.5YR 6/8 (Reddish yellow)	c,m,ds	C	2,m,sbk	vs,vp	fi	h	Cs	Hard pan at 114cm
Profile AC 7.712567N 5.244153E										
Ap	0 – 19	10YR 2/1 (Black)	-	SL	1,f,cr	ss,np	vfr	l	Gs	Many fine roots, few stones, earthworm activities
Bh1	19 – 35	5YR 2.5/2 (Dark reddish brown)	fe,fi,fa	SL	1,f,cr	ss,np	vfr	lo	Gs	few fine roots, few stones, few dark markings, ants and termites activities
Bh2	35 – 60	7.5YR ¾ (Dark brown)	fe,m,ds	CL	2,c,sbk	vs,sp	fi	h	Gw	Few fine roots, stones and many dark markings, ants and termites activities
Bh3	60 -94	7.5YR 4/3 (Dark brown)	c,m,pr	CL	3,m,abk	vs,vp	vfi	h	Gw	Few stones, many dark markings, cutans,

Profile AD 7.713800N 5.244635E										
Ap	0 – 18	10YR 4/4 (Dark yellowish brown)	-	SL	1,f,cr	ss,np	vfr	s	-	Many medium roots
B	18 – 34	10YR 5/6 (Yellowish brown)	-	SL	1,c,cr	ss,np	vfi	s	-	Many medium roots
Btx	34 – 64	7.5YR 4/6 (Strong brown)	-	C	3,m,abk	vs,vp	vfi	vh	Gw	Hard pan materials at 64cm
Profile AE 7.713694N 5.245869E										
Ap	0 – 35	5YR 3/3 (Dark reddish brown)	-	SL	1,f,cr	ns,np	Lo	s	-	Common fine roots, termites activities
Bh	35 – 79	7.5YR ¾ (Dark brown)	fe,f,ds	SCL	2,m,sbk	vs,sp	Fi	h	Gw	Few fine roots, many stones, dark markings and termites activities
Bhx	79 – 120	5YR 5/8 (Yellowish red)	c,m,ds	C	3,m,sbk	vs,vp	Fi	h	Gw	Many stones, termites activities, hard pan material at 120cm
Profile AF 7.712131N 5.246052E										
Ap	0 – 20	10YR 3/2 (Very dark grayish brown)	-	SL	1,f,cr	ss,np	Vfi	s	Gs	Common coarse roots
B	20 – 49	10YR 4/4 (Dark yellowish brown)	-	SL	1,m,cr	ss,np	Vfr	s	Gs	Few coarse roots, stones
Bt	49 – 85	7.5YR 5/8 (Strong brown)	-	SCL	3,c,abk	vs,vp	Fi	h	Cw	few medium roots
Btx	85 – 105	5YR 6/8 (Reddish yellow)	-	C	3,m,abk	vs,vp	Ffi	vh	Cw	Few medium roots, hard pan materials at 105 cm
Profile AG 7.710802N 5.246470E										
Ap	0 – 9	2.5YR N2.5/0 (Black)	-	SL	1,f,cr	ns,np	Vfr	l	-	Common fine roots
Bw1	9 – 20	2.5Y 5/2 (Greyish brown)	-	S	0,c	ns,np	Lo	l	-	Common fine roots
Bw2	20 – 60	5YR 6/3 (Light reddish brown)	-	S	0,c	ns,np	Lo	l		Few fine roots, water table at 60cm

Key: *Mottles: fe= few, c= common, ma= many, fi= fine, m= medium, fa= faint, ds= distinct, pr= prominent*
Texture: G= gravelly, S= sand, LS= loamy sand, SL= sandy loam, L= loam, SCL= sandy clay loam, CL= clay loam, SC= sandy clay, C= clay
Structure: 0= structureless 1= weak, 2= moderate, 3= strong, f= fine, m= medium, c= coarse, cr= crumb, gr= granular, sbk= sub angular block abk= angular blocky
Consistence: ns= non sticky, np= non plastic, ss= slightly sticky, sp= slightly plastic, vs= very sticky, vp= very plastic, lo= loose, vfr= very friable, fi= firm, vfi= very firm, l= loose, s= soft, h= hard, vh= very hard
Boundary: cw = clearly wavy, gs = gradually smooth, gw = gradually wavy, cs = clearly smooth

Table 4: T-test for morphological properties of parent materials

Parameter	Schists	Older Granite	t-test value	P(two tailed)
Colour	2.907	1.861	4.281	0.000
Texture	17.093	10.442	3.374	0.002
Structure	24.628	16.163	3.547	0.009
Consistence	1.862	1.759	0.385	NS

$P \leq 0.05$ level, NS>0.05

Table 5: T-test for morphological properties of horizons

Parameter	Surface horizon	Subsurface horizon	t-test value	P(two tailed)
Colour	3.188	2.727	2.362	0.032
Texture	9.063	17.870	-7.419	0.000
Structure	19.375	28.590	-3.483	0.003
Consistence	1.063	1.953	-3.923	0.001

$P \leq 0.05$

Table 6: Correlation matrix for morphological properties

	Colour	Texture	Consistence
Texture	-0.207		
Consistence	0.007	0.278*	
Structure	0.057	0.724**	-0.088

* Correlation is significant at 0.05 level (two tailed)
** Correlation is significant at 0.01 level (two tailed)

CONCLUSION AND RECOMMENDATION

The difference in the morphological properties between the parent materials indicates that their inherent characteristics differ. This establishes that there are different soils over the lithosequence studied.

Pedogenic processes identified in the

study areas include: plinthization, humification, melanization, braunification, ferritization, ferralitic weathering, elluviation and illuviation (argilluviation), insitu weathering and faunal pedoturbation.

Construction of contour ridges along with the maintenance of plant cover, utilization of wetland areas for fisheries and dry season farming, maintenance of plant cover, incorporation of crop residues and soil crusting are the management options suggested for the soils at both locations.

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