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INFLUENCE OF TOPOGRAPHY ON PEDOLOGIC FORMS OF IRON IN BASEMENT COMPLEX SOILS OF GIWA LOCAL GOVERNMENT AREA, KADUNA STATE, NIGERIA

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ABSTRACT

A toposequence formed on Basement Complex rocks in Giwa Local Government Area of Kaduna State was studied with the aim of investigating the influence of topography on the distribution of pedologic forms of iron in the area. The area, which spanned 15.55 ha was delineated into upper slope (US), middle slope (MS) and lower slope (LS) positions. Two profile pits were sunk in each slope position and described following standard procedures. Soil samples were also collected for determination of selected physical and chemical soil parameters in the laboratory. The results showed that topography had significant influence on sand, silt and organic carbon (OC) contents across various slope positions. Sand content was highest on US (711.87 g kg^{-1}) and lowest on LS (671.20 g kg^{-1}). Conversely, silt, clay and OC contents were higher on LS than on MS and US. This was attributed to translocation of finer particle sized and organic materials down the slope as preconditioned by topography. Si/C ratio was higher on LS, indicating advancement in soil development, compared to MS and US. Oxalate extractable iron (Fe_{ox}) was highest in LS (0.26%), followed by MS (0.23%) and US (0.22%). Dithionite extractable iron (Fe_d) was highest in the US (0.85%), followed by LS (0.66%) and MS (0.65%). The Fe_{ox}/Fe_d ratio varied thus MS (0.43), > LS (0.43) >e US (0.27). The higher ratio of Fe_{ox}/Fe_d on LS and MS indicated long-term weathering and soil maturation, in comparison with US. Fe_d/Clay ratio indicated higher affinity of Fe_d to clay minerals on MS (33.66), compared to LS (25.27) and US (19.06). Suggestion for further studies include exploring clay mineralogy, organic matter decomposition and redox processes, as these factors may also affect iron dynamics in soils.

Key words: basement complex soils, pedologic forms of iron, soil properties, toposequence

INTRODUCTION

Iron is the most abundant element in the earth's crust (Maniyunda *et al.*, 2014; Olayinka *et al.*, 2015). It is an essential element for soil fertility and it plays a significant role in ensuring the proper functioning of ecosystems (Havlin *et al.*, 2005; Brady and Weils, 2016). Iron is a constituent of the lithosphere and it occurs in varying mineralogical forms as distinct particles or associated with surfaces of other minerals (Maniyunda *et al.*, 2014). The study of iron dynamics in soil is important, especially in regions characterized by diverse topographic features. The influence of topography as a soil forming factor affects soil formation and distribution in any given agricultural landscape (Jimoh *et al.,* 2017). The set of soils formed as a result of topography acting primarily as soil forming factors are called toposequence (Olatunji *et al.*, 2015). The differences between the soils of a toposequence are generally related to differences in their positions and drainage patterns; however, slope steepness is one of the most important factors that causes variation in moisture condition along a toposequence (Ogunkunle, 1993; Obalum *et al.*, 2011; Olayinka *et al.*, 2015).

The nature of iron dispersion in the soil may serve as an indicator of the stage and degree of soil development and environmental conditions (Juo *et al.*, 1974; Udo, 1980; Mahaney and Fahey, 1988; Schwertmann and Taylor, 1989). Iron exists in various forms in the soils which can be evenly dispersed throughout the soil, concentrated in particular horizons, or found in morphological features such as nodules, mottles, and concretions (Ojanuga, 1979; Schwertmann and Taylor, 1989; Dolui and Chatto-padhyay, 1997). These forms significantly contribute to soil colour, structure, drainage, and nutrient availability, thereby influencing plant growth and overall ecosystem dynamics (Maniyunda *et al.*, 2014). Furthermore, iron acts as a catalyst for numerous biochemical processes within the soil, such as nitrogen fixation and nutrient cycling (Brady and Weil, 2016).

The topography of an area plays a pivotal role in shaping soil characteristics by impacting factors like soil moisture, temperature, and drainage patterns (Olayinka *et al.*, 2015; Jimoh *et al.,* 2017; Awwal, 2021). Specifically, the concept of toposequence, which refers to a sequence of soils formed on a slope, holds

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particular significance in understanding the distribution and transformation of iron in Basement Complex soils. As water flows downslope, it interacts with the soil, carrying and redistributing iron along with other elements. Consequently, variations in topography create distinct microenvironments that influence soil development and the accumulation patterns of iron (Olatunji *et al.*, 2015; Jimoh, 2015; Awwal, 2021).

The amount of amorphous iron oxides in most Alfisols and Ultisols derived from acidic parent rocks is comparatively higher than easily available iron oxides, which indicates lesser pedogenic processes taking place in these soils (Juo *et al*., 1974; Juo, 1980). Juo (1980) who characterized Alfisols and Ultisols in relation to their management for crop production, found that the content of amorphous iron oxides ranged from 0.05 to 0.2%, which comprised less than 10% of the total free iron oxides. Maniyunda *et al*. (2014) who studied forms of iron in soils formed on Basement Complex rocks in Kaduna State, asserts that parent rock type may influence the amount of total free iron oxides present in soil. Predominance of easily available and total reducible iron oxide in soils can be used to predict the developmental stage of soils (Juo *et al*., 1974; Olatunji *et al*., 2015). Previous studies considered the influence of parent material on iron distribution; however, this study focuses on its distribution as preconditioned by topography, being an important soil forming factor in a toposequence.

Giwa Local Government Area (LGA) of Kaduna State predominantly features Basement Complex soils derived from ancient rocks that form the region's geological foundation (Wright and McCurry, 1970; National Bureau of Statistics NBS, 2009; Maniyunda, 2012). These soils typically exhibit characteristics such as low fertility, high clay content, and highly weathered minerals (Malgwi *et al.*, 2002). Owing to their origins from diverse rock types and intricate geological processes, Basement Complex soils display considerable variability in terms of iron content and distribution (Maniyunda, 2012; Olayinka *et al*., 2015). This study investigates the influence of topography on the abundance of oxalate and citrate-bicarbonate-dithionite extractable forms of iron found in a toposequence formed on Basement Complex rocks within Giwa LGA, Kaduna State, Nigeria. Gaining an understanding of how toposequence influences the distribution of pedogenic forms of iron in these soils will assist in unraveling the intricate connection between soil developmental processes, landscape dynamics, and ecosystem functioning.

MATERIALS AND METHODS

Study Area

The research was done on an agricultural landscape situated in Hayin Gada, within the Giwa LGA, Kaduna State. This specific site occupies an area of ca. 15.55 ha and is positioned between Latitude 11°11′22.6"N to 11°11′12.3"N and Longitude 7°34′20.4"E to 7°34′32.5"E. The area is underlain by Basement Complex Rocks as shown by its geological map in Figure 1.

Zaria is located in a region characterized by a tropical savannah climate, which experiences separate wet and dry seasons (Abaje *et al.*, 2012). The wet season occurs between May and October, while the dry season typically spans from November to April. The mean annual rainfall in the area was 1071.7 mm between 1988 and 2018. Temperature variations range

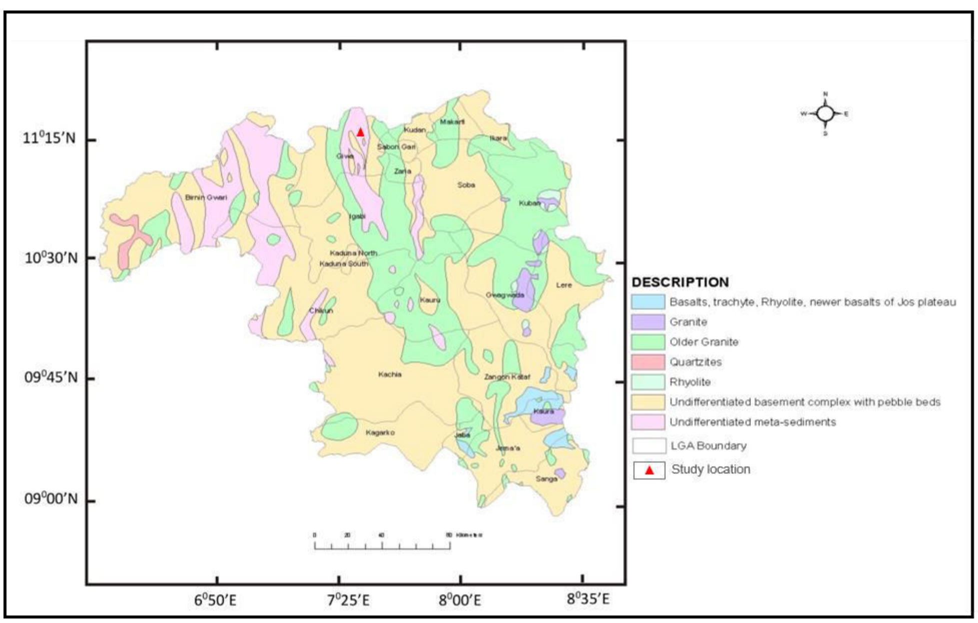


Figure 1: Geological Map of Kaduna State Showing the Study Location (National Bureau of Statistics NBS, 2009)

from around 20°C during cold nights to over 33°C on hot days, with an average of 27°C. Relative humidity during the dry season is ca. 16%, while it can reach up to 72% during the rainy season (IAR Meteorological Unit, 2020). The study area is in the Northern Guinea Savannah agro-ecological zone, which is typically open, sub-humid woodland savannah, predominantly covered with short to medium grasses (Suleiman, 2014).

Some notable shrub and tree species found in the region include *Parkia biglobosa, Mangifera indica, Adansonia digitata*, and *Musasp*. L. The uncultivated areas of the study site are mostly occupied by expansive grasses, primarily *Pennisetum typhodeum* and *Andropogon gayanus*. The study area is situated within the Kaduna Plains, which exhibit a vast and gently undulating topography with long slopes, except in the vicinity of Funtua and the Southern Nupe plains where the terrain is noticeably dissected. The dissection of the East-West watershed is believed to be a result of uplift along its axis, leading to the subsequent rejuvenation of rivers south of it. This is evidenced by the presence of terraces, gully erosion, and an increased number of stream tributaries (McCurry, 1973). The study area displays a medium textured dendritic drainage pattern, with a few inconspicuous mesas found on interfluves within Samaru, Zaria.

Field Studies

Field studies were conducted on an agrarian landscape located in Hayin Gada, Giwa LGA, along Zaria-Sokoto Road, North-East of the Ahmadu Bello University Teaching Hospital, Kaduna State, Nigeria. The studied landscape covered a total area of approximately 15.5 ha. The field investigations involved site identification, soil sampling, and the morphological description of profile pits. For the purpose of this study, a suitable toposequence was identified. Ground-truthing, based on morphological properties, was carried out to delineate distinct topographic positions within the area, which were then mapped at a detailed scale of 1:3,000. Three out of the five identified topographic positions, namely upper slope (US), middle slope (MS), and lower slope (LS), were selected for the study. Two profile pits were dug on each of the three slope positions along the toposequence. The pits were sampled based on genetic horizons according to the procedure described in Soil Survey Manual (Soil Science Division, 2017). Geographical locations of the profiles were recorded using a Geographical Positioning System (GPS) device. Figure 2 presents the various slope positions identified in the field, along with their corresponding elevations and profile pit locations.

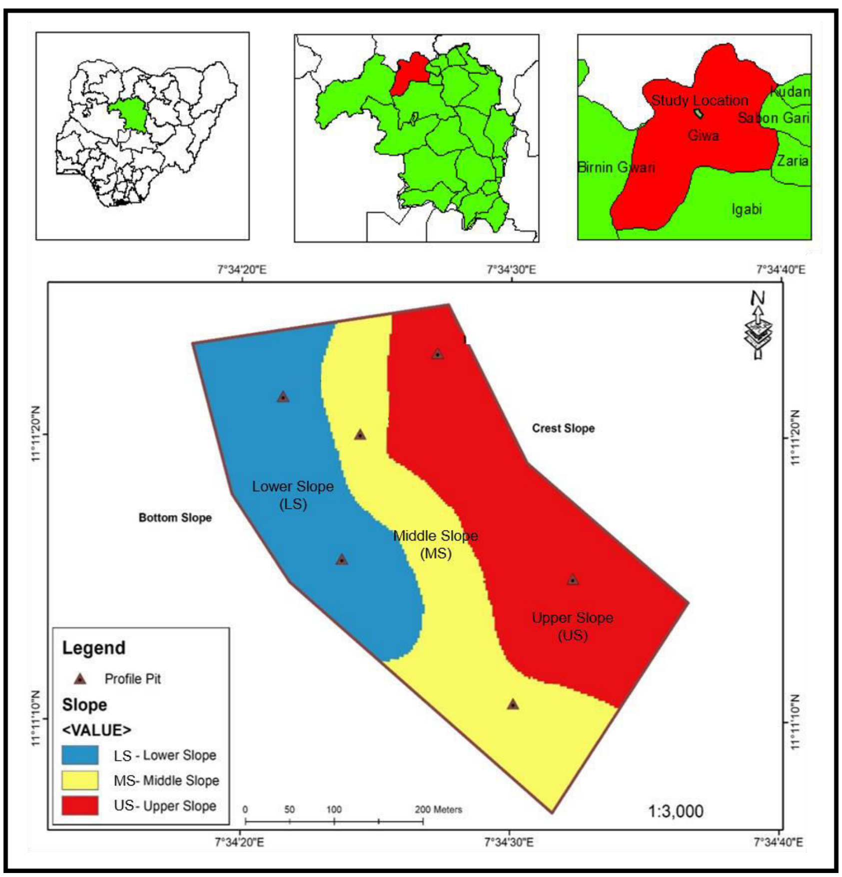


Figure 2: Map showing Nigeria, Kaduna State, Giwa Local Government Area and the study location

Laboratory Studies

Soil samples collected were passed through 2 mm aperture mesh and used for laboratory studies following standard laboratory methods. The hydrometer method of Gee and Or (2002) was utilized to determine the particle size distribution. Soil reaction was measured in a 1:1 soil-to-water paste. Cation exchange capacity (CEC) was determined through the neutral (pH 7.0) ammonium acetate (NH_4OAc) saturation method (Rhoades, 1982). Organic carbon (OC) content was determined using the Walkley-Black dichromate wet oxidation method (Nelson and Sommers, 1996), while available phosphorus was assessed using methods outlined in the soil laboratory manual (IITA, 1979).

To assess the extractable forms of Fe oxides (oxalate and citrate-bicarbonate-dithionite {CBD}), separate extractants were prepared and determined. Amorphous inorganic form of Fe oxide (oxalate extractable form) was extracted using ammonium oxalate (pH 3) in the dark (Mckeague and Day, 1966), using the modified Tamm's method as described by IITA (1979). Iron in the extract was determined using Atomic Absorption Spectrophotometer (AAS) at 280 nm wavelength. The free iron (citrate-bicarbonate-dithionite extractable form) was extracted using the Mehra and Jackson (1960) method as described by IITA (1979). The content of Fe in the extract was determined after ten times dilution on a Pye Unicam model Sp 192 atomic absorption spectrophotometer (AAS) at 280 nm wavelength.

Statistical Analysis

To evaluate the soil properties, descriptive statistics such as mean and range were employed. The mean differences in the extractable forms of iron present in the three slope positions were compared using a one-way analysis of variance. Means of the data recorded for the three different topographic positions were separated using least significant difference (LSD) at 0.05 level of significance. All analyses were conducted using SPSS Statistics 17.0 software (SPSS Inc., 2008).

RESULTS AND DISCUSSION

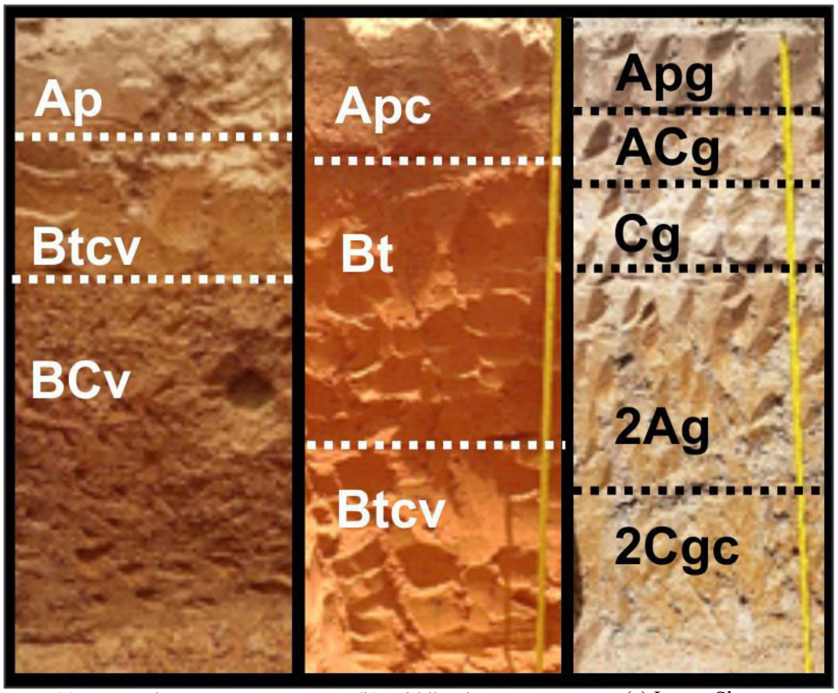
Morphological Properties

The studied landscape spanned 15.55 ha and it was characterized by a gently sloping terrain, with elevations ranging from 666-675 m asl. The soils in this area were divided into three slope positions: upper slope (US) with an area of 4.53 ha, middle slope (MS) with an area of 4.95 ha, and lower slope (LS) with an area of 6.07 ha.

The study area had generally deep soils (> 150 cm) with variations in depth across different slope positions. The LS position had an average depth of 190 cm, while the MS and US positions had depths ranging from 168.5 cm to 169 cm. Soil depth in LS was significantly higher ($p < 0.05$) than in MS and US, likely due to deposition processes. Similar trends have been reported on toposequence soils by several researchers (Idoga *et al.*, 2007; Maniyunda *et al.*, 2014; Awwal *et al.*, 2022). Earlier reports by Fagbami (1981), Raji (1995), Ezenwa and Esu (1999), and Idoga *et al.* (2007) attributed the extent of soil depth to a number of factors including parent material, erosion and slope of the area. Ogunkunle (1993) reported that soils on upper to mid slope position developed on Basement Complex rocks were found to be deep and attributed shallow depth on crest to erosion process. The restriction of soil depth by plinthite in MS and US affected effective soil depth and could resist root growth (Odunze, 2006).

The soils exhibited different colours, with LS having dark greyish brown (10YR 4/2, moist) to very dark grayish brown (10YR 3/2, moist) surface horizons (Figure 3). The grey coloration and presence of mottles in these soils was attributed to gleization due to poor drainage (Fawole *et al.,* 2016). Soils at MS have yellowish brown to strong brown colours (10YR 5/4, moist to 10YR 4/6, moist), while US slopes having yellowish red (10YR 4/6, moist) to dark yellowish brown (5YR 5/8, moist) colour. The yellowish-brown coloration of these (MS and US) soils indicates braunification as a significant pedo-genetic process taking place in the soils (Buol *et al.,* 1980) associated with improved drainage compared to the LS. It was noted that brightness of soil colour increased as slope position increased (i.e., US is brighter than MS, which is in turn brighter than LS). This can be explained in terms of improvement in drainage sequence (Khormali and Nabiollaby, 2007; Olatunji *et al.,* 2007; Jimoh, 2015). Few to common, distinct yellowish red (5YR 5/8, wet) mottles were noticed in subsurface soils of LS. This was attributed to the very poor drainage status of the soils. The presence of soft to hard Fe and Mn concretions were observed in the subsurface soils of MS and US. This indicated accumulation and aggregations of iron and manganese oxides resulting in plinthization. The presence of mottling and variations in soil colour proved useful in differentiating soils of LS. Mottling is often associated with variations in moisture levels and the presence of reduced iron and manganese compounds. In contrast, the differentiation of soils in MS and US relied on the presence of concretions, which are hardened masses of minerals, and the texture of the soil. These distinct features help distinguish soils across different slope positions within the toposequence.

The soil profile analysis revealed interesting characteristics and variations among the different positions on the toposequence. The Ap horizon, representing the topmost layer, generally exhibited clear and smooth horizon boundaries, indicating distinct soil layers. However, in one pit of the US profile, a wavy



(a) Upper Slope (b) Middle Slope (c) Lower Slope

Figure 3: Profile of representative pedons on the different slope positions

boundary was observed, suggesting potential disturbances or soil movement in that specific location. One noteworthy finding was the increase in the number of horizons with descending slope position. Soils on US had three horizons, MS had three to four horizons, and LS had the highest number of horizons with five distinct layers. This trend suggests a progressive development and differentiation of soil horizons as we move from the US to the LS. The pronounced horizonation between Ap horizon and the subsoil, compared to within the subsoil horizons, aligns with the findings of Hussaini (2011) and Maniyunda (2012), who attributed this phenomenon to the accumulation of organic matter and the subsequent humification process, resulting in melanization. Erosion of fine particles by surface runoff down the slope from higher positions could contribute to this process by exposing the underlying subsoil and facilitating the formation of additional horizons. Furthermore, the boundaries between subsurface horizons in MS and US were characterized by a diffuse and wavy pattern, indicative of the presence of plinthite. Plinthite is a hard, iron-rich layer formed due to the accumulation of clay minerals. Its occurrence suggests specific soil-forming processes and conditions unique to those slope positions.

The observed differences in horizonation among the slope positions was attributed to the dynamics of water movement within the toposequence landscape. Soils on LS exhibited more pronounced horizonation, likely due to recent deposition and higher water availability for horizon development. In contrast, MS and US experienced rapid surface runoff, limiting water movement through the soil profile and resulting in less developed and thinner horizons.

Physical and Chemical Properties

Table 1 presents the soil parameters in the different slope positions, while Table 2 shows the ranking of means of physical and chemical properties determined in the study area. The parameters include sand, silt and, clay contents, Si/C ratio, pH, cation exchange capacity (CEC), organic carbon (OC), and available phosphorus.

Sand content ranged from 605.2 to 785.2 g kg^{-1} across all slope positions. The mean sand content was highest in the US (711.87 g kg^{-1}), followed by the MS (699.49 g kg^{-1}) and the LS (671.20 g kg^{-1}). Silt content varied from 100 to 200 g kg^{-1}, with the mean content decreasing from the LS (163.00 g kg^{-1}) to the MS (130.00 g kg^{-1}) and the US (125.00 g kg^{-1}). Clay content ranged from 84.8 to 234.8 g kg^{-1}, with the highest mean content in the LS (184.80 g kg^{-1}), followed by the MS (170.51 g kg^{-1}) and the US (163.13 g kg^{-1}). Sand was the dominant particle size in the soils as supported by several earlier researchers who worked on Basement Complex soils (Fasina *et al.*, 2007; Voncir *et al.*, 2008; Obi and Akinbola, 2009; Ande, 2010; Maniyunda, 2012; Jimoh, 2015; Aliyu, 2016). This may also be attributed to erosion of medium to fine particles from US to MS and LS (Mortimore, 1970; Lawal *et al.*, 2013; Maniyunda and Gwari, 2014; Jimoh *et al.*, 2017).

Table 1: Showing means and ranges of some physical and chemical properties of soils in the study area

Soil Parameter	Unit	Lower Slope		Middle Slope		Upper Slope	
		Range	Mean	Range	Mean	Range	Mean
Sand content	g kg^{-1}	605.2 - 705.2	671.20	645.2 - 775.2	699.49	685.2 - 785.2	711.87
Silt content	g kg^{-1}	100.0- 200.0	163.00	100.0- 160.0	130.00	100.0– 130.0	125.00
Clay content	g kg^{-1}	94.8 - 234.8	184.80	94.8 - 214.8	170.51	84.8 - 194.8	163.13
Si/C		0.68 - 2.11	1.10	0.49 - 1.69	0.86	0.51 - 1.53	0.84
Soil pH		5.23 - 7.44	5.74	4.37 - 5.77	5.18	4.29 - 5.87	5.23
CEC	cmol(+)kg^{-1}	6.98 - 13.23	10.06	4.29 - 12.82	9.97	5.98 - 11.05	9.50
Organic carbon	g kg^{-1}	1.88 - 11.03	4.46	1.17 - 6.8	3.85	0.23 - 4.22	2.07
Available phosphorus	mg kg^{-1}	0.69 - 13.89	4.15	1.2 - 9.6	3.28	1.54 - 46.13	9.63

Table 2: Mean Ranking of Physical and Chemical Properties in Different Slope Positions

Parameter	Unit	LS	MS	US	SE±	LOS
Sand content	g kg^{-1}	671.20c	699.49b	711.87a	14.03	*
Silt content	g kg^{-1}	163.00a	130.00b	125.00c	12.87	*
Clay content	g kg^{-1}	184.80	170.51	163.13	15.64	NS
Si/C	-	1.10	0.86	0.84	0.18	NS
pH	-	5.74	5.18	5.23	0.22	NS
CEC	cmol(+)kg^{-1}	10.06	9.97	9.50	0.72	NS
OC	g kg^{-1}	4.46a	3.85b	2.07c	0.58	**
AvP	mg kg^{-1}	4.15	3.28	9.63	3.59	NS

Si/C - silt-clay ratio; CEC - cation exchange capacity; OC - organic carbon; av. P - available phosphorus. LOS - Level of Significance: NS (not significant) > 0.05, * ≤ 0.05, ** ≤ 0.01. Note: Means followed by the same letters in the rows are not significantly different at 5% LOS.

The Si/C ratio varied from 0.49 to 2.11, with the highest mean ratio in the LS (1.10), followed by the MS (0.86) and the US (0.84). As an indicator of soil weathering, Si/C being highest in LS suggests greatest weathering activities in this slope position (Obalum *et al.*, 2012). This is justified by frequent erosion of silt and clay fractions from surface soils in US and MS. Though there was no significant ($p < 0.05$) difference, the results suggest that the soils on LS were pedologically older than those on MS and US positions.

The soil pH values ranged between 4.29 and 7.44 across three slope positions of the study. The mean soil pH value was highest in the LS (5.74), followed by the US (5.23) and the MS (5.18). All the soils were generally acidic as often reported of Basement Complex soils (Jimoh, 2015; Aliyu, 2016; Awwal, 2021). However, LS had a higher mean pH (5.74) than MS (5.18) and US (5.23) slope positions (Table 2). This might be an indication of higher leaching taking place at the MS and US compared to the LS as suggested by Osinuga *et al*. (2022) who studied toposequence in Alabata, Southwest, Nigeria.

The soil CEC, which is an important indicator of soil fertility, ranged from 4.29 to 13.23 cmol(+)kg^{-1} across the study area. The mean CEC values were found to be similar among the three slope positions, with the LS position having a mean value of 10.06 cmol(+)kg^{-1}, the MS with 9.97 cmol(+)kg^{-1}, and the US with 9.50 cmol(+)kg^{-1}. The mean CEC values increased down the slope, from US to LS (Table 2), which implied that soils of LS will have higher nutrient retention capacity than soils of MS and US.

Soil organic carbon (OC) content varied from 0.23 to 11.03 g kg^{-1}. The mean OC content was highest in the LS (4.46 g kg^{-1}), followed by the MS (3.85 g kg^{-1}) and the US (2.07 g kg^{-1}). These values were rated low to medium for LS, and low for both MS and US. Slope position was found to significantly ($p < 0.001$) affect mean OC distribution in the study area (Table 2). The LS had higher mean organic OC which was similar to MS, both of which were significantly higher than US. Similar observations were reported by Brunner *et al.* (2004), Mulumba (2004), Essoka and Jaiyeoba (2008), Oku *et al*. (2010), Tsado *et al*. (2010), Lawal *et al.* (2014), and Osinuga *et al*. (2020) who studied toposequence soils. This was attributed to transportation and deposition of organic residues down slope. Available phosphorus levels ranged from 0.69 to 46.13 mg kg^{-1}, with the highest mean content in the US (9.63 mg kg^{-1}), followed by the LS (4.15 mg kg^{-1}) and then the MS (3.28 mg kg^{-1}). There were no significant differences among the different toposequence positions.

Pedologic Forms of Fe across the Slope Positions

Table 3 presents the oxalate and dithionite extractable forms of iron in soils across different slope positions within the study area. Additionally, it includes the Fe_{ox}/Fe_d ratio and the Fe_d/Clay ratio, all of which are presented in forms of bar charts in Figures 3(a-d).

The Fe_{ox} (oxalate extractable iron) values, which represented the concentration of iron readily available for plant uptake through chelation with oxalate extractant, ranged from 0.22 to 0.26% across all the slope positions. The highest Fe_{ox} value was observed in

Table 3: Ranking of means of oxalate and dithionite extractable forms of fe in different slope positions

Slope Position	Fe_{ox} (%)	Fe_d (%)	Fe_{ox}/Fe_d	Fe_d/Clay
LS	0.26	0.66b	0.42a	25.27b
MS	0.23	0.65b	0.43a	33.66a
US	0.22	0.85a	0.27b	19.06c
LOS	NS	*	*	*
SE ±	0.005	0.045	0.030	2.374

LOS - Level of Significance: NS (not significant), > 0.05, *≤0.05, **≤0.01. Note: Means followed by similar alphabets in the columns are not significantly different at 5% LOS.

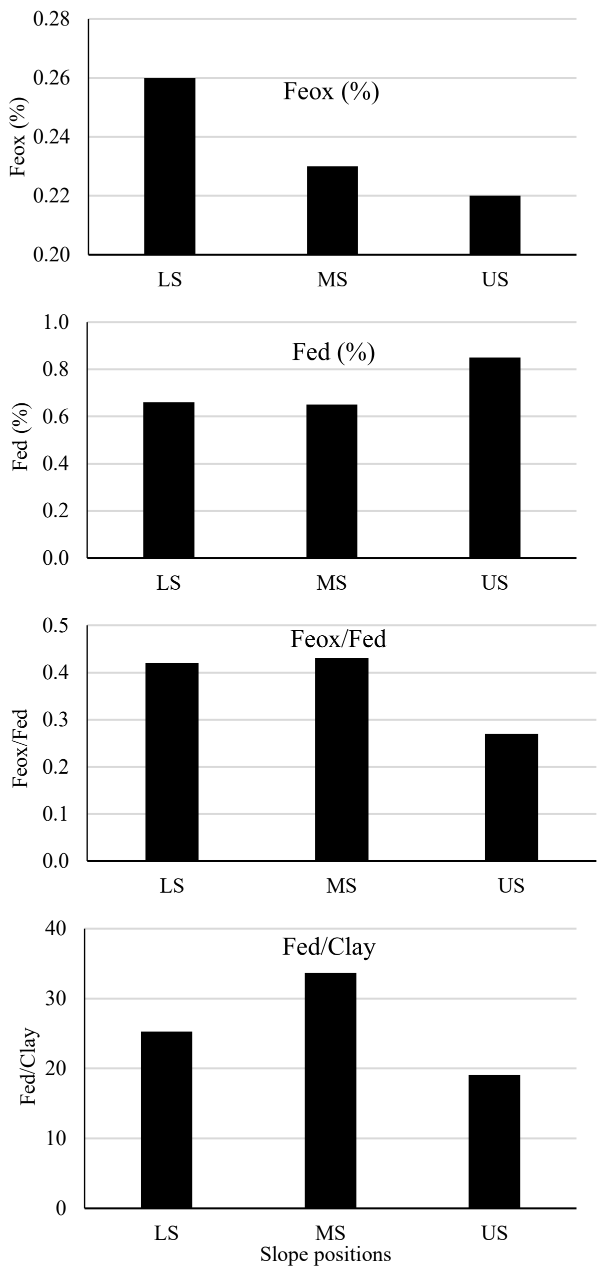


Figure 3(a): Mean Fe_{ox} (a), Fe_d (b), Fe_{ox}/Fe_d (c) and Fe_d/clay (d) in the study location

the LS (0.26%), followed by the MS (0.23%), and the lowest value was found in the US (0.22%). These values were generally within the ranges reported by earlier researchers who worked on Basement Complex soils of the Savanna (Mustapha and Singh, 2003; Yaro, 2005; Maniyunda, 2012). The Fe_d (dithionite extractable iron) values, which reflect the total reducible iron content in the soil, including crystalline and amorphous iron forms, ranged from 0.65 to 0.85%. The highest Fe_d value was observed in the US (0.85%), followed by the LS (0.66%), and the lowest value was found in the MS (0.65%) (Table 3). The Fe_{ox}/Fe_d ratio is the proportion of easily available iron to the total reducible iron content in the soil and its values as recorded ranged between 0.27 and 0.43 across all the slope positions studied.

The MS had the highest Fe_{ox}/Fe_d ratio (0.43), closely followed by LS (0.42), and the lowest ratio was found in the US (0.27). A higher Fe_{ox}/Fe_d ratio indicates a fairly larger proportion of readily available iron, which is desirable for plant nutrient uptake. The dominance of oxalate extractable iron indicates long-term weathering and soil maturation (Olatunji *et al*., 2015). The Fe_{ox}/Fe_d ratio is higher on the MS, followed by LS, and US had the lowest ratio. This indicates that soil development is in the preceding order of LS > MS > US, which is similar to the results of Si/C ratio.

The Fe_d/Clay ratio values is used to express the variations in iron retention capacity in relation to clay minerals present in the soil. From the results, MS exhibited the highest Fe_d/Clay ratio (33.66), followed by the LS (25.27), and the lowest ratio was found in the US (19.06). The higher Fe_d/Clay ratio in MS and LS in relation to US implies a higher affinity of Fe_d to clay minerals in the study area.

CONCLUSION

Iron is an important constituent of the earth's crust and its distribution in the soil as affected by topography can be used to investigate the dominant soil formation processes in the area. This study was on the influence of topography on the distribution of pedologic iron forms in Basement Complex rocks in northern Nigeria. Topography influenced a number of soil parameters, including particle size distribution and organic carbon content in the study area. Clay content was higher in the LS than in the MS and US, while sand content was higher in the US than in the MS and the LS. This signified translocation of finer particles from upper to lower slope position as preconditioned by topography. The Si/C ratio was also increased from the LS to the US, indicating higher weathering activities in the lower slope positions. The oxalate extractable iron (Fe_{ox}) values were highest in the LS (0.26%), indicating longer weathering and soil maturation; compared to in MS (0.23%) and US (0.22%). The dithionite extractable iron (Fe_d) values ranged from 0.65 to 0.85%, with the US having the highest concentration, indicating the availability of iron in more labile forms. The Fe_{ox}/Fe_d ratio ranged from 0.27 to 0.43, indicating a larger proportion of readily available iron in the MS. The Fe_d/Clay ratio ranged from 19.06 to 33.66, suggesting variations in iron retention capacity. Also, variations in clay mineralogy, organic carbon content and soil pH can also affect iron availability and retention in soils, hence, further investigation into the factors influencing iron dynamics in soils such as mineralogy, organic matter decomposition and redox processes are suggested explorations for further studies in the study area.

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