THE EFFECT OF SLOPE ASPECTS ON THE MORPHOLOGICAL, PHYSICAL, AND CHEMICAL PROPERTIES OF SOILS OF A MOUNTAINOUS AREA OF EASTERN OKLAHOMA

By

GODFREY A. UZOCHUKWU

Bachelor of Science in Agriculture

Oklahoma State University

Stillwater, Oklahoma

1979

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
December, 1980

THE EFFECT OF SLOPE ASPECTS ON THE MORPHOLOGICAL, PHYSICAL, AND CHEMICAL PROPERTIES OF SOILS OF A MOUNTAINOUS AREA OF EASTERN OKLAHOMA

Thesis Approved:

Thesis Adviser

Dean of Graduate College

ACKNOWLEDGMENTS

The author wishes to thank the Agronomy Department for the use of their facilities for this study. To Dr. Fenton Gray, the major adviser, I wish to extend special thanks for his honest interest and thoughtful guidance in the planning and preparation of this thesis and also throughout my graduate education. The author also appreciates the help of the committee members: Dr. Lester Reed and Dr. Wilfred McMurphy.

The author is grateful for the help of the following individuals: Thomas Reinsch, Edward Abernathy, and Kim Olszewski who helped to collect and describe the soil pedons.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The objective of this study is to measure the morphological, physical, and chemical properties of soils developed on north and south slope aspects of a mountainous area of Eastern Oklahoma and to use these properties in soil classification and land use interpretation. These properties are essential parts of soil survey reports. In the mountainous area of Eastern Oklahoma, there appears to be vegetative differences between north and south-facing slopes. Microclimate, vegetation, and soil differences are the result of slope orientation. The differences in microclimate, vegetation, and parent material produce differences in soil properties.

The research area (Figure 1) selected for the study is at the Winding Stair Mountains near the town of Poteau, Leflore County, Eastern Oklahoma. Little research has been done on this subject in this part of the state. The Oklahoma Highway Department, however, conducted some research but not for the mentioned purposes. The limiting factor in this study is insufficient climatic data.

Climate is known to affect vegetation indirectly and soil development from leaching, weathering, eluviation, and illuviation processes.

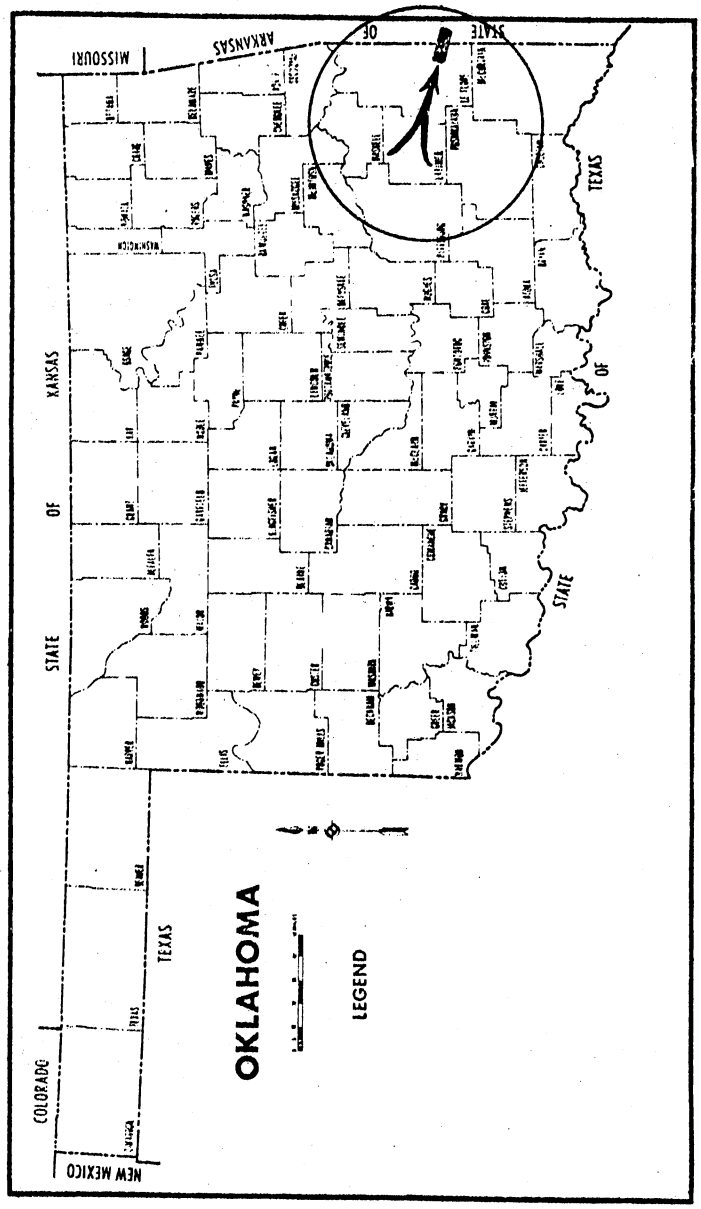


Figure 1. Location of the Study Area.

CHAPTER II

REVIEW OF LITERATURE

Relief is related to the following soil properties within specific geographic regions: depth of the solum, thickness and organic matter content of the A horizon, wetness of the profile, color of the profile, degree of differentiation, soil reaction, soluble salt content, temperature character of the initial material, and kind and degree of "pan" development. These conditions are more apt in humid regions where soils of nearly level relief tend to have thicker sola than those on slopes.

Different slope aspects support different vegetation due to climatic differences. Rainfall distribution is greatly affected by slope aspects. Forest canopy causes irregular distribution of rainfall which could be related to the kinds of tree. Soil temperatures are affected by forest vegetation. Soil moisture affects soil temperature and soil texture affects water movement. The type of canopy, leaf layer, soil texture and its moisture-holding capacity will affect the uniformity of soil temperature near the surface (14). The differing soil properties and plant associations are due to the effect of microclimate and vegetation acting upon similar parent material and relief (10). Slope influences the microclimate, soil moisture, movement and distribution of surficial materials. Temperature differences exist between the north and the south aspects. Temperatures are generally higher at the south slope aspect than their corresponding north slope aspects.

Microclimate and relief appear to have a greater effect on soil morphology and related physical properties than on soil chemical properties. Soils on the north-facing slopes are darker in color than those on the south-facing slopes. The soils on the north slopes have more organic matter throughout their solums (5). Organic matter is probably oxidized faster on the south slope aspects due to warmer temperatures. Leaves tend to remain on the north slope, but are washed off on the south slopes. The pedons in the lower slope positions appear to be mostly strongly developed in chroma and structure morphologically (13).

A comparison of soils on different slope positions shows some significant relationships. All the pedons have argillic horizons and were classified as Ultisols (5). Soils on the middle slope positions were all placed in skeletal families (5). In the upper slope positions, two profiles were clayey and two were fine-loamy (5). The soils were all high in silt. Ultisols are characterized by B horizons that contain large amounts of translocated clay (17). The surface horizons of Ultisols are generally sandy or loamy if erosion has not been severe while the subsurface horizons are clayey or loamy in texture (17).

Clay content increases downslope (1). Weathering of primary minerals is more rapid downslope and most of the clay present can be attributed to weathering of the underlying rock. Once clay formation begins, the soil has a higher water-holding capacity that results in accelerated clay formation as compared to soils in which clay contents are low.

Very little differences were found in most of the chemical properties (12, 13). The amounts and distribution of exchangeable cations, organic matter are about the same irrespective of slope aspects (12). Only minor differences in cation exchange capacity, pH, extractable

aluminum, and clay mineral distribution were found (13).

Ultisols are low base status soils. Base saturation is less than 35% by sum of cations (17). The bases are held in the vegetation and the upper few centimeters of the soil. In most Ultisols, the base saturation decreases with depth because vegetation has circled the bases. Ultisols are soils of warm humid climates. They are usually moist, but during the dry season of the year, they are dry part of the time. Other soils that may occur in the study area include Inceptisols and Alfisols.

Inceptisols occur in subhumid to humid climates. They develop mainly in the more clayey parent materials. Inceptisols may range from very poorly-drained to well-drained. These soils lack illuvial horizons enriched in silicate clays, gypsum, or salts. This condition makes it impossible for Inceptisols to have an argillic horizon.

Alfisols are high base status soils. Base saturation is more than 35% by sum of cations, but less than 50% (by NH_4OAc) in some subhorizons (17). Leaching of the bases from the soil may occur almost every year or may be infrequent (17). Alfisols are formed under forest vegetation. They are usually moist for 90 consecutive days during a period when temperature is suitable for plant growth (17). Alfisols have illuvial horizons. They are not as highly weathered as Ultisols.

CHAPTER III

FIELD PROCEDURE

Six sites were chosen on the north and south slope aspects of the Winding Stair Mountains. The sites were approximately sixty meters apart up and down the slope (Figure 2). Each slope aspect was divided into three sections consisting of top north, mid north, bottom north, and top south, mid south, and bottom south. The exact location of the study sites are given with Soil descriptions on pages 11 to 17. Soil profiles were examined and described on each of the six sites and the morphology of the soils determined in dug pits. The soil pedons occurring on each of the six sites were sampled in dug pits for physical and chemical analysis. The percent slope was measured at each of the six sites.

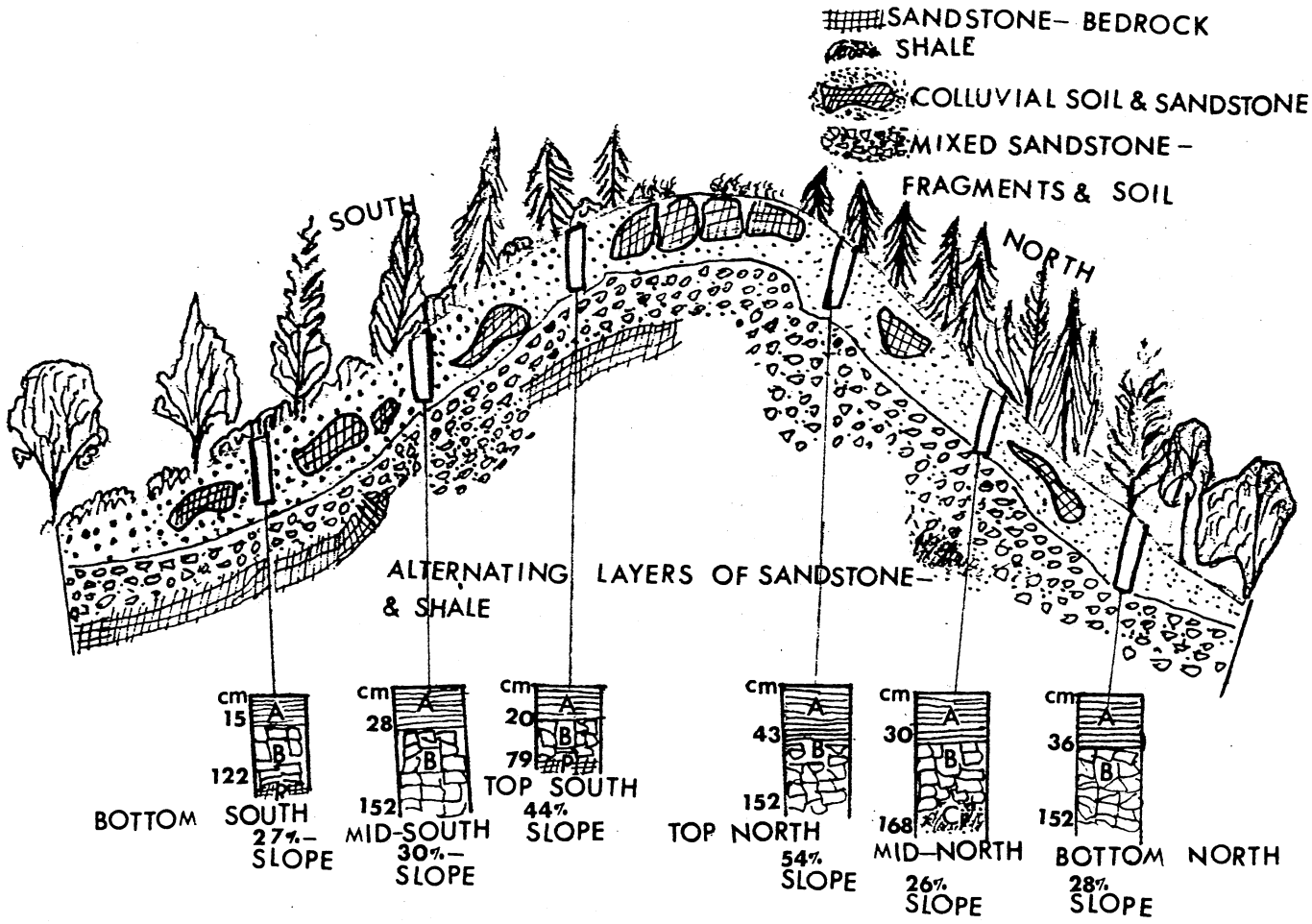


Figure 2. Generalized Diagram Showing the Relationship Between Vegetation, Parent Material, and Soil Pedons on the South-facing and North-facing Slopes.

CHAPTER IV

LABORATORY MATERIALS AND METHODS

Physical Analysis

Particle size distribution was determined on a 40 g sample by hydrometer method as described by the United States Salinity Staff (19).

Chemical Analysis

Samples were saturated with ammonium acetate to determine the cation exchange capacity and then determine the amount of exchangeable ammonium according to the procedures outlined by the United States Salinity Staff (19). This same procedure was used to determine the exchangeable cation except that samples were not saturated with sodium acetate and washed with 95% ethanol. Exchangeable sodium and potassium were determined on ammonium acetate extracts with the Perkin-Elmer atomic adsorption spectrophotometer (19). Calcium and magnesium were determined by the Versenate titration method. Corning pH meter was used to determine the soil pH on a 1:1 soil-water mixture and 1:1 soil-KCl mixture. Soil organic matter was determined by the potassium dichromate wet oxidation method of Schollenberger (15). Soil hydrogen was determined on a 10 g soil as discussed by Peech, Corrian, and Baker. Aluminum determination was according to procedures in Agronomy monographs (2).

CHAPTER V

RESULTS AND DISCUSSION

Physiography

The six study sites are located in the Winding Stair Mountains of Southeastern Oklahoma. Winding Stair Mountains stand at about 485 m to 545 m above the valleys. Mountain slopes are steep. Rock outcrops, sandstone rock, cobbles, and boulders of various diameters are common.

Geology

The study areas are located in the Ouachita Mountain Geological Province. Sandstones and shales are the dominant rock types (9). The relationship between sandstone, shale, boulder, and colluvial soil is shown in Figure 2 at the study sites. The study sites are dominated by alternating layers of sandstone and shale.

Climate

The study sites are located in a moist and humid area. Southeasterly winds prevail, bringing warm moist air from the Gulf of Mexico. Table I shows some soil temperature readings as recorded by the staff of the Soil Conservation Service at Poteau. The temperature readings were taken at the north and south slope aspects at elevations of 636 m and 364 m, at the depth of twenty inches with a thermometer, respectively.

TABLE I

SOIL TEMPERATURE STUDIES (DEPTH 20 INCHES) AT WINDING STAIR MOUNTAINS, LEFLORE COUNTY, EASTERN OKLAHOMA

Slope Aspect	Elevation (m)	1977 Sept. 9	1977 Dec. 12	1978 Mar. 14	1978 June 13	1978 Oct. 2	1978 Dec. 13	1979 Mar. 12	1979 June 12	1979 Sept. 19	1979 Dec. 20	1980 Mar. 18
		←					°F					→
North	636	66	44	39	63	65	41	41	64	63	38	44
North	364	69	43	43	67	68	49	46	65	65	42	47
South	636	67	49	44	63	68	48	47	64	66	43	46
South	364	70	49	46	68	72	51	49	67	69	47	50

The results show that the north slopes are slightly cooler than the south slopes. Soil temperatures are affected by forest vegetation. Forest canopy causes irregular distribution of rainfall which could be related to the kinds of trees. There are trees only at the north aspect while the south aspect supports trees mixed with grasses. The type of canopy, leaf layer, will affect the uniformity of soil temperature near the surface (14). Rainfall averages 137 to 142 cm per year (9).

Vegetation

The sites are composed of primarily forest land. The north-facing slopes consist of white oak (Quecus alba), northern red oak (Q. rubra), blackjack oak (Q. marilandica), post oak (Q. stellata), hickory (Carya spp.), maple (Acer saccharinum), black cherry (Prunus serotina), and shortleaf pine (Pinus echinata). The south-facing slopes consist of shortleaf pine, blackjack and post oak, hickory and scattered grasses. Figure 2 shows the representative vegetation on the north-facing and south-facing slopes.

Soil Descriptions

Top North

Location: 1000 m south and 400 m east of the northwest corner of Sec 17, T3N, R25E.

Slope: 54%

Parent Material: Colluvium

Soil Profile:

Horizon	Depth (cm)	Description (Colors are for moist soils)
A1	0-20	Very dark gray (10 YR 3/1), stony silt loam;

Horizon	Depth (cm)	Description (Colors are for moist soils)
		weak medium granular structure; friable; fine to medium roots; sandstone fragments 2 mm to 76 mm in diameter make up 10% by volume, 76 mm to 25 cm in diameter make up 3% by volume, and greater than 25 cm in diameter make up 21% by volume; extremely acid; clear wavy boundary.
A2	20-43	Dark yellowish brown (10 YR 4/4); stony loam; weak medium subangular blocky structure; friable; medium roots; sandstone fragments same as A1; very strongly acid; gradual wavy boundary.
B11	43-61	Dark yellowish brown (10 YR 4/4); gravelly loam; weak medium subangular blocky structure; friable; few medium roots; fragments of sandstone 2mm to 76 mm in diameter make up 25% by volume, and 76 mm to 25 cm in diameter make up 5% by volume; very strongly acid; gradual wavy boundary.
B12	61-84	Yellowish brown (10 YR 5/4); gravelly loam; moderate medium subangular blocky structure; firm coarse roots, sandstone fragments 2 mm to 76 mm make up 20% by volume and 76 mm to 25 cm make up 9% by volume; very strongly acid; gradual smooth boundary.
B21t	84-107	Strong brown (7.5 YR 5/6); gravelly loam; moderate medium blocky structure; firm; clay films on faces of peds; sandstone fragments 2 mm to 76 mm in diameter make up 25% by volume and 76 mm to 25 cm make up 20% by volume; very strongly acid; gradual wavy boundary.
B22t	107-152	Yellowish red (5 YR 5/6); gravelly clay loam; moderate medium subangular blocky structure; very firm; patchy clay films on the faces of peds; sandstone fragments same as in B22t; very strongly acid; gradual wavy boundary.

Mid North

Location: 990 m south and 300 m east of the northwest corner of Sec 17, T3N, R25E.

Slope: 26%

Parent Material: Colluvium (upper part of the solum) and Residuum from shale (lower part of the solum).

Soil Profile:

Horizon	Depth (cm)	Description (Colors are for moist soils)
A1	0-18	Very dark gray (10 YR 3/1); stony loam; moderate fine granular structure; very friable; many fine to medium roots; sandstone fragments 2 mm to 76 mm in diameter make up 10% by volume, 76 mm to 25 cm in diameter make up 3% by volume, and greater than 25 cm in diameter make up 23% by volume; strongly acid; clear wavy boundary.
A2	18-30	Dark grayish brown (10 YR 4.5/2) stony loam; moderate granular structure; friable; medium roots; sandstone fragments same as in A1; medium acid; gradual smooth boundary.
B1t	30-51	Strong brown (7.5 YR 5.5/6); gravelly clay loam; moderate subangular blocky structure; friable; medium roots; clay films on faces of peds; sandstone fragments 2 mm to 76 mm in diameter make up 25% by volume and 76 mm to 25 cm in diameter make up 7% by volume; strongly acid; gradual smooth boundary.
B21t	51-76	Strong brown (7.5 YR 5/6); gravelly clay loam; weak medium subangular blocky structure; firm; clay skins on faces of peds; sandstone fragments same as in B1; strongly acid; gradual smooth boundary.
IIB22t	76-114	Dark red (2.5 YR 3.5/6); clay; moderate angular blocky structure; firm; patchy clay films on faces of peds; sandstone fragments 2 mm to 76 mm make up 8% by volume and 76 mm to 25 cm make up 5% by volume; strongly acid; gradual smooth boundary.
IIB23t	114-150	Dark red (2.5 YR 3.5/6); clay; moderate angular blocky structure; firm; common fine and medium reddish mottles; patchy clay films on faces of peds; sandstone fragments same as in B22t; very strongly acid; abrupt irregular boundary.
IIICr	150-168	Gray shale (10 YR 5.5/1); massive; very firm; very strongly acid.

Bottom North

Location: 602 m south and 100 m east of northwest corner of Sec 17, T3N, R25E.

Slope: 28%

Parent Material: Colluvium

Soil Profile:

Horizon	Depth (cm)	Description (Colors are for moist soils)
A1	0-15	Very dark gray (10 YR 3/1); stony silt loam; moderate fine granular structure; friable; many fine roots; sandstone fragments 2 mm to 76 mm in diameter make up 15% by volume, 76 mm to 25 cm in diameter make up 17% by volume, and greater than 25 cm in diameter make up 21% by volume; strongly acid; abrupt boundary.
A2	15-36	Yellowish brown (10 YR 5.5/4); silt loam; moderate fine granular structure; friable; medium roots; sandstone fragments same as in A1; very strongly acid; clear wavy boundary.
B11	36-61	Light yellowish brown (10 YR 6.5/4); gravelly loam; weak subangular blocky structure; moderately firm; few medium roots; sandstone fragments 2 mm to 76 mm in diameter make up 25% by volume, 76 mm to 25 cm in diameter make up 18% by volume; very strongly acid; gradual smooth boundary.
B12	61-76	Reddish yellow (7.5 YR 6.5/6); gravelly loam; moderate medium subangular blocky structure; firm; few clay films on faces of peds; sandstone fragments same as in B1; strongly acid; gradual smooth boundary.
B21t	76-102	Strong brown (7.5 YR 5.5/6); gravelly clay loam; moderate medium subangular blocky structure; firm; clay films on faces of peds; sandstone fragments same as in B11; strongly acid; gradual smooth boundary.
B22t	102-152	Reddish yellow (5 YR 6/6); gravelly clay; moderate medium angular blocky structure; very firm; patchy clay films on faces of peds; few red mottles; sandstone fragments 2 mm to 76 mm in diameter make up 22% by volume and 76 mm to 25 cm make up 16% by volume; strongly acid.

Top South

Location: 300 m east and 100 m south of northwest corner of Sec 20, T3N, R25E.

Slope: 44%

Parent Material: Colluvium from sandstone

Soil Profile:

Horizon	Depth (cm)	Description (Colors are for moist soils)
A1	0-10	Very dark grayish brown (10 YR 3/2); stony sandy loam; weak fine medium granular structure; very friable; fine roots; sandstone fragments 2 mm to 76 mm in diameter make up 9% by volume, 76 mm to 25 cm in diameter make up 20% by volume; strongly acid; clear wavy boundary.
A2	10-20	Yellowish brown (10 YR 5/4); stony loam; moderate medium granular structure; very friable; medium roots; sandstone fragments same as in A1; very strongly acid; gradual wavy boundary.
B1	20-43	Yellowish brown (10 YR 5/4); gravelly loam; moderate fine granular structure; firm; sandstone fragments 2 mm to 76 mm in diameter make up 23% by volume, 76 mm to 25 cm in diameter make up 10% by volume; very strongly acid; gradual wavy boundary.
B21t	43-53	Yellowish brown (10 YR 5/4); gravelly loam; medium angular blocky structure; firm; clay films on faces of peds; sandstone fragments same as in B1; very strongly acid; gradual wavy boundary.
B22t	53-66	Strong brown (7.5 YR 5/6); gravelly clay loam; moderate medium subangular blocky structure; firm; clay films on faces of peds; sandstone fragments 2 mm to 76 mm in diameter make up 25% by volume and 76 mm to 25 cm make up 5% by volume; very strongly acid; gradual wavy boundary.
B23t	66-79	Red (2.5 YR 5/6); gravelly clay loam; moderate medium subangular blocky structure; firm; clay films on faces of peds; sandstone fragments same as in B22t; very strongly acid; gradual wavy boundary.

Horizon	Depth (cm)	Description (Colors are for moist soils)
R	79	Hard sandstone.

Mid South

Location: 300 m east and 166 m south of northwest corner of Sec 20, T3N, R25E.

Slope: 30%

Parent Material: Colluvium

Soil Profile:

Horizon	Depth (cm)	Description (Colors are for moist soils)
A1	0-13	Very dark gray (10 YR 3/1); stony loam; fine medium granular structure; friable; many fine and medium roots; sandstone fragments 2 mm to 76 mm in diameter make up 12% by volume, 76 mm to 25 cm in diameter make up 10% by volume and greater than 25 cm make up 24% by volume; very strongly acid; clear wavy boundary.
A2	13-28	Yellowish brown (10 YR 5/4); stony loam; moderate fine medium granular structure; very friable; medium roots; sandstone fragments same as in A1; very strongly acid; clear wavy boundary.
B1	28-43	Yellowish brown (10 YR 5/4); gravelly loam; moderate medium subangular blocky structure; firm; sandstone fragments 2 mm to 76 mm in diameter make up 30% by volume and 76 mm to 25 cm in diameter make up 10% by volume; very strongly acid; gradual wavy boundary.
B21t	43-64	Dark brown (7.5 YR 4/4); gravelly loam; moderate medium subangular blocky structure; firm; clay films on faces of peds; sandstone fragments same as in B1; very strongly acid; gradual wavy boundary.
B22t	64-74	Yellowish red (5 YR 4/6); gravelly clay loam; moderate medium subangular blocky structure; firm; clay films on faces of peds; sandstone fragments 2 mm to 76 mm make up 23% by volume and 76 mm to 25 cm make up 15% by volume; very strongly acid; gradual wavy boundary.

Horizon	Depth (cm)	Description (Colors are for moist soils)
B23t	74-152	Yellowish red (5 YR 5/6); gravelly clay loam; moderate medium subangular blocky structure; firm; clay films on faces of peds; sandstone fragments same as in B22t; very strongly acid.

Bottom South

Location: 300 m east and 227 m south of northwest corner of Sec. 20, T3N, R25E.

Slope: 27%

Parent Material: Colluvium from interbedded sandstone and shale.

Soil Profile:

Horizon	Depth (cm)	Description (Colors are for moist soils)
A1	0-8	Brown (10 YR 4/3); stony sandy loam; weak medium granular structure; friable; sandstone fragments 2 mm to 76 mm in diameter make up 10% by volume, 76 mm to 25 cm in diameter make up 5% by volume, and greater than 25 cm in diameter make up 24% by volume; extremely acid; clear wavy boundary.
A2	8-15	Brown (10 YR 5/3); stony sandy loam; weak medium granular structure; friable; sandstone fragments same as in A1; extremely acid, clear wavy boundary.
B1	15-33	Strong brown (7.5 YR 5/6); stony sandy loam; weak medium granular structure; friable; sandstone fragments 2 mm to 76 mm in diameter make up 10% by volume, 76 mm to 25 cm in diameter make up 5% by volume, and greater than 25 cm in diameter make up 23% by volume; extremely acid; gradual smooth boundary.
B21t	33-61	Red (2.5 YR 5/8); stony sandy clay loam; weak medium subangular blocky structure; firm; clay films on faces of peds; sandstone fragments same as in B1, extremely acid; gradual smooth boundary.
B22t	61-81	Red (2.5 YR 4/8); stony clay loam; weak medium subangular blocky structure; very firm; clay films on faces of peds; sandstone fragments

Horizon	Depth (cm)	Description (Colors are for moist soils)
		same as in B21t; extremely acid; gradual wavy boundary.
B23t	81-122	Red (2.5 YR 4/8); stony clay; weak medium subangular blocky structure; very firm; patchy clay films on faces of peds; sandstone fragments 2 mm to 76 mm in diameter make up 12% by volume, 76 mm to 25 cm in diameter make up 5% by volume, and greater than 25 cm in diameter make up 25% by volume; extremely acid.

Soil Morphological Properties

The morphology of all six soil pedons is summarized in Tables II to VII. The soil pedons on the north slope aspect are slightly darker in color than their corresponding soil pedons on the south slope aspect. When all the soil pedons are paired for slope, both opposite in aspect, some textural relationship exists. The texture of A1 horizon of the soil pedon at top north is stony silt loam (21% by volume of stones observed) while the texture of A1 horizon of the soil pedon at top south is stony sandy loam (20% by volume of stones observed). Top south contains more percent gravel by volume than top north and also is shallower. In the soil pedons at mid north and mid south, the texture of A1 and A2 horizons is stony loam. The texture of IIB22t and IIB23t horizon of the soil pedon at mid north is clay while the texture of B22t and B23t horizons of the soil pedon at mid south is gravelly clay loam. The texture of the A1 horizon of the soil pedon at bottom north is stony silt loam while the texture of the A1 horizon of the soil pedon at bottom south is stony sandy loam. The soil pedon at bottom south is dominated by stones in their Bt horizons while the Bt horizons of the soil pedon at bottom north are dominated by gravels. The solums of the

TABLE II

MORPHOLOGICAL, PHYSICAL, AND CHEMICAL DATA FOR TOP NORTH

FIELD SOIL TYPE: SITE 1† 54 PERCENT SLOPE
LOCATION: 3300' S AND 1320' E OF THE NW CORNER OF SEC. 17, T3N, R2SE
LEFLORE COUNTY, OKLAHOMA
SAMPLERS:

PROFILE DESCRIPTION:

SAMPLE NUMBER	HORIZON	DEPTH (CM.)	THICKNESS (CM.)	COLOR (M)	TEXTURE*	STRUCTURE	CONSISTENCE
80-OK-40-21- 1	A1	0- 20	20	10YR3/1		1MGR	MFR
80-OK-40-21- 2	A2	20- 43	23	10YR4/4		1MSBK	MFR
80-OK-40-21- 3	B11	43- 61	18	10YR4/4		1MSBK	MFI
80-OK-40-21- 4	B12	61- 84	23	10YR5/4		2MSBK	MFI
80-OK-40-21- 5	B21T	84-107	23	7.5YR5/6		2MSBK	MVFI
80-OK-40-21- 6	B22T	107-152	45	5YR5/6		2MSBK	MVFI

CHEMICAL DATA: ANALYST: UZOCHUKWU

SAMPLE NUMBER	PH:1 H2O	PH:1 KCL	CEC	EXTRACTABLE CATIONS, MEQ/100 GMS H	CA	MG	K	NA	AL	%BASE SATURATION NAAC	SUM OF CAT.	% OM
80-OK-40-21- 1	4.4	3.6	14.8	12.06	0.49	0.33	0.10	0.03	1.90	6.4	7.3	3.60
80-OK-40-21- 2	4.9	3.8	7.4	4.34	0.17	0.16	0.02	0.03	1.36	5.1	8.0	0.79
80-OK-40-21- 3	4.8	3.8	7.2	4.74	0.17	0.16	0.02	0.03	1.49	5.2	7.4	0.81
80-OK-40-21- 4	5.0	3.8	7.4	3.25	0.25	0.35	0.04	0.03	1.27	8.9	16.9	0.55
80-OK-40-21- 5	4.6	3.6	10.7	5.42	0.25	0.45	0.05	0.03	2.17	7.3	12.6	0.30
80-OK-40-21- 6	4.6	3.6	15.4	11.95	0.33	0.66	0.11	0.03	4.09	7.3	8.6	0.30

PHYSICAL DATA: ANALYST: UZOCHUKWU

SAMPLE NUMBER	%SAND	%SILT	%CLAY	TEXTURE	%>2MM	SAND SUBFRACTIONS %VCS	%CS	%MS	%FS	%VFS
80-OK-40-21- 1	36.5	51.8	11.7	SIL	13.9	1.4	0.9	3.8	19.0	11.4
80-OK-40-21- 2	44.2	42.9	12.9	L	12.3	2.9	1.2	4.8	22.8	12.5
80-OK-40-21- 3	42.3	42.6	15.2	L	17.2	4.1	1.3	5.5	20.4	11.0
80-OK-40-21- 4	47.8	36.5	15.7	L	19.9	7.1	2.3	8.1	19.9	10.5
80-OK-40-21- 5	48.2	29.0	22.8	L	25.4	6.7	2.7	5.2	21.4	12.3
80-OK-40-21- 6	36.0	28.2	35.8	CL	16.1	4.2	1.6	3.9	16.9	9.4

INTERPRETIVE CALCULATIONS:

SAMPLE NUMBER:	CA/MG	CEC/CLAY	ESP	CLAY FREE PARTICLE SIZE DISTRIBUTION SILT	VCS	CS	MS	FS	VFS
80-OK-40-21- 1	1.50	126.61	0.18	58.70	1.63	0.88	4.34	21.57	12.88
80-OK-40-21- 2	1.00	57.24	0.36	49.29	3.28	1.40	5.50	26.17	14.36
80-OK-40-21- 3	1.00	47.57	0.37	50.18	4.88	1.48	6.44	24.05	12.97
80-OK-40-21- 4	0.71	47.22	0.36	43.28	8.35	2.69	9.58	23.63	12.43
80-OK-40-21- 5	0.55	46.80	0.25	37.56	8.63	3.52	6.69	27.72	15.87
80-OK-40-21- 6	0.50	43.12	0.17	43.93	6.57	2.42	6.06	26.30	14.72

*Computer did not include the coarse fragments in the textural classes (see soil descriptions).
†Site 1 refers to top north.

TABLE III

MORPHOLOGICAL, PHYSICAL, AND CHEMICAL DATA FOR MID NORTH

FIELD SOIL TYPE: SITE 2+, 2% PERCENT SLOPE
LOCATION: 2970' S AND 990' E OF THE NW CORNER OF SEC 17 , T3N , R 25E
LEFLORE COUNTY , OKLAHOMA
SAMPLERS:

PROFILE DESCRIPTION:

SAMPLE NUMBER	HORIZON	DEPTH (CM.)	THICKNESS (CM.)	COLOR (M)	TEXTURE*	STRUCTURE	CONSISTENCE
80-OK-40-22- 1	A1	0- 18	18	10YR3/1		2MGR	MVFR
80-OK-40-22- 2	A2	18- 30	12	10YR4.5/2		1MGR	MFR
80-OK-40-22- 3	B1T	30- 51	21	7.5YR5.5/6		1MSBK	MFR
80-OK-40-22- 4	B21T	51- 76	25	5YR5/6		1MSBK	MFI
80-OK-40-22- 5	IIB22T	76-114	38	2.5YR3.5/6		2MABK	MFI
80-OK-40-22- 6	IIB23T	114-150	36	2.5YR3.5/6		2MABK	MFI
80-OK-40-22- 7	IIICR	150-168	18	10YR5.5/1		M	MVFI

CHEMICAL DATA: ANALYST: LZOCHOWSKI

	PH:1			EXTRACTABLE CATIONS, MEQ/100 GMS						%BASE SATURATION		%
SAMPLE NUMBER	H2O	KCL	CEC	H	CA	MG	K	NA	AL	NAAC	SUM OF CAT.	OM
80-OK-40-22- 1	5.2	4.5	11.9	8.67	2.68	1.52	0.38	0.06	0.54	39.0	34.9	4.55
80-OK-40-22- 2	5.6	4.5	9.6	6.23	0.66	0.54	0.25	0.05	0.81	22.5	19.3	1.67
80-OK-40-22- 3	5.5	4.3	7.2	5.89	0.82	0.29	0.21	0.05	1.63	19.0	18.9	0.55
80-OK-40-22- 4	5.2	4.2	8.2	7.79	0.82	0.41	0.24	0.06	2.44	18.6	16.5	0.17
80-OK-40-22- 5	5.1	4.0	20.8	25.91	0.41	1.24	0.39	0.07	8.94	10.1	7.6	0.17
80-OK-40-22- 6	4.9	3.8	21.5	28.32	0.41	0.66	0.38	0.08	9.49	7.2	5.1	0.17
80-OK-40-22- 7	4.6	3.9	31.2	24.32	0.25	0.70	0.27	0.06	10.84	4.1	5.0	0.17

PHYSICAL DATA: ANALYST: LZOCHOWSKI

						SAND SUBFRACTIONS				
SAMPLE NUMBER	%SAND	%SILT	%CLAY	TEXTURE	%>2MM	%VCS	%CS	%MS	%FS	%VFS
80-OK-40-22- 1	40.1	42.9	17.0	L	15.3	0.8	0.6	3.3	22.4	13.1
80-OK-40-22- 2	35.7	48.5	15.8	L	6.8	0.9	0.6	4.9	17.4	11.8
80-OK-40-22- 3	40.9	30.7	28.4	CL	4.3	1.4	0.7	3.8	21.5	13.6
80-OK-40-22- 4	43.1	23.5	33.4	CL	4.4	1.5	0.7	10.7	19.7	10.5
80-OK-40-22- 5	12.0	8.4	79.6	C	2.6	0.2	0.2	0.6	7.2	3.8
80-OK-40-22- 6	13.0	8.5	78.5	C	1.3	0.3	0.2	0.6	7.6	4.4
80-OK-40-22- 7	1.7	40.8	57.5	SIC	0.0	0.1	0.1	0.1	0.7	0.8

INTERPRETIVE CALCULATIONS:

				CLAY FREE PARTICLE SIZE DISTRIBUTION					
SAMPLE NUMBER:	CA/MG	CEC/CLAY	ESP	SILT	VCS	CS	MS	FS	VFS
80-OK-40-22- 1	1.76	69.91	3.50	51.66	0.97	0.71	3.92	26.95	15.79
80-OK-40-22- 2	1.23	42.04	0.73	57.64	1.11	0.69	5.86	20.71	13.99
80-OK-40-22- 3	2.86	25.53	0.67	42.91	1.95	0.95	5.25	29.98	18.97
80-OK-40-22- 4	2.00	24.64	0.72	35.29	2.26	1.06	16.00	29.60	15.80
80-OK-40-22- 5	0.33	26.16	0.34	41.06	1.06	0.75	3.07	35.16	18.88
80-OK-40-22- 6	0.43	27.34	0.38	39.50	1.29	1.00	2.65	35.27	20.29
80-OK-40-22- 7	0.35	54.14	0.19	56.02	0.12	0.12	0.18	1.65	1.91

*Computer did not include the the coarse fragments in the textural classes (see soil descriptions).
+Site 2 refers to mid north.

TABLE IV

MORPHOLOGICAL, PHYSICAL, AND CHEMICAL DATA FOR BOTTOM NORTH

FIELD SOIL TYPE: SITE 3+, 28 PERCENT SLOPE
LOCATION: 1987' S AND 333' E OF THE NW CORNER SEC 17, T3N , R 25E
LEFLORE COUNTY , OKLAHOMA
SAMPLERS:

PROFILE DESCRIPTION:

SAMPLE NUMBER	HORIZON	DEPTH (CM.)	THICKNESS (CM.)	COLOR (M)	TEXTURE*	STRUCTURE	CONSISTENCE
80-OK-40-23- 1	A1	0- 15	15	10YR3/1		2MGR	MFR
80-OK-40-23- 2	A2	15- 36	21	10YR5.5/4		1MGR	MFR
80-OK-40-23- 3	B11	36- 61	25	10YR6.5/4		1MSBK	MFI
80-OK-40-23- 4	B12	61- 76	15	7.5YR6.5/6		1MSBK	MFI
80-OK-40-23- 5	B21T	76-102	26	7.5YR5.5/6		2MSBK	MFI
80-OK-40-23- 6	B22T	102-152	50	5YR6/6		1MABK	MVFI

CHEMICAL DATA: ANALYST: UZOCHUKWU

SAMPLE NUMBER	PH:1 H2O	PH:1 KCL	CEC	EXTRACTABLE CATIONS, MEQ/100 GMS H	CA	MG	K	NA	AL	%BASE SATURATION NAAC	SUM OF CAT.	% OM
80-OK-40-23- 1	5.5	4.4	16.8	11.25	2.49	1.63	0.37	0.04	0.27	26.9	28.7	4.97
80-OK-40-23- 2	5.0	4.1	5.4	3.66	0.24	0.16	0.15	0.03	0.84	10.9	14.0	1.05
80-OK-40-23- 3	5.0	4.1	5.8	3.52	0.17	0.63	0.14	0.19	1.06	19.4	24.3	0.55
80-OK-40-23- 4	5.4	4.2	5.8	3.52	0.17	0.66	0.19	0.03	1.19	17.7	22.7	0.30
80-OK-40-23- 5	5.3	4.1	7.4	5.42	0.21	1.03	0.24	0.02	1.41	20.3	21.7	0.28
80-OK-40-23- 6	5.0	4.0	16.7	11.52	0.17	1.48	0.32	0.06	5.31	12.2	15.0	0.19

PHYSICAL DATA: ANALYST: UZOCHUKWU

SAMPLE NUMBER	%SAND	%SILT	%CLAY	TEXTURE	%>2MM	SAND SUBFRACTIONS %VCS	%CS	%MS	%FS	%VFS
80-OK-40-23- 1	24.7	62.7	12.6	SIL	10.8	0.4	0.3	2.7	16.1	5.2
80-OK-40-23- 2	31.1	51.4	17.6	SIL	10.7	0.8	0.5	3.0	16.1	10.7
80-OK-40-23- 3	35.7	44.8	19.5	L	6.6	1.0	0.8	3.9	18.8	11.3
80-OK-40-23- 4	41.2	36.7	22.1	L	9.3	0.8	0.7	10.9	18.8	10.2
80-OK-40-23- 5	40.3	27.9	31.9	CL	19.5	2.7	2.5	5.1	19.1	10.9
80-OK-40-23- 6	23.9	13.6	62.5	C	2.9	1.5	0.8	1.8	12.1	7.7

INTERPRETIVE CALCULATIONS:

SAMPLE NUMBER:	CA/MG	CEC/CLAY	ESP	CLAY FREE PARTICLE SIZE DISTRIBUTION SILT	VCS	CS	MS	FS	VFS
80-OK-40-23- 1	1.53	133.42	0.24	71.76	0.42	0.33	3.09	18.39	6.00
80-OK-40-23- 2	1.48	31.02	0.57	62.31	0.93	0.59	3.66	19.48	13.03
80-OK-40-23- 3	0.26	30.01	3.29	55.64	1.26	0.94	4.89	23.29	13.98
80-OK-40-23- 4	0.25	26.39	0.53	47.08	0.95	0.92	13.94	23.94	13.14
80-OK-40-23- 5	0.20	23.13	0.30	40.89	3.96	3.67	7.43	28.05	16.00
80-OK-40-23- 6	0.11	26.67	0.34	36.28	3.94	2.09	4.78	32.41	20.51

*Computer did not include the coarse fragments in the textural classes (see soil descriptions).
+Site 3 refers to bottom north.

TABLE V

MORPHOLOGICAL, PHYSICAL, AND CHEMICAL DATA FOR TOP SOUTH

FIELD SOIL TYPE: SITE 4+, 44 PERCENT SLOPE
LOCATION: 990' E AND 330' S OF THE NW CORNER OF SEC. 28 , T 3N ,R 25E
LEFLORE COUNTY ,OKLAHOMA
SAMPLERS:

PROFILE DESCRIPTION:

SAMPLE NUMBER	HORIZON	DEPTH (CM.)	THICKNESS (CM.)	COLOR (M)	TEXTURE*	STRUCTURE	CONSISTENCE
80-OK-40-24- 1	A1	0- 10	10	10YR3/2		1MGR	MVFR
80-OK-40-24- 2	A2	10- 20	10	10YR5/4		2MGR	MVFR
80-OK-40-24- 3	B1	20- 43	23	10YR5/4		2MGR	MFI
80-OK-40-24- 4	B21T	43- 53	10	10YR5/4		2MABK	MFI
80-OK-40-24- 5	B22T	53- 66	13	7.5YR5/6		2MSBK	MFI
80-OK-40-24- 6	B23T	66- 79	13	2.5YR5/6		2MSBK	MFI

CHEMICAL DATA: ANALYST: UZOCHUKWU

	PH1:1			EXTRACTABLE CATIONS, MEQ/100 GMS						%BASE SATURATION		%
SAMPLE NUMBER	H2O	KCL	CEC	H	CA	MG	K	NA	AL	NVAC	SUM OF CAT.	OM
80-OK-40-24- 1	5.1	3.9	10.5	6.64	1.22	0.84	0.16	0.04	0.00	21.6	25.4	3.28
80-OK-40-24- 2	4.6	3.9	7.6	5.96	0.17	0.33	0.10	0.02	1.36	8.2	9.4	1.13
80-OK-40-24- 3	4.6	3.9	6.4	5.42	0.17	0.31	0.11	0.05	1.36	9.9	10.5	0.60
80-OK-40-24- 4	4.5	3.7	7.4	5.83	0.17	0.37	0.12	0.02	2.41	9.1	10.4	0.66
80-OK-40-24- 5	4.6	3.7	12.0	9.49	0.17	0.37	0.15	0.02	2.96	6.0	7.0	0.67
80-OK-40-24- 6	4.6	3.8	16.2	12.20	0.17	1.07	0.24	0.03	3.79	9.3	11.0	0.42

PHYSICAL DATA: ANALYST: UZOCHUKWU

						SAND SUBFRACTIONS				
SAMPLE NUMBER	%SAND	%SILT	%CLAY	TEXTURE	%>2MM	%VCS	%CS	%MS	%FS	%VFS
80-OK-40-24- 1	52.9	33.6	13.6	SL	12.1	1.7	0.6	5.1	36.6	8.9
80-OK-40-24- 2	46.8	38.9	14.2	L	7.1	1.0	0.4	5.9	31.1	8.4
80-OK-40-24- 3	41.6	42.4	16.0	L	13.8	1.1	0.4	4.2	28.5	7.4
80-OK-40-24- 4	40.3	37.9	21.7	L	18.9	1.7	0.6	3.3	26.7	8.1
80-OK-40-24- 5	41.2	31.1	27.8	CL	32.4	2.1	0.9	4.2	26.0	8.0
80-OK-40-24- 6	32.4	33.2	34.5	CL	32.4	3.4	1.1	3.6	18.6	5.6

INTERPRETIVE CALCULATIONS:

				CLAY FREE PARTICLE SIZE DISTRIBUTION					
SAMPLE NUMBER:	CA/MG	CEC/CLAY	ESP	SILT	VCS	CS	MS	FS	VFS
80-OK-40-24- 1	1.45	77.13	0.38	38.82	1.93	0.73	5.92	42.35	10.24
80-OK-40-24- 2	0.50	53.16	0.29	45.40	1.18	0.50	6.83	36.29	9.81
80-OK-40-24- 3	0.53	40.11	0.82	50.53	1.29	0.51	4.96	33.91	8.80
80-OK-40-24- 4	0.45	34.07	0.30	48.47	2.15	0.79	4.15	34.10	10.34
80-OK-40-24- 5	0.45	43.05	0.19	43.01	2.94	1.19	5.78	36.03	11.05
80-OK-40-24- 6	0.15	47.02	0.19	50.63	5.24	1.68	5.56	28.41	8.48

*Computer did not include the coarse fragments in the textural classes (see soil descriptions).
+Site 4 refers to top south.

TABLE VI

MORPHOLOGICAL, PHYSICAL, AND CHEMICAL DATA FOR MID SOUTH

FIELD SOIL TYPE: SITE 5+, 30 PERCENT SLOPE
LOCATION: 990' E AND 550' S OF THE NW CORNER OF SEC 20 ,T 3N ,R 2SE
LEFLORE COUNTY ,OKLAHOMA
SAMPLERS:

PROFILE DESCRIPTION:

SAMPLE NUMBER	HORIZON	DEPTH (CM.)	THICKNESS (CM.)	COLOR (M)	TEXTURE*	STRUCTURE	CONSISTENCE
80-OK-40-25- 1	A1	0- 13	13	10YR3/1		1MGR	MVFR
80-OK-40-25- 2	A2	13- 28	15	10YR5/4		2MGR	MFR
80-OK-40-25- 3	B1	28- 43	15	10YR5/4		1MSBK	MFI
80-OK-40-25- 4	B21T	43- 64	21	7.5YR4/4		1MSBK	MFI
80-OK-40-25- 5	B22T	64- 74	10	5YR4/6		2MSBK	MFI
80-OK-40-25- 6	B23T	74-152	78	5YR5/6		2MSBK	MFI

CHEMICAL DATA: ANALYST: UZOCHUKWU

SAMPLE NUMBER	PH:1 H2O	PH:1 KCL	CEC	EXTRACTABLE CATIONS, MEQ/100 GMS H	CA	MG	K	NA	AL	%BASE SATURATION NAAC	SUM OF CAT.	% OM
80-OK-40-25- 1	5.0	3.9	11.5	10.43	1.24	0.41	0.04	0.04	1.11	15.0	14.2	3.77
80-OK-40-25- 2	4.9	4.0	7.9	7.25	0.41	0.41	0.04	0.04	1.04	11.3	11.0	1.66
80-OK-40-25- 3	4.9	4.0	7.3	5.56	0.41	0.08	0.03	0.05	1.03	7.9	8.8	1.15
80-OK-40-25- 4	5.0	3.9	9.4	8.54	0.33	0.25	0.03	0.03	1.98	6.8	7.0	0.92
80-OK-40-25- 5	4.8	3.7	15.3	13.01	0.37	0.29	0.08	0.03	4.07	5.0	5.6	0.55
80-OK-40-25- 6	4.8	3.6	15.8	13.41	0.41	0.41	0.11	0.03	3.79	6.1	6.7	0.55

PHYSICAL DATA: ANALYST: UZOCHUKWU

SAMPLE NUMBER	%SAND	%SILT	%CLAY	TEXTURE	%>2MM	SAND SUBFRACTIONS %VCS	%CS	%MS	%FS	%VFS
80-OK-40-25- 1	45.8	40.4	13.8	L	9.2	1.2	0.5	5.7	29.7	8.7
80-OK-40-25- 2	44.6	40.6	14.7	L	18.7	1.1	0.3	5.3	26.9	11.1
80-OK-40-25- 3	45.3	39.6	15.1	L	12.7	1.3	0.6	5.2	27.5	10.7
80-OK-40-25- 4	42.0	36.7	21.3	L	20.6	1.2	0.3	4.9	25.9	9.7
80-OK-40-25- 5	39.6	25.1	35.3	CL	20.2	2.3	1.1	4.3	24.3	7.7
80-OK-40-25- 6	39.7	26.1	34.1	CL	26.6	1.9	0.5	6.4	22.5	8.4

INTERPRETIVE CALCULATIONS:

SAMPLE NUMBER:	CA/MG	CEC/CLAY	ESP	CLAY FREE PARTICLE SIZE DISTRIBUTION SILT	VCS	CS	MS	FS	VFS
80-OK-40-25- 1	3.00	83.26	0.34	46.84	1.40	0.54	6.67	34.44	10.12
80-OK-40-25- 2	1.00	53.90	0.50	47.65	1.25	0.38	6.20	31.57	12.96
80-OK-40-25- 3	5.01	46.44	0.72	46.68	1.58	0.70	6.12	32.34	12.58
80-OK-40-25- 4	1.34	43.87	0.28	46.59	1.55	0.36	6.23	32.91	12.35
80-OK-40-25- 5	1.29	43.25	0.17	38.86	3.49	1.63	6.59	37.51	11.92
80-OK-40-25- 6	1.00	46.19	0.17	39.67	2.84	0.83	9.76	34.20	12.71

*Computer did not include the coarse fragments in the textural classes (see soil descriptions).
+Site 5 refers to Middle south.

TABLE VII

MORPHOLOGICAL, PHYSICAL, AND CHEMICAL DATA FOR BOTTOM SOUTH

FIELD SOIL TYPE: SITE 6+,27 PERCENT SLOPE
LOCATION: 550' E AND 750' S OF THE NW CORNER OF SEC 20 , T 3N , R 25E
LEFLORE COUNTY ,OKLAHOMA
SAMPLERS:

PROFILE DESCRIPTION:

SAMPLE NUMBER	HORIZON	DEPTH (CM.)	THICKNESS (CM.)	COLOR (M)	TEXTURE*	STRUCTURE	CONSISTENCE
80-OK-40-26- 1	A1	0- 8	8	10YR4/3		1MGR	MFR
80-OK-40-26- 2	A2	8- 15	7	10YR5/3		1MGR	MFR
80-OK-40-26- 3	B1	15- 33	18	7.5YR5/6		1MGR	MFR
80-OK-40-26- 4	B21T	33- 61	28	2.5YR5/8		1MSBK	MFI
80-OK-40-26- 5	B22T	61- 81	20	2.5YR4/8		1MSBK	MVFI
80-OK-40-26- 6	B23T	81-122	41	2.5YR4/8		1MSBK	MVFI

CHEMICAL DATA: ANALYST: UZOCHUKWU

	PH 1:1			EXTRACTABLE CATIONS, MEQ/100 GMS						%BASE SATURATION		%
SAMPLE NUMBER	H2O	KCL	CEC	F	CA	MG	K	NA	AL	NAAC	SUM OF CAT.	OM
80-OK-40-26- 1	4.1	3.6	10.3	7.93	0.41	0.54	0.04	0.07	1.19	10.5	11.7	3.09
80-OK-40-26- 2	4.3	3.8	7.8	6.23	0.33	0.47	0.02	0.04	1.22	11.0	12.2	2.56
80-OK-40-26- 3	4.2	3.9	5.7	3.93	0.25	0.23	0.02	0.03	1.15	9.2	11.7	0.72
80-OK-40-26- 4	4.3	3.7	12.1	7.93	0.25	0.17	0.04	0.03	2.94	4.0	5.7	0.42
80-OK-40-26- 5	4.0	3.5	19.0	12.20	0.17	0.16	0.11	0.04	4.38	2.5	3.7	0.42
80-OK-40-26- 6	4.0	3.4	29.9	20.33	0.12	0.18	0.14	0.07	7.62	1.7	2.5	0.30

PHYSICAL DATA: ANALYST: UZOCHUKWU

						SAND SUBFRACTIONS				
SAMPLE NUMBER	%SAND	%SILT	%CLAY	TEXTURE	%>2MM	%VCS	%CS	%MS	%FS	%VFS
80-OK-40-26- 1	66.9	20.6	12.5	SL	14.5	1.9	1.2	19.8	34.5	9.5
80-OK-40-26- 2	52.2	39.3	8.5	SL	11.6	1.6	1.2	11.8	27.8	9.8
80-OK-40-26- 3	58.0	30.0	12.0	SL	5.8	1.0	0.9	18.3	28.7	9.0
80-OK-40-26- 4	48.0	27.7	24.3	SCL	7.1	1.0	0.7	9.3	28.4	8.6
80-OK-40-26- 5	40.6	21.9	37.5	CL	8.3	1.1	0.7	8.4	22.5	7.8
80-OK-40-26- 6	24.3	19.3	56.4	C	9.0	0.6	0.2	2.9	15.6	5.0

INTERPRETIVE CALCULATIONS:

				CLAY FREE PARTICLE SIZE DISTRIBUTION					
SAMPLE NUMBER:	CA/MG	CEC/CLAY	ESP	SILT	VCS	CS	MS	FS	VFS
80-OK-40-26- 1	0.77	80.15	0.70	23.57	2.14	1.38	22.59	39.47	10.85
80-OK-40-26- 2	0.70	91.71	0.51	42.92	1.80	1.34	12.86	30.37	10.71
80-OK-40-26- 3	1.09	47.16	0.47	34.07	1.17	1.05	20.83	32.64	10.24
80-OK-40-26- 4	1.47	49.83	0.22	36.59	1.31	0.97	12.22	37.52	11.40
80-OK-40-26- 5	1.00	50.70	0.21	35.07	1.69	1.19	13.51	35.97	12.56
80-OK-40-26- 6	0.68	53.04	0.23	44.30	1.35	0.56	6.76	35.67	11.37

*Computer did not include the coarse fragments in the textural classes (see soil descriptions).
+Site 6 refers to bottom south.

soil pedons at the north slope aspect seem to be more developed than their corresponding south slope pedons. Granular and blocky are the dominant structures found in all the sites except for the IIICr horizon at mid south which is massive. The consistence ranges from friable to firm in all the pedons at all the sites (for a complete soil description see pages 11 to 18).

Soil Physical Properties

The particle size distribution of all six soil pedons is summarized in Tables II to VII. Some differences in particle size distribution is observed when all the soil pedons are paired for slope both opposite in aspect. The A1 and A2 horizons of the soil pedon at top north have more silt percentage (51.8 and 42.9) than the A1 and A2 horizons of the soil pedon at top south (33.6 and 38.9). The A1 and A2 horizons of the soil pedon at mid north contains more silt (42.9 and 48.5) than the A1 and A2 horizons of the soil pedon at mid south (40.4 and 40.6). The IIB22t and IIB23t horizons of the soil pedon at mid north have a very low silt content (8.4 and 8.5) when compared with their corresponding B22t and B23t horizons of the soil pedon at mid south (36.7 and 25.1). The low silt content can be attributed to a change in parent material from colluvium to residuum from shale. The A1 and A2 horizons of the soil pedon at bottom north have more silt percentage (62.7 and 51.4) than the A1 and A2 horizons of the soil pedon at bottom south (20.6 and 39.3).

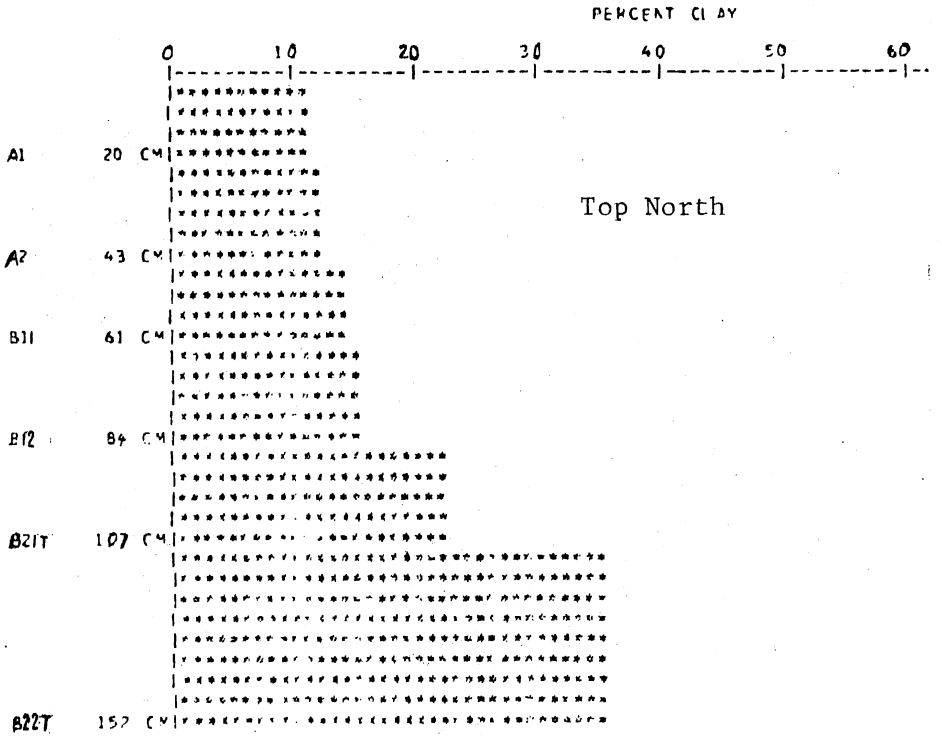
The highest sand percentage (48.2) was found in the B22t horizon of the soil pedon at top north while the highest sand percentage (52.9) was found in the A1 horizon of the soil pedon at top south. The horizons of the soil pedon at mid north had sand percentage ranging from

39.6 at the B22t horizon to 45.8 at the A1 horizon. In general, the soil pedons at the north slope aspect have a lower sand percentage than the corresponding south slope aspect pedons.

The clay percentage in the horizons of the soil pedon at top north ranges from 11.7 in the A1 horizon to 35.8 in the B22t horizon. The clay percentage ranges from 13.6 in the A1 horizon to 34.5 in the B23t horizon in the soil pedon at top south. The clay percentage of the soil horizons of the soil pedon at mid north ranges from 17.0 in the A1 to 79.6 in the IIB22t horizon. Figure 4 shows that the maximum clay accumulation occurs in the IIB22t horizon at mid north. This high clay accumulation can be attributed to the weathering of the underlying rock. Clay content increases downslope. Once the clay accumulation begins, the soil has a higher water-holding capacity that results in accelerated clay formation. In the soil pedon at mid south, the clay percentage ranges from 13.8 in the A1 horizon to 35.3 in the B22t horizon. The B22t horizon of the soil pedon at bottom north has the highest clay percentage (62.5). Clay percentage of the soil pedon at bottom south is 56.4 in the B23t horizon. There is an increase in clay content with depth at bottom north and bottom south. Soil pedons at the north slope aspect have more clay accumulation than the south slope aspect pedons (Figures 3 to 5).

Soil Chemical Properties

The soil chemical analysis for all the pedons at top north, mid north, bottom north, top south, mid south, and bottom south is summarized in Tables II to VII.



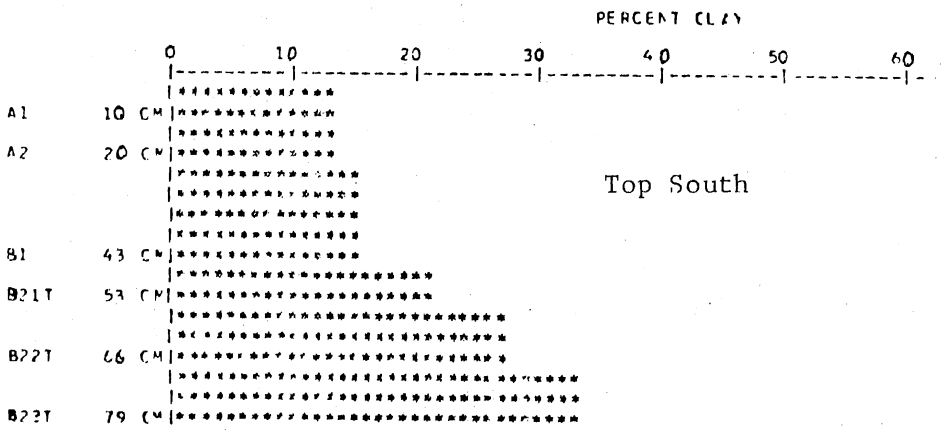
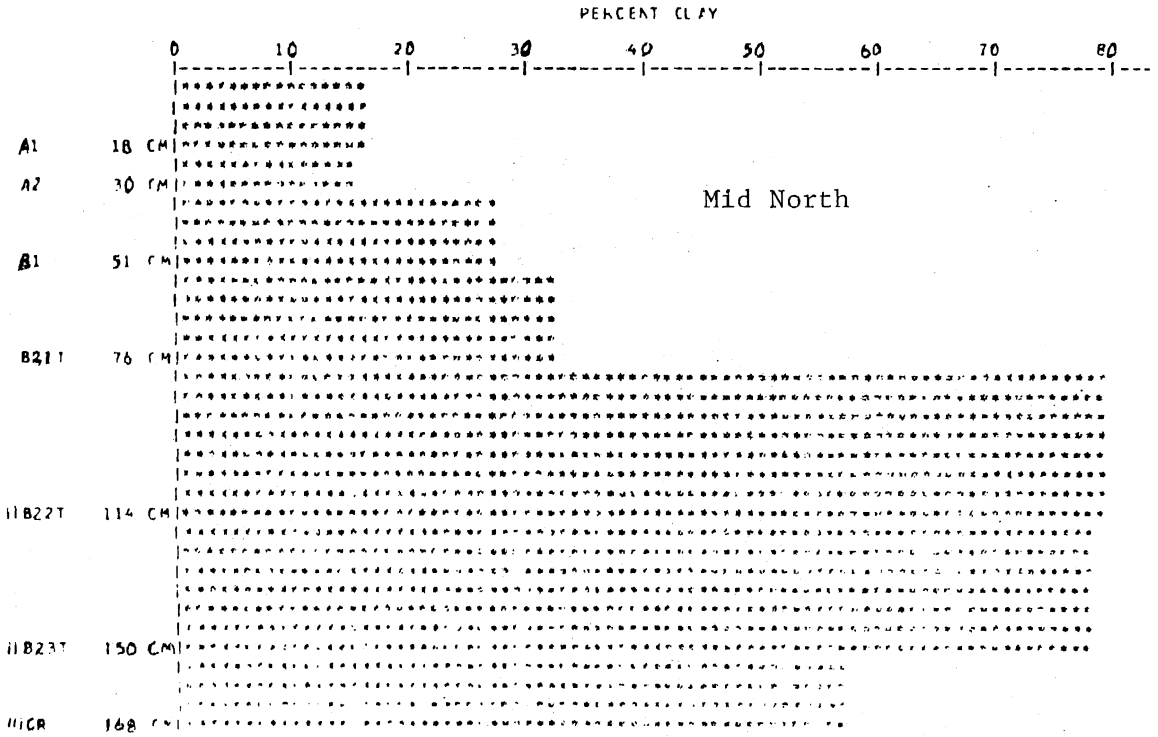


Figure 3. Clay Distribution in Depth (cm) Within the Profiles of Top North and Top South.



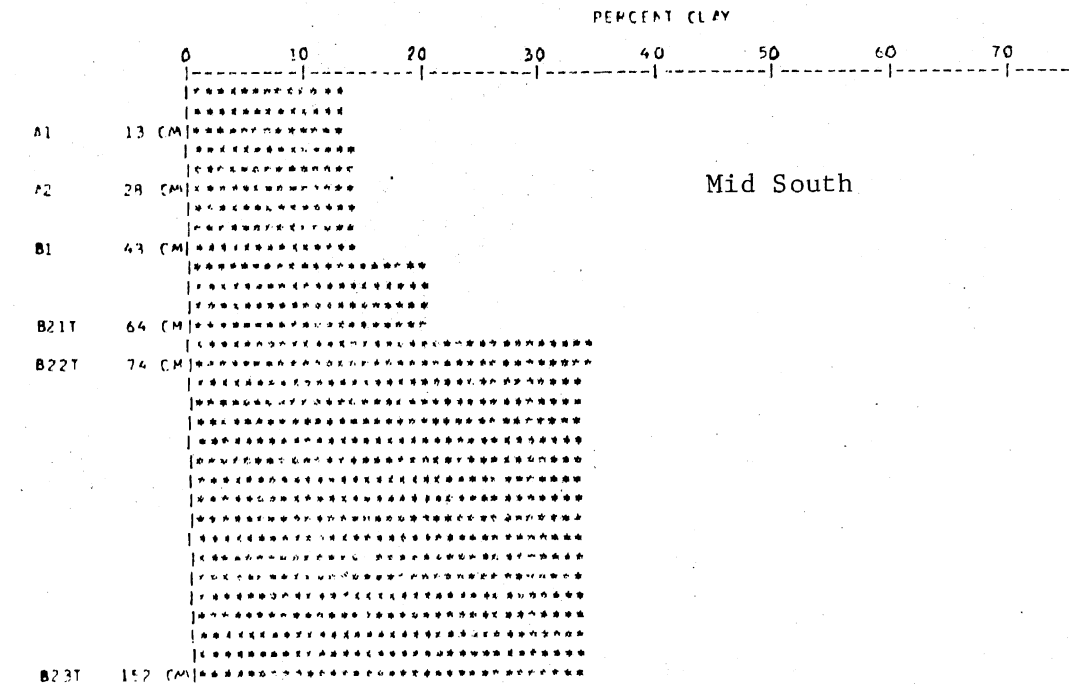


Figure 4. Clay Distribution in Depth (cm) Within the Profiles of Mid North and Mid South.

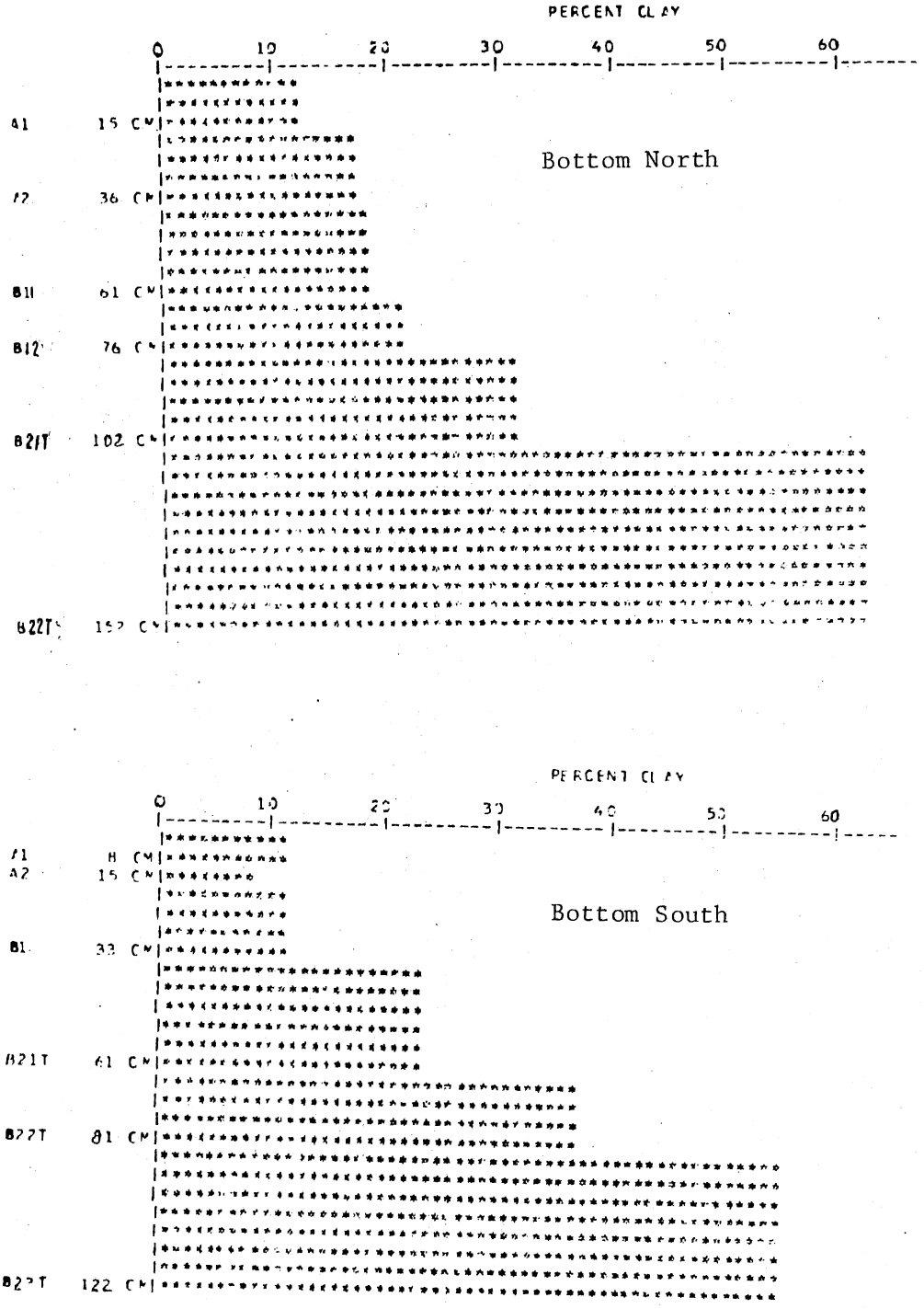


Figure 5. Clay Distribution in Depth (cm) Within the Profiles of Bottom North and Bottom South.

Organic Matter

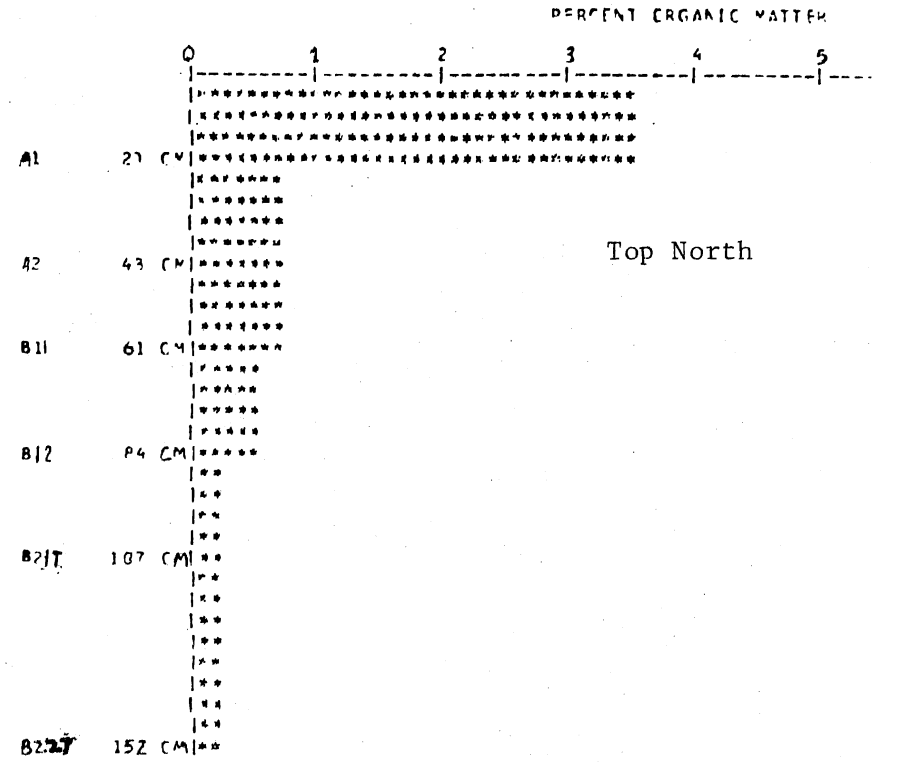
The soil pedons at the north slope aspect have more organic matter throughout their A1 horizons than their corresponding pedons at the south slope aspect (Figures 6 to 8). Organic matter is probably oxidized faster on the south slopes due to warmer temperatures. Leaves tend to remain on the north slopes, but are washed off on the south slopes due to a more open vegetation.

Bases and pH

The base saturation (by sum of cations) is less than 35% in all the horizons of all the pedons at all the sites with pH values of 5.6 or less. The highest base saturation (34.9%) is in the A1 horizon of the soil pedon at mid north while the lowest base saturation (2.5%) was found in the B23t horizon of the soil pedon at bottom south.

Cation Exchange Capacity

Cation exchange capacity (meq/100 g) ranges from 5.4 in the A2 horizon of the soil pedon at bottom north to 31.2 in the IIICr horizon of the soil pedon at mid north. Cation exchange capacity does appear to increase with the amount of clay and organic matter content.



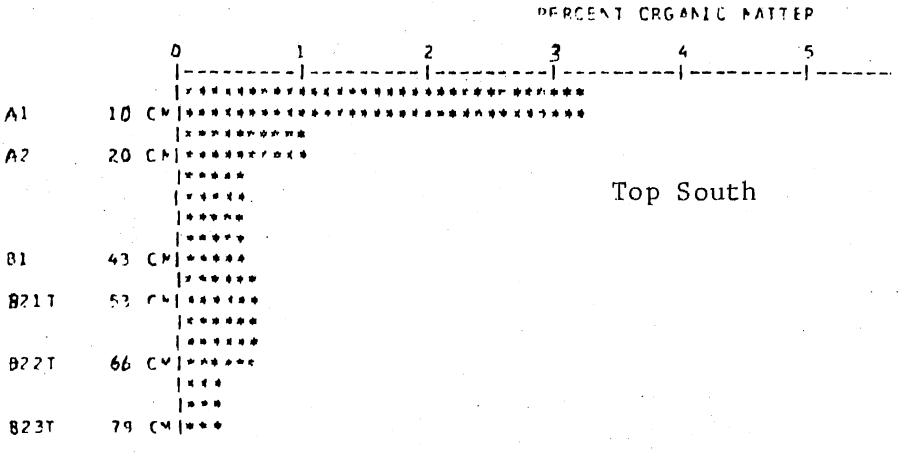
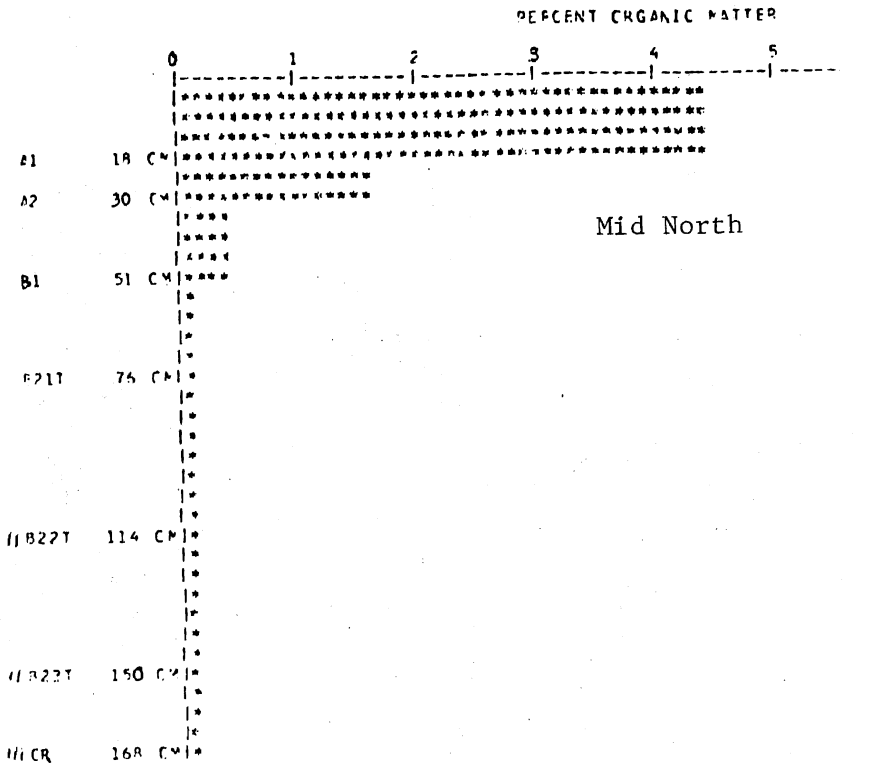


Figure 6. Distribution of Organic Matter with Depth (cm) in the Profiles of Top North and Top South.



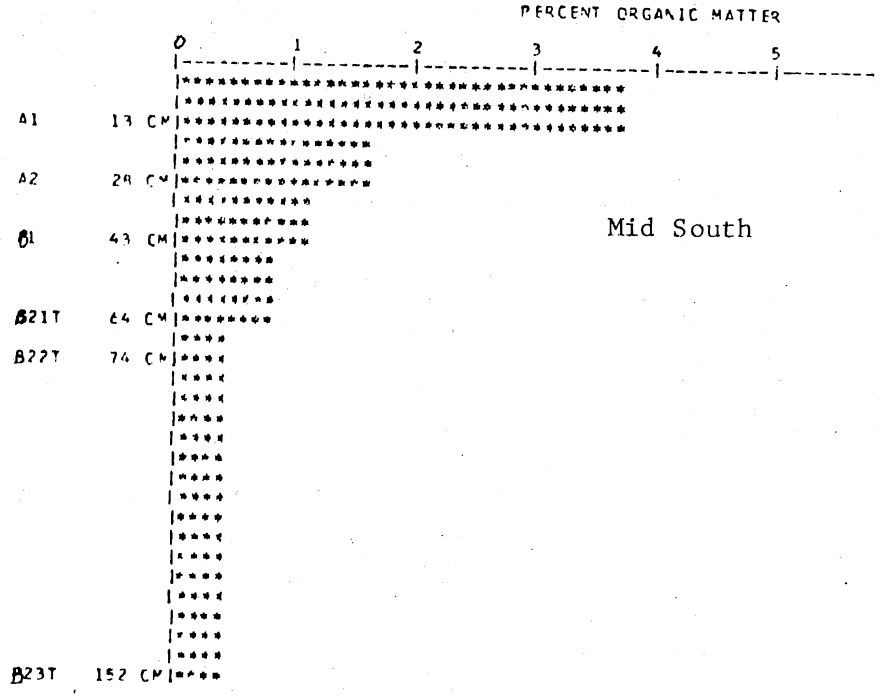
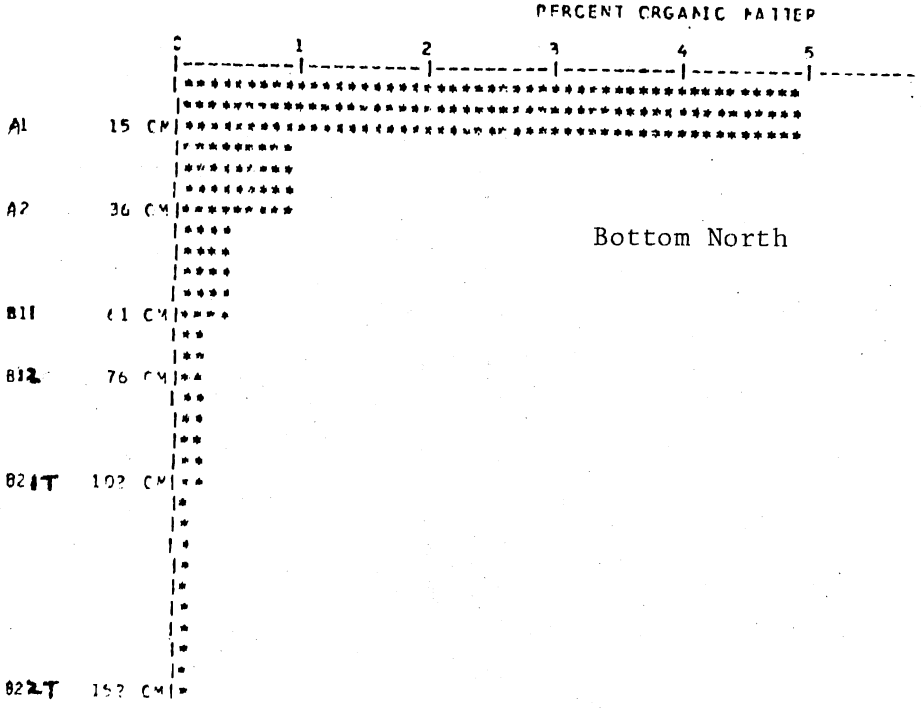


Figure 7. Distribution of Organic Matter with Depth (cm) in the Profiles of Mid North and Mid South.



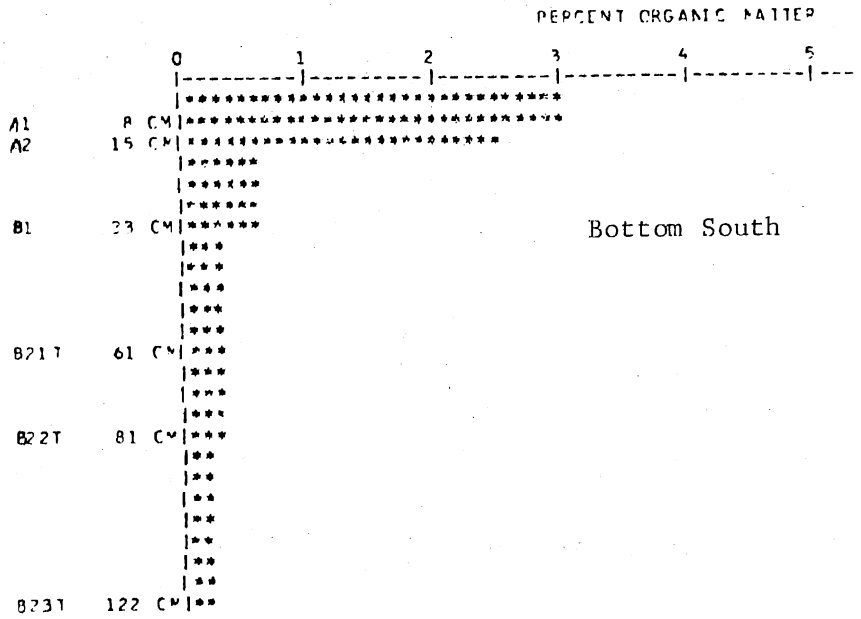


Figure 8. Distribution of Organic Matter with Depth (cm) in the Profiles of Bottom North and Bottom South.

CHAPTER VI

SOIL CLASSIFICATION

In a comparison of soils of different slope positions, the top slope positions are placed in loamy-skeletal and fine loamy textural families and all those in the middle slope positions are placed in clayey (mixed) and loamy-skeletal families. In the bottom slope positions, one profile is clayey-skeletal and the other is loamy-skeletal (Table VIII).

TABLE VIII

CLASSIFICATION OF THE SOILS AT THE STUDY SITES

Pedon	Order	Sub-group	Family
Top north	Ultisol	Typic Hapludult	Loamy-skeletal, silicious, thermic
Mid north	Ultisol	Typic Hapludult	Clayey (fine), mixed thermic
Bottom north	Ultisol	Typic Hapludult	Clayey-skeletal, mixed thermic
Top south	Ultisol	Typic Hapludult	Fine-loamy, silicious, thermic.
Mid south	Ultisol	Typic Hapludult	Loamy-skeletal, silicious, thermic
Bottom south	Ultisol	Typic Hapludult	Loamy-skeletal, silicious, thermic

CHAPTER VII

SOIL INTERPRETATIONS

A soil scientist has the responsibility of making accurate interpretations of the soil properties which he uses. Soil interpretations are divided into two sections, agricultural and non-agricultural interpretations.

Agricultural Interpretations

Soils of the Winding Stair Mountains are best suited for forestry. The soil potential and suitability for forestry is presented in Table IX.

TABLE IX

SOIL POTENTIAL AND LIMITATIONS FOR FORESTRY

Site	Soil Potential	Limitations
Top north	Fair	Erosion
Mid north	Good	Erosion
Bottom north	Fair	Erosion
Top south	Good	Erosion
Mid south	Fair	Erosion
Bottom south	Fair	Erosion

Non-Agricultural Interpretations

The soil potential and suitability for parks and playgrounds is presented in Table X. Soil potentials are rated as being good, fair, and poor. A good rating indicates that most soil properties are favorable for the specified use. A fair rating indicates that some of the soil properties and site features are unfavorable for the specified use and a poor rating indicates that some of the soil properties are unfavorable and will be difficult to overcome.

TABLE X

SOIL POTENTIAL AND LIMITATIONS FOR PARKS AND PLAYGROUNDS

Site	Soil Potential	Limitations
Top north	poor	Steep slopes
Mid north	fair	Steep slopes
Bottom north	poor	Steep slopes
Top south	fair	Steep slopes
Mid south	poor	Steep slopes
Bottom south	poor	Steep slopes

CHAPTER VIII

SUMMARY

The morphological, physical, and chemical properties of soils developed on north and south slope aspects of a mountainous area of Eastern Oklahoma were measured. The soils were classified (using the Soil Taxonomy, 17) and their land uses interpreted.

Soil developed on the north-facing slopes were found to be deeper than those developed on the south-facing slopes. The north-facing slopes support a forest vegetation while the south-facing slopes support both forest and grass vegetation. On the morphological properties, soils on the north-facing slopes appear to be slightly darker in color than those on the south-facing slopes. The texture of A1 horizon of the soil pedon at top north is stony silt loam, while the texture of A1 horizon of the soil pedon at top south is stony sandy loam. The texture of IIB22t and IIB23t horizons of the soil pedon at mid north is clay while the texture of B22t and B23t horizons of the soil pedon at mid south is gravelly clay loam. The texture of the A1 horizon of the soil pedon at bottom north is stony silt loam, while the texture of the A1 horizon of the soil pedon at bottom south is stony sandy loam.

Soils developed on the north-facing slopes were found to have a lower sand percentage than those developed on the south-facing slope. On the other hand, soils developed on the south-facing slopes were found to have a lower clay content than soils developed on the north-

facing slopes. Clay content was found to increase downslope probably because of weathering of the underlying rock. The pedons on the north-facing slopes were found to have more organic matter throughout their A1 horizons than their corresponding pedons at the south-facing slope. Soils on the north-facing slopes were found to have a higher cation exchange capacity. Four soil pedons were placed in skeletal families.

Some similarities were also observed on the morphological, physical, and chemical properties of the soil pedons on the north and south-facing slopes. The texture of A2 of the soil pedons at top north and top south is gravelly loam. All the pedons at all the sites had a fairly well-developed solum. The following conclusions were drawn based on the study: 1) Ultisols were developed on both north and south-facing slopes, 2) north slopes were found to have more clay accumulation than south-facing slopes, 3) south-facing slopes were found to be higher in sand than the north-facing slopes, 4) differences in textural families were observed, 5) north-facing slopes were found to have more organic matter throughout their A1 horizon, 6) there were differences in vegetation, 7) south-facing slopes were found to be shallower than north-facing slopes.

LITERATURE CITED

1. Birkeland, P. W. 1974. Pedology, Weathering, and Geomorphological Research. New York, Oxford University Press.

2. Black, C. A. (Ed.). 1965. Methods of soil analysis: Part 1 and Part 2. Agronomy Monograph, No. 9., American Society of Agronomy, Madison, Wisconsin.

3. Buol, Hole, and McCraken. 1973. Soil Genesis and Classification. Iowa State University Press. Ames, Iowa.

4. Finney, C. Holoway, and Heddleson. 1962. The influence of microclimate on the morphology of certain soils of the Allegheny Plateau of Ohio. Soil Sci. Soc. Am. Proc. 26:287-292.

5. Franzmeir, Pederson, Longwell, Byre, Losche. 1969. Properties of some soils in the Cumberland Plateau as related to slope aspect and position. Soil Sci. Soc. Am. Proc 33:755-761.

6. Gray, F. and H. M. Galloway. 1959 (Revised 1969). Soils of Oklahoma. Oklahoma Agricultural Experiment Station Bulletin, MP-56.

7. Gray, F. and M. H. Roozitalab. 1976. Benchmark and Key Soils of Oklahoma: A Modern Classification System. Oklahoma Agricultural and Experimental Station, MP-97.

8. Gray, F. and J. C. Fell. 1979. Teaching aid for morphology, classification and use of Oklahoma Soils. Agronomy Department, Oklahoma State University.

9. Hayes, C. J. 1977. Slope stability of certain selected colluvial soils. Research and Development Division, Oklahoma Department of Transportation.

10. Hutchens, Blevins, Hill, White. 1975. The influence of soils and microclimate on vegetation of forested slopes in Eastern Kentucky. Soil Sci. 121:234-241.

11. Laboratory Methods and Procedures for Collecting Soil Samples. Soil Survey Staff. 1972. U.S.D.A.

12. Losche, McCraken, Davey. 1970. Soils of steeply sloping landscapes in the Southern Appalachian Mountains. Soil Sci. Soc. Am. Proc 34:473-477.

13. Macyk, Pawluk, Lindsay. 1978. Relief and microclimate as related to soil properties. Canada Journal of Soil Sci. 58:421-438.

14. Roland and Millette. 1975. Microvariations in soil climate under two kinds of forest cover. Canada Journal of Soil Sci. 55: 447-456.

15. Schollenberger, C. J. 1931. Determination of organic matter. Soil Sci. 31:483-496.

16. Soils of the Southern United States and Puerto Rico. 1973. Staff U.S.D.A. and Agricultural Experiment Stations of the Southern States and Puerto Rico Land-Grant Universities. Southern Cooperative Series Bulletin, No. 174.

17. Soil Conservation Service. 1975. Soil Taxonomy. Agriculture Handbook No. 436, U.S.D.A., Washington, D. C.

18. Soil Survey of Leflore County, Oklahoma. 1931. U.S.D.A. and Oklahoma Agricultural Experiment Station.

19. United States Salinity Staff. 1954. Soil Survey Manual. Agriculture Handbook No. 60., U.S.D.A.

VITA

Godfrey A. Uzochukwu

Candidate for the Degree of

Master of Science

Thesis: THE EFFECT OF SLOPE ASPECTS ON THE MORPHOLOGICAL, PHYSICAL, AND CHEMICAL PROPERTIES OF SOILS OF A MOUNTAINOUS AREA OF EASTERN OKLAHOMA

Major Field: Agronomy

Biographical:

Personal Data: Born in Mgbidi-Awgu, Enugu-Nigeria, January 30, 1956, the son of Mr. and Mrs. Ndukwe Uzochukwu.

Education: Graduated from Achi High School, Achi, in June 1974; received Bachelor of Science in Agriculture degree from Oklahoma State University in December, 1979; completed requirements for the Master of Science degree in Agronomy at Oklahoma State University, Stillwater, Oklahoma in December, 1980.

Professional Experience: Student Manager, Southwestern Company, Nashville, Tennessee, 1976-1977; Laboratory assistant, Agronomy Department, Oklahoma State University, Stillwater, 1978-1980; Teaching assistant, Agronomy Department, Oklahoma State University, Stillwater, Summer 1980, and Graduate Research Assistant, Langston University, Fall 1980.