PHYSICAL ANALYSIS OF SOME ALFISOLS OF THE UPPER COASTAL PLAIN: SURFACE GEOLOGY-SOIL RELATIONSHIPS

By

ROGER ERWIN

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Oklahoma State University

Stillwater, Oklahoma

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Thesis Approved:

T. H. Silker
Thesis Adviser

Alex R. Ross

Edward E. Sturgeon

Lester W. Reed

Fenton Gray

D. D. Durham
Dean of the Graduate College

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CHAPTER I

INTRODUCTION

Two concepts of plant association development on a site have been followed by various disciplines. One of these is covered in the mono-climax concept. Spurr (14) cites Clement's mono-climax concept in the following manner:

> Given indefinite time and no disturbance to the community or site, the plant associations in a given climatic region would approach the same composition and structure (page 337).

Spurr (14) stresses that a second alternative, called the polyclimax concept, can be used to interpret plant association and soil development on a given site. He states:

> For any combination of organisms and environment, succession will move toward a climax, but the species nature of the climax will vary with the specific environment and biotic condition (page 339).

The mono-climax concept indicates that climate is credited as a major factor in molding the soil profile nature. It is inferred that trees and other biotic agents help alter bedrock material into a common soil profile, with like texture, color and pH, regardless of how widely diverse the bedrock material is. The degree of soil development and similarity in lithology is suggested as a major response of the climate.

The polyclimax concept allows for more than one major factor, such as climate, as an input unit that helps mold the soil order and climax plant association. It can be inferred from Spurr's reference to "specific environment" that the soil order can be an end product of interaction between a diverse bedrock and climate.

Silker, Nelson and Reed (11) have documented that two soil orders can be found contiguous to each other, with a similar physiographic position, in one climatic area and above one recognized bedrock. Each soil order supports a unique plant association. A post oak-blackjack oak-winged elm-black hickory-red oak association[1/] is found exclusively above Alfisols. A chinkapin oak-cedar elm-hackberry-redbud-bois d'arc-hickory laciniosa association[2/] is found exclusively above Mollisols, Inceptisols or Vertisols.

Nelson's (9) discriminant analysis procedure shows one or both of these plant associations is responding to some major site factor other than climate. He indicates:

> The great physical and chemical differences found on all plots between the adjacent Alfisols and Mollisols (or Inceptisols) overlying the same geologic formation, leads one to believe that the Alfisols on the ridges are depositional in nature and are in no way directly related to the geologic strata they cover (mapped strata). Thus one could visualize a second distinct and younger, geologic material laying above the mapped Cretaceous formations (page 72).

Samples collected in this study, along with those studied by Nelson, are considered supplements to samples obtained throughout the western Gulf Coastal Plain by Silker (13). The overall thrust is to comprehend ecosystem nature and clarify site evaluation for Ultisols and Alfisols of the western Coastal Plain.

[1/] Quercus stellata, Wang.; Quercus marilandica, Muench.; Ulmus alata, Michx.; Carya texana, Buckl.; Quercus falcata, Michx., respectively.

[2/] Quercus muehlenbergii, Engelm.; Ulmus crassifolia, Nutt.; Celtis occidentalis, L.; Cercis canadensis, L.; Maclura pomifera (Raf), Schu.; Carya laciniosa, Nutt., respectively.

Silker (12) states that site evaluation should concentrate on:

> .... the cumulative effect of surface soil texture; surface soil depth; subsoil texture; substratum position, texture and continuity; geologic origin of soil; aspect; topographic position; drainage position; climate and plant and animal association on site (page 3).

Of all these factors the concept of the geologic origin of the soil material is held to be the most important in determining the type of plant association that may develop on a site.

Plant association development has been considered to be an independent variable that has helped weather soils in situ from various bedrock strata. Nelson's data, however, supports Silker's (12) view that Alfisols on the ridges or interstream divides are the result of fluvial deposits of Pliocene?-Pleistocene age and the plant associations are respondents to a soil mantle already present.

This study covers a more extensive area and a greater diversity of bedrock materials than the samples studied by Nelson. The objective is to determine if textural and chemical data of samples will indicate whether the soil profile has weathered in situ from various bedrock units or is the product of fluvial deposits. If the latter is determined then Pliocene?-Pleistocene fluvial deposits can be recognized at interstream divide positions as far as 60 miles north of the present Red River floodplain.

CHAPTER II

LITERATURE REVIEW

Recognition of a Quaternary, alluvial plain depositional surface has been noted by Bernard, LeBlanc and Major in the lower Coastal Plain area of southeast Texas (2). They state:

> Thus the Quaternary coastwise plains of southeast Texas represent a series of coalescing alluvial and deltaic plains which were developed by the seven river systems during the high standing sea level substages of each interglacial stage. The erosional surfaces beneath each sedimentary sequence were developed during the lower sea level substages of each glacial stage (page 176).

Bernard, et al.(2) note the presence of gravels within the Willis Formation, which is considered to represent the base of the Pleistocene. They further point to a source, other than marine, for the materials deposited in the Willis Formation:

> The composition of the Willis gravels indicates that they were derived from sources further removed from the Gulf Coast (page 218).

Doering (4) recognized that Quaternary history includes not only the normal geologic forces of uplift and warping but the deposition of a mantle along the lower Gulf Coast. He states:

> Quaternary history is interpreted as having been initiated on the North American continent by uplift and warping of interior areas on such a scale as to have caused a sharp rejuvenation of the forces of erosion and transportation and to have resulted in the deposition of the coarse Citronelle as a basal formation along the Gulf Coast (page 1816).

Doering (5), in a later paper, recognized the Citronelle as being a fluvial mantle. He states:

> Beginning of Pleistocene--uplift in mountain area and in interior part of Piedmont Plateau; rejuvenation of streams and transportation of mantle of decayed material on peneplain to coast; deposition of Citronelle Formation on the coastal peneplain as a continuous fluvial apron (page 201).

Doering does not indicate that he recognizes the existence of a mantle deposit of Quaternary age on the upper Coastal Plain.

Silker noted the existence of ridge-top red-yellow podzolic soil "islands" that are lithologically similar to Citronelle Formation materials but lie considerably up-slope and west and north of the materials mapped by Doering. He suggested that these may be remnants of the Quaternary mantle that has been isolated by stream dissection (12). He also suggested that a once-continuous, favorable to compensatory soil mantle would have allowed pine and associated hardwoods to migrate to the "lost pine island" zone, between Navasota and Bastrop, Texas, before stream dissection isolated the areas as disjunct communities (10). This view would enhance the position that plants were "respondents" to a favorable environmental factor rather than having altered various bedrock into soil and slowly migrated westward through genetic adaptation ("drought resistant" ecotype adaptation). These "pine islands" extend into a high evapotranspiration zone that is some 90 miles west of the commercial pine-hardwood zone that follows the 42-inch precipitation boundary.

Nelson (9) studied a portion of the area studied by Silker (13). Older geologic maps of the area stress geologic history only in terms of outcrop units that are 10 feet or more in thickness. Thus, only the dominant units or members are delineated. A few small "islands" of Quaternary alluvial mantle are mapped near Broken Bow, west of Lukfata Creek and near Antlers, Oklahoma, but both the 1960 Geologic Map of the

United States (16) and the 1954 Geologic Map of Oklahoma (8) delineate primarily Pennsylvanian to Cretaceous bedrock materials in the study area. Alfisols and Ultisols in the study area have thus been interpreted as weathering from various bedrock materials as diverse as Pennsylvanian shale and sandstone and Cretaceous limestone, marl or chalk.

The 1966 Geologic Atlas of Texas, Texarkana Sheet (1) is the first of recent maps to delineate five sequential terraces of Quaternary alluvium. Some of these materials are mapped 15 miles south of the present Red River channel. Plots 10 and 12 (Tables IX and XI, Appendix) of this study lie above Quaternary fluvial deposits shown on the Geologic Atlas of Texas, Texarkana Sheet (1). Thus, there is suggestion that some Alfisols in this upper Coastal Plain area may occur above high terrace deposits, or at interstream divide positions, and may have the same geologic history as the alluvial plain deposits mapped as the Citronelle Formation in the lower Coastal Plain.

Nelson's (9) upper Coastal Plain samples suggested: "The Alfisols studied were not weathered in situ but were the end result of a fluvial depositional process." Nelson explains why the Alfisols are thought to be depositional in the following manner:

> The Alfisols are shown to be the result of fluvial deposition by the presence of washed gravel in the solums of all profiles and the absence of washed gravel in the underlying geologic formations from which these soils were previously thought to have weathered (page 78).

Nelson states that the polyclimax theory can be used to explain the development process of Alfisols, Ultisols and Psamments of the upper Coastal Plain and up-slope areas. The plant associations on the site are considered respondents to the regional climate but more so to the edaphic and geologic patterns of the upper Coastal Plain. Since the plant associations developed on the site following fluvial deposition of the soil profile, they may be used as diagnostic indicators of the soil profile patterns, variations and soil orders of the Gulf Coastal Plain ecosystem. Nelson (9) states: "The sequence, depth and texture of the fluvial strata of the Gulf Coastal Plain can largely influence the kinds or associations of plants adapting or responding to a site" (page 79).

The major thrust of this paper is an attempt to determine, from physical and chemical analysis, if the Alfisols studied in the upper Coastal Plain were weathered in place from diverse bedrock materials or may have some other genetic history.

CHAPTER III

METHODS AND PROCEDURES

The study area includes the southeastern corner of Oklahoma and the southwestern corner of Arkansas (Figure 1).

The topography is level to rolling with an elevation ranging from 700 to 300 feet. Secondary and intermittent streams draining into the Red River have controlled the dissection of the topography.

The average annual precipitation is 46 inches per year. Sporadic summer drought and a high evapotranspiration rate are common in this warm and humid climate (7).

The land surface is made up of a series of on-lapping marine deposits that butt against the south face of the Ouachita Mountains. Some outlier units of alternating and tilted shale and sandstone beds of Pennsylvanian bedrock (typical of the Ouachitas) are found contiguous to on-lapping Lower Cretaceous limestone bedrock. Younger Cretaceous deposits sampled include unconsolidated or weakly cemented sands, clays, chalks or marls (8).

Only those stratigraphic units that are 10 feet or more in thickness are shown on geologic maps, including the U. S. Geologic Map (16) and the Geologic Map of Oklahoma (8). Map scale has permitted the delineation of small "islands" of Pleistocene alluvium above predominately Cretaceous bedrock on the Geologic Map of Oklahoma. The 1966 Geologic Atlas of Texas, Texarkana Sheet (1) is the first to delineate

PLOT NO.	LOCATION
2	ATOKA
3	ANTLERS
4	ANTLERS
7	LUKFATA CR.
8	EAGLETOWN
9	GOODWATER
10	TOM
11	FOREMAN
12	FOREMAN

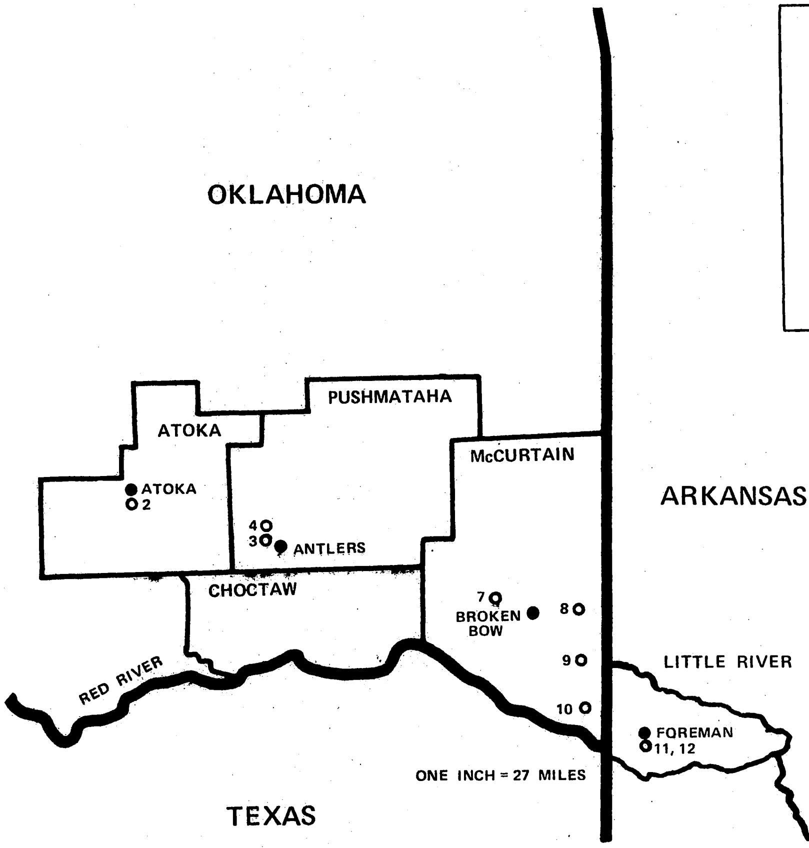

Figure 1. Area of Study

units of Pleistocene alluvium of considerable size. These units occupy the highest elevations in the upper Coastal Plain of southeastern Oklahoma, southwestern Arkansas, and northeastern Texas, and are numbered as high, sequential terraces. Study plots 10, 11 and 12 lie on two of the latter recognized terraces.

Bedrock samples were chosen to show as great a contrast in physical and chemical nature as possible. Susquehanna and Susquehanna-like soils were studied as representative units of the red-yellow podzolic (Alfisol and Ultisol soil orders) group (13). The sample locations and the bedrock over which they lie are listed in Table I.

The sampling procedure used was developed by a Ph.D. candidate, since some samples were shared for different types of analysis. The samples examined were taken from opened pits or highway road cuts. Profiles varied from 3 to 14 feet deep above the bedrock. At each location a vertical face was cleaned off and the profile was classified by soil scientists from the Soil Conservation Service. Wherever possible bulk samples 6 inches deep and 12 inches square were taken from each horizon. At least two-inch thick samples were taken from thinner horizons. Undisturbed cores were taken from each horizon for physical and chemical analysis. Bedrock material was obtained by using a rock-core drill or a chisel to remove fresh samples 1 to 3 feet below the bedrock surface.

Soil Physical Analysis

Samples from each soil horizon were dry-worked through a 1/4 inch sieve to remove rock fragments and gravel of 1/4 inch and larger size. Each horizon sample was then oven-dried and allowed to stabilize in

TABLE I

PLOT NUMBER, LOCATION, GEOLOGIC AGE OF BEDROCK AND ROCK UNIT

Plot	Location	Geologic Age of Bedrock	Rock Unit
2	Atoka, Oklahoma	Pennsylvanian Sandstone	Stanley Formation
3	Antlers, Oklahoma	Pennsylvanian Shale	Stanley Formation
4	Antlers, Oklahoma	Pennsylvanian Sandstone	Stanley Formation
7	Lukfata Creek, Oklahoma	Cretaceous Limestone	DeQueen Formation
8	Eagletown, Oklahoma	Cretaceous Limestone	DeQueen Formation
9	Goodwater, Oklahoma	Cretaceous Limestone	Goodland Formation
10	Tom, Oklahoma	Cretaceous Marl	Brownstown Formation
11	Foreman, Arkansas	Cretaceous Chalk	Annona Formation
12	Foreman, Arkansas	Cretaceous Marl	Marlbrook Formation

air-dry conditions. The air-dried sample was then weighed. One quarter (by weight) of the air-dried sample was removed and wet-sieved through a 2 mm screen to remove rock fragments and washed gravel. Both the greater than 1/4 inch and 2 mm to 1/4 inch gravel lots were washed, dried and weighed. Weight of the 1/4 inch and larger gravel was added to four times the weight of 2 mm to 1/4 inch gravel to obtain total gravel weight per sample. This total gravel weight was added to the air-dried soil and gravel sample weight to give gross sample weight. Gravel weight was then divided by the gross sample weight and multiplied by 100 to give gravel percent per horizon.

Additional soil samples for each horizon were air-dried and sieved through a 2 mm sieve. Thirty gram samples were weighed and particle size determination of silt and clay was made by using the Bouyoucous hydrometer and the Day (3) procedure. Sand was separated from each sample by sieving through a standard 270 mesh (0.053) sieve. The sand was air-dried and its weight recorded. Some samples were estimated to have an excess of carbonates which could interfere with particle size dispersion in the Day procedure. These samples were treated with I N 4.8 pH Na Acetate + Acetic Acid ($NaCH_3CO_2$) to remove the carbonates. Two washings in a centrifuge were used to remove the charged supernatant. The Day procedure was then followed.

Soil Chemical Analysis

Soil samples for each horizon were sieved through a 20 mesh screen. The percentage of carbonates for each horizon was determined by reacting 5 gram soil samples with I N Acetic Acid (CH_3 OOH). After 12 hours each sample was filtered and a 2 ml. aliquot was removed. Each aliquot was titrated with a standard base (NaOH) to determine the percent carbonates per horizon. This analysis was adapted from the procedure proposed by Gedroits (6).

CHAPTER IV

RESULTS AND DISCUSSION

Samples in this study covered Nelson's sample area (9) and, in addition, interstream divide positions as far as 60 miles north of the present Red River floodplain. A greater diversity of bedrock materials was also studied, including Pennsylvanian shale and sandstone, and two additional Cretaceous limestone units.

The objective of this study was to determine if textural and chemical data will indicate whether Alfisol profiles in the upper Coastal Plain have weathered *in situ* from various bedrock units or have been influenced by some other genetic history. Clearing this point should also clarify whether a monoclimax or polyclimax concept is the more applicable in interpreting an ecosystem.

Certain criteria must be met in order to identify whether soil materials have been weathered in place or represent an alluvial plain deposit. Soils weathered in place will have: (a) the same type of textural material as found in the bedrock, such as a clayey or silty clay from a shale bedrock; no sharp textural boundary (grain size difference) will be evident between bedrock and contact B or C horizon material, (b) pH of the solum and bedrock will be very similar, (c) grains (sand or silt forming soil fabric) in B or C horizons will have the same degree of sorting as grains in bedrock materials.

Soils resulting from an alluvial deposit will have: (a) a sharp basal and lateral contact, (b) units may change in texture but within each unit sand grain size will decrease upward, (c) grains will be poorly sorted and (d) small or medium-scale bedding may occur in some units.

Data in Tables II through XI (in the Appendix) show that there is a sharp basal contact between the lowest B or IIC horizon and the bedrock for all nine plots studied. No gravel was found in eight of the bedrock units, while Plot 12 bedrock had only one gravel grain size and it was less than 3 mm in diameter. In contrast, Table II shows that the contact B or IIC horizons, and upper horizons, had a considerable amount of washed gravel. The gravel was particularly concentrated in A_1 - A_2 horizons in all nine plots. The latter condition is especially emphasized in Figure 2. Pennsylvanian sandstone bedrock lies below the point of the board scale that is sub-divided in feet and fractions.

Plots 2 and 3 (Tables III and IV of Appendix) show an abrupt shift in ratio of sand and silt size particles between lower horizons and bedrock units. Both plots have bedrock particles that are predominantly silt to fine sand size. Yet, the contact B horizon in Plot 2 shifts to 43.3 percent sand while the B_3 horizon of Plot 3 increased in percent sand and ratio of clay.

Plot 4 (Table V in Appendix) shows a distinct shift in sand and clay content in the B_{22t} horizon contact with the bedrock. The bedrock has a 65.37 percent sand and 4.69 percent clay content in comparison with the B_{22t} horizon which has a 23.3 percent sand and 53.3 percent clay.

Plot 7 (Table VI in Appendix) shows a shift similar to Plot 4. The limestone bedrock has 61.16 percent sand and 6.92 percent clay while the B_{26t} horizon has 16.67 percent sand and 46.67 percent clay.

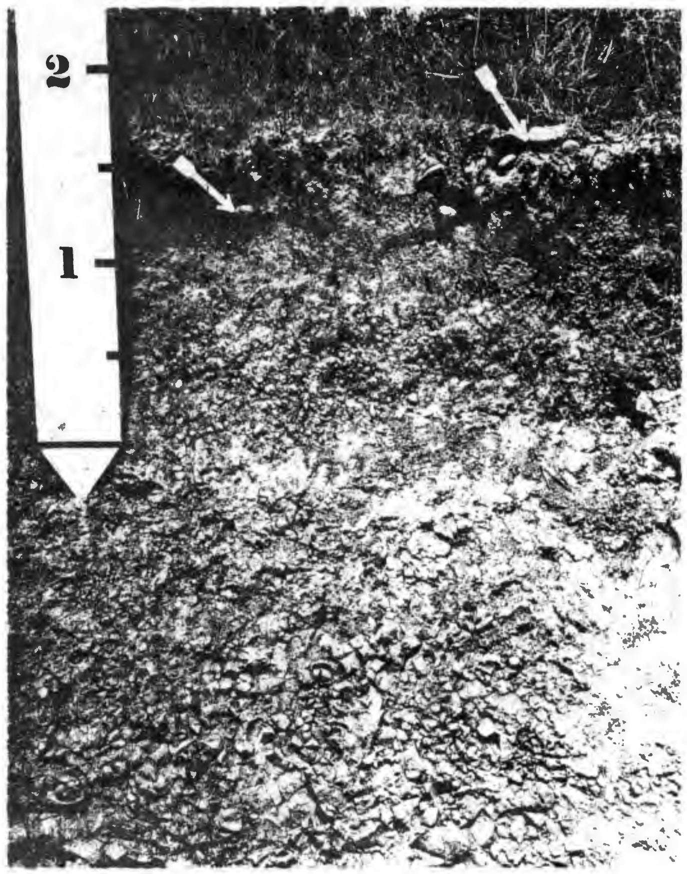

Figure 2. Plot 2 (Table III of Appendix) Showing Heavy Concentration of Gravel in A_1 - A_2 Horizons of Soil Profile, Atoka, Oklahoma.

TABLE II

PERCENT GRAVEL, BY HORIZONS, IN ALFISOLS OF THE WESTERN GULF COASTAL PLAIN

Soil Horizon	Plots Sampled 2	3	4	7	8	9	10	11	12
A_1	11.02	61.42	21.42	2.19	4.10	0.94	1.54	1.95	21.25
A_2	8.11	81.85	52.06	5.76	-	1.04	14.46	-	-
B_1	-	-	-	-	-	0.54	-	0.41	-
B_{21t}	2.65	3.27	19.02	0.06	0.26	0.55	6.15	0.06	17.05
B_{22t}	6.35	0.35	3.61	0.01	0.13	0.42	1.67	0.13	1.27
B_{22t}	-	-	-	-	0.02	-	-	-	-
B_{23t}	-	-	-	0.00	-	-	0.28	-	14.51
B_{24t}	-	-	-	0.03	-	-	-	-	-
B_{25t}	-	-	-	0.65	-	-	-	-	-
B_{26t}	-	-	-	8.00	-	-	-	-	-
B_3	-	24.65	-	-	-	-	-	-	-
IIC	-	-	-	-	-	-	-	0.20	0.61
C	-	-	-	-	-	0.95	-	1.57	-
	Underlying Bedrock								
R	0	0	0	0	0	0	0	0	T 1/
	Pennsylvanian Sandstone	Pennsylvanian Shale	Pennsylvanian Sandstone	Cretaceous Limestone	Cretaceous Limestone	Cretaceous Limestone	Cretaceous Marl	Cretaceous Chalk	Cretaceous Marl

1/ Trace (1 grain, < 3mm).

The contact B_{23t} horizon in Plot 9 (Table VIII in Appendix) shows a sharp basal contact with the limestone bedrock. The contact B_{23t} horizon has 7.4, 20.6 and 70.2 sand, silt and clay content, respectively, while the limestone bedrock has 37.4, 7.22 and 55.39 percent sand, silt and clay content, respectively.

The contact C horizon of Plot II (Table X in Appendix) shows a sharp basal contact with the chalk bedrock. The contact C horizon has a 53.3 percent sand, 10 percent silt and 36.7 percent clay content while the chalk bedrock has 0.10 percent sand, 42.3 percent silt and 57.6 percent clay.

Plot 12 (Table XI in Appendix) bedrock marl has a 0.62, 41.07 and 58.31 percent sand, silt and clay content, respectively, while the sand in the contact IIC horizon shifts to 5.33 percent.

Evidence of fluvial bedding is suggested in plots 7 and 12 (Tables VI and XI in Appendix). In Plot 7 the B_{21t} horizon shows 23.30, 36.7 and 40.0 percent sand, silt and clay, respectively, which the B_{22t} horizon shows 55.0 percent sand, 6.67 percent silt and 38.33 percent clay. Horizon B_{23t} then shows a 15.0, 45.0 and 40.0 percent sand, silt and clay content, respectively. These shifts in texture (especially sand and silt ratios) suggest fluvial bedding.

Plot 12 data (Table XI in Appendix) suggest horizons B_{21t}, B_{22t}, B_{23t} and IIC are equivalent to fluvial beds. The B_{21t} horizon has a 19.98, 25.10, 54.92 and 17.05 percent sand, silt, clay and gravel content, respectively. The B_{22t} horizon texture shifts abruptly with a 6.99, 30.72, 63.27 and 1.27 percent sand, silt, clay and gravel content, respectively. The B_{23t} horizon shows 22.04, 65.54, 12.42 and 14.51 percent sand, silt, clay and gravel content in comparison with the IIC horizon which shows 5.33, 40.72, 44.94 and 0.61 percent sand, silt, clay and gravel, respectively. The relatively high sand, and matching washed gravel content, of horizons B_{21t} and B_{23t}, and the relatively low content of sand and gravel in the alternating B_{22t} and IIC horizons suggests that there was a different hydrologic condition prevailing when materials were deposited in each strata (bed).

CHAPTER V

SUMMARY AND CONCLUSIONS

The study area includes the southeastern corner of Oklahoma and the southwestern corner of Arkansas.

Nine Susquehanna and Susquehanna-like soils were studied on Coastal Plain sites at interstream-divide positions as representative units of the Alfisol soil order (red-yellow podzolic soils). Underlying bedrock studied included Pennsylvanian sandstone and shale and Cretaceous limestone, marl and chalk. The overall thrust of the study was to comprehend ecosystem nature and clarify site evaluation for Alfisols of the upper western Coastal Plain. The objective was to determine if textural and chemical data of the samples would indicate whether the Alfisol profiles have weathered _in situ_ from various bedrock units or may have some other genetic history.

The following single or cumulative conditions have been met in the nine Alfisols studied to qualify them as fluvial deposits: (a) red-yellow materials have a sharp basal contact with bedrock (washed gravel in solum or discontinuity in grain size), (b) grains are poorly sorted in the solum and (c) strong textural shifts between some soil horizons suggest the horizons are equivalent to beds. The data, therefore, suggest the Alfisols studied did not weather in place from bedrock of diverse nature but attained their state largely through fluvial deposition.

Thus, the polyclimax theory is favored with regard to site development and ecosystem interpretation for Alfisols in the upper, western Coastal Plain. That is, some primary factor other than climate has had a major input in controlling the solum and the ecosystem. Data suggests the following conclusions: (a) the red-yellow material with the sharp basal contact is an alluvial plain deposit that is in no way related to the diverse bedrock below, (b) if the surface material is recognized as alluvial plain deposits their considerable depth would suggest they were deposited antecedent to plant distribution and association, (c) the depth and texture of the surficial, sandy and gravelly A_1 - A_2 materials could be considered the prime reservoir for storage and retention of moisture important to certain plants, (d) this variable-surface reservoir could be considered the key area of the ecosystem, along with climate, in having controlled distribution and association of the acid-tolerant or acid-preference plant groups that Nelson (9) documented, (e) Alfisols (and probably associated Ultisols and Psamments) in the upper Coastal Plain could be considered to have the same geologic history as their counterparts that occur above the Citronelle Formation, mapped as alluvial plain (Pliocene?-Pleistocene) deposits in the lower Coastal Plain (13). Inclusion and mapping of inland areas (particularly material two feet or more in thickness) in the same geologic-control unit would considerably expand the extent of this fluvial mantle and interpretation of control within the ecosystem (12).

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APPENDIX

TABLE III

ATOKA, OKLAHOMA, PLOT NO. 2 1/

County: Atoka
Region: Upper Coastal Plain
Underlying Bedrock: Pennsylvanian Sandstone

Soil Order: Alfisol
Soil Series: (Susquehanna-like)
Elevation: 590 feet

Horizon	Depth (Inches)	Color	Field pH	Texture	Particle Size Distribution % Sand	Silt	Clay	Gravel %	$CaCO_3$ %
A_1	0- 4	10 YR 5/2	6.5	Gravelly, fine sandy loam	58.33	30.00	11.67	11.02	0.0
A_2	4-10	10 YR 5/4	5.7	Gravelly, fine sandy loam	63.33	25.00	11.67	8.11	0.0
B_{21t}	10-20	5 YR 5/6	5.5	Clay loam	40.00	23.30	36.67	2.65	0.0
B_{22t}	20-28	2.5 Y 5/2	5.5	Clay loam	43.33	25.00	31.67	6.35	0.0
R	28+	Olive	6.5	Soft sandstone, M-Pa., (Stanley Fm.)	15.97	54.21	29.82	0.0	0.0

1/ Bedrock analysis from Ph.D. candidate.

TABLE IV

ANTLERS, OKLAHOMA, PLOT NO. 3 1/

County: Pushmataha
Region: Upper Coastal Plain
Underlying Bedrock: Pennsylvanian Shale

Soil Order: Alfisol
Soil Series: (Susquehanna-like)
Elevation: 510 feet

Horizon	Depth (Inches)	Color	Field pH	Texture	Particle Size Distribution % Sand	Silt	Clay	Gravel %	$CaCO_3$ %
A_1	0- 3	10 YR 6/3	6.0	Gravelly, very fine sandy loam	43.33	40.00	16.67	61.42	0.0
A_2	3-12	10 YR 6/4	5.5	Gravelly, very fine sandy loam	43.33	35.00	21.67	81.85	0.0
B_{21t}	12-24	2.5 YR 3/6	5.5	Clay	10.00	20.00	70.00	3.27	0.0
B_{22t}	24-32	5 Y 5/2	6.3	Clay	5.00	18.33	76.67	0.35	0.0
B_3	32-40	5 Y 5/2	7.0	Clay	23.33	10.00	66.67	24.65	0.0
R	40+	Olive-grey	7.0	Shale, (Miss.-Pa.) (Stanley Fm.)	19.29	54.25	26.46	0.0	0.0

1/ Bedrock analysis from Ph.D. candidate.

TABLE V

ANTLERS, OKLAHOMA, PLOT NO. 4 [1/]

County: Pushmataha
Region: Upper Coastal Plain
Underlying Bedrock: Pennsylvanian Sandstone

Soil Order: Alfisol
Soil Series: (Susquahanna-like)
Elevation: 510 feet

Horizon	Depth (Inches)	Color	Field pH	Texture	Particle Size Distribution % Sand	Silt	Clay	Gravel %	$CaCO_3$ %
A_1	0- 2	10 YR 5/2	6.6	Gravelly, fine sandy loam	48.33	38.34	13.33	21.42	0.0
A_2	2- 7	10 YR 5/4	6.2	Gravelly, fine sandy loam	46.67	43.33	10.00	52.06	0.0
B_{21t}	7- 9	2.5 YR 4/6	5.4	Clay	(Not analyzed)			-	0.0
B_{21t}	10-15	2.5 YR 4/6	5.4	Clay	23.33	28.34	48.33	19.02	0.0
B_{22t}	15-20	2.5 Y 6/2	6.3	Clay	23.33	23.34	53.33	3.61	0.0
R	20+	Yellow	-	Sandstone, (Miss.-Pa.) (Stanley Fm.)	65.37	29.94	4.69	0.0	0.0

[1/] Bedrock analysis from Ph.D. candidate.

TABLE VI

LUKFATA CREEK, OKLAHOMA, PLOT NO. 7 [1/]

County: McCurtain
Region: Upper Coastal Plain
Underlying Bedrock: Cretaceous Limestone

Soil Order: Alfisol
Soil Series: (Susquehanna-like)
Elevation: 610 feet

Horizon	Depth (Inches)	Color	Field pH	Texture	Particle Size Distribution % Sand	Silt	Clay	Gravel %	$CaCO_3$ %
A_1	0- 3	10 YR 4/2	7.0	Silty loam	35.00	55.00	10.00	2.19	0.0
A_2	3-9	7.5 YR 5/4	6.4	Silty loam	40.00	48.33	11.67	5.76	0.0
B_{21t}	9-15	5 YR 4/4	5.6	Clay	23.30	36.70	40.00	0.06	0.0
B_{22t}	15-19	2.5 Y 6/2	5.6	Clay	55.00	6.67	38.33	0.01	0.0
B_{23t}	19-26	2.5 Y 6/2	6.0	Clay	15.00	45.00	40.00	0.00	0.0
B_{24t}	26-32	2.5 Y 5/2	7.5	Clay	10.00	36.67	53.33	0.03	0.0
B_{25t}	32-40	5 Y 5/2	7.5	Clay	17.50	30.00	52.50	0.65	0.0
B_{26t}	40-56	5 Y 6/2	8.0	Clay	16.67	36.67	46.67	8.01	13.66
-	66-70	-	-	Sand lens	(Not analyzed)			-	0.0
R	70+	Grey	-	Hard limestone, Lower Cret. - (DeQueen Fm.)	61.16	31.92	6.92	0.0	71.99

[1/] Bedrock analysis from Ph.D. candidate.

TABLE VII

EAGLETOWN, OKLAHOMA, PLOT NO. 8 [1/]

County: McCurtain
Region: Upper Coastal Plain
Underlying Bedrock: Cretaceous Limestone

Soil Order: Alfisol
Soil Series: Vaiden
Elevation: 425 feet

Horizon	Depth (Inches)	Color	Field pH	Texture	Particle Size Distribution % Sand	Silt	Clay	Gravel %	$CaCO_3$ %
A_1	0- 3	10 YR 4/2	7.0	Gravelly, silty loam	48.33	45.00	6.67	4.10	0.0
B_{21t}	3- 8	2.5 YR 4/6	5.5	Clay	18.33	23.34	58.33	0.26	0.0
B_{22t}	8-17	R 2.5 4/8	5.8	Clay	23.30	23.37	53.33	0.13	0.0
B_{22t}	17-24	R 2.5 4/8	5.8	Clay	16.67	40.00	43.33	0.02	0.0
R	24+	Grey	-	Macro-fossiliferous lime-stone (Lower Cret. -- DeQueen Fm.)	19.83	35.29	44.88	0.0	63.58

[1/] Bedrock analysis from Ph.D. candidate.

TABLE VIII

GOODWATER, OKLAHOMA, PLOT NO. 9 [1/]

County: McCurtain
Region: Upper Coastal Plain
Underlying Bedrock: Goodland Limestone

Soil Order: Alfisol
Soil Series: Cadeville
Elevation: 375 feet

Horizon	Depth (Inches)	Color	Field pH	Texture	Particle Size Distribution %			Gravel %	$CaCO_3$ %
					Sand	Silt	Clay		
A_1	0- 3	10 4/2	6.0	Gravelly Loam	34.32	55.54	10.14	1.41528	0.00
A_2	3- 7	2.5 6/4	5.5	Gravelly Silt Loam	27.80	62.20	10.00	2.23602	0.00
B_1	7-12	5 5/6	5.5	Silty Clay Loam	15.40	54.60	30.00	1.49535	0.00
B_{21t}	12-20	2.5 5/4	5.5	Clay	9.40	48.60	42.00	0.48406	0.00
B_{22t}	20-46	10 6/2	6.0	Clay	7.20	38.80	54.00	0.61266	0.00
B_{23t}	46-62	5 5/3	6.5	Clay	7.40	20.60	72.00	0.31764	0.00
R	62+	-	-	(Goodland limestone)	37.40	7.22	55.39	0.0	92.92

[1/] Major portion of data from M.S. candidate; bedrock analysis from Ph.D. candidate.

TABLE IX

TOM, OKLAHOMA, PLOT NO. 10 1/

County: McCurtain
Region: Upper Coastal Plain
Underlying Bedrock: Brownstown Marl

Soil Order: Alfisol
Soil Series: Cadeville
Elevation: 355 feet

Horizon	Depth (Inches)	Color	Field pH	Texture	Particle Size Distribution % Sand	Silt	Clay	Gravel %	$CaCO_3$ %
A_1	0- 3	10 2/2	5.0	Gravelly Silt Loam	25.97	65.70	8.33	1.54178	0.13
A_{12}	3- 8	10 6/6	5.0	Gravelly Silt Loam	33.33	50.02	16.65	14.45605	0.00
B_{21t}	8-18	2.5 4/6	5.6	Clay	17.65	45.72	36.63	6.14975	0.00
B_{22t}	18-30	2.5 4/6	5.9	Clay	12.32	39.40	48.28	1.67201	0.00
B_{23t}	30-47	10 4/6	6.0	Clay	3.99	21.19	74.92	0.27809	1.09
R	47+	Grey	8.0	Brownstown marl	1.80	61.20	37.00	0.00000	55.97

1/ Major portion of data from M.S. candidate; bedrock analysis from Ph.D. candidate.

TABLE X

FOREMAN, ARKANSAS, PLOT NO. 11 [1/]

County: Little River
Region: Upper Coastal Plain
Underlying Bedrock: Cretaceous Chalk

Soil Order: Alfisol
Soil Series: Oktibbeha (Approaching lithic)
Elevation: 410 feet

Horizon	Depth (Inches)	Color	Field pH	Texture	Particle Size Distribution %			Gravel %	$CaCO_3$ %
					Sand	Silt	Clay		
A_1	0- 5	10 YR 3/3	7.5	Fine sandy loam	63.30	20.00	16.67	1.95	0.0
B_1	5-10	10 YR 5/6	7.5	Fine sandy loam	50.00	18.33	31.67	0.41	0.0
B_{21t}	10-16	2.5 YR 4/6	7.5	Clay	26.67	15.00	52.33	0.06	0.0
B_{22t}	16-20	2.5 YR 4/6	7.5	Clay	20.00	6.67	73.33	0.13	0.0
II C	20-23	2.5 YR 6/6	7.5	Clay	21.67	5.00	73.33	0.20	0.0
C	23-25	-	8.0	Clay	53.33	10.00	36.66	1.57	0.0
R	25+	Grey	-	Chalk, Upper Cretaceous, (Annona Fm.)	0.10	42.33	57.58	0.00	94.28

[1/] Major portion of data from M.S. candidate; bedrock analysis from Ph.D. candidate.

TABLE XI

FOREMAN, ARKANSAS, PLOT NO. 12 [1/]

County: Little River
Region: Upper Coastal Plain
Underlying Bedrock: Marlbrook Marl

Soil Order: Alfisol
Soil Series: Oktibbeha
Elevation: 370 feet

Horizon	Depth (Inches)	Color	Field pH	Texture	Particle Size Distribution % Sand	Silt	Clay	Gravel %	$CaCO_3$ %
A_1	0- 3	10 3/1	6.0	Silty Clay	30.97	40.73	28.30	21.25131	0.00
B_{21t}	3-12	5 5/8	5.5	Clay	19.98	25.10	54.92	17.04701	0.00
B_{22t}	12-20	5 5/8	5.0	Silty Clay	6.99	30.72	63.27	1.27126	0.00
B_{23t}	20-34	2.5 6/6	5.0	Silty Clay	22.04	65.54	12.42	14.50842	15.61
IIC	34-62	2.5 6/6	7.5	Silty Clay	5.33	40.72	44.94	0.61107	54.41
R	62+	Grey	8.0	Marlbrook marl	0.62	41.07	58.31	0.00093	54.73

[1/] Major portion of data from M.S. candidate; bedrock analysis from Ph.D. candidate.

VITA

Roger Erwin

Candidate for the Degree of

Master of Science

Thesis: PHYSICAL ANALYSIS OF SOME ALFISOLS OF THE UPPER COASTAL PLAIN: SURFACE GEOLOGY-SOIL RELATIONSHIPS

Major Field: Forest Resources

Biographical:

Personal Data: Born at Guthrie, Oklahoma, August 2, 1942, the son of Roy and Luceal Erwin.

Education: Graduated from Poteau Senior High School, Poteau, Oklahoma, in May, 1960; received Bachelor of Science degree with a major in Forestry at Oklahoma State University in May, 1965; completed requirements for a Master of Science degree in May, 1975.

Professional Experience: Worked as a Forestry Aid with the United States Forest Service during the summers of 1962 and 1963, Kistachie National Forest, Louisiana; served as a Forestry Aid during the summers of 1964, 1965 and 1972 with the Bureau of Land Management in South Dakota, California and Montana; Graduate Research Assistant, Department of Forestry, Oklahoma State University, 1972-1973; served as an inventory forester with the State of South Dakota during the summer of 1973.

Membership: Society of American Foresters