CHARACTERISTICS AND EXTENT OF BENCHMARK AND KEY SOILS WITH A MODERN CLASSIFICATION FOR OKLAHOMA SOILS

By

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CHAPTER I

INTRODUCTION

In recent years the system of classifying soils in Oklahoma has been revised. "Soils of Oklahoma", MP 56, utilized the 1938 soil classification. The objective of this thesis is to classify soils of Oklahoma based on the U. S. Comprehensive Soil Classification that is currently used by the national cooperative soil survey, and has been operative in Oklahoma since 1965. The new classification was originally published in 1960 with supplements in 1967 and 1968.

The current system defines soil classes in terms of observable or measurable properties. Genesis does not appear in the definitions of soil classes. The system has six categories. Beginning with the most inclusive, they are the order, suborder, great group, subgroup, family, and series.

Ten soil orders are recognized: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Alfisols, Ultisols, Spodosols, Oxisols and Histosols. The first seven orders occur in Oklahoma.

CHAPTER II

REVIEW OF LITERATURE

Man has always tried to classify surrounding objects in order to recognize their differences and similarities. Soils have not been an exception, as human life directly depends on the existence of soils.

Early soil classifications were not sophisticated because the uses of soils were simple and practical. But with increasing uses of soils, their classification has become more scientific and complex. Kubiena (1) states, "show me your classification system and I will tell you how far you have come in the perception of your research problems" (p. 170).

Jacob S. Joffe (12) defined a classification as "a process of logical reasoning based on the properties and characteristics of representative units of natural bodies for the purpose of studying, identifying, and grouping them". He continues "classification is not a science, it is just a tool in the work shop of scientists" (p. 349). Cline (2) believes that the purpose of any classification is to organize our knowledge so that the properties of objects may be remembered and their relationship may be easily understood for a specific objective.

Early soil classification was based on the color of soils. Many investigators from different countries were using it as a classifying characteristic (22). For instance, the expression Bleached soil implied that all of the iron had been washed out of the soil.

The first important attempts to classify soils were made on the basis of geology. Some of these were considered useful systems for parent materials but not for true soils. Many completely different soils can be developed from the same parent material depending on climate, vegetation, relief, time, and living organisms. Thaer (1) in 1835 proposed a classification system based on textural properties, and Fallou (1) in 1862 developed a soil classification primarily based upon geologic origin and parent materials. Later, F. Van Richthofen (23) introduced a soil classification based on the mode of weathering which was actually a classification for regolithic materials.

Dokuchaev in 1879 made real progress toward soil classification, when he proposed the first genetic classification of soils. He was the first investigator who included climate among the factors that determined a regular distribution of soils in the world (9). Dokuchaev considered soil as an independent natural body formed under the influence of five soil forming factors. He defined it as:

> the layers of material lying on the surface of the earth or near it, which have been changed by natural processes under the influence of water, air, and living and dead organic matters (8, p. 21).

A natural body has been defined by Vernadskii, in 1937, as:

> any object in nature which attains the status of individuality, endowed with an independent existence, capable of being distinguished and isolated from its environment, with an internal constitution, and controlled by specific laws in nature (11, p. 10).

Sibirtsev (9) worked out the concepts of Dokuchaev's classification and formulated a theory of the zonality of soils. He recognized the effect and importance of (a) parent materials, (b) physio-geographical conditions, (c) organisms, and (d) climate. He classified soils into three categories (1) zonal of fully developed soils, (2) intrazonal soils or soils in which local soil forming factors predominate over the general or zonal factors and (3) azonal or incompletely developed soils which can be found at the borders of the true soil zones. Glinka (1867-1929) who is very famous in the western world due to the widespread translation of his books, was one of Dokuchaev's outstanding students. Glinka's classification is based on the maturity of soil profile development and the effects of leaching by penetrating water.

Hilgard (1833-1916) probably was the first American Soil Scientist to conceive of soil as a natural body. He classified soils into two general groups, humid and arid (10). Coffey was another early American investigator who believed that soil classification should be based on climatic and vegetational differences (1). C. F. Marbut (1863-1935) was perhaps the most outstanding American scientist, he introduced the concepts of Dukuchaev, Glinka, and Sibirtsev to the United States. Marbut (16) indicated that in any soil classification the following fundamental conceptions must be met: (1) the true soil considered as a natural body, is the weathered surface horizon of the earth's crust, (2) there must be an unweathered part or, in other words, a parent material, (3) since a soil is a natural body, developed by natural forces acting through natural processes on a natural material, its' true nature must be determined through a study of the natural or virgin soil, (4) a soil classification must be scientific, based on criteria comparable with that used in the classification of other natural bodies, (5) each soil developed under the soil forming factors has a series of horizons.

In 1927, Marbut proposed a system of soil classification to be used universally. He classified soils into pedocals and pedalfers (17). Pedocals which had almost the same properties as Hilgard's arid soils, were characterized by the presence of calcium carbonate accumulation in the soil profile. Pedalfers which may be compared to humid soils did not have any accumulation of calcium carbonate. Recognizable characteristics of these soils were an accumulation of sesquioxides accompanied by clay minerals. Marbut's classification was revised and published in the USDA Year Book of Agriculture by Kellog, Baldwin, and Thorp in 1938 (1). The concepts of zonal, intrazonal, and azonal classes were again considered the highest categories in the revised classification, while the Pedalfer-Pedocal concept was de-emphasized and more importance was put on the concept of soil as a three dimensional body (13).

Most systems of soil classification in general use up to 1950 had some defects. Many put emphasis on virgin soils, but the greatest need was for a classification of cultivated, eroded or reworked soils, or even soils made from transported materials (13). It was very difficult to place alluvial soils, which do not have developed soil horizons, into a system utilizing a strong genetic base. For these and other reasons the 1938 soil classification was incapable of being a comprehensive and quantitative system and had many faults which have been described by C. E. Kellogg. Kellogg (13) states that soil classification should be based on a combination of soil characteristics. He believes that the system must be one that can be interpreted in terms of genesis and behavior; however, genesis and behavior should be one step removed from the classification itself. He adds "the most useful soil classification is a general one that can be interpreted accurately for a wide variety of uses" (p. 1).

Modern USSR soil classification has a general approach first expressed by Dokuchaev and Sibirtsev. It has a strong emphasis on the genesis of soils. Soil properties and pedogenic processes in the true soil, in relation to soil forming factors, are other criteria in the USSR soil classification (1). In western Europe genesis and zonality concepts, accompanied with some laboratory data such as silica: sesquioxides and silica: alumina ratios, have been emphasized in the soil classification. Western European soil scientists put less emphasis on clay translocation and argillic horizons than do American soil investigators (1). Soil scientists in other countries such as Canada, Australia and Brazil have worked out soil classifications that are best suited for their own soils.

In the U.S. Comprehensive Soil Classification has been created and developed within the USDA under the leadership of G. D. Smith, in cooperation with foreign soil scientists and American universities. The differentiating characteristics in this system are properties of soils, including temperature and moisture. Cline (13) believes that if the basis of grouping is good, the differentiating characteristics should be associated with some covarying properties called "accessory characteristics".

The comprehensive system has taxa defined in terms of observable and measuralbe soil properties. Genesis does not appear in the definitions, "it lies behind them" (24, p. 8). The reasons for defining the new taxa, based on soil properties, have been explained by C. D. Smith (24). He believes the definitions of taxa must be as precise as possible, and adds that if the taxa are defined in genetic terms, any given soil may be classified in as many ways as there are genetic viewpoints. Soils of unknown genesis can not be classified if definitions are expressed in terms of soil genesis. M. C. Cline (3) in describing the comprehensive system wrote "the major contribution in my judgement, lies in the fact that the definitions are precisely quantitative to the extent that knowledge permits" (p. 444).

In the comprehensive system an entirely new nomenclature was considered essential. A formative element from each of the higher categories is successively carried down to the sub-categories in their nomenclature, from order through family. The comprehensive system is flexible and allows future modification which may be necessary because of new knowledge and understanding of soils.

Structure of the U. S. Comprehensive Soil Classification System

The system consists of six categories. They are the Order, Suborder, Great Group, Subgroup, Family and Series respectively from highest to lowest levels of generalization.

The greatest difference between the Comprehensive system and the 1938 U. S. Soil Classification is the addition of the subgroup category. The need for an additional category between the great group and the family category, bridging the enormous gap that existed in the 1938 soil classification was emphasized by James Thorp and G. D. Smith (32).

Diagnostic horizons are employed in the comprehensive system to define soil classes. Presence or absence of specific diagnostic horizons are used as differentiating characteristics for the highest categories of soils. The diagnostic horizons that have formed at the surface of soils are called epipedon. An epipedon is not identical with the A horizon: it may be thinner than the A horizon or include some of the B horizon. Other diagnostic horizons have been formed below the soil surface. They show the accumulation of materials leached from upper horizons, or they demonstrate other properties and features which can be used for differentiation of soils. These horizons may be exposed by removal of surface layers.

The diagnostic horizons of mineral and organic soils, as well as other layers or horizons and macrofeatures employed in the U. S. Comprehensive Soil Classification, are defined precisely in the soil taxonomy.

CHAPTER III

MATERIALS AND METHODS

The soil map of Oklahoma based on the United States Comprehensive soil classification has been compiled using "Soils of the Southern States and Puerto Rico" (Figure 1). The mapping units are associations of the great groups. Soils of the state have been classified into seven orders, thirteen suborders, and twenty six great groups. Typical and extensive soils of Oklahoma have been designated as "Benchmark soils" by the Cooperative Soil Survey. Key soils are other important soils in the state. Thirty five benchmark and key soils have been selected to represent the soils of Oklahoma. The location maps showing the general distribution and extent of the important great groups have also been assembled. Schematic soil horizon diagrams for each benchmark and key soil have been prepared showing depth, color, texture, structure, and other significant features of each horizon. Main uses and limitations of the benchmark and key soils have been recognized in our study. In addition, physical and chemical characteristics; including cation exchange capacity, extractable bases and hydrogen, total phosphorus, pH, percent organic matter, and particle size distribution of the pedons obtained from published sources, are presented in tables.

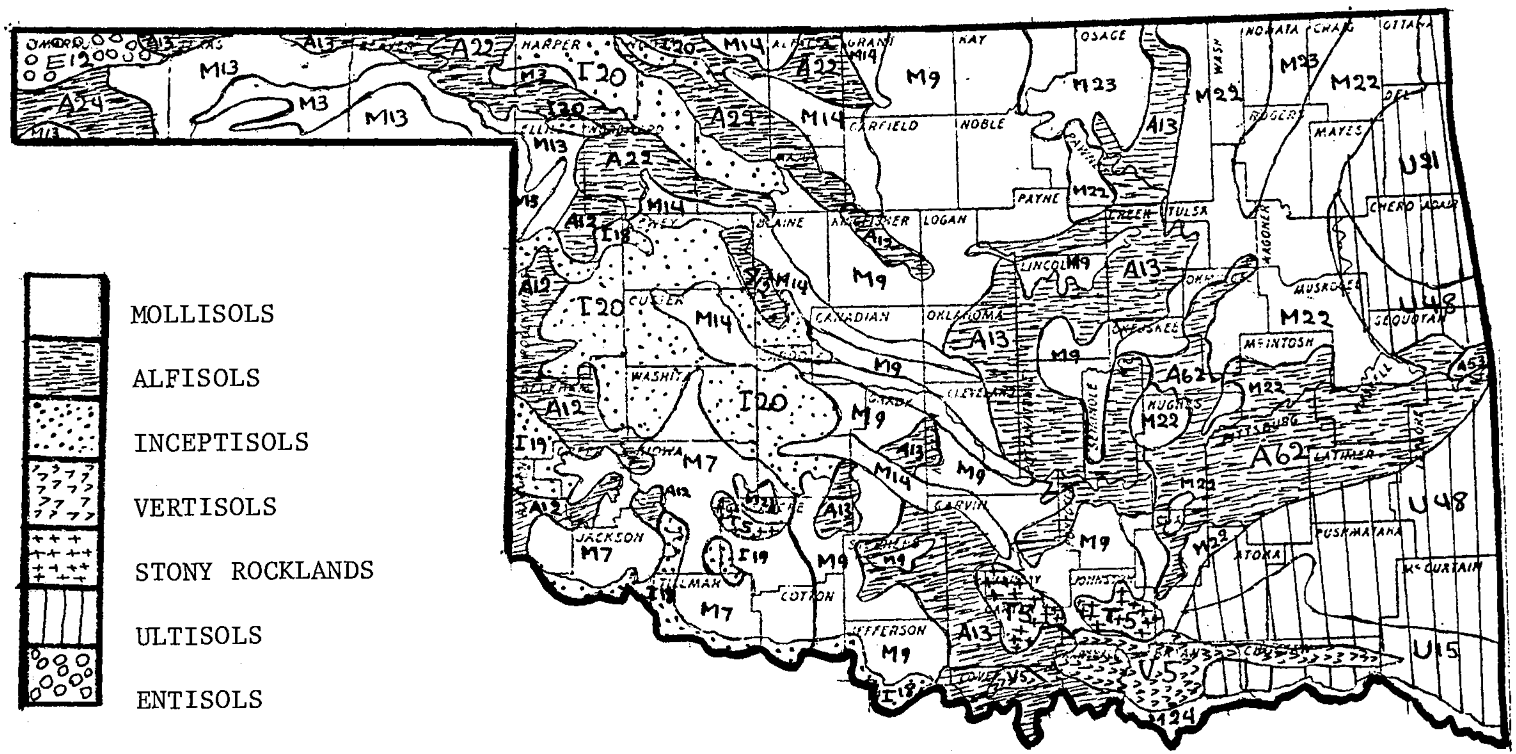


Figure 1. Soil Associations of the Great Groups in Oklahoma

Legends

1. Alfisols

   A12 Paleustalfs, Haplustalfs, Ustochrepts
   A13 Paleustalfs, Haplustalfs
   A22 Haplustalfs, Ustipsamments, Ustorthents
   A24 Haplustalfs, Paleustalfs (thermic)
   A53 Hapludalfs, Fragiudults, Haplaquepts
   A62 Hapludalfs, Hapludults, Argiudolls

2. Mollisols

   M3 Calciustolls, Haplustolls, Calciorthids
   M7 Paleustolls, Natrustolls
   M9 Paleustolls, Argiustolls, Ustochrepts
   M13 Paleustolls, Argiustolls, Calciustolls
   M14 Argiustolls, Haplustolls, Ustifluvents
   M22 Paleudolls, Albaqualfs, Argiudolls
   M23 Argiudolls, Haplustolls, Paleudolls
   M24 Hapludolls, Udifluvents

3. Ultisols

   U15 Paleudults, Paleudalfs, Hapludults
   U21 Paleudults, Fragiudults, Paleudalfs
   U43 Hapludults, Dystrochrepts (Steepthermic)
   U48 Hapludults, Dystrochrepts, Paluedalfs

4. Inceptisols

   I18 Ustochrepts, Argiustolls, Ustifluvents
   I19 Ustochrepts, Argiustolls, Paleustolls
   I20 Ustochrepts, Argiustolls, Haplustalfs

5. Vertisols

   V5 Pellusterts, Paleustolls, Haplustolls

6. Entisols

   E12 Torriorthents, Ustochrepts, Calciustolls

7. Types

   T5 Stony Rockland

CHAPTER IV

RESULTS AND DISCUSSION

Mollisols and Their Classification in Oklahoma

Mollisols are commonly the very dark colored, base rich soils of grasslands which are developed in central, western, including the central panhandle, eastern and north eastern Oklahoma. They cover more of Oklahoma than any other soil order which is formed in the state.

A characteristic property of Mollisols is mollic epipedons containing high amounts of calcium or calcic horizons. The presence of high base saturation and abundant calcium indicate that these soils are developed in subhumid to semiarid climatic zones where the leaching of bases is slow or impossible. However, moisture is adequate for relatively large annual additions of organic matter. Most have had a grass vegetation at one time, though many may have been forested during an earlier period. While it is true that all Mollisols have mollic epipedons, the presence of a mollic epipedon does not automatically qualify a soil as a Mollisol. For example, mollic epipedons are also present in some Vertisols and Inceptisols. There are two suborders of Mollisols in Oklahoma: (1) Ustolls, and (2) Udolls.

Ustolls

Ustolls occur mostly in central, north and south central, as well as north and south western Oklahoma. They are the more or less freely drained Mollisols of subhumid to semi-arid climates. Rainfall usually occurs during the growing season, often in heavy showers. Droughts are frequent and may be severe, as a result the soils usually desicate once or twice a year. In addition to the mollic epipedon some of these soils have a calcium horizon with soft powdery lime or a calcic horizon. Ustolls may have cambic, argillic, or natric horizons. These are used in part to define the great groups of Ustolls of which five appear in Oklahoma: (a) Paleustolls, (b) Natrustolls, (c) Argiustolls, (d) Haplustolls, (e) Calciustolls.

Paleustolls occur mostly in central, north central, south and north western Oklahoma on old stable landforms. They have a thick argillic horizon or, more commonly, clayey argillic horizons, or a petrocalcic horizon; but they never have duripans or natric horizons within 1 meter of the surface.

Natrustolls are Ustolls that have a natric horizon. They occur primarily in south western Oklahoma. The most common horizon sequences are either a natric horizon in the lower part of the mollic epipedon or a thin albic horizon overlying a columnar natric horizon. There is usually a Ca or Sa horizon below the natric horizon; but never petrocalcic horizons or duripans within 1 meter of the surface. Sodium content is more than 15 percent of the extractable bases in the subsoil horizons.

Argiustolls occur mostly in central and western Oklahoma and have an argillic horizon in or below the mollic epipedon. Most have a calcium or calcic horizon below the argillic horizon, and some have a Sa or Cs horizon below the calcium horizon. There are no duripans, natric, or petrocalcic horizons within 1 meter of the surface.

Haplustolls are dominantly formed in central Oklahoma. They have a cambic horizon or a only slightly altered parent material below the mollic epipedon. Most Haplustolls have horizons in which carbonates or soluble salts have accumulated; but soils from acid sediments have no horizons of carbonate accumulation. A few have a calcic horizon, if their parent material contained lime. There are no duripans or petrocalcic horizons within 1 meter of the surface.

Calciustolls occur mostly in north western Oklahoma. All surface horizons are calcareous and there are commonly calcic horizons in the subsurface. Either parent materials have had more carbonate than the limited rainfall could remove from the surface horizons, or there is a continuing external source of carbonates. They have no argillic horizon above the calcic, gypsic, or petrocalcic horizon; no natric horizons nor duripans appear within 1 meter of the surface.

Udolls

Udolls are mostly formed in north Oklahoma with some also found in the south east extending to the boundaries of Ultisols. They are the more or less freely drained Mollisols of humid continental climates. In addition to the mollic epipedon, cambic or argillic horizons may be present. There are no albic horizons, nor characteristics associated with wetness, namely, mottles, iron-manganese concretions or both. Udolls are not saturated with water at any period and have no calcareous or calcic horizons. There are three great groups of Udolls in Oklahoma: (1) Paleudolls, (2) Argiudolls, (3) Hapludolls.

Paleudolls occur in north eastern Oklahoma and have a thick argillic horizon in which the clay content decreases slowly with depth.

Argiudolls are mostly developed in north eastern Oklahoma and have a relatively thin argillic horizon or one in which the clay content decreases rapidly with depth. There may be a weakly developed calcium horizon below the argillic horizon; however, most are not calcareous to any considerable depth below the argillic horizon.

Hapludolls occur mostly in extreme south eastern Oklahoma with a brownish cambic horizon, but never an argillic horizon, below the mollic epipedon. There may be a calcium horizon below the cambic, but the secondary carbonates are usually concentrated in hard concretions.

Morphology, Distribution and Characteristics of the Benchmark Soils of Mollisols

Seventeen soil series from seven great groups are selected as benchmark soils to represent the Mollisols of Oklahoma. The great groups and their benchmark soil series that have been studied are listed in Table I.

Location maps of the great groups and the soil horizon diagrams of the benchmark soils are shown in Figures 2 through 25. The maps show the general distribution of the great groups throughout the state. The schematic soil horizon diagram for each benchmark soil shows depth, texture, structure and other significant features of the horizons. Main uses and limitations of benchmark soils are included in order to provide additional information on the soils. Chemical and physical characteristics including cation exchange capacity, extractable calcium, magnesium, potassium, sodium and hydrogen, total phosphorus, pH, percent organic matter, and particle size distribution of pedons have been obtained from

TABLE I

MOLLISOL GREAT GROUPS AND THEIR BENCHMARK SOILS

Great Groups of Mollisols	Benchmark Soil Series
1. Agriustolls	Zaneis, St. Paul, Richfield, Pond-Creek, Kingfisher
2. Haplustolls	Port, Canadian
3. Paleustolls	Kirkland, Norge, Tillman, Bethany, Renfrow
4. Argiudolls	Summit
5. Natrustolls	Foard
6. Paleudolls	Newtonia, Dennis
7. Hapludolls	Collinsville

published sources and are presented in Tables II through VIII.

Alfisols and Their Classification in Oklahoma

Alfisols are developed in central, south central, eastern and western Oklahoma. They occur in climates which have a period when evapotranspiration exceeds precipitation. Water movement through the solum has been adequate to remove free carbonates from the epipedons and most of the argillic horizons; but inadequate to remove a substantial part of the exchangeable bases held by the soils. They

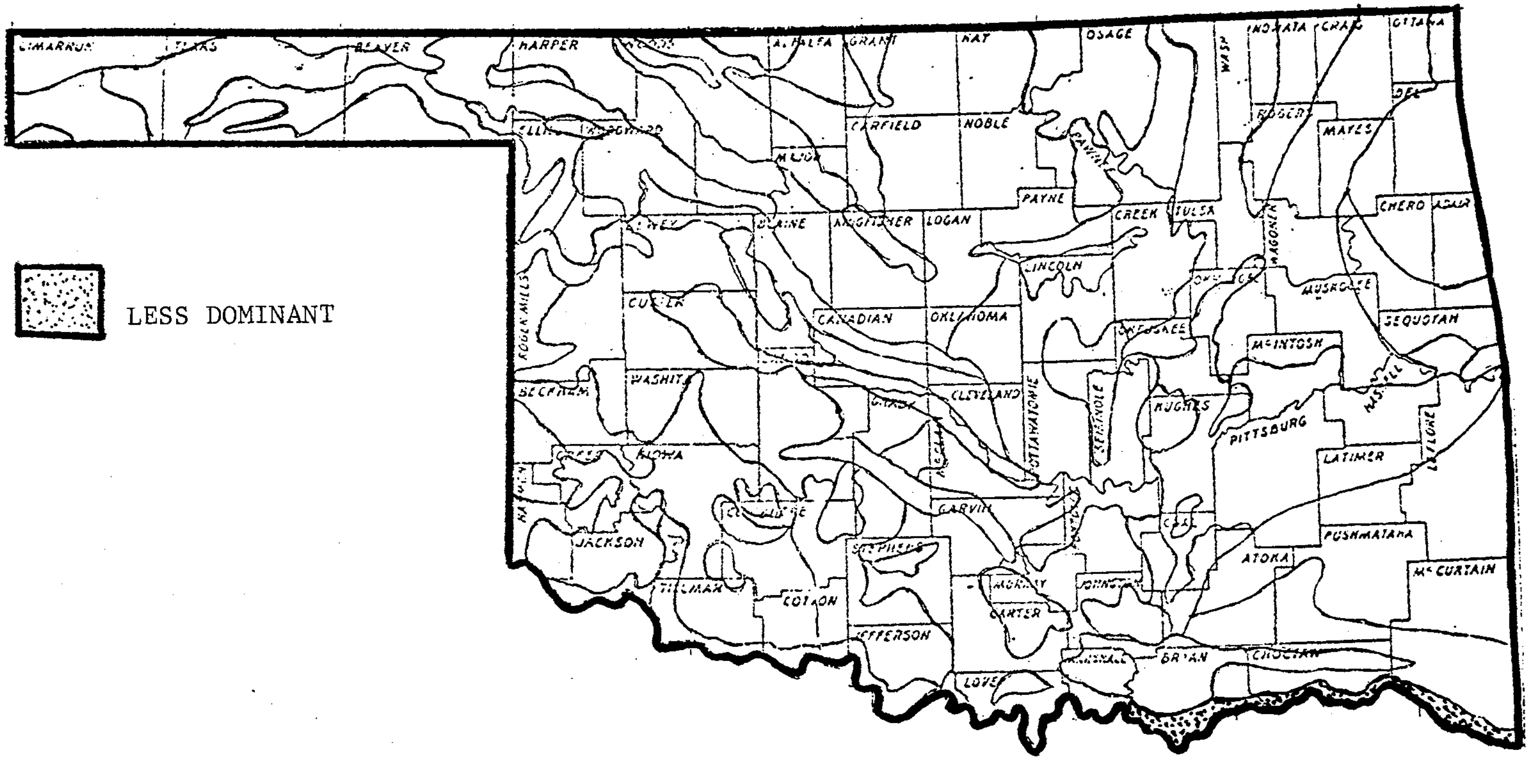
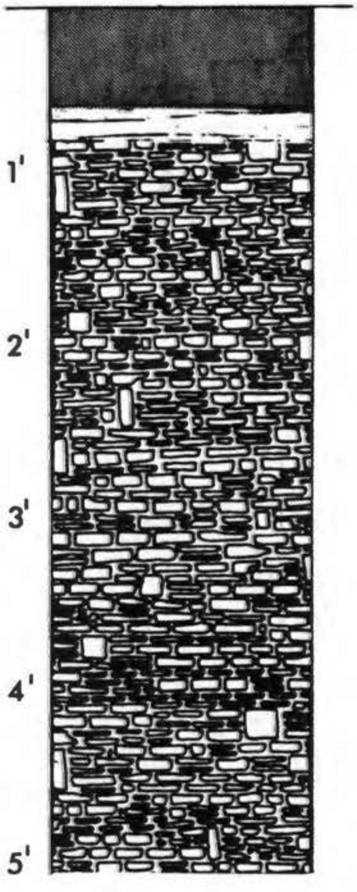


Figure 2. General Distribution of Hapludolls

HAPLUDOLL



A1	0-7"	Very dark grayish brown fine sandy loam; granules
C	7-9"	Brown fine sandy loam; massive
R	9"	Yellowish brown sandstone

MAIN USES AND LIMITATIONS: Pasture and range; shallow; low available water capacity; erosion.

Figure 3. Profile of Collinsville

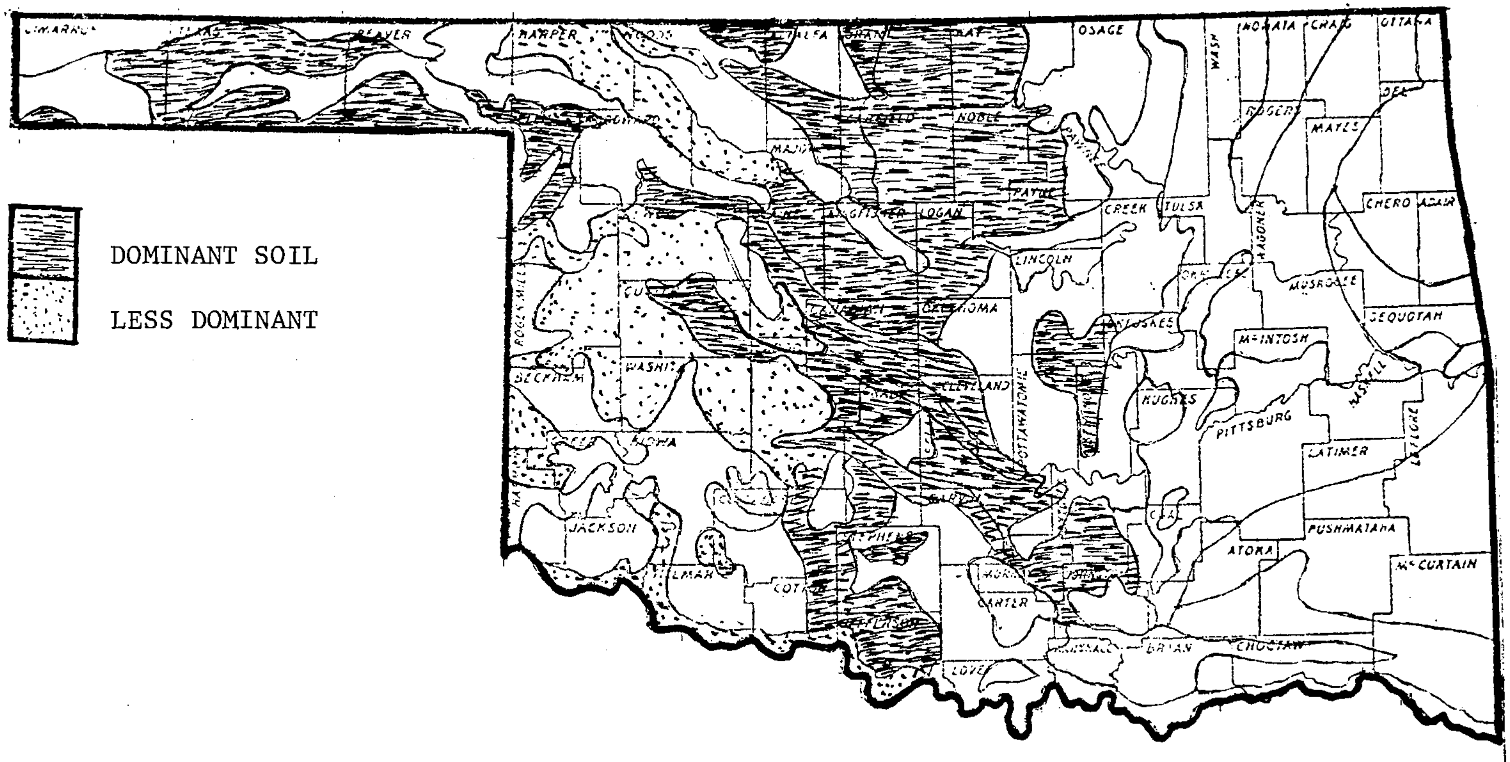
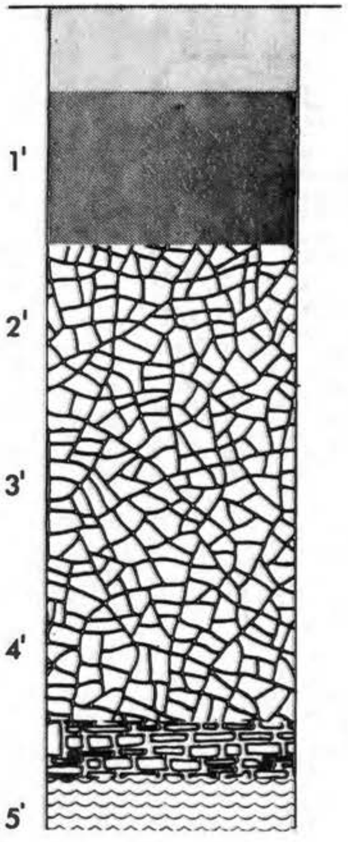


Figure 4. General Distribution of Argiustolls

ARGIUSTOLL

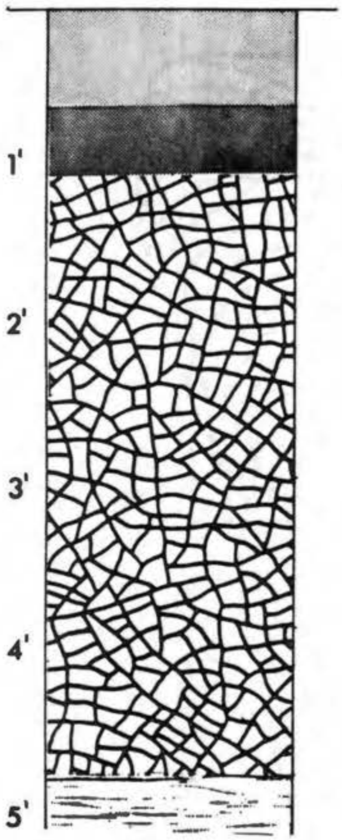


Ap	0-6"	Brown loam; granules
A1	6-11"	Dark brown loam; granules
B1	11-17"	Reddish brown clay loam; granules
B21t	17-28"	Reddish brown clay loam; prisms and subangular blocks
B22t	28-40"	Yellowish red clay loam; prisms and subangular blocks
B3	40-52"	Red clay loam; prisms and subangular blocks
C	52-60"	Red alternating layers of sandstone and sandy shale

MAIN USES AND LIMITATIONS: Pasture, Rangeland and Cropland; Erosion, Runoff; Many gullies.

Figure 5. Profile of Zaneis

ARGIUSTOLL

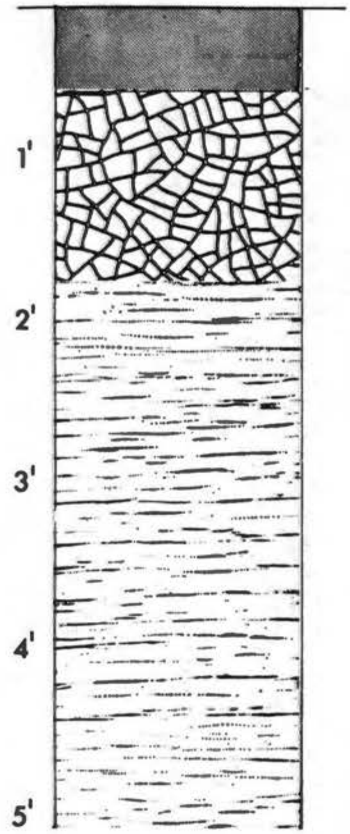


Ap	0-7"	Brown silt loam; granules
A1	7-12"	Dark brown silt loam, granules.
B1	12-18"	Dark brown silty clay loam; subangular blocks
B21t	18-34"	Reddish brown silty clay loam; subangular blocks
B22t	34-45"	Reddish brown silty clay loam; subangular blocks
B3	45-56"	Reddish brown silty clay loam; subangular blocks
C	56-70"	Yellowish red silt loam; massive; $CaCO_3$ concretions

MAIN USES AND LIMITATIONS: Cropland; slightly droughty; severe erosion on slopes; moderately slow permeability.

Figure 6. Profile of St. Paul

ARGIUSTOLL

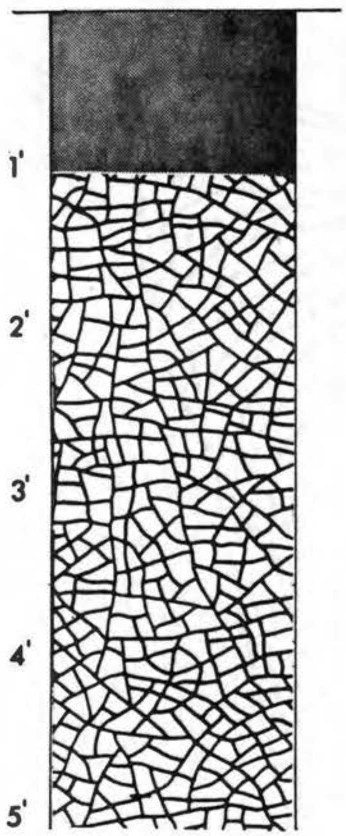


Ap	0-6"	Grayish brown silt loam; granules.
B2t	6-16"	Dark grayish brown heavy silty clay loam; subangular blocks
B3ca	16-20"	Grayish brown silty clay loam; subangular blocks
Cca	20-30"	Light gray light silty clay loam; unconsolidated
C	30-60"	Very pale brown silt loam; unconsolidated

MAIN USES AND LIMITATIONS: Cropland; some wind erosion; moderate to high shrink-swell potential; slow permeability.

Figure 7. Profile of Richfield

ARGIUSTOLL

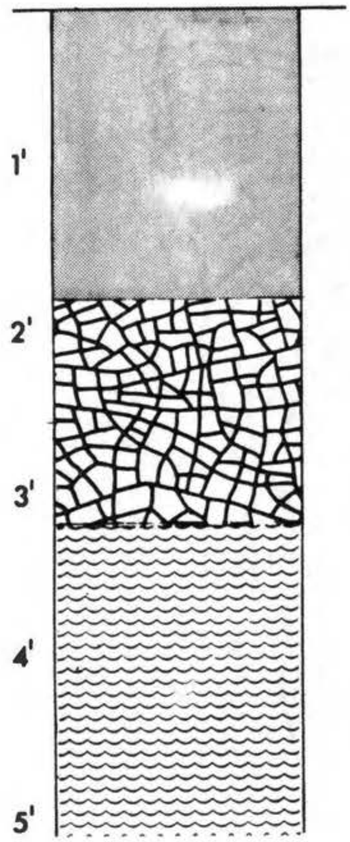


Ap	0-6"	Dark brown silt loam; granules
A12	6-12"	Dark brown silt loam, granules
B1	12-22"	Reddish brown silty clay loam; subangular blocks
B21t	22-30"	Reddish brown silty clay loam; subangular blocks
B22t	30-46"	Reddish brown heavy silty clay loam; subangular blocks
B3	46-60"	Reddish brown heavy silty clay loam; subangular blocks

MAIN USES AND LIMITATIONS: Cropland; severe erosion on slopes; moderately slow permeability.

Figure 8. Profile of Pond Creek

ARGIUSTOLL



A1	0–14"	**Reddish brown silt loam; granules**
B1	14–21"	**Reddish brown silty clay loam; granules**
B21t	21–32"	**Reddish brown silty clay loam; granules**
B22t	32–38"	**Reddish brown silty clay loam; subangular blocks**
C	38–46"	**Red partially weathered silty red beds**

MAIN USES AND LIMITATIONS: Cropland; severe erosion on slopes; moderately slow permeability.

Figure 9. Profile of Kingfisher

TABLE II

CHEMICAL AND PHYSICAL CHARACTERISTICS OF HAPLUDOLLS

HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	EXTRACTABLE CATIONS MEQ/100G. H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
							COLLINSVILLE LOAM (19)							
A1	0- 8	18.4	31.2	51.7	17.1	16.3	8.1	7.2	3.4	0.2	0.1	6.0	3.7	115.
B	8-16	11.1	25.4	51.0	23.5	15.1	10.6	3.0	2.1	0.13	0.1	5.2	1.6	101.

TABLE III

CHEMICAL AND PHYSICAL CHARACTERISTICS OF ARGUISTOLLS

HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	EXTRACTABLE CATIONS MEQ/100G. H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
							ZANEIS LOAM (18)							
A1	0-11	28.4	48.6	33.9	17.5	11.5		4.8	3.2	0.5	0.3	5.9	2.5	168.
B1	11-23	24.1	40.4	29.1	30.5	16.1		6.6	4.4	0.3	0.4	5.6	1.5	156.
B21T	23-32	23.3	37.8	29.5	32.7	15.9		6.6	5.1	0.4	0.6	5.7	1.2	137.
B22T	32-42	24.3	39.7	32.5	27.8	14.0		6.0	5.7	0.3	0.6	5.8	0.7	88.
B31	42-48	23.4	39.8	33.5	26.7	14.3		6.1	5.7	0.3	0.6	5.9	0.4	61.
B32	48-58	23.3	41.6	33.3	25.1	13.5		6.4	6.7	0.3	0.6	6.2	0.2	45.
C	58-78	26.6	45.3	33.1	21.6	11.4		5.3	5.1	0.3	0.6	6.4	0.1	41.
							KINGFISHER SILT LOAM (18)							
A11	0- 7	22.4	23.3	63.8	12.9	9.6		6.0	3.0	0.8	0.4	6.4	2.1	216.
A12	7-14	21.1	21.8	60.8	17.4	11.2		7.7	4.0	0.7	0.5	7.0	1.5	176.
A3	14-19	19.6	20.7	59.9	19.4	11.8		8.3	5.4	0.5	0.3	7.2	1.3	162.
B21	19-28	18.0	18.8	53.4	27.8	16.6		10.9	6.3	0.5	0.7	7.3	1.0	156.
B22	28-36	17.7	18.4	53.7	27.9	17.3		10.9	7.0	0.5	0.6	7.3	0.8	156.
B3	36-44	17.4	18.2	58.4	23.4	13.2		8.3	7.2	0.4	1.1	7.3	0.4	152.
C1	44-56	19.2	20.0	63.3	16.7	8.4		4.3	6.5	0.3	2.3	7.8	0.4	136.
C2	56-68	19.9	21.5	58.8	19.7	9.1		12.2	9.2	0.3	3.5	8.2	0.1	196.
							ST. PAUL SILT LOAM (27)							
A1P	0- 7	29.6	35.2	51.3	13.5	10.1	2.8	6.1	2.5	1.0	0.1	6.2	1.48	
A12	7-14	25.7	31.4	49.8	18.8	13.5	2.6	9.2	3.9	0.8	0.1	6.6	1.40	
A13	14-20	25.5	32.4	46.7	20.9	14.6	1.7	10.2	4.3	0.6	0.1	7.0	1.10	
B1	20-28	25.1	33.8	43.2	23.0	15.9	1.9	11.4	5.2	0.6	0.1	7.3	0.90	
B21	28-34	19.7	27.0	42.4	30.6	19.4	2.2	13.5	6.7	0.9	0.1	7.5	0.91	
B22	34-46	20.0	26.2	43.9	29.9	19.8	1.7	13.6	7.2	0.9	0.1	7.5	0.81	
B3	46-55	30.0	43.4	35.2	21.4	15.5	1.0	11.3	6.7	0.6	0.1	7.9	0.52	
CCA	55-65	46.1	61.8	23.7	14.5	11.3	0.1		5.3	0.5	0.1	8.1	0.29	
							RICHFIELD SILT LOAM (28)							
AP	0- 4	10.4	12.5	59.1	28.4	22.7	1.2		4.0	2.8		7.4	2.09	
B21T	4- 8	5.2	5.9	60.5	33.6	25.1	1.2	17.6	5.5	1.9		7.1	1.17	
B22T	8-13	6.3	6.8	61.2	32.0	25.2	2.0	17.9	7.3	1.5		7.2	0.96	
B2CA	13-25	5.3	5.9	52.0	42.1	21.4				1.7	0.1	8.2	0.69	
CCA	25-37	6.2	6.8	65.9	27.3	21.8				2.6	0.4	8.2	0.46	
C1	37-50	6.2	6.7	67.6	25.7	22.2				3.0	1.4	8.5	0.38	
C2	50-62	6.6	7.4	66.9	25.7	21.6				2.7	1.8	8.5	0.41	
							POND CREEK SILT LOAM (30)							
AP	0- 8	13.4	19.5	64.2	16.3	10.6	1.1	5.7	9.8	0.70	1.1	5.5	2.0	275.
B1	8-16	11.0	15.3	55.9	28.8	21.3	0.6	10.4	6.7	0.64	0.6	6.7	2.1	275.
B21T	16-26	9.0	18.1	45.0	36.9	18.2	1.6	13.0	8.9	0.66	1.6	7.1	1.5	275.
B22T	26-36	10.5	22.4	45.1	32.5	26.7	1.7	16.2	8.4	0.60	1.7	7.4	1.2	250.
B23T	36-48	14.2	32.5	41.3	26.2	16.5	0.0	9.0	6.0	0.50	0.0	7.3	1.0	225.
B24T	48-56	20.6	33.9	42.4	23.7	15.8	0.0	7.8	5.8	0.50	0.0	7.5	1.0	200.
B3	56-67	18.3	25.0	53.8	21.2	13.0	0.0	10.6	2.4	0.49	0.0	7.6	0.2	200.
C1	67-86	17.7	20.1	61.7	18.2	13.4	0.0	11.4	7.2	0.46	0.0	8.2	0.4	275.

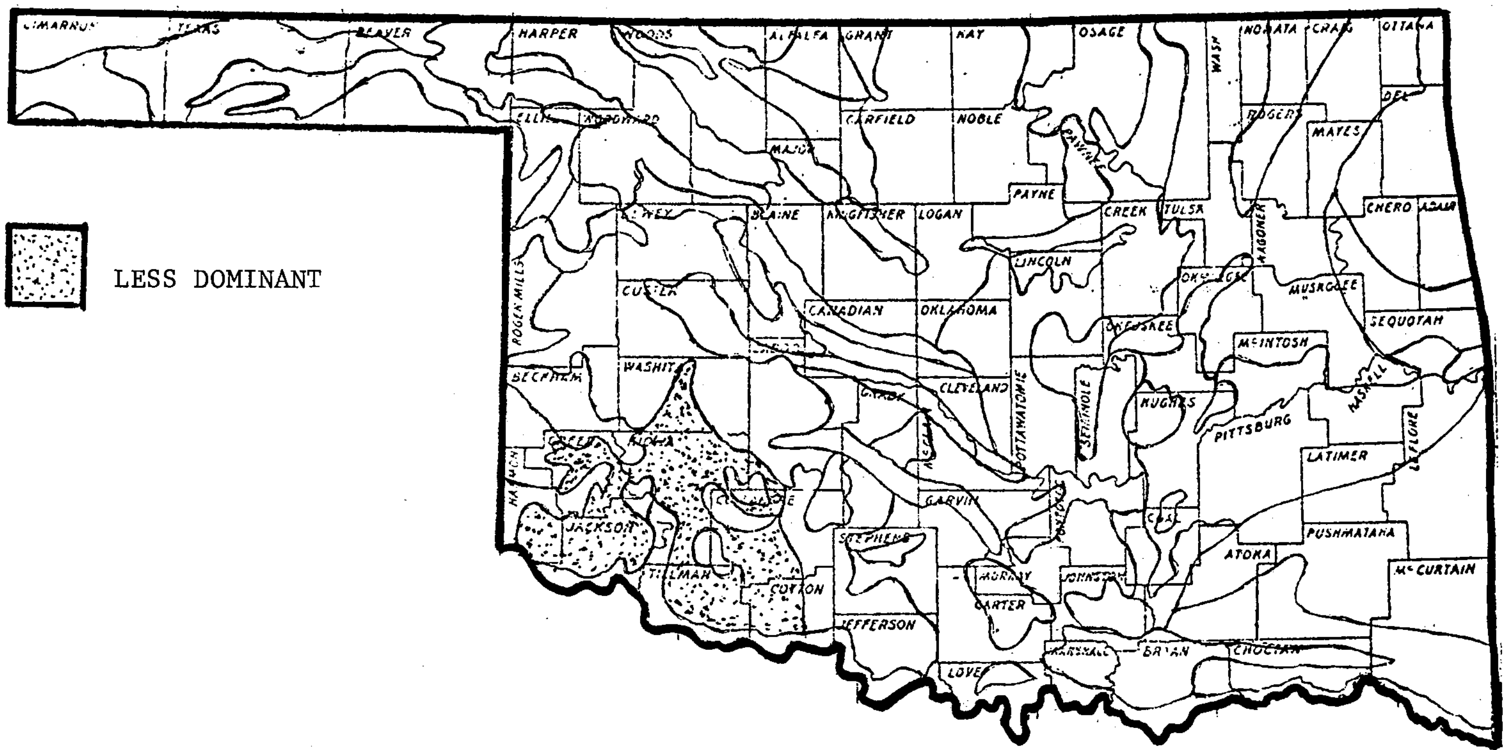
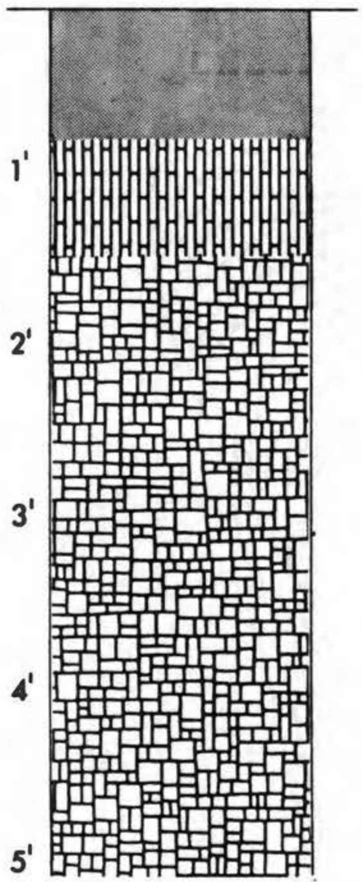


Figure 10. General Distribution of Natrustolls

NATRUSTOLL



Ap	0-9"	Brown silt loam; granules
B21t	9-17"	Brown silty clay; prisms and blocks; alkaline
B22t	17-22"	Brown silty clay; blocks; slickensides; alkaline
B31	22-38"	Brown heavy silty clay loam; blocks; slickensides; alkaline
B32	38-48"	Brown heavy silty clay loam; blocks; slickensides; alkaline

MAIN USES AND LIMITATIONS: Cropland; very slow permeability; droughty; erosion on slopes; high shrink-swell potential.

Figure 11. Profile of Foard

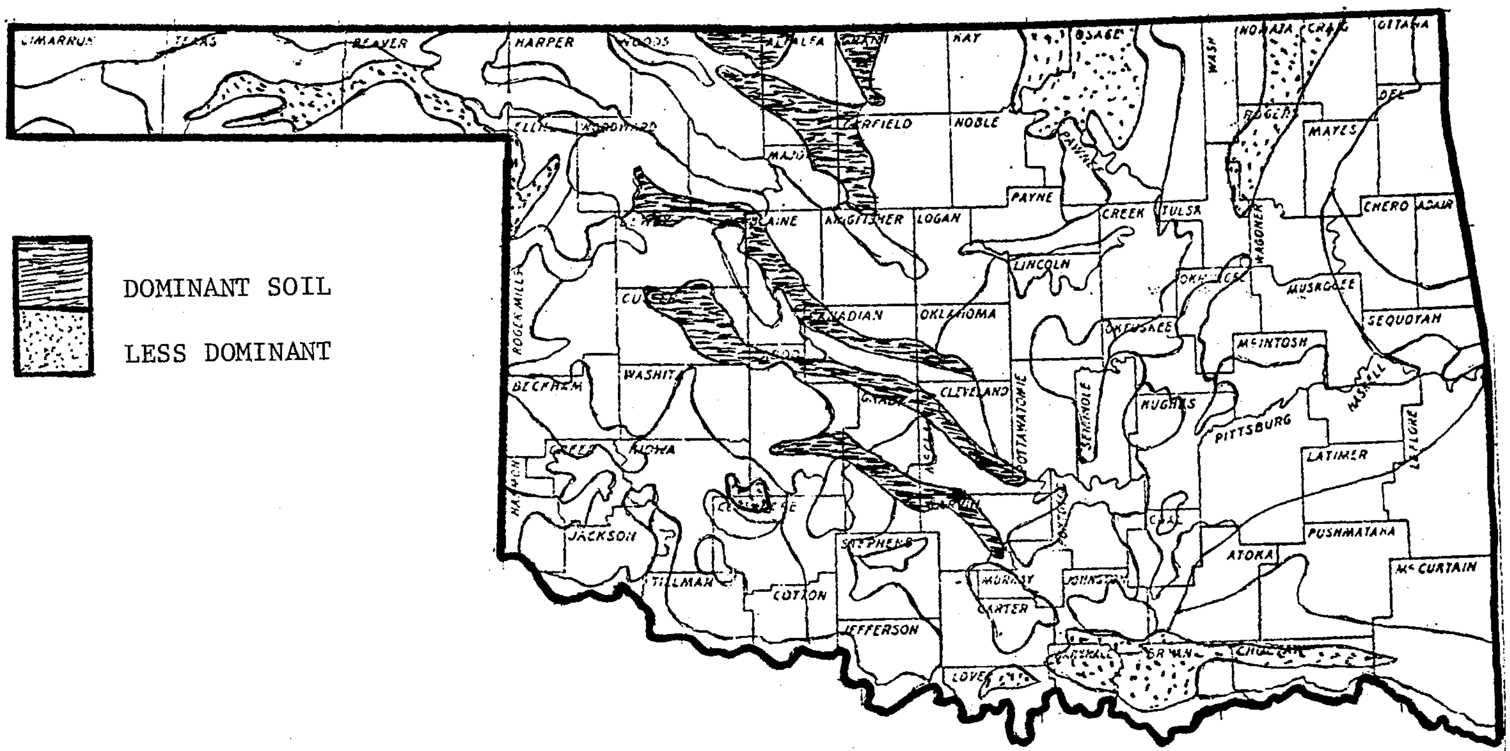
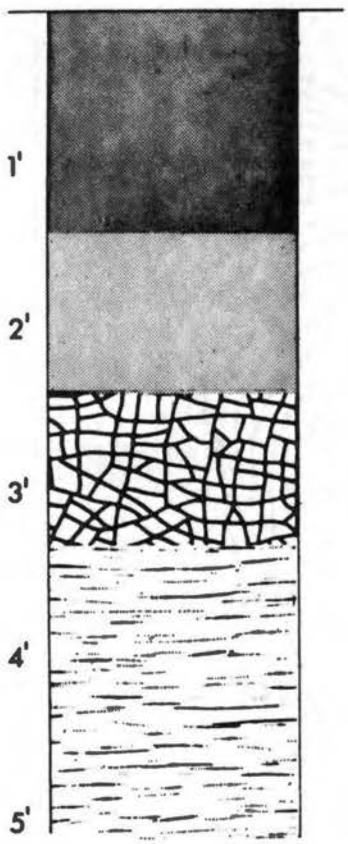


Figure 12. General Distribution of Haplustolls

HAPLUSTOLL

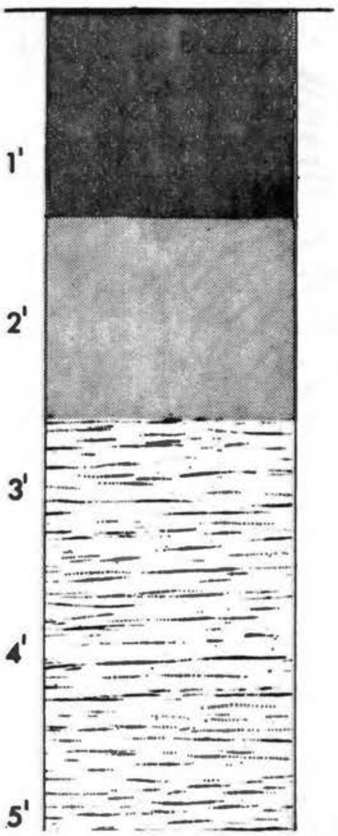


A11	0-16"	Brown silt loam; granules
A12	16-27"	Reddish brown silty clay loam; granules
B2	27-38"	Reddish brown silty clay loam; subangular blocks
C1	38-54"	Reddish brown silty clay loam; massive
C2	54-60"	Red silt loam; massive; calcareous

MAIN USES AND LIMITATIONS: Cropland and improved pastures; slow permeability, some flooding.

Figure 13. Profile of Port

HAPLUSTOLL



Ap	0-6"	Dark grayish brown fine sandy loam; granules
A12	6-15"	Dark grayish brown fine sandy loam; granules
B2	15-30"	Brown fine sandy loam; granules
C	30-60"	Pale brown fine sandy loam; massive; calcareous

MAIN USES AND LIMITATIONS: Cropland; slight wind erosion, occasional flooding and run off.

Figure 14. Profile of Canadian

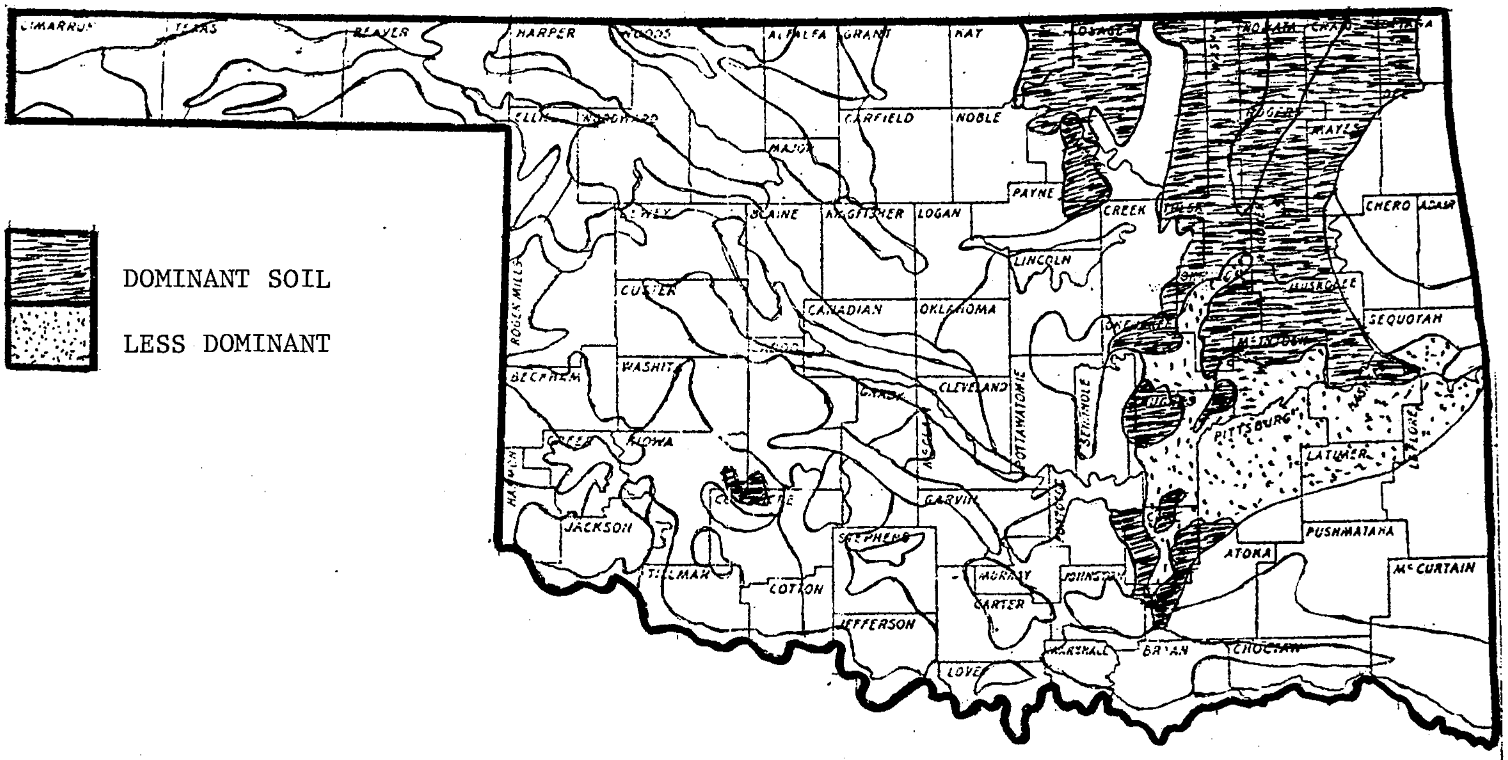
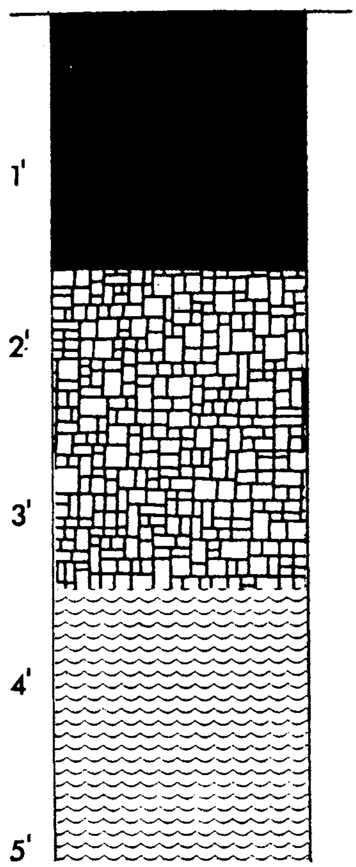


Figure 15. General Distribution of Argiudolls

ARGIUDOLL



A1	0-10"	Black silty clay loam; granules
B1	10-18"	Black silty clay; granules
B21t	18-26"	Very dark brown clay; blocks; mottles
B22t	26-40"	Very dark grayish brown clay; blocks; mottles
C	40-60"	Mottled dark gray, olive brown and yellowish brown clay; massive; black and white concretions

MAIN USES AND LIMITATIONS: Cropland; pasture and meadow; slow permeability; moderate to high shrink-swell potential; severe erosion on slopes.

Figure 16. Profile of Summit

TABLE IV

CHEMICAL AND PHYSICAL CHARACTERISTICS OF NATRUSTOLLS

							EXTRACTABLE CATIONS MEQ/100G.							
HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
						FOARD SILTY CLAY LOAM (27)								
AP	0- 8	14.1	12.4	60.0	21.6	17.0	3.1	8.8	5.6	0.4	1.3	6.6	1.02	
B21	8-14	9.4	12.2	45.4	42.4	31.8	2.4	16.8	13.1	0.5	4.2	7.7	1.21	
B22	14-21	10.9	16.8	49.6	33.6	23.9				0.4	4.5	8.3	0.64	
B1CA	21-30	10.0	16.9	49.4	33.7	24.2				0.4	5.8	8.2	0.36	
B2CA	30-44	10.0	16.5	48.3	35.2	25.4				0.4	7.2	8.1	0.24	
B3	44-54	11.6	18.2	47.4	34.4	24.6				0.4	7.1	7.9	0.14	
C1	54-64	13.0	19.5	47.4	33.1	22.6				0.4	7.8	8.0	0.10	
C2	64-70	14.4	21.9	46.9	31.2	21.0				0.4	6.8	8.1	0.07	

TABLE V

CHEMICAL AND PHYSICAL CHARACTERISTICS OF HAPLUSTOLLS

							EXTRACTABLE CATIONS MEQ/100G.							
HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
						PORT SILT LOAM (30)								
AP	0- 8	10.6	32.0	52.0	16.0	10.6	1.7	13.3	4.5	0.61	0.08	7.6	2.20	275.
A12	8-18	14.0	20.4	63.6	16.0	11.2	2.1	6.8	3.9	0.65	0.08	6.8	2.58	419.
B2	18-20	16.0	18.8	67.2	14.0	10.3	1.7	5.9	4.5	0.34	0.12	7.0	1.38	363.
A11	20-36	8.0	10.4	73.6	16.0	14.5	1.5	8.8	5.6	0.35	0.11	7.2	2.80	275.
A12	36-44	7.8	9.4	72.6	18.0	16.3	1.3	9.9	6.6	0.39	0.11	7.3	3.83	275.
A13	44-51	10.2	12.4	67.6	20.0	17.2	1.3	9.7	6.1	0.44	0.13	7.4	2.78	263.
B21	51-60	12.2	15.2	64.8	20.0	16.8	1.0	9.3	6.1	0.52	0.11	7.7	1.78	388.
B22	60-70	12.0	14.4	65.6	20.0	22.2	0.8	9.9	6.4	0.37	0.23	7.7	1.18	49.
						CANADIAN FINE SANDY LOAM (19)								
A1	0-15	48.8	72.8	22.1	5.0	7.3	0.0	5.1	1.7	0.25	0.07	7.2	1.07	240.
B2	15-26	45.5	79.5	15.1	5.0	7.9	0.0	7.8	1.4	0.25	0.07	8.0	0.98	254.
C	26-60	52.1	69.3	25.6	5.0	5.7	0.0	24.8	2.3	0.14	0.05	8.0	0.49	241.

TABLE VI

CHEMICAL AND PHYSICAL CHARACTERISTICS OF ARGIUDOLL

							EXTRACTABLE CATIONS MEQ/100G.							
HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
						SUMMIT SILTY CLAY LOAM (27)								
A11	0- 5	9.3	11.4	60.2	28.4	26.7		18.6	4.2	1.4	0.1	5.8	6.19	
A12	5-11	9.4	11.2	56.7	32.1	27.2		19.9	4.1	0.8	0.1	5.7	4.14	
B1	11-15	7.6	9.4	54.6	36.0	27.1		21.0	4.2	0.8	0.2	5.8	3.26	
B21T	15-20	6.9	8.5	51.0	40.5	29.1		24.1	4.4	0.9	0.3	5.8	2.43	
B22T	20-31	5.7	7.0	47.1	45.9	31.3		26.4	4.6	1.0	0.4	6.6	1.12	
B23T	31-39	6.0	8.0	44.4	47.6	32.2		28.9	5.0	1.1	0.5	7.5	0.74	
B3	39-52	5.1	10.0	45.3	44.7	32.2		30.7	5.3	1.1	0.8	7.7	0.41	
C	52-64	5.2	8.4	45.2	46.4	33.8		31.4	5.9	1.2	0.8	7.7	0.26	

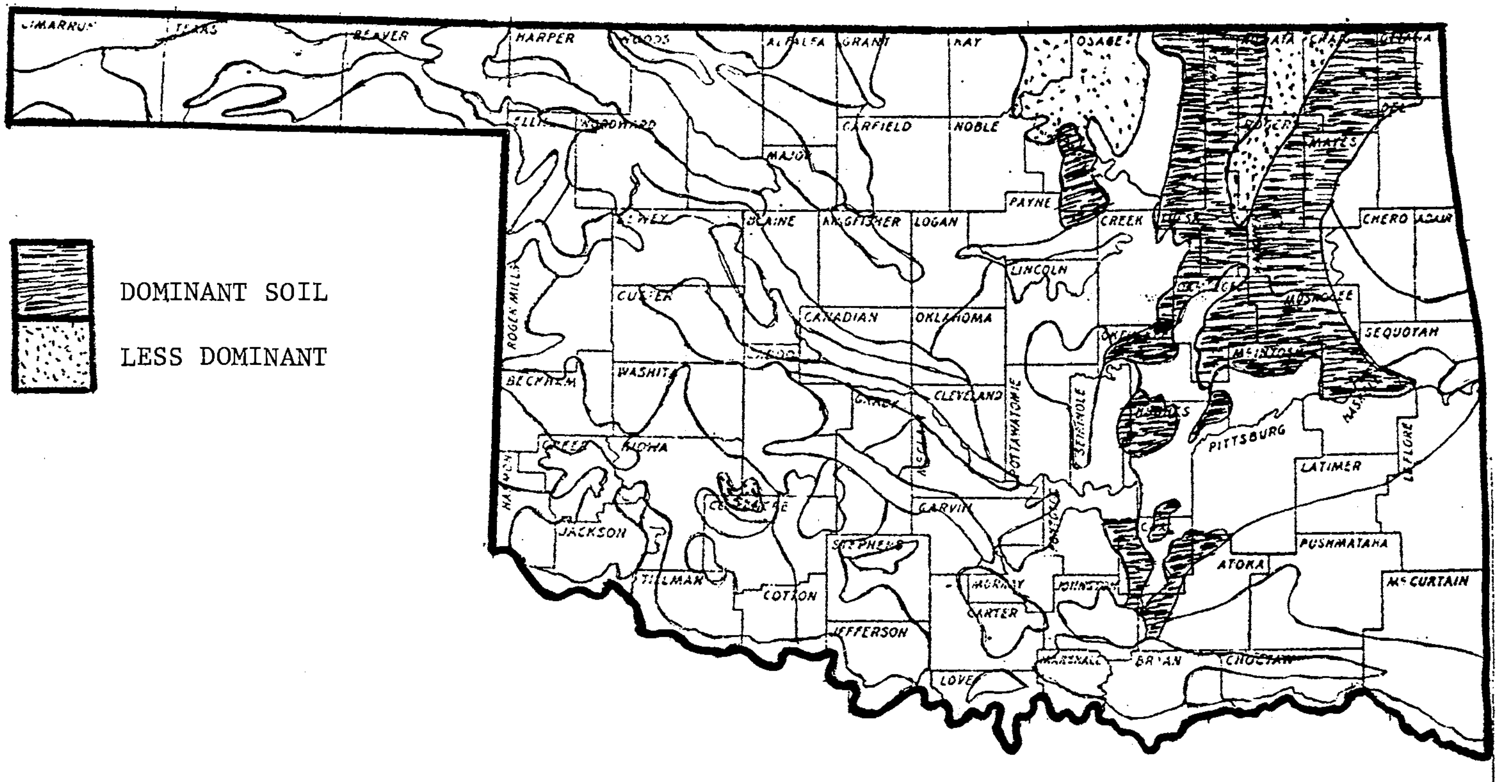
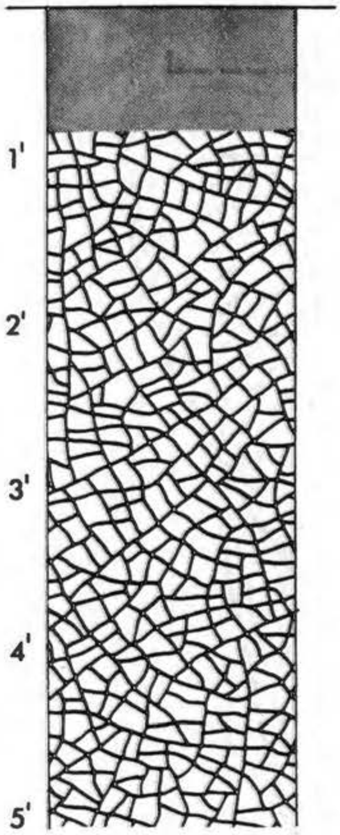


Figure 17. General Distribution of Paleudolls

PALEUDOLL

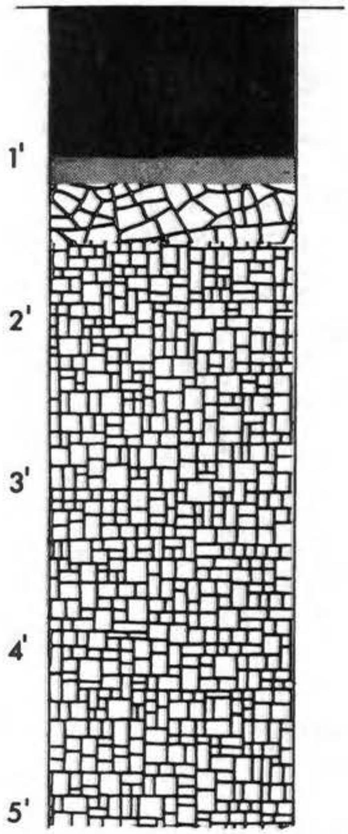


Ap	0-9"	Dark brown silt loam; granules
B1	9-18"	Dark reddish brown silt loam; Subangular blocks
B21t	18-26"	Yellowish red silty clay loam; subangular blocks
B22t	26-40"	Dark red silty clay; subangular blocks
B23t	40-51"	Dark red silty clay; subangular angular blocks
B3	51-61"	Red clay; subangular blocks; dark concretions

MAIN USES AND LIMITATIONS: Cropland including fruits, pasture; erosion on slopes.

Figure 18. Profile of Newtonia

PALEUDOLL



A1	0-11"	Very dark grayish brown silt loam; granules
A2	11-13"	Dark brown silt loam; granules
B1	13-17"	Dark brown silty clay loam; subangular blocks; mottles; dark concretions
B2t	17-36"	Yellowish brown clay; blocks; mottles; dark concretions
B31	36-50"	Coarsely mottled yellowish brown and light gray clay; blocks; black concretions
B32	50-68"	Yellowish brown silty clay loam; blocks; mottles; black concretions.

MAIN USES AND LIMITATIONS: Cropland; pasture and meadow; slow permeability; erosion on slopes; low fertility.

Figure 19. Profile of Dennis

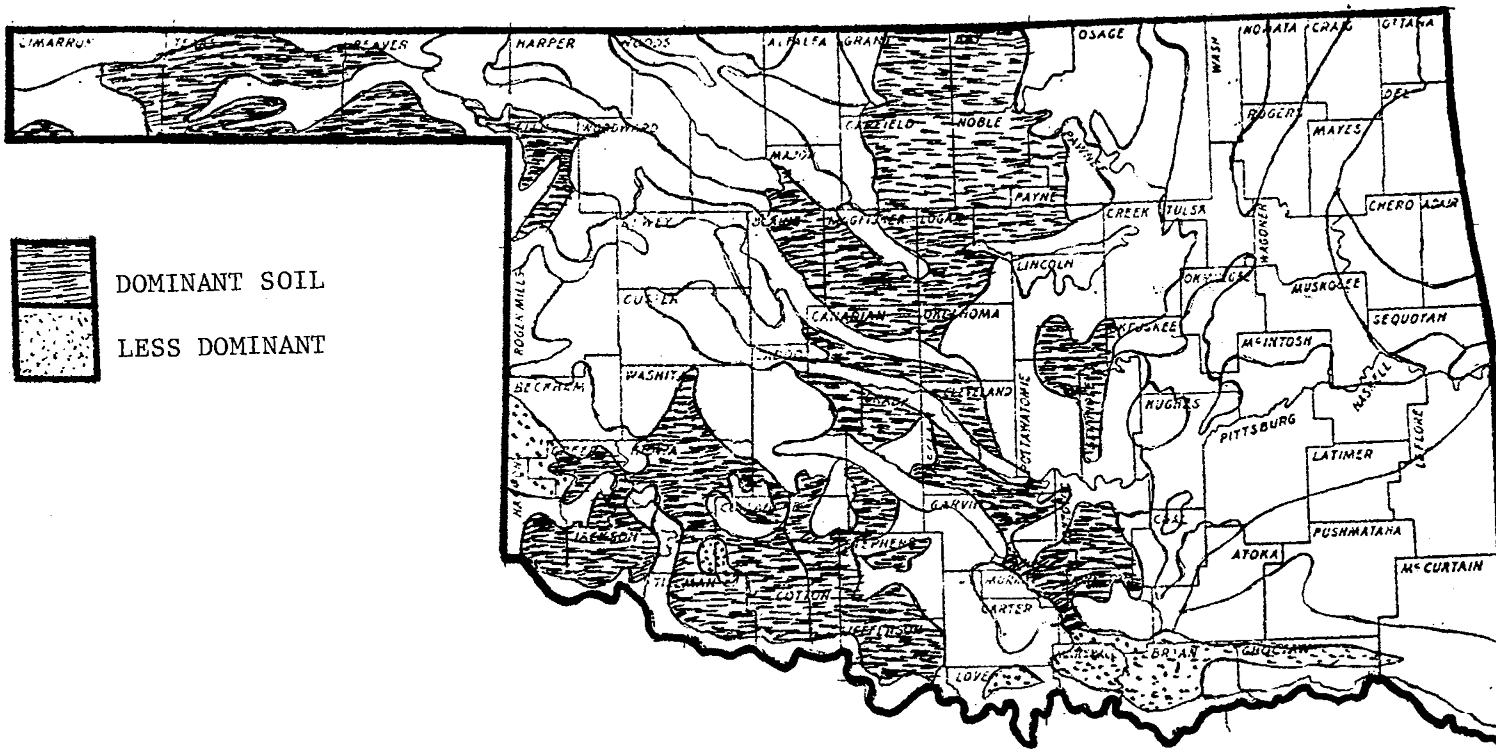
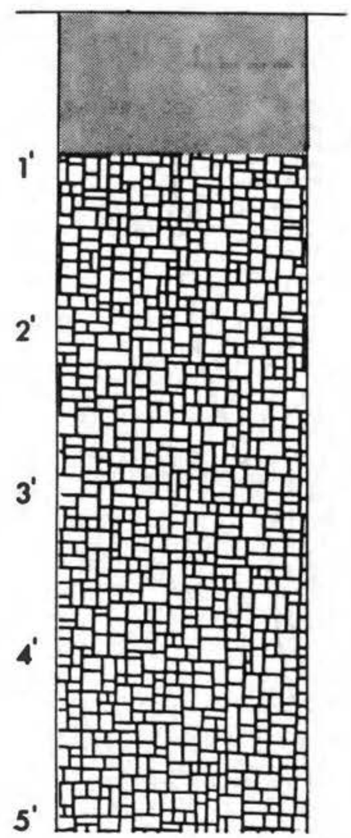


Figure 20. General Distribution of Paleustolls

PALEUSTOLL

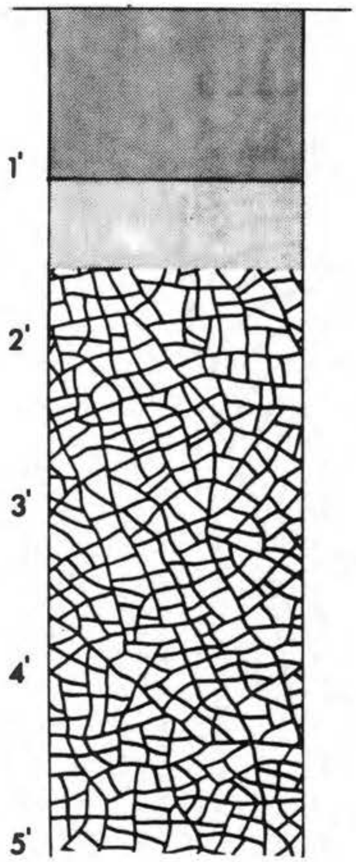


Ap	0-10"	Dark grayish brown silt loam; granules
B21t	10-28"	Dark grayish brown silty clay; blocks
B22t	28-42"	Brown silty clay; blocks
B23tca	42-62"	Reddish brown silty clay; blocks; iron, manganese, $CaCO_3$ concretions

MAIN USES AND LIMITATIONS: Cropland and pasture; very slow permeability droughty; high shrink swell potential; erosion.

Figure 21. Profile of Kirkland

PALEUSTOLL

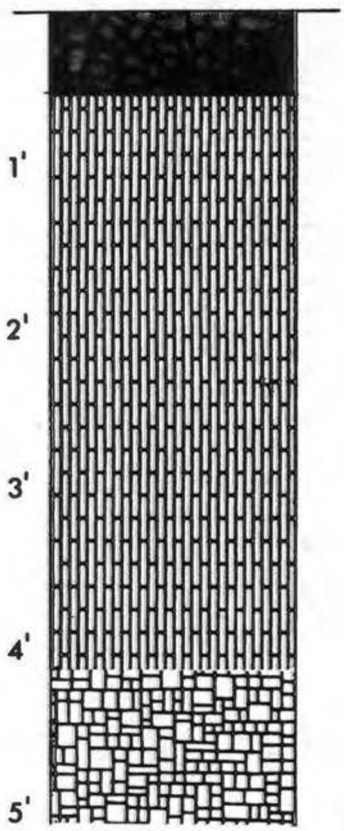


A1	0-12"	Dark brown silt loam; granules
B1	12-18"	Reddish brown silty clay loam; granules
B21t	18-36"	Reddish brown silty clay loam; subangular blocks
B22t	36-48"	Red silty clay loam; subangular blocks
B3	48-66"	Red silty clay loam; subangular blocks

MAIN USES AND LIMITATIONS: Cropland and hay; pasture on steeper areas; slow permeability; severe erosion on slopes.

Figure 22. Profile of Norge

PALEUSTOLL

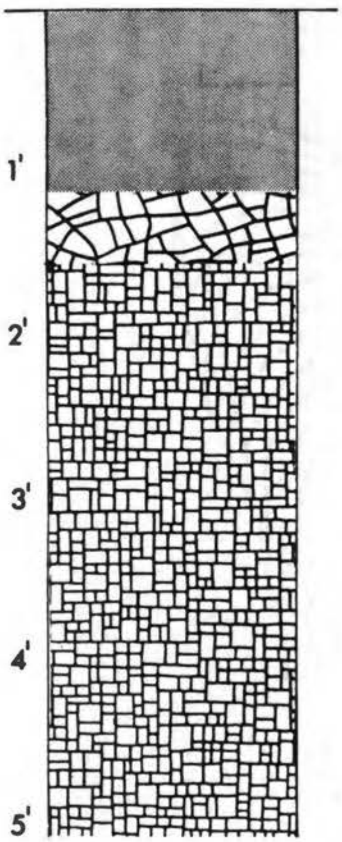


Ap	0-6"	Brown silty clay loam; subangular blocks; few $CaCO_3$ concretions
B21t	6-14"	Dark reddish brown clay; prisms and angular blocks; $CaCO_3$ concretions
B22t & B23t	14-38"	Reddish brown clay; Prisms and angular blocks; $CaCO_3$ concretions
B24t	38-49"	Red clay; prisms and angular blocks; $CaCO_3$ concretions
B25tca	49-60"	Red clay; angular blocks; $CaCO_3$ concretions and clay coatings

MAIN USES AND LIMITATIONS: Cropland, improved pastures; very slow permeability droughty; high shrink swell potential; erosion on slopes.

Figure 23. Profile of Tillman

PALEUSTOLL

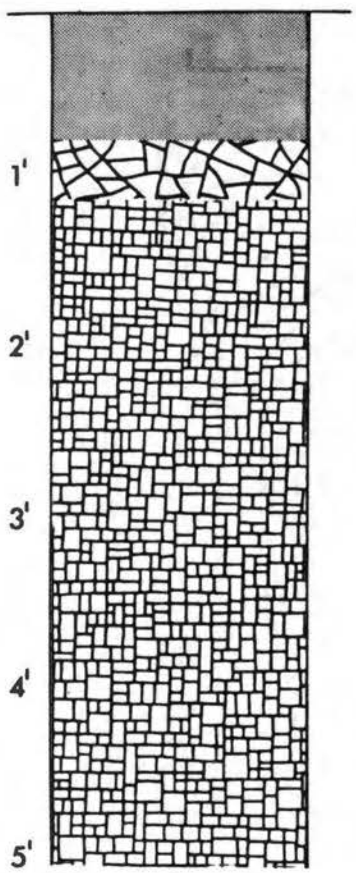


Ap	0-6"	Dark grayish brown silt loam; granules
A12	6-14"	Dark grayish brown silt loam: granules
B1t	14-18"	Dark grayish brown clay loam; subangular blocks
B21t	18-36"	Dark brown silty clay; blocks
B22t	36-56"	Brown silty clay; blocks; iron-manganese concretions
B23t	56-72"	Brown silty clay; blocks; mottles; Fe-Mn concretions

MAIN USES AND LIMITATIONS: Cropland; and some pasture; slow permeability; High shrink-swell potential; erosion on slopes; slightly droughty in summer.

Figure 24. Profile of Bethany

PALEUSTOLL



A1	0-9"	Brown silt loam; granules
B1	9-13"	Reddish brown clay loam; subangular blocks
B21t	13-25"	Reddish brown clay; blocks
B22t	25-40"	Reddish brown clay; blocks; calcareous
B3	40-65"	Red clay, blocks; $CaCO_3$ concretions; calcareous

MAIN USES AND LIMITATIONS: Cropland; pasture on slopes; slow permeability; high shrink-swell potential; erosion on slopes; droughty.

Figure 25. Profile of Renfrow

TABLE VII

CHEMICAL AND PHYSICAL CHARACTERISTICS OF PALEUDOLLS

							EXTRACTABLE CATIONS MEQ/100G.							
HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
						NEWTONIA SILT LOAM (27)								
A1P	0- 6	9.0	17.5	67.1	15.4	7.3	3.2	5.6	0.6	0.5	0.1	6.5	1.50	
A12	6- 9	8.7	17.6	66.0	16.4	7.3	3.2	5.8	0.7	0.3	0.1	6.4	1.41	
B1	9-18	7.3	14.6	61.1	24.3	8.0	4.8	4.8	1.3	0.3	0.1	6.2	1.20	
B21	18-26	6.7	13.7	54.4	31.9	9.8	6.6	4.8	2.4	0.3	0.1	5.5	1.03	
B22	26-40	8.0	16.0	41.8	42.2	12.4	7.9	5.7	3.9	0.3	0.1	5.4	0.69	
B31	40-51	8.6	17.8	40.5	41.7	13.4	7.6	5.4	4.3	0.3	0.1	5.4	0.41	
B32	51-61	7.5	19.6	38.8	41.6	14.1	8.2	5.7	4.6	0.4	0.1	5.2	0.36	
						DENNIS SILT LOAM (27)								
A11	0-12	12.7	24.4	55.8	19.8		7.8	7.3	2.7	0.2	0.2	5.4	2.55	
A3	12-16	11.3	20.9	55.6	23.5		7.6	7.5	2.8	0.2	0.4	5.4	1.95	
B1	16-26	9.6	19.5	49.1	31.4		7.6	9.0	3.1	0.3	0.6	5.6	1.28	
B2	26-31	6.9	12.2	44.9	42.9		7.9	11.4	4.6	0.3	1.0	5.8	0.84	
B3	31-40	6.5	12.9	45.0	42.1		7.1	12.4	5.0	0.3	1.1	5.9	0.53	
C1	40-54	6.8	14.0	42.9	43.1		6.0	14.5	5.8	0.4	1.4	6.3	0.31	
C2	54-72	6.4	13.6	45.0	41.4		4.5	14.6	6.6	0.3	1.4	6.6	0.29	
C3	72-90	6.9	16.5	46.9	36.6		3.7	12.9	6.2	0.3	1.3	6.6	0.12	

TABLE VIII

CHEMICAL AND PHYSICAL CHARACTERISTICS OF PALEUSTOLLS

							EXTRACTABLE CATIONS MEQ/100G.							
HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
						KIRKLAND CLAY LOAM (31)								
AP	0- 6		27.2	48.5	24.3	14.4		9.8	3.9	0.3	0.5	5.3	2.4	246.
B22T	6-19		14.6	38.2	47.2	27.8		17.3	4.4	0.4	2.1	6.7	1.6	152.
B23T	19-30		22.5	32.2	45.3	28.6		18.1	9.1	0.3	2.4	7.8	0.9	102.
B24T	30-38		27.6	36.1	36.3	28.2		17.5	8.1	0.3	4.0	7.9	0.6	96.
B25T	38-48		30.6	34.6	34.8	26.6		10.5	6.2	0.3	3.3	7.7	0.4	78.
B3	48-57		42.5	28.1	29.4	21.2		13.3	7.4	0.3	4.3	7.6	0.3	38.
C	57-+		32.8	33.3	33.9	21.9		10.8	6.1	0.3	4.2	7.5	0.2	89.
						NORGE SILT LOAM (27)								
A11	0- 8	15.6	21.6	58.5	20.9		6.3	7.4	2.2	0.6	0.1	5.6	3.10	
A12	8-13	15.2	19.5	56.3	24.2		7.0	7.2	2.5	0.4	0.1	5.5	2.60	
B1	13-19	13.7	17.9	53.9	28.2		6.8	7.4	3.2	0.4	0.1	5.6	1.93	
B21T	19-26	11.2	13.5	53.8	32.7		7.1	8.1	3.6	0.5	0.1	5.4	1.33	
B22T	26-35	10.8	12.7	54.4	32.9		6.0	8.1	4.0	0.5	0.1	5.6	0.78	
B3	35-46	10.5	12.3	56.7	31.0		4.2	8.5	4.0	0.5	0.1	5.8	0.45	
C1	46-60	10.5	12.1	57.1	30.8		4.0	10.2	4.7	0.5	0.2	6.0	0.24	
C2	60-90	8.5	10.6	53.1	36.3		4.0	14.0	5.9	0.7	0.3	6.0	0.16	
						BETHANY SILT LOAM (27)								
A1P	0-10	17.6	19.1	66.4	14.5	11.7	3.9	7.4	2.6	0.4	0.1	6.2	1.67	
A1	10-18	13.5	14.6	64.9	20.5	15.3	3.1	9.1	4.1	0.3	0.2	6.5	1.53	
B1	18-22	9.2	10.7	58.3	31.0	21.9	3.6	11.4	8.3	0.4	0.8	6.9	1.05	
B2	22-40	7.1	8.6	52.2	39.2	28.1	2.0	14.7	11.9	0.4	1.7	7.5	0.76	
B3	40-57	9.6	12.9	48.6	38.5	26.8				0.4	2.4	8.1	0.28	
C1	57-64	12.7	14.8	45.5	39.7	25.2				0.4	2.7	7.9	0.19	
C2	64-76	13.8	15.8	44.8	39.4	23.0				0.4	2.7	7.6	0.14	
						RENFROW SILT LOAM (27)								
A1	0-11	16.5	27.0	49.6	23.4		6.6	7.0	4.5	0.3	0.2	5.6	2.62	
A3	11-13	12.8	20.2	45.6	34.2		7.8	8.6	7.5	0.3	0.8	5.7	1.97	
B2	13-21	8.3	14.3	40.8	44.9		5.3	11.7	12.0	0.4	1.6	6.6	1.21	
B3	21-30	8.2	14.2	41.9	43.9							8.0	0.66	
C	30-55	4.4	10.1	47.8	42.1							7.9	0.22	
						TILLMAN CLAY LOAM(33)								
A1	0- 6					19.2		9.1	6.0	1.0	0.7	6.5	1.44	488.
B21	6-18					24.4		15.3	10.0	0.8	0.8	6.6	1.06	316.
B22	18-30					23.6		20.3	11.5	0.6	1.6	7.5	0.56	188.
BCA	30-44					23.3		19.3	13.7	0.7	3.0	7.5	0.48	112.
C1	44-66					24.0		15.7	13.3	0.7	4.0	7.5	0.30	126.
C2	66-84					21.0		30.2	12.9	0.6	4.4	7.5	0.10	172.

may have fragipans, natric and petrocalcic horizons, plinthite or other features that are used to define the various great groups. A very few that are very wet during a part of the year have umbric epipedons; however, the most common diagnostic horizons are ochric epipedons overlying argillic horizons. Alfisols are classified into five suborders, but in Oklahoma only three suborders are found: (1) Aqualfs, (2) Udalfs, and (3) Ustalfs.

Aqualfs

Aqualfs are formed principally in north eastern Oklahoma. They are gray and mottled soils in which ground water is near the surface during a considerable part of the year, but drops below the argillic horizon for the rest of the year. The moisture regime is aquic, or there is artificial drainage. There is only one great group of Aqualfs in Oklahoma: (a) Albaqualfs.

Albaqualfs seasonally have a saturated layer above a slowly permeable argillic horizon. Soil texture changes abruptly between the albic horizon or ochric epipedon and the argillic horizon. There are no fragipans, duripans or natric horizons. In Oklahoma, the major vegetation is tall grasses or cross timbers.

Udalfs

Udalfs are more or less freely drained soils with a udic moisture regime, developed in eastern and south eastern Oklahoma. Many have only an argillic horizon below the Ap horizon due to erosion. Others, however, occur on a stable surface that retains most of the eluvial horizons. A few have a natric horizon, and some possess fragipans in or below the argillic horizon. There are two great groups of Udalfs in Oklahoma: (a) Paleudalfs, and (b) Hapludalfs.

Paleudalfs are developed mostly in eastern Oklahoma in association with Ultisols (Udults) on a stable surface. Many are formed on sandstones, shales, and limestones. They have thick argillic horizons, but never fragipans, natric or agric horizons.

Hapludalfs are soils of temperature regions that have argillic horizons, but never have fragipans or albic horizons. Many Hapludalfs on slopes have lost their eluvial horizons due to extensive cultivation; however, there is usually a thin, very dark brown A1 horizon above a light colored eluvial horizon in a virgin soil.

Ustalfs

Ustalfs occur mostly in south central, central and western Oklahoma, usually developing on stable landforms. They are soils of warm subhumid to semiarid regions with a calcium or calcic horizon below or within the argillic horizon where the parent materials contain carbonates. The soil minerals have been strongly weathered throughout the soil profile. There are two great groups of Ustalfs in Oklahoma: (a) Paleustalfs and (b) Haplustalfs.

Paleustalfs are thick soils on old stable landforms. Paleustalfs may have a calcium or calcic horizon in or under the argillic horizon, but never natric horizons or duripans within 1 meter of the surface.

Haptustalfs are developed on recent erosional surfaces or deposits which have a thin argillic horizon with a gradual boundary. They have no duripans, natric and petrocalcic horizons within one and one-half meters of the surface.

Morphology, Distribution and Characteristics of the Benchmark Soils of Alfisols

Eight soil series of Alfisols have been selected as benchmark soils to represent this group of soils in Oklahoma. The great groups and their benchmark soils selected for our study are listed in Table IX.

TABLE IX

ALFISOL GREAT GROUPS AND THEIR BENCHMARK SOILS

Great Groups of Alfisols	Benchmark Soil Series
1. Haplustalfs	Nobscot, Stephenville, Grandfield, Dougherty, Konawa
2. Albaqualfs	Parsons, Taloka
3. Paleustalfs	Eufaula

Location maps of the great groups and the soil horizon diagrams of the benchmark soils are shown in Figures 26 through 36. Chemical and physical characteristics of pedons obtained from published sources are presented in Tables X through XII.

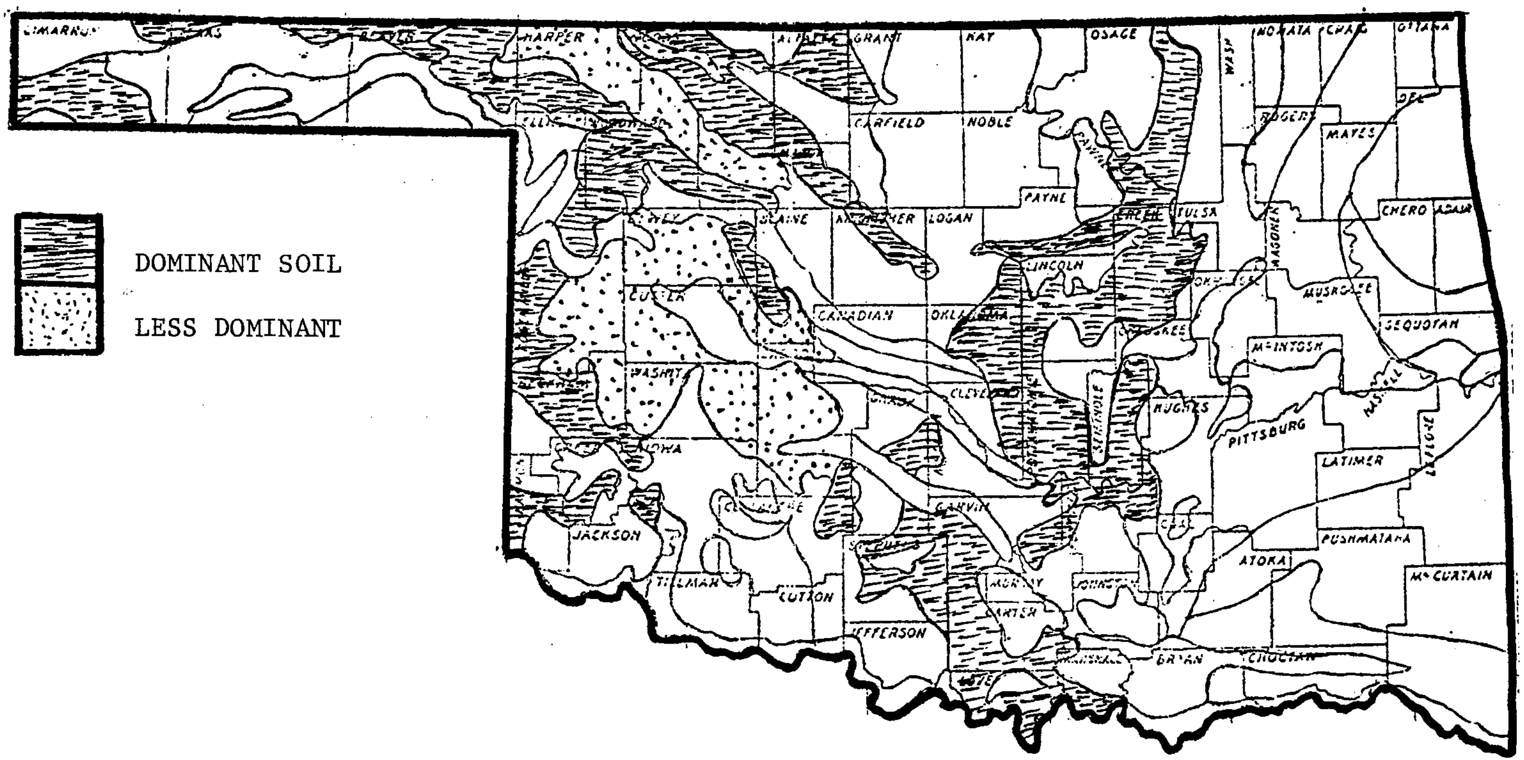
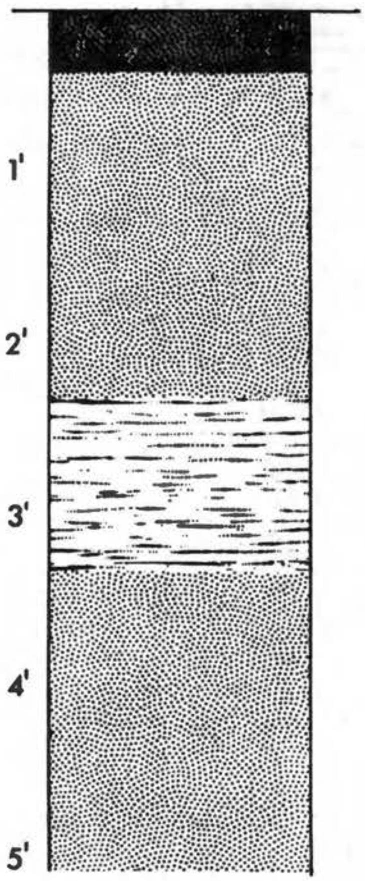


Figure 26. General Distribution of Haplustalfs

HAPLUSTALF

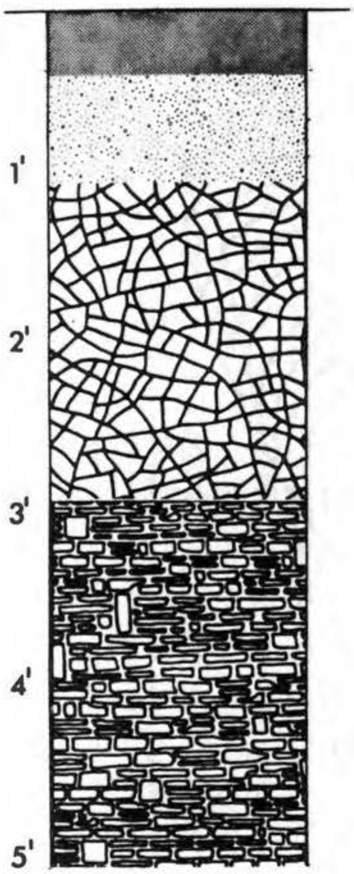


A1	0-4"	Grayish brown fine sand; single grain
A2	4-27"	Very pale brown fine sand; single grain
B2t	27-39"	Red light fine sandy loam; massive, bands
B3	39-65"	Light red fine sand; single grain

MAIN USES AND LIMITATIONS: Pasture and Cropland; severe wind erosion; low available water capacity; low fertility.

Figure 27. Profile of Nobscot

HAPLUSTALF

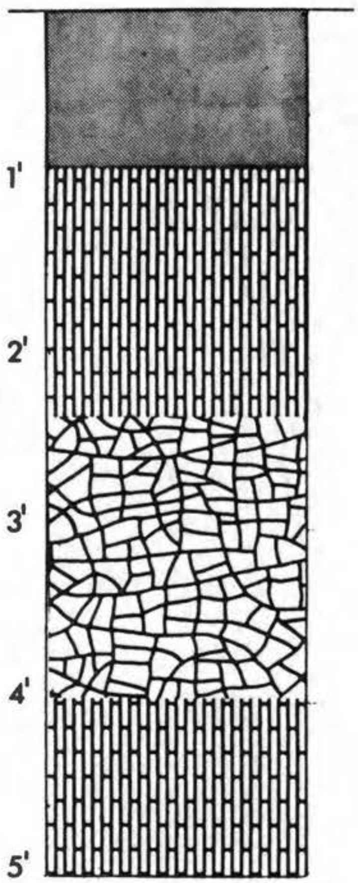


A1	0-4"	Brown fine sandy loam; granules
A2	4-12"	Light brown fine sandy loam; massive
B21t	12-22"	Yellowish red sandy clay loam; subangular blocks
B22t	22-34"	Red light sandy clay laom; subangular blocks
R	34-40+"	Light red slightly acid sandstone

MAIN USES AND LIMITATIONS: Cropland, wooded pasture and range; moderate water holding capacity; low fertility; severe wind and water erosion.

Figure 28. Profile of Stephenville

HAPLUSTALF

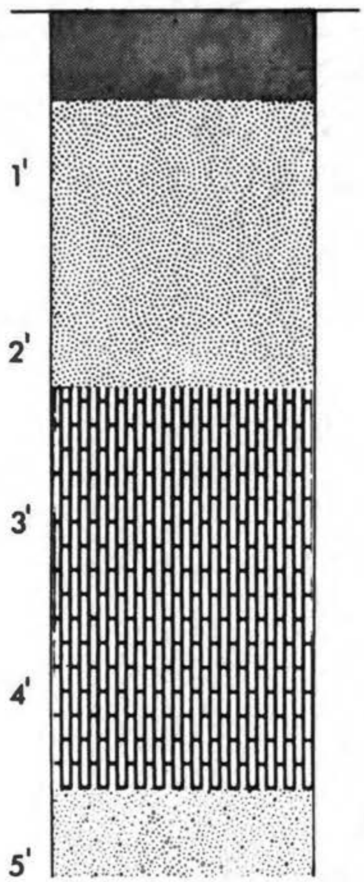


Ap	0-6"	Reddish brown fine sandy loam; granules
A1	6-10"	Reddish brown fine sandy loam; granules
B1	10-18"	Reddish brown fine sandy loam; prisms
B21t	18-28"	Yellowish Red heavy fine sandy loam; prisms and subangular blocks
B22t	28-48"	Reddish brown light sandy clay loam; subangular blocks
B3	48-70"	Yellowish red fine sandy loam; prisms; calcareous

MAIN USES AND LIMITATIONS: Cropland and pasture; severe wind and water erosion.

Figure 29. Profile of Grandfield

HAPLUSTALF

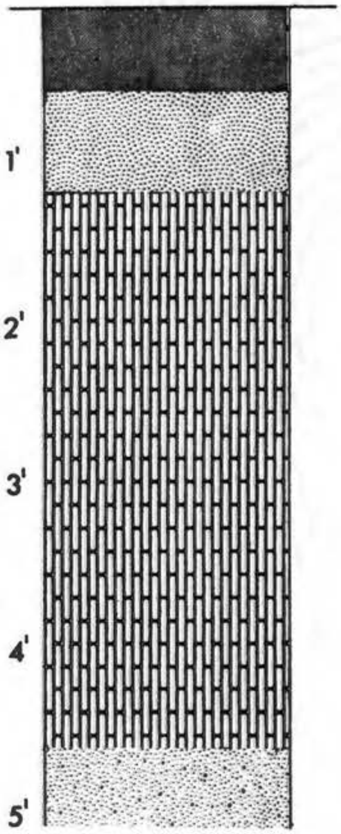


Ap	0-6"	Grayish brown loamy fine sand; granules
A2	6-26"	Very pale brown loamy fine sand; massive
B2t	26-42"	Yellowish red sandy clay loam; prisms and subangular blocks
B3	42-54"	Yellowish red fine sandy loam; prisms
C	54-74"	Yellowish red loamy fine sand; massive

MAIN USES AND LIMITATIONS: Cropland; pasture and forest; wind and water erosion; moderately low available water capacity; low fertility.

Figure 30. Profile of Dougherty

HAPLUSTALF



Ap	0-6"	Grayish brown loamy fine sand; granules
A2	6-14"	Pale brown loamy fine sand; single grain
B2t	14-38"	Yellowish red sandy clay loam; prisms and subangular blocks
B3	38-54"	Yellowish red fine sandy loam; prisms
C	54-70"	Yellowish red loamy fine sand; massive

MAIN USES AND LIMITATIONS: Cropland, pasture, range and woodland; severe erosion; low fertility.

Figure 31 Profile of Konawa

TABLE X

CHEMICAL AND PHYSICAL CHARACTERISTICS OF HAPLUSTALFS

							EXTRACTABLE CATIONS MEQ/100G.							
HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
						DOUGHERTY LOAMY FINE SAND (27)								
A1	0- 6	17.5	80.6	17.3	2.1	2.8		1.8	0.2	0.1		6.7	0.65	
A2	6-22	16.2	87.3	11.6	1.1	1.2		0.5	0.1	0.1		6.1	0.12	
B2	22-30	18.9	70.1	5.2	24.7	10.4	6.6	1.6	3.2	0.3	0.1	4.9	0.26	
B31	30-38	24.2	81.6	4.6	13.8	6.0	4.2	0.2	1.8	0.2		5.0	0.09	
B32	38-56	17.6	88.5	2.9	8.6	3.7	3.1		0.8	0.1		5.0	0.07	
C	56-72	21.3	94.2	4.0	1.8	1.1	0.8		0.2			5.6		
						STEPHENVILLE FINE SANDY LOAM (27)								
A1	0- 6	9.4	82.2	14.1	3.7	5.2		3.1	0.9	0.2		5.8	1.58	
A2	6-14	8.5	85.4	10.1	4.5	1.9		0.4	0.4	0.1		5.2	0.19	
B21T	14-18	5.8	68.4	6.1	25.5	9.9		3.9	2.6	0.2		4.9	0.53	
B22T	18-27	4.5	61.1	4.3	34.6	12.1		4.9	3.1	0.3		4.9	0.53	
B3	27-31	3.0	70.7	3.7	25.6	9.7		3.8	2.8	0.2		5.1	0.26	
R	31-40	8.6	79.0	5.3	15.7	5.9		2.2	2.3	0.2		5.4	0.05	
						GRANFIELD FINE SANDY LOAM (34)								
AP	0- 8	16.3	85.6	4.1	10.3	12.4	0.9	6.5	2.9	0.7	0.1		1.63	197
B1	8-12	2.9	82.2	6.2	11.6	12.6	0.3	6.7	3.3	0.4	0.1		1.30	159
B21T	12-20	4.7	61.8	10.0	28.2	21.2	3.5	9.9	6.4	0.5	0.1		1.53	205
B22T	20-31	4.3	48.7	36.2	15.1	13.7	2.1	7.7	4.5	0.3	0.1		0.62	155
B23T	31-45	2.5	62.0	21.9	16.1	11.0	0.7	5.8	4.6	0.2	0.1		0.26	130
B24T	45-51	3.2	64.9	19.2	15.9	7.9	0.7	6.7	5.0	0.2	0.1		0.25	95
B31	51-64	4.5	70.5	16.6	12.9	7.2	0.9	4.9	4.7	0.1	0.1		0.20	262
						NOBSCOT FINE SAND (27)								
A1	0- 5	7.5	90.1	7.9	2.0	4.1	1.9	3.3	0.4	0.1	0.1	6.6	1.48	
A21	5-13	8.2	93.6	4.9	1.5	1.5	0.7	1.0	0.2	0.1	0.1	6.1	0.31	
A22	13-20	8.5	94.8	3.3	1.9	1.3	0.7	0.7	0.1	0.1	0.1	5.7	0.22	
B21	20-32	6.5	87.2	3.7	9.1	7.1	2.8	3.6	1.5	0.2	0.1	5.3	0.41	
B22	32-44	6.9	90.8	2.1	7.1	4.6	1.6	2.9	1.0	0.1	0.1	5.2	0.15	
B3	44-54	6.0	92.4	1.7	5.9	3.5	1.4	2.2	0.8	0.1	0.1	5.9	0.10	
C	54-65	8.6	92.3	2.5	5.2	3.0	1.2	1.9	0.8	0.1	0.1	6.3	0.07	
						KONAWA FINE SANDY LOAM (5)								
AP	0- 9	0.0	56.9	34.3	8.8	5.9	2.7	2.1	0.7	0.2	0.1	5.6	1.61	150.
A2	9-14	0.0	64.7	30.3	5.0	3.6	1.8	2.4	0.3	0.1	0.1	6.5	0.53	100.
B22T	14-26	0.0	55.4	27.1	17.5	12.3	3.9	5.5	2.8	0.4	0.1	5.8	0.77	125.
B23T	26-44	0.0	67.6	27.4	5.0	9.7	3.1	4.0	2.8	0.3	0.1	5.4	0.36	74.
B3	44-55	0.0	65.7	26.8	7.5	9.5	2.9	3.7	2.8	0.4	0.01	5.8	0.10	50.
C	55-60	0.0	69.5	23.5	7.0	6.3	2.4	2.6	2.3	0.1	0.1	5.9	0.05	50.

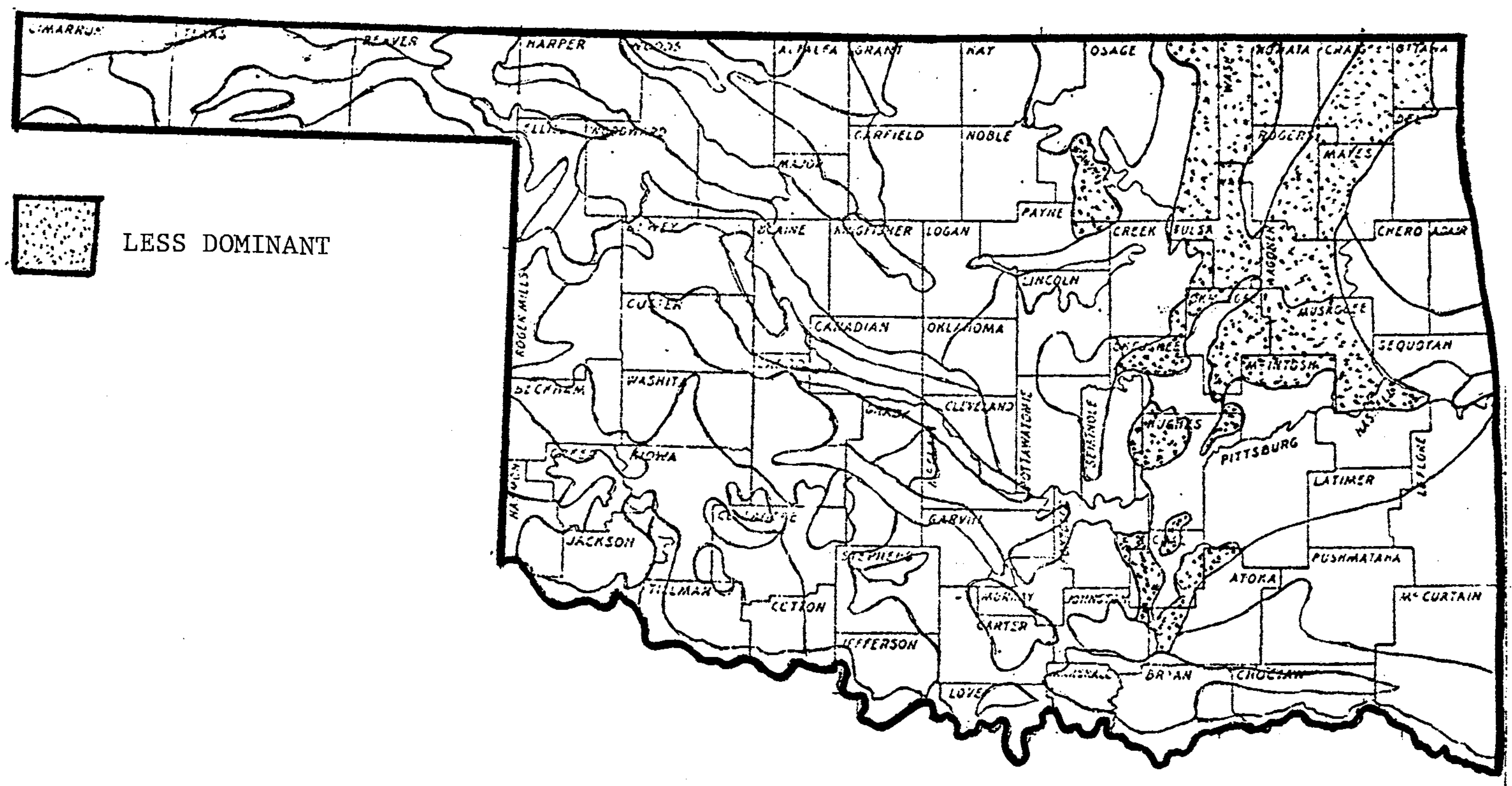
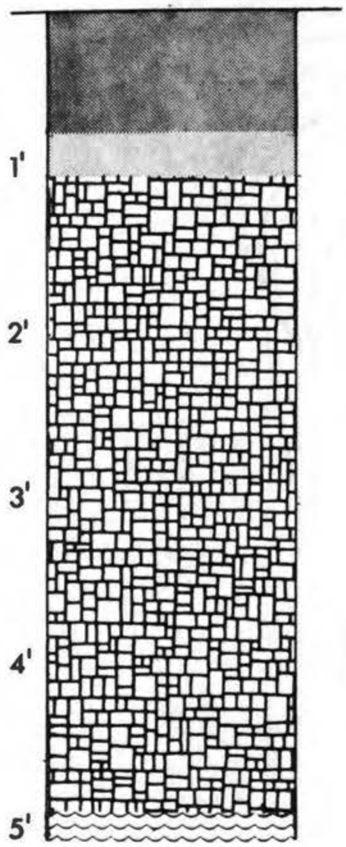


Figure 32. General Distribution of Albaqualfs

ALBAQUALF

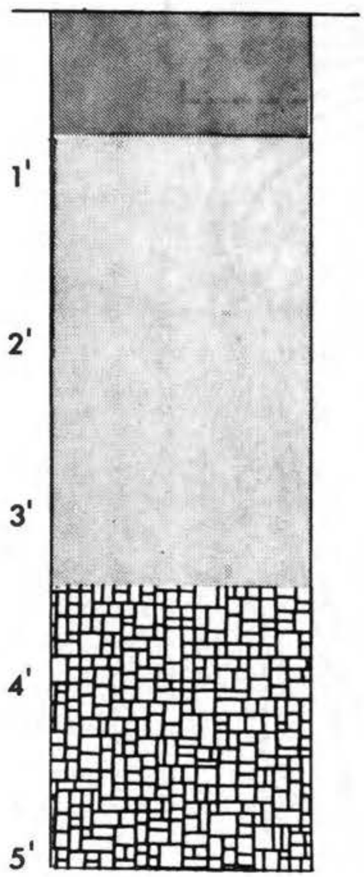


A1	0-9"	Very dark grayish brown silt loam; granules
A2	9-12"	Grayish brown silt loam, granules; mottles
B21tg	12-22"	Very dark grayish brown clay; blocks; mottles
B22tg	22-36"	Grayish brown clay; blocks; mottles
B23t & B3	36-58"	Coarsely mottled gray, yellowish brown and yellowish red clay; blocks
C	58-80"	Coarsely mottled gray, yellowish brown and very dark gray clay; massive

MAIN USES AND LIMITATIONS: Cropland, pasture; very slow permeability; seasonal wetness; low fertility; very droughty; severe erosion on slopes; high shrink-swell potential.

Figure 33. Profile of Parsons

ALBAQUALF



A1	0-8"	Very dark grayish brown silt loam; granules
A21	8-20"	Dark grayish brown silt loam; granules; mottles
A22	20-28"	Grayish brown silt loam; granules; mottles; black concretions
B21t	28-34"	Dark grayish brown silty clay; prisms and blocks; mottles
B22t & B23t	34-60"	Brown silty clay loam; blocks; mottles; black concretions

MAIN USES AND LIMITATIONS: Cropland, meadow and pasture; very slow permeability; low fertility; droughty; erosion on slopes; high shrink-swell potential.

Figure 34. Profile of Taloka

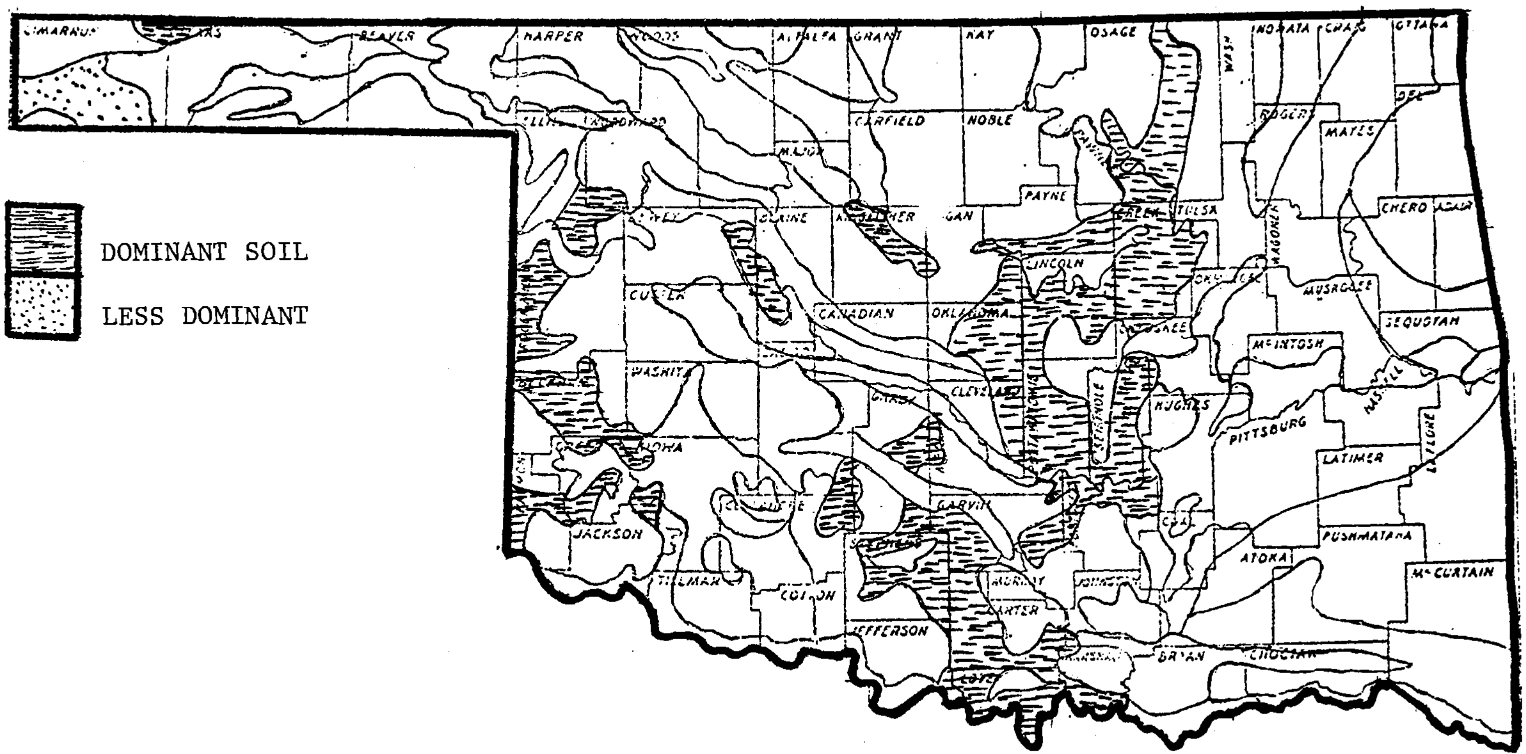
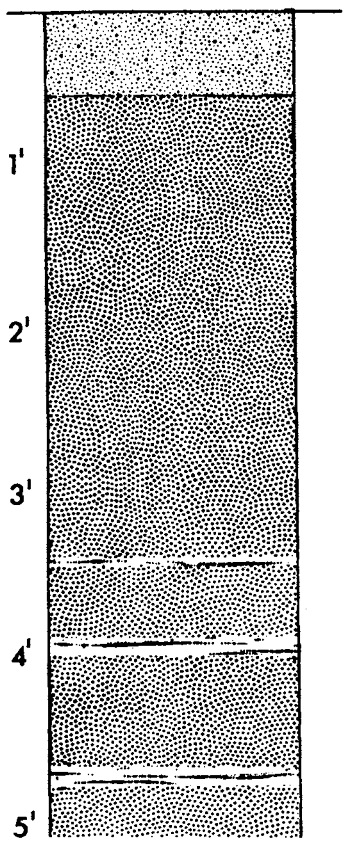


Figure 35. General Distribution of Paleustalfs

PALEUSTALF



Ap	0-6"	Pale brown loam fine sand; massive
A21	6-40"	Pink fine sand; single grains
A22 & B2t	40-80"	Pink fine sand; single grains with some bands

MAIN USES AND LIMITATIONS: Wooded pasture or old field pasture, some cropland, very severe wind and water erosion; low fertility; low water holding capacity.

Figure 36. Profile of Eufaula

TABLE XI

CHEMICAL AND PHYSICAL CHARACTERISTICS OF ALBAQULFS

HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	EXTRACTABLE CATIONS MEQ/100G. H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
							PARSONS SILT LOAM (27)							
A11	0- 6	6.8	17.4	70.4	12.2		6.3	5.8	0.8	0.1	0.1	5.7	1.98	
A12	6-10	6.6	18.4	69.2	12.4		7.0	2.9	0.8	0.1	0.4	5.2	1.09	
A21	10-14	6.2	19.5	66.6	13.9		6.2	2.4	0.8	0.2	0.5	5.5	0.66	
A22	14-16	5.0	18.9	55.5	25.6		8.6	4.8	2.3	0.3	1.3	5.6	0.86	
B21	16-22	2.8	7.2	35.0	57.8		16.2	12.5	5.9	0.5	3.4	5.4	1.50	
B22	22-28	2.6	6.6	34.1	59.3		12.2	14.1	6.8	0.4	3.8	5.3	1.26	
B31	28-37	4.0	10.4	40.2	49.4		9.6	12.0	6.2	0.4	3.3	5.3	0.55	
B32	37-43	5.3	14.8	46.7	38.5		5.2	9.6	4.8	0.4	2.6	5.4	0.29	
C1	43-66	6.1	18.2	45.5	36.3		6.2	9.7	4.8	0.4	2.3	5.4	0.19	
C2	66-84	6.2	16.4	43.3	40.3		5.8	12.6	6.1	0.4	2.5	5.6	0.10	
							TALCKA SILT LOAM(27)							
A11	0- 8	14.0	27.1	64.4	8.5		3.4	4.5	0.9	0.2	0.1	5.7	2.12	
A12	8-14	14.1	25.8	65.3	8.9		4.5	2.0	0.7	0.1	0.1	5.0	0.97	
A21	14-20	14.3	27.6	63.8	8.6		3.7	1.5	0.5	0.2	0.2	5.1	0.55	
A22	20-26	13.8	27.8	63.5	8.7		3.7	1.5	0.6	0.1	0.3	5.5	0.33	
B1	26-28	12.7	24.8	57.3	17.9		5.1	3.2	1.9	0.1	1.2	5.9	0.50	
B21	28-34	8.8	15.8	44.1	40.1		7.8	8.9	4.8	0.2	3.2	6.0	0.81	
B22	34-44	9.9	16.0	45.4	36.6		4.8	9.3	5.1	0.3	3.4	6.6	0.50	
B31	44-60	11.8	20.5	47.4	32.1		3.6	8.4	4.8	0.3	3.2	6.9	0.29	
B32	60-78	12.4	20.9	45.9	33.2		3.4	9.6	5.5	0.4	3.2	6.5	0.15	
C	78-99	12.5	22.1	45.5	32.4		4.3	9.4	5.2	0.3	3.0	5.2	0.07	

TABLE XII

CHEMICAL AND PHYSICAL CHARACTERISTICS OF PALEUSTALFS

HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	EXTRACTABLE CATIONS MEQ/100G. H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
							EUFAULA LOAMY FINE SAND (3)							
AP	0- 9	12.6	65.6	20.5	13.9	4.1	0.00	2.2	0.90	0.01	0.17	6.8	1.22	112.
A1	9-19	14.7	78.2	9.3	12.5	2.6	0.00	1.4	0.60	0.01	0.11	7.2	0.60	75.
A21	19-36	14.1	82.9	4.5	12.5	1.3	0.00	0.5	0.40	0.01	0.06	7.5	0.19	37.
A22	36-50	14.5	66.3	0.2	13.5	1.4	0.00	0.4	0.50	0.01	0.04	7.3	0.14	50.
B2T	50-56	18.6	69.7	5.2	25.0	8.9	0.19	3.2	1.00	0.02	0.31	6.2	0.42	50.
B3	56-70	17.3	47.6	23.6	26.8	12.9	0.26	2.8	2.30	0.02	0.32	5.8	0.24	88.

Inceptisols and Their Classification in Oklahoma

Inceptisols are formed dominantly in western Oklahoma, and are restricted to a climate in which there is some leaching in most years. They can be developed on almost any parent material and may occur in any climatic zone except an arid climate. Ochric and Umbric epipedon overlying a cambic horizon are the most common sequences of Inceptisols horizonation; however, mollic epipedons over a cambic horizon have been observed. They may have duripans or fragipans, but never have an argillic, spodic, natric or oxic horizons. Soil forming factors such as native vegetation, topography, and parent material are as diverse as the soils themselves. Inceptisols, however, are considered young soils which have not developed diagnostic features. There are two suborders of Inceptisols in Oklahoma: (1) Ochrepts and (2) Aquepts.

Ochrepts

Ochrepts are well to excessively drained upland soils with a loamy to clayey texture range. They have light color surface horizons due to their low organic matter content. Many have an ochric epipedon over a cambic horizon, and may also have calcic horizons, duripans or fragipans. There are two great groups of Ochrepts in Oklahoma: (a) Ustochrepts and (b) Dystrochrepts.

Ustochrepts are developed principally in western, north central and central Oklahoma in subhumid to semiarid climate. Ustochrepts have calcium or calcic horizons, but never a fragipan or a duripan within 1 meter of the surface.

Dystrochrepts are usually formed in eastern Oklahoma in association with Ultisols (Udults). Dystrochrepts are acid soils of humid to perhumid climate. Parent materials are moderately or weakly consolidated, acid, metamorphic or sedimentary rocks. The common horizon sequence is an Ochric epipedon on a cambic horizon. Carbonates are not present in the cambic or C horizon. They have no fragipans or duripans within 1 meter of the surface.

Aquepts

Aquepts are poorly drained soils of floodplains which usually have ground water close to the soil surface at some time during the year; as a result, they generally have mottles and other characteristics associated with wetness. Many have a cambic horizon and in addition some have a fragipan. There is only one great group of Aquepts in Oklahoma: (a) Haplaquepts.

Haplaquepts are formed mostly in eastern Oklahoma in association with Alfisols (Hapludalfs) and Ultisols (Fragiudults). There soils usually occur in a humid climate with a natural forest vegetation. Many have now been drained and cultivated. They usually have a Ochric epipedon, but never a fragipan or duripan close to the surface.

Morphology, Distribution and Characteristics of the Benchmark Soils of Inceptisols

Three soil series of Inceptisols have been selected as benchmark soils to represent this group of soils in Oklahoma. The great group and its benchmark soils selected for our purpose are:

Great Groups of Inceptisols	Benchmark Soil Series
Ustochrepts	Darnell, Quintan, Dill

Here again, a location map showing the distribution of the great group, soil horizon diagrams of the benchmark soils, main uses, limitations, and the chemical and physical characteristics of pedons obtained from public sources are presented in Figures 37 through 40 and Table XIII.

Entisols and Their Classification in Oklahoma

Entisols occur mostly in floodplains and on steep slopes throughout the state. They show little or no evidence of active soil formation. Presence of the ochric epipedon is usually used to differentiate between initial materials and these soils. Entisols usually have A horizons with little accumulation of organic matter. Parent materials occur immediately below the A horizon because they have not lost clay or organic matter by eluviation processes. The reasons for being young or undeveloped soils are different; for many soils, the time period has been too short for horizons to be developed. Other Entisols are very old and composed mainly of quartz and other materials that have not been weathered to form different horizons. They may have an anthropic, albic or organic horizon. The Entisols of western Oklahoma are shallow soils which show little effect of weathering processes. There are three sub-orders of Entisols in Oklahoma: (1) Fluvents, (2) Psamments and (3) Orthents.

Fluvents

Fluvents usually occur in recent water deposited sediment floodplains and fans of rivers which are frequently flooded, unless protected by dams. Organic matter content decreases irregularly with depth.

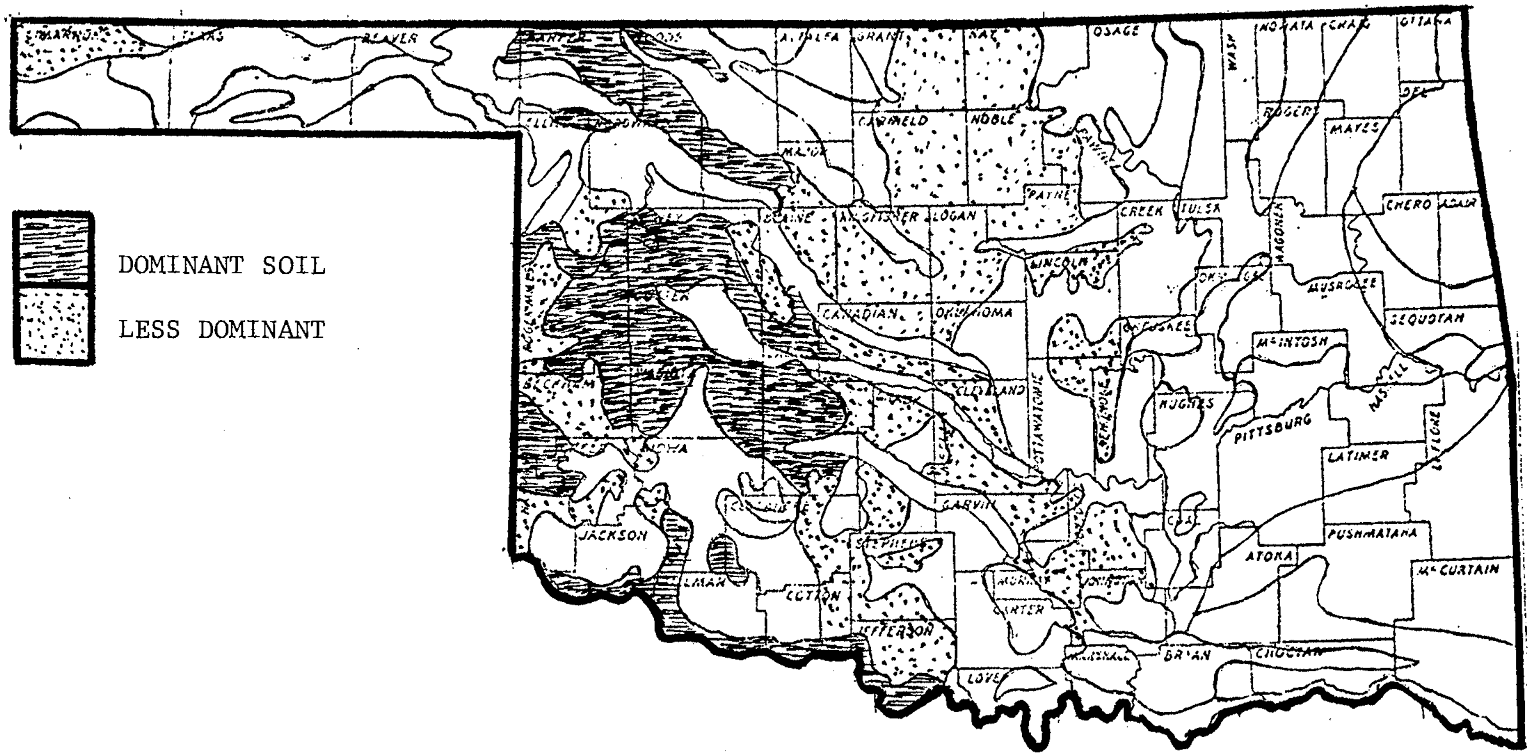
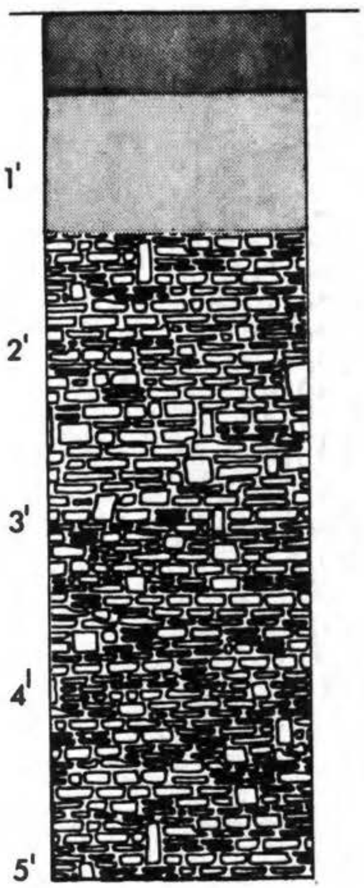


Figure 37. General Distributior of Ustochrepts

USTOCHREPT

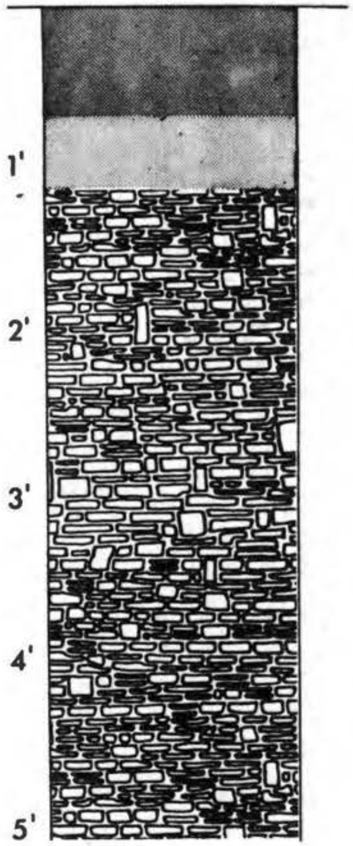


A	0-5"	Brown fine sandy loam; granules
B	5-15"	Light brown fine sandy loam; granules
C	15-30"	Red hard sandstone

MAIN USES AND LIMITATIONS: Forested pasture; very little cropland; rapid runoff; low water holding capacity; low fertility; erosion; droughty; rock outcrops; steep slopes.

Figure 38. Profile of Darnell

USTOCHREPT

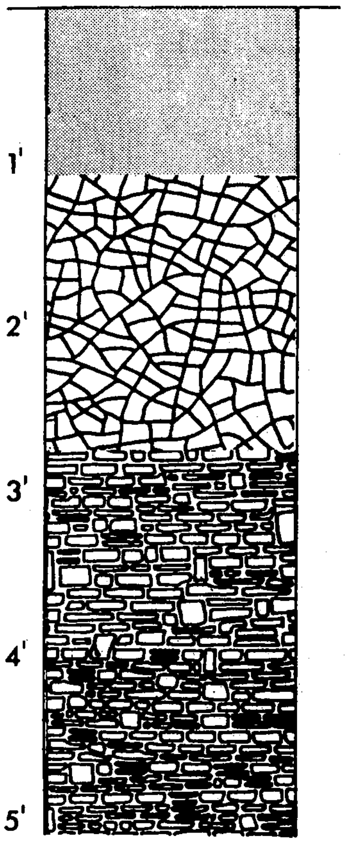


A	0-8"	Reddish brown loam; granules; calcareous
B2	8-13"	Red loam; granules; calcareous
C	13-65"	Red weakly cemented calcareous sandstone

MAIN USES AND LIMITATIONS: pasture and rangeland; very low water holding capacity; severe erosion; rapid runoff; steep slopes.

Figure 39. Profile of Quinlan

USTOCHREPT



A1	0-12"	Reddish brown fine sandy loam; granules
B2	12-32"	Red fine sandy loam; subangular blocks
C	32-40"	Weakly cemented non calcareous red sandstone

MAIN USES AND LIMITATIONS: Cropland; severe erosion; low water holding capacity.

Figure 40. Profile of Dill

TABLE XIII

CHEMICAL AND PHYSICAL CHARACTERISTICS OF USTOCHREPTS

							EXTRACTABLE CATIONS MEQ/100G.							
HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
							DILL FINE SANDY LOAM (31)							
A1	0-12	19.8	35.6	58.4	6.0	10.7	0.0	6.0	2.0	0.19	0.13	6.4	0.70	100.
B2	12-32	16.4	45.6	47.3	7.0	13.2	0.0	5.4	5.6	0.18	0.15	6.2	0.63	175.
C	32-40	15.4	40.0	55.0	5.0	12.2	0.0	7.6	7.6	0.08	0.15	6.9	0.05	150.
							QUINLAN VERY FINE SANDY LOAM (7)							
A	0- 8	42.7	79.9	13.8	6.3								0.9	
B	8-14	43.2	72.2	17.7	10.1								1.0	
R	14-	53.9	72.1	21.6	6.3								0.5	
							DARNELL FINE SANDY LOAM (19)							
A1	0- 4					8.8	3.1	5.8	1.4	0.2	0.1	6.8	2.4	
B2	4-12					5.9	3.8	2.4	0.7	0.1	0.0	5.7	1.0	
R	12-14													

They can have any vegetation or moisture regime. Soil texture varies from loamy very fine sand to very fine sand. There are two great groups of fluvents in Oklahoma: (a) Ustifluvents and (b) Udifluvents.

Ustifluvents are developed on floodplains of rivers throughout the state. Floods commonly occur during rainy season, but they may come at any season. They have an ustic moisture regime.

Udifluvents mostly occur in the south eastern Oklahoma near the Texas boundary. Floods may come in any season. They are usually developed in a humid climate with a udic moisture regime. Many have had no vegetation except pasture or cultivated crops because the sediments that form the soils were deposited while the soils were being used. Some, however, are under forest.

Psamments

Soil texture is uniformly sand or coarse loamy sand. Psamments occur under any vegetation or climatic regime. Some consist of quartz sand which can not develop diagnostic horizons. Water holding capacity is low, and characteristics associated with wetness are absent. There is only one great group of psamments in Oklahoma: (a) Ustipsamments.

Ustipsamments are freely drained sands which occur mostly in north western Oklahoma. Most Ustipsamments are under grasses or savannah vegetation while those which are cultivated tend to blow. They have a Ustic moisture regime.

Orthents

Orthents are soils of recent erosional surfaces which have no recognizable diagnostic horizons. They may occur in any climate zone under any vegetation, but can not be developed in areas with high water tables or on sand dunes. There are two great groups of Orthents in Oklahoma: (a) Torriorthents and (b) Ustorthents.

Torriorthents are dry or salty soils which have been mostly developed in the western panhandle. Torriorthents occur on moderate to steep slopes, and vegetation is usually sparse, mainly salt tolerant grasses which are used for limited grazing.

Ustorthents are generally developed in north west Oklahoma under a mixture of tall and short grasses. Ustorthents are usually developed on soft sedimentary deposits or on hard rocks with moderate to steep slopes.

Morphology, Distribution and Characteristics of the Benchmark Soils of Entisols

Two soil series of Entisols have been selected as benchmark soils to represent this group of soils in Oklahoma. The great groups and their benchmark soils selected for our studies are listed in Table XIV.

TABLE XIV

ENTISOL GREAT GROUPS AND THEIR BENCHMARK SOILS

Great Groups of Entisols	Benchmark Soil Series
1. Ustipsamments	Tivoli
2. Ustifluvents	Yahola

Location maps showing the distribution of the great groups, soil horizon diagrams of the benchmark soils, main uses, limitations, and the chemical and physical characteristics of pedons obtained from published sources are presented in Figures 41 through 44 and Tables XV and XVI.

Ultisols and Their Classification in Oklahoma

Ultisols occur only in south and north eastern Oklahoma. They generally have a horizon in which there is translocated clay or an argillic horizon with low base saturation. Precipitation usually exceeds ~~transportation~~ evapotranspiration at a period during the year; consequently, water moves through the soil and the leaching processes occur. There is a balance between the bases released by weathering and the bases leached by water. Vegetation plays an important role in the maintenance of the bases against leaching processes. Ultisols are usually developed in a climate which is warm humid and has a seasonal deficiency in amounts of rainfall. Low fertility and low base saturation in these soils are the major limitations to agricultural use. There is only one suborder of Ultisols in Oklahoma: (1) Udults.

Udults

Udults are soils of humid climates with well distributed rainfall. They usually have a forest vegetation with a low organic matter content. Some have fragipans or plinthites or both in or under the argillic horizon. There are three great groups of Ultisols in Oklahoma: (a) Paleudults, (b) Hapludults and (c) Fragiudults.

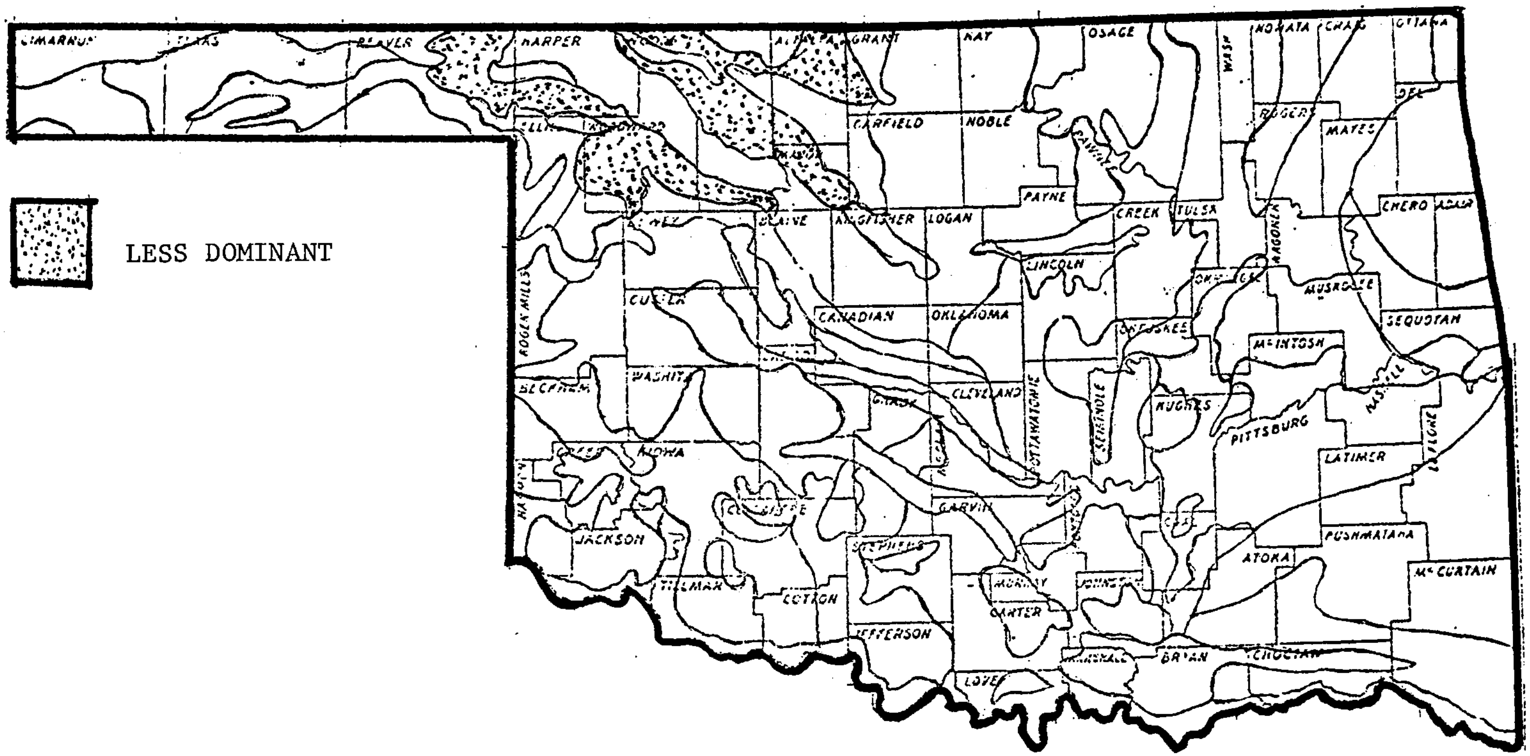
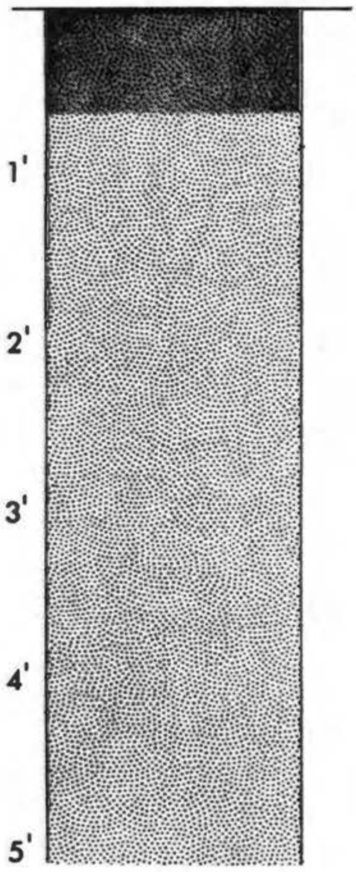


Figure 41. General Distribution of Ustipsamments

USTIPSAMMENT



A1	0-7"	Pale brown fine sand; single grains
C	7-60"	Yellow fine sand; single grain

MAIN USES AND LIMITATIONS: Rangeland; severe wind erosion; very low water holding capacity; low fertility.

Figure 42. Profile of Tivoli

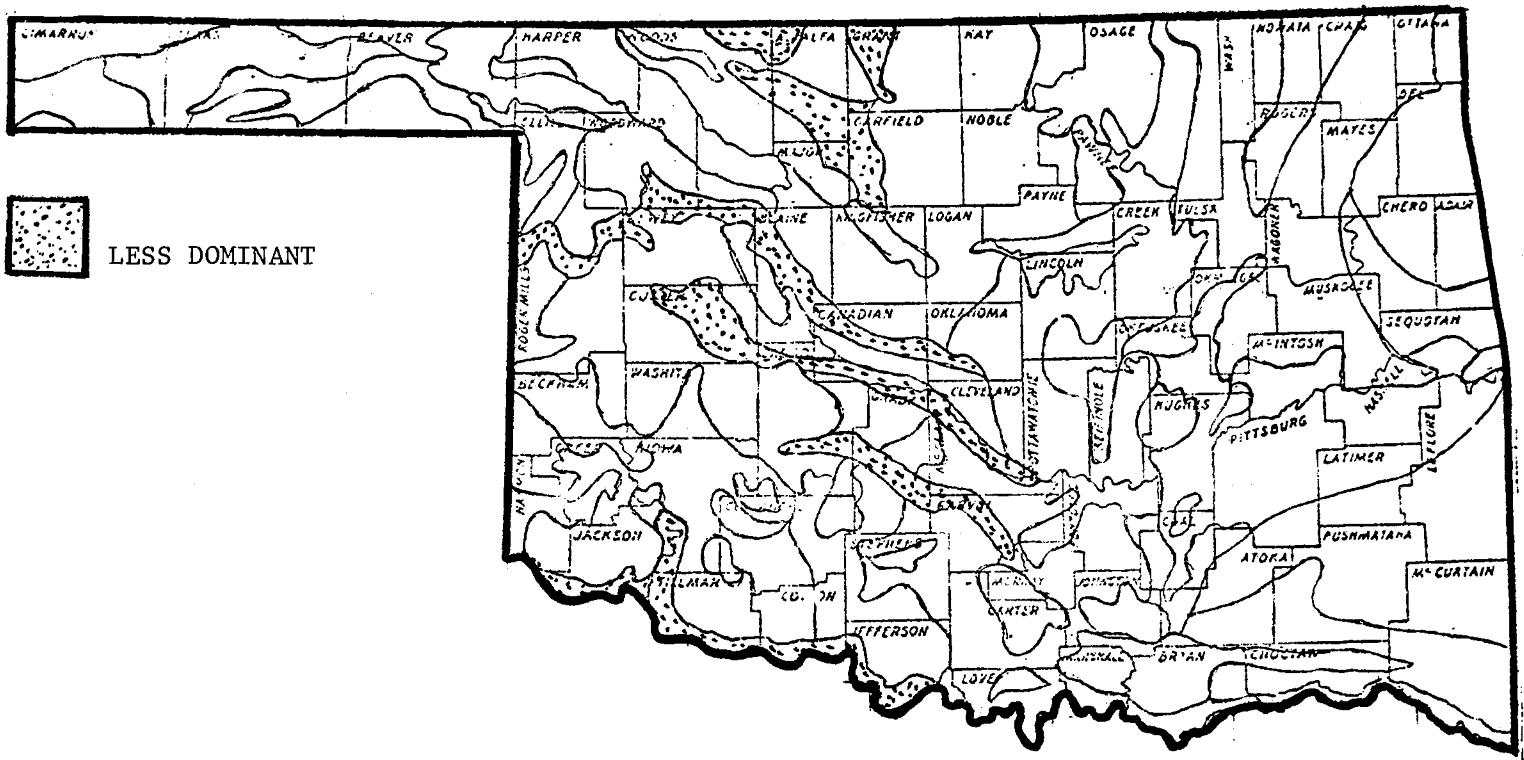
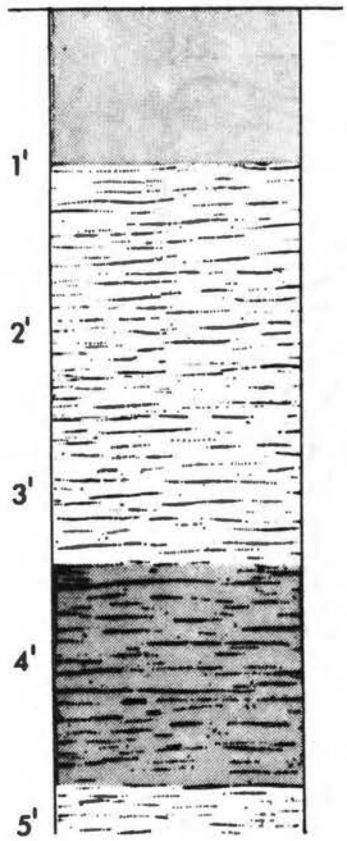


Figure 43. General Distribution of Ustifluvents

USTIFLUVENT



Ap	0-11"	Reddish brown fine sandy loam; granules; calcareous
C1	11-40"	Reddish yellow fine sandy loam; massive; calcareous
C2	40-56"	Reddish brown loam; granules; calcareous
C3	56-72"	Yellowish red fine sandy loam; massive; calcareous

MAIN USES AND LIMITATIONS: Cropland and pasture; wind erosion; flooding; slight droughty.

Figure 44. Profile of Yahola

TABLE XV

CHEMICAL AND PHYSICAL CHARACTERISTICS OF USTIFLUVENTS

HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
							EXTRACTABLE CATIONS MEQ/100G.							
						YAHOLA FINE SANDY LOAM (29)								
A	0-10	59.8	63.4	29.0	7.6	5.4				0.33		7.4	0.9	350.
AC	10-22	59.8	63.4	29.0	7.6	6.8				0.33		7.4	1.3	310.
C	22-60	38.3	43.0	48.7	8.3	2.5				0.10		7.7	0.2	210.

TABLE XVI

CHEMICAL AND PHYSICAL CHARACTERISTICS OF USTIPSAMMENTS

HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
							EXTRACTABLE CATIONS MEQ/100G.							
						TIVOLI FINE SAND (28)								
A1	0- 6	5.9	93.2	4.1	2.7	2.5	1.2	1.8	0.5	0.2	0.1	5.9	0.59	
AC	6-12	7.8	96.5	0.9	2.6	1.8	1.2	1.1	0.5	0.2	0.1	6.3	0.16	
C1	12-32	6.4	95.9	0.6	3.5	2.1	1.6	1.4	0.3	0.1	0.1	6.5	0.16	
C2	32-52	9.4	94.2	1.9	3.9	2.3	1.2	1.4	0.7	0.2	0.1	6.3	0.10	
C3	52-90	7.7	95.7	1.3	3.0	1.8	1.2	1.1	0.4	0.1	0.1	5.7	0.09	

Paleudults occur in south and north eastern Oklahoma on old gently sloping landforms. Surface horizons are generally light in color due to the low amount of organic matter. In the subsurface, Paleudults have a thick argillic horizon but never contain a fragipan.

Hapludults are mostly developed in eastern Oklahoma on moderate to steep slopes. Surface horizons are generally light in color as a result of acid leaching of bases, clay minerals, and organic matter. Clay minerals are of the kaolinitic type for most of these soils. Hapludults commonly have ochric epipedon; and in the subsurface, they have a relatively thin argillic horizon, but never a fragipan or large amount of plinthites.

Fragiudults occur in north eastern Oklahoma mainly on Mississippian limestones and dolomites. These soils are usually found on gentle slopes under forest vegetation with an argillic horizon above a fragipan.

Morphology, Distribution and Characteristics of the Key Soils of Ultisols

Three soils series of Ultisols have been selected as key soils to represent this group in Oklahoma. The great groups and key soils chosen for our studies are shown in Table XVII. Location maps showing general distribution of the great groups, schematic soil horizon diagrams of the key soils, main uses, limitations, and the chemical and physical characteristics of pedons obtained from published sources are presented in Figures 45 through 49 and Table XVIII.

TABLE XVII

ULTISOL GREAT GROUPS AND THEIR KEY SOILS

Great Group of Ultisols	Key Soil Series
1. Hapludults	Harsells
2. Paleudults	Bowie, Clarksville

Vertisols and Their Classification in Oklahoma

Vertisols occur mostly in south eastern Oklahoma extending into Texas. They are clayey soils that develop deep wide cracks at sometime during the year. When it rains, the water runs into cracks and causes the soil to be remoistened both from below and above. Some materials from the surface fall or are washed into the cracks. Vertisols have a uniform texture and no evidence of eluviation and illuviation processes can be observed. The dominant exchangeable cations are calcium and magnesium. Since these materials are mostly clay, high in montmorillonite, they shrink and swell creating gilgai reliefs on the soil surface. Shrink and swell is the source of many engineering problems associated with Vertisols. There is only one suborder of Vertisols in Oklahoma: (1) Usterts.

Usterts

Usterts are tropical and subtropical region soils which have two

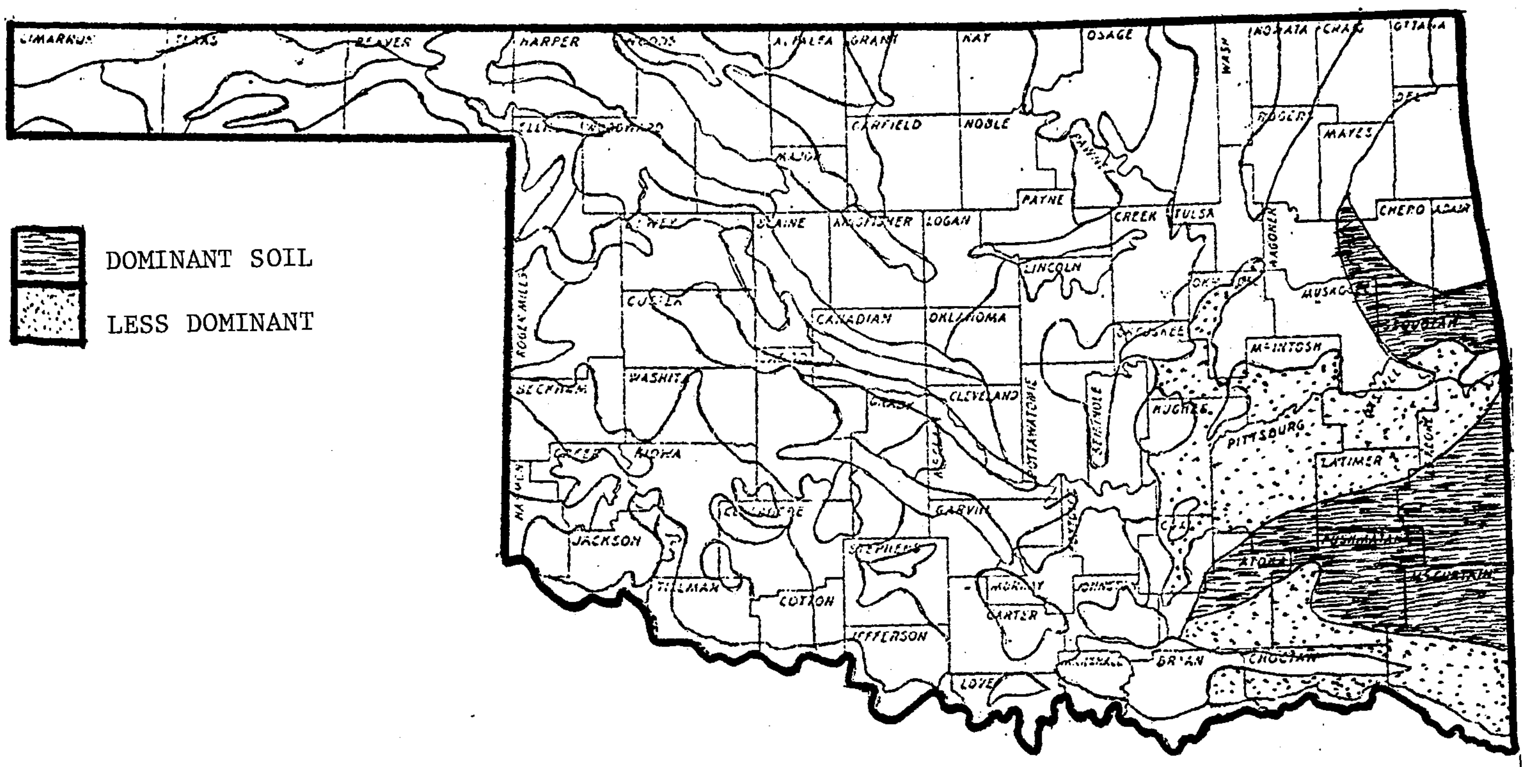
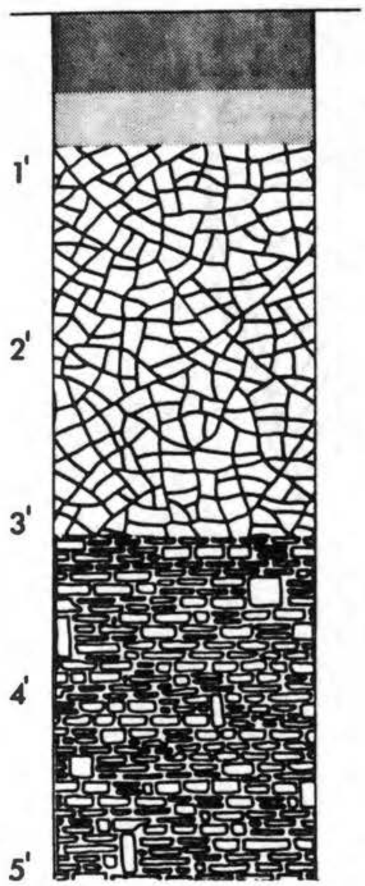


Figure 45. General Distribution of Hapludults

HAPLUDULT



Ap	0-5"	Dark grayish brown fine sandy loam; granules
A2	5-9"	Brown fine sandy loam; granules
B1	9-13"	Yellowish brown loam; subangular blocks
B21t & B22t	13-20"	Yellowish brown sandy clay loam; subangular blocks
B3	30-36"	Yellowish brown channery sandy loam; subangular blocks
R	36"	Acid sandstone

MAIN USES AND LIMITATIONS: Cropland, Range, Pasture and forest; Erosion low fertility.

Figure 46. Profile of Hartsells

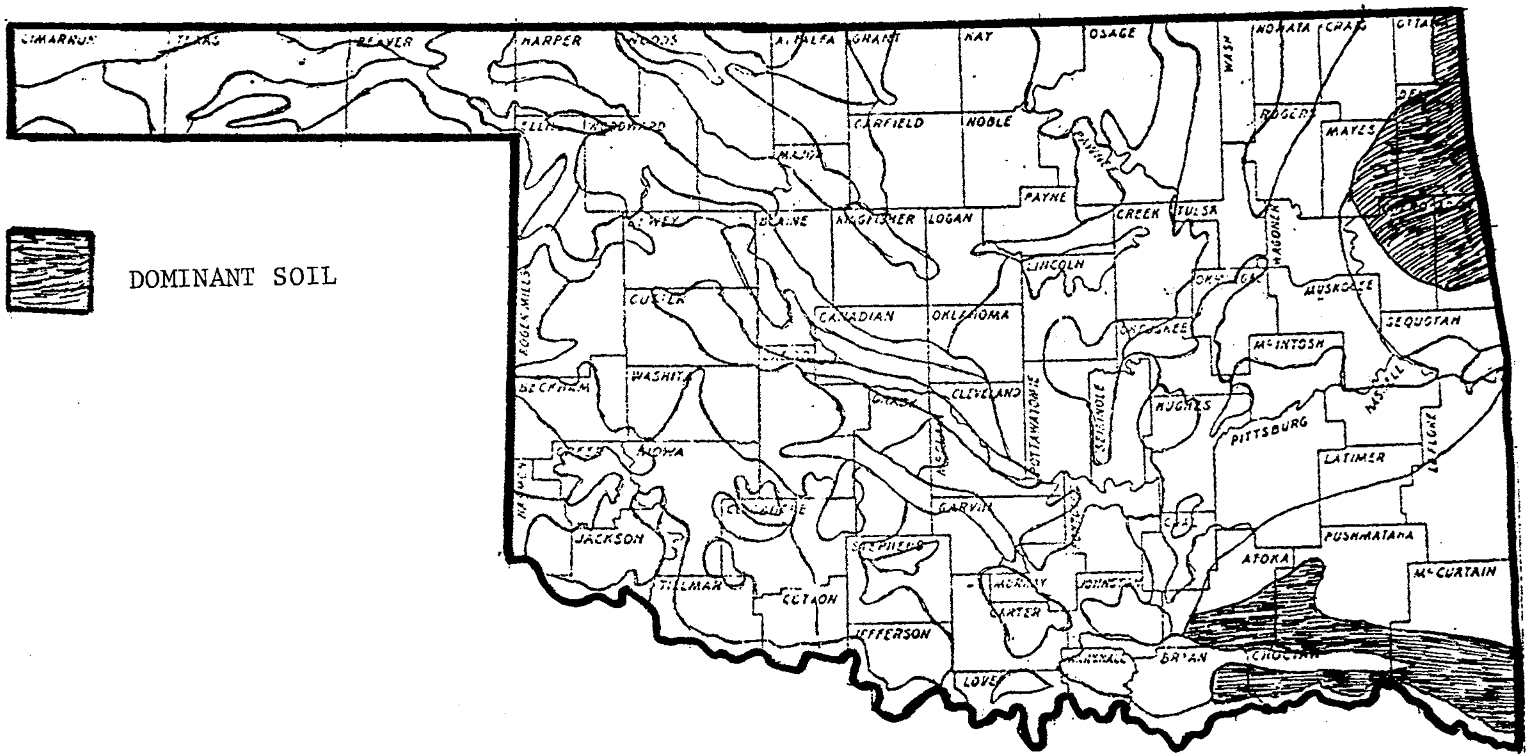
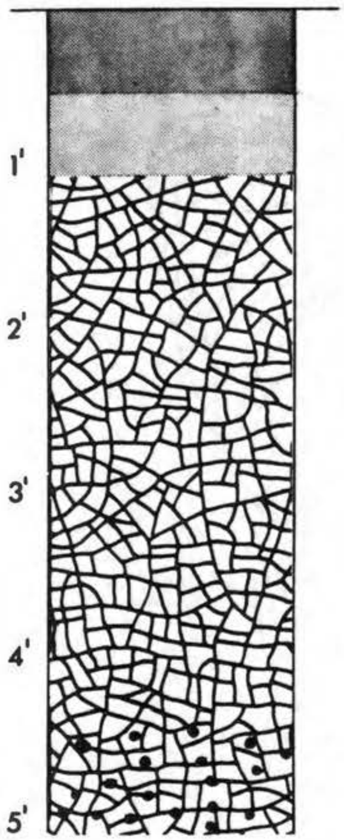


Figure 47. General Distribution of Paleudults

PALEUDULT

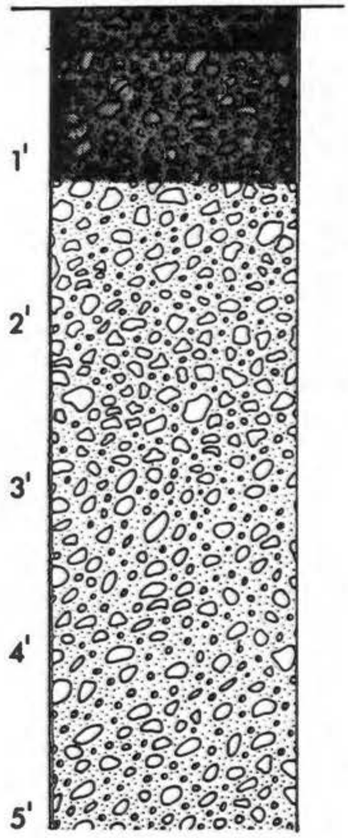


Ap	0-6"	Grayish brown fine sandy loam; structureless
A2	6-12"	Very pale brown fine sandy loam; structureless
B21t	12-42"	Brownish yellow sandy clay loam; subangular blocks; mottles
B22t	42-60"	Prominently mottled yellowish brown red and gray sandy clay loam; blocks and subangular blocks; plinthite

MAIN USES AND LIMITATIONS: Forest, some pastures and some cropland; low fertility; severe erosion.

Figure 48. Profile of Bowie

PALEUDULT



A1	0-3"	Grayish brown very cherty silt loam; granules
A2	3-13"	Pale brown very cherty silt loam; subangular blocks
B1	13-20"	Light yellowish brown very cherty light silty clay loam; subangular blocks
B21t	20-38"	Strong brown very cherty silty clay loam; subangular blocks; black concretions
B22t	38-47"	Strong brown cherty heavy silty clay loam; subangular blocks
B23t	47-63"	Yellowish red very cherty silty clay; subangular blocks; mottles

MAIN USES AND LIMITATIONS: Forest, pastures, rangelands and some croplands; low fertility; severe erosion.

Figure 49. Profile of Clarksville

TABLE XVIII

CHEMICAL AND PHYSICAL CHARACTERISTICS OF PALEUDULTS

							EXTRACTABLE CATIONS MEQ/100G.							
HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
							BOWIE SANDY LOAM (6)							
A1	0- 5	22.7	51.8	40.6	7.6	10.2	0.4	4.7	1.6	0.20	0.07	5.6	3.4	
A2	5-14	23.2	47.1	42.8	10.1	5.2		2.3	0.9	0.36	0.11	4.8	0.7	
B21T	14-32	17.6	36.2	39.6	24.2	14.1	9.3	2.2	1.1	0.05	0.09	4.6	0.5	
B22T	32-54	14.5	33.4	40.9	25.7	16.5	14.3	1.5	2.6	0.51	0.46	4.8		
B23T	54-65	11.5	38.6	38.3	23.1	16.6	14.1	1.8	1.2	0.40	0.35	4.6		
							CLARKSVILLE VERY CHERTY SILT (4)							
A1	0- 2	2.9	7	83	10	34.5		5.0	2.3	0.31	0.13	5.8	1.3	120.
A21	2-14	4.0	8	82	12	44.2		1.4	1.0	0.10	0.13	5.2	0.8	35.
A22	14-21	4.5	9	71	20	29.7		1.1	0.4	0.15	0.13	4.8	0.6	31.
B1	21-31	6.1	12	71	17	25.4		0.5	2.0	0.26	0.17	4.6	0.5	20.
B2T	31-48	5.9	12	57	31	34.5		0.4	1.7	0.18	0.13	4.5	0.3	TR.
B3	48-70	9.5	19	10	71	24.0		0.4	1.5	0.28	0.13	4.5	0.4	35.

TABLE IXX

CHEMICAL AND PHYSICAL CHARACTERISTICS OF HAPLUDULTS

							EXTRACTABLE CATIONS MEQ/100G.							
HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
							HARTSELLS LOAM (6)							
A1	0- 6	17.5	47.1	39.1	13.9	10.9	11.1	1.61	0.87	0.30	0.04	5.1	2.7	
A2	6-16	19.8	48.5	37.7	13.8	4.7	2.6	0.61	0.98	0.05	0.04	5.2	0.7	
B22T	16-26	12.7	33.8	31.8	34.4	14.6	12.0	0.71	1.57	0.34	0.04	5.1		
B3	26-34	15.3	53.2	26.6	20.3	14.7	13.1	0.91	0.48	0.20	0.07	5.4		
R	34-+	20.8	52.0	31.6	16.4	12.1	12.1	0.71	0.98	0.05	0.09	5.2		

rainy and two dry seasons. They are usually developed on marine deposits, alluvium or basic rocks with gentle slopes. Cracks close once or twice during the year. There is only one great group of Usterts in Oklahoma: (a) Pellusterts.

Pellusterts occur in south eastern Oklahoma on limestones and limy clays which have black to gray surface horizons. Most of these soils are level or in depressions with gilgai microreliefs or slickensides.

Morphology, Distribution and Characteristics of the Key Soil of Vertisols

One soil series of Vertisols has been selected as a key soil to represent this group in Oklahoma. The great group and its key soil chosen for our purpose is shown in Table XX.

TABLE XX

VERTISOL GREAT GROUP AND ITS KEY SOIL

Great Groups of Vertisols	Key Soil Series
Pellusterts	San Saba

Here again, a location map showing the general distribution of the great group, soil horizon diagram, main uses, limitations, and the chemical and physical characteristics of the key soil obtained from the published sources is presented in Figures 50 and 51 and Table XXI.

Aridisols and Their Classification in Oklahoma

Aridisols occur mostly in the central and eastern Panhandle of Oklahoma in association with Mollisols. They are light colored soils of dry regions which are not leached and usually contain calcium carbonates or other salt accumulations. Horizons may be the result of translocation, accumulation and cementation of carbonates, silicate clays or other salts; or they may be simply an alternation of the parent materials without any substantial accumulation of materials. They usually occur in water and wind deposited sediments in subhumid to arid climatic zones under scattered shrubs. Aridisols usually have ochric epipedons and one or more of the following subsurface horizons: argillic, cambic, natric, gypsic, clacic, petrocalcic horizons or duripans. Agricultural uses are mainly limited due to the shortage of water. There is only one suborder of Aridisols in Oklahoma: (1) Orthids.

Orthids

Orthids are soils with an accumulation of soluble salts and carbonates which may have calcic, salic, gypsic, petrocalcic, petrogypsic, or cambic horizons as well as duripans; but never have argillic or natric horizons. There is only one great group of Orthids in Oklahoma: (a) Calciorthids.

Calciorthids are mostly developed in the central and eastern Panhandle in association with calciustolls. Calciorthids contain

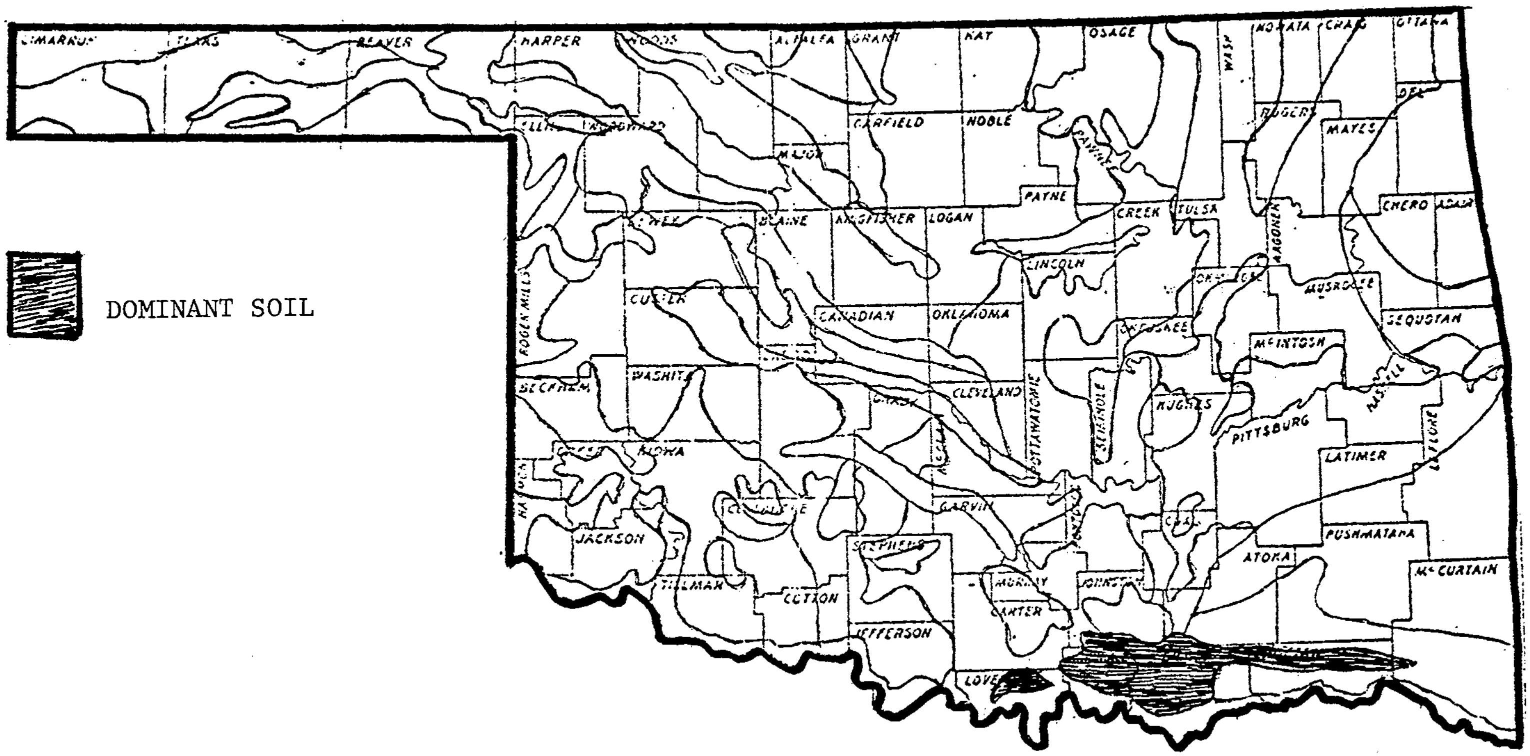
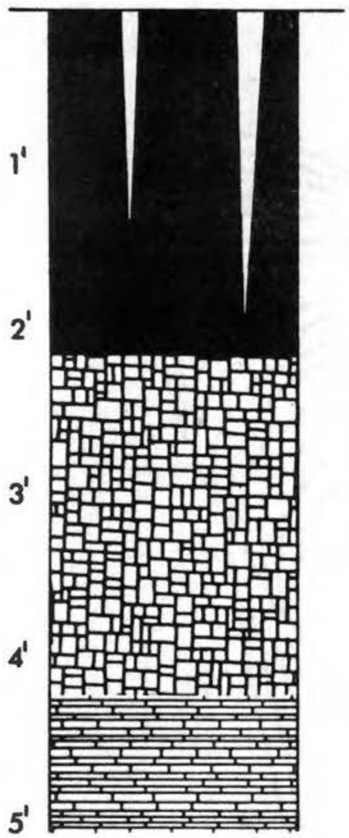


Figure 50. General Distribution of Pellusterts

PELLUSTERT



Ap	0-4"	Very dark gray clay; granules
A1	4-25"	Very dark gray clay; blocks
AC	25-50"	Dark gray clay; blocks; slickensides
C	50-60"	Light olive brown clay; massive

MAIN USES AND LIMITATIONS: Cropland, pasture and range; very slow permeability; high shrink swell potential; cracks.

Figure 51. Profile of San Saba

TABLE XXI

CHEMICAL AND PHYSICAL CHARACTERISTICS OF PELLUSTERTS

							EXTRACTABLE CATIONS MEQ/100G.							
HORIZON	DEPTH IN.	%VFS	%SAND	%SILT	%CLAY	%CEC	H	CA	MG	K	NA	PH 1:1	OM	TOTAL P PPM
						SAN SABA (20)								
A1P	0- 5		5.7	45.7	48.6	46.9			3.2	0.72	0.75	7.2	2.8	
A12	5-15		5.9	43.6	50.5	48.3			3.4	0.53	2.4	7.5	2.6	
A13	15-28		8.0	46.9	45.1	47.7			3.6	0.56	5.9	7.8	2.0	
AC1	28-35		7.9	42.5	49.6	46.7			3.0	0.53	8.5	7.9	1.4	
AC2	35-54		5.8	42.7	51.5	46.5			3.1	0.55	11.5	8.0	1.1	
C	54-64		12.1	50.4	37.5	28.0			2.0	0.37	7.3	8.1	0.3	

large amounts of lime in the parent material. The limited rainfall is incapable of completely removing the lime from the surface. The common horizons are Ochric epipedons and calcic horizons. Some have cambic horizons but none have duripans or petrocalcic horizons. Irrigation and cultivation cause trace element nutrient deficiencies in these soils.

Morphology, Distribution and Characteristics of the Key Soil of Aridisols

One soil series of Aridisols has been selected as a key soil to represent this group of soils in Oklahoma. The great group and its key soil chosen for our purpose is shown in Table XXII.

TABLE XXII

ARIDISOL GREAT GROUP AND ITS KEY SOIL

Great Groups of Aridisols	Key Soil Series
Calciorthids	Potter

A location map showing the general distribution of the great group, soil horizon diagram, main uses and limitations of the key soil are presented in Figures 52 and 53. Physical and chemical properties of the Potter series have not been published.

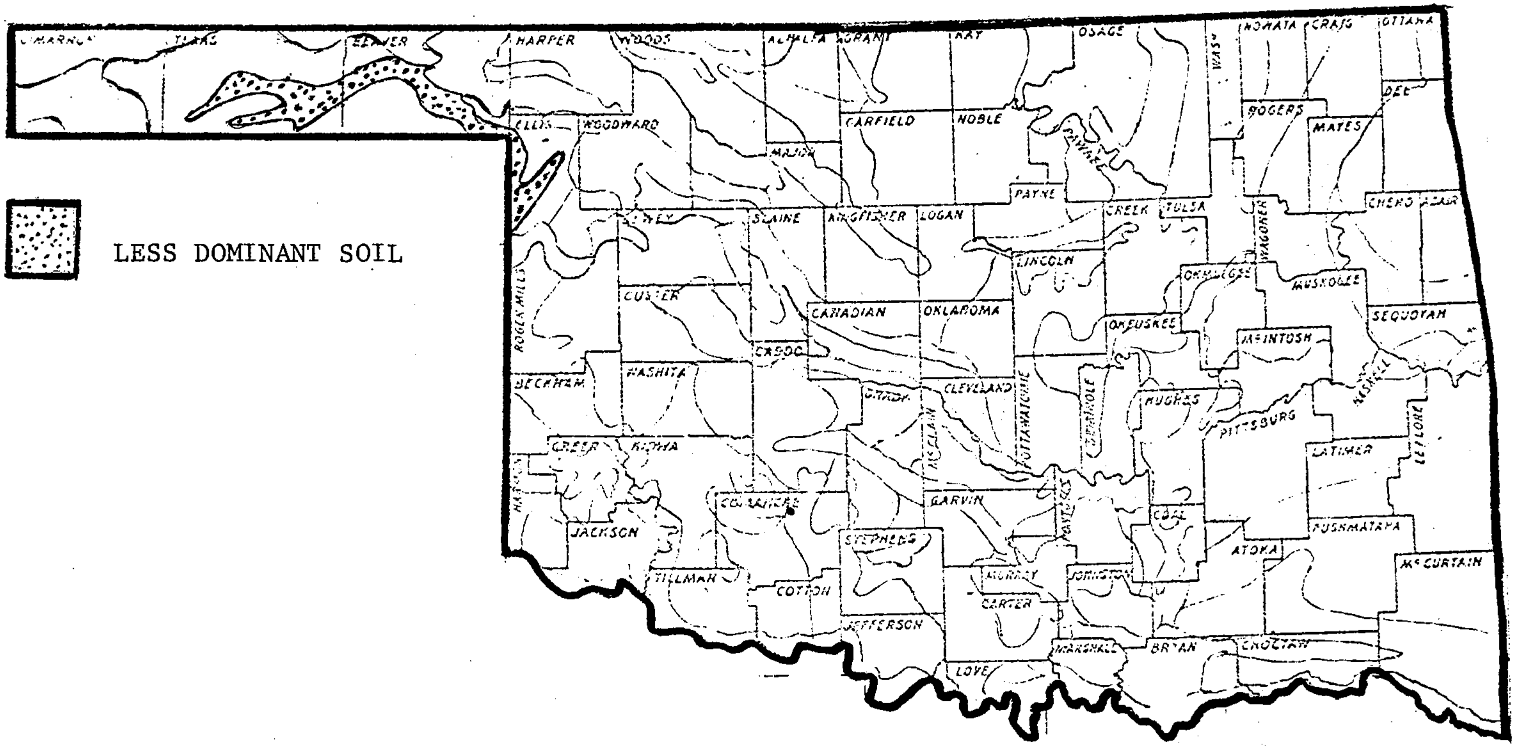
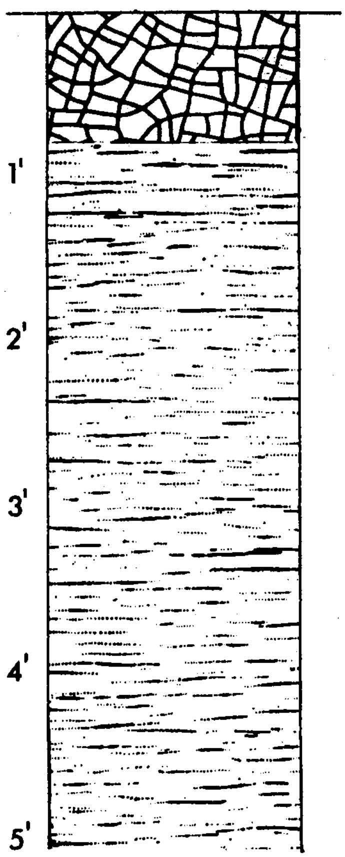


Figure 52. General Distribution of the Calciorthids

CALCIORTHID



A11	0-4"	Grayish brown loam; subangular blocks; white concretions
A12	4-9"	Pale brown loam; subangular blocks; white concretions
Cca	9-30"	White Caliche fragments and soft powdery caliche and loamy materials

MAIN USES AND LIMITATIONS: Rangelands; wind and water erosion; excessive runoff; droughty.

Figure 53. Profile of Potter

CHAPTER V

SUMMARY AND CONCLUSION

Soils of Oklahoma are classified into seven orders, thirteen suborders, and twenty-six great groups. The soil orders which have developed in Oklahoma are: Mollisols, Alfisols, Inceptisols, Ultisols, Entisols, Vertisols, and Aridisols.

Mollisols, which occupy more Oklahoma landforms than any soil orders, are classified into two suborders: (1) Ustolls which are developed in north and south central and western Oklahoma in a subhumid to semiarid climate. There are five great groups of Ustolls throughout the state which are Paleustolls, Natrustolls, Argiustolls, Haplustolls, and Calciustolls; (2) Most Udolls are principally found in eastern Oklahoma in a humid climatic zone. The great groups of Udolls are Paleudolls, Argiudolls, and Hapludolls.

In Oklahoma Alfisols are divided into three suborders. (1) Aqualfs are developed in north eastern Oklahoma under tall grasses and crosstimbers. Albaqualfs are the only great group of Aqualfs in the state. (2) Udalfs are mostly formed in eastern and south eastern Oklahoma in a humid climate. The great groups of Udalfs are Paleudalfs and Hapludalfs. (3) Ustalfs occur mostly in central, south central and western Oklahoma in a subhumid to a semiarid climate. Ustalfs consist of two great groups within the state, Paleustalfs and Haplustalfs.

Inceptisols are classified into two suborders. (1) Ochrepts consist of Ustochrepts which are developed in western and central Oklahoma in a subhumid to semiarid climate and Dystrochrepts which are formed in eastern Oklahoma in association with Ultisols in a humid climate; (2) Aquepts occur as Haplaquepts in a humid climate in eastern Oklahoma.

Ultisols are developed in north and south eastern Oklahoma in a humid climate under forest vegetation. Udults is the only suborder of Ultisol throughout the state which are classified into Paleudults, Hapludults and Fragiudults.

Entisols occur in flood plains and on steep slopes throughout the state and are classified into three suborders. (1) Fluvents which are divided into Ustifluvents and Udifluvents, (2) Psamments occur as Ustipsamments in north western Oklahoma which show little effect of weathering processes, (3) Orthents occur as torriorthents and Ustorthents in north western Oklahoma under a mixture of short and tall grasses.

Vertisols which occur in south eastern Oklahoma and extend into Texas are classified as Usterts. Pellusterts are the only great group of Usterts within the state. They have been developed on limestones and limy clays.

Aridisols which have been developed in the Panhandle are classified as Orthids. Calciorthids which occur in association with calciustolls in a semiarid climate is the only great group of Orthids throughout the state.

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