MINERALOGICAL DIFFERENCES OF LOAMY SOILS
ON THE CIMARRON RIVER TERRACE SYSTEM
IN PAYNE COUNTY, OKLAHOMA, IN
RESPECT TO THEIR GENESIS
AND ORIGIN

By

JAMES EDWARD HENLEY

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Oklahoma State University

Stillwater, Oklahoma

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Thesis Approved:

Fenton Gray
Thesis Adviser

Lester W. Reed

W. E. McMurphy

Norman N. Durham

1062935

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CHAPTER I

INTRODUCTION

Soils developed in Pleistocene alluvial sediments on high terrace levels of the Cimarron River in Payne County show many similarities in profile development even though there are apparent differences in the ages of the terrace levels. To ascertain the effect of weathering, obtain information on genesis, and properly classify these soils, it is helpful to study the coarse grain fraction of selected horizons in these soils. The study of coarse grain mineralogy of loamy soils is an important tool for determining both the origin of the sediment source and the effect of weathering on mineralogy. Weathering is reflected by mineralogical composition with older sediments having a higher ratio of resistant to weatherable minerals than the younger sediments. The coarse grain mineralogy also reflects the origin of the sediment source.

This study deals with the mineralogical composition of the 0.05-0.10 mm. grain size fraction of selected soil horizons located on sample sites representing the Cimarron River terrace system and the adjacent upland.

There were two major objectives of the study. They were as follows:

1) One objective was to determine the mineralogical composition of the very fine sand fraction in selected horizons to arrive at

a ratio that would indicate differences in weathering, show the possible origin of the sediment the soils formed in, and aid in the understanding of soil development in this catena of soils.

2) The second objective was to determine the proper classification of the soils on the terrace levels of the Cimarron River to facilitate the mapping of these soils in the Soil Survey Report of Payne County.

CHAPTER II

REVIEW OF LITERATURE

The Cimarron River terrace system in Payne County consists of four recognized terrace levels. The four terrace levels in the study area were mapped by Blair (2). He identified these levels as the Lawrie, Perkins, Summit View, and Paradise with the Lawrie being the lowest level and the Paradise the highest. He determined the vertical distance of the terrace tops above the river was respectively 15 to 25 feet, 45 to 60 feet, 140 to 170 feet, and 170 to 230 feet. It seems to be universally accepted that the terrace levels formed corresponding to periods of glaciation, but which of the four major glaciation periods, Nebraskan, Kansan, Illinoian, or Wisconsin, was responsible for what terrace is largely a matter of speculation.

In a study by Fay (4) on terrace deposits of the South Canadian River in Blaine, Dewey, and Custer Counties, five terrace levels were recognized. These terraces were 300, 270, 220, 150, and 50 feet above the present flood plain. Fay stated that the upper two were of Kansan age, the middle two of Illinoian age, and the lower terrace of Wisconsin age. In a later publication, Fay (5) stated that only three terraces are mapped, though five may be identified. He stated that the upper two levels are covered by sand dunes. The terraces of the lower three levels recognized by Fay correspond roughly with the elevations of the upper three levels on the Cimarron River and may have formed during the same glacial cycles. There was a general agreement with Weaver (14), who studied terrace deposits in Hughes County, that the source of the sediment was Cretaceous and older rocks of the Rocky Mountain area or Tertiary sediments of the High Plains. Since the Cimarron River drainage encompasses much of the same geology as that of the South Canadian, it would be safe to assume that their sediment source is very similar.

In Logan County, Galloway (6) described the geology of the Cimarron River terrace system as Quaternary deposits. Soils mapped on these terraces were the Teller, Vanoss, Minco, Norge, Bethany and Reinach series.

In Major County, Allgood, Conradi, Rhoads, and Brinlee (1) described the terraces of the Cimarron River as Pleistocene sediments and soils mapped on these terrace levels were Shellabarger, Pratt, Minco, Canadian, and Reinach.

In both of these counties, the adjacent uplands consisted of various formations of the Permian Redbeds.

Stahnke (12) stated that to study the effect of weathering on the mineralogical composition of a soil, it is necessary to examine both the relatively unweathered portion of the solum and a more intensively weathered horizon. Also, the weathered and unweathered portions of the soil must have similar origins before a measure of the kind and degree of weathering can be determined.

Pettijohn (8) determined weathering indices for several heavy minerals. Zircon, tourmaline, and garnet are examples of minerals he considered relatively stable. Epidote, the amphiboles and pyroxenes are minerals he considered susceptible to weathering.

Ruhe (9) used two weathering ratios, the ratio of (zircon + tourmaline)/(amphiboles + pyroxenes) and the ratio of quartz/feldspar to study weathering on three groups of paleosols. Stahnke and Gray (11) used the ratio of (zircon + tourmaline)/hornblende to determine weathering intensities in a mineralogical study of thick-surfaced Brunizemic soils. They found the differences in weathering ratios inconsistant and partially attributed it to the low percentage of hornblende.

Buckhannan and Ham (3) identified nonopaque heavy minerals in samples of recent riverwash, Pleistocene alluvium, the Ogallala formation, and various Permian materials. They found that most of the sediments came from portions of Oklahoma drained by the South Canadian River. They found that the presence of epidote, kyanite, augite, and basaltic hornblende in the Pleistocene sediments could be used as a criteria for differentiating Permian from Pleistocene sediments. Epidote was found to be present in both Permian and Pleistocene sediments but it composed 15-30% of the Pleistocene sediments and less than 1 percent of the Permian sediment.

Marshall and Jeffries (7) summarized the relation between the heavy mineral composition and degree of weathering and parent material homogenity as follows:

1) Qualitative and quantitative differences in the suite of the most stable heavy minerals are characteristic of materials of different geologic origin.

2) Qualitative similarity of the suite of stable heavy minerals but quantitative differences in the mineral ratios are characteristic of differences in conditions of deposition.

3) A combination of qualitative and quantitative similarity in the stable heavy mineral suite, qualitative similarities in the unstable mineral suite, and quantitative dissimilarity in the unstable mineral suite is characteristic of differences in the degree of weathering between the materials being compared.

In a study by Stahnke (12) on the genesis of a sequence of Mollisols in Western and Central Oklahoma, no indications of weathering trends were observed. The results of the mineralogical analysis of the very fine sand fraction did indicate a homogenity of parent materials for the soils studied. Minerals identified in the heavy mineral suite were: Zircon, Tourmaline, Garnet, Epidote, Hornblende and Lamprobolite. Quartz and Feldspar composed the bulk of the light mineral suite.

CHAPTER III

METHODS OF STUDY

Sampling Procedure

Six sample sites were used in the study. The sample sites were located on the flood plain, on each of the four recognized terrace levels, and on the adjacent upland. All the sample sites were located on the north side of the Cimarron River in Western Payne County. This area provided a very good representation of the entire terrace system. To achieve relevant results on the effect of weathering on the mineralogical composition of the soils on the Cimarron River terrace system, it was necessary to place the sample sites on the oldest part of the terrace landscape. The sample sites were located on the nearly level top of each terrace level. These nearly level tops represented the oldest surfaces on each of the terrace levels.

The sample site locations were determined from detailed field studies, aerial photographs, and a crossectional map of the Cimarron River terrace system compiled by Blair (2). The elevations of the sites and their vertical distance above the river is shown in Table I.

The flood plain was sampled because it is an important component in the overall terrace system. Its mineralogical composition provides good comparisons of weathering ratios and origins of the sediments between the most recent and the oldest of the alluvial sediments. The upland was sampled to provide information on the influence of the

TABLE I

ELEVATIONS AND VERTICAL DISTANCES OF THE SAMPLE SITE ABOVE THE RIVER

Sample Site	Elevation (Feet)	River Elevation (Feet)	Height Above The River (Meters)	Height Above The River (Feet)
FLOOD PLAIN	854	845	2.7	9
LAWRIE TERRACE	865	850	4.5	15
PERKINS TERRACE	910	840	21.0	70
SUMMIT VIEW TERRACE	1020	845	53.0	175
PARADISE TERRACE	1065	850	65.5	215
UPLAND	1130	850	85.0	280

Permian Redbeds on the terrace system. The upland site was located well above any recognized terrace deposits.

A pedon was described and sampled at each of the six sample sites. Figure 1 shows the locations of the sample sites. Pedon descriptions were written using standard horizon nomenclature. All pedons were described to at least 183 cm. or bedrock. The soils were sampled and described by three methods: a Bull coring machine mounted on a $\frac{1}{2}$-ton pickup was used to sample the soil on the Paradise level, a manually operated auger was used to sample the soil on the flood plain, Lawrie terrace, Perkins terrace, and Summit View terrace, and a pit was dug on the upland site. This variety of sample methods was used to aid in locating the sites in the most representative areas. At most locations it was not feasible to dig soil pits due to the presence of crops. The pickup mounted coring machine was not used in each instance because of limited access to the sample sites. The auger offered the greatest mobility in reaching and sampling the most representative areas without disturbing standing crops.

Physical Analysis of the Soil

The physical analysis of the soil consisted of the particle size analysis. The particle size is necessary for determining classification at the family and great group level. It is also important for determining homogenity of the sediment source and it gives indications of the mechanism of deposition.

Particle Size Distribution

The particle size distribution was determined by the hydrometer

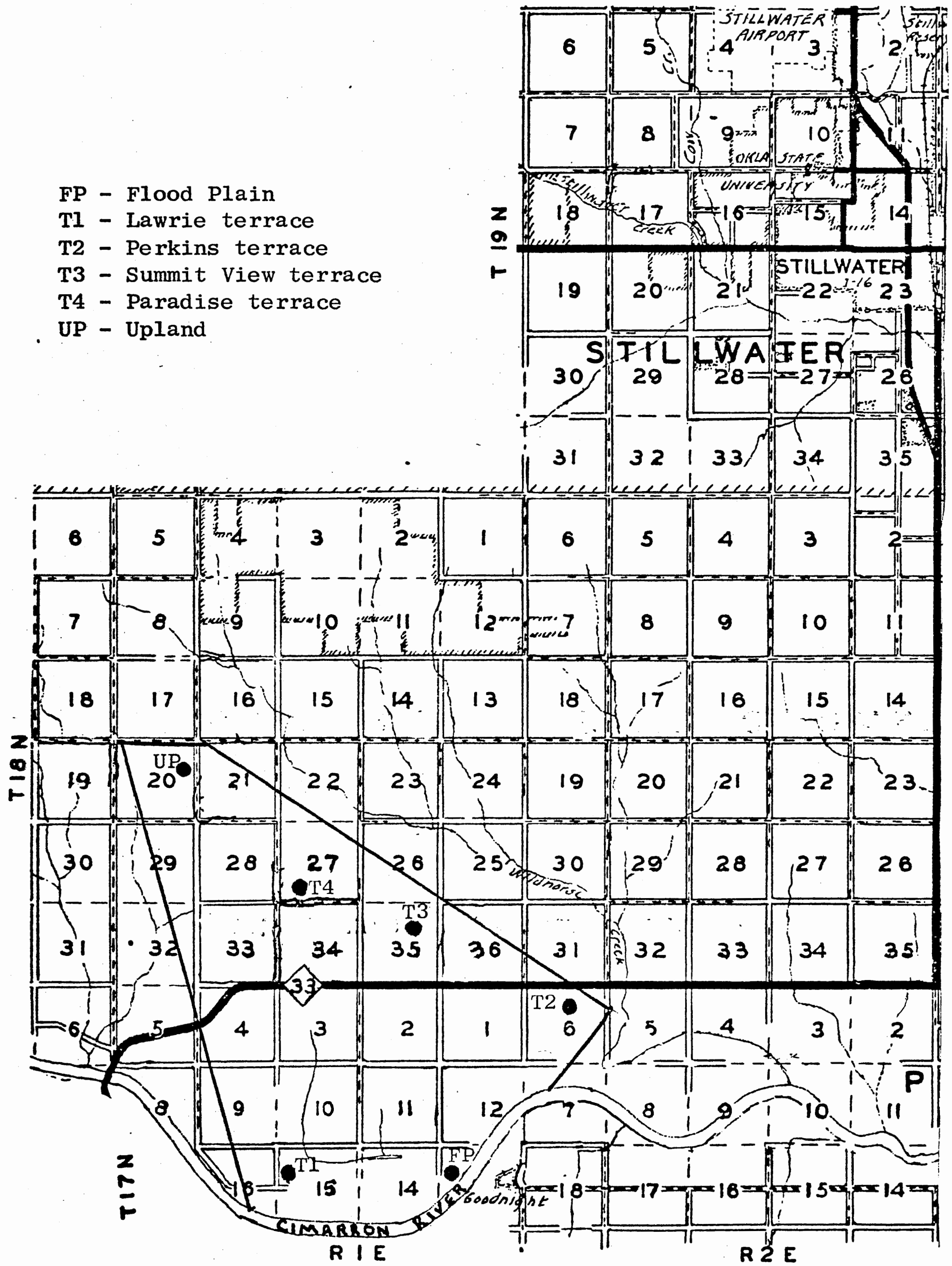

Figure 1. Map of a Segment of Payne County and Sample Site Locations

method used by the Oklahoma State University Soil Morphology Laboratory. The <.002, 0.002-0.05, and 0.05-2.0mm. fractions were expressed as a percentage of organic matter free, carbonate free soil. The 0.05-2.0 mm. fraction was further broken into four of the standard sand subfractions.

Mineralogical Analysis of the Very Fine Sand Fraction

The heavy and light minerals of the very fine sand fraction of selected horizons were studied to determine mineralogical composition.

Mineralogical Determinations

Mineralogical analysis of the very fine sand fraction of selected horizons was done at the National Soil Survey Laboratory in Lincoln, Nebraska. Procedures outlined in Soil Survey Investigations Report No. 1 (13) were used. Grain counts of approximately 300 to 330 grains per slide were made for the upper horizons and ocular estimations were used for mineralogical analysis of the lower horizons.

The mineralogical composition of the AC, B21, and B21t horizons was determined and light and heavy minerals were identified and listed.

In the C horizons, only the percentage of resistant minerals and feldspars was determined. These ocular determinations were very accurate.

CHAPTER IV

RESULTS AND DISCUSSION

The study provided an in depth look at the coarse grain mineralogical components of a suite of soils that have been extensively mapped on most of the river systems in Central Oklahoma. The data gathered may be applicable for soils formed on terraces of the Cimarron River throughout Oklahoma. The development of soils on the terrace levels was most certainly influenced by the soil forming factors of climate and time. The sampling of the flood plain and upland provided necessary supplemental information for the overall genesis of soil development on the Cimarron River terrace system.

Field Studies

The Cimarron River terrace system is illustrated in Figure 2. The horizontal scale of Figure 2 is proportional, but the vertical scale has been exaggerated approximately 33-times to aid in recognition of the different levels.

Soils on the sample sites were not all within the range of established series. The sample site on the flood plain was within the range of the Yahola series and the sample site on the Perkins terrace was within the range of the Teller series. The soil on the Lawrie terrace sample site had been mapped with the Reinach series in the unfinished Soil Survey of Payne County, but the sample site had a coarse loamy

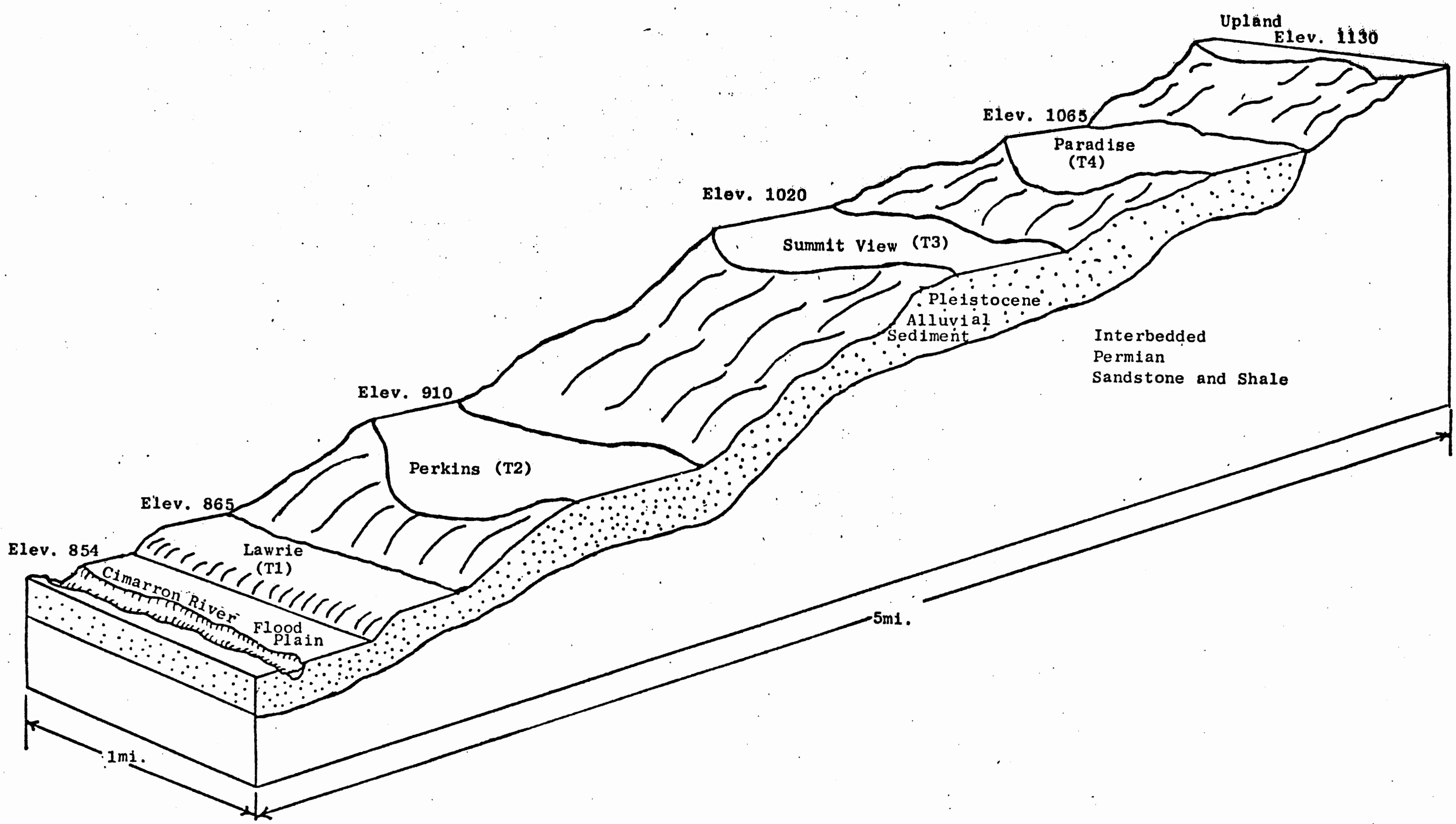

Figure 2. Block Diagram of the Study Area

family classification and Reinach must have a coarse silty family classification. The abundance of fine sand in the family control section of the Lawrie terrace sample site may be due to aeolian deposition of sand. Soils on the north side of the Cimarron River on the Lawrie terrace are often mantled with aeolian material. The soil had a mollic epipedon in excess of 50 cm, and would be best described as a pachic varient of the Canadian series. The Canadian series is classified as a coarse-loamy mixed thermic Udic Haplustoll.

The soils on the Summit View and Paradise terrace sample sites had been mapped with the Pond Creek series on the unfinished Soil Survey of Payne County. The Pond Creek series is a fine-silty, mixed, thermic, Pachic Argiustoll. The soils on the sample sites classify as fine-loamy, mixed, thermic, Udic Argiustolls. The soils on the sample sites had more fine sand in the family control section, than is allowed in the Pond Creek series, and did not have a mollic epipedon thick enough to qualify as pachic. The Teller series has the same classification as the soils on the Summit View and Paradise terrace sample sites but the established range of the Teller series does not allow colors in the B2t horizon browner than 5YR. The soils on the Summit View and Paradise terraces are best described as a brown varient of the Teller series.

The soils developed on the Paradise and Summit View sites did not have a higher silt content in the argillic horizon than the soil developed on the Perkins terrace sample site. Mechanical analysis did not indicate the presence of lithological discontinuities. This suggests that the soils developed in a uniform sediment source and the silt content resulted from the nature of the alluvial sediments rather than an aeolian mantle. The brown argillic horizon may be attributed to the age of the higher terraces in relation to the age of the Perkins terrace, or it may be the result of a somewhat restricted internal drainage condition due to differences in pore sizes between the silty B and the sandier C horizon. The soils on these upper two terrace levels have a more distinctive clay bulge than the soil developed on the Perkins terrace indicating a greater degree of development.

The soil on the upland sample site was in a siliceous mineralogy group. It had greater than 90 percent resistant minerals in the 0.02-2.0 mm size fraction of the mineralogical control section. It would be best described as a siliceous varient of the Stoneburg series, as this is the only characteristic that is outside of the range of the Stoneburg series. Figure 3 shows diagrams of the profile sequences of the sample sites.

The soil profiles were described as follows:

- Flood Plain Sample Site -

Location: 3300 feet South and 100 feet East of the Northwest corner of Section 13, Township 17N, Range 2E
Vegetation: Cultivated Field in Winter Wheat
Slope: 0.5%
Elevation: 854 Feet (9 feet above riverbed)

*Colors are for moist soils unless otherwise stated.

Ap 0-20 cm. -- Strong brown (7.5YR4/6) fine sandy loam; weak fine granular structure; slightly hard, very friable; calcareous; moderately alkaline, clear wavy boundary.

AC 20-64 cm. -- Yellowish red (5YR5/6) very fine sandy loam; weak fine granular structure; slightly hard, very friable; calcareous; moderately alkaline; gradual wavy boundary.

C1 64-91 cm. -- Reddish yellow (7.5YR7/6) fine sand; single grained; loose, very friable; calcareous; moderately alkaline; gradual wavy boundary.

C2 91-112 cm. -- Reddish brown (5YR4/4) fine sandy loam; common thin strata of silt loam and very fine sandy loam; single grained; loose, very friable; calcareous; moderately alkaline; gradual wavy boundary.

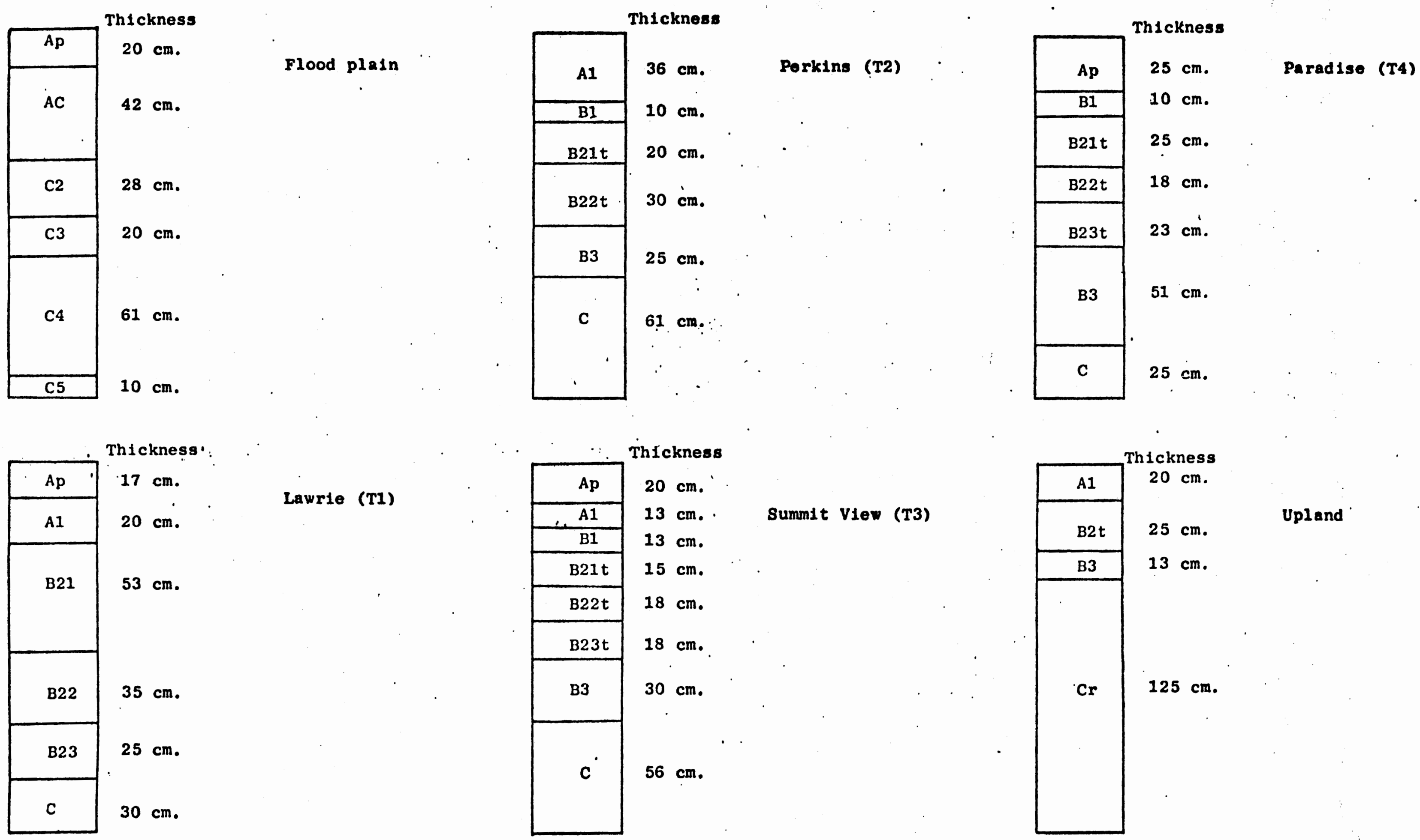

Figure 3. Soil Profiles of the Sample Sites

C3 112-173 cm. -- Yellowish red (5YR5/6) very fine sandy loam; single grained; loose; very friable; calcareous; moderately alkaline; gradual wavy boundary.

C4 173-183 cm. -- Reddish yellow (7.5YR7/6) very fine sandy loam; single grained; loose; very friable; calcareous; moderately alkaline.

- Lawrie Terrace Sample Site -

Location: 2300 feet South and 300 feet East of the Northwest corner of Section 15, Township 17N, Range 1E.
Vegetation: Winter Wheat
Slope: 0.5%
Elevation: 865 feet (15 feet above riverbed)

*Colors are for moist soils unless otherwise stated.

Ap 0-18 cm. -- Dark brown (7.5YR3/2) fine sandy loam; weak medium granular structure; slightly hard, very friable; neutral; clear smooth boundary.

A1 18-38 cm. -- Dark brown (7.5YR3/2) fine sandy loam; moderate medium granular structure; slightly hard, very friable; slightly acid; gradual smooth boundary.

B21 38-91 cm. -- Dark reddish brown (5YR3/3) fine sandy loam; weak fine granular structure; slightly hard, very friable; neutral, clear smooth boundary.

B22 91-127 cm. -- Reddish brown (5YR4/4) fine sandy loam; weak fine granular structure; hard, very friable; moderately alkaline; gradual smooth boundary.

B23 127-152 cm. -- Yellowish red (5YR4/6) clay loam; weak fine granular structure; hard, very friable; moderately alkaline; clear smooth boundary.

C 152-183 cm. -- Yellowish red (5YR5/6) silt loam; massive; slightly hard, very friable; calcareous; moderately alkaline.

- Perkins Level Sample Site -

Location: 2500 feet East and 200 feet South of the Northwest corner of Section 6, Township 17N, Range 2E
Vegetation: Alfalfa
Slope: 0.5%
Elevation: 910 feet (70 feet above riverbed)

*Colors are for moist soil unless otherwise stated.

A1 0-36 cm. -- Dark reddish brown (5YR3/3) loam; weak fine granular structure; slightly hard, very friable; medium acid; clear smooth boundary.

B1 36-46 cm. -- Dark reddish brown (5YR3/3) loam; moderate fine subangular blocky structure; slightly hard, very friable; slightly acid; clear smooth boundary.

B21t 46-66 cm. -- Reddish brown (5YR4/4) loam; dark reddish brown (5YR3/4) on faces of peds; moderate coarse prismatic structure breaking to moderate medium subangular block structure; thin, near continuous clay film on faces of peds; very hard, firm; neutral, gradual smooth boundary.

B22t 66-96 cm. -- Brown (7.5YR4/4) loam; moderate coarse prismatic structure breaking to moderate medium subangular blocky; thin nearly continuous clay films on faces of peds; very hard, firm; mildly alkaline; gradual smooth boundary.

B3 96-122 cm. -- Strong brown (7.5YR4/6) fine sandy loam; weak coarse prismatic structure; few, thin patchy clay film on faces of peds; very hard, friable; mildly alkaline; gradual smooth boundary.

C 122-183 cm. -- Strong brown (7.5YR5/6) fine sandy loam; massive; very hard, friable; mildly alkaline.

- Summit View Level Sample Site -

Location: 2959 feet East and 1700 feet South of the Northwest corner of Section 35, Township 18N, Range 1E.
Vegetation: Winter Wheat
Slope: 0.5%
Elevation: 1020 Feet (175 feet above riverbed)

*Colors are for moist soils unless otherwise stated.

Ap 0-20 cm. -- Dark brown (10YR3/3) fine sandy loam; weak fine granular structure; slightly hard, very friable; mildly alkaline; clear smooth boundary.

A1 20-33 cm. -- Very dark grayish brown (10YR3/2) loam; moderate medium granular structure; slightly hard, very friable; mildly alkaline; gradual smooth boundary.

B1 33-46 cm. -- Dark brown (7.5YR3/4) loam; moderate medium and fine subangular blocky structure; slightly hard, very friable; neutral; clear smooth boundary.

B21t 46-61 cm. -- Dark brown (7.5YR3/4) loam; moderate medium subangular blocky structure; very hard, firm; thin patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t 61-79 cm. -- Brown (7.5YR4/4) clay loam; weak coarse prismatic structure breaking to moderate medium subangular blocky; very hard, firm; thin, near continuous clay film on faces of peds; neutral; gradual smooth boundary.

B23t 79-97 cm. -- Strong brown (7.5YR5/6) sandy clay loam; weak coarse prismatic structure breaking to moderate medium subangular blocky; very hard, firm; thin near continuous clay film on faces of peds; neutral; clear smooth boundary.

B3 97-127 cm. -- Yellowish brown (10YR5/8) fine sandy loam; weak coarse prismatic structure; many fine distinct strong brown (7.5YR5/6) and very pale brown (10YR7/3) mottles; very hard, friable; few thin patchy clay film on faces of peds; neutral; clear smooth boundary.

C 127-183 cm. -- Yellowish brown (10YR5/8) fine sandy loam; massive; very hard, friable; neutral.

- Paradise Level Sample Site -

Location: 1200 feet East and 300 feet North of the Southwest corner of Section 27, Township 18N, Range 1E.
Vegetation: Winter Wheat
Slope: 0.5%
Elevation: 1065 Feet (215 feet above riverbed)

*Colors are for moist soils unless otherwise stated.

Ap 0-25 cm. -- Dark reddish brown (5YR3/3) loam; weak fine granular structure; slightly hard, very friable; slightly acid; clear smooth boundary.

B1 25-36 cm. -- Dark reddish brown (5YR3/3) loam; weak medium subangular blocky structure; hard, very friable; neutral; clear smooth boundary.

B21t 36-61 cm. -- Brown (7.5YR4/4) loam; moderate medium subangular blocky structure; hard, friable; thin, near continuous clay film on faces of peds; neutral; clear smooth boundary.

B22t 61-79 cm. -- Brown (7.5YR4/4) sandy clay loam; moderate medium and coarse subangular blocky structure; hard, firm; thin near continuous clay films on faces of peds; neutral, gradual smooth boundary.

B23t 79-102 cm. -- Strong brown (7.5YR5/8) fine sandy loam; moderate coarse prismatic structure; very hard, firm; common thin patchy clay films on faces of peds; neutral; clear smooth boundary.

B3 102-152 cm. -- Strong brown (7.5YR5/8) fine sandy loam; weak coarse prismatic structure; very hard, friable; mildly alkaline; gradual smooth boundary.

C1 152-193 cm. -- Reddish yellow (7.5YR6/6) loamy fine sand; massive; very hard, friable; mildly alkaline; gradual smooth boundary.

C2 193-218 cm. -- Strong brown (7.5YR5/8) fine sandy loam; massive; very hard, friable; mildly alkaline.

- Upland Sample Site -

Location: 1500 feet South and 300 feet West of the Northeast corner of Section 20, Township 18N, Range 1E.
Vegetation: Buffalo grass and Blue Grama
Slope: 1%
Elevation: 1130 Feet (280 feet above riverbed)

*Colors are for moist soil unless otherwise stated.

A1 0-20 cm. -- Dark reddish brown (5YR3/3) sandy clay loam; moderate medium granular structure; slightly hard, very friable; mildly alkaline; gradual smooth boundary.

B2t 20-46 cm. -- Red (2.5YR5/6) sandy clay loam; weak coarse prismatic structure breaking to moderate medium subangular blocky; very hard, friable; neutral; clear smooth boundary.

B3 46-58 cm. -- Red (2.5YR4/8) clay loam; weak medium subangular blocky structure; very hard, friable; ten percent weathered strong brown (7.5YR5/8) and dark red (2.5YR3/6) fragments of sandstone less than 76 mm. across; neutral; abrupt smooth boundary.

Cr 58 + cm. -- Red (2.5YR5/6) Permian sandstone.

Particle Size Distribution

The results of the particle size analysis for all horizons is shown in Appendix Tables VI-XI. The particle size distribution is shown graphically in Figures 4-6. The graphs show that the clay content generally increases from the lowest to the highest terrace level. The graphs also show distinctive clay bulges in the upper three terrace levels. These clay bulges indicate the presence of an argillic horizon. Figure 5 shows the particle size distribution of the Lawrie terrace level. There is a sharp decrease in the sand fraction and an increase in the silt fraction. This indicates two different ages of material, or material deposited by different mechanisms of deposition. This discontinuity can probably be attributed to an aeolian blanket of fine

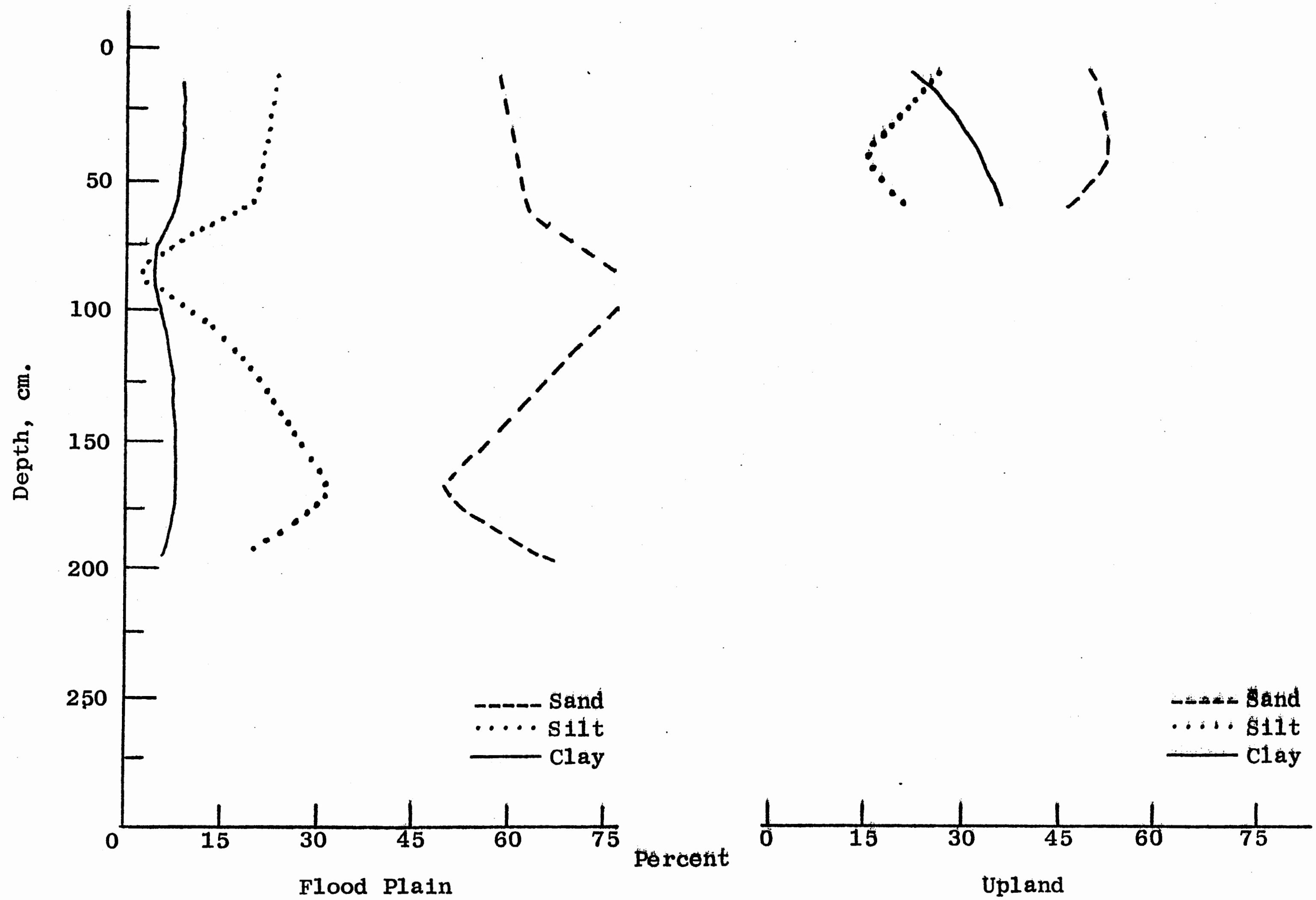

Figure 4. Particle Size Distribution of the Flood Plain and Upland Sample Sites

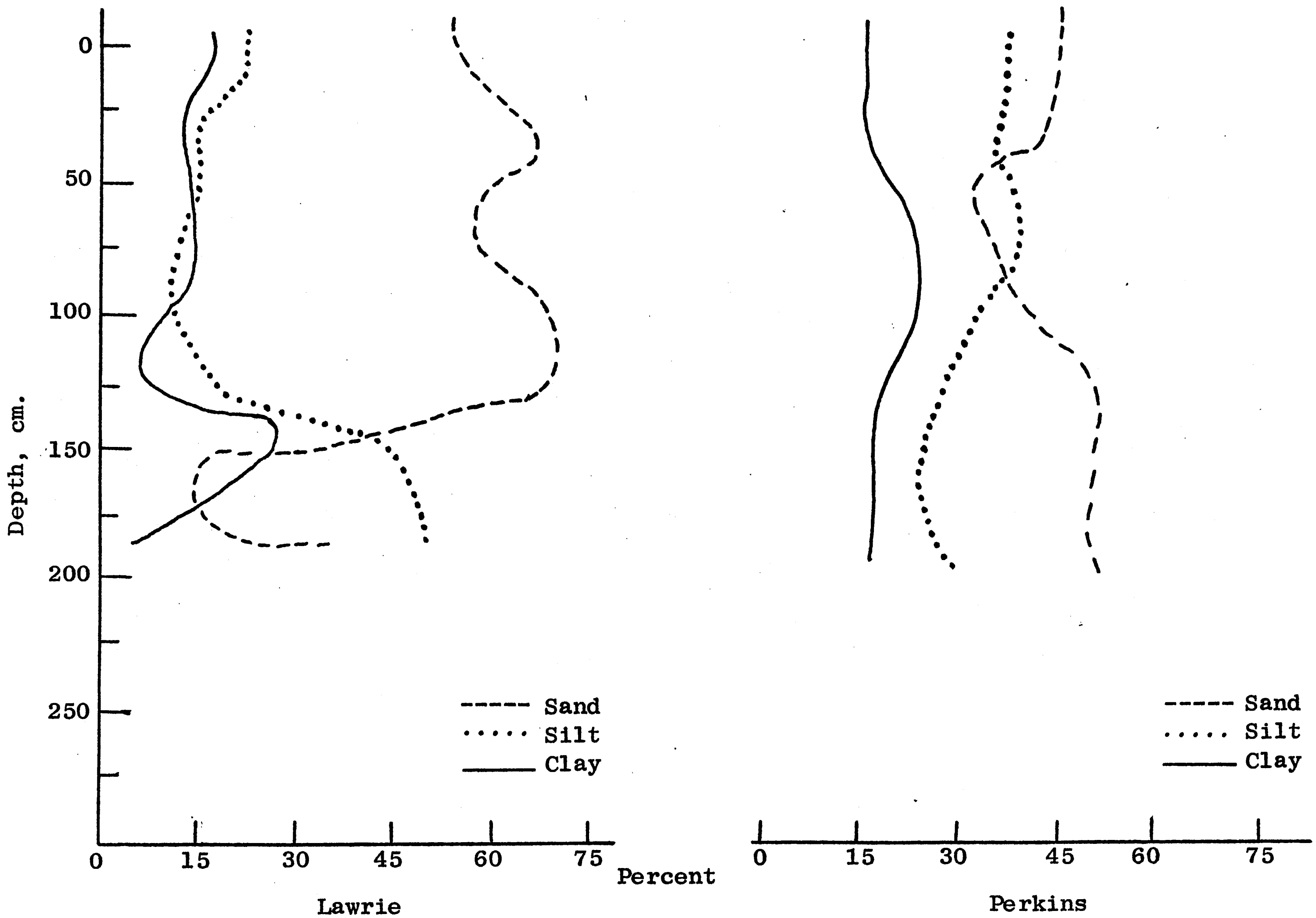

Figure 5. Particle Size Distribution of the Lawrie and Perkins Terrace Sample Sites

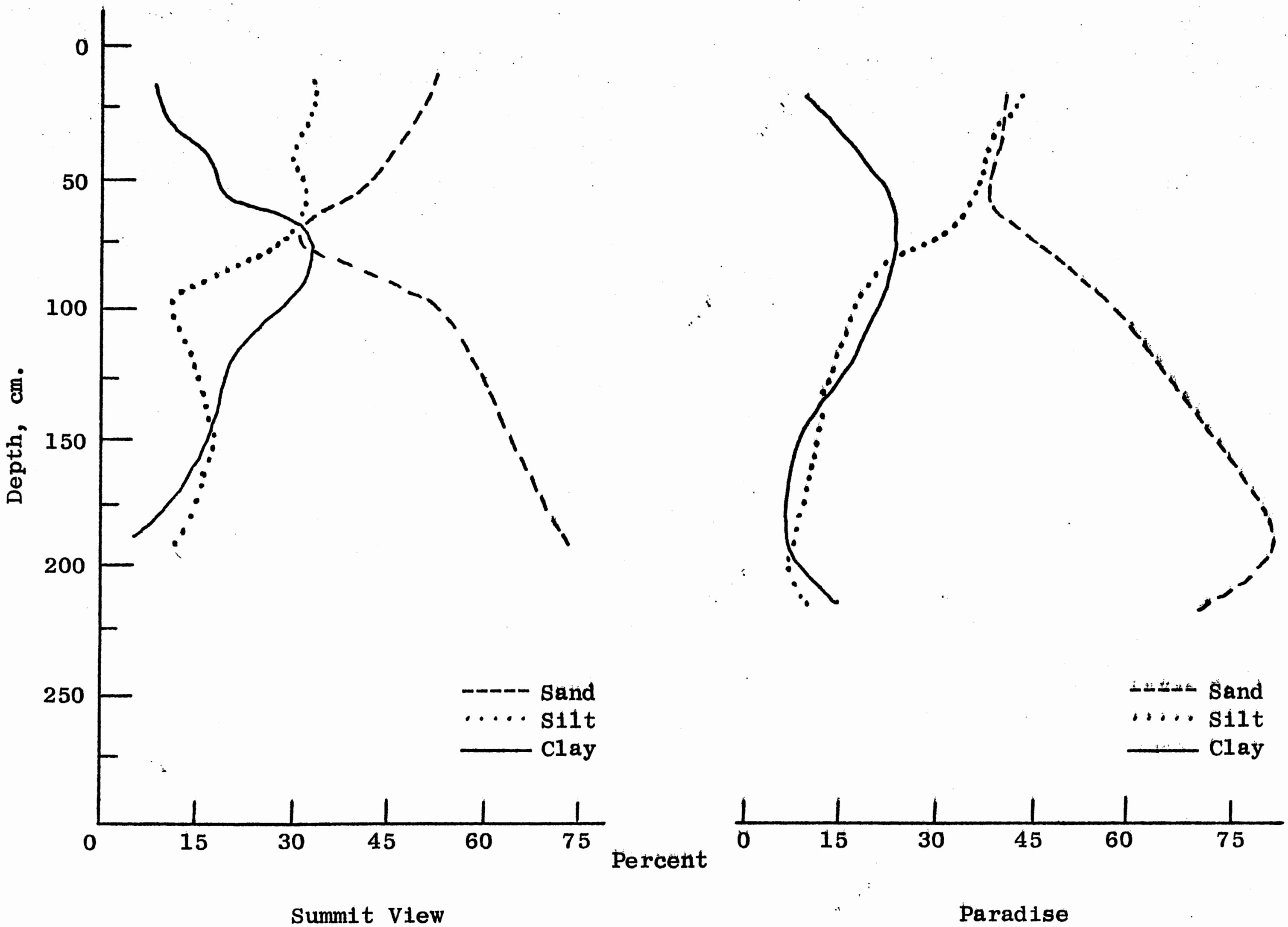

Figure 6. Particle Size Distribution of the Summit View and Paradise Terrace Sample Sites

sand that mantles many of the low terraces on the north side of the Cimarron River.

The Summit View, Paradise, and Perkins terrace sample sites show a higher silt content in the B2t horizon than in the C horizon. This is apparently not due to an aeolian silt blanket, because the particle size distribution does not indicate any type of discontinuity. The siltier texture of the B2t horizons of the soils on these terrace level sample sites is probably due to the stratified nature of the alluvial sediments. Alluvium often exhibits vertical sorting upon deposition and the B2t horizons may have developed in slightly siltier alluvium on these upper terrace levels.

The flood plain was dominated by very fine sands, and the low clay content indicates little profile development. The distribution curve in Figure 4 shows how stratified alluvial material is presented, with the silts and sands exhibiting the greatest fluctuations.

The upland site showed a regular increase in clay content with little fluctuation in the silt and sand content.

The relatively constant percent of sand on a clay free basis throughout the profiles of soils on the upper three terrace levels indicates a rather homogeneous sediment source and a singular mechanism of deposition. This mechanism of deposition was probably alluvial in nature. The Lawrie terrace sample site did appear to be influenced by an aeolian blanket of fine sands.

The generally increasing clay content in the B horizon from the lowest through the highest terrace level indicates that soils on the terrace levels are in different stages of development. The clay content decreases with depth within individual profiles indicating none of the soils studied are completely mature.

The particle size data answered questions concerning the family classification. Soils sampled on the Summit View and Paradise terraces were thought to have a fine-silty family control section. The soil on the Lawrie terrace sample site was believed to have a coarse-silty family control section. Particle size data showed that the soils sampled on the Summit View and Paradise terrace level sample sites had a fine-loamy family classification and soil on the Lawrie terrace sample site had a coarse-loamy family classification.

Sand Mineralogy

Light Minerals

The 0.05-0.10 mm. size fraction was analyzed for light minerals. Light minerals are those that have a specific gravity less than 2.95. The light minerals were studied to arrive at ratios that would indicate weathering trends within individual profiles, as well as between different terrace levels. They also help determine the origin of the sediment.

The light mineral suite of all the sample sites was found to consist mainly of quartz and potassium feldspars. The flood plain sample site also contained two percent calcite, two percent kaolinite, one percent muscovite, one percent plagioclase feldspar, and traces of chlorite. The terrace levels contained trace amounts of plant opal, plagioclase feldspars, chlorite, and muscovite in the light mineral suite.

There was a general quartz content of 76 to 86 percent and a feldspar content between 12 and 20 percent in the Pleistocene alluvial sediments of the Cimarron River terrace system. There was a slight increase in the quartz/feldspar ratio as the elevation above the river increased. Table II illustrates the percentage of quartz and feldspars in the horizons analyzed. There was very little difference in the quartz/feldspar ratio within individual pedons indicating very little weathering in individual pedons on the different terrace levels. The upland site, representing Permian material, had 97 percent quartz and two percent potassium feldspars in the B2t horizon.

The quartz and feldspar content between the Perkins and Summit View terrace level was almost the same even though there was 120 feet difference in elevation between these terrace levels. This indicated that very little weathering occured between the formation of Summit View terrace and the formation of the Perkins terrace. A possible explanation may be that there was an arid interglacial period between the times these terraces were formed. The Lawrie terrace has the lowest quartz/feldspar ratio rather than the flood plain. This indicates the sediments on the flood plain are very recent sediments being influenced by either the adjacent siliceous Permian sandstones or sediments coming from previously weathered material on higher terrace levels.

The light mineral suite shows very little indications of weathering within individual soil profiles on terrace levels, and only exhibits very slight indications of weathering intensities between different terrace levels. The sediment source appears to be homogeneous, and the mechanism of deposition appears to be singular. The results show that all the loamy soils sampled on the Cimarron River terrace system have a

TABLE II

PERCENTAGE OF QUARTZ AND FELDSPARS AND RATIO OF QUARTZ/FELDSPAR IN THE VERY FINE SAND FRACTION

Sample Site	Horizon	Quartz	Feldspar	Quartz/Feldspar Ratio
		%	%	
FLOOD PLAIN	AC	81	13	6.2
	C3	80	13	6.15
LAWRIE TERRACE	B21	76	20	3.8
	C	78	20	3.9
PERKINS TERRACE	B21t	83	16	5.18
	C	85	15	5.6
SUMMIT VIEW TERRACE	B21t	82	16	5.12
	C	85	15	5.6
PARADISE TERRACE	B21t	86	12	7.16
	C2	87	12	7.25
UPLAND	B2t	97	2	48.5
	Cr	97	2	48.5

mixed mineralogy classification. The upland site was shown to have a siliceous mineralogy classification.

Heavy Minerals

The nonopaque heavy minerals, those having a specific gravity greater than 2.95, were identified. The composition of the heavy mineral suite was studied to help determine sediment homogenity and see if any weathering trends could be observed.

Table III shows the composition of the heavy mineral suite listed in order of abundance. Of the horizons selected for mineralogical analysis, only the upper horizon of each sample site was analyzed for heavy minerals. This gave an indication of the heavy mineral composition in the mineralogical control section.

The heavy mineral data indicated that the heavy mineral suite generally makes up less than one percent of the mineralogical composition of the very fine sand fraction. In most instances the heavy minerals only constituted a trace of the mineralogical fraction.

The heavy minerals of the very fine sand fraction of the terrace sediments consisted primarily of epidote, hornblende, zircon, tourmaline, garnet, and biotite. The upland site had only hornblende and zircon in the heavy mineral suite, and only in trace amounts.

The heavy mineral data does not indicate any weathering trend, but it does indicate a homogeneous sediment source on the terrace system. The upland site does not have as large a variety of heavy minerals as the Pleistocene alluvial sediments on the terrace system.

TABLE III

NONOPAQUE HEAVY MINERALS IN THE VERY FINE SAND FRACTION

Sample Site	Horizon	Heavy Minerals	Percent
FLOOD PLAIN	AC	Epidote	Trace
		Hornblende	Trace
		Tourmaline	Trace
LAWRIE TERRACE	B21	Epidote	Trace
		Zircon	Trace
		Hornblende	Trace
		Garnet	Trace
PERKINS TERRACE	B21t	Biotite	Trace
		Garnet	Trace
		Tourmaline	Trace
		Epidote	Trace
		Hornblende	Trace
		Zircon	Trace
SUMMIT VIEW TERRACE	B21t	Zircon	1
		Tourmaline	Trace
		Epidote	Trace
PARADISE TERRACE	B21t	Hornblende	1
		Epidote	Trace
		Biotite	Trace
		Zircon	Trace
UPLAND	B2t	Horneblende	Trace
		Zircon	Trace

Summary of Factors Relating to the Origin of the Sediments

Field studies, particle size analysis, and mineralogical analysis of the heavy and light minerals of the very fine sand fraction were used to arrive at a determination of the origin of the sediments. The field studies indicated the possibility of aeolian influences on the origin of loamy soils on the terrace levels, but the particle size distribution and mineralogical analysis did not indicate anything but a homogeneous sediment source and a singular mechanism of deposition for most of the terrace levels. The Lawrie terrace did show the influence of a possible aeolian mantle of more recent sediments in the particle size distribution, but the mineralogical analysis indicated a homogeneous sediment source. The mineralogical composition in the mineralogy control section of all the sample sites is shown in Table IV. The mineralogical analysis of the upland site indicates that it developed on Permian sandstone.

Loamy soils on the Cimarron River terrace system in Payne County seem to have developed in a rather homogeneous sediment source with a singular mechanism of deposition that is most commonly alluvial. Changes in textures within individual soil pedons are probably due to the stratified nature of the alluvial sediments rather than being sediments of different origin or having different methods of deposition.

Soil Classification

The soils on the sample sites were classified according to the Seventh Approximation as outlined in Soil Taxonomy (10). The results are given in Table V. The chemical compositon, primarily a percentage

TABLE IV

MINERALOGICAL COMPOSITION OF THE VERY FINE SAND FRACTION OF THE MINERALOGY CONTROL SECTION

Sample Site	Horizon	Minerals	Percent
FLOOD PLAIN	AC	Quartz	81
		K Feldspar	13
		Kaolinite	2
		Calcite	2
		Muscovite	1
		Plagioclase Feldspar	1
		Epidote	Trace
		Hornblende	Trace
		Chlorite	Trace
		Tourmaline	Trace
		Opaque	Trace
LAWRIE TERRACE	B21	Quartz	76
		K Feldspar	20
		Opaque	2
		Plagioclase Feldspar	1
		Epidote	Trace
		Zircon	Trace
		Hornblende	Trace
		Tourmaline	Trace
		Muscovite	Trace
		Garnet	Trace
PERKINS TERRACE	B21t	Quartz	83
		K Feldspar	16
		Opaque	Trace
		Biotite	Trace
		Garnet	Trace
		Tourmaline	Trace
		Epidote	Trace
		Hornblende	Trace
		Zircon	Trace
		Chlorite	Trace
SUMMIT VIEW TERRACE	B21t	Quartz	82
		K Feldspar	16
		Opaque	1
		Zircon	1
		Muscovite	1
		Plagioclase Feldspar	Trace
		Tourmaline	Trace
		Plant Opal	Trace
		Epidote	Trace
PARADISE TERRACE	B21t	Quartz	86
		K Feldspar	12
		Hornblende	1
		Epidote	Trace
		Muscovite	Trace
		Biotite	Trace
		Zircon	Trace
		Plagioclase Feldspar	Trace
UPLAND	B2t	Quartz	97
		K Feldspar	2
		Hornblende	Trace
		Chlorite	Trace
		Opaque	Trace
		Zircon	Trace

TABLE V

A CLASSIFICATION ACCORDING TO THE SEVENTH APPROXIMATION

Soil	Order	Suborder	Great Group	Subgroup	Family Classification	
					Texture	Mineralogy
Flood Plain	Entisol	Fluvent	Ustifluvent	Typic Ustifluvent	Coarse-Loamy	Mixed
Lawrie Terrace	Mollisol	Ustoll	Haplustoll	Udic Haplustoll	Coarse-Loamy	Mixed
Perkins Terrace	Mollisol	Ustoll	Argiustoll	Udic Argiustoll	Fine-Loamy	Mixed
Summit View Terrace	Mollisol	Ustoll	Argiustoll	Udic Argiustoll	Fine-Loamy	Mixed
Paradise Terrace	Mollisol	Ustoll	Argiustoll	Udic Argiustoll	Fine-Loamy	Mixed
Upland	Mollisol	Ustoll	Argiustoll	Udic Argiustoll	Fine-Loamy	Siliceous

of organic matter and base saturation, was presumed to be compatable with the classification given these soils.

The study used both particle size data and mineralogy for classification of the soils. The particle size data was needed for classification at the family and great group level. The mineralogy was needed to place the soils in the correct mineralogical group. The soils sampled on the flood plain and terraces all had mixed mineralogy. The soil on the upland had siliceous mineralogy. The study answered questions concerning the proper family and mineralogical classification of loamy soils on the Cimarron River terrace system.

CHAPTER V

SUMMARY AND CONCLUSIONS

The objectives of the study were to determine the mineralogical composition of the very fine sand fraction in order to arrive at a means of showing the effects of weathering within individual soil profiles as well as between different terrace levels on the Cimarron River, show the possible origin of the sediment, and provide insight on the development of soils on the Cimarron River terrace system. Information pertinent to classification of Loamy soils on the Cimarron River terrace system was also determined.

The study provided an in depth look at the mineralogical components of Loamy soils on the Cimarron River terrace system. The elevations of the sample sites were determined in an attempt to correlate soil development and weathering with the height of the soil above the Cimarron River.

This study incorporated the elements of geomorphic position with soil development. The understanding of how the position of a soil on the landscape effects its development and subsequent classification is an important concept of soil mapping.

Particle size distribution data was obtained to help substantiate field observations and mineralogical data. The particle size distribution shows discontinuities that may result from different sediments or different mechanisms of deposition.

Field studies indicated that the development of soils on the terrace levels increased with elevation above the river. The color of the B2t horizon became more brown on the Summit View and Paradise terrace levels. The color of the B2t may have become more brown with increasing age, a somewhat restricted internal drainage condition, or it may have been due to the original color of the alluvial sediments when they were deposited.

The particle size distribution data indicated that most of the soils studied, with the exception of the Lawrie terrace sample site, had an alluvial mechanism of deposition. The particle size distribution on the Lawrie terrace indicated a discontinuity that probably resulted from an aeolian mantle of fine sand. The particle size distribution data indicated that all of the sample sites had less than 35 percent clay and greater than 15 percent fine sand in the family control section. The soils on the flood plain and Lawrie sample site had less than 18 percent clay in the family control section. The general trend of clay distribution between the terrace levels was to increase as the elevation became higher. The general trend of clay distribution within individual pedons was to decrease with depth.

The studies of the sand mineralogy indicates that the soils on the Cimarron River terrace system developed in uniform, predominantly Pleistocene, sediments. There was a slight increase in resistant minerals and a decrease in weatherable minerals as the elevation above the river became higher. There was almost no difference in the percentage of resistant and weatherable minerals between the Perkins and Summit View terrace level although there was a large difference in elevation. There is no clear explanation for this phenomena. The mineralogy within the individual pedons sampled showed no appreciable difference of resistant and weatherable minerals between the AC, B21, or B21t horizons and the C horizons. This shows that there is almost no indications of the effect of weathering on mineralogy within individual profiles on the Cimarron River terrace system. The upland site, representing Permian materials, was markedly different from the terrace sediments. The influence of the adjacent Permian uplands on the Cimarron River terrace system was not reflected in the mineralogy of the terrace sediments.

The study did show that Loamy soils on the Cimarron River terrace system in Payne County have dominantly mixed mineralogy. It also showed that quartz and potassium feldspars make up greater than 95 percent of the whole mineral suite.

Further study of the mineralogy of soils developed on the younger erosional surfaces of the Cimarron River terrace system would provide important additional information. Similar studies on the other major river systems would also prove interesting. Additional work regarding the clay mineralogy of the soils on the Cimarron River terrace system needs to be done to provide a more complete package of information on this agriculturally important suite of soils.

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APPENDIX

TABLE VI

PARTICLE SIZE DISTRIBUTION OF THE FLOOD PLAIN AND UPLAND SAMPLE SITES

Horizon	Depth cm	Diameter, mm					
		<0.002	0.002-0.05	0.05-0.10	0.10-0.25	0.25-0.50	0.50-1.0
		%	%	%	%	%	%
			----Flood Plain----				
Ap	0-20	12.9	25.4	30.0	27.5	4.1	0.1
AC	20-64	11.1	22.0	43.0	22.3	1.6	0.0
C1	64-91	6.5	2.3	13.8	67.6	9.8	0.0
C2	91-112	8.8	16.7	34.5	38.4	1.6	0.0
C3	112-173	9.8	35.8	42.7	11.1	0.6	0.0
C4	173-183	7.3	22.2	40.4	23.5	5.7	0.9
			----Upland----				
A1	0-20	22.7	27.8	17.3	31.8	0.2	0.2
B2t	20-46	32.3	15.2	14.3	38.0	0.2	0.0
B3	46-58	33.0	22.8	16.5	27.3	0.4	0.2

TABLE VII

PARTICLE SIZE DISTRIBUTION OF THE LAWRIE AND PERKINS TERRACE SAMPLE SITES

Horizon	Depth cm	Diameter, mm <0.002	0.002-0.05	0.05-0.10	0.10-0.25	0.25-0.50	0.50-1.0
		%	%	%	%	%	%
			----Lawrie----				
Ap	0-18	16.3	24.6	21.3	31.4	6.1	0.3
A1	18-38	13.5	17.1	21.2	38.7	9.2	0.3
B21	38-91	14.8	13.3	12.4	40.1	18.4	1.0
B22	91-127	12.1	22.7	17.1	33.1	14.2	0.8
B23	127-152	28.3	47.2	15.9	7.4	1.1	0.1
C	152-183	8.4	53.1	36.9	1.5	0.1	0.0
			----Perkins----				
A1	0-36	17.1	39.0	12.5	25.8	5.5	0.1
B1	36-46	19.3	37.6	13.4	24.7	4.9	0.1
B21t	46-66	24.9	41.9	6.8	20.0	6.5	0.2
B22t	66-96	24.3	32.4	10.0	25.4	7.8	0.1
B3	96-122	18.6	29.1	12.0	31.3	8.9	0.1
C	122-183	17.4	29.8	12.5	26.9	13.3	0.1

TABLE VIII

PARTICLE SIZE DISTRIBUTION OF THE SUMMIT VIEW AND PARADISE TERRACE SAMPLE SITES

Horizon	Depth cm	Diameter, mm <0.002	0.002-0.05	0.05-0.10	0.10-0.25	0.25-0.50	0.50-1.0
		%	%	%	%	%	%
			----Summit View----				
Ap	0-20	11.3	35.7	11.1	30.2	10.8	0.6
A1	20-33	13.8	35.3	10.9	28.6	10.8	0.6
B1	33-46	18.4	33.0	10.7	27.2	10.1	0.6
B21t	46-61	22.0	33.9	9.3	25.0	9.1	0.8
B22t	61-79	35.6	29.8	6.1	18.8	9.1	0.6
B23t	79-97	29.4	13.8	7.2	25.6	15.0	9.0
B3	97-127	18.8	17.0	8.9	34.4	19.5	1.4
C	127-183	10.0	13.9	9.4	40.9	23.9	1.9
			----Paradise----				
Ap	0-25	12.5	43.8	9.2	19.5	14.6	0.4
B1	25-36	17.8	40.9	9.7	17.7	13.4	0.5
B21t	36-61	24.9	35.8	9.8	18.1	10.9	0.5
B22t	61-79	25.3	25.6	8.2	23.1	17.2	0.6
B23t	79-102	19.5	18.7	8.0	26.8	26.3	0.7
B3	102-152	10.6	14.1	7.0	31.4	35.8	1.1
C1	152-193	9.5	10.2	8.8	36.1	34.0	1.4
C2	193-218	15.3	11.6	8.7	42.4	21.4	0.6

TABLE X

PARTICLE SIZE DISTRIBUTION ON A CLAY FREE BASIS OF THE LAWRIE AND PERKINS TERRACE SAMPLE SITES

Horizon	Depth cm	0.002–0.05	0.05–0.10	0.10–0.25	0.25–0.50	0.50–1.0
		%	%	%	%	%
			----Lawrie----			
Ap	0–18	30	25	37	7	1
A1	18–38	20	24	45	10	0
B21	38–91	15	15	47	21	1
B22	91–127	26	19	38	16	1
B23	127–152	65	22	11	1	0
C	152–183	57	40	2	1	0
			----Perkins----			
A1	0–36	47	16	31	6	0
B1	36–46	47	16	31	6	0
B21t	46–66	55	9	27	9	0
B22t	66–96	43	13	32	10	0
B3	96–122	36	15	38	11	0
C	122–183	36	16	33	16	0

TABLE XI

PARTICLE SIZE DISTRIBUTION ON A CLAY FREE BASIS OF THE SUMMIT VIEW AND PARADISE TERRACE SAMPLE SITES

Horizon	Depth cm	Diameter, mm 0.002-0.05	0.05-0.10	0.10-0.25	0.25-0.50	0.50-1.0
		%	%	%	%	%
			----Summit View----			
Ap	0-20	40	12	33	12	1
A1	20-33	41	13	34	13	0
B1	33-46	40	13	33	12	0
B21t	46-61	44	12	32	12	1
B22t	61-79	47	9	30	14	0
B23t	79-97	20	10	37	21	12
B3	97-127	21	11	43	23	1
C	127-183	15	10	46	27	2
			----Paradise----			
Ap	0-25	51	10	22	17	0
B1	25-36	50	12	22	16	0
B21t	36-61	51	12	24	13	0
B22t	61-79	35	11	31	23	1
B23t	79-102	24	10	34	33	0
B3	102-152	16	8	35	40	1
C1	152-193	11	10	40	38	1
C2	193-218	14	11	50	25	1

VITA

James Edward Henley

Candidate for the Degree of

Master of Science

Thesis: MINERALOGICAL DIFFERENCES OF LOAMY SOILS ON THE CIMARRON RIVER TERRACE SYSTEM IN PAYNE COUNTY, OKLAHOMA, IN RESPECT TO THEIR GENESIS AND ORIGIN

Major Field: Agronomy

Biographical:

Personal Data: Born in Enid, Oklahoma, August 18, 1953, the son of Mr. and Mrs. Henry E. Henley; married Mollye Ann Wade December 1, 1979.

Education: Graduated from Pond Creek High School, Pond Creek, Oklahoma, in May, 1971; received Bachelor of Science degree in Range Management from Oklahoma State University in 1975; completed requirements for the Master of Science degree at Oklahoma State University in July, 1980.

Professional Experience: Soil Conservationist, Soil Conservation Service, 1976-1977; Soil Scientist, Soil Conservation Service, 1977-present.