THE STUDY OF THE DIAGNOSTIC PROPERTIES OF SOME OKLAHOMA SOIL SERIES BY LABORATORY METHODS FOR SOIL CLASSIFICATION PURPOSES

By

Pongpit Piyapongse

Bachelor of Science

Kasetsart University

Bangkok, Thailand

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Dean of the Graduate School

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CHAPTER I

INTRODUCTION

The fact that soils are basic to all types of agriculture has long been recognized. Because of its importance, the scientific study of soils has been carried on for many years. As the knowledges of soil science progressed, several areas of soil sciences were established. Soil chemistry, soil physics, soil micro-biology, soil fertility, soil management, and soil conservation have been born.

The progress of the many areas of soil science are dependent upon knowing the kind and amount of various soils. As inventory of our soil resources is essential, therefore, some universal system of soil classification is necessary. There are numerous schools of thought concerning soil classification. Several attempts have been made in order to classify soils for the last several decades, but there is no classification system that could be called perfect and satisfactory to all, because soil is a gradual system, there are no sharp boundaries between them.

For each system of soil classification, the diagnostic properties such as color, texture, structures and chemical properties are being used as a guide to separate one soil from another. Some soil series in Oklahoma are correlated to other series, some are not. It is rather difficult to separate some soils by field studies only.

Laboratory analysis of physical and chemical properties help separate soils for classification purposes. For example, Minco and Teller series are very similar to one another when studied in the field, but when some of their chemical properties are determined, they can be separated by the fact that the Minco series has a lower cation exchange capacity and contains a higher sand fraction than Teller. By studying the diagnostic properties of soils, both laboratory and field methods, we can classify soils with more confidence.

The purposes of this paper is to study some diagnostic properties of some soil series in Oklahoma by laboratory methods and attempt to classify these soil series according to the comprehensive system of soil classification of the Seventh Approximation set up by the Soil Survey Staff of the Soil Conservation Service, USDA, August, 1960. The attempt is made to try out this new classification scheme, to test how it works out for some Oklahoma soil series. This paper is to serve and assist soil scientists in classifying these soils and study their correlations.

The methods and procedures employed in this study have been used in several soil survey laboratories. The methods were based upon accuracy, time and economical aspects of the reagents used.

It is hoped that the results from this study will be useful in helping to separate one series from another based upon certain laboratory procedures as well as physical determinations in the field.

CHAPTER II

REVIEW OF LITERATURE

A. History of Soil Classification

According to Jenny (2), since the beginning of the present century a great amount of work on soil identification and mapping has been carried out in all parts of the world. Attempts to coordinate the great mass of data frequently have been made, but almost exclusively along the line of soil classification. The idea of classification has stood foremost in the minds of many great soil scientists of the past, and the present day leaders in field soil studies continue in the same direction. Smith (5) states that about 1870 a new concept of soil was developed and introduced by the Russian school led by Dokuchaev. Joffe (3) reported that Dokuchaev, as a trained geologist, started out with the geologic point of view on soils, current in those days. As he came in contact with the vast stretches of Russian chernozem, his keen eye noted the specific characteristics and features (morphology) of the soils in a definite geographic region. Joffe (3) also states that a critical and scholarly analysis of the Dokuchaev School of Pedology has been made by Kossovich. He applied the methods of chemistry and physics in interpreting the genesis of soils and in characterizing

the morphological features of the various soil types. Glinka (1) summed up the reports of various investigators on the field methods in study of the profiles from pupils and followers of Dokuchaev and reported to the First International Congress of Soil Science. After this first meeting, there were several other meetings contributed to soil classification, but as the new results of researches in soil science came out many concepts have been changed, the classification schemes have been modified many times.

B. Analytical Aspects of Soil Classification

Piper (4) states that the choice of the analytical methods for any given determination depends upon several factors, particularly the purposes for which the analysis is required. The methods may be physical, chemical or biological. In the final choice, accuracy and reproductibility of the value obtained should be of first importance and the results should be directly comparable with results obtained in the laboratory. The methods selected should be such that with proper equipment and organization large numbers of analyses can be readily run.

Wright (7) states that in problems concerned with fertility, the static factors, such as exchangeable bases, the presence or absence of calcium carbonate and available phosphoric acid are of great value in indicating the cause of fertility. Many soil samples are submitted to routine examination with the objective of classifying soils into groups of similar mechanical and chemical composition and defining the characteristics of soil types. Samples are also

analyzed at intervals in order to find the changes which are taking place due to differential soil management treatment.

Willard (6) asserted that the number of chemical reactions, the type of apparatuses used and the various techniques utilized by the analytical chemists today make one who is broadly trained in this field valuable in solving problems quite outside of analytical chemistry.

C. The Present Scheme of Soil Classification in the Higher Categories.

This scheme is presented in Appendix A.

D. Nomenclature and Classification Schemes in the Seventh Approximation

According to Smith (5) a name is essential for each class in each category. This part is quoted from the new classification schemes set up by Soil Survey Staff of Soil Conservation Service, USDA, August, 1960. (See Appendix B).

CHAPTER III

MATERIALS AND METHODS

Soil samples used were collected from the following wide-spread areas of Oklahoma.

Town	County	Area
Heavener	LeFlore	Southeast
Woodward	Woodward	Northwest
Pauls Valley	Garvin	Southern
Perkins	Payne	Central

Soils used were selected because there is presently a need for their classification. Analytical Methods employed were selected from the common methods used by several soil survey laboratories.

Soil Classification schemes were based on the comprehensive system of soil classification on the Seventh Approximation set up by the Soil Survey Staff of the Soil Conservation Service, USDA, August, 1960.

LABORATORY PROCEDURES

1. Mechanical Analysis (Bouyoucos Method)

Weigh out 50 grams of air dried soils into a beaker. Cover soil with water and allow to soak for at least 20 minutes.

For clay soils, the soaking period should be longer. Overnight soaking for such soil is desirable.

Transfer the soil suspension from the beaker to a dispersing cup. (This transfer should be quantitative and a wash bottle should be used to free the soil which adheres to the beaker).

Fill the dispersing cup to within 2 inches of the top with distilled water.

Add 10 ml. of 1 N NaOH to the dispersing cup. (NaOH is dispersing agent). Add 10 ml. of a saturated solution of Sodium Oxalate to the dispersing cup. (Na Oxalate is precipitating agent).

Mechanically disturb soil for seven minutes. (For heavy clay soils, the dispersing time should be extended to 20-30 minutes).

Transfer the suspension to graduate cylinder and add water to 1000 ml. mark. Shake the cylinder vigorously using a rubber stopper or palm of the hand over the top of cylinder. Invert the cylinder several times.

Place cylinder on table and begin timing immediately. Insert a hydrometer and take a reading at the end of 40 seconds. Record hydrometer and temperature reading.

Make a second set of readings (Hydrometer and temperature) at the end of two hours.

In case there is considerable foam on the top of the suspension; add 1-2 drops of Iso Amyl Alcohol.

Record data and calculate % sand, % silt and % clay from the data as follows:

For every degree Centigrade above or below 18 degrees Centigrade, a correction of 0.25 should be made in hydrometer reading. Correction is plus for reading above 18 degrees and minus for reading below 18 degrees. Multiply the 40 second hydrometer reading by

2, add the temperature correction and subtract from 100. This is the percentage of sand in the sample. Multiply two hours hydrometer reading by two and add the temperature correction. This is the percentage of clay. The rest of the sample is silt.

With these data, soil class is determined from the triangular chart which is the guide for textural classification used by USDA.

2. Soil Color

The color of the soil is determined by comparing the soil samples with the Munsell Color Chart. The color usually is determined both on air dried soil and on moist soil. The moist soil was made by dampening a small amount of air-dried soil with a few drops of distilled water. Usually moist soil is slightly darker than air-dried soil.

3. Organic Matter

Weigh 0.5 gram of soil into 200 ml. beaker. Add 10 ml. of .4N $K_2Cr_2O_7$. Add 15 ml. Conc. H_2SO_4. Heat to 165°C (not over) by shaking or whirling motion. It is wise to pour H_2SO_4 in each sample at the time to heat. Work out one at a time instead of pouring H_2SO_4 in the samples before heating, because we gain 132°C when we pour H_2SO_4 in soil samples. If we let it cool it takes longer time to heat up to 165°C again.

Allow to cool and add 100 ml. H_2O. Add four drops of Orthophenanthroline indicator. Titrate with ferrous ammonium sulfate (FAS) to reddish tinge.

%O M = (Blank - ml. FAS) (N. FAS) (1.25) = % O M

$$N \text{ FAS} = \frac{\text{Nx ml. } K_2Cr_2O_7}{\text{ml. FAS in blank}}$$

Reagents:

1. Chromic Acid - Dissolve 9.807 grams of potassium dichromate in a small amount of water and make up to 1 liter with concentrated sulfuric acid.

2. Ferrous Ammonium Sulfate - Dissolve 78.44 grams of ferrous ammonium sulfate in distilled water containing 20 ml. of concentrated sulfuric acid and make up to 1 liter.

3. Ortho-Phenanthroline Ferrous Sulphate. Disolve 1.48 grams of Ortho Phenanthroline in 100 millilters of .025 Normal Ferrous Sulphate.

4. pH

Place 25 grams of soil in 30 ml. beaker - moisten with distilled water to a thin paste. Add water cautiously without stirring the soil until water just wets the entire soil mass. At this point add dropwise until the surface glistens slightly. Allow to stand briefly and stir with a glass rod. Add drops of water until a "thin paste" is formed that barely flows to close a hole left by the stirring rod. Make a pH reading after about 10 minutes.

A pH of 7 indicates neutrality, a pH less than 7 indicates acidity, and a pH over 7 indicates basic or alkaline.

Ranges of pH

pH below 5.6; strongly acid

pH 5.6 - 6.0; moderately acid

pH 6.1 - 6.5; slightly acid

pH 6.6 - 7.3; neutral

pH 7.4 - 7.8; slightly alkaline

pH 7.9 and above, moderately to highly alkaline.

5. Nitrogen

Weigh 5 grams of soil which has been passed through a 100 mesh sieve. Wrap with filter paper; put in Kjeldahl digestion flask; add 20 grams of Na_2SO_4; 3 granules of selenium and 25 ml. Conc. H_2SO_4. Digest in Kjeldahl digestion apparatus. Use low temperatures for first 10 to 30 minutes until frothing stops, and then gradually increase temperature until sample is completely charred. Digestion should take 1 to 2 hours. Run a blank determination.

Let cool, add 250 ml. H_2O. Add 75 ml. of Conc. NaOH to the digestion flask, and distill on the distillation rack.

Use 500 ml. receiving flask; add 25 ml. standard acid. Distill until the distilate volume is about 300 mi. Titrate with standard NaOH.

Calculate:

$$\text{Percent Nitrogen} = \frac{(\text{Blank} - \text{ml. NaOH}) \times \text{N. NaOH} \times .014}{\text{wt. of sample}}$$

6. Cation Exchange Capacity

Weigh out 5 grams of soil and place in a 100 ml. beaker. Add 50 ml. of normal ammonium acetate and place on a hot plate for 1 hour at 70°C. Use cover glass on beaker. Filter through a Buchner funnel (5.5 cm.) with suction. Close off the suction. Place 50 ml. (accurate) of 1 normal ammonium acetate in a beaker and in approximately 10 ml.

aliquots leach the soil in the Buchner funnel without any additional suction other than that in the flask. Remove the funnel and pour the leachate into a flask. Stopper and label. Use this 100 ml. for Mg, Ca, K, and Na determinations.

Replace the funnel and soil to the suction flask. Turn on suction briefly and moisten with a little methanol. Turn off suction. Continue leaching with 5 ml. aliquot of methanol until 10 aliquots have been used. Add a 5 ml. aliquot of methanol and test this filtrate with Nestler reagent for the presence of ammonia. When free from ammonia place the filter paper and soil in a Kjeldahl flask. Add 400 ml. of tap water and approximately 5 grams of MgO. Place on distillation rack and collect the distillate in standard acid (usually 25 ml. of tenth normal is sufficient acid). Back titrate with standard alkali solution.

Run a blank using filter paper, MgO and tap water.

Keep a 10 ml. pipette handy so as to be able to add more acid should any of the samples require it.

Calculate from formula:--

Cation Exchange Capacity (CEC) in milliequivalents (M.E.) per 100 grams = (Blank-Vol. NaOH titrate) x N. NaOH x $\frac{100}{5}$ x 1

Exchangeable bases. Exchangeable bases were determined on the ammonium acetate leachates using the Beckman Model DU-Flame Spectrophotometer with a photomultiplier attachment.

CHAPTER IV

RESULTS AND DISCUSSION

The profile description and the analytical data for each of the several profiles are given in the following pages by individual soil series. The description for each of the several soil series was made from the specific profile as taken from the field. These profiles may vary from the modal profile for the established series, however the variations are thought to fall within the range of the characteristics for the modal profile of the particular series.

AXTELL SERIES

Location: Love County, Oklahoma. Non-cultivated, under scrub oak, forest of Post Oak and Blackjack.

Slope: 0-1%.

Remarks: This soil is described as a forested planosol in the official series description. Profile was described from the sample sacks.

FIELD DESCRIPTION

A_1 0-6" Dark brown (7.5YR 3/2 moist) silt loam, brown (7.5YR 5/2) dry; porous massive; slightly hard dry, very friable moist; pH 4.65 (Hellige); clear boundary.

A_2 6-9" Brown (7.5YR 4/2 moist) loam or coarse silt loam, pinkish gray (7.5YR 6/2) dry; porous massive; slightly hard dry, very friable moist; pH 4.5; abrupt boundary.

B_{21} 9-22" Dark reddish brown (5YR 3/4 moist) silty clay, reddish brown (tYR 4/3) dry; weak medium irregular blocky; very hard dry, firm moist; pH 7.5; gradual boundary.

B_{22} 22-34" Dark reddish brown (5YR 3/3 moist) silty clay, reddish brown (5YR 4/3) dry, with a few distinct, fine and medium grayish brown and yellowish brown mottles; weak medium irregular blocky; very hard dry, very firm moist; pH 7.5; weakly calcareous with a few small $CaCO_3$ concentrations in the lower part.

TABLE Ia

PHYSICAL PROPERTIES OF AXTELL SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
48	0-6	32.50	56.25	11.25	SiL	7.5YR 5/2	7.5YR 3/2
49	6-9	34.13	52.62	13.25	SiL	7.5YR 6/2	7.5YR 4/2
50	9-22	23.75	30.88	45.37	C	5YR 4/3	5YR 3/4
51	22-34	16.00	36.63	47.37	C	5YR 4/3	5YR 3/3

TABLE Ib

CHEMICAL PROPERTIES OF AXTELL SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 grams				Base Saturation %
							Ca	Mg	K	Na	
48	0-6	4.65	1.94	.0862	13.12	7.81	2.3	2.6	.17	.08	65.9
49	6-9	4.50	.99	.0673	8.53	8.74	1.7	4.5	.10	1.3	86.9
50	9-22	7.40	.74	.0474	9.05	24.59	18.0	16.8	.87	6.9	173
51	22-34	7.55	.28	.0464	3.50	26.13	22.0	16.5	.87	7.5	179

BETHANY SERIES

Location: NE/NE/NE Section 23, TWP. 18N R.1W. Payne County, Oklahoma.

Slope: 0-1%.

Remarks: This profile is distinctly mottled. The official series description does not mention mottling. This profile is on the light textured end of the Bethany Series.

FIELD DESCTIPTION

A_1	0-12"	Very dark grayish brown (10YR 3/2 moist), coarse silt loam, grayish brown (10YR 5/2) dry; moderate medium granular; friable moist; pH 5.4; clear boundary.
B_1	12-23"	Dark brown (10YR 3/3 moist) light clay loam, brown (10YR 4/3) dry; compound, weak medium subangular blocky and moderate medium granular; friable moist, hard dry; pH 5.7; clear boundary.
B_{21}	23-34"	Dark brown (10YR 4/3 moist) clay loam, brown (10YR 5/3) dry, few fine distinct, yellowish red and light brownish gray mottles; few small black concretions; weak medium subangular blocky; firm, very hard; pH 5.9; gradual boundary.
B_{22}	34-42"	Same as above but moderate medium subangular blocky, mottles common, pH 5.9; gradual boundary.
B_3	42-48"	Dark brown (10YR 4/3 moist), light clay loam, pale brown (10YR 6/3) dry; common medium and fine, distinct, light gray, yellowish red and brownish yellow mottles, weak medium subangular blocky; firm, very hard; pH 6.2; gradual boundary.
C	48-55"	Brown (10YR 5/3 moist) light sandy clay loam, pale brown (10YR 6/3) dry; mottles as above; friable, hard; massive; pH 5.75.

TABLE IIa

PHYSICAL PROPERTIES OF BETHANY SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
6	0-12	33.80	46.12	20.00	L	10YR 5/2	10YR 3/2
5	12-23	25.75	47.25	27.00	L	10YR 5/3	10YR 3/3
4	23-34	38.63	29.62	31.75	CL	10YR 5/3	10YR 4/3
3	34-42	41.75	24.88	33.37	CL	10YR 5/3	10YR 4/3
2	42-48+	39.75	30.88	29.37	CL	10YR 6/3	10YR 4/3
1	48-55+	66.50	15.50	18.00	SL	10YR 6/3	10YR 5/3

TABLE IIb

CHEMICAL PROPERTIES OF BETHANY SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 grams				Base Saturation %
							Ca.	Mg.	K	Na.	
6	0-12	5.40	1.62	.0932	10.08	9.28	5.6	4.8	.66	.25	121
5	12-23	5.75	1.56	.0884	10.23	13.62	7.5	5.8	.61	.12	103
4	23-34	5.95	.85	.0654	7.53	19.45	10.5	9.5	.61	.12	106
3	34-42	5.95	.59	.0372	9.19	15.79	8.3	8.8	.46	.15	112
2	42-48	6.20	.38	.0353	6.24	14.17	8.2	7.8	.25	.25	117
1	48-55+	5.75	.38	.0396	5.56	13.83	8.3	7.8	.40	.18	120

Profile No. 3

CANADIAN SERIES

Location: Southern Great Plain Field Station. Woodward, Oklahoma.

Slope: 0-1%.

Remarks:

FIELD DESCRIPTION

Modal Profile - Non-cultivated.

A_{1-1} 0-10" Very dark brown (10YR 2/3) fine sandy loam, dark brown (10YR 3/3) dry; weak fine and medium granular structure; very friable moist; pH 7.3; non-calcareous; clear boundary, 8 to 17 inches thick.

A_{1-2} 10-10" Dark brown (10YR 3/3) fine sandy loam, brown (10YR 4/3) dry; very weak fine granular, almost single grain structure; very friable moist; pH 7.6; non-calcareous; gradual boundary, 4 to 13 inches thick.

C_1 19-35" Brown (10YR 4/3) light fine sandy loam, brown (10YR 5/3) dry; single grain structure; very friable to loose; pH 7.6; calcareous; gradual boundary, 10-20 inches thick.

C_2 35-60+" Yellowish brown (10YR 5/4), loamy fine sand, light yellowish brown (10YR 6/4) dry; common, fine and medium, faint gray, pale brown and grayish brown mottles in lower 8 inches; single grain structure; loose to very friable; pH 8.3; calcareous.

TABLE IIIa

PHYSICAL PROPERTIES OF CANADIAN SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
W3	0-10	75.75	18.78	5.37	Heavy LS	10YR 3/3	10YR 2/3
W10	10-19	80.00	10.25	7.75	LS	10YR 4/3	10YR 3/3
W6	19-35	68.00	25.25	6.75	SL	10YR 5/3	10YR 4/3
W17	35-60	89.00	4.00	7.00	LS	10YR 6/4	10YR 5/4

TABLE IIIb

CHEMICAL PROPERTIES OF CANADIAN SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca.	Mg.	K	Na.	
W3	0-10	7.35	2.05	.0923	12.88	6.70	6.2	3.3	.76	.25	156
W10	10-19	7.60	1.07	.0515	12.05	6.70	6.2	3.1	.41	.21	146
W6	19-35	7.55	0.77	.0468	9.54	4.40	19.8	4.3	2.05	.03	596
W17	35-60	8.30	0.53	.0142	2.16	1.62	36.0	5.3	2.04	.24	269

Profile No. 4

ENDERS SERIES

Location: Southeast Oklahoma Pasture Fertility Station, Coalgate, Oklahoma. SE¼ and S/60A NE ¼ Section 3, NW ¼ SW ¼ and S ½ SW ¼ NW ¼ Section 2; T IN: R 11 E.

Slope: 3-5%

Remarks:

FIELD DESCRIPTION

A_p	0-3"	Brown (7.5 YR 4/4; 7.5YR 3/4, moist) loam, weak medium granular structure; slightly hard when dry; pH 5.8; clear boundary.
B_1	3-10"	Yellowish red (5YR 5/8; 5YR 4/6, moist) clay loam, moderate medium granular; slightly hard when dry; pH 5.0; clear boundary.
B_{21}	10-23"	Reddish yellow (6YR 6/8; 6YR 6/8, moist) clay loam, weak medium subangular blocky to massive structure; very hard when dry; pH 5.0; gradual boundary.
B_{22}	23-30"	Reddish yellow (6YR 6/8; 6YR 5/8, moist) clay loam, very medium subangular blocky to massive structure; very hard when dry; pH 5.0; gradual boundary.
B_3	30-37+"	Reddish yellow (7.5 6/8; 7.5 YR 5/8, moist) clay loam, weak massive; hard dry; pH 4.7; containing streaks of white sandstone or shale.

TABLE IVa

PHYSICAL PROPERTIES OF ENDERS SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
30	0-7	35.75	50.75	13.50	SiL	10YR 6/3	10YR 3/3
29	7-13	33.75	43.75	22.50	L	10YR 6/4	10YR 5/8
28	13-23	28.00	44.50	27.50	CL	10YR 6/6	10YR 5/8
24	23-31	15.75	46.75	33.50	SiCL	11YR 6/6	11YR 5/4
26	31-38	28.00	36.50	35.50	CL	Mottled Pale Yel loam.	Red, Gray low Clay

TABLE IVb

CHEMICAL PROPERTIES OF ENDERS SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
30	0-7	6.8	1.24	.1571	4.57	7.76	5.6	3.1	.56	.08	120
29	7-13	5.1	0.67	.0488	7.96	6.72	2.8	3.1	.35	.08	94
28	13-23	5.1	0.67	.0522	7.03	8.14	2.3	3.3	.25	.08	72
24	23-31	5.0	0.31	.0411	4.37	9.56	1.5	3.3	.20	.26	55
26	31-38	4.8	0.31	.0582	3.08	13.23	1.4	2.8	.25	.21	35

ENTERPRISE SERIES

Location: Southern Great Plains Field Station; Woodward, Oklahoma

Slope: 8-12%.

FIELD DESCRIPTION

Modal Profile - Non-cultivated.

A_{1-1}	0-10"	Dark brown (10YR 3/3) fine sandy loam; brown (10YR 5/3) dry; weak fine and medium granular structure; very friable most; pH 7.5 (Hellige); non-calcareous; gradual boundary.
A_{1-2}	10-20"	Same as above, but calareous; clear boundary.
C	20-60"	Brown (7.5YR 4/4) fine sandy loam; brown (7.5 YR 5/4) dry; weak fine and medium granular structure; very friable moist; calcareous; roots abundant; clear boundary.

TABLE Va

PHYSICAL PROPERTIES OF ENTERPRISE SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
W16	0-10	72.50	22.75	4.75	SL	10YR 5/3	10YR 3/3
W24	10-20	74.25	20.75	5.00	SL	10YR 5/3	10YR 3/3
W20	20-60	85.00	8.50	6.50	LS	7.5YR 4/4	7.5YR 5/4

TABLE Vb

CHEMICAL PROPERTIES OF ENTERPRISE SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
W16	0-10	7.65	1.76	.0524	19.48	6.43	6.6	2.5	1.02	.15	159
W24	10-20	8.00	1.85	.1051	10.20	7.00	20.0	3.3	.41	.15	340
W20	20-60	8.20	1.27	.0596	12.35	5.35	35.4	6.2	.51	.06	788

LINCOLN SERIES

Location: Southern Great Plains Field Station; Woodward, Oklahoma.

Slope: 0-1%.

Remarks:

FIELD DESCRIPTION

Modal Profile - Non-cultivated.

A_1	0-10"	Brown (10YR 4/3) fine sand; brown (10YR 5/3) dry; single grain structure; loam; pH 7.4 (Hellige); clear boundary.
C_1	10-24"	Light yellowish brown (10YR 6/4) fine sand; very pale brown (10YR 7/4) dry; single grain structure; loose; pH 8.3; gradual boundary.
C_2	24-60"	Same color as above; fine sand medium sand; stratified below 40 inches with thin lenses of very dark gray (10YR 3/1) moist; sandy clay loam; sandy loam and coarse sand (averaging loam); single grain above 40 inches; porous massive in lenses; loose to friable depending on texture; calcareous.

TABLE VIa

PHYSICAL PROPERTIES OF LINCOLN SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Clay %	Clay %		Dry	Moist
W22	0-10	85.88	9.12	5.00	S	10YR 5/3	10YR 4/3
W21	10-60	81.25	11.88	6.87	LS	10YR 6/4	10YR 7/4

TABLE VIb

CHEMICAL PROPERTIES OF LINCOLN SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 grams				Base Saturation %
							Ca	Mg	K	Na	
W22	0-10	7.40	1.18	.0339	20.18	3.11	3.3	2.1	.20	.03	181
W21	10-16	8.35	0.31	.0189	9.51	1.49	7.1	2.5	.10	.03	653

Profile No. 1

MINCO SERIES

Location: 0.9 miles west of Thackerville; Love County, Oklahoma, North side of road; cultivated field, cotton.

Slope: 0.1%.

Remarks: Field has been limed; probably fertilized. This profile is surrounded by Daugherty Loamy Fine Sand.

FIELD DESCRIPTION

A_1P 0-7" Dark brown (10YR 3/3 moist) heavy loamy fine sand; brown (10YR 5/3) dry; weak medium and fine granular; soft dry; very friable moist; pH 7.5 (Hellige); clear boundary.

AC 7-12" Dark brown (7.5YR 3/4 moist) heavy loamy fine sand, brown (7.5YR 5/4) dry; moderate medium granular; slightly hard; very friable; pH 7.2; gradual boundary.

C_1 12-36" Yellowish red (5YR 4/6 moist) light fine sandy loam, reddish yellow (5YR 6/6) dry; very weak granular; hard, friable; pH 6.0; gradual boundary.

C_2 36-54" Strong brown (7.5YR 4/6 moist) light sandy loam, reddish yellow (7.5 YR 6/6) dry; porous massive; hard dry, friable, pH 6.0.

TABLE VIIa

PHYSICAL PROPERTIES OF MINCO SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
36	0-7	79.75	18.88	1.37	Heavy LS	10YR 5/3	10YR 3/3
37	7-12	82.38	14.62	3.00	LS	7.5YR 5/4	7.5YR 3/4
38	12-36	77.38	15.87	6.75	Light SL	5YR 6/6	5YR 4/6
39	36-54	83.50	10.75	5.75	Heavy LS	7.5YR 6/6	7.5YR 4/6

TABLE VIIb

CHEMICAL PROPERTIES OF MINCO SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
36	0-7	7.50	.73	.0322	13.14	3.25	1.9	0.8	1.0	.02	115
37	7-12	7.20	.31	.0303	5.93	3.05	1.3	1.0	1.1	.04	115
38	12-36	6.00	.10	.0199	2.91	4.20	0.95	1.2	0.51	.06	64.7
39	36-54	6.00	.18	.0218	4.78	4.17	0.11	1.0	1.2	.13	58.5

NORGE SERIES

Location: 75 yards SW of old pump house near center of Section 36, on Perkins Research Station, Perkins, Oklahoma.

Slope: 1.5%.

Remarks: Although this unit was correlated Norge, it was sampled and described as Teller by Roy M. Smith, on the basis of the clay content of the B_2 horizon.

FIELD DESCRIPTION

A_1	0-9"	Dark brown (10YR 3/3 moist) fine sandy loam, brown (10YR 5/3) dry; weak fine and medium granular; friable moist; pH 5.8 (Hellige); clear boundary.
B_1	9-16"	Reddish brown (5YR 4/4 moist) heavy fine sandy loam, reddish brown (5YR 5/4) dry; very weakly granular or porous massive; friable moist; pH 5.5; gradual boundary.
B_{21}	16-24"	Dark reddish brown (5YR 3/4 moist) light sandy clay loam, reddish brown (5YR 4/4) dry; weak medium subangular blocky; friable moist; pH 5.3; gradual boundary.
B_{22}	24-46"	Brown (7.5YR 4/4 moist) clay loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky; firm moist; pH 5.8; gradual boundary.
C	46-54"	Strong brown (7.5YR 4/6 moist) heavy sandy loam, strong brown (7.5YR 5/6) dry; porous massive; friable; pH 5.8.

TABLE VIIIa

PHYSICAL PROPERTIES OF NORGE SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
52	0-9	65.50	21.88	12.62	SL	10YR 5/3	10YR 3/3
53	0-16	70.50	17.75	11.75	SL	5YR 5/4	5YR 4/4
54	16-24	68.38	16.62	15.00	SL	5YR 4/4	5YR 3/4
55	24-46	62.63	19.50	17.87	SL	7.5YR 5/4	7.5YR 4/4
56	46-54+	78.75	9.50	11.75	SL	7.5YR 5/6	7.5YR 4/6

TABLE VIIIb

CHEMICAL PROPERTIES OF NORGE SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
52	0-9	5.80	1.30	.0635	11.87	8.30	3.8	1.6	.41	.13	71.5
53	9-16	5.50	0.70	.0341	11.90	10.30	4.0	2.8	.20	.17	69.6
54	16-24	5.30	0.50	.0454	6.38	11.65	2.8	3.6	.25	.17	58.5
55	24-46	5.80	0.52	.0512	5.89	11.07	4.5	5.0	.35	.26	91.3
56	46-54+	5.80	0.23	.0227	5.87	11.60	4.0	5.1	.20	.13	81.2

OKEMAH SERIES

Location: Okfuskee County, East Central, Oklahoma.

Slope: 1-3%.

Remarks:

FIELD DESCRIPTION

A_1	0-17"	Very dark grayish brown (10YR 3/2 moist) silt loam, dark grayish brown (10YR 4/2) dry; granular; slightly hard; very friable; gradual boundary.
A_3	17-23"	Dark brown (10YR 4/3 moist) heavy silt loam, pale brown (10YR 6/3) dry; granular; slightly hard, very friable, clear boundary.
B_{21}	23-28"	Olive brown (2.5YR 4/4 moist) light clay; light olive brown (2.5YR 5/4) dry; common, fine and medium; distinct yellowish red, gray and strong brown mottles; weak medium subangular blocky; very hard dry; firm moist; clear boundary.
B_{22}	28-32"	Color same as above; clay; few fine, distinct, strong brown, pale brown mottles; few small black concretions; moderate medium and coarse blocky; extremely hard dry; firm; very sticky; gradual boundary.
B_{23}	32-42"	Same as above.

TABLE IXa

PHYSICAL PROPERTIES OF OKEMAH SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
16	0-14	56.38	30.75	12.87	SL	10YR 4/2	10YR 3/2
19	14-23	50.75	29.75	19.50	L	10YR 6/3	10YR 4/3
18	23-28	35.00	24.38	40.62	C	2.5YR 5/4	2.5YR 4/4
17	28-32	36.88	17.62	45.50	C	2.5YR 5/4	2.5YR 4/4
20	32-42	34.00	22.50	43.50	C	2.5YR 5/4	2.5YR 4/4

TABLE IXb

CHEMICAL PROPERTIES OF OKEMAH SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
16	0-14	5.90	1.72	.0975	10.25	17.27	3.1	3.3	.20	.10	38.8
19	14-23	5.20	1.04	.1029	5.86	43.42	5.8	16.1	.51	3.4	58.2
18	23-28	5.30	1.39	.0991	8.14	46.48	5.5	12.1	.46	2.6	44.4
17	28-32	6.75	0.71	.0421	9.83	49.29	3.9	10.0	.25	.70	30.1
20	32-42	7.10	0.52	.0459	6.68	51.82	5.9	16.6	.51	4.0	52.1

OTERO SERIES

Location: 400'E. and 325'S. of NW'4 corner, Sec. 35; Southern Great Plains Field Station, Woodward, Oklahoma.

Slope: 4%.

Remarks: This soil appears to have been reworked by wind and/or water.

FIELD DESCRIPTION

A_1	0-14"	Dark yellowish brown (10YR 3/4 moist) loamy fine sand, brown (10YR 5/3) dry; very weakly granular; very friable, soft; alkaline but non-calcareous; gradual boundary.
AC	14-29"	Brown (7-5YR 4/3 moist), light loamy sand, light brown (7+5YR 6/4) dry; very weak granular, almost structureless; very friable, soft; calcareous; clear boundary.
C_1	29-52"	Brown (7-5YR 5/4 moist) sand, light brown dry; a few chips of reddish yellow and red; single grain structure; loose; calcareous; gradual boundary.
C_2	52-65"	Same color as above; medium sand; with many small gravel, coarse sand and a few loamy permian chips; structureless; loose; strongly calcareous with many line concretions.

TABLE Xa

PHYSICAL PROPERTIES OF OTERO SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
W2	0-14	90.50	6.63	2.87	S	10YR 5/3	10YR 3/4
W5	14-29	89.63	7.62	2.75	S	7.5YR 6/4	7.5YR 4/3
W8	29-52	94.50	5.50	----	S	7.5YR 6/4	7.5YR 5/4
W4	52-65	94.50	5.50	----	S	7.5YR 6/4	7.5YR 5/4

TABLE Xb

CHEMICAL PROPERTIES OF OTERO SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
W2	0-14	7.30	0.85	.0335	14.71	9.00	5.8	2.5	.25	.03	96.3
W5	14-29	8.25	0.64	.0221	16.79	2.91	16.0	6.2	.25	.03	772
W8	29-52	8.30	0.37	.0151	14.21	6.20	34.0	5.2	.41	.06	279
W4	52-65	8.45	0.41	.0165	14.41	2.09	34.0	5.2	.20	.06	273

REINACH SERIES #1

Location: 1150'N and 325'W of SE corner, Section 35; Southern Great Plains Field Station, Woodward, Oklahoma.

Slope: 0-1%.

Remarks: See Reinach #2.

FIELD DESCRIPTION

A_1	0-12"A_1	Dark brown (10YR 3/3 moist), fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium granular; friable moist, slightly hard dry; pH 6.8 (Hellige); non-calcareous; gradual boundary.
A_c	12-32"	Dark brown (7.5YR 3/2 moist) fine sandy loam, brown (7.5YR 4/2) dry; weak medium granular; friable moist, slightly hard dry; pH 6.8; gradual boundary.
C	32-54"	Yellowish red (5YR 4/6 moist) fine sandy loam, yellowish red (5YR 5/6) dry; weak medium and fine granular; very friable moist, slightly hard; pH 7.0; weakly calcareous in lower part; clear brown dry.
CD	54-64"	Yellowish red (5YR 5/6 moist) light loam, reddish yellow (5YR 6/6) dry; weakly massive; friable moist; calcareous with about 10% of segregated soft lime concretions; free water in fine capillaries. This horizon a mixture of alluvium and weathered Permian redbeds.

TABLE XIa

PHYSICAL PROPERTIES OF REINACH #1

Lab No.	Depth Inch	Particle Size Distribution Sand %	Silt %	Clay %	Textural Class	Color Dry	Color Moist
W18	0-12	56.50	32.50	11.00	SL	10YR 4/2	10YR 3/3
W14	12-32	72.25	21.25	6.50	SL	7.5YR 4/2	7.5YR 3/2
W28	32-54	65.75	21.50	12.75	SL	5YR 5/6	5YR 4/6
W19	54-64	71.20	12.93	15.87	SL	5YR 6/6	5YR 5/6

TABLE XIb

CHEMICAL PROPERTIES OF REINACH #1

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
W18	0-12	6.8	1.05	.0524	11.67	7.31	4.5	3.3	.46	.03	113
W14	12-32	6.8	0.99	.0598	9.60	8.33	6.4	4.5	.25	.03	134
W28	32-54	7.0	0.58	.0303	11.10	6.23	5.8	4.3	.30	.24	170
W19	54-64	7.5	0.42	.0094	2.75	3.72	31.6	9.0	4.40	.06	120

REINACH SERIES #2

Location: 840'N, 460'W of $E\frac{1}{4}$ corner, Section 35, Southern Great Plains Field Station, Woodward, Oklahoma.

Slope: 0-1%.

Remarks: This is Reinach fine sandy loam that is moderately deep over Permian redbeds; temporary high water table varies from 40 to 60 inches during the wet season.

FIELD DESCRIPTION

A_{11}	0-16"	Dark brown (7.5YR 3/2 moist) light loam, brown (7.5YR 4/2) dry; moderate medium granular; friable moist, slightly hard dry; pH 7.5 (Hellige); non-calcareous; gradual boundary.
A_{12}	16-24"	Same as above except very slightly lighter color (same color chip); weak medium and fine granular; gradual boundary.
C	24-44"	Dark reddish brown (5YR 3/4 moist) light loam, reddish brown (5YR 4/4) dry; very weakly granular; friable moist, slightly hard dry; pH 7.5, non-calcareous; free capillary water at 40"; clear boundary.
CD	44-60"	Yellowish red (5YR 4/6 moist) loam, yellowish red (5YR 6/6) dry; massive; friable moist, hard dry; strongly calcareous, with many fine and medium splotches and streaks of segregated lime; this is a mixture of the above alluvial materials and the Permian (loamy) redbeds.

TABLE XIIa

PHYSICAL PROPERTIES OF REINACH #2

Lab No.	Depth Inch	Particle Size Distribution Sand %	Silt %	Clay %	Textural Class	Color Dry	Color Moist
W27	0-16	55.50	29.75	14.75	SL	7.5YR 4/2	7.5YR 3/2
W13	16-24	53.25	32.25	14.50	SL	7.5YR 4/2	7.5YR 3/2
W23	24-44	53.50	32.13	14.37	SL	5YR 4/4	5YR 3/4
W25	44-60	45.00	37.63	17.37	SL	5YR 6/6	5YR 4/6

TABLE XIIb

CHEMICAL PROPERTIES OF REINACH SERIES #2

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
W27	0-16	7.55	1.20	.0492	14.14	6.36	6.9	4.5	.46	.18	189
W13	16-24	7.45	1.07	.0549	11.30	9.27	6.9	4.5	.61	.15	131
W23	24-44	7.45	0.73	.0489	8.69	9.48	7.1	4.8	.30	.15	130
W25	44-60	8.10	0.36	.0189	11.04	6.02	5.8	3.3	.61	.18	164

TELLER SERIES #1

Location: 200 yards NW of Turner School and 40 feet south of field gate entrance, Love County, Oklahoma. Old cultivated field.

Slope: 0-1%.

Remarks: This soil has recently been correlated Teller fine sandy loam. In this area some of the surface soils have been removed by wind.

FIELD DESCRIPTION

A_1P 0-6" Dark brown (7.5YR 3/4 moist) light fine sandy loam, brown (7.5YR 5/4) dry; weak medium and fine granular; very friable moist; pH 6.1 (Hellige); clear boundary.

B_1 6-9" Dark reddish brown (5YR 3/4 moist), loam, reddish brown (5YR 5/4) dry; weak coarse prismatic, crushes easily to medium and coarse granular; red faces have dark; somewhat shiny appearance; friable moist; pH 6.3; gradual boundary.

B_2 9-42" Dark yellowish red (5YR 3/6 moist) heavy loam, yellowish red (5YR 5/6) dry; compound, weak coarse prismatic and subangular blocky; friable moist; very hard dry; pH 6.3; gradual boundary.

C 42-54" Dark red (2.5YR 3/6 moist) heavy fine sandy loam, red (2.5YR 4/6) dry; porous massive; friable; pH 6.5.

TABLE XIIIa

PHYSICAL PROPERTIES OF TELLER SERIES #1

Lab No.	Depth Inch	Particle Size Distribution Sand %	Silt %	Clay %	Textural Class	Color Dry	Color Moist
44	0-6	64.00	34.63	1.37	SL	7.5YR 5/4	7.5YR 3/4
45	6-9	53.00	34.75	12.25	SL	5YR 5/4	5YR 3/4
46	9-42	52.87	28.88	18.25	L	5YR 5/6	5YR 3/6
47	42-54	69.63	14.00	16.37	SL	2.5YR 4/6	2.5YR 3/6

TABLE XIIIb

CHEMICAL PROPERTIES OF TELLER SERIES #1

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
44	0-6	6.15	0.54	.0350	8.94	5.52	3.7	1.3	.26	.08	96.7
45	6-9	6.30	0.52	.0521	5.78	7.79	5.5	3.1	.46	.08	117
46	9-42	6.30	0.62	.0407	8.83	8.46	6.2	3.3	.48	.17	119
47	42-54	6.50	0.30	.0308	5.64	7.51	4.7	3.3	.51	.08	114

TELLER SERIES #2

Location: 5.1 miles south of Rush Creek bridge south of Pauls Valley, Garvin County, Oklahoma. Tree nursery east side of road.

Slope: 0.5%.

Remarks: Historically this soil has been considered "good Teller" by some of the state's leading soil morphologists.

FIELD DESCRIPTION

A_1	0-10"	Very dark grayish brown (10YR 3/2 moist) coarse loam, grayish brown (10YR 5/2) dry; weak medium granular; very friable moist; slightly hard dry; pH 6.3 (Hellige); gradual boundary.
B_1	10-17"	Dark brown (10YR 3/3 moist) fine sandy loam, brown (10YR 5/3) dry; weak medium and coarse prismatic, friable moist, hard dry; pH 6.3; clear boundary.
B_2	17-36"	Dark reddish brown (6YR 3/4 moist) loam, brown (6YR 5/4) dry; weak coarse prismatic separating easily to weak subangular blocks; friable moist, hard dry; pH 6.0; clear boundary.
C	36-54"	Yellowish red (5YR 4/6 moist) fine sandy loam, yellowish red (5YR 5/6) dry; porous massive; friable; hard; pH 6.5.

TABLE XIVa

PHYSICAL PROPERTIES OF TELLER SERIES #2

Lab No.	Depth Inch	Particle Size Distribution Sand %	Silt %	Clay %	Textural Class	Color Dry	Color Moist
40	0-10	54.00	32.75	13.25	SL	10YR 5/2	10YR 3/2
41	10-17	61.50	25.13	13.37	SL	10YR 5/3	10YR 3/3
42	17-36	54.13	29.62	16.25	SL	6YR 5/4	6YR 3/4
43	36-54+	60.25	29.50	10.25	SL	5YR 5/6	5YR 4/6

TABLE XIVb

CHEMICAL PROPERTIES OF TELLER SERIES #2

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
40	0-10	6.30	1.81	.0995	10.55	8.27	4.3	2.5	.46	.08	88.7
41	10-17	6.30	0.64	.0834	4.45	8.27	4.7	2.5	.35	.04	91.7
42	17-36	6.00	0.78	.0464	9.25	8.21	4.2	2.6	.20	.08	86.2
43	36-54+	6.50	0.35	.274	7.40	6.76	3.1	2.8	.26	.08	92.3

TELLER SERIES #3

Location: 4.4 miles south of Rush Creek Bridge, south of Pauls Valley, Garvin County, Oklahoma. Cultivated field, now in bermuda and triple-awn grass.

Slope: 0-1%.

Remarks: Some coarse and grains and a few pea size gravel throughout the profile. Color fits Vanoss somewhat better than Teller.

FIELD DESCRIPTION

A_1	0-7"	Dark brown (10YR 3/3 moist) light sandy loam, brown (10YR 5/3) dry; weak medium granular; very friable; pH 6.3 (Hellige); clear boundary.
B_1	7-10"	Dark brown (7.5YR 3/4 moist) fine sandy loam, brown (7.5YR 5/4) dry; moderate medium granular; friable; pH 6.5; gradual boundary.
B_2	10-30"	Brown (7.5YR 4/4 moist) heavy fine sandy loam, light brown (7.5YR 6/4) dry; weak medium prismatic; friable moist; pH 6.3; gradual boundary.
B_3	30-42"	Brown (7.5YR 4/4 moist) fine sandy loam; brown (7.5YR 5.4) dry; weak medium granular; friable moist; pH 6.3; clear boundary.
C	42-54"	Yellowish red (5YR 4/6 moist) sandy loam; yellowish red (5YR 6/6) dry; porous massive; very friable moist; pH 6.1.

TABLE XVa

PHYSICAL PROPERTIES OF TELLER SERIES #3

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
31	0-7	72.37	18.38	9.25	SL	10YR 5/3	10YR 3/3
32	7-10	68.00	20.75	11.25	SL	7.5YR 5/4	7.5YR 3/4
33	10-30	65.87	20.88	13.25	SL	7.5YR 6/4	7.5YR 4/4
34	30-42	69.00	19.75	11.25	SL	75.YR 5/4	7.5YR 4/4
35	42+	76.25	13.50	10.25	SL	5YR 6/6	5YR 4/6

TABLE XVb

CHEMICAL PROPERTIES OF TELLER SERIES #3

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
31	0-7	6.30	0.80	.0464	10.00	4.66	2.8	2.1	.41	.08	115
32	7-10	6.50	0.44	.0638	4.00	6.30	4.5	2.1	.35	.08	111
33	10-30	6.30	0.65	.0557	6.00	7.83	5.5	2.5	.61	.26	113
34	30-42	6.30	0.49	.0365	7.78	6.34	3.3	3.3	.20	.08	108
35	42+	6.10	0.24	.0426	3.26	6.05	3.5	4.1	.25	.08	131

TIVOLI SERIES

Location: Southern Great Plains Field Station, Woodward, Oklahoma.

Slope: 5-15%.

Remarks:

FIELD EESCRIPTION

Modal Profile - Non-cultivated.

A_1	0-7"	Dark grayish brown (10YR 4/1.5) loamy fine sand; grayish brown (10YR 5/2) dry; single grain structure, loose; very slight acid; pH 6.5 (Hellige); clear boundary.
AC	7-30"	Brown (10YR 5/2) fine sand; brown (10YR 4/3) dry; single grain structure; loose moist; loose and slightly hard (clods) dry; pH 6.0; gradual boundary.
C	30-60"	Yellowish brown (10YR 5/4) fine sand; light yellowish brown (10YR 6/4) dry; single grain structure; loose; pH 6.0.

TABLE XVIa

PHYSICAL PROPERTIES OF TIVOLI SERIES

Lab No.	Depth Inch	Particle Size Distribution Sand %	Silt %	Clay %	Textural Class	Color Dry	Color Moist
W31	0-7	86.25	8.38	5.37	S	10YR 5/2	10YR 4/1.5
W30	7-30	97.50	2.50	----	S	10YR 4/3	10YR 5/3
W15	30-60	95.25	3.15	1.60	S	10YR 6/4	10YR 5/4

TABLE XVIb

CHEMICAL PROPERTIES OF TIVOLI SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
W31	0-7	6.50	2.11	.0881	13.89	6.09	4.4	2.8	2.5	.03	160
W30	7-30	6.50	0.49	.0161	17.65	5.05	3.5	2.8	.46	.24	138
W15	30-60	7.85	0.34	.0253	7.79	4.81	10.8	2.5	10	.03	279

VANOSS SERIES

Location: NE/NE/NE 26-18N-1W; Payne County, Oklahoma.

Slope: 0-1%.

FIELD DESCRIPTION

A_{11} 0-17" Dark brown (10YR 3/3 moist) light loam, brown (10YR 5/3) dry; weak medium and fine granular; friable, slightly hard; pH 6.0; gradual boundary.

A_{12} 17-24" Dark brown (10YR 3/3 moist) loam, brown (10YR 5/3) dry; moderate medium granular; friable, slightly hard; pH 6.2; clear boundary.

B_2 24-36" Dark yellowish brown (10YR 4/4 moist) light clay loam, yellowish brown (10YR 5/4) dry; weak medium and coarse subangular blocky; friable, hard; pH 7.0; gradual boundary.

B_3 36-44" Same color as above; light sandy clay loam; few fine reddish yellow and pale brown specks; weak medium subangular blocky; friable, hard; pH 7.4; gradual boundary.

C 44-54" Colors same as above; slightly more mottles; light sandy clay loam; porous massive; friable, hard; pH 7.7.

TABLE XVIIa

PHYSICAL PROPERTIES OF VANOSS SERIES

Lab No.	Depth Inch	Particle Size Distribution Sand %	Silt %	Clay %	Textural Class	Color Dry	Color Moist
15	0-17	75.75	17.63	6.62	SL	10YR 5/3	10YR 3/3
7	17-24	68.00	23.00	9.00	SL	10YR 5/3	10YR 3/3
13	24-36	60.50	18.63	20.87	SCL	10YR 5/4	10YR 4/4
14	36-44	70.88	13.12	16.00	SL	10YR 5/4	10YR 4/4
8	44-54	81.20	5.30	13.50	SL	10YR 5/4	10YR 4/4

TABLE XVIIb

CHEMICAL PROPERTIES OF VANOSS SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
15	0-17	6.00	1.152	.0909	7.34	8.35	3.5	1.9	.79	.10	75.3
7	17-24	6.20	1.104	.0701	9.13	10.10	3.7	2.9	.53	.10	71.5
13	24-36	7.00	0.813	.0485	9.72	9.40	4.2	3.9	.38	.10	91.2
14	36-44	7.40	0.496	.0315	9.13	10.91	4.9	5.1	.35	.10	95.7
8	44-54	7.75	0.357	.0523	3.95	8.97	4.2	4.8	.35	.10	105

VERNON SERIES

Location: NE/NE/NE Section 21, T.19N, R.1W; Payne County, Oklahoma. Wheat field.

Slope: 2.5%.

Remarks: Field contains appreciable amounts of Renfrow Series.

FIELD DESCRIPTION

A_1P	0-6"	Dark reddish brown (5YR 3/4 moist) clay loam, reddish brown (5YR 4/4) dry, moderate medium granular; friable moist, hard dry; weakly calcareous; clear boundary.
AC	6-16"	Dark red (2.5YR 3/6 moist) clay, reddish brown (2.5YR 4/4) dry; moderate medium and coarse granular; friable moist, very hard dry; strongly calcareous with a few fine $CaCO_3$ concretions; gradual boundary.
C	16-40"	Dark red (10YR 3/6 moist) clay, weak red (10YR 4/4) dry; weak medium and coarse subangular blocky; very hard dry, firm moist; strongly calcareous with 2% $CaCO_3$ concretions; many slickensides below 26 inches.

TABLE XVIIIa

PHYSICAL PROPERTIES OF VERNON SERIES

Lab No.	Depth Inch	Particle Size Distribution Sand %	Silt %	Clay %	Textural Class	Color Dry	Color Moist
12	0-6	36.38	31.87	31.75	CL	5YR 4/4	5YR 3/4
9	6-16	31.25	21.00	47.25	C	2.5YR 4/4	2.5YR 3/6
10	16-26	20.00	27.00	53.00	C	10YR 4/4	10YR 3/6
11	26-40	22.20	19.93	57.98	C	10YR 4/4	10YR 3/6

TABLE XVIIIb

CHEMICAL ANALYSIS OF VERNON SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 grams				Base Saturation %
							Ca	Mg	K	Na	
12	0-6	7.60	1.91	.1101	10.09	22.84	32.0	2.6	3.0	.24	165
9	6-16	7.70	1.04	.0673	9.05	18.10	40.0	4.0	6.6	.30	281
10	16-26	8.10	0.50	.0302	11.49	22.98	33.8	5.2	2.0	.26	179
11	26-40	8.10	0.15	.0209	4.16	21.76	34.0	6.5	4.0	.26	205

WAYNESBORO SERIES

Location: Southeast Oklahoma Pasture Fertility Station, Coalgate, Oklahoma.
SE¼ and S/60A NE¼ Sec. J; NW¼. SW¼ and S½ SW¼ NW¼ Sec. 2; T 1N; R 11 E.

Slope: 1-3%.

Remarks:

FIELD DESCRIPTION

AP	0-7"	Pale brown (10YR 6/3; 10YR 3/3, moist) silt loam, weak medium granular, slightly hard when dry, pH 6.8; clear boundary.
B_{2-1}	7-13"	Light yellowish brown (10YR 6/4; 10YR 5/8, moist), loam, moderate medium granular to weak medium blocky, slightly hard when dry; pH 5.1; gradual boundary.
B_{2-2}	13-23"	Brownish yellow (10YR 6/6; 10YR 5/8, moist) clay loam, weak medium blocky to massive; hard when dry; pH 5.1; gradual boundary.
B_3	23-31"	Brownish yellow (11YR 6/6, 11YR 5/6, moist) silty clay loam, weak medium blocky to massive structure; very hard when dry; pH 5.0; clear boundary.
C_1	31-38+"	Mottled red, gray and pale yellow clay loam, weak coarse blocky to massive structure; very hard when dry; pH 4.8.

TABLE XIXa

PHYSICAL PROPERTIES OF WAYNESBORO SERIES

Lab No.	Depth Inch	Particle Size Distribution			Textural Class	Color	
		Sand %	Silt %	Clay %		Dry	Moist
23	0-3	40.00	38.60	21.50	L	7.5YR 4/4	7.5YR 3/4
27	3-10	29.75	36.75	33.50	CL	5YR 5/8	5YR 4/6
25	10-23	26.50	36.25	37.25	CL	6YR 6/8	6YR 5/8
21	23-30	29.00	41.50	29.50	CL	6YR 6/8	6YR 5/8
22	30-37	30.25	41.25	28.50	CL	7.5YR 6/8	7.5YR 5/8

TABLE XIXb

CHEMICAL PROPERTIES OF WAYNESBORO SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca.	Mg.	K	Na	
23	0-3	5.80	1.65	.1784	5.33	10.28	4.5	4.8	.76	.08	98.6
27	3-10	5.00	0.73	.0543	7.79	10.53	4.5	4.5	.46	.08	90.5
25	10-23	5.00	0.29	.0465	3.61	10.00	5.5	4.1	.12	.04	97.6
21	23-30	5.00	0.25	.0312	4.64	7.83	5.0	3.1	.11	.10	107
22	30-37	4.70	0.05	.0284	1.02	6.65	5.0	2.5	.10	.24	117

YAHOLA SERIES

9x - Mixed alluvial land.

Location: 640' South and 60' West of the center of Section 36 Township 23N, Range 21W; Southern Great Plains Field Station, Woodward, Oklahoma.

Slope: 0-1%.

Remarks: This is Yahola FSL that is moderately deep over a weathered Permian (loamy) redbeds. Temporary high water tables just above Permian contact during wet seasons.

This unit comprises moderately well drained, sandy mixed alluvial soils moderately deep over weakly consolidated Permian redbeds. The soils have brown, sandy loam surface horizons; reddish, highly stratified substrate and generally contain free capillary water just above the Permian contact. This unit differs from Reinach, in being shallower over redbeds, less deeply leached by carbonates, slightly coarser textured and more highly stratified.

FIELD DESCRIPTION

Representative Profile - cultivated.

A_1 0-9" Dark brown (7.5YR 3/4) fine sandy loam, brown (7.5YR 5/4) dry; weak medium and fine granular structure; very friable moist; calcareous; clear boundary.

A_c 9-20" Reddish brown (5YR 3/4) sandy loam, reddish brown (5YR 5/4) dry; stratified with a 2-3 inch band of loamy fine sand; weak medium and fine granular; very friable moist; calcareous; few chips or granules of 5YR 6/6 dry gradual boundary.

C 20-36" Yellowish red (5YR 4/6) sandy loam stratified with loamy, fine sand and fine sandy loam (averaging light sandy loam), yellowish red (5YR 5/6) dry; very friable moist; free capillary water below 28 inches; strongly calcareous with 50%-70% of soft and hard segregated line concentrated within a 3-4 inch band; few gravels and coarse sands accumulated below the carbonate band; abrupt boundary.

D 36-50" Red (2.5YR 4/6) very fine sandy loam, red (2.5YR 5/6) dry; weakly massive; friable moist, very hard dry; calcareous. This horizon is the weathered (unconsolidated) upper part of the Permian redbed contact.

Range in Characteristics: Types include FSL, L and SL with SL predominating. The degree of stratification within horizons 2 and 3 may vary widely within a few feet. Horizon 3 is mottled in some areas.

TABLE XXa

PHYSICAL PROPERTIES OF YAHOLA SERIES

Lab No.	Depth Inch	Particle Size Distribution Sand %	Silt %	Clay %	Textural Class	Color Dry	Color Moist
W29	0-9	70.00	20.63	9.37	SL	7.5YR 5/4	7.5YR 3/4
W7	9-20	72.50	17.00	10.50	SL	5YR 5/4	5YR 3/4
W11	20-36	86.88	7.62	5.50	LS	5YR 5/6	5YR 4/6
W26	36-50	61.75	28.50	9.75	SL	2.5YR 5/6	2.5YR 4/6

TABLE XXb

CHEMICAL PROPERTIES OF YAHOLA SERIES

Lab No.	Depth Inch	pH	O.M. %	N %	C/N	C E C M.E./100 Grams	Extractable Cations M.E./100 Grams				Base Saturation %
							Ca	Mg	K	Na	
W29	0-9	8.05	1.31	.0695	10.93	5.82	14.2	2.5	2.1	.03	323
W7	9-20	7.95	1.08	.0540	11.60	4.98	18.5	2.5	1.0	.03	442
W11	20-36	8.10	0.63	.0164	22.28	5.07	22.2	6.2	.60	.06	573
W26	36-50	7.95	0.24	.0240	5.80	4.94	13.0	3.6	2.0	.25	381

TABLE XXI

SOIL CLASSIFICATION ACCORDING TO THE PRESENT USE AND THE SEVENTH APPROXIMATION

Classification According to Present Use				Classification According to the Seventh Approximation	
Soil Series	Order	Sub-Order	Great Soil Group	Name	Official Number
AXTELL	Intra-Zonal	Hydromorphic	Forested Planosol	Albaqualf	7.11
BETHANY	Zonal	Dark colored soils of subhumid grasslands	Reddish Prairie	Orthic Argustoll	5.63
CANADIAN	Azonal		Alluvial	Hapludent	1.43
ENDERS	Zonal	Light-colored Podzolized soils of the timbered regions	Red. Yellow Podzolic	Orthic Typochrult	8.230
ENTERPRISE	Azonal		Regosol	Entic Haplustoll	5.62-1
LINCOLN	Azonal		Alluvial	Orthic Orthopsamment	1.220
MINCO	Zonal	Dark-colored soils of sub-humid grasslands	Youthful Reddish Prairie	Orthic Hapludoll	5.220

TABLE XXI (Continued)

Classification According to Present Use				Classification According to the Seventh Approximation	
Soil Series	Order	Sub-Order	Great Soil Group	Name	Official Number
NORGE	Zonal	Dark-colored soils of subhumid grasslands	Reddish Prairie	Orthic Argudoll	5.530
OKEMAH	Zonal	Dark-colored soils of sub-humid grasslands	Reddish Prairie	Abollic Argudoll	5.53-5.2
OTERO	Intra-Zonal		Calcic-Regosol	Orthic Orthopsamment	1.220
REINACH #1	Azonal		Alluvial	Hapludent	1.43
REINACH #2	Azonal		Alluvial	Hapludent	1.43
TELLER #1	Zonal	Dark-colored soils of sub-humid grasslands	Youthful Reddish Prairie	Orthic Argudoll	5.530
TELLER #2	Zonal	Dark-colored soils of sub-humid grasslands	Youthful Reddish Prairie	Orthic Argudoll	5.530
TELLER #3	Zonal	Dark-colored soils of sub-humid grasslands	Youthful Reddish Prairie	Orthic Argudoll	5.530

TABLE XXI (Continued)

Classification According to Present Use				Classification According to the Seventh Approximation	
Soil Series	Order	Sub-Order	Great Soil Group	Name	Official Number
TIVOLI	Azonal		Regosol	Orthic Quarzopsamment	1.210
VANOSS	Zonal	Dark-colored soils of sub-humid grasslands	Reddish Prairie	Orthic Argudoll	5.530
VERNON	Azonal		Lithosol	Vertic Hapludent	1.43-2
WAYNESBORO	Zonal	Dark-colored soils of sub-humid grasslands	Red Yellow Podzolic	Orthic Typochrult	8.230
YAHOLA	Azonal		Alluvial	Orthic Hapludent	1.430

SUGGESTED CLASSIFICATION OF THE SEVERAL SERIES

Axtell Series

Axtell series comprises forested planosols that occupy slowly drained areas within the zone of Red and Yellow Podzolic soils. The profile studied has a silt loam surface over a clay subsoil. This varies from the modal profile which is fine sandy loam in the surface. According to the 7th Approximation this soil would be classified as Albaqualf (7.11) due to claypan content. It has no natric horizon and there is an abrupt textural change from an albic horizon to an argillic horizon.

Bethany Series

The Bethany series occurs as a Reddish prairie soil in central Oklahoma. The profile studied has a pH ranging from 5.4 in the surface to 5.7 in the subsoil. In texture it is a loam over clay loam. It is proposed to classify this series as Orthic Argustoll (5.630). The clay content does not increase more than 20 percent within a vertical distance of 3 inches.

Canadian Series

Canadian series comprises youthful brown or dark brown soils. The profile studied has a pH of 7.35 in the surface and 8.3 in the subsoil.

Textures range from heavy loamy sand to sandy loam. These soils are super saturated with bases. It is proposed to classify this soil as Hapludent (1.43); texture is as fine or finer than loamy fine sand.

Enders Series

The Enders series includes Red-Yellow Podzolic soils derived from acid shales or sandy shales and thin-beded sandstones. The profile studied has a pH of 6.8 in the surface and a pH of 4.8 in the subsoil. The texture is silt loam over a clay loam. It is proposed to classify this soil as Orthic Typochrult (8.230) due to the low base exchange capacity and the mottling of the subsoil.

Enterprise Series

The Enterprise series occurs as reddish, alkaline, youthful soils. The profile studied has a pH ranging from 7.6 in the surface to 8.2 in the subsoil. The organic matter content is high throughout the profile. It is proposed to classify this series as Entic Haplustoll (5.62-1) because it has no combic horizon and no mottles with chromas of 2 or less within 1 meter of the surface.

Lincoln Series

The Lincoln Series occurs as pale brown to yellowish brown and brown calcareous alluvial soils. The profile studied has a sandy texture, ranging from fine sand in the surface to a loamy sand subsoil. It is calcareous through the profile and super saturated with basic

materials. It is proposed to classify this series as Orthic Orthopsamment (1.220) due to its coarse texture to the depth of 30 inches or more and the presence of calcium carbonate concretions and lack of mottles within 40 inches.

Minco Series

The Minco series consist of brown non calcareous youthful soils of the Reddish Prairies. The profile studied was thought to be a Teller, but due to low cation exchange capacity and lighter texture it is classified as the Minco series. This profile has a heavy loamy sand surface and sandy loam in the subsoil with pH of 7.5 in the surface and 6.0 in the subsoil. It is believed to be an Orthic Hapludoll (5.520) since the cambic horizon is free from calcium carbonate in some part and has no underlying seguum.

Norge Series

The Norge series occurs in freely drained Reddish Prairie soils developed in calcareous or alkaline old alluvium in central Oklahoma and Texas. The profile studied was taken from the Perkins Experimental Station. It has a sandy loam texture throughout the profile with a pH of 5.8 through the C horizon. It is believed to be an Orthic Argudoll (5.530) because of its having no increase of as much as 20 percent clay in a 3-inch vertical distance.

Okemah Series

The Okemah series are moderately well drained slightly acid soils, developed over olive and gray weakly consolidated shale and clay. The profile studied has a pH of 5.9 in the surface and 7.1 in the subsoil. It has a sandy loam surface and a dense clay subsoil. It is proposed to classify this series as an Albollic Argudoll (5.53 - 5.2) due to the increasing of clay content of 20 percent within a vertical distance of 3 inches.

Otero Series

The Otero series occurs as an Intra-zonal soil (Calcic-Regosol) developed on high dissected stream terraces. This profile appears to have been reworked by wind and/or water. It has a sandy texture and is calcareous throughout the profile. It is proposed to classify this series as an Orthic Orthopsamment (1.220) due to the coarse texture and highly saturated basic condition. Calcium carbonate is present and there is a lack of mottles.

Reinach Series #1

The Reinach series consist of reddish youthful soils, with silty or moderately sandy subsoils developed in calcareous reddish alluvium in Reddish Prairie zone. The profile studied is a fine sandy loam with a pH of 6.8 in the surface. It has a fine sandy loam, weakly calcareous subsoil with a pH of about 7.0. It is believed to be a Hapludent (1.43) because it is an alluvial soil with textures as fine or finer than loamy

very fine sand within the depth of 20 inches.

Reinach Series #2

This profile was taken about 300 feet north of Reinach Series #1. This is Reinach that is moderately deep to deep over Permian Redbeds. It has a temporarily high water table varying from 40 to 60 inches during the wet season. It is also believed to be a Hapludent (1.43).

Teller Series #1

The Teller series are youthful Reddish Prairie soils developed on stream terraces in southeastern Oklahoma. This profile has a pH of 6.15 with a sandy loam texture surface; the sandy loam subsoil has a pH of 6.5. It is believed to be an Orthic Argudoll (5.530) because of having more advanced stage of development than Albollic Hapludoll (5.52 - 5.21).

Teller Series #2

This profile was taken from Garvin County, Oklahoma. Historically this soil has been considered "good Teller" by some of the leading soil morphologists in the state. This profile has a pH of 6.3 in the surface and 7.4 in the subsoil. It is believed to be an Orthic Argudoll (5.530) due to having more advance stage of development than Albollic Hapludoll (5.52 - 5.21).

Teller Series #3

This profile was taken from Pauls Valley, Garvin County, Oklahoma. It has a pH of 6.3 in the surface, and a pH of 6.1 in subsoil. It is proposed to classify this series as Orthic Argudoll (5.530). It is in a more advanced stage of development than Albollic Hapludoll (5.52 - 5.21).

Tivoli Series

The Tivoli series are light-colored loose sands with no textural change throughout the profile. The profile studied has a pH of 6.5 with a light loamy sand surface, and a pH of 6.0 with fine sand textured subsoil. It is believed to be an Orthic Quarzopsamment (1.210) because the texture is coarser than loamy very fine sand to the depth of 30 inches or more. The A_1 horizon is high in organic matter.

Vanoss Series

The Vanoss series are deep well-drained youthful Reddish Prairie soils. The profile studied has a pH of 6 in the surface and a pH of 7.7 in the subsoil. It is believed to be an Orthic Argudoll (5.530). It has a mollic epipedon. It has no cambic or albic horizon above the argillic horizon.

Vernon Series

The Vernon series occurs as a reddish calcareous Lithosol on red

calcareous shale or clay. The profile studied has a pH of 7.75 in the clay loam surface, and a pH of 7.8 in the clay subsoil. It is classified as a Vertic Hapludent (1.43-2). The R horizon may be shallow or deep.

Waynesboro Series

The Waynesboro series occurs on old high terraces. The profile studied was taken from the southeastern part of Oklahoma. The profile has a loam surface with a pH of 5.8 and a clay loam subsoil with a pH of 4.7. It is believed to be an Orthic Typochrust (8.230) because it occurs in a humid climate; the parent materials are not highly basic; and the hue of this soil is redder than that of many Typochrults (8.23).

Yahola Series

The Yahola series occurs as reddish calcareous Alluvial soils. The profile studied has a sandy loam surface with a pH of 8.0, and a sandy loam subsoil with a pH of 7.9. It is proposed to classify this series as Orthic Hapludent (1.430). It is a good to moderately well drained soil. It has no plaggen or anthropic epipedon with textures as fine or finer than loamy very fine sand within the depths of 20 inches.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purposes of the study were to correlate laboratory data for an attempt to classify some of Oklahoma soil series by the new classification scheme in the Seventh Approximation. Twenty profiles representing several counties in Oklahoma were analyzed to study some diagnostic properties, such as color, texture, pH, carbon nitrogen ratio, cation exchange capacity, and percent base saturation.

The results have supplied information for the following conclusions:

1. The new classification scheme in the Seventh Approximation could be used to classify the soil series studied through the order, suborder, great group and subgroup categories.
2. The following names and official numbers have been proposed for the series studied. Axtell, Albaqualf (7.11); Bethany, Orthic Argustoll (5.630); Canadian, Hapludent (1.43); Enders, Orthic Typochrult (8.230); Enterprise, Enthic Haplustoll (5.62-1); Lincoln, Orthic Orthopsamment (1.220); Minco, Orthic Hapludoll (5.520); Norge, Orthic Argudoll (5.530); Okemah, Orthic Argudoll (5.530); Otero, Orthic Orthopsamment (1.220); Reinach #1, Hapludent (1.43); Reinach #2, Hapludent (1.43); Teller #1, Orthic Argudoll (5.530); Teller #2, Orthic Argudoll (5.530); Tivoli,

Orthic Orthopsamment (1.220); Vanoss, Orthic Argudoll (5.530); Vernon, Vertic Hapludent (1.43-2); Waynesboro, Orthic Typochrult (8.230); Yahola, Orthic Hapludent (1.430).

3. The names in the Seventh Approximation might sound strange, but this can be studied and familiarized like other branches of texonomic names in biological science.

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A P P E N D I X E S

APPENDIX A

PRESENTLY USED CLASSIFICATION

SOIL CLASSIFICATION IN THE HIGHER CATEGORIES

Order	Suborder	Great Soil Groups
Zonal soils. . .	1. Soils of the cold zones.	Tundra soils.
	2. Light-colored soils of arid regions.	Desert soils. Red Desert soils. Sierozem. Brown soils. Reddish-brown soils.
	3. Dark-colored soils of semi-arid, sub-humid, and humid grasslands.	Chestnut soils. Reddish Chestnut soils. Chernozem soils. Prairie soils. Reddish Prairie soils.
	4. Soils of the forest-grassland transition.	Degraded Chernozem. Noncalcic Brown or Shantung Brown soils.
	5. Light-colored podzolized soils of the timbered regions.	Podzol soils. Gray wooded, or Gray Podzolic soils.[1] Brown Podzolic soils. Gray-Brown Podzolic soils.[1] Red-Yellow Podzolic soils.

[1]New or recently modified great soil groups.

APPENDIX A (Continued)

Order	Suborder	Great Soil Groups
	6. Lateritic soils of forested warm-temperature and tropical regions.	Reddish-Brown Lateritis soils.[1] Yellowish-Brown Lateritic soils. Laterite soils.[1]
Intrazonal soils.	1. Halomorphic (saline and alkali) soils of imperfectly drained arid regions and littoral deposits.	Solonchak, or Saline soils. Solonetz soils. Soloth soils. Humic Gley soils[1] (includes Wiesenboden). Alpine Meadow soils.
	2. Hydromorphic soils of marshes, swamps, seep areas, and flats.	Bog soils. Half-Bog soils. Low-Humic Gley soils.[1] Planosols. Ground-Water Podzol soils. Ground-Water Laterite soils.
	3. Calcimorphic soils.	Brown Forest soils (Braunerde). Rendzina soils.
Azonal soils.		Lithosols. Regosols (includes Dry Sands). Alluvial soils.

[1]New or recently modified great soil groups.

APPENDIX B

Briefly, the classification into the Higher Categories as projected in the Seventh Approximation (August, 1960) along with some explanation of the nomenclature is as follows:

NAMES OF ORDERS, SUBORDERS, AND GREAT GROUPS

Order	Suborder	Great Group
1. Entisol. . . .	1.1 Aquent.	1.11 Cryaqyebt,
		1.12 Psammaquent.*
		1.13 Hydraquent.
		1.14 Haplaquent.
	1.2 Psamment.	1.21 Quarzopsamment.
		1.22 Orthopsamment.*
	1.3 Ustent.	1.31 Psammustent.*
		1.32 Orthustent.*
	1.4 Udent	1.41 Cryudent.
		1.42 Agrudent.
		1.43 Hapludent.
		1.44 Plaggudent.
2. Vertisol . . .	2.1 Aquert.	2.11 Grumaquert.
		2.12 Mazaquert.
	2.2 Ustert.	2.21 Grumustert.
		2.22 Mazustert.
3. Inceptisol . .	3.1 Aquept.	3.11 Halaquept.
		3.12 Umbraquept.*
		3.13 Fragaquept.
		3.14 Cryaquept.
		3.15 Ochraquept.*
	3.2 Andept.	3.21 Cryandept.
		3.22 Durandept.
		3.23 Ochrandept.*
		3.24 Umbrandept.*
		3.25 Hydrandept.
	3.3 Umbrept	3.31 Cryumbrept.
		3.33 Haplumbrept.
		3.34 Anthrumbrept.

APPENDIX B (Continued)

Order	Suborder	Great Group
	3.4 Ochrept.	3.41 Cryochrept.
		3.43 Eutrochrept.
		3.44 Dystrochrept.
		3.45 Ustochrept.
		3.46 Fragochrept.
4. Aridisol. . .	4.1 Orthid*.	4.11 Camborthid.
		4.12 Durorthid.
		4.13 Calcorthid.
		4.14 Salorthid.
	4.2 Argid.	4.21 Haplargid.
		4.22 Durargid.
		4.23 Natrargid.
		4.24 Nadurargid.
5. Mollisol. . .	5.1 Rendoll.	5.11 ---(Rendoll).
	5.2 Alboll	5.21 Argalboll.
		5.22 Natralboll.
	5.3 Aquoll	5.31 Haplaquoll.
		5.32 Argaquoll.
		5.33 Calcaquoll.
		5.34 Duraquoll.
		5.35 Natraquoll.
	5.4 Altoll	5.41 Vermaltoll.
		5.42 Haplaltoll.
		5.43 Argaltoll.
	5.5 Udoll.	5.51 Vermudoll.
		5.52 Hapludoll.
		5.53 Argudoll.
	5.6 Ustoll	5.61 Vermustoll.
		5.62 Haplustoll.
		5.63 Argustoll.
		5.64 Durustoll.
		5.65 Calcustoll.
		5.66 Natrustoll.
6. Spodosol. . .	6.1 Aquod.	6.11 Cryaquod.
		6.12 Humaquod.*
		6.13 Ferraquod.
		6.14 Placaquod.
		6.15 Thermaquod.
		6.16 Duraquod.

APPENDIX B (Continued)

Order	Suborder	Great Group
	6.2 Humod.	6.21 Orthumod.
		6.22 Thermhumod.
	6.3 Orthod*.	6.31 Cryorthod.
		6.32 Placorthod.
		6.33 Typorthod.
	6.4 Ferrod	
7. Alfisol. . . .	7.1 Aqualf	7.11 Albaqualf.
		7.12 Glossaqualf.
		7.13 Ochraqualf.
		7.14 Umbraqualf.
		7.15 Fragaqualf.
		7.16 Natraqualf.
	7.2 Altalf	7.21 Cryaltalf.
		7.22 Typaltalf.
		7.23 Natraltalf.
		7.24 Fragaltalf.
	7.3 Udalf	7.31 Agrudalf.
		7.32 Typudalf.
		7.33 Fragudalf.
		7.34 Glossudalf.
		7.35 Graglossudalf.
	7.4 Ustalf	7.41 Durustalf.
		7.42 Natrustalf.
		7.43 Rhodustalf.
		7.44 Ultustalf.*
		7.45 Typustalf.
8. Ultisol. . . .	8.1 Aquult	8.11 Plintaquult.
		8.12 Ochraquult.*
		8.13 Umbraquult.*
		8.14 Fragaquult.
	8.2 Ochrult.	8.21 Plintochrult.
		8.22 Rhodochrult.
		8.23 Typochrult.
		8.24 Fragochrult.

APPENDIX B (Continued)

Order	Suborder	Great Group
	8.3 Umbrult.	8.31 Plintumbrult. 8.32 Typumbrult.
9. Oxisol.		
10. Histosol. . . .		

* Used temporarily for want of a better name. The prior formative element is duplicated in such a way that two different subgroups may have identical names.

APPENDIX B (Continued)

FORMATIVE ELEMENTS IN NAMES OF SOIL ORDERS

No. of Order[1]	Name of Order	Formative Element in Name of Order	Derivation Formative Element	Mnemonicon and Pronunciation of Formative Elements
1	Entisol	ent	Nonsense syllable.	recent
2	Vertisol	ert	L. verto, turn.	invert
3	Inceptisol	ept	L. inceptum, beginning	inception
4	Aridisol	id	L. aridus, dry.	arid
5	Mollisol	oll	L. mollis, soft.	mollify
6	Spodosol	od	Gk. spodos, wood ash	Podzol; odd
7	Alfisol	alf	Nonsense syllable	Pedalfer
8	Ultisol	ult	L. ultimus, last	Ultimate
9	Oxisol	ox	F. oxide, oxide	oxide
10	Histosol	ist	G. histos, tissue.	histology

[1]Numbers of the orders are listed here for the convenience of those who became familiar with them during development of the system of classification.

APPENDIX B (Continued)

FORMATIVE ELEMENTS IN NAMES OF SUBORDERS

Formative Element	Derivation of Formative Element	Mnemonicon	Connotation of Formative Element
acr	Gk. akros, highest.	acrobat	Most strongly weathered.
alb	L. albus, white.	albino	Presence of albic horizon (a bleached eluvial horizon).
alt	L. altus, high.	altitude	Cool, high altutides of latitudes.
and	Modified from Ando.	Ando	Ando-like.
aqu	L. aqua, water.	aquarium	Characteristics associated with wetness.
arg	Modified from agrillic horizon; L. argilla, white clay	argillite	Presence of argillic horizon (a horizon with illuvial clay).
ferr	L. ferrum, iron.	ferruginous	Presence of iron.
hum	L. humus, earth.	humus	Presence of organic matter.
ochr	Gk. base of ochros, pale	ocher	Presence of ochric epipedon (a light-colored surface).
orth	Gk. orthos, true.	orthophonic	The common ones.
psamm	Gk. psammos, sand.	psamite	Sand textures.
rend	Modified from Rendzina.	Rendzina	Rendzina-like.
ud	L. udus, humid.	udometer	Of humid climates.

APPENDIX B (Continued)

FORMATIVE ELEMENTS IN NAMES OF SUBORDERS
(Continued)

Formative Element	Derivation of Formative Element	Mnemonicon	Connotation of Formative Element
umbr	L. umbra, shade	umbrella	Presence of umbric epipedon (a dark-colored surface).
ust	L. ustus, burnt	combustion	Of dry climates, usually hot in summer.

APPENDIX B (CONTINUED)

FORMATIVE ELEMENTS FOR NAMES OF GREAT GROUPS

(Formative element is added to suborder name to obtain name of great group)

Formative Element	Derivation of Formative Element	Mnemonicon	Connotation of Formative Element
agr	L. ager, field.	agriculture	An agric horizon.
alb	L. albus, white.	albine	An albic horizon.
anthr	Gk. anthropos, man.	anthropology	An anthropic epipedon.
arg	Modified from argillic horizon; L. argilla, white clay.	argillite	An argillic horizon.
brun[1]	L.L. brunus, brown.	brunet	Dark-brown colors.
calc	Modified from calcium.	calcium	A calcic horizon.
camb	L.L. cambiare, to exchange	change	A cambic horizon.
crust	L. crusta, crust.	crust	Crusting.
cry	Gk. kryos, coldness.	crystal	Cold.
crypt[1]	Gk. kryptos, hidden.	cryptogram	With a deep horizon.
dur	L. durus, hard.	durable	A duripan.
dystr	Modified from dystrophic, infertile.	dystrophic	Low base saturation.

APPENDIX B (Continued)

Formative Element	Derivation of Formative Element	Mnemonicon	Connotation of Formative Element
eutr	Modified from eutrophic, fertile.	eutrophic	High base saturation.
ferr	L. ferrum, iron.	ferric	Presence of iron.
frag	Modified from L. fragilis, brittle.	fragile	Presence of fragipan.
fragloss	Composed of fra(g) and gloss.		See the formative elements frag and gloss.
gloss	GK. flossa, tongue.	glossary	Tongued.
grum	L. grumus, crumb.	Grumusol	Granular structure.
hal	Gk. hals, salt.	halophyte	Salty.
hapl	Gk. haplous, simple.	haploid	Minimum horizon.
hum	L. humus, earth.		Presence of humus.
hydr	Gk. hydor, water.	hydrophobia	Presence of water.
maz	Gk. maza, flat cake, from masso, knead.		Massive.
nadur	Compound of na(tr), below, and dur, above		
natr	Modified from natrium, sodium.		Presence of natric horizon.
ochr	Gk. base of ochros, pale.	ocher	Presence of ochric epipedon (a light-colored surface).

APPENDIX B (Continued)

Formative Element	Derivation of Formative Element	Mnemonicon	Connotation of Formative Element
orth	Gk. orthos, true.	orthophonic	
plan	Modified from allophane.		Presence of allophane.
plac	Gk. base of plax, flat stone.		Presence of a thin plan.
plag	Modified from Ger. plaggen, sod.		Presence of plaggen horizon.
plint	Modified from G. plinthos, brick.		Presence of plinthite.
psamm	Gk. base of psammos, sand.	psammite	Sand texture.
quarz	Ger. quarz, quartz.	quartz	High quartz content.
rhod	Gk. base of rhodon, rose.	rhododendron	Dark-red colors.
sal	L. base of sāl, salt.	saline	Presence of salic horizon.
therm	Gk. base of thermos, hot.	thermal	Warm.
typ	Modified from type, typical.		Typical.
ult	Modified from ultimus, last.	ultimate	Strongly weathered.
umbr	L. base of umbra, shade.	umbrella	Fragrance of umbric epipedon.
ust	L. base of ustus, burnt.	combustion	Dry climate, usually hot in summer.
verm	L. base of vermes, worm.	vermiform	Wormy, or mixed by animals.

[1]Very tentatively proposed for great groups of the Oxisol order.

APPENDIX C

PRESENT SOIL ORDERS AND APPROXIMATE EQUIVALENTS IN REVISED

SEVENTH APPROXIMATION CLASSIFICATION

Present Order	Approximate Equivalents
1. Entisols	Azonal soils, and some Low Humic Gley soils
2. Vertisols	Grumusols.
3. Inceptisols	Ando, Sol Brun Acide, some Brown Forest, Low-Humic Gley, and Humic Gley soils.
4. Aridisols	Desert, Reddish Desert, Sierozem, Solonchak, some Brown and Reddish Brown soils, and associated Solonetz.
5. Mollisols	Chustnut, Chernozem, Brunizen (Prairie), Rendzinas, some Brown, Brown Forest, and associated Solonetz Humic Gley soils.
6. Spodosol	Podzols, Brown Podzolic soils, & Ground-water Podzols.
7. Alfisols	Gray-Brown Podzolic, Gray Wooded soils, Noncalcic Brown soils, Degraded Chernozem, and associated Planosols and some Half-Bog soils.
8. Ultisols	Red-Yellow Podzolic soils, Reddish-Brown Lateritic soils of the U. S., and associated Planosols and Half-Bog soils.
9. Oxisols	Laterite soils, Latosols.
10. Histosols	Bog soils.

VITA

PONGPIT PIYAPONGSE

Candidate for the Degree of

Master of Science

Thesis: THE STUDY OF THE DIAGNOSTIC PROPERTIES OF SOME OKLAHOMA SOIL SERIES BY LABORATORY METHODS FOR SOIL CLASSIFICATION PURPOSES

Major Field: Soils

Biographical:

Personal Data: Born in Surin, Thailand, March 8, 1931.

Education: Attended grade and high school in Nakorn Sri Thamarat and Pitsanuloke, Thailand. Received the Bachelor of Science degree with a major in Agronomy in 1956 from Kasetsart University, Thailand. Graduate study at Oklahoma State University, 1960-1962.

Professional Experience: Employed as an agriculture officer in the soils section, Technical Division of the Rice Department, Thailand Ministry of Agriculture since 1956. Served in the Royal Thai Army, 1957. Part-time teaching in soil survey and mapping at the College of Agriculture Kasetsart University, Thailand.

Member: Phi Delta Kappa, Honorary Professional Education Fraternity. Agronomy Club, Oklahoma State University.