Characterization of Representative Grassland and Slickspot Soils in Oklahoma

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Characterization of Representative Grassland and Slickspot Soils in Oklahoma

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The objective of this research report is to present data obtained from plant, chemical, physical, and mineralogical analyses of seven soil profiles (pedons) occurring in a typical toposequence of grassland soils containing slickspots. A representative toposequence from which samples were collected occurs in NW ¼ of Section 17, T 25N., R 5E., 30 miles west of Pawhuska, Oklahoma, Osage County. The soils selected for this study are representative of many farms and ranches throughout Oklahoma, Kansas, and Texas.

From the seven profiles, samples were obtained from 79 pedogenic soil horizons and underlying strata of geological materials. Characterization procedures were carried out using a slipped block design in order to remove day-to-day variations in the laboratory. Vegetative counts were made at the seven sampling sites. A mechanical analysis procedure was developed for more accurate particle-size measurements. Diagnostic horizons of mollic, argillic, and natric occurred with some variations in thickness throughout the toposequence.

Soil reaction and exchangeable sodium percentages showed the most variation from the normal soils (Ustolls). Salinity, alkalinity, and sodicity classes were established based upon quantitative values which have proven crop effects. According to this classification, profiles 1, 2, 4, and 7 belong to the alkaline-strongly sodic soils which support short grasses. Profiles 3, 5, and 6 are mollisols which support tall and mid-grasses.

Additional index words: Selected pedons, Sodic soils, Ustolls, Method for Mechanical Analysis, Range Vegetation analysis.

Introduction and Review of Literature

Kellogg (1959) states that soil scientists need to know what characteristics are important, what degrees of difference in each are significant, how they react to one another, and, finally, what combination of charac-

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teristics are significantly unlike other combinations. Arnold (1965) states that soils have certain morphological features and associated properties which can be expressed qualitatively and in most instances quantitatively.

Simonson (1959) views horizon differentiation to be due to the processes of addition, removal, transfer, and transformation. These proceed in Aridisols as well as in Alfisols and Mollisols with a difference only in the intensity of the processes, strongly affected by the soil-forming factors. Formation of calcium carbonates from the combination of CO_2 and Ca^{++} is one of the important features in the genesis of Mollisols.

For example, there is a small loss of soluble salts and a small gain of organic matter in Aridisols, there is a significant amount of gain in organic matter and recycling of bases in Mollisols. In a process of intense leaching, calcium carbonate leaches out. If leaching is not pronounced this compound accumulates in the profile, in the form of powder or concretion and may form a calcic horizon. Quantitative measurement of "calcium carbonate equivalent" is thus the indirect determination of a soil moisture regime.

Smith (1963) states that the soils in a given taxon will have many common properties and that from those we should select the ones which serve our purposes best. Those characteristics which are related to the genesis of the soil, and which can be used to construct the framework of their genesis and taxonomy were examined. The amount, type and distribution of soluble salts, exchangeable bases, and pH, together with the other chemical and physical properties of the soil, are considered the most important measurements.

According to Northcote and Skene (1972) the term "salt affected" soil in its broadest sense may be taken to include (1) soils in which the growth of plants is subnormal or where only halophytic species persist, (2) soil profiles with particular morphologies, or (3) soils merely containing greater amounts of soluble salts than are found in "normal" soils. The criteria used by these Australian Scientists for soil salinity, sodicity and alkalinity were dictated to some extent by past analytical practices.

Several limits have been suggested for distinguishing salt affected soils from normal soils. The United States Salinity Laboratory (1954) used terms which closely agree with the Russian classification of salt affected soils. The term "non-saline alkali" or "sodic" is applied to soils for which the ESP is greater than 15 and the conductivity of the saturation extract is less than 4 mmohs/cm at 25°C. The pH reading usually ranges between 8.5 and 10. These sodic soils frequently occur in different types of climatic regions in irregular sized and shaped spots referred to as "slickspots" which are numerous in Oklahoma, both in cultivation and rangelands. Data is needed so as to better classify these soils, predict their behavior, and reclaim for use in our society.

Procedures Applied

Timon (1962) developed a statistical design called "slipped block design" which was utilized for the analyses. The basic model for this design is the same as for a general two-way classification without interaction. The use of this design should remove the effect of time-to-time laboratory variations and lower the variance of a treatment mean.

The selection of a study site was based on the analysis of landforms from aerial photos of Osage County, Oklahoma. Recognizable light tone sports were examined in the field and found to correspond to slickspots, areas dominated by blue grama grasses within a predominantly little bluestem area. Soil pedons were sampled from seven deep pits dug with a back hoe using plant associations as indicators. The soils were described in detail and laboratory investigations which included chemical, physical, and mineralogical analysis were made on the sampled and representative pedons. (See Figure 1).

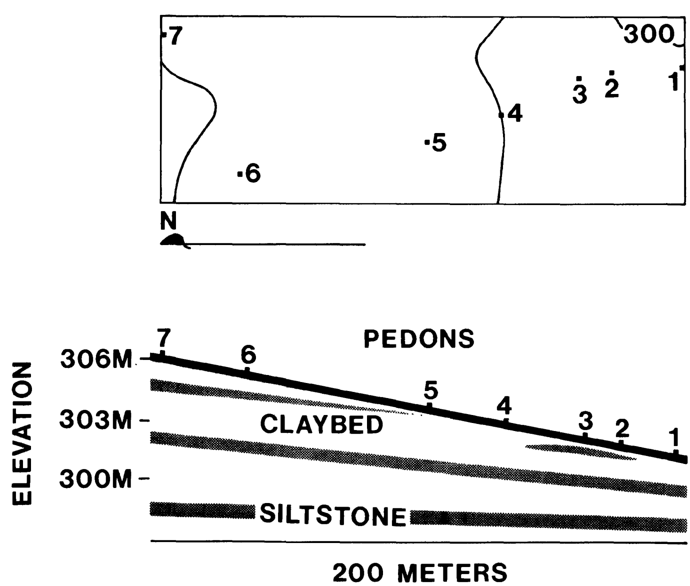


Figure 1. A cross section of the toposequence located in NW¼ of Section 17, T 25N, 5E, Osage County, Oklahoma.

Vegetation

The vegetative cover of each sampling site was studied using the point method of pasture analysis as explained by Levy (1933). Dr. Wilfred McMurphy of Oklahoma State University conducted the measurements using a ten point frame.

Morphology

In describing the pedons, the nomenclature of horizon designation was the same as that in the Soil Survey Manual (1951) with amendments from Soil Classification, A Comprehensive System 7th Approximation (1961).

Statistical design

Seven arbitrary soil samples were added to the 79 research samples, and the total was then randomly numbered from 01 through 86. A slipped block design with 86 treatments, 17 basic blocks and two replicates was constructed with the following model (Table 1):

$$Y_{ijk} = \mu + \rho_i + \beta_j + \tau_k + \epsilon_{ijk}$$
$$i = 1, 2$$
$$j = 1, 2. \ldots, 17$$
$$k = 1, 2, \ldots, 86$$

All the laboratory analyses of the samples were carried out using this design. A multiple regression method was used to adjust the treatments effects according to the block effects, assuming that $\Sigma\rho_i \; \Sigma\beta_j = \Sigma\tau_k = 0$. The SAS Program (1972) available in the computer center at Oklahoma State University was used to process the statistical analysis. In order to obtain an adjusted treatment mean, a constant equal to the unadjusted overall mean was added to each treatment effect. A FORTRAN Program was used to compute the adjusted values of physical and chemical properties.

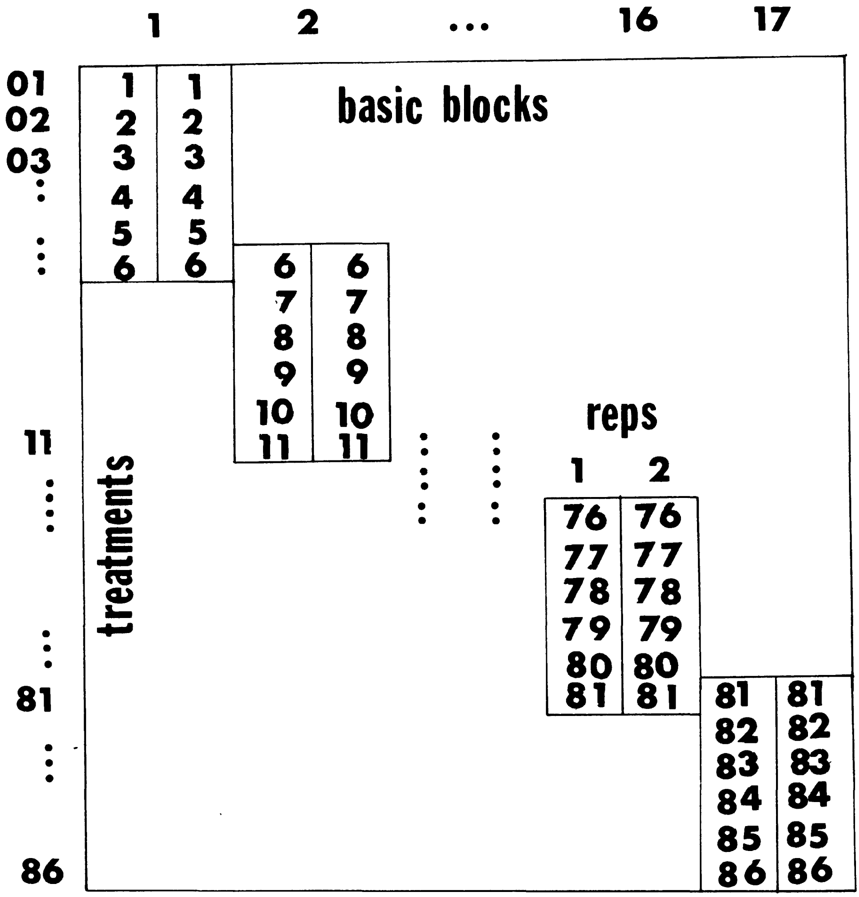
Mechanical analyses

Natural peds were used for particle size analysis. Some of the subsurface horizons and parent materials of silty shales contained carbonates as a cementing agent. Two procedures earlier developed by the Soil Survey Staff (1967) and Kittrick and Hope (1963) were combined by the author to obtain complete dispersion of the soils. The procedure used is explained in detail in the following pages.

A. Materials

1. Cellulose tubes, 5½ inches wide
2. Buckets, 8-10 liters
3. Paper clips, and rubber bands

Table 1. Slipped block design as used for laboratory analysis.



4. Plastic or glass tubes, ¼ inch in diameter, 5 inches long.
5. Plastic thread
6. Centrifuge tubes 250-ml

B. Chemicals

1. Sodium acetate .5 to 1.0 N solution, pH adjusted to 5 using acetic acid. (Use technical grade NaAc).
2. Hydrogen peroxide 35 percent

C. Removing carbonates

1. Cut an 8-in. piece of the cellulose tube (5¼ in); make a ½ in. fold. Fold three times on one end, use paper clips to seal it. The tube is now a 6½″ x 5½″ dialysis membrane sack.
2. Weigh 40 grams of the air dried soil (natural peds or disturbed soil, depending on the purpose of experiment).
3. Add 200 ml of NaAc (B.1.) solution and install a plastic or glass tube in the mouth of the sack. Use a rubber band to shut the mouth of the sack. Move the tube outward so that the end of the plastic or glass tube is not in the soil solution in the sack. Use the plastic thread to suspend the sack in a bucket containing 5 liters of the B.1. solution with the plastic tube above the solution.
4. Leave it for one week. The CO_2 bubbles from the reaction of the carbonates and acid pH solution will fill the sacks, knead the membranes to release bubbles of CO_2. Keep the contents in the bucket until no more bubbles form. For soils of Oklahoma two weeks should be enough.
5. Siphon the solution into another container, from the bucket, and fill the bucket with city water. Keep the samples in this solution for one week.
6. Siphon off the water, fill the bucket with fresh city water and keep it for 24 hours.
7. Remove the water, and transfer the soil solutions from the sacks into 250 ml centrifuge tubes. Centrifuge at 6000 R.P.M. for 10 minutes, discard the clear solution. Break down the soil in the tube, using 25 ml of distilled water, and mechanical vibrator, stirring rod, or a malt mixer with a rubber tip.
8. For best results add 25 ml of 0.5 N. NaAc, to the Centrifuge tubes, place in a water bath, and raise the temperature to 75° - 80°C. Use glass stirring rods and mix the samples continuously for 30 minutes.
9. Cool the bottles, and cenrtifuge at 6000 R.P.M. for 10 minutes. Discard the clear solution, add 25 ml of distilled water, and break down the soil again. The sample is now ready for step D.

D. Removing organic matter

1. Place the centrifuge tubes in a water bath and add 2 ml of 35 percent H_2O_2. While stirring the samples rise the temperatures to 75 - 80°C. Maintain this temperature, continue stirring the samples, and gradually add 2 ml portions of H_2O_2. When OM is removed the color of the soil tends to be light. For a soil with a 2.5% OM, 10-12 ml of H_2O_2 is usually sufficient for removal.

2. Cool the bottles, centrifuge, and discard the clear solution.
3. Add 50 ml of distilled water, break down the soil in the bottom of the tubes, shake 5 minutes and then centrifuge again. If the solution is clear it means the sample is not dispersed, repeat step D-3 until the soil goes into dispersion.

E. Complimentary mechanical dispersion of soil

1. Wash the soil suspension in a 10-mesh sieve, (do not use more than 300 ml of water), and collect the material retained by sieve, in a 30 ml beaker, and the material which passed through the sieve in a 400 ml beaker.
2. Use a sonic vibrator, with the large needle, set the dial on 80, and vibrate the sample in the 400 ml beaker for 5 minutes. For best results turn the beaker around the needle continuously to complete the break down of coagulums.
3. Transfer into a 1000 ml hydrometer jar, place in a constant temperature room of water bath, and use either pipette or hydrometer for analysis.

F. Pipette method of analysis

1. Apply the pipette method of analysis as outlined by Day (1965). Use a 25 ml sampling pipette in the constant temperature room. The settling time for 20, 5, and 2-micron particles are 4.68, 75.00, and 469.00 minutes respectively at 21°C. The same author explains all the details for the pipette method of analysis.
2. Pipette 25 ml of the suspension from exactly 10 cm below the *existing surface* of the solution. Transfer the pipetted material into 100 ml beakers which usually have been weighed to a tenth of a milligram with an analytical balance. Wash the pipette with 25 ml of distilled water in the same beaker. Place the beakers in an oven at 100°C for 24 hours. Cool them in a desicator, and weigh the beakers and contents to a tenth of a milligram. The same procedure should be followed after each of the three chosen time intervals.
3. Pass the soil suspension through sieves no. 18, 35, 60, 140, and 270, and wash thoroughly with distilled water using a rubber hose. Dry the retained material and weigh. Save the suspension which contains silt and clay for clay mineralogy if desired.

G. Calculation

S = original weight of soil
g = weight of material retained on sieve No. 10
om = percent organic matter content of the soil
tss = percent total soluble solids content of the soil

cc = percent calcium carbonate content of the soil
CF = calculation factor which is the function of the removed material.

$$CF = \frac{100.00}{(S\text{-}g) - \frac{(S\text{-}g)\ (om + tss + cc)}{100}}$$

vcs = dry weight of the particles retained on sieve No. 18
cs = dry weight of the particles retained on sieve No. 35
ms = dry weight of the particles retained on sieve No. 60
fs = dry weight of the particles retained on sieve No. 140
vfs = dry weight of the particles retained on sieve No. 270
msi = dry weight of the particles from the first pipetting
fsi = dry weight of the particles from the second pipetting
c = dry weight of the particles from the third pipetting

Particles coarser than 2 mm $\% \ GRA = \frac{g \cdot (100)}{S}$

Very coarse sand	$\% \ VCS = vcs \cdot CF$
Coarse sand	$\% \ CS = cs \cdot CF$
Medium sand	$\% \ MS = ms \cdot CF$
Fine sand	$\% \ FS = fs \cdot CF$
Total sand	$\% \ Sand = \%VCS + \%CS + \%MS + \%FS + \%VFS$
Clay	$\% \ clay = C \cdot CF \cdot \frac{1000}{25}$
Fine silt	$\% \ FSI = (fsi - c) \cdot CF \cdot \frac{1000}{25}$
Medium silt	$\% \ MSI = (msi - fsi) \cdot CF \cdot \frac{1000}{25}$
Coarse silt	$\% \ CSI = 100.0 - (\% \ Sand + \% \ Clay + \% \ MSI + \% \ FSI)$
Total silt	$\% \ Silt = \% \ CSI + \% \ MSI + \% \ FSI$

Chemical analyses

Unless other sources are named, the constituents of the exchange complex and the soluble components of the soils were measured applying the procedures introduced by the United States Salinity Laboratory (1954) and used by the Soil Characterization Laboratory at Oklahoma State University. Extractable bases were measured in a NH_4—acetate soil extract. The amount of total soluble salts, soluble cations and anions were determined in a water soil extract. Total soluble solids, resistivity of the soil water extract and conductivity were also measured. These laboratory procedures are fully described in Bakhtar (1973).

Extractable Al^{+++} was determined as explained by McLean (1965) in Agronomy Monograph No. 9. Extractable acidity was measured using the method described by Soil Survey Staff(1967). Soil reaction was determined in a 1:1 mixture of soil and water and a 1:1 mixture of soil and 1.0 N KCl. A perchloric acid-digestion method was used to measure total phosphorus. Soil Survey Staff (1967) presents full details on this procedure. Determination of organic matter was accomplished as explained by United States Salinity Laboratory Staff (1954). An acetic acid dissolution method was used to measure calcium carbonate equivalent as introduced by Gedroits (1963).

Mineralogical analyses

Sand fractions were separated and clay particles were separated from the silt size material. The fine clay ($<0.2\mu$) and coarse clay (0.2 to 2.0μ) particles were subsequently separated by means of a Sharples super centrifuge. After flocculation and washing of excess salts the clay suspensions were dispersed and mounted on ceramic slides. A General Electrix X-ray (VRD-6) diffractometer was used to obtain 2θ angles for the clay minerals. The 2θ angles were then converted into a diffraction spacing and clay minerals were identified qualitatively.

Results

Vegetation

The results of the point method of vegetation analysis are presented in Table 2. Little bluestem is the predominant grass in the area of all of the pedons except pedons 1 and 7, where buffalo and blue grama grasses predominate. A direct relationship does not exist between the density or type of vegetation population and sodium content. The total vegetation population is larger in slickspots than in the surrounding normal soils. Slickspots give a light tone to aerial photos due to the abundance of short grasses, not because of the total population of vegetative cover. The predominance of tall grasses within an area such as the study site does not necessarily indicate the absence of sodium in the profile.

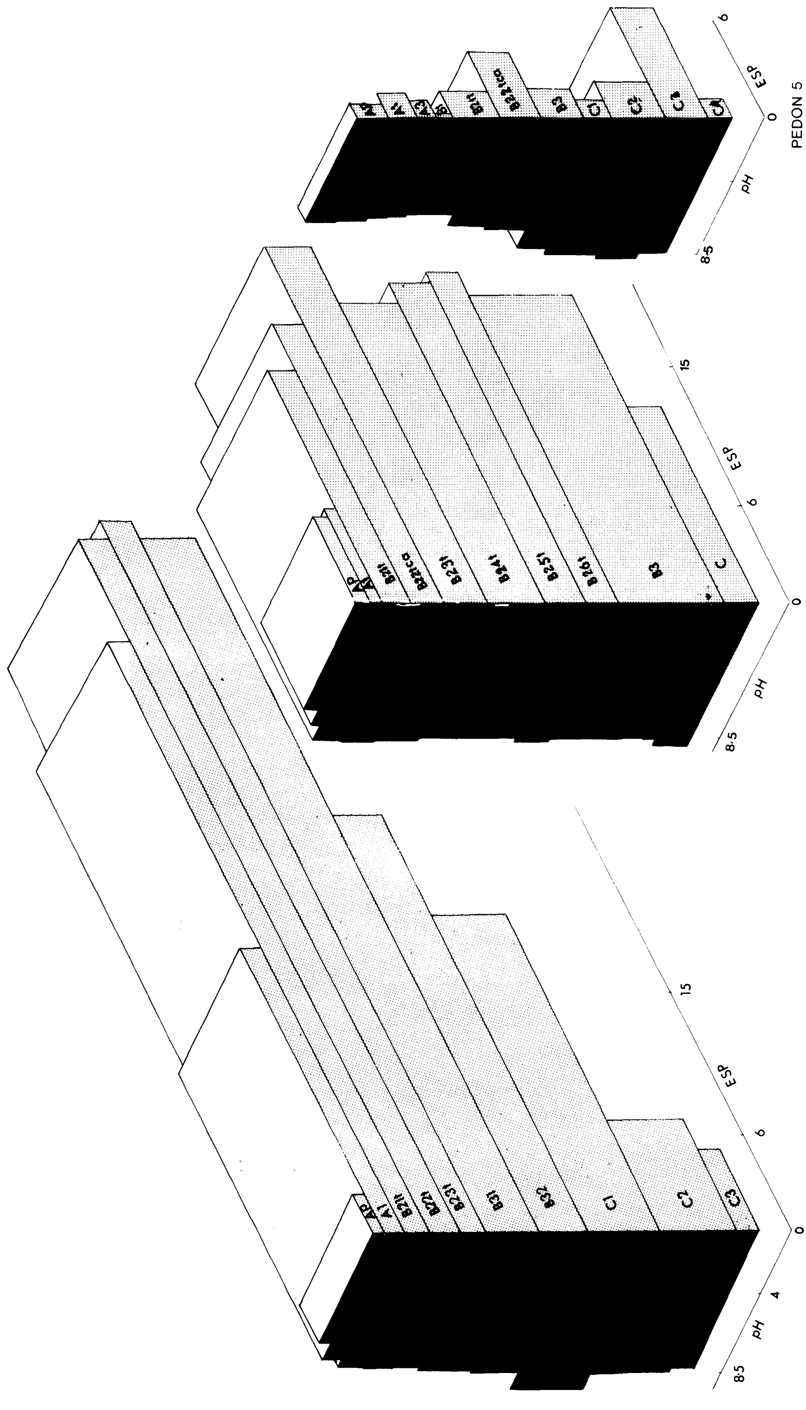


Figure 2. Variation of pH and ESP within depth for Pedons 7, 1 and 5.

Table 2. Analysis of vegetation covering the research area.

Name	Pedon 1 Count/400	%	Pedon 2 Count/400	%	Pedon 3 Count/400	%	Pedon 4 Count/400	%	Pedon 5 Count/400	%	Pedon 6 Count/400	%	Pedon 7 Count/400	%
Bare ground	272	68	288	72	295	73.7	310	77.5	297	74.2	302	75.5	300	75.0
1. Andropogon scoparius little Bluestem			49	43.7	61	58.0	50	55.5	56	54.3	64	65.3	7	7.0
2. Andropogon gerardi big bluestem			12	10.7	20	19.0	7	7.7	14	13.5	13	13.2	3	3.0
3. Sorghastrum nutans indiangrass			1	.8	4	3.8	12	13.3	13	12.6	7	7.1	1	1.0
4. Panicum virgatum switchgrass			1	.8			3	3.3	2	1.9	3	3.0		
TOTAL DECREASERS	0		63	56.3	85	80.9	72	80.0	85	82.5	87	88.7	11	11.0
5. Bouteloua curtipendula sideoats grama					5	4.7	1	1.1	1	.9	2	2.0		
6. Eragrostic spectabilis purple lovegrass					1	.9			1	.9				
7. Sporobolus asper tall dropseed			3	2.7	1	.9	3	3.3			2	2.0		
8. Andropogon saccharoides silver bluestem					1	.9	4	4.4			1	1.0	1	1.0
9. Bouteloua gracilis blue grama	94	13.4	7	6.3					6	5.8	2	2.0	42	42.0
10. Buchloe dactyloides buffalograss	32	25.0	17	15.2					1	.9			5	5.0
11. Leptoloma cognatum fall witchgrass			2	1.8										
12. Chloris verticillata windmillgrass	1	.8	2	1.8	1	.9			4	3.8			1	1.0
13. Paspalum stramineum sand paspalum			1	.8										
14. Panicum scribnerianum scribner panicum											1	1.0		
15. Bouteloua hirsuta hairy grama									1	.9				
TOTAL INCREASERS	127	39.2	32	28.6	9	8.3	8	8.8	14	13.2	8	8.0	49	49.0
16. Bromus japonicus Japanese brome			3	2.7	1	.9	2	2.2					4	4.0
17. Aristida oligantha prairie threeawn			6	5.4	1	.9	5	5.5	3	2.9	1	1.0	34	34.0
TOTAL ANNUAL GRASSES			9	8.1	2	1.8	7	7.7	3	2.9	1	1.0	38	38.0
18. Ambrosia psilostachya western ragweed	1	.8	3	2.7	1	.9	1	1.1			1	1.0	2	2.0
19. Aster ericoides heath aster			2	1.8	1	.9	1	1.1						
20. vernonia baldwini baldwin ironweed			1	.8			1	1.1			1	1.0		
21. Lespedeza virginica slender lespedeza					2	1.9								
22. Linum sulcatum flax									1	.9				
TOTAL FORBS	1	.8	6	5.3	4	3.7	10	3.3	4	3.8	2	1.0	2	2.0
23. Symphoricarpos orbiculatus buckbrush					4	3.8								
24. Carex spp. sedge			2	1.8	1	.9								
TOTAL VEGETATION	128	32	112	28	105	26.3	90	22.5	103	25.8	98	24.5	100	25.0

Table 3. Field and laboratory findings—Pedon 1.

PROFILE DESCRIPTION:

SAMPLE NUMBER	LAB NO.	HORIZON	DEPTH	THICKNESS	COLOR(M)	TEXTURE	STRUCTURE	CONSISTENCE
70-CK-57-1-01	77	AP	0- 10CM	10CM	10.0YR 3/2	VFSL	1M&CPL	MVFR
70-CK-57-1-02	30	A1	10- 17CM	7CM	10.0YR 3/1	SIL	1MPL	MVFR,DVH
70-CK-57-1-03	67	B21T	17- 35CM	18CM	10.0YR 2/1	SIC	3MPR-3FABK	MVFI,DEH
70-CK-57-1-04	31	B22TCA	35- 55CM	20CM	10.0YR 3/2	SIC	1CPR-2FABK	MVFI,DEH
70-CK-57-1-05	16	B23T	55- 83CM	28CM	10.0YR 4/2	SICL	1CPR-2MFMABK	MVFI,DEH
70-CK-57-1-06	3	B24T	83-119CM	36CM	10.0YR 4/2	SICL	1MABK	MVFI,DEH
70-CK-57-1-07	42	B25T	119-144CM	25CM	7.5YR 4/2	SICL	1MABK	MVFI,DEH
70-CK-57-1-08	24	B26T	144-165CM	21CM	7.5YR 4/2	SICL	1F&MABK	MVFI,DEH
70-CK-57-1-09	34	B3	165-231CM	66CM	7.5YR 4/2	SIC	1MABK	MVFI,DEH
70-CK-57-1-10	6	C	231-253CM	22CM				

PHYSICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	PER CENT GRA	VCS	CS	MS	FS	VFS	SAND	CSI	MSI	FSI	SILT	CLAY	CLASS
70-CK-57-1- 1	77	0.00	0.37	0.04	0.13	1.66	5.95	8.15	43.28	31.62	4.62	79.52	12.33	SIL
70-CK-57-1- 2	30	0.69	0.37	0.11	0.24	2.40	7.21	10.34	48.71	23.45	1.25	73.41	16.25	SIL
70-CK-57-1- 3	67	0.00	0.41	0.03	0.11	0.78	1.68	3.00	24.07	30.24	5.00	59.32	37.69	SICL
70-CK-57-1- 4	31	0.87	0.36	0.01	0.10	1.80	5.49	7.77	32.03	20.65	3.05	55.73	36.50	SICL
70-CK-57-1- 5	16	0.87	0.00	0.00	0.05	1.01	4.52	5.58	30.73	20.28	4.11	55.12	40.21	SIC
70-CK-57-1- 6	3	0.00	0.00	0.05	0.16	3.42	5.42	9.05	27.52	16.57	5.34	49.44	42.58	SIC
70-CK-57-1- 7	42	1.35	0.46	0.11	0.26	3.05	5.61	9.49	32.88	16.85	4.42	54.16	36.35	SICL
70-CK-57-1- 8	24	0.99	0.00	0.06	0.09	0.77	5.46	6.38	33.34	16.91	3.83	54.08	40.42	SIC
70-CK-57-1- 9	34	1.06	0.44	0.14	0.15	3.64	8.25	12.62	29.82	14.91	3.47	48.20	39.18	SICL
70-CK-57-1-10	6	9.25	0.00	0.07	0.15	1.78	1.43	3.42	30.58	15.49	8.77	54.94	42.60	SIC

CHEMICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	EXTRACTABLE CATIONS MEQ/100 GMS CA	MG	K	NA	H	AL	EXCHANGEABLE CATIONS MEQ/100 GMS CA	MG	K	NA	SUM
70-CK-57-1- 1	77	4.47	0.18	0.23	0.95	2.63	0.00	4.47	0.14	0.22	0.47	5.29
70-CK-57-1- 2	30	7.15	3.43	0.10	1.22	1.50	0.00	7.13	3.39	0.08	0.78	11.38
70-CK-57-1- 3	67	17.45	4.97	0.42	6.51	0.02	0.00	17.35	4.84	0.41	4.20	26.80
70-CK-57-1- 4	31	19.97	7.75	0.36	7.15	0.11	0.00	19.95	7.50	0.34	4.76	32.55
70-CK-57-1- 5	16	12.66	7.56	0.40	7.63	0.73	0.00	12.61	7.73	0.38	6.34	27.05
70-CK-57-1- 6	3	16.62	7.44	0.39	5.64	0.00	0.00	16.57	7.40	0.37	5.03	29.37
70-CK-57-1- 7	42	11.83	8.17	0.42	7.35	0.32	0.00	11.83	8.06	0.41	5.74	26.04
70-CK-57-1- 8	24	15.75	9.14	0.34	7.44	0.16	0.00	15.73	9.09	0.33	5.87	31.01
70-CK-57-1- 9	34	16.00	8.58	0.39	6.83	1.09	0.00	16.00	8.47	0.38	5.25	30.11
70-CK-57-1-10	6	36.14	6.31	0.10	3.79	0.00	0.00	36.09	6.23	0.08	2.67	45.08

SAMPLE NUMBER	LAB NO.	SOLUBLE CATIONS MEQ/100 GMS CA	MG	K	NA	SUM	SOLUBLE ANIONS MEQ/100 GMS CL	SO4	CO3	HCO3	SUM
70-CK-57-1- 1	77	0.00	0.05	0.01	0.48	0.54	0.03	0.00	0.03	0.37	0.44
70-CK-57-1- 2	30	0.02	0.04	0.01	0.44	0.51	0.55	0.00	0.06	0.46	1.08
70-CK-57-1- 3	67	0.09	0.13	0.02	2.31	2.55	1.88	0.00	0.03	1.76	3.68
70-CK-57-1- 4	31	0.02	0.25	0.02	2.39	2.68	2.13	0.00	0.06	1.75	3.95
70-CK-57-1- 5	16	0.05	0.13	0.02	1.29	1.50	0.97	0.00	0.07	0.65	1.69
70-CK-57-1- 6	3	0.05	0.05	0.02	1.60	1.72	1.97	0.00	0.00	1.46	3.43
70-CK-57-1- 7	42	0.00	0.10	0.01	1.61	1.73	1.25	0.00	0.03	1.42	2.70
70-CK-57-1- 8	24	0.02	0.06	0.02	1.58	1.67	1.49	0.00	0.19	1.47	3.15
70-CK-57-1- 9	34	0.00	0.11	0.01	1.56	1.69	1.55	0.00	0.11	1.53	3.18
70-CK-57-1-10	6	0.05	0.08	0.02	1.12	1.27	1.32	0.00	0.00	1.26	2.58

SAMPLE NUMBER	LAB NO.	PER CENT OM	PPM TOTAL P	PER CENT CACO3	PER CENT TSS	MIC MHS 1:5 EC	1:1 PH KCL	H2O	MEQ/100 GMS CEC
70-CK-57-1- 1	77	2.36	161.56	0.53	0.02	93.14	5.48	6.72	8.62
70-CK-57-1- 2	30	2.11	150.56	0.67	0.07	99.21	6.03	7.67	12.95
70-CK-57-1- 3	67	2.27	172.56	1.19	0.21	418.01	7.13	8.47	28.36
70-CK-57-1- 4	31	1.84	184.56	1.50	0.31	518.86	7.28	8.62	27.19
70-CK-57-1- 5	16	1.36	190.56	0.91	0.23	282.34	7.03	8.52	26.27
70-CK-57-1- 6	3	0.65	129.56	1.00	0.19	273.25	7.18	8.52	26.51
70-CK-57-1- 7	42	0.62	115.56	1.01	0.13	278.77	7.13	8.42	28.47
70-CK-57-1- 8	24	0.48	121.56	1.36	0.16	270.16	7.08	8.62	28.05
70-CK-57-1- 9	34	0.24	140.56	1.46	0.14	311.50	7.23	8.52	28.22
70-CK-57-1-10	6	0.24	195.56	17.27	0.15	203.47	7.39	8.87	21.44

INTERPRETIVE CALCULATIONS:

SAMPLE NUMBER	LAB NO.	% CA/MG	% CEC/CLAY	ESP	SSP	SAR	% SOLUBLE/EXTRACTABLE CA	MG	% BASE SATURATION NAAC	SUM CAT
70-CK-57-1- 1	77	2435.90	69.94	5.40	91.94	4.44	0.00	34.40	61.37	66.82
70-CK-57-1- 2	30	208.49	79.70	5.99	88.60	3.77	0.26	1.10	87.85	88.33
70-CK-57-1- 3	67	350.84	75.26	14.81	92.85	9.72	0.54	2.73	94.51	99.94
70-CK-57-1- 4	31	257.55	74.51	17.49	92.80	9.22	0.09	3.33	119.70	99.65
70-CK-57-1- 5	16	161.10	70.30	22.41	89.39	6.10	0.40	1.67	95.70	97.37
70-CK-57-1- 6	3	223.24	62.26	18.96	93.93	10.24	0.31	0.63	110.79	100.00
70-CK-57-1- 7	42	144.91	78.32	20.16	95.75	10.08	0.00	1.27	91.48	98.79
70-CK-57-1- 8	24	172.21	69.39	20.92	95.47	11.51	0.12	0.62	110.57	99.48
70-CK-57-1- 9	34	186.58	72.02	18.61	96.00	9.70	0.00	1.25	106.70	96.50
70-CK-57-1-10	6	572.59	50.33	12.47	90.70	6.11	0.14	1.33	210.22	100.00

Morphology and characterization

Study of the genesis and taxonomy of soils requires the precise identification of their characteristics. The morphological, physical, and chemical data of the seven selected pedons are presented in the following pages.

Pedon 1 (Table 3) is a dark-colored soil, developed on a slightly concave relief. The soil is slowly and somewhat poorly drained and the level of groundwater noted to be at 165 cm below the surface in July. The A horizon is 17 cm and presents a platy structure. The value and chroma of the B21t horizon are smaller than Ap, due to accumulation of dispersed organic matter in this horizon. Prismatic structure of the subsurface horizons is the most important feature of this soil. Prisms are capped with silt loam material which is lighter in color than the prisms. Continuous clay films, segregated calcium carbonates in thread-like form, and fine and medium distinct strong brown mottles are noticeable below the B23t horizon. The B3 horizon was noted to be below the surface of the groundwater.

The laboratory analyses of the soil samples indicate that clay increases and silt decreases abruptly from the A to the B horizon. The clay distribution curve is similar to those of argillic horizons, except that clay content remains nearly constant through the B and C horizons. The particle size distribution of the control section indicates that this pedon fits into the fine textural family. The profile contains more than one percent organic matter to a depth of 55 cm (Figure 3). The soil reaction is neutral to basic for the A horizon and strongly basic for the subsurface horizons. The electrical conductivity of the soil water extract shows an insignificant amount of soluble salts. Exchangeable bases occupy more than 60 percent of the exchange complex of this profile and exchangeable Na^+ saturates 14 to 22 percent of the cation exchange capacity of the subsurface horizons (Figure 2).

Pedon 2 (Table 4) is similar to Pedon 1. This soil presents a dark-colored profile developed on a smooth relief. The soil is somewhat poorly drained and the level of the groundwater was noted to be at 170 cm below the surface in July. The A horizon is 30 cm thick, with a coarse platy parting to weak medium granular structure. An abrupt, smooth boundary exists between the A and B horizons. The upper part of the B horizon presents a strong medium prismatic parting to moderate medium angular blocky structure. The upper 2.5 cm of prisms are capped and sides are coated with a silt loam material which presents a lighter color than the prisms. Continuous clay films are observable in subsurface horizons. About 50 percent of the peds are coated with dark gray organic stains while fine distinct strong brown mottles are observable within the B horizon above the level of the groundwater. Calcium carbonate concretions are present more than 100 cm from the surface.

The results of the laboratory examinations indicate more than a 25 percent increase in clay content from A to B, which increases to B23t and reduces gradually to the bottom of the profile. The particle size distribution of the upper 100 cm indicates that this soil belongs to the fine family in textural classification. Organic matter decreases gradually from the surface to the bottom of the profile, staying above one percent in the top 77 cm (Figure 3). The A and B21t horizons are neutral in reaction and the lower horizons have a basic reaction. The electrical conductivity of the soil water extract indicates no evidence of salinity. Exchangeable

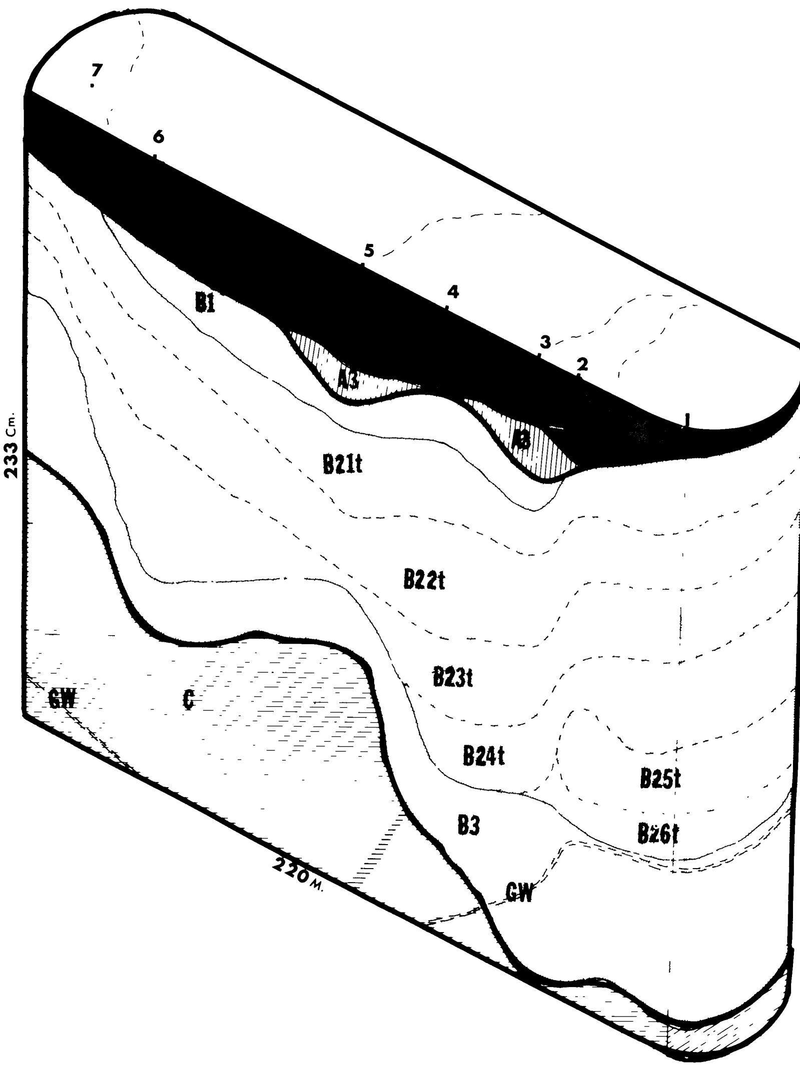


Figure 3. The horizonation of sampled pedons.

Table 4. Field and laboratory findings—Pedon 2.

PROFILE DESCRIPTION:

SAMPLE NUMBER	LAB NO.	HORIZON	DEPTH	THICKNESS	COLOR(M)	TEXTURE	STRUCTURE	CONSISTENCE
70-CK-57-2-01	25	AP	0- 20CM	20CM	10.0YR 3/1	VFSL	1M&CPL-1MGR	MVFR,DH
70-CK-57-2-02	4	A2	20- 30CM	10CM	10.0YR 3/1	SIL	M	MVFR,DH
70-CK-57-2-03	48	B21T	30- 48CM	18CM	10.0YR 2/2	SICL	3MPR-2MABK	MFI,DVH
70-CK-57-2-04	43	B22T	48- 71CM	23CM	10.0YR 3/2	SICL	2MPR-2F&MAB	MVFI,DEH
70-CK-57-2-05	23	B23T	71- 99CM	28CM	10.0YR 4/2	SIC	1CPR-1MABK	MVFI,DEH
70-CK-57-2-06	20	B24TCA	99-119CM	20CM	10.0YR 4/2	SIC	1MABK	MVFI,DEH
70-CK-57-2-07	36	B25TCA	119-154CM	35CM	10.0YR 4/2	SIC	1F&MABK	MVFI,DEH
70-CK-57-2-08	81	B26T	154-170CM	16CM	10.0YR 4/2	SIC	1MABK	MVFI,DEH
70-CK-57-2-09	58	B3	170-223CM	53CM	10.0YR 4/3	SIC	1M&CABK	MVFI,DEH
70-CK-57-2-10	53	C	223-259CM	36CM				

PHYSICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	PER CENT												
		GRA	VCS	CS	MS	FS	VFS	SAND	CSI	MSI	FSI	SILT	CLAY	CLASS
70-CK-57-2- 1	25	0.89	0.00	0.04	0.11	0.81	5.57	6.52	53.06	17.30	1.78	72.14	22.22	SIL
70-CK-57-2- 2	4	0.00	0.00	0.05	0.20	4.01	7.94	12.20	49.35	14.67	3.36	67.38	21.52	SIL
70-CK-57-2- 3	48	1.30	0.50	0.11	0.30	2.34	4.46	7.70	47.55	14.35	3.24	65.14	27.16	SICL
70-CK-57-2- 4	43	1.24	0.52	0.12	0.26	2.88	6.25	10.03	36.13	14.64	3.02	53.78	36.19	SICL
70-CK-57-2- 5	23	0.94	0.00	0.00	0.00	0.08	4.45	4.54	35.84	15.55	3.18	54.57	41.82	SIC
70-CK-57-2- 6	20	0.94	0.00	0.00	0.00	1.39	5.50	6.89	34.60	16.07	3.30	53.96	40.10	SIC
70-CK-57-2- 7	36	1.22	0.46	0.07	0.19	3.31	8.82	12.86	33.30	13.75	3.05	50.11	37.04	SICL
70-CK-57-2- 8	81	0.00	0.39	0.03	0.07	2.73	7.87	11.09	23.88	24.58	4.83	53.29	35.62	SICL
70-CK-57-2- 9	58	0.75	0.49	0.06	0.15	2.60	5.75	9.05	32.50	22.79	3.73	59.02	31.93	SICL
70-CK-57-2-10	53	1.54	0.55	0.16	0.33	4.75	8.41	14.21	46.37	8.60	3.25	58.22	27.57	SICL

CHEMICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	EXTRACTABLE CATIONS MEQ/100 GMS						EXCHANGEABLE CATIONS MEQ/100 GMS				
		CA	MG	K	NA	H	AL	CA	MG	K	NA	SUM
70-CK-57-2- 1	25	9.88	5.02	0.15	1.44	2.79	0.00	9.80	4.92	0.13	1.08	15.94
70-CK-57-2- 2	4	11.42	3.22	0.09	0.67	1.75	0.00	11.37	3.19	0.08	0.49	15.14
70-CK-57-2- 3	48	10.08	6.11	0.28	3.34	2.18	0.00	10.06	5.99	0.27	2.92	19.25
70-CK-57-2- 4	43	12.40	2.81	0.30	5.94	0.65	0.00	12.40	2.72	0.30	5.23	20.65
70-CK-57-2- 5	23	17.45	10.69	0.30	7.41	0.00	0.00	17.40	10.51	0.29	5.78	34.08
70-CK-57-2- 6	20	9.26	15.79	0.33	7.13	0.00	0.00	9.21	15.68	0.31	5.53	30.73
70-CK-57-2- 7	36	16.67	10.28	0.32	6.19	0.00	0.00	16.67	10.16	0.32	4.65	31.80
70-CK-57-2- 8	81	12.81	7.55	0.37	5.42	0.00	0.00	12.81	7.46	0.36	4.05	24.68
70-CK-57-2- 9	58	23.32	9.27	0.37	4.35	0.00	0.00	23.32	8.13	0.36	3.16	34.98
70-CK-57-2-10	53	13.84	6.98	0.36	1.94	0.00	0.00	13.83	6.78	0.35	1.52	22.48

SAMPLE NUMBER	LAB NO.	SOLUBLE CATIONS MEQ/100 GMS					SOLUBLE ANIONS MEQ/100 GMS				
		CA	MG	K	NA	SUM	CL	SO4	CO3	HCO3	SUM
70-CK-57-2- 1	25	0.08	0.10	0.02	0.36	0.56	0.53	0.00	0.07	0.56	1.16
70-CK-57-2- 2	4	0.05	0.03	0.01	0.17	0.27	0.32	0.00	0.00	0.36	0.68
70-CK-57-2- 3	48	0.02	0.11	0.01	0.42	0.56	0.56	0.00	0.03	0.48	1.08
70-CK-57-2- 4	43	0.00	0.09	0.00	0.71	0.80	0.85	0.00	0.03	0.72	1.60
70-CK-57-2- 5	23	0.04	0.08	0.02	1.62	1.77	1.40	0.00	0.17	1.45	3.02
70-CK-57-2- 6	20	0.05	0.11	0.02	1.60	1.78	2.01	0.00	0.07	1.76	3.85
70-CK-57-2- 7	36	0.00	0.12	0.01	1.54	1.67	1.63	0.00	0.09	1.49	3.20
70-CK-57-2- 8	81	0.00	0.08	0.01	1.38	1.47	1.10	0.00	0.03	1.18	2.31
70-CK-57-2- 9	58	0.00	0.14	0.01	1.19	1.33	1.01	0.00	0.03	1.17	2.21
70-CK-57-2-10	53	0.01	0.20	0.01	0.42	0.64	0.70	0.00	0.03	0.53	1.26

SAMPLE NUMBER	LAB NO.	PER CENT	PPM	PER CENT	PER CENT	MIC MHS	1:1 PH		MEQ/100 GMS
		CM	TOTAL P	CACO3	TSS	1:5 EC	KCL	H2O	CEC
70-CK-57-2- 1	25	3.09	228.56	0.72	0.13	45.54	5.73	7.02	18.04
70-CK-57-2- 2	4	2.43	174.56	0.44	0.09	29.23	5.73	7.02	13.95
70-CK-57-2- 3	48	2.15	153.56	0.71	0.06	109.33	5.98	6.97	22.16
70-CK-57-2- 4	43	1.29	139.56	0.83	0.07	172.31	6.58	7.77	31.53
70-CK-57-2- 5	23	0.63	124.56	1.79	0.21	297.61	7.08	8.62	31.14
70-CK-57-2- 6	20	0.62	132.56	1.34	0.18	327.05	7.18	8.62	29.33
70-CK-57-2- 7	36	0.32	125.56	1.44	0.13	311.50	7.28	8.52	28.74
70-CK-57-2- 8	81	0.24	153.56	1.10	0.07	283.70	6.88	8.37	23.14
70-CK-57-2- 9	58	0.08	165.56	1.74	0.06	249.00	7.13	8.42	30.96
70-CK-57-2-10	53	0.04	182.56	0.63	0.02	97.08	6.68	7.72	26.01

INTERPRETIVE CALCULATIONS:

SAMPLE NUMBER	LAB NO.	% CA/MG	% CEC/CLAY	ESP	SSP	SAR	% SOLUBLE/EXTRACTABLE CA	MG	% BASE SATURATION NAAC	SUM CAT
70-CK-57-2- 1	25	196.57	81.16	6.02	69.64	1.67	0.82	2.09	88.36	85.12
70-CK-57-2- 2	4	354.49	64.81	3.54	68.45	1.25	0.45	0.85	108.54	89.66
70-CK-57-2- 3	48	165.12	81.61	13.19	82.11	2.32	0.18	1.88	86.87	89.82
70-CK-57-2- 4	43	441.28	87.14	16.58	93.57	4.86	0.00	3.17	65.50	96.97
70-CK-57-2- 5	23	163.22	74.45	18.58	93.74	9.10	0.26	0.78	109.46	100.00
70-CK-57-2- 6	20	58.64	73.15	18.84	92.25	8.08	0.55	0.68	104.77	100.00
70-CK-57-2- 7	36	162.24	77.61	16.19	95.41	8.79	0.00	1.20	110.63	100.00
70-CK-57-2- 8	81	169.74	64.97	17.48	95.80	9.57	0.00	1.11	106.63	100.00
70-CK-57-2- 9	58	251.94	96.96	10.22	93.40	6.48	0.00	1.66	112.96	100.00
70-CK-57-2-10	53	198.27	94.23	5.83	76.95	1.83	0.08	2.96	86.43	100.00

bases have saturated more than 60 percent of the exchange complex in the descending order of: Ca^{++}, Mg^{++}, Na^{+}, and K^{+}. Exchangeable sodium also saturates from 13 to 18 percent of the cation exchange capacity of the subsurface horizons.

Pedon 3 (Table 5) consists of dark-colored horizons developed on a smooth relief. The soil is moderately well drained and the level of the groundwater was noted to be at a depth of 190 cm from the surface in July. The A horizon is 40 cm thick and a mainly granular structure. Continuous clay films, a few non-intersecting slickensides, and strong brown mottles are noticeable in the subsurface horizons. The B3 horizon was noted to be below the level of the groundwater.

The laboratory analyses of the soil samples indicate a high amount of silt which decreases with depth. Clay content increases about 20 percent from A1 to A3 horizon. The particle size distribution of the control section indicates that this soil belongs to the fine silty family in textural classification. This soil contains more than one percent organic matter from the surface to the depth of 100 cm (Figure 3). Soil reaction varies from acid to neutral, basic and strongly basic with the profile. Base saturation is more than 60 percent of the total cation exchange capacity. Exchangeable sodium saturates a negligible percentage of the exchange complex.

Pedon 4 (Table 6) is a dark-colored soil developed on a smooth relief with two percent slope. The soil is somewhat poorly drained, and the level of groundwater was not found within 320 cm of the surface at the time of sampling. The A horizon is 33 cm thick with a platy structure. An abrupt wavy boundary separates the A and B horizons. The B horizon presents a moderate coarse prismatic, parting to moderate medium angular blocky structure. Prisms are coated and have 2 cm caps of silty loam material which are very dark grayish-brown in color. Continuous clay films, fine black concentrations, and very dark brown organic stains are observable below the B1 horizon. Calcium concretions are also occurring in B23tca and lower horizons.

Laboratory data denote an increase of about 50 percent in clay content from the A to the B horizons. Clay content increases with depth, and the C2 horizon contains 82 percent total clay. The particle size analysis of the control section places this pedon in the fine textural family. Organic matter decreases within the profile, but the top 100 cm contains more than one percent organic matter (Figure 3). The soil reaction is neutral in the first 80 cm and changes to strongly basic in the lower parts of the profile. Exchangeable bases are in the order of: Ca^{++}, Mg^{++}, Na^{+}, and K^{+} and saturate more than 60 percent of the total cation exchangeable sodium saturates 14 to 19 percent of the total exchange complex of the horizons below the A1 horizon.

Pedon 5 (Table 7) is similar to Pedon 6. This profile is a dark-colored soil which is redder in subsurface horizons. The soil is developed

Table 5. Field and laboratory findings—Pedon 3.

PROFILE DESCRIPTION:

SAMPLE NUMBER	LAB NO.	HORIZON	DEPTH	THICKNESS	COLOR(M)	TEXTURE	STRUCTURE	CONSISTENCE
70-CK-57-3-01	44	AP	0- 15CM	15CM	10.0YR 2/1	SIL	1MSBK-2MGR	MVFR,DH
70-CK-57-3-02	13	A1	15- 22CM	7CM	10.0YR 2/1	SIL	2MGR	MVFR,DH
70-CK-57-3-03	5	A3	22- 40CM	18CM	10.0YR 2/2	SIL	1CPR-2MGR	MFR,DH
70-CK-57-3-04	76	B1	40- 53CM	13CM	10.0YR 3/2	SICL	1M&CPR-2MGR	MFR,DVH
70-CK-57-3-05	64	B21T	53- 66CM	13CM	7.5YR 3/2	SICL	2MPR-2MGR	MFI-DVH
70-CK-57-3-06	80	B22T	66- 99CM	33CM	7.5YR 4/2	SICL	2MPR-2F&MABK	MVFI,DEH
70-CK-57-3-07	2	B23T	99-126CM	27CM	7.5YR 4/2	SIC	1MPR-2MABK	MVFI,DEH
70-CK-57-3-08	10	B24T	126-149CM	23CM	7.5YR 4/2	SIC	1M&CABK	MVFI,DEH
70-CK-57-3-09	73	B25TCA	149-170CM	21CM	7.5YR 4/2	SIC	1M&CABK	MVFI,DEH
70-CK-57-3-10	17	B26T	170-190CM	20CM	7.5YR 4/4	SIC	1M&CABK	MVFI,DEH
70-CK-57-3-11	33	B31	190-226CM	36CM	7.5YR 5/4	SIC	1CABK	MVFI,DEH
70-CK-57-3-12	11	C	226-256CM	30CM	5.0YR 5/6	SICL	M	MVFI,DEH

PHYSICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	PER CENT GRA	VCS	CS	MS	FS	VFS	SAND	CSI	MSI	FSI	SILT	CLAY	CLASS
70-CK-57-3- 1	44	1.21	0.44	0.07	0.19	3.49	7.97	12.17	49.14	13.55	2.33	65.02	22.81	SIL
70-CK-57-3- 2	13	0.77	0.00	0.00	0.07	1.08	8.02	9.17	46.43	13.35	3.65	63.43	28.32	SICL
70-CK-57-3- 3	5	0.00	0.00	0.04	0.13	3.94	7.58	11.69	40.85	11.27	3.24	55.36	34.03	SICL
70-CK-57-3- 4	76	0.00	0.38	0.01	0.05	2.31	6.76	9.51	30.61	25.20	4.01	59.81	30.67	SICL
70-CK-57-3- 5	64	0.00	0.41	0.00	0.08	1.76	4.04	6.30	34.61	24.29	3.86	62.75	30.96	SICL
70-CK-57-3- 6	80	0.00	0.43	0.04	0.09	2.26	6.46	9.29	25.54	26.94	2.79	55.27	35.45	SICL
70-CK-57-3- 7	2	0.00	0.00	0.09	0.21	3.84	6.54	10.68	28.17	12.66	4.85	45.68	44.67	SIC
70-CK-57-3- 8	10	0.80	0.00	0.10	0.25	3.98	6.91	11.25	32.45	12.75	4.99	50.18	39.52	SICL
70-CK-57-3- 9	73	0.47	0.49	0.13	0.11	2.98	6.76	10.47	22.13	22.47	5.12	49.72	39.81	SICL
70-CK-57-3-10	17	1.84	-0.00	0.08	0.05	3.06	8.71	11.90	31.66	10.84	2.78	45.28	43.62	SIC
70-CK-57-3-11	33	0.96	0.45	0.07	0.11	4.23	10.44	15.31	35.04	9.50	1.97	46.51	38.18	SICL
70-CK-57-3-12	11	1.61	0.00	0.42	0.48	4.92	11.36	17.18	38.36	6.97	3.66	48.98	34.50	SICL

CHEMICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	EXTRACTABLE CATIONS MEQ/100 GMS CA	MG	K	NA	H	AL	EXCHANGEABLE CATIONS MEQ/100 GMS CA	MG	K	NA	SUM
70-CK-57-3- 1	44	11.06	10.43	0.55	0.37	6.07	0.00	11.00	10.13	0.49	0.32	21.94
70-CK-57-3- 2	13	12.45	5.08	0.34	0.07	5.82	0.00	12.30	4.88	0.30	0.07	17.55
70-CK-57-3- 3	5	13.53	5.49	0.27	0.05	6.28	0.00	13.41	5.37	0.25	0.05	19.08
70-CK-57-3- 4	76	10.44	2.91	0.38	0.62	5.41	0.00	10.42	2.79	0.37	0.25	13.83
70-CK-57-3- 5	64	10.80	3.74	0.37	0.45	6.05	0.00	10.80	3.60	0.36	0.31	15.07
70-CK-57-3- 6	80	12.66	4.77	0.45	0.87	4.99	0.00	12.66	4.67	0.44	0.52	18.29
70-CK-57-3- 7	2	17.96	8.37	0.38	0.55	2.91	0.00	17.91	8.31	0.37	0.44	27.02
70-CK-57-3- 8	10	16.67	8.06	0.35	0.64	2.28	0.00	16.62	7.95	0.33	0.50	25.40
70-CK-57-3- 9	73	22.65	4.56	0.43	1.29	0.88	0.00	22.36	4.26	0.41	0.62	27.65
70-CK-57-3-10	17	28.83	8.32	0.33	1.65	0.08	0.00	28.51	8.00	0.32	1.28	38.11
70-CK-57-3-11	33	17.19	7.55	0.36	1.21	1.35	0.00	17.16	7.20	0.35	0.80	25.52
70-CK-57-3-12	11	14.82	6.62	0.30	0.59	2.64	0.00	14.77	6.54	0.29	0.48	22.08

SAMPLE NUMBER	LAB NO.	SOLUBLE CATIONS MEQ/100 GMS CA	MG	K	NA	SUM	SOLUBLE ANIONS MEQ/100 GMS CL	SO4	CO3	HCO3	SUM
70-CK-57-3- 1	44	0.06	0.30	0.06	0.05	0.47	0.39	0.00	0.03	0.42	0.84
70-CK-57-3- 2	13	0.15	0.20	0.03	0.00	0.38	0.18	0.00	0.00	0.28	0.46
70-CK-57-3- 3	5	0.12	0.12	0.02	0.00	0.26	0.14	0.00	0.00	0.20	0.34
70-CK-57-3- 4	76	0.02	0.13	0.02	0.36	0.53	0.10	0.00	0.03	0.32	0.45
70-CK-57-3- 5	64	0.00	0.14	0.01	0.14	0.28	0.20	0.00	0.03	0.29	0.52
70-CK-57-3- 6	80	0.00	0.10	0.01	0.35	0.45	0.09	0.00	0.03	0.23	0.35
70-CK-57-3- 7	2	0.05	0.07	0.01	0.11	0.24	0.19	0.00	0.00	0.15	0.35
70-CK-57-3- 8	10	0.05	0.11	0.02	0.15	0.33	0.25	0.00	0.00	0.30	0.55
70-CK-57-3- 9	73	0.29	0.30	0.02	0.67	1.27	0.85	0.00	0.03	0.93	1.82
70-CK-57-3-10	17	0.32	0.33	0.02	0.36	1.02	0.97	0.00	0.07	0.84	1.88
70-CK-57-3-11	33	0.03	0.34	0.01	0.40	0.78	0.70	0.00	0.03	0.64	1.38
70-CK-57-3-12	11	0.05	0.08	0.01	0.11	0.25	0.26	0.00	0.00	0.30	0.56

SAMPLE NUMBER	LAB NO.	PER CENT OM	PPM TOTAL P	PER CENT CACO3	PER CENT TSS	MIC MHS 1:5 EC	1:1 PH KCL	H2O	MEQ/100 GMS CEC
70-CK-57-3- 1	44	4.48	275.56	0.53	0.07	78.27	5.48	6.17	22.88
70-CK-57-3- 2	13	3.75	248.56	0.48	0.11	20.58	5.53	6.52	20.83
70-CK-57-3- 3	5	3.05	218.56	0.61	0.09	11.55	5.28	6.37	22.16
70-CK-57-3- 4	76	2.61	196.56	0.64	0.01	86.98	5.33	6.47	19.56
70-CK-57-3- 5	64	2.07	180.56	0.73	0.00	204.40	5.48	6.57	24.33
70-CK-57-3- 6	80	1.20	143.56	0.65	0.02	79.06	5.48	6.77	23.61
70-CK-57-3- 7	2	0.87	128.56	0.95	0.08	30.06	6.23	7.42	29.06
70-CK-57-3- 8	10	0.63	121.56	0.66	0.08	37.37	6.58	7.62	29.19
70-CK-57-3- 9	73	0.58	93.56	1.43	0.04	210.05	6.98	8.07	25.32
70-CK-57-3-10	17	0.52	105.56	2.61	0.15	156.47	7.18	8.17	30.16
70-CK-57-3-11	33	0.42	98.56	1.10	0.07	130.86	6.88	8.12	27.34
70-CK-57-3-12	11	0.30	142.56	0.75	0.07	22.48	6.53	7.67	23.47

INTERPRETIVE CALCULATIONS:

SAMPLE NUMBER	LAB NO.	CA/MG	CEC/CLAY	ESP	SSP	SAR	SOLUBLE/EXTRACTABLE CA	MG	BASE SATURATION NAAC	SUM CAT
70-CK-57-3- 1	44	106.03	100.29	1.38	14[illegible]	0.18	0.52	2.99	95.90	78.32
70-CK-57-3- 2	13	245.30	73.56	0.36	0.00	0.00	1.24	4.05	84.27	75.10
70-CK-57-3- 3	5	246.59	65.10	0.23	0.00	0.00	0.89	2.28	86.11	75.23
70-CK-57-3- 4	76	358.50	63.77	1.30	75.93	1.88	0.24	4.50	70.69	71.88
70-CK-57-3- 5	64	289.10	78.59	1.26	62.14	0.76	0.00	3.76	61.94	71.35
70-CK-57-3- 6	80	265.52	66.61	2.20	84.02	2.24	0.00	2.06	77.47	78.58
70-CK-57-3- 7	2	214.55	65.05	1.52	51.09	0.63	0.28	0.80	93.00	90.29
70-CK-57-3- 8	10	206.80	73.86	1.70	52.65	0.73	0.31	1.41	87.03	91.77
70-CK-57-3- 9	73	496.57	53.50	2.43	60.72	1.76	1.28	7.02	109.21	96.93
70-CK-57-3-10	17	346.48	59.15	4.25	43.14	0.91	1.11	4.07	126.32	99.80
70-CK-57-3-11	33	227.74	71.61	2.94	64.82	1.32	0.16	4.79	93.33	94.99
70-CK-57-3-12	11	223.84	68.01	2.05	50.85	0.63	0.35	1.17	94.11	89.32

Table 6. Field and laboratory findings—Pedon 4.

PROFILE DESCRIPTION:

SAMPLE NUMBER	LAB NO.	HORIZON	DEPTH	THICKNESS	COLOR(M)	TEXTURE	STRUCTURE	CONSISTENCE
70-OK-57-4-01	40	AP	0- 22CM	22CM	10.0YR 2/2	SIL	1M&CPL	MVFR,DH
70-OK-57-4-02	75	A1	22- 33CM	11CM	10.0YR 3/2	SIL	1CPL	MVFR,DH
70-OK-57-4-03	83	B1	33- 53CM	20CM	10.0YR 4/3	SICL	2CPR-2MABK	MFI,DEH
70-OK-57-4-04	63	B21T	53- 81CM	28CM	7.5YR 3/2	SICL	2MPR-3F&MABK	MVFI,DEH
70-OK-57-4-05	66	B22T	81-104CM	23CM	7.5YR 4/2	SICL	1CPR-2F&MABK	MVFI,DEH
70-OK-57-4-06	49	B22TCA	104-124CM	20CM	7.5YR 4/4	SICL	2MABK	MVFI,DEH
70-OK-57-4-07	35	B23TCA	124-152CM	28CM	5.0YR 4/4	SICL	1MABK	MFI,DEH
70-OK-57-4-08	74	B24T	152-180CM	28CM	5.0YR 4/6	SICL	1MABK	MFI,DEH
70-OK-57-4-09	15	B31	180-200CM	20CM	2.5YR 4/4	SIC	1M&CABK	MFI,DEH
70-OK-57-4-10	61	B32CA	200-228CM	28CM	5.0YR 4/6	SICL	1MABK	MFI,DVH
70-OK-57-4-11	59	C1	228-259CM	31CM	5.0YR 4/4	C		MVFI,DEH
70-OK-57-4-12	45	C2	259-289CM	30CM	5.0YR 4/4	C		
70-OK-57-4-13	27	C3	289-320CM	31CM	5.0YR 4/4	C		

PHYSICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	PER CENT												CLASS
		GRA	VCS	CS	MS	FS	VFS	SAND	CSI	MSI	FSI	SILT	CLAY	
70-OK-57-4- 1	40	1.17	0.40	0.06	0.27	6.22	9.88	16.84	55.77	6.24	1.68	63.70	19.46	SIL
70-OK-57-4- 2	75	0.00	0.38	0.08	0.19	3.73	13.17	17.55	33.51	26.17	3.89	63.57	18.87	SIL
70-OK-57-4- 3	83	0.00	0.42	0.03	0.10	2.84	7.64	11.01	27.31	24.24	6.63	58.18	30.80	SICL
70-OK-57-4- 4	63	0.00	0.41	0.00	0.08	1.74	2.33	4.55	28.32	25.25	5.14	58.71	36.78	SICL
70-OK-57-4- 5	66	0.00	0.42	0.01	0.07	1.77	3.85	6.12	25.21	25.59	5.53	56.33	37.55	SICL
70-OK-57-4- 6	49	1.47	0.52	0.11	0.23	2.53	4.85	8.34	36.60	13.47	4.88	54.95	36.71	SICL
70-OK-57-4- 7	35	3.85	0.42	0.06	0.04	3.39	8.54	12.45	28.24	11.77	3.95	43.96	43.59	SIC
70-OK-57-4- 8	74	0.00	0.50	0.09	0.11	3.31	6.36	10.36	15.86	22.85	6.98	45.68	43.95	SIC
70-OK-57-4- 9	15	1.09	0.00	0.05	0.04	0.46	3.43	3.98	17.03	14.73	13.67	45.43	51.43	SIC
70-OK-57-4-10	61	0.76	0.57	0.09	0.10	0.00	0.00	0.76	9.05	20.92	17.35	47.32	53.18	SIC
70-OK-57-4-11	59	16.97	2.39	1.29	1.27	1.46	2.90	9.30	16.73	12.87	9.56	39.16	51.54	C
70-OK-57-4-12	45	2.50	0.67	0.43	0.59	1.25	1.68	4.62	11.48	0.00	4.28	15.76	82.28	C
70-OK-57-4-13	27	3.25	0.70	0.67	0.68	1.12	2.16	5.34	7.16	2.53	13.32	23.01	71.66	C

CHEMICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	EXTRACTABLE CATIONS MEQ/100 GMS						EXCHANGEABLE CATIONS MEQ/100 GMS				
		CA	MG	K	NA	H	AL	CA	MG	K	NA	SUM
70-OK-57-4- 1	40	3.90	3.69	0.20	0.62	4.19	0.00	8.89	3.46	0.18	0.41	12.93
70-OK-57-4- 2	75	5.24	0.80	0.22	1.24	3.81	0.00	5.24	0.77	0.21	0.75	6.97
70-OK-57-4- 3	83	5.45	1.99	0.29	2.65	3.28	0.00	5.45	1.97	0.28	2.20	9.90
70-OK-57-4- 4	63	9.67	5.59	0.33	4.56	2.51	0.00	9.67	5.53	0.33	3.98	19.50
70-OK-57-4- 5	66	10.24	5.64	0.34	5.68	0.40	0.00	10.24	5.58	0.33	4.95	21.10
70-OK-57-4- 6	49	11.88	7.44	0.30	5.89	0.09	0.00	11.88	7.34	0.29	4.68	24.19
70-OK-57-4- 7	35	13.56	7.86	0.25	5.85	0.73	0.00	13.58	7.75	0.24	4.54	26.12
70-OK-57-4- 8	74	11.37	5.80	0.31	5.79	0.42	0.00	11.37	5.76	0.31	4.98	22.41
70-OK-57-4- 9	15	15.75	8.84	0.14	4.72	0.66	0.00	15.70	8.77	0.12	4.08	28.67
70-OK-57-4-10	61	37.74	7.75	0.22	5.33	0.00	0.00	37.74	7.60	0.21	3.88	49.42
70-OK-57-4-11	59	38.15	7.29	0.32	4.04	0.00	0.00	38.15	7.16	0.31	3.04	48.66
70-OK-57-4-12	45	40.26	5.57	0.20	3.80	0.00	0.00	40.26	6.50	0.19	2.84	49.80
70-OK-57-4-13	27	28.16	9.81	0.19	2.75	0.00	0.00	28.08	9.70	0.18	2.01	39.96

SAMPLE NUMBER	LAB NO.	SOLUBLE CATIONS MEQ/100 GMS					SOLUBLE ANIONS MEQ/100 GMS				
		CA	MG	K	NA	SUM	CL	SO4	CO3	HCO3	SUM
70-OK-57-4- 1	40	0.01	0.23	0.02	0.21	0.47	0.53	0.00	0.03	0.46	1.03
70-OK-57-4- 2	75	0.00	0.03	0.01	0.49	0.53	0.04	0.00	0.03	0.33	0.41
70-OK-57-4- 3	83	0.00	0.02	0.01	0.44	0.47	0.00	0.00	0.03	0.40	0.44
70-OK-57-4- 4	63	0.00	0.06	0.01	0.58	0.65	0.45	0.00	0.03	0.40	0.88
70-OK-57-4- 5	66	0.00	0.06	0.01	0.72	0.79	0.50	0.00	0.03	0.45	0.98
70-OK-57-4- 6	49	0.00	0.11	0.01	1.21	1.33	1.16	0.00	0.03	1.04	2.23
70-OK-57-4- 7	35	0.00	0.10	0.01	1.32	1.44	1.29	0.00	0.09	1.26	2.64
70-OK-57-4- 8	74	0.00	0.03	0.01	0.82	0.86	0.11	0.00	0.03	0.57	0.71
70-OK-57-4- 9	15	0.05	0.06	0.01	0.65	0.77	0.25	0.00	0.00	0.35	0.60
70-OK-57-4-10	61	0.00	0.15	0.01	1.46	1.62	1.24	0.00	0.03	1.32	2.60
70-OK-57-4-11	59	0.00	0.13	0.01	1.00	1.14	0.90	0.00	0.03	1.10	2.04
70-OK-57-4-12	45	0.00	0.17	0.01	0.96	1.13	0.64	0.00	0.03	1.11	1.78
70-OK-57-4-13	27	0.08	0.12	0.01	0.74	0.96	0.84	0.00	0.12	0.92	1.87

SAMPLE NUMBER	LAB NO.	PER CENT	PPM	PER CENT	PER CENT	MIC MHS	1:1 PH		MEQ/100 GMS
		OM	TOTAL P	CACO3	TSS	1:5 EC	KCL	H2O	CEC
70-OK-57-4- 1	40	3.76	225.56	0.41	0.08	92.76	5.79	6.62	17.47
70-OK-57-4- 2	75	2.25	172.56	0.29	0.02	87.68	5.33	6.82	11.27
70-OK-57-4- 3	83	1.81	156.56	0.56	0.01	111.24	5.28	7.02	13.90
70-OK-57-4- 4	63	1.77	130.56	0.93	0.04	117.91	6.18	7.37	28.21
70-OK-57-4- 5	66	1.03	109.56	0.92	0.03	138.50	6.88	8.22	26.65
70-OK-57-4- 6	49	0.60	115.56	0.71	0.10	239.46	6.98	8.22	25.93
70-OK-57-4- 7	35	0.38	107.56	1.10	0.13	228.24	7.18	8.47	26.51
70-OK-57-4- 8	74	0.41	115.56	0.77	0.03	154.65	6.73	8.27	24.92
70-OK-57-4- 9	15	0.35	163.56	0.86	0.11	114.71	6.73	8.12	28.08
70-OK-57-4-10	61	0.39	194.56	6.08	0.08	257.37	7.03	8.42	33.88
70-OK-57-4-11	59	0.37	310.56	7.46	0.04	212.54	7.08	8.52	31.82
70-OK-57-4-12	45	0.37	270.56	4.26	0.06	220.22	6.93	8.02	36.81
70-OK-57-4-13	27	0.28	366.56	1.74	0.07	138.56	6.83	8.17	34.73

INTERPRETIVE CALCULATIONS:

SAMPLE NUMBER	LAB NO.	CA/MG	CEC/CLAY	ESP	SSP	SAP	SOLUBLE/EXTRACTABLE		BASE SATURATION	
							CA	MG	NAAC	SUM CAT
70-OK-57-4- 1	40	241.43	39.77	2.34	55.59	0.85	0.09	6.67	74.04	75.54
70-OK-57-4- 2	75	653.98	59.72	6.57	94.24	5.64	0.00	3.97	61.87	64.65
70-OK-57-4- 3	83	274.50	45.14	15.96	95.40	6.69	0.00	0.89	71.21	75.11
70-OK-57-4- 4	63	172.97	76.71	14.09	92.92	4.61	0.00	1.15	69.12	88.61
70-OK-57-4- 5	66	181.43	70.98	18.59	94.18	5.88	0.00	1.08	79.18	98.12
70-OK-57-4- 6	49	159.64	70.65	18.03	94.20	7.33	0.00	1.49	93.26	99.63
70-OK-57-4- 7	35	172.90	60.42	17.12	94.79	8.26	0.00	1.32	98.54	97.28
70-OK-57-4- 8	74	156.14	56.70	19.97	96.17	8.89	0.00	0.59	89.94	98.18
70-OK-57-4- 9	15	178.23	54.60	14.52	86.41	3.82	0.32	0.72	102.10	97.76
70-OK-57-4-10	61	486.69	53.71	11.44	93.70	7.48	0.00	2.00	145.87	100.00
70-OK-57-4-11	59	523.29	61.75	9.56	92.17	5.50	0.00	1.85	152.93	100.00
70-OK-57-4-12	45	603.40	44.72	7.73	90.36	4.66	0.00	2.58	135.31	100.00
70-OK-57-4-13	27	286.93	48.46	5.77	82.58	3.33	0.30	1.19	115.06	100.00

Table 7. Field and laboratory findings—Pedon 5.

PROFILE DESCRIPTION:

SAMPLE NUMBER	LAB NO.	HORIZON	DEPTH	THICKNESS	COLOR(M)	TEXTURE	STRUCTURE	CONSISTENCE
70-CK-57-5-01	84	AP	0- 20CM	20CM	10.0YR 3/2	SIL	2M&CPL	MVFR,DH
70-CK-57-5-02	41	A1	20- 38CM	18CM	10.0YR 3/2	SIL	2F&MGR	MVFR,DH
70-CK-57-5-03	68	A3	38- 50CM	12CM	7.5YR 3/2	SIL	1CPR-2MGR	MFR,DH
70-CK-57-5-04	7	B1	50- 60CM	10CM	5.0YR 3/2	SICL	1CPR-2MGR	MFI,DVH
70-CK-57-5-05	51	B21T	60- 91CM	31CM	5.0YR 4/3	SICL	2MPR-2FABK	MVFI,DVH
70-CK-57-5-06	22	B22TCA	91-116CM	25CM	5.0YR 4/3	SICL	2MABK	MVFI,DEH
70-CK-57-5-07	47	B3	116-142CM	26CM	5.0YR 5/3	SICL		
70-CK-57-5-08	69	C1	142-160CM	18CM	5.0YR 5/3			
70-CK-57-5-09	39	C2	160-193CM	33CM	5.0YR 4/2			
70-CK-57-5-10	19	C3	193-220CM	27CM	5.0YR 5/2			
70-CK-57-5-11	8	C4	220-236CM	16CM	2.5YR 4/2			

PHYSICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	PER CENT GRA	VCS	CS	MS	FS	VFS	SAND	CSI	MSI	FSI	SILT	CLAY	CLASS
70-CK-57-5- 1	84	0.00	0.38	0.03	0.12	4.79	12.44	17.76	34.75	22.56	5.54	62.84	19.40	SIL
70-CK-57-5- 2	41	1.21	0.43	0.09	0.28	6.93	12.62	20.34	43.01	10.16	1.50	54.77	24.89	SIL
70-CK-57-5- 3	68	0.00	0.43	0.04	0.19	4.08	9.57	14.31	29.21	23.40	3.93	56.54	29.15	SICL
70-CK-57-5- 4	7	0.80	0.00	0.16	0.41	5.52	10.97	17.07	38.34	10.51	3.59	52.44	31.45	SICL
70-CK-57-5- 5	51	1.24	0.54	0.14	0.24	3.68	8.50	13.10	40.75	11.58	4.13	56.47	30.43	SICL
70-CK-57-5- 6	22	0.91	0.00	0.00	0.00	2.07	11.26	13.34	36.33	12.23	3.82	52.38	35.27	SICL
70-CK-57-5- 7	47	1.21	0.45	0.07	0.15	1.70	9.85	12.23	40.97	14.39	5.41	60.78	26.99	SIL
70-CK-57-5- 8	69	0.00	0.41	0.00	0.03	2.14	12.32	14.89	24.94	27.10	6.39	58.43	26.69	SIL
70-CK-57-5- 9	39	1.52	0.43	0.02	0.11	3.36	6.49	10.41	39.39	19.90	5.56	64.85	24.74	SIL
70-CK-57-5-10	19	4.80	0.00	0.05	0.00	1.51	17.69	19.25	44.30	13.48	4.47	62.25	19.17	SIL
70-CK-57-5-11	8	0.80	0.00	0.05	0.15	2.96	8.39	11.55	33.18	22.67	9.17	65.02	24.40	SIL

CHEMICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	EXTRACTABLE CATIONS MEQ/100 GMS CA	MG	K	NA	H	AL	EXCHANGEABLE CATIONS MEQ/100 GMS CA	MG	K	NA	SUM
70-CK-57-5- 1	84	7.56	1.83	0.40	0.42	5.28	0.00	7.53	1.54	0.37	0.12	9.56
70-CK-57-5- 2	41	8.18	5.44	0.19	0.37	5.78	0.00	8.18	5.26	0.19	0.31	13.94
70-CK-57-5- 3	68	7.20	3.17	0.31	0.29	6.45	0.00	7.18	3.07	0.30	0.21	10.76
70-CK-57-5- 4	7	9.36	5.80	0.20	0.07	5.98	0.00	9.31	5.68	0.18	0.07	15.24
70-CK-57-5- 5	51	8.74	6.52	0.26	0.46	5.32	0.00	8.74	6.38	0.25	0.39	15.77
70-CK-57-5- 6	22	10.91	7.81	0.20	0.92	2.80	0.00	10.89	7.75	0.19	0.91	19.73
70-CK-57-5- 7	47	11.22	6.98	0.18	0.53	2.57	0.00	11.22	6.79	0.17	0.43	18.61
70-CK-57-5- 8	69	16.00	2.76	0.22	0.40	0.61	0.00	15.57	2.38	0.21	0.25	18.42
70-CK-57-5- 9	39	17.14	5.23	0.09	0.50	0.19	0.00	16.94	4.84	0.09	0.37	22.25
70-CK-57-5-10	19	12.76	4.77	0.03	0.97	0.25	0.00	12.43	4.55	0.02	0.89	17.89
70-CK-57-5-11	8	23.21	6.16	0.08	0.28	0.28	0.00	22.96	5.93	0.07	0.16	29.12

SAMPLE NUMBER	LAB NO.	SOLUBLE CATIONS MEQ/100 GMS CA	MG	K	NA	SUM	SOLUBLE ANIONS MEQ/100 GMS CL	SO4	CO3	HCO3	SUM
70-CK-57-5- 1	84	0.02	0.30	0.03	0.31	0.66	-0.00	0.00	0.03	0.53	0.56
70-CK-57-5- 2	41	0.00	0.17	0.01	0.06	0.24	0.30	0.00	0.03	0.26	0.59
70-CK-57-5- 3	68	0.02	0.10	0.01	0.07	0.20	0.22	0.00	0.03	0.22	0.48
70-CK-57-5- 4	7	0.05	0.12	0.02	0.00	0.19	0.37	0.00	0.00	0.22	0.60
70-CK-57-5- 5	51	0.00	0.14	0.01	0.07	0.21	0.33	0.00	0.03	0.20	0.57
70-CK-57-5- 6	22	0.02	0.06	0.01	0.01	0.09	0.14	0.00	0.07	0.15	0.36
70-CK-57-5- 7	47	0.00	0.19	0.01	0.09	0.30	0.40	0.00	0.03	0.28	0.71
70-CK-57-5- 8	69	0.43	0.38	0.00	0.15	0.96	1.23	0.00	0.09	0.76	2.07
70-CK-57-5- 9	39	0.20	0.39	0.00	0.13	0.71	0.62	0.00	0.03	0.63	1.29
70-CK-57-5-10	19	0.33	0.22	0.01	0.08	0.64	0.33	0.00	0.07	0.59	0.99
70-CK-57-5-11	8	0.25	0.23	0.02	0.12	0.62	0.37	0.00	0.00	0.58	0.95

SAMPLE NUMBER	LAB NO.	PER CENT OM	PPM TOTAL P	PER CENT CACO3	PER CENT TSS	MIC MHS 1:5 EC	1:1 PH KCL	H2O	MEQ/100 GMS CEC
70-CK-57-5- 1	84	3.73	218.56	0.55	0.03	121.05	5.28	6.42	11.11
70-CK-57-5- 2	41	2.38	173.56	0.44	0.04	54.61	5.28	6.27	19.59
70-CK-57-5- 3	68	2.16	165.56	0.56	0.01	27.00	4.98	6.17	19.14
70-CK-57-5- 4	7	1.77	155.56	0.52	0.08	-2.92	5.03	6.12	20.37
70-CK-57-5- 5	51	0.37	126.56	0.43	0.00	56.00	5.13	5.92	22.45
70-CK-57-5- 6	22	0.44	99.56	0.69	0.07	4.01	5.43	6.72	21.91
70-CK-57-5- 7	47	0.22	90.56	0.48	0.02	64.24	5.88	6.97	23.01
70-CK-57-5- 8	69	0.28	94.56	0.84	0.02	138.50	7.03	8.12	20.92
70-CK-57-5- 9	39	0.24	151.56	1.43	0.03	130.67	7.38	8.42	16.49
70-CK-57-5-10	19	0.19	219.56	1.18	0.08	87.94	7.33	8.67	12.98
70-CK-57-5-11	8	0.16	329.56	2.25	0.09	77.85	7.23	8.37	15.16

INTERPRETIVE CALCULATIONS:

SAMPLE NUMBER	LAB NO.	% CA/MG	% CEC/CLAY	ESP	SSP	SAR	% SOLUBLE/EXTRACTABLE CA	MG	% BASE SATURATION NAAC	SUM CAT
70-CK-57-5- 1	84	412.73	57.26	1.05	57.18	1.08	0.33	19.27	86.03	64.43
70-CK-57-5- 2	41	150.41	79.08	1.58	37.85	0.30	0.00	3.32	70.81	70.67
70-CK-57-5- 3	68	227.05	65.66	1.11	45.76	0.43	0.25	3.35	56.20	62.52
70-CK-57-5- 4	7	161.49	64.79	0.35	0.00	0.00	0.55	2.10	74.81	71.83
70-CK-57-5- 5	51	134.14	73.75	1.76	44.94	0.37	0.00	2.17	70.26	74.76
70-CK-57-5- 6	22	139.75	62.11	4.14	10.56	0.06	0.17	0.73	90.08	87.58
70-CK-57-5- 7	47	160.55	35.28	1.89	43.82	0.42	0.00	2.96	80.87	87.87
70-CK-57-5- 8	69	580.21	78.38	1.20	19.92	0.32	2.77	16.03	88.04	96.80
70-CK-57-5- 9	39	327.65	55.58	2.27	24.89	0.33	1.17	8.00	134.87	99.17
70-CK-57-5-10	19	267.66	57.70	6.85	15.24	0.21	2.65	4.78	137.81	98.64
70-CK-57-5-11	8	377.02	62.11	1.05	24.93	0.36	1.11	3.83	192.11	99.04

on a slightly convex relief and is moderately well drained. Groundwater level did not occur within 236 cm of the surface at the time of sampling. The A horizon is 50 cm thick with moderate fine and medium granular structure which continues to the B1 horizon. The B12t horizon displays a moderate medium prismatic parting to moderate fine granular blocky structure. Common distinct yellowish-red mottles and continuous or patchy clay films are present within the B horizon.

The laboratory analyses of the soil samples indicate an increase of about 20% in clay content from A1 to the A3 horizon. The B22tca horizon contains the largest amount of clay within this pedon. The particle size distribution of the upper 100 cm denotes the soil to be fine-silty in textural classification. The first 60 cm of the surface of the profile contains more than 1 percent organic matter (Figure 3). The soil reaction varies from neutral to strongly basic through the depth of the profile. Exchangeable bases are in the order of Ca^{++}, Mg^{++}, Na^{++}, and K^{+} and saturate more than 56 percent of the total exchange capacity. Exchangeable sodium percentage is insignificant and soluble salts are absent in this pedon (Figure 2).

Pedon 6 (Table 8) is a dark-colored soil which gets redder with depth. The soil is formed on a slightly convex relief. The soil is poorly drained and groundwater level was found at 233 cm below the surface. The A horizon is 35 cm thick with a weak fine platy to moderate medium granular structure. The B1 horizon displays a moderate medium prismatic parting to strong medium granular structure. Fine distinct yellowish mottles, and patchy and continuous clay films are noticeable within the B horizons. A few soft masses of calcium carbonate which cause slight to strong effervescence are present in the lower level of the profile.

The laboratory analyses of the pedogenic horizons indicate the clay content increases about 20 percent from the A1 to the B1 horizon. The mechanical analysis of the control section places this pedon into the fine-silty textural class. Organic matter is more than 1 percent in the upper 100 cm of the profile (Figure 3). The soil reaction varies from neutral to basic and strongly basic through the profile. The conductivity of 1:5 soil water extract indicates no significant amount of soluble salts. Exchangeable bases saturate 52 percent of B22t and more than 69 percent of the exchange capacity of the other horizons. Bases are present in the descending order of Ca^{++}, Mg^{++}, Na^{++}, and K^{+}. Exchangeable sodium saturates a negligible percent of the total cation exchange capacity of this pedon.

Pedon 7 (Table 9) displays a profile which is very dark grayish-brown in Ap and is dark brown in the A1 horizon. The horizons are redder toward the deeper layers of the profile. The soil is slow and somewhat

Table 8. Field and laboratory findings—Pedon 6.

PROFILE DESCRIPTION:

SAMPLE NUMBER	LAB NO.	HORIZON	DEPTH	THICKNESS	COLOR(M)	TEXTURE	STRUCTURE	CONSISTENCE
70-OK-57-6-01	32	AP1	0- 5CM	5CM	10.0YR 3/2	SIL	1FPL	MFR,DH
70-OK-57-6-02	9	AP2	5- 20CM	15CM	10.0YR 3/2	SIL	M-1MGR	MFR,DH
70-OK-57-6-03	85	A1	20- 35CM	15CM	10.0YR 3/2	SIL	2MGR	MFR,DH
70-OK-57-6-04	37	B1	35- 50CM	15CM	7.5YR 3/2	SICL	2MPR-3MGR	MFI-DH
70-OK-57-6-05	62	B21T	50- 68CM	18CM	5.0YR 4/3	SICL	1MPR-3MGR	MVFI,DVH
70-OK-57-6-06	78	B22T	68-101CM	33CM	5.0YR 4/3	SICL	2MABK	MVFI,DEH
70-OK-57-6-07	28	B23T	101-126CM	25CM	5.0YR 4/4	SIC	2MABK	MVFI,DEH
70-OK-57-6-08	1	B24CA	126-160CM	34CM	5.0YR 4/4	SIC	1MABK	MVFI,DEH
70-OK-57-6-09	56	B3	160-185CM	25CM	5.0YR 4/4	SICL	1CABK	MFI,DVH
70-OK-57-6-10	14	C1	185-205CM	20CM	5.0YR 4/4	SICL	M	MFI,DVH
70-OK-57-6-11	46	C2	205-233CM	28CM	5.0YR 7/2			
70-OK-57-6-12	38	C3	233-261CM	28CM	5.0YR 4/3			
70-OK-57-6-13	57	C4	261-279CM	18CM	5.0YR 4/3			

PHYSICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	PER CENT												
		GRA	VCS	CS	MS	FS	VFS	SAND	CSI	MSI	FSI	SILT	CLAY	CLASS
70-OK-57-6- 1	32	1.32	0.38	0.05	0.13	4.11	11.84	16.51	45.44	12.62	1.23	59.29	24.20	SIL
70-OK-57-6- 2	9	0.81	0.00	0.09	0.35	5.00	9.96	15.39	46.15	12.19	2.93	61.27	24.30	SIL
70-OK-57-6- 3	85	0.00	0.39	0.04	0.16	3.38	10.35	14.33	33.73	24.25	5.62	63.59	22.08	SIL
70-OK-57-6- 4	37	1.21	0.40	0.05	0.26	5.28	11.10	17.09	38.13	12.76	2.13	53.02	29.89	SICL
70-OK-57-6- 5	62	0.00	0.42	0.04	0.24	0.71	4.52	5.92	30.88	25.52	4.73	61.13	32.95	SICL
70-OK-57-6- 6	78	0.00	0.39	0.04	0.07	2.24	6.57	9.31	21.10	24.20	3.01	48.31	42.38	SIC
70-OK-57-6- 7	28	1.06	0.45	0.12	0.15	3.56	9.04	13.32	30.41	11.53	3.62	45.56	41.12	SIC
70-OK-57-6- 8	1	0.00	0.00	0.05	0.12	4.24	8.69	13.11	31.25	7.43	4.22	42.89	45.08	SIC
70-OK-57-6- 9	56	1.22	0.51	0.10	0.15	1.61	5.69	8.06	34.52	24.68	5.49	64.59	27.25	SICL
70-OK-57-6-10	14	0.82	0.00	0.00	0.00	1.24	10.99	12.23	36.11	13.98	6.39	56.49	32.22	SICL
70-OK-57-6-11	46	1.21	0.45	0.07	0.14	1.33	10.20	12.19	46.57	15.75	5.97	68.29	19.52	SIL
70-OK-57-6-12	38	1.20	0.44	0.05	0.10	5.80	12.53	18.92	29.03	18.46	7.83	55.32	25.76	SIL
70-OK-57-6-13	57	0.75	0.48	0.03	0.08	2.51	7.62	10.72	24.68	30.78	11.18	66.63	22.64	SIL

CHEMICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	EXTRACTABLE CATIONS MEQ/100 GMS						EXCHANGEABLE CATIONS MEQ/100 GMS				
		CA	MG	K	NA	H	AL	CA	MG	K	NA	SUM
70-OK-57-6- 1	32	11.47	3.74	0.48	0.45	5.14	0.00	11.29	3.29	0.39	0.34	15.31
70-OK-57-6- 2	9	9.93	4.20	0.19	0.04	5.35	0.00	9.76	4.00	0.17	0.04	13.97
70-OK-57-6- 3	85	7.25	2.19	0.34	0.43	5.98	0.00	7.23	1.98	0.32	0.13	9.65
70-OK-57-6- 4	37	8.90	5.13	0.25	0.41	6.57	0.00	8.90	4.96	0.24	0.34	14.44
70-OK-57-6- 5	62	9.05	3.94	0.32	0.39	7.27	0.00	9.05	3.83	0.31	0.27	13.45
70-OK-57-6- 6	78	10.34	5.18	0.44	0.77	6.53	0.00	10.34	5.13	0.43	0.43	16.33
70-OK-57-6- 7	28	14.56	6.41	0.29	1.06	3.18	0.00	14.54	6.37	0.28	0.86	22.05
70-OK-57-6- 8	1	18.22	7.44	0.35	0.57	1.96	0.00	17.87	7.20	0.34	0.32	25.74
70-OK-57-6- 9	56	15.59	5.41	0.34	0.97	1.41	0.00	15.41	6.03	0.33	0.61	22.38
70-OK-57-6-10	14	14.51	6.36	0.18	0.52	1.50	0.00	14.46	5.26	0.16	0.39	21.27
70-OK-57-6-11	46	12.71	5.23	0.15	0.95	0.33	0.00	12.66	4.84	0.15	0.56	18.21
70-OK-57-6-12	38	24.31	4.16	0.05	0.72	0.00	0.00	24.78	3.88	0.05	0.45	29.16
70-OK-57-6-13	57	30.01	5.23	0.17	0.97	0.00	0.00	29.93	4.96	0.17	0.64	35.70

SAMPLE NUMBER	LAB NO.	SOLUBLE CATIONS MEQ/100 GMS					SOLUBLE ANIONS MEQ/100 GMS				
		CA	MG	K	NA	SUM	CL	SO4	CO3	HCO3	SUM
70-OK-57-6- 1	32	0.18	0.45	0.08	0.11	0.82	0.76	0.00	0.03	0.63	1.42
70-OK-57-6- 2	9	0.17	0.20	0.02	0.00	0.39	0.40	0.00	0.00	0.30	0.70
70-OK-57-6- 3	85	0.02	0.21	0.01	0.31	0.56	0.00	0.00	0.03	0.35	0.38
70-OK-57-6- 4	37	0.00	0.17	0.01	0.07	0.24	0.31	0.00	0.03	0.24	0.58
70-OK-57-6- 5	62	0.00	0.12	0.01	0.13	0.25	0.07	0.00	0.03	0.24	0.34
~~70-OK-57-6- 6~~	~~78~~	~~0.00~~	~~0.35~~	~~0.01~~	~~0.34~~	~~0.40~~	~~0.05~~	~~0.00~~	~~0.03~~	~~0.24~~	~~0.32~~
70-OK-57-6- 7	28	0.02	0.04	0.01	0.20	0.27	0.24	0.00	0.06	0.23	0.54
70-OK-57-6- 8	1	0.35	0.24	0.02	0.24	0.85	0.59	0.00	0.00	0.76	1.35
70-OK-57-6- 9	56	0.19	0.39	0.01	0.36	0.94	0.91	0.00	0.03	0.84	1.78
70-OK-57-6-10	14	0.05	0.11	0.01	0.14	0.31	0.21	0.00	0.00	0.31	0.52
70-OK-57-6-11	46	0.04	0.39	0.00	0.38	0.83	0.71	0.00	0.03	0.77	1.51
70-OK-57-6-12	38	0.03	0.28	0.00	0.26	0.57	0.62	0.00	0.03	0.63	1.29
70-OK-57-6-13	57	0.08	0.27	0.01	0.33	0.68	0.78	0.00	0.03	0.67	1.48

SAMPLE NUMBER	LAB NO.	PER CENT	PPM	PER CENT	PER CENT	MIC MHS	1:1 PH		MEQ/100 GMS
		OM	TOTAL P	CACO3	TSS	1:5 EC	KCL	H2O	CEC
70-OK-57-6- 1	32	4.48	240.56	0.99	0.11	113.50	5.88	6.77	18.88
70-OK-57-6- 2	9	3.08	214.56	0.58	0.12	18.56	5.38	6.27	17.89
70-OK-57-6- 3	85	2.86	191.56	0.55	0.02	115.07	5.03	6.27	11.81
70-OK-57-6- 4	37	2.25	192.56	0.30	0.03	50.38	5.23	6.17	20.72
70-OK-57-6- 5	62	1.68	162.56	0.75	0.00	25.66	4.98	6.27	25.71
70-OK-57-6- 6	78	1.22	121.56	0.57	0.00	64.51	5.13	6.42	22.57
70-OK-57-6- 7	28	0.46	108.56	0.92	0.03	50.03	6.08	7.37	28.13
70-OK-57-6- 8	1	0.35	103.56	0.89	0.11	127.94	6.73	7.82	25.28
70-OK-57-6- 9	56	0.24	109.56	0.81	0.04	158.84	6.88	7.72	24.27
70-OK-57-6-10	14	0.18	127.56	0.70	0.07	28.20	6.43	7.77	21.40
70-OK-57-6-11	46	0.29	164.56	0.56	0.04	144.75	5.83	7.97	21.03
70-OK-57-6-12	38	0.05	317.56	4.34	0.04	120.70	7.43	8.47	13.16
70-OK-57-6-13	57	0.03	283.56	2.76	0.02	139.32	7.13	8.32	18.70

INTERPRETIVE CALCULATIONS:

SAMPLE NUMBER	LAB NO.	% CA/MG	% CEC/CLAY	ESP	SSP	SAR	% SOLUBLE/EXTRACTABLE		% BASE SATURATION	
							CA	MG	NAAC	SUM CAT
70-OK-57-6- 1	32	307.01	78.02	1.78	17.34	0.28	1.61	13.57	81.11	74.86
70-OK-57-6- 2	9	236.35	73.63	0.20	0.00	0.00	1.70	4.94	78.09	72.31
70-OK-57-6- 3	85	330.75	53.47	1.08	66.12	1.27	0.34	10.64	81.79	61.77
70-OK-57-6- 4	37	173.53	69.33	1.64	39.76	0.33	0.00	3.39	69.67	68.73
70-OK-57-6- 5	62	229.58	78.04	1.04	61.57	0.74	0.00	3.02	52.32	64.92
70-OK-57-6- 6	78	199.65	53.26	1.92	89.62	3.14	0.00	0.92	72.37	71.43
70-OK-57-6- 7	28	227.02	68.41	3.05	76.07	1.63	0.13	0.63	78.40	87.38
70-OK-57-6- 8	1	244.72	56.09	1.28	34.75	0.64	1.95	3.33	101.79	92.91
70-OK-57-6- 9	56	243.07	89.06	2.51	48.81	0.95	1.20	6.43	92.20	94.08
70-OK-57-6-10	14	228.04	66.40	1.80	52.25	0.69	0.35	1.69	99.38	93.39
70-OK-57-6-11	46	242.98	107.74	2.68	60.24	1.16	0.35	8.15	86.60	98.21
70-OK-57-6-12	38	596.53	51.08	3.43	60.10	0.95	0.13	7.20	221.57	100.00
70-OK-57-6-13	57	573.81	82.59	3.41	59.64	1.12	0.27	5.37	190.92	100.00

Table 9. Field and laboratory findings—Pedon 7.

PROFILE DESCRIPTION:

SAMPLE NUMBER	LAB NO.	HORIZON	DEPTH	THICKNESS	COLOR(M)	TEXTURE	STRUCTURE	CONSISTENCE
70-CK-57-7-01	12	AP	0- 7CM	7CM	10.0YR 3/2	FSL	2M&CPL	MVFR,DH
70-CK-57-7-02	21	A1	7- 20CM	13CM	7.5YR 3/2	FSL	1M&CPL	MVFR,DH
70-CK-57-7-03	18	B21T	20- 35CM	15CM	7.5YR 3/2	CL	2M&CPR	MVFI,DEH
70-CK-57-7-04	60	B22T	35- 55CM	20CM	5.0YR 4/3	SICL	2MPR-3F&MABK	MVFI,DEH
70-CK-57-7-05	71	B23T	55- 71CM	16CM	5.0YR 4/3	SICL	2F&MABK	MVFI,DEH
70-CK-57-7-06	26	B31	71-104CM	33CM	5.0YR 4/4	SICL	1MABK	MVFI,DVH
70-CK-57-7-07	65	B32	104-134CM	30CM	5.0YR 4/4	SICL	1M&CABK	MVFI,DVH
70-CK-57-7-08	70	C1	134-180CM	46CM	5.0YR 4/3			
70-CK-57-7-09	52	C2	180-228CM	48CM	5.0YR 4/2			
70-CK-57-7-10	50	C3	228-243CM	15CM	5.0YR 5/3			

PHYSICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	PER CENT GRA	VCS	CS	MS	FS	VFS	SAND	CSI	MSI	FSI	SILT	CLAY	CLASS
70-CK-57-7- 1	12	0.82	0.00	0.04	0.14	4.82	16.28	21.28	52.76	9.82	2.93	65.50	14.05	SIL
70-CK-57-7- 2	21	0.92	0.00	0.00	0.12	3.76	16.40	20.27	55.22	10.47	1.18	66.86	13.75	SIL
70-CK-57-7- 3	18	0.87	0.00	0.00	0.04	3.50	11.66	15.20	35.92	9.13	1.84	46.89	38.79	SICL
70-CK-57-7- 4	60	0.94	0.50	0.07	0.19	2.98	9.57	13.32	28.65	20.08	3.03	51.76	34.92	SICL
70-CK-57-7- 5	71	0.00	0.43	0.00	0.03	3.68	10.49	14.64	20.87	21.72	4.72	47.30	38.06	SICL
70-CK-57-7- 6	26	0.89	0.36	0.00	0.00	7.96	17.92	26.24	29.15	7.45	2.80	39.40	34.38	CL
70-CK-57-7- 7	65	2.54	0.45	0.00	0.06	7.60	17.31	25.42	25.40	19.26	5.57	50.23	24.36	SIL
70-CK-57-7- 8	70	0.00	0.41	0.00	0.01	5.75	12.62	18.78	17.76	30.37	8.07	56.20	25.02	SIL
70-CK-57-7- 9	52	10.20	0.74	0.17	0.26	1.84	11.34	14.36	48.67	15.30	7.11	71.09	14.55	SIL
70-CK-57-7-10	50	10.05	0.65	0.10	0.16	1.76	20.50	23.18	48.18	10.95	5.77	64.90	11.92	SIL

CHEMICAL ANALYSIS:

SAMPLE NUMBER	LAB NO.	EXTRACTABLE CATIONS MEQ/100 GMS CA	MG	K	NA	H	AL	EXCHANGEABLE CATIONS MEQ/100 GMS CA	MG	K	NA	SUM
70-CK-57-7- 1	12	6.68	2.40	0.11	0.44	2.19	0.00	6.63	2.29	0.09	0.23	9.24
70-CK-57-7- 2	21	4.78	2.71	0.04	1.91	1.01	0.00	4.73	2.68	0.03	1.45	8.89
70-CK-57-7- 3	18	5.86	4.97	0.22	9.91	0.83	0.00	5.81	4.89	0.20	8.35	19.25
70-CK-57-7- 4	60	6.07	6.16	0.43	15.07	0.97	0.00	6.07	5.91	0.41	12.11	24.50
70-CK-57-7- 5	71	4.31	4.15	0.40	15.13	0.05	0.00	4.31	4.05	0.39	11.25	20.01
70-CK-57-7- 6	26	5.24	6.21	0.20	10.93	0.00	0.00	5.22	6.19	0.19	9.18	20.79
70-CK-57-7- 7	65	10.49	3.63	0.20	7.69	0.00	0.00	10.49	3.55	0.18	5.11	19.34
70-CK-57-7- 8	70	13.79	2.71	0.23	5.60	0.00	0.00	13.79	2.62	0.22	4.04	20.67
70-CK-57-7- 9	52	29.34	3.79	0.09	1.79	0.00	0.00	29.34	3.63	0.09	1.08	34.15
70-CK-57-7-10	50	25.56	4.46	0.08	1.14	0.00	0.00	25.58	4.26	0.08	0.66	30.58

SAMPLE NUMBER	LAB NO.	SOLUBLE CATIONS MEQ/100 GMS CA	MG	K	NA	SUM	SOLUBLE ANIONS MEQ/100 GMS CL	SO4	CO3	HCO3	SUM
70-CK-57-7- 1	12	0.05	0.11	0.03	0.21	0.40	0.39	0.00	0.00	0.42	0.81
70-CK-57-7- 2	21	0.05	0.03	0.01	0.45	0.55	0.56	0.00	0.07	0.51	1.14
70-CK-57-7- 3	18	0.05	0.08	0.02	1.56	1.71	1.60	0.00	0.07	0.83	2.50
70-CK-57-7- 4	60	0.00	0.24	0.02	2.96	3.22	1.90	0.00	0.03	1.16	3.09
70-CK-57-7- 5	71	0.00	0.10	0.01	3.88	3.99	1.81	0.00	0.03	1.23	3.07
70-CK-57-7- 6	26	0.02	0.02	0.01	1.75	1.79	1.21	0.00	0.12	0.99	2.32
70-CK-57-7- 7	65	0.00	0.08	0.01	2.58	2.67	1.88	0.00	0.17	1.72	3.77
70-CK-57-7- 8	70	0.00	0.09	0.01	1.56	1.66	1.03	0.00	0.11	1.36	2.50
70-CK-57-7- 9	52	0.00	0.16	0.00	0.71	0.87	0.85	0.00	0.03	0.91	1.78
70-CK-57-7-10	50	0.00	0.20	0.01	0.48	0.69	0.93	0.00	0.03	0.75	1.72

SAMPLE NUMBER	LAB NO.	PER CENT OM	PPM TOTAL P	PER CENT CACO3	PER CENT TSS	MMC MHS 1:5 EC	1:1 PH KCL	H2O	MEQ/100 GMS CEC
70-CK-57-7- 1	12	2.65	163.56	0.38	0.11	41.78	5.83	6.92	9.55
70-CK-57-7- 2	21	1.69	126.56	0.60	0.13	92.29	6.33	7.07	8.14
70-CK-57-7- 3	18	1.89	130.56	0.89	0.24	335.53	6.99	8.42	22.33
70-CK-57-7- 4	60	1.61	123.56	1.00	0.24	662.59	7.38	8.47	27.14
70-CK-57-7- 5	71	1.03	110.56	0.96	0.25	733.32	7.38	8.42	24.76
70-CK-57-7- 6	26	0.51	93.56	1.10	0.16	315.90	7.28	8.67	20.92
70-CK-57-7- 7	65	0.32	78.56	1.78	0.17	479.64	7.48	8.77	19.23
70-CK-57-7- 8	70	0.35	117.56	1.26	0.11	287.96	7.18	8.92	19.99
70-CK-57-7- 9	52	0.21	225.56	16.80	0.04	156.88	7.58	8.82	15.29
70-CK-57-7-10	50	0.18	93.56	6.24	0.04	138.91	7.43	8.72	11.31

INTERPRETIVE CALCULATIONS:

SAMPLE NUMBER	LAB NO.	% CA/MG	% CEC/CLAY	FSP	SSP	SAR	% SOLUBLE/EXTRACTABLE CA	MG	% BASE SATURATION NAAC	SUM CAT
70-CK-57-7- 1	12	278.71	67.92	2.40	58.81	1.05	0.77	4.77	96.76	80.81
70-CK-57-7- 2	21	176.51	59.17	17.93	84.37	3.24	1.08	1.02	109.28	89.81
70-CK-57-7- 3	18	117.33	57.57	37.39	92.72	8.52	0.88	1.70	86.20	95.88
70-CK-57-7- 4	60	98.51	77.73	44.63	94.70	12.00	0.00	4.12	90.26	96.18
70-CK-57-7- 5	71	103.99	65.05	45.43	98.10	25.05	0.00	2.37	80.81	99.73
70-CK-57-7- 6	26	84.42	60.86	43.90	97.43	18.48	0.35	0.28	99.37	100.00
70-CK-57-7- 7	65	288.79	78.88	26.60	97.50	17.88	0.00	2.34	100.58	100.00
70-CK-57-7- 9	70	509.44	79.90	20.21	96.03	10.44	0.00	3.42	103.38	100.00
70-CK-57-7- 9	52	774.55	105.07	7.09	88.70	3.59	0.00	4.27	223.32	100.00
70-CK-57-7-10	50	573.89	94.69	5.84	80.39	2.16	0.00	4.72	270.33	100.00

poorly drained and occurs on a slightly convex area. Groundwater was not noted on the day of digging the pit, but water had seeped in seven days later and accumulated at the depth of 236 cm which is 56 cm below the lower boundary of the solum. The A horizon is only 20 cm thick with a medium and coarse platy structure. The B2 subhorizons are prismatic in structure. The prisms are capped with material which is lighter in color than the prisms. Peds are coated with black stains. Patchy and continuous clay films and a few soft masses of calcium carbonate are observable in subsurface horizons.

The quantitative analysis of this pedon indicates that clay increases from 13 to 38 percent from the A to B horizon. The physical analysis of the control section dénotes that this soil belongs to the fine textural classes in family grouping. Organic matter decreases with depth, and the upper 71 cm indicates more than one percent organic matter (Figure 4). The soil reaction is neutral in Ap, basic in A1, and strongly basic throughout the rest of the profile. The chemical analysis of the soil water extract shows that: although soluble salt content is not significantly high, the major salts are sodium bicarbonates. The exchangeable Ca^{++}, Mg^{++}, Na^{+}, and K^{+} occupy more than 80 percent of the total cation exchange capacity of this profile. Exchangeable sodium content is very high in subsurface horizons and saturates up to 45 percent of the exchange complex (Figure 2).

Clay mineralogy

The X-ray diffraction patterns for the selected A, B, and C horizons of the selected pedons 1, 4, and 7 are given in this section separately. The cation exchange capacity and K_2O content of fine and coarse clays are also presented in this section (Table 10). The CEC/clay ratio can be found in the tables presenting the morphology and laboratory findings (Tables 3 through 9).

Pedon 1. The x-ray diffraction patterns (Figure 4) showed the coarse and the fine clay maxima of A1 to be 15.76A which did not expand as the specimen was solvated with glycerol. This reflects the presence of micaceous clays. A diffraction spacing of 10.15A° was found for the B23t indicating the presence of illite. The fine clay particles of B23t showed the maximum of 7.24A° which is obtained from metaholloysite. The B3 horizon is very similar to the B23t horizon and contains illite and metaholloysite. In the C horizon the coarse and fine clay maxima are at approximately 14A°, with glycerol coarse clay expands to 17.65A° but fine clays remain the same. This indicates the presence of some montmorillonite in the coarse subfractions and of vermiculite in the fine subfractions of the C horizons.

Pedon 4. The x-ray diffraction patterns indicate (Figure 5) a diffraction spacing of approximately 18.39A° for the mg-saturated specimens of Ap. The fine and coarse specimens did not expand when solvated with glycerol. This reflects considerable low angle scatter due to inter-

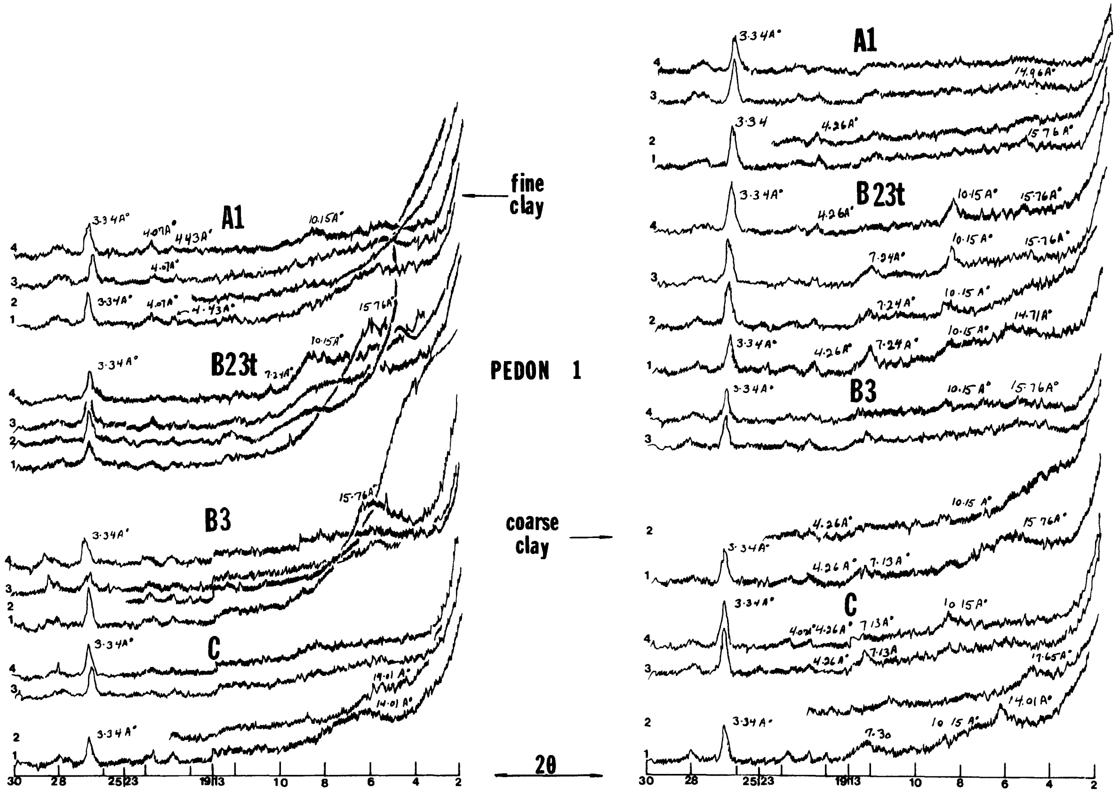


Figure 4. X-ray diffractograms for Pedon 1: (1) Mg-saturated, (2) glycerol solvated, (3) K-saturated and (4) heated to 500° C.

Table 10. Laboratory Analysis of the Clay Subfactions

Horizon	Lab. No.	Coarse Clay 2.0-0.2 μ Percent	% K_2O	CEC	Fine Clay <0.2 μ Percent	% K_2O	CEC	FC/CC
				PEDON 1				
A1	30	58.16	2.71	44.75	41.84	1.04	78.98	0.72
B23t	16	42.58	2.54	40.16	57.42	1.20	75.25	1.35
B3	34	51.73	2.20	56.63	48.27	0.99	75.71	0.93
C	6	75.40	2.16	46.88	24.59	1.28	59.55	0.33
				PEDON 4				
Ap	40	54.28	2.02	58.56	45.72	1.15	62.82	0.84
B22t	66	38.36	2.08	40.43	61.64	1.05	64.48	1.61
B31	15	67.08	2.32	58.60	32.92	1.01	58.58	0.49
C2	45	71.01	3.04	34.93	28.91	2.41	49.28	0.41
				PEDON 7				
Ap	12	61.23	2.27	64.55	38.37	0.81	70.36	0.62
B21t	18	48.39	1.81	49.48	51.61	0.59	64.38	1.06
B23t	71	52.82	1.76	59.95	47.18	1.08	56.43	0.89
C3	50	82.07	2.23	55.09	17.92	1.88	72.22	0.21

layered montmorillonite in coarse and fine subfractions. The x-ray diffraction patterns of B22t are similar to Ap. The coarse clay of B31 has a good' 14.01A° and 7.24A° maximum which collapses when heated to 500°C. This indicates the presence of vermiculite and kaolinite. The good 10.04A° maximum is sharpened when saturated with K+ and remained sharp when heated to 500°C. This reflects the contracted mica. The clear 7.31A° maximum demonstrates the presence of kaolinite.

The clay mineralogy data indicates a mixture of micaceous and montmorillonitic minerals in all of the selected horizons. Of particular significance in this determination is the x-ray diffraction patterns, the cation exchange capacity of less than 80 mgq/100 and the K_2O content of less than four percent of either fine or coarse clay particles.

Discussion

Soil characterization is the measurement of soil properties for the better understanding of soil genesis and taxonomy. The quantitative values which the experimenter uses to judge a character under investigation may not be a single measurement. It may be a derived number of some function of several measurements under time to time laboratory conditions. The slipped block design removes day to day errors of measurements when treatments effects are adjusted for block effects. Calculations for this design are time consuming; however, computers were

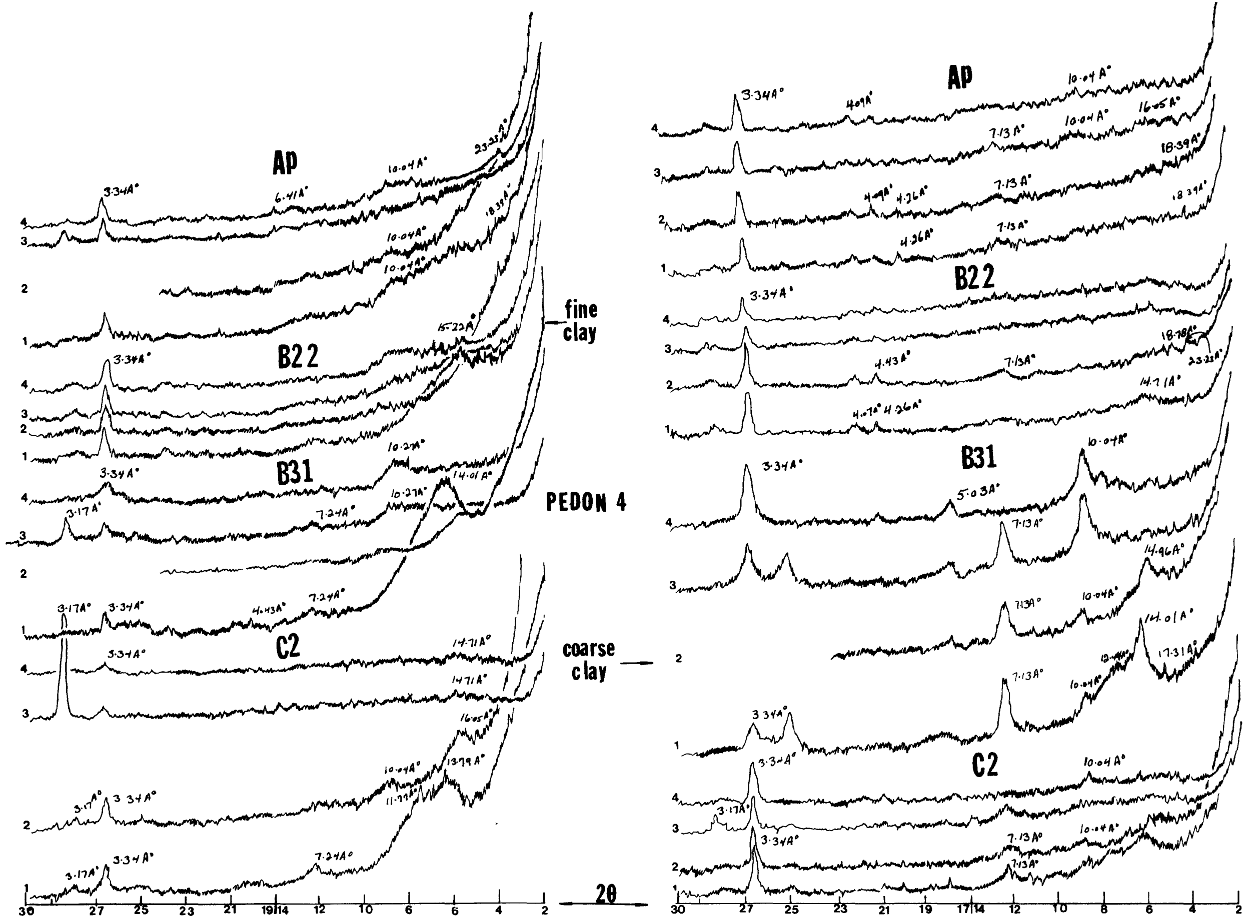


Figure 5. X-ray diffractograms for Pedon 4: (1) Mg-saturated, (2) glycerol solvated, (3) K-saturated and (4) heated to 500° C.

applied to enhance the computation processes. In clustering the horizons, the treatment effects were used, and no manipulations were necessary.

The morphology and laboratory data indicate the presence of mollic epipedons and argillic horizons (Figure 3 and Tables 3-9). Organic matter, value, and chroma, base saturation and the total thickness of the surface horizons are in the range of those for mollic epipedons. Clay distribution curves, fine/coarse clay ratios of greater than one, and the presence of clay skins around the peds prove the existence of argillic horizons, some diagnostic, subsurface horizons were recognized as natric horizons.

For the purposes of numerical taxonomy, all the laboratory and interpretative data are considered in clustering the pedogenic horizons. The following criteria are suggested by the author for distinguishing the salt affected soils from non-salt affected soils. These criteria are somewhat similar to those used for Australian soils as explained by Northcothe and Skene (1972).

Salinity. The conductivity values of the 1:5 soil water extract at 25°C have been chosen in order to represent the salinity classes. These limits are based on the soluble salt content which have a bearing on the performance of many, although not all, agricultural crops.

Class 1. Non-Saline : $ECX10^6 \leqslant 800$
Class 2. Saline : $800 < ECX10^6 < 1600$
Class 3. Strongly Saline : $1600 \leqslant ECX10^6$

Alkalinity. The values of pH of a 1:1 soil water paste express the alkalinity of a soil. The pH values of 8.0 to 9.0 reflect significant amounts of exchangeable sodium held in the exchange complex. Soils with pH 9.0 are invariably strongly alkaline and soluble carbonates are present in the water extract.

Class 1. Non-alkaline : $pH \leqslant 8.0$
Class 2. Alkaline : $8.0 < pH < 9.0$
Class 3. Strongly Alkaline : $9.0 \leqslant pH$

Sodicity. The percent of exchangeable sodium reflects the processes of soil formation as well as having agricultural importance. Values of less than 6 indicated no change in the morphology of the profiles. Those subsurface horizons with ESP of 6 or more reflect particular morphological features like dispersion of soil colloids and formation of prismatic structure parting to blocky structure. When ESP exceeds 15, soils exhibit adverse properties due to dominance of exchangeable sodium. Soil colloids disperse almost completely, prismatic and columnar structures are capped with silty material due to removal of clay particles. The changes in physical properties decreases the soil productivity and produces the sodic soils—those with slickspots on the surface.

Class 1. Non-Sodic : ESP $\leqslant$ 6
Class 2. Sodic : 6 < ESP < 15
Class 3. Strongly Sodic : $\leqslant$ESP

One meter is the profile depth adopted for consideration and maximum values for ECX10^6, pH, and ESP within the profile, irrespective of the position of the horizon is taken to be diagnostic. Using the three criteria: Salinity, alkalinity, and sodicity, a salt-affected soil is classified according to the most highly salt-affected category, it fits into within the criteria. All of the pedons under investigation belong to the non-saline class. Within this class pedons 1, 2, 4, and 7 fit into the alkaline-strongly sodic class which indicates a pH of 8.0 to 9.0 and an ESP of 15 or more for the upper one meter of the profile. (See Figure 4).

Table 11. Comparison of Numerical and Conventional Taxonomy.

Pedon	Numerical Taxonomy Group	Conventional Taxonomy Subgroup	Family
1	I	Typic Natrustoll	fine, mixed, thermic
2	I	Typic Natrustoll	fine, mixed, thermic
3	III	Pachic Argiustoll	fine, silty, mixed, thermic
4	IV	Nazdic Argiustoll	fine, mixed, thermic
5	V	Pachic Argiustoll	fine, silty, mixed, thermic
6	V	Pachic Argiustoll	fine, silty, mixed, thermic
7	II	Typic Natrustoll	fine, mixed, thermic

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