9-1976

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Lewis, David T., "Properties of Soils in the Solid Set Irrigation Area of the Sandhills Agricultural Laboratory" (1976). *Historical Research Bulletins of the Nebraska Agricultural Experiment Station (1913-1993)*. 51.
http://digitalcommons.unl.edu/ardhistrb/51

Research Bulletin

278

September 1976

Properties of Soils in the Solid Set Irrigation Area of the Sandhills Agricultural Laboratory

by

David T. Lewis

The Agricultural Experiment Station
Institute of Agriculture and Natural Resources
University of Nebraska – Lincoln
H. W. Ottoson, Director

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Issued September 1976, 1,000

SUMMARY

The introduction of irrigated agriculture and the attendant increase in intensity of land use for agricultural purposes in the Sandhills region of Nebraska requires additional data regarding soils in the area. This work investigated landscape relationships and some of the morphological, physical, chemical, and mineralogical properties of the soil in one irrigated valley.

The soils in this valley contain greater amounts of silt and clay than do the soils on the nearby dunes. In addition, some of the valley soils contain layers of much higher clay content and corresponding cation exchange and water holding capacity than the dunal soils and irregular patterns on weathering ratios suggest that the geological materials, hence the soils, in the valleys are highly stratified.

Significant amounts of potassium bearing feldspar minerals were present, but no apatite minerals were noted. Clays were largely illite, but some chlorite-like clays were noted in the soils at one site. The presence of the layers that contain a relatively high amount of clay, the abundance of potassium feldspars, and the absence of a reserve of phosphorus in these soils as well as the other chemical and physical data have significant bearing on planning agricultural practices on the land.

Properties of Soils in the Solid Set Irrigation Area of the Sandhills Agricultural Laboratory

David T. Lewis[1]

INTRODUCTION

The Sandhills region of Nebraska has until recently been used principally as rangeland. With the development of center pivot irrigation systems, part of the area has come under cultivation practices that include the addition of supplemental water from deep wells and heavy applications of fertilizer materials. To plan the application of proper amounts of water and fertilizer and to understand the results of application of these materials, it is necessary to have detailed information regarding the chemical, physical, and mineralogical properties of the soil being irrigated and fertilized. This study gathered these data for an irrigated area at the Sandhills Agricultural Laboratory located near the town of Tryon in McPherson County, Nebraska.

The Sandhills Agricultural Laboratory is located within the Valentine-Anselmo Soil Association (8, 13). Within this association the soils on the ridges formed in eolian sand on a dune topography (5) and have been correlated as Valentine fine sand (Typic Ustipsamment). Soils in the interdunal valleys within this region are often somewhat higher in silt and clay content and have a thicker surface horizon than the Valentine soils, and are most often within the Dunday Soil Series (Entic Haplustoll) or within the Anselmo Series (Typic Haplustoll) (2). Burzlaff (1) reported that soils in the interdunal valleys of the Sandhills had finer textures and a greater amount of organic matter in the surface horizons than the soils in the dunes.

The area studied is within a broad valley between large dunes. Even so, the soils were mapped as Valentine fine sand during the soil survey of McPherson County (13). A recent and more detailed survey showed that the soils on part of this area contained layers of finer materials within the soil profile (unpublished data, Dr. Daryl Smika, A.R.S., U.S.D.A.). These soils were tentatively named Valentine fine sand, loamy substratum phase. The presence of these finer materials within the profile has an effect on irrigation and fertility management practices and has implications as to the origin of the materials within this and other interdunal valleys where more intensive farming is or may be practiced under irrigation. For this reason a study was undertaken to determine the major chemical, physical, and mineralogical properties of these soils.

Very few of these types of data for soils within the Sandhills exist.

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[1] David T. Lewis is Associate Professor, Soil Survey, Department of Agronomy.

The Soil Survey Staff (15) has characterized the modal profiles of many of the Soil Series presently established in the region, but present no data regarding mineral types. Sautter (12) found 18 to 25 percent potassium feldspars within the Valentine soils and Dune sand but made no mention of the presence of finer materials within the profile. Unpublished data (Dr. Hank Bart, Department of Geology, University of Nebraska, Lincoln) indicate 23–28 percent total feldspar content in dune sand (probably the Valentine soil), but no data were taken for soils in the interdunal valleys.

MATERIALS AND METHODS

Preliminary field examination of soils in the solid set irrigation area of the Sandhills Agricultural Laboratory led to the selection of a sequence of five soils for study. These soils are on a transect across the area and include soils representative of the area and a soil on one of the nearby large dunes. Pits were dug at each site and samples of each soil horizon were taken for laboratory analysis. Elevations were taken along the transect so that relative topographic positions of the soils sampled would be known.

Particle size distribution was determined with the pipette (6) after removal of carbonates and divalent cations with soidum acetate and of organic matter with hydrogen peroxide. Sand was separated from the silt and clay fraction by sieving. The various separates were prepared for petrographic and x-ray studies following the method outlined by Jackson (4). Heavy and light minerals in the sand and silt fraction were separated in bromoform (10) and plated on slides in gelatin for petrographic analysis (3). Staining procedures like those described by Sautter (12) were used to aid in identification of potassium feldspars.

Soil reaction was determined using a Beckman glass electrode pH meter at 1:1 soil-water ratio and cation exchange capacity was measured by the ammonium acetate method. A Perkin-Elmer, Model 303 atomic absorption spectrophotometer and an Instrumentation Laboratory flamephotometer, Model 143, were used to determine the amount of extractable bases. Available phosphorus was determined by the modified Bray method and organic carbon was determined by chromic acid reduction.

Oriented specimens of clay were mounted on glass slides for x-ray diffraction analysis following Mg saturation and glycerol solvation. Apatite content was determined through the method described by Shipp and Matelski (14).

RESULTS

Location of the soil samples and their relative landscape positions are shown in Figure 1. Sites 1 through 4 are within the solid set irrigation area located in a dry valley with the north valley wall marked by a dune with a crest 21 meters above the average elevation

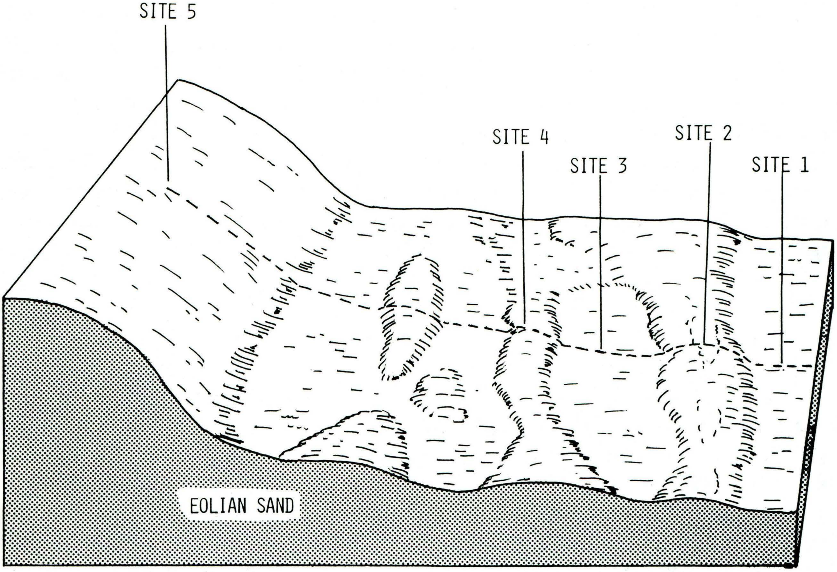


Figure 1. Landscape relationships and location of sample sites.

of the valley floor. The longitudinal axis of this dune is approximately E-W and appears to be one of the dunes formed during the second episode of dune formation in the Sandhills (5). The low ridges on which sites 2 and 4 are located are 2 to 3 meters higher in elevation than the location of sites 1 and 3 (Figure 1).

Morphological descriptions follow.

Site 1

A1	0–30 cm very dark gray (10YR3/1) fine sand, weak very fine granular structure, very friable, clear smooth boundary.
AC	30–45 cm dark grayish brown (10YR4/2) loamy fine sand, weak very fine granular structure, very friable, clear smooth boundary.
C1	45–85 cm brown (10YR5/3) loamy fine sand, structureless massive, very friable, abrupt wavy boundary.
C2	85–120 cm brown (10YR4/3) fine sand, structureless massive, friable, abrupt wavy boundary.
II Ab	120–140 cm very dark grayish brown (10YR3/2) fine sandy loam with common medium distinct dark brown (7.5YR4/4) mottles, moderate fine subangular blocky structure, friable, clear wavy boundary.
II Bb	140–155 cm very dark grayish brown (2.5YR3/2) fine sandy loam with common medium distinct dark brown (7.5YR4/4) mottles, moderate medium blocky structure, friable, clear wavy boundary.

III Ab	155–177 cm very dark brown (10YR2/2) loamy fine sand, moderate very fine blocky structure, friable, clear wavy boundary.
III C	177–225 cm light gray (10YR7/1) fine sand, structureless single grain, very friable.

Site 2

Alp	0–20 cm very dark grayish brown (10YR3/2) loamy fine sand, moderate very fine granular structure, friable, abrupt smooth boundary.
A12	20–43 cm dark brown (10YR3.5/2) loamy fine sand, weak very fine granular structure, friable, gradual wavy boundary.
AC	43–73 cm dark grayish brown (10YR4/2) loamy fine sand, structureless single grain, friable, gradual wavy boundary.
C1	73–135 cm grayish brown (10YR5/2) fine sand, weak coarse prismatic structure, slightly hard, abrupt wavy boundary.
C2	135–180 cm yellowish brown (10YR5/4) fine sand, moderate coarse prismatic structure, very hard.

Site 3

Alp	0–32 cm very dark gray (10YR3/1) fine sand, weak very fine granular structure, very friable, clear wavy boundary.
A12	32–65 cm very dark grayish brown (10YR3/2) fine sand, weak coarse blocky structure that crushes easily to single grain, slightly hard, gradual wavy boundary.
A13	65–105 cm very dark grayish brown (10YR3/2) fine sand, weak coarse blocky structure, hard, abrupt wavy boundary.
A14	105–155 cm very dark gray (10YR3/1) loamy fine sand, weak coarse blocky structure, hard, clear wavy boundary.
C	155–190+ cm grayish brown (10YR5/2) loamy very fine sand, single grain, very friable.

Site 4

A1	0–23 cm very dark grayish brown (10YR3/2) fine sand, weak fine granular structure, friable, clear wavy boundary.
AC1	23–43 cm dark grayish brown (10YR4/2) fine sand, weak fine blocky structure, friable, clear wavy boundary.
AC2	43–75 cm dark brown (10YR4/3) fine sand, structureless single grain, friable, abrupt wavy boundary.
II Ab	75–87 cm dark brown (10YR3/3) sandy clay loam, weak medium platy structure, hard, clear wavy boundary.
II Bb	87–110 cm dark brown (10YR4/3) sandy clay loam, moderate coarse prismatic structure, hard, clear wavy boundary.
II C	110–185 cm dark brown (10YR4/3) loamy very fine sand, structureless, massive, friable.

Site 5

A1	0–10 cm dark grayish brown (10YR4/2) fine sand, weak very fine granular structure, loose, clear wavy boundary.
AC	10–55 cm brown (10YR5/3) fine sand, structureless single grain, loose, abrupt wavy boundary.
Ab	55–80 cm dark grayish brown (10YR4/2) fine sand, structureless massive that crushes easily to single grain, slightly hard, clear wavy boundary.
ACb	80–115 cm grayish brown (10YR5/2) fine sand, structureless massive that crushes easily to single grain, slightly hard, clear wavy boundary.
C	115–150 cm light brownish gray (10YR6/2) fine sand, structureless single grain, loose.

Particle size analysis of the soils at the five sites is shown in Table 1. As expected, the predominant separates in the soils of the study area are fine and very fine sand. However, within the IIAb, IIBb, and IIIAb horizons of site 1 and the IIAb and IIBb horizons of the soil profile at site 4, appreciable amounts of clay as well as silt were present. As indicated by the horizon nomenclature, these horizons represent a lithology different from that of overlying horizons. In both profiles, the change in lithology is accompanied by a buried soil horizon. At site 1, two buried A horizons are present indicating the burial of two older soils by more recent deposits of somewhat different particle size distribution.

Chemical properties of the soils studied are shown in Table 2. The values shown are in approximate agreement with those established for Valentine soils (15) except in the profiles that have buried horizons of finer texture as part of the solum. Here the values for organic carbon and cation exchange capacity are considerably greater than would be expected for Valentine soils. Available phosphorus is very low in all profiles and does not show an increase in the buried soil horizons as has been reported elsewhere (7). However, the buried soil horizons are somewhat higher in extractable potassium, calcium, and magnesium than are the overlying horizons.

The mineral types present within the fine and very fine sand fractions of the soils in the study area are shown in Tables 3 and 4. The amount of heavy minerals in the samples was very low ranging from 0.63 to 1.93 percent. Amounts of the various minerals varied from profile to profile as well as from horizon to horizon within each profile. Only trace amounts of apatite were found. Weathering ratios calculated using relative amounts of quartz and total feldspars produced irregular curves for most profiles as shown in Figures 2 through 6.

Distinct peaks at 10 Å and at 7.15 Å were evident on x-ray scans of oriented specimens of the clay fraction after it had been saturated

Table 1. Particle size distribution.

Horizon	Fine sand	Very fine sand	Total sand	Silt	Clay	Textured class	Available water Cm H_2O/ cm soil
			Site 1				
A1	42.6	32.0	88.1	5.2	5.6	fs	.05
AC	42.9	30.9	86.9	6.0	6.6	lfs	.08
C1	43.1	33.4	88.1	5.8	6.1	lfs	.08
C2	47.1	40.7	92.7	0.3	7.0	fs	.05
II Ab	36.2	32.5	77.2	8.4	14.5	fsl	.13
II Bb	30.6	26.1	64.0	19.7	16.3	fsl	.13
III Ab	40.4	33.3	82.7	4.7	12.5	lfs	.08
III C	52.9	30.7	94.6	2.0	3.5	fs	.05
			Site 2				
A1p	47.1	25.8	89.4	3.5	7.2	lfs	.08
A12	47.7	23.8	87.8	2.9	8.7	lfs	.08
AC	46.1	25.2	88.7	1.7	8.6	lfs	.08
C1	52.2	23.8	92.5	0.7	6.9	fs	.05
C2	53.6	23.4	91.9	0.2	7.9	fs	.05
			Site 3				
A1p	47.0	30.8	89.5	5.8	3.8	fs	.05
A12	46.6	29.1	88.9	6.7	3.6	fs	.05
A13	49.3	27.9	92.5	3.8	3.6	fs	.05
A14	38.2	31.9	81.9	7.5	7.6	lfs	.08
C	34.6	31.4	86.6	6.2	6.1	lvfs	.10
			Site 4				
A1	48.2	27.1	91.7	4.7	3.3	fs	.05
AC1	45.9	27.6	88.7	4.3	6.0	fs	.05
AC2	44.0	24.0	90.5	3.7	5.8	fs	.05
II Ab	17.3	38.6	64.6	9.1	21.4	scl	.19
II Bb	11.3	44.6	58.4	12.9	22.4	scl	.19
II C	25.0	44.7	77.8	11.1	11.1	lvfs	.10
			Site 5				
A1	66.7	20.1	96.2	1.3	2.5	fs	.05
AC	66.6	10.4	97.4	0.5	2.1	fs	.05
Ab	65.3	11.7	97.3	0.9	1.8	fs	.05
ACb	66.4	13.8	96.9	0.9	2.0	fs	.05
C	65.7	15.2	96.7	0.5	2.7	fs	.05

with magnesium. Irregular peaks existed at 14 Å also but these were not clearly defined. On heating of these samples to 500°C, the peaks at 7.15 Å were not evident and no hint of any peaks at 14 Å was evident except in all horizons of the soil at Site 5. When samples were solvated with glycerol only the IIAb, the IIBb, and IIC horizons of the soil at Site 4 showed any evidence of peaks at 17.8 Å.

These patterns indicate that the predominant clay minerals present were illite and kaolinite. The 14 Å peak that remained in the pattern from Site 5 after heating is indicative of a chlorite mineral. Not much chlorite has been recognized in the soils of Nebraska. Mason (9) indicates that this mineral may form in the presence of sea

Table 2. Chemical properties.

			me/100 g						
			Extractable bases						
Horizon	pH	%O.C.	Ca	Mg	K	Na	Cation exchange capacity	% B.S.	PPM available phosphorus
				Site 1					
A1	6.2	0.53	3.8	0.9	0.4	–	4.5	100	6.3
AC	6.3	0.31	3.7	0.9	0.3	–	4.6	100	2.6
C1	6.5	0.16	3.2	0.8	0.3	0.06	4.3	100	2.1
C2	6.5	0.14	3.9	0.9	0.3	–	5.0	100	1.9
II Ab	6.5	0.18	9.1	2.2	0.7	0.10	11.7	100	2.4
II Bb	6.5	0.23	5.3	1.3	0.4	0.10	7.5	95	1.7
III Ab	6.6	0.18	5.8	1.5	0.4	0.06	7.2	100	1.7
C	6.5	0.03	3.6	1.1	0.2	–	4.9	100	2.4
				Site 2					
A1p	6.5	0.34	2.5	0.7	0.3	–	3.5	99	2.4
A12	6.0	0.35	2.7	0.7	0.3	–	4.3	86	2.6
AC	6.0	0.30	3.0	0.7	0.2	–	4.2	92	3.6
C1	6.3	0.14	2.2	0.6	0.1	–	3.1	96	2.8
C2	6.4	0.07	2.7	0.8	0.2	–	3.9	95	2.4
				Site 3					
Alp	6.1	0.40	2.7	0.7	0.3	–	3.7	98	4.5
A12	5.9	0.31	2.9	0.6	0.2	–	4.2	89	3.4
A13	6.1	0.26	2.4	0.5	0.1	–	3.1	99	2.8
A14	6.1	0.33	4.4	1.0	0.2	–	5.5	100	4.7
C	6.3	0.15	3.1	0.8	0.2	–	4.4	94	2.5
				Site 4					
A1	6.5	0.28	2.5	0.5	0.3	0.04	4.6	74	5.5
AC1	6.3	0.41	3.8	0.8	0.3	0.03	7.3	68	2.4
AC2	6.2	0.25	3.5	0.8	0.2	0.04	6.6	70	2.6
II Ab	6.0	0.50	9.4	2.6	0.4	0.07	16.6	75	1.7
II Bb	6.4	0.36	9.8	2.5	0.4	0.09	16.9	76	2.1
II C	6.8	0.06	5.0	1.5	0.3	0.06	6.6	100	1.7
				Site 5					
A1	7.1	0.31	2.8	0.5	0.2	0.03	2.6	100	7.8
AC	6.7	0.07	1.9	0.4	0.2	0.04	1.9	100	3.6
Ab	6.5	0.17	1.7	0.3	0.2	–	1.8	100	4.5
ACb	6.7	0.18	1.6	0.4	0.1	–	2.1	100	2.4
C	6.6	0.11	1.5	0.4	0.1	0.05	2.1	100	2.6

water and thus become part of a sedimentary rock. Its presence here probably relates to the source of the sediments from which the dune sand of the Sandhills was derived. The only evidence of montmorillonite in the soils at the five sites was in the IIAb, IIBb and IIC horizons of the soil at Site 4.

DISCUSSION AND CONCLUSIONS

Data support previous conclusions (1, 13) *regarding the presence* of finer textured soils within the interdunal valleys of part of the

Table 3. Percent heavy minerals in the very fine and fine sand fractions.

Horizon	Muscovite	Biotite	Amphiboles[a]	Pyroxenes[b]	Epidote	Zircon	Tourmaline	Opaque	Others[c]
Site 1									
A1	12.8	2.4	23.6	27.4	7.4	3.0	–	14.4	9.0
AC	23.4	5.0	17.6	18.8	5.2	3.6	0.2	13.0	13.2
C1	24.0	5.6	11.0	10.8	2.4	5.4	0.2	27.8	12.8
C2	9.2	7.2	23.2	23.6	4.8	1.8	0.2	11.4	18.6
II Ab	10.0	6.4	23.4	22.0	6.6	2.4	0	10.0	19.2
II Bb	19.2	4.0	14.6	21.4	4.8	1.6	0	21.2	13.2
III Ab	18.6	4.6	16.8	22.0	4.6	2.2	0.2	12.0	19.0
III C	17.2	4.6	17.0	23.6	4.2	2.4	0.4	13.4	17.2
Site 2									
A1p	16.2	3.6	8.0	12.6	5.2	4.4	0	29.0	21.0
A12	18.6	2.0	8.8	16.4	6.0	6.0	0	23.6	18.6
AC	18.6	3.2	9.2	16.0	6.6	6.6	0	22.0	17.8
C1	23.0	1.4	11.9	14.2	4.4	6.0	0	20.2	18.9
C2	16.6	4.0	17.6	26.2	5.6	4.2	0	12.0	13.8
Site 3									
A1p	10.0	4.4	21.6	25.6	4.6	4.6	0	9.2	20.0
A12	9.4	4.0	19.4	22.6	5.0	4.4	0.4	16.6	18.2
A13	13.2	2.6	22.4	20.2	6.8	4.2	0	13.0	17.6
A14	10.6	3.4	23.8	26.6	5.4	1.8	0	11.2	17.2
C	14.2	2.0	23.8	23.6	6.6	2.0	0.4	12.0	15.4
Site 4									
A1	11.4	9.0	13.2	19.8	6.4	4.4	0.2	21.0	14.6
AC1	9.0	4.6	10.2	16.2	8.0	5.2	0	28.4	18.4
AC2	10.0	6.8	8.8	18.6	8.6	6.2	0.2	21.2	19.6
II Ab	15.4	7.0	12.0	28.4	7.2	2.6	0.2	14.0	13.2
II Bb	15.0	6.2	6.4	33.2	6.0	2.2	0	14.6	16.4
II C	15.6	4.4	19.4	28.0	4.8	1.6	0.2	11.2	14.8
Site 5									
A1	7.8	2.2	18.8	19.4	5.0	6.8	0.2	22.2	17.6
AC	19.8	13.2	6.6	11.0	6.2	6.4	0.2	23.6	13.0
Ab	11.4	7.4	9.4	14.4	7.0	7.6	0	26.6	16.2
ACb	9.0	10.4	10.0	12.2	8.2	8.8	0.4	19.2	21.8
C	16.0	7.4	7.0	15.0	7.6	6.8	0.2	20.6	19.4

[a] Amphiboles include hornblende, actinolite, tremolite.

[b] Pyroxenes include angite hypersthene, diopside and enstatite.

[c] Other minerals include corundum, clinozoisite, staurolite, rutile, brookite, titanite, andalusite, garnet and some unknown.

Sandhills. The morphological descriptions of the soils and particle size distribution (Table 1) indicate that clay as well as silt are higher in all horizons of the soils at sites 1 through 4 than in the soil on the dunes at site 5. Cation exchange capacity is also higher in the horizons of soils at sites 1 through 4 than in the soil at site 5 reflecting the greater clay content (Table 2). This higher cation exchange capacity includes mostly a greater amount of calcium and magnesium, although extractable potassium is somewhat greater where horizons of

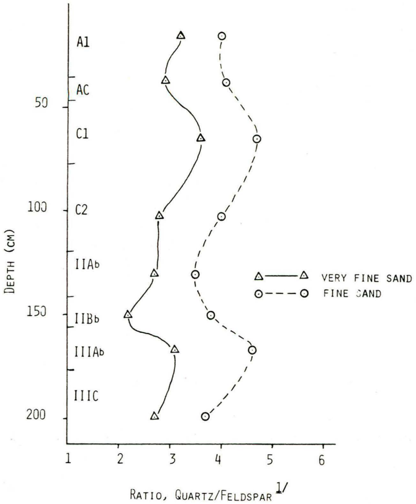
Table 4. Percent of selected light minerals in the fine and very fine sand functions.

	Potassium feldspar		Quartz		Others[a]/	
Horizon	Fine sand	Very fine Sand	Fine sand	Very fine sand	Fine sand	Very fine sand
			Site 1			
A1	17.3	13.5	78.8	75.8	3.9	10.7
AC	16.5	11.1	80.0	74.2	3.5	14.7
C1	16.3	12.0	80.6	77.2	3.1	11.8
C2	17.7	11.0	78.8	73.8	3.5	15.2
II Ab	19.4	15.1	76.2	72.6	4.4	12.3
II Bb	13.8	14.2	77.8	68.6	8.4	17.0
III Ab	17.4	14.0	78.8	74.4	3.8	11.6
III C	13.7	13.4	77.4	72.2	8.9	14.4
			Site 2			
A1P	17.1	13.4	81.8	74.0	8.9	16.6
A12	15.6	12.9	78.0	70.6	13.8	16.5
AC	16.6	12.8	78.4	73.4	10.0	14.8
C1	15.6	13.3	76.6	72.2	12.2	14.5
C2	15.4	11.8	77.2	71.0	17.2	17.2
			Site 3			
A1P	11.4	10.0	79.8	77.4	8.8	12.6
A12	17.1	9.2	77.2	70.4	5.7	13.6
A13	15.6	13.1	79.6	72.0	4.8	16.2
A14	13.3	10.3	76.0	71.0	10.7	18.7
C	13.1	10.9	74.4	71.4	12.5	17.7
			Site 4			
A1	12.6	15.0	79.0	74.2	8.4	10.8
AC1	18.1	13.9	78.0	74.4	3.9	11.7
AC2	15.9	12.3	80.0	76.8	4.1	10.9
II Ab	15.8	12.9	80.5	71.6	3.7	15.5
II Bb	19.6	14.8	74.0	74.6	6.4	10.6
II C	18.0	14.4	78.0	73.6	4.0	12.0
			Site 5			
A1	18.5	14.0	76.0	75.6	5.5	10.4
AC	17.6	15.1	79.0	74.6	3.4	10.3
Ab	13.8	13.3	81.4	77.0	4.8	9.7
ACb	11.9	11.5	79.0	71.0	9.1	17.5
C	12.0	14.2	80.2	72.0	7.8	13.8

[a] This includes largely plagioclage feldspars. However, a small percent of volcanic glass and opal were also noted.

higher clay content exist. Sodium content is negligible in all horizons at all sites.

The presence of buried horizons in the soils studied is also evident (as indicated by the "b" designation on several horizons). Two buried A horizons were noted in the profile at site 1 while one buried A horizon was evident at both sites 4 and 5. No apparent association with the micro or macro relief of the area and the presence of the buried soils was apparent. Figure 1 indicates that buried soils were associated with both low ridges and small valleys within the major valley as well as with the soil on the major dune (site 5). Additional



1/ CALCULATED ON THE BASIS OF MINERAL GRAINS COUNTED

Figure 2. Quartz to feldspar ratios, site 1.

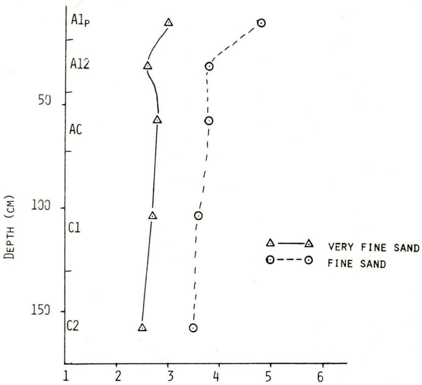


Figure 3. Quartz to feldspar ratios, site 2.

observations made in the vicinity of the study area indicate that buried A horizons are quite common there. One such horizon about one mile from the study area and at present overlain by 1.5 m of more recent sand was 1.8 meters thick.

The presence of the buried soils indicates that the materials within the area have moved periodically following a period of time long enough for vegetation to become well established and a soil profile to form. Since at every location when buried soils were noted they appeared to have been more strongly developed than the soil that exists presently in surficial deposits, it appears that the stable period was for a longer period of time than the present soils have been forming, unless the climate has changed.

In addition to the buried soils, the presence of changes in lithology (indicated by Roman Numerals preceding the horizon designation) within soils at sites 1 and 4 indicate that stratification or layering of the materials by deposition has taken place. These suppositions are supported by the patterns of weathering ratios (Fig. 2–6) calculated using the ratio of quartz to feldspar (resistant/weatherable) minerals in the soil.

Mineral studies within both the light and heavy mineral fraction point to the presence of a considerable amount of potassium bearing feldspar (Table 4) but no apatite was evident. The abundance of potassium in a weatherable mineral has produced a medium level of plant available potassium in the soil through weathering (Table 2), and potassium will probably continue to be released through weather-

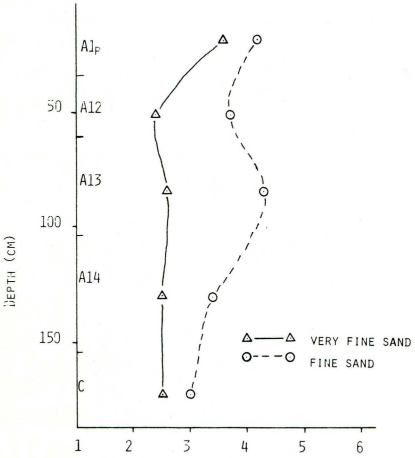


Figure 4. Quartz to feldspar ratios, site 3.

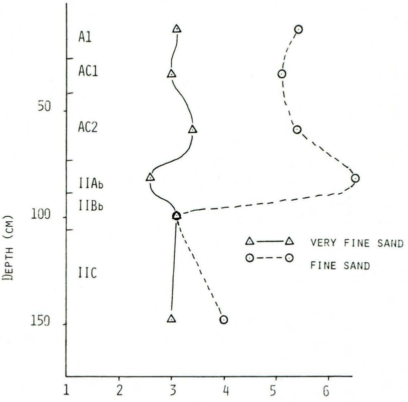


Figure 5. Quartz to feldspar ratios, site 4.

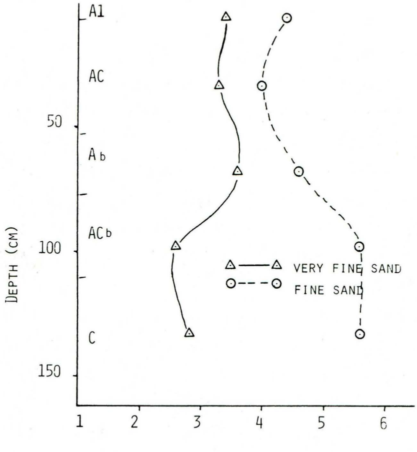


Figure 6. Quartz to feldspar ratios, site 5.

ing, but at a slow rate. The lack of the mineral apatite and the low or very low levels of available phosphorus point to a probable need for supplemental phosphorus over the coming years if the area continues to be used for irrigated row crop agriculture.

In addition, if irrigation is to be used most effectively, careful planning in the application of water and fertilizer is necessary. For example, at site 1 strata (IIAb and IIBb horizons) exist that will hold 4.5 cm of available water, while at site 4 a combination of strata (IIAb and IIBb horizons) exist that will hold 6.65 cm of available water. These strata are within the root zone of most crops, and will not only hold more available water than strata above or below, but lower the permeability of the profile to where movement of water downward and subsequent leaching are altered a great deal when compared to the soil conditions that exist at sites 2 and 3. Here the soil permeability is rapid and no layers of relatively high water holding capacity exist. More frequent application of water will be required, and leaching will be more severe here. However, if irrigation water amounts are planned for the soils at sites 1 and 4, plants at sites 2 and 3 will probably develop moisture stress between applications of water and the soils will be leached by each application.

Nutrient requirements and nutrient retention also are quite variable at these sites due to the variability in the silt and clay content in the soil horizons. Higher cation exchange capacity in the soils at sites 1 and 4 make nutrient loss through leaching less likely. At sites 2 and 3, amounts of soluble nutrients in excess of amounts required by the plant will likely be lost through leaching, representing an economic loss to the producer and a pollution threat to the ground water.

These data suggest that the geologic processes operating in the Sandhills result in stratified deposits in at least some of the interdunal valleys. These stratified deposits have soils formed in them and the soils have inherited certain characteristics from the stratified deposits. The soil characteristics are more variable than allowed for in the ordinary concept of soils normally associated with these valleys. In fields when soils vary as do those reported here, more critical management of irrigation and fertility practices are necessary than would be the case if variable strata were not present.

LITERATURE CITED

1. Burzlaff, D. F. 1962. A soil and vegetation inventory and analysis of three Nebraska Sandhills range sites. Nebr. Agr. Exp. Sta., Res. Bull. 206.
2. Elder, J. A. 1969. Soils of Nebraska. Univ. of Nebr., Conservation and Survey Div. Resource Rep. No. 2.
3. Fairbairn, H. W. 1943. Gelatinized slides for refraction index immersion mounting. Amer. Min. 28:396–397.
4. Jackson, M. L. 1956. Soil chemical analysis, advanced course. Published by the author, Dept. of Soils, Univ. of Wis.
5. Keech, C. F. and R. Bentall. 1971. Dunes on the plains—the Sand Hills region of Nebraska. Univ. of Nebr. Conservation and Survey Div. Resource Rep. No. 4.
6. Kilmer, V. J. and L. T. Alexander. 1949. Methods of making mechanical analysis of soils. Soil Sci. 68:15–24.
7. Lewis, D. T., G. A. Peterson, and D. H. Sander. 1973. How ancient soils affect crops. Univ. of Nebr. Farm, Ranch, and Home Quarterly, Spring 1973.
8. Lewis, D. T., P. N. Seevers, and J. V. Drew. 1975. Use of satellite imagery to delineate soil associations in the Sandhills region of Nebraska. Soil Sci. Soc. Amer. Proc. 39:330–335.
9. Mason, B. 1966. Principles of geochemistry. John Wiley and Sons, Inc. New York.
10. Matelski, R. 1961. Separation of minerals by subdividing solidified bromoform after centrifugation. Soil Sci. 71:269–272.
11. Reed, E. C. and V. H. Dreeszen. 1965. Revision of the classification of the pleistocene deposits of Nebraska. Univ. Of Nebr., Conservation and Survey Div., Nebr. Geol. Survey Bull.
12. Sautter, E. H. 1954. The potassium feldspar content of some Nebraska soils. M.Sc. Thesis. C. Y. Thompson Library, Univ. of Nebr., Lincoln.
13. Sherfey, L. E. 1969. Soil survey of McPherson Co., Nebr. S.C.S. U.S.D.A. Publication, U.S. Gov't. Printing Office, Washington, D.C.
14. Shipp, R. F. and R. P. Matelski. 1960. A microscopic determination of Apatite and a study of phosphorus in some Nebraska soil profiles. Soil Sci. Soc. Amer. Proc. 24:450–452.
15. Soil Survey Staff. 1966. Soil survey laboratory data and descriptions of some soils of Nebraska. Soil Survey Investigations Report No. 5, S.C.S., U.S.D.A. and Conservation and Survey Div., Uni. of Nebr., Lincoln.