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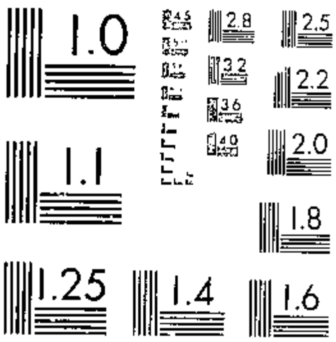

MICROCOPY RESOLUTION TEST CHART
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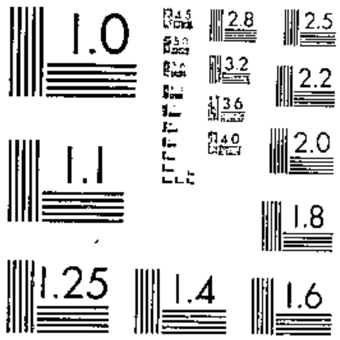

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AUGUST 1934

THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE SOILS FROM THE EROSION EXPERIMENT STATIONS—SECOND REPORT

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UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, D.C.

Technical Bulletin No. 430 — August 1934

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CONTENTS

INTRODUCTION

In Technical Bulletin 316 of the United States Department of Agriculture (*16*)[1] a report was given on the physical and chemical characteristics of the soils from the erosion experiment stations which had been established up to 1932. The report covered Houston black clay at Temple, Tex.; Kirvin fine sandy loam at Tyler, Tex.; Vernon fine sandy loam at Guthrie, Okla.; Shelby silt loam at Bethany, Mo.; Colby silty clay loam at Hays, Kans.; Cecil sandy clay loam at Statesville, N.C.; Palouse silt loam at Pullman, Wash.; and Marshall silt loam at Clarinda, Iowa. Since that bulletin was completed early in 1932, two new stations have been established, one on Clinton silt loam at La Crosse, Wis., and the other on Muskingum silt loam at Zanesville, Ohio. In addition, a series of plots have been established on Nacogdoches fine sandy loam at the Tyler (Tex.) station. The physical and chemical characteristics of these three soils, together with other data bearing on the erosional characteristics of all of the soils, are presented in this bulletin. Especially important among these are the volume relations of the soils and their settling volumes compared with their other water relations.

When an erosion station is established a 50-pound sample is collected from each important layer of the soil profile down to and includ-

[1] Italic numbers in parentheses refer to Literature Cited, p. 61.

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ing the upper part of the parent material. These samples are sent to this laboratory, small subsamples are removed for study, and the remainder is placed in storage. In this and in the previous bulletin (*16*) these samples are designated as typical profile samples or profile samples.

As soon as the plots are established, a composite sample is taken of each soil layer in each plot, the plot being sampled at 10-foot intervals. The soil layers, to a depth of 48 inches, are sampled in this manner. These samples are designated as profile composite samples, or profile composites.

At the end of each year, each plot is sampled to a depth of 7 inches at 10-foot intervals and the samples composited. These samples are designated as annual composites.

In addition, an aliquot of the run-off and the wash-off is taken after each rain and evaporated to dryness. At the end of each year the accumulated samples from each plot are sent to the laboratory for analysis. The size of the aliquot taken depends on the treatment of the plot, the aim being to have an accumulated sample of wash-off at the end of the year of at least 100 grams. In some cases, particularly with the sod plots, the total erosion is very small and does not result in a sample sufficient for analysis.

EXPERIMENTAL METHODS

The same methods of analysis were used in this work as in that previously reported. The mechanical analyses were made by the method of Olmstead and others (*17*). The colloid by water vapor absorption was determined by the method of W. O. Robinson (*19*). The moisture equivalent was determined by the method of Briggs and McLane (*5*). The suspension percentage and dispersion ratios were determined by the method of Middleton (*14*). Percolation ratios were computed by the formula of Slater and Byers (*21*). Colloids were extracted by the method outlined by Holmes and Edgington (*11*). Chemical analyses of the soils and colloids were made by the methods of W. O. Robinson (*20*). The pH determinations were made electrometrically, by means of the hydrogen electrode (*4*). Specific-gravity determinations were made by the method outlined by Hillebrand (*10 pp. 55–57*).

DESCRIPTION OF SAMPLES

The 3 new soils discussed in this bulletin are described in the same manner as the 8 soils in the previous bulletin (*16*). The series description is taken from the files of the Division of Soil Survey of this Bureau, while the specific description of the samples are those given by the collectors.

NACOGDOCHES SERIES

The Nacogdoches soils consist of brown to reddish-brown fine sandy loam, overlying red clay subsoil, which is quite friable, although not so friable as the subsoil of Orangeburg or Greenville. At depths of about 2 to 4 feet, there is considerable bright-yellow extremely friable material of ocherous character. The substratum, or partly decomposed parent material, consists of greenish-yellow soft material derived apparently from a glauconitic limestone. There is much greenish-yellow, soft and semihard rock throughout the profile of many areas, and there are frequently shell casts derived from the underlying limestone which is of a rather greenish color. The soil is very high in content of iron and low in silica. It is much like the red soils of eastern Cuba, which have undergone very extreme weathering.

The samples of Nacogdoches fine sandy loam were collected in March 1932 by B. H. Hendrickson at the erosion station, 9 miles northwest of Tyler, Tex. They were described by Mr. Hendrickson as follows: (1) From 0 to 8 inches, chocolate brownish-red gravelly fine sandy loam; (2) from 8 to 18 inches, blood-red clay; (3) from 18 to 40 inches, red-yellow clay; (4) from 40 to 66 inches, red-yellow clay, some sand grains; and (5) from 66 to 72 inches, red-yellow sandy clay, rather heavy.

CLINTON SERIES

The Clinton series is characterized by gray or gray-brown soils and by light-brown or yellowish-brown compact subsoils. The subsoils are not highly calcareous. The topography is rolling to broken and drainage is well established. The soils are derived by weathering from loess and are typically developed north of Missouri in the loess belt on the eastern bank of the Mississippi. The series differs from the Memphis in the gray or gray-brown color of the soil and from the Knox in having a more compact subsoil and a lower lime content in both soil and subsoil.

The samples of Clinton silt loam were collected by R. H. Davis in August 1932 at the erosion station, 4 miles east of La Crosse, Wis. In the Soil Survey of La Crosse County, Wis. (*9*) this soil was mapped as Knox silt loam. This designation is still used in Wisconsin and the profile has been described very completely by Kellogg (*12*). The samples were described by Mr. Davis as follows: (1) From 0 to 8 inches, dark-brown heavy silt loam; (2) from 8 to 20 inches, yellowish-brown granular heavy silt loam; (3) from 20 to 32 inches, dark grayish-yellow friable silt loam; (4) from 32 to 44 inches, splotched yellow and gray friable silt loam; and (5) from 44 to 66 inches, sandy clay splotched brick red and gray, soft red sandstone and flint stone present.

MUSKINGUM SERIES

The soils of the Muskingum series consist, in the uncultivated soil, of a dark-brown layer, ranging up to about 4 or 5 inches in thickness. In the types heavier than sand or loamy sand, the structure is coarsely granular. The subsurface, ranging up to a thickness of about 2 inches, is gray or pale yellow, silty or sandy, and where silty, has a well-defined platy structure. The upper subsoil is yellowish brown, often with a more or less well defined reddish shade, decidedly heavier than the gray layer in texture but not sufficiently heavy to constitute a hardpan or claypan. The upper part of this layer breaks into small angular fragments due to jointing, the fragments ranging around one-fourth to one-half inch in diameter, but downward these fragments become larger and the jointing less well defined. The lower part of this layer grades into somewhat loose disintegrated sandstones and shales, or lies on partly decomposed shale or sandstone. The thickness of this layer ranges up to about 2 feet. This soil series occurs in southeastern Ohio, in western Pennsylvania, West Virginia, and probably elsewhere, and is included among the soils of the mid-latitude zone of the United States east of the prairies. It was formerly included in the Dekalb soils.

The samples of Muskingum silt loam were collected by E. B. Deeter in April 1933, at the erosion station, 7 miles west of Zanesville, Ohio. They are described by Mr. Deeter as follows: (1) (*a*) From 0 to 1 inch, light grayish-brown silt loam (when dry), mixed with grass roots and organic matter. When wet, the color is a fairly dark brown. This was mixed to form one sample with (*b*) from 2 to 7 inches, yellowish-brown silt loam, with small pieces of shale in small to almost negligible quantity. Very compact and puddles easily. In fields, the dry soil is inclined to crust, and in this condition water tends to run off rather than to percolate into the soil. (2) From 8 to 13 inches, yellow silty clay loam with very faint mottling of gray or light yellow. Contains small pieces of black material (manganese?). Compact and difficult to penetrate. (3) From 14 to 24 inches, compact yellow silty clay, mottled somewhat with gray. Fragments of shale are present. (4) From 25 to 46 inches, light reddish-yellow silty clay, with faint mottlings of gray. Very compact, and shale is abundant. (5) From 47 to 72 inches, heavy dense gray clay with some mottlings of yellow. Shale is present but not abundant.

COMPOSITION AND PROPERTIES OF THE PROFILE SAMPLES

PHYSICAL PROPERTIES

The various physical tests and their relationship to erosional behavior were very fully discussed in the previous bulletin (*16, pp. 13–15*). The general discussion will not be repeated here. However, each of the three new soil profiles will be considered not only with respect to their relationship to each other but also to the eight profiles previously studied. The physical data and hydrogen-ion concentration are presented in table 1.

Table 1.—*Mechanical analyses* [1] *and physical data of typical profiles of erosion-station soils*

Sample no.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay	Organic matter by H_2O_2	Colloid <0.002 mm	Colloid by water-vapor absorption	Moisture equivalent	Dispersion ratio	Ratio of colloid to moisture equivalent	Erosion ratio	Suspension percentage	Percolation ratio	pH
NACOGDOCHES FINE SANDY LOAM, TYLER, TEX.																		
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*						
9475	0–8	[2] 2.0	0.9	10.3	48.4	8.1	9.8	18.0	2.2	16.1	18.6	14.3	28.2	1.30	21.7	7.84	6.0	5.3
9476	8–18	.2	.5	7.4	32.3	5.3	4.9	48.4	.7	47.1	50.5	25.2	13.8	2.00	6.9	7.38	----	4.4
9477	18–40	.2	1.1	10.5	37.5	5.8	5.9	38.9	.0	38.2	52.5	25.1	16.0	2.09	7.7	7.17	----	4.6
9478	40–66	.1	.3	11.2	47.0	6.2	.8	34.3	.0	31.7	32.9	18.6	11.5	1.77	6.5	4.04	----	5.0
9479	66–72	.2	1.1	11.6	41.4	6.0	5.6	34.0	.0	32.7	45.2	22.5	12.4	2.01	6.2	4.93	----	5.1
CLINTON SILT LOAM, LA CROSSE, WIS.																		
10362	0–8	0.0	0.2	0.3	0.6	4.9	72.7	19.1	1.7	11.2	13.7	23.9	32.9	0.57	57.7	30.22	53.0	5.9
10363	8–20	.0	.1	.1	.3	6.1	68.5	24.3	.1	18.8	20.3	23.5	26.7	.86	31.0	24.75	----	5.3
10364	20–32	.0	.1	.2	.4	6.3	65.8	27.6	.0	21.8	24.7	24.7	35.5	1.00	35.5	32.90	----	5.2
10365	32–44	.0	.7	1.6	1.7	6.7	66.5	22.4	.0	18.2	21.1	22.4	39.2	.94	41.7	34.82	----	5.4
10366	44–66	1.0	13.7	31.0	19.0	3.9	7.6	23.2	.0	21.4	19.8	13.8	34.8	1.43	24.3	10.71	----	5.6
MUSKINGUM SILT LOAM, ZANESVILLE, OHIO																		
B407	0–7	0.6	1.3	1.0	1.3	2.1	63.2	28.4	1.9	19.9	21.0	25.5	34.5	0.82	42.1	31.60	38.5	4.7
B408	8–13	1.7	2.1	1.2	1.6	2.6	53.2	37.1	.3	27.3	30.4	26.2	23.1	1.16	19.9	20.90	----	4.8
B409	14–24	4.2	4.6	2.7	4.2	5.5	43.9	34.8	.0	25.3	27.6	21.0	30.3	1.31	23.1	23.86	----	4.8
B410	25–46	4.2	3.6	2.7	4.2	10.2	46.5	28.5	.0	20.3	19.0	19.4	41.1	.98	41.9	30.77	----	4.8
B411	47–72	1.1	1.6	2.0	7.0	6.1	51.6	30.4	.0	19.0	17.3	19.8	51.9	.87	59.6	42.55	----	6.4

[1] Determinations by H. W. Lakin, T. M. Shaw, and F. P. Trilety

[2] 50.8 percent of this sample consisted of gravel > 2 mm.

In the previous bulletin (*16*), the soils were divided into two groups on the basis of their mechanical analyses—those in which the texture is variable within the profile, and those with uniform texture throughout. However, in the latter group, the uniformity is relative rather than absolute. On the same basis the Nacogdoches would be placed in the first group with the Kirvin, Vernon, and Cecil, while the Clinton and Muskingum would be placed in the second group with the Houston, Colby, Palouse, Marshall, and Shelby.

The Nacogdoches profile consists of a sandy topsoil over a heavy clay subsoil, but the difference is not as great as in the Kirvin profile which occurs at the same station. The mechanical analyses of this profile indicate considerable weathering, which is confirmed by the chemical analyses, which will be discussed later. The surface horizon contains over 50 percent of gravel and rock which do not pass the 2-millimeter sieve, and hence do not enter into the analysis. This gravel undoubtedly has an important bearing on the physical and erosional properties of the soil in the field, but cannot be considered from the laboratory viewpoint. The three lower horizons of the profile are remarkably uniform in texture, as well as in the other physical properties. The fourth horizon is notable in that it contains practically no silt. The texture of the whole profile is unusual in that the bulk of the material falls into the fine sand and clay groups, with very little very fine sand and silt.

Clinton and Muskingum silt loams are similar in texture to the other silt loams, particularly the Palouse and Marshall. Both have slightly less clay and more silt in the first horizon than in the second, but the sum of the silt and clay is very nearly the same in both. The third horizon of the Clinton contains more clay and colloid and less silt than the second, which indicates that conditions are more favorable for illuviation in this horizon than in the second. This is not usual in soils. The fifth horizon contains about the same percentage of clay as the layers above but the remainder of the material is altogether different and evidently constitutes the original material upon which the loess was deposited.

The three lower horizons of the Muskingum are quite uniform in texture. There is a gradual decrease in colloid content from the second to the fifth horizon, in which it is practically the same as in the first horizon.

Certain physical characteristics of soils have been shown by Middleton (*14*) to be indicative of erosional behavior. These properties are the dispersion ratio, the ratio of colloid (by water-vapor absorption) to moisture equivalent, and the erosion ratio. The suspension percentage which is used in both the determination of the dispersion ratio and the percolation ratio is the fraction consisting of silt and clay, expressed in percentage of the soil, which is dispersed, and remains suspended in distilled water under specific conditions (*14*). The dispersion ratio is the ratio of the suspension percentage to the total percentage of silt and clay in the soil, multiplied by 100. The erosion ratio is the quotient obtained by dividing the dispersion ratio by the ratio of colloid to moisture equivalent. The percolation ratio is the quotient obtained by dividing the suspension percentage by the ratio of colloid to moisture equivalent. A full explanation and discussion of these determinations is given in the previous report (*16*).

The physical properties other than the mechanical analyses indicate the Nacogdoches to be the least erosive of the three soils. The dispersion ratio is low and the colloid-moisture equivalent ratio is high, resulting in a low value of the erosion ratio. This applies particularly to the surface horizon which is a fine sandy loam. It is exceptional for a soil of this class to have a low dispersion ratio. This is unquestionably owing to the chemical character of the colloid, which makes it highly resistant to dispersion by water. Kirvin fine sandy loam (*16*) which occurs at the same station has a much higher dispersion and erosion ratio and lower colloid-moisture equivalent ratio in the surface horizon. The suspension percentage and percolation ratio are also low, the percolation ratio being the lowest of any of the 11 erosion station soils. In the second and lower horizons the colloid-moisture equivalent ratios are exceptionally high, in the experience of the writers having been exceeded only by the Nipe clay from Cuba reported by Middleton (*14*). This, together with the low value of the dispersion ratio, results in low values of the erosion ratios comparable with those of the lower horizons of the Kirvin and Cecil. The erosion ratios of the four lower horizons are all of nearly the same value, indicating that the layers are about equally resistant to erosion. A general summary of the physical properties of this soil indicates that it should be the most resistant to erosion of any of the 11 soils, and that such erosion as occurs should be of the sheet rather than the gully type. This accords with field experience.

The physical properties of the Clinton soil, on the other hand, indicate that it should be the most erosive of the 11 soils. In all horizons the erosion ratio is high and is the highest of all the erosion station soils in the surface horizon. The dispersion ratios and suspension percentages are all very high and the colloid-moisture equivalent ratios are low. The percolation ratio is the highest of all of the soils, as is also the silt content, both of which have been shown by Slater and Byers (*21*) to have an important bearing on permeability. These data indicate that percolation in this soil should be very slow, consequently the run-off should be large, which, taken together with a very erosive soil, should result in very rapid erosion.

The data for the Muskingum soil indicate that it is not quite as susceptible to erosion as the Clinton. The second horizon has a lower erosion ratio than in the Clinton, but in the lower horizons the erosion ratio increases with depth and the fifth horizon has a higher erosion ratio than the first, which condition generally favors severe gully formation. As compared to the silt loam soils previously reported, the data indicate that the Clinton and Muskingum should be much more susceptible to erosion than the Marshall, Palouse, or Shelby. It has been the writers' observation that silt loam soils are particularly susceptible to erosion owing to the fact that the large quantity of silt and comparatively small quantity of colloid are not conducive to the formation of a firm aggregated structure which is necessary to resist the erosive effects of surface wash. The same thing is true of the sandy soils, particularly the fine sandy loams, which have about the same quantity of colloid but with the silt replaced by fine sand and very fine sand. This condition is favorable for a very friable, loose structure which is desirable for tillage operations but also is conducive to severe erosion except on level surfaces. The character of the colloid is undoubtedly of greater importance than the amount, as is shown by the Nacogdoches. Compared with the surface horizons of the Clinton and the Muskingum, the surface horizon of the Nacogdoches is intermediate in quantity of colloid but the character of the colloid is such that it places the Nacogdoches far below the Clinton and Muskingum in susceptibility to erosion.

CHEMICAL COMPOSITION OF THE SOIL AND COLLOID OF REPRESENTATIVE PROFILES

In table 2 are presented the complete analyses of three of the representative profiles of the erosion-station soils. The corresponding data for the other eight soils in the erosion-station series are to be found in Technical Bulletin 316, table 2 (*16*). The analyses of the whole soil do not furnish the detailed information concerning the soil character which may be obtained by colloid analyses, but they are essential to the presentation of a complete picture of the soils. In addition, they offer certain specific information not furnished by either the mechanical or colloid analyses.

TABLE 2.—*Chemical analyses of typical profiles of erosion-station soils*

Sample no.	Depth	SiO_2	TiO_2	Fe_2O_3	Al_2O_3	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	N	Organic matter [1]	Ratio of organic matter to nitrogen
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
NACOGDOCHES FINE SANDY LOAM, TYLER, TEX.																	
9475	0- 8	76.00	0.48	11.80	5.93	0.07	0.51	0.12	0.19	0.02	0.26	0.16	4.99	100.53	0.10	1.89	18.9
9476	8-18	60.45	.51	15.72	14.75	.01	.37	.21	.26	04	.27	.10	6.90	99.59	.06	1.13	18.8
9477	18-40	61.60	.47	17.78	12.56	.00	.29	.21	.18	.00	.29	.14	6.25	99.77	.03	.42	14.0
9478	40-66	76.85	.53	5.82	11.82	.00	.22	.03	.22	.01	.20	.02	4.40	100.12	.02	.11	5.5
9479	66-72	65.50	.46	16.93	11.19	.00	.12	.04	.16	.01	.34	.03	5.29	100.07	.02	.19	9.5
CLINTON SILT LOAM, LA CROSSE, WIS.																	
10362	0- 8	76.80	0.33	1.92	11.46	0.15	0.33	0.16	2.30	1.12	0.22	0.22	4.13	99.14	0.13	1.55	11.9
10363	8-20	75.50	.71	3.87	11.76	.08	1.22	.41	2.32	1.05	.22	.14	3.21	100.49	.05	.59	11.8
10364	20-32	73.40	.72	4.10	12.87	.07	1.06	.35	2.23	1.09	.16	.11	3.14	99.30	.04	.36	9.0
10365	32-44	75.10	.72	3.70	11.85	.07	.94	.26	2.58	.89	.19	.03	2.69	99.02	.03	.28	9.3
10366	44-66	82.30	.76	2.78	10.14	.00	1.09	.19	.49	.32	.16	.04	2.50	100.77	.02	.18	9.0
MUSKINGUM SILT LOAM, ZANESVILLE, OHIO																	
B-407	0- 7	75.18	1.12	3.74	11.11	0.12	0.49	0.05	2.11	0.72	0.06	0.07	5.20	99.98	0.15	2.41	16.1
B-408	7-13	68.49	.88	6.48	15.42	.09	.42	.20	2.49	.61	.03	.05	4.71	99.87	.06	.53	8.8
B-409	14-24	59.21	1.01	8.00	21.37	.07	.26	.30	2.93	.38	.04	.02	6.45	100.04	.04	.20	5.0
B-410	25-46	60.91	1.10	6.54	21.50	.07	.22	.05	2.79	.18	.01	.03	6.14	99.54	.04	.13	3.2
B-411	47-72	59.47	1.11	7.17	21.86	.11	.28	.09	3.28	.18	.03	.02	6.15	99.75	.04	.11	2.8

[1] CO_2×factor 0.471.

None of the three soils under discussion, the Nacogdoches fine sandy loam, the Clinton silt loam and the Muskingum silt loam, is calcareous, and consequently no determination was made of the trace amounts of carbonates which normally occur (*1*). The Nacogdoches is a red soil which is highly weathered and with low base and very high iron oxide content. The relations in general are those of a soil practically free from undecomposed minerals other than quartz. The organic matter in all three soils shows the usual concentration in the A horizon and the normal decrease in the carbon-nitrogen ratio except in the case of the lowest stratum of the Nacogdoches (*2*). The small increase of organic matter without corresponding increase of nitrogen is not adventitious. In this layer B. H. Hendrickson, of the Tyler Station, has reported the presence of graphite particles. The lowest stratum of the Clinton silt loam shows in its analytical results the same divergence from the material above it as is indicated by the mechanical analyses (table 1). This divergence is not so marked in the colloidal material (table 3).

All three soils show evidence of the operation of the podzolization process in respect to concentration of iron oxide and alumina in the B horizons. The Clinton and Muskingum soils show the presence of considerable quantities of undecomposed feldspars. The pH values (table 1) of all three soils are low and indicate a high degree of leaching. It is to be remarked that the acidity of the Muskingum soil is materially greater in the A horizon than the Nacogdoches, despite the greater quantity of bases.

The analyses of the colloids of the three soil profiles are given in table 3. These colloids were extracted in the usual manner by use of a supercentrifuge. No attempt was made at complete extraction of the colloid, but only to make the extraction sufficiently exhaustive so that the material should be fully representative of the total colloid. For this purpose the soil was dispersed from 4 to 8 times until the quantity of colloid obtained showed marked decrease. The centrifuge was run at such a rate that no particles larger than 1μ were obtained in the colloid material (*6*). No dispersing agent, other than water was used except in the lower three layers of the Nacogdoches, in which it proved desirable to add a small quantity of ammonia to increase the stability of the dispersion. The quantity of colloid extracted, as compared with the total quantity present, varied from 45 percent in the case of the Nacogdoches surface soil to 98 percent in the case of the fourth layer of the Muskingum. This latter is an unusually large fraction of the total colloid. The colloids were collected from the centrifugate by filtration through Pasteur-Chamberland filters, and were dried on a water bath. The analyses, as reported, are comparable in all respects with those given in Technical Bulletin 316 (*16*) for the other erosion-station soils, except that the organic matter is determined by combustion and the trace quantities of carbonates were not determined.

TABLE 3.—*Chemical analyses of colloids in typical profiles of erosion-station soils*

Sample no.	Depth	Colloid extracted	SiO_2	TiO_2	Fe_2O_3	Al_2O_3	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	N	Organic matter[1]	Ratio of organic matter to nitrogen
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
NACOGDOCHES FINE SANDY LOAM, TYLER, TEX.																		
9475	0–8	45	27.00	0.59	30.60	23.20	0.19	1.28	0.20	0.53	0.10	0.76	0.13	15.54	100.12	0.34	3.32	9.8
9476	8–18	87	31.35	.61	26.71	26.97	.03	.59	.21	.24	.04	.36	.06	12.22	99.39	.15	1.26	8.4
9477	18–40	71	30.81	.59	25.95	28.50	.02	.52	.12	.34	.08	.46	.09	12.21	99.69	.14	.74	5.3
9478	40–66	70	38.12	.67	16.66	31.06	.02	.46	.20	.64	.10	.36	.05	12.20	100.54	.16	.38	2.4
9479	66–72	58	29.80	.58	29.57	25.08	.03	.33	.28	.17	.09	.55	.05	12.62	99.15	.17	.57	3.4
CLINTON SILT LOAM, LA CROSSE, WIS.																		
10362	0–8	75	45.10	0.76	7.02	23.99	0.43	1.36	1.88	1.83	0.16	0.68	0.16	17.07	100.44	0.55	4.89	8.9
10363	8–20	84	47.10	.76	10.00	25.27	.21	1.07	2.04	1.59	.09	.60	.16	11.48	100.37	.18	1.60	8.9
10364	20–32	80	47.85	.69	11.65	23.61	.15	1.16	2.01	1.59	.12	.60	.12	10.37	99.92	.13	1.25	9.6
10365	32–44	79	48.30	.74	8.02	27.05	.14	.97	2.12	1.52	.14	.54	.12	10.38	100.04	.18	1.37	7.6
10366	44–66	88	48.45	.77	6.49	30.20	.03	.77	1.32	1.22	.08	.39	.07	10.94	100.73	.08	.59	7.4
MUSKINGUM SILT LOAM, ZANESVILLE, OHIO																		
B-407	0–7	55	44.00	0.62	9.97	26.67	0.14	0.93	1.98	2.51	0.17	0.49	0.09	13.18	100.75	0.36	3.94	10.9
B-408	7–13	77	43.10	.72	13.00	27.26	.11	.95	1.90	2.78	.06	.44	.05	10.00	100.37	.19	1.25	6.6
B-409	14–24	93	42.70	.73	11.13	29.79	.06	.65	1.54	3.25	.12	.55	.02	9.55	100.09	.11	.52	4.7
B-410	25–46	98	45.05	.84	8.28	30.73	.05	.74	1.21	3.56	.09	.60	.01	9.08	100.24	.11	.30	2.7
B-411	47–72	78	46.80	.92	5.26	31.30	.07	.82	1.62	4.26	.16	.80	.02	8.39	100.42	.11	.27	2.5

[1] CO_2 × factor 0.471.

Comparison of the data of table 3, for the colloids, with those of table 2, for the soils, shows the same general relationships as in the other erosion-station soils. The silica content of the colloids is much less than that of the soils and the sesquioxide content correspondingly greater. The calcium content of the colloids is greater in general than in the soils, and particularly is this the case in the surface horizons. Magnesium also concentrates in the colloid of the Clinton and Muskingum soils, as is generally true of the erosion-station soils, but this is not the case with the three samples from upper layers of the Nacogdoches, and in this respect it stands alone. The nearest approach to this behavior is in the Kirvin fine sandy loam at the same station (*16*). Potassium likewise ordinarily concentrates in the colloid but in the Clinton soil this is not the case except in the lowest stratum. Presumably this is additional evidence of undecomposed feldspars in the loess. In confirmation of this the silt was examined by use of a petrographic microscope and found to contain upwards of 5 percent of feldspars. This is quite in harmony with the loessial soils reported by Brown and Byers (*6*). The presence of undecomposed feldspars in the Clinton is also indicated by the high calcium content of the lower portions of the soil, as compared with that in the colloid. The feldspathic content of the Clinton is further indicated by the high sodium content of the soil. The lower sodium content of the extracted colloid is quite in harmony with the usual relation found in humid soils.

The organic matter is uniformly higher in the colloid than in the soil, but by no means all of the organic matter is dispersed. This is shown by comparing the total organic matter with that found in the colloids. In the surface layers only about 30 percent of the organic matter in the soil appears in the colloid. In the lower layers the extracted organic matter rises to nearly 100 percent of that in the soil. In harmony with this relation is the fact that the organic matter-nitrogen relation is uniformly lower in the colloid than in the soil. It is to be expected that undecomposed organic matter which has a high carbon-nitrogen ratio would have less tendency to disperse than well-decomposed material or bacterial remains.

In order to facilitate the comparison of these three soil colloids with each other the derived data are collected in table 4 which is followed by the corresponding data from the eight other erosion-station colloids (table 5). The latter are partly recalculated from table 3 of Technical Bulletin 316 (*16, p. 28*).

TABLE 4.—*Derived data from the colloid analyses of the erosion-station soils.*

NACOGDOCHES FINE SANDY LOAM, TYLER, TEX.

Sample no.	Depth	Mol ratio					Combined water	Total water of soil acid	Mol ratio $\frac{SiO_2}{H_2O}$
		$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$			
	Inches						*Percent*	*Percent*	
9475	0–8	1.07	1.98	2.35	0.843	12.9	12.22	13.29	0.63
9476	8–18	1.21	1.97	3.12	.632	27.8	10.96	11.44	.83
9477	18–40	1.16	1.83	3.15	.582	29.8	11.47	11.86	.79
9478	40–66	1.53	2.05	6.08	.337	29.4	11.82	12.25	.74
9479	66–72	1.12	1.94	2.68	.723	31.0	12.05	12.40	.72

TABLE 4.—*Derived data from the colloid analyses of the erosion-station soils*—Con.

CLINTON SILT LOAM, LA CROSSE, WIS.

Sample no.	Depth	Mol ratio					Combined water	Total water of soil acid	Mol ratio $\frac{SiO_2}{H_2O}$
		$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$			
	Inches						*Percent*	*Percent*	
10362	0- 8	2.60	3.10	17.10	0.187	8.1	12.18	14.67	0.98
10363	8-20	2.53	3.17	12.52	.253	8.9	9.88	11.64	1.23
10364	20-32	2.62	3.44	10.92	.315	8.9	9.12	10.88	1.34
10365	32-44	2.55	3.03	16.00	.189	9.1	9.01	10.73	1.37
10366	44-66	2.44	2.72	19.85	.137	13.3	10.35	11.62	1.27

MUSKINGUM SILT LOAM, ZANESVILLE, OHIO

Sample no.	Depth	$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	Combined water	Total water of soil acid	Mol ratio $\frac{SiO_2}{H_2O}$
B-407	0- 7	2.26	2.80	11.73	0.230	7.8	9.24	11.34	1.21
B-408	7-13	2.06	2.68	8.81	.305	7.6	8.75	10.53	1.24
B-409	14-24	1.97	2.43	10.2	.239	8.3	9.03	10.06	1.21
B-410	25-40	2.12	2.49	14.5	.172	9.1	8.78	10.23	1.32
B-411	47-72	2.29	2.54	23.6	.107	7.6	8.12	9.05	1.41

The data of the Nacogdoches fine sandy loam offer several points of special interest. In its A horizon it presents the lowest silica-sesquioxide ratio of any soil in the United States, so far reported. This ratio continues to be very low throughout the profile except in the C_1 horizon (40–66 inches). Attention has already been called to the slightly abnormal organic matter content of the C_2 horizon (66–72 inches). The divergence of the C_1 horizon (40–66 inches) from those above it is even more marked. In the mechanical analysis (table 1) it will be noted that there is a sharp increase in the fine sand and an even more marked decrease in the silt content. This is reflected not only in a decidedly different appearance of the soil but in its complete analysis (table 2), which is characterized by a higher silica and lower iron oxide content than the horizons above and below it. This divergence follows into the colloid and shows itself in the silica-sesquioxide, silica-ferric oxide and ferric oxide-alumina ratios particularly but not so markedly, relatively speaking, in the silica-alumina ratio. It would seem clear that this portion of the colloid is derived chiefly at least from a layer of parent material of low iron content.

The Nacogdoches soil is an extremely red soil and the inference may properly be drawn that nearly, if not quite, all of the iron content is free iron oxide. The alumina, on the other hand, is probably associated with the silica. The lateritic character of the colloid is further indicated by its low base content, as shown by the silica-total base ratio. The silica-base ratio of the A horizon is much smaller; in other words, the relative base content is much higher than in lower layers. This may be taken to indicate the greater base-holding capacity of the organic colloid and that a considerable portion of the bases present are associated with the organic matter. The soil of the other erosion stations most similar to the Nacogdoches is the Cecil from North Carolina (table 5). Particular attention is directed to the differences between the Nacogdoches and the Kirvin colloid, which has been developed under identical conditions of temperature and rainfall (table 5).

TABLE 5.—*Derived data from the colloid analyses of the erosion-station soils published in Technical Bulletin 316*

Sample no.	Depth	Mol ratio					Combined water	Total water of soil acid	Mol ratio $\frac{SiO_2}{H_2O}$
		$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$			
CECIL SANDY CLAY LOAM, STATESVILLE, N.C.									
	Inches						*Percent*	*Percent*	
6977	0–6	1.34	1.65	6.94	0.238	13.1	14.65	15.75	0.64
6978	6–32	1.28	1.60	7.27	.233	17.5	13.98	14.58	.69
6979	32–60	1.43	1.88	7.35	.256	25.7	12.85	13.32	.81
KIRVIN FINE SANDY LOAM, TYLER, TEX.									
6678	0–12	2.02	2.75	7.58	0.363	17.5	10.76	11.76	1.10
6679	12–24	1.74	2.28	7.39	.308	17.7	11.32	12.10	1.00
6680	24–51	1.89	2.42	8.81	.274	18.6	11.22	11.92	1.06
6681	51–63	2.03	2.48	10.61	.234	20.3	10.65	11.33	1.17
6682	63–75	1.80	2.47	6.84	.360	24.0	11.03	11.57	1.07
VERNON FINE SANDY LOAM, GUTHRIE, OKLA.									
6718	0–3	2.65	3.45	11.40	0.303	7.0	9.50	12.37	1.12
6719	3–10	2.44	3.12	11.20	.279	7.4	9.43	11.48	1.18
6720	10–27	2.34	2.94	11.38	.259	7.5	9.07	11.58	1.18
6721	27–58	2.35	2.88	13.07	.221	6.7	8.41	10.55	1.21
PALOUSE SILT LOAM, PULLMAN, WASH.									
8069	0–20	2.48	3.23	10.92	0.301	6.6	9.55	12.03	1.16
8070	20–33	2.45	3.32	9.52	.350	7.1	9.56	11.69	1.19
8071	33–62	2.45	3.25	10.02	.324	7.2	9.80	11.90	1.17
8072	62–75	2.57	3.45	10.15	.339	7.4	9.41	11.40	1.20
8073	75–84	2.61	3.50	10.21	.343	7.0	9.30	11.42	1.27
SHELBY SILT LOAM, BETHANY, MO.									
6797	0–8	2.65	3.31	13.22	0.252	8.8	10.38	12.60	1.16
6798	8–12	2.62	3.30	11.42	.262	9.1	10.63	12.52	1.17
6799	12–20	2.60	3.28	11.18	.295	8.7	9.44	11.35	1.30
6800	20–24	2.60	3.38	11.47	.293	7.8	9.41	11.42	1.28
6801	24–48	2.71	3.57	11.22	.319	7.3	8.94	11.03	1.33
6802	48–60	2.67	3.54	10.84	.326	7.4	8.78	10.88	1.35
6802B	60–84	2.91	4.33	8.89	.487	7.6	8.15	10.26	1.47
MARSHALL SILT LOAM, CLARINDA, IOWA									
8736	0–13	2.91	3.69	13.68	0.270	7.6	9.56	12.21	1.23
8737	13–24	2.88	3.66	13.45	.272	7.7	9.87	12.32	1.22
8738	24–45	2.91	3.72	13.40	.278	8.2	9.49	11.56	1.32
8739	45–71	2.83	3.57	13.65	.262	8.7	8.61	10.58	1.43
HOUSTON BLACK CLAY, TEMPLE, TEX.									
6096	0–3	3.26	3.90	19.56	0.200	5.5	9.32	13.77	1.12
6097	14–20	3.24	3.92	18.75	.209	4.8	8.50	13.40	1.13
6098	24–30	3.25	3.91	18.88	.207	5.4	8.13	12.77	1.21
6099	30–50	3.25	3.97	18.45	.215	5.1	8.29	13.03	1.20
COLBY SILTY CLAY LOAM, HAYS, KANS.									
6842	2–10	3.45	4.25	19.41	0.230	6.2	7.49	10.75	1.50
6843	10–20	3.41	4.18	18.47	.227	6.0	7.50	11.17	1.43
6844	20–33	3.47	4.29	18.55	.231	5.7	7.58	11.20	1.44
6845	33–47	3.52	4.27	20.32	.210	5.1	6.94	10.89	1.47
6846	47–60	3.57	4.38	19.39	.226	5.8	7.11	10.66	1.53
6847	60–72	3.56	4.37	19.17	.228	5.2	6.93	10.94	1.47

The Clinton silt loam and the Muskingum silt loam are both representative of the gray-brown podzolic soils but they show marked differences. It is probable that these differences are due in part to the difference in parent material. In the Clinton this is loess, and in the Muskingum is glacial drift. In part, the differences are due to the maturity of the Clinton as compared with the relatively immature Muskingum. It is possible, also, that the Clinton soils have not been wholly developed under forest cover. Their silica-sesquioxide and alumina ratios indicate an acid complex sharply different from the Nacogdoches. The iron content is not free iron oxide, since on treatment with hydrogen peroxide the inorganic residue is nearly white. Nevertheless, both the Clinton and Muskingum soils show distinct evidence of podzolization in the concentration of iron oxide in the B_1 and B_2 horizons. Despite their low pH values (table 1), both colloids have a very high total base content, as compared with Nacogdoches (table 4) and the Cecil and Kirvin (table 5). The other erosion-station soil most closely associated with the Clinton and Muskingum with respect to the colloid properties is Vernon fine sandy loam (table 5). In color, however, the Vernon is markedly different.

In tables 4 and 5, columns 8, 9, and 10, are assembled certain data which require detailed consideration. These involve the water content of the 11 erosion-station soil colloids. "Combined water" of the colloid is determined by subtracting the organic matter and carbon dioxide found from the ignition loss. These values are found in column 8 of the tables. This value is subject to two sources of error, both of which are at present unavoidable. The so-called "organic matter" is determined by combustion and the carbon dioxide found is multiplied by the Wolff factor 0.471. This factor is known to be uncertain (*1*). The ignition loss is determined on the colloid dried at 105° C. It is certain that this temperature produces changes in the organic matter (*1*) and it is illogical to conclude that no combined water is given off at 105°. Despite these uncertainties, the combined water of this series of colloids offers some interesting features. The two lateritic colloids, Cecil and Nacogdoches, show an average percentage of combined water of 13.83 and 11.70 percent, while the next most lateritic colloid, the Kirvin, has a mean value of 10.99. By contrast with these, the three gray-brown podzolic soils, the Vernon, Clinton, and Muskingum, have values of 9.25, 10.11, and 8.78 percent. The three prairie soils, the Marshall, Shelby, and Palouse, have values of 9.38, 9.39, and 9.54 percent. The chernozem soil, the Colby, has a mean value of 7.25 percent. The Houston is not a true chernozem. It is more properly a rendzina soil and has a mean combined water content of 8.56 percent. It is apparent, that, while sharp distinctions are not shown, yet in general it is true that the different great soil groups have distinctively different combined-water values.

In column 9 of tables 4 and 5 are given a series of figures for what is called the "total water of the soil acids." These values are calculated on the assumption that the colloids contain a definite acid, or series of acids, as outlined by Brown and Byers (*6*) and Byers (*7*). If these acids exist the bases present in the colloids may be assumed to replace the water which would otherwise be present, though it must be recognized that a portion of the bases are held by the organic acids. For this purpose, then, the water equivalent of the bases is calculated and the amount is added to the water percentage. Due allowance is to be made for the carbonates present, which are calculated on the assumption that they are wholly calcium carbonate, and for the organic matter. The resulting values, therefore, represent the water present, on the basis of the inorganic material less the calcium carbonate, as 100 percent. It will be noted that in general this recalculation brings about a decrease in the differences between the water content of the colloids, since the colloids of lower water of combination are those of higher base content. The means of the percentages of the representatives of the four groups become: Cecil, Nacogdoches, and Kirvin, 14.55, 12.25, and 11.74 percent, respectively. The corresponding values for the gray-brown podzolic group become: Vernon, 11.49 percent; Clinton, 11.87 percent; and Muskingum, 10.42 percent. For the prairie group: Marshall, 11.67 percent; Shelby, 11.45 percent; and Palouse, 11.69 percent. For the Houston, the mean percentage is 13.25 percent, and for the Colby 10.93 percent.

In column 10 of tables 4 and 5 are found the molecular ratio of the silica to the total water of the soil acids. In the calculation of these data the ratio has been determined on the total combined water before correcting for the organic matter and carbonates present. This is essential because these affect the silica percentages, as well as the combined water and total bases. These values are of very special significance, since, despite the known sources of uncertainty in the water values, and the possible presence of undecomposed silicate particles of colloidal dimensions, two definite regularities may be observed. The silica-water ratio increases progressively with the silica-sesquioxide ratios. This means that the water content of the colloid increases with increase in the sesquioxide content. If, therefore, decrease of the silica-sesquioxide ratio is regarded as a measure of the degree of weathering, the silica-acid water ratio is a corroborative indication. In each soil profile the general relation is a progressive general increase with depth, as is to be expected if a decrease of the ratio is an indication of increase of water content with increased weathering.

In the paper previously referred to (7) in connection with the constitution of the soil acids, it is assumed that an acid of the halloysitic type should, if pure and stable at 105° C., have a combined-water content of 19.6 percent, corresponding to the composition H_3AlSiO_5 ($3H_2O.Al_2O_3.2SiO_2$). In this type of colloid the silica-acid water ratio should be $2SiO_2/3H_2O = 0.667$, and the silica-alumina ratio should be 2. The mean value of the SiO_2/H_2O ratio for the Cecil colloid is 0.71 and the silica-alumina ratio is 1.74. In the Nacogdoches colloid the corresponding ratios are 0.74 and 1.95. If, then, as the above statement implies, the iron content of these two soils is assumed to be ferric oxide, anhydrous at 105°, the water content of the soil acid may be recalculated. This is done by multiplying the values shown in column 9 by $\frac{100}{100\ \text{percent} - Fe_2O_3}$. Such assumption and recalculation is not permissible with the other colloids, since their general behavior indicates that the iron present is at least partially associated with the silica. The quantities so arrived at are for the Cecil colloid 18.0, 16.61, and 15.89 percent, respectively, for the three depths, an average of 16.83; and for the Nacogdoches colloid 19.15, 15.61, 16.00, 14.70, and 17.60 percent, respectively, an average of 16.61 percent. When the close relationship to silicic acid that halloysitic is supposed to have is considered, the results are as nearly theoretical as can reasonably be expected.

A colloid which contains as its major acid component pyrophyllic acid: $H_3AlSi_2O_6(3H_2O.Al_2O_3.4SiO_2)$ should have as its silica-acid water ratio $4SiO_2/3H_2O=1.33$, and a silica-alumina ratio of 4. Its acid-water percentage should be 13.6 percent. The nearest approach to these values among the erosion station soils is found in the Colby colloid. The silica-sesquioxide ratio has a mean value of 3.49. The silica-acid water ratio has a mean value of 1.47. The water content is but 10.93 instead of 13.6 percent. With these facts considered in the light of the properties to be expected of an acid of the type of pyrophyllic acid, the evidence of its existence may be considered as fairly satisfactory. More definite information in this direction must await the development of more accurate determination of the water relations of the colloids, and especially of the combined water evolved before drying at 105° C. is complete.

The other colloids of the erosion-station soils have silica-sesquioxide, silica-alumina, and silica-acid water ratios which lie between the limits of the values for the Cecil and the Colby colloids. They may then, without serious doubt, be considered as containing colloids which are, so far as their acid complex is concerned, intermediate in character between these two extremes. The nearest approach to the halloysitic type of acid is found in the Kirvin colloid. It is a red soil and therefore a part at least of the iron present is to be regarded as free ferric oxide. The silica-total base ratio indicates that the soil is much leached. The corresponding values for the Vernon colloid, as well as the other ratios, indicated for that soil a much closer relation to the pyrophyllic types, despite the low silica-acid water ratio. The Houston colloid is an intersting example in that its very high colloidal calcium carbonate may be assumed to keep the colloidal complex wholly saturated with bases, and by consequence make the loss of water by dehydration less marked. Its acid water is therefore exceptionally high. There is available no other comparable analyses of rendzina soils but it is probable that a similar condition exists in all such soils.

An interesting relation is also found in comparing the hydrogen-ion concentration of the soils with the silica-base ratios of the colloids. The highly acid soils are the A and B horizons of the Kirvin, Cecil (*16*), and Nacogdoches (table 1), with a range between the limits of 3.8 to 5.3; and the Muskingum, Clinton (table 1), and Marshall, which, excluding the C horizons, have a range of pH values from 4.7 to 5.9. Notwithstanding this relatively slight difference in pH values, the silica-base ratios of the first group range from a minimum of 12.9 in the surface layer of the Nacogdoches (pH = 5.3) to 29.4 in the fourth layer of the same soil (pH = 5.0). The mean value of the silica-base ratios of the three lateritic colloids is 20. The minimum silica-base ratio for the other three soils is 7.6 in the surface of the Marshall (pH = 5.6) and in the second layer of the Muskingum (pH = 4.8), while the maximum is 9.1 in the fourth layer of the Clinton (pH = 5.4) and in the fourth layer of the Muskingum (pH = 4.8). The mean value of the ratios for the three soils is 8.2. In these considerations the lowest layer in each soil is not included except in the case of the Cecil. It will be noted also that particularly in the Nacogdoches and

Cecil soils the silica-total base ratio is materially lower; that is, the base content is higher in the surface layer than in those beneath it. Even allowing for an influence of the organic matter out of all proportion to its quantity, two inferences are to be drawn. There is no relation between the base content of a soil colloid and the pH value of the soil. It would seem warranted also to infer that a distinct difference exists between the inorganic soil acid of the lateritic soils and the corresponding complex in soils of higher silica-sesquioxide and higher silica-water ratios. It would appear that these relationships ought to be clarified through a study of the base exchange and base-holding capacities of these colloids. This study is already under way.

EROSIONAL CHARACTERISTICS AS INDICATED BY THE PHYSICAL AND CHEMICAL DATA

The preceding discussion of chemical data relative to these soils and their colloids does not make any attempt to associate these data with the erosional characteristics of the soils, or to include pertinent material from the tables of physical data relative to erosion. However, since erosion is the chief concern of these studies, their bearing on erosion should be discussed. For this purpose the erosion ratio makes a convenient starting point. Insofar as it has been possible to check this ratio it is the best single criterion of erosion, and where information is lacking as to the actual behavior of the soil in the field, the erosion ratio may be taken as a fair guide to the behavior to be expected.

The general relations of the physical properties of the Nacogdoches, Clinton, and Muskingum soils to their erosion ratios and to their erosional behavior have already been pointed out (p. 7). It may be noted further that while the Nacogdoches has a somewhat erosive A horizon, the field behavior shows that it is somewhat less erosive than is indicated by its ratio. The character of its colloid is such that it is very permeable to water and consequently has a low relative run-off except under dashing rains. Its colloid relatively is nonplastic, as is to be expected from its high iron oxide content (apparently nonhydrous) and its low silica-sesquioxide ratio. This effect of permeability, extending as it does throughout the profile, further accentuates the effect of low run-off.

In the Clinton profile the high erosion ratio is accentuated by the low permeability (high percolation ratio) which is in large part due to the abnormally high silt content. It is also in part due to the readily dispersible character of the colloid. The cementing effect in the colloids of high silica-sesquioxide ratio is much less marked than in lateritic colloids, and is further emphasized by the low colloid content of the Clinton.

The Muskingum silt loam is the most markedly podzolic of the erosion-station soils. It is also the least mature of these soils. It is, however, extensively leached, as shown by its pH values (table 1). It might therefore be expected to be less erosive than the Clinton. That it is so is indicated by the various ratios. It is, however, much more readily eroded than ought to be expected of a soil having its general characteristics. It is probable that its exceptionally high silt content, with consequent slow percolation, is partially responsible for its somewhat high erosivity. It is also probable that the character of the colloid, which is readily dispersible, is also a contributing influence. Below 2 feet the erosion ratio increases sharply. It is to be assumed, therefore, that this soil is subject to gully erosion to a marked degree whenever initial exposure of the C horizon occurs. The depth of the soil to the parent rock is not great. Indeed, the description of the Muskingum series indicates that the normal soil depth is less than the profile investigated. The gully formations must therefore be shallow. In order to facilitate a comparison between the physical properties of the soils and the chemical characteristics of the colloids of the A horizons of all the erosion-station soils some of these have been brought together in table 6.

TABLE 6.—*The colloid content and erosion ratio of the A horizons of the erosion-station soils and certain colloid ratios*

Soil type	Erosion ratio	Colloid percentage by mechanical analysis	$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	$\frac{\text{Silica}}{\text{Water of soil acid}}$
Clinton silt loam	57.7	11.2	2.69	8.1	0.98
Kirvin fine sandy loam	50.2	5.6	2.02	17.5	1.10
Muskingum silt loam	42.1	19.9	2.26	7.8	1.21
Vernon fine sandy loam	30.3	5.2	2.65	7.0	1.10
Shelby silt loam	28.8	24.3	2.05	8.8	1.12
Cecil sandy clay loam	22.9	17.3	1.34	13.1	.04
Nacogdoches fine sandy loam	21.7	16.1	1.07	12.9	.03
Palouse silt loam	19.4	24.0	2.48	6.6	1.16
Marshall silt loam	14.2	32.4	2.91	7.6	1.23
Colby silty clay loam	13.0	32.1	3.45	6.2	1.50
Houston black clay	8.1	44.0	3.26	5.5	1.12

In table 6 the soils are arranged in the order of decreasing erosion ratio, as shown in column 2. The colloid content is an index to the general character of the soil texture. The silica-alumina and silica-soil water ratios are indices of the nature of the colloid and the silica-total base ratio indicates in a general way the extent of weathering and leaching.

A careful study of the data given in table 6 has revealed no general relationship between the erosional character of the soils and the chemical character of their colloids. That there is no readily discernible relationship is not surprising. Soil erosion, aside from its dependence upon slope, character of cover, rainfall, and season, is determined by the resultant of a large number of factors such as texture, structure, and permeability, all of which, while influenced by the kind of colloid, are more affected by its quantity. There are, however, certain relationships which are clear. The Clinton silt loam, with its high silica, high base, and moderate water content, has a low colloid content. It is relatively tremendously erosive, as compared with Nacogdoches fine sandy loam, with nearly the same colloid content but very different colloid constitution. Again, in the case of the Kirvin fine sandy loam, the low colloid content permits high erosivity, as compared with the Cecil sandy clay loam, although the retarding effect of the colloid in the Cecil is also enhanced by the low silica and low base content. Such comparisons cannot be made general, since the relatively small differences between the Kirvin and Cecil erosion ratios cannot be traced to the same influences. Other like comparisons might be made only to find that the apparent relationships do not hold generally. It may as well be admitted that the colloid composition in itself plays a secondary role in erosion.

VOLUME WEIGHT AND RELATED PROPERTIES

In pursuance of the study of the physical properties of the soils from the erosion stations it became desirable to know the field-volume weights of the soils. Several methods of determining volume weight were tried out, and the cylinder method [2] of Curry (*8*) was found to give results as accurate as the depth to which the cylinder is driven, could be measured. However, this method was not very well adapted to securing samples from widely separated stations and getting them transported to the laboratory for analysis. In lieu of this, cans were prepared of 24-gage galvanized iron, 3 inches in diameter and 2½ inches high. The bottoms were crimped and soldered on to the sides so that they were absolutely flat. The cans were fitted with tight-fitting covers. These cans were substantial enough to be driven into very stiff soil without distortion. In procuring a volume-weight sample by this method the face of the profile is exposed and a perfectly smooth surface is prepared in the middle of the horizon to be sampled. The can is forced horizontally into the soil until the inside of the bottom is flush with the face of the profile. The soil is then dug away from around the can, leaving a cone-shaped projection of soil in front of the can. The can is then removed and the cone-shaped mass trimmed off with a knife until the surface is flat and exactly flush with the top of the can. The cover is then placed on the can and the joint taped and painted with melted paraffin.

Duplicate samples of each horizon of each soil profile, and in addition duplicate samples taken by forcing the can vertically downward into the surface soil, were taken by this method and sent to the laboratory. The samples were collected by the men in charge at the various stations. The cans had previously been weighed and their volumes measured so that when they were received in the laboratory the tape and paraffin were removed, the cans weighed and placed in a drying oven at 105° C. for 48 hours. They were then cooled in a desiccator and weighed, and from these data the volume weight and moisture content were calculated. Since all of the samples were taken in duplicate, one of each of the duplicate samples was removed from the can, rolled to pass a 2-millimeter sieve, and used for the specific-gravity determination. The remainder of the samples are being held for further study. The results of the volume-weight determinations are presented in table 7, column 3.

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[2] The cylinder was made of good grade steel tubing, 3 inches in diameter, 0.08 inch thick, and 13 inches long; 0.02 inch was machined off the inside and outside to 1 inch from the cutting edge which was tapered from the original outside wall to within 0.01 inch of the original inside wall and casehardened. This left the main cylinder wall 0.04 inch thick. A steel band one-half inch wide and one-eighth inch thick was shrunk on to the cylinder at the top for the insertion of the driving plug, and to prevent collapse of the wall while being driven. The cylinder was polished inside and out and owing to the thinness of the wall and the baffle on both the inside and outside, there was no detectable amount of compression of the soil.

TABLE 7.—*Field volume weights of erosion-station soils and related data*

Sample and location	Depth to center of can (inches)	Volume weight	Specific gravity	Porosity	Moisture content	Calculated moisture content at saturation	Calculated weight of an acre-inch of soil [1]
				Percent by volume	*Percent by weight*	*Percent by weight*	*Tons*
Kirvin fine sandy loam, Tyler, Tex.	Surface	1.87	2.66	29.7	7.8	15.9	211.9
	6	1.73	2.69	35.7	11.7	20.6	196.0
	18	1.31	2.81	53.4	30.4	40.7	148.4
	30	1.48	2.85	48.1	20.8	32.5	167.7
	40	1.44	2.77	48.0	30.7	33.3	163.2
Nacogdoches fine sandy loam, Tyler, Tex.	Surface	1.46	2.76	47.1	10.6	32.2	165.4
	5	1.62	2.86	43.4	13.7	26.8	183.6
	15	1.52	2.97	48.8	24.1	22.1	172.2
	38	1.38	2.86	51.7	31.4	37.5	156.4
	72	1.24	2.99	58.5	33.0	47.2	140.5
Vernon fine sandy loam, Guthrie, Okla.	Surface	1.49	2.63	43.3	14.4	29.1	168.8
	2½	1.54	2.63	41.5	14.0	26.9	174.5
	8	1.55	2.66	41.7	13.0	26.9	175.6
	22	1.63	2.69	39.4	17.7	24.2	184.7
	38	1.61	2.69	40.2	18.8	25.0	182.4
Muskingum silt loam, Zanesville, Ohio	Surface	1.37	2.64	48.1	24.8	35.1	155.2
	3½	1.46	2.66	45.1	16.7	30.9	165.4
	9	1.41	2.70	47.8	17.0	33.9	159.8
	17	1.46	2.68	45.5	16.6	31.2	165.4
	32	1.91	2.78	31.3	13.7	16.4	216.4
	54	1.87	2.78	32.7	16.3	17.5	211.9
Cecil sandy clay loam, Statesville, N.C.	Surface	1.49	2.66	44.0	22.3	29.5	168.8
	3	1.45	2.65	45.3	20.7	31.2	164.3
	27	1.33	2.77	52.0	28.7	39.1	150.7
	65	1.48	2.78	46.8	27.1	31.6	167.7
Shelby silt loam, Bethany, Mo.	Surface	1.41	2.62	46.2	26.1	32.7	159.8
	3½	1.43	2.62	45.4	20.0	31.7	162.0
	10	1.33	2.66	50.0	20.3	37.6	150.7
	13	1.30	2.69	51.7	31.1	39.8	147.3
	16	1.43	2.70	47.0	20.0	32.9	162.0
	22	1.72	2.65	35.1	17.5	20.4	194.9
	36	1.77	2.72	34.9	15.1	19.7	200.6
	54	1.85	2.71	31.7	13.4	17.1	209.6
	72	1.85	2.71	31.7	13.3	17.1	209.6
Palouse silt loam, Pullman, Wash.	Surface	1.38	2.64	47.7	20.6	34.5	156.4
	10	1.35	2.71	50.2	20.2	37.2	153.0
	26½	1.51	2.73	44.7	22.0	29.6	171.1
	48½	1.65	2.73	39.6	19.3	24.0	187.0
	68½	1.71	2.73	37.4	17.8	21.9	193.8
	79½	1.63	2.73	40.3	18.1	24.7	184.7
Colby silty clay loam, Hays, Kans.	Surface	1.13	2.65	57.4	16.3	50.8	128.0
	5	1.35	2.64	48.9	20.4	36.2	153.0
	15	1.40	2.68	47.8	15.8	34.1	158.6
	26	1.46	2.69	45.7	16.2	31.3	165.4
	40	1.48	2.68	44.8	15.1	30.3	167.7
	53	1.40	2.69	48.0	18.0	34.3	159.0
	66	1.57	2.69	41.6	17.5	26.5	177.9
Clinton silt loam, La Crosse, Wis.	Surface	1.26	2.62	51.9	25.5	41.2	142.8
	4½	1.27	2.64	51.9	27.0	40.9	143.9
	18	1.44	2.70	46.7	22.3	32.4	163.2
	30	1.49	2.71	45.0	17.0	30.2	168.8
	45	1.80	2.70	33.3	14.0	18.5	203.9
	60	1.46	2.81	48.0	26.5	32.9	165.4
Marshall silt loam, Clarinda, Iowa	Surface	1.16	2.63	55.9	25.5	48.2	131.4
	6½	1.15	2.64	56.4	27.5	49.0	130.3
	18½	1.06	2.67	60.3	28.1	56.8	120.1
	34½	1.11	2.69	58.7	28.1	52.8	125.8
Houston black clay, Temple, Tex.	Surface	1.03	2.64	61.0	24.6	59.2	116.7
	4	1.01	2.65	61.9	27.0	61.3	114.4
	11	1.27	2.67	52.4	22.7	41.2	143.9
	20	1.51	2.69	43.9	18.8	29.1	171.1
	35	1.62	2.71	40.2	16.6	24.8	183.6

[1] The weight of an acre-inch of soil in tons is equal to 113.31 × the volume weight.

The soils are listed in table 7 in the order of decreasing volume weight of the first horizon. This arrangement places the light-textured sandy soils at the top of the list, with high volume weights, while the heavy-textured clay soils are at the bottom of the list with low volume weights. Aside from this, there is no correlation between the texture of the soil and the volume weight, or between the volume weight and the specific gravity. The range in volume weight is quite large—from 1.01 in the first horizon of the Houston to 1.91 for the fourth horizon of the Muskingum. In 6 cases the surface sample agrees fairly well with the first horizon and in 5 cases the divergence is markedly either more or less, the greatest difference being shown by the Colby—1.13 for the surface and 1.35 for the first horizon. However, the writers do not place much confidence in the results for the surface samples owing to greater difficulty in getting uniform samples at the surface as compared with the lower horizons.

The Nacogdoches and Houston profiles are of particular interest. The volume weight of the Nacogdoches decreases from 1.62 in the first horizon to 1.24 in the fourth horizon, while the Houston increases from 1.01 in the first horizon to 1.62 in the fourth horizon. In the same order, the porosity and moisture content increase in the Nacogdoches and decrease in the Houston. This would indicate that the Nacogdoches is much better drained than the Houston, owing to the greater capacity for water in the lower horizons. This may also aid in explaining the low erosion of the Nacogdoches.

The Clinton, Colby, Palouse, and Vernon soils show the same general trend toward higher volume weights in the lower horizons as the Houston, although in each of these cases there is one horizon which is out of order to make a straight gradation. The Marshall, Muskingum, Shelby, Cecil, and Kirvin soils all have higher volume weights in the first than in the second horizons, and in general the volume weights of their various horizons are quite irregular.

So far as the writers are aware, the relation between the volume weight of soils and their erosional behavior has not been discussed elsewhere. It would appear that when such wide differences in weight appear as are shown by the surface and A horizons of the Kirvin and Houston soils such difference ought to have an apparent effect on erosion. The soil of the greater volume weight might be expected to be less readily brought into suspension and, other things being equal, should settle more rapidly through a viscous medium. If such result does occur, it is effectively masked by other relations. The Kirvin is, of all the erosion soils, the most readily dispersed, and is one of the most readily eroded. The volume weight of the soils has, however, a very significant importance in erosional considerations, as will be pointed out later.

The specific gravity of soils has, besides a direct interest, additional value because of its value in calculating the porosity of soils. The specific gravity of all horizons of the erosion-station soils was determined. The usual pyknometer method was employed with water as a menstrum. The resulting data are found in table 7, column 4. In each profile there is an increase in specific gravity with depth. This increase is probably due in large part to the decrease in organic matter. Such relation is by no means shown with the volume weights. The soils differ materially from each other. The greatest specific gravity is shown by the 72-inch sample of the Nacogdoches fine sandy loam, 2.99. It is of interest to note that the volume weight of this layer is but 1.24 and is the lowest volume weight for the profile. The lowest specific gravity of any of these samples is shown by the surface samples of the Clinton and Shelby soils. While it is true that in general the more highly weathered soils have the highest specific gravity, there is no direct relation detectable, either with the quantity or character of colloid. It is of passing interest to note that the conventionally used mean specific gravity of soils, 2.65, is fairly well maintained by these 11 profiles, the mean value being 2.71. The mean value for the 22 samples representing the upper horizons is 2.66.

From the data on the field volume weight and the specific gravity the porosity of the soil may be calculated. The porosity is defined as the percentage by volume of the soil which is unoccupied by soil particles. This space may, in the field, be occupied either by air or by water or partly by air and partly by water. The formula used for the calculation is:

$$\frac{S-A}{S}\times 100=\text{porosity},$$

where S=specific gravity and A=volume weight (apparent specific gravity). The resulting values are in column 5 of table 7. The porosity range in the 11 profiles is between the limits 29.7 percent for the surface sample of the Kirvin fine sandy loam and 61 percent for the surface of the Houston black clay and 61.9 percent for the A horizon. There is no uniform behavior of the soils with respect to porosity within each profile, although in general the relation holds that increase of colloid content is accompanied by increase in the porosity. There does not appear to be a quantitative relation.

In column 6 of table 7 are given the moisture content of the samples, as received from the stations. The men in charge of the various stations were requested to collect these samples when in their judgment the soil was at its maximum field carrying capacity; or, as soon after the winter rains as the soil could be considered as having been freed from gravitational water and not appreciably dried by surface evaporation. It was not possible to meet this condition in every case, nor in all cases within a single profile. In general, however, the moisture percentages represent the normal field carrying capacity fairly well. The data in column 7 are in weight percentage.

In column 7 of table 7 is presented the calculated moisture content at saturation in percentage by weight. The quantity is obtained by dividing the porosity by the volume weight. This quantity represents the percentage by weight of the moisture in the soil when all the pore space is filled with water. It seems to the writers that this value gives a better expression of pore space than does porosity, since soil workers are, as a rule, more familiar with weight than with volume relations. For example, the 54-inch sample of the Muskingum soil has a porosity of 32.7 percent by volume and a moisture content of 16.3 percent. This relation does not make apparent at a glance to what degree the soil approaches saturation. The saturation-weight percentage in column 7 is 17.5 percent and consequently since the sample contains 16.3 percent it is very nearly saturated. Indeed, it is probable that under field conditions a soil is practically never saturated in the sense that no part of its pore space is occupied by air. The nearest approach to saturation in this sense in the series of soils under examination is the 40-inch sample of the Kirvin fine sandy loam, which contains 30.7 percent moisture or 92.2 percent of its saturation capacity.

In connection with the work of the erosion experiment stations it is desired to express the rate of erosion in terms of the periods of time required, at a given rate, to remove the A horizon partially or completely. What is measured is the tons of material per acre. In making such calculations it is usual to use an arbitrarily selected mean value of 4,000,000 pounds per acre-foot, or 2,000,000 pounds for the plow depth taken as 6⅔ inches. It would be better if the actual weight per acre-foot for each soil were known, or, perhaps more conveniently, the weight per acre-inch. In table 7, column 3, is given the volume weight of each portion of the soil profiles and from this may be calculated the weight per acre-inch. The formula used in the calculation is:

$$\frac{16.3872 \times 144 \times 43,560}{453.59 \times 2,000} = 113.3 \text{ tons},$$

in which 16.3872 is the number of cubic centimeters per cubic inch, 43,560 = the number of square feet per acre, and 453.59 = the number of grams per pound. An equally applicable formula is:

$$\frac{62.424 \times 43,560}{12 \times 2,000} = 113.3 \text{ tons}.$$

The value 113.3 tons is the weight of an acre-inch of water and therefore 113.3 × the volume weight (apparent specific gravity) is the weight of an acre-inch of dry soil. In column 8 of table 7 are given the resulting weights per acre-inch of each profile sample.

It may be questioned whether these calculations are based upon an adequately accurate volume weight. It must be conceded that they are more satisfactory than an arbitrarily selected average figure. It will be seen that they range from a maximum value of 216.4 tons per acre-inch for the 32-inch sample of the Muskingum to 114.4 tons for the 4-inch sample of the Houston. Also, the variations between successive layers are so great at times as to make somewhat doubtful the estimation of the weight of an acre-foot. It is interesting, however, to note that if we take the mean value of the surface and A horizon samples and multiply each by 12 the extreme quantities are 1,386.6 tons or 2,793,200 pounds, and 2,447.4 tons or 4,894,800 pounds per acre-foot. Yet if we take the mean of all the corresponding values for the 22 surface samples (the surface samples and the A horizon) the value per acre-foot becomes 1,879.56 tons or 3,759,120 pounds per acre-foot. When it is considered that the erosion station soils do not represent sands at all, and also not the extreme organic or highest clay soils, the results are a good confirmation of the conventional 4,000,000 pounds per acre-foot.

An additional point of interest is the fact that the A horizon of the soils is a variable quantity and therefore the quantity in tons representing the removal of the A horizon by erosion will vary not only with the soil weight per acre-foot but with the depth of the horizon. It is perhaps not essential to carry out calculations in full to show this. An example will suffice. On the basis of the above data the A horizon, or surface soil, of the Kirvin fine sandy loam, with a depth of 12 inches, represents a soil weight of 2,352 tons per acre, while the Cecil sandy clay loam, with an A horizon of but 6 inches, represents a weight of but 986 tons, and the Houston black clay, depth 8 inches, represents 915 tons.

SETTLING VOLUME AND RELATED PROPERTIES

When soils are thoroughly mixed with a small excess of water and allowed to stand for 24 hours or more, they settle to a definite volume, leaving a clear supernatant liquid or one faintly opalescent with colloid. This volume is greater by far than the field volume of the dry soil. In a study of this soil property, which has been called the settling volume of soils, of the erosion-station soils, it was noted that the volume was quite different for the various soils, when comparison was made under strictly comparable conditions. A report upon this property of the erosion-station soils has been made by Middleton and Byers (*15*). The essential portions of this bulletin, together with certain additional data, are included in this discussion.

The settling volume is defined as the maximum volume that a given quantity of soil can maintain in an excess of water under specific conditions. The water content of the soil at the settling volume has

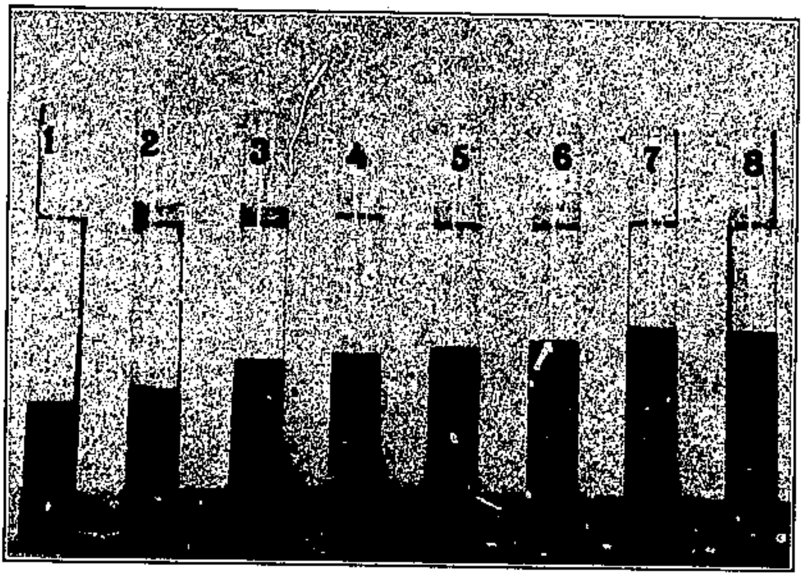

FIGURE 1.—Settling volumes of A horizons. 1, Kirvin fine sandy loam; 2, Vernon fine sandy loam; 3, Cecil sandy clay loam; 4, Shelby silt loam; 5, Palouse silt loam; 6, Colby silty clay loam; 7, Marshall silt loam; 8, Houston black clay.

been designated as the water-saturation capacity. This quantity obviously represents the maximum water content of a soil-water equilibrium system.

The settling volume is determined as follows: A quantity of air-dry soil, equivalent to 50 g of oven-dry soil, is placed in a 250-cc beaker and 35 to 40 cc of water is added. The soil and water are vigorously stirred and the beaker placed in a vacuum desiccator and evacuated until the mixture boils vigorously. The mixture is poured into a 100-cc graduate, with the minimum quantity of water required for rinsing the beaker. The resulting volume is usually about 90 cc. The graduate is covered by the palm of one hand and shaken vigorously. It is then set on the table, the inside washed down with a fine jet of water, and the volume made up to 100 cc. The suspension is allowed to stand for 24 hours, and the soil volume noted. The graduate is again shaken and allowed to stand 24 hours. The process is repeated until a constant volume is reached; this obtains usually after 3 or 4 shakings. The volume is noted to the nearest 0.5 cc. Duplicates agree within 1 cc and the difference is seldom so great. The line between soil suspension and water is very sharp. Occasionally there is a suspension of colloid of small magnitude in the supernatant liquid, but when it finally clears, the flocculated material seldom changes the volume by more than 1 cc. On long standing, indeed for several weeks, the volume of the suspension does not change materially.

An illustration of the relationships shown by different soils when treated as described is shown in figure 1.

The settling volumes of the first 2 horizons of the 11 soils were carefully determined. The results are found in table 8, column 4.

In table 8 the soils are listed in the order of increasing settling volumes of the A horizons. This places them practically in the same order as in table 7, where they are placed in the order of decreasing volume weights of the first horizons. Included in table 8 are the colloid content by water-vapor absorption, (column 5) the moisture equivalent (column 6), and the water-saturation capacity (column 7). This last quantity is calculated by subtracting the absolute volume of the soil from the settling volume and dividing this difference, which numerically corresponds to the weight of the water present, by the weight of the soil. The quotient times 100 gives the "water-saturation capacity" expressed in percentage. This term may not be well chosen because of its similarity to the term "maximum water-holding capacity" as used by Hilgard, but no better term has occurred to the writers. In column 8 is given the volume weight of the soil in suspension. The quantities are calculated by dividing the weight of the soil by the settling volume. They represent the minimum volume weight the soil is able to maintain in the presence of water. Since the field volume weight of the soils represents an approach toward this condition, the field volume weights of the corresponding horizons, as given in table 7, are also given in column 9. The field volume weights are in every case much higher than the minimum volume weight of the soil in suspension, yet there is a rather close correlation between the two values. This relation may be brought out more clearly by plotting the data as in figure 2.

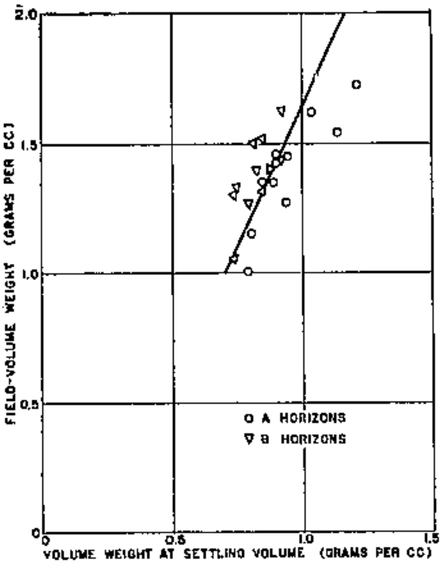

FIGURE 2.—Relation of field volume weight to volume weight at settling volume.

In figure 2 the field volume weights are plotted as ordinates and the settling volume weights as abscissae. Were the correlation perfect, these points would, of course, lie upon the same line. They do not, but the deviation is not great. If a median line be drawn between the points it will be observed that all of the A horizon points, except one, are on one side of the line, while all the B horizon points, save one, are on the other side. This occurs because in all cases, except the Houston, the settling volume of the A horizon is more dense than the corresponding B horizon. This is probably owing to the fact that the B horizon has a greater colloid content than the A horizon. In the field, volume weights of the B horizon are sometimes greater and sometimes less than in the A horizon. In this connection preliminary experiments in this laboratory indicate that repeated wetting and drying of soils under certain conditions produce a maximum volume which, at least in some soils, approaches closely the settling volume of soils.

If, in a similar manner, the relation between the settling volume of these soils and the colloid content (column 5, table 7) is considered, it

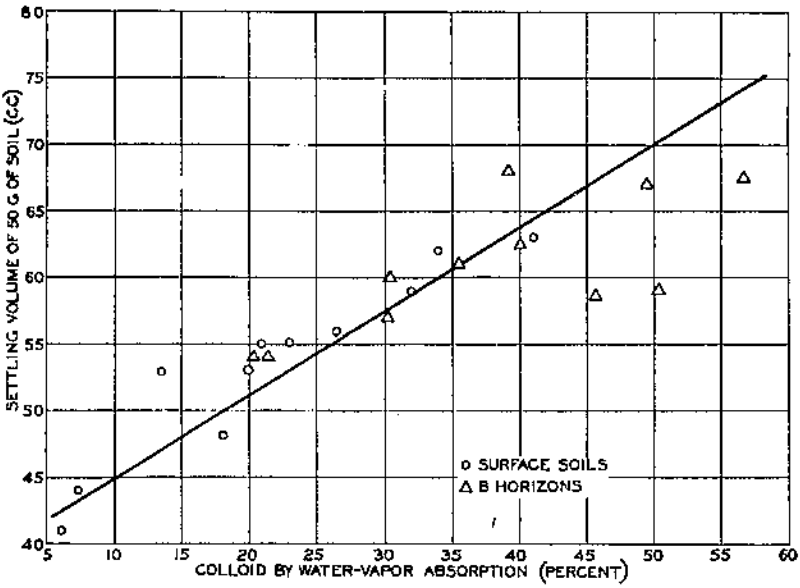

FIGURE 3.—Relation of the settling volume to the colloid by water-vapor absorption.

is to be observed that in general the settling volume increases with the colloid content. The correlation is far from quantitative, as indicated by figure 3.

The divergence of the points from any specific line is quite marked. It may properly be concluded that some other and quite definite factor than colloid content is of moment in determining the settling volume, although unquestionably the quantity of colloid is of considerable importance.

The moisture equivalent of soils is a property of soils which, while largely dependent upon the kind and quantity of colloid is considerably modified by the general textural composition. Inspection of the settling volume values (column 4, table 8) as related to the moisture equivalent again indicates a general correlation. If these values are plotted, as before, the result indicated in figure 4 is obtained.

TABLE 8.—*Settling volume of profile samples*

Sample no.	Soil type and location	Horizon	Settling volume	Colloid by water-vapor absorption	Moisture equivalent	Water saturation capacity	Volume weight of soil in suspension on dry basis	Field volume weight
			Cc	*Percent*	*Percent*	*Percent*	*Grams per cc*	*Grams per cc*
6678	Kirvin fine sandy loam, Tyler, Tex	A	41	5.9	7.9	45.0	1.22	1.73
6679		B	67½	56.6	30.5	98.8	.74	1.31
6718	Vernon fine sandy loam, Guthrie, Okla	A	44	7.4	9.6	50.2	1.14	1.54
6720		B	54	21.5	17.7	70.8	.93	1.63
9475	Nacogdoches fine sandy loam, Tyler, Tex	A	48	18.6	14.3	59.6	1.04	1.62
9476		B	59	50.5	25.2	83.0	.85	1.52
10362	Clinton silt loam, La Crosse, Wis	A	53	13.7	23.9	68.0	.94	1.27
10363		B	54	20.3	23.5	71.0	.93	1.44
6977	Cecil sandy clay loam, Statesville, N.C	A	53	20.0	20.0	68.0	.94	1.45
6978		B	58½	45.7	26.6	80.4	.86	1.33
B407	Muskingum silt loam, Zanesville, Ohio	A	55	21.0	25.5	72.0	.91	1.46
B408		B	57	30.4	26.2	77.6	.88	1.41
6797	Shelby silt loam, Bethany, Mo	A	55	23.1	24.5	72.0	.91	1.43
6798		B	67	49.6	34.9	86.8	.75	1.33
8069	Palouse silt loam, Pullman, Wash	A	56	26.4	25.1	74.0	.89	1.35
8070		B	61	35.0	27.8	85.4	.82	1.51
6842	Colby silty clay loam, Hays, Kans	A	59	32.1	27.3	80.0	.85	1.35
6843		B	60	30.7	25.2	82.6	.83	1.40
8736	Marshall silt loam, Clarinda, Iowa	A	62	33.9	30.1	88.0	.81	1.15
8737		B	68	39.4	31.8	98.4	.74	1.06
6096	Houston black clay, Temple, Tex	A	63	41.1	30.5	88.4	.79	1.01
6097		B	62½	40.2	27.6	87.8	.80	1.27

It is obvious that a much closer relation exists between the moisture equivalent of the soil and the settling volume than with any of the other properties considered. There is still something lacking for satisfactory results, though it seems clear that the quantity of colloid is of major importance.

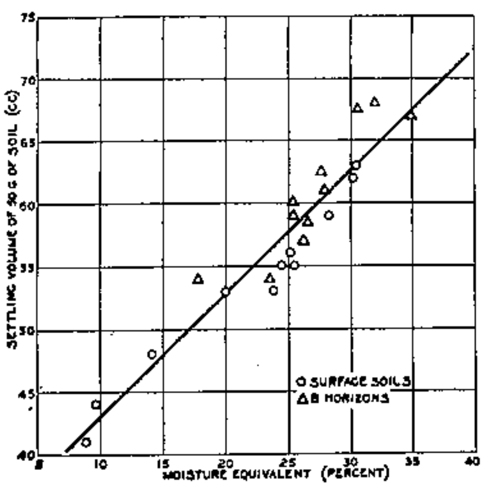

FIGURE 4.—Relation between moisture equivalent and settling volume.

In order to determine whether the character of the colloid is of any moment in determining the settling volume of the soils the colloids of 9 of the erosion-station surface soils were obtained and their settling volumes determined exactly as for the soils except that only 10 g of colloid were employed. The quantity of colloid is not important in showing relative settling volumes, as indicated by the Shelby silt loam. Samples of this colloid of 5, 10, and 25 g were used with 100 cc of water, and the settling volumes obtained were 11, 21.5, and 53 cc, respectively. The results obtained with the nine colloids used are found in table 9, together with their specific gravity and the silica-sesquioxide ratios. From the settling volume and specific gravity of these colloids the water-saturation capacity and apparent specific gravity (volume weight in suspension) are calculated.

TABLE 9.—*Settling volume of colloids from the A horizons of the erosion-station soils and related properties*

Soil from which colloid was extracted	Settling volume	Specific gravity	Silica-sesquioxide ratio	Water-saturation capacity	Volume weight of soil in suspension on dry basis
	Cc			*Percent*	
Nacogdoches fine sandy loam	16.0	2.92	1.07	126	0.63
Cecil sandy clay loam	19.0	2.69	1.34	153	.52
Kirvin fine sandy loam	18.5	2.75	2.02	147	.54
Shelby silt loam	21.5	2.64	2.65	177	.47
Palouse silt loam	22.0	2.69	2.48	183	.45
Marshall silt loam	22.0	2.62	2.91	182	.45
Clinton silt loam	22.5	2.60	2.69	187	.44
Colby silty clay loam	24.5	2.67	3.45	208	.41
Houston black clay	26.0	2.67	3.26	223	.38

The data of table 9 reveal at once a definite relation between the composition of the colloids, as shown by their silica-sesquioxide ratios and their settling volumes. The colloids of the lateritic type are in general of low settling volume and the high silica-sesquioxide ratios have greatly increased water-saturation capacities. The wide variation of the different colloids in respect to settling volume also indicates a dependence of these volumes upon the character of the colloid and consequently their effect upon the settling volume of soils. When an attempt is made to establish a definite relation by plotting the

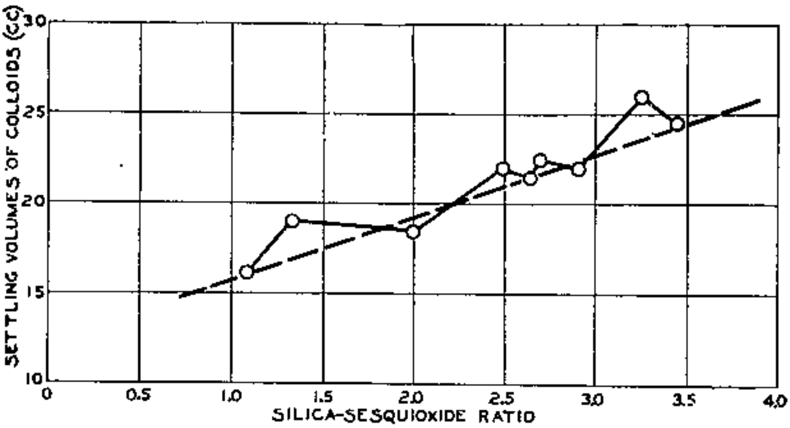

FIGURE 5.—Relation of the settling volume of the colloids to their silica-sesquioxide ratios.

settling volume relations against the silica-sesquioxide ratios, the results are as shown in figure 5.

It is quite clear that while the settling volume of the colloids is, to a degree, dependent upon the composition of the colloids, yet that composition is not wholly expressed by the silica-sesquioxide ratio. That a relationship exists between the composition of colloids and their water relationships has already been pointed out by Anderson and Mattson (*3*) and the nature of the differences in composition giving rise to these differences has been discussed by Byers (7). The data on water of composition of the soil acids given in tables 4 and 5 are not sufficiently accurate to be used in this connection.

It may then be concluded that the settling volume of the soils is a soil property which depends in part upon the constitution of the colloid, the quantity of colloid and upon the other textural properties. It seems at present impossible more closely to define the contributing influences.

The relation of the settling volume to the water-saturation capacity has already been mentioned (p. 25), and the value has been determined for the 11 erosion-station soils. The water-saturation capacity represents the greatest quantity of water which may remain in equilibrium with the soil. This quantity cannot, of course, be found in any field sample but the condition represented by it must be approached when, under very heavy rain, the surface of a soil reaches the condition described by the term "quagmire." It must also be similar to the situation which obtains at the bottom of still ponds into which eroded material has been discharged. The relation of this soil property to certain other soil-water relations which have been determined for these soils is of particular interest. It is perhaps best shown graphically as in figure 6.

The soils in figure 6 are arranged in the order of increasing water-vapor-absorption values; that is, in the order of increasing colloid content of the A horizons. The spaces between successive soils are not proportional to any quantity but are arbitrarily made equal. The percentage content of water at the moisture equivalent, maximum water-holding capacity, and water-saturation capacity of the same horizons are then plotted upon the perpendicular axis. The successive values are connected by straight lines. Also in the figure are included the water-saturation capacities of the colloids of nine soils. The corresponding figures for the Vernon and Muskingum colloids are not available at present.

An inspection of the graph (fig. 6) for the soils makes very clear that in general the same influences determine all the water relationships. It is apparent that both the composition of the colloid and the texture affect the water relationships. Perhaps the most interesting feature of the graph is the abnormally great influence of the colloid of the Clinton silt loam.

That the settling volume of soils and colloids and the water-saturation capacities are real and determinable soil properties is abundantly shown by this graph and the data from which it is derived. How useful they can be made in soil study and interpretation remains for the future to show.

PROPERTIES OF COMPOSITE PLOT SAMPLES

In the previous report (*16*) are given the data for the composite plot samples of the Houston, Cecil, Kirvin, Vernon, Shelby, and Colby soils. Herewith the data are given for the Palouse, Marshall, Nacogdoches, and Clinton soils. This completes the series except for the Muskingum, the samples of which have not been received. As in the previous case (*16*) these samples were subjected to the following determinations: Colloid by water-vapor absorption, moisture equivalent, dispersion ratio, and complete mechanical analysis. From the results of these determinations the colloid-moisture equivalent ratio and the erosion ratio were calculated. The average value of each determination for all the plots (except desurfaced plots) at each

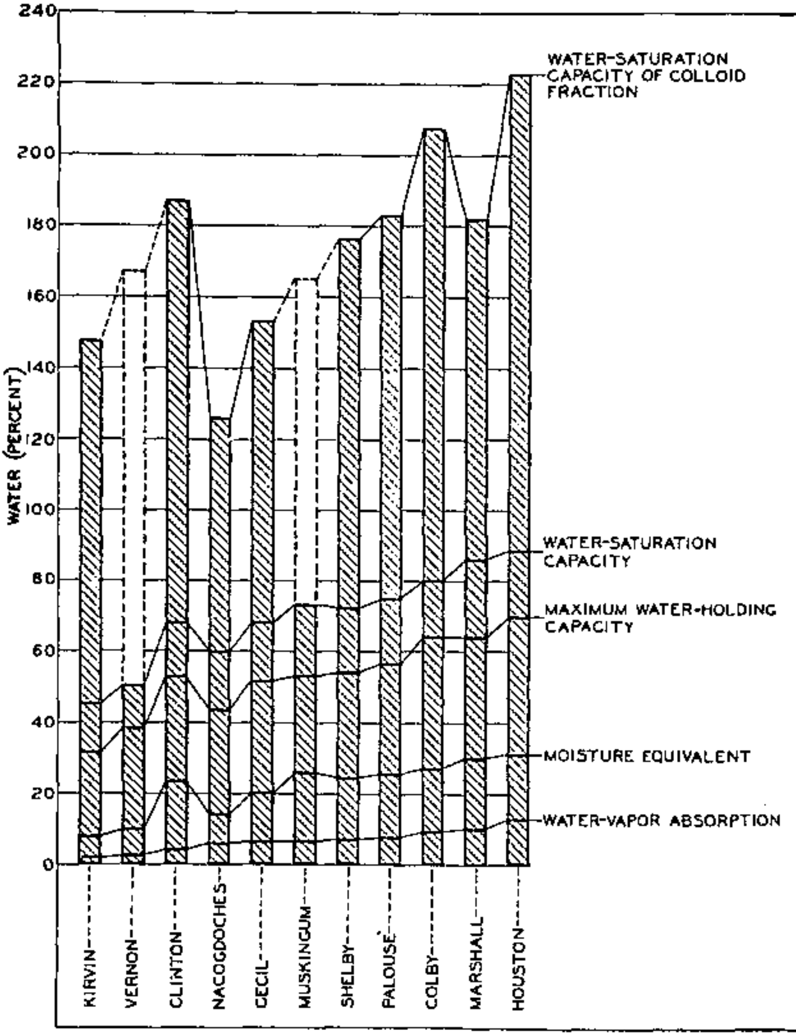

FIGURE 6.—Water relationships of the erosion-station soils.

station was computed for each horizon, and the standard deviation and the coefficient of variability were calculated. The data for the four soils are given in tables 10, 11, 12, and 13.

TABLE 10.—*Analyses of plot composite samples, by horizons, from Palouse silt loam* [1]

Plot no.	Sand in horizon—					Silt in horizon—					Clay in horizon—					Colloid <0.002 mm in horizon—					Organic matter by H_2O_2 in horizon—				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
P [2]	6.4	5.9	6.0	7.2	6.6	64.0	55.6	58.2	63.0	64.0	27.5	37.5	35.4	29.8	29.2	24.0	33.8	32.0	26.6	25.9	1.8	0.8	0.1	0.0	0.0
1 [3]	7.9	7.0	6.4	7.1	-----	63.2	60.4	56.0	55.2	-----	26.6	30.6	36.5	36.8	-----	22.7	25.3	31.3	32.0	-----	1.8	1.5	.9	.5	-----
2 [4]	7.2	7.4	5.6	6.0	-----	61.2	58.1	57.4	58.0	-----	29.6	32.8	36.0	35.1	-----	24.5	28.0	31.5	32.1	-----	1.7	1.3	.8	.4	-----
3	7.7	7.1	5.9	5.0	-----	60.1	59.5	56.7	55.1	-----	30.1	31.4	36.4	39.3	-----	24.0	28.3	33.6	33.7	-----	1.7	1.6	.7	.4	-----
4	7.5	6.8	6.1	5.6	-----	62.2	61.0	56.9	56.7	-----	28.4	30.6	36.2	37.2	-----	22.8	25.6	29.8	34.0	-----	1.7	1.3	.8	.3	-----
5	8.7	6.7	6.2	5.2	-----	58.9	61.5	58.4	57.2	-----	30.4	30.4	34.8	37.3	-----	25.2	25.9	30.8	32.7	-----	1.4	1.1	.4	.2	-----
6	7.1	6.4	5.8	5.6	-----	62.1	60.8	57.7	55.5	-----	28.8	31.5	35.8	38.4	-----	22.8	27.7	30.4	33.0	-----	1.5	1.0	.3	.0	-----
7	9.2	6.0	6.6	5.6	-----	58.5	62.8	57.2	57.5	-----	29.7	29.4	35.2	36.0	-----	21.7	26.3	30.0	32.6	-----	2.0	1.5	1.0	.6	-----
8	6.3	6.3	7.0	6.1	-----	63.6	61.3	59.1	56.6	-----	27.9	30.7	32.7	36.7	-----	23.6	27.5	31.6	32.6	-----	2.0	1.4	1.0	.4	-----
9	6.3	6.8	5.7	5.7	-----	62.0	60.1	57.3	56.4	-----	20.8	31.5	36.1	37.6	-----	23.8	26.6	30.8	33.8	-----	1.5	1.2	.6	.3	-----
10	5.9	6.4	5.8	5.6	-----	64.2	61.8	58.0	55.7	-----	27.7	30.0	35.1	38.3	-----	21.5	26.1	27.9	34.2	-----	1.9	1.4	.7	.1	-----
11	7.1	6.1	6.2	4.8	-----	63.2	63.3	62.2	58.2	-----	27.8	28.7	30.5	36.5	-----	22.8	22.4	29.0	31.7	-----	1.6	1.7	.9	.2	-----
12	6.4	6.0	6.1	5.9	-----	64.2	64.1	60.3	55.2	-----	27.5	28.2	31.5	37.9	-----	23.1	24.4	27.9	33.3	-----	1.7	1.6	.7	.5	-----
13	6.8	6.5	6.6	6.0	-----	62.9	61.4	59.5	55.5	-----	28.3	30.5	33.0	38.0	-----	27.8	29.0	28.3	33.1	-----	1.6	1.2	.5	.2	-----
14 [5]	-----	5.8	6.0	6.2	5.6	-----	60.0	59.1	55.8	49.5	-----	33.0	33.8	37.3	44.5	-----	28.9	30.7	33.8	38.2	-----	.8	.7	.3	.1
15 [6]	6.8	6.8	8.0	6.9	5.9	55.6	55.6	59.4	57.7	55.6	36.3	37.2	31.6	34.4	37.8	32.4	32.4	27.8	20.5	32.5	-----	-----	-----	-----	-----
Average [7]	7.2	6.6	6.2	5.7	-----	62.0	61.2	58.2	56.4	-----	28.7	30.5	34.6	37.3	-----	23.6	26.4	30.2	33.0	-----	1.7	1.4	.7	.3	-----
Standard deviation	.9	.4	.4	.5	-----	1.8	1.5	1.6	1.1	-----	1.1	1.2	1.9	1.1	-----	1.6	1.7	1.6	.8	-----	.2	.2	.2	.2	-----
Coefficient of variability	12.9	6.4	6.4	9.6	-----	2.9	2.5	2.8	1.9	-----	3.9	3.9	5.6	2.9	-----	6.7	6.5	5.3	2.3	-----	10.6	14.4	30.2	55.5	-----

Plot no.	Colloid by water-vapor absorption in horizon—					Moisture equivalent in horizon—					Dispersion ratio in horizon—					Ratio of colloid to moisture equivalent in horizon—					Erosion ratio in horizon—				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*															
P [2]	26.4	35.6	35.8	30.4	30.8	25.1	27.8	27.6	25.5	25.5	20.4	16.2	21.6	28.6	26.2	1.05	1.28	1.30	1.19	1.21	19.4	12.7	16.6	24.0	21.7
1 [3]	25.5	30.4	37.0	38.6	-----	24.1	26.2	27.0	27.9	-----	30.8	19.9	22.7	26.9	-----	1.06	1.16	1.34	1.38	-----	29.1	17.2	16.9	19.5	-----
2 [4]	26.2	29.4	34.2	35.1	-----	24.9	26.3	27.6	28.0	-----	31.3	18.4	24.8	29.3	-----	1.05	1.12	1.24	1.25	-----	29.8	16.4	20.0	23.4	-----
3	25.2	29.2	33.9	37.2	-----	24.8	25.7	27.2	28.8	-----	35.5	22.4	25.3	27.7	-----	1.02	1.14	1.25	1.29	-----	34.8	19.6	20.2	21.5	-----
4	25.6	28.7	34.3	37.0	-----	25.2	25.8	27.7	28.4	-----	33.4	21.1	22.2	28.4	-----	1.02	1.11	1.24	1.30	-----	32.7	19.0	17.9	21.8	-----
5	25.5	27.4	32.8	36.3	-----	24.6	25.8	27.5	28.5	-----	25.3	16.5	18.8	20.7	-----	1.04	1.06	1.19	1.27	-----	24.3	15.6	15.8	16.3	-----
6	24.8	28.0	33.1	36.3	-----	24.7	26.2	28.0	28.4	-----	25.5	19.3	22.9	28.0	-----	1.00	1.07	1.18	1.28	-----	25.5	18.0	19.4	21.9	-----
7	24.6	27.4	32.7	36.6	-----	24.9	26.1	27.8	28.5	-----	30.2	20.2	20.0	22.5	-----	.98	1.05	1.18	1.28	-----	30.8	19.2	16.9	17.6	-----

8	25.3	28.8	33.0	36.6	-----	25.0	26.1	27.7	28.5	-----	29.8	21.9	26.0	30.6	-----	1.01	1.10	1.19	1.28	-----	29.5	19.9	21.8	23.9	-----
9	24.6	26.7	32.1	36.5	-----	25.2	26.0	26.8	28.4	-----	31.1	23.5	21.1	27.2	-----	.98	1.03	1.20	1.29	-----	31.7	22.8	17.6	21.1	-----
10	25.4	26.9	31.2	36.1	-----	23.8	25.0	26.8	27.9	-----	30.3	19.6	21.2	27.4	-----	1.07	1.08	1.16	1.29	-----	28.3	18.1	18.3	21.2	-----
11	24.4	26.4	31.3	37.0	-----	24.6	25.6	27.1	28.7	-----	34.8	24.5	21.0	23.1	-----	.99	1.03	1.16	1.29	-----	35.2	23.8	18.1	17.9	-----
12	26.1	27.6	30.9	36.9	-----	24.9	25.9	26.8	28.6	-----	30.1	28.8	21.0	24.0	-----	1.05	1.07	1.15	1.29	-----	28.7	26.9	18.3	18.6	-----
13	25.4	27.8	32.0	38.4	-----	24.2	25.2	25.6	28.0	-----	28.7	21.1	22.7	26.7	-----	1.05	1.10	1.25	1.37	-----	27.3	19.2	18.2	19.5	-----
14 [5]	-----	29.8	30.2	34.7	34.4	-----	25.6	25.9	27.1	27.0	-----	25.2	24.3	24.2	31.2	-----	1.16	1.17	1.28	1.27	-----	21.7	20.8	18.9	24.6
15 [6]	31.5	33.5	27.4	30.5	35.4	25.5	26.6	24.8	26.1	27.1	30.2	30.4	28.3	27.2	28.5	1.24	1.26	1.10	1.17	1.31	24.4	24.1	25.6	23.3	21.8
Average [7]	25.3	28.1	33.0	36.8	-----	24.7	25.8	27.2	28.4	-----	30.5	21.3	22.3	26.3	-----	1.02	1.09	1.21	1.30	-----	29.8	19.7	18.4	20.3	-----
Standard deviation	.5	1.1	1.6	.9	-----	.4	.4	.6	.3	-----	2.9	3.0	2.0	2.8	-----	.03	.04	.05	.04	-----	3.1	3.0	1.5	2.3	-----
Coefficient of variability	2.1	4.0	4.8	2.4	-----	1.6	1.5	2.3	1.0	-----	9.5	13.9	9.1	10.6	-----	3.00	3.60	4.20	2.70	-----	10.4	15.3	8.4	11.2	-----

[1] Mechanical analyses by H. W. Lakin and T. M. Shaw.
[2] Profile sample.
[3] Short plot.
[4] Long plot.
[5] Desurfaced plot.
[6] Desurfaced and refilled to original level, 1932.
[7] Average does not include profile sample or desurfaced plots.

TABLE 11.—*Analyses of plot composite samples, by horizons, from Marshall silt loam* [1]

Plot no.	Sand in horizon—				Silt in horizon—				Clay in horizon—				Colloid <0.002 mm in horizon—				Organic matter by H_2O_2 in horizon—			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
P [2]	2.1	1.5	3.5	18.1	59.0	56.5	61.6	55.2	35.3	39.4	33.8	26.5	32.4	34.6	28.2	20.3	3.2	2.3	0.8	0.0
1 [3]	2.2	1.6	1.0	1.1	60.4	60.0	58.9	63.8	34.1	35.8	37.9	33.9	29.9	32.0	33.6	28.5	3.1	2.3	1.9	.8
2 [4]	2.1	1.7	1.2	1.1	59.6	57.1	58.2	62.2	34.9	38.2	38.7	35.9	30.5	33.2	33.9	29.3	3.1	2.6	1.5	.5
3	2.4	1.6	.9	1.0	58.2	58.2	59.8	64.1	35.8	37.7	38.0	34.1	30.6	33.3	33.4	28.5	2.9	2.4	1.1	.4
4	1.8	1.7	1.2	1.0	60.4	58.5	58.7	64.4	34.5	36.8	38.3	33.8	29.7	32.4	33.1	28.3	3.1	2.6	1.7	.4
5	1.8	1.3	1.1	3.0	61.1	59.4	60.4	63.6	33.7	36.3	37.4	32.8	29.7	31.0	31.7	27.8	2.6	2.6	.7	.1
6	2.0	1.5	1.4	1.2	60.7	58.7	58.2	64.1	33.9	36.8	38.7	34.1	29.7	32.5	33.6	29.0	3.0	2.6	1.4	.0
7	2.0	1.4	1.0	.5	61.7	58.5	61.4	66.4	33.3	37.5	36.6	32.5	30.4	33.0	32.0	25.9	2.2	2.0	.8	.4
8	1.5	1.4	.9	1.0	60.7	59.6	58.6	64.2	34.6	36.3	39.2	34.2	29.9	33.4	31.2	30.8	2.3	2.1	.7	.0
9 [5]	------	1.1	.9	1.0	------	54.5	57.3	64.0	------	42.1	40.8	34.3	------	35.5	34.2	27.5	------	1.8	.7	.3
Average [6]	2.0	1.5	1.1	1.2	60.4	58.8	59.3	64.1	34.4	36.9	38.1	33.9	30.1	32.6	32.8	28.5	2.8	2.4	1.2	.3
Standard deviation	.3	.1	.2	.7	1.0	.9	1.0	1.1	.7	.8	.8	1.0	.4	.8	1.0	1.3	.3	.2	.4	.3
Coefficient of variability	13.0	9.4	15.7	58.0	1.6	1.5	1.7	1.7	2.1	2.1	2.0	2.8	1.2	2.3	2.9	4.6	12.4	9.6	36.6	86.6

Plot no.	Colloid by water-vapor absorption in horizon—				Moisture equivalent in horizon—				Dispersion ratio in horizon—				Ratio of colloid to moisture equivalent in horizon—				Erosion ratio in horizon—			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*												
P [2]	33.9	39.4	33.1	21.4	30.1	31.8	29.3	23.3	16.1	7.9	18.2	31.8	1.13	1.24	1.13	0.92	14.2	6.4	16.1	34.5
1 [3]	33.3	36.9	38.8	36.0	30.4	31.7	32.1	30.4	26.0	24.1	23.9	33.2	1.10	1.16	1.21	1.18	23.6	20.8	19.8	28.1
2 [4]	33.4	36.7	38.7	35.0	30.6	31.8	32.4	29.9	27.0	25.7	23.5	33.8	1.09	1.15	1.19	1.17	24.8	22.3	19.8	28.9
3	32.2	35.8	38.2	35.6	30.3	32.2	32.3	30.8	29.7	26.0	27.9	32.1	1.06	1.11	1.18	1.16	28.0	23.4	23.6	27.7
4	32.9	36.4	38.7	34.8	30.4	31.7	32.8	30.5	26.1	28.9	28.6	36.1	1.08	1.15	1.18	1.14	24.2	25.1	24.2	31.7
5	32.9	35.9	39.4	34.1	29.7	31.5	32.3	29.5	26.0	21.3	28.3	36.0	1.11	1.14	1.22	1.16	23.4	18.7	23.2	31.0
6	31.9	36.0	38.5	33.8	29.7	31.8	32.9	30.0	26.1	26.5	26.6	36.1	1.07	1.13	1.17	1.13	24.4	23.4	22.7	31.9
7	32.6	36.8	38.2	33.1	30.2	32.5	32.7	29.5	27.7	26.1	27.4	30.4	1.08	1.13	1.17	1.12	25.6	23.1	23.4	27.1
8	32.7	36.8	39.9	35.7	30.2	31.7	32.9	30.3	28.1	25.0	23.8	34.3	1.08	1.16	1.21	1.18	26.0	21.5	19.7	29.1
9 [5]	------	40.5	39.1	33.9	------	33.0	32.3	29.4	------	18.3	23.2	33.2	------	1.23	1.21	1.15	------	14.9	19.2	28.9
Average [6]	32.7	36.4	38.8	34.8	30.2	31.9	32.6	30.1	27.1	25.5	26.3	34.0	1.08	1.14	1.19	1.16	25.0	22.3	22.1	29.4
Standard deviation	.5	.4	.5	1.0	.3	.3	.3	.4	.4	2.0	2.0	1.9	.02	.02	.02	.02	1.4	1.8	1.8	1.7
Coefficient of variability	1.5	1.2	1.4	2.7	1.0	1.0	.9	1.5	1.5	8.0	7.7	5.7	1.4	1.4	1.5	1.9	5.5	8.2	8.2	5.9

[1] Mechanical analyses by H. W. Lakin and T. M. Shaw.
[2] Profile sample.
[3] Short plot.
[4] Long plot.
[5] Desurfaced plot.
[6] Average does not include profile sample or desurfaced plot.

TABLE 12.—*Analyses of plot composite samples, by horizons, from Nacogdoches fine sandy loam*[1]

Plot no.	Sand in horizon—					Silt in horizon—					Clay in horizon—					Colloid <0.002 mm in horizon—					Organic matter by H_2O_2 in horizon—				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
P[2]	69.7	45.7	55.1	64.8	60.3	9.8	4.9	5.9	0.8	5.6	18.0	48.4	38.9	34.3	34.0	16.1	47.1	38.2	31.7	32.7	2.2	0.7	0.0	0.0	0.0
3[3]	69.9	48.1	53.5	-----	-----	10.1	5.5	5.9	-----	-----	18.0	45.9	40.3	-----	-----	17.2	45.8	38.8	-----	-----	1.5	.3	.0	-----	-----
2	69.7	45.0	54.8	-----	-----	8.7	5.0	5.2	-----	-----	19.3	49.2	39.6	-----	-----	16.8	46.8	33.9	-----	-----	1.8	.5	.0	-----	-----
3	69.2	48.3	57.3	-----	-----	10.3	5.3	4.5	-----	-----	18.0	45.6	37.9	-----	-----	15.1	43.2	35.8	-----	-----	2.1	.4	.0	-----	-----
4[4]	-----	49.0	54.6	-----	-----	-----	5.0	4.9	-----	-----	-----	45.2	40.0	-----	-----	-----	44.0	38.6	-----	-----	-----	.2	.0	-----	-----
Average[5]	69.6	47.1	55.2	-----	-----	9.7	5.3	5.2	-----	-----	18.4	46.9	39.3	-----	-----	16.4	45.3	36.2	-----	-----	1.8	.4	.0	-----	-----
Standard deviation	.3	1.5	1.6	-----	-----	.7	.2	.6	-----	-----	.6	1.6	1.0	-----	-----	.9	1.5	2.0	-----	-----	.2	.1	.0	-----	-----
Coefficient of variability	.4	3.2	2.9	-----	-----	7.4	3.9	11.0	-----	-----	3.4	3.5	2.6	-----	-----	5.6	3.3	5.6	-----	-----	13.6	20.9	.0	-----	-----

Plot no.	Colloid by water-vapor absorption in horizon—					Moisture equivalent in horizon—					Dispersion ratio in horizon—					Ratio of colloid to moisture equivalent in horizon—					Erosion ratio in horizon—				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*															
P[2]	18.6	50.5	52.5	32.9	45.2	14.3	25.2	25.1	18.6	22.5	28.2	13.8	16.0	11.5	12.4	1.30	2.00	2.10	1.77	2.01	21.7	6.9	7.6	6.5	6.2
1[3]	20.8	50.9	48.6	-----	-----	14.2	25.2	25.0	-----	-----	23.8	18.4	12.8	-----	-----	1.46	2.02	1.94	-----	-----	16.3	9.1	6.6	-----	-----
2	21.5	52.1	47.9	-----	-----	15.1	26.8	25.3	-----	-----	24.9	22.3	15.6	-----	-----	1.42	1.95	1.89	-----	-----	17.5	11.4	8.3	-----	-----
3	19.9	49.0	45.9	-----	-----	15.7	25.5	24.4	-----	-----	27.4	19.3	16.2	-----	-----	1.27	1.92	1.88	-----	-----	21.6	10.1	8.6	-----	-----
4[4]	-----	51.2	48.3	-----	-----	-----	25.9	24.9	-----	-----	-----	17.1	13.7	-----	-----	-----	1.98	1.94	-----	-----	-----	8.6	7.1	-----	-----
Average[5]	20.7	50.7	47.5	-----	-----	15.0	25.8	24.9	-----	-----	25.4	20.0	14.9	-----	-----	1.38	1.96	1.90	-----	-----	18.5	10.2	7.8	-----	-----
Standard deviation	.7	1.3	1.1	-----	-----	.6	.7	.4	-----	-----	1.5	1.7	1.5	-----	-----	.08	.04	.03	-----	-----	2.3	.9	.9	-----	-----
Coefficient of variability	3.2	2.5	2.4	-----	-----	4.1	2.7	1.5	-----	-----	5.9	8.3	10.0	-----	-----	5.9	2.2	1.4	-----	-----	12.3	9.3	11.3	-----	-----

[1] Mechanical analyses by H. W. Lakin and T. M. Shaw.
[2] Profile sample.
[3] Short plot.
[4] Desurfaced plot.
[5] Average does not include profile sample or desurfaced plot.

TABLE 13.—*Analyses of plot composite samples, by horizons, from Clinton silt loam* [1]

Plot no.	Sand in horizon—					Silt in horizon—					Clay in horizon—					Colloid <0.002 mm in horizon—					Organic matter by H_2O_2 in horizon—				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
P [2]	6.0	6.6	7.0	10.7	68.6	72.7	68.5	65.8	66.5	7.6	19.1	24.3	27.0	22.4	23.2	11.2	18.8	21.8	18.2	21.4	1.7	0.1	0.0	0.0	0.0
1 [3]	4.9	4.2	8.7	24.8	----	75.4	69.8	64.0	48.6	----	17.6	25.3	26.5	26.1	----	12.0	20.9	21.8	24.8	----	1.7	.4	.5	.3	----
2 [4]	5.3	5.8	8.3	15.5	----	75.0	69.3	63.8	59.8	----	17.6	23.8	27.4	24.3	----	10.9	20.0	22.9	19.8	----	1.8	.6	.2	.2	----
3	4.9	5.9	8.0	19.7	----	80.6	69.4	64.8	55.6	----	12.5	24.3	26.8	24.3	----	11.8	18.5	22.7	20.1	----	1.7	.4	.3	.0	----
4	5.3	4.6	6.0	11.0	----	74.8	69.6	66.9	63.9	----	18.2	25.5	26.7	24.6	----	11.3	19.5	22.2	22.2	----	1.3	.1	.2	.1	----
5	4.7	5.1	5.3	7.2	----	77.3	71.2	68.2	68.5	----	16.1	22.7	25.8	23.7	----	11.9	18.0	22.4	21.9	----	1.6	.7	.6	.3	----
6	4.8	5.4	5.7	7.5	----	77.2	71.5	68.7	68.6	----	16.2	22.6	25.3	23.5	----	10.7	18.1	22.0	21.4	----	1.6	.3	.1	.1	----
7	5.4	4.1	5.4	7.2	----	77.0	72.1	69.0	69.0	----	15.8	23.2	25.4	23.5	----	11.1	18.4	22.1	21.7	----	1.5	.3	.1	.1	----
8	5.0	4.8	6.0	6.6	----	76.3	72.1	68.0	69.5	----	16.8	22.2	25.4	23.5	----	12.8	18.2	23.1	20.8	----	1.4	.6	.4	.3	----
9	5.7	5.2	6.4	6.6	----	74.8	69.8	66.1	67.7	----	17.6	24.5	27.1	25.4	----	12.6	19.9	23.2	20.4	----	1.5	.3	.1	.2	----
10	5.1	5.5	5.7	7.3	----	75.2	71.8	66.6	66.0	----	17.5	21.8	27.2	26.2	----	13.4	17.3	23.0	22.9	----	1.9	.5	.2	.1	----
11 [5]	----	5.3	6.6	8.0	----	----	71.5	67.0	67.3	----	----	22.3	25.9	23.3	----	----	18.9	23.3	20.7	----	----	.5	.0	.0	----
Average [6]	5.1	5.1	6.6	11.3	----	76.4	70.7	66.6	63.7	----	16.6	23.6	26.4	24.5	----	11.9	18.9	22.5	21.6	----	1.6	.4	.3	.2	----
Standard deviation	.3	.6	1.2	6.2	----	1.7	1.1	1.8	6.4	----	1.6	1.2	.8	1.0	----	.8	1.0	.5	1.4	----	.2	.2	.2	.1	----
Coefficient of variability	5.8	11.7	18.4	54.4	----	2.2	1.6	2.7	10.0	----	9.4	5.2	2.9	4.1	----	7.0	5.5	2.1	6.5	----	10.8	69.2	51.0	52.4	----

Plot no.	Colloid by water-vapor absorption in horizon—					Moisture equivalent in horizon—					Dispersion ratio in horizon—					Ratio of colloid to moisture equivalent in horizon					Erosion ratio in horizon—				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*															
P [2]	13.7	20.3	24.7	21.1	19.8	23.9	23.5	24.7	22.4	13.8	32.9	26.7	35.5	39.2	34.8	0.57	0.86	1.00	0.94	1.43	57.4	31.0	35.5	41.7	24.3
1 [3]	14.1	21.4	24.6	26.5	----	21.6	23.5	24.1	22.4	----	39.0	31.6	32.5	34.0	----	.65	.91	1.02	1.18	----	60.0	34.7	31.8	28.8	----
2 [4]	13.3	20.5	24.9	23.0	----	21.6	23.5	24.4	22.7	----	37.0	30.8	31.2	34.1	----	.62	.87	1.02	1.01	----	59.7	35.4	30.6	33.8	----
3	13.9	21.4	25.6	24.1	----	22.0	23.8	24.7	22.3	----	34.4	31.8	34.8	40.6	----	.63	.90	1.04	1.08	----	54.6	35.3	33.5	37.6	----
4	14.3	21.6	25.8	25.3	----	22.0	24.6	25.4	23.7	----	31.1	32.2	35.1	42.9	----	.65	.88	1.02	1.07	----	47.8	36.6	34.4	40.1	----
5	14.4	20.2	25.5	24.8	----	22.0	23.4	25.0	24.3	----	30.5	28.5	30.4	36.6	----	.65	.86	1.02	1.02	----	46.9	33.1	29.8	35.9	----
6	14.1	20.5	24.8	23.8	----	21.4	23.9	25.3	24.3	----	29.5	30.7	36.5	42.8	----	.66	.86	.98	.98	----	44.7	35.7	37.2	43.2	----
7	13.4	20.3	25.3	26.0	----	21.8	23.4	24.3	24.3	----	31.0	29.0	30.3	41.0	----	.61	.87	1.04	1.07	----	50.8	33.3	29.1	38.3	----
8	13.5	19.1	25.0	24.0	----	21.7	23.3	24.9	24.2	----	31.6	26.4	33.6	40.6	----	.62	.82	1.00	.99	----	51.0	32.2	33.6	41.0	----
9	14.4	22.1	26.2	24.7	----	21.5	24.3	25.6	24.1	----	32.0	32.7	39.2	46.3	----	.67	.91	1.02	1.03	----	47.7	35.9	38.4	44.9	----
10	15.2	19.1	25.4	24.6	----	21.8	23.3	24.0	24.4	----	30.8	35.1	33.9	35.1	----	.70	.82	1.06	1.01	----	44.0	42.8	31.9	34.7	----
11 [5]	----	19.4	26.0	23.6	----	----	23.3	25.6	23.9	----	----	34.5	40.5	47.0	----	----	.83	1.02	.99	----	----	41.6	39.7	47.5	----
Average [6]	14.1	20.6	25.3	24.7	----	21.7	23.7	24.8	23.7	----	32.7	30.9	33.8	39.4	----	.65	.87	1.02	1.04	----	50.7	35.5	33.0	37.8	----
Standard deviation	.5	1.0	.5	1.0	----	.2	.4	.5	.8	----	2.9	2.3	2.7	3.9	----	.03	.03	.02	.06	----	5.4	2.8	2.9	4.5	----
Coefficient of variability	3.9	4.7	1.9	4.0	----	1.0	1.8	2.2	3.4	----	9.0	7.5	7.9	9.9	----	4.0	3.5	2.1	5.4	----	10.7	7.8	8.7	12.0	----

[1] Mechanical analyses by H. W. Lakin and T. M. Shaw.
[2] Profile sample.
[3] Short plot.
[4] Long plot.
[5] Desurfaced plot.
[6] Average does not include profile sample or desurfaced plot.

These data indicate that the plot samples of these four soils, like those of the six previously studied, are characterized by a high degree of uniformity. The differences in many cases are probably well within the experimental error. The only case where any distinct lack of uniformity is shown is in the fourth horizon of the Clinton. The first four plots contain much more sand in this horizon than do the rest. These differences are also reflected in the silt, clay, and colloid content, but not to as great an extent. Differences appear also in the other soil properties. It would appear that the soil depth is less in the lower numbered plots than is the case with the remainder of the plots.

The plot samples compare very satisfactorily with the original profile samples in all cases, particularly with respect to the colloid, moisture equivalent, and mechanical analyses. The dispersion and erosion ratios are quite similar in the Nacogdoches and Clinton but are at a greater variance in the Palouse and Marshall, particularly in the second horizon of the Marshall. Since the plots are very uniform in respect to these determinations, the only way the writers are able to account for these differences is by assuming that there was a structural difference between the profile samples and the plot samples, or at least a structural difference caused by seasonal variation in the times of sampling.

The surface of the desurfaced plots (listed in the tables as the second horizon) agrees very well with the corresponding horizon of the normal plots in all cases except plot 15 of the Palouse. This plot, while classed as a desurfaced plot, is unlike any other plot at any of the stations, in that it was desurfaced and then refilled with clay from a nearby outcrop. The normal desurfaced plot (plot 14) was found to give unsatisfactory results, owing to the accumulation of snow during the winter in the place from which the surface soil had been removed.

The coefficients of variability are, in general, very low. The notable exceptions are in the fourth horizons of the Marshall and Clinton. In both of these cases the largest coefficient of variability is in the percentage of sand.[3]

In order better to compare the uniformity of these soils the coefficients of variability have been averaged for each horizon of each soil, and are shown in table 14.

TABLE 14.—*Average*[1] *coefficients of variability of composite plot samples*

Horizon	Palouse silt loam	Marshall silt loam	Clinton silt loam	Nacogdoches fine sandy loam
1	5.0	3.2	5.0	5.4
2	6.4	3.9	5.5	4.3
3	5.4	4.7	5.4	5.4
4	5.0	9.4	12.2	
Average	5.7	5.3	7.2	5.0

[1] Coefficients of variability for organic matter are not included.

[3] In all cases the standard deviation of the organic matter is relatively very low, but owing to the very low percentage of organic matter, especially in the lower horizons, the coefficient of variability is high and, in this and the following discussion (table 14), has not been considered.

The Nacogdoches has the lowest average coefficient of variability for these four soils and also for the entire series (*16, p. 42*). However, the Nacogdoches has the smallest number of plots (four), and consequently represents a smaller area. The Marshall is next in uniformity to the Nacogdoches, and just above the Colby (5.2) in the previous series. The surface horizon of the Marshall has the minimum coefficient of variability for any horizon of the whole series. In the previous series the lowest coefficient of variability was given by the second horizon of the Houston which was 4.7. In this series this figure is equaled or exceeded by the first three horizons of the Marshall and the second horizon of the Nacogdoches. With the exception of the fourth horizon of the Clinton and the Marshall, as previously mentioned, all four of these soils show an exceptionally high degree of uniformity.

RUN-OFF AND EROSION DATA

The erosion-station plots were established for the purpose of studying the effect of water in producing erosion under different conditions of cover and cultivation. The laboratory investigations in connection with these plots were organized primarily to discover whether, as erosion proceeded, marked changes are produced in the character of the residual soils. For future comparison the profile composite samples were collected and the fundamental physical properties determined and placed on record ((*16, pp. 36–41*), and tables 10–13 in this bulletin). The annual composites from each plot are taken to a uniform depth of 7 inches and subjected to a like examination. If material alteration of the soil surface is effected as a result of erosion, the results of the analyses, when compared with the original profile composite analyses, should reveal the extent and character of the changes. Such comparisons, as well as those made with the corresponding data on the material removed under various cover and other conditions, ought to give information concerning the modes of prevention of erosion. It is not to be expected that marked changes would appear within a period of a few years only, but the course of operations may be followed by annual examination. It is also possible, by such laboratory examinations, to establish comparisons between the soils at the different stations. The station first established is at Guthrie, Okla., and began operations in 1929. The station most recently established is near Zanesville, Ohio, and began operations in 1933. Sufficient time has not elapsed to give adequate data for final conclusions.

Run-off and erosion data are now available for one or more years from 7 of these stations and for 8 of the soils. No data are yet available from the Pullman, La Crosse, and Zanesville stations. The samples submitted by the stations of the dissolved solids obtained by evaporation of the run-off water have been so small and so contaminated by colloids that no analyses have been made. The annual composites (p. 2) have been examined by the same methods employed for the profile composites. The solid material removed by erosion from each plot, the wash-off samples, have also been examined in exactly the same manner. The results of these examinations are brought together with the data for the profile composite samples in tables 15 to 22, inclusive. In order to make clearer the significance of the data presented in these tables it should be mentioned that at each station the plots are subjected to a cropping system such that some plots are subject to severe erosion each year. Other plots are protected, so far as possible, from erosion. Some are subjected to rotations, so that the amount of erosion varies from year to year. In addition, one or more plots are desurfaced in order to expose the B horizon to erosion. In addition to these variations, the fertilizer practice is different at the several stations.

It should also be noted that the wash-off samples have been collected at different times during the year and have been repeatedly oven-dried and rewet. This entails considerable segregation of material and aggregation of the colloid fraction. This segregation may readily be observed by inspection of the samples. It might have been anticipated that the wash-off material would be readily dispersed. As a matter of fact, the treatment to which it has been subjected leaves it readily dispersed but the original structure of the soil is completely destroyed. This fact makes the comparative value of the dispersion ratio doubtful, and, in consequence, the erosion ratio has not the same significance as it has in the uneroded soil.

TABLE 15.—*Analyses of annual composite samples and wash-off of Vernon fine sandy loam at Guthrie, Okla.; and related data* [1]

[Total rainfall 33.66 inches in 1930; 29.2 inches in 1931; 37.4 inches in 1932; slope 7.7 percent]

Plot no.	Sample	Colloid by water-vapor absorption	Moisture equivalent	Dispersion ratio	Ratio of colloid to moisture equivalent	Erosion ratio	Sand	Silt	Clay	Colloid <0.002 mm	Organic matter by H_2O_2	Erosion	Run-off	Erosion per inch of run-off	Crop treatment
		Percent	*Percent*				*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Tons per acre*	*Percent*	*Tons per acre*	
	Profile composite	5.2	7.1	41.8	0.73	57.3	76.0	16.0	7.0	5.6	0.7	--------	--------	--------	
	1930 wash-off [2]	5.5	10.2	59.2	.54	109.6	72.7	18.5	7.1	5.7	.4	21.26	11.55	5.5	Cotton.
	1931 composite	5.2	7.7	25.6	.68	37.7	75.2	16.7	7.0	6.5	.8	--------	--------	--------	
1 [3]	1931 wash-off	8.1	15.2	68.3	.53	129.0	61.1	23.1	13.2	11.7	1.7	7.93	10.37	2.2	Do.
	1932 composite	5.7	7.0	39.4	.81	48.6	75.3	16.9	6.6	5.9	.8	--------	--------	--------	
	1932 wash-off	4.2	5.3	55.5	.79	70.2	79.1	14.9	5.0	3.7	.9	47.93	19.33	9.3	Do.
	Profile composite	7.0	9.5	33.0	.74	44.6	72.9	17.0	9.0	6.7	.9	--------	--------	--------	
	1930 wash-off	7.6	13.7	68.2	.55	124.0	65.4	24.0	8.5	7.7	1.6	14.49	10.04	4.3	Do.
	1931 composite	6.8	9.8	24.0	.69	34.8	72.7	17.5	8.4	7.2	1.3	--------	--------	--------	
2	1931 wash-off	6.8	10.8	60.8	.63	96.5	69.8	20.0	8.7	6.9	1.3	25.51	13.48	5.5	Do
	1932 composite	6.6	8.7	36.8	.76	48.5	72.9	17.5	8.1	7.2	1.0	--------	--------	--------	
	1932 wash-off	5.8	8.5	56.3	.68	82.7	75.3	16.7	6.9	4.7	.9	88.04	15.43	21.3	Do.
	Profile composite	6.4	9.3	32.3	.69	46.8	73.1	17.0	8.5	6.7	1.0	--------	--------	--------	
	1930 wash-off	6.1	11.8	54.8	.52	105.4	66.4	20.9	10.6	7.6	.7	17.56	13.11	4.0	Do.
	1931 composite	6.7	9.3	28.5	.72	39.6	72.8	18.2	7.7	6.8	1.1	--------	--------	--------	
3	1931 wash-off	6.7	10.5	60.4	.64	94.4	67.1	22.1	8.9	7.2	1.5	11.57	13.21	2.6	Do.
	1932 composite	5.6	8.1	40.0	.69	57.9	74.3	17.1	7.5	6.7	.9	--------	--------	--------	
	1932 wash-off	5.1	6.2	54.4	.82	66.3	74.7	17.3	6.8	5.0	.9	68.52	14.70	17.4	Do.
	Profile composite	7.6	9.4	32.7	.81	40.3	72.9	16.1	9.8	7.6	1.0	--------	--------	--------	
	1930 wash-off	14.5	22.6	77.8	.64	121.5	45.4	31.5	19.0	15.0	3.5	3.09	13.36	.69	Wheat (oats).
	1931 composite	6.9	9.4	25.1	.73	34.4	72.6	18.1	8.0	6.5	1.1	--------	--------	--------	
4	1931 wash-off	25.0	32.3	57.8	.77	75.1	26.6	43.1	22.8	17.8	6.9	.98	10.59	.27	Sweetclover.
	1932 composite	6.6	8.6	38.4	.77	49.9	72.8	17.7	8.2	6.7	1.0	--------	--------	--------	
	1932 wash-off	9.8	14.0	53.8	.70	76.9	59.9	27.3	11.0	8.7	1.5	39.31	12.46	11.8	Cotton.
	Profile composite	6.4	9.8	40.7	.65	62.6	74.0	15.8	8.8	6.6	1.1	--------	--------	--------	
	1930 wash-off	16.8	29.5	--------	.57	--------	38.5	37.5	18.8	12.0	5.8	.51	9.76	.16	Sweetclover.
	1931 composite	7.8	9.2	27.3	.85	32.1	72.5	18.3	8.1	6.2	.5	--------	--------	--------	
5	1931 wash-off	14.0	19.4	61.0	.72	84.7	50.1	31.1	15.6	13.3	2.7	5.89	10.36	1.7	Cotton.
	1932 composite	7.6	9.6	38.5	.79	48.7	71.8	17.6	9.1	6.6	1.2	--------	--------	--------	
	1932 wash-off	18.3	24.1	51.4	.76	67.7	46.3	28.0	21.6	15.7	3.4	.98	11.00	.33	Wheat.
	Profile composite	7.4	10.1	36.1	.73	49.4	71.8	16.8	10.0	8.1	1.2	--------	--------	--------	
	1930 wash-off	8.1	12.5	60.2	.65	92.6	72.0	16.2	9.8	8.1	.5	13.32	11.95	3.3	Cotton.
	1931 composite	8.1	9.4	23.6	.86	27.4	71.7	17.9	9.2	7.9	.9	--------	--------	--------	
6	1921 wash-off	31.2	42.0	60.1	.74	81.2	14.8	42.9	34.4	23.4	7.3	.52	10.96	.14	Wheat.
	1932 composite	7.2	9.3	39.4	.77	50.9	73.6	16.1	9.1	7.6	.8	--------	--------	--------	
	1932 wash-off	35.2	43.3	63.3	.81	78.1	15.1	38.9	36.3	26.7	8.5	.56	9.00	.23	Sweetclover.

7	Profile composite	7.3	10.5	33.5	.70	47.9	71.5	17.1	9.9	7.9	1.4				
	1930 wash-off	7.5	11.8		.64		70.7	17.1	9.9	6.6		.06	2.83	.06	Bermuda grass.
	1931 composite	9.0	11.1	28.9	.81	35.7	71.7	17.6	9.5	8.4	1.2				
	1931 wash-off	14.3	23.6	57.5	.61	94.2	62.0	19.8	13.9	10.6	2.9	.01	.47	.06	Do.
	1932 composite	7.7	10.3	34.1	.75	45.6	72.8	16.5	8.9	7.1	1.4				
	1932 wash-off	21.4	31.2	56.2	.69	81.4	42.0	36.2	16.8	10.4	4.1	.03	1.69	.07	Do.
8	Profile composite	7.2	10.5	31.3	.69	45.4	70.5	19.2	9.1	7.5	1.0				
	1930 wash-off	7.5	9.8	52.6	.76	69.2	72.1	16.7	9.3	7.1	.8	18.09	22.95	2.3	Bare.
	1931 composite	8.5	9.1	32.2	.93	34.6	71.9	16.5	10.3	7.9	.9				
	1931 wash-off	11.4	15.6	49.8	.73	68.2	61.3	24.2	12.1	10.1	1.9	6.33	21.52	.86	Do.
	1932 composite	6.2	8.7	36.0	.71	50.5	73.2	16.8	8.8	7.6	.7				
	1932 wash-off	9.0	10.8	49.5	.83	59.6	70.6	17.6	10.2	8.0	1.1	13.85	27.34	1.9	Do.
9 [5]	Profile composite	13.4	13.3	23.1	1.01	22.9	65.8	14.9	18.6	16.2	.5				
	1930 wash-off	13.7	13.4	42.6	1.02	41.8	57.9	18.7	22.9	19.9	.5	35.25	26.39	4.0	Cotton.
	1931 composite	16.1	14.7	33.7	1.10	30.6	62.1	17.7	19.4	17.7	.4				
	1931 wash-off	19.5	22.1	57.5	.88	65.3	44.8	24.0	30.1	24.9	.7	13.69	23.65	1.7	Do.
	1932 composite	12.6	13.5	31.6	.93	29.5	69.7	14.9	14.7	13.1	.4				
	1932 wash-off	17.9	17.2	55.8	1.04	53.6	52.5	21.5	24.0	20.3	1.7	51.95	31.73	6.1	Do.
Average [6]	Profile composite	6.8	9.5	35.2	.72	49.3	72.8	16.9	9.0	7.1	1.0				
	1930 wash-off	9.2	15.2	62.1	.61	103.7	62.9	22.8	11.6	8.7	1.9	11.05	11.94	2.54	
	1931 composite	7.4	9.4	26.9	.78	34.5	72.6	17.6	8.5	7.2	1.0				
	1931 wash-off	14.7	21.2	59.5	.67	90.4	51.6	28.3	16.2	12.6	3.3	7.34	11.23	1.67	
	1932 composite	6.7	8.8	37.8	.76	50.1	73.3	17.0	8.3	6.9	1.0				
	1932 wash-off	13.6	17.9	55.1	.76	72.9	57.9	24.6	14.3	10.4	2.7	32.40	13.87	7.79	

[1] Mechanical analyses by H. W. Lakin and T. M. Shaw.
[2] No composite samples were taken in 1930.
[3] Short plot.
[4] Long plot.
[5] Desurfaced plot.
[6] Average does not include desurfaced plot.

NOTE.—Profile composite samples were taken to a depth of 5 inches.

TABLE 16.—*Analyses of annual composite samples and wash-off of Kirvin fine sandy loam at Tyler, Tex.; and related data*[1]

[Total rainfall 36.1 inches in 1931; 46.71 inches in 1932; 8.75 percent slope]

Plot no.	Sample	Colloid by water-vapor absorption	Moisture equivalent	Dispersion ratio	Ratio of colloid to moisture equivalent	Erosion ratio	Sand	Silt	Clay	Colloid <0.002 mm	Organic matter by H_2O_2	Erosion	Run-off	Erosion per inch of run-off	Crop treatment
		Percent	*Percent*				*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Tons per acre*	*Percent*	*Tons per acre*	
	Profile composite	5.1	7.8	28.8	0.65	44.3	77.5	14.3	7.4	5.9	0.5				
	1931 composite	6.8	8.3	41.7	.82	50.8	79.3	13.0	6.7	4.9	.6				
1 [2]	1931 wash-off	6.9	10.0	58.9	.69	85.3	75.7	17.4	4.9	3.6	1.6	9.93	12.0	2.29	Cotton.
	1932 composite	6.0	7.0	37.7	.86	43.8	77.9	13.2	7.8	5.8	.8				
	1932 wash-off	6.6	10.0	64.1	.66	97.8	73.2	10.7	14.2	8.3	1.6	12.36	19.1	1.39	Do.
	Profile composite	6.7	8.5	31.2	.79	39.5	76.3	13.8	9.4	7.2	.4				
	1931 composite	6.1	8.3	33.8	.74	45.7	78.1	14.3	6.7	5.4	.5				
2 [3]	1931 wash-off	6.2	9.8	61.9	.63	98.3	73.5	19.0	6.1	3.7	1.0	21.89	13.6	4.46	Do.
	1932 composite	6.2	7.1	32.4	.87	37.2	75.8	14.6	8.6	7.3	.7				
	1932 wash-off	5.0	6.1	76.4	.82	93.2	78.4	13.3	7.6	5.5	.6	44.26	21.8	4.35	Do.
	Profile composite	6.7	8.4	33.6	.80	42.0	76.1	15.4	7.7	5.5	.4				
	1931 composite	5.5	8.1	27.0	.68	39.7	78.1	14.3	6.7	4.8	.7				
3	1931 wash-off	6.7	10.1	57.5	.66	87.1	72.5	17.6	8.6	4.7	.8	17.24	13.2	3.61	Do.
	1932 composite	6.0	7.3	38.4	.82	46.8	76.9	14.7	7.7	6.1	.5				
	1932 wash-off	6.7	9.6	49.7	.70	71.0	73.6	16.2	9.0	6.6	1.0	17.48	25.0	1.50	Do.
	Profile composite	6.1	7.9	33.3	.77	43.3	76.2	15.2	7.8	5.9	.4				
	1931 composite	5.5	8.5	42.2	.65	64.9	77.7	14.8	6.6	5.0	.6				
4	1931 wash-off	7.0	10.6	59.0	.66	89.4	72.0	17.5	9.2	5.8	1.0	14.47	13.6	2.95	Cotton (fertilized).
	1932 composite	7.2	7.5	34.4	.96	35.8	77.4	13.6	8.1	6.5	.6				
	1932 wash-off	5.7	8.0	64.6	.71	91.0	76.6	13.6	8.5	6.8	.9	19.23	25.3	1.63	Cotton.
	Profile composite	6.0	8.0	25.3	.75	33.7	76.0	14.7	8.5	7.2	.7				
	1931 composite	6.1	8.4	40.6	.73	55.6	78.4	14.5	6.3	5.2	.7				
5	1931 wash-off	6.8	10.5	57.2	.65	88.0	74.0	15.4	9.0	5.2	1.0	16.59	12.0	3.83	Cotton (cover crop).
	1932 composite	5.6	7.3	38.6	.77	50.1	78.3	13.3	7.6	6.3	.5				
	1932 wash-off	5.4	8.9	62.9	.61	103.2	75.7	14.2	8.6	6.4	1.2	17.87	23.8	1.61	Corn (cover crop).
	Profile composite	3.1	8.2	29.7	.74	40.0	76.8	13.8	8.7	6.4	.6				
	1931 composite	5.9	7.9	32.9	.75	43.9	78.8	11.8	8.4	7.0	.5				
6	1931 wash-off	6.5	10.3	61.8	.63	98.1	75.0	15.3	8.6	5.2	.7	20.72	16.6	3.46	Do.
	1932 composite	5.8	7.5	36.1	.77	46.9	79.0	12.4	7.7	6.7	.8				
	1932 wash-off	6.2	8.9	60.8	.70	86.8	74.2	14.3	9.4	6.7	1.8	11.64	26.5	.94	Lespedeza (cover crop).
	Profile composite	6.3	8.3	27.3	.76	35.9	78.3	12.0	8.4	6.6	1.0				
	1931 composite	5.8	8.5	32.3	.68	47.5	78.3	12.2	8.5	7.5	.5				
7	1931 wash-off	11.1	17.4	59.3	.64	92.7	59.3	24.4	13.2	8.8	2.9	3.46	9.4	1.02	Do.
	1932 composite	6.3	7.3	35.4	.86	41.2	78.8	13.2	7.0	5.6	.8				
	1932 wash-off	6.4	9.4	57.6	.68	84.7	74.8	14.7	9.0	6.6	1.1	18.11	18.7	.97	Cotton (cover crop).

8	Profile composite	6.7	8.7	22.0	.77	28.6	76.8	12.5	9.6	7.0	.8	-----	-----	-----	
	1931 composite	5.8	9.3	36.8	.62	59.4	78.4	12.0	8.5	7.8	.6	-----	-----	-----	
	1931 wash-off	13.9	21.5	61.0	.65	93.8	61.3	19.3	12.8	11.5	5.1	.49	2.6	.52	Bermuda sod.
	1932 composite	6.6	8.2	35.4	.80	44.3	78.8	12.9	7.1	5.0	1.0	-----	-----	-----	
	1932 wash-off	3.2	6.4	53.8	.50	107.6	84.8	6.3	7.0	4.7	.9	.09	1.9	.11	Do.
9	Profile composite	7.5	8.6	27.5	.87	31.6	79.2	10.7	9.3	7.6	.8	-----	-----	-----	
	1931 composite	6.6	8.4	39.2	.79	49.6	78.3	11.1	9.7	8.0	.5	-----	-----	-----	
	1931 wash-off	7.4	9.3	53.3	.80	66.6	76.5	13.9	8.0	5.5	1.4	14.90	13.7	3.02	Bare (hard fallow).
	1932 composite	8.0	7.5	24.9	1.07	23.3	80.4	12.3	6.4	5.3	.6	-----	-----	-----	
	1932 wash-off	7.9	9.8	63.1	.81	77.9	76.0	12.7	9.4	6.8	1.6	13.15	23.2	1.21	Do.
10 [4]	Profile composite	61.2	35.3	14.8	1.73	8.6	24.9	6.3	67.9	65.6	.6	-----	-----	-----	
	1931 composite	62.0	35.4	14.2	1.75	8.1	25.2	7.5	66.4	64.9	.4	-----	-----	-----	
	1931 wash-off	54.4	28.5	16.4	1.91	8.6	27.3	9.2	63.0	60.1	.3	46.50	17.6	7.32	Cotton (fertilized; cover crop).
	1932 composite	69.5	38.5	9.2	1.80	5.1	20.3	9.2	69.8	68.0	.4	-----	-----	-----	
	1932 wash-off	60.5	30.0	13.0	2.02	6.4	18.7	6.3	73.8	71.9	.7	56.33	33.6	3.59	Do.
11 [4]	Profile composite	62.3	35.0	15.2	1.78	8.5	24.2	7.2	67.9	65.0	.5	-----	-----	-----	
	1931 composite	65.5	36.4	15.9	1.80	8.8	22.4	7.3	69.2	68.0	.6	-----	-----	-----	
	1931 wash-off	55.8	20.2	13.3	1.91	7.0	26.4	7.8	65.2	63.6	.2	58.02	16.8	9.57	Cotton (fertilized).
	1932 composite	63.7	35.6	8.9	1.79	5.0	26.4	9.2	63.4	63.0	.7	-----	-----	-----	
	1932 wash-off	59.2	31.1	14.5	1.90	7.6	19.6	6.2	73.1	70.0	.4	67.45	27.2	5.30	Do.
12 [4]	Profile composite	57.4	32.9	14.9	1.74	8.6	28.9	7.8	62.4	59.7	.7	-----	-----	-----	
	1931 composite	52.7	31.4	14.7	1.68	8.7	33.7	8.0	57.4	52.6	.4	-----	-----	-----	
	1931 wash-off	47.7	26.2	14.3	1.82	7.9	32.5	9.3	57.3	55.6	.0	60.23	18.4	9.07	Cotton.
	1932 composite	63.6	35.4	10.1	1.80	5.6	31.4	9.4	57.7	57.4	1.1	-----	-----	-----	
	1932 wash-off	53.7	28.3	15.2	1.90	8.0	27.7	6.6	64.2	61.4	.8	73.66	27.6	5.71	Do.
Average [5]	Profile composite	6.4	8.3	28.7	.77	37.7	77.0	13.6	8.5	6.6	.6	-----	-----	-----	
	1931 composite	6.0	8.4	34.3	.72	50.8	78.4	13.1	7.6	6.2	.6	-----	-----	-----	
	1931 wash-off	8.1	12.2	58.9	.67	88.8	71.1	17.8	7.9	6.0	1.7	13.30	11.9	2.80	
	1932 composite	6.4	7.4	34.8	.86	41.0	78.1	13.4	7.6	6.1	.7	-----	-----	-----	
	1932 wash-off	5.9	8.6	61.4	.69	90.4	76.4	12.9	9.2	6.5	1.2	17.13	20.6	1.52	

[1] Determinations bases by H. W. Lakin and T. M. Shaw.
[2] Short plot.
[3] Long plot.
[4] Desurfaced plot.
[5] Average does not include desurfaced plots.

NOTE.—Profile composite samples were taken to a depth of 10 to 12 inches, except desurfaced plots, which were sampled to a depth of 7 inches.

TABLE 17.—*Analyses of annual composite samples and wash-off of Colby silty clay loam, Hays, Kans.; and related data* [1]

[Total rainfall 31.39 inches in 1931; 29.63 inches in 1932; slope 5 percent]

Plot no.	Sample	Colloid by water-vapor absorption	Moisture equivalent	Dispersion ratio	Ratio of colloid to moisture equivalent	Erosion ratio	Sand	Silt	Clay	Colloid <0.002 mm	Organic matter by H_2O_2	Erosion	Run-off	Erosion per inch of run-off	Crop treatment
		Percent	*Percent*				*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Tons per acre*	*Percent*	*Tons per acre*	
	Profile composite	29.3	25.2	22.7	1.16	19.6	17.6	47.3	33.2	28.7	1.4				
	1931 composite	29.9	27.5	25.3	1.09	23.2	15.7	49.6	32.2	27.5	1.9				
1 [2]	1931 wash-off	43.7	42.9	49.2	1.02	48.2	4.1	44.2	47.4	36.6	3.4	0.36	2.96	0.57	Wheat.
	1932 composite	30.5	25.6	18.5	1.19	15.5	18.4	46.4	31.4	27.1	3.0				
	1932 wash-off	32.4	30.3	57.4	1.07	53.7	6.8	51.2	38.6	32.5	2.8	5.82	15.96	1.23	Do.
	Profile composite	32.0	26.8	18.6	1.19	15.7	18.3	45.7	34.5	27.9	.9				
	1931 composite	30.1	27.4	26.6	1.10	24.2	15.4	50.1	31.9	27.4	2.1				
2 [3]	1931 wash-off	40.3	43.5	58.6	.93	63.0	5.4	43.9	47.0	40.5	2.6	.33	4.77	.32	Do.
	1932 composite	31.0	25.8	16.6	1.20	13.8	17.1	47.0	32.2	27.0	2.8				
	1932 wash-off	35.7	35.3	71.6	1.01	70.8	4.8	48.7	43.3	36.3	2.8	5.96	11.57	1.74	Do.
	Profile composite	30.6	27.5	19.9	1.11	17.9	15.6	47.0	34.9	27.7	1.7				
	1931 composite	30.4	27.1	24.5	1.12	21.9	16.2	48.8	32.1	27.7	2.2				
3	1931 wash-off	43.8	41.7	67.5	1.05	64.3	2.2	44.7	49.2	40.0	3.0	.27	2.79	.45	Do.
	1932 composite	30.6	26.0	16.2	1.18	13.7	17.6	48.4	31.1	26.2	2.2				
	1932 wash-off	46.1	43.2	81.8	1.07	80.2	1.5	42.3	52.1	44.0	3.3	5.69	15.35	1.25	Do.
	Profile composite	31.6	28.6	18.4	1.10	16.7	14.0	48.5	33.8	26.3	2.9				
	1931 composite	32.7	29.3	20.9	1.12	18.7	12.4	52.9	31.0	26.3	2.8				
4	1931 wash-off	33.1	37.8	31.7	.88	36.0	9.6	53.1	32.9	27.1	3.9	.03	.33	.40	Native grass clipped.
	1932 composite	33.2	27.8	16.2	1.19	13.6	14.2	52.4	29.6	26.5	3.0				
	1932 wash-off	33.7	33.1	53.8	1.02	52.7	10.0	49.3	37.3	30.0	2.8	.06	.88	.23	Do.
	Profile composite	31.9	27.8	19.5	1.15	16.8	15.4	48.4	34.3	29.5	1.5				
	1931 composite	30.0	26.8	26.6	1.12	23.7	15.5	43.9	38.0	29.0	1.8				
5	1931 wash-off	30.8	30.4	50.8	1.01	50.3	10.6	50.2	36.2	30.6	2.1	20.85	11.79	8.23	Kafir.
	1932 composite	30.5	25.1	17.2	1.22	14.1	18.1	46.2	32.4	27.5	2.6				
	1932 wash-off	48.0	43.5	68.3	1.10	62.1	3.4	41.2	51.6	42.8	3.2	38.26	25.53	5.05	Fallow.
	Profile composite	31.1	26.6	20.5	1.17	17.5	16.5	47.3	34.4	28.5	1.5				
	1931 composite	30.5	26.9	24.1	1.13	21.8	16.5	43.3	37.5	28.4	2.1				
6	1931 wash-off	43.9	42.6	60.6	1.03	58.8	2.4	43.0	50.7	40.8	3.0	.65	6.27	.49	Wheat.
	1932 composite	30.5	25.7	23.0	1.19	19.3	18.0	43.8	35.0	27.7	2.6				
	1932 wash-off	43.6	42.3	65.2	1.03	63.3	9.1	44.6	43.4	36.0	2.3	23.10	25.80	3.02	Kafir.
	Profile composite	30.1	26.5	19.0	1.14	16.7	18.2	45.1	34.5	27.1	1.7				
	1931 composite	30.7	26.7	24.2	1.15	21.0	15.2	47.8	34.2	28.4	1.9				
7	1931 wash-off	34.2	32.4	51.6	1.06	48.7	8.6	49.3	39.1	34.3	2.2	8.02	6.90	5.44	Fallow.
	1932 composite	30.8	26.0	22.4	1.18	19.0	17.7	46.2	32.9	27.8	2.4				
	1932 wash-off	39.7	41.2	77.3	.96	80.5	4.4	48.3	43.9	36.0	2.7	6.50	17.20	1.28	Wheat.

8	Profile composite	30.3	26.4	18.8	1.15	16.3	16.6	47.2	33.8	26.9	1.8				
	1931 composite	30.6	26.9	27.0	1.14	23.7	15.8	48.5	33.0	27.7	1.6	-------	-------	-------	
	1931 wash-off	35.2	32.8	49.9	1.07	46.6	8.8	50.1	38.5	27.7	1.6	15.30	11.09	6.45	Kafir.
	1932 composite	30.1	25.4	19.5	1.18	16.5	18.2	47.0	31.7	27.0	2.4	-------	-------	-------	
	1932 wash-off	41.0	40.8	70.0	1.08	64.8	7.2	50.5	39.7	32.6	2.0	31.27	21.76	4.85	Do.
9	Profile composite	29.9	28.2	17.5	1.06	16.6	14.5	52.4	31.1	26.7	.8	-------	-------	-------	
	1931 composite	33.2	29.3	20.5	1.13	18.1	12.6	53.9	29.9	26.4	2.9	-------	-------	-------	
	1931 wash-off	38.2	40.3	52.2	1.06	49.2	5.8	52.8	36.7	32.2	3.8	.0025	.05	.23	Native grass (not clipped).
	1932 composite	33.3	28.3	15.3	1.18	13.0	14.7	50.5	30.3	25.7	4.0	-------	-------	-------	
	1932 wash-off	38.0	37.4	-------	1.02	-------	6.1	47.6	42.8	38.0	2.3	.0035	.02	.50	Do.
10 [4]	Profile composite	26.7	25.2	25.5	1.06	24.1	15.0	47.7	37.1	27.8	.0	-------	-------	-------	
	1931 composite	29.0	24.7	23.3	1.17	19.9	11.8	50.7	36.3	29.0	.5	-------	-------	-------	
	1931 wash-off	33.7	32.5	63.0	1.04	60.6	3.9	46.6	47.0	33.2	1.5	3.40	15.43	1.03	Wheat.
	1932 composite	26.8	22.9	18.4	1.17	15.7	16.3	48.1	34.1	26.1	1.0	-------	-------	-------	
	1932 wash-off	26.0	31.0	63.2	.84	75.2	9.1	56.8	33.4	25.1	.7	37.21	28.50	4.40	Do
Average [5]	Profile composite	30.8	27.1	19.3	1.14	17.1	16.3	47.7	33.8	27.7	1.6	-------	-------	-------	
	1931 composite	30.9	27.5	24.4	1.12	21.8	15.0	48.8	33.3	27.6	2.1	-------	-------	-------	
	1931 wash-off	38.1	38.3	52.5	1.02	51.7	6.4	47.9	42.0	34.4	2.8	5.09	5.22	2.51	
	1932 composite	31.2	26.2	18.3	1.19	15.4	17.1	47.5	31.8	26.9	2.8	-------	-------	-------	
	1932 wash-off	40.1	38.6	68.2	1.04	66.0	5.9	47.1	43.6	36.5	2.7	12.96	14.90	2.13	

[1] Mechanical analyses by H. W. Lakin and T. M. Shaw.
Short plot.
[3] Long plot.
[4] Desurfaced plot.
[5] Average does not include desurfaced plot.

NOTE.—Profile composite samples were taken to a depth of 10 inches, except desurfaced plot, which was sampled to a depth of 12 inches.

TABLE 18.—*Analyses of annual composite samples and wash-off of Houston black clay at Temple, Tex.; and related data* [1]

[Total rainfall in 1931, 25.17 inches; in 1932, 31.25 inches; slope 4 percent]

Plot no.	Sample	Colloid by water-vapor absorption	Moisture equivalent	Dispersion ratio	Ratio of colloid to moisture equivalent	Erosion ratio	Sand	Silt	Clay	Colloid <0.002 mm	Organic matter by H_2O_2	Erosion	Run-off	Erosion per inch of run-off	Crop treatment
		Percent	*Percent*				*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Tons per acre*	*Percent*	*Tons per acre*	
1 [2]	Profile composite	38.6	29.7	12.5	1.30	9.6	11.1	23.9	62.9	44.2	1.8	--------	--------	--------	
	1931 composite	42.6	31.4	14.7	1.36	10.8	9.6	24.7	63.1	45.4	1.8	--------	--------	--------	
	1931 wash-off	38.3	34.3	27.5	1.12	24.6	6.7	28.0	62.6	40.1	1.9	4.9	5.7	3.4	Corn.
	1932 composite	42.3	30.2	10.9	1.40	7.8	10.8	24.2	61.8	43.3	2.4	--------	--------	--------	
	1932 wash-off	39.6	31.4	31.0	1.26	24.6	8.0	25.9	63.4	45.0	2.0	19.8	13.0	4.9	Do.
2 [3]	Profile composite	36.4	29.8	12.3	1.22	10.1	9.3	27.5	62.0	44.7	.8	--------	--------	--------	
	1931 composite	40.3	30.5	14.1	1.32	10.7	8.3	25.7	63.4	45.7	2.0	--------	--------	--------	
	1931 wash-off	38.6	31.5	26.1	1.23	21.2	6.7	24.3	65.9	45.8	2.6	1.5	5.3	1.1	Do.
	1932 composite	39.8	28.9	9.5	1.38	6.9	8.2	24.8	63.9	43.2	2.3	--------	--------	--------	
	1932 wash-off	39.4	31.3	33.9	1.26	26.9	6.4	23.7	67.6	45.7	1.9	20.6	10.5	6.3	Do.
3	Profile composite	38.6	30.8	9.7	1.25	7.8	9.5	26.6	62.2	45.4	1.2	--------	--------	--------	
	1931 composite	43.0	32.6	14.0	1.32	10.6	8.4	24.9	63.9	47.5	2.2	--------	--------	--------	
	1931 wash-off	40.1	35.5	34.3	1.13	30.3	3.6	22.1	71.2	47.4	2.2	2.5	5.2	1.9	Do.
	1932 composite	42.6	30.0	10.3	1.42	7.2	9.3	25.0	62.1	44.2	2.9	--------	--------	--------	
	1932 wash-off	40.2	32.1	34.2	1.25	27.4	7.8	23.7	66.0	44.6	2.1	18.9	11.1	5.4	Do.
4	Profile composite	39.3	30.2	11.9	1.30	9.1	9.7	25.9	62.6	45.4	1.3	--------	--------	--------	
	1931 composite	42.3	32.4	15.8	1.31	12.1	8.5	24.9	63.8	46.3	2.2	--------	--------	--------	
	1931 wash-off	42.6	37.9	36.1	1.12	32.2	1.0	20.7	75.0	46.8	2.3	.8	4.2	.8	Do.
	1932 composite	43.8	31.1	9.6	1.41	6.8	8.6	25.0	62.8	44.6	2.8	--------	--------	--------	
	1932 wash-off	38.8	31.2	30.3	1.24	24.4	7.5	24.8	64.6	43.6	2.2	Trace	Trace	--------	Oats (green manure).
5	Profile composite	40.2	30.5	9.2	1.32	7.0	9.3	24.9	64.8	48.4	.8	--------	--------	--------	
	1931 composite	41.7	31.6	12.9	1.32	9.8	8.6	24.4	64.2	46.2	2.1	--------	--------	--------	
	1931 wash-off	43.4	33.7	35.0	1.29	27.1	5.4	24.7	66.3	43.7	2.8	.6	1.8	1.3	Corn.
	1932 composite	42.6	29.9	9.2	1.42	6.5	8.6	24.3	63.8	44.9	2.6	--------	--------	--------	
	1932 wash-off	40.8	31.2	34.2	1.31	26.1	6.5	24.1	66.8	45.8	1.8	.5	.6	2.6	Oats.
6	Profile composite	39.0	31.1	11.2	1.25	9.0	10.9	25.2	63.6	45.7	1.0	--------	--------	--------	
	1931 composite	42.4	33.2	15.6	1.28	12.2	8.3	24.9	63.7	46.2	2.4	--------	--------	--------	
	1931 wash-off	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	None	None	--------	Bermuda grass.
	1932 composite	43.7	31.3	9.8	1.40	7.0	8.6	24.4	63.4	44.6	3.0	--------	--------	--------	
	1932 wash-off	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	None	None	--------	Do.
7	Profile composite	39.8	29.2	9.6	1.36	7.1	9.3	25.3	64.8	46.3	.3	--------	--------	--------	
	1931 composite	42.2	32.3	13.7	1.31	10.5	7.4	25.8	64.6	46.8	1.5	--------	--------	--------	
	1931 wash-off	41.4	34.8	34.7	1.19	29.2	3.2	23.7	70.0	47.5	2.1	1.0	3.3	1.2	Cotton.
	1932 composite	42.5	29.6	11.3	1.44	7.8	9.5	24.9	62.2	44.0	2.7	--------	--------	--------	
	1932 wash-off	40.7	32.5	35.5	1.25	28.4	6.2	24.3	67.1	45.8	2.0	19.8	10.9	5.8	Corn.

8	Profile composite	38.2	29.3	8.4	1.30	6.5	8.8	24.7	65.7	46.0	.3				
	1931 composite	41.3	31.3	12.6	1.32	9.5	7.7	25.5	64.1	46.0	2.0	--------	--------	--------	
	1931 wash-off	40.0	37.5	42.8	1.07	40.0	1.0	16.9	79.2	44.7	2.1	.7	3.0	.9	Do.
	1932 composite	42.0	29.7	10.8	1.41	7.7	7.7	24.6	64.5	45.5	2.4	--------	--------	--------	
	1932 wash-off	37.4	31.3	35.9	1.20	20.9	7.0	21.7	68.7	45.1	1.9	.4	.3	4.3	Oats.
9	Profile composite	39.0	30.1	13.4	1.30	10.3	9.6	25.1	64.6	45.2	.3				
	1931 composite	40.3	31.6	12.6	1.28	9.8	8.4	25.4	63.5	49.7	2.0	--------	--------	--------	
	1931 wash-off	36.6	31.2	21.6	1.17	18.5	9.4	26.1	61.5	41.3	2.2	.2	1.8	.4	Oats (green manure).
	1932 composite	41.8	29.8	9.9	1.40	7.1	8.6	24.6	64.8	46.0	1.6	--------	--------	--------	
	1932 wash-off	39.1	32.8	36.0	1.19	30.2	5.1	23.4	68.6	46.1	2.2	9.2	7.2	4.1	Cotton.
10	Profile composite	39.4	29.9	11.8	1.32	8.9	9.1	20.8	69.8	47.0	.0				
	1931 composite	40.6	31.4	9.2	1.29	7.1	7.7	26.0	63.8	45.7	1.8	--------	--------	--------	
	1931 wash-off	37.4	33.7	37.1	1.11	33.4	5.0	23.3	68.7	41.5	2.2	.5	2.3	.9	Corn.
	1932 composite	42.3	30.4	9.0	1.39	6.5	8.1	24.4	65.4	45.7	1.6	--------	--------	--------	
	1932 wash-off	37.9	32.9	31.4	1.15	27.3	5.9	22.0	69.3	48.7	2.0	Trace	Trace	--------	Oats (green manure).
11[4]	Profile composite	30.4	24.0	6.0	1.27	4.7	8.1	26.8	64.8	37.3	.1				
	1931 composite	30.6	25.8	10.3	1.19	8.7	8.0	26.8	64.0	41.2	.8	--------	--------	--------	
	1931 wash-off	32.7	29.9	36.1	1.09	33.1	5.2	28.6	64.2	38.1	1.3	.4	2.4	.7	Corn.
	1932 composite	31.7	24.4	11.6	1.30	8.9	7.4	24.5	66.7	41.9	.8	--------	--------	--------	
	1932 wash-off	31.9	26.5	26.6	1.20	22.2	9.8	23.3	65.5	40.5	.9	1.3	2.1	2.0	Oats.
Average[5]	Profile composite	38.9	30.1	11.0	1.29	8.5	9.7	25.0	64.3	45.8	.8				
	1931 composite	41.7	31.8	13.5	1.31	10.3	8.3	25.2	63.8	46.6	2.0	--------	--------	--------	
	1931 wash-off	39.8	34.5	32.8	1.16	28.5	4.7	23.3	68.9	44.3	2.3	1.3	3.3	1.2	--
	1932 composite	42.3	30.1	10.0	1.41	7.1	8.8	24.6	63.5	44.9	2.4	--------	--------	--------	
	1932 wash-off	39.3	31.9	33.6	1.23	27.2	6.7	23.7	66.9	45.6	2.0	8.9	5.4	3.3	

[1] Mechanical analyses by H. W. Lakin and T. M. Shaw.
[2] Short plot.
[3] Long plot.
[4] Desurfaced plot.
[5] Average does not include desurfaced plots.

NOTE.—Profile composite samples taken to a depth of 10 to 12 inches, except desurfaced plots, which were sampled to a depth of 7 inches.

TABLE 19.—*Analyses of composite surface samples and wash-off of Shelby silt loam, Bethany, Mo.; with related data* [1]

[Total rainfall, 42.52 inches in 1931, 27.04 inches in 1932; slope 8 percent]

Plot no.	Sample	Colloid by water-vapor absorption	Moisture equivalent	Dispersion ratio	Ratio of colloid to moisture equivalent	Erosion ratio	Sand	Silt	Clay	Colloid <0.002 mm	Organic matter by H_2O_2	Erosion	Run-off	Erosion per inch of run-off	Crop treatment
		Percent	*Percent*				*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Tons per acre*	*Percent*	*Tons per acre*	
L-1 [2]	Profile composite	24.7	24.3	25.4	1.02	24.9	23.8	45.9	26.5	22.1	3.5	-------	-------	-------	
	1931 composite	24.6	25.9	37.1	.95	39.1	24.4	45.7	26.7	23.4	2.5	-------	-------	-------	
	1931 wash-off	25.4	27.5	53.9	.92	58.6	16.7	51.0	28.6	23.8	3.0	105.78	28.22	8.8	Corn.
	1932 composite	24.9	24.6	20.7	1.01	20.5	25.1	44.5	27.2	23.4	2.8	-------	-------	-------	
	1932 wash-off	22.8	26.2	57.8	.87	66.4	17.1	48.1	30.9	26.1	3.3	52.26	15.34	12.6	Do.
U-1 [3]	Profile composite	27.1	27.0	28.3	1.00	28.3	13.3	52.2	29.6	24.1	4.3	-------	-------	-------	
	1931 composite	25.8	27.6	35.3	.93	38.0	14.2	52.6	29.2	24.6	3.4	-------	-------	-------	
	1932 composite	26.5	26.5	22.2	1.00	22.2	14.2	49.5	32.2	27.8	3.8	-------	-------	-------	
2	Profile composite	25.0	24.3	30.7	1.03	29.8	24.8	45.2	25.6	20.9	3.8	-------	-------	-------	
	1931 composite	24.8	25.5	39.5	.97	40.7	24.9	45.3	26.5	22.2	2.5	-------	-------	-------	
	1931 wash-off	25.4	27.9	57.6	.91	63.3	17.9	49.2	29.1	25.9	3.2	85.17	30.10	6.7	Do.
	1932 composite	24.3	23.9	20.4	1.02	20.0	26.6	40.9	28.8	23.5	3.1	-------	-------	-------	
	1932 wash-off	24.7	27.1	52.3	.91	57.5	16.8	46.8	32.8	25.2	3.4	48.58	19.07	9.4	Do.
3	Profile composite	24.3	25.0	26.6	.97	27.4	23.8	43.9	28.9	22.9	3.3	-------	-------	-------	
	1931 composite	25.2	26.4	37.2	.95	39.2	24.5	45.6	26.6	23.2	2.7	-------	-------	-------	
	1931 wash-off	26.4	28.5	55.1	.93	59.2	17.1	48.8	30.3	25.6	3.4	54.02	24.33	5.2	Corn (wheat).
	1932 composite	24.6	24.3	27.3	1.01	27.0	25.7	44.0	26.6	23.5	3.3	-------	-------	-------	
	1932 wash-off	31.9	36.2	-------	.88	-------	6.6	48.8	38.9	33.6	5.2	1.56	4.17	1.4	Wheat.
4	Profile composite	24.5	24.7	29.8	.99	30.1	24.9	42.9	27.6	22.0	3.8	-------	-------	-------	
	1931 composite	25.7	26.1	38.5	.98	39.3	23.7	46.5	26.0	23.6	3.1	-------	-------	-------	
	1931 wash-off	32.4	36.6	52.0	.89	58.4	11.8	46.1	38.3	33.2	2.1	3.21	8.26	.9	Wheat (clover).
	1932 composite	24.3	23.9	22.1	1.02	21.7	25.4	44.5	26.1	23.8	3.4	-------	-------	-------	
	1932 wash-off	30.6	-------	-------	-------	-------	20.2	37.8	37.2	34.0	4.0	.20	1.06	.7	Clover.
5	Profile composite	26.1	25.3	27.4	1.03	26.6	23.4	44.6	27.4	23.2	4.1	-------	-------	-------	
	1931 composite	26.5	26.8	36.2	.99	36.5	22.6	45.5	28.0	25.0	3.4	-------	-------	-------	
	1931 wash-off	36.3	36.6	40.8	.99	41.2	10.8	43.1	42.4	38.4	2.7	1.71	10.51	.4	Do.
	1932 composite	25.0	24.5	21.9	1.02	21.5	24.0	44.8	27.0	24.3	3.6	-------	-------	-------	
	1932 wash-off	27.2	30.3	53.5	.90	59.4	13.3	47.1	35.1	28.6	3.9	19.63	16.31	4.5	Do.
6	Profile composite	26.0	24.9	27.8	1.04	26.7	23.1	44.5	28.2	24.5	3.6	-------	-------	-------	
	1931 composite	25.3	26.6	34.8	.95	36.6	22.8	45.4	28.3	23.5	2.9	-------	-------	-------	
	1931 wash-off	39.5	38.2	40.0	1.03	38.8	10.6	42.0	45.8	39.4	2.6	.97	8.14	.3	Clover (fertilizer).
	1932 composite	25.2	25.3	21.8	1.00	21.8	22.4	46.9	27.0	22.4	3.4	-------	-------	-------	
	1932 wash-off	31.1	33.1	50.9	.94	54.1	12.6	45.0	37.5	31.8	4.5	9.82	9.49	3.8	Corn.

7	Profile composite	25.1	24.3	26.1	1.03	25.3	22.5	47.1	25.6	22.5	4.1				
	1931 composite	24.8	26.7	38.1	.93	41.0	23.5	45.3	27.4	24.0	3.4				
	1931 wash-off	37.0	38.9	41.2	.95	43.4	15.6	30.8	40.8	35.3	2.9	.39	2.18	.4	Alfalfa (fertilizer).
	1932 composite	20.3	25.2	18.3	1.04	17.6	22.8	45.6	27.8	24.9	3.5				
	1932 wash-off											.00	1.12	0	Alfalfa.
8	Profile composite	27.5	25.5	26.7	1.08	24.7	21.8	46.6	26.8	24.4	4.0				
	1931 composite	26.2	27.3	36.2	.96	37.7	22.3	46.2	27.8	24.8	3.2				
	1931 wash-off	40.3	40.6	44.8	.99	45.3	8.1	44.3	43.6	40.4	3.2	.89	11.12	.2	Timothy.
	1932 composite	27.2	25.2	21.6	1.08	20.0	22.2	46.7	27.0	22.6	3.8				
	1932 wash-off											.00	1.56	0	Grass.
9	Profile composite	25.8	25.5	26.9	1.01	26.6	23.0	46.8	26.6	23.3	3.0				
	1931 composite	27.8	27.5	35.7	1.01	35.3	21.3	45.0	30.1	26.6	2.9				
	1931 wash-off	25.8	27.9	55.1	.92	59.8	15.6	49.7	30.7	26.5	3.4	108.44	19.74	12.9	Fallow.
	1932 composite	27.9	24.9	23.2	1.12	20.7	22.3	45.0	26.7	26.0	3.5				
	1932 wash-off	26.7	24.0	51.5	1.11	46.4	15.4	45.9	34.7	29.1	3.5	84.15	25.83	12.0	Do.
10 [4]	Profile composite	43.2	29.3	15.9	1.47	10.8	19.9	36.1	41.9	39.2	1.8				
	1931 composite	41.4	31.4	25.3	1.32	19.2	20.1	33.7	43.5	39.2	2.2				
	1931 wash-off	40.6	30.1	20.4	1.35	21.8	15.7	36.9	45.3	41.7	1.5	71.93	20.35	8.3	Do.
	1932 composite	41.4	29.7	23.1	1.39	16.6	20.1	34.5	43.1	39.8	2.0				
	1932 wash-off	47.5	30.7	31.9	1.55	20.6	11.9	32.2	53.8	48.6	1.9	43.10	19.78	8.1	Do.
Average [5]	Profile composite	25.6	25.1	27.6	1.02	27.0	22.4	46.0	27.3	23.0	3.7				
	1931 composite	25.7	26.6	36.9	.96	38.3	22.4	46.3	27.7	24.1	3.0				
	1931 wash-off	32.1	37.6	48.9	.95	52.0	13.8	46.0	36.4	32.1	2.9	40.06	15.84	3.9	
	1932 composite	25.6	24.8	22.0	1.03	21.3	23.1	45.2	27.8	24.2	3.4				
	1932 wash-off	28.0	29.5	53.2	.94	50.8	14.6	45.6	35.3	29.8	4.0	24.02	10.44	4.9	

[1] Determinations by H. W. Lakin, T. M. Shaw, and F. P. Trilety.
[2] Lower half of plot 1 (long plot).
[3] Upper half of plot 1.
[4] Desurfaced plot.
[5] Average does not include desurfaced plot.

NOTE.—Profile composite samples were taken to a depth of 8 inches.

TABLE 20.—*Analyses of annual composite samples and wash-off of Cecil sandy clay loam, Statesville, N.C.; with related data* [1]

[Total rainfall 44.35 inches in 1931, 50.52 inches in 1932; 10 percent slope]

Plot no.	Sample	Colloid by water-vapor absorption	Moisture equivalent	Dispersion ratio	Ratio of colloid to moisture equivalent	Erosion ratio	Sand	Silt	Clay	Colloid <0.002 mm	Organic matter by H_2O_2	Erosion	Run-off	Erosion per inch of run-off	Crop treatment
		Percent	*Percent*				*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Tons per acre*	*Percent*	*Tons per acre*	
1 [2]	Profile composite	42.0	25.3	15.4	1.66	9.3	33.2	13.4	53.0	47.0	0.2	-------	-------	-------	
	1931 composite	35.2	22.3	23.6	1.58	14.9	40.3	15.1	43.2	38.7	1.2	-------	-------	-------	
	1931 wash-off	29.2	19.4	15.9	1.50	10.6	46.0	13.2	39.5	34.5	.9	17.46	10.99	3.59	Cotton.
	1932 composite	36.0	22.0	19.0	1.64	11.6	39.7	13.4	45.0	38.7	1.6	-------	-------	-------	
	1932 wash-off	32.6	19.8	15.4	1.65	9.3	42.9	13.2	42.6	38.4	.9	7.53	6.94	2.14	Do.
2 [2]	Profile composite	38.8	23.3	16.7	1.67	10.0	34.6	14.8	50.2	44.1	.2	-------	-------	-------	
	1931 composite	40.7	24.2	15.7	1.68	9.3	36.9	17.0	44.9	43.7	.9	-------	-------	-------	
	1931 wash-off	30.9	20.9	19.0	1.48	12.8	43.4	14.0	41.3	35.2	1.1	19.71	11.38	3.91	Corn and cowpeas.
	1932 composite	38.1	22.8	17.9	1.67	10.7	40.1	13.5	47.1	41.0	1.0	-------	-------	-------	
	1932 wash-off	27.9	18.8	19.9	1.48	13.4	47.5	12.8	38.5	33.4	.7	4.70	3.69	2.53	Cotton (ryeand vetch).
3 [2]	Profile composite	43.0	26.0	14.3	1.65	8.7	31.8	10.4	57.0	52.8	.4	-------	-------	-------	
	1931 composite	42.3	24.6	17.0	1.72	9.9	35.6	12.9	50.2	46.4	1.0	-------	-------	-------	
	1931 wash-off	32.8	20.8	10.3	1.58	6.5	42.2	14.3	42.2	36.7	.8	20.26	7.29	6.27	Do.
	1932 composite	39.5	23.1	19.1	1.71	11.2	37.2	13.0	48.3	41.8	1.1	-------	-------	-------	
	1932 wash-off	34.3	21.0	21.6	1.63	13.2	42.4	13.3	43.4	39.6	.5	3.15	5.49	1.14	Corn and cowpeas.
4	Profile composite	29.5	22.4	19.8	1.32	15.0	40.3	12.9	45.8	40.7	.7	-------	-------	-------	
	1931 composite	29.8	22.0	17.2	1.35	12.7	43.7	16.8	36.7	31.5	2.3	-------	-------	-------	
	1931 wash-off	21.7	20.8	24.5	1.04	23.5	49.1	15.5	33.0	27.8	1.8	64.79	26.20	5.58	Fallow.
	1932 composite	31.2	21.8	22.5	1.43	15.7	42.6	15.7	39.2	32.3	1.9	-------	-------	-------	
	1932 wash-off	20.0	18.0	30.8	1.11	27.7	55.8	13.7	28.4	23.6	1.4	57.34	36.98	3.07	Do.
5	Profile composite	27.4	22.5	20.8	1.22	17.1	42.8	14.7	40.9	36.1	1.1	-------	-------	-------	
	1931 composite	29.3	21.8	15.1	1.34	11.3	42.7	16.6	37.1	33.0	1.3	-------	-------	-------	
	1931 wash-off	27.2	22.0	21.5	1.24	17.3	41.8	16.5	40.0	34.3	1.4	17.22	13.62	2.85	Corn and wheat.
	1932 composite	31.4	21.8	20.1	1.44	14.0	44.2	15.5	38.1	30.7	1.8	-------	-------	-------	
	1932 wash-off	24.0	18.2	24.7	1.32	18.7	54.3	12.6	31.5	27.0	1.2	3.15	16.34	.38	Wheat and lespedeza.
6	Profile composite	28.9	22.6	22.0	1.28	17.2	42.9	10.4	46.1	40.4	.3	-------	-------	-------	
	1931 composite	31.2	23.3	18.4	1.34	13.7	43.5	16.8	38.2	33.8	1.3	-------	-------	-------	
	1931 wash-off	38.0	40.2	38.9	.95	40.9	19.3	21.3	54.9	38.1	3.4	.81	9.60	.19	Lespedeza.
	1932 composite	29.9	22.1	20.4	1.35	15.1	44.2	15.5	38.1	31.1	1.7	-------	-------	-------	
	1932 wash-off	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.00	1.06	.00	Do.
7	Profile composite	32.2	23.1	21.6	1.39	15.5	41.6	11.6	45.8	41.0	.8	-------	-------	-------	
	1931 composite	31.3	23.4	18.2	1.34	13.6	43.0	15.7	38.8	34.2	2.0	-------	-------	-------	
	1931 wash-off	33.9	31.4	36.2	1.08	33.5	27.2	20.8	47.8	38.4	2.9	2.22	11.31	.44	Do.
	1932 composite	30.4	22.0	19.9	1.38	14.4	43.7	11.8	42.3	29.7	1.9	-------	-------	-------	
	1932 wash-off	28.8	22.3	22.6	1.20	17.5	41.8	11.5	43.9	38.4	1.9	2.46	4.80	1.02	Cotton.

8	Profile composite	32.7	22.3	21.6	1.47	14.7	41.1	12.4	45.6	39.6	.6				
	1931 composite	32.8	22.9	18.3	1.43	12.8	43.3	16.1	38.2	33.0	2.0				
	1931 wash-off	30.6	22.9	19.3	1.34	14.4	37.6	17.4	43.5	37.6	1.2	11.95	14.16	1.90	Do.
	1932 composite	32.2	22.7	22.4	1.42	15.8	40.8	17.6	40.1	32.8	1.2				
	1932 wash-off	30.3	21.1	16.9	1.44	11.7	43.4	19.6	36.1	33.0	.5	5.18	5.11	2.01	Corn.
9	Profile composite	30.4	23.1	17.6	1.32	13.4	40.7	17.3	40.7	34.4	.8				
	1931 composite	32.0	23.2	15.8	1.38	11.4	42.5	20.0	35.2	33.1	2.0				
	1931 wash-off	31.2	32.4	32.8	1.15	28.5	24.3	32.5	39.6	37.8	2.6	9.12	14.62	1.41	Sod.
	1932 composite	36.8	24.1	27.9	1.53	18.3	40.8	16.8	40.5	34.3	1.4				
	1932 wash-off											.00	1.13	.00	Do.
10	Profile composite	32.1	23.8	22.7	1.35	17.2	40.0	18.2	41.2	35.2	.4				
	1931 composite	33.9	23.6	14.5	1.44	10.1	40.7	17.9	39.7	35.0	1.2				
	1931 wash-off	34.4	23.1	20.6	1.49	13.8	46.5	18.3	33.4	26.8	1.4	11.88	11.65	2.30	Cotton.
	1932 composite	33.8	23.1	23.3	1.46	16.0	40.7	18.2	39.7	34.4	1.1				
	1932 wash-off	31.9	21.2	24.7	1.50	16.5	42.9	14.2	42.0	33.7	.6	4.95	5.76	1.70	Do.
11 [3]	Profile composite	29.7	21.8	19.4	1.36	14.3	41.3	20.5	37.9	32.0	.2				
	1931 composite	32.9	22.7	13.2	1.45	9.1	41.7	17.4	39.7	33.7	.8				
	1931 wash-off	30.9	23.5	23.9	1.32	18.1	38.3	19.7	39.8	31.7	1.8	18.16	9.53	4.29	Do.
	1932 composite	31.2	21.8	18.8	1.43	13.1	41.6	17.7	38.9	27.9	1.2				
	1932 wash-off	34.4	22.0	18.1	1.56	11.6	38.7	16.5	43.3	37.1	1.1	5.66	4.00	2.80	Do.
12 [4]	Profile composite	36.1	23.5	19.2	1.54	12.4	37.5	9.9	51.3	44.3	.9				
	1931 composite	36.5	24.1	16.5	1.52	10.9	38.9	15.0	44.4	39.6	1.3				
	1931 wash-off	32.0	22.6	22.9	1.42	16.1	41.8	17.2	39.2	33.0	1.5	13.77	13.68	2.27	Do.
	1932 composite	39.0	24.4	17.7	1.60	11.1	37.7	14.9	45.7	40.2	1.3				
	1932 wash-off	35.5	21.8	21.0	1.63	12.9	40.0	13.0	45.1	39.0	1.4	8.20	9.80	1.67	Do.
Average [5]	Profile composite	31.0	22.8	20.5	1.36	15.2	40.9	14.2	43.9	38.2	.6				
	1931 composite	32.2	23.0	16.4	1.40	11.7	42.2	16.9	38.7	34.1	1.6				
	1931 wash-off	31.8	26.5	26.7	1.23	22.9	36.2	19.9	41.2	33.9	2.0	16.66	13.82	2.36	
	1932 composite	32.9	22.6	21.4	1.45	14.8	41.8	16.0	40.3	32.6	1.5				
	1932 wash-off	29.3	20.7	22.7	1.41	16.7	45.3	14.4	38.6	32.8	1.2	9.66	9.44	1.41	

[1] Mechanical analyses by H. W. Lakin and T. M. Shaw.
[2] Desurfaced plot.
[3] Long plot.
[4] Short plot.
[5] Average does not include desurfaced plots.

NOTE.—Profile composite samples taken to a depth of 7 inches.

TABLE 21.—*Analyses of composite surface samples and wash-off of Marshall silt loam, Clarinda, Iowa; and related data*[1]

[Total rainfall in 1932, 28.76 inches; June 1 to Dec. 31, 21.15 inches; slope 9.64 percent]

Plot no.	Sample	Colloid by water-vapor absorption	Moisture equivalent	Dispersion ratio	Ratio of colloid to moisture equivalent	Erosion ratio	Sand	Silt	Clay	Colloid <0.002 mm	Organic matter by H_2O_2	Erosion[2]	Run-off[2]	Erosion per inch of run-off	Crop treatment
		Percent	*Percent*				*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Tons per acre*	*Percent*	*Tons per acre*	
1[3]	Profile composite	33.3	30.4	26.0	1.10	23.6	2.2	60.4	34.1	29.9	3.1				
	1932 composite	32.3	27.6	18.2	1.17	15.6	2.1	61.9	32.9	29.2	2.9				
	1932 wash-off	26.5	28.4	56.6	.93	60.9	2.5	60.8	33.7	33.1	2.6	42.81	18.7	10.8	Corn.
2[4]	Profile composite	33.4	30.6	27.0	1.09	24.8	2.1	59.6	34.9	30.5	3.1				
	1932 composite	33.7	28.2	17.0	1.20	14.2	2.2	59.8	34.6	30.8	2.9				
	1932 wash-off	26.2	28.5	58.4	.92	63.5	2.2	65.6	29.1	28.3	2.7	43.46	21.1	9.7	Do.
3	Profile composite	32.2	30.3	29.7	1.06	28.0	2.4	58.2	35.8	30.6	2.9				
	1932 composite	33.5	28.3	17.6	1.18	14.9	2.0	60.9	33.8	29.4	2.9				
	1932 wash-off	26.7	28.2	53.8	.95	56.6	2.8	62.0	32.0	27.4	2.9	42.07	23.0	8.7	Do.
4	Profile composite	32.9	30.4	26.1	1.08	24.2	1.8	60.4	34.5	29.7	3.1				
	1932 composite	33.6	28.8	15.4	1.17	13.2	2.2	61.0	33.5	29.0	2.9				
	1932 wash-off	25.6	27.5	52.9	.93	56.9	2.5	59.6	34.9	30.8	2.7	49.15	27.6	8.4	Do.
5	Profile composite	32.9	29.7	26.0	1.11	23.4	1.8	61.1	33.7	29.7	2.6				
	1932 composite	30.8	28.0	15.8	1.10	14.4	2.1	60.9	33.8	28.5	2.7				
	1932 wash-off	27.9	30.4	58.2	.92	63.2	1.9	61.0	33.8	29.4	3.0	1.36	8.8	.7	Oats.
6	Profile composite	31.9	29.7	26.1	1.07	24.4	2.0	60.7	33.9	29.7	3.0				
	1932 composite	32.4	28.2	17.6	1.15	15.3	2.5	58.9	35.0	30.3	3.0				
	1932 wash-off	29.2	31.7	60.2	.92	65.4	2.2	60.0	34.9	29.8	2.6	.80	9.4	.4	Clover.
7	Profile composite	32.6	30.2	27.7	1.08	25.6	2.0	61.7	33.3	30.4	2.2				
	1932 composite	32.6	28.2	15.5	1.16	13.4	2.2	58.8	35.3	31.0	2.9				
	1932 wash-off	27.2	30.3	57.1	.90	63.5	2.6	61.4	33.0	27.9	2.8	1.15	13.8	.4	Alfalfa.
8	Profile composite	32.7	30.2	28.1	1.08	26.0	1.5	60.7	34.6	29.9	2.3				
	1932 composite	32.9	28.7	18.9	1.15	16.5	2.0	58.9	35.1	30.4	3.2				
	1932 wash-off	27.8	29.9	57.3	.93	61.6	2.6	60.4	33.7	29.2	2.9	1.19	13.9	.4	Bluegrass.
9[5]	Profile composite	40.5	33.0	18.3	1.23	14.9	1.1	54.5	42.1	35.5	1.8				
	1932 composite	40.9	31.1	12.4	1.32	9.4	1.1	56.4	40.2	35.6	1.7				
	1932 wash-off	32.4	29.0	36.8	1.12	32.9	1.6	59.0	36.8	34.2	2.1	39.30	14.7	12.6	Corn.
Average[6]	Profile composite	32.7	30.2	27.1	1.08	25.0	2.0	60.4	34.4	30.1	2.8				
	1932 composite	32.7	28.3	17.0	1.16	14.7	2.2	60.1	34.3	29.8	2.9				
	1932 wash-off	27.1	29.4	56.8	.93	61.5	2.4	61.4	33.1	29.5	2.8	22.75	17.0	4.9	

[1] Mechanical analyses by H. W. Lakin and T. M. Shaw.
[2] Erosion and run-off data for 7 months only.
[3] Short plot.
[4] Long plot.
[5] Desurfaced plot.
[6] Average does not include desurfaced plot.

NOTE.—Profile composite samples were taken at depths ranging from 6 to 18 inches.

TABLE 22.—*Analyses of annual composite samples and wash-off of Nacogdoches fine sandy loam, at Tyler, Tex.; and related data* [1]

[Total rainfall 36.10 inches in 1931, 46.71 inches in 1932; 10 percent slope]

Plot no.	Sample	Colloid by water-vapor absorption	Moisture equivalent	Dispersion ratio	Ratio of colloid to moisture equivalent	Erosion ratio	Sand	Silt	Clay	Colloid <0.002 mm	Organic matter by H_2O_2	Erosion [2]	Run-off [2]	Erosion per inch of run-off	Crop treatment
		Percent	*Percent*				*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Tons per acre*	*Percent*	*Tons per acre*	
	Profile composite	20.8	14.2	23.8	1.46	16.3	69.9	10.1	18.0	17.2	1.5				
	1931 composite	19.6	14.3	22.3	1.37	16.3	59.3	9.4	19.0	18.0	1.6				
1 [3]	1931 wash-off	37.6	36.9	62.0	1.03	60.2	38.5	19.4	34.8	28.9	6.5	1.20	15.0		Cotton.
	1932 composite	21.4	14.0	21.5	1.53	14.0	69.3	9.9	18.7	15.6	1.6				
	1932 wash-off	18.9	16.2	62.0	1.17	53.0	72.0	6.3	18.7	10.9	2.0	3.18	15.0	0.45	Do.
	Profile composite	21.5	15.1	24.9	1.42	17.5	69.7	8.7	19.3	16.8	1.8				
	1931 composite	23.2	15.4	19.5	1.51	12.9	66.9	9.2	21.9	19.8	1.6				
2	1931 wash-off	38.8	40.5	58.7	.96	61.2	35.3	19.2	36.2	28.0	8.4	.93	14.1		Do.
	1932 composite	25.2	14.6	20.6	1.73	11.9	68.5	10.5	19.2	16.1	1.4				
	1932 wash-off	25.1	20.7	60.4	1.21	49.9	55.3	15.2	24.8	21.5	4.3	4.06	16.6	.52	Do.
	Profile composite	19.9	15.7	27.4	1.27	21.6	69.2	10.3	18.0	15.1	2.1				
	1931 composite	21.1	15.7	19.9	1.34	14.9	68.5	9.2	20.2	17.5	1.7				
3	1931 wash-off											.06	3.4		Bermuda grass.
	1932 composite	21.7	15.2	22.3	1.43	15.6	70.2	10.9	16.6	13.7	2.1				
	1932 wash-off	62.4										.00	1.7		Do.
	Profile composite	51.2	25.9	17.1	1.98	8.6	49.0	5.0	45.2	44.0	.2				
	1931 composite	52.6	25.5	13.8	2.06	6.7	45.0	5.3	48.9	47.5	.4				
4 [4]	1931 wash-off	50.3	23.7	16.1	2.12	7.6	40.3	5.1	53.5	51.4	.7	18.49	15.0		Cotton.
	1932 composite	49.3	24.5	19.6	2.01	9.7	47.2	6.5	45.6	43.7	.5				
	1932 wash-off	48.7	22.6	19.7	2.15	9.2	43.2	6.3	49.5	48.7	.7	[5] 29.48	[5] 21.1	2.99	Do.
	Profile composite	20.7	15.0	25.4	1.38	18.5	69.6	9.7	18.4	16.4	1.8				
	1931 composite	21.3	15.1	30.6	1.41	14.7	64.9	9.3	20.4	18.4	1.6				
Average [6]	1931 wash-off	38.2	38.7	60.4	1.00	60.7	36.9	19.3	35.5	28.5	7.5	.73	10.8		
	1932 composite	22.8	14.6	21.5	1.56	13.8	69.3	10.4	18.2	15.1	1.7				
	1932 wash-off	35.5	18.5	61.2	1.19	51.5	63.7	10.8	21.8	16.2	3.2	2.41	11.1	.32	

[1] Mechanical analyses by H. W. Lakin and T. M. Shaw.
[2] Erosion and run-off data for 1931 are for 6 months only.
[3] Short plot.
[4] Desurfaced plot.
[5] Includes estimates of losses from 1 rain as a water boil caused the tank to run over.
[6] Average does not include desurfaced plot.

NOTE.—Profile composite samples were taken to a depth of 8 inches, except desurfaced plot, which was sampled to a depth of 18 inches.

Since, as already mentioned, the data available at present are not sufficient to justify final conclusions, these tables will not be discussed in detail. Attention will merely be drawn to certain special features and general relations.

Throughout the plots it is to be generally expected that the wash-off material should be considerably different from surface composites. It would appear that the more readily dispersed and transported material would be removed to a greater extent than the coarser particles. Inspection of the tables shows that in the Shelby, Colby, Nacogdoches, and Vernon soils there is a marked increase in clay and colloid content and in the moisture equivalent of the wash-off, as compared with the plot composites. In the other four soils but little difference is to be noted. Practically in every case the organic content of the wash-off is greater than in the soil composite.

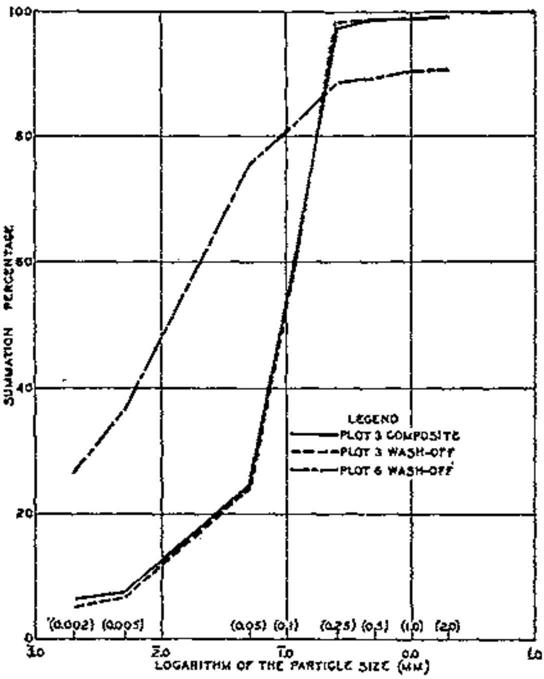

FIGURE 7.—Comparison of the mechanical composition of wash-off and plot composite samples of Vernon fine sandy loam, 1932

The water-vapor absorption of the wash-off is somewhat decreased by the removal of soluble salts and by consequence the colloid content as determined by the water-vapor-absorption method is relatively less than is shown by mechanical analysis. The moisture equivalent is relatively less affected by the loss of soluble salts and consequently the colloid-moisture equivalent ratio is usually less for wash-off than for the soil.

In general the mechanical composition of the wash-off varies with the quantity of eroded material. Plots in cultivated crops, as well as those bare or in fallow, have the greatest erosion and the eroded material is increasingly similar to the plot composite. Those in noncultivated crops such as wheat, grass, lespedeza, etc., have low erosion and the eroded material differs more widely from the soil. This is illustrated by figure 7.

In figure 7 the mechanical analysis of wash-off from plot 6 of the Vernon fine sandy loam is compared with that from plot 3. The mechanical analyses of the two plots are essentially identical. The wash-off, however, of plot 3 is 68.5 tons per acre; that from plot 6 is but 0.56 ton.

In figure 7 the summation percentages of the mechanical analysis fractions are plotted against the logarithm of the particle sizes after the method of G. W. Robinson (*18*). It should be noted that in the method of mechanical analysis used in this laboratory the colloid <0.002 mm is included in the clay. Since organic matter is included in the mechanical analysis but without respect to particle size, the organic content does not appear in the curves and therefore the curves show also, by the degree of divergence from 100 percent, the relative amounts of organic matter in the samples.

Inspection of these curves shows the very close similarity of the heavy wash-off of plot 3 to the original soil and the wide difference shown by the light wash-off from plot 6. The most striking points shown by figure 7 are the increased relative amounts of colloid and organic matter in the wash-off from plot 6 as compared with plot 3. The data in table 15 may be used to show that while plot 3 lost 122 times as much soil as plot 6, it lost but 23 and 22 times as much colloid and organic matter, respectively. Since colloid and organic matter are important constituents of the soil with respect to plant growth, it may readily be seen that damage by erosion is not necessarily proportional to extent of erosion. Slight erosion may be relatively more detrimental to fertility than severe erosion.

Another feature of slight erosion is shown by plot 8 of the Kirvin fine sandy loam (table 16). This plot is in grass, and erosion is very slight—1.8 pounds of oven-dry material in the wash-off sample. The run-off material amounted to 0.081 pound. If the run-off residue be considered as wholly colloid, as it certainly is for the most part, this quantity would increase the wash-off colloid from 4.7 to 8.8 percent. This indicates that 47 percent of the colloid removed is lost in the run-off. This behavior of the colloid is general and is especially marked in those soils where, though dispersion is difficult, coagulation of colloid also is slow. It is probable therefore that in all cases where erosion is small a quantity of colloid in excess of its relative amount in the soil is removed by erosion.

It is difficult to correlate mathematically the mechanical composition of the wash-off with the quantity of wash-off on the various plots because of the number of different components shown by mechanical analysis. The moisture equivalent, however, is a very good index of mechanical composition, particularly when the components of the material are all derived from the same soil (*13*). Therefore the correlation coefficients between the moisture equivalents and the quantity of wash-off have been calculated (*22*) and are shown in table 23.

TABLE 23.—*Correlation coefficient between the moisture equivalent of the wash-off and the quantity of wash-off*

Soil type	1931 wash-off	1932 wash-off
	r	r
Kirvin fine sandy loam	−0.87	[1]−0.32
Vernon fine sandy loam [2]	−.71	−.76
Cecil sandy clay loam	−.57	−.63
Shelby silt loam	−.04	−.90
Colby silty clay loam	−.02	+.50
Marshall silt loam		−.93
Houston black clay	+.04	+.11

[1] Omitting plot 8, $r = -0.92$.

[2] For 1930 wash-off, $r = -0.69$.

In all but three cases there is a definite negative correlation coefficient. This means that the moisture equivalent decreases relatively with increase of wash-off. Since moisture equivalent is primarily, though not wholly, dependent upon colloid content and organic matter, this result again emphasizes the fact that more coarse material is removed when the wash-off is greater; hence the deleterious effect of erosion is relatively greater the smaller the quantity of wash-off. In the case of the Houston black clay the correlation coefficient is positive but is so small that it indicates no material difference in this soil whether the erosion be small or great. This soil not only is dispersed with difficulty but the mechanical composition is largely silt and clay. Consequently, the soil may be expected to move practically as a whole if it moves at all. In the case of the Colby, the 1931 wash-off behaves normally but the 1932 samples of wash-off show a positive correlation coefficient which would seem to indicate that in 1932 the wash-off has distinctly more colloid content than corresponds to its relative amount. No explanation of this anomalous behavior is at hand and it will be of interest to observe in future samples whether it continues to behave in this manner.

In tables 15 to 22 are included the data of the plot composites, which are taken annually to a depth of 7 inches, for 1931 and 1932. In general, it is not to be expected that these samples should yet show any marked changes in comparison with each other. They are usually somewhat different in character from the surface plot profile composites, also given in the tables. The latter samples, the plot profile composites, are taken to the depths corresponding to the A horizon for each soil. The tabulated data do not show any differences which may not be accounted for by experimental error, except in the case of the Shelby silt loam (table 19) for plot 9.

In this plot, which was fallow in both 1931 and 1932, the quantity of erosion is exceptionally high, being 193 tons per acre for the 2 years. This corresponds to a removal of the surface of the plot to a depth of 1.2 inches, since this soil weighs 162 tons per acre-inch. The A horizon of this soil is but 8 inches in depth; therefore, the removal of so large a quantity of soil results in the inclusion in the 7-inch plot composite of a portion of the B horizon. The A horizon has a normal content of 24.3 percent of colloid and the B 48.7 percent (*16, table 1*). This type of alteration may be expected to appear in all the plots of the various stations when erosion shall have progressed sufficiently. In the case of the soils having deep A horizons, as in the Palouse silt loam, and in those of fairly uniform texture in the upper horizons, as in the Houston black clay and Colby silty clay loam, these differences should be slow in appearing. They cannot yet be noted. In the case of the Cecil soil the profile plot composites were taken to a depth of 7 inches, although the surface horizon is but 6 inches. Further, the plot composites are quite variable in their colloid content. Despite these unsatisfactory data the composite of plot 4, which has the maximum erosion, begins to show increasing influence of the B horizon. It should also be mentioned that the control plots at the erosion experiment stations are somewhat protected from gully erosion by the limited length of the plots and the lip of the catchment tanks. The erosion shown by them is therefore not strictly comparable with field conditions.

The erosion and rainfall data shown in tables 14 to 21 are taken from the annual progress reports of the various erosion experiment stations. Access to these reports, not yet published, was given us through the courtesy of H. H. Bennett, until recently the director of these stations.

When an attempt is made to compare the relationships shown by the soil data and erosion results at the different stations with each other, serious difficulties are encountered. These arise from the following circumstances. While the general set-up of the plots and their management is the same at all the stations, yet the kind of crop treatment, slope of plots, amount and character of the rainfall, and temperature changes are all quite varied. It is therefore problematical how far the influence of the character of the soil, as shown by analytical data, may be traced. Were it possible to hold all other variables constant except soil composition as expressed by structure, texture, and chemical character, the problem would be relatively easy.

The situation at the Tyler station closely approximates these conditions in that the Kirvin fine sandy loam and Nacogdoches fine sandy loam plots are located on areas of nearly the same slope; the former at 8¾ percent, the latter at 10 percent. There are, however, but 3 normal plots of the Nacogdoches and 9 of the Kirvin. The climatic conditions are of course identical. If comparison be limited to plots receiving identical treatment, certain definite conclusions may be reached. A comparison of tables 1 and 4 shows that the surface horizon of the Nacogdoches is lower than that of the Kirvin in respect to the silica-sesquioxide ratio, the base content, the suspension percentage, the dispersion ratio, and the percolation ratio. It is higher in the water content of the soil colloid acid, the colloid-moisture equivalent ratio, and colloid content.

The physical properties which are correlated by the erosion ratios indicate a much lower rate of erosion for the Nacogdoches soil.

The erosion ratio seems to represent the erosional characteristics of the soils better than any other single criterion. It is therefore of special interest to compare the directly comparable plots of these two soils with respect to the erosion ratio and the actual erosion (table 24)

TABLE 24.—*Comparison of erosion ratio and erosion of Nacogdoches fine sandy loam and Kirvin fine sandy loam under identical conditions, 1932*

Plot no.	Soil	Erosion ratio	Erosion	Crop
			Tons per acre	
1 [1]	Nacogdoches	14.0	3.18	Cotton.
1 [1]	Kirvin	43.8	12.36	Do.
2	Nacogdoches	11.9	4.06	Do.
3	Kirvin	46.8	17.48	Do.
3	Nacogdoches	15.6	.00	Grass.
8	Kirvin	44.3	.09	Do.
4 [2]	Nacogdoches	9.7	29.48	Cotton.
12 [2]	Kirvin	5.6	73.66	Do.

[1] Short plot.
[2] Desurfaced plot.

Inspection of table 24 shows a very close correlation for the normal plots. In the grass plots the erosion is so small in both cases as to obscure any marked difference of behavior. The total lack of harmony between the erosion ratios and the erosion in the desurfaced plots is in part accounted for by the greater run-off on the Kirvin plots (tables 16 and 22) despite the higher colloid percentage. Another factor tending to distort the results is that the desurfaced plots are not nearly so well protected from erosion by the crop as are the surface horizons of the same soil. This is because of poor growth upon the desurfaced plots. It is in general true that desurfaced plots show a higher erosion than corresponds to their erosion ratios.

In comparing the erosional characteristics of the soils at the different stations with the natural erosion which occurs in the field, one of the more disturbing influences is in the character and quantity of the rainfall. With a given soil one might logically expect that other things being equal the quantity of erosion would be directly proportional to the quantity of precipitation. During a term of years this is probably the case. However, in a short period the quantity effect may be wholly obscured by the relative intensities of the precipitation. An example of this influence is found in the results at the Statesville Erosion Station (table 20). In 1931 the mean erosion from the plots was 16.65 tons per acre, with a rainfall of 44.35 inches. In 1932 the erosion was but 9.66 tons per acre and the rainfall 50.52 inches. The explanation of this wide difference may probably be found in the extremely heavy, almost torrential, rains of 1931.

The usual effect of alteration of rainfall is illustrated by the results at the Guthrie Station (table 15) where for 1930, 1931, and 1932 the mean erosion on the plots was 11.05, 7.34, and 32.40 tons per acre, while the rainfall was 33.66, 29.20, and 37.40 inches, respectively. The mean run-off in inches was 4.02, 3.28, and 5.19 inches, respectively. It is obvious that the amount of erosion is proportional to some function of the run-off but what that function is the available data are not sufficient to determine. It is true also that considerable modification in the results obtained may be expected depending upon whether precipitation occurs as rain or snow and upon ground frozen or already saturated with water.

Topographical conditions must also be taken into account in considering the erosive effects of rainfall. Among these perhaps the most important are the length and degree of the slopes which are subject to erosion. At all the stations 1 or 2 plots longer or shorter than the normal plots have been included in the set-up. It was to have been expected that erosion would increase with the length of the plot on a given slope. Only in one instance, the Kirvin soil at Tyler, Tex., has this been consistently true (table 16). At the other stations the reported results are variable. Only at the Tyler Station have plots been established which are designed to show the effect of differences of slope on erosion. No laboratory studies have, as yet, been made upon the eroded material from these plots. The field results at present available are not sufficient to permit the drawing of definite conclusions. Neither can any definite deductions be drawn from the erosion data of the different stations as to the effect of degree of slope upon erosion.

It is not within the province of this bulletin to discuss the effects of crop cover and of cultivation upon erosion, but it is evident that these have an important bearing upon the field problems and should be mentioned in this connection because they affect the conclusions to be drawn from the field data with reference to laboratory results.

When the various conditions which affect erosion are considered it becomes evident that great difficulties are encountered in any attempt to segregate the effects produced by differences in the soil. This is especially true when the attempt is made to estimate these effects quantitatively and to determine their causes. It is therefore of special interest to determine to what extent the erosion ratio correlates the soil composition with actual erosion. For this purpose the data given in table 25 have been segregated.

TABLE 25.—*Comparison of the average erosion ratio of the annual composite samples with the average erosion for 1931 and 1932; desurfaced plots not included*

Soil type	Average erosion ratio	Average erosion	Soil type	Average erosion ratio	Average erosion
		Tons per acre			*Tons per acre*
Kirvin fine sandy loam	45.0	15.2	Nacogdoches fine sandy loam [1]	13.8	2.4
Vernon fine sandy loam	42.3	19.9	Cecil sandy clay loam	13.3	13.2
Shelby silt loam	29.8	32.0	Houston black clay	8.7	5.1
Colby silty clay loam	18.6	9.0			
Marshall silt loam [1]	14.7	22.8	Average	23.4	15.0

[1] Data for 1 year only.

Attention has already been called to the total failure of the erosion ratio as a means of prediction of the behavior of the desurfaced plots (p. 57). In table 25 it will be seen that a fair general correlation exists for the surface soils. The soils having the greatest erosion ratios have high erosion losses but the quantitative comparison is not good. The outstanding exception is in the case of the Marshall, which, with an erosion ratio of less than average value, shows actual erosion above the average. It is to be observed that in the two sets of plots showing the widest variations, the Kirvin fine sandy loam and the Marshall silt loam, the slopes of the plots are 8.75 and 9.64 percent while for the two sets showing the closest correlation, the Houston black clay and the Colby silty clay loam, the slopes are 4 and 5 percent. Despite this poor showing it seems quite clear that the erosion ratio represents a fair qualitative indication of the behavior of a surface soil. Whether it can be used quantitatively along with other factors is not certain.

GENERAL REMARKS

It is not necessary to repeat in this bulletin the general remarks made in Technical Bulletin 316 (*16*). What is there said, however, is well borne out by the present data, so far as these apply. It is now proposed to study the plasticity, the shrinking, and the swelling volumes of these soils, with a view not only of relating these to the erosional problem, but also the chemical composition and texture of the soils. It is also proposed to study with great care the exchangeable base and acid content of these soils. While these studies are in progress field data will accumulate. It is to be hoped that eventually it may be possible to so correlate field data with laboratory examination as to permit the establishment of criteria by which the field behavior of soils may be predicted. If this becomes possible it will follow that appropriate conservation measures will also be indicated.

From the information at present available it would seem that eventually adequate data will be collected along all needed lines except with respect to the influence of slope.

The data being collected concerning these soils have a special value quite aside from their bearing upon erosion. These soils represent five of the great soil groups recognized in the classification of soils by the Division of Soil Survey. They therefore present exceptionally detailed information on a set of diverse soil types. It is to be hoped that these studies may be supplemented by like careful examination of other soil types within the same groups and particularly by studies of the great groups not represented by the erosion station soils. It would be of great interest were it possible to have detailed data concerning the chemical composition, physical properties, and field behavior of at least one soil type in each State. Such an accumulation of accurate and comparable information must be made before a full comprehension of soils can be reached.

SUMMARY

A previous bulletin on the soils of the erosion experiment stations presented much physical and chemical information concerning eight soil profiles. The present bulletin contains similar data for the three soil profiles from the more recently established stations and includes a large quantity of additional data for the soils of all the stations thus far established. The determinations made include mechanical analyses, chemical analyses of both soil and colloid, specific gravity, field volume weight, porosity, dispersion ratio, erosion ratio, moisture equivalent, and a number of other moisture relationships.

The soils of the erosion stations represent five of the great soil groups, and the wide divergence of the properties and composition of both soils and colloids occasion considerations of much theoretical importance. For example, the highly lateritic Nacogdoches series appears to contain a very weak acid which is assumed to be of the halloysitic type, and the iron oxide appears to be free and nearly anhydrous. By contrast the Colby series appears to contain a considerably stronger acid, assumed to be of the pyrophyllic type and the iron content appears to be a part of the silicate complex. Various ratios of theoretical interest are presented and the silica-combined water ratio is calculated and its significance discussed.

A series of experiments on the settling volume of soils is reported and from the results is deduced a new soil-water relationship which is called the water-saturation capacity. The relation of this soil property to the other soil-moisture properties is discussed and illustrated. It is pointed out that while the field volume weights are uniformly greater than the volume weights of the soils at their settling volume, yet there is a close correlation between these values. Attention is also directed to the influence of colloid composition, as well as of quantity of colloid, on soil-moisture relationships.

Determinations of the fundamental physical data of composite samples from each plot and of the eroded material from each plot are reported. A study of the eroded material shows marked differences in the quantity and character of the wash-off. When the quantity of eroded material is large it is similar in character to the whole soil. When the erosion is slight, the fine material predominates. Slight erosion, therefore, may be relatively more detrimental to fertility

than more severe erosion. These data supplemented by the field data on rainfall, run-off, and erosion reported from the stations show that erosional effects vary greatly with the kind of soil, the amount and intensity of rainfall, the kind of crop and cultivation, the slope, and perhaps other factors. Data for 2 years only are available. It is planned to follow these relations over a much longer period.

The laboratory determination most closely correlated with field erosion is the erosion ratio. Even this ratio has but qualitative significance. No definite relationship between the erosional behavior of soils and their properties as determined in the laboratory has been established. The influence of the soil itself is partially obscured by climatic and other influences.

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