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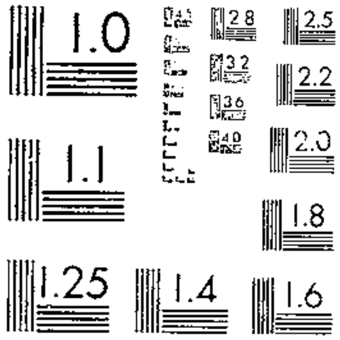

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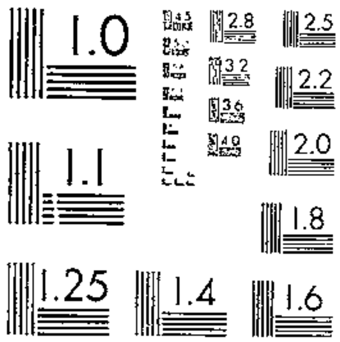

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NATIONAL BUREAU OF STANDARDS 1963-A

TECHNICAL BULLETIN No. 594 — JANUARY 1938

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THE CHEMICAL COMPOSITION OF SOILS AND COLLOIDS OF THE NORFOLK AND RELATED SOIL SERIES[1]

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INTRODUCTION

The Soil Chemistry and Physics Research Division of the Bureau of Chemistry and Soils has been engaged for a number of years in a study of the relations between the chemical composition of soils and the field classification developed by the late C. F. Marbut and his coworkers in the Soil Survey Division. In the Soils of the United States (*11*)[2] the soils are classified in six categories, all of which are based primarily upon characteristics determinable by field observation and study. Category I, soil class, depends solely upon texture, and as has been shown, no specific chemical relation exists between the soil classes. Category II, the soil series, however, is based upon all characteristics other than texture, and it is to be expected that a definite relation exists between the soils of a given series, such as certain similarities in composition. In the different textural classes of a given series wide differences are to be expected, as the relative quantities of finer and coarser materials vary.

[1] Received for publication May 25, 1937.
[2] Italic numbers in parentheses refer to Literature Cited, p. 33.

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Study of a number of soil series has developed the fact that the colloids of a given soil series have essentially the same chemical composition. This relation has been illustrated by studies of the Leonardtown, Miami, Chester, and Cecil series (*9*, *10*).

Also, studies of members of category IV, the great soil groups, have shown that there is a wide variation in chemical composition of both soils and colloids between the groups but a general similarity of profile relations within each group. These results are summarized in Technical Bulletin 484 (*4*).

Category III, local environmental groups (family groups) "includes groups the units in each of which have some features in common, developed by local rather than general environmental conditions." The differences in chemical composition between members of these families have not heretofore been studied in this laboratory, but not long before his death, Marbut himself selected a family of soils that would well repay examination. This family, which may well be called the Norfolk family, is a group of closely related soil series developed upon the Atlantic Coastal Plain in North Carolina. Such a group, which consists of soils that have developed from a common parent material but vary in characteristics because of differences in relief or drainage, in current soils literature is called a catena. The profiles selected for study have all been formed from unconsolidated sedimentary material. This material, transported from the Piedmont Plateau and the Appalachian Mountains, had been deposited in the shallow ocean along its shores.

The genesis of the Atlantic Coastal Plain, according to Stephenson (*5*) and Cooke (*6*), is rather complex. It is fundamentally a series of terraces or terrace plains. This rather level plain, gently sloping toward the sea, was at first poorly drained. The drainage systems were at that time largely confined to the rivers that rise in the Piedmont Plateau and cross the plain on their way to the sea. Since that time numerous laterals have been formed, and other rivers rising within the Atlantic Coastal Plain drain much of it. There are, however, large areas of remote, higher lands that are scarcely reached by any drainage system. The larger swamplands, such as the Great Dover Swamp of Craven and Jones Counties and the Holly Shelter Swamp of Pender County, are typical. At the other extreme, areas adjacent to the older well-developed drainage systems show the effect of excessive drainage by their color and the depth of the water table. Soils developed under such widely divergent drainage conditions may be expected to differ from each other chemically as they obviously do physically.

On the basis of the relationship of drainage to their formation, these soils would be located somewhat as shown in the diagram in figure 1, but in reality they rarely if ever are found in exactly this order because the general irregularities in the topography interfere with any uniform variation in the drainage of the lands lying between any two drainage systems. The Orangeburg and Ruston soils are generally found adjacent to good drainage systems where the land is highly dissected by their laterals. At the other extreme are the swamplands, known by the Indians as pocosins. They are located upon the more remote, undissected, flat to depressed areas upon which much organic matter has accumulated and, due to the wet and poorly drained conditions, has not been destroyed by oxidation and bacterial decomposition. These elevated swamplands serve now as heads to many streams.

For the following reasons it was deemed important to make a thorough study of each of the soil series comprising this soil family:

The weathered product of these soils, especially that which has accumulated in the lower horizons, apparently differs in texture and color.

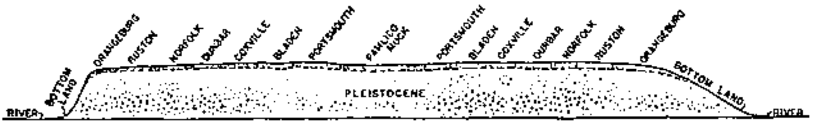


FIGURE 1.—Hypothetical relative position of various soils with respect to the larger drainage systems.

There is a noticeable difference in the manner of growth of some of the native vegetation growing upon the various soils. Variations in the different soils influence the quality of cultivated plants.

These soils are all either of agricultural importance or would become so if properly drained and treated.

This family offers an excellent opportunity to study the family relationships developed primarily as a result of differences dependent upon drainage.

DESCRIPTION OF SOILS

In sampling these soils no attempt was made to locate and sample soil series adjacent to each other but rather to select a large area of well-developed soil typical of each of the series. Nevertheless the soils selected are all within 15 miles of Kinston, N. C. The soils were selected and sampled by the authors. The results of their critical field examination are reported in the following description of the soil profiles.

ORANGEBURG SERIES

Soils of the Orangeburg series are widely distributed in the Atlantic and Gulf Coastal Plains from North Carolina to Texas. These soils are closely associated with the Red Bay, Magnolia, and Cuthbert series. The surface relief ranges from smooth, almost level, to gently rolling and hilly. Both surface drainage and internal drainage are very good, due to the high position where the soils occur and to the friable consistency of the profile, particularly the sandy material of the C horizon. The sandy loams and loamy sands are the main types. The sample of the Orangeburg series used in this investigation was fine sandy loam collected 1½ miles southeast of Williams Pond, Wayne County, N. C. This area occupies rolling to gently sloping uplands overlooking the Cape Fear River and is the largest area of well-developed Orangeburg soil in this section of the State. A description of the profile follows:

Horizon A, 0 to 10 inches. This ranged from light grayish-brown to faintly reddish-yellow loamy fine sand. It was mellow and friable and had a single-grained structure.

Horizon B, 16 to 30 inches. Bright-red heavy fine sandy clay. It broke into irregular-shaped lumps and was easily crushed into a friable mass. The unsampled portion extended to a depth of about 7 feet. It was massive, friable, and uniform in color throughout.

Horizon C, 80 to 100 inches. Mottled and streaked light-red, light-gray, or almost whitish and yellow fine sandy clay material. It was somewhat compact but quite brittle. It was lighter in texture than the B horizon.

RUSTON SERIES

The soils of the Ruston series are widely distributed in the Atlantic and Gulf Coastal Plains, especially from North Carolina to east Texas. The surface relief ranges from almost level, gently rolling to hilly. Both the surface drainage and internal drainage are good. These soils are intermediate in color between the soils of the Orangeburg and Norfolk series. Some iron crust occurs in places on the more hilly areas, and small rounded quartz gravel or small rounded iron accretions are present in some places. The sandy loams predominate.

The profile of Ruston fine sandy loam selected for this investigation was 2 miles south of Fremont, in Wayne County. The sample was selected from a hedgerow adjacent to the highway and bordering a field planted to cotton. It is described as follows:

Horizon A, 0 to 10 inches. Grayish-yellow loamy fine sand containing a small amount of organic matter.

Horizon B, 16 to 30 inches. Reddish-yellow to yellowish-brown heavy fine sandy clay of uniform color, texture, and structure. It had no definite cleavage or breakage, but it broke into irregular-shaped lumps and was easily crushed into a friable mass.

Horizon C, 40 to 54 inches. Mottled and streaked light-red, light-gray, and yellow fine sandy clay.

Above the C layer and extending to the B layer was mottled light-red and yellow fine sandy clay slightly more friable than the B horizon but heavier than the C. The transitional material between the A and B horizons was heavier than the A horizon and lighter than the B.

NORFOLK SERIES

The soils of the Norfolk series are the most widely distributed of any series in the Coastal Plains. They may occur anywhere between Long Island, N. Y., and eastern Texas. They are developed to the greatest extent in the Carolinas, where they constitute the normally developed soils of the middle and higher parts of the Coastal Plain of the region. These soils occupy almost level, undulating to gently rolling relief except for some of the sand members in the sand hill, and here the surface ranges from undulating to hilly. For the most part, surface drainage and internal drainage are good. Some of the flatter areas require ditching, and in such places the mottled condition of the lower part of the B horizon indicates poor drainage and aeration. In texture these soils range from coarse sand to very fine sandy loam.

The Norfolk fine sandy loam selected for this investigation was collected 3 miles north of Bests, in Wayne County. The sample was taken from a virgin area forested with loblolly pine, small oaks, dogwood, and sweetgum. It had the following characteristics:

Horizon A, 0 to 12 inches. Grayish-yellow light-textured fine sandy loam to loamy fine sand. The first 2 or 3 inches were dark gray, due to the presence of a small amount of organic matter.

Horizon B, 14 to 34 inches. Yellow fine sandy clay of uniform color, texture, and structure. It broke into irregular-shaped lumps having no definite structural characteristics, but was easily crushed into a mealy mass. Between 12 and 14 inches was yellow heavy fine sandy loam. This represents the gradation zone between the soil and the subsoil. Below 34 inches and extending to 36 inches there was also a gradation zone between the typical B horizon and the C horizon, and the material in this layer was yellow fine sandy clay, slightly mottled with light red or gray.

Horizon C, 36 to 80 inches. Yellow, mottled with light gray or almost white, and light-red fine sandy clay. This layer had about the same texture as the B horizon. It had a slightly platy or laminated structure, was slightly compact but very brittle, and readily crumbled into a friable mass. At 80 to 90 inches was light-red and gray or purplish-red fine sandy loam to loamy fine sand.

DUNBAR SERIES

In regard to color, drainage, and profile development, the soils of the Dunbar series are intermediate between the soils of the Norfolk series and those of the Coxville series. They are developed in the flatwoods region of the Coastal Plain and in low flat areas in the adjacent higher part. They occupy predominantly flat, undulating to gently sloping areas. Surface drainage is fair to poor; internal drainage is hindered by rather heavy subsoils. The sandy loams and fine sandy loam are the main soil types.

The soil selected for this investigation was fine sandy loam. The sample was collected from a forested area half a mile north of Grainger, in Lenoir County. In places there was about half an inch of leafmold on the surface. The profile had the following characteristics:

Horizon A_1, 0 to 5 inches. Dark-gray light-textured fine sandy loam containing considerable organic matter.

Horizon A_2, 5 to 12 inches. Grayish-yellow mellow and friable fine sandy loam.

Horizon B_1, 16 to 28 inches. Mottled light-gray and brownish-yellow heavy fine sandy clay. It broke into irregular-shaped lumps but crumbled fairly easily into a granular and friable mass.

Horizon B_2, 28 to 48 inches. Light-gray and yellow heavy fine sandy clay with bright red mottlings. The bright red occurred in splotches or streaks and was not uniformly distributed throughout the layer. There was practically no difference between the structure and texture of this layer and those of the B_1 horizon.

Field examination of this profile showed that there was practically no change in structure, texture, or color of this material to a depth of 80 inches.

In the profiles previously described in this report there was a rather definite C horizon, but in the Dunbar, Coxville, Bladen, and Portsmouth soils, all of which are poorly drained, the C horizon was not well defined.

COXVILLE SERIES

The Coxville series is one of the large and important series in the seaward or flat part of the Atlantic Coastal Plain, particularly in the Carolinas. The soils occupy flat level areas, and the natural surface drainage is poor, as the areas in many places have not been invaded by natural drainageways. Open ditches are necessary to reclaim these soils for agricultural purposes. The banks of ditches stand up well because of the heavy subsoil.

The sample used in this investigation was collected 4 miles southeast of West Crossroads, in Lenoir County. It is described as follows:

Horizon A, 0 to 9 inches. Fine sandy loam. The first 4 inches were dark gray to almost black, due to the presence of a large amount of organic matter, and the 5 inches below this were light gray. The lower part of the layer was slightly mottled with yellow or brownish yellow as it graded into the subsoil.

Horizon B, 26 to 34 inches. Light to bluish-gray clay or very heavy fine sandy clay mottled and streaked with brownish yellow and some splotches of bright red. It was plastic when wet. The bright-red splotches were not uniformly distributed and did not occur everywhere. Some areas of the Coxville do not show any red mottlings, although they have the same texture and structure as mottled areas.

Horizon C, 44 to 66 inches. Steel-gray heavy somewhat plastic clay. The upper part of the layer had some mottlings of yellow and brown. The water table was at the bottom of the red mottlings, which was 36 inches below the surface of the land. In other words, no red mottlings appeared below the top of the water table.

BLADEN SERIES

The soils of the Bladen series have dark-gray to grayish-brown surface layers. In some places the first inch or two is almost black, due to the large amount of organic matter and leafmold. The subsoils are characterized by steel-gray or light-gray heavy tenacious plastic clays or sandy clays streaked or mottled with brownish yellow or ocherous color. The subsoils extend to a depth of 3 to 5 feet, at which depth the steel gray or bluish gray predominates.

These soils occupy low, flat areas and are naturally poorly drained, some being semiswampy. In many places they appear to be intermediate between the tidal marsh and Coxville soils. In soil development they are one step removed from tidal marsh. They differ from the Coxville in being more poorly drained, having a plastic subsoil, and having no bright-red mottling in the subsoil.

The sample used in this investigation was collected three-fourths of a mile southwest of Airy Grove School, in Lenoir County. The description follows:

Horizon A, 0 to 8 inches. Dark-gray loam.

Horizon B, 10 to 36 inches. Steel-gray or bluish-gray heavy plastic clay streaked with brownish yellow.

Horizon C, 36 to 54 inches. Steel-gray or bluish-gray heavy plastic clay faintly streaked in places with brownish yellow. At the time the sample was collected, the water table was 3 feet below the level of the land.

PORTSMOUTH SERIES

The soils of the Portsmouth series are widely distributed in the Coastal Plain, particularly in the seaward portion. The series is characterized by dark-gray to black soils to a depth of 8 to 12 inches. The subsoils in some places are mottled yellow and gray sandy clays; in others they are rather heavy clays or light-gray sands. The black color of the soil is due to an accumulation of organic matter under semiswampy conditions. These soils occupy level and flat areas, and in some of the bays and pocosins, natural drainageways have not been established. Water stands on the surface after heavy rains, and artificial drainage is necessary to reclaim these soils for agricultural purposes.

The Portsmouth fine sandy loam sampled was collected 1½ miles southeast of Southwood School, in Lenoir County, or about 6 miles southwest of Kinston. The description follows:

Horizon A, 0 to 15 inches. Black fine sandy loam containing a large amount of finely divided organic matter. The area was forested with old-field and loblolly pines, together with some sweetgum and in places an undergrowth of myrtle and gallberry. Below the black layer and grading into the subsoil, was a light-gray to whitish layer of fine sandy loam or loamy fine sand ranging from 2 to 4 inches in thickness.

Horizon B, 15 to 35 inches. Light-gray to almost white fine sandy clay. It was mottled with brownish yellow and was slightly sticky. It graded into light-gray fine sand or mottled light-gray and brownish-yellow light fine sandy clay.

Horizon C, 40 to 70 inches. Light-gray, sticky fine sand to fine sandy clay.

PAMLICO MUCK

Pamlico muck occurs in the South Atlantic and Gulf States, principally in large areas in the so-called bays and pocosins. It is strongly acid throughout its profile. It consists of fairly well decomposed organic matter, together with a noticeable amount of fine sand, silt, and clay. When wet it is black, but when dry it is dark brown to black. It extends down to 3 to 5 feet, or more, being fairly uniform throughout. It is underlain by light-gray fine sand or light-gray sticky fine sandy clay or clay. The surface relief is flat, in many places being higher than the surrounding mineral soils. Natural drainage is poor; water stands on the surface part of the time. Streams head in the muck areas. The natural vegetation consists of pond pine, locally called gnarly-top pine, bay bushes, a few gums, and a thick undergrowth of greenbriers, locally known as bamboo briers. Pamlico muck is practically unused for agricultural purposes. The series was established in Pamlico County, N. C., in 1935.

The sample of Pamlico muck described below is representative of large areas of muck in eastern North Carolina. It was collected from the Great Dover Swamp, a typical pocosin, 4 miles south of Cove, in Jones County. This area was burned over to a depth ranging from a few inches to a foot or more during an extremely dry season a few years ago. At the time the sample was collected, the water table was at the surface, and water was in all the burned holes and slight depressions.

0 to 36 inches black muck. Well-decomposed to fairly well decomposed organic matter, together with mineral matter, mainly silty clay and a small amount of fine sand.

40 to 60 inches. Bluish to steel-gray medium to fine sandy clay. It was somewhat sticky. Lying between the black muck and this sandy clay material was a thin layer of brown sand. The brown color apparently was due to stains from the organic matter.

Pamlico muck collected 3 miles south of Cove, N. C.:

0 to 24 inches. Black muck composed largely of fairly well decomposed to well-decomposed organic matter containing a relatively small amount of mineral matter made up of fine sand, silt, and clay. Many roots of gallberry, bay bushes, and greenbriers occurred in the first 6 to 10 inches. The water table was at the surface, and all burned holes were filled with water. The muck at this place was about 3½ to 4 feet deep over the thin layer of brown sticky sand, which was underlain by steel-gray or bluish-gray sticky fine sandy clay similar to the underlying material of the sample collected 4 miles south of Cove.

The vegetative growth on these two areas of Pamlico muck, and in fact on all the Great Dover Swamp, consists of small pond pines with an undergrowth of gallberry and bay bushes, interlaced in many places with a thick growth of greenbriers.

The parent material from which the soils of this region have been derived through the soil-forming processes is quite variable as to texture, consistence, and color. It consists of beds of unconsolidated sands, sandy clays, and clays, the various layers or beds of material occurring irregularly. The character of the parent material, together with the internal drainage, has in a large measure influenced the various profiles. The Orangeburg, Ruston, and Norfolk soils in this section have normal or mature profiles and are underlain by beds of unconsolidated sands and sandy clays. The Dunbar soils have a young to immature profile development.

Owing to the prevailingly high water table the Coxville, Bladen, and Portsmouth soils have not developed a normal profile, and consequently have imperfect drainage. Some of these areas maintain the surface configuration formed when the material was laid down by the sea. The entire solum of both the Coxville and Bladen soils is heavy, and the underlying parent material is also very heavy, as compared with the parent material underlying the Orangeburg and Norfolk soils.

METHODS OF EXAMINATION

Each sample was pulverized fine enough to pass through a ½-inch mesh sieve. It was then thoroughly mixed, and subsampled.

The mechanical analyses were made by the standard method devised by Olmstead, Alexander, and Middleton (*12*) of this Bureau.

The colloidal material was extracted by mechanical agitation, separation by supercentrifuge, and Pasteur-Chamberland filtration. After extraction it was air-dried. These soils, especially the A horizon, contain rather large quantities of pure quartz sand and silt. Therefore, all the sand and silt that could easily be freed from the colloid-bearing material were removed before it was centrifuged.

Complete chemical analyses of both the soils and their colloids were made by the procedure described by Robinson (*13*). The organic matter was determined by the combustion method, the empirical factor 0.471 being used for calculating organic-matter content from the carbon dioxide value. The pH values of the soils were determined by the use of the hydrogen electrode described by Bailey (*1*).

ANALYTICAL RESULTS

The data for each soil examined are presented in separate tables, followed by a discussion of each table and a compilation of pertinent data relative to the essential characteristics of these soils as a group.

The tables of derived data given for each colloid consist of molecular ratios and values calculated for the combined water and the water assumed to be represented by the composition of the hypothetical acids of the colloid. The ratios expressed in the tables require two arithmetical operations. The quantities found by analysis are divided by their respective formula weights, and the resulting quotients (moles) are compared as independent ratios. In the silica-total base ratio the bases included, recorded as oxides, are calcium, magnesium, potassium, and sodium. The combined water is the ignition loss less the organic matter. The water considered in the ratios is the combined water plus the water equivalent of the four bases. The combined water of the soil acid is the sum of the combined water and the water equivalent of the bases divided by 100 less the organic matter.

ORANGEBURG FINE SANDY LOAM

The Orangeburg soil series is the most thoroughly drained of the group of soils herein considered. The data in table 1 show the Orangeburg soil profile to be very highly modified by eluviation. A shallow A horizon, low in colloid, and a very deep B horizon, high in colloidal content, are characteristic of the Orangeburg series. How the shallow A horizon has so enriched the B horizon, which is many times thicker, cannot easily be explained, unless it be assumed that much of the top material has been removed by erosion. It is obvious that the percentages of sand and silt of the A and B horizons are widely different by reason of the almost complete removal of clay from the A horizon to the B. It is to be noted, however, that the A and B horizons are much more nearly uniform in both silt and sand when these constituents are calculated on a clay-free basis. This is not true for the C horizon, as it is much lower in silt and higher in the coarser sand fractions. The predominance of coarser sands undoubtedly contributes largely to the excellent subdrainage.

TABLE 1.—*Mechanical analysis of Orangeburg fine sandy loam (soil)* [1]

Sample no.	Horizon	Depth	Fine gravel (2–1 mm)	Coarse sand (1–0.5 mm)	Medium sand (0.5–0.25)	Fine sand (0.25–0.1 mm)	Very fine sand (0.1–0.05 mm)	Silt (0.05–0.005 mm)	Clay (0.005–0 mm)	Colloid (0.002–0 mm)	Organic matter by H_2O_2
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C288	A	0-6	1.6	9.8	10.6	26.1	26.3	20.0	5.0	3.0	0.4
C289	B	16-30	.0	4.0	4.1	9.7	17.4	17.0	47.1	46.5	.0
C290	C	80-100	3.6	12.4	14.3	27.1	6.6	8.3	27.7	27.7	.0

[1] Determinations by T. M. Shaw and E. F. Miles.

Table 2 shows the chemical analysis of Orangeburg fine sandy loam. These data, like those of the mechanical analysis, show the transfer of clay and colloid from the A to the B horizon. The increase of titanium in the B horizon would indicate that it is associated with the clay content of the soil. The high ignition loss observed in the B horizon is due to the presence of the accumulated hydrated clay material. The soil has a very low, yet rather uniform, content of all other constituents except silica, iron oxide, and alumina. The somewhat high pH value of the A horizon is probably the result of accumulations of organic ash.

TABLE 2.—*Chemical analysis of Orangeburg fine sandy loam* [1]

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C288	A	0-6	96.10	0.75	1.85	0.63	0.01	0.12	[2]
C289	B	16-30	66.90	1.44	18.04	6.11	.03	.04	0.08
C290	C	80-100	83.22	.79	9.67	2.38	.01	.07	.01

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	pH	N	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*
C288	A	0-6	0.03	[2]	0.02	0.02	0.97	100.56	5.1	0.02	0.55
C289	B	16-30	.12	0.03	.02	.04	7.47	100.32	4.8	.02	.32
C290	C	80-100	.11	.01	.02	.02	3.40	99.71	4.6	.03	.08

[1] Determinations by G. Edgington.
[2] Trace.

As may be seen from the chemical data in table 3 the colloid in the A and B horizons is very much the same in chemical composition except for an accumulation of iron oxide in the B horizon. This is very much in evidence from the color as well as the chemical data. The higher silica and lower iron oxide contents of the colloid of the C horizon indicate a less weathered or laterized colloid than that of the A and B horizons. The color of the C horizon shows the presence of free iron oxide. This iron oxide may have been transferred from the above horizon as a result of the very low water table and the very sandy open structure of the soil profile.

TABLE 3.—*Chemical analysis of the colloid of Orangeburg fine sandy loam*

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C288	A	0-10	29.94	1.03	34.81	11.62	0.03	0.50	0.57
C289	B	10-30	31.07	1.57	36.31	12.85	.02	.64	.30
C290	C	80-100	41.41	1.12	34.60	8.04	.01	.43	.25

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C288	A	0-10	0.74	0.16	0.47	0.19	19.67	99.63	4.43
C289	B	10-30	.33	.20	.09	.15	16.41	99.84	.91
C290	C	80-100	.24	.18	.09	.11	13.18	100.56	.70

Table 4 gives the derived data for the three horizons of the Orangeburg soil profile. The ratios of silica to the sesquioxides in the A and B horizons clearly show laterization. The solution of silicate silica is much more pronounced in these two horizons than in the C. This is also shown by the higher combined water of soil acids in the upper horizons. The character of the colloid in the A and B horizons of the Orangeburg differs but little from that of the Cecil colloid (*10*), both being low in bases and high in combined water and possessing a low ratio of silica to the sesquioxides.

TABLE 4.—*Derived data for the colloid of Orangeburg fine sandy loam*

Sample no.	Horizon	Depth	Molecular ratio								Combined water	Combined water of the soil acid
			$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	$\frac{H_2O+B}{SiO_2}$	$\frac{H_2O+B}{Al_2O_3}$	$\frac{H_2O+B}{R_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$		
		Inches									*Pct.*	*Pct.*
C288	A	0-10	1.21	1.46	6.88	15.0	1.76	2.60	2.13	0.21	15.84	16.57
C289	B	10-30	1.19	1.46	6.41	21.9	1.70	2.48	2.02	.23	15.90	16.05
C290	C	80-100	1.77	2.08	12.29	35.7	1.02	2.09	1.80	.17	12.73	12.82

RUSTON FINE SANDY LOAM AND LOAMY FINE SAND

The Ruston series of soils is very widely distributed and presents a considerable variation of types. It seemed of interest, therefore, to present here the analysis of a second profile to show that this soil, like the Cecil, Miami, Chester, and Leonardtown (*9*, *10*), has a colloid of similar type wherever found, despite the difference in the mechanical and chemical composition of the soils themselves. The profile selected for this purpose was from Georgia, and the data concerning it are given in tables 5, 6, 7, and 8, immediately following the corresponding data for the North Carolina soils.

The first part of table 5 shows the mechanical analysis of the Ruston fine sandy loam from North Carolina. The most marked feature of this profile, like that of the Orangeburg, is the evidence of transfer of the clay material from the A horizon. However, the data do not show that this material has accumulated in the B horizon alone but indicate that it has been distributed throughout the lower strata of the soil profile. This probably has been brought about by the sandy nature of the Ruston profile and the variations in the water table. The mechanical analysis of the soil from Georgia shows this profile to be very dissimilar from the North Carolina profile in texture, but it nevertheless shows the same type of distribution of clay and colloid.

TABLE 5.—*Mechanical analysis of Ruston fine sandy loam* [1]

FROM NORTH CAROLINA

Sample no.	Horizon	Depth	Fine gravel (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-0.1 mm)	Very fine sand (0.1-0.05 mm)	Silt (0.05-0.005 mm)	Clay (0.005-0.0 mm)	Colloid (0.002 mm to 0 mm)	Organic matter by H_2O_2
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C201	A	0-10	0.6	2.7	4.4	21.1	31.1	31.5	7.9	6.7	0.7
C202	B	16-30	.9	2.6	3.7	16.5	10.7	26.3	29.4	28.3	.1
C203	C	40-54	.6	3.6	0.7	22.0	14.0	17.2	30.8	29.6	.1

FROM GEORGIA

Sample no.	Horizon	Depth	Fine gravel (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-0.1 mm)	Very fine sand (0.1-0.05 mm)	Silt (0.05-0.005 mm)	Clay (0.005-0.0 mm)	Colloid (0.002 mm to 0 mm)	Organic matter by H_2O_2
161	A	0-14	5.7	22.0	20.2	24.3	6.8	10.7	9.2	7.3	0.7
162	B	14-40	3.3	14.1	10.3	13.0	9.0	11.4	38.6	34.4	.1
163	C	40-60	3.3	18.2	14.3	15.6	8.2	8.0	32.2	29.6	0

[1] Determinations by T. M. Shaw and E. F. Miles.

The two sets of analyses given in table 6 present interesting similarities despite the differences imposed upon them by reason of textural differences. Both soils are extremely low in bases and in phosphates, indicating that both are highly leached. Both soils have a low iron oxide content, considering that both are reddish-brown soils.

TABLE 6.—*Chemical analysis of Ruston fine sandy loam* [2]

FROM NORTH CAROLINA

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C201	A	0-10	93.02	1.06	2.85	0.84	0.01	0.13	0.05
C202	B	16-30	79.98	1.23	10.06	3.88	.01	.15	.01
C203	C	40-54	75.51	.95	11.36	4.35	.01	.03	.04

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	pH	N	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*
C201	A	0-10	0.05	0.01	0.04	0.06	1.70	99.82	6.0	0.02	0.88
C202	B	16-30	.11	.02	.06	.07	4.22	99.80	5.0	.03	.31
C203	C	40-54	.22	.01	.08	.01	4.22	99.75	4.8	.02	.17

[2] Determinations by G. Edgington.

TABLE 6.—*Chemical analysis of Ruston fine sandy loam*—Continued

FROM GEORGIA

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
161	A	0-14	87.28	1.14	4.78	2.40	0.10	0.30	0.04
162	B	14-40	75.01	.75	12.82	5.29	.05	.07	.12
163	C	40-60	81.02	.58	11.23	3.30	.03	.09	.09

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	pH	N	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*
161	A	0-14	0.24	0.17	0.07	0.21	3.35	100.08	4.8	0.04	1.85
162	B	14-40	.29	.03	.05	.01	5.04	100.13	4.9	.04	.50
163	C	40-60	.30	.06	.05	.02	3.37	100.18	4.8	.02	.21

Table 7 gives the analyses of the colloids of the Ruston soils from North Carolina and Georgia. These data show the Ruston colloid to be laterized but not so much as that of the Orangeburg. It is to be noted that the alumina is abnormally high in the B horizon of the North Carolina profile. The colloid is very much debased and almost equally so in both profiles. The slightly higher base content and phosphorus in the A horizon of the North Carolina profile may perhaps be ascribed to the adventitious presence of artificial fertilizer, although both profiles were presumably virgin soils. On the whole, the colloids of the Georgia and North Carolina profiles are so similar in chemical composition that they are practically identical.

TABLE 7.—*Chemical analysis of the colloid of Ruston fine sandy loam*

FROM NORTH CAROLINA

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C291	A	0-10	34.79	1.28	31.41	10.90	0.02	0.63	0.51
C292	B	10-30	35.15	1.03	36.88	9.88	.01	.39	.50
C293	C	40-54	38.47	1.31	32.08	12.41	.01	.19	.45

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C291	A	0-10	0.95	0.84	0.63	0.22	17.67	99.88	4.92
C292	B	10-30	.65	.44	.23	.17	15.15	100.38	1.00
C293	C	40-54	.60	.30	.23	.11	13.33	100.09	.62

FROM GEORGIA

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
161	A	0-14	37.16	0.93	31.30	12.81	0.10	0.46	0.23
162	B	14-40	36.59	.09	32.57	12.70	.07	.43	.20
163	C	40-60	38.49	.08	33.87	12.08	.04	.43	.27

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
161	A	0-14	0.70	0.29	0.17	0.12	16.87	101.23	4.53
162	B	14-40	.70	.35	.20	.09	15.30	100.31	2.55
163	C	40-60	.74	.41	.16	.10	13.37	100.94	1.27

In table 8 are given the derived data for the colloids of the Ruston profiles. The molecular ratios for the major constituents of both are essentially the same except in the B horizon of the North Carolina profile, where the alumina content is abnormally high and the iron oxide content is abnormally low. Since the bases of its A horizon, as previously pointed out, are higher than in the Georgia profile, the ratio of silica to total bases in this horizon is much lower. The silica-base ratios, however, are so low as to indicate intensive leaching. The combined water is fairly uniform within each. The average value in the North Carolina soil is 13.77 percent, whereas in the Georgia soil it is 12.42. The ratios of combined water to sesquioxides and also to alumina are approximately uniform within both profiles, but the colloids of the Georgia profile are more dehydrated.

TABLE 8.—*Derived data for the colloid of Ruston fine sandy loam*

FROM NORTH CAROLINA

Sample no.	Horizon	Depth	Molecular ratio								Combined water	Combined water of the soil acid
			$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	$\frac{H_2O+B}{SiO_2}$	$\frac{H_2O+B}{Al_2O_3}$	$\frac{H_2O+B}{R_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$		
		Inches									*Pct.*	*Pct.*
C201	A	0-10	1.54	1.88	8.46	11.0	1.20	2.42	1.00	0.22	13.47	14.17
C202	B	10-30	1.39	1.02	9.44	18.1	1.39	2.26	1.92	.18	14.67	14.82
C203	C	40-54	1.61	2.00	8.22	26.0	1.14	2.29	1.84	.24	13.17	13.25

FROM GEORGIA

Sample no.	Horizon	Depth	$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	$\frac{H_2O+B}{SiO_2}$	$\frac{H_2O+B}{Al_2O_3}$	$\frac{H_2O+B}{R_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$	Combined water	Combined water of the soil acid
161	A	0-14	1.60	2.01	7.71	21.8	1.16	2.32	1.84	0.26	12.34	13.48
162	B	14-40	1.53	1.90	7.68	21.7	1.22	2.23	1.77	.25	12.81	13.05
163	C	40-60	1.57	1.93	8.47	21.7	1.11	2.11	1.72	.23	12.10	12.79

NORFOLK FINE SANDY LOAM

The mechanical analysis of the Norfolk fine sandy loam is given in table 9. Two outstanding features are shown by these data: (1) The extent to which the clay has been transferred from the A horizon to both the lower horizons, and (2) the uniform content of silts and sands in the three horizons. This fact becomes obvious when the percentages of the silts and sands are figured on a clay-free basis. The large quantity of this coarser material and its uniform distribution throughout the profile, together with the low water table, have no doubt contributed to the transfer of the clay from the upper part of this soil.

TABLE 9.—*Mechanical analysis of Norfolk fine sandy loam*[1]

Sample no.	Horizon	Depth	Fine gravel (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-0.1 mm)	Very fine sand (0.1-0.05 mm)	Silt (0.05-0.005 mm)	Clay (0.005-0 mm)	Colloid (0.002-0 mm)	Organic matter by H_2O_2
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C294	A	0-12	1.7	6.6	9.9	25.9	17.8	28.4	8.9	4.9	0.07
C295	B	12-34	1.0	5.1	7.7	20.4	14.0	22.7	28.8	23.5	.02
C296	C	30-80	1.2	4.8	7.9	19.7	13.7	21.3	31.3	30.1	.00

[1] Determinations by T. M. Shaw and E. F. Miles.

Table 10 gives the chemical analysis of the three horizons of the Norfolk soil profile. The variations in this soil profile are characteristic of a mature profile developed under good drainage and oxidation. This is evidenced by the structure, color, and location of the clay, as pointed out in the description of the soil and by its mechanical analysis. The chemical data given in table 10 show a pronounced transfer of the major constituents from the A horizon to the lower horizons, as indicated by decrease of silica and increase of sesquioxides. The nature of this transfer is better interpreted from the subsequent data on the colloidal fraction of this soil. The whole soil has a very low yet uniform content of the minor constituents.

TABLE 10.—*Chemical analysis of Norfolk fine sandy loam* [1]

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C294	A	0-12	94.26	1.01	2.08	0.69	0.01	0.07	0.03
C295	B	12-34	82.67	1.14	8.87	3.18	.01	.08	.02
C296	C	36-80	78.99	1.05	11.03	4.45	.02	.01	.05

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	pH	N	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*
C294	A	0-12	0.03	0.01	0.01	0.01	1.67	99.85	5.1	0.02	0.80
C295	B	12-34	.07	.01	.02	.02	3.64	99.73	4.6	.03	.40
C296	C	36-80	.02	.03	.01	.03	4.18	99.85	4.6	.02	.21

[1] Determinations by G. Edgington.

The data presented in table 11 show that the colloids of the three horizons of the Norfolk soil profile have about the same content of both the major and minor constituents, with the exception of organic matter. The chemical composition reported by Davis (7) for 23 Alabama Norfolk soil profiles also shows the colloids in both the surface and subsoil layers to be very much the same in respect to the major constituents.

TABLE 11.—*Chemical analysis of the colloid of Norfolk fine sandy loam*

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C294	A	0-12	35.97	1.23	32.14	10.70	0.01	0.35	0.58
C295	B	12-34	37.51	1.10	34.41	12.41	.01	.50	.52
C296	C	36-80	38.73	.90	34.10	11.97	.01	.28	.42

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C294	A	0-12	0.52	0.18	0.10	0.12	17.83	99.73	4.65
C295	B	12-34	.53	.27	.10	.11	14.03	101.53	1.06
C296	C	36-80	.30	.20	.07	.09	14.29	101.36	.77

The derived data in table 12 indicate a very unusual uniformity of all the ratios for the horizons. Taken alone, the silica-sesquioxide ratios indicate extensive weathering of soil material, and indeed these ratios as well as the silica-alumina ratios warrant the classification of this as lateritic soil. If fractionation of the colloid material by translocation is regarded as essential to podzolization, there is little evidence of this process. The soil has a distinctly bleached A horizon, but this bleaching is due to removal of the colloid as a whole and not to the differential removal of iron oxide. The iron oxide-alumina ratio being essentially the same in all three horizons, the silica-alumina is slightly nearer that of halloysite than it is in the Orangeburg and Ruston colloids, and if the alumina is regarded as wholly combined as an alumino-silicate the degree of hydration is essentially the same as that of the other soils, as indicated by the water-alumina ratios. The silica-sesquioxide and silica-alumina ratios of the Norfolk colloids reported by Davis (7) are fairly constant within the profile but differ widely among the profiles. Usually these ratios are somewhat lower than those in the profile shown in table 12. This may perhaps be due to the higher temperature and rainfall of southern Alabama. Where the ratios of the Alabama soils are markedly high, there is evidence in some instances, from the location shown on the map (7), of possible contamination of the soils by material derived from other soil series.

TABLE 12.—*Derived data for the colloid of Norfolk fine sandy loam*

Sample no.	Horizon	Depth	Molecular ratio								Combined water	Combined water of the soil acid
			$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	$\frac{H_2O+B}{SiO_2}$	$\frac{H_2O+B}{Al_2O_3}$	$\frac{H_2O+B}{R_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$		
		Inches									*Pct.*	*Pct.*
C204	A	0-12	1.57	1.90	8.01	21.4	1.76	2.41	1.99	0.21	13.69	14.36
C205	B	12-34	1.51	1.86	8.02	19.7	1.70	2.23	1.81	.23	13.54	13.68
C206	C	36-80	1.57	1.93	8.57	20.6	1.02	2.31	1.89	.22	13.91	14.02

DUNBAR FINE SANDY LOAM

The data in table 13 show the Dunbar soil to be composed largely of sand, very fine sand, and silt. The profile is rather uniform in texture, so far as the coarser material is concerned, but shows the usual increase of clay and colloid with depth, presumably by reason of transfer of material. In this soil profile, four samples were taken on the basis of field differences, the two upper layers being regarded as parts of the A horizon. The two lower layers are separated from the A horizon by a transition interval of 4 inches. The lowest layer does not constitute a C horizon. It is evidently modified by transferred material. If any material unaffected by the upper strata exists in this profile it is at much greater depth. For purposes of comparison, however, the lowest layer is regarded as a C horizon.

TABLE 13.—*Mechanical analysis of Dunbar fine sandy loam* [1]

Sample no.	Horizon	Depth	Fine gravel (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-0.1 mm)	Very fine sand (0.1-0.05 mm)	Silt (0.05-0.005 mm)	Clay (0.005-0 mm)	Colloid (0.002-0 mm)	Organic matter by H_2O_2
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C298	A_1	0-5	0.3	1.2	3.4	29.3	23.4	31.1	8.0	4.7	3.2
C299	A_2	5-12	.3	1.0	3.3	27.8	22.4	32.9	11.6	7.5	.6
C300	B_1	16-28	.4	.9	2.9	23.4	19.4	30.9	21.8	16.6	.1
C301	B_2	28-44	.4	1.0	2.9	21.8	17.7	29.7	26.2	23.0	.2

[1] Determinations by T. M. Shaw and E. F. Miles.

Table 14 gives the chemical composition of the four soil layers of Dunbar fine sandy loam. This soil was very heavily forested. The forest produced a rather dense shade, which was conducive to the accumulation of organic matter. When the samples were taken the field conditions were such as to best differentiate the horizons of this soil profile in respect to color and texture. Observed differences were slight, however, and were confined largely to the color and the clay content. The soil remained friable and mellow throughout the profile, particularly in the lowest layer. The data show that there was less eluviation than in the previous soils. Excessive leaching is indicated in this soil by the high acidity and the paucity of divalent and monovalent bases. The combination of extensive leaching with less extensive eluviation is perhaps to be ascribed to a relatively high mean water level.

TABLE 14.—*Chemical analysis of Dunbar fine sandy loam* [1]

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C298	A_1	0-5	92.81	0.92	1.57	0.57	0.02	0.01	0.01
C299	A_2	5-12	93.82	.98	2.66	.72	.01	.01	.01
C300	B_1	16-28	89.46	1.16	5.28	1.49	.02	.01	.10
C301	B_2	28-44	86.32	1.21	6.51	3.10	.02	.01	.03

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	pH	N	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*
C298	A_1	0-5	0.01	0.11	0.01	0.06	3.64	99.74	4.9	0.08	3.47
C299	A_2	5-12	.01	.01	.01	.06	1.38	99.68	4.5	.02	.72
C300	B_1	16-28	.06	.06	.01	.05	1.87	99.57	4.4	.02	.23
C301	B_2	28-44	.03	.01	.01	.04	2.44	99.82	[illegible]	.02	.26

[1] Determinations by G. Edgington.

The colloid of the Dunbar soil (table 15) is rather uniform in composition, with the exception of the high organic content of the A_1 horizon. If the constituents are considered on an inorganic basis, the silica is highest in the A_1 horizon, whereas the iron oxide is concentrated in the B_2 horizon. In this respect the iron oxide is characteristic of a podzolic profile.

TABLE 15.—*Chemical analysis of the colloid of Dunbar fine sandy loam*

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C298	A_1	0-5	41.47	1.90	26.01	4.75	0.02	0.15	0.36
C299	A_2	5-14	43.48	1.60	33.20	6.69	.02	.07	.58
C300	B_1	14-28	43.70	1.22	32.62	8.21	.02	.07	.58
C301	B_2	28-48	40.81	1.35	29.91	12.92	.02	.09	.64

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C298	A_1	0-5	0.26	0.31	0.10	0.20	23.41	99.84	13.23
C299	A_2	5-14	.28	.22	.05	.08	14.61	100.88	2.30
C300	B_1	14-28	.33	.01	.05	.07	13.09	98.97	.88
C301	B_2	28-48	.36	.15	.07	.08	13.20	99.63	.99

In table 16 are given the derived data for the colloid of the Dunbar soil profile. The high silica-sesquioxide and silica-alumina ratios and their manner of variation indicate a more highly podzolized soil profile than has been found in the other soils of this group. Though laterization appears to be the dominant soil-forming process, incipient podzolization has affected the surface horizon. This has perhaps been caused by the presence of the accumulated organic matter in the A_1 horizon, which has somewhat increased the acid character of the soil profile. There is an even more marked removal of bases, as shown by the silica-total base ratios, than appears in the previous soils. The water ratios are very similar to those for the colloid of the Norfolk soil, although the total quantity of combined water of the soil acid is somewhat less.

TABLE 16.—*Derived data for the colloid of Dunbar fine sandy loam*

Sample no.	Horizon	Depth	Molecular ratio $\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	$\frac{H_2O+B}{SiO_2}$	$\frac{H_2O+B}{Al_2O_3}$	$\frac{H_2O+B}{R_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$	Combined water	Combined water of the soil acid
		Inches									*Percent*	*Percent*
C298	A_1	0–5	2.35	2.61	23.11	35.6	0.85	2.21	1.99	0.11	10.55	12.13
C299	A_2	5–14	1.97	2.23	17.22	35.0	.97	2.16	1.91	.13	12.0[illegible]	12.94
C300	B_1	14–28	1.96	2.27	14.00	39.1	1.06	2.38	2.03	.16	13.21	13.45
C301	B_2	28–48	1.81	2.24	8.37	36.6	1.02	2.31	1.86	.26	12.55	12.67

COXVILLE FINE SANDY LOAM

The data in table 17 clearly show that the Coxville fine sandy loam is much heavier in texture throughout the profile than the others of this group. It is composed largely of clay, silt, and fine sand. The combined gravels, coarse sands, and medium sands make up less than 1 percent of the material in any one horizon. The profile is very uniform in composition, with the exception of the higher content of clay in the lower horizons. The mechanical composition of this Coxville soil profile tends to confirm the opinion of many that the Coxville soil series has been formed from deposited material of shallow quiet waters, such as sea marsh, bay, sound, or lagoon. This profile, like that of the Dunbar, does not show sharp horizontal differentiation, and consequently transitional bands between both A and B and B and C horizons were not sampled. It is doubtful whether the 44- to 66-inch stratum represents a true C horizon. It would also seem doubtful whether the clay and colloid removed from the A horizon has accumulated in the lower strata.

TABLE 17.—*Mechanical analysis of Coxville fine sandy loam* [1]

Sample no.	Horizon	Depth	Fine gravel (2–1 mm)	Coarse sand (1–0.5 mm)	Medium sand (0.5–0.25 mm)	Fine sand (0.25–0.1 mm)	Very fine sand (0.1–0.05 mm)	Silt (0.05–0.005 mm)	Clay (0.005–0 mm)	Colloid (0.002–0 mm)	Organic matter by H_2O_2
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C302	A	0–9	0.1	0.3	0.1	9.9	17.4	45.9	21.1	13.5	4.7
C303	B	26–34	.1	.3	.3	6.7	12.3	38.9	40.8	31.6	.5
C304	C	44–66	.2	.2	.4	9.8	14.4	30.1	41.9	39.6	.0

[1] Determinations by T. M. Shaw and E. F. Miles.

The chemical data of table 18 show the Coxville soil profile to be like the other soil profiles of this group, in that the content of its major constituents reveals a marked degree of eluviation from the A horizon. It is also impoverished with respect to the minor constituents. The soil of this profile has a higher acidity (pH 4.3) than the other soils of this group presented here, and unlike the acidity of the other soil profiles its value is but little modified by the accumulated organic matter in the A horizon.

TABLE 18.—*Chemical analysis of Coxville fine sandy loam* [1]

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C302	A	0-9	85.92	1.31	4.79	1.07	0.02	0.09	0.09
C303	B	26-34	79.78	1.19	10.30	3.75	.03	.05	.11
C304	C	44-66	76.55	1.10	13.16	3.52	.02	.14	.09

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	pH	N	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*
C302	A	0-9	0.15	0.03	0.01	0.40	6.18	100.06	4.3	0.11	4.30
C303	B	26-34	.33	.01	.03	.01	4.02	99.61	4.4	.03	.52
C304	C	44-66	.33	.01	.02	.03	4.90	99.87	4.2	.03	.42

[1] Determinations by G. Edgington.

Table 19 shows the chemical composition of the colloidal material in the three horizons of the Coxville soil profile. The most obvious difference in composition between the three horizons is the extent to which the iron has been transferred from the A to the B horizon. This no doubt is the result of the soluble effect of the organic matter and also the acid character of the clay. This condition is more in evidence in this profile than in the Dunbar. The fluctuating water table, which, judging from the mottled colorings of this soil profile, is very pronounced, may have carried the dissolved iron out of the reducing zone to a lower level, where it may have been thrown out of solution by the air that penetrates the soil as the water table is lowered. This is more or less borne out by the description previously given of the soil profile, where it is stated that there is no red or yellow mottled clay material to be found beneath the mean water table. This would indicate that the deposition of the iron compound takes place in the zone of the soil profile that lies above the water table and below the organic reducing zone of the surface horizon. There is but slight alteration in the content of the other constituents in the different horizons, except the higher sulphur percentage of the A horizon, which is associated with the organic matter.

TABLE 19.—*Chemical analysis of the colloid of Coxville sandy loam*

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C302	A	0-9	42.23	1.05	29.88	4.62	0.02	0.15	0.57
C303	B	26-34	42.43	1.24	28.25	13.73	.02	.18	.49
C304	C	44-66	41.26	.80	32.42	9.20	.03	.42	.24

TABLE 19.—*Chemical analysis of the colloid of Coxville sandy loam*—Continued

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C302	A	0-9	0.06	0.15	0.03	0.15	20.14	99.65	9.10
C303	B	26-34	.09	.12	.18	.07	12.74	100.10	1.50
C304	C	44-66	.40	.19	.02	.06	12.57	100.61	.88

The derived data given in table 20 for the colloid of the Coxville soil show small variations in the ratios within the profile. The only marked deviations from uniformity are in the silica-iron oxide and the iron oxide-alumina ratios. The probable explanation of these variations is given in the previous paragraph. The silica-sesquioxide and silica-alumina ratios are markedly higher than those for the Orangeburg, Ruston, and Norfolk soils but are not decidedly different from those of the Dunbar. These higher values are well above the silica-alumina ratios for halloysitic acid (*4*). This indicates less removal of silica from the colloid and may be taken to indicate less complete decomposition of the parent minerals.

TABLE 20.—*Derived data for the colloid of Coxville fine sandy loam*

Sample no.	Horizon	Depth	Molecular ratio								Combined H_2O	Combined H_2O of the soil acids
			$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	$\frac{H_2O+B}{SiO_2}$	$\frac{H_2O+B}{Al_2O_3}$	$\frac{H_2O+B}{R_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$		
		Inches									*Percent*	*Percent*
C302	A	0-9	2.19	2.40	24.2	27.0	0.91	2.18	1.99	0.10	11.51	12.66
C303	B	26-34	1.95	2.55	8.2	29.9	.91	2.34	1.80	.31	11.66	11.81
C304	C	44-66	1.96	2.31	12.7	35.6	.95	2.20	1.83	.18	12.57	12.68

BLADEN LOAM

The data in table 21 show the mechanical composition of the Bladen loam soil profile. It is to be noted that it has suffered little from eluviation, as evidenced by the high clay and colloid content of the A horizon. It has a very low gravel and sand content. There is but little evidence of transfer of clay materials from the A horizon to the B. It is sufficiently high in clay content to be almost impervious to water.

TABLE 21.—*Mechanical analysis of Bladen loam*[1]

Sample no.	Horizon	Depth	Fine gravel (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-1 mm)	Very fine sand (0.1-0.05 mm)	Silt (0.05-0.005 mm)	Clay (0.005-0 mm)	Colloid (0.002-0 mm)	Organic matter by H_2O_2
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C305	A	0-8	0.7	2.9	4.0	25.2	19.4	20.0	25.5	11.4	2.2
C306	B	10-38	.8	2.3	3.2	22.9	16.1	23.7	30.8	23.9	.2
C307	C	38-51	1.0	2.5	3.2	21.8	14.6	22.6	33.8	28.6	.4

[1] Determinations by T. M. Shaw and E. F. Miles.

The chemical data for the composition of the Bladen soil profile, given in table 22, show this profile to be more uniform in composition than previously presented soil profiles of this group. In this respect it is similar to that of the Dunbar profile. Silica, alumina, iron oxide, and titanium oxide taken together make approximately 99 percent of the inorganic soil. It is a remarkable profile among the soils of this group; it has a low iron oxide content and is even more acid than the Coxville. The removal of the iron oxide and the high acidity are to be attributed to the exceedingly high water table.

TABLE 22.—*Chemical analysis of Bladen loam* [1]

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C305	A	0-8	89.96	1.01	3.80	0.72	0.01	0.07	0.02
C306	B	10-38	85.06	1.17	7.63	2.18	.02	.07	.04
C307	C	38-54	82.66	1.15	9.43	2.08	.02	.07	.09

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	pH	N	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*
C305	A	0-8	0.03	0.01	0.00	0.06	3.90	99.65	4.4	0.09	2.74
C306	B	10-38	.02	.01	.05	.05	3.28	99.58	4.3	.05	.64
C307	C	38-54	.04	.02	.03	.02	4.07	99.65	4.3	.05	.81

[1] Determinations by G. Edgington.

The data in table 23 show that the colloids of the Bladen profile are very uniform in alumina content. The content of silica decreases with depth, while the iron oxide content increases. Since the soil and colloid are nearly white, independent of organic matter present, the iron oxide is not present as such. It is presumably combined as a silicate. The content of titanium is high. It is probably contaminated with ilmenite ($FeTiO_3$). A considerable quantity of finely divided ilmenite was identified in the silt.

TABLE 23.—*Chemical analysis of the colloid of Bladen loam*

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C305	A	0-8	45.76	1.19	31.33	8.29	0.02	0.57	0.30
C306	B	16-30	44.54	3.06	31.83	6.41	.01	.14	.33
C307	C	30-54	42.89	.83	31.60	8.73	.01	.25	.31

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C305	A	0-8	0.20	0.17	0.30	0.15	16.65	100.23	6.41
C306	B	16-30	.09	.06	.07	.06	12.77	99.40	2.03
C307	C	30-54	.16	.13	.05	.19	14.39	99.57	2.44

The derived data for the colloid of the Bladen soil profile (table 24) show that this material differs but little in composition from that of the Dunbar and Coxville profiles. In general, it is slightly higher in silica, as indicated by the silica-sesquioxide ratios. The ratios for silica-iron oxide and iron oxide-alumina show an increase of iron oxide with depth. In this respect the colloid of the Bladen soil profile is more comparable to that of the Dunbar. The iron oxide-alumina ratios show that in comparison with the alumina the iron oxide content is lower in the colloids of the Bladen profile than in the colloids of profiles previously examined.

TABLE 24.—*Derived data for the colloid of Bladen loam*

Sample no.	Horizon	Depth	Molecular ratio								Combined H_2O	Combined H_2O of the soil acids
			$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	$\frac{H_2O+B}{SiO_2}$	$\frac{H_2O+B}{Al_2O_3}$	$\frac{H_2O+B}{R_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$		
		Inches									*Percent*	*Percent*
C305	A	0-8	2.33	2.48	30.86	34.1	0.77	1.92	1.80	0.07	10.64	10.90
C306	B	10-36	2.11	2.38	18.32	58.8	.78	1.84	1.64	.13	10.37	10.64
C307	C	36-54	1.97	2.31	13.02	42.8	.95	2.19	1.87	.17	12.25	12.55

PORTSMOUTH FINE SANDY LOAM

The mechanical analysis given in table 25 shows the Portsmouth profile to be much lower in both colloid and silt than other members of this group of soils. The colloid is lowest in the surface horizon, which no doubt is the result of eluviation. The data for the lower horizons, however, indicate that this was lateral instead of vertical. The large quantities of sand in this soil profile give it a rather loose, porous structure, which would be conducive to a deep well-drained and aerated soil if it were not for the high water table. The effect of this high water table and of anaerobic conditions doubtless has had much to do in determining the character of the colloid.

TABLE 25.—*Mechanical analysis of Portsmouth fine sandy loam*

Sample no.	Horizon	Depth	Fine gravel (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-0.1 mm)	Very fine sand (0.1-0.05 mm)	Silt (0.05-0.005 mm)	Clay (0.005-0 mm)	Colloid (0.002-0 mm)	Organic matter by H_2O_2
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C308	A	0-15	0.8	5.1	7.2	33.6	21.3	19.2	6.7	3.0	6.0
C309	B	15-35	.9	4.2	5.9	30.4	21.6	21.6	15.2	11.1	.2
C310	C	50-60	1.0	6.2	8.8	34.0	19.4	14.2	15.3	11.9	.2

The data for the chemical analysis of this soil, given in table 26, together with the data of table 27, show the sands and silts reported in table 25 to consist almost wholly of quartz, as is largely true of all these related soils. The surface soil is slightly more acid (pH 4.1) than that of the Coxville or Bladen, which difference may be ascribed to the somewhat higher organic content. The lower horizons are about the same (pH 4.3 to 4.4) as the Dunbar, Coxville, and Bladen soils. These low pH values are the result of the practically complete removal of bases from the profile. This is also shown by the chemical composition, these values probably being the lower limit for normal soils. The high organic content of the surface soil is an indication of approach to peaty conditions, which would arise were the water table slightly higher or more constant. The anaerobic conditions developed during wet periods doubtless account for the almost complete absence of iron and manganese in this profile.

TABLE 26.—*Chemical analysis of Portsmouth fine sandy loam*

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C308	A	0-15	90.39	0.77	1.69	0.37	0.01	0.11	0.01
C309	B	15-35	91.52	.09	4.30	.95	.02	.16	.01
C310	C	50-60	91.98	.79	4.26	.73	.01	.12	.02

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO	Ignition loss	Total	pH	N	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*
C308	A	0-15	0.01	0.01	0.04	0.06	6.82	100.27	4.4	0.12	7.00
C309	B	15-35	.07	.02	.01	.02	1.71	99.84	4.5	.02	.10
C310	C	50-60	.03	.01	.01	.01	1.85	99.82	4.4	.02	.34

TABLE 27.—*Chemical analysis of the colloid of Portsmouth fine sandy loam*

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C308	A	0-15	33.50	1.82	22.23	2.09	0.02	0.41	0.15
C309	B	16-35	45.27	3.63	33.78	2.30	.01	.12	.16
C310	C	40-70	46.54	2.57	32.00	3.71	.01	.19	.28

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C308	A	0-15	0.19	0.19	0.08	0.21	39.38	100.37	30.98
C309	B	16-35	.30	.18	.06	.13	14.06	100.00	2.37
C310	C	40-70	.16	.31	.09	.16	14.24	100.56	2.34

Table 27 gives the chemical composition of the colloid of the three horizons of the Portsmouth profile. These data show that the colloid in the three horizons is virtually uniform in inorganic composition. The composition of the colloid in the A horizon differs sharply from that in the B and C horizons by reason of its high organic content. The soluble and leaching effect of water is shown by its low content of exchangeable material, and the inorganic colloid may be regarded perhaps as being largely a single clay complex.

The derived data for the Portsmouth fine sandy loam colloid (table 28) show this material to be essentially the same in character as that of the coll ids from other soils of this group having relatively poor drainage and a high water table. The silica-sesquioxide and silica-alumina ratios are slightly higher for the Portsmouth profile than they are for the other soil profiles of the poorly drained soils. The manner of variation within the profile would indicate incipient podzolization. The iron oxide is so low in all the horizons that the variation in the ratios of silica to iron oxide or iron oxide to alumina has but little significance. The relatively high combined water of the soil acid has but little meaning in the A horizon, because when the organic matter is so high (table 27) the uncertainty introduced in calculating the organic matter from the carbon content results in uncertainty regarding the combined water relations.

TABLE 28.—*Derived data for the colloid of Portsmouth fine sandy loam*

Sample no.	Horizon	Depth	Molecular ratio								Combined H_2O	Combined H_2O of the soil acids
			$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	$\frac{H_2O+B}{SiO_2}$	$\frac{H_2O+B}{Al_2O_3}$	$\frac{H_2O+B}{R_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$		
		Inches									*Percent*	*Percent*
C308	A	0–15	2.41	2.56	42.4	37.0	0.83	2.21	2.08	0.06	8.67	14.56
C309	B	16–35	2.19	2.28	52.0	62.0	.88	2.00	1.92	.04	11.93	12.22
C310	C	40–70	2.30	2.47	33.3	40.6	.88	2.16	2.01	.07	12.24	12.52

PAMLICO MUCK

In table 29 are given the mechanical composition of two samples, C313 and C311, of the organic horizon and one sample, C312, of the inorganic material, or subsoil, of the Great Dover Swamp. The material of this swamp has recently been classified as Pamlico muck. The data show that both the organic and inorganic horizons of this swamp contain higher percentages of the coarser sand fractions than the better drained soils. The organic horizon is low in silt and clay. The separations were made after removal of organic matter. The organic matter was not analyzed. The content of colloidal material in the subsoil, 14.8 percent, does not indicate the accumulation of any great amount of inorganic colloid in the so-called B horizon.

TABLE 29.—*Mechanical analysis of Pamlico muck*[1]

Sample no.	Horizon	Depth	Fine gravel (2–1 mm)	Coarse sand (1–0.5 mm)	Medium sand (0.5–0.25 mm)	Fine sand (0.25–0.1 mm)	Very fine sand (0.1–0.05 mm)	Silt (0.05–0.005 mm)	Clay (0.005–0 mm)	Colloid (0.002–0 mm)	Organic matter by H_2O_2
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C313	A	0–24	4.8	10.5	16.7	29.3	3.9	11.4	7.4	5.4	12.3
C311	A	0–36	3.3	7.8	15.9	23.4	6.8	12.9	7.6	3.1	21.1
C312	B	40–60	4.1	11.5	17.3	30.1	4.1	14.2	17.6	14.8	.8

[1] Determinations by T. M. Shaw and E. F. Miles.

The chemical analyses of the three samples are given in table 30. The data show that this material is composed largely of quartz and organic matter. This accords with the indication of extensive removal of clay and colloid shown by the mechanical analyses. The low percentages of iron oxide, alumina, and manganese are the result of much leaching by a large quantity of water in contact with a high content of acid organic matter (pH 3.8). The quantities of soluble bases are also low, yet they are comparable in value to those of the other poorly drained soils. The data indicate that the phosphorus and sulphur are associated with the organic matter and are fairly well retained by it.

TABLE 30.—*Chemical analysis of Pamlico muck*

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C313	A	0-24	82.87	0.45	2.16	0.43	0.01	0.16	0.01
C311	A	0-36	74.02	.47	2.33	.39	.01	.03	.01
C312	B	40-60	90.61	.64	4.46	.75	.01	.16	.11

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	pH	N	Organic matter
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*
C313	A	0-24	0.01	0.10	0.06	0.07	13.65	99.08	3.8	0.31	13.55
C311	A	0-36	.03	.09	.07	.08	21.61	99.74	3.8	.36	23.43
C312	B	40-60	.10	.01	.03	.03	2.98	99.89	4.3	.04	1.47

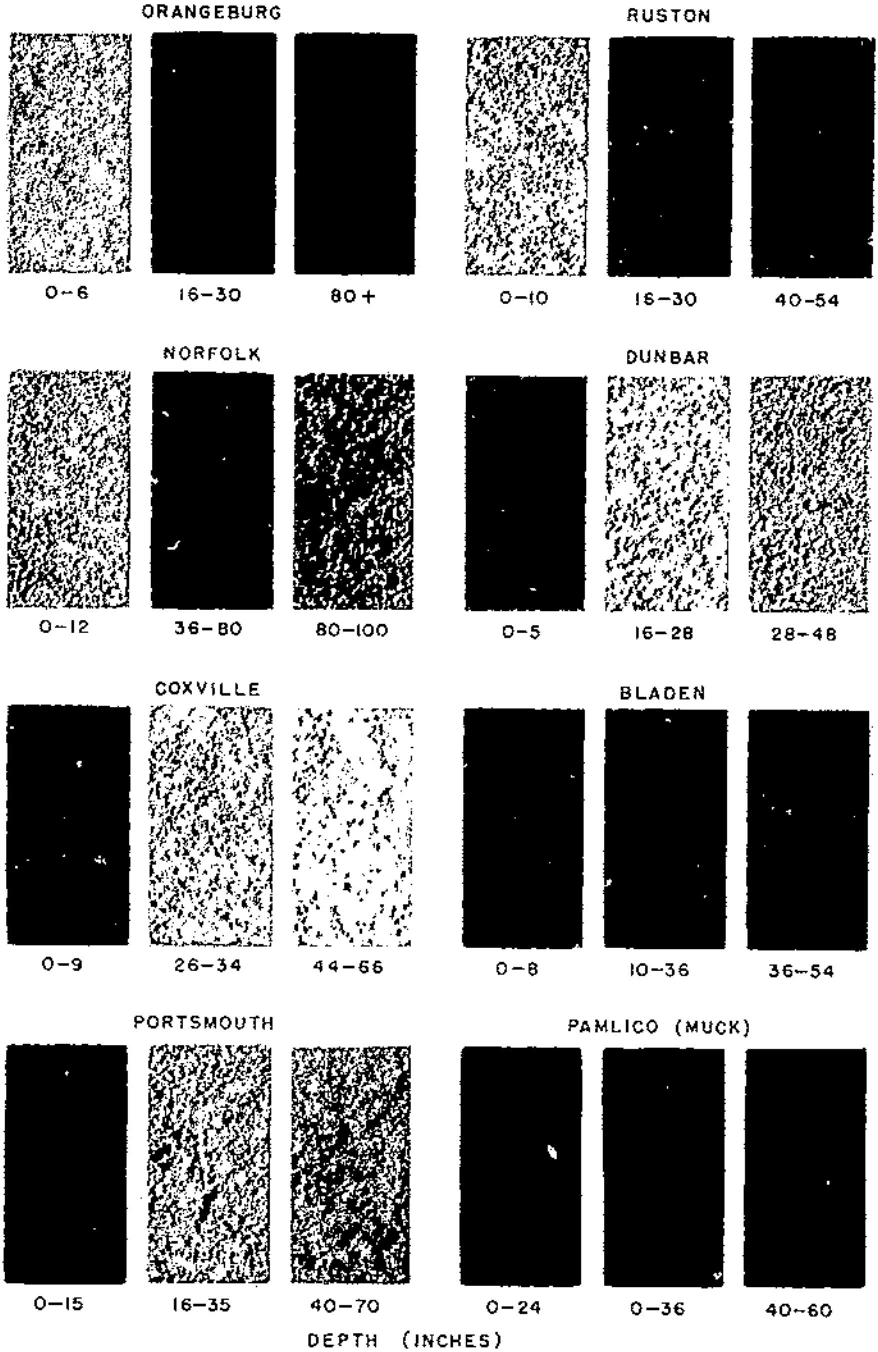
The chemical analysis of the colloidal material of Pamlico muck, given in table 31, shows the colloid of the upper layers to be composed largely of organic matter. Although 4.6 percent of organic matter is found in the colloid of the underlying layer, this does not represent the true organic content of this colloid. In sampling, the sample of subsoil became unavoidably contaminated with the overlying material. There is a very definite separation between the muck and its subsoil. When estimated upon inorganic free bases, the percentages of the constituents of the inorganic colloid show the colloids of Pamlico muck to be practically the same in composition as that of the other poorly drained soils of the Norfolk family.

TABLE 31.—*Chemical analysis of the colloid of Pamlico muck*

Sample no.	Horizon	Depth	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C313	A	0-24	23.10	0.65	17.13	2.55	0.004	0.16	0.29
C311	A	0-36	21.13	.60	15.51	1.05	.004	.17	.19
C312	B	40-60	45.80	.51	30.58	5.38	.012	.56	.49

Sample no.	Horizon	Depth	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	Organic matter
		Depth	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C313	A	0-24	0.18	0.13	0.27	0.26	55.28	100.01	50.60
C311	A	0-30	.18	.12	.27	.09	60.29	99.61	56.14
C312	B	40-60	.24	.28	.21	.12	15.45	99.05	4.60

The derived data for Pamlico muck (table 32) show the inorganic portion of this material to be very similar in composition to that of the Portsmouth. It has a rather high and definite silica-alumina ratio. The silica-iron oxide ratios show the absence of iron characteristic of waterlogged soils. The data show the colloid of this profile to be somewhat lower in combined water and combined water of soil acid. As already mentioned, however, these values may be in considerable error, due to the lack of an adequate method for the accurate estimation of high organic matter. The data of tables 31 and 32 show that the two A horizons have about the same chemical composition. No. C311 was obtained from a point somewhat farther from the edge of the swamp and appears to have been less affected by "wash."



NORFOLK SOIL FAMILY (NATURAL COLOR).

TABLE 32.—*Derived data for the colloid of Pamlico muck*

Sample no.	Horizon	Depth	Molecular ratio								Combined H_2O	Combined H_2O of the soil acids
			$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{\text{Total bases}}$	$\frac{H_2O+B}{SiO_2}$	$\frac{H_2O+B}{Al_2O_3}$	$\frac{H_2O+B}{R_2O_3}$	$\frac{Fe_2O_3}{Al_2O_3}$		
		Inches									*Percent*	*Percent*
C313	A	0-24	2.09	2.30	24.0	27.3	1.61	2.43	1.50	0.10	4.93	9.96
C311	A	0-30	2.26	2.38	53.3	30.0	2.39	1.59	2.20	.04	0.35	14.60
C312	B	40-60+	2.29	2.54	22.6	28.0	2.10	3.50	1.88	.10	11.34	11.88

GENERAL DISCUSSION

It cannot be positively asserted that the parent material is exactly the same in all these soils, since any alluvial or colluvial deposits may be expected to vary somewhat and variations of the Coastal Plain deposits may in part account for the location of the present drainage lines. It is perhaps true that the poorly drained areas roughly indicate the location of denser deposits of Coastal Plain materials. It is fairly certain, however, that the parent material was fairly well weathered before the soil-forming processes of the present cycle began to affect the character and distribution of the soil components. These soils have obviously reached their present condition under the influence of like temperature and rainfall. This by no means is to be interpreted as saying that no differences in these respects have existed. It may safely be assumed that as the soils differentiated the effectiveness of the rainfall varied, and temperature variations also ensued. At present fairly wide differences in types of vegetative cover exist, ranging from the characteristic swamp vegetation of the Pamlico muck through pines to the hardwoods of the well-drained soil. These different types of vegetation must be assumed to have played a part in the soil development.

The most outstanding environmental condition that shows variation, however, is drainage. It may properly be assumed, therefore, that differences in drainage, supplemented by other differences developed as a result, are the primary cause of the differences in these soil series. This appears to be especially applicable to the colloids. To better envisage these relationships the individual properties are brought together in tables 33 to 38 and considered separately.

COLOR

This group of soils shows a very striking variation in color both within individual profiles and between the different series. These differences are apparent in the color chart presented in plate 1. The striking differences can be fully appreciated only by observing the soils while wet and in place. The A horizons of the different soils range from very light gray to almost black. These differences are ascribed chiefly to the variations in the organic-matter content and the low iron oxide content.

In the B horizons the color gradually changes from deep red in the well-drained Orangeburg to light gray in the Portsmouth. While the red and yellow are undoubtedly due to ferric hydroxide, more or less hydrated, the color intensity is by no means proportional to the quantity of iron present. This is more clearly evident by comparison of the colors of the extracted colloids than of the soils themselves. Thus the deep-red colloid of the Orangeburg contains 12.85 percent of ferric oxide, and the fairly yellow colloid of the Coxville has 13.73 percent. The gray colloids of the Bladen and Portsmouth contain 6.44 percent and 2.3 percent, respectively. These quantities are quite sufficient to produce distinct coloration, if present as free ferric oxide. While it is not safe, perhaps, to assume that the lighter colors are wholly due to iron existing as a part of the silico-iron complex, it seems apparent that such a complex exists in these soils. It is evident from plate 1 and table 34 that the intensity of the red and yellow colors of the soils vary inversely with the ratio of silica to sesquioxide. In the better drained soils free ferric oxide undoubtedly exists, but it is not apparent whether shades of yellow are due to hydrations or particle size. The data shed no light on the question.

In the C horizons the colors of the soils are only slightly more uniform than in the B horizons. The considerable variation is doubtless due to the translocation of colloidal material characteristic of each soil.

MECHANICAL ANALYSES

An obvious characteristic of this group of soils, with the exception of the Coxville, is the sandy character of the surface horizon. The general impression that the entire soil profile is similarly sandy is not warranted. On the contrary, these soils contain more clay than the many soils in which clay is formed from the weathering of geological material in place.

A general conception of the size of particle distribution of these soils may be had from the condensed data on the mechanical analyses (table 33). The extent of eluviation that has taken place in the profiles may be seen from a comparison of the clay content of the A horizons with that of the lower horizons. It varies with the maturity of the soil profile. The soil series that have not developed a well-defined soil profile, namely, the Portsmouth, Bladen, and Coxville, have suffered eluviation but not to the same extent as the well-developed soil profiles of the Orangeburg, Ruston, and Norfolk soil series.

The data for silt content show no evidence of its removal from one horizon to another. They do show, with a few exceptions, a higher percentage content of silt in the A horizons than in the lower part of the soil profile. This is the result of the removal of the clay from the A horizon.

TABLE 33.—*Condensed data on mechanical analysis of the Norfolk and related soil series*

FINE GRAVEL AND SAND (2- TO 0.05-MM DIAMETER)

Horizon	Orangeburg	Ruston		Norfolk	Dunbar [1]	Coxville	Bladen	Portsmouth
		North Carolina	Georgia					
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
A	74.0	59.8	79.0	61.9	57.6	28.1	52.2	69.0
B	35.8	43.4	49.7	48.2	47.0	19.7	45.3	63.0
C	64.0	51.7	59.0	47.3	43.8	25.0	42.1	70.3

[1] The values for the B_2 horizon are used in lieu of a definite C horizon, and the A_2 horizon is considered as a transitional zone.

TABLE 33.—*Condensed data on mechanical analysis of the Norfolk and related soil series*—Continued

SILT (0.05- TO 0.005-MM DIAMETER)

Horizon	Orangeburg	Ruston		Norfolk	Dunbar	Coxville	Bladen	Portsmouth
		North Carolina	Georgia					
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
A	20.0	31.5	10.7	28.4	31.1	45.9	20.0	19.2
B	17.0	26.3	11.4	22.7	30.9	38.9	23.7	21.6
C	8.3	17.2	8.0	21.3	29.7	30.1	22.6	14.2

CLAY (0.005- TO 0.0-MM DIAMETER)

Horizon	Orangeburg	Ruston North Carolina	Ruston Georgia	Norfolk	Dunbar	Coxville	Bladen	Portsmouth
A	5.0	7.0	9.2	8.9	8.0	21.1	25.5	6.7
B	47.0	30.1	38.6	28.8	21.8	40.8	30.8	15.2
C	27.7	30.8	32.2	31.3	26.2	44.9	33.8	15.3

SILICA-SESQUIOXIDE RATIOS

Table 34 gives the molecular ratios of silica to sesquioxides for the colloids of the Norfolk and related soil series. The soils series are arranged from left to right according to lack of development of their drainage systems. It may be noted that, in general, the silica-sesquioxide ratios increase in the same order. The extreme variations are not sufficient to make these values useful as a means of distinguishing soil series, but they are strikingly indicative of changes in soil character by environment.

TABLE 34.—*Silica-sesquioxide ratios for colloids of the Norfolk and related soil series*

Horizon	Orangeburg	Ruston		Norfolk	Dunbar [1]	Coxville	Bladen	Portsmouth
		North Carolina	Georgia					
A	1.20	1.54	1.60	1.55	2.34	2.19	2.32	2.42
B	1.19	1.39	1.53	1.51	1.96	1.95	2.11	2.18
C	1.77	1.61	1.57	1.57	1.81	1.96	1.97	2.30

[1] See table 33.

It is perhaps reasonable to assume that the greater part of the clay content now present in these soils existed in the soil parent material at the time it was laid down. This assumption is supported by the fact that the residual material other than clay is essentially quartz. It is also reasonable to assume that the clay in this parent material, as it came from somewhat the same source, was rather uniform in chemical composition at the time of its deposition. If the two above assumptions be true, then differences in the composition of the colloids of these soil series are the result of the differences in the present active soil-forming processes.

The silica-sesquioxide ratios for the colloid in the A horizons of this group of soils, with a few exceptions, show a gradual increase in value, ranging from 1.2 in the well-drained soils to 2.4 in the poorly drained soils. The B and C horizons show similar relationships. The low silica-sesquioxide ratios for the well-drained soils indicate a material alteration in the assumed composition of the original colloid complex. This effect is less marked in the poorly drained soils. The low silica-sesquioxide ratios in the first two horizons of the Orangeburg profile are indicative of a highly laterized soil in which more silicates than sesquioxides have been broken down and removed by solution. The silica-sesquioxide ratio of 1.77 for the colloid of the C horizon at a depth of 100 inches shows that the colloids of the deeper Orangeburg soil have not been altered to such an extent as those in the upper horizons. The silica-sesquioxide ratios for the colloids of other soil profiles are slightly lower in the B horizon than they are in the A horizon. This type of variation is indicative of incipient podzolization and is slightly more pronounced in the poorly drained soils. The silica-sesquioxide ratios of the Dunbar, Coxville, Bladen, and Portsmouth colloids indicate that they have not been affected by the same soil-forming processes as were operative in the well-drained soils. They were, however, greatly altered by the almost complete removal of iron oxide and of a large part of the monovalent and divalent bases. This chemical alteration is the type expected in frequently submerged soils (*14*).

SILICA-ALUMINA RATIOS

The silica-alumina ratios are given in table 35. In general these ratios show the same type of variation from the well-drained soils to the poorly drained as shown by the silica-sesquioxide ratios in table 34. The ratios of silica to alumina for the colloids of the Orangeburg, Ruston, and Norfolk are perhaps more indicative of the silicate complex than the silica-sesquioxide ratios, since the iron oxide is probably present as such. Baver (*2*) reports the removal of the sesquioxides from the colloids of a Norfolk soil, thereby changing the silica-sesquioxide ratio from 1.63 to 2.19 and causing a corresponding change in total base-exchange capacity from 20.7 to 42.5 milliequivalents per 100 g of colloid. Undoubtedly the free, more or less hydrated, iron oxide is responsible for the color of these soils. The ratio of silica to sesquioxides is more nearly indicative of the composition of the colloids of the lighter colored soils and those of high organic content than is the ratio of silica to alumina. It seems probable that in these soils the iron forms an integral portion of the silicate complex.

TABLE 35.—*Silica-alumina ratios for colloids of the Norfolk and related soil series*

Horizon	Orangeburg	Ruston		Norfolk	Dunbar[1]	Coxville	Bladen	Portsmouth	Pamlico muck
		North Carolina	Georgia						
A	1.46	1.86	2.01	1.90	2.61	2.40	2.46	2.53	2.29
B	1.40	1.61	1.90	1.85	2.27	2.55	2.38	2.28	2.38
C	2.03	2.00	1.93	1.94	2.24	2.32	2.31	2.47	2.54

[1] See table 33.

IRON OXIDE-ALUMINA RATIOS

As may be seen from table 36 the ratios of iron oxide to alumina are approximately the same in the colloids for the first four soil series. There is but slight evidence of the removal of more iron oxide than alumina from any one horizon to another. In the remaining soil series, Dunbar, Coxville, Bladen, and Portsmouth, the average ratio of iron oxide to alumina is less than it is in the better drained soils. This is to be expected, however, for in these soils, which have higher water tables and poorer drainage, the anaerobic conditions (*14*) and the organic matter present have reduced the iron, resulting in its removal by solution.

TABLE 36.—*Iron oxide-alumina ratios for colloids of the Norfolk and related soil series*

Horizon	Orangeburg	Ruston		Norfolk	Dunbar[1]	Coxville	Bladen	Portsmouth
		North Carolina	Georgia					
A	0.21	0.22	0.26	0.21	0.11	0.10	0.07	0.06
B	.23	.18	.25	.23	.16	.31	.13	.04
C	.17	.24	.23	.22	.26	.18	.47	.07

[1] See table 33.

SILICA-TOTAL BASE RATIOS

In table 37 are assembled the formula-weight ratios of silica to total bases; that is, the ratio of SiO_2 to the sum of CaO, MgO, K_2O, and Na_2O present in the colloids. That these ratios are very large, that is, the base content is very low, is evident. If the base-free complex in the colloids is assumed to be essentially halloysitic acid ($3H_2O.Al_2O_3.2SiO_2$) (*4*), it follows that, since the average ratio of silica to bases as shown in table 37 is 30:1, the assumed acid is but one forty-fifth saturated. This contrasts sharply with the corresponding relation shown by Brown, Rice, and Byers (*3, p. 39*) for certain dry-land soils in which, on a similar assumption of the existence of the colloid as pyrophylic acid ($3H_2O.Al_2O_3.4SiO_2$), the acid is almost one-sixth saturated. These relations are in harmony with the pH values of the soils. It may be assumed, therefore, that in the more completely debased soils, for example, the Portsmouth and Bladen, there is very nearly the minimum pH value that can be reached by a soil of corresponding composition. Hester and Shelton (*8*) have shown that by debasing they were able to lower the pH values of virgin Portsmouth, Bladen, and Norfolk soils only to the extent of 0.6, 0.8, and 0.3, respectively. A portion of this alteration must be ascribed to organic matter. In general, judging from the silica-base ratios, such soils should not be expected to be highly productive without the addition of fertilizers.

TABLE 37.—*Silica-total base ratios for colloids of the Norfolk and related soil series*

Horizon	Orangeburg	Ruston		Norfolk	Dunbar[1]	Coxville	Bladen	Portsmouth	Pamlico muck[2]
		North Carolina	Georgia						
A	15	12	22	21	30	26	34	36	27
B	23	18	22	20	30	30	59	61	30
C	36	25	22	30	30	36	43	41	28

[1] See table 33.
[2] The Pamlico muck samples do not represent horizons.

CONSTITUTION OF THE COLLOIDS

In table 38 comparisons of the major constituents of the colloids are made in two different forms. In one column the molecular quantities of the water and silica are compared with that of alumina taken as unity. In a second column a similar comparison is made, the sum of the alumina and iron oxide being taken as unity. These relations are given for each horizon.

TABLE 38.—*Molecular composition of the acid complex of the colloids of the Norfolk and related soil series and the acidity of the soils*

Soil	Horizon A		Horizon B		Horizon C		pH
	Calculated with Al_2O_3 equal to 1.0	Calculated with sesquioxides (R_2O_3) equal to 1.0	Calculated with Al_2O_3 equal to 1.0	Calculated with sesquioxides (R_2O_3) equal to 1.0	Calculated with Al_2O_3 equal to 1.0	Calculated with sesquioxides (R_2O_3) equal to 1.0	
Orangeburg	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	5.1
	1.5 SiO_2	1.2 SiO_2	1.5 SiO_2	1.2 SiO_2	2.0 SiO_2	1.8 SiO_2	4.8—4.8
	2.6 H_2O	2.1 H_2O	2.5 H_2O	2.0 H_2O	2.1 H_2O	1.6 H_2O	4.6
Ruston (North Carolina)	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	6.0
	1.9 SiO_2	1.5 SiO_2	1.9 SiO_2	1.4 SiO_2	2.0 SiO_2	1.6 SiO_2	5.0—5.0
	2.4 H_2O	2.0 H_2O	2.3 H_2O	1.0 H_2O	2.3 H_2O	1.8 H_2O	4.8
Ruston (Georgia)	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	4.8
	2.0 SiO_2	1.6 SiO_2	1.9 SiO_2	1.5 SiO_2	1.9 SiO_2	1.6 SiO_2	4.9—4.9
	2.3 H_2O	1.8 H_2O	2.2 H_2O	1.8 H_2O	2.1 H_2O	1.7 H_2O	4.8
Norfolk	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	5.1
	1.9 SiO_2	1.6 SiO_2	1.9 SiO_2	1.5 SiO_2	1.9 SiO_2	1.6 SiO_2	4.6—4.6
	2.4 H_2O	2.0 H_2O	2.2 H_2O	1.8 H_2O	2.3 H_2O	1.9 H_2O	4.6
Dunbar[1]	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	4.9
	2.6 SiO_2	2.3 SiO_2	2.3 SiO_2	2.0 SiO_2	2.3 SiO_2	1.8 SiO_2	4.5—4.5
	2.2 H_2O	2.0 H_2O	2.4 H_2O	1.9 H_2O	2.3 H_2O	1.9 H_2O	4.4
Coxville	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	4.3
	2.4 SiO_2	2.2 SiO_2	2.5 SiO_2	2.0 SiO_2	2.0 SiO_2	2.0 SiO_2	4.4—4.4
	2.2 H_2O	2.0 H_2O	2.3 H_2O	1.8 H_2O	2.2 H_2O	1.8 H_2O	4.2
Bladen	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	4.4
	2.5 SiO_2	2.3 SiO_2	2.4 SiO_2	2.0 SiO_2	2.3 SiO_2	2.0 SiO_2	4.3—4.3
	2.0 H_2O	1.8 H_2O	1.0 H_2O	1.7 H_2O	2.2 H_2O	1.9 H_2O	4.3
Portsmouth	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	4.1
	2.5 SiO_2	2.4 SiO_2	2.3 SiO_2	2.2 SiO_2	2.5 SiO_2	2.3 SiO_2	4.3—4.3
	2.2 H_2O	2.1 H_2O	2.0 H_2O	1.9 H_2O	2.2 H_2O	2.0 H_2O	4.4
Pamlico muck[2]	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	1.0 Al_2O_3	1.0 R_2O_3	3.8
	2.3 SiO_2	2.0 SiO_2	2.4 SiO_2	2.3 SiO_2	2.6 SiO_2	2.3 SiO_2	3.8—4.3
	1.6 H_2O	1.5 H_2O	2.4 H_2O	2.3 H_2O	2.1 H_2O	1.9 H_2O	4.3

[1] See table 33.
[2] The Pamlico muck samples do not represent horizons.

It may be seen from a careful examination of the data that the colloids of these eight soil series fall into two distinct groups. The ratios of silica to alumina for the colloids in the first group, the Orangeburg, Ruston, and Norfolk, range from 1.5 to 2.0; the ratios of silica to sesquioxides range from 1.2 to 1.8. In the second group of soils, the Dunbar, Coxville, Bladen, Portsmouth, and the Pamlico muck, these ratios range from 2.3 to 2.6 and from 1.8 to 2.4, respectively. It may be observed that all the silica-sesquioxide ratios in the second group are 2 or above, except that for the colloid of the C horizon of the Dunbar profile, which was 1.8. This low ratio is to have been expected, as splotches and streaks of bright-red material were noted in this horizon and no true C horizon was obtained. (See description of Dunbar soil profile, p. 5.)

It is assumed that the silica-alumina ratios for the colloids of the well-drained soils of this group are more nearly indicative of the composition of the silicate complex than the silica-sesquioxide ratios. As a result of the excellent drainage and aerobic conditions in the Orangeburg, Ruston, and Norfolk soil profiles, free iron oxide and hydroxide have formed and accumulated in a colloidal state.

In the second group of soils, the drainage ranges from fair to very poor. In some of the soil series the water table is nearly at the surface throughout the year; in others it is more variable. These conditions result in anaerobic conditions and the usual consequences suffered by submerged soils (*14*). No indication of the existence of free iron oxide or hydroxide is in evidence, except to a slight extent in the Coxville and Dunbar profiles. The iron present, therefore, may be assumed to be wholly or largely a part of the complex silicate. Neither of the above assumptions is necessarily wholly true. Because a soil is red it does not follow that all the iron present is free iron oxide nor, if the soil is apparently free from red or yellow when organic matter is removed, that all the iron is in the silicate complex. These are to be regarded as limiting conditions. To what extent much free iron oxide is indicative of free alumina is problematical.

In Technical Bulletin 484 (*4*) the hypothesis is expressed that—

the fundamental inorganic complexes are definite amphoteric alumino-silica acids with the properties to be expected of such compounds. The colloids themselves are assumed to be salts of these acids with more or less replacement of acid hydrogen by metals and of hydroxyl groups by acid ions. The iron content of the soils is assumed to play the same role as alumina except that its compounds more readily reach complete hydrolytic decomposition.

In connection with this hypothesis it may be noted that in the more highly colored colloids of these soils, those of the A and B horizons of the Orangeburg, Ruston, and Norfolk, the silica-sesquioxide ratios are not above 1.6. The silica-alumina ratios, however, range from 1.9 to 2.0 in all the samples from the Norfolk, Ruston, and Orangeburg, except the A and B horizons of the Orangeburg. On the other hand the silica-sesquioxide ratios of the remaining colloids range from 1.8 to 2.4, with an average value of 2.1. The silica-alumina ratios range from 2.3 to 2.6, with an average value of 2.4. It will be seen from these values that if the above-quoted hypothesis be accepted, these colloids are dominated by the presence of an acid of the general type of halloysitic acid (*4*) ($3H_2O.Al_2O_3.2SiO_2$), with free iron oxide present in the red soils. Whether the low ratios of the A and B horizons of the Orangeburg are due to the presence of free alumina or to another acid of lower ratio, possibly the hypothetical allophanic acid, cannot be asserted until better methods of separation of colloidal components are available.

With reference to the combined water of this hypothetical acid it may be noted from the data of table 38 that in no case does the quantity of water present equal that assumed to be characteristic of the hypothetical acid. The mean value for the water-alumina ratios of the whole group, with the exception of the Pamlico muck, is 2.2. The Pamlico muck is omitted not only because it does not present a developed soil profile (p. 7) but because the quantity of organic matter invalidates any conclusions concerning water relations. If instead of the water-alumina ratios the water-sesquioxide ratios are used for the poorly drained, light-colored soils the mean value becomes 2.1. It has already been shown that these colloids are almost wholly free from bases. It is to be expected, therefore, that weak acids of this type would tend automatically to dehydrate even in the presence of water. In any event the mean value of the major constituents of these inorganic colloids may be expressed as $2.3H_2O.Al_2O_3.1.99SiO_2$. As the coefficient for the silica was determined by taking the mean values of the silica-alumina ratios for the Orangeburg, the two Ruston, and the Norfolk profiles and the silica-sesquioxide ratios for the remaining soils, this value may appear synthetic but it was arrived at legitimately.

CONCLUSIONS

The detailed study of the associated soil series through field examination and the laboratory analysis reported herein warrant certain general conclusions. The soils are closely related, and differences which warrant their segregation into separate soil series are primarily those that result from differences in degree of drainage and its consequences. The differences in drainage depend essentially upon such factors as proximity to well-developed drainage systems, elevation, and slope of land, and small differences in the texture of the parent material. The soils most remote from the drainage systems are frequently the poorest drained.

Analytical data for the colloids of this group of soils show them to be all thoroughly leached, but the poorly drained soils are more depleted of bases, iron, and manganese than are the better drained ones. Even though drainage conditions are such as to greatly impede the movement of water, nevertheless ultimately much water does appear to move from these soils laterally rather than by evaporation.

The colloids of the lower horizons of the well-drained soils are red to yellow, showing the presence of some hydrated iron oxides. The dominant light color of the colloids of the poorly drained soils, exclusive of organic matter, indicates that the iron is present as a part of the silicate complex. From a study of the ratios of silica to alumina and silica to total bases, it is concluded that the colloids of all this group of soils is dominated by the presence of a highly debased aluminosilicate of the general type of halloysitic acid ($3H_2O.Al_2O_3.2SiO_2$).

SUMMARY

At the instance of the late C. F. Marbut of the Soil Survey Division, this study was initiated for the purpose of pointing out soil changes brought about by local environmental conditions operating upon essentially the same soil parent material.

Analytical data are presented for profiles of eight soil series of the Atlantic Coastal Plain. These include mechanical and chemical analyses of the soils, determination of their pH values, and chemical analyses of their colloids. Also, derived data from the analytical results are presented.

These soils, which have developed from the same parent material and under the same climatic conditions but with variable drainage, are all acid. The acidity ranges in pH from 5.1 in the best drained to 3.8 in the poorest drained soils. The extent of eluviation increases with drainage, but the degree of leaching and debasing increases with the lack of drainage. The monovalent and divalent bases, as well as manganese, are low in all the soils, but they are lowest in the poorly drained ones. The accumulation of organic matter under poor drainage conditions accompanies the depletion of bases.

The character of the colloids is indicated by the derived data. The degree of variation of the major constituents in the soil colloids is expressed by the silica-sesquioxide ratios, which range from 1.2 in the well-drained soils to 2.4 in the poorly drained ones. The presence of decomposing organic matter under poor drainage conditions tends to deplete the iron content of the colloids. The ratio of iron to alumina ranges from 0.26 in the best drained soils to as low as 0.04 in those with

poor drainage. The combined water as compared to alumina is essentially constant. It ranges from 2.6 in the better drained soils to 1.9 in the poorly drained ones.

It is concluded that the dominant differentiating role is played by differences in drainage and by the effects resulting from the drainage conditions. It is also concluded that the colloid of all the soils is dominated by the presence of a highly debased alumino-silicic acid of the halloysitic type ($3H_2OAl_2O_3.2SiO_2$). It is suggested that the marked absence of base ions is an important consideration in the utilization of these soils for agricultural purposes.

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