PROPERTIES OF BIN SOILS

at the

National Tillage Machinery Laboratory

USDA, ARS, Auburn, Alabama

by

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INTRODUCTION

This report supersedes a previous report prepared in 1968 by John A. Batchelor, Jr, entitled “Physical Properties of Bin Soils at Tillage Machinery Laboratory.” The present report includes information for all soils presently in the bins of the Laboratory. This report also provides the current soil series nomenclatures and the soil sub-group nomenclature.

The soils of the National Tillage Machinery Laboratory have been selected to provide a wide range of physical properties for research purposes. The soils are located in nine outdoor bins and two indoor bins. The physical arrangement of the soils is shown in the sketch of the bin layout. Soil depth varies: the Decatur clay loam, Norfolk sandy loam, and Congaree clay loam bins are 5 feet deep; Blanton loamy sand is 4 feet deep, and other bins are 18 to 20 inches deep. Each bin is uniform in mechanical composition throughout its depth, i.e., natural profiles are not reproduced. Each soil was selected and mixed at the original site before transporting to the bins. In most cases surface layers were removed along with roots and other plant materials before the bin soil was collected. The soils are stone free except for small amounts of gravel which have inadvertently gotten mixed into the soil from the subsoil drainage beds. The small amount of gravel has not changed the character of the soil. The Lakeland sand was replaced in 1966. The original sand was used in underwater studies and many fine particles were washed away so that the properties of the soil were markedly changed.

Some of the soils have special characteristics which are important in soil-machine relations. The Davidson clay does not scour well on metal surfaces, hence tillage tools tend to push or bulldoze the soil rather than cause sliding. This soil is used to evaluate the scouring properties of different surface materials. The Houston, Oktibbeha, Sharkey, Vaiden and Wilcox soils are sticky, plastic, and swell and shrink. They provide the most difficult handling problems. Depending on moisture and structure they are commonly called “gumbo” or “buckshot” soils.

The remaining soils are fairly easily handled in normal moisture ranges. They provide physical conditions normally found in agricultural soils.

Additional soils are used in the Laboratory in smaller amounts (1 to 3 cubic yards). These soils are specifically chosen for special projects and are changed from time to time depending on needs. Since these are used in special studies their descriptions are included in the specific reports covering the research results and their properties are not included in this report.

ENGINEERING CLASSIFICATION AND ORIGIN OF SOILS

Soil Number	Present Name[1]	U.S.C.S.[2]	Origin
1	Congaree clay loam	ML-CL	Alabama Power Company Dam, formerly Marvin Bird Farm, Phenix City, Alabama
2	Davidson clay	CL	Cass McCormick Farm, Ashland, Alabama
3	Decatur silt loam	CL-ML	TVAWR-2311, formerly Robert H. Walker Farm, Harris Station, Alabama
4	Decatur clay loam	CL-ML	Redstone Arsenal, Huntsville, Alabama
5	Hiwassee sandy loam	SP-SC	A.D. Jones Farm, Molena, Georgia
6	Houston clay	CH-OH	George L. Breeden Farm, Brown, Alabama
7	Wilcox clay	CH-OH	W.L. Bruce Farm, Catherine, Alabama
8	Blanton loamy sand[3]	SP-SM	Tuskegee National Forest, Tuskegee, Alabama
9	Hiwassee clay	CH	John Harris Farm, Auburn, Alabama
10	Norfolk sandy loam	SP-SM	Agricultural Engineering Farm, Auburn University, Marvyn, Alabama
11	Oktibbeha clay	CH	J. R. Barns Farm, LeGrand, Alabama
12	Sharkey silty clay	CH-MH	Delta Experiment Station, Stoneville, Mississippi
13	Vaiden silty clay	CL-ML	Alma Crawford Farm, Hamberg, Alabama

[1]USDA Classification System
[2]Unified Soil Classification System
[3]Bin filled in March, 1966. All test data reported prior to this date were on Lakeland sand

Soil Number	Present (1984) Soil Series Name	Present (1984) Soil Sub-Group Name	Present (1984) Soil Family Name
1	Congaree clay loam	Typic Udifluvents	Fine loamy, mixed, nonacid, thermic[1]
2	Davidson clay	Rhodic Paleudults	Clayey, kaolinitic, thermic (oxidic)
3	Decatur silt loam	Rhodic Paleudults	Clayey, kaolinitic, thermic
4	Decatur clay loam	Rhodic Paleudults	Clayey, kaolinitic, thermic
5	Hiwassee sandy loam	Typic Rhodudults	Clayey, kaolinitic, thermic (oxidic)
6	Houston clay	Typic Chromuderts	Very fine, montmorillonitic, thermic
7	Wilcox clay	Vertic Hapludalfs	Fine, montmorillonitic, thermic
8	Blanton loamy sand	Grossarenic Paleudults	Loamy, siliceous, thermic
9	Hiwassee clay	Typic Rhodudults	Clayey, kaolinitic, thermic
10	Norfolk sandy loam	Typic Paleudults	Fine loamy, siliceous, thermic
11	Oktibbeha clay	Vertic Hapludalfs	Very fine, montmorillonitic, thermic
12	Sharkey silty clay	Vertic Haplaquepts	Very fine, montmorillonitic, nonacid, thermic
13	Vaiden silty clay	Aquentic Chromuderts	Very fine, montmorillonitic, thermic
14	Lakeland sand - No longer in soil bins		

[1]Thermic indicates that the mean soil summer temperature is 59° to 72°F higher than the mean winter temperature.

Soil Number	Previous (1966) Soil Series Name	Previous (1972) Sub-Group Name
1	Congaree clay loam	Typic Udifluvents
2	Davidson clay	Rhodic Paleudults
3	Decatur silt loam	Rhodic Paleudults
4	Decatur clay loam II	Rhodic Paleudults
5	Hiwassee sandy loam	Typic Rhodudults
6	Houston clay	Typic Chromuderts
7	Hurricane clay	Vertic Albaqualfs
8	Lakeland loamy sand	Typic Quartzisamments
9	Lloyd clay	Typic Hapludults
10	Norfolk sandy loam	Typic Paleudults
11	Oktibbeha clay	Vertic Hapludalfs
12	Sharkey silty clay	Vertic Haplaquepts
13	Vaiden silty clay	Aquentic Chromuderts
14	Lakeland sand - No longer in soil bins	

Soil Number	1954 Soil Series Name
1	Congaree not in soil bins in 1954
2	Davidson clay
3	Decatur silty clay loam
4	Decatur clay not in soil bins
5	Hiwassee sandy loam
6	Houston clay
7	Hurricane clay
8	Blanton loamy sand not in soil bins in 1954
9	Lloyd clay
10	Norfolk sandy loam not in soil bins
11	Oktibbeha clay
12	Sharkey silty clay
13	Vaiden silty clay
14	Lakeland sand

Soil Number	Original (1935) Soil Names
1	Congaree not in soil bins in 1935
2	Davidson clay
3	Decatur clay
4	Decatur clay not in soil bins in 1935
5	Davidson loamy sand
6	Houston clay
7	Lufkin clay
8	Blanton loamy sand not in soil bins in 1935
9	Cecil clay
10	Norfolk sandy loam not in soil bins in 1935
11	Oktibbeha clay
12	Sharkey clay
13	Eutaw clay
14	Norfolk sand

OUTDOOR SOIL BINS

↑N

Bin 9	Bin 8	Bin 7	Bin 6	Bin 5	Bin 4	Bin 3	Bin 2	[1]Bin 1
SHARKEY SILTY CLAY Soil No 12	HIWASSEE CLAY Soil No 9	VAIDEN SILTY CLAY Soil No 13	DECATUR SILT LOAM Soil No 3	DAVIDSON CLAY Soil No 6	HIWASSEE SANDY LOAM Soil No 5	OKTIBBEHA CLAY Soil No 11	CONGAREE CLAY LOAM Soil No 1	BLANTON LOAMY SAND Soil No 8
WILCOX CLAY Soil No 7						HOUSTON CLAY Soil No 6		

INDOOR SOIL BINS

DECATUR CLAY LOAM Soil No 4	NORFOLK SANDY LOAM Soil No 10

[1]Bin # for quick reference to outdoor research efforts. Blue lettering indicates additions during the digitization process.

MECHANICAL ANALYSIS[1] AND SPECIFIC GRAVITY

			Particle Size Distribution										
			Total					Sand			Silt		
Soil Number	Soil Type	Gravel Content > 2mm % Total Soil	Sand 2-0.05	Silt 0.05-0.002	Clay <0.002	Very Coarse 2-1	Coarse 1-0.5	Med. 0.5-0.25	Fine 0.25-0.01	Very Fine 0.01-0.05	0.05-0.02	0.02-0.002	Specific Gravity (g/cc)
			Percent < 2mm										
1	Congaree clay loam	0.0	20.2	50.9	28.9	0.0	0.5	0.5	7.9	11.3	13.9	37.0	2.67
2	Davidson clay	5.9	24.9	30.9	44.2	1.7	3.7	4.1	9.8	5.6	8.6	22.3	2.72
3	Decatur silt loam	1.2	18.8	54.9	26.3	0.4	1.6	2.6	8.4	5.8	22.2	32.7	2.67
4	Decatur clay loam	0.0	26.9	43.4	29.7	0.2	0.9	3.8	17.4	4.6	14.3	29.1	2.69
5	Hiwassee sandy loam	0.1	73.1	10.9	16.0	2.0	19.5	23.3	25.4	2.9	2.6	8.3	2.66
6	Houston clay	0.6	5.1	32.4	62.5	0.4	0.4	0.5	2.0	1.8	11.3	21.1	2.68
7	Wilcox clay	0.1	5.5	28.1	66.4	0.1	0.6	1.0	2.1	1.7	8.3	19.8	2.65
8	Blanton loamy sand	0.0	82.9	12.6	4.5	5.0	27.7	22.5	22.4	5.3	3.6	9.0	2.65
9	Hiwassee clay	1.5	23.2	17.2	59.6	2.2	4.3	3.7	7.4	5.6	6.0	11.2	2.72
10	Norfolk sandy loam	0.0	71.6	17.4	11.0	6.8	25.5	16.6	17.4	5.3	5.0	12.4	2.65
11	Oktibbeha clay	0.3	20.6	18.3	61.1	0.6	1.3	1.0	4.3	13.4	11.5	6.8	2.68
12	Sharkey silty clay	0.0	1.6	41.2	57.2	0.2	0.2	0.2	0.4	0.6	6.2	35.0	2.67
13	Vaiden silty clay	0.2	9.3	44.7	46.0	1.2	1.2	1.2	2.6	2.1	19.7	25.0	2.66

[1]by Dr. L.T. Alexander, Chief, Soil Survey Laboratories, USDA, SCS, Beltsville, Maryland

Chemical Properties

Soil Number	Soil	Cation Exchange Capacity (me./100g)	Organic Matter Dry Weight Basis (%)	pH
1	Congaree clay loam	10	2.8	6.4
2	Davidson clay	8	2.6	5.8
3	Decatur silt loam	9	2.4	5.9
4	Decatur clay loam	8	1.1	5.0
5	Hiwassee sandy loam	5	2.5	5.8
6	Houston clay	44	3.7	7.2
7	Wilcox clay	43	5.0	5.6
8	Blanton loamy sand	2	0.7	5.4
9	Hiwassee clay	5	1.7	5.7
10	Norfolk sandy loam	3	0.0	4.9
11	Oktibbeha clay	25	2.6	5.7
12	Sharkey silty clay	37	3.9	5.8
13	Vaiden silty clay	24	2.9	5.6

MINERALOGICAL ANALYSIS[1]

Soil Number	Soil	Mineral Content of Clay Fraction							
		Mont.[2]	Chlorite	Vermiculite[3]	Mica[4]	Int.[5]	Qtz[6]	Kaolinite (%)	Gibbsite (%)
		X-Ray Diffraction Determinations						Differential Thermal Analysis Determinations	
1	Congaree clay loam	--[7]	--	xx	--	--	--	58	10
2	Davidson clay	--	--	xx	--	--	--	42	30
3	Decatur silt loam	--	--	xxx	--	--	--	48	--
4	Decatur clay loam	--	--	xxx	--	--	--	48	--
5	Hiwassee sandy loam	--	--	xx	--	--	--	55	10
6	Houston clay	xxx[8]	--	--	--	--	--	48	--
7	Wilcox clay	xxxx	--	--	--	--	--	t	--
8	Blanton loamy sand	--	--	xxx	--	--	--	45	t
9	Hiwassee clay	--	--	xx	--	--	--	68	6
10	Norfolk sandy loam	--	--	xxx	--	--	--	42	5
11	Oktibbeha clay	--	--	xxx	--	--	--	45	--
12	Sharkey silty clay	xxxx	--	--	--	--	--	5	--
13	Vaiden silty clay	xxx	--	--	--	--	--	48	--

[1]By Dr. J.B. Dixon, Assoc. Prof. of Agronomy and Soils, Auburn University, Auburn, Alabama
[2]Mont. - Montmorillonite
[3]Spring does not collapse to 10°A on heating to 600°C. An aluminous chlorite, poorly crystalline (chlorite-vermiculite and/or montmorillonite intergrade)
[4]10 to 15 percent mica may be present as indicated by chemical analysis on similar soils but was not detected by X-ray data.
[5]Int. - Interstratified layer silicates.
[6]Qtz. - Quartz
[7]Relative amounts: dash = not detected, t = trace, x = small, xx = moderate, xxx = abundant, xxxx = dominant
[8]Contains some interlayer material as described under footnote 3

Amorphous was not determined.

Comments on X-Ray Diffraction Analysis and Differential Thermal Analysis Data and Soil Conservation Service Interpretations of Clay Fractions

by

J.B. Dixon, Associate Professor Agronomy and Soils, Auburn University

Soil Number	
1	Congaree - the 12A peak (Mg, glycol) indicates the presence of about 15% mica-vermiculite interstratified mixture.
2	Davidson - the shoulder in the 12.6-11A region (Mg, glycol) indicates mica-vermiculite interstratified mixture. The presence of diaspore is difficult to prove by DTA because interlayer OH gives an endotherm in the same region. An X-ray peak for diaspore does not appear to be present to confirm it.
3	Decatur clay loam (inside bin) - a trace of vermiculite-mica interstratified mixture is indicated by the skewness of the 14A peak (Mg, glycol) toward 10A. The skewness of the kaolin peak toward 10A indicates the presence of some halloysite. Both of the above observations are consistent with our data for Decatur. A trace of interstratified vermiculite-montmorillonite is evident in both Decatur samples.
4	Decatur Silt Loam (outside bin) - both XRD and DTA data indicate more interlayer material in 4 than 3.
5	Trace of interstratified vermiculite and mica is in this Hiwassee.
6	Our data on Houston indicates less kaolinite and a little vermiculite which is evident in the 2-0.2 clay. Some interlayering of hydroxy-Al is evident by failure of the expansibles to collapse to 10A. Our data also indicate interlayer Al apparently formed during Cretaceous or earlier time (as was the kaolinite) rather than in the present neutral or alkaline soil.
7	Wilcox (formerly Hurricane and Lufkin) - we have not studied this soil or any other one with so little kaolinite or other minerals aside montmorillonite. It is evident that much lees interlayer OH-Al is present than in Houston. It appears to collapse almost completely to 10A (K, 600°C).
8	Blanton loam sand (formerly Lakeland II) - this sample contains a large amount of interlayer hydroxy-Al as indicated by resistance to collapse (K, 600°C) and the DTA endotherm 350°C to the kaolinite peak.

9 Hiwassee (formerly Lloyd) - there is an appreciable amount of interlayer hydroxy-Al in this sample too, indicated by XRD and DTA data.

10 Norfolk sandy loam - same comment as for Hiwassee.

11 Oktibbeha - this sample contains an appreciable amount of vermiculite-montmorillonite interstratified mixture or it may be montmorillonite with interlayer material holding the spacing at 14A before heating.
Our data on Oktibbeha soils also indicate appreciable montmorillonite is present.

12 Sharkey - this sample probably contains more than 5% kaolinite. The XRD data indicate about 15%. The DTA peak overlaps that of montmorillonite and is uncertain. The montmorillonite in this sample is essentially free of interlayer hydroxy-Al.

13 Vaiden - this sample has similar mineralogy to Houston,

SOIL MOISTURE RETENTION

Soil Number	Soil	Soil Moisture Suction			
		1/3 ATM	1 ATM	3 ATM	15 ATM
		Percent Moisture, Dry Weight Basis			
1	Congaree clay loam	31.5	24.6	20.2	16.4
2	Davidson clay	19.8	17.0	14.6	12.4
3	Decatur silt loam	22.0	16.7	11.9	9.5
4	Decatur clay loam	24.0	15.6	12.0	10.3
5	Hiwassee sandy loam	8.0	7.2	6.2	5.4
6	Houston clay	33.1	30.0	28.0	22.5
7	Wilcox clay	44.9	38.5	32.4	27.0
8	Blanton loamy sand	4.7	4.1	2.3	1.9
9	Hiwassee clay	27.6	24.1	20.4	18.7
10	Norfolk sandy loam	7.1	6.6	5.1	3.9
11	Oktibbeha clay	27.9	24.9	21.7	18.5
12	Sharkey silty clay	32.6	29.0	26.5	22.0
13	Vaiden silty clay	24.2	22.2	19.9	15.5

RHEOLOGICAL PROPERTIES

Soil Number	Soil	Lower Plastic Limit	Lower Liquid Limit	Plasticity Index	Sticky Point
		Percent Moisture, Dry Weigh Basis		Number	Percent Moisture Dry Weigh Basis
1	Congaree clay loam	31.2	45.2	14.0	45.2
2	Davidson clay	22.2	31.3	12.3	23.0
3	Decatur silt loam	18.0	30.9	12.8	26.9
4	Decatur clay loam	17.5	30.3	12.8	21.5
5	Hiwassee sandy loam	14.3	16.6	2.3	16.0
6	Houston clay	33.2	62.3	29.1	45.2
7	Wilcox clay	37.4	73.5	36.1	46.8
8	Blanton loamy sand	----	15.4	non-plastic	----
9	Hiwassee clay	23.5	54.8	31.3	31.7
10	Norfolk sandy loam	17.6	20.5	2.9	17.9
11	Oktibbeha clay	25.2	63.2	38.0	37.6
12	Sharkey silty clay	28.3	75.5	47.2	39.6
13	Vaiden silty clay	24.8	47.9	23.1	32.0

Note: The National Tillage Machinery Laboratory is currently named the National Soil Dynamics Laboratory. Citation for this report: Batchelor, J.A. Jr., 1984. Properties of Bin Soils at National Tillage Machinery Laboratory. Paper No. 218. USDA-ARS, Auburn, AL., 16p.