CHEMICAL, PHYSICAL, AND MINERALOGICAL PROPERTIES OF CERTAIN SOIL PROFILES IN THE LOWER MISSISSIPPI DELTA

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ABSTRACT

The soils of the lower Mississippi Delta are derived from the Mississippi or Red River depositions or some combination of these two.

Profiles of the Iberia, Baldwin, Buxin, Sharkey, and Mhoon were selected for the study. The comparative results indicate that the Sharkey was highest in cation exchange capacity and exchangeable calcium and magnesium. Base saturation was highest in the Iberia and lowest in the Baldwin. The variation in cation exchange capacity was possibly due, in general, to the differences in texture, except for the Iberia. The clay fraction of the Iberia contained slightly larger quantities of high cation exchange capacity minerals than the other soil series of the study.

Silica was highest in the Baldwin while the oxides of aluminum, iron, magnesium, and potassium were highest in the Buxin. Iberia was highest in calcium oxide. Silica-sesquioxide and silica-ferric oxide ratios were highest in the Sharkey and lowest in the Buxin. The silica-alumina ratio was highest in the Baldwin and lowest in the Buxin. The comparison of the Buxin with soils of the Mississippi River deposition indicates that the Red River depositions were generally lower in silica-sesquioxide ratios and total calcium oxide and higher in total magnesia and potash.

The X-ray patterns indicate that montmorillonite and illite were the dominant clay minerals present. The greatest quantities of montmorillonite were generally found in the Iberia profiles, although this was not always true. Also, in general, the content of montmorillonite increased and illite decreased with profile depth. Secondary minerals were halloysite, kaolinite, vermiculite, and chlorite. The cation exchange capacity of the clay fraction also indicated the higher content of montmorillonite or associated minerals in the Iberia than in the Buxin, Baldwin, Sharkey or Mhoon soils.

INTRODUCTION

The alluvial soils comprising the study are located in the southern part of the Mississippi Delta, bordered on the East by the Mississippi River and on the South by the Gulf of Mexico. The Iberia, Baldwin, and Buxin soils occur at higher elevation and are more highly leached than the Sharkey and Mhoon soils developed from the more recent alluvium of the Mississippi River. Iberia, Baldwin and Buxin soils are generally located nearer the Atchafalaya River, while the Sharkey and Mhoon are located nearer the Mississippi River. The Red River generally flows into the Atchafalaya; but at certain periods, when the Mississippi River is at low stage, the flow is into the Mississippi River. In certain instances the Mississippi and Red River depositions from which certain of these soils are derived were either mixed or settled out in mixed layers.

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The purpose of this study has been to determine the similarities or differences of the different soil series by physical, chemical and mineralogical methods. Several profiles of each series have been studied and the surface layer of a representative soil from each series is presented in the data.

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MORPHOLOGY

The Iberia soils occur as the flat land bordering the Baldwin areas. They were developed under ponded conditions with very little leaching. They are high in organic matter and soil reaction and have a high water table. There are no physical indications of Red River influences.

The profiles in the Baldwin occur on the outer and lower flanks of the natural levee ridge. They are more highly leached, slightly more acid, and show more profile development than the Iberia. Red River influence seems evident in certain of these profiles, although there is no definite evidence.

Buxin soils occur on the inner flanks of the natural levees of Bayou Teche and are derived from mixtures of Mississippi River and old Red River alluvium in varying amounts. Predominantly these depositions are from the older Red River sediments.

Sharkey soils occur as a back-water deposition of the Mississippi River. They are young, unleached and may resemble the Iberia in general surface appearance. Sharkey soils are of heavy texture and do not exhibit horizontal differences in the profile.

The Mhoon soils are lighter in texture than the Sharkey and are called the mixed lands of the natural levee of the Mississippi River. They are also young, unleached and undeveloped.

EXPERIMENTAL METHODS

Exchangeable cations and cation exchange capacity of the soils were determined by the ammonium acetate method described by Peech, *et al.* (1947, pp. 7-12), with certain modifications for adaptation to the Perkins-Elmer Flame Photometer as described by Driskell (1954, p. 11). The cation exchange capacity of the clay fraction was determined by saturating the clay with potassium at pH 7.0, displacing the exchangeable potassium, and determining the exchangeable potassium with the flame photometer.

The ultimate analysis of the clay fraction (less than two micron diameter) was determined on all major constituents as described by Hillebrand and Lundell (1951, pp. 645-818) for the oxides of silica, aluminum, iron, titanium, calcium and magnesium. Potassium was determined by the method described by Shapiro and Brannock (1952, p. 12).

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The X-ray diffraction patterns were made on the clay fraction according to the procedures of Jeffries and Jackson (1949, pp. 57-73).

RESULTS AND DISCUSSION

The data given in Table I indicate that cation exchange capacity, and exchangeable calcium and magnesium were highest in the Sharkey. This is possibly due to the unweathered characteristics of the Sharkey profiles, the source of deposition, and textural composition. Total cation exchange capacity varied somewhat with the texture of the soil. Exchangeable potassium was highest in the Sharkey and Buxin, while exchangeable sodium was highest in the Baldwin and Buxin. Soil pH was approximately equal for the Iberia, Mhoon and Sharkey and was higher than the Baldwin and Buxin. Base saturation was lowest in the Baldwin and highest in the Iberia.

TABLE I. — TEXTURAL CLASSIFICATION, pH, AND CATION EXCHANGE PROPERTIES OF CERTAIN SURFACE SOILS OF THE LOWER MISSISSIPPI DELTA

Series	Texture	pH	Milliequivalents per 100 gm. of soil					Base saturation
			Ca	Mg	K	Na	Cation exchange capacity	
Iberia	SiClLo	6.3	18.7	4.0	0.5	0.2	22	91
Baldwin	SiClLo	5.7	12.4	3.6	.5	.3	21	79
Buxin	SiCl	5.9	14.6	6.3	.7	.3	26	83
Sharkey	SiCl-Cl	6.2	28.8	10.5	.7	.1	34	88
Mhoon	SiCl	6.4	18.6	7.6	.4	.1	23	83

CHEMICAL PROPERTIES OF THE CLAY FRACTION

Table II indicates that Baldwin contained slightly the highest while Iberia contained the lowest silica content. Other series varied between these values. Aluminum oxide was equally highest in the Sharkey and Buxin and lowest in the Baldwin. Ferric oxide was highest in the Buxin and lowest in the Sharkey. This indicates that soils with Red River influence were

TABLE II. — SILICATE ANALYSIS OF THE CLAY FRACTION (LESS THAN 2 μ DIAMETER) OF CERTAIN SURFACE SOILS OF THE LOWER MISSISSIPPI DELTA

Series	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	$\frac{SiO_2}{R_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$
Iberia	49.61	22.46	6.48	1.75	2.14	0.89	3.16	3.75	20.34
Baldwin	52.99	22.05	6.93	.92	2.02	1.49	3.40	4.08	20.33
Buxin	51.48	23.65	8.47	.76	3.37	2.33	3.01	3.69	16.16
Sharkey	52.62	23.61	5.11	1.25	2.15	2.10	3.45	3.92	28.42
Mhoon	52.49	23.14	6.29	1.26	2.17	2.22	3.28	3.85	22.19

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high in ferric oxide, while the Mississippi River depositions contained smaller amounts; therefore, if the Baldwin contained appreciable quantities of Red River depositions, the content of ferric oxide would have been high. It is slightly higher than the Mhoon, considerably higher than the Sharkey, yet considerably lower than the Buxin; therefore, no definite indication was shown that the Baldwin was related to the Red River depositions.

The silica-sesquioxide ratio was lowest in the Buxin and highest in the Sharkey and Baldwin. The silica-alumina ratio is relatively high in all profiles, but it was slightly highest in the Baldwin and lowest in the Buxin, which may be indicative that these two are not closely related in parent material. Considerable variation is observed in the silica-ferric oxide ratios. Sharkey contains a much higher ratio than other soils of this study. The Buxin soil was high in ferric iron and gave the lowest ratio.

Of the five soils reported, Iberia was highest in total calcium oxide and lowest in total potash. Certain other profiles of Iberia have shown larger quantities of total potash to be present; in fact, the Iberia frequently resembles the Baldwin in this respect. Total magnesia was much higher in the Buxin than in the other soils. The Iberia, Baldwin, Sharkey and Mhoon soils were very similar in magnesia content. Total potash was highest in the Buxin, which was only slightly higher than the Sharkey and Mhoon.

X-RAY PROPERTIES AND CATION EXCHANGE CAPACITY OF CLAY FRACTION

An interpretation of the X-ray diffraction patterns given in Table III indicates that montmorillonite and illite are the predominant clay minerals present. In certain instances, these may occur as interstratified montmorillonoids. The Iberia profiles generally contained slightly higher montmorillonite peaks than Baldwin. Certain profiles of Buxin resembled the Baldwin, while others resembled the Iberia. The Sharkey and Mhoon were quite similar to the Iberia in clay minerals content with the exception of

TABLE III. — CLAY MINERALS CONTENT AND CATION EXCHANGE CAPACITY OF THE CLAY FRACTION (LESS THAN 2 μ DIAMETER) OF CERTAIN SURFACE SOILS OF THE LOWER MISSISSIPPI DELTA

Series	Dominant[1]	Secondary[1]	Cation exchange capacity in m.e./100 gm.
Iberia	MI[2]	HK	74
Baldwin	IM[2]	HK	56
Buxin	MI[2]	HK	52
Sharkey	MI	HK	57
Mhoon	IM	KVC	58

[1] M-montmorillonite, I-illite, H-halloysite, K-kaolinite, V-vermiculite, C-chlorite.
[2] Interstratified montmorillonoid.

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slightly less montmorillonite. There was an indication that, generally, montmorillonite increased and illite decreased with depth in all profiles except certain of the Buxin, in which the unweathered surface layers contained as much montmorillonite as the lower layers. The secondary minerals were not easily identified on the X-ray patterns and further work should be done before definite conclusions are made. Apparently, the secondary minerals were mostly kaolinite, halloysite and possibly traces of vermiculite and chlorite. The cation exchange capacity of the clay fractions compared favorably with the identification of clay minerals, further indicating that the Iberia contained larger quantities of montmorillonite than the other series, as evidenced by the cation exchange capacity of the clay fraction.

REFERENCES

Driskell, B. N. (1954) *Methods and procedures for soil and plant analyses* (mimeographed): Crops and Soils Department, Louisiana State University, p. 11.

Hillebrand, W. F., and Lundell, G. E. F. (1948) *Applied inorganic analysis:* John Wiley and Sons, Inc., pp. 645-818.

Jefferies, C. D., and Jackson, M. L. (1949) *Mineralogical analysis of soils:* Soil Science Society of America Proceedings, vol. 68, pp. 57-73.

Peech, Michael, Dean, L. A., and Reed, J. Fielding (1947) *Methods of soil analysis for soil-fertility investigations:* U.S.D.A. Circ. No. 757, pp. 7-12.

Shapiro, Leonard, and Brannock, W. W (1952) *Rapid analysis of silicate rocks:* Geological Survey, Circular No. 165, p. 12.

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