Classification of Some Dark Colored Northern Indiana Soils[1]

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Abstract

The classification of some of the dark colored, well drained, acid outwash soils in Northern Indiana needed clarification. These soils had been classified into the Soil Taxonomy System as Typic Argiudolls. In the previous system they had been classified as Brunizems. These soils have many shale fragments throughout the profile and are strongly to very strongly acid. The laboratory data indicate that they have low base saturation throughout the B horizons and to a depth of at least 1.8 meters and that they should be classified as Ultic Hapludalfs. This classification does not recognize their similarity to Mollisols.

Introduction

There are approximately 227,000 acres of acid outwash soils containing variable amounts of shale in Lake, Porter, LaPorte and St. Joseph Counties. These soils have been classified in the Tracy, Door and associated series in past soil surveys. About 65,000 acres of these soils developed under prairie or mixed prairie and forest vegetation and the remaining acreage developed under forest vegetation. Carbonates are present below 8 to 10 feet. Soil scientists have observed pyrite crystals in the leached part of some profiles and gypsum crystals in the unleached part.

Shale bedrock formations (Coldwater, Ellsworth and Antrim formations) underlie the drift in this area and in Michigan to the north of this area (1). Shales in the soil mantle are assumed to have been a part of these formations prior to glaciation. Samples from bore holes into the shale bedrock contain an average of 1.4% sulphur (John R. Hill, unpubl. data).

The purpose of the field and laboratory study was to collect information that would help to classify these soils according to the latest soil classification (3). We also wanted to learn why these soils were so much more acid and deeply leached than other soils in the area.

Mollisols are soils that have a thick dark surface horizon high in organic matter and are relatively rich in base saturation throughout the profile (> 50% by NH_4OAC method to a depth of 1.8 m) (3). Alfisols are usually relatively low in organic matter, have a subsurface horizon with an accumulation of silicate clays (argillic horizon), and have a relatively high base saturation (> 35% by sum of cations at a depth of

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about 1.8 m). Ultisols are similar to Alfisols except Ultisols have a lower base saturation.

Soils that have certain combinations of characteristics are placed in intergrade classes. For example, a well-drained soil with a dark surface layer typical of Mollisols and an argillic horizon typical of Alfisols or Ultisols is an Argiudoll (Mollisol with argillic horizon) if the base saturation is between 50 and 35%; and is a Humic Hapludult (Ultisol high in humus) if the base saturation is less than 35%.

Method

Representative profiles were sampled and described in St. Joseph, LaPorte and Porter Counties. The samples were characterized for physical and chemical properties at the U.S.D.A. Soil Conservation Service Laboratory at Beltsville, Maryland. Standard laboratory procedures were used in the determinations. The symbols in the headings of Tables 1 and 2 indicate the particular method used (2).

Tables 1 and 2 give the partial laboratory data of two representative profiles from prairie areas. One of Door loam from Porter County and one of Door silt loam (now Coupee silt loam) from St. Joseph County. Descriptions of the two profiles follow.

The profile from Porter County (Table 1) has an argillic horizon. It has clay films on ped surfaces which indicate clay movement but it does not have the clay increase from the eluvial (A) horizons to the illuvial (B2) horizons that is typical of argillic horizons. The original material of the A horizon contained more clay than that of the B2 horizons and subsequent clay movement was masked by the original material difference. The base saturation by sum of cations at 1.8 m deep is 39%. The weighted average particle size distribution in the control section, 43 to 93 cm in this profile, places the soil in the coarse-loamy class, borderline to fine loamy. The complete classification at the family level is Ultic Hapludalfs, coarse-loamy, mixed, mesic. "Coarse-loamy" is a particle size class; "mixed" is a mineralogy class; and "mesic" is a temperature class.

TABLE 1. *Laboratory data for Door loam, Porter County, Indiana.*

Depth in cm	Horizon	Total % of < 2 mm			Coarse fragments	pH	Base Saturation		%
		2.0-.05 mm Sand 1B1b	0.05-0.002 mm Silt 3A1	Clay <.002 mm	2-76 mm % of <76 mm 3B1	(1:1) H_2O 8C1a	Sum Cations 5C3	NH_4 OAC 5C1	Organic Carbon 6A1a
0-20	Ap	45.8	33.0	21.2	--	5.6	52	71	2.94
20-33	A1	48.9	31.3	19.8	1	5.8	43	58	2.57
33-43	A3	55.1	26.7	18.2	9	5.5	30	50	1.60
43-61	B21t	58.7	23.8	17.6	12	5.5	24	40	0.81
61-79	B22t	62.1	19.9	18.0	19	5.4	28	43	0.43
79-99	B23t	67.8	16.6	15.6	18	5.4	28	45	0.42
99-129	B24t	60.3	19.3	20.4	26	5.2	25	41	0.24
129-167	B31	53.9	21.2	25.0	44	5.3	39	62	0.51
167-200	B32	66.1	14.1	19.7	33	5.7	39	69	0.44
200-225	IIC	89.9	4.8	5.3	5	5.8	28	56	0.14

The profile from St. Joseph County (Table 2) also has an argillic horizon, but the base saturation at 1.8 m deep is 29%, less than the 35% upper limit for Ultisols. Also, the profile has a sharp texture change at about 84 cm and because this change is within the control section, 53 to 103 cm for this profile, the soil is placed in a contrasting-texture family. The complete classification of this profile is Humic Hapludults, fine-loamy over sandy-skeletal, mixed, mesic.

Table 2. *Laboratory data for Door (Coupee) silt loam, St. Joseph County, Indiana.*

Depth in cm	Horizon	Total % of < 2 mm: Sand 2.0-.05 mm 1B1b	Silt 0.05-0.002 mm 3A1	Clay <.002 mm	Coarse fragments 2-76 mm % of < 76 mm 3B1	pH (1:1) H_2O 8C1a	Base Saturation: Sum Cations 5C3	NH_4 OAC 5C1	% Organic Carbon 6A1a
0-25	Ap	14.9	58.8	28.3	--	5.8	47	55	3.30
25-36	A1	16.1	58.8	25.9	--	5.6	35	49	2.64
36-53	B1	15.9	60.5	23.6	--	5.3	29	41	1.18
53-66	B21t	36.7	34.9	28.4	1	5.0	38	49	0.65
66-84	B22t	51.5	27.7	20.8	2	5.0	37	46	--
84-92	IIB31	80.1	9.8	10.1	5	5.1	29	35	--
92-112	IIB32	87.7	5.6	6.7	14	5.2	20	28	0.13
112-132	IIB33	90.8	3.6	5.6	18	5.2	23	26	0.12
132-152	IIC1	94.7	2.1	3.2	5	5.3	19	25	0.12
152-183	IIC2	84.1	3.8	9.1	52	5.2	29	38	0.11
183-249	IIC3	91.7	2.0	6.3	7	5.3	43	53	0.25

From other data[2] representing soils in this area, it is apparent that most of the soils have base saturations more than 35% at the critical depth, so we consider most of the soils to be Alfisols instead of Ultisols. To separate those series in the coarse-loamy family from those in the fine-loamy over sandy or sandy-skeletal family, a new soil series, Coupee, was established to represent the latter family.

If argillic horizons were not present in these soils, they would be Inceptisols. They are borderline to Inceptisols in that the argillic horizons are not moderately or strongly developed. Field observations as recorded in the pedon descriptions shows the presence of clay films to be sufficient for an agrillic horizon. Laboratory data (not included in table) shows that the ratio of fine clay to total clay is larger in the illuvial horizon than it is in the eluvial horizon. Ratio of fine clay to total clay in the St. Joseph County profile is: AP — 0.37, B21t — 0.53, and the IIB32 — 0.57. In stratified materials, where the horizons differ in texture originally, it is not expected that there will always be more clay in the argillic horizons than is in the overlying "A" horizons.

In soil classification it is the goal to group soils with the greatest similarity of important properties in the same class. The soils of this study both developed under prairie grasses, as did most Mollisols,

[2] Laboratory characterization data for Door and related soils (1974) unpublished. On file at Purdue University, Agronomy Department and State Office of the USDA, SCS.

and, except for the lower base saturation in the B horizons, have the characteristics of Mollisols. They are used for intensive crop production as are other Mollisols of the area. In defining Mollisols it was decided, however, that low base status soils should be excluded to maintain homogeneity of base saturation in the Mollisol order. With minor changes in the classification system (3) the similarity of these soils to Mollisols would be recognized (Mollic Hapludalfs instead of Ultic Hapludalfs). This change is under consideration.

Laboratory tests for sulphur showed no sulphur present in the weathered shale in the profile. Since the unweathered shale rock contains about 1.4% sulphur and the shale fragments remaining in the soil contain none, it is assumed that sulphur-containing minerals in the shale weathered to form sulphuric acid which greatly accelerated the leaching of carbonates. These soils are leached to a greater depth and have lower base status than other soils in the area which have developed from materials with similar texture but lower shale content. The relatively rapid permeability of the soil, high rainfall (34 inches/year) and great depth to the water table, also hasten the leaching.

Literature Cited

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Appendix 1

Profile description—Door (Coupee) silt loam.

Location—St. Joseph County, Indiana—300 feet W and 120 feet S of NE corner of SW ¼ of NE ¼ Sec. 30, T38N, R1E.

Vegetation—wheat stubble seeded in red clover

Physiography—Terrace

Slope—1%

Elevation—745 feet

Natural Drainage and Permeability—Well drained, moderate permeability.

Parent Material—loamy material over shaley sand and gravel.

Ap-0 to 25 cm, black (10YR 2/1) silt loam; very dark brown (10YR 2/2) crushed; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

A1-25 to 36 cm, black (10YR 2/1) silt loam, very dark brown (10YR 2/2) crushed; moderate medium granular structure; friable; medium acid; clear wavy boundary.

B1-36 to 53 cm, brown (10YR 5/) heavy silt loam, very dark grayish brown (10YR 3/2) on faces of most peds; moderate medium and fine subangular blocky structure; friable; many very fine random, inped, continuous pores with discontinuous very dark brown (10YR 2/2) linings in pores and old root channels; strongly acid; clear wavy boundary.

B21t-53 to 66 cm, brown (10YR 4/3) light clay loam; moderate medium subangular blocky structure; firm; thin discontinuous dark brown (10YR 3/3) clay films on faces of peds; common very fine, random, inped continuous pores with thin discontinuous very dark grayish brown (10YR 3/2) clay linings in pores and old root zones; few fine pebbles 2.5 cm and less in diameter; medium acid; clear wavy boundary.

B22t-66 to 84 cm, dark yellowish brown (10YR 4/4) light clay loam; brown (10YR 4/3) coatings on faces of peds; moderate coarse and medium subangular blocky structure; firm; few fine random, inped, continuous pores with discontinuous dark brown (10YR 3/3) linings; thin discontinuous clay films on faces of peds; few fine pebbles about 2 cm in diameter; distinct increase in sand content over above horizon; medium acid; clear wavy boundary.

IIB31-84 to 92 cm, dark brown (10YR 3/3) loamy sand; weak course subangular blocky structure; very friable; discontinuous very dark grayish brown (10YR 3/2) clay films; 10-15% gravel; common shale fragments; medium acid (pH 5.6); clear wavy boundary.

IIB32-92 to 112 cm, dark brown (7.5YR 4/4) medium and coarse sand; weak coarse subangular blocky structure; loose; few loamy sand bands dark brown (7.5YR 3/2) 2 mm thick; 10-15% gravel 1 to 2 cm in diameter, common shale fragments; medium acid; clear wavy boundary.

IIB33-112 to 132 cm, dark brown (7.5YR 4/4) medium and coarse sand; single grained; loose; 10-15% gravel 1 to 2 cm in diameter; numerous shale fragments; medium acid; clear wavy boundary.

IIC1-132 to 152 cm, pale brown (10YR 6/3) fine and medium sand; single grained; loose; few shale fragments; few pebbles; slightly acid; clear wavy boundary.

IIC2-152 to 183 cm, brown (10YR 5/3) fine gravel and medium and coarse sand; single grained; loose; 50% fine shale fragments; medium acid; clear wavy boundary.

IIC3-183 to 249 cm, light brownish gray (10YR 6/2) medium sand and dark brown (7.5YR 4/4) loamy sand bands 50 mm thick (bands make up about 50% of horizon by volume) and are irregularly spaced.

APPENDIX 2

Profile description—Door loam.

Location—Porter County, Indiana—380 feet west and 740 feet north of SE corner of SE¼ Sec. 32, T35N, R5W.

Vegetation—Alfalfa

Physiography—Terrace

Slope—1%

Elevation—748 feet

Natural Drainage and Permeability—Well drained, moderate permeability

Parent Material—Loamy outwash high in shale over sandy and gravelly outwash high in shale.

Ap-0 to 20 cm, black (10YR 2/1) loam; moderate medium and fine granular; friable; medium acid; abrupt smooth boundary.

A1-20 to 33 cm, very dark brown (10YR 2/2) loam; moderate medium granular structure; friable; slight acid; clear wavy boundary.

A3-33 to 43 cm, very dark grayish brown (10YR 3/2) loam; weak medium subangular blocky and moderate medium granular structure; friable; very dark brown (10YR 2/2) lining in voids and fillings in worm casts; strongly acid; clear wavy boundary.

B21t-43 to 61 cm, brown (10YR 4/3) heavy loam; thin dark brown (10YR 3/3) coatings on faces of peds; weak medium subangular blocky structure; friable; thin discontinuous clay films on faces of peds and linings in some pores; few fine shale fragments and pebbles; very dark grayish brown (10YR 3/2) lining in some voids and in old root and worm channels; strongly acid; clear wavy boundary.

B22t-61 to 79 cm, brown (10YR 4/3) sandy clay loam; moderate medium subangular blocky structure; friable; thin discontinuous dark brown (10YR 3/3) clay films on faces of peds; common pebbles and shale fragments; few yellowish brown (10YR 5/6) dark reddish brown (5YR 2/2) and black (10YR 2/1) oxides; strongly acid; clear wavy boundary.

B23t-79 to 99 cm, yellowish brown (10YR 5/4) sandy clay loam; brown (10YR 4/4) coatings on faces of peds; moderate medium and coarse subangular blocky structure; friable; 15% fine gravel and shale; thin discontinuous dark yellowish brown (10YR 4/4 and 3/3) clay films on faces of peds and linings in some voids; few, fine yellowish brown (10YR 5/6) oxides; strongly acid; clear wavy boundary.

B24t-99 to 129 cm, brown (10YR 5/3) shaley loam (shale is dominantly less than 1 cm long and 5 mm thick); weak medium and coarse subangular block structure; friable; thin discontinuous dark brown (7.5YR 4/4) clay films on faces of peds and coatings on shale fragments; few fine yellowish brown (10YR 5/6) and yellowish red (5YR 4/6) oxides; very strongly acid; clear wavy boundary.

B31-129 to 167 cm, brown (10YR 5/3) and grayish brown (10YR 5/2) shaley loam; weak coarse subangular blocky structure; friable; common fine dark reddish brown (5YR 2/2) oxides; very strongly acid; abrupt wavy boundary.

B32-167 to 200 cm, strong brown (7.5YR 5/6) and dark brown (7.5YR 4/4) shaley loam; weak coarse subangular blocky structure; firm slightly cemented; yellowish red (5YR 4/6) thin clays films on faces of pebbles; this horizon is layered and high in oxides; medium acid; abrupt wavy boundary.

IIC-200 to 225 cm, light brownish gray (10YR 6/2) medium sand; single grained; loose; few shale fragments; medium acid.