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Variations in Mankato Glacial Till and Related Soil Types in Hamilton County, Iowa¹

By ALLEN R. HIDLEBAUGH

Abstract. Soil surveys in Hamilton County, Iowa, have shown a need for the revision of the Clarion and Nicollet soil series to include the fine textured variant soils found there or for the establishment of new series. The results of this study show that sufficient differences exist to warrant the establishment of new series for the fine textured variants of Clarion and Nicollet. They are higher in clay content, have lower chroma in the A horizon, have higher gravel content, have higher bulk density, are firmer in consistence, have finer and better developed structure, and mottling occurs at shallower depths, than the normal Clarion and Nicollet soils.

Riecken, Allaway, and Smith (1947, p. 432) made a study of some of the classification and mapping problems in the Wisconsin drift area and summarized previous literature related to these problems. They presented some of the profile characteristics of the Clarion soils. Soil Conservation Service soil surveys in Hamilton County since 1948 have indicated a need for the revision of the Clarion and Nicollet series to include the fine textured variants recognized in the field or for the establishment of new series to fit the fine textured variant soils.

PROFILES STUDIED

Two profiles of Clarion, four profiles of Clarion fine textured variant (FT), two profiles of Nicollet, and four profiles of Nicollet fine textured variant (FT) were used in this study. The present paper presents data on one profile each of Clarion, Clarion-FT, Nicollet, and Nicollet-FT. The Clarion-FT profile, P-261, Nicollet profile, P-624, and Nicollet-FT profile, P-620, were collected in Hamilton County by Hidlebaugh (1960). Clarion profile, P-471, was collected in Polk County by McCracken (1956).

Three of these profiles have been described in detail by Hidlebaugh (1960). Profile P-471 has been described in detail by McCracken (1956). Profile descriptions of each of the four soil profiles are given below. Terminology used is that of the Soil Survey Manual (1951).

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SOIL PROFILE DESCRIPTIONS

Clarion-FT clay loam, profile no. P-621

Location: 400 feet north and 100 feet east of SW corner of NE $\frac{1}{4}$ of NW $\frac{1}{4}$ sec. 1, T86N, R26W, Hamilton County, Iowa.

Vegetation: Native vegetation assumed to be prairie grasses; present vegetation is alfalfa sod.

Parent material: Mankato glacial till.

Slope and aspect: Gradient of 5 percent to east.

Depth (inches)	Horizon designation	Horizon morphology
0-6	A ₀	Black (10YR 2/1 moist) friable clay loam; moderate fine granular structure; pH 6.2.
6-12	A ₁₂	Black (10YR 2/1 moist) friable heavy clay loam; moderate fine granular structure; pH 6.2.
12-19	A ₃	Very dark gray (10YR 3/1 moist) friable heavy clay loam; moderate fine subangular blocky structure; pH 5.6.
19-27	B ₁	Very dark grayish-brown (10YR 3/2 moist) friable heavy clay loam; very dark gray (10YR 3/1 moist) ped coatings; moderate fine subangular blocky structure; thin continuous clay skins; pH 5.7.
27-35	B ₂₁	Dark brown (10YR 4/3 moist) firm heavy clay loam; very dark gray (10YR 3/1 moist) ped coatings; strong fine subangular blocky structure; thin continuous clay skins; pH 5.8.
35-42	B ₂₂	Dark yellowish-brown (10 YR 4/4 moist) firm light clay; yellowish-red (5YR 5/8 moist) mottles; dark grayish-brown ped coatings; strong fine subangular blocky structure; thick continuous clay skins; pH 5.9.
42-48	B _{3ca}	Dark yellowish-brown (10YR 4/4 moist) to yellowish-brown (10YR 5/8 moist), red (2.5 YR 4/8 moist) and light grayish-brown (2.5Y 6/2 moist) mottles; moderate medium subangular blocky structure; thin continuous clay skins; iron and manganese stains; pH 6.6.
48-60	C _{1ca}	Yellowish-brown (10YR 5/6 moist) friable clay loam; strong brown (7.5YR 5/8 moist) and light olive gray (5Y 6/2 moist) mottles; grayish-brown (2.5 Y 5/2 dry) ped coatings; weak medium subangular blocky structure; thin discontinuous clay skins; iron and manganese stains; lime streaks; pH 7.5.

Clarion loam, profile no. P-471

Location: SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$, Sec. 12, T80N, R24W, Polk County, Iowa.

Vegetation: Native vegetation assumed to be prairie grasses; cultivated field in corn-oats-meadow rotation.

Parent materials: Cary glacial till.

Slope and aspect: Gradient of 4 percent to north.

Depth (inches)	Horizon designation	Horizon morphology
0-9	A _p	Very dark brown (10YR 2/2 moist) friable loam; moderate medium granular structure; pH 6.7.
9-13	B ₁	Dark brown (10YR 3/3 moist) friable loam; very dark brown (10YR 2/2 moist) ped coatings; weak fine and medium subangular blocky structure; pH 6.0.
13-17	B ₂₁	Dark brown (10YR 3/3 moist) friable loam; very dark brown (10YR 2/2 moist) ped coatings; weak fine and medium subangular blocky structure; pH 5.6.

17-22	B ₂₂	Dark brown (10YR 3/3 moist) slightly firm loam; very dark brown (10YR 2/2 moist) and very dark grayish brown (10YR 3/2 moist) ped coatings; weak medium subangular blocky structure; pH 5.7.
22-27	B ₂₃	Yellowish brown (10YR 3/3 moist) and brown (10YR 4/3 moist) slightly firm loam; weak medium subangular blocky structure; pH 5.8.
27-30	B ₃	Yellowish brown (10YR 5/4 moist) with some splotches of dark brown (10YR 3/3 moist) slightly firm loam; very weak coarse subangular blocky structure; pH 6.2.
30-36	C ₁	Yellowish brown (10YR 5/4 moist) friable loam; dark brown (10YR 3/3 moist) ped coatings; massive structure; iron and manganese concretions; pH 6.5.
36-54	C ₂	Light yellowish-brown (10YR 6/4 moist) friable loam; reddish yellow (7.5 YR 6/6 moist) mottles; massive structure; numerous lime concretions; pH 7.6.

Nicollet-FT clay loam, profile no. P-620

Location: 75 feet north and 250 feet west of SE corner of N $\frac{1}{2}$ of NW $\frac{1}{4}$ sec. 1, T86N, R26W, Hamilton County, Iowa.

Vegetation: Native vegetation assumed to be prairie grasses; present vegetation alfalfa sod.

Parent material: Mankato glacial till.

Slope and aspect: Gradient of 3 percent to south.

Depth (inches)	Horizon designation	Horizon morphology
0-7	A _{1p}	Black (10YR 2/0-2/1 moist) friable clay loam; weak fine granular structure; pH 5.8.
7-11	A ₁₂	Black (10YR 2/1 moist) friable heavy clay loam; moderate fine granular structure; pH 5.8.
11-17	A ₃ B ₁₁	Very dark gray (10YR 3/1 moist) friable heavy clay loam; dark grayish-brown (10YR 4/2 moist) mottles; moderate fine subangular blocky structure; pH 5.8.
17-22	B ₁₂	Very dark gray (10YR 3/1 moist) friable heavy clay loam; dark grayish-brown (10YR 4/2 moist) mottles; gray (2.5Y 6/0 dry) ped coatings; moderate fine subangular blocky structure; thin continuous clay skins; pH 5.7.
22-28	B ₂	Dark grayish-brown (10YR 4/2 moist) friable heavy clay loam; very dark gray (10YR 3/1 moist) and yellowish-red (5YR 4/6 moist) mottles; gray (2.5Y 6/0 dry) ped coatings; moderate to strong fine subangular blocky structure; thin continuous clay skins; pH 6.1.
28-34	B _{3ca}	Dark grayish-brown (10YR 4/2 moist) friable; light clay loam; very dark grayish-brown (10YR 3/2 moist) and dark red (2.5YR 3/6 moist) mottles; gray (2.5Y 6/0 dry) ped coatings; moderate fine to medium subangular blocky structures; thin discontinuous clay skins; lime concretions; pH 7.4.
34-48	C _{11ca}	Dark yellowish-brown (10YR 4/4 moist) friable heavy loam; gray (2.5Y 5/0 moist) mottles; gray (2.5Y 6/0 dry) ped coatings; weak medium to coarse subangular blocky structure; lime concretions; pH 7.6.
48-58	C _{12ca}	Dark yellowish-brown (10YR 4/4 moist) friable light clay loam; gray (2.5Y 5/0 moist) mottles; gray (2.5Y 6/0 dry) coatings on cleavage faces; massive structure; iron and manganese concretions; pH 7.6.

Nicollet clay loam, profile no. P-624

Location: 1,550 feet east and 100 feet north of SW corner of SE $\frac{1}{4}$ sec. 4; T88N, R26W, Hamilton County, Iowa.

Vegetation: Native vegetation assumed to be prairie grasses, present vegetation bluegrass.

Parent materials: Mankato glacial till.

Slope and aspect: Gradient of 2 percent to the north.

Depth (inches)	Horizon designation	Horizon morphology
0-7	A ₁₁	Black (10YR 2/1 moist) friable light clay loam; moderate fine granular structure; pH 5.4.
7-13	A ₁₂	Black (10YR 2/1 moist) friable clay loam; moderate fine granular structure; pH 5.5.
13-19	A ₃	Black (10YR 2/1 moist) to very dark gray (10YR 3/1 moist) friable clay loam; moderate fine granular structure; pH 5.6.
19-26	B ₁	Very dark grayish-brown (10YR 3/2 moist) to dark grayish-brown (10YR 4/2 moist) friable clay loam; very dark gray (10YR 3/1 moist) mottles; moderate fine subangular blocky structure; thin discontinuous clay skins; pH 5.8.
26-33	B ₂	Olive brown (2.5Y 4/3 moist) friable clay loam; very dark gray (10YR 3/1 moist) mottles; moderate fine subangular blocky structure; thin continuous clay skins; pH 6.4.
33-42	C _{1cag}	Olive gray (5Y 5/2 moist) friable heavy loam; yellowish-brown (10YR 5/6 moist) mottles; very dark gray (10YR 3/1 moist) organic stains; weak fine subangular blocky structure; manganese stains; lime concretions; pH 7.6.
42-52	C _{1cag}	Light brownish-gray (2.5Y 6/2 moist) friable loam; yellowish-brown (10YR 5/8 moist) and yellowish-red (5YR 5/8 moist) mottles; massive; manganese stains; lime concretions; pH 7.7.

MORPHOLOGICAL COMPARISON

A study of the morphological descriptions of the profiles collected in this study and the Clarion profile previously collected shows several differences between the normal Clarion and Nicollet profiles and the profiles of the fine textured variants of Clarion and Nicollet soils.

The differences between the normal and fine textured variants of Clarion soils are summarized as follows:

A₁—horizon differences

The Clarion-FT soils are lower in chroma (10YR 2/1 moist) versus (10YR 2/2 moist) for the Clarion. The Clarion-FT soils have a finer structure—moderate fine granular, versus a moderate medium granular, for the Clarion soils. The texture of the Clarion is loam while that of the Clarion-FT is clay loam.

B₂—horizon differences

Clarion-FT soils are dark yellowish-brown (10YR 4/4 moist) to yellowish-brown (10YR 5/4 moist) in contrast to a dark

brown (10YR 3/3 moist) for the Clarion soils. The Clarion-FT soils have a finer, more strongly developed structure—moderate to strong fine subangular blocky structure—than the Clarion soils. The texture of the Clarion soils is loam while that of the Clarion-FT soils is clay loam to a light clay. There are clay skins present in the Clarion-FT soils while none are present in the Clarion soils. Mottling is also present in the Clarion-FT soils and none is present in the Clarion soils; the color of the mottling is yellowish-red (5YR 5/8 moist), very dark gray (10YR 3/1 moist), and very dark grayish-brown (10YR 3/2 moist).

C—horizon differences

The texture of the Clarion soils is loam, versus a clay loam for the Clarion-FT soils.

The differences between the normal and fine textured variant

Nicollet soils are as follows:

A₁—horizon differences

Nicollet-FT soils are lower in chroma—(10YR 2/0-2/1 moist) versus (10YR 2/1-3/1 moist) for the Nicollet soils. The Nicollet-FT soils have a finer structure—weak to moderate fine granular, versus moderate medium granular, for the normal Nicollet soils.

B₂—horizon differences

The Nicollet-FT soils are dark grayish-brown (10YR 4/2 moist) and dark yellowish-brown (10YR 4/4 moist) and very dark gray (10YR 3/1 moist), versus olive brown (2.5Y 4/3 4/4 moist), very dark grayish-brown (10YR 3/2 moist), dark grayish brown (10YR 4/2 moist), very dark gray (10YR 3/1 moist), light olive brown (2.5Y 5/4 moist) for the Nicollet soils. The structure of the Nicollet-FT soils is moderate to strong fine subangular blocky and prismatic versus a weak to moderate medium to fine subangular blocky, for the Nicollet soils. Clay skins are thicker and more nearly continuous in the Nicollet-FT soils.

C—horizon differences

The texture of the Nicollet soils is loam to sandy clay loam while that of the Nicollet-FT soils is a heavy loam to a light clay loam.

The above variations in morphological characteristics clearly show that the normal Clarion or Nicollet soil can be separated from its fine textured variant counterparts.

LABORATORY STUDIES

Mechanical analyses, pH, bulk density, and organic carbon were

obtained on Clarion profile, P-471 and have been reported by McCracken (1956). Similar data and also total nitrogen were obtained in this study and have been reported by Hidlebaugh (1960). Data for the four profiles are presented in Table 1.

Table 1

Clay Content, Gravel Content, pH, Bulk Density, Total Nitrogen and Total Carbon of Selected Horizons of Clarion Profile P-471, Clarion-FT Profile P-621, Nicollet Profile P-624, and Nicollet-FT Profile P-620

Horizon	Depth (inches)	pH ^a	Pct. Clay, <2 microns	Pct. Gravel, >2mm.	Pct. Total nitrogen ^b	Pct. Organic carbon ^c	Bulk Density
Clarion-FT Clay Loam, Profile No. P-621							
A _{1p}	0-6	6.2	33.5	0.1	0.236	3.11	1.09
A ₁₂	6-12	6.1	38.0	0.1	0.236	2.91	1.12
A ₃	12-19	5.6	37.7	0.4	0.174	2.04	1.21
B ₁	19-27	5.7	38.7	2.6	0.118	1.58	1.26
B ₂₂	35-42	5.9	40.1	1.0	0.053	0.49	1.31
C _{1ca}	48-60	7.5	31.4	5.5	0.032	0.49	
Clarion Loam, Profile No. P-471							
A _p	0-9	6.7	25.0	<1		1.96	1.17
B ₁	9-13	6.0	26.8	<1		1.90	
B ₂₁	13-17	5.6	27.2	<1		1.46	1.06
B ₂₂	17-22	5.7	27.8	<1		1.29	1.15
B ₃	27-30	6.2	24.8	<1		1.06	
C ₂	36-54	7.6	24.5	6.5			
Nicollet-FT Clay Loam, Profile No. P-620							
A _{1p}	0-7	5.8	34.6	0.3	0.248	3.04	1.09
A ₁₂	7-11	5.8	39.0	0.1	0.205	2.04	1.22
B ₁₂	17-22	5.7	38.7	5.7	0.123	1.72	1.35
B ₂	22-28	6.1	36.6	5.1	0.088	1.30	1.40
B _{3ca}	28-34	7.4	29.4	14.5	0.063	0.11	1.64
C _{1ca}	48-58	7.6	28.4	5.5	0.034	0.19	
Nicollet Clay Loam, Profile No. P-624							
A ₁₁	0-7	5.4	29.8	0.2	0.309	3.80	1.07
A ₁₂	7-13	5.5	31.1	0.7	0.252	3.53	0.96
A ₃	13-19	5.6	31.0	0.9	0.192	1.97	1.17
B ₁	19-26	5.8	32.2	1.0	0.129	1.56	1.21
B ₂	26-33	6.4	33.1	1.2	0.066	0.96	1.28
C _{1cag}	42-52	7.7	16.5	0.4	0.021	0.68	

^apH by glass electrode.

^bTotal nitrogen by Kjeldahl method.

^cTotal carbon by total combustion method.

Discussion

Mechanical analyses. The distribution of clay (less than 0.002 mm. or 2 microns) with profile depth is presented in Figure 1. The Clarion-FT soils and Nicollet-FT soils are higher in clay content (5 to 8 percent in the A_p horizon, and 3 to 12 percent in the B₂ horizon, and 5 to 7 percent in the C horizon) than the normal Clarion and Nicollet soils.

The distribution of gravel (greater than 2mm.) with profile depth

is presented in Table 1. The FT soils are higher in gravel content in the B horizon (2 to 5 percent) but contents of the A_p and C horizons are similar.

Bulk density. The bulk density values of the four profiles are presented in Table 1. The Clarion-FT and Nicollet-FT soils have higher bulk densities in the B horizons than the Nicollet soils.

Chemical characteristics. Total nitrogen percentage, organic carbon percentage, and pH are presented in Table 1 for each of the four profiles.

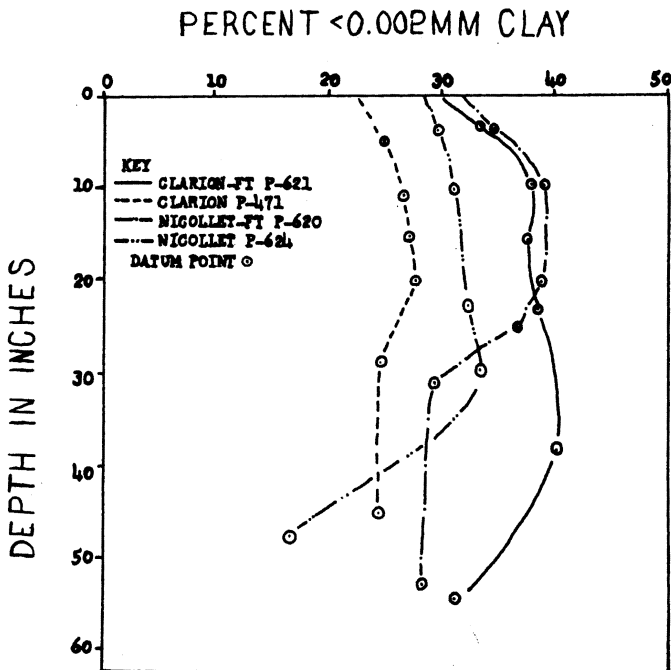


Figure 1. Distribution of clay (less than 0.002 mm. or 2 microns) with depth in Clarion-FT profile P-621, Clarion profile P-471, Nicollet-FT profile P-620, and Nicollet profile P-624.

CONCLUSIONS

The following conclusions are listed as a result of this study:

1. The fine textured variant Clarion and Nicollet soils are significantly different from what has been considered the normal Clarion and Nicollet soils. They differ by the following properties:

- a) The color of A₁ is lower in chroma.
- b) Mottling occurs at shallower depths.
- c) Clay percentage is higher in A₁, B₂ and C.
- d) The consistence is firmer.

- e) The structure is finer and of stronger grade; structural peds have glossy coatings which may indicate the presence of clay skins.
2. New series should be established for the fine textured variant soils.
3. The features of the fine textured variant soils observable by field examination will allow a reasonably accurate field separation of the normal and the fine textured variant soils.

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