Characteristics of Some Soils of the Iowan Till Area of Northeast Iowa

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The published county soil surveys show that Carrington loam and silt loam soils occur extensively in the CC and CKC areas of northeast Iowa outlined in Figure 1. Most of these soil surveys were made from 1914 to 1930, and as pointed out by Simonson, Riecken and Smith (1952), the former Carrington series in this area is now considered to consist of several series. In the present study several morphologically different profiles formerly included with the Carrington loam and silt loam soil types were sampled and certain laboratory determinations made. The data obtained and a brief discussion of their significance are presented.

Soil Forming Factors of the Area

Kay and Graham (1944) considered the glacial till in the areas designated as "CC" and "CKC" in Figure 1 to be of Iowan age, and, according to Ruhe and Scholtes (1955), was deposited about 24,000 years ago. Riecken, Allaway and Smith (1947) reported that several till samples of these areas ranged in clay content from about 22 to 32 percent. The till samples collected in the Howard County area were generally somewhat higher in clay content than the till in other parts of the CC and CKC areas. On the basis of general field studies, they outlined a "plastic till variant" of Carrington soils which is shown as the CKC area of Figure 1.

Kay (1931) reported that a "pebble band", a layer of coarse textured material containing many pebbles, was common in the area. Some of these pebbles have been called ventifacts. This pebble band commonly occurs at a depth of 15 to 30 inches and is about 3 to 6 inches thick. Below the pebble band the material is a slightly firm to firm till. Commonly the till contains more coarse material and is more compact than the material above the pebble band. Thus, the parent material for the Carrington loam and silt loam types is "two-story".

The Carrington loam and silt loam types of the CC and CKC areas outlined in Figure 1 usually occur on upland convex sites of 1 to about 5 percent slopes. The profiles collected in this study

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PRINCIPAL SOIL ASSOCIATION AREAS IN IOWA

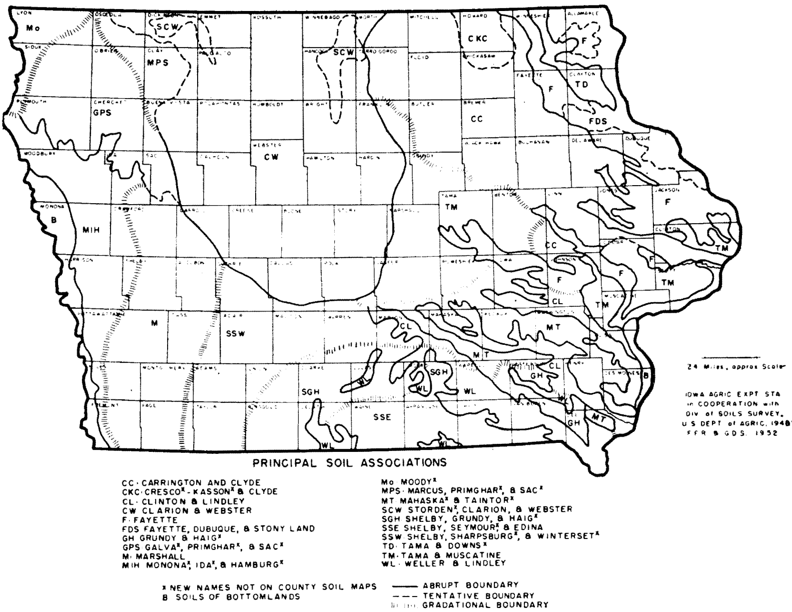

Figure I. Distribution of soils formed from Iowan Till, as shown by "CC" and "CKC", in relationship to principal soil association areas of Iowa.

were taken from convex sites of about 2 to 3 percent slope.

Vegetation is one of the more important soil forming factors of this area. At time of settlement, prairie was the dominant vegetation of the area, though smaller areas of trees were present near the major streams. Ruhe and Scholtes (1956) consider that in the period of about 16,000 to about 5,000 years ago the climatic environment of Iowa was favorable to forest, and predominantly since that time to prairie.

Ruhe and Scholtes (1956) consider the maximum time of soil formation in the CC and CKC areas of Figure 1 could be as much as 24,000 years on sites that had not undergone any erosion changes since the retreat of the Iowan glacier. Whether the age of the profile sample sites of this study approaches this maximum, or is considerably less, is not known at this time.

Description of Profiles Sampled

The locations and descriptions of the five profiles collected are given below. Terminology, including the moist color designation, is as outlined in the Soil Survey Manual (1951). Profile P-409 is classified by the authors as a Gray-Brown Podzolic soil profiles P-224, P-225, and S-227 as Brunizems and profile P-225 as a Gray-Brown Podzolic Brunizem intergrade.

P-224 Location: SW corner of SE¼ SE¼ NW¼ Sec. 27, R 13 W, T 99 N, Howard County, Iowa, or about in the center of the county.

A 0-7″ Black (10YR2/1)* silt loam; granular structure.

7-17 Very dark gray (10YR3/1) silt loam; granular structure.

A-B 17-21 Dark grayish brown (10YR4/2-5/4) slightly plastic clay loam; few faint fine yellowish red (5YR5/8) mottles; granular structure; pebble band in this layer.

B_2 21-25 Brown (10YR5/3) slightly plastic clay loam; subangular blocky structure coated with pinkish gray (5Y7/2); few faint yellowish red (5YR5/6) mottles.

B_2 25-40 Light olive gray, gray and light gray (5Y6/2, 5/1, 7/2) plastic clay loam; coated moderate fine subangular blocky structure; reddish yellow (5YR6/8 to 5/6) mottles.

B_3 40-50 Gray, pinkish gray and light olive gray (5YR6/1, 7/2 and 6/2) plastic clay loam; strongly mottled with yellowish red (5YR5/6) and yellowish brown (10YR5/6); moderately weak irregular fine blocky structure.

C 50+ Gray to light olive gray (5Y6/1-6/2) plastic clay loam; calcareous; strongly mottled and splotched with yellowish brown (10YR5/6).

P-225 Location: SE corner of W¼ SE¼ Sec. 8, R 12 W, T 96 N, Chickasaw County, Iowa, or in the north central part of the county.

A_1 0-10″ Black to very dark gray (10YR2/1-3/1) silt loam; fine granular structure.

A_2 10-15 Dark grayish brown (10YR4/2-3/2) silt loam which is gray when dry; very weak granular structure.

A_3 15-20″ Dark yellowish brown (10YR4/4) silt loam; very weak granular structure.

B_1 20-25 Brown (10YR5/3) clay loam; faint yellowish brown (10YR 5/8) mottles; weak granular structure which tends to be oriented into weak platy layers.

B_2 25-35 Yellowish brown to brown (10YR5/6-5/3) slightly plastic clay loam; yellowish brown (10YR5/8, 6/8, 5/6) mottles; some vertical faces strained with dark organic matter; moderate fine blocky structure. (Pebble band at top of layer, but not too evident.)

B_2 35-42 Dark grayish brown (10YR4/2-5/2) slightly plastic clay loam; very dark gray and yellowish brown (10YR3/1-5/8) mottling; moderate fine blocky structure.

B_3 42-54 Yellowish brown to light olive gray (10YR5/8 to 5Y6/2) slightly plastic clay loam; some cleavage faces coated with gray to very dark grayish brown (10YR6/1 to 3/2); weak fine blocky to massive structure; calcareous at base of layer.

P-226 Location: SE corner of N½ SW¼ Sec. 10, R 9 W, T 89 N, Buchanan County, Iowa, or about in the center of the county.

A_1 0-6″ Very dark brown (10YR2/2) silt loam; fine granular structure.

A_1 6-11 Very dark gray (10YR3/1) silt loam; fine granular structure.

A_3 11-15 Very dark grayish brown (10YR3/2) silt loam; weakly developed fine granular structure.

B_1 15-23 Dark grayish brown to dark brown (10YR4/2-4/3) silt loam; weak fine subangular blocky structure.

B_2 23-28 Yellowish brown (10YR5/4) very slightly plastic loam with few faint brownish yellow (10YR6/8) mottles; pebble band at top of layer; moderately weak fine blocky structure.

B_3 28-34 Light yellowish brown to yellowish brown (10YR5/4-6/4) very slightly plastic loam; few faint fine yellowish brown mottles; weakly developed fine blocky structure.

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*Munsell colors on moist soil.

P-227 Location: SW corner of N¼ SW¼ Sec. 20, R 18 W, T 98 N, Mitchell County, Iowa, or in the west center part of the county.

A_1 0-11" Very dark brown to black (10YR2/2-2/1) friable silt loam; moderately weak very fine granular structure.

A_3-B_1 11-21" Very dark grayish brown (10YR3/2 to 4/2) silt loam; moderately weak fine granular to subangular blocky structure.

B_2 21-29 Dark grayish brown (10YR4/2) loam; very few faint fine yellowish brown (10YR5/6) mottles; moderately weak fine blocky structure; pebble band is in this layer.

B_2-B_3 29-34 Dark brown (10YR4/3-4/4) slightly plastic loam; very few faint fine yellowish brown (10YR5/6) mottles; moderately weak fine blocky structure.

B_3 34-40 Light yellowish brown (10YR5/4-6/4) slightly plastic loam; very few faint fine yellowish brown (10YR5/6) mottles; weak fine blocky structure.

P-409 Location: NW¼ NE¼ Sec. 3, R 15 W, T 99 N, Mitchell County, Iowa, or in the northeast part of the county.

A_1 0-3" Very dark brown (10YR2/2) silt loam; very weak very fine platy to granular structure.

A_2 3-7 Pale brown (10YR6/3) silt loam; weak very fine platy structure.

A_3 7-10 Yellowish brown (10YR5/4) silt loam; irregular very fine granular structure which is oriented into platy units; peds are coated pale brown (10YR6/3).

B_1-B_2 10-16 Grayish brown and yellowish brown (10YR5/2-5/6); some areas of strong brown (7.5YR5/8); slightly plastic clay loam; irregular moderately weak fine subangular blocky structure; pebble band at base of layer.

B_2 16-22 Grayish brown (10YR5/2) plastic clay loam; few faint fine yellowish red (5YR5/8) mottles; moderate fine blocky structure with glossy clay and organic matter coatings.

B_2-B_3 22-30 Gray (10YR6/1)plastic clay loam; few faint fine yellowish red (5YR5/8) mottles; moderate fine blocky structure with gray (10YR4/1) clay skins.

B_3 30-40 Yellowish brown and grayish brown (10YR5/6-5/2) plastic clay loam; irregular moderately weak fine blocky structure; some vertical faces with gray and yellowish brown (10YR 4/1-5/8) coatings.

B_3-C_1 40-46 Yellowish brown (10YR5/6) plastic clay loam; weak irregular subangular structure; calcareous beneath this horizon.

Laboratory Studies

Total nitrogen and carbon, pH, exchangeable Ca, Mg, K, Na, and H, and particle size data were obtained on all five profiles. Bulk density data were obtained for all profiles except P-409. An outline of, or reference to, the standard methods used is given by White (1950).

Physical Properties

The particle size data obtained by the pipette method are plotted in Figure 2. In the upper part of the profiles there is more silt and less sand* than in the lower part. In general, the pebble band, noted in the profile descriptions, demarcates the materials of dif-

*See Soil Survey Manual (1951) for sand, silt, and clay diameters.

ferent sand and silt content. Also, bulk density data by White (1950) show the till, the material below the pebble band, has a bulk density of about 1.55 to 1.8; but the material above the pebble band has a bulk density of about 1.15 to 1.40.

The 0.002 mm. clay data are also plotted in Figure 2. There is no striking difference in clay content between the upper and lower parts within profiles P-226 and P-227, though there is somewhat more clay in the lower parts of profiles P-224, P-225, and P-409. Profiles P-226 and P-227 have about the same content of clay in their lower parts, or about 20 to 25 percent; but profiles P-224, P-225, and P-409 have about 28 to 32 percent clay in their lower layers. In the morphological descriptions for the 15- to 30-inch layers, profiles P-226 and P-227 have mostly brown colors, but profiles P-224, P-225, and P-409 have mottled colors or gray and brown colors. This is interpreted by the authors as indicating these latter profiles are less well drained than the former, due chiefly

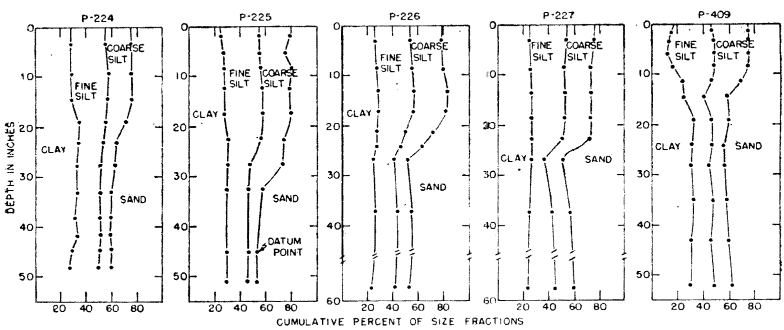

Figure 2. Cumulative percent of size fractions in profiles P-224, P-225, P-226, P-227 and P-409.

to the higher clay content of the till from which they are forming in part.

As the B horizons are forming from a two-story parent material, an evaluation of the amount of clay accumulation in the B horizons is not possible with the present data. However, there does appear to be a slight accumulation of clay in the B horizon of profiles P-224, P-225, and P-409.

Exchangeable Cations

Exchangeable cation data are presented in Figure 3 or in Table 1. Percent base saturation is plotted in Figure 4. In Figure 3 are plotted the sum of the milliequivalents of the exchangeable H, Ca, and Mg cations. These sums, or the cation exchange capacity, are closely related to the clay and organic matter content of each layer. Profiles P-409 and P-225 have a lower value in their A_2

Table 1.
Total nitrogen and carbon, and pH and exchangeable Na and K for profiles P-224, P-225, P-226, P-227 and P-409.

Depth inches	pH	K (m. e./100 gm.)	Na (m. e./100 gm.)	N (percent)	C (percent)
P-224					
0-7	6.0	0.18	0.09	0.305	3.89
7-12	5.4	0.12	0.09	0.222	2.54
12-17	5.0	0.10	0.09	0.134	1.41
17-21	4.7	0.12	0.11	0.090	0.74
21-25	4.7	0.12	0.12	0.046	0.50
25-30	4.8	0.12	0.10	0.035	0.39
30-36	4.9	0.12	0.10	0.039	0.35
36-40	5.8	0.14	0.11	0.039	0.29
40-43	6.9	0.11	0.11	....	0.29
43-46	7.9	......	......	....	......
46-50	8.1	......	......	....	......

Depth inches	pH	K (m. e./100 gm.)	Na (m. e./100 gm.)	N (percent)	C (percent)
P-227					
0-6	5.6	0.34	0.04	0.258	3.37
6-11	5.8	0.29	0.06	0.187	2.42
11-16	5.2	0.34	0.06	0.102	1.42
16-21	5.2	0.34	0.06	0.091	1.09
21-24	5.1	0.42	0.06	0.065	0.87
24-29	5.3	0.28	0.06	0.040	0.34
29-34	5.4	......	......	....	0.21
34-40	....	0.34	0.06	0.027	0.15
55-60	8.0	0.27	0.04	....	......

Depth inches	pH	K (m. e./100 gm.)	Na (m. e./100 gm.)	N (percent)	C (percent)
P-225					
0-4	5.3	0.29	0.07	0.319	3.65
4-7	5.2	0.21	0.06	0.291	3.44
7-10	5.1	0.21	0.08	0.243	2.43
10-15	4.9	0.22	0.06	0.147	1.12
15-20	4.7	0.25	0.06	0.095	0.70
20-25	4.5	0.36	0.06	0.056	0.46
25-30	4.5	0.35	0.05	0.036	0.29
30-35	5.0	0.29	0.04	0.026	0.20
35-42	5.5	0.30	0.04	....	0.15
42-48	6.8	0.21	0.04	....	0.09

Depth inches	pH	K (m. e./100 gm.)	Na (m. e./100 gm.)	N (percent)	C (percent)
P-409					
0-3	5.2	0.14	......	0.183	2.50
3-5	5.1	0.06	......	0.070	0.95
5-7	5.1	0.06	......	0.052	0.54
7-10	4.9	0.06	......	0.043	0.35
10-13	4.7	0.07	......	0.036	0.36
13-16	4.7	0.11	......	0.038	0.30
16-22	4.6	0.12	......	0.033	0.22
22-26	4.6	0.15	......	0.025	0.20
26-30	4.7	0.19	......	0.023	0.18
30-40	5.1	0.19	......	0.020	0.22
40-46	6.3	0.19	......	0.021	0.15
50-54	7.9	0.16	......	....	......

Depth inches	pH	K (m. e./100 gm.)	Na (m. e./100 gm.)	N (percent)	C (percent)
P-226					
0-6	5.0	0.42	0.04	0.281	3.37
6-11	5.0	0.28	0.05	0.229	2.73
11-15	5.1	0.28	0.06	0.151	1.72
15-19	4.9	0.32	0.07	0.091	1.04
19-23	4.9	0.35	0.06	0.065	0.61
23-25	5.0	0.32	0.07	0.036	0.44
25-28	5.0	0.30	0.06	0.023	0.22
28-34	....	0.22	0.07	0.018	0.18
34-40	5.2	0.28	0.06	....	0.15
56-60	....	0.27	0.04	....	
60-70	7.7	0.22	0.04	....	

layers, and the shape of their cation curves are different from that of profiles P-224, P-226, and P-227. Also from Figure 3, it is evident that exchangeable Ca^{++} is present in a higher proportion than exchangeable Mg^{++}. The exchangeable H^{+} values are also plotted in Figure 3, with profile P-409 having a curve of different shape than the others. Profiles P-216 and P-227 have a lower content of exchangeable H^+ in the 25- to 35-inch layer than do profiles P-224, P-225, and P-409. The base saturation values, plotted in Figure 4, also show that profiles P-226 and P-227 have a higher base status in the 25- to 35-inch layer than the other profiles. On the basis of texture and natural drainage, one would anticipate a greater leaching in profiles P-226 and P-227 than in the others. Another explanation will be offered later.

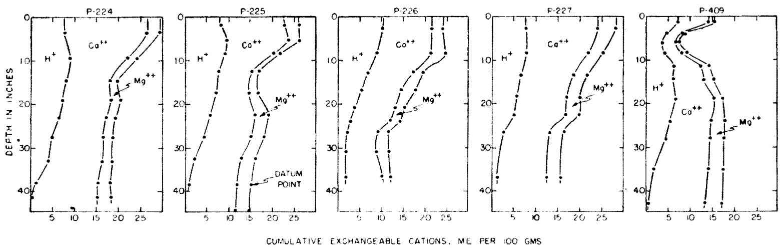

Figure 3. Cumulative exchangeable Ca++, Mg++ and H+ in profiles P-224, P-225, P-226, P-227 and P-409.

Total Nitrogen and Carbon

The total nitrogen and carbon content of each profile is shown in Table 1, and the former values are plotted in Figure 5. Profile P-409 is lower in nitrogen and carbon than the other profiles. Profiles P-224 and P-225 have slightly higher nitrogen content than P-226 and P-227. As noted above, the latter profiles are the better drained, and this may explain why their organic matter content is slightly lower. However, these four profiles have quite similar nitrogen contents as well as distribution with depth. From its morphology we anticipated P-225 would have a slightly lower nitrogen content in its A_2 layer. This will be discussed later.

Discussion

Profiles P-226 and P-227 appear to be very similar and are derived in part from the more friable phase of the till. These two profiles have characteristics of the Brunizem as outlined by Smith, et al. (1950). If these soils supported any vegetation other than prairie, then it must have been for a very short period.

Profile P-409 has characteristics of Gray-Brown Podzolic soils as reported by White and Riecken (1955), Green (1952), Smith, et al. (1950), and Muckenhirn and others (1955). Profile P-409 could have been forested during the entire period since the retreat of the Iowan glacier. However, the small size of the area of Gray-Brown Podzolic soils at the sampling site may indicate that it had not supported forest vegetation for the entire period. The forest boundary may have receded and advanced, according to climatic conditions, from a forest nucleus somewhere in the Wapsipinicon River Valley a quarter-mile away. McComb and Loomis (1944) suggest that forest boundaries have receded and advanced in the post-glacial period.

Interpretation of the data for the profiles P-224 and P-225 is more speculative. These profiles have nitrogen content and distribution quite similar to profiles P-226 and P-227 and other Brunizems (Smith, et al., 1950). Studies by White and Riecken (1955) and others indicate that Gray-Brown Podzolic soils have thicker sola with lower base status than the analogous Brunizem. On a lightly forested Tama soil White (1953) found that the decrease in the base status and pH of the B horizon proceeds quite

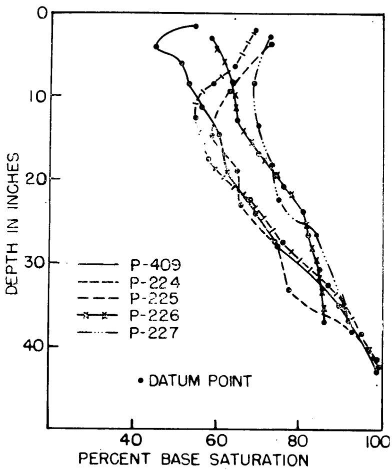

Figure 4. Percent base saturation with depth in profiles P-224, P-225, P-226, P-227 and P-409.

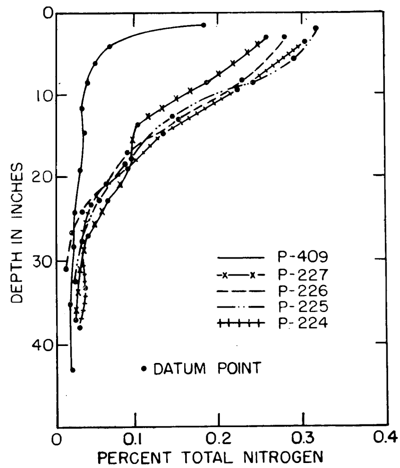

Figure 5. Percent total nitrogen with depth in profiles P-224, P-225, P-226, P-227 and P-409.

rapidly and ahead of a pronounced textural A_2 horizon. On Brunizem-Gray Brown Podzolic intergrade profiles, where forest presumably had encroached on prairie, White and Riecken (1955) showed the intergrade or transition profiles had nitrogen and base status curves like Gray-Brown Podzolic soils. These considerations, and the base status data of profiles P-224 and P-225, lead us to the conclusion that these profiles existed in some earlier time under forest, and their lower base status is a relict feature. From their morphology it seems that P-225 was under forest for a longer period than P-224. However, the nitrogen content and distribution in profiles P-224 and P-225 could have developed under-prairie. Therefore, it seems reasonable to conclude that these profiles have been under prairie vegetation for the latter stage of their formation.

The two profiles, P-226 and P-227, are considered to be quite similar, and should be classed in the same series, possibly with the Kenyon series. Profile P-409 should be included with a new series yet to be established. Profile P-224 should be included with the Cresco series, proposed by Simonson, et al. (1952). Profile P-225 is somewhat similar to the Kasson series of Minnesota, and it may be appropriate to include it with that series.

Summary

Data have been obtained for five profiles formerly included with the Carrington silt loam and loam types in Iowa. The particle size data indicate that these profiles formed from two-story parent materials. The above-the-pebble-band material is higher in silt and lower in sand and bulk density than the till material below the pebble band.

Two profiles, P-226 and P-227, have formed in part from a more friable phase of the till. They have characteristics of Brunizem soils, and they presumably developed principally under prairie.

One profile, P-409, has characteristics of Gray-Brown Podzolic soils. It developed in part from the more firm phase of the till and presumably dominantly under forest.

Profiles P-224 and P-225 have nitrogen contents similar to Brunizem soils, but have base status indicating they have some relict features of forest influence. P-225 has more evident relict forest influence features than P-224. These two profiles have formed in part from the more firm phase of the till.

Of the five profiles studied, two profiles, P-226 and P-227, may be within the range of the Kenyon series. Profile P-409 may need to be included with a new series yet to be established. Profile P-224 can be included with the proposed Cresco series, and P-225 possibly with the Kasson series.

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