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Profile Characteristics of Some Forest-Formed Soils Derived from Iowan Till[1]

By J. M. SOILEAU and F. F. RIECKEN

Abstract. Three profiles were collected in Bremer and Floyd counties to represent the proposed Coggon series; detailed field and laboratory studies were conducted on these profiles. The Coggon soils have developed under forest vegetation from a "two-story" parent material consisting of a silty mantle-pebble band-glacial till sequence. Being formed from Iowan-age glacial till, the Coggon profiles exhibit an amount of development that is low compared to other Gray-Brown Podzolic soils of Iowa. Coarser parent material might possibly explain why Coggon is less developed than the Weller soils, which are formed from presumably younger, loessial parent material. On the other hand, the lack of development in Coggon could be explained by its youth if one considers the possibility that the present geomorphic surface of the Iowan till represents a rather young pedi-sedimented surface which is more recent than the last glaciation.

From published county soil survey reports, about 63,000 acres have been mapped as Lindley loam and silt loam types in the Iowan till area of northeast Iowa (Brown, 1936). Counties shown as having more than 4,000 acres include Buchanan, Bremer, Chickasaw, Floyd, Linn, and Worth. However, recent trends are to restrict Lindley series to areas of pre-Wisconsin till, which include paleosols (Prill and Riecken, 1958). Therefore, the tentative Coggon series has been proposed to replace much of the loam and silt loam types of the Lindley series in the Iowan till area (Simonson, *et al.*, 1952). In the current re-survey of the soils of Bremer and Winneshiek counties the tentative Coggon series is shown on the soil legends.

The main purpose of the present study was to obtain additional information on the morphology of the proposed Coggon series to aid in its characterization and definition.

FIELD STUDIES AND SOIL PROFILE DESCRIPTIONS

The Iowan drift area of northeast Iowa has been outlined by Kay and Graham (1943). The Carrington-Clyde and Cresco-Clyde soil associations are the main soils of the area (Simonson, *et al.*, 1952). These are considered to be prairie-formed soils (White and Riecken, 1956), in contrast to the Lindley and proposed Coggon series, which are considered to have formed under forest vegetation.

Field visits were made to the main area shown as Lindley loam and silt loam on the various published county soil maps (Brown,

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1936). Subsequently, three soil profiles were collected in Bremer and Floyd counties to represent the proposed Coggon series. Detailed morphological descriptions were made and are reported elsewhere (Soileau, 1958). Generalized descriptions are given below for two profiles, with the nomenclature essentially that of the Soil Survey Manual (USDA, 1951). Munsell colors are on moist basis unless otherwise stated.

P-628 Coggon loam

Site and location: About 120 feet north and 60 feet west of the southeast corner of the SW¼ Sec. 1, Township 93 North, Range 13 West, Bremer County, on a 4 percent, south-facing slope; bluegrass pasture with scattered hickory and oak trees; site perhaps has never been cultivated.

A_1: 0-4 in. Very dark gray (10YR 3/1) granular, friable loam.

A_2: 4-9 in. Dark grayish brown (2.5Y 4/2) platy, friable loam.

A_3: 9-11 in. Transitional; dark grayish brown (10YR 4/2) friable loam.

B_1: 11-14 in. Dark grayish brown (10YR 4/2), fine to medium blocky, friable, heavy loam.

B_2: 14-18 in., 18-23 in., 23-26 in. Pebble band in upper part of this horizon. Dark brown to brown (10YR 4/3, 4/2, 5/3) with mottles of yellowish brown. Medium blocky, friable sandy clay loam; the structure pieces have glossy coatings (clay skins or clay films).

B_3: 26-30 in., 30-35 in. Mottled yellowish brown (10YR 5/4, 5/6) with some dark gray glossy clay film coatings on structure pieces and in root channels; medium blocky, friable sandy clay loam.

C_1 35-41 in., 41-50 in., 50-54 in. Mottled light brownish gray and brownish yellow; friable to firm sandy clay loam; structure is coarse blocky to almost massive, with roots along vertical cleavage planes; along the cleavage planes dark glossy coatings occur in patches.

C_2: 54-64 in., 64-74 in., 74-84 in., 84-94 in. Mottled yellowish brown, slightly firm loam; massive, highly calcareous till.

P-629 Coggon loam

Site and location: About 725 feet south and 390 feet east of the northwest corner of the NE¼ NE¼ Sec. 22, Township 93 North, Range 12 West, Bremer County, on a south-facing convex slope of 4 percent gradient. Bluegrass pasture with scattered hickory and oak trees; site perhaps has never been cultivated.

A_1: 0-3 in. Very dark gray (10YR 3/1) granular friable loam.

A_2: 3-8 in. Dark grayish brown (10YR 4/2), friable loam; platy.

A_3: 8-11 in. Transitional; dark grayish brown (10YR 4/2) friable loam.

B_1: 11-15 in. Mottled brown (10YR 5/3) and yellowish brown (10YR 5/4); friable loam; fine blocky.

B_2: 15-20 in., 20-25 in., 25-31 in. Pebble band in upper part of this horizon. Mottled brown (10YR 5/3), yellowish brown (10YR 5/6), pale brown (10YR 6/3). Friable to slightly firm sandy clay loam; fine and medium blocky; glossy coatings on structure pieces.

B_3: 31-37 in., 37-44 in. Mottled brown and grayish brown slightly firm sandy clay loam; medium blocky.

C_1: 44-52 in., 52-62 in., 62-72 in., 72-82 in. Mottled yellowish brown and grayish brown; slightly firm sandy clay loam; massive.

C_2: 82-94 in. As above, but calcareous.

The important genetic horizon features of the three Coggon profiles are: the thin, dark colored surface layer (A_1), the dark gray (light gray when dry) platy subsurface layer (A_2), and the brownish-yellow, blocky structured subsoil (B_2). Quite characteristic but difficult to describe are the following features: (a) the occurrence of glossy coatings (clay films) on the B layer natural structure pieces or peds; these coatings are more common on the vertical faces and are variable in thickness and continuousness; (b) the light gray (when dry), grainy ped surfaces in the lower subsoil (B_3-C_1). These grainy surfaces seem to be sand-sized materials, possibly mainly quartz, and are more evident along major vertical cleavage planes, especially after the soil has air-dried.

Laboratory Studies

The following analyses were made on bulk samples collected in the field: particle size analysis by the pipette method, bulk density, exchangeable cations (hydrogen, calcium, magnesium, and potassium), pH, total carbon, total nitrogen, and free iron. Standard methods of soil analysis were used, the details of which are reported

Table 1

Laboratory Data on Coggon Loam (P-629)

Genetic horizon	Depth (in.)	Particle size data[a] >2 mm. (%)	Sand (%)	Clay (%)	N (%)	C (%)	Free Fe (%)	Exchangeable cations Ca m.e./100 gms.	Mg	H	pH
A_1	0-3	0.1	36.4	13.7	.23	2.77	.74	8.6	3.1	4.9	6.2
A_2	3-8	0.2	39.6	12.3	.09	0.99	.70	3.6	2.4	3.1	6.0
A_3	8-11	0.4	37.0	14.9	.06	0.62	.86	3.6	2.5	2.6	5.7
B_1	11-15	0.7	36.5	16.1	.05	0.47	.89	3.4	2.6	2.9	5.6
B_{21}	15-20	1.8	34.3	21.5	.05	0.39	1.15	5.3	1.9	3.3	5.5
B_{22}	20-25	9.7	42.5	24.2	.03	0.25	1.33	4.9	2.4	4.3	5.3
B_{23}	25-31	3.2	57.8	22.0	.02	0.17	1.65	3.8	2.9	4.3	5.2
B_{31}	31-37	2.8	52.9	25.2	.02	0.17	1.77	5.2	3.0	4.5	5.1
B_{32}	37-44	3.5	52.5	25.7	.02	0.15	1.89	7.0	2.5	4.0	5.0
C_{11}	44-52	3.6	50.5	26.2	.02	0.11	1.52	8.8	2.2	2.8	5.2
C_{12}	52-62	3.6	51.0	25.3	.01	0.09	1.79	11.1	1.4	1.8	5.4
C_{13}	62-72	3.1	49.9	25.5	.01	0.08	1.62	–	–	0.2	7.1
C_{14}	72-82	3.1	50.9	24.6	.01	0.08	1.42	9.7	2.6	0.1	7.4
C_2	82-94	3.6	52.0	23.5	.01	0.45	1.28	–	–	–	8.0

[a]Based on material less than 2 mm.; sand = 2-.05 mm.; clay = less than .002 mm.

elsewhere (Soileau, 1958). The free iron method is the one described by Simonson, *et al.* (1957). Bulk density was determined by the core method, and the results obtained are reported elsewhere (Soileau, 1958). Laboratory data for one Coggon profile are given in Table 1, and particle size data for the other two profiles are given in Figure 1.

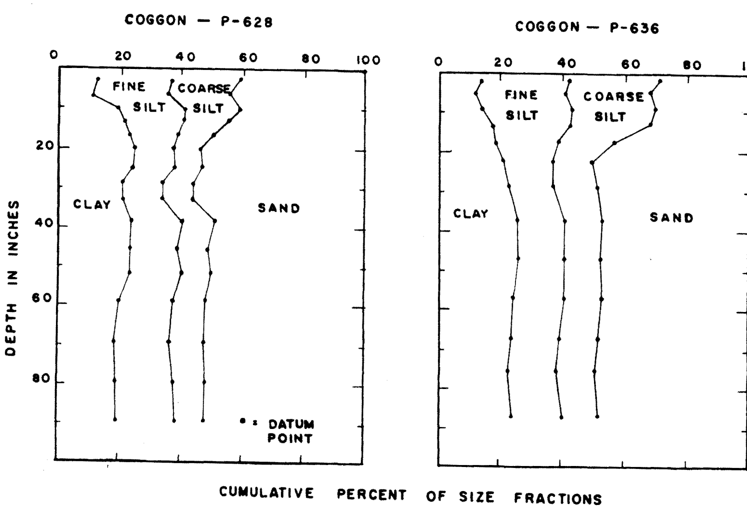

Figure 1. Particle size distribution with depth of Coggon P-628 and P-636 profiles.

Discussion

The particle size data given in Figure 1 and Table 1 verify field observation that a "pebble band" occurs at about the 15- to 20-inch depth in the three profiles. A somewhat similar situation previously was reported on by White and Riecken (1956) for prairie-formed Iowan till-derived soils. All three Coggon profiles analyzed contain a much higher percentage of silts above the pebble band than below. Also to be noted is that in the Coggon profiles the maximum clay content occurs in the B horizon but does not exceed 26 percent; the minimum clay content occurs in the A_2 horizon.

The total nitrogen data given in Table 1 are in agreement with the morphology in that nitrogen and organic carbon decrease abruptly below the A_1 horizon, a characteristic common to Gray-Brown Podzolic soils (White and Riecken, 1955).

From data in Table 1, it is seen that the general trend in the Coggon profiles is a relatively high base saturation in the A_1 horizon, minimum base saturation values in the A_2, and then progressive increase with depth to the zone of free carbonates. In all Coggon profiles the highest pH of the solum occurs in the surface A_1 horizon, and there is a gradual decrease with depth to a minimum value in the B horizon. Calcium is the dominant exchangeable base.

Free iron content more or less follows the content of clay throughout the Coggon profiles. A somewhat similar relationship previously was reported for other well drained Gray-Brown Podzolic soils (Green and Riecken, 1953; Simonson, *et al.*, 1957; White and Riecken, 1955).

Comparison With Other Gray-Brown Podzolic Series

Compared to the Hayden profiles studied by Green and Riecken (1953), the Coggon profiles have a pebble band, and evidently have formed in a "two-story" parent material (White and Riecken, 1956). The pebble band has been observed to be a feature of the Iowan till landscape (Kay and Graham, 1943). The Coggon profiles have a lower base saturation and a greater depth to carbonates than the Hayden profiles.

Compared to Lindley profiles, the Coggon profiles have less clay in the B horizon; paleosol profiles, perhaps of Late Sangamon age, have been reported to be inclusions with the Lindley series (Green and Riecken, 1953). The Lindley soils may have a more reddish or stronger brown colored B horizon than the Coggon soils.

Compared to loess-derived Gray-Brown Podzolic soils (White and Riecken, 1955), the Coggon profiles have high amounts of sand-sized materials.

Soil Formation

Formation of soil is considered to be influenced by parent material, vegetation, topography (natural drainage), time, and climate. Comparing Coggon profiles to Fayette, Hayden, and Weller profiles, it seems that all have formed under good natural drainage conditions, if free iron distribution with depth is considered. In Figure 2 the general relationship of free iron and clay distribution with depth can be noted. Green and Riecken (1953) and Simonson, *et al.* (1957) have observed that in Gray-Brown Podzolic profiles the free iron and clay are positively related.

From data presented in this paper, it is concluded that the Coggon series is quite similar to Fayette, Hayden, and Weller series in horizon sequence, nitrogen content, and base saturation with depth (Green and Riecken, 1953; Simonson, *et al.*, 1952; White and Riecken, 1955). All of these series are presumed to have formed under forest, dominantly of oak-hickory types, and are classified with the Gray-Brown Podzolic great group of soils (Simonson, *et al.*, 1952). Climate presumably has been similar in these series for a considerable period, possibly since the end of the last glacial sub-age.

There remains the consideration of the influence of parent material and time. In 1956 Ruhe and Scholtes considered the age of uneroded uplands of Iowan till of northeastern Iowa to be about 16,000 to 24,000 years. On this basis, the Coggon profiles of this study would be of that age. Other data indicate the Iowan till may have been deposited before the Farmdale loess and that the Iowan till is older than 29,000 to 35,000 years (Ruhe, *et al.*, 1957). On the other hand, there may be some basis for suspecting that the present geomorphic surface of the Iowan till in northeastern Iowa may be a rather young pedi-sedimented surface (Ruhe, 1956), which is more recent than the last glaciation.

On the basis of clay content, base saturation, and Ca/Mg ratios (White and Riecken, 1955), the Weller profile (Figure 2) is a more strongly developed profile than Coggon. If the 1956 landscape ages of Ruhe and Scholtes are used, the Weller profile is younger by about 2,000 to 8,000 years. In searching for an explanation for less development of the Coggon than the Weller, the differences in parent material could be considered important. The Weller profile is loess-derived; the silt particles possibly could have weathered to form more clay than the Coggon profile, where a considerable sand-sized fraction occurs.

However, if one considers the possibility that the Coggon sites are rather young geomorphic surfaces, consisting of a pedi-sediment overlying a pebble band on glacial till, then the lack of development in the Coggon could be explained by its youth. In this respect, it can be pointed out that White and Riecken (1956) found little evidence of textural profile development in prairie-formed Iowan till-derived soils.

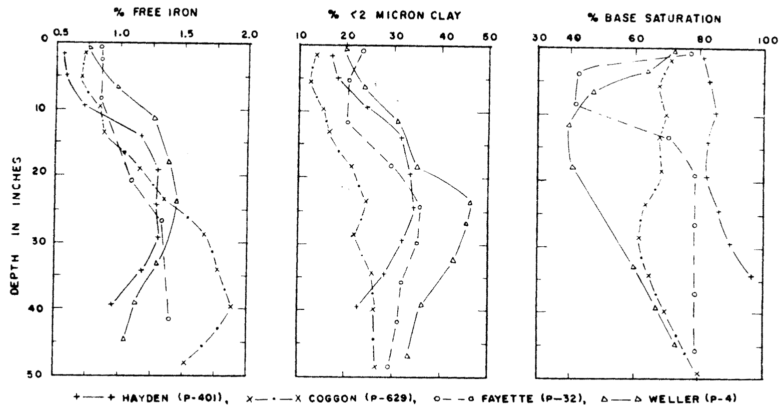

Figure 2. Free Fe, per cent clay, and base saturation distribution with depth in profiles Hayden (P-401), Coggon (P-629), Fayette (P-32), and Weller (P-4) series.

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