Between 1927 & 1930 ??

The Well-drained soil profile
On the Illinoian till-sheet.

(Introduction - to be written) by Paul MacClintock

It seems to be cogent at the present time to summarize the evidence gathered from field observation in regard to the horizons developed in the upper part of the till sheet during its weathering. The succession of these horizons from surface downward comprises the soil profile. Profiles on the Illinoian till-sheet may most easily be grouped into two major categories. First, those formed under well-drained conditions, in which the sesquioxide decomposition products are largely removed in the ground-water circulation, and second, those formed under poorly drained conditions, in which the sesquioxide products are largely retained. The former is commonly a deep silty profile, while the latter is commonly shallower, heavier, clay profile, known to geologists, when it is well- developed, as gumbotil. This present discussion will concern itself only with the first of the two kinds. It is obvious that the two so grade into each other that sharp lines of demarkation can not , in many cases be drawn, though there is reason to think that fundamental and delicate response to subsurface moisture conditions may be significant in some cases. The subject is here considered from the geological standpoint; centering on the processes involved, as manifested by their results observed in the field.

The obvious processes are (1) oxidation of iron, (2) leaching of the carbonates, (3) disintegration of the silicates, and (4) formation of the dense subsoil horizon. Doubtless these processes are in progress contemporaneously, but the fact is that they have progressed to different depths. They may be considered therefore to have progressed at different rates, and for this reason the soil section does not pre-

sent a continously grading soil profile but rather one made up of fairly distinct horizons grading relatively quickly one into the next There are ~~course~~ of course gradations and variations within an horizon but they are of a distinctly different, and smaller, order of ~~mabgnitude~~ fro magnitude from the variations ~~from~~ between one horizon to another. In a young profile the horizons are not yet developed clearly, for the processes have not had time to differentiate zones according to speed of activity of the weathering agents. A mature profile then, is one which is old enough for the faster processes to have outrun the slower ones enough to produce characteristic zones.

In the weathering ~~to~~ the till-sheet oxidation of the iron has progressed deepest so that the surface of the drift sheet is rusty in color commonly to depths of 2o to 3o feet, while the leaching of the carbonates falls short of this depth by 5 to 10 feet. As a result there is a practically omnipresent zone which is oxidized but unleached. Likewise leaching has outrun silicate decomposition so that there is a zone which has been oxidized and leached of its carbonates but which still contains undecomposed silicates. And thirdly, there is present a zone in which the clay-like products of the decomposition have not been removed. This zone is then recognized by its greater clay content than either that above or below. Above the latter zone of <u>decomposing</u> silicates lies the zone in which the silicates have been largely <u>decomposed</u>, and furthermore from which the clay-like decomposition products, as well as the clay matrix original to this zone, have been sufficiently removed to leave a siliceous silt. And finally the subsoil is an horizon of accumulation of material added to it by percolating water(illuviation) from the surface soil or topsoil

from which material has been removed by downward percolating water (eluviation) to leave a light silt. (Fig 1) It is to be recognized that all these phases of soil formation do not proceed to completion except in a purely theoretical way for it is obvious that during the weathering of the drift sheet the whole surface is being lowered continually, though very slowly. We are therefore discussing features transitory in one sense but permanent in another. It is a process involving the lowering of the whole profile as a unit, (as a group of horizons) with the elements of the profile remaining fixed only with referrence to each other. It is observably true, however, that even in this progressive process of lowering the surface by weathering, the aforementioned subprocesses have produced horizons different enough in characteristics to be recognizable in the field.

With these considerations in mind a generalized profile, composed of the most fundamental horizons, may be constructed. The variations of individual profiles; in the thickness of zones, the character of zones or even in the absence of one zone, depend on the local conditions of that particular profile. But in each case most of the fundamental horizons are recognized. In specifying the horizons of the profile the soil technologists have adopted the system of lettering the horizons from the surface downward. The surface soil being designated by A, the subsoil by B, and all the material below the subsoil by C. To quote from Glinka[1]

[1] The Great soil Groups of the World and their Development. By K. D. Glinka. Translated from German by C. F. Marbut. Edwards Bros. Ann Arbor Mish. P 12 1927.

"In recent investigations of the soil horizons are designated as follows; the letter A is used to de-

signate the eluvial horizon, that is to say, the horizon from which in the process of soil formation either by chemical of mechanical means more of less material has been removed. With the letter B the illuvial horizon is usually designated. This is the horizon into which material has been carried, chemically or mechanically. The parent rock beneath is designated by the letter C."

And from Shaw[2];

C. F. Shaw, University of California Publications.

" Horizon A is the upper part of the soil mass from which material has been removed by percolationg water, the horizon of eluviation, the surface soils. Horizon B is the horizon of deposition to which material has been added by percolating waters; the horizon of illuviation; the subsoil. Horizon C is the horizon of relatively unweathered material underlying the B horizon; the parent material."

This mode of designating the horizons has many obvious advantages from the technical point of view for it does not limit interpretation by narrowing, and possibly immature, definition. But for the geologist and for the non-specialist in general there seems to be no need for abandoning the well-known and commonly used terminology of top-soil and subsoil. Furthermore the C horizon of the specialist lumps together zones of such different character and particularly of such different mode of origin, that there seems to be need for other terms which will carry with them the idea of the genisis of the horizon specified. The proposed generalized well-drained profile for the Illinoian till-sheet using genesis as the fundamental consideration is as follows:-

(Fig 1.)

Name of horizon	Character	Process	Result.
Topsoil	Silt light, fluffy.	Removal of clay; Decomposition of Silicates; Leaching of carbonates; oxidation of iron; Eluviation	Iron oxidized Carbonates lchd * Sil. Decompsd. Eluviated.
Subsoil	Clay-silt Dense, slick.	Illuviation	Iron oxid. Carb. Lchd. * Silic. Decomp'd Illuviated.
Eluviated Till "Eluviatil"	Silt Friable, siliceous.		Iron oxidized Carbs. lchd. Silic. Decomp clay removed.
Clay till-cap.	Clay silt Decomposing silicates.		Iron oxidized Carbs. Lchd. Silicates decomposing. Some illuviation.
Cellular till	Till Cellular, porous holes left by solution of carbonate pebbles.		Iron oxidized Carbs. Lchd.
"Oxi-calc" till	Till Calcareous buff.		Iron oxidized
Fresh till	Till Calcareous, blue-gray		

* Note. Where carbonates are present in the upper part of the profile they are of secondary origin, ~~and~~ formed by ~~the~~ carbonation, and have no significance in this discussion.

The new term introduced which might be elucidated are;

(1) "Eluviatil". It is used to designate that horizon of friable silt below the heavier subsoil layer. It is the zone in which silicates are largely, though not commonly entirely, disintegrated, but particularly from which both the clay matrix of the original till and also what clay-like decomposition products were formed in the silicate decomposition have been removed. Downward percolating water was evidently the agent. Such a process being designated as eluviation the concept of eluviated till and hence "eluviatil" naturally followed. The character of having the silicates decomposed is not sufficient to characterize this zone for this is true even to a greater extent in the topsoil and the subsoil.

(2) "Clay till-cap" This horizon is composed of heavier, partly decomposed till, in which there is more clay present making it a heavier and darker zone than either the one above or below it. The clay is probably partly residual within this zone itself and partly added to it from above. It is leached of its carbonates, and is oxidized, but so are all the zones above it as well as the one below it. Hence, since it is still till in structure but has acquired a heavier character and since it is the top of the recognizable till it is designated as the "clay till-cap".

(3) Cellular till is so designated because of its most outstanding characteristic, i.e. its cellular aspect produced by the solution and removal of the calcareous pebbles original to the till. (Photo Fig 2). It, however, still possesses the structure and texture of till. It is leached and oxidized, but since this is also true of all the zones above it, the designation of oxidized and leached zone has little

specific value as characteristic of this particular horizon.

The following sections are given as examples of well-drained profiles. They were measured and described at exposures along the highways or railroads where the material could be studied in a fresh cut. They all represent the weathering of the top of the till-sheet during the time since its deposition. Where pebbles are specified it is meant that they are conspicuous on the surface of the exposure. The fact is that there are small chert pebbles entirely throughout all the soil profiles given, but are commonly not seen till the material is screened. Screening tests have not yet failed to reveal small pebbles in all the profiles formed in till.

Well-drained Profiles.

Note; the word till is used only for material that shows the original texture and structure of till. Material which has been reworked to destroy these characteristics is not called till.

I. 4 miles south of Greendale, Marion County?
Road cut along I. C. RR.

Topsoil	1. Silt, light, fluffy	1'
Subsoil	2. Clay-silt, heavier	1 1/2'
Eluviatil	3. Silt, friable granular, few pebbles,	5'
	4. Silt, slightly clayey, buff, pebbles	1'
Clay till-cap	5. Silt, clayey, dark buff,	1'
Cellular till	6. Till, leached porous,	4'
"Oxi-calc till	7. Till, calcareous, buff	15'
Fresh till	8. Till, calcareous, blue-gray	10'

II. 6 3/4 miles south Greendale , Marion County.
I. C. RR. cut.

Topsoil	1. Silt, light, fluffy,	1'
subsoil	2. Clay-silt, darker buff,	1 1/2 '
Eluviatil.	3. Silt , porous	3 1/2'
Clay till-cap	4. Silt, heavier, dark reddish buff, containing igneous stones	3'
Cellular till	5. Till , leached, buff, cellular, porous	3 1/2'
"Oxi-calc" till	6. Till, calcareous , buff,	3'+

Note, the till-cap here bends downward toward the main valley, as obviously the corresponding element of a poorly-drained profile would not do.

III. 3 1/2 miles south of Greendale, Marion County.
I. C. RR. Cut, 100 yards south of the bridge.

Topsoil	1. Silt, light fluffy, friable,	1 1/2 '
Subsoil	2. Silt, heavier,	2'
Eluviatil	3. Silt, fairly light, some pebbles becomes heavier toward bottom and grades into;	6'
Till-cap	4. Till, leached, slightly stickier and more stony than 3.	5'
Oxi-calc till	5. Till, calcareous, buff	3'

Note, the cellular till is not differentated in this profile.

IV 1/2 mile east of Greendale, Marion county.
I. C. RR. cut.

Topsoil	1. Silt, light, friable.	1 1/2'
Subsoil	2. Clay silt, dense	1'
Eluviatil	3. Silt, drab, buff-mottled.	2'
	4. Silt, slightly more clayey	2 1/2'
	5. Silt, buff friable, pebbles,	2 1/2'
Clay till-cap	6. Till, clayey, denser stickier, buff, greenstone and granite pebbles	2'
Cellular till	7. Till leached, buff,	1'
Oxi-calc till	8. Till, calcereous, buff,	3'+

V. 1 1/2 Miles east southeast of Pigeon, Jefferson County.
I. C. RR. cut.

Topsoil	1. Silt, light, friable	1 1/2'
Subsoil	2. Clay-silt, denser, slick,	1 1/2'
Eluviatil	3. Silt, light, friable, porous,	4'
Clay till-cap	4. Clay zone, heavier, clay seemingly impregnated from above into the cracks etc.	2'
Cellular till	5. Till, silty, porous, cellular; holes where limestone pebbles have been dissolved out, clay in most holes as lining or on the bottom in one a small chert brachippod,	3'
Oxi-calc till	6. Till, calcareous, buff	3'+

VI. 5 miles west of Marion, williamson County.
Highway cut.

Topsoil	1. Silt, light, friable	1'
Subsoil	2. Clay silt, dense	1'
Eluviatil	3. Silt, lightish, no pebbles porous	2'
	4. Silt, lightish, siliceous pebbles	2'
Cellular till	5. Till, cellular, silty feel, yellow buff, siliceous pebbles	4'

VII. 1 mile southeast of Herron, Williamson County.
Exposure at a strip mine.

Topsoil	1. Silt, light	1 1/2'
Subsoil	2. Clay silt, heavy	2'
Eluviatil	3. Silty till, porous, cellular, honeycombed granular feel, few siliceous pebbles	8'+

VIII. 4 miles southeast of Attila, Williamson County.
I. C. RR. cut.

Topsoil	1. Silt, light, friable,	1'
Subsoil	2. Clay silt, denser,	1 1/2 '
Eluviatil	3 silt, friable, porous,	4 1/2 to 5 '
Clay till-cap	4. Dark buff top of true till	1 1/2'
Cellular till	5. Till, cellular, porous, leached,	2'

IX. 1 mile west of New Hope, Williamson County.
I. C. RR. cut.

Topsoil,	1. Silt, light	1'
Subsoil	2. Clay-silt, heavy	1 1/2'
Eluviatil	3. Silt, light granular, porous,	3 1/2 to 5 '
Clay till-cap	4. Till, brownish-buff, heavier,	1 1/2 to 2'
Cellular till	5. Till, lighter, cellular, porous,	2'

X. 1 mile south of Akin, Franklin County.
I. C. RR. cut.

Topsoil	1. Silt, light, fluffy,	1'
Subsoil,	2. Clay-silt, denser	2'
Eluviatil	3. Silt, porous, holes clay-lined , veinlets clay-filled, scattered siliceous pebbles	4'
Cellular till	4. Till, porous, cellular,	4'+

XI. 1 mile northwest of Akin, Frankoin County.
I. C. RR. cut.

Topsoil	1. Silt, light	1'
Subsoil	2. Clay-silt, heavy,	1 1/2'
Eluviatil	3. silt, granular, pebbles scattered	10'
Clay till-cap	4. Darkish heavier zone at top of till	1 1/2'
Cellular till	5. Till, cellular, granular, porous,	1 1/2'

XII. 1/2 mile east of Christopher, Franklin County.
C.B.&Q. rr. bridge.

Topsoil	1. Silt light,	1'
Subsoil	2. Clay-silt heavier,	1 1/2'
Eluviatil	3. Silt, porous, friable	4'
	4. silt, porous, friable, siliceous pebbles	1'
Clay till-cap	5. Clayey silt, darker buff, many pebbles,	2'
Cellular till	6. Till , porous, cellular, cells clay-lined,	8'

XIII 1 mile east of Christopher, Franklin County.

Topsoil	1. Silt, light,	1 1/2'
Subsoil	2. Clay-silt, heavier,	1'
Eluviatil	3. Silt, pebbly, porous	4 1/2'
	4. Silt, friable	5'
Clay till-cap	5. Clayey zone, some igneous pebbles	3'
Cellular till	6. Till, cellular, porous leached	5'
Oxi-calc till	7. Till, calcareous, buff,	5'

XIV 3 miles west of Millstadt, St. Clair County.
Road cut.

Loess	1. Loess, leached, brown	15'
Eluviatil	2. Silt, scattered pebbles, granular,	2 to 2 1/2'
Clay till-cap	3. Till, dense, clayey,	2'
Cellular till	4. Till, cellular, leached, porous,	3'
Oxi-calc till	5. Till, calcareous, buff.	5'+

(Note, loess has been deposited on the soil profile of the till)

XV. 2 miles northwest of Okawville, Washington County.
Road cut.

Topsoil	1. Silt, light, friable,	2'
Subsoil	2 Clay silt	1 1/2'
Eluviatil	3. Silt, friable, porous, cellular, holes and tubes lined with dark fatty clay,	3'

XVI. 3 miles west of Ashly, Washington County.
Road cut.

Topsoil	1. silt , light, friable,	1'
Subsoil	2. Heavy silt, darker,	2'
Eluviatil	3. Silt friable, many siliceous pabbles,	4'+

XVII. 3 miles west of Nashville, Washington County.

Topsoil	1. Silt, light, fluffy,	1'
Subsoil	2. Heavy clay silt	2'
Eluviatil	3. Silt, sandy, gritty, friable, many silic. pebbles and typical clay-lined holes and cracks	5'+

XVIII. 1 1/2 miles north of Ramsey, Fayette County.

Topsoil	1. silt, light, friable	1 1/2'
Subsoil	2. Heavy clay silt	2'
Eluviatil	3. Silt, friable, light buff	3'
Clay till-cap	4. Silt, heavier, dark buff,	3'
Cellular till	5. Till, leached, porous, red?buff	1'
oxi-calc till	6. Till, calcareous, buff,	15'

From the scrutiny of the various profiles it is evident that the top soil and the subsoil are remarkably persistant features. It also appears that the eluviatil horizon is ever-present and fairly uniform in its character. It is silty, granular, porous, and contains scattered residual pebbles which are more abundant in its lower part and become fewer toward its top. It commonly contains numerous cracks, pores, and passage-ways of various kinds usually lined with dark brown clay. It does however, vary in thickness from 2 or 3 feet to 5 or 6 feet. In general where it is thicker it is also of lighter texture, suggesting that the conditions which made it lighter also made it thicker. A further point in this connection is that where the eluviatil is light and thick the clay till-cap is poorly developed. Fig. 3. (The first section is found in the I. C. cut, 3/4 miles south of the Helm School in the center of section 25, Marion County., while the latter is a highway cut on the west side of Opossom Creek 2 miles north of Oconee, Shelby County.)

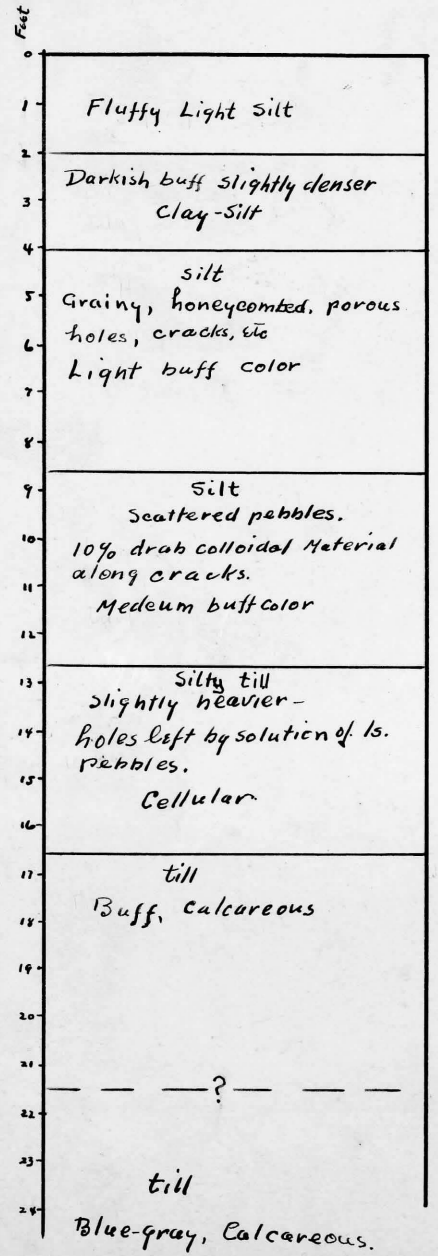
The conclusion is that those profiles showing the thick and light eluviatil horizon and the poorly formed clay till-cap were formed under very well-drained conditions with thorough penetration of water to a deep-lying water-table and a vigorous enough movement of the phreatic water to remove or distribute the clay. Likewise it follows that profiles with less well-developed eluviatil horizon and better developed till-cap were formed under medium well-drained conditions. Figure 3 shows examples of these two types, the latter being the most common of the well-drained profiles of the Illinoian till-sheet.

(Fig 3)

Well-drained Profiles on the Illinoian till-sheet.

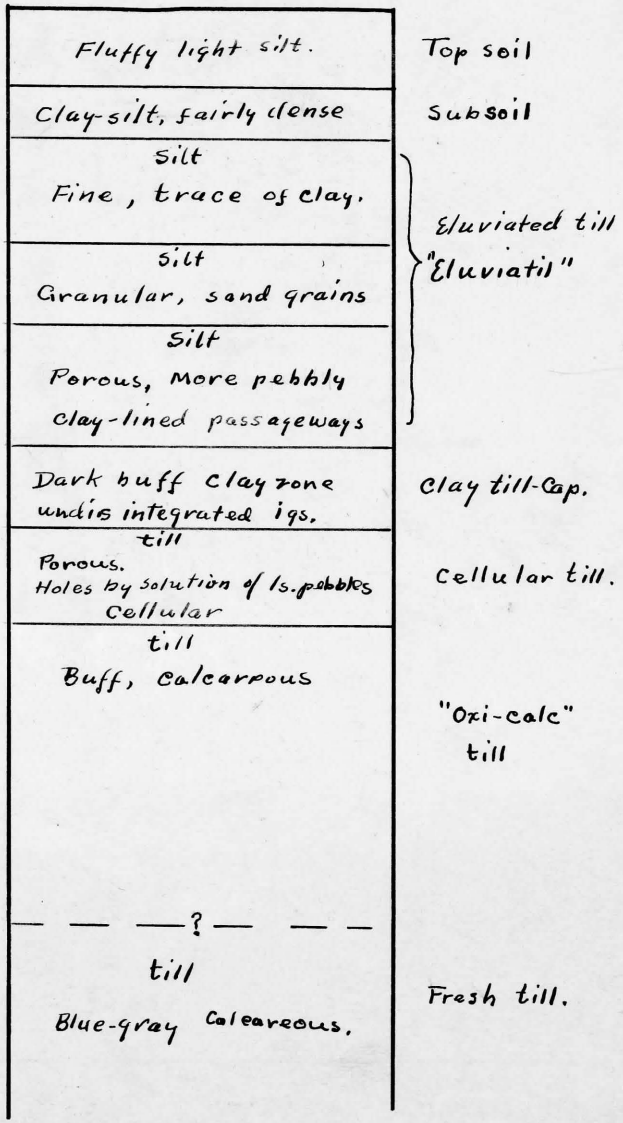
Very Well-drained profile.

Helm Type



Medium well-drained profile.

Oconee Type.



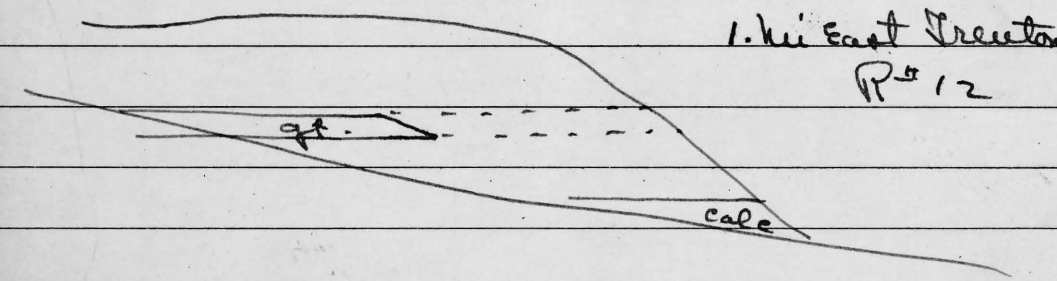
HOT & COLD RUNNING WATER STEAM HEAT

The Park Hotel

Dick Geoppner, Proprietor

Travelers Home

Salem, Illinois.



1. ½ mi East Trenton
R# 12

good. gt. 6-8'

3½ SE Carlinville
R# 4

Notes

Points for consideration beyond the present exposition

(1) Discussion of causes of formation of the subsoil.

(a) Fault action
(b) ppt^{n} of colloids by bases
(c) ppt^{n} of colloids by filtering action

(2) Discussion of secondary profile in the top of a primary profile.

(a) Formation of a thick profile under optimum conditions of temperature and drainage, moisture

(b) Formation of a secondary + thinner profile in the upper part of the primary one

(c) ~~distribution of resis~~
Criteria
i. distribution of residual pebbles -
ii. Study of mechanical analysis of zones.
iii. distribution of the iron.

(3). A second profile formed in ~~material~~ new material deposited on top of the original profile.

(a) Eolian material
(b) Wash -
(c) Criteria
i. mineral composition.
ii. Pebble content.
iii. Texture and size.
iiii. Rounding + shape of grains