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# A BURIED SANGAMON SOIL IN SOUTHEASTERN WISCONSIN

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## ABSTRACT

A truncated paleosol believed to have formed during the Sangamonian Age is well exposed in the highwall of a gravel pit near East Troy in northeastern Walworth County, Wisconsin. If our interpretation is correct, this paper reports the first positive identification of a buried Sangamon Soil in the area of late Wisconsinan glaciation in the State of Wisconsin.

The soil is formed in the upper part of a thick sand and gravel outwash unit and is overlain by calcareous pink loam till that is considered to be the Tiskilwa till of northeast Illinois and southeast Wisconsin. The main horizon of the paleosol is interpreted as the Bt horizon of a well-drained Alfisol (Gray-Brown Podzolic) belonging to the suborder of Udalfs. It is a dark reddish-brown, highly argillic, severely weathered zone in which many of the clasts are in an advanced state of decomposition. In several places the soil has large vertical pendants that hang below the usual base of the soil by as much as a meter. A detailed soil profile description, which includes laboratory data on grain-size distribution and clay-mineral composition, through one such pendant is presented to substantiate our interpretation of the weathered zone as the Sangamon Site.

When the site was first examined a decade ago, the upper part of the paleosol appeared to be developed in two parent materials, the outwash and an overlying thin finer grained deposit interpreted as (Illinoian) till. A thin bed of light yellowish-brown silt, possibly loess of Altonian age, was observed between this older till and the Tiskilwa till above. The upper few centimeters of the silt were darker in color and suggestive of an incipient paleosol (Farmdale?). Enlargement of the pit during the past few years has resulted in removal of the apparently wedge-shaped intermediate units, so that today Tiskilwa till is seen resting directly on the paleosol developed in the outwash.

Near the center of the pit wall the Sangamon Soil reaches the modern surface, and both the soil and overlying Tiskilwa till are absent in the south part of the pit. Here the outwash is overlain by younger sandy-loan till belonging to the New Berlin Formation (equivalent to the Haeger Till Member of Illinois terminology). The contact zone involving the three units is unusual and creates a local stratigraphic problem because the till units abut against each other and New Berlin till actually underlies the Sangamon Soil for a short distance. The relationship is interpreted to be the result of deformation that occurred during deposition of the New Berlin till.

## INTRODUCTION

In Walworth County, about 1.5 km southwest of East Troy, the remains of a buried soil are exposed under till in the west-facing high wall of a gravel pit under a continuous deposit of till. The pit is located in the NW corner of Sec. 31, T. 4 N., R. 18 E., just northeast of the overpass on Wisconsin Highway 15 over Townline Road in the town of Spring Prairie. The pit is operated intermittently by B. R. Amon and Sons of Bowers.

The prominent feature of the paleosol is a weathered and oxidized, clay-enriched (argillic Bt) horizon developed in an outwash of cobbly sand and gravel. The soil was truncated and disturbed by overriding glaciers that deposited at least two younger tills. Based on soil characteristics and stratigraphic position, we conclude that this paleosol is the Sangamon Soil.

Buried or relict soil profiles of possible Sangamonian age have been reported from several localities in Wisconsin beyond the late Wisconsinan glacial boundary, mostly in the Driftless Area; the interpretations of most of these sites have been challenged. To our knowledge, the Sangamon Soil has not previously been identified from any site behind the Late Wisconsinan (Woodfordian) boundary. Therefore, if our interpretation of the East Troy site is correct, this paper reports the first identification of the Sangamon Soil in the area of Late Wisconsinan glaciation in tbe State of Wisconsin.

The site was first visited by Schneider in 1972. It was independently discovered, probably in 1973, by David W. Hadley, formerly with the Wisconsin Geological and Natural History Survey. Similar interpretations of the geology were made by Schneider and Hadley, who subsequently examined the site together in 1975. Periodic visits to the site were made by Schneider with his classes between 1975 and 1980. Schneider, Follmer, and Ardith Hansel of the Illinois State Geological Survey studied the site in 1982.

## STRATIGRAPHY

The soil is overlain by 1 to 6 m of pink calcareous loam till that is believed to belong to the Tiskilwa Member (Early Woodfordian). The Tiskilwa Member is the upper part of the Zenda Formation in the new Pleistocene lithostratigraphic classification in Wisconsin (Mickelson and others, 1983) and correlates with the Tiskilwa Till Member of the Wedron Formation in Illinois (Willman and Frye, 1970). The pinkish gray to brown color of the till, the grain-size distribution of the matrix (45 percent sand, 34 percent silt, 21 percent clay),* and the clay-mineral composition (24 percent expandable clay, 64 percent illite, 12 percent kaolinite plus chlorite) are typical of Tiskilwa till in southeastern Wisconsin. The till is now known to occur at or near the surface throughout much of central and eastern Walworth County, especially in a belt 11 to 18 km wide from the Illinois state line northward to the Kettle Interlobate Moraine (Schneider, 1983). It has been observed at many sites near the East Troy pit and was well exposed southwest of the pit a few years ago during construction of new Wisconsin Highway 15.

The soil is formed in the upper part of a thick unit of well-stratified outwash sand and gravel with many cobbles in the upper part. The thickness of the outwash exposed in the pit face is estimated to be about 15 m.

* Grain-size boundaries used in this paper are 2 mm, 0.0625 mm, 0.004 mm and percentages are based on the less-than-2 mm fraction. Clay mineral identifications were made by H. D. Glass from X-ray diffraction data using oriented aggregate techniques on the less-than-0.002 mm material.

A power-auger hole (Wisconsin Geological and Natural History Survey Boring ET-2) was drilled below the floor of the pit to a depth of more than 22 m without encountering bedrock; the deposits consisted mostly of well-sorted sand with some interbedded gravel layers. Some workers have suggested that the outwash here was deposited near the axis of the preglacial Troy Valley, but from a recent bedrock topography map prepared by Green (1968, fig. 2), it appears that the site more likely is near the break in slope between the upland surface and the valley wall of a tributary to the main Troy Valley.

Little information is available to judge the age of the outwash. Beyond the outer margin of the overlying till, the surficial deposits are mapped as Early Wisconsinan (Frye, Willman, and Black, 1965) or Illinoian (Alden, 1918). Outwash deposits older than Wisconsinan were recognized by Borman (1977) in Walworth County, but he did not identify any stratigraphic units. South of Walworth County in Boone County, Illinois, Berg, Kempton, and Stecyk (1981) described an Illinoian outwash that could be related to this site, but the correlations at this time are circumstantial. The highest level terrace mapped by Anderson (1967) along the Rock River near Rockford is likely related to this site. This terrace is covered by Wisconsinan loess and contains about one meter of highly weathered, reddish brown gravel over about 6 m of unweathered gravel. We conclude that the terrace described by Anderson is Illinoian and was weathered during the Sangamonian. Therefore, considering the regional stratigraphic relations, the East Troy outwash is assigned to the Illinoian Stage.

## DESCRIPTION AND INTERPRETATION OF THE PALEOSOL

At times during pit operations, the soil has been continuously exposed for a lateral distance of about 50 m. It appears as a leached dark reddish-brown horizontal layer about 1 m thick. The main body of the soil is a weathered, clayey Bt horizon developed in cobbly sandy gravel. The Bt is dark reddish brown and strongly contrasts with the yellowish-brown gravel below and the pinkish-brown till above. In places the soil has large vertical pendants, whose tapered ends extend below the usual base of the soil by as much as a meter (fig. 1). The top of the soil is truncated at all places observed in 1982, which suggests either proglacial fluvial scour or the direct effects of the overriding glacier. Small-scale shear is evident in places where paleosolic material (Bt) has been sheared or injected into the overlying calcareous till. The displaced material commonly pinches out along a thrust plane and appears now as a low-angle joint. In other places the paleosolic material appears interstratified with the till in a contact zone up to 1 m thick.

A soil profile with the largest pendant exposed in 1982 in the northern part of the pit was selected for study. The major features are sketched on figure 1. An attempt to discriminate pedologic boundaries from geologic boundaries was made because they are commonly confused. Commonly a stratigraphic boundary predetermines the position of a pedologic boundary, but in other cases the boundaries are independent of each other. The main pedologic boundary in the soil here is the base of the Bt horizon, shown as a heavy line on figure 1. An excellent example of cross-cutting relationships is illustrated by the layer of fine gravel. This layer passes through the pendant. Near the middle of the pendant the layer sags about 5 cm, which is evidence for solution collapse.

The Bt is a zone of excessive accumulation of reddish-brown clay with accessory features such as preponderant diffuse iron stains and discrete manganese stains. Selected details are described in table 1. So much clay has accumulated in the Bt that the sand,

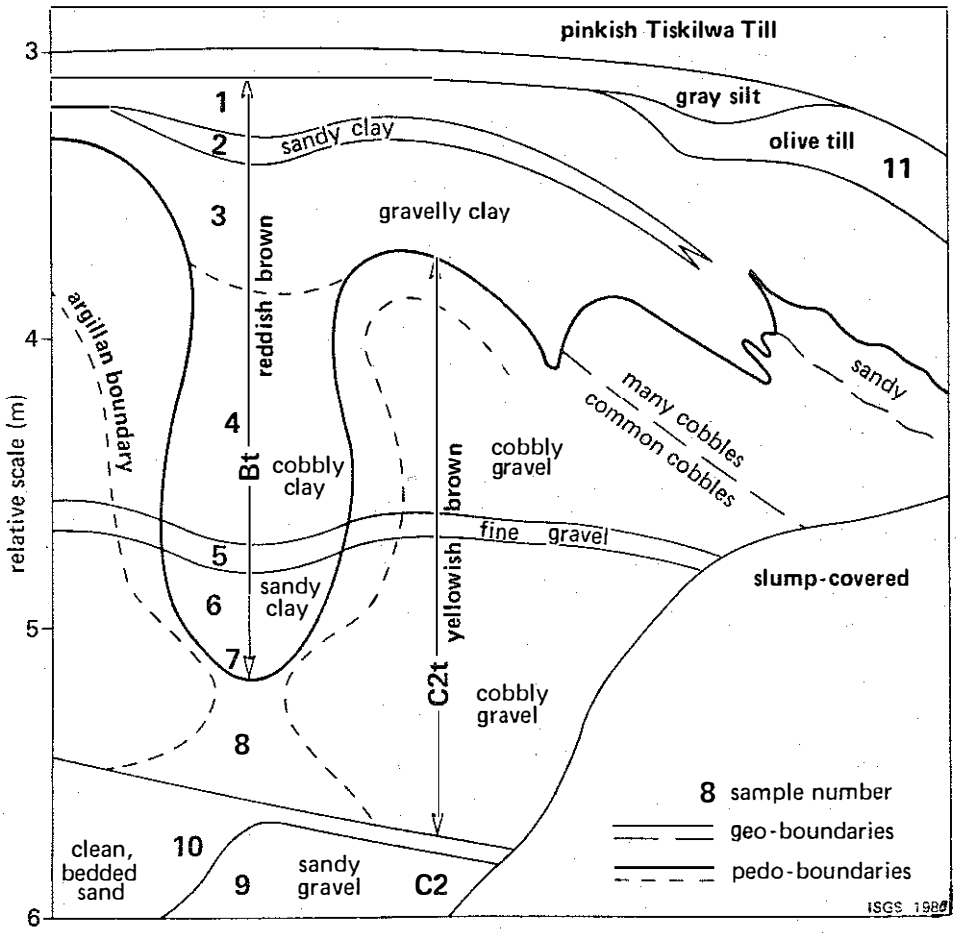


FIGURE 1.--Sketch of part of high wall of pit showing major features of buried soil.

gravel, and cobbles are totally enveloped in layers and masses of translocated clay (argillans). During formation, pedoturbation and desiccation cracking continually opened up avenues for continued soil-water movement and clay accumulation.

Surrounding the pendant is a diffuse zone of localized clay enrichment that dissipates laterally away from the pendant into the calcareous gravel (C2t). The outer margin of this zone is shown on figure 1 with a short dashed line. This zone appears to be constricted near the base of the pendant, but below it appears to fan out. The outer margin is very difficult to determine because of the discontinuous nature of the clay accumulation, which seems to occur in a random pattern of enrichment. However, this penomenon is clearly related to the Bt development because it is adjacent to the Bt horizon and disappears with depth.

At the contact with the clean bedded sand, the argillans abruptly stop and clay-free iron stains continue into the upper few centimeters. Below and to the left on figure 1 the sand is clean and gray (gleyed). Argillans reappear in the sandy gravel at the base as though they went around the clean sand. The circumstances suggest that the sand formed a hydraulic discontinuity and remained wetter than the surrounding gravel. The staining and argillan patterns indicate a direction of soil-water movement. Funneling may have occurred in the upper Bt. Leaching water appears to break broken through the Bt boundary and fanned out below the pendant.

Table 1. Sangamon Soil profile description at East Troy Gravel Pit

| Geologic Unit | Sample no. | Horizon | Depth (cm) | Description |
|---|---|---|---|---|
| Tiskilwa till | - | C2 | 0-290+ | 7.5YR 5/4 loam; few stains, jointed; few secondary carbonates; dolomitic. |
| silt | - | C1g | 290-300 | 5Y 5/2 silt loam; few iron stains, pinches out to right above Sample 11. |
| till | 11 | C1g | 300-340 | 2.5Y 5/4 loam with common 5/6 mottles; stratified in places with layers of Bt material; leached; basal deformation zone of meltout till(?). |
| Outwash | 1 | Bt1 | 300-340 | 7YR 5/6 gravelly sandy clay loam; common red and dark stains; weakly cemented, traces secondary carbonates along joints; leached; eroded upper surface. |
| " | 2 | Bt2 | 340-350 | 7YR 5/8 loamy sand lense; uniform. |
| " | 3 | Bt3 | 350-410 | 6YR 4/4 to 5/6 gravelly sandy clay loam; few 2.5YR 3/4 and 2/1 stains; many argillans; many rotten igneous and sedimentary cobbles; traces of carbonates. |
| " | 4 | Bt4 | 410-450 | 5YR 3/3 gravelly clay, many thick masses of argillans, some slickensided; some large areas of manganese staining; many rotten rocks 1 to 10 cm in diameter; traces of carbonates. |
| " | 5 | Bt5 | 450-460 | 5YR 3/3 gravelly sandy clay lense; coarse fraction better sorted than adjacent horizons; sags about 5 cm in middle of pendant, leached. |
| " | 6 | Bt6 | 460-490 | 5YR 3/3 gravelly sandy clay loam; poorly sorted; fewer cobbles, nearly all hard; leached. |
| " | 7 | Bt7 | 490-510 | 5YR 3/3 to 4/4 gravelly sandy loam; more color and textural variation; friable; a decrease in argillans and stains cause a color boundary at base where uncoated coarse fragments dominate color appearance; base of beta horizon pendant. |
| " | 8 | C2t | 510-550 | Yellow, gray and brown gravelly sandy loam; partly weathered gravel dominated by carbonates, many soft; weakly cemented; common 5YR 4/4 argillans around pendant that decrease away to form a discontinuous boundary with clean bedded sand lense; argillans reappear in sandy gravel at base of exposure. |
| " | 9 | " | 550-580 | |
| " | 10 | " | 540-580 | |

Comments:

1. This profile contains the main part of a truncated Sangamon Soil that has the morphology of a Fox-like soil with an overdeveloped Bt pendant. Classification: best fit is Typic Paleudalf.

2. Bt horizons 3 to 6 in the exposure are very hard and coarsely crazed by desiccation. Natural soil structures are confounded with exposure-induced cracking. Iron staining is essentially continuous, but redder in places, and dominates matrix color. Argillans appear to diffuse away from the pendant.

3. Sampled from the northwest wall of a gravel pit in the northwest corner of Sec. 31, T. 4 N., R. 18 E., Walworth County.

Table 2. Particle size and clay mineral data of Sangamon Soil profile at East Troy Gravel Pit

| Sample Number | Horizon | Depth (cm) | Sand[1] (%) | Silt[1] (%) | Clay[1] (%) | Exp[2] (%) | I[3] (%) | K + C[4] (%) |
|---|---|---|---|---|---|---|---|---|
| 11 | C2g | 300-340 | 54 | 28 | 18 | 38 | 45 | 17 |
| 1 | Bt1 | 300-340 | 56 | 15 | 29 | 29 | 52 | 19 |
| 2 | Bt2 | 340-350 | 84 | 2 | 14 | -- | -- | -- |
| 3 | Bt3 | 350-410 | 64 | 7 | 29 | -- | -- | -- |
| 4 | Bt4 | 410-450 | 23 | 29 | 48 | -- | -- | -- |
| 5 | Bt5 | 450-460 | 52 | 10 | 38 | 28 | 58 | 14 |
| 6 | Bt6 | 460-490 | 55 | 8 | 37 | 26 | 54 | 20 |
| 7 | Bt7 | 490-510 | 76 | 3 | 21 | -- | -- | -- |
| 8 | C2t | 510-550 | 64 | 16 | 20 | 26 | 57 | 17 |
| 9 | C2t | 550-580 | 70 | 18 | 12 | 32 | 49 | 18 |
| 10 | C2g | 540-580 | -- | -- | -- | 16 | 66 | 18 |

1. Weight percent of less than 2 μm fraction; sand - 2.0 to 0.62 mm, silt - 0.62 to 0.002 mm, clay - less than 0.002 mm.

2. Exp - expandable clay minerals (17Å, glycolated).

3. I - illite (mica, 10Å).

4. K + C - kaolinite and chlorite (7Å).

Other geologic boundaries in the profile control or at least are coincident with weathering boundaries. The material below the Bt horizon is yellowish-brown, calcareous cobbly gravel. Most parts seem to contain about 50 percent limestone and dolomite cobbles. This zone, which shows some alteration, some argillans, and yet contains primary carbonate minerals is designated a C2t horizon. Many cobbles up to 10 cm in diameter are in the C2t and seem to disappear in the pendant. Near the middle of figure 1, above the final gravel lens, the amount and orientation of the cobbles delineate a subtle boundary. More cobbles are present above the boundary which represents a change in the depositional environment. Weathering and clay accumulation follow this geologic boundary to the left of and above the small pendant, but depart at the pendant where the Bt boundary cuts up across the "many cobbles" layer. A more sandy layer occurs stratigraphically above and to the right and appears to be detached from the "sandy clay" layer in the Bt. This suggests early detachment, perhaps by slump, during parent-material formation, followed by the development of the soil.

At the sampling location, the soil is abruptly truncated by a gray silt. No interstratification is present but the silt pinches out to the right above olive-brown loam till that is interstratified with Bt material. The till seems to be related to the overlying Tiskilwa till, as if it is a basal deformation zone of the Tiskilwa. However, the silt is not deformed and appears to be a fluvial deposit on an erosion surface. A possibility is that the olive till was deposited by an early advance of the ice, then exposed to glaciofluvial erosion during a minor retreat of the glacier. Then, the main body of Tiskilwa till was deposited during a subsequent advance.

## CLASSIFICATION OF THE PALEOSOL

The best modern soil analogs of this buried soil are the deep phases of the Fox and Ockley Series, which are both Alfisols. At present, Fox is defined as having a solum (A and B) thickness of less than 1 m, and Ockley has a solum thickness up to 1.5 m. To classify a paleosol according to modern soil taxonomy is difficult because the actual climatic and chemical parameters during formation must be estimated. Considering the morphological expression alone, this soil can be considered a Udalf or in older soil classification terms, it is similar to a reddish, clayey Gray-Brown Podzolic of the Midwest or a minimal Red-Yellow Podzolic of the Tennessee region.

Particle-size distribution and clay-mineral data (table 2) were determined on samples collected through the pendant as shown on figure 1 in order to aid our attempts to classify the soil. Although the presence or absence of pendants is secondary in the classification of soils of this type, we think that this large pendant is the most interesting part of the soil-stratigraphic unit exposed in the pit wall.

The lack of an A horizon presents an obstacle, so we attempted to reconstruct the nature of the original soil. In doing this, the B horizon provides the clues--features that are dependent on A-B horizon relationships. All of the subdivisions of the Bt horizon contain evidence of illuviation, (thick continuous clay skins or argillans). The variation in sand, silt and clay contents reflects the original stratification of the outwash. The clay of the upper Bt is similar to the Fox and Ockley series, but the large size of the pendant suggests development that is greater than what is considered to be normal for these soil series. Many

cobbles up to about 10 cm in diameter in the Bt are in an advanced stage of decomposition and can be cut with a knife. Most of the cobbles are igneous and sedimentary (silty) types that also might have contributed to the clay content upon weathering, but the in-situ clay could not be identified because of the large amount of argillans.

The large amount of illuvial clay suggests that this soil belongs to the Alfisol Order, although Mollisol and Ultisol options are possible. The dark color of the argillans suggests that the original epipedon was rich in humus, as in a Mollisol, but the color of the lower half of the Bt closely matches the type concept of the Ockley Series, a Typic Hapludalf. A forest or grassland origin is not interpretable from the morphology, but other parameters, not measured in this study, such as the composition of the contained humic acids, could theoretically be used to differentiate the dominant sources of the humic material.

The large size of the pendant suggests the more intense or longer weathering conceptually associated with Ultisols rather than Alfisols. However, the clay-mineral data indicate that substantial amounts of illite are still present. One of the requirements of an Ultisol is that less than 10 percent of the weatherable minerals remain in the 20 to 200 µm fraction of the Bt horizon (Soil Survey Staff, 1975). Because the illite was determined from the less-than-2 µ fraction, even less weathering would be expected in the coarser fractions. Therefore, the type of weathering indicated by the clay mineral data places this soil into the range of Alfisols. Samples with no clay mineral results presented in table 2 were analyzed, but clay-mineral species were not resolved by the no-pretreatment method employed. This appears to be caused by the abundant iron, which interferes with the x-ray diffraction method for measuring clay minerals. The method used by the Illinois State Geological Survey is one that is routinely employed for distinguishing stratigraphic boundaries and the correlation of material units. In view of this constraint, the unresolved x-ray diffraction peaks indicate a moderately to strongly weathered, oxidized material.

Considering all available information, the best fit classification for the profile is a Typic Paleudalf. A Paleudalf is distinguished from a Hapludalf mainly on the basis of clay distribution. A Paleudalf as described by the Soil Survey Staff (1975) must meet the requirement that the clay content does not decrease from the maximum by more than 20 percent within a depth of 1.5 m below the soil surface. A Udalf that decreases in clay content, more than that is a Hapludalf. At the other locations where the Bt is about a meter thick, a Hapludalf classification seems best in spite of the redness which favors the Paleudalf interpretation.

In reconstruction of the probable A and E horizons, it would be expected to be sandy because its parent material was probably outwash. Modern equivalents of Paleudalfs that have been described (Soil Survey Staff, 1975) on sandy parent material on the coastal plains in Texas have sandy epipedons that are about 1 m thick. Where the epipedon is sandy (loamy sand) the profile is classified as an Arenic Paleudalf. If our pendant profile here had less sand in the epipedon, it would remain in the taxon of a Typic Paleudalf. However, one must rememeber that this is a borrowed classification from a system for living soils. The soil features described here are the remains of a fossil soil.

## LOCAL STRATIGRAPHIC CORRELATION PROBLEMS

The Sangamon Soil rises southward from the described profile (fig. 1) and reaches the ground surface near the

center of the pit wall (fig. 2). Both the soil and the overlying Tiskilwa till are absent in the southern part of the pit, and they terminate in a way that creates a local stratigraphic problem. Beyond the termination, the gravel is overlain by calcareous yellowish-brown pebbly sandy loam till of the New Berlin Formation (Mickelson and others, 1983). The New Berlin till was deposited by the Delavan Sublobe of the Lake Michigan Lobe (Alden, 1904, 1918; Schneider, 1982) in Late Woodfordian time. It is the surface till in the immediate area of the East Troy pit and throughout much of southeast Wisconsin, mostly in Walworth and Waukesha Counties. It also covers parts of Kenosha, Racine, Milwaukee, Washington, and Ozaukee Counties. New Berlin till is found behind (northeast of) the Darien Moraine and between the Kettle Interlobate Moraine on the west and the Valparaiso Moraine or its equivalent on the east. The New Berlin till is about equivalent to the Haeger Till Member of the Wedron Formation in Illinois (Willman and Frye, 1970).

The New Berlin till is distinguished from the Tiskilwa till by its lighter and yellowish-brown color, greater stone content, and coarser matrix. Results of particle-size analyses of three samples of New Berlin till from the East Troy pit average 62 percent sand, 27 percent silt, and 11 percent clay. Results of clay-mineral analyses of five samples of New Berlin till from the East Troy pit average 20 percent expandable clay minerals, 66 percent illite, and 14 percent kaolinite plus chlorite.

Near the center of the pit wall the two tills are in contact with each other in an unusual way (fig. 2). The stratigraphic relationships between the tills and between the New Berlin till and the paleosol are unclear. The tills abut against each other, and the New Berlin till underlies the paleosol for a distance of about 1 m. The age relationship of the Tiskilwa till and the New Berlin till is well established by regional relations and by many stratigraphic sections that show the New Berlin Formation ovelying the Tiskilwa Member of the Zenda Formation. Thus, there is no question about the relative age of the tills, although the relationship cannot be demonstrated in the East Troy pit. We interpret the relationship seen here as the result of deformation produced by the bulldozing action of the ice that deposited the New Berlin till. Although the mechanics are not understood, the snout of the advancing ice apparently shoved and lifted the inclined part of the Sangamon Soil and overlying Tiskilwa till and injected a mass of basal New Berlin till into and below the paleosol (fig. 2). In that part of the pit south of the contact zone, the Sangamon Soil and Tiskilwa till were completely eroded before basal New Berlin till was plastered on top of the outwash sequence. Less than a kilometer to the south, however, 5 m (exposed) of Tiskilwa till is overlain sharply by 3 m of New Berlin sand and gravel.

When this site was examined in 1972 and 1975, additional stratigraphic units were present between the paleosol and the overlying pink till. The latter was observed to overlie a thin bed of light yellow calcareous silt (loess?), the upper few centimeters of which were darker in color and suggestive of a faint A1 horizon of an incipient paleosol (Farmdale?). Although Altonian loess has not been previously identified in southeastern Wisconsin, the silt is possibly equivalent to the Roxana Silt of Illinois (Frye and Willman, 1960; Willman and Frye, 1970).

The silt either rested upon a stone line (Schneider's interpretation) or contained a concentration of cobbles at its base (Hadley's interpretation). In either case, this stone concentration marked the top of the paleosol. The upper part of the paleosol, although

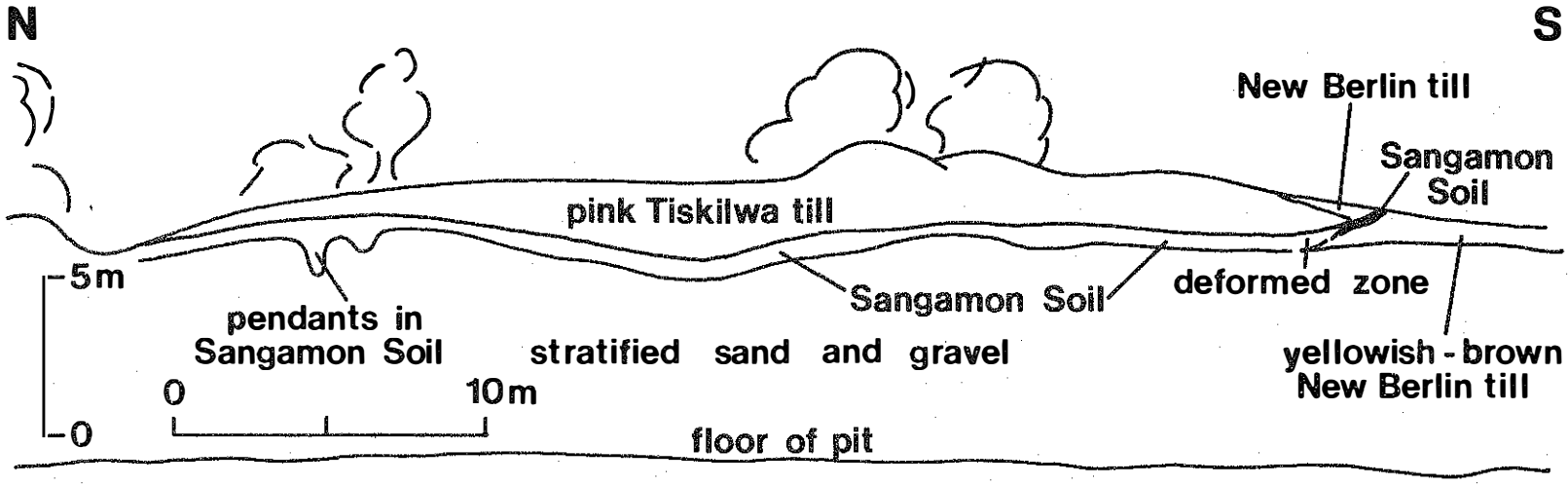


FIGURE 2.--North-south sketch of part of the East Troy gravel pit as seen in 1982. The Sangamon Soil is continuous across the exposure, as shown, but is partially concealed by slump and slope wash. Modern soil profile (not shown) is at the sketched surface in some places, but in other places it has been removed or truncated by mining operations. Height of pit wall is about 10 m; approximate length of section is 50 m.

similar in most of its characteristics to that below, contained fewer stones and had more silt; it resembled a strongly developed B horizon developed from till rather than gravel. Both Schneider and Hadley interpreted this to be a two-material profile, with the upper part of the B horizon having formed from till and the lower part from gravel. However, the geologic contact between the gravel and the till, if present, was masked by pedogenesis; both parent materials were weathered by the same soil-forming episode.

Unfortunately, these additional stratigraphic units have not been visible in recent years. Pit enlargement during the past 5 or 6 years has resulted in the removal of the weathered till, the stone line, and the overlying silt with its possible incipient soil; thus, the pink Tiskilwa till is now seen in direct contact with the paleosol. Apparently the sand and gravel unit was overlapped from the west by a wedge of till and a thin layer of silt, both of which have been removed as mining operations have moved the pit face eastward.

Neither the Illinoian till (weathered or unweathered) nor the younger silt are now exposed elsewhere in the pit, and neither the till, the paleosol, nor the silt have been identified at any other site in southeast Wisconsin. Fortunately, however, samples of both the till and the silt were collected from the East Troy site in 1977. Analyses of these samples seem to confirm the field interpretations.

## CONCLUSIONS

The exposure at the East Troy pit reveals stratigraphic relationships that have been suspected to exist for some time, probably since Alden's report in 1918 or longer, but they have not been confirmed until now. Because the Sangamon Soil and other pre-Woodfordian features are widespread beyond the Wisconsinan border, it follows that they should occur under Late Wisconsinan deposits where spared from glacial and other causes of erosion.

The fragmentary information developed from the study of this site leads to the conclusion that the weathered, clayey paleosol exposed in the wall of the pit is the Sangamon Soil. The paleosol is developed in a coarse cobbly outwash that is judged to be Illinoian in age. Morphology and composition of the overlying unweathered till indicate that it can be identified as the Tiskilwa till, which was deposited by an early glacial advance of Woodfordian Age. The confidence of this identification and the assumption that the paleosol represents the last interglacial age or the last time during which a warm-climate soil could have formed in this area form the main arguments for this interpretation. The relation of the Sangamon Soil and Tiskilwa till to the younger New Berlin till at this exposure creates some confusion but can be explained as a local anomaly caused by glacial deformation. It appears that New Berlin till was down thrusted through Tiskilwa till into the Sangamon Soil at the only place where the two tills are in contact at this site.

## ACKNOWLEDGEMENTS

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