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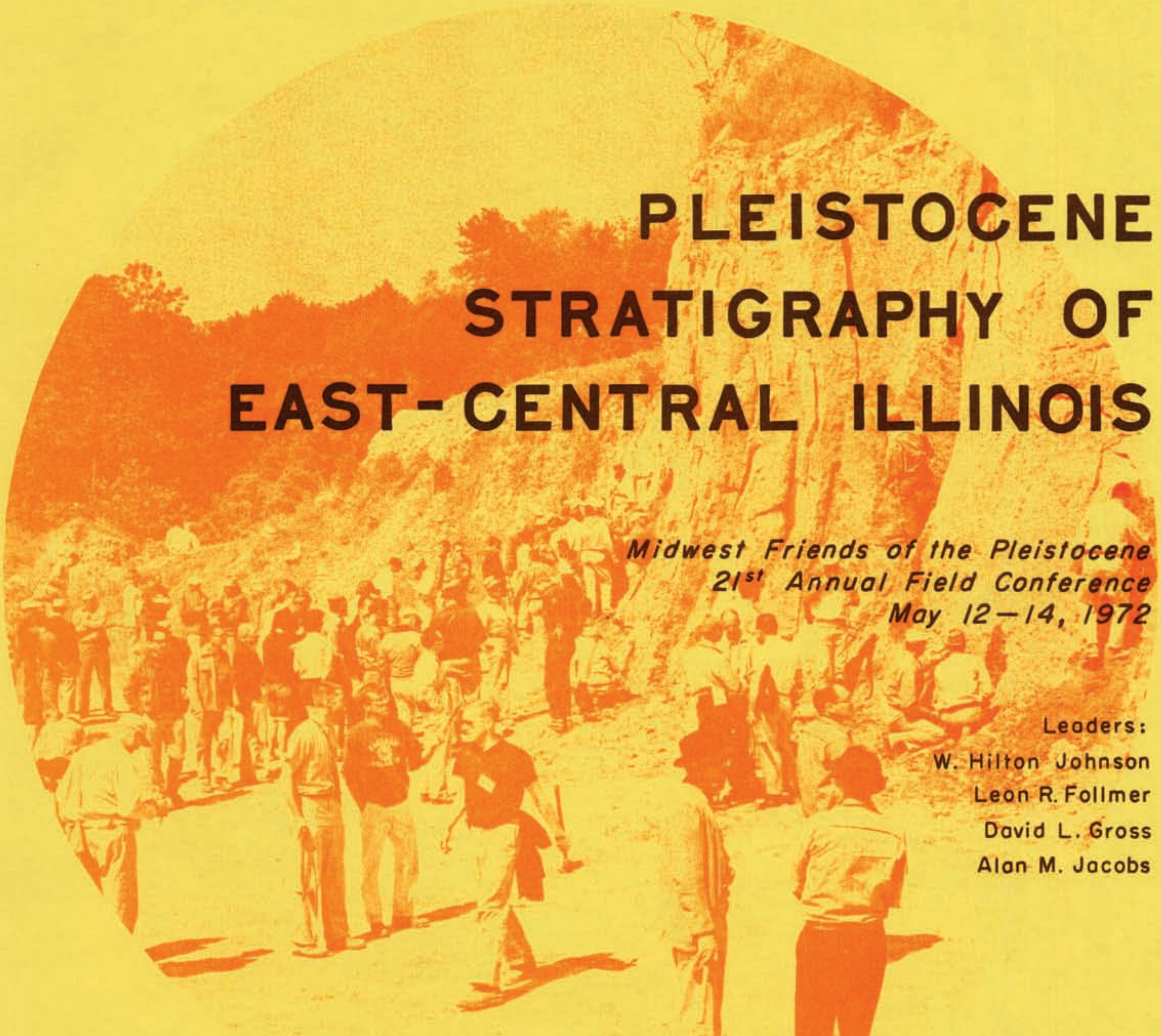

# PLEISTOCENE STRATIGRAPHY OF EAST-CENTRAL ILLINOIS

*Midwest Friends of the Pleistocene*
*21st Annual Field Conference*
*May 12–14, 1972*

Leaders:
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Alan M. Jacobs

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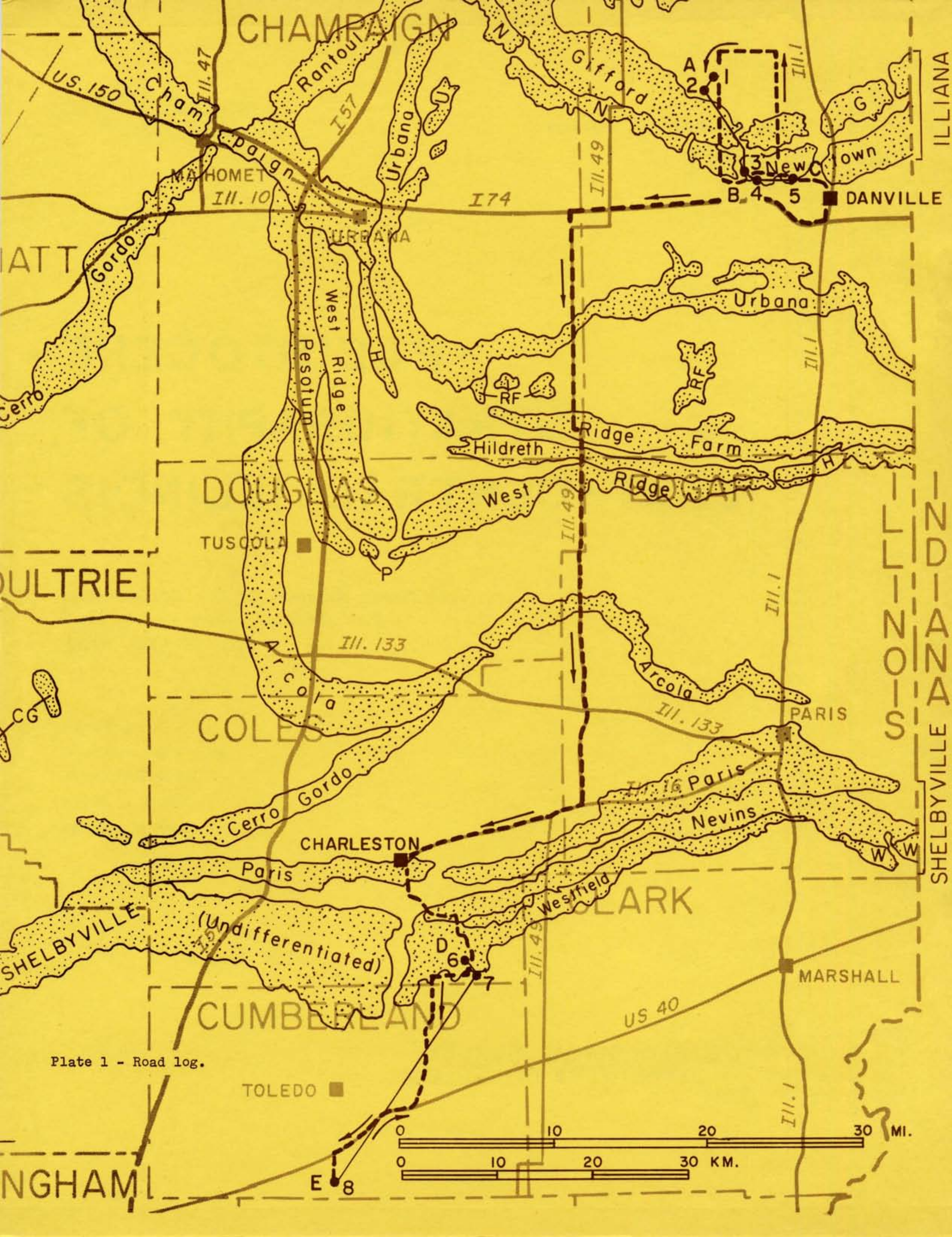



Plate 1 - Road log.

# PLEISTOCENE STRATIGRAPHY OF EAST-CENTRAL ILLINOIS

W. H. Johnson, Leon Follmer, D. L. Gross, and A. M. Jacobs

## INTRODUCTION

This field conference is designed (1) to show representative sections of the Pleistocene stratigraphy in two areas of east-central Illinois, one in the area of Woodfordian drift and the other in the area of Illinoian drift; (2) to demonstrate the emphasis on lithology in developing the rock-stratigraphic framework in the two areas and in making correlations between them; (3) to demonstrate the magnitude of glacial and fluvial erosion during the Quaternary and the resulting complexities in the stratigraphic record; and (4) to introduce several problems that as yet have not been satisfactorily solved in these areas. The problems include, first, the determination of the source of many of the tills in this part of Illinois, in particular the relationship of the Decatur Sublobe of the Erie Lobe to the Peoria Sublobe of the Lake Michigan Lobe (Willman and Frye, 1970), and, second, the nature of the Altonian record, particularly the origin of Altonian sediments in the area of Illinoian drift.

In the past 15 years Pleistocene studies in Illinois have concentrated on the physical characteristics of the deposits and their distribution in space because this information is needed in applied geology. The result of this approach has been the development of a sound rock-stratigraphic framework, which in turn has significantly contributed to our understanding of the Pleistocene history in Illinois. Willman and Frye (1970) recently summarized this history and the Pleistocene stratigraphy of Illinois, with emphasis on the stratigraphy of western and northern Illinois where their work was concentrated. This field conference provides an opportunity to summarize similar data for a portion of eastern Illinois.

## LOCATION

The field conference will concentrate on two relatively small areas, one in central Vermilion County in the area of Woodfordian drift, and the other in southern Coles and Cumberland Counties encompassing an area of Woodfordian

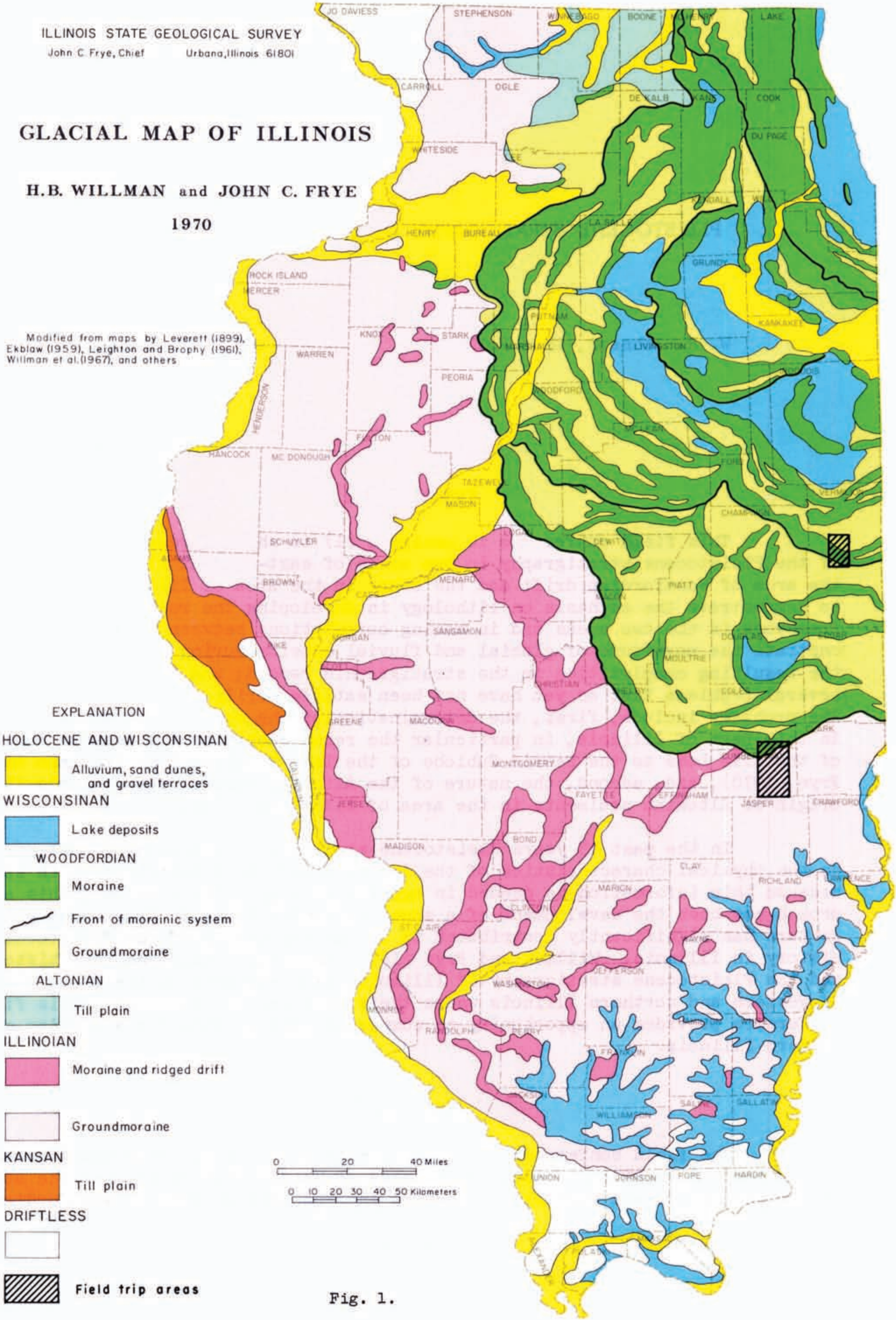

ILLINOIS STATE GEOLOGICAL SURVEY
John C. Frye, Chief
Urbana, Illinois 61801
GLACIAL MAP OF ILLINOIS
H.B. WILLMAN and JOHN C. FRYE
1970
Modified from maps by Leverett (1899), Ekblaw (1959), Leighton and Brophy (1961), Willman et al. (1967), and others
EXPLANATION
HOLOCENE AND WISCONSINAN
Alluvium, sand dunes, and gravel terraces
WISCONSINAN
Lake deposits
WOODFORDIAN
Moraine
Front of morainic system
Groundmoraine
ALTONIAN
Till plain
ILLINOIAN
Moraine and ridged drift
Groundmoraine
KANSAN
Till plain
DRIFTLESS
Field trip areas
0 20 40 Miles
0 10 20 30 40 50 Kilometers

Fig. 1.

drift and an area of Illinoian drift just south of the Woodfordian limit (fig. 1). The Pleistocene stratigraphy of these two small areas is representative of the regional stratigraphy of both the Woodfordian drift in the Decatur Sublobe and the Illinoian and older drift in the eastern part of Illinois. Saturday will be spent in the northern area, Sunday in the southern area, and the conference will end near the town of Jewett, in Cumberland County, Sunday at 1 p.m.

## Acknowledgments

Much of our knowledge of the Pleistocene geology of east-central Illinois has been derived from the studies George W. White, his students, and his associates made of the strip-mine exposures in the Danville area.

Also important to this conference are the efforts of several members of the Illinois State Geological Survey staff. Analyses of clay minerals were made by H. D. Glass, the grain-size analyses by W. A. White and his assistants, radiocarbon dating by Dennis Coleman, studies of molluscan faunas by A. Byron Leonard, and chemical analyses by David B. Heck. John C. Frye and H. B. Willman corroborated field relations and assisted in assigning rock- and soil-stratigraphic names.

# REGIONAL STRATIGRAPHY

## Introduction

The field conference will focus on Pleistocene studies made in the past six years by P. B. DuMontelle, L. R. Follmer, J. P. Ford, H. D. Glass, D. L. Gross, A. M. Jacobs, W. H. Johnson, J. P. Kempton, J. A. Lineback, and S. R. Moran. Some of the studies have been published (Jacobs and Lineback, 1969; Johnson et al., 1971; Johnson, Gross, and Moran, *in press*; Johnson, 1971; and Kempton, DuMontelle, and Glass, *in press*) while other studies are continuing or nearing completion. The latter include work by Follmer on some of the paleosols and loesses, a study of Coles County by Ford, one on Vermilion County by Johnson, work in the area of the Decatur $2^{\circ}$ sheet by Lineback, and a regional synthesis by Johnson, Kempton, Lineback, and others in the Decatur Sublobe. The following discussion summarizes both published and unpublished work and should be considered as a preliminary report pending completion of current studies.

## Stratigraphic Principles

Willman and Frye (1970, p. 37-45) summarized the principles of stratigraphic classification used in recent Pleistocene studies in Illinois. A scheme of multiple independent classifications is recognized, and four formal classifications have been adopted for use in the Pleistocene: rock stratigraphy, soil stratigraphy, morphostratigraphy, and time stratigraphy. The emphasis of this conference will be on rock-stratigraphic classification, the use of rock stratigraphy in regional correlations, and soil-stratigraphic classification.

| TIME STRATIGRAPHY | | | ROCK STRATIGRAPHY | | | SOIL STRATIGRAPHY |
|---|---|---|---|---|---|---|
| QUATERNARY SYSTEM, PLEISTOCENE SERIES | Holocene Stage | | Cahokia Alluvium | | | Modern Soil |
| | Wisconsinan Stage | Valderan Substage | | | | |
| | | Twocreekan Substage | | | | |
| | | Woodfordian Substage | Peoria Loess | | Richland Loess | |
| | | | | Henry Formation; Batavia Mbr.; Wedron Formation | Snider Till Member | |
| | | | | | Batestown Till Member | |
| | | | | | Glenburn Till Member | |
| | | | | | Oakland Till Member | |
| | | | | | Morton Loess | |
| | | Farmdalian Substage | Robein Silt | | | Farmdale Soil |
| | | Altonian Substage | Roxana Silt, sandy-silt facies | | | |
| | | | Unnamed silt | | | |
| | Sangamonian Stage | | | | | Sangamon Soil |
| | Illinoian Stage | Jubileean Substage | Pearl Formation | Glasford Formation | Radnor Till Member | |
| | | | | | Roby Silt Member | |
| | | Monican Substage | | | Vandalia Till Member | |
| | | | | | Mulberry Grove Silt Member | Pike Soil (?) |
| | | Liman Substage | | | Smithboro Till Member | |
| | | | | | Petersburg Silt | |
| | Yarmouthian Stage | | | | | Yarmouth Soil |
| | Kansan Stage | | Banner Formation | | Tilton Till Member | |
| | | | | | Hillery Till Member | |
| | | | | | Harmattan Till Member | |
| | | | | | Belgium Member | |
| | | | | | Hegeler Till Member | |
| | Aftonian Stage | | | | | |
| | Nebraskan Stage | | | | | |

Fig. 2 - Time-stratigraphic classification of the Pleistocene deposits of Illinois and pertinent rock- and soil-stratigraphic units in the field trip areas.

Rock-stratigraphic units are based in part on observable physical characteristics sufficiently distinctive to make the units identifiable by common field and subsurface methods. Data on texture and composition generated in the laboratory also are useful in characterizing the units and in making regional correlations.

Several buried soils are recognized in the field conference area and are correlated to named soil-stratigraphic units that have been defined or recognized elsewhere in Illinois (Willman and Frye, 1970). Such correlations are based on the stratigraphic position of the top of the soil; that is, the soil is identified by its position relative to the rock-stratigraphic unit or units that overlie it. The material in which the soil is developed is identified separately as a rock-stratigraphic unit.

The time-stratigraphic units currently recognized in Illinois (Willman and Frye, 1970) and the pertinent rock-stratigraphic and soil-stratigraphic units that will be observed and/or discussed during the field conference are shown in figure 2.

## Laboratory Data and Techniques

Many glacial tills are quite similar in appearance, and in certain field situations it is difficult or impossible to make a definite stratigraphic identification. However, all of the tills that will be seen during the field conference have one or more distinctive characteristics in texture or composition that can be determined in the laboratory and can then be used with other data for stratigraphic interpretation. Laboratory data also are essential in the evaluation of buried soils and in sedimentology.

Table 1 lists the types of analysis used in the laboratories of the Illinois Geological Survey to obtain data for the field conference, as well as those responsible for the analyses. The laboratory data are summarized in table 2 and illustrated in figure 3.

## Description of Rock-Stratigraphic Units

The following rock-stratigraphic units have been, or are, in the process of being formally defined and described in detail (Ford, *in preparation*; Jacobs and Lineback, 1969; Johnson, 1964 and 1971; Johnson, Gross, and Moran (*in press*); and Willman and Frye, 1970). This discussion briefly summarizes these descriptions and puts the units in a stratigraphic framework for reference during the field conference. It includes only units that are pertinent to or will be observed during the conference (fig. 2).

### Banner Formation

The Banner Formation consists of the glacial tills and intercalated outwash of sand, gravel, and silt deposited during the Kansan Stage in Illinois and is bounded at the top by the Yarmouth Soil (Willman and Frye, 1970). Five members of the Banner Formation have been defined in the Danville region, and alluvial sediments of Kansan or Yarmouthian age are included in the formation.

TABLE 1—ANALYTIC TECHNIQUES USED IN THE STUDY OF PLEISTOCENE DEPOSITS IN EAST-CENTRAL ILLINOIS

| Analyzed for | Techniques | Remarks | Analyst |
|---|---|---|---|
| Grain-size distribution (in unweathered samples) | Sieving and hydrometer | Sand: 0.062-2.0 mm<br>Silt: 0.004-0.062 mm<br>Clay: < 0.004 mm | W. A. White and assistants |
| Grain-size distribution (in soil profiles) | Sieving and pipetting | Sand: 0.062-2.0 mm<br>Silt: 0.002-0.062 mm<br>Clay: < 0.002 mm | W. A. White and assistants |
| Clay minerals | X-ray diffraction of oriented aggregates | Clay fraction < 0.002 mm | H. D. Glass |
| Carbonates (calcite and dolomite) | Chittick apparatus | After Dreimanis (1962) | W. H. Johnson and others |
| Heavy minerals | Sieving for 62 μ to 250 μ fraction; bromoform separation; grain counts with polarizing microscope | 100 transparent grains per slide counted | A. M. Jacobs |
| Pollen | HCl, HF, KOH, silicone oil | Relative pollen frequency | A. M. Jacobs |
| Inorganic carbon | $CO_2$ absorption on LiOH | | D. B. Heck |
| Total carbon | High-temperature combustion | | P. E. Gardner |
| Organic carbon | Differentiation between total carbon and inorganic carbon | | |
| Total phosphorous ($P_2O_5$) | $HNO_3$ extraction, precipitated by $NH_4$ complex | | D.B. Heck |
| Iron and manganese | Colorimetric determination on sodium dithionite ($Na_2S_2O_4$) extract | | D.B. Heck |
| Radiocarbon age | Benzene liquid scintillation counting | | D. Coleman |
| Till fabric | Pebble orientation | | S. Smith |
| Lithology of pebbles in tills | Pebbles embedded in plaster, sawed, identified with binocular microscope | | S. Avcin<br>A. M. Jacobs |

TABLE 2—GRAIN-SIZE DISTRIBUTION, CLAY MINERAL CONTENT, AND CARBONATE CONTENT IN UNWEATHERED TILLS OF DESCRIBED SECTIONS

| | Grain-size distribution (% of < 2 mm) | | | Clay minerals (% of < 2 μ) | | | Carbonates (% of < 74 μ) | | |
|---|---|---|---|---|---|---|---|---|---|
| Till member | Sand | Silt | Clay | Expandable clay minerals | Illite | Kaolinite plus chlorite | Calcite | Dolomite | Total carbonate |
| SNIDER | | | | | | | | | |
| mean | 15 | 47 | 38 | 3 | 83 | 14 | 6 | 17 | 23 |
| s.d.* | 6 | 5 | 8 | 1 | 3 | 3 | 1 | 1 | 1 |
| no.† | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| BATESTOWN | | | | | | | | | |
| mean | 28 | 38 | 34 | 3 | 79 | 18 | 5 | 19 | 24 |
| s.d. | 3 | 3 | 4 | 1 | 4 | 4 | 1 | 2 | 2 |
| no. | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 24 | 24 |
| GLENBURN | | | | | | | | | |
| mean | 34 | 42 | 25 | 13 | 64 | 24 | 5 | 18 | 23 |
| s.d. | 5 | 6 | 5 | 4 | 5 | 3 | 2 | 2 | 4 |
| no. | 30 | 30 | 30 | 25 | 25 | 25 | 30 | 30 | 30 |
| OAKLAND | | | | | | | | | |
| mean | 18 | 46 | 36 | 22 | 53 | 25 | 3 | 11 | 14 |
| s.d. | 13 | 9 | 5 | 7 | 5 | 3 | 1 | 2 | 2 |
| no. | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| RADNOR | | | | | | | | | |
| mean | 40 | 41 | 19 | 7 | 75 | 19 | 5 | 26 | 31 |
| s.d. | 5 | 2 | 5 | 3 | 6 | 5 | 1 | 3 | 4 |
| no. | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 10 |
| VANDALIA | | | | | | | | | |
| mean | 39 | 41 | 20 | 19 | 63 | 18 | 9 | 20 | 29 |
| s.d. | 7 | 7 | 4 | 11 | 11 | 4 | 2 | 4 | 5 |
| no. | 49 | 49 | 49 | 46 | 46 | 46 | 38 | 38 | 38 |
| SMITHBORO | | | | | | | | | |
| mean | 20 | 55 | 26 | 35 | 46 | 19 | 4 | 16 | 20 |
| s.d. | 6 | 8 | 4 | 13 | 12 | 3 | 1 | 3 | 4 |
| no. | 11 | 11 | 11 | 10 | 10 | 10 | 10 | 10 | 10 |
| TILTON | | | | | | | | | |
| mean | 37 | 40 | 23 | 15 | 65 | 20 | 12 | 18 | 30 |
| s.d. | 5 | 7 | 4 | 5 | 6 | 2 | 2 | 2 | 4 |
| no. | 12 | 12 | 12 | 12 | 12 | 12 | 9 | 9 | 9 |
| HILLERY | | | | | | | | | |
| mean | 31 | 41 | 29 | 8 | 71 | 22 | 13 | 13 | 26 |
| s.d. | 4 | 1 | 4 | 6 | 2 | 4 | 2 | 2 | 1 |
| no. | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| HARMATTAN | | | | | | | | | |
| mean | 25 | 42 | 33 | 16 | 62 | 22 | 7 | 16 | 23 |
| s.d. | 6 | 10 | 5 | 10 | 8 | 3 | 2 | 5 | 6 |
| no. | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| HEGELER‡ | | | | | | | | | |
| mean | 20 | 51 | 29 | 33 | 27 | 40 | 0.2 | 0.4 | 0.6 |
| s.d. | 5 | 5 | 5 | 4 | 3 | 4 | 0.2 | 0.2 | 0.4 |
| no. | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

* Standard deviation; † number of samples; ‡ data for Hegeler Till Member is from Johnson (1971).

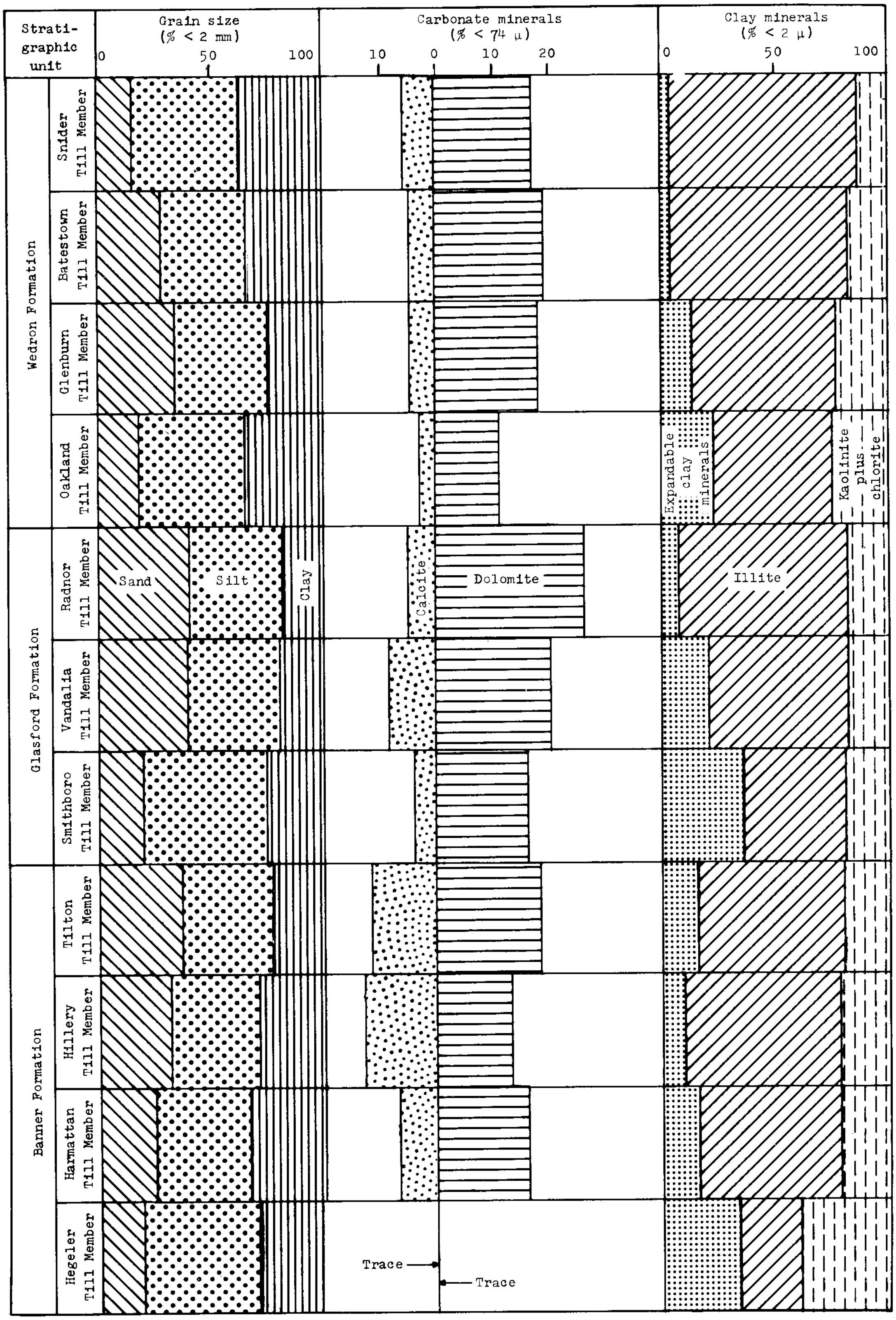



Fig. 3 - Mean grain-size, clay mineral, and carbonate composition of tills in the field trip areas.

*Hegeler Till Member* — The Hegeler Till Member is a greenish gray till that rests on bedrock and is overlain by the Belgium Member (Johnson, 1971). It has been observed in only one area of the Harmattan Strip Mine, where it is up to 8 feet thick. The till is massive, silty, and contains many small, rounded, siliceous pebbles (table 3, fig. 3). The lower portion of the unit, however, also contains a large variety of crystalline pebbles derived from Precambrian rocks of the Canadian Shield.

The unit has a unique mineral composition for tills in Illinois. It has a very low carbonate and illite content and a very high vermiculite and expandable clay mineral content (table 2, fig. 3). The implications of the composition on its origin and age have been discussed by Johnson (1971). He assigned the Hegeler to the Kansan Stage but suggested that it may belong to the Nebraskan Stage. The regional extent of the unit is not known, but similar materials resting on bedrock have been noted in a test pit for coal in west-central Illinois (A. M. Jacobs, personal communication) and in a quarry in south-central Illinois (I. E. Odom, personal communication). The unit will not be observed during the field conference because it is no longer accessible.

*Belgium Member* — The Belgium Member consists of silt and clay that occur below the Harmattan Till Member and above the Hegeler Till Member, or, where the Hegeler is absent, above noncalcareous silt and colluvial deposits on the bedrock (Johnson, 1971). The silt is tan to dark gray-brown, calcareous, fossiliferous, and locally carbonaceous. The upper part of the Belgium consists of a thin brown clay which is faintly laminated and highly calcareous. The molluscan fauna (Leonard, Frye, and Johnson, 1971) consists predominantly of terrestrial species and is indicative of a partially wooded terrain in a north-temperate climate. However, as the Belgium Member appears to have accumulated in a lacustrine and/or alluvial environment in a broad, shallow bedrock valley, the fossils contained in the sediments were apparently washed into the valley bottom from surrounding slopes. The Belgium Member can be observed at Stop 4, Harmattan Strip Mine Section No. 4 (fig. 16).

*Harmattan Till Member* — The Harmattan Till Member is a gray to olive-gray till that occurs below the Hillery Till Member and above the Belgium Member or bedrock (Johnson, Gross, and Moran, *in press*). The till is hard and massive and varies considerably in texture and composition (table 2, fig. 3). These variations appear to be primarily the result of deformation within the unit, which has resulted in the "stacking" of different types of till in various combinations in a section.

The till is best known from exposures in the Harmattan Strip Mine near Danville. It has been observed in one other section in the Danville area and tentative correlations have been suggested with till exposed in western Indiana and in central Illinois (Johnson, Gross, and Moran, *in press*). The till and related outwash can be observed at Stop 4, Harmattan Strip Mine Section No. 4 (figs. 16, 17).

*Hillery Till Member* — The Hillery Till Member is a distinct, reddish brown till that stratigraphically occurs between two gray tills, the Harmattan Till Member below and the Tilton Till Member above (Johnson, Gross, and Moran, *in press*). It is best known in the Danville area and in most sections rests

TABLE 3—PEBBLE LITHOLOGY DATA FOR UNWEATHERED TILL SAMPLES
(Values are percentage of total pebbles from a bulk sample of the till)

| Till member | Section | No. of pebbles counted | Limestone | Dolomite | Shale | Sandstone | Siltstone | Mudstone | Conglomerate | Coal | Chert | Quartzite | Marble | Jasper | Limonite | Granite | Diorite | Gabbro | Quartz |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (% of total pebbles > 3/8 inch) | | | | | | | | | | | | | | | | |
| Snider | Harmattan No. 2 | 37 | 5 | 14 | 3 | 30 | 3 | 3 | — | — | 32 | 3 | — | — | — | 5 | — | — | 3 |
| Batestown | Harmattan No. 4 | 39 | 8 | 31 | 5 | 21 | — | — | — | — | 28 | — | — | — | 3 | 3 | 3 | — | — |
| Batestown | Harmattan No. 4 | 33 | 9 | 18 | — | 36 | 3 | 3 | — | — | 12 | 9 | — | — | — | 3 | 3 | — | 3 |
| Glenburn | Emerald Pond | 12 | 8 | 33 | — | 17 | 8 | — | — | — | 8 | 17 | — | — | — | 8 | — | — | — |
| Radnor | Harmattan No. 4 | 35 | — | 49 | 3 | 11 | — | — | — | — | 20 | 6 | — | 6 | — | 3 | 3 | — | — |
| Vandalia | Harmattan No. 4 | 40 | 9 | 13 | 2 | 4 | — | — | — | — | 7 | 1 | 1 | 1 | — | 1 | 1 | — | — |
| Vandalia | Jewett | 32 | 9 | 6 | — | 9 | 6 | — | 3 | — | 44 | 9 | — | — | — | 6 | — | — | 6 |
| Smithboro | Drainage Ditch | 29 | 14 | 31 | — | 14 | 3 | — | — | — | 35 | — | — | — | — | 3 | — | — | — |
| Tilton | Emerald Pond | 44 | 32 | 5 | 3 | 3 | — | — | — | — | 23 | 23 | — | — | — | 9 | — | 5 | — |
| Hillery | Harmattan No. 4 | 21 | 29 | 33 | 5 | 19 | — | — | — | — | 10 | — | — | — | — | 5 | — | — | — |
| Harmattan | Harmattan No. 4 | 27 | 15 | 15 | 4 | 11 | 4 | — | — | 7 | 22 | 11 | — | — | — | 3 | 3 | — | 4 |
| Hegeler | Harmattan No. 2 | 20 | — | — | — | — | — | — | — | — | 85 | 10 | — | — | — | — | — | 5 | — |
| Kansan till (undiff.) | Jewett | 25 | 16 | 4 | — | 32 | 8 | — | — | — | 24 | 12 | — | — | — | 4 | — | — | — |

directly on bedrock. The till is very hard and massive, and it normally contains more silt than sand or clay. It also has more calcite in the < 74 μ fraction than all the other tills. It differs from the Tilton in color and in containing less dolomite in the < 74 μ fraction (table 2, fig. 3).

Although not widely known, the Hillery has been observed in several localities in central and south-central Illinois and in western Indiana. It therefore appears to be a rather extensive, but discontinuous, rock unit. The Hillery will be observed at Stop 4, Harmattan Strip Mine Section No. 4 (figs. 16, 17), and at Stop 5, School House Branch Section of Hungry Hollow (figs. 18, 19).

*Tilton Till Member* — The Tilton Till Member is a gray to brownish gray till that occurs above the Hillery Till Member. It is overlain by alluvial sediments of the Banner Formation, the Smithboro or Vandalia Till Members of the Glasford Formation, or a younger unit. It is the Vandalia Till that generally overlies it in the Danville area. The Tilton Till contains a weathered zone in the upper portion in two sections near Danville, and in other sections the upper part of the till is often oxidized. Outwash related to the till is rather common in many sections, and the till contains more sand and silt than clay in the < 2 mm fraction. The Tilton is somewhat similar to the Vandalia Till but has a higher calcite content in the < 74 μ fraction (table 2, fig. 3).

The Tilton Till Member is thought to be stratigraphically equivalent to till that has been called "eastern Kansan" or "Kansan" in eastern and central Illinois in the past decade (Willman, Glass, and Frye, 1963; Johnson, 1964; and Jacobs and Lineback, 1969). The Tilton Till will be observed at Stop 3, Emerald Pond Section (figs. 14, 15), at Stop 4, Harmattan Strip Mine Section No. 4 (figs. 16, 17), and at Stop 5, School House Branch Section of Hungry Hollow (figs. 18, 19).

*Unnamed sediments of the Banner Formation* — Sediments in two different stratigraphic positions are included as portions of the Banner Formation. Silts below the Belgium Member and above the local bedrock that were described by Johnson (1971) were exposed near the base of the Harmattan Strip Mine Section No. 4 (Stop 4). That part of the section is now under water. Sediments, apparently of alluvial origin, that lie above the Tilton Till Member in the School House Branch Section of Hungry Hollow (Stop 5) are probably of Yarmouthian age and are later discussed in more detail in the introduction to Stop 5.

## Petersburg Silt

The Petersburg Silt was named by Willman, Glass, and Frye in 1963, and the unit was later classified as a formation (Willman and Frye, 1970). It is predominantly silt, often of loessial origin, that was laid down as a proglacial deposit in the early part of the Illinoian Stage. A thin silt below the Smithboro Till Member in the School House Branch Section of Hungry Hollow (Stop 5) was included in the Petersburg Silt (Johnson, Gross, and Moran, *in press*). Because this silt is partly weathered (see discussion for Stop 5), it may be somewhat older than the Petersburg Silt in the type section, which is calcareous and generally unweathered. For this reason we have concluded that it is better included in the Banner Formation.

Glasford Formation

The Glasford Formation consists of the glacial tills and intercalated outwash of sand, gravel, and silt deposited in Illinois during the Illinoian Stage (Willman and Frye, 1970). Seven members of the Glasford Formation have been defined or identified in south-central and east-central Illinois, five of which will be seen on the field trip.

*Smithboro Till Member* — The Smithboro Till Member is a silty till that lies below the Mulberry Grove Member or Vandalia Till Member and rests on the Petersburg Silt or on till or outwash of the Banner Formation (Jacobs and Lineback, 1969; Willman and Frye, 1970). The type section is in south-central Illinois, and till in the Danville region has been correlated with the Smithboro on the basis of strong similarities in texture and composition (Johnson, Gross, and Moran, *in press*). In addition to being silty, the Smithboro contains less carbonate in the < 74 μ fraction than most of the other tills, and the clay fraction contains the largest quantity of expandable clay minerals (table 2, fig. 3). Wood and mollusk shells in the till, along with its composition, suggest that the glacier that deposited the till incorporated large quantities of Petersburg Silt.

The Smithboro is widespread in southeastern and eastern Illinois and has been observed in western Indiana. It will be seen at Stop 5, School House Branch Section of Hungry Hollow (figs. 18, 19), at Stop 7, Hutton Section (figs. 23, 24), and at Stop 8, Jewett Section (fig. 25).

*Mulberry Grove Silt Member* — The Mulberry Grove Silt Member includes silt and related sediments that lie between the Smithboro and Vandalia Till Members (Jacobs and Lineback, 1969; Willman and Frye, 1970). It is a thin, lenticular deposit that is generally calcareous and locally carbonaceous. In the Danville region, some of the sediments that have been included in the unit are colluvial in origin and are noncalcareous. The Mulberry Grove Silt Member will be observed at Stop 5, School House Branch Section of Hungry Hollow (fig. 18), and, poorly exposed, at Stop 7, Hutton Section (fig. 23).

*Vandalia Till Member* — The Vandalia Till Member is the surficial till in large areas of southeastern and south-central Illinois. It was named and defined by Jacobs and Lineback in 1969 and was later made a formal member of the Glasford Formation by Willman and Frye (1970). In most places it overlies the Mulberry Grove or Smithboro Members or the Banner Formation and is overlain by either younger Illinoian sediments (Roby Silt or Radnor Till Members) or Wisconsinan sediments (Roxana Silt or Wedron Formation).

The Vandalia till is brown to brownish gray and is generally coarser than the other tills in this part of Illinois. It contains considerable interbedded sand, gravel, and silt. The till can be recognized by its high sand content in the < 2 mm fraction and its relatively high calcite content in the < 74 μ fraction (table 2, fig. 3). The unit will be observed at Stop 1, Higginsville Section (figs. 8, 9), at Stop 4, Harmattan Strip Mine Section No. 4 (figs. 16, 17), at Stop 5, School House Branch Section of Hungry Hollow (figs. 18, 19), at Stop 6, Center School Section (figs. 21, 22), at Stop 7, Hutton Section (figs. 23, 24), and at Stop 8, Jewett Section (figs. 25, 26).

*Roby Silt Member* — The Roby Silt Member includes silts and related sediments that lie between the Vandalia and Radnor Till Members (Johnson, 1964; Willman and Frye, 1970). As originally defined, the unit included only related sediments deposited in a lake, or perhaps a series of lakes, in central Illinois, but the unit is here extended to include similar deposits in the same stratigraphic position in eastern Illinois. In the Danville area, the Roby Silt Member has been described from Harmattan Strip Mine Section No. 3 (Leonard, Frye, and Johnson, 1971) and will be observed at Stop 1, Higginsville Section (fig. 8). In the Danville area, the Roby is predominantly silt that is calcareous and locally fossiliferous and carbonaceous.

Wood from the unit in Harmattan Strip Mine Section No. 3 yielded a radiocarbon date of > 47,000 years B.P. (ISGS-29). The molluscan fauna from that section has been described (Leonard, Frye, and Johnson, 1971), and the fauna from the Higginsville Section is listed and explained in the discussion of that section.

*Radnor Till Member* — The Radnor Till Member was named and defined by Willman and Frye (1970) to include a gray, silty till in central Illinois that overlies the Toulon Member, the upper part of which is stratigraphically equivalent to the Roby. The Radnor Till is bounded at the top by the Sangamon Soil. The till and related sediments were deposited during the last recognized Illinoian glaciation in Illinois. The unit is here extended to eastern Illinois to include till and related outwash in the same stratigraphic position that is similar in composition. The Radnor in the Danville area varies somewhat and in places contains more sand and less silt than the Radnor in the type area. As more data on its character and distribution become available, it may eventually be appropriate to establish it as a new rock unit in eastern Illinois, but this does not seem necessary at the present time.

Although it was not definitely recognized, the existence of this till in the Danville area was suggested by Johnson, Gross, and Moran (*in press*) on the basis of laboratory data. Further field studies have documented its presence in the area, and in the Higginsville Section it is separated from the Vandalia by the Roby Silt Member. The unoxidized till varies from light to dark gray and varies somewhat in texture, but it generally contains from 30 to 40 percent sand in the < 2 mm fraction. It is distinguished from the Vandalia Till by containing less calcite and more dolomite in the < 74 μ fraction and more illite in the clay fraction (table 2, fig. 3). Interbedded silt and sand are common in some sections, in the Higginsville, for example. This interbedding and the presence of structures that may be of collapse origin in the same sections suggest that both superglacial and ice-contact deposition may have taken place. The till is rather common in sections north of Danville, but it has not been observed to the south. Central Vermilion County is apparently the southern limit of the late Illinoian advance. The unit will be observed at Stop 1, Higginsville Section (figs. 8, 9), at Stop 2b, Collison Branch Section No. 2 (figs. 10, 11), and at Stop 4, Harmattan Strip Mine Section No. 4 (figs. 16, 17).

## Pearl Formation

The Pearl Formation consists of sand and gravel that has the Sangamon Soil in its top (Willman and Frye, 1970). It is largely a pebbly sand that was deposited as outwash overlying or extending beyond the Illinoian till. Materials included in the Pearl Formation will be observed at Stop 6, Center School Section (figs. 21, 22). In that section the Sangamon Soil is developed in the Pearl, and it is difficult to interpret the origin of the parent materials because of subsequent modification by pedogenic processes.

Unnamed Silt

A thin carbonaceous silt, which has yielded a radiocarbon date of 48,000 ± 1,700 years B.P. (ISGS-63), is exposed in the Higginsville Section (Stop 1, fig. 8). The date suggests an Altonian age for the silt, but the stratigraphic situation is not clear, and for this reason no formal stratigraphic designation is made at this time. Pollen and other data, as well as problems of interpretation of the silt, are described and discussed in the explanation of the Higginsville Section.

Roxana Silt

The Roxana Silt is largely silt of loessial origin, but it also includes some windblown sand and some sand, silt, and clay of colluvial origin (Frye and Willman, 1960; Willman and Frye, 1970). It rests on the Sangamon Soil and is bounded at the top by the Robein Silt or the Farmdale Soil. The Roxana is thickest and best developed in western and west-central Illinois, where it has been subdivided into three formal members and where several soils have been recognized in it (Willman and Frye, 1970).

Silt and colluvium in the Collison Branch Section No. 2 (Stop 2b, figs. 12, 13) above the Radnor Till that are weathered and are part of the paleosol in the section are included as a portion of the Roxana Silt. The stratigraphic and pedologic situation is discussed further in the explanation for that section. These materials may be older than typical Roxana Silt, but the Roxana is the only appropriate rock unit currently available to which the materials can be assigned.

*Roxana Silt, sandy silt facies* — In eastern Illinois, a sandy silt, which occurs in the stratigraphic position of the Roxana, is included as a facies of the Roxana Silt. The materials, their stratigraphic relations, and their origin are discussed in more detail on p. 25-27 and in the explanation of the Center School Section, Stop 6, where the facies will be observed (fig. 21). It will also be seen at Stop 7, Hutton Section (figs. 23, 24), and at Stop 8, Jewett Section (figs. 25, 26).

Robein Silt

The Robein Silt includes carbonaceous silt, sandy silt, and peat and rests on the Roxana Silt or on an older unit; it is usually overlain by the Peoria Loess, the Morton Loess, or the Wedron Formation (Willman and Frye, 1970). The Robein is a thin but widespread and distinctive deposit that accumulated immediately prior to the advance of the Woodfordian glaciers in Illinois. It has been radiocarbon dated in many localities in Illinois and is for the most part Farmdalian in age. Recent dates in south-central Illinois, however, indicate that the unit in that area is of early Woodfordian age, which makes the top of the unit time transgressive (Kempton and Gross, 1971). The Robein will be observed at Stop 4, Harmattan Strip Mine Section No. 4 (figs. 16, 17), and at Stop 6, Center School Section (figs. 21, 22).

Wedron Formation

The Wedron Formation consists of the glacial tills and intercalated outwash of sand, gravel, and silt deposited in Illinois during the Woodfordian Substage of the Wisconsinan Stage (Frye et al., 1968; Willman and Frye, 1970). The formation extends from the basal contact with the Morton Loess or an older unit to the top of the till below the Two Creek deposits at Two Creeks, Wisconsin. In east-central Illinois, four members of the Wedron Formation have been formally defined.

*Oakland Till Member* — The basal Woodfordian till in eastern Illinois was named Oakland by Ford (*in preparation*). In the type area it is a brown to brownish gray till that overlies the Robein Silt and is overlain by the Glenburn Till Member. It is characterized by relatively large amounts of expandable clay minerals in the clay fraction and by a low carbonate content (table 2, fig. 3). The till is not as continuous as the overlying Glenburn Till and is now known from only one exposure in the Danville area. Till of the same type has, however, been described in several borings farther west (Kempton, DuMontelle, and Glass, *in press*). Because of its sporadic distribution, Ford interpreted it as being of local origin and suggested it was the result of the same ice advance as the Glenburn Till. The Oakland will be observed at Stop 4, Harmattan Strip Mine Section No. 4 (figs. 16, 17).

*Glenburn Till Member* — The Glenburn Till Member is a brownish gray to reddish brown till that lies between the Oakland Till Member or an older unit and the overlying Batestown Till Member (Johnson, Gross, and Moran, *in press*). The Glenburn varies from a rather distinctly pink till to one that is more gray-brown but oxidizes to a pink color. It is sandier and contains less illite in the clay fraction than the overlying Batestown Till, and it contains less calcite in the $< 74\ \mu$ fraction than the Vandalia Till (table 2, fig. 3). Although absent from several sections in the Danville region, the till is extensive in the Decatur Sublobe. To the west, similar till has been noted in the subsurface in the Champaign-Urbana area (Kempton, DuMontelle, and Glass, *in press*), has been observed in exposures along the Sangamon River near Mahomet, and appears in several borrow pits along Interstate 74 between Mahomet and Bloomington. To the south, it eventually becomes the surficial till beyond the margin of the Batestown Till and extends to the area of the Shelbyville Moraine (fig. 4). Thus it appears to have been deposited by the most extensive advance of the Woodfordian glacier in eastern Illinois. Two radiocarbon dates (see discussion in explanations of Higginsville and Emerald Pond Sections) from the Danville area suggest that the Glenburn might be older than the Woodfordian. Our interpretation that it is Woodfordian is based on the presence of the Glenburn above the Robein Silt in several sections in this part of Illinois. The Glenburn will be observed at Stop 1, Higginsville Section (figs. 8, 9), at Stop 2a, Collison Branch Section No. 1 (figs. 10, 11), at Stop 3, Emerald Pond Section (figs. 14, 15), at Stop 4, Harmattan Strip Mine Section No. 4 (figs. 16, 17), and at Stop 6, Center School Section (figs. 21, 22).

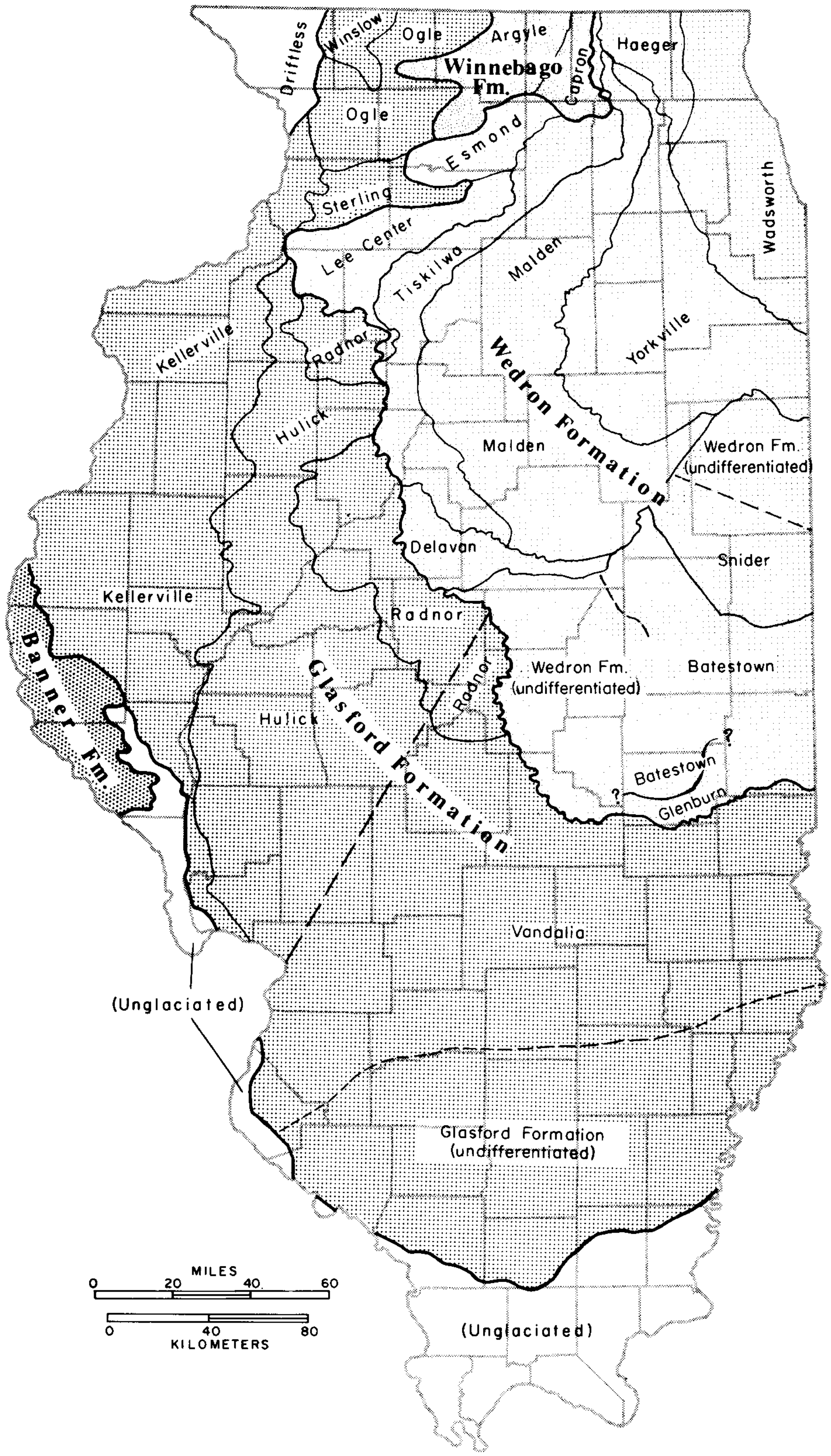



Fig. 4 - Areal distribution of the dominantly till formations and members of Illinois. Western and northern Illinois from Willman and Frye (1970). Mapping in eastern and southern Illinois based on work in progress and subject to change; Glasford Formation by L. R. Follmer, A. M. Jacobs, J. A. Lineback, R. M. Mason; Wedron Formation by J. P. Ford, W. H. Johnson, J. P. Kempton, and J. A. Lineback.

*Batestown Till Member* — The Batestown Till Member is a gray, often silty till that occurs stratigraphically between the Snider and Glenburn Till Members in the Danville region (Johnson, Gross, and Moran, *in press*). It is the surficial till beyond the margin of the Snider Till at the frontal edge of the Illiana Morainic System and extends southward to the northern part of Coles County (Ford, *in preparation*) (fig. 4). The Batestown oxidizes to a rather characteristic light olive-brown. It is a coarser till than the overlying Snider; both have a high illite content (table 2, fig. 3).

The Batestown appears to be equivalent to the upper of two gray tills reported in the Champaign-Urbana area (Kempton, DuMontelle, and Glass, *in press*). However, a lower zone that has been observed within the Batestown in the Danville region may be equivalent to the lower of these gray tills. The Batestown will be observed at Stop 1, Higginsville Section (figs. 8, 9), at Stop 2a, Collison Branch Section No. 1 (figs. 10, 11), at Stop 3, Emerald Pond Section (figs. 14, 15), and at Stop 4, Harmattan Strip Mine Section No. 4 (figs. 16, 17).

*Snider Till Member* — The Snider Till Member is a gray, silty and clayey till that lies stratigraphically above the Batestown Till and is the surficial till in and north of the Illiana Morainic System (Johnson, Gross, and Moran, *in press*). The till is characterized by a coarse, blocky structure, and secondary calcium carbonate concentrations are common in the joints just below the leached zone of the Modern Soil developed in the top of the till.

Although it varies somewhat, the till's most diagnostic characteristic is its fine-grained texture. The sand content in the < 2 mm fraction varies from less than 5% in extreme northwestern Vermilion County to over 20% in rare localities near Danville. This variation in texture was noted by Wascher and Winters (1938) while they were mapping the soils of the county. Vertical variations in texture within the till also have been observed in some sections, but these variations appear to be either gradational or local and seem to have no regional stratigraphic significance. The fine-grained texture of the Snider probably reflects erosion and incorporation of lacustrine silts and clays by the glacier that deposited the till. The lacustrine sediments apparently accumulated during the time of ice withdrawal following the deposition of the Batestown Till. The Snider Till Member will be observed at Stop 1, Higginsville Section (figs. 8, 9), at Stops 2a and 2b, Collison Branch Sections 1 and 2 (figs. 10, 11, 12, 13), and at Stop 3, Emerald Pond Section (figs. 14, 15).

Peoria Loess, Morton Loess, Richland Loess

The widespread loessial silt that was deposited during the Woodfordian Substage is included in one of three formations, depending on the stratigraphic position (Frye and Willman, 1960). The loess that accumulated on the Illinoian drift plain beyond the margin of the Wedron Formation is called the Peoria Loess. It generally overlies the Farmdale Soil developed in the Roxana or Robein Silts. The Peoria Loess will be observed at Stop 7, Hutton Section (figs. 23, 24), and at Stop 8, Jewett Section (figs. 25, 26).

The loess that was buried by the Wedron Formation is called the Morton Loess, and the loess that was deposited on top of the Wedron Formation is called the Richland Loess. The Morton will not be observed on the field trip.

Relatively thin Richland Loess will be observed at Stop 1, Higginsville Section (fig. 8), at Stop 3, Emerald Pond Section (fig. 14), at Stop 4, Harmattan Strip Mine Section No. 4 (fig. 16), at Stop 5, School House Branch Section of Hungry Hollow (fig. 18), and at Stop 6, Center School Section (fig. 21).

Henry Formation

The Henry Formation includes sandy and gravelly outwash of Wisconsinan age that is overlain only by the Richland Loess or other post-Wedron Formations (Willman and Frye, 1970).

*Batavia Member* — The Batavia Member includes the surficial sand and gravel deposits that lie on the upland areas and were deposited primarily along the fronts of moraines as outwash plains. The Batavia Member will be observed at Stop 4, Harmattan Strip Mine Section No. 4 (fig. 16), where outwash related to the Illiana Morainic System is exposed.

## Description of Soil-Stratigraphic Units

The following soil-stratigraphic units have been identified in the field trip area by regional correlation. The following discussion places the paleosols in a stratigraphic framework, and the physical characteristics of the soils that will be observed on the field trip are included in the discussions of the field trip stops.

Yarmouth Soil

The soil developed in the uppermost part of the Banner Formation (Stop 5, School House Branch Section of Hungry Hollow, fig. 18; Stop 8, Jewett Section, fig. 25) is in the proper stratigraphic position to be the Yarmouth Soil. The soil is overlain by the Smithboro Till Member, the oldest Illinoian till (Liman Substage) at present known in eastern Illinois. The soil is developed in till or related sediments that occupy the same stratigraphic position as till in western Illinois that contains a soil that has been correlated across the Mississippi River to the area of the type Yarmouth Soil in Iowa (Willman and Frye, 1970).

Pike Soil (?)

The Pike Soil was named and defined by Willman and Frye (1970). The type section is located in western Illinois, where the soil is generally developed in the Kellerville Till Member of the Glasford Formation and overlain by the Duncan Mills Member or the Hulick Till Member of the Glasford Formation or by the Teneriffe Silt. A weak soil developed in sediments between the Smithboro and Vandalia Till Members of the Glasford Formation in the School House Branch Section of Hungry Hollow (Stop 5) (fig. 18) is tentatively correlated with the Pike Soil because the Smithboro is probably correlative with the Kellerville, and the Vandalia with the Hulick. Although poorly exposed, materials that are part of this same soil are present at Stop 7, Hutton Section (figs. 23, 24). The soil is not known in other sections in eastern Illinois, and no firm correlation of the stratigraphic sequence in eastern Illinois with that in western Illinois has been made.

### Sangamon Soil

The Sangamon Soil was named by Leverett in 1898 for a soil in the till of Illinoian age that lies immediately below Wisconsinan deposits in Sangamon County in central Illinois. Willman and Frye (1970) recently established paratypes for the Sangamon Soil in and near Sangamon County, where the soil is often developed in the till of the middle Illinoian (Monican Substage) and is overlain by the Roxana Silt. The Sangamon is a widely recognized soil in the Midcontinent region, and paleosols exposed in the Center School (fig. 21), Hutton (fig. 23), and Jewett Sections (fig. 25) (Stops 6, 7, 8) are easily correlated with the Sangamon Soil of the type area.

The situation in the Danville region is not so clear. Johnson, Gross, and Moran (*in press*) reported that, because of extensive erosion, there was essentially no evidence of the Sangamon Soil in the sections they studied. A newly discovered exposure (Stop 2b, Collison Branch Section No. 2, fig. 12), however, does contain a truncated soil profile, the lower part of which is developed in the Radnor Till Member of the late Illinoian (Jubileean Substage). The upper part of the soil, however, is developed in material that is younger in age and appears to be colluvial or alluvial in origin. Although the upper material is definitely not loessial in origin, it is tentatively included in the Roxana Silt, and only the lower part of the profile is considered part of the Sangamon Soil. The problems of interpretation of the soil are considered further in the discussion of Collison Branch Section No. 2 (Stop 2b).

### Farmdale Soil

The widespread and distinctive Farmdale Soil was formally named by Willman and Frye (1970) to include the peaty and carbonaceous deposits of the Robein Silt and the moderate to better drained profiles developed in Roxana Silt. The soil is usually overlain by the Morton or Peoria Loess or by the Wedron Formation. In addition to the upper part of the soil at Stop 2b, the Collison Branch Section No. 2, described in the preceding paragraph, the Farmdale Soil will be observed at Stop 6, the Center School Section (fig. 21), Stop 7, Hutton Section (fig. 23), and Stop 8, Jewett Section (fig. 25).

## STRATIGRAPHY OF THE DANVILLE REGION

The Pleistocene stratigraphy of the Danville region was recently considered and re-evaluated by Johnson, Gross, and Moran (*in press*). With the exception of the Belgium Member of the Banner Formation, the Roby Silt and Radnor Till Members of the Glasford Formation, the Robein Silt, and the Oakland and Glenburn Till Members of the Wedron Formation, all of the stratigraphic units described in the preceding section and currently recognized in the Danville area had been described and reported earlier by Eveland (1952) or by Ekblaw and Willman (1955). The interpretation of the units, however, is considerably different. In the two earlier reports, the ages of the stratigraphic units were

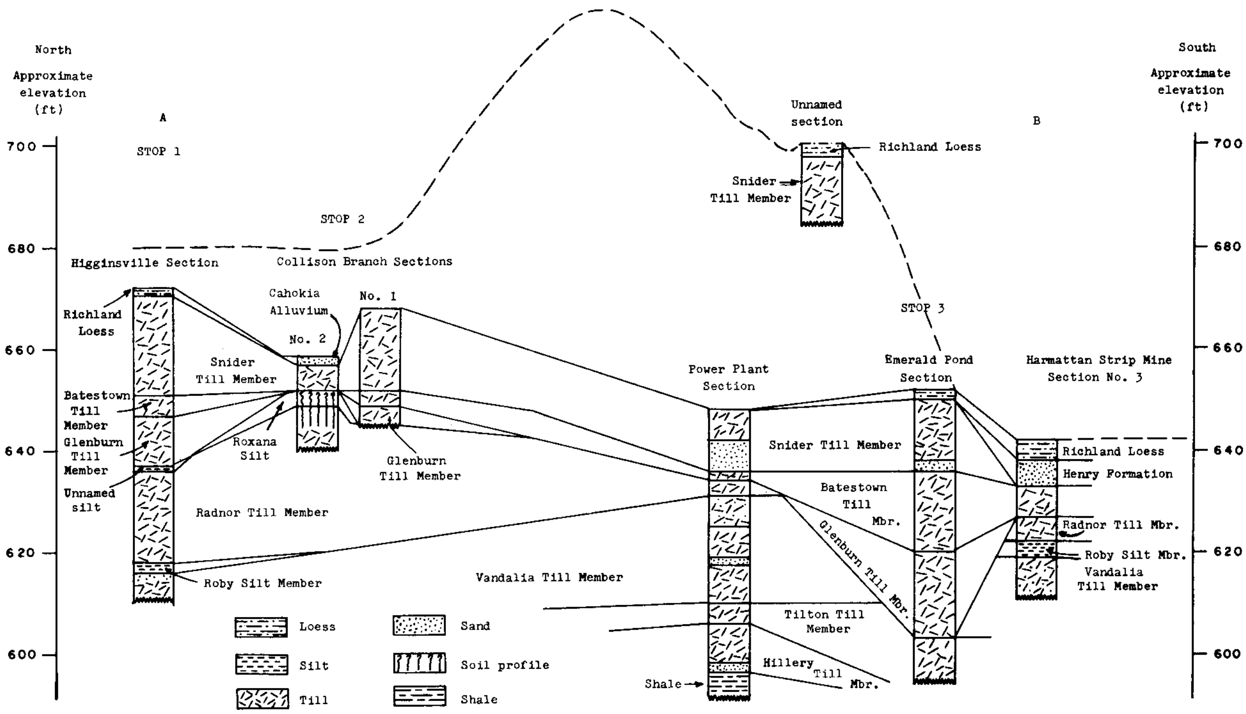



Fig. 5 - North-south cross section showing correlation of stratigraphic units in measured sections. The dashed line at the top of the diagram shows the generalized topography away from the major valleys. Length of cross section approximately 8 miles. Line of cross section and location of stops shown on route map (pl. 1, inside covers).

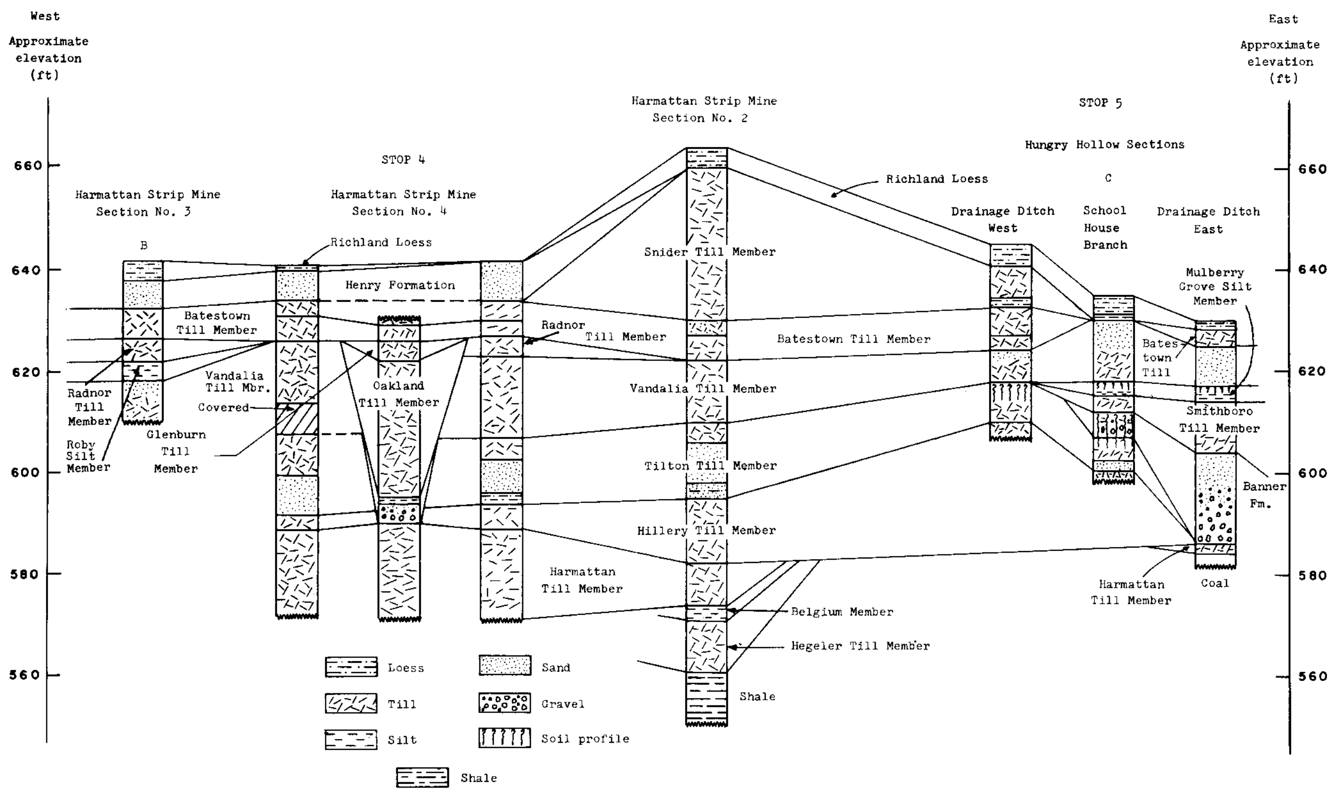



Fig. 6 - East-west cross section showing correlation of stratigraphic units in measured sections. Length of cross section approximately 4 miles. Line of cross section and location of stops shown on route map (pl. 1, inside covers).

based on the interpretation of two weathered zones in the Drainage Ditch Section and School House Branch Section of Hungry Hollow. Eveland interpreted the two soils as the Sangamon and Yarmouth Soils, respectively. Ekblaw and Willman interpreted the lower and most developed as the Sangamon Soil and the upper as having formed during a period of colluviation and weathering in the Wisconsinan. (In current terminology, it would most likely be the Farmdale Soil.) The tills above the Sangamon Soil were related by Ekblaw and Willman (1955) to end moraines south of Danville or called Farmdale (Altonian in the current terminology), and the lower tills were called Illinoian by Ekblaw and Willman or Kansan by Eveland.

Our approach has been to base the ages of the stratigraphic units on correlations with stratigraphic units of known age elsewhere in Illinois (Johnson, Gross, and Moran, *in press*). We established Illinoian age by correlation with units in the Illinoian type area, Kansan age by correlation with units in southern and central Illinois that have long been recognized as Kansan, and Wisconsinan age by determination of stratigraphic position in relation to the Robein Silt. Radiocarbon dates helped to establish Woodfordian age for some units.

The soils were classified according to their position in the stratigraphic sequence: the truncated soil developed in the youngest Illinoian till is the Sangamon, the weak soil developed in materials between the middle and oldest Illinoian tills is the Pike, and the soil developed in the youngest Kansan till is the Yarmouth. Our interpretation is off one stage from the earlier interpretation of Ekblaw and Willman. The soil they considered to be the Sangamon we consider the Yarmouth, and the "soil" they considered to be within the Wisconsinan we consider to be the Pike Soil, which is within the Illinoian.

Figures 5 and 6 are north-south and east-west cross sections, respectively, which show the correlation of the Danville sections that will be observed during the field conference. A few other measured sections appear in figures 5 and 6 to show the stratigraphy in more detail. The stratigraphic situation is complex because of the multiple episodes of glaciation and associated erosion and/or deposition by the ice. Weathering and fluvial erosion during interglacial periods added to the complexity. Consequently, most of the record of weathering has been lost, and in most sections no paleosols are preserved. For the same reasons, several of the tills are no longer continuous units, being preserved only locally in favorable positions, such as former alluvial valleys. In view of the magnitude of erosion for which there is documentation, it is remarkable that the stratigraphic record in the area is so complete. Although the Altonian is not well represented, the record of the Kansan, the Illinoian, and the Woodfordian at Danville is probably as complete as any in the Midcontinent region.

The glacial tills in Illinois have been related to source areas and to particular glacial lobes on the basis of geographic location and distribution, configuration of end moraines, till fabric, and mineral composition. The tills in the eastern part of the state have generally been referred to the Lake Michigan Lobe, the Saginaw Lobe, or the Erie Lobe. However, because workers have used various criteria, there is a lack of agreement among them concerning the lobe source of some of the tills.

Table 4 summarizes the lobe sources or ice movement directions suggested for the tills in the eastern part of the state by recent workers. They have more or less agreed on the pre-Wisconsinan tills, but not on the Woodfordian tills. Willman and Frye (1970) considered the Decatur Sublobe to be part of the Erie Lobe, on the basis of their interpretation of the Gibson City re-entrant as being the result of interference between the Peoria Sublobe of the Lake Michigan Lobe and the Decatur Sublobe of the Erie Lobe. Their interpretation would make the surficial Woodfordian tills in east-central Illinois the result of glaciation by the Erie Lobe. Johnson, Gross, and Moran (*in press*), however, noting the predominance of dolomite over calcite in these tills (table 2), related them to the Lake Michigan Lobe, reasoning that the high dolomite content reflected the dolomitic bedrock (Silurian) around the southern periphery of Lake Michigan.

Heavy minerals have proved useful in determining the source area of tills in Illinois, and Willman, Glass, and Frye (1963) reported that the garnet and epidote contents are particularly diagnostic. The tills deposited by the Lake Michigan Lobe generally have about equal amounts of garnet and epidote, whereas tills derived from a more easterly source contain much larger amounts of garnet than epidote. Although no systematic study of the heavy minerals in the tills in the field trip area has been made, a few samples from each unit were analyzed to obtain data for the field trip (tables 5, 6). Unfortunately, the data are limited and are not in good agreement with the results reported by Willman, Glass, and Frye (1963) for a few samples in the Danville area. Consequently, at the present time no interpretations regarding source areas can be made from heavy mineral data.

Willman and Frye (1970) suggested that the drift of the Illiana Morainic System (Decatur Sublobe) is younger but apparently close in age to the drift of the Bloomington Morainic System (Peoria Sublobe). This interpretation is based primarily on topographic relations in the area of the Gibson City re-entrant. Subsurface work on the tills in McLean County (Peoria Sublobe) and in Champaign-Urbana (Decatur Sublobe) by Kempton, DuMontelle, and Glass (*in press*), based on lithologic correlations between tills in the two sublobes, suggests significantly different age relations. Major problems in the area, therefore, include working out relations between the Decatur and Peoria Sublobes and in determining the source lobes for the tills.

## STRATIGRAPHY OF SOUTH-CENTRAL AND SOUTHEASTERN ILLINOIS

Recent work on the Pleistocene deposits in south-central and southeastern Illinois includes studies by Jacobs and Lineback (1969), Follmer (1970), and Ford (*in preparation*).

The stratigraphic framework of the Illinoian and older deposits was established by Jacobs and Lineback (1969) in the Vandalia region. They showed that there were two widespread and distinct Illinoian tills, the Smithboro and the Vandalia, which had been deposited by different glacial advances. In addition, they demonstrated that a thin silt, the Mulberry Grove Silt Member, had been deposited during the time of deglaciation between the Smithboro and Vandalia advances, that the glacier that deposited the Vandalia Till had undergone widespread stagnation, and that a variety of well sorted to partly sorted sediments had been deposited over the Vandalia Till during wasting of the ice.

TABLE 4—LOBE SOURCE OF TILLS OR ICE-MOVEMENT DIRECTIONS

| | Lobe source | | Ice-movement direction | |
|---|---|---|---|---|
| | (Johnson, Gross, and Moran, in press) | (Willman, Glass, and Frye, 1963; Willman and Frye, 1970) | (Lineback, in press) | (Smith, 1970) |
| Till unit | Based on carbonate mineralogy (% by weight) | Based on moranic configuration, X-ray clay and carbonate mineralogy and heavy minerals | Based on fabric of tills in south-central Illinois | Based on fabric of tills in the Danville area |
| Snider | Lake Michigan | Erie† | | No preferred orientation |
| Batestown | Lake Michigan | Erie† | | South-southwest |
| Glenburn | Lake Michigan | Erie† | | Southwest‡ |
| Oakland | Lake Michigan* | Erie† | | |
| Radnor | Lake Michigan* | | | |
| Vandalia | Saginaw | Saginaw | South-southwest | Southwest |
| Smithboro | Lake Michigan | | Southeast | |
| Tilton | Erie | Erie | South-southwest | South-southeast |
| Hillery | Erie | | | South-southwest |
| Harmattan | Lake Michigan | | | West-southwest‡ |
| Hegeler | | | | |

* Not included in original source; interpretation based on new data using the same criteria.
† Based on the interpretation that the Woodfordian tills in the Decatur Sublobe were deposited by the Erie Lobe.
‡ Till fabric probably strongly influenced by local subglacial topography.

TABLE 5—HEAVY MINERAL DATA FOR UNWEATHERED TILL SAMPLES
(Value for opaques is percentage of total heavy minerals. Values for transparent minerals are percentage of total (0.062 mm-0.25 mm) transparent minerals.)

| Till member | Section sampled | Sample no. | Transparent heavy minerals (%) | | | | | | | | | | | | | | | | | Opaque heavy minerals (% of total) | Garnet to epidote ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Garnet | Epidote | Zircon | Andalusite | Sillimanite | Muscovite | Biotite | Tourmaline | Staurolite | Sphene | Enstatite | Rutile | Hornblende | Augite | Hypersthene | Kyanite | Topaz | | |
| Snider | Emerald Pond | P-5393 | 21 | 9 | — | 4 | 6 | 11 | — | 1 | 3 | 2 | 3 | 1 | 37 | — | 4 | — | — | 47 | 2.4 |
| Snider | Emerald Pond | P-5392 | 10 | 9 | 7 | 1 | 2 | — | — | 2 | 3 | 6 | 9 | 7 | 37 | 6 | 2 | — | — | 51 | 1.1 |
| Batestown | Harmattan No. 4 | P-11918 | 24 | 19 | — | 9 | 2 | — | 1 | 3 | 3 | 7 | 5 | — | 16 | 2 | 8 | — | — | 80 | 1.2 |
| Batestown | Emerald Pond | P-5374 | 16 | 20 | 8 | 1 | 4 | — | — | 1 | — | 4 | — | — | 41 | — | 5 | 1 | — | 50 | 0.8 |
| Batestown | Harmattan No. 4 | P-11920 | 13 | 13 | 2 | — | 1 | 4 | — | — | 1 | 5 | 8 | 3 | 25 | 12 | 10 | — | 2 | 45 | 1.0 |
| Glenburn | Higginsville | P-5339 | 13 | 13 | 3 | 5 | 4 | 3 | — | 2 | — | 2 | 4 | — | 48 | 2 | 2 | — | — | 46 | 1.0 |
| Glenburn | Harmattan No. 4 | P-11925 | 12 | 12 | 4 | 8 | 5 | 33 | — | 2 | — | 5 | — | 1 | 16 | 1 | 2 | — | — | 52 | 1.0 |
| Glenburn | Harmattan No. 4 | P-11901 | 9 | 16 | 2 | 4 | 4 | 3 | — | 3 | 1 | 1 | 6 | 1 | 39 | 1 | 10 | 1 | — | 23 | 0.6 |
| Radnor | Higginsville | P-5347 | 6 | 19 | 3 | 8 | 6 | 2 | — | 3 | 1 | 7 | 7 | — | 27 | 8 | 6 | 1 | — | 53 | 0.4 |
| Radnor | Collison No. 2 | P-11763 | 17 | 22 | 1 | — | — | — | — | 3 | 1 | 3 | 7 | — | 32 | 4 | 7 | — | 2 | 40 | 0.8 |
| Vandalia | Higginsville | P-5356 | 14 | 16 | — | 7 | 1 | — | — | 3 | — | 12 | 5 | 3 | 22 | — | 17 | — | — | 22 | 0.9 |
| Vandalia | Harmattan No. 4 | P-11892 | 15 | 14 | 1 | 9 | 1 | — | — | 1 | 1 | 6 | 6 | 1 | 29 | 4 | 10 | 1 | — | 29 | 1.0 |
| Vandalia | Jewett | P-3443 | 16 | 16 | 1 | 6 | 5 | 1 | 2 | — | 1 | 2 | — | — | 46 | 1 | — | — | — | — | 1.0 |
| Vandalia | Jewett | P-3444 | 27 | 13 | 2 | 2 | — | — | 1 | — | 1 | 2 | 2 | — | 44 | 2 | 2 | — | — | — | 2.1 |
| Smithboro | School House | P-5600 | 23 | 9 | 6 | 3 | 2 | 1 | 3 | 1 | 1 | 3 | 3 | 1 | 37 | 2 | 4 | 1 | — | 25 | 2.6 |
| Smithboro | Drainage Ditch | P-5600 | 40 | 10 | — | 3 | 1 | 5 | — | 1 | 1 | 3 | 6 | 4 | 23 | 4 | 2 | — | — | 29 | 4.1 |
| Smithboro | Jewett | P-3434 | 17 | 14 | 3 | 5 | 2 | 4 | 2 | 1 | 1 | 6 | 1 | — | 39 | 1 | 1 | — | — | — | 1.2 |
| Smithboro | Jewett | P-3435 | 18 | 21 | — | 3 | — | 9 | — | — | 2 | 2 | — | — | 41 | 1 | 1 | — | — | — | 0.9 |
| Tilton | School House | P-11785 | 19 | 14 | 3 | 2 | 1 | 1 | — | 6 | 2 | 8 | 10 | — | 25 | 5 | 3 | 1 | 2 | 11 | 1.4 |
| Tilton | Harmattan No. 4 | P-11894 | 25 | 5 | 6 | — | 5 | 1 | 1 | 3 | 1 | — | 2 | — | 46 | 2 | 3 | — | — | 39 | 4.8 |
| Hillery | School House | P-5473 | 11 | 16 | 3 | 3 | — | — | 1 | 10 | 3 | 4 | 1 | — | 30 | 6 | 10 | 1 | — | 28 | 0.7 |
| Hillery | Harmattan No. 4 | P-11896 | 28 | 15 | 2 | 5 | 1 | — | — | 2 | — | 2 | 4 | 5 | 28 | 5 | 4 | 1 | — | 42 | 1.9 |
| Harmattan | Harmattan No. 4 | P-11913 | 3 | 4 | 2 | 2 | 2 | 59 | 2 | — | — | 4 | 1 | — | 19 | 1 | — | 1 | — | 31 | 0.8 |
| Harmattan | Harmattan No. 4 | P-11911 | 25 | 6 | 4 | 4 | — | 21 | — | 4 | 2 | 6 | — | — | 14 | 4 | 8 | 2 | — | 60 | 4.3 |
| Hegeler | Harmattan No. 2 | P-10212 | 10 | 22 | 11 | 3 | 3 | — | — | 3 | — | 2 | 2 | — | 38 | — | 6 | — | — | 80 | 0.5 |

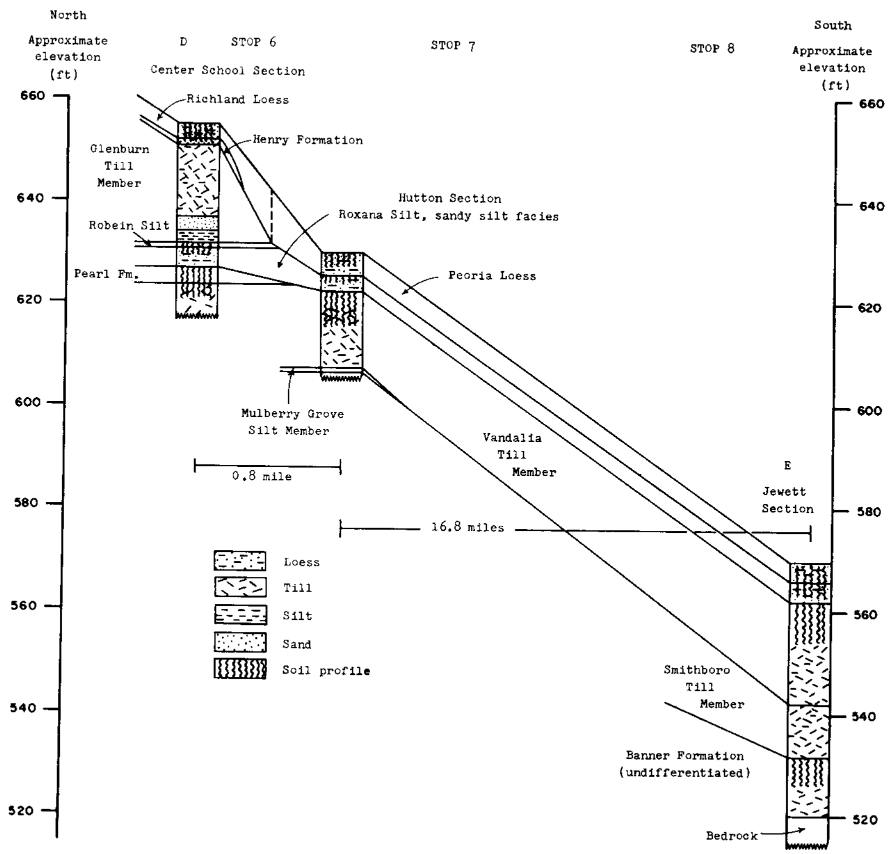



Fig. 7 - North-south cross section showing correlation of stratigraphic units in measured sections at Stops 6, 7, and 8. Length of cross section approximately 18 miles. Line of cross section and location of stops shown on route map (pl. 1, inside covers).

Ford et al. (1971) and Ford (*in preparation*) considered the stratigraphy and distribution of Pleistocene deposits near the Illinoian-Wisconsinan glacial boundary in Coles County. The Illinoian and Kansan stratigraphic units delineated by Jacobs and Lineback (1969) were traced northward beneath tills, outwash, and silts of Wisconsinan age (fig. 7). Ford noted that the Vandalia varies in texture and that the lower portion of the till locally contains about 10 percent less sand in the < 2 mm fraction and about 10 percent more expandable clay minerals in the < 2 μ fraction than the more typical till in the upper part of the Vandalia.

Within the Wisconsinan, thin Roxana Silt was noted locally above the Sangamon Soil and below the Robein Silt. Three Woodfordian tills were recognized—the Oakland, Glenburn, and Batestown—and proglacial silts, sands, and gravels were in many places associated with the tills. Ford suggested that the Oakland and Glenburn were deposited by an initial lobe of Woodfordian ice and that the Batestown was deposited during a readvance of the Woodfordian ice that did not extend as far as the initial advance (fig. 4).

The Roxana Silt has been studied and defined in areas of Illinois where it is relatively thick and where it is near the source areas, which are the Wabash, Illinois, and Mississippi River Valleys. The recognition of Roxana

Silt in areas away from these source valleys is difficult because it is pedologically altered from its original state and because it is mixed with materials from the underlying Sangamon Soil. This is particularly true in south-central Illinois, a region where the Peoria Loess is also thin (< 6 feet).

Follmer (1970), in a study area approximately 9 miles south of the Hutton Section (Stop 7), established the presence of a thin zone below the Peoria Loess and above the Sangamon Soil that he referred to as Zone II, the standard pedologic designation for a second parent material below that which occurs at the surface. He suggested that Zone II was probably equivalent to the Roxana Silt.

A deeply weathered profile underlies the Peoria Loess in the same region, and the entire profile has often been recognized as the Sangamon Soil developed in Illinoian drift. Follmer (1970) noted, however, that the upper part of the profile (Zone II) is continuous across the present undulating landscape and is significantly enriched with silt, particularly in the medium silt fraction (16-31 μ). This fraction is also often the most abundant, or modal, fraction in the recognized loess deposits of Illinois. Processes other than eolian can influence the particle-size distribution of a surface soil, but they cannot explain the enrichment in medium silt. Fluvial sedimentological processes are not capable of producing a continuous, silt-enriched zone across an undulating landscape. Weathering affects particle size but is not capable of generating an enrichment of the medium silt fraction compared to the coarse silt fraction (31-62 μ), because the chemical reaction rates of quartz and feldspar, the dominant silt-size minerals, increase with decreasing particle size and, therefore, the smaller particles would weather faster than the larger ones. For these reasons, Follmer (1970) concluded that an eolian process was the best explanation for the silt enrichment in Zone II. He estimated from the apparent enrichment of medium silt in Zone II that 7 to 14 inches of loess were deposited and incorporated into the top of the weathering profile.

He observed much evidence of mixing with underlying material in the morphologic as well as mineralogic characteristics. In about 50 borings, the Zone II thickness averaged about 40 inches and ranged from 16 inches on drainage divides to 60 inches in closed depressions. Pedologically, the weathered profile that contains the Sangamon Soil appears to have overthickened surficial horizons because the B maximum of the Sangamon is below Zone II, which places it, on the average, at about 40 to 60 inches below the contact with the Peoria Loess. Occasionally, two solums can be recognized, which indicates that a younger soil (the Farmdale) is superposed on the Sangamon Soil. This is quite evident in some depressions or other poorly drained sites where the Robein Silt is present.

The silt-enriched zone extends across much of south-central Illinois and is stratigraphically equivalent to the Roxana Silt. The zone is therefore recognized as a facies of the Roxana and will be referred to as Roxana Silt, sandy silt facies.

The general characteristics of the Roxana Silt, sandy silt facies, can be summarized from Follmer's study (1970). The texture varies somewhat according to the landscape position on which it is found. Convex areas tend to contain considerable silt and have relatively high sand and low clay contents.

Textures in these higher positions are generally silt loam or loam with a silt content of about 50 percent. The sand content is quite conspicuous in these positions and can be readily used to delineate the base of the Peoria Loess. Defining the base of the sandy silt facies is difficult because it is gradational with the underlying Sangamon Soil. If the suggested origin for the sandy silt facies is correct, then this gradational contact must be expected on all stable surfaces because mixing of the two materials is inevitable when thin increments of loess are deposited on an actively developing soil.

The texture of the sandy silt facies in depressions or other low areas is heavier textured, as would be expected. The silt still dominates the $< 2$ mm fraction, with less sand and more clay than occur in better drained positions. Textures in such positions are silty clay loam or clay loam, and in near-by level areas a clay loam texture is normal.

The thickness of the sandy silt facies increases towards the depressions on the Sangamonian surface that are generally still expressed on the modern surface. Sangamonian depressions are partly filled with pre-Roxana accretionary materials, which have much the same appearance as the sandy silt facies but which have low values for the medium-to-coarse silt ratios, indicating that they were derived from a till source. In some field localities the separation of the accretionary materials from the sandy silt facies is arbitrary, and laboratory analysis is required to make the distinction.

# ROAD LOG

Saturday, May 13, 1972

| Miles | |
|---|---|
| 0.0 | The buses will leave promptly at 8:00 a.m. from the south entrance of the Hotel Wolford. Drive west on Harrison Street. |
| 0.5 | Turn right (north) on Logan Street. |
| 0.6 | Bear left, stay on Logan Street. |
| 0.9 | Bear right, stay on Logan Street. |
| 1.1 | Turn left (west) on Williams Street. |
| 1.7 | North Fork of Vermilion River. |
| 3.2 | On the left (south) side of the road is the Drainage Ditch Section of Ekblaw and Willman (1955). On the right (north) side of the road is the School House Branch Section of Hungry Hollow (Stop 5 on this trip). |
| 3.9 | The Harmattan Strip Mine may be seen on the left (south) side of the road. |
| 4.3 | T intersection, turn right (north). On the right (north) is a view of the crest of the Newtown Moraine. On the left (south) note the uneven pavement where the road was built over strip-mine spoil. |
| 4.7 | Crest of the Newtown Moraine, elevation 700 feet. |
| 5.9 | The crest of the Gifford Moraine may be seen ahead. The Newtown and Gifford Moraines compose the Illiana Morainic System and appear to be composed solely of the Snider Till Member. In and north of the morainic system, road and stream cuts expose only the Snider Till, except locally where streams have cut through the Snider and exposed older units. The Snider and older units are exposed at the Higginsville (Stop 1), Collison Branch (Stops 2a and 2b), and Emerald Pond (Stop 3) Sections. The base of the Snider Till in these sections (as well as in several others north of the moraines) occurs between approximately 640 to 655 feet in elevation. This is the same general elevation as the drift plain south of the Newtown Moraine. We interpret the higher elevation of the Illiana Morainic System to be the result of moraine building and deposition of the Snider Till. |
| 7.1 | Crest of Gifford Moraine, elevation 730 feet. |
| 8.4 | Town of Snider's Corner. |
| 12.5 | Turn left (west) on one-lane concrete road. |

15.1 Railroad crossing in town of Jamesburg.

15.5 Intersection; continue straight ahead on gravel road.

16.7 Turn left (south) on gravel road.

17.7 *Stop 1 - Higginsville Section* - The section is about a quarter of a mile west, on the east bluff of the Middle Fork of the Vermilion River.

## STOP 1 - HIGGINSVILLE SECTION

### Discussion of the Stratigraphy

The Higginsville Section is a large bluff section that exposes the three youngest Woodfordian tills (Snider, Batestown, and Glenburn) and the two youngest Illinoian tills (Radnor and Vandalia) now known in this area (figs. 8, 9). A thin carbonaceous silt also is present beneath the Glenburn Till, and the Roby Silt lies between the Radnor and Vandalia Tills. The section is somewhat unusual in that, with the exception of the basal Woodfordian till, the Oakland, the till sequence for the upper part of the stratigraphic section is complete. The primary purpose of the stop, therefore, is to introduce the units in this part of the section. There are, however, several problems of interpretation. Most of these concern the relations between the Radnor Till, the unnamed, overlying, thin carbonaceous silt, and the Glenburn Till; the lack of any indication of Sangamonian weathering in the Radnor; and the origin of deformational structures within the Radnor. Analytical data on grain-size distribution, clay mineral content, and carbonate content of the Higginsville and other selected sections are given in table 7.

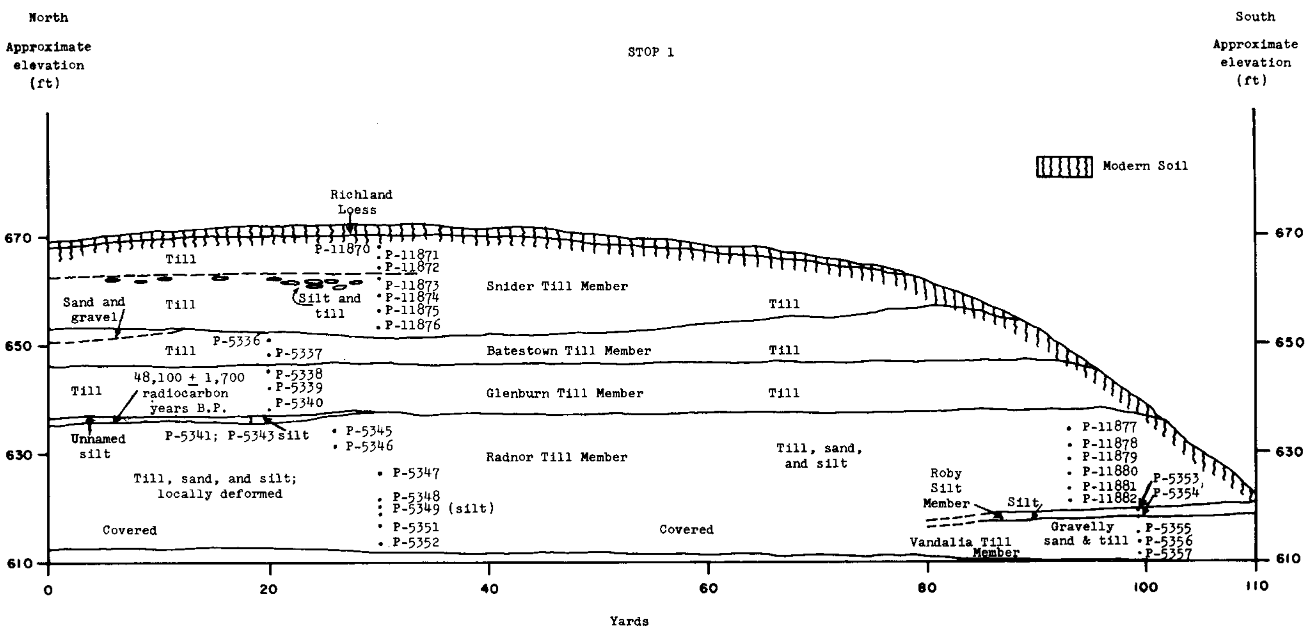



Fig. 8 - Sketch of the Higginsville Section.

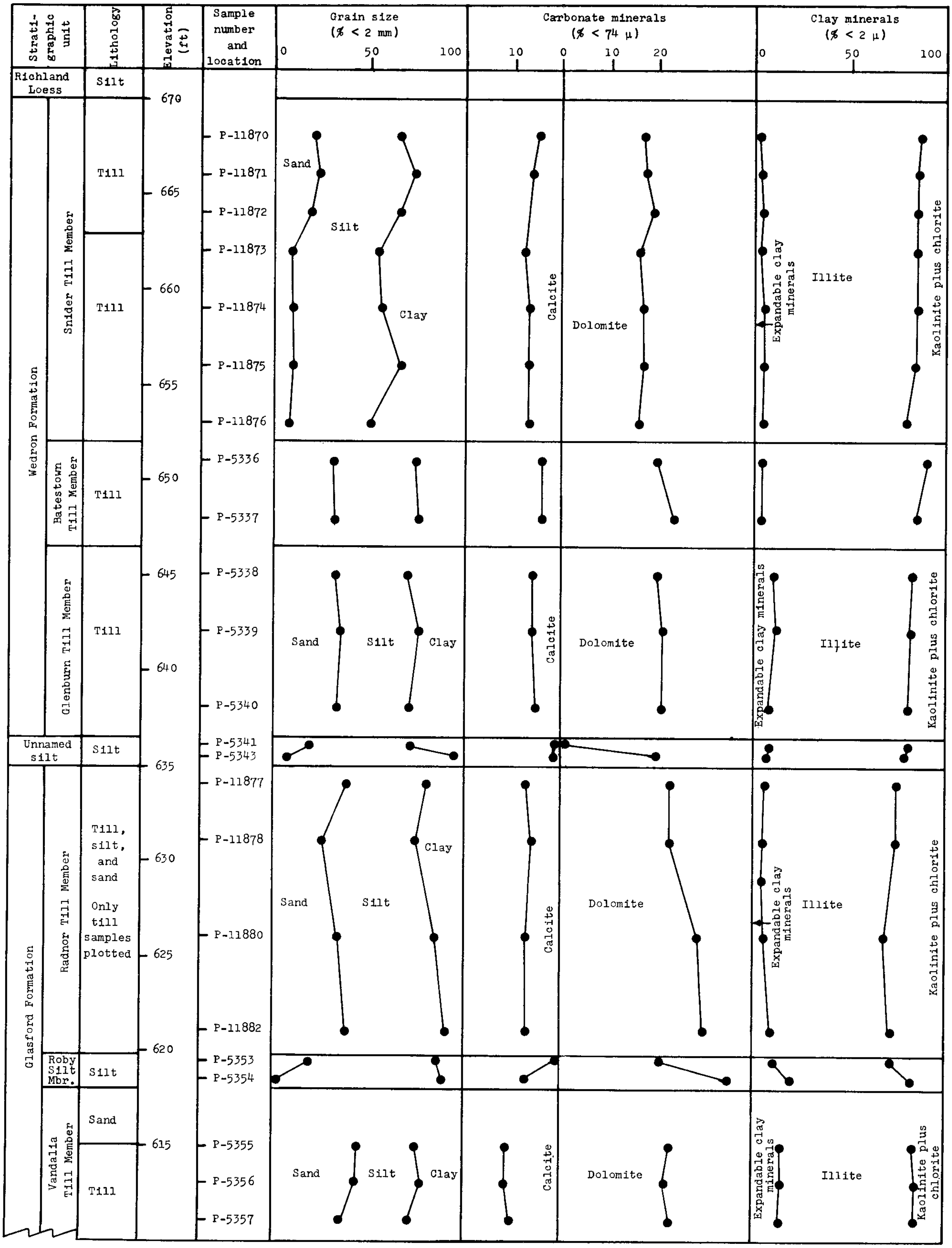



Fig. 9 - Grain size, carbonate mineral, and clay mineral data for the Higginsville Section, Stop 1.

The silt beneath the Glenburn is about 1 foot thick and is exposed for about 30 yards along the northern part of the exposure. Although the silt is not deformed, the upper few feet of gravelly sand and till in the Radnor immediately below the silt are contorted into a series of folds that are truncated and overturned to the south. The lower part of the silt is calcareous and the upper part of the Radnor, except for a little oxidation, is unweathered. Many small fragments of wood from the silt yielded a radiocarbon date of 48,100 ± 1,700 years B.P. (ISGS-63).

A normal interpretation of the carbon-14 date would be that the glacier that deposited the till above the silt overrode a vegetated landscape about 50,000 radiocarbon years ago, killed the vegetation, and buried the carbonaceous deposit. With such an interpretation, both the silt and the till would be Altonian in age. At this time we do not think this is the correct interpretation for the following reason: the overlying till is lithologically similar to and is in the same stratigraphic position as the Glenburn Till, which lies above carbonaceous silt (the Robein) that has been dated from 20,000 to 23,000 radiocarbon years B.P. in several localities in east-central Illinois. We therefore believe the till is the Glenburn and is Woodfordian in age.

If our interpretation of the age of the till is correct, the age and origin of the silt becomes a problem. Is the radiocarbon date correct? Did the silt with organic debris accumulate in situ? Dennis Coleman, radiocarbon analyst for the State Geological Survey, feels that the date is a minimum date and the wood might be older. His point is that it would take very little modern contamination or wood about 20,000 radiocarbon years B.P. mixed with old wood to give a date of about 50,000. If the sample was contaminated, it probably would be Illinoian in age; if not, it is Altonian. If the deposit is Altonian, it apparently correlates in time with similar deposits in Ontario that Dreimanis has included in the Port Talbot Interstade (Goldthwait et al., 1965), and it is apparently older than the glaciation responsible for the deposition of the Argyle Till Member of the Winnebago Formation (Altonian) in northern Illinois (Frye et al., 1969).

The second question above is more difficult to answer. If the silt did accumulate in situ and if it is at least 30,000 radiocarbon years older than the overlying till, the silt must have been buried at an earlier date by some other deposit for which we have no record preserved today. This is possible but perhaps not too likely. If the deposit did not accumulate in situ, it would mean that at some date after accumulation it was moved more or less as a unit for some unknown distance to its position today. The most likely agent to accomplish this would be the glacier that deposited the overlying till. Although this explanation may not seem too likely either, it does offer certain advantages for interpreting the structures below the silt and for explaining the lack of weathering in the material below the silt.

The structures beneath the silt appear to be the result of drag created by the movement of a body such as a glacier over the top of the beds. If the silt accumulated in situ, the glacier that deposited the overlying Glenburn Till could not be responsible because the silt is not deformed. However, if the silt was incorporated in the base of a glacier and moved as a block, the structures could have been created by that glacier, the one that deposited the Glenburn. If the structures originated in this fashion but were created by a glacier older than the silt, the structures are the only record of that advance. They may have originated in some other manner, and some observers of the section have suggested that they might be the result of cryoturbation prior to the accumulation of the silt.

The lack of significant weathering in the underlying materials is also a problem if the silt accumulated in situ. First, no evidence of Sangamonian weathering is present in the upper part of the Radnor Till. This is not unusual in the area because of glacial erosion during the Wisconsinan. It is a problem here, however, because there is no evidence, other than the deformation, of a glacial advance younger than the Radnor and older than the silt in the area. Neither is there evidence of truncation by fluvial erosion. It therefore becomes easier to explain the erosional removal of the Sangamon Soil by the same glacier that later formed the structures and deposited the overlying slab of carbonaceous silt and till. Second, the lack of any profile development in the silt or of weathering beneath it is also difficult to explain if the silt accumulated in situ. Even though the time of accumulation was probably not great, there should be more oxidation of the underlying material if the in-situ explanation is correct.

In summary, the simplest explanation of the observed facts is that the erosional removal of the Sangamon Soil, the deformation in the upper part of the Radnor, the emplacement of the large slab of carbonaceous silt, and the deposition of the Glenburn Till were accomplished by one or more glaciers during the early Woodfordian. In view of the uncertainties, however, other interpretations are possible, particularly if new information becomes available.

Although samples of the Roby Silt contained only a few grains of pollen, samples of the carbonaceous silt beneath the Glenburn contained pollen in abundance. Pollen analyses of silt revealed

Upper 4 inches:

| | | | |
|---|---|---|---|
| *Pinus* (pine) | 22% | *Betula* (birch) | 4% |
| *Picea* (spruce) | 53% | *Salix* (willow) | 2% |
| *Juniperus* (juniper) | 3% | *Populus* (poplar) | 7% |
| Total conifer | 78% | *Quercus* (oak) | 2% |
| | | *Alnus* (alder) | 2% |
| Nonarboreal | 4% | Total deciduous | 17% |

Lower 6 inches:

| | | | |
|---|---|---|---|
| *Pinus* (pine) | 25% | *Betula* (birch) | 3% |
| *Picea* (spruce) | 23% | *Salix* (willow) | 2% |
| *Juniperus* (juniper) | 5% | *Populus* (poplar) | 14% |
| Total conifer | 53% | *Quercus* (oak) | 3% |
| | | *Alnus* (alder) | 3% |
| | | Total deciduous | 25% |

Nonarboreal - 21% (includes 12% *Cyperaceae* [sedge]).

If the radiocarbon date for the unit is reasonably accurate, the pollen suggests that the vegetation at the middle of the Altonian Substage in this area was characterized by conifer forests containing some deciduous trees. At 48,000 years B.P., dense conifer forests were dominant, with spruce locally abundant and more abundant than pine. Prior to 48,000 years B.P., the forests were more open. This enabled pine pollen to blow in from other areas and mask the actual abundance of spruce. The higher percentage of deciduous trees and the lower percentage of spruce in the lower part of the silt suggest that the climate was warmer prior to 48,000 years B.P. but became cooler after that date, perhaps as a result of the glacial advance that deposited the Argyle Till of northern Illinois.

A. B. Leonard identified and interpreted the molluscan fauna preserved in the Roby Silt. The fauna was washed from two 50-pound samples, one collected from the upper, carbonaceous part of the unit and the other from the lower part of the unit, which contained very little plant material.

| Mollusks identified | Relative abundance |
|---|---|
| *Armiger exigua* Leonard | Rare (< 10 shells) |
| *Columella alticola* (Ingersoll) | Abundant (> 20 shells) |
| *Columella edentula* (Draparnaud) | Rare |
| *Deroceras laeve* (Müller) | Rare |
| *Euconulus fulvus* (Müller) | Rare |
| *Gastrocopta pentodon* (Say) | Rare |
| *Gyraulus* sp. | Rare |
| *Lymnaea dalli* Baker | Rare |
| *Lymnaea parva* Lea | Rare |
| *Pupilla muscorum* (Linné) | Moderately abundant (10-20 shells) |
| *Sphaerium* cf. *occidentale* Prime | Rare |
| *Succinea gelida* Baker | Abundant |
| *Vallonia gracilicosta* Reinhardt | Abundant |
| *Vertigo hubrichti* Pilsbry | Abundant |
| *Vertigo morsei* Sterki | Abundant |
| *Vertigo oughtoni* Pilsbry | Abundant |

The recovered fauna is conspicuously terrestrial in its composition and in the large number of individual terrestrial specimens; five aquatic or semi-aquatic species are represented by only a few shells, whereas eleven strictly terrestrial species are represented by a fairly large number of shells. Of the terrestrial species that have modern representatives the majority are northern species. The abundance of *Vertigo oughtoni*, one of the most sensitive and restricted of the mollusks present, indicated to Leonard that the local climate tended toward subarctic, or at least very cool. The silt apparently accumulated in a small pond on the till surface, and most of the shells were washed in from the surrounding slopes.

Molluscan faunas in general are not of great value for stratigraphic correlations within the Pleistocene in Illinois (Leonard, Frye, and Johnson,

1971) because most of the species present occur in Kansan through Woodfordian deposits. The fauna did yield the first *Columella edentula* and *Vertigo oughtoni* reported in Pleistocene deposits in Illinois, the first *Deroceras laeve* in deposits younger than Kansan in Illinois, and the first *Sphaerium* cf. *occidentale* in deposits older than Woodfordian in Illinois.

## Higginsville Section

Section measured on the east valley side of the Middle Fork Vermilion River in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ NE$\frac{1}{4}$, Sec. 26, T. 21 N., R. 13 W., Collison Quadrangle, Vermilion County, Illinois

| | Thickness (ft) |
|---|---|
| Pleistocene Series | |
| Wisconsinan Stage | |
| Woodfordian Substage | |
| Richland Loess . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 1.6 |

*Modern Soil*

| Horizon | Depth (in.) | P-No. | | |
|---|---|---|---|---|
| A1 | 0-2 | — | Silt; dark grayish brown (10YR 4/2) silt loam; granular; abundant roots. | |
| A2 | 2-8 | — | Silt; brown (10YR 5/3) silt loam; moderate to strong platy structure; thin silt coatings common. | |
| B1 | 8-13 | — | Silt; yellowish brown (10YR 5/4) heavy silt loam; weak to moderately strong subangular blocky structure; thin, discontinuous silt coatings. | |
| B21 | 13-19 | — | Silt; yellowish brown (10YR 5/4) silty clay loam; moderate to strong subangular blocky structure; discontinuous silt and clay coatings; contains a few pebbles. | |

Wedron Formation
Snider Till Member

| Horizon | Depth (in.) | P-No. | | |
|---|---|---|---|---|
| IIB22 | 19-30 | — | Till; olive brown (2.5Y 4/4) clay loam; strong angular blocky structure; abundant silt coatings in upper part; thick brown to dark brown (10YR 3.5/3) clay coatings in lower part; thin gravelly sand locally between loess and till. . | 0.9 |
| IIC1 | 30-102 | 11870<br>11871<br>11872 | Till; olive brown (2.5Y 4/4), calcareous, silty clay loam; blocky structure; prominent clay coatings, roots, and secondary $CaCO_3$ along joints. . . . . . . . . . . . . . . . . . . . . | 6.0 |

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IIC2 | 8.5-20.5 (ft) | 11873 to 11876 | Till; olive (5Y 5/3) (at top) to grayish brown (2.5Y 5/2) (at base), calcareous light silty clay; blocky structure; discontinuous zones of calcareous yellowish brown silt from half an inch to 24 inches thick interbedded with till in upper 3 feet. . . . . . . . | 12.0 |

Batestown Till Member

Till, light olive brown (2.5Y 5/4) (at top) to dark gray (5Y 4/1) (at base) calcareous loam; medium blocky structure; local, discontinuous gravelly sand in upper 2 feet. Samples P-5336 (top), P-5337 (base). . . 3.5

Glenburn Till Member

Till, brown to dark brown (7.5YR 4/2) (at top) to dark grayish brown (at base), calcareous loam; coarse blocky structure; brown oxidation along joints; pinkish cast on surface; wood and silt sheared into lower part of till. Samples P-5338 (top) to P-5340 (base). . . . . . . 9.0

Altonian Substage

Unnamed silt

Silt, black to dark reddish brown silt loam, noncalcareous, carbonaceous; contains wood fragments, pebbles, and some sand; radiocarbon date on wood 48,100 ± 1,700 years B.P. (ISGS-63). Sample P-5341. . . . 0.4

Silt; dark gray silt loam, calcareous, stratified; thin zones of oxidized sand; contains wood fragments. Sample P-5343. . . . . . . . . . . 0.6

Illinoian Stage

Jubileean Substage

Glasford Formation

Radnor Till Member

Till and interbedded sand and silt; till, gray (2.5Y 6/0) to olive gray (2.5Y 5/2.5), calcareous loam; soft to hard; blocky structure; sand, yellowish brown to dark brown, stratified; beds vary from fine sand to coarse, gravelly sand; silt, light gray to tan, well sorted; sands at upper contact contorted and folded; silts, sand, and till locally deformed throughout unit; base of unit not exposed in northern and central parts of the exposure. Till samples P-5345-5348, P-5350-5351, P-11877-11878, P-11880, P-11882; silt samples P-5349, P-11879, P-11881 . . . . . . . . . . . . . . . . . . . . . . . . . . 25.0

Roby Silt Member (south part of exposure)

Silt, dark brownish black to dark gray silt loam, calcareous, carbonaceous; contains wood fragments. . . . . . . . . . . . . . . . . . . . . 0.5

Silt; gray to tan silt loam, calcareous; massive; contains mollusk shells. Sample P-5354. . . . . . . . . . . . . . . . . . . . . . . . 1.0

Monican Substage

Vandalia Till Member (south part of exposure)

Sand; reddish brown sandy loam, calcareous; grades to brown, calcareous till; sandy loam interbedded with zones of gravelly sand. P-5355. . . 4.0

| | Thickness (ft) |
|---|---|
| Till; grayish brown sandy loam; blocky structure; hard; base not exposed. Samples P-5356 (top), P-5357 (base). . . . . . . . . . . . . . . | 4.0 |
| Total section | 68.5 |

17.7 Continue ahead (southeast).

17.9 Railroad crossing.

18.3 Turn right (south) on blacktop road.

18.9 Middle Fork of the Vermilion River.

19.6 T intersection; turn right (west).

21.0 *Stops 2a and 2b - Collison Branch Sections 1 and 2* - The sections are about one quarter and one half miles northeast of the road on the north bank of Collison Branch stream.

The buses will drive ahead to the town of Collison, turn around, and return to pick up the group.

## STOPS 2a AND 2b - COLLISON BRANCH SECTIONS

At Stops 2a and 2b, two relatively small sections will be observed along Collison Branch, a small tributary of the Middle Fork Vermilion River. The valley of Collison Branch contains several terrace levels, the most prominent of which is cut into the Snider Till Member. A small section just north of where we enter the pasture exposes thin, silty alluvium overlying the cut surface developed on the Snider Till. The Modern Soil has developed a beta horizon below the alluvium and in gravelly sand associated with the till. We ask you to avoid spending time at this exposure until we have discussed and examined the two formal field trip sections.

### Stratigraphy of Stop 2a

Collison Branch Section No. 1, located in a cut bank along the creek, exposes the Snider, Batestown, and Glenburn Tills (figs. 10, 11). The Batestown is quite thin and is

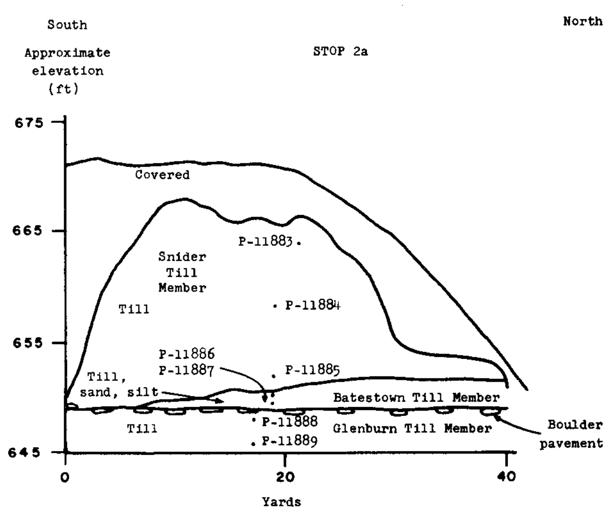



Fig. 10 - Sketch of the Collison Branch Section No. 1.

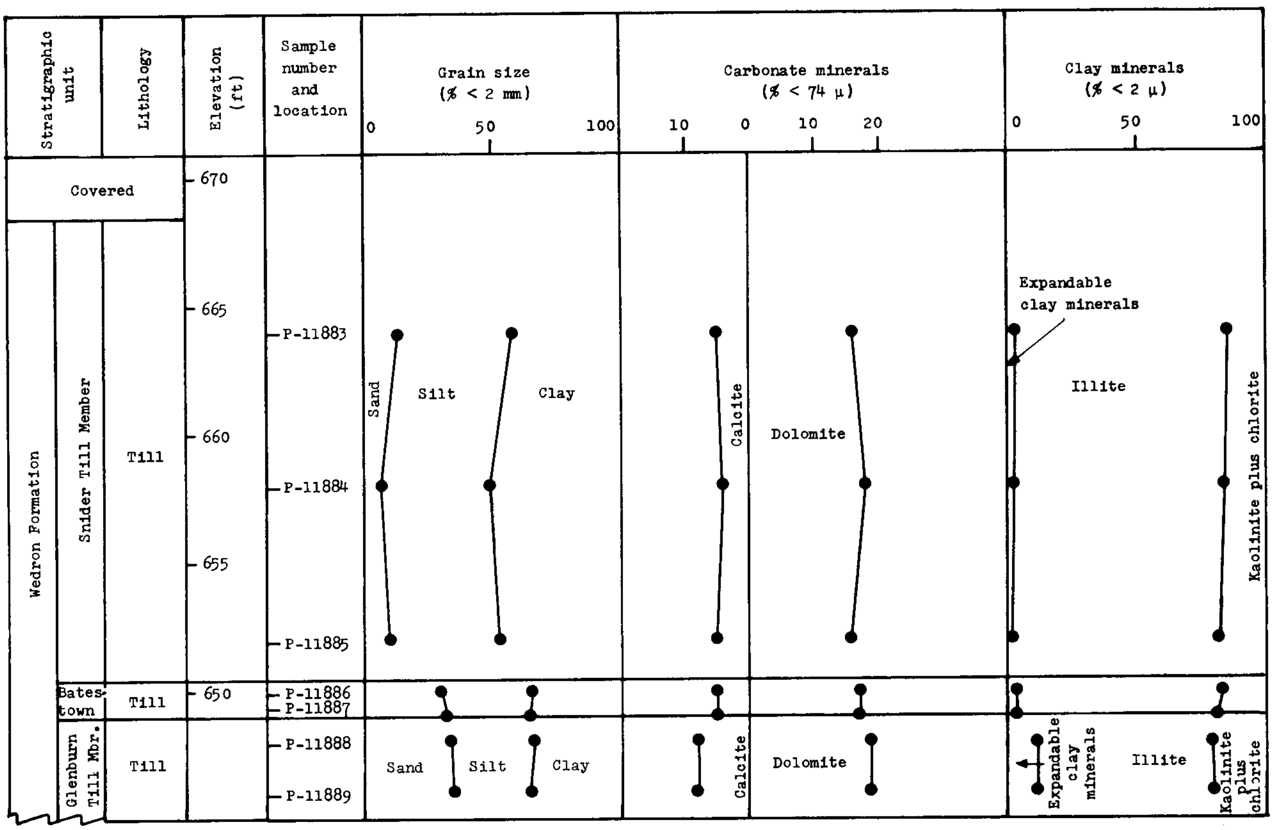



Fig. 11 - Grain size, clay mineral, and carbonate mineral data for the Collison Branch Section No. 1, Stop 2a.

missing at the south end of the exposure. A prominent boulder pavement is developed at the upper contact of the Glenburn. The upper surface of the boulders are faceted and striations with orientations from N 35° E to N 55° E are preserved. The main purpose of this short stop is to develop our position in the stratigraphic column and to review the three Woodfordian tills.

## Collison Branch Section No. 1

Section measured in cutbank on northwestern side on the valley of Collison Branch in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$, Sec. 34, T. 21 N., R. 13 W., Collison Quadrangle, Vermilion County, Illinois. Upper portion of section not exposed.

| | Thickness (ft) |
|---|---|
| Pleistocene Series | |
| Wisconsinan Stage | |
| Woodfordian Substage | |
| Wedron Formation | |
| Snider Till Member | |
| Till, olive gray (5Y 4/2) at top to dark gray (5Y 4/1) at base; light silty clay; calcareous; strong blocky structure; rootlets and secondary $CaCO_3$ along joints; local silt stringers in the till. P-11883 (top), P-11884 (middle), and P-11885 (base). . . . . . . . . . . . . . . . . . . . | 18.0 |

| | Thickness (ft) |
|---|---|
| Batestown Till Member | |
| Till, dark grayish brown (2.5Y 4/2) to dark gray (5Y 4/1) loam, calcareous; weak blocky structure; unit contains interbedded sand and silt; discontinuous sand at upper contact. P-11886 (top) and P-11887 (base). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 0-4.0 |
| Glenburn Till Member | |
| Till, brown to dark brown (7.5YR 4/2) (at top) to dark grayish brown (10YR 4/2) (at base) loam; calcareous; weak, coarse blocky structure; boulder pavement at top striated N 45° ± 10° E. P-11888 (top), P-11889 (base). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 4.0 |
| Total section | 24.0 |

## Stratigraphy of Stop 2b

Collison Branch Section No. 2, about a quarter of a mile downstream from Stop 2a, is one of the few places in this part of Illinois where the Sangamon Soil can be seen (fig. 12). The upper part of the section contains thin alluvium overlying the Snider Till Member. The alluvium occurs on the cut terrace described in the introduction to these sections.

The Snider overlies two buried soils with a boulder pavement marking the top of the upper soil. The lower soil is developed in the Radnor Till Member. Thus, two tills, the Batestown and Glenburn, are missing from the section. Near the center of the exposure, a discontinuous silty to sandy silt colluvial zone that appears to be forming the A horizon of the Farmdale Soil pinches out at the erosional contact beneath the Snider Till. About 6 feet to the right in the described section, two diffuse stone lines occur within the Farmdale, indicating that the IIB1 horizon is also of colluvial origin. The problems at this section are with the missing till members, the weathered colluvial zones, and the associated stone lines, all of which make interpretations of the stratigraphy and the buried soils difficult. Analytical data on grain-size distribution and clay mineral content, along with chemical analyses, for selected soil profiles are given in table 8.

The upper 1.5 feet of material in the Farmdale Soil lies on a stone line, which appears to mark an erosion surface truncating an older soil developed in the Radnor Till Member. We believe that the older soil was the Sangamon, and that the level of truncation was about the top of the IIIB3 horizon. Subsequent alteration has led to the development of weak IIIB2 characteristics in this horizon. There are two types of material above the lower stone line that are themselves separated by a discontinuous stone line that apparently formed during the late part of the Sangamonian or the early Wisconsinan (Altonian). We have included these materials in the Roxana Silt. They contain the A and IIB1 horizons of the upper buried soil and, because the soil is overlain by till of the Wedron Formation, it is the Farmdale Soil.

The A horizon of the Farmdale consists of a discontinuous zone that has a pinkish cast. It is thickest at the west end of the section and becomes more silty toward the top. It contains significantly more expandable clay minerals than the materials below and may contain a loessial component. It is a different and younger deposit than the till-derived materials immediately below.

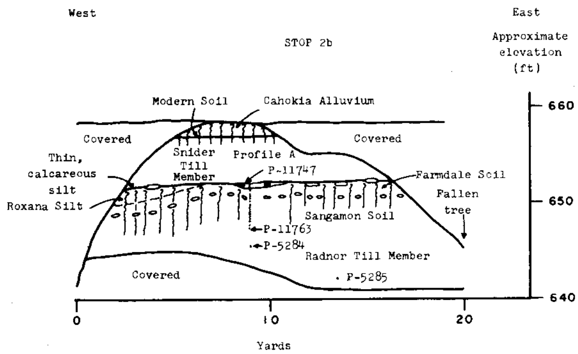



Fig. 12 - Sketch of the Collison Branch Section No. 2.

The IIB1 horizon is about a foot thick and rests on a weakly defined and somewhat diffuse stone line. The materials in the horizon were clearly derived from the weathered till on which they rest and appear to be colluvial in origin. The horizon has a weak horizontal structure that appears to be crude stratification but may, in part, be the result of deformation by later advances over the soil.

The Sangamon Soil is developed in Radnor Till. It does not have strongly developed soil structure and there has been only moderate alteration of illite in the clay fraction. For these reasons we interpret it as the lower horizons of a once thicker Sangamon Soil. The reduction of hornblende in the overlying IIB1 horizon, compared to the calcareous till (horizon IIIC2, table 6), suggests that the IIB1 was derived from highly weathered material and lends further support to the truncation interpretation.

The IIIB2 and IIIB3 horizons are generally similar except that the former has a greater accumulation of clay. The horizons are mottled brown, yellowish brown, and gray and contain many pockets and krotovina filled with pinkish gray material derived from the A horizon. Clay coatings, silt coatings, and dark stains and concretions are locally abundant. The upper part of the IIB2 horizon has 10 to 18 percent more 2 μ clay than the calcareous till.

The till is considered to be the Radnor because of the relatively high illite content in the clay fraction and the low calcite and relatively high dolomite contents in the < 74 μ fraction (fig. 13). The presence of a truncated buried soil in the till supports the stratigraphic interpretation because the

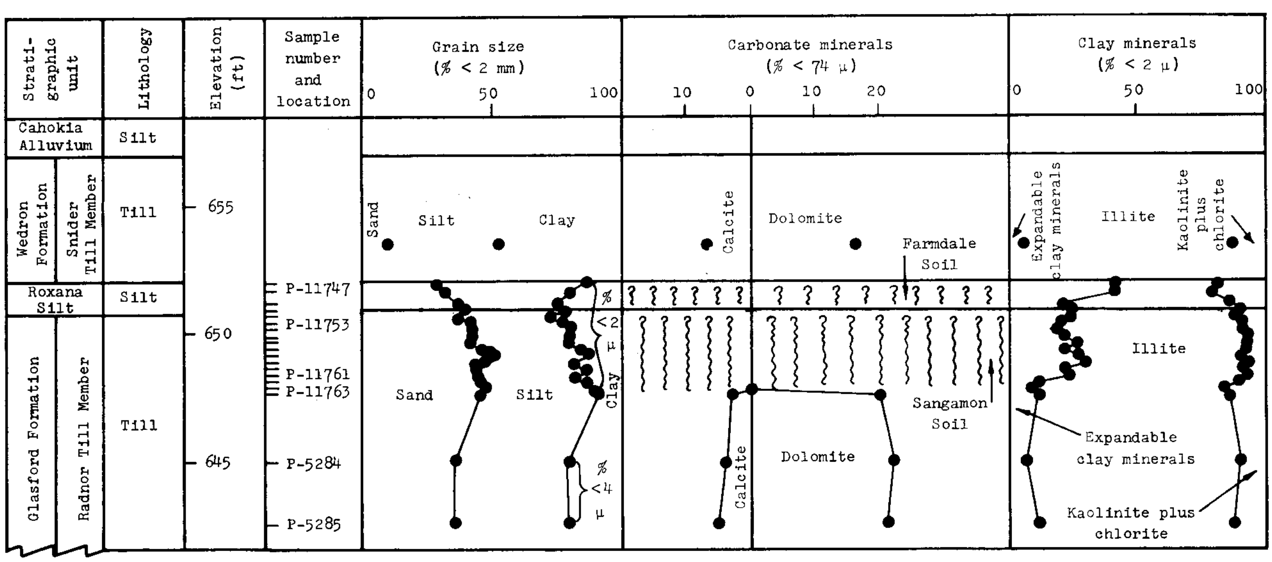



Fig. 13 - Grain size, carbonate mineral, and clay mineral data for the Collison Branch Section No. 2, Stop 2b.

Radnor is the youngest Illinoian till now known. This is the only section known in Vermilion County where definite evidence of Sangamonian weathering can be demonstrated. In view of the fact that the Batestown and Glenburn were not preserved in the section, it appears only fortuitous that the Farmdale-Sangamon Soils were preserved.

## Collison Branch Section No. 2

Section measured in cutbank on north valley side of Collison Branch in the northeast corner, NW¼ SW¼ SW¼, Sec. 35, T. 21 N., R. 13 W., Collison Quadrangle, Vermilion County, Illinois

| | Thickness (ft) |
|---|---|
| Pleistocene Series | |
| Holocene or Wisconsinan Stage | |
| Cahokia Alluvium | |
| Silt, sandy yellowish brown (10YR 5/4) to dark brown (10YR 4/3), noncalcareous; alluvium on cut terrace; contains Modern Soil. . . . . . . | 2.0 |
| Wisconsinan Stage | |
| Woodfordian Substage | |
| Wedron Formation | |
| Snider Till Member | |
| Till, olive brown (2.5Y 4/4); upper part leached and part of Modern Soil; lower part calcareous silty clay; blocky structure; secondary $CaCO_3$ and clay coatings down joints; unit rests on boulder pavement. P-5276 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 5.0 |
| Wisconsinan Stage | |
| Altonian Substage | |
| Roxana Silt | |

### *Farmdale Soil*

| Horizon | Depth (in.) | P-No. | | |
|---|---|---|---|---|
| A | 0-3<br>3-6 | 11747<br>11748 | Silt; brown (10YR 4/3) silt loam, faintly pink; few yellowish brown stains on ped surfaces; moderate, fine, angular blocky structure. . . . . . . . . . . . . . . . . . . | 0.5 |
| IIB1 | 6-9<br>9-12<br>12-15 | —<br>11749<br>11750 | Colluvium; strong brown (7.5YR 5/6) loam with common brown and yellowish brown mottles; few clay coatings, many silt coatings; friable; moderate, coarse, angular blocky structure; upper 3 inches mixed with A horizon; stone line at top and stone concentration near base. . . | 1.0 |

Illinoian Stage
Jubileean Substage
Glasford Formation
Radnor Till Member

*Sangamon Soil* (truncated)

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IIIB2 | 15-18<br>18-21<br>21-24<br>24-27<br>27-30 | 11751<br>11752<br>11753<br>11754<br>11755 | Till; mixed shades of brown (7.5YR 5/4-5/6) and yellowish brown (10YR 5/6) clay loam with pockets of gray (10YR 7/2); many thick, brown clay coatings with slight pinkish hue; krotovina filled with pinkish gray loamy material common; few black stains and concentrations; slightly firm; moderate, coarse, angular blocky structure. | |
| IIIB3 | 30-33<br>33-36<br>36-39<br>39-42<br>42-45 | 11756<br>11757<br>11758<br>11759<br>11760 | Till; brown (7.5YR 5/5) loam with many gray mottles; few clay coatings; krotovina common; common black stains and concretions; friable; weak, medium, subangular blocky structure; abrupt lower boundary. | |
| IIIC1 | 45-48<br>48-51 | 11761<br>11762 | Till; yellowish brown (10YR 5/4-4/4) loam with few dark stains; friable; weak, angular blocky structure; leached. | |
| IIIC2 | 51-54<br>78-81<br>108-111 | 11763<br>5284<br>5285 | Till; yellowish brown (10YR 5/4) loam with few dark brown (7.5YR 4/4) stains; soft; weak, angular blocky structure; calcareous; lower part of till is grayish brown (2.5Y 5/2) with iron stains on joints. . . . . . . . . . . . . . . . | 8.5 |
| | | | Total section | 17.0 |

21.0 Drive east, backtracking over the same road.

22.4 Bear right (south) on main blacktop road.

26.5 Town of Newtown on the crest of the Newtown Moraine.

27.5 Contact of Snider Till Member and Batestown Till Member. As we come off the Newtown Moraine, we go onto a drift plain underlain by the Batestown Till. At this position there is a thin and narrow outwash plain south of the moraine because meltwater from the glacier was channeled down what is now Glenburn Creek. To the west, the outwash plain is more extensive and the outwash deposits are thicker. Richland Loess is generally 1 to 2 feet thick in the area of Snider Till and 3 to 4 feet thick in the area where the Batestown is the surface till.

28.5 Turn left (east) on one-lane concrete road; we are traveling east down the valley of Glenburn Creek.

29.0 Crossroads at town of Glenburn; continue straight ahead.

29.9 Channel sandstone (Pennsylvanian) outcrop on left (north).

30.2 Enter Kickapoo State Park.

30.4 Middle Fork Vermilion River.

31.0 Y intersection; bear right toward shelter.

31.1 Turn right (south).

31.4 LUNCH at park pavilion; note strip mine spoil to the northeast.

31.4 Turn around (follow circle out of pavilion area).

31.8 Bear right (north).

32.1 Leave Kickapoo State Park.

32.3 Turn left (north) on gravel road.

32.7 *Stop 3 - Emerald Pond Section* - The buses will turn around and drive 0.4 miles back to the main blacktop road.

## STOP 3 - EMERALD POND SECTION

### Discussion of the Stratigraphy

The Emerald Pond Section is the type section for the Snider, Batestown, and Glenburn Till Members of the Wedron Formation. The section is a long north-south exposure located at the frontal margin of the Illiana Morainic System. The purpose of the stop is to show the type section of the three Woodfordian tills, relations between the Snider Till Member and the Illiana Morainic System, and the unusual situation where Woodfordian till rests directly on Kansan till, in this case the Tilton Till Member. The group will examine the lower part of the section at the north end of the exposure first and will work south, up the section, to the highway.

The north end of the section exposes the Batestown, Glenburn, and Tilton Till Members (figs. 14, 15). Sand and silt inclusions, probably resulting from ice contact sedimentation, are particularly prominent in the upper part of the Batestown. The Glenburn is not quite as pink in this section as it is at the Higginsville Section (Stop 1). This slight variation in color is characteristic of the Glenburn and has been noted elsewhere in central and eastern Illinois (Kempton, DuMontelle, and Glass, *in press*). The contact between the Glenburn and the Tilton is distinct but rather subtle, and the difference in the calcite content of the two tills can be noted in the field by the rate and degree of effervescence.

We believe the exposure cuts obliquely to longitudinally across a buried valley, and that the Glenburn Till fills the valley that has been cut through the Illinoian units into the Kansan Tilton Till. A boring near the highway penetrated Radnor and Vandalia Till immediately below the Batestown, and the section in the strip mine (Harmattan Strip Mine Section No. 3; Leonard, Frye, and Johnson, 1971) directly south of this exposure contains the Batestown, Radnor, Roby, and

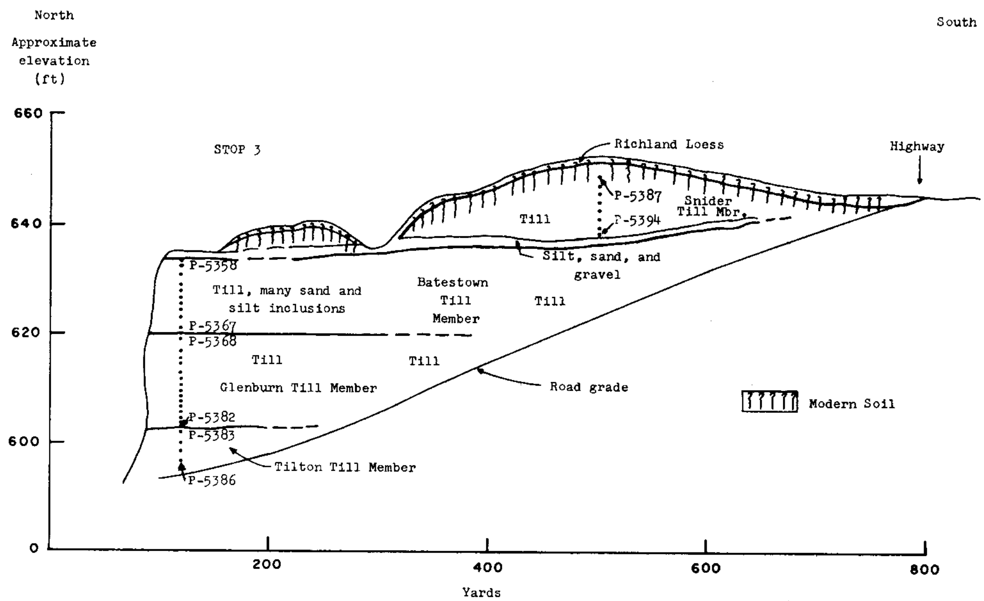



Fig. 14 - Sketch of the Emerald Pond Section.

Vandalia units overlying the Tilton Till. The relationship of the Glenburn to the filled valley and the truncation of the Illinoian units will be more evident at Stop 4, where the section cuts directly across the same valley and both sides of the valley are exposed.

One problematical radiocarbon date exists from the section. The date (> 38,000 radiocarbon years (ISGS-15) is from a piece of wood collected on a field trip from near the base of the Glenburn Till. The date is not consistent with our stratigraphic interpretation that the Glenburn is Woodfordian, and we are forced to interpret it as being old wood incorporated into a young till. Because the valley that contains the Glenburn does truncate old units, some of which do contain abundant wood (Roby Silt Member), the incorporation of old wood is definitely possible. Radiocarbon dates from the Harmattan Strip Mine Section No. 4 (Stop 4) support this interpretation.

The south end of the section is higher topographically and exposes the Snider and Batestown Tills. The Snider is slightly coarser at this stop than at Stops 1 and 2, and thin outwash occurs between the two tills. The front of the Illiana Morainic System occurs north of the highway, and the southward slope of the top of this part of the exposure corresponds to the frontal slope of the Newtown Moraine. The Snider Till feathers out north of the highway and is not exposed directly south in the strip mine. Therefore, the morainic front corresponds to the margin of the Snider Till, and the end moraine is the result of deposition of the Snider.

## Emerald Pond Section

Section measured along gravel road parallel to east valley bluff of the Middle Fork Vermilion River; upper unit best exposed and described 300 yards north of east-west blacktop road; remainder of the section described 600 yards north of the road in the

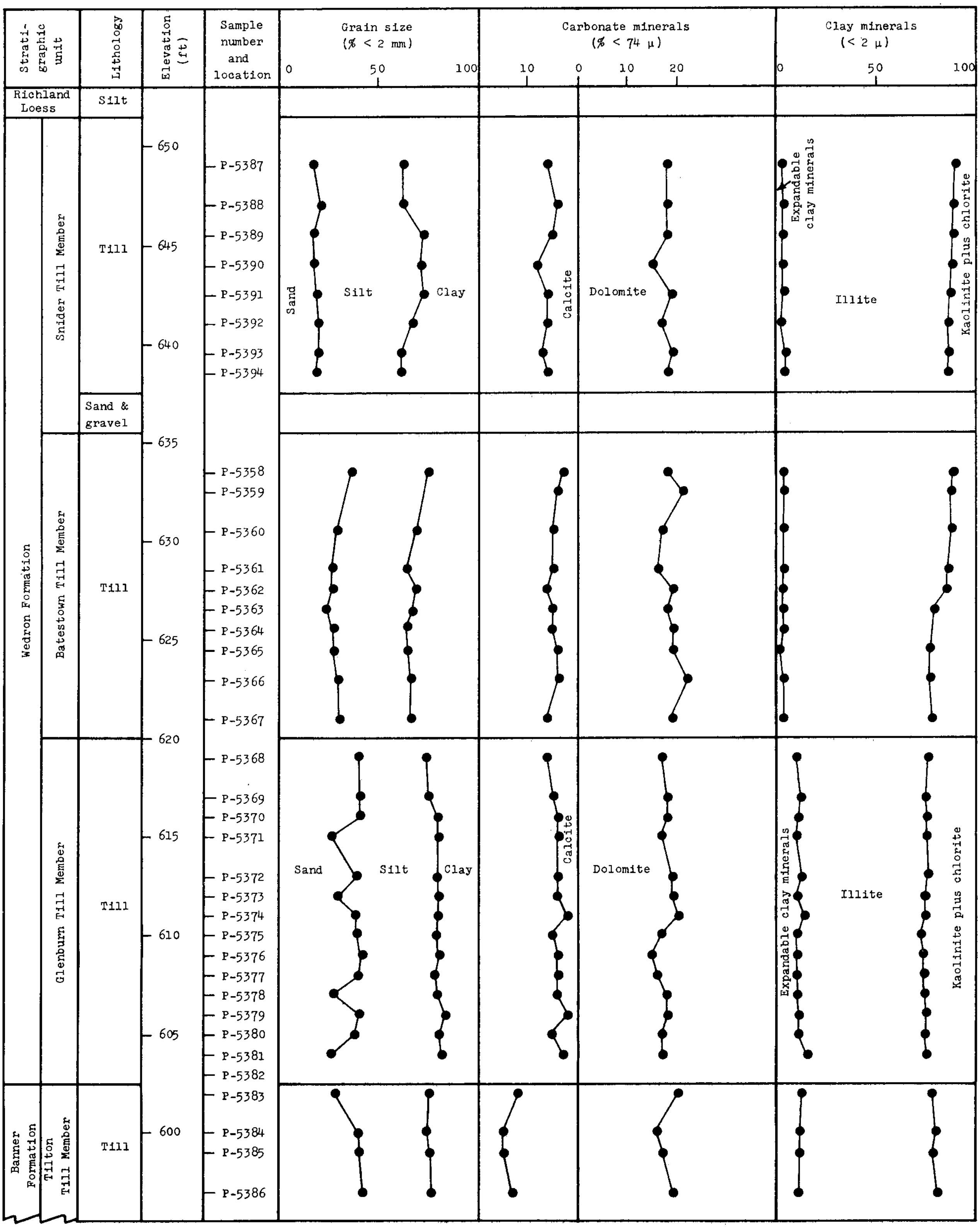



Fig. 15 - Grain size, carbonate mineral, and clay mineral data for the Emerald Pond Section, Stop 3.

SW¼ SW¼, Sec. 33, T. 20 N., R. 12 W., Danville NW Quadrangle, Vermilion County, Illinois. Type section for the Snider Till Member, the Batestown Till Member, and the Glenburn Till Member. Section modified after Johnson, Gross, and Moran (in press).

| | Thickness (ft) |
|---|---|
| Pleistocene Series | |
| Wisconsinan Stage | |
| Woodfordian Substage | |
| Richland Loess | |
| Silt, thin; A and upper B horizons of Modern Soil. . . . . . . . . . . | 1.5 |
| Wedron Formation | |
| Snider Till Member | |
| Till, upper 2 feet leached, lower part of B horizon of Modern Soil; till, calcareous, light olive brown (2.5Y 5/3) grading to grayish brown (2.5Y 5/2) at base of unit, clayey; not many pebbles; shale fragments common; jointed; coarse to medium, irregular blocky structure; manganese- and iron-staining and accumulation of secondary $CaCO_3$ common on joint surfaces; locally some interbedded sand and silt. P-5387 (top) to P-5394 (base). . . . . . . . . . . . . . . . . . . . . . . . . . . | 14.0 |
| Silt, calcareous, yellowish brown, laminated. . . . . . . . . . . . . | 0.1 |
| Sand and gravel, calcareous, yellow to dark grayish brown, mostly well sorted coarse sand; locally, upper 1 foot is coarse, sandy gravel. . . | 2.0 |
| Batestown Till Member | |
| Till, calcareous, light olive brown (2.5Y 5/4) grading to dark gray (5Y 4/1) at 6.5 feet below top; upper portion contains many sand and silt stringers with no preferred orientation and a boulder concentration; thin silt bed 4 feet below top; lower portion silty, soft; weak, blocky to platy structure. P-5358 (top) to P-5367 (base). . . . . . . | 14.0 |
| Glenburn Till Member | |
| Till, calcareous, brown to dark brown (7.5YR 4/2) at top to dark brown (10YR 3/3) at base; pinkish cast; joints prominent with iron staining and oxidation of till along joint surfaces; sand stringers locally; radiocarbon date of wood from base > 38,000 radiocarbon years B.P. (ISGS-15). P-5368 (top) to P-5382 (base). . . . . . . . . . . . . . . | 17.0 |
| Kansan Stage | |
| Banner Formation | |
| Tilton Till Member | |
| Till, calcareous, slightly oxidized, dark brown (10YR 3.5/3) to dark grayish brown (10YR 4/2) at base; numerous 1- to 3-inch horizontal, irregular sand zones; concentration of white sandstone fragments locally at upper contact; oxidized joints less prominent. P-5383 (top) to P-5386 (base). . . . . . . . . . . . . . . . . . . . . . . . . . . . | 9.0 |
| Composite section | 57.6 |

33.1 Leave Stop 3, turn left (east) on blacktop road; note abandoned strip mine on right (south).

33.4 ***Stop 4 - Harmattan Strip Mine Section No. 4*** - Turn right (south) into abandoned school yard.

## STOP 4 - HARMATTAN STRIP MINE SECTION NO. 4

### Discussion of Stratigraphy

The Harmattan Strip Mine Section No. 4 (fig. 16), a long east-west exposure along the north highwall of the Harmattan Strip Mine, exposes all of the known tills in the area except the Snider, Smithboro, and Hegeler Tills. The purposes of the stop are to show that the Snider Till does not extend beyond the Illiana Morainic System, to introduce the Oakland, Hillery, and Harmattan Tills, to demonstrate the relationship of the Glenburn and Oakland Tills to a filled, buried valley, to demonstrate on the basis of two radiocarbon dates that the Glenburn and Oakland Tills are Woodfordian in age, and to note the almost complete absence of any evidence of weathering in the section other than that related to the Modern Soil.

The Batestown Till Member is the surficial till beyond the Illiana Morainic System and in places in this section a boulder pavement occurs in the middle of the unit. The upper and lower parts of the till are similar mineralogically and texturally, and the significance of the break between them is not known. The Batestown is overlain by outwash, which forms the outwash plain in front of the Illiana Morainic System.

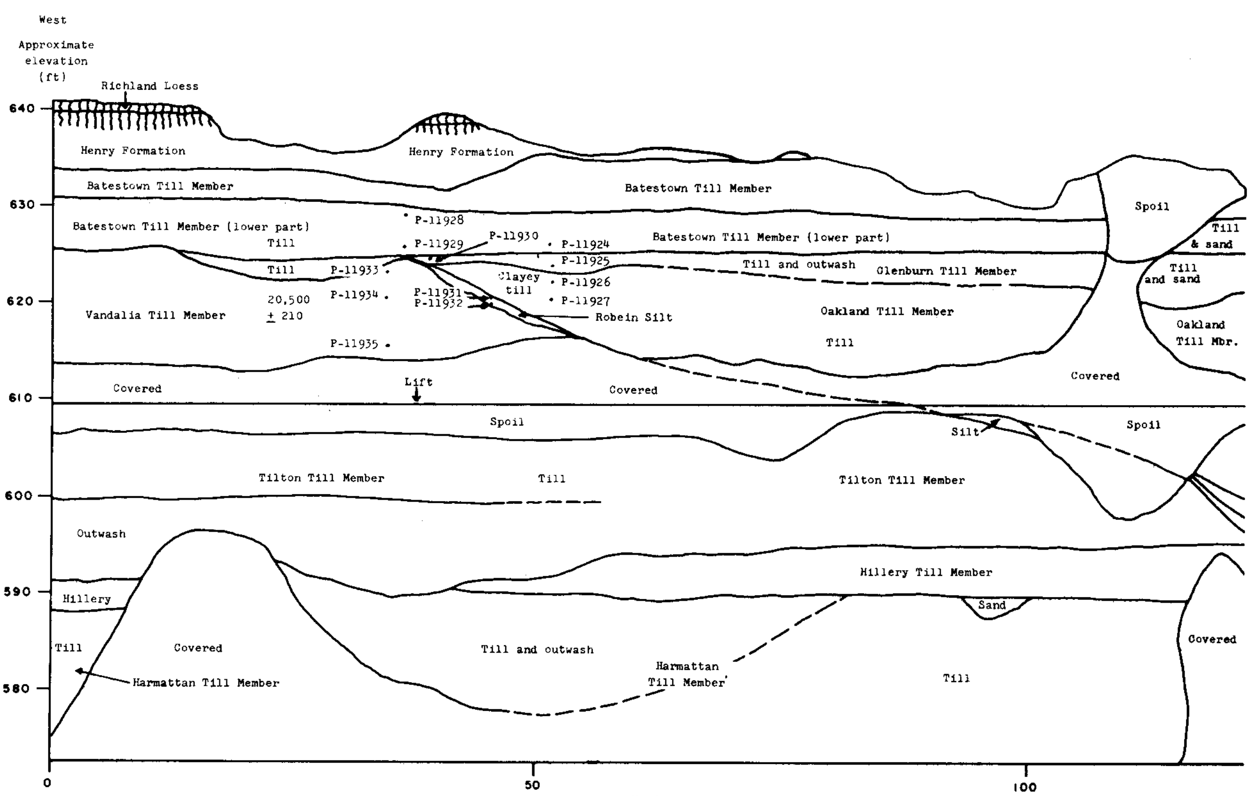
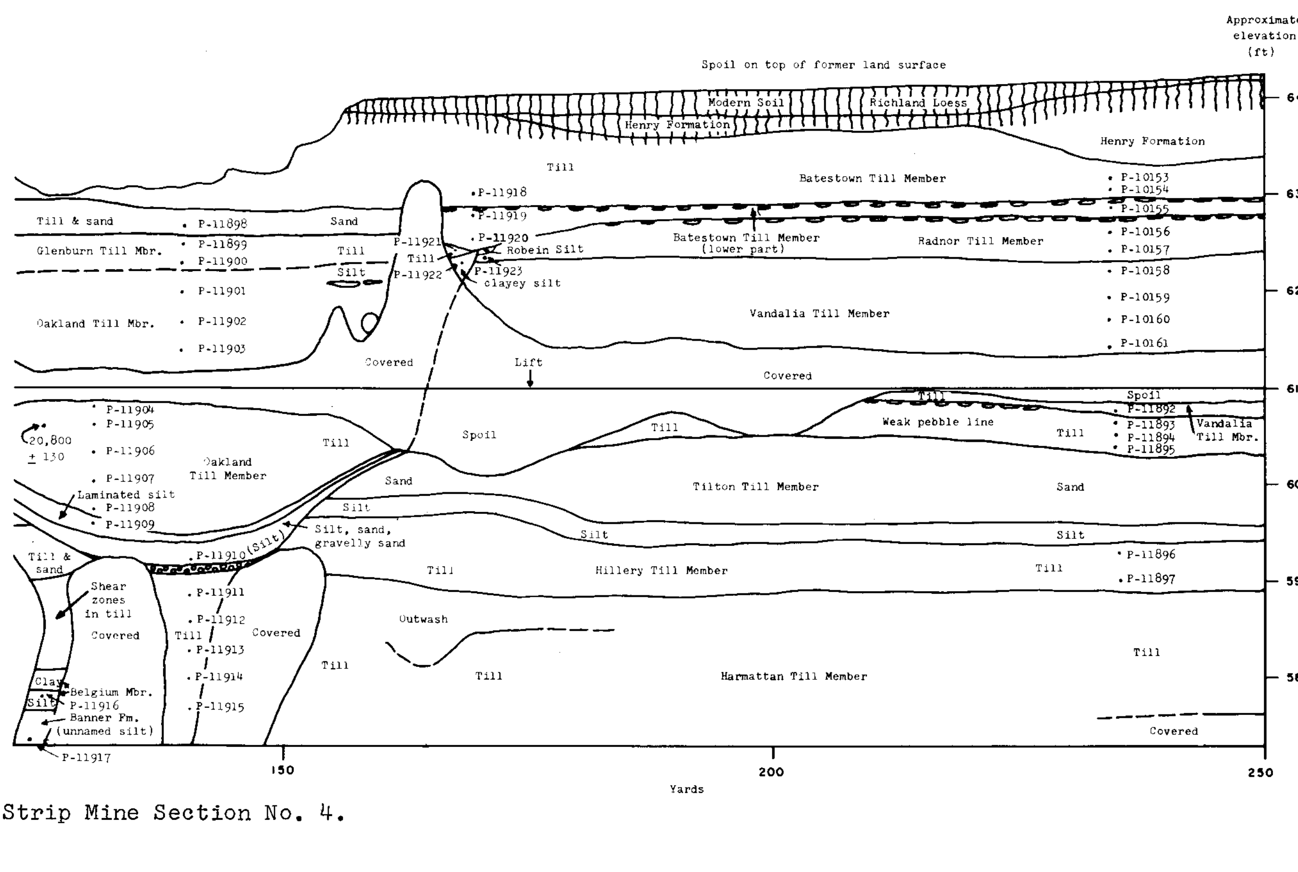



Fig. 16 - Sketch of the Harmattan

The most critical stratigraphic relations in the section involve the Oakland and Glenburn Tills, the buried valley in which they occur, and the radiocarbon dates. Mineralogically, the Oakland and the Glenburn are quite distinct (fig. 17), but in the field the contact between them is rather subtle and is somewhat easier to observe from a distance than up close. The main field difference is that the Oakland weathers with a brownish cast and the Glenburn with a pinkish cast. The Glenburn here is only a few feet thick, and most of the valley fill is Oakland. The Oakland becomes quite silty, and the lower part contains abundant wood. The till rests on silt and sand, gravelly sand, and gravel.

The buried valley in which these two tills occur truncates the Radnor, Vandalia, Tilton, and Hillery Till Members. The margins or sides of the valley are exposed, and a thin, slightly carbonaceous silt occurs on the upper slope of both sides of the valley. The silt may be locally derived loess; it is assigned to the Robein Silt rather than the Morton Loess, however, because it is carbonaceous. The lower part of the valley contains alluvial silt, sand, and gravel overlain by well laminated silts. The laminated silts are clearly lacustrine in origin and suggest that the valley may have drained to the north and was ponded by the glacier that deposited the Oakland Till Member. The silty character of the lower part of the Oakland Till is the result of incorporation of silt from the sides and bottom of the valley.

Wood from the Robein Silt on the western slope of the valley yielded a radiocarbon date of 20,500 ± 210 years B.P. (ISGS-83), and wood from the Oakland Till Member yielded a date of 20,800 ± 130 radiocarbon years B.P. (ISGS-81). These dates indicate that the valley was filled in the early Woodfordian. Be-




Strip Mine Section No. 4.

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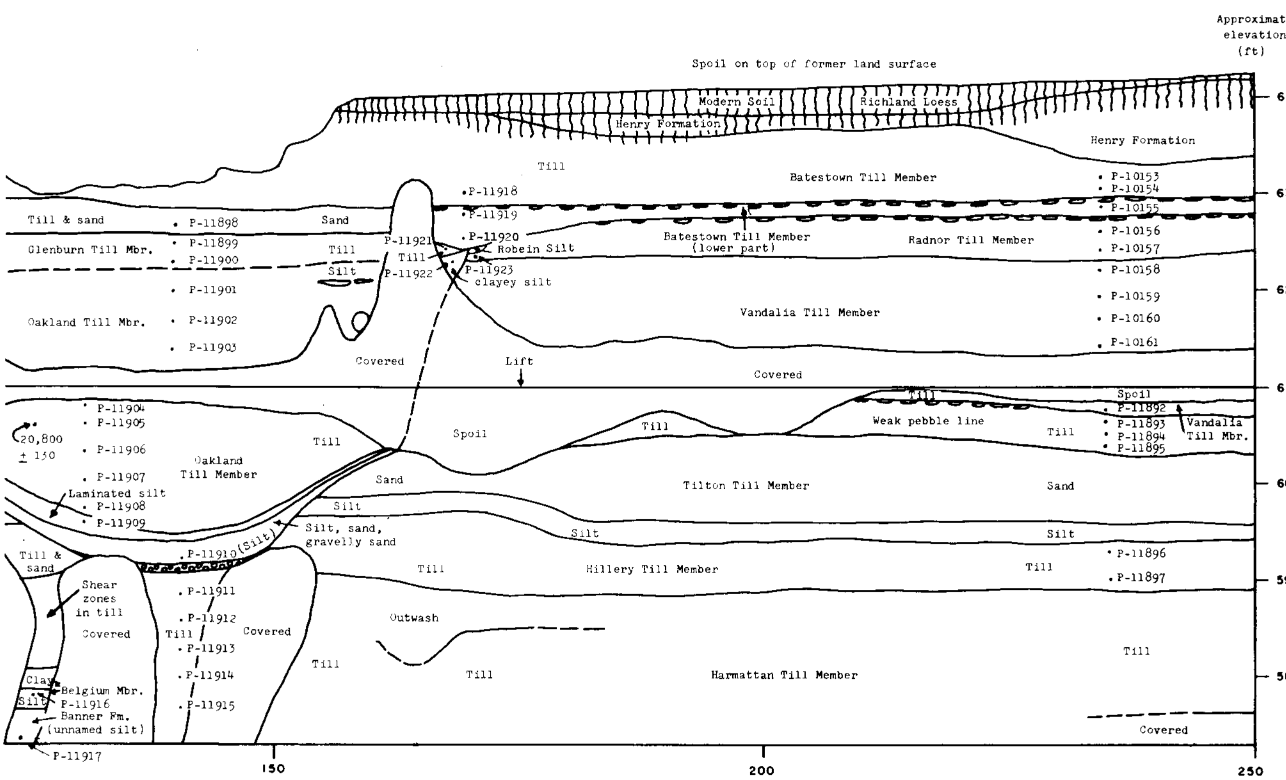
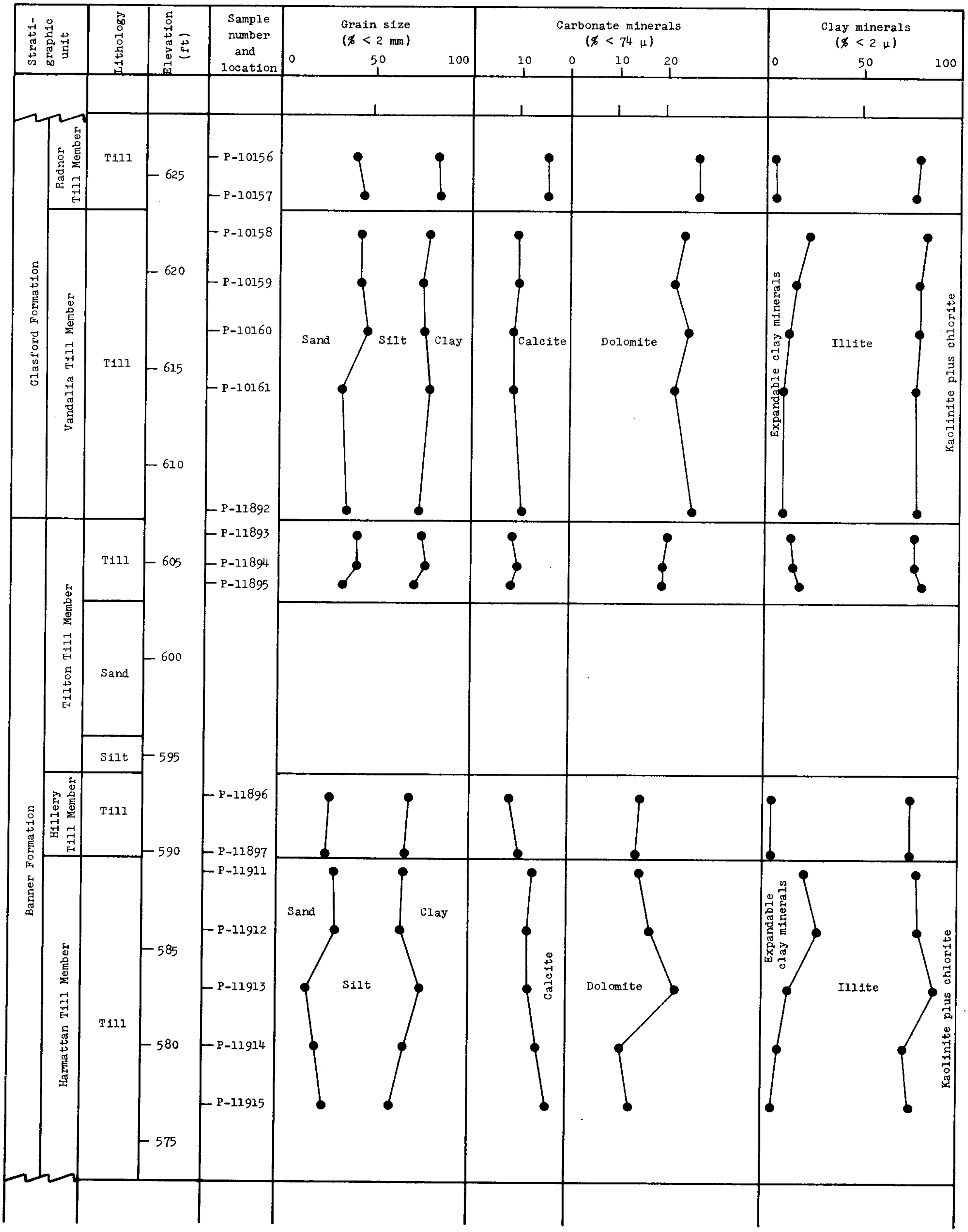



Strip Mine Section No. 4.


Strati-graphic unit
Lithology
Elevation (ft)
Sample number and location
Grain size (% < 2 mm)
0
50
100
Carbonate minerals (% < 74 μ)
10
0
10
20
Clay minerals (% < 2 μ)
0
50
100
Glasford Formation
Radnor Till Member
Vandalia Till Member
Banner Formation
Tilton Till Member
Hillery Till Member
Harmattan Till Member
Till
Sand
Silt
625
620
615
610
605
600
595
590
585
580
575
P-10156
P-10157
P-10158
P-10159
P-10160
P-10161
P-11892
P-11893
P-11894
P-11895
P-11896
P-11897
P-11911
P-11912
P-11913
P-11914
P-11915
Sand
Silt
Clay
Calcite
Dolomite
Expandable clay minerals
Illite
Kaolinite plus chlorite

cause there is very little evidence of weathering on the valley slopes, the time of valley cutting was probably late Altonian or Farmdalian.

The lower part of the section is not accessible because it is covered by water. However, clay and silt of the Belgium Member and unnamed silt of the Banner Formation are exposed in a small area in the central part of the section. The sediments have been deformed by one of the overriding glaciers, but, because of spoil, it is not possible to determine their exact structural relation to the Harmattan Till Member. The older units, the Harmattan, Hillery, and Tilton Till Members, can best be viewed at the east end of the section, and a bird's-eye view of the entire section can be obtained from the spoil piles on the south side of the strip mine pit.

## Harmattan Strip Mine Section No. 4

Composite section measured along 250-yard exposure on the north highwall of the Harmattan Strip Mine in the NE$\frac{1}{4}$ NE$\frac{1}{4}$ NW$\frac{1}{4}$, Sec. 4, T. 19 N., R. 12 W., Danville NW Quadrangle, Vermilion County, Illinois.

| | Thickness (ft) |
|---|---|
| Pleistocene Series | |
| Wisconsinan Stage | |
| Woodfordian Substage | |
| Richland Loess | |
| Silt, yellowish brown (10YR 5/4) to brown (10YR 4/4) silt loam to silty clay loam, noncalcareous; A and upper B horizons of Modern Soil. . . . . | 0-3.0 |
| Henry Formation | |
| Batavia Member | |
| Sand, yellowish brown to dark yellowish brown sandy loam; medium sand, noncalcareous; lower 6 feet coarse sand and fine gravel, cross-bedded, lower portion locally calcareous; unit highly clay-enriched just above calcareous drift; part of discontinuous outwash plain of Newtown Moraine; upper part of B horizon of Modern Soil. . . . . . . . | 0-9.0 |
| Wedron Formation | |
| Batestown Till Member | |
| Till, light olive brown (2.5Y 5/4) where oxidized to dark gray (5Y 5/1) at base; loam; fine, blocky structure; iron stains on joints; upper part locally in B horizon of Modern Soil. P-10153, P-10154, P-11918.. | 3-9.0 |
| Batestown Till Member, lower part | |
| Till and sand; variable unit; till very dark gray (2.5Y 3/1) loam; blocky structure; no stains on joints; sand interbedded with till, gray, stratified, poorly sorted; all calcareous; locally a boulder pavement at top. P-10155, P-11919, P-11920, P-11898, P-11924, P-11928, P-11929. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 1.5-6.0 |
| Glenburn Till Member | |
| Till, brown to dark brown (7.5YR 4/2) loam, weathers with pinkish cast, calcareous; fine, blocky structure; locally contains thin zones of sand and gravelly sand; upper part of fill in buried valley. P-11899, P-11900, P-11930, P-11925, P-11921. . . . . . . . . . . . . . . . . | 0-6.0 |

| | Thickness (ft) |
|---|---|
| Oakland Till Member | |
| Till, brown to dark brown (10YR 4/3) loam at top to silt loam at base; weathers with brownish cast; calcareous; coarse, blocky structure; strong staining on joints; till more grayish brown to gray toward base; contains inclusions of silt, many wood fragments, and mollusk shells; radiocarbon date on wood 12 feet below top 20,800 ± 130 years B.P. (ISGS-81); part of valley fill. P-11901-11908, P-11926, P-11927, P-11922 | 0-28.0 |
| Silt, brown to grayish brown silt loam, calcareous, very strongly laminated; contains wood fragments; locally a thin coarse sand in middle. P-11909. | 0-2.0 |
| Silt, sand, and gravelly sand; variable unit, stratified, calcareous, gray to dark gray except where oxidized to brown, carbonaceous; wood fragments near top; contains mollusk shells. P-11910. | 0-3.0 |
| Gravel, sandy, calcareous; rocks up to 1 foot in diameter; base of fill in valley. | 0-1.0 |
| Robein Silt | |
| Silt, light grayish brown (2.5Y 5/2) in upper part to dark grayish brown (10YR 4/2) in lower, calcareous, carbonaceous; contains wood fragments and mollusk shells; radiocarbon date on wood 20,500 ± 210 years B.P. (ISGS-83). P-11931, P-11932 | 0-2.0 |
| Illinoian Stage | |
| Jubileean Substage | |
| Glasford Formation | |
| Radnor Till Member | |
| Till, grayish brown to light grayish brown (2.5Y 5.5/2) loam, calcareous; blocky structure; contains interbedded sand and silt; boulder pavement locally at top of unit; truncated by valley fill; occurs only on the east side of the valley fill. P-10156, P-10157, P-11923. | 0-5.0 |
| Vandalia Till Member | |
| Till, dark grayish brown to dark brown (10YR 4/2.5) loam to sandy loam; grades to dark gray (10YR 4/1) at 4 feet; calcareous; hard, blocky structure; locally contains sand in upper portion; the bench between lifts occurs within this unit. P-10158-10161, P-11892, P-11933-11935. | 0-15.0 |
| Kansan Stage | |
| Banner Formation | |
| Tilton Till Member | |
| Till, dark grayish brown (10YR 4/2) loam, calcareous; hard, blocky structure; thin silt streaks and pebble concentration at top. P-11893-11895. | 0-4.0 |
| Sand, tan to yellowish brown, calcareous, well sorted, stratified; local thin gray silt zones; lower portion medium to coarse sand and fine gravel. | 0-7.0 |
| Silt, gray, calcareous, massive, discontinuous. | 0-2.0 |

| | Thickness (ft) |
|---|---|
| Hillery Till Member | |
| Till, brown to dark brown (7.5YR 4.5/2) silt loam, calcareous; hard, blocky structure; contains discontinuous silt and sand zones. P-11896, P-11897. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 0-8.0 |
| Harmattan Till Member | |
| Till, dark gray (5Y 4/1) loam, calcareous; upper portion soft and sandy, lower part finer grained; hard, blocky structure; locally contains material sheared into the till; till locally cut out by channels filled with outwash. P-11911-11915. . . . . . . . . . . . . | 18.0 |
| Belgium Member (exposed only in central part of the exposure and probably part of a larger shear structure) | |
| Clay, brown to dark brown, calcareous, deformed, highly slickensided. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 2.0 |
| Silt, dark grayish brown, calcareous, massive; contains mollusk shells; upper part carbonaceous. P-11916. . . . . . . . . . . . . . . . | 2.5 |
| Banner Formation | |
| Silt, olive brown to grayish brown, noncalcareous; lower portion contains fragments of shale and siltstone; upper portion silt loam; appears colluvial in origin. P-11917. . . . . . . . . . . . . . . . . . . | 4.0 |
| Total section | 70.0 |

33.4 Leave Stop 4 and continue east.

34.0 Rise onto frontal slope of Newtown Moraine.

35.2 Stop sign, turn right (south).

35.4 Drop down off frontal slope of Newtown Moraine.

35.7 Turn left (east); again note road built over strip-mine spoil to the south.

36.7 *Stop 5 - School House Branch Section of Hungry Hollow* - Turn left (north) at abandoned house.

## STOP 5 - SCHOOL HOUSE BRANCH SECTION OF HUNGRY HOLLOW

### Discussion of Stratigraphy

The School House Branch Section is located along the cutbank of a branch of Hungry Hollow, a tributary of the North Fork Vermilion River (figs. 18, 19). The section is about a fifth of a mile north of the Drainage Ditch Section of Hungry Hollow, which was described by Eveland (1952) and by Ekblaw and Willman (1955), and which was visited by the State Geologists 4th Biennial

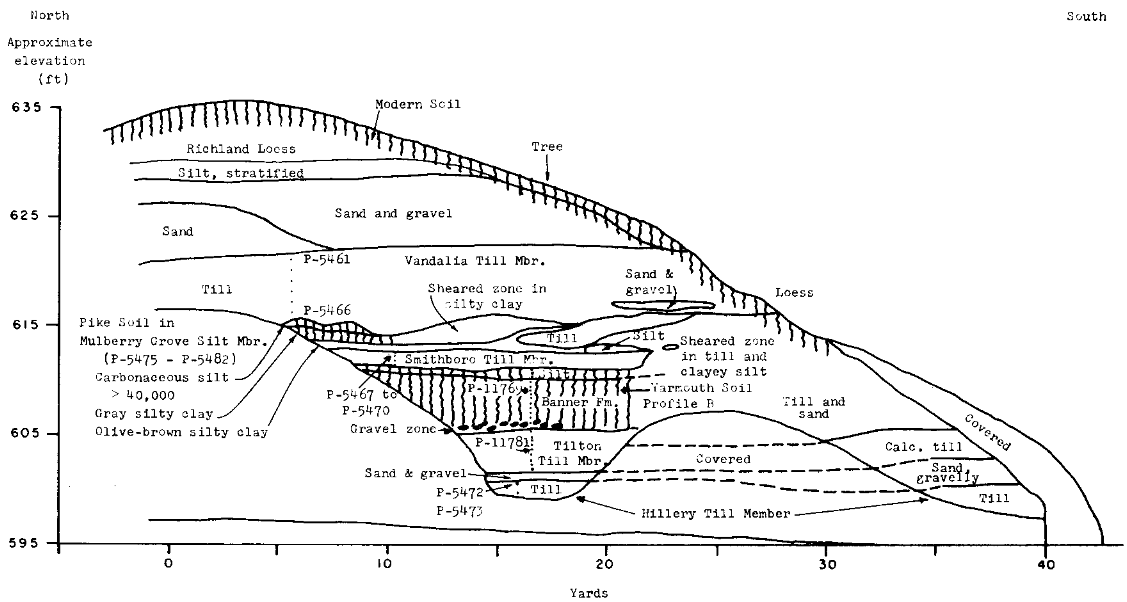



Fig. 18 - Sketch of the School House Branch Section of Hungry Hollow.

Conference Pleistocene Field Trip in 1953 (fig. 20). Most of the Drainage Ditch Section is now overgrown, but the School House Branch Section exposes a similar stratigraphic sequence. The purposes of the stop are to introduce the Mulberry Grove Silt and Smithboro Till Members; to study two buried soils, one in the Mulberry Grove Member and one in the Banner Formation; and to contrast our current interpretation of the stratigraphy with previous interpretations.

Because the section is located in a valley below the level of the upland, the Snider and Batestown Tills, which are exposed in the Drainage Ditch Section, are absent. The youngest glacial materials beneath the loess are outwash and till of the Vandalia Till Member. The till rests on carbonaceous silt and clayey silt, which have been distorted somewhat by the overriding glacier that deposited the Vandalia Till. The deposits are included in the Mulberry Grove Silt Member.

The carbonaceous silt is dolomitic and contains abundant wood fragments. Wood from this zone yielded a date of > 40,000 radiocarbon years B.P. (ISGS-23). The silty clay is noncalcareous and the clay fraction contains large amounts of expandable clay minerals of the type that are characteristic of accretion-gleys in Illinois (Willman, Glass, and Frye, 1966). The Mulberry Grove Silt Member in this section therefore appears to be a sequence of colluvial or accretionary deposits that accumulated in a soil-forming environment. The resulting soil is tentatively correlated with the Pike Soil of western Illinois on the basis of its stratigraphic position. The interpretation of the origin of the materials is essentially the same as that of Ekblaw and Willman (1955), although they did not refer to the deposits as a soil.

The Mulberry Grove Silt Member overlies a thin, silty till that is correlated with the Smithboro Till Member of south-central Illinois. In addition to its silty character, the till contains abundant wood and a few molluscan fossils. Till with similar characteristics is more than 10 feet thick in the eastern end of the Drainage Ditch Section and pinches out to the west. Ekblaw and Willman (1955) interpreted it as the fill of a buried valley. The Smithboro in these sections is very similar to the lower part of the Oakland Till at the Harmattan Strip Mine Section No. 4, but the two tills, although similar in lithology, occur at different stratigraphic positions.

The Smithboro Till rests on a thick soil, the lower part of which is developed in the Tilton Till Member. The soil is correlated with the Yarmouth Soil on the basis of its stratigraphic position. The soil is complex, and more than one interpretation of the origin of the materials in the upper part of the soil is possible.

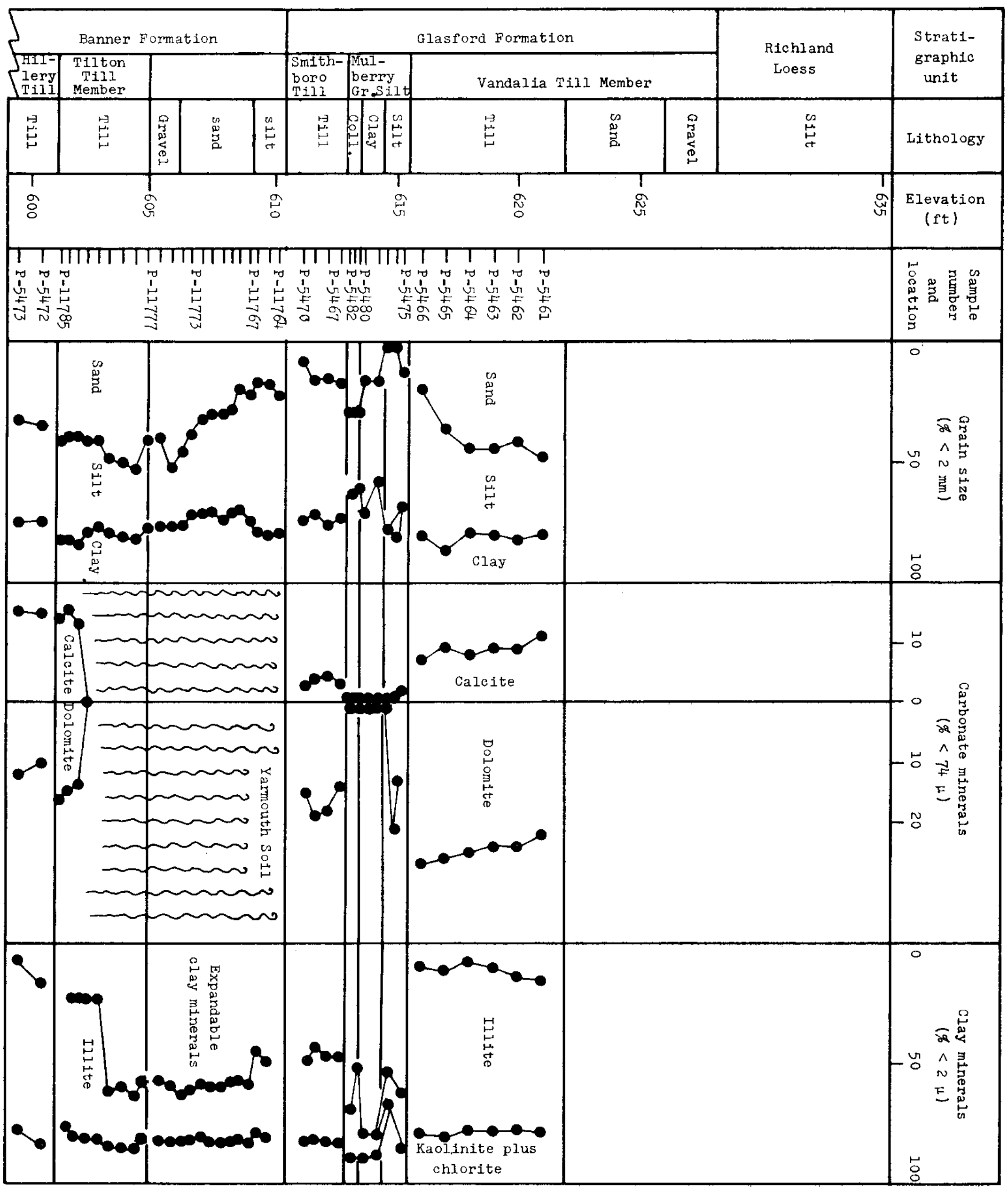



Fig. 19 - Grain size, carbonate mineral, and clay mineral data for the School House Section of Hungry Hollow.

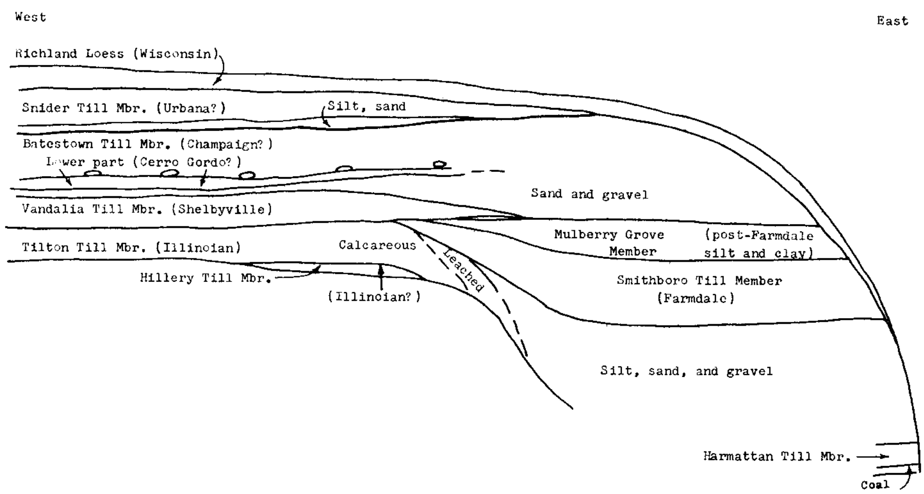



Fig. 20 - Sketch of section exposed along part of the diversion ditch for the Hungry Hollow stream (modified from Ekblaw and Willman, 1955). Terminology and interpretation of Ekblaw and Willman (1955) shown in parentheses.

The upper 15 inches of the Yarmouth have weak A horizon characteristics but appear also to be part of a depositional unit. Johnson, Gross, and Moran (*in press*) interpreted the silt as being correlative with the Petersburg Silt, a pro-Illinoian loess and waterlaid silt in western Illinois. It does occur in the proper stratigraphic position to be the Petersburg, but the fact that it is weathered and may be related in origin to the materials below it casts doubt on that interpretation. Consequently, we have included the silt stratigraphically with the materials of the Banner Formation below.

From 15 inches to 66 inches, the Yarmouth appears to be developed in materials of alluvial origin. The basal zone of this segment is a coarse gravel, which is overlain by a sandy zone, over which is a sandy silt, and, finally, the upper 15 inches of silt. The sorting of the sediments, their dark color, the upward fining of the sequence, and the position of the sediments in a former valley suggest an alluvial origin for the deposits. They were probably deposited during the Yarmouthian Stage and are included in the Banner Formation (fig. 2).

The IIIB3 horizon of the soil is developed in the Tilton Till Member of the Banner Formation. The upper 2 feet of the till (IIIB3) contains more sand than the till below, which may indicate that it is related to the water-deposited materials above. It appears morphologically like till, however, and is included with the Tilton. An alternative, but less likely, interpretation for the upper 66 inches of the soil is that the materials are outwash and ablation deposits related to the melting of the glacier that deposited the Tilton Till.

The profile has lost much of its original pedologic morphology and appears somewhat like unweathered material. Apparently conditions after burial were such that retrogressive morphologic development took place, and the best indications of intense weathering are the clay accumulation in the B horizon, the depth of leaching, and the alteration of the clay minerals to the expandable type that are characteristic of the B zones of well developed buried soils in Illinois (Willman, Glass, and Frye, 1966).

Figure 20 is a diagram sketched after Eveland (1952) and Ekblaw and Willman (1955) showing the Drainage Ditch Section as we now interpret the stratigraphy. The names in parentheses are the interpretations of Ekblaw and Willman. As noted earlier, they considered the thick buried soil to be the Sangamon because it was the first major soil below the Modern Soil in these sections. Consequently, the tills above the soil were Wisconsinan and those below were Illinoian or older. The oldest of the Wisconsinan tills was called Farmdale and more recently has been referred to as the "Danville" till of Altonian age (Frye and Willman, 1960). We have based our interpretation of the stratigraphy on till correlation, which indicates that the oldest two tills above the buried soil are lithologically related to the Smithboro and Vandalia Tills in the area of Illinoian drift and that the till below the soil is lithologically related to Kansan till in eastern Illinois. Therefore, the major buried soil is the Yarmouth, and the accreted soil above the Smithboro is probably the Pike. The occurrence of the truncated Sangamon Soil in the Radnor Till in Collison Branch Section No. 2 supports this interpretation. We are generally in agreement with Ekblaw and Willman (1955) on the origin of the materials in the section.

## School House Branch Section of Hungry Hollow

Section measured along the east bank of a meander in the SE$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$, Sec. 2, T. 19 N., R. 12 W., Danville NW Quadrangle, Vermilion County, Illinois. Type section of the Tilton Till Member. Section modified after Johnson, Gross, and Moran (in press).

| | Thickness (ft) |
|---|---|
| Pleistocene Series | |
| Wisconsinan Stage | |
| Woodfordian Substage | |
| Richland Loess | |
| Silt, noncalcareous, massive, yellowish brown to dark brown; contains Modern Soil. . . . . . . . . . . . . . . . . . . . . . . . . . . . | 4.0 |
| Silt, calcareous, stratified, yellowish brown with gray mottling; not present on north portion of exposure. . . . . . . . . . . . . . . . . . | 1.5 |
| Illinoian Stage | |
| Glasford Formation | |
| Vandalia Till Member | |
| Gravel and interbedded sand, calcareous, gray to grayish brown; high-angle cross-bedding dips to the south; upper 6 inches colluviated and poorly sorted. . . . . . . . . . . . . . . . . . . . . . . . . . . . | 2.0 |
| Sand, calcareous, yellowish brown to grayish brown, well sorted, medium sized, angular to subangular; lower 6 inches gravelly. . . . . . . . . | 4.0 |
| Till, calcareous, dark brown (10YR 3.5/3) in upper 6 inches; grades to dark gray (10YR 4/1) at base; hard; coarse, blocky structure; stains on joints common; lower portion of till contains streaks of sand and silt. P-5461 (top) to P-5466 (base). . . . . . . . . . . . . . . . . | 6.0 |
| Mulberry Grove Silt Member (contains Pike Soil) | |
| Silt, calcareous, carbonaceous, very dark brownish gray; contains wood fragments; lower 3 inches gray, not calcareous or carbonaceous; peat mat locally at top of unit; radiocarbon date on wood > 40,000 years B.P. (ISGS-23). P-5475 (top) to P-5477 (base). . . . . . . . . . . | 1.0 |

| | Thickness (ft) |
|---|---|
| Clay, noncalcareous, gray to brownish gray; contains a few pebbles; upper part locally carbonaceous; cracks on surface when dry. P-5478, P-5479 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 1.0-1.5 |
| Colluvium, noncalcareous, sandy, pebbly clay, yellow to olive-brown, faintly laminated; lower portion gray and till-like. P-5480 (top) to P-5482 (base). . . . . . . . . . . . . . . . . . . . . . . . . . . | 0.5-1.5 |
| Smithboro Till Member | |
| Till, calcareous, dark brown (10YR 3/3), very silty with only a few pebbles; contains abundant wood fragments and a few mollusk shell fragments. P-5467 (top) to P-5470 (bottom). . . . . . . . . . . . . . | 2.0-4.0 |

Yarmouthian Stage
Banner Formation

*Yarmouth Soil*

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| A | 0-5<br>5-10<br>10-15 | 11764<br>11765<br>11766 | Silt; dark grayish brown (10YR 4/2) silt loam with many red stains and few reddish black stains along joints; firm; massive to weak, coarse, angular blocky structure. . . . . . . | 1.3 |
| IIB(?) | 15-20<br>20-25<br>25-30<br>30-35<br>35-40<br>40-45 | 11767<br>11768<br>11769<br>11770<br>11771<br>11772 | Silt, sandy; very dark grayish brown (10YR 3/2) silty clay loam to clay loam, common red and black stains along joints; firm; weak, coarse, angular blocky structure. . . . | 2.5 |
| IIB21g | 45-50<br>50-54 | 11773<br>11774 | Sand; greenish gray (5GY 5/1) loam with few continuous red and black stains along joints; few indistinct krotovina filled with silty material; firm; massive. . . . . . . . . . . . | 0.7 |
| IIB22g | 54-60<br>60-66 | 11775<br>11776 | Gravel; greenish gray (5GY 5/1) gravelly loam with few red and black stains; firm; massive; slightly cemented. . . . . . . . . . . . . . | 1.0 |
| Kansan Stage<br>Banner Formation<br>Tilton Till Member | | | | |
| IIIB3 | 66-72<br>72-78<br>78-84<br>84-91 | 11777<br>11778<br>11779<br>11780 | Till; yellowish brown (10YR 5/4) loam with yellowish red stains; many large gray mottles in upper 6 inches; few krotovina; few dark brown (7.5YR 3/2) clay coatings; friable; weak, angular, blocky structure. . . . . . . | 2.0 |
| IIIC1 | 91-96<br>96-101 | 11781<br>11782 | Till; very dark grayish brown (2.5Y 3/2) ped interiors with lighter colored (2.5Y 4/2) exteriors; loam; few yellowish red and black stains; few dark (10YR 4/2) clay coatings; firm; massive to weak, coarse, angular blocky structure; leached. . . . . . . . . . . . . | 1.0 |

| | | | | Thickness (ft) |
|---|---|---|---|---|
| IIIC2 | 101-105<br>105-110<br>110-115<br>115-125 | 11783<br>11784<br>11785<br>— | Till, dark grayish brown (1Y 4/2) loam with many dark gray stains; yellowish brown mottles common; firm, brittle; weak, coarse, angular, blocky structure; calcareous. . . . . | 2.0 |
| IVC3 | 125-143 | — | Sand; yellowish brown (10YR 5/6) fine gravel at top grading to fine sand at base; calcareous. . . . . . . . . . . . . . . . . . . . . | 1.5 |

Hillery Till Member

| | |
|---|---|
| Till, calcareous, dark reddish brown (5YR 3/3), very hard; base not exposed. P-5472 (top) to P-5473 (base). . . . . . . . . . . . . . . . . . | 1.5 |
| Total section | 36.0 |

Miles

36.7 Leave Stop 5 and continue east.

38.9 Stop sign; turn right (south) on Logan Street.

39.0 Turn left (east) on Williams Street.

39.3 Jog right; stay on Williams Street.

39.9 Turn right (south) on Hazel Street.

40.2 END OF SATURDAY TRIP, Hotel Wolford.

Sunday, May 14, 1972

0.0 Assemble in Hotel Wolford parking lot and be ready to leave at 7:30 a.m. Turn right on Hazel Street.

0.05 Turn right on Harrison Street.

0.4 Turn left on Gilbert Street.

0.8 Vermilion River.

1.8 Turn right (west) on I-74 (marked to Urbana).

5.1 Salt Fork of the Vermilion River.

7.5 Middle Fork of the Vermilion River.

10.6 For the next several miles the Illiana Morainic System may be seen to the northeast. We are now driving west, but in a few miles we shall turn south and begin crossing a series of Woodfordian moraines (see map inside the front or back cover). We are now on the Batestown Till Member of the Wedron Formation, which continues until we are within a few miles of the southern margin of the Wisconsinan drift (fig. 4). In the next 37 miles we shall cross the Urbana, Ridge Farm, Hildreth, West Ridge, and Arcola Moraines, which generally do not mark major changes in till composition.

The till within a few miles of the southern Wisconsinan boundary is Glenburn, but detailed mapping of the boundary between Glenburn and Batestown has been completed only in Coles County (fig. 4). Stop 6 is in the Shelbyville Morainic System, which is composed of Glenburn Till. Stop 7, 0.7 mile south of Stop 6, is on the flat Illinoian till plain just south of the terminal Wisconsinan moraine.

| Miles | |
|---|---|
| 19.1 | Leave I-74 at the Ogden-Royal exit. |
| 19.5 | Stop sign; turn left (south). |
| 20.4 | Stop sign; continue straight ahead on Illinois 49. |
| 24.3 | Salt Fork of the Vermilion River. |
| 28.3 | Crest of the Urbana Moraine. |
| 34.7 | Illinois 49 turns left (east) just past a railroad crossing; stay on Illinois 49. You are now on the Ridge Farm Moraine. |
| 35.7 | Illinois 49 turns right (south); stay on Illinois 49. Crest of the Ridge Farm Moraine may be seen half a mile to the south. |
| 36.2 | On crest of Ridge Farm Moraine; crest of Hildreth Moraine may be seen 0.9 mile ahead (south). |
| 37.2 | Crest of Hildreth Moraine. |
| 39.3 | Crest of West Ridge Moraine. |
| 43.9 | Stop sign at junction with U. S. 36; continue ahead (south) on Illinois 49. |
| 47.8 | Crest of Arcola Moraine. |
| 54.2 | Stop sign at junction with Illinois 133; continue ahead on Illinois 49. |
| 60.9 | City of Kansas; turn right (west), stay on Illinois 49 and Illinois 16. |
| 63.3 | Junction of Illinois 49 and 16; continue ahead (west) on Illinois 16. |
| 70.9 | Charleston Stone Quarry on right; this is an alternate stop in case of high water at the Center School Section. |
| 74.1 | Stop light at junction of Illinois 130 and 16; turn left (south) on Illinois 130. |
| 74.3 | Eastern Illinois University may be seen on the right. |
| 76.7 | Embarras River. |
| 78.1 | Leave Illinois 130, turn left (east) on concrete county road marked to Hutton; now on the crest of the Shelbyville Morainic System. |
| 79.3 | Bear right (south); stay on main road. |

82.5 T intersection; turn right (south) on blacktop road.

83.1 Turn right (south); stay on main blacktop road.

83.8 *Stop 6 - Center School Section* - Park along the road; please pull off as far as possible. The section is 50 yards west, on the east bank of West Branch Hurricane Creek.

## STOP 6 - CENTER SCHOOL SECTION

### Discussion of the Stratigraphy

The Center School Section is a stream-cut along the east bank of the West Branch Hurricane Creek. The section has been described by Ford (*in preparation*) and is located about half a mile north of the frontal margin of the Shelbyville Moraine. The purposes of the stop are to show typical stratigraphic relations just inside the margin of Woodfordian glaciation, to display typical Robein Silt, to introduce the sandy silt facies of the Roxana Silt, and to study two contrasting profiles of the Sangamon Soil that are developed in fluvial or glaciofluvial deposits overlying the Vandalia Till.

The till in the upper part of the section (fig. 21) is correlated with the Glenburn Till of the Danville area. It is not quite as sandy here, but Ford (*in preparation*) reported that the Glenburn Till in this area becomes sandier to the northeast in Coles County. Other compositional characteristics are similar to typical Glenburn Till. The till rests on proglacial outwash and lacustrine silt. Although in the stratigraphic position of the Morton Loess, the silt is included in the Glenburn Till Member because it is not loess and is more closely related to the till. A thin cap of Richland Loess and the Henry Formation occur at the top of the section.

The Glenburn unit rests on typical Robein Silt, which is 18 inches thick at the north end of the exposure and eventually pinches out to the south. It is a dark, carbonaceous unit and contains abundant wood. A log from the top of the unit yielded a radiocarbon date of 20,500 ± 130 years B.P. (ISGS-89). The Robein, where present, forms the O2 horizon of the Farmdale Soil.

A sample from the most carbonaceous part of the Robein yielded the following pollen assemblage:

| | | | |
|---|---|---|---|
| *Pinus* (pine) | 31% | *Populus* (poplar) | 10% |
| *Picea* (spruce) | 35% | *Quercus* (oak) | 5% |
| *Juniperus* (juniper) | 9% | | |
| Total conifer | 75% | Total deciduous | 15% |

Total nonarboreal - 11%, of which 10% are *Cyperaceae* (sedge)

The assemblage suggests that the vegetation was characterized by dense conifer forests with a few deciduous trees, and implies a proglacial climate rather than an interstadial climate. Thus, the pollen data agree with the radiocarbon date, which indicates an early Woodfordian age for the deposit.

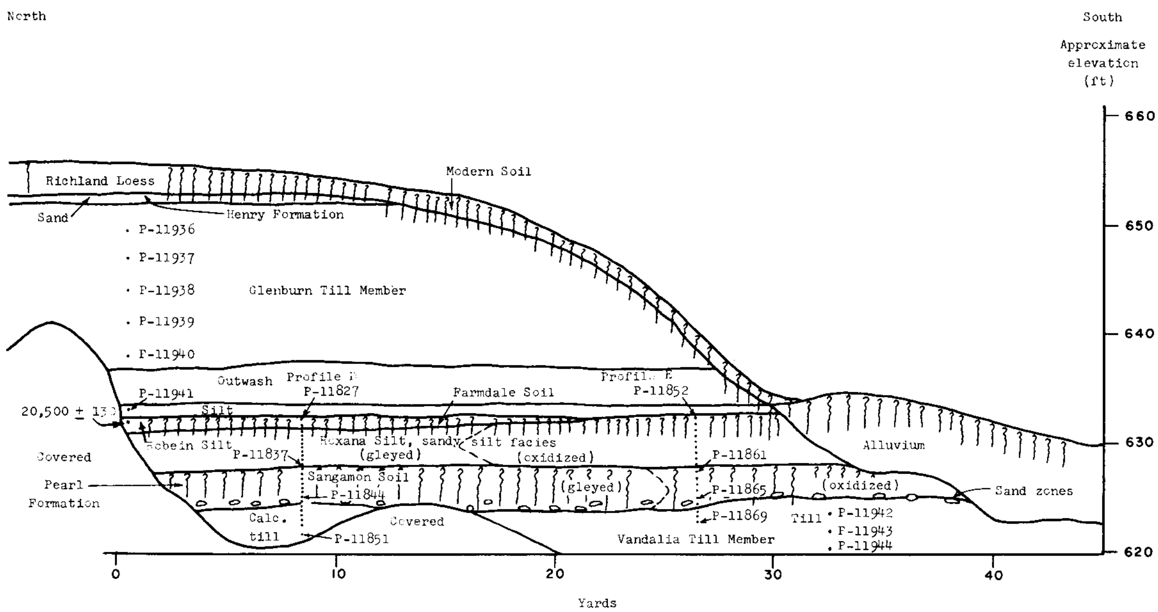



Fig. 21 - Sketch of the Center School Section.

The next 9 feet of the section are difficult to interpret from both geologic and pedologic standpoints. Our interpretations are based on both field observations and laboratory data from the section and on regional stratigraphic and sedimentological relations. Two profiles were described and sampled to establish the lateral relations of the geologic materials and to compare the pedologic characteristics. Profile D (figs. 21 and 22) is of the gleyed portion of the section and contains the Robein Silt at the top. Profile E (figs. 21 and 22) is located about 50 feet to the south where the profile is oxidized and does not contain the Robein Silt. Underlying the Robein is a unit that is continuous across the outcrop and cuts across the pedologic boundaries from the gleyed to the oxidized portion. In the upper part, this zone contains more than 50 percent silt, which decreases with depth. The sand content is around 40 percent, and the clay content is the smallest of the < 2 mm fraction. This zone we are calling the sandy silt facies of the Roxana Silt.

Below the sandy silt facies, subtle color changes are evident and the texture becomes richer in clay in the gleyed section. At profile E, the oxidized equivalent, a noticeable increase in the pebble content can be observed. Close examination of this contact reveals some A horizon characteristics in the lower material. This contact is interpreted as the surface of the Sangamon Soil. Most of the Sangamon Soil is developed in transported material which rests on a stone line, a zone rich in gravel. Some soil development extends down through this material and into the underlying Vandalia Till. Some doubts exist concerning the interpretation of the material overlying the stone line. The sand content of 50 to 60 percent in the < 2 mm fraction of the gravel-rich zone (P-11846, P-11865, and P-11866) and the fining upward of the sequence suggest a waterlaid origin. We therefore have correlated this unit to the Pearl Formation, an outwash deposit defined by Willman and Frye (1970) to include all Illinoian surficial outwash that overlies or extends beyond Illinoian till.

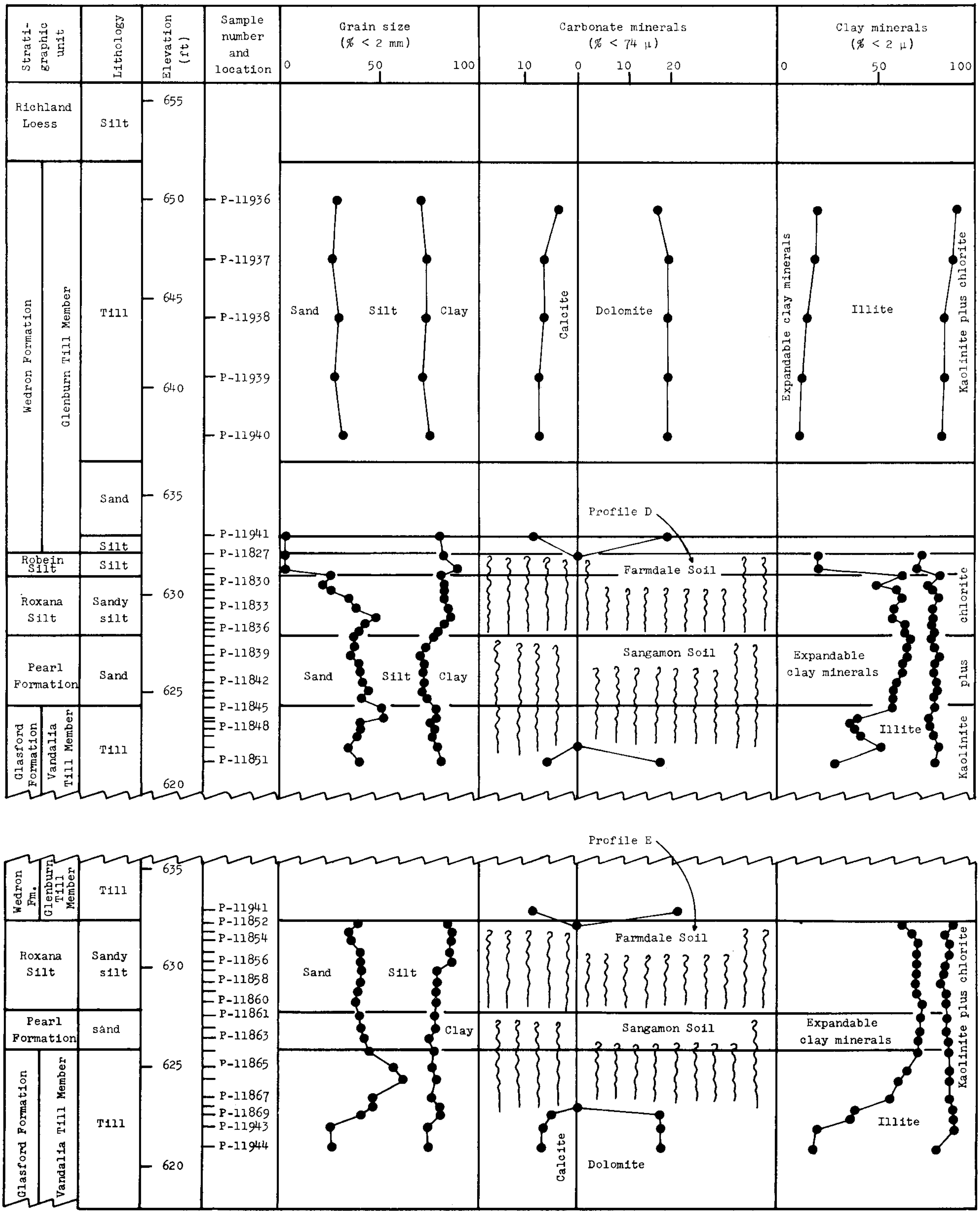



Fig. 22 - Grain size, carbonate mineral, and clay mineral data for the Center School Section.

However, an alternate explanation may be considered. An erosional episode may have occurred during late Illinoian, or even during the Sangamonian Stage, which generated a lag concentrate that was subsequently buried by colluvium. A Sangamonian erosion cycle may be the better interpretation because the Sangamon Soil is not very strongly developed at this section, compared to its development in the Hutton and Jewett Sections. A less well developed soil implies that it is a younger soil, or that it is developed on a younger geologic surface. But this is not conclusive evidence in itself because local conditions during soil formation control the strength of soil development, from weakly to well developed, as can be demonstrated in profiles of the Modern Soil that are developed in Peoria Loess in Illinois.

The clay mineralogy of the Pearl Formation at the Center School Section is controlled by the pedologic conditions imposed on the material and does not help much in establishing the origin of the materials. In both the gleyed portion (profile D) and the oxidized portion (profile E) the clay mineral assemblage is dominated by the expanding types of clay minerals and contains minor amounts of illite, chlorite, and kaolinite (table 8). A significant change in clay mineralogy occurs near the base of the stone line in both profiles. The underlying till-derived horizons have more illite and less expandables. However, the change does not occur at the same stratigraphic position in each profile. In the gleyed section the change occurs in the gravel-rich zone (P-11846), whereas in the oxidized section the change occurs down in the till (P-11868) about 6 inches below the base of the gravel. These clay mineral changes are pedologic and coincide with a geologic boundary at profile D but not at profile E. This is one example of a cross-cutting relationship of pedologic and geologic boundaries. Other examples of such cross-cutting are well displayed at this section. Most striking of these is the boundary between the oxidized and gleyed portions of the section that cuts across relatively homogeneous material. The different soil-forming conditions caused the color pattern that is quite evident at this section. The oxidized portion of the Farmdale Soil appears to wedge out into its equivalent gley, and the gleyed portion of the Sangamon Soil appears to wedge out into its oxidized equivalent. This pedologic boundary is shown on figure 21 as a dashed line.

The lower horizons of the Sangamon Soil are in the Vandalia Till. At profile D the gleyed horizons lie directly over the calcareous till, but at profile E the weathered horizons are separated from the calcareous till by a leached horizon, IIICl. The unusually high amounts of expandable clay minerals in the lowest gleyed horizon (P-11850) is from contamination caused by crayfish activity.

Near stream level, the Vandalia Till at this section becomes more silty and contains much greater amounts of expandable clay minerals. This appears to be a characteristic of the Vandalia, described by Ford (*in preparation*); it is also present at the Hutton Section, Stop 7.

## Center School Section

Section measured on the east stream bank of West Branch, Hurricane Creek, in the NW¼ NW¼ SW¼, Sec. 15, T. 11 N., R. 10 E., Toledo Quadrangle, Coles County, Illinois.

Pleistocene Series
Wisconsinan Stage
Woodfordian Substage
Richland Loess

*Modern Soil*

| Horizon | Depth (in.) | P-No. | Description | Thickness (ft) |
|---|---|---|---|---|
| A1 | 0-4 | — | Silt; dark grayish brown (10YR 4/2) silt loam; platy structure; friable; rootlets common. | |
| A2 | 4-10 | — | Silt; light yellowish brown (10YR 6/4) silt loam; platy to granular structure; friable. | |
| B1 | 10-16 | — | Silt; light yellowish brown (10YR 6/4) heavy silt loam; silt coatings common; fine, subangular, blocky structure. | |
| B2 | 16-32 | — | Silt; yellowish brown (10YR 5/4) silty clay loam; moderate to strong, subangular, blocky structure; silt coatings common; a few clay coatings. | |
| B3 | 32-42 | — | Silt; yellowish brown (10YR 5/4) silty clay loam; massive to weak, blocky structure; a few gray mottles and black concretions. . . . | 3.5 |
| Henry Formation | | | | |
| IIB3 | 42-47 | — | Sand; dark yellowish brown (10YR 4/4) sandy loam; massive; iron- and clay-enriched zone (beta horizon). . . . . . . . . . . . . . . . | 0.5 |
| Wedron Formation<br>Glenburn Till Member | | | | |
| IIIB3 | 47-66 | — | Till; yellowish brown (10YR 5/4) loam; dark reddish brown staining on joints; a few clay coatings; weak, blocky structure. . . . . . . | 1.5 |
| IIIC1 | 5.5-19.5 (ft) | — | Till; yellowish brown (10YR 5/4) loam; calcareous; soft; weak, moderate to coarse, blocky structure at base; till grades to dark gray (10YR 4/1) at base; joints stained throughout; sand and silt inclusions in the upper 6 feet; lower 6 inches oxidized. Samples P-11936 (top) to P-11940 (base). . . . . | 14.0 |
| IVC2 | 19.5-23.5 (ft) | — | Sand; gravelly, tan to yellowish brown loamy sand; calcareous; medium to coarse; beds 1 to 3 inches thick; lower 6 inches fine sand and silt. . . . . . . . . . . . . . . . . . . . | 4.0 |

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IVC3 | 23.5-24.0 | — | Silt; gray silt loam; calcareous, laminated, firm; contains a few wood fragments. Sample P-11941. . . . . . . . . . . . . . . . . . | 0.5 |

## Profile D

Robein Silt

### *Farmdale Soil*

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| O2 | 0-10<br>10-17 | 11827<br>11828 | Silty muck; wood fragments radiocarbon dated 20,500 ± 130 years B.P. (ISGS-89); dark brown (7.5YR 3.15/1) darkening to very dark gray (10YR 3/1) on exposure; soft; massive. . . . | 1.5 |

Altonian Substage

Roxana Silt, sandy silt facies

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IIBg | 17-20<br>20-25<br>25-30<br>30-35<br>35-40<br>40-45<br>45-50<br>50-55<br>55-61 | 11829<br>11830<br>11831<br>11832<br>11833<br>11834<br>11835<br>11836<br>11837 | Sand silt; dark gray (5Y 4/1) loam grading downward to dark gray (N 4/0) with few strong brown mottles; common krotovina filled with dark gray (10YR 4/1) loam; few secondary carbonate concretions (5Y 8/2, dry); many thin clay coatings; massive to weak platy structure; friable. . . . . . . . . . . . . . . . | 3.5 |

Illinoian Stage

Monican Substage

Pearl Formation

### *Sangamon Soil*

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IIIA | 61-65<br>65-70 | 11838<br>11839 | Sand, clayey, silty; greenish gray (5G 5/1) clay loam with few red mottles; few clay coatings (5G 4/1); massive; firm; when dry has many silt coatings and reveals a relict granular structure. . . . . . . . . . . . . | 0.7 |
| IIIBg | 70-75<br>75-80<br>80-85<br>85-90<br>90-95<br>95-101<br>101-105 | 11840<br>11841<br>11842<br>11843<br>11844<br>11845<br>11846 | Sand; clayey, silty; greenish gray (5G 5/1) clay loam with few red mottles; zones of intense olive (5Y 4/3) staining increasing toward base of gley; common krotovina filled with loam (10YR 4/1); few clay coatings; concentration of poorly sorted gravel at base; massive to weak blocky structure. . . | 2.9 |

Glasford Formation

Vandalia Till Member

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IVBg | 105-110<br>110-115<br>115-120<br>120-128 | 11847<br>11848<br>11849<br>11850 | Till; greenish gray (5G-5BG 5/1) clay loam with few red and olive (5Y 4/3) mottles increasing to nearly 50% of lower portion of horizon; thick clay accumulations at base in probable crayfish terminal pocket; firm; massive. . . . . . . . . . . . . . . . | 1.9 |

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IVC | 128-135 | 11851 | Till; calcareous, dark grayish brown (2.5Y 4/1) loam with prominent yellowish brown (10YR 5/8) stains along joints, few black stains; dense, hard. . . . . . . . . . . . . . | 0.5 |
| | | | Total section | 35.0 |

## Profile E

Pleistocene Series
  Wisconsinan Stage
    Altonian Substage
      Roxana Silt, sandy silt facies

### *Farmdale Soil*

| | | | |
|---|---|---|---|
| IIA1* | 0-6 | 11852 | Sandy silt; brown (10YR 4/3) loam with many gray mottles and few yellowish brown and black stains; few clay coatings, pores and channels; friable, massive to weak, platy to granular structure. |
| IIA2 | 6-12 | 11853 | Sandy silt; brown (10YR 4/3-5/3) loam with common gray and few yellowish brown and black mottles; few clay coatings, silt coatings, pores, and channels; friable, weak, platy to granular structure. |
| IIB1 | 12-18 | 11854 | Sandy silt; brown (10YR 5/3) loam with few gray and common red mottles; few clay coatings and silt coatings; fewer pores and channels than horizon above; slightly firm, very weak granular structure. |
| IIB2 | 18-24<br>24-30 | 11855<br>11856 | Sandy silt; brown (10YR 4/3-5/3) loam with few red stains and mottles; very few clay coatings and common silt coatings; slightly firm, massive to weak granular structure; appears to have relict angular blocky structure. |
| IIB31 | 30-36<br>36-42 | 11857<br>11858 | Sandy silt; grayish brown (10YR 5/2-5/3) loam with many gray mottles and few red stains increasing to common with depth; segregated textures*; clay coatings rare in upper part and a few in lower part are gray or reddish gray; porous; slightly firm; massive, with relict blocky structure. |

* Segregated textures throughout IIB3 horizon; brown zones are sandy and gray zones are clayey; shapes and distribution of texture zones suggest old krotovina that are nearly assimilated into the Farmdale Soil. This profile description begins with horizon II for the first material to avoid a miscorrelation of the Roxana Silt, sandy silt facies, of Profile D.

| Horizon | Depth (in.) | P-No. | |
|---|---|---|---|
| IIB32 | 42-48<br>48-52 | 11859<br>11860 | Sandy silt; grayish brown (10YR 5/2-5/3) loam with many gray and common yellowish brown mottles; red stains are more segregated than above; segregated texture*; few large gray or reddish gray clay coatings; few silt coatings and black concretions; slightly firm, massive. |

Illinoian Stage
Monican Substage
Pearl Formation

*Sangamon Soil*

| | | | |
|---|---|---|---|
| IIIA | 52-60 | 11861 | Sand, silty, clayey; yellowish brown (10YR 5/3-5/4) loam with few pebbles; few yellowish brown mottles and red stains; zones of silt coatings; friable, massive structure; relict A2 structure. |
| IIIB1 | 60-66 | 11862 | Sand, silty, clayey; grayish brown (10YR 5/2) loam with many pebbles; prolific red staining covering most peds; common reddish black stains and few clay coatings of same color; few silt concentrations between peds; slightly firm; massive to weak, coarse, subangular blocky structure. |
| IIIB2 | 66-72<br>72-78 | 11863<br>11864 | Sand, silty, clayey; gray to brown (10YR 5/1-5/2-5/3) loam with common yellowish brown mottles; ped interiors gray in upper part becoming browner with depth; few gray clay coatings; silt coatings and black concretions; firm, massive to weak, blocky structure. |
| IIB31 | 78-84<br>84-90 | 11865<br>11866 | Sand, gravelly, clayey; yellowish brown (9YR 5/4-5/6-10YR 5/8) gravelly loam with variable textures and colors; peds have grayish brown interiors and yellowish brown rinds; appears to be an iron accumulation zone; few clay coatings; friable; massive. |

Glasford Formation
Vandalia Till Member

| | | | |
|---|---|---|---|
| IVB32 | 90-96 | 11867 | Till; yellowish brown (10YR 6/4-5/8) loam with few large gray mottles; few clay coatings; common voids; slightly firm, massive. |
| IVC1 | 96-104 | 11868 | Till; yellowish brown (10YR 5/4) loam with many yellowish red (5YR 4/8) stains along joints; few gray clay coatings; firm, brittle, blocky structure; leached. |
| IVC2 | 104-110 | 11869 | Till; olive brown (1Y 5/3) loam with common yellowish brown and black stains along joints; few joints gleyed; dense, brittle, blocky structure; calcareous. Samples P-11942 to 11944. |

* Segregated textures throughout IIB3 horizon; brown zones are sandy and gray zones are clayey; shapes and distribution of texture zones suggest old krotovina that are nearly assimilated into the Farmdale Soil. This profile description begins with horizon II for the first material to avoid a miscorrelation of the Roxana Silt, sandy silt facies, of Profile D.

83.8 Leave Stop 6; continue ahead (south).

84.2 Continue ahead over bridge onto the flat Illinoian drift plain.

84.5 *Stop 7 - Hutton Section -* Park along road; please pull off as far as possible. The section is one-half mile east of the road on the southwest bank of a stream.

## STOP 7 - HUTTON SECTION

### Discussion of the Stratigraphy

The Hutton Section also is located along the West Branch of Hurricane Creek, but about half a mile south of the margin of the Glenburn Till Member and south of the front of the Shelbyville Moraine (figs. 23, 24). The purposes of the stop are to contrast the section here with that at the last stop, to continue study of the sandy silt facies of the Roxana Silt, and, if the creek level is low, to see the Mulberry Grove Silt and Smithboro Till Members.

Beyond the margin of the Wedron Formation, all of the Woodfordian loess is included in the Peoria, and in this section it is 4.5 feet thick. The Modern Soil is entirely developed in the Peoria Loess. The lowest foot is gray and is probably related to the Morton Loess or the basal gray silt in the Wedron Formation. Underlying the Peoria Loess is 3 feet of the Roxana Silt, sandy silt facies. The sand content increases from 2.5 percent at the base of the Peoria to 27.8 percent in the top of the Roxana. The sandy silt facies at this section is essentially the same morphologically and mineralogically as the sandy silt facies at the Center School Section. This is the basis for our correlation and allows us to establish the stratigraphic relations of the sandy silt facies, which underlies the Wedron Formation, Robein Silt, or the Peoria Loess and overlies the Sangamon Soil.

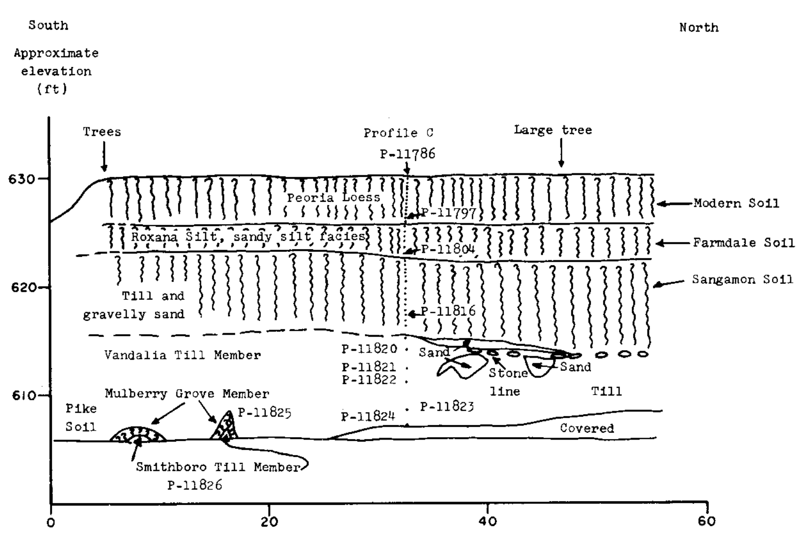



Fig. 23 - Sketch of the Hutton Section.

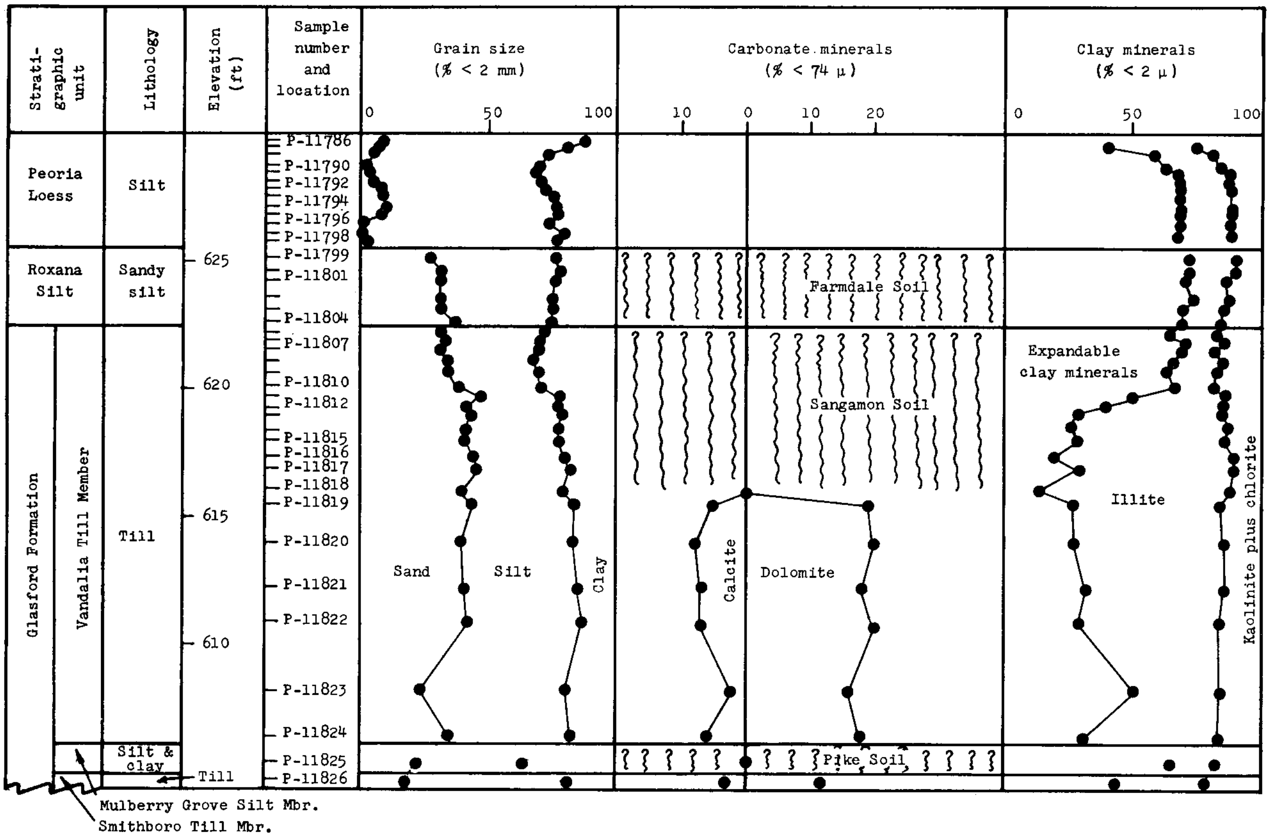



Fig. 24 - Grain size, carbonate mineral, and clay mineral data for the Hutton Section.

At this section, the sand content of the sandy silt facies ranges from 27.8 percent to 36.8 percent, and the silt content decreases with depth from 47.6 percent to 37.2 percent. The clay content ranges from 23.0 percent to 26.3 percent and is mostly fine clay (< 0.5 μ), indicating that most of the clay is pedogenic. These texture trends compare closely with those of the sandy silt facies at the Center School and Jewett Sections if some allowances for variation due to the landscape position are made. The clay minerals in this unit are dominantly the expanding type, along with small amounts of illite, chlorite, and kaolinite. This clay mineral assemblage also indicates a soil-forming environment during and/or after the accumulation of the materials that compose the unit.

There is some evidence for a Farmdale Soil in the sandy silt facies. The primary evidence of a buried soil in the sandy silt facies is the fact that it is leached, because essentially all parent materials for the soils of the Midwest were initially calcareous. Other lines of evidence that are more difficult to assess but may be equally important are its structural, textural, mineralogical, and other chemical characteristics. This discussion will be primarily confined to the morphologic features and to some of the more important analytical data that support our interpretations. All other analytical data are given in tables 7 and 8.

The soil structure in the Farmdale Soil at this exposure is weak. When moist the soil appears massive, but when dry it shows certain structural features. The upper 12 inches has some characteristics of both A and B horizons. The A-horizon characteristics include granular, pelletoidal, and platy structures that appear welded together while in a fresh, moist condition. During the process of drying, these structural features can be recognized and are often coated with light-colored silt (silt coatings) and occasionally with darker clay coatings. The next 24 inches is the B horizon of the Farmdale Soil. The common B-horizon characteristics are a blocky structure, clay coatings, occasional silt coatings, pore or channel fillings (krotovina), and concretions (black, brown, red, or yellow) of iron, manganese, or more rarely, carbonates. In some sections the entire sandy silt facies is dominated by subtle A-horizon characteristics, such as will be seen at the Jewett Section, Stop 8.

Much of the morphologic evidence for the buried Farmdale and Sangamon Soils can be observed at this section. Buried soils retrogress, in comparison with modern soil development, by losing many of the morphologic characteristics mentioned above. The Farmdale and Sangamon Soils of the Center School Section in particular have lost most of their morphologic characteristics. The Yarmouth Soil at Stops 5 and 8 has lost essentially all of its morphologic expression. Such retrogressive development is related primarily to the depth of burial and to the environmental conditions after burial that promoted the regression to a morphology of parent material. The Center School Section has about 24 feet of Wedron Formation overlying the Farmdale Soil, whereas at the Hutton Section only 4.5 feet of Peoria Loess overlies the Farmdale. The relation of morphology to depth of burial is the same in most other exposures of buried soils, the morphology's being better expressed or preserved at shallow depths than at greater depths.

The sandy silt facies grades into the top of the Vandalia Till Member of the Glasford Formation, which contains the Sangamon Soil. Much mixing of the Farmdale and Sangamon profiles is attested by the large number of krotovina present in the Sangamon Soil and by the laboratory data. The Vandalia Till contains sand lenses that are very apparent towards the base of the Sangamon Soil. This may raise some doubt about the origin of the material in which the Sangamon Soil has formed. Weathering during the development of the Sangamon Soil was so intense that most of the original characteristics of the parent materials were obscured. From morphological evidence, it appears that the bulk of the Sangamon Soil developed in till. However, a significant change in the laboratory data that occurs in the middle of the Sangamon B horizon at 119 inches is not evident in the morphology of the profile. At this point there is a slight decrease in the total clay and fine clay content, an increase in the sand content, a significant decrease in the silt content, and a change in the ratios of medium silt to coarse silt. The ratios (about 1.1 to 1.5) above this point suggest a contribution from loess or another source of medium-sized silt. Below this point the ratios (0.6 to 0.9) are characteristic of the Vandalia Till, except for the lower two samples from the Vandalia (IVC2, P-11824, and P-11825), which are siltier and have a much larger silt ratio, suggesting incorporation of a proglacial loess.

A significant change in clay mineral distribution takes place in the Sangamon Soil at the Hutton Section at the same depth as the changes in particle-size distribution. The upper horizons of the Sangamon Soil are dominated by the expanding types of clay minerals, and the amounts of illite, chlorite, and kaolinite are minor. Below this point, the expandables decrease rapidly and the illite fraction becomes dominant. This apparent 30 or 40 percent depletion of illite is a characteristic of the Sangamon Soil described by Willman, Glass, and Frye (1966). The abruptness of the change even resembles the clay mineral trends found in accretion-gley soils. However, the clay mineral assemblages in soils are influenced by the source of the parent material and by the environment existing when the soil was formed; they do not by themselves indicate the process by which the parent materials of the soil were formed. The clay mineral change in the Sangamon B horizon at the Hutton Section is probably a pedologic boundary reflecting the reducing conditions in the upper B horizon during Sangamonian time.

In a true accretion-gley profile, a boundary between in-situ and accretionary materials can be recognized, and this boundary often coincides with the lower boundary of the reducing (gleying) environment. A reducing environment is inferred from the fact that an intensely mottled horizon containing iron concretions often occurs immediately under the gleyed horizon. The interpretation is that the soluble ferrous iron originated in the gley, moved down into the underlying horizon, and precipitated as ferric hydroxides. These pedologic horizons in poorly drained soils generate pedologic boundaries and, in some instances, cut across geologic boundaries; in other instances they seem to be controlled by the geologic boundaries, as can be observed where a thin till or fine-textured material overlies a sand or other coarse-textured materials. These problems of boundary interpretation may also be present in the more oxidized positions, but there the soil characteristics are easier to recognize and separate from the inherited geologic characteristics. Many factors are involved in this problem of boundary interpretation, but the important ones appear to be the thickness of the geologic unit and the intensity of weathering during soil formation.

Near the base of the Sangamon Soil at the Hutton Section, sand lenses occur, and associated with them are some interesting features. Mass movement of the till is indicated by the discontinuous sets of oriented cobbles at the top of some sand lenses. Small blocks of till appear to be thrust into some of the lenses. Other sand lenses pinch out in arcuate forms. These features suggest an ablation origin for the upper 7 to 10 feet of the Vandalia Till.

The sand lenses with cobbles tend to coincide with the base of the Sangamon Soil and suggest that they were a barrier for further downward development of the soil. This may explain the frequent occurrence of a sandy zone at the base of many modern and buried soils. When this zone appears to be prohibiting the downward development of a soil, it often forms a beta horizon, an accumulation zone of hydrous iron oxides and colloidal deposits, that generally overlies a calcareous horizon.

At the Hutton Section, the silty phase of the Vandalia crops out from 0 to 4 feet above normal stream level. It is a bluish, dark gray silt loam that is massive and compact. Downstream about 50 feet, a distorted buried soil profile, correlated to the Pike Soil, is poorly exposed beneath the Vandalia. A thin, dark gray, organic-rich A horizon overlies a greenish gray gleyed B horizon. The silty Smithboro Till Member of the Glasford Formation was sampled by hand auger below the water line. The Smithboro is quite silty, low in sand and clay, and high in expandable clay minerals. These characteristics, combined with the known stratigraphic relations, form the basis for correlating it to the Smithboro in other sections.

## Hutton Section

Measured on west stream bank of West Branch of Hurricane Creek in NW¼ SE¼ NW¼, Sec. 22, T. 11 N., R. 10 E., Toledo Quadrangle, Coles County, Illinois.

Pleistocene Series
Wisconsinan Stage
Woodfordian Substage
Peoria Loess

Thickness (ft)

### *Modern Soil*

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| A1 | 0-3 | 11786 | Silt; brown (10YR 4/3) silt loam; granular; friable. | |
| A2 | 3-7 | 11787 | Silt; light yellowish brown (10YR 6/4) silt loam; platy; friable. | |
| B1 | 7-12<br>12-16<br>16-20 | 11788<br>11789<br>11790 | Silt; light yellowish brown (10YR 6/4) silty clay loam with few strong brown mottles; many silt coatings; granular to blocky structure. | |
| B2 | 20-24<br>24-28<br>28-31 | 11791<br>11792<br>11793 | Silt; yellowish brown (10YR 5/4) silty clay loam with common strong brown mottles; few black concretions; silt coatings common; few clay coatings; blocky structure. | |
| B3 | 31-36<br>36-40<br>40-44 | 11794<br>11795<br>11796 | Silt; yellowish brown (10YR 5/4) silty clay loam with common strong brown and few gray mottles; few silt coatings and clay coatings; weak, blocky structure. | |
| C1 | 44-48<br>48-53 | 11797<br>11798 | Silt; leached gray (2.5Y 6/1) silt loam with few yellowish brown mottles; weak, blocky to massive structure. | |
| | | | | 4.5 |

Altonian Substage
Roxana Silt, sandy silt facies

### *Farmdale Soil*

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IIA | 53-59<br>59-65 | 11799<br>11800 | Sandy silt; appears as a unit with a mixture of A and B horizon characteristics; leached grayish brown (10YR 5/2) loam with many gray and yellowish brown mottles; few black concretions; weak, blocky to massive structure; friable; when dry, has weak, granular structure and better displays relict A and B horizon features; occluded silt coatings and platyness in A, clay coatings and blockyness in B. . . . . . . . . . . . . . . . . . . . . | 3.0 |
| IIB | 65-71<br>71-77<br>77-83<br>83-89 | 11801<br>11802<br>11803<br>11804 | | |

Illinoian Stage
Monican Substage
Glasford Formation
Vandalia Till Member

*Sangamon Soil*

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IIIA(?) | 89-94<br>94-99 | 11805<br>11806 | Mixed; has color and morphologic continuity with horizon above but is more granular, has pebbles and A-horizon characteristics, increase of silt coatings, pores, voids; transitional between II and III. | |
| IIIB2 | 99-104<br>104-109<br>109-114<br>114-119<br>119-125<br>125-131<br>131-136 | 11807<br>11808<br>11809<br>11810<br>11811<br>11812<br>11813 | Till(?); mixed gray and brown (10YR 5/1-5/3-5/8) clay loam, increasingly yellowish brown with depth; dark gray clay coatings, black concretions and stains common; krotovina filled with yellowish brown loam common; firm, blocky structure. | |
| IIIB3 | 136-142<br>142-148<br>148-154 | 11814<br>11815<br>11816 | Till(?); yellowish brown (10YR 5/8) loam with many gray mottles; a few black and yellowish brown iron concretions; many crayfish terminal pockets filled with loam; friable; massive. | |
| IIIC1 | 154-162<br>162-170 | 11817<br>11818 | Till(?); leached yellowish brown (10YR 5/4) loam with few yellowish brown (10YR 5/8) and gray mottles; massive, breaking to coarse platy structure; dark stains along joints; sand lenses at base. . . . . . . . . . . . . . | 6.8 |
| IVC2 | 170-176<br>192-196<br>210-214<br>228-232<br>258-262<br>282-286 | 11819<br>11820<br>11821<br>11822<br>11823<br>11824 | Till; dark gray (2.5Y 4/1) calcareous loam; dense; hard; cobbles up to 6 inches; bluish gray (5BG 5/1) coatings along joints; upper 7 inches oxidized to yellowish brown; adjacent to sampled profile, the upper zone contains discontinuous oxidized sand lenses (not sampled) up to 3 feet thick; discontinuous stone lines present in upper zone. . . . . . . . . . | 9.7 |

Mulberry Grove Silt Member (not well exposed)

*Pike Soil*

| | | | | |
|---|---|---|---|---|
| VA | 295-298 | — | Silt, organic; leached, dark gray (10YR 4/1) silt loam; massive, contorted structure. . . . | 0.3 |
| VBg | 298-310 | 11825 | Clay; leached dark greenish gray (5GY 4/1 exteriors, 5BG 4/1 interiors) clay loam with inclusion of bluish green sand; a few black clay coatings; massive, contorted structure. . . . | 1.0 |

| | | | | Thickness (ft) |
|---|---|---|---|---|
| Smithboro Till Member (not well exposed) | | | | |
| VIC | 310-315 | 11826 | Till; dark gray (5Y 4/1), calcareous silt loam; friable; massive structure. . . . . . . | 0.4 |
| | | | Total section | 25.5 |

84.5 Leave Stop 7; continue ahead (south).

84.8 Turn right (west).

85.9 T intersection; turn right (north).

86.4 Turn left (west).

88.2 Stop sign; turn left (south) on Illinois 130.

88.6 Drop off Shelbyville Moraine onto Illinoian drift plain.

94.1 Cross Hurricane Creek.

97.9 Junction with I-70; continue ahead on Illinois 130.

98.5 Junction of Illinois 130 and U.S. 40; turn right (west) on U.S. 40.

103.9 Turn left (south) on blacktop road marked to Jewett.

104.0 Turn right (west).

104.5 Turn left (south); cross railroad.

106.2 Bridge over Muddy Creek.

106.4 *Stop 8 - Jewett Section* - The described section is the roadcut on the left (east).

## STOP 8 - JEWETT SECTION

### Discussion of the Stratigraphy

The Jewett Section is exposed in a north-south roadcut in the south bank of Muddy Creek, a tributary of the Embarras River. It is about 25 miles south of the Shelbyville Moraine and about 75 miles southwest of exposures seen on Saturday's stops near Danville, Illinois. The section was described by Jacobs and Lineback (1969) when they established the rock-stratigraphic classification of the Illinoian deposits in this area. Although partly overgrown, the section exposes both the Vandalia and Smithboro Till Members relatively near their type sections. The section also exposes the Yarmouth Soil developed in outwash of the Banner Formation, thin Peoria Loess, and the Roxana Silt, sandy silt facies. Jacobs and Lineback (1969) described the section exposed on the west side of the road. Figure 25 is

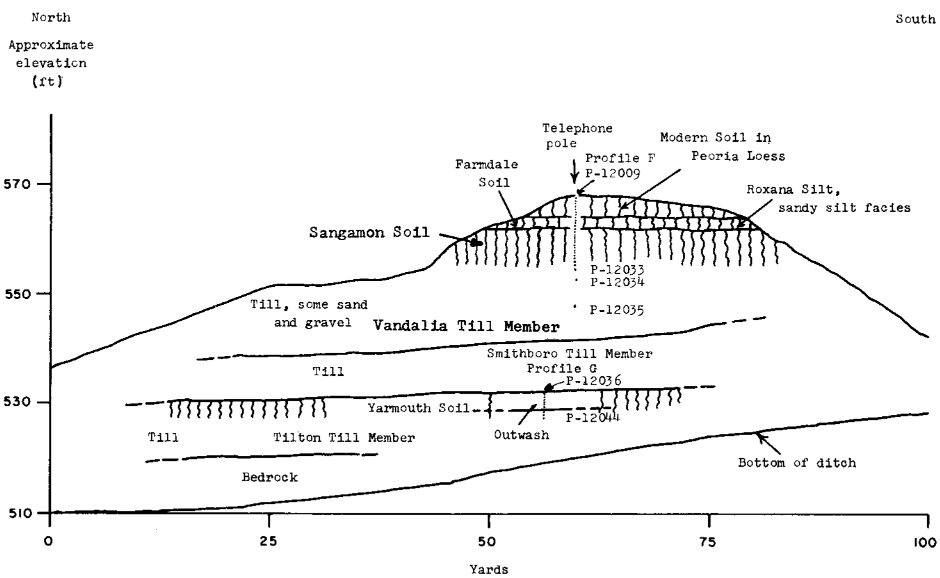



Fig. 25 - Sketch of the Jewett Section, east side of road.

a sketch of the section on the east side of the road and the described section in the guidebook is modified after Jacobs and Lineback for the east side of the road. Figure 26 shows laboratory data for samples collected by Jacobs and Lineback on the west side.

The Modern Soil is developed in Peoria Loess and is complicated by the development of a fragipan, a dense, impermeable zone, in the lower part of the Peoria. The profile is unusual in that the top of the fragipan is developed in the Peoria rather than in the Roxana Silt, sandy silt facies, the more common alternative in this part of Illinois. The fragipan overlies weak Farmdale Soil in the Roxana Silt, sandy silt facies.

The sandy silt facies contains large polygonal structures that are first expressed in the base of the Peoria in the fragipan and extend down through the Roxana Silt and into the top of the Sangamon Soil. These polygonal structures are indistinctly outlined with silt concentrations in the Roxana portion and prominently indicated by the dark clay coatings in the upper horizons of the Sangamon Soil. In the Jewett Section these structures appear to be related to the development of the fragipan, which is considered to be an ongoing, active process and not a relic of a past process.

A well developed Sangamon Soil is present in the Vandalia Till. It has developed in till in a well drained position and is representative of the well drained Sangamon Soil in Illinois. It has moderately strong structural development and is characterized by yellowish brown colors, in contrast to the gray colors of the Sangamon Soil that were observed at the Center School and Hutton Sections.

The section exposes typical Vandalia and Smithboro Tills for this area, the Vandalia being sandy and the Smithboro being silty. The tills here are quite similar both texturally and mineralogically to tills at Danville that have been correlated to these units. The till and outwash below the Smithboro were called

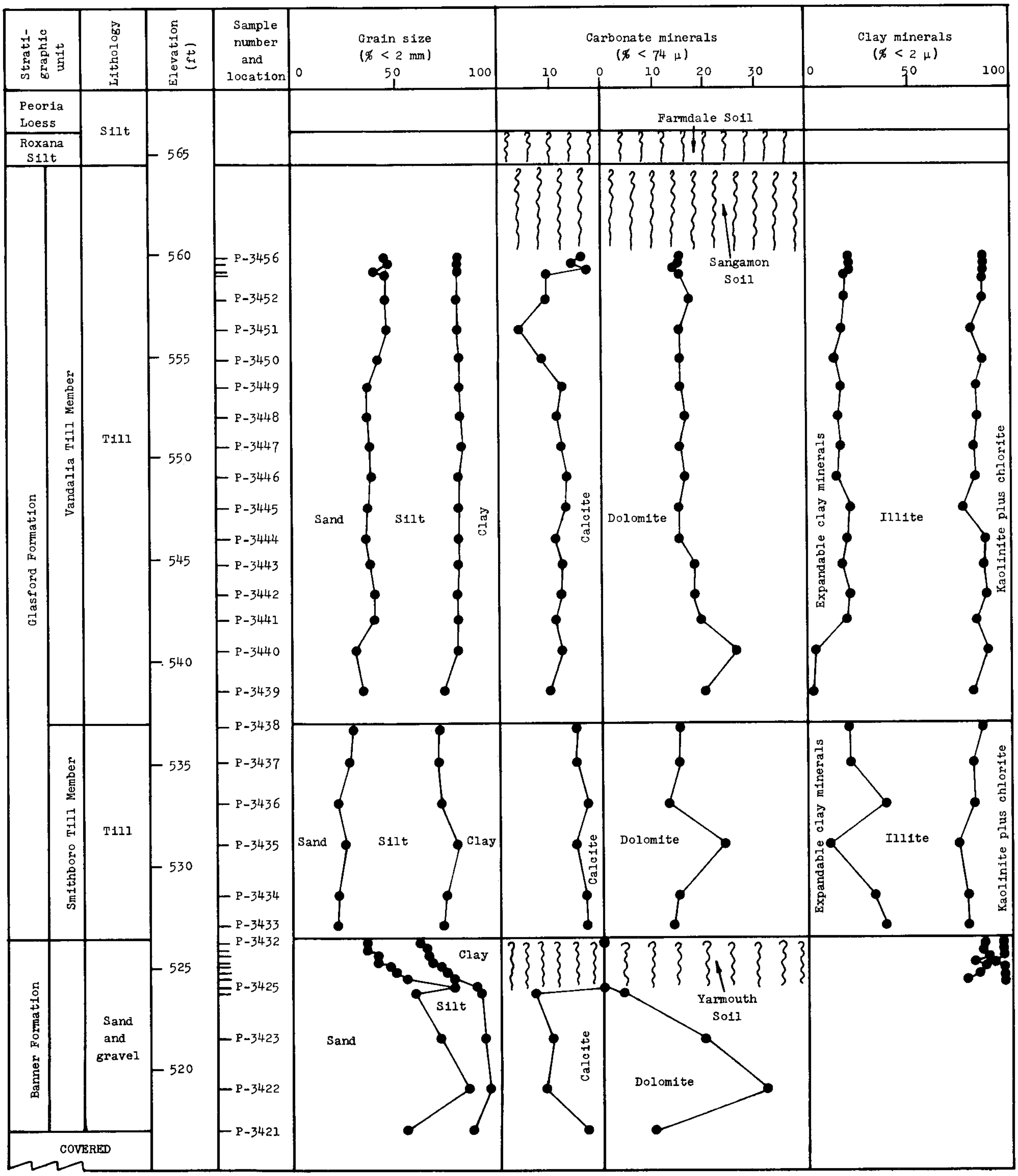



Fig. 26 - Grain size, carbonate mineral, and clay mineral data for the Jewett Section. Section measured on the west side of the road.

Kansan by Jacobs and Lineback (1969) and are now included in the Banner Formation. It contains a weakly expressed buried soil, the Yarmouth Soil, which has been truncated and/or modified by subsequent burial in the section. The till appears to be in the stratigraphic position of the Tilton Till Member and has many compositional characteristics of the Tilton. However, it is not as sandy, and for this reason a definite correlation has not as yet been made.

## Jewett Section

Section measured along a roadcut on the east side of the road 2 miles south of Jewett in the NW¼ SW¼ NW¼, Sec. 31, T. 9 N., R. 9 E., Greenup Quadrangle, Cumberland County, Illinois. Section is modified from Jacobs and Lineback (1969).

Pleistocene Series — Thickness (ft)
Wisconsinan Stage
Woodfordian Substage
Peoria Loess

*Modern Soil — Ava Silt Loam*

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| A1 | 0-3 | 12009 | Silt; dark brown (10YR 4/2-4/3) silt loam; many roots; porous; friable; granular structure. | |
| A2 | 3-7 | 12010 | Silt; yellowish brown (10YR 5/4) silt loam; many roots; porous; friable; platy structure. | |
| B1 | 7-13 | 12011 | Silt; yellowish brown (10YR 5/6) silt loam; few roots; many silt coatings; granular and fine blocky structure. | |
| B2 | 13-18<br>18-23 | 12012<br>12013 | Silt; strong brown (7.5YR 5/6) silty clay loam; a few silt coatings; moderate to strong, fine, angular, blocky structure. | |
| B3 | 23-30 | 12014 | Silt; yellowish brown (10YR 5/6) silty clay loam with few yellowish red stains; few silt coatings; weak, medium, blocky structure. | |
| B' 2x | 30-36 | 12015 | Silt; brown (10YR 5/3) silty clay loam with many yellowish brown mottles; common dark brown clay coatings; many silt coatings with concentrations between some peds; firm; friable; weak, platy to blocky structure; top of fragipan (? ). | |
| B' 3x | 36-42 | 12016 | Silt; yellowish brown (10YR 5/4) silt loam with few strong brown stains; many silt coatings and concentrations; friable; blocky to weak, platy, polygonal structures. | 3.5 |

Altonian Substage
Roxana Silt, sandy silt facies

*Farmdale Soil*

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IIA1x | 42-48 | 12017 | Sandy silt; yellowish brown (10YR 4.5/4) silt loam with few reddish brown stains and clay coatings in pores and along ped surfaces; few silt coatings and massive concentrations of silt along large indistinct polygonal structures; brittle; massive to weak platy structure. | |
| IIA2x | 48-54 | 12018 | Sandy silt; yellowish brown (10YR 5/4) silt loam to loam with few reddish brown stains and clay coatings in pores and ped surfaces; prominent platy structure when dry, with tops of plates more completely stained than bottoms; worm holes, some open, some filled with fecal pellets; dry samples brittle; rewetted samples friable, soft. | |
| IIBx | 54-60 | 12019 | Sandy silt; much the same as above, but slightly more clayey; platy structure less evident. | |
| IIBx | 60-66 | 12020 | Sandy silt; brown (10YR 5/3) silt loam with a few yellowish brown stains; common silt coatings; few pores; brittle; massive breaking to blocky structure. | |
| | | | | 2.0 |

Illinoian Stage
Monican Substage
Vandalia Till Member

*Sangamon Soil*

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| IIIA2 | 66-69<br>69-72 | 12021<br>12022 | Mixed; yellowish brown (10YR 5/5) loam with few thin, discontinuous, dark brown clay coatings; common silt coatings; few small black concretions; porous; granular. | |
| IIIB1 | 72-75<br>75-78 | 12023<br>12024 | Till; yellowish brown (10YR 5/6) loam to clay loam with few grayish brown mottles; black, clay-rich fillings along large polygonal structures; few dark brown clay coatings and silt coatings; weak, granular to blocky structure. | |
| IIIB2 | 78-84<br>84-90<br>90-96 | 12025<br>12026<br>12027 | Till; yellowish brown (10YR 5/4-5/8) clay loam with gray mottles common; many thick, dark brown clay coatings; common silt coatings dissipate downwards; large polygonal structures, 6 to 12 inches in diameter, bounded by thick, black clay fillings with many roots; moderate to strong blocky structure. | |
| IIIB31 | 96-102<br>102-108 | 12028<br>12029 | Till; yellowish brown (10YR 5/5) clay loam with few gray mottles; common dark brown clay coatings; gypsum crystals in few large, | |

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| | | | irregular voids coated with dark brown clay; few masses of gypsum; friable; weak, blocky structure. | |
| IIIB32 | 108-114 | 12030 | Sand; strong brown (7.5YR 4/6) sandy loam with many red stains; few black stains;many thin clay coatings; slightly firm; massive; colloid accumulation zone, beta horizon. | |
| IIIC1 | 114-119<br>119-124 | 12031<br>12032 | Till; yellowish brown (10YR 5/3-5/4) loam with few yellowish brown (10YR 5/8) mottles; few black stains; few clay coatings; few gypsum masses associated with roots in voids; soft, massive; leached. | |
| IIIC2 | 124-134<br>160-164<br>208-212 | 12033<br>12034<br>12035 | Till; yellowish brown (10YR-2.5Y 5/4) with few yellowish brown (10YR 5/8) stains and few dark brown stains in upper portion; greenish gray (5GY 6/1) stains along joints prominent in middle portion; hard, brittle, weak, coarse, blocky structure; calcareous. | |
| IIIC2 | 212-306<br>(17.7-25.5 ft) | — | Till; gray, calcareous loam; lower 2 feet coarser textured and oxidized yellowish brown to light olive-brown colors. Sandy in relation to till below (Smithboro). | 20.0 |
| Liman Substage<br>Smithboro Till Member | | | | |
| IVC3 | 306-426<br>(25.5-35.5 ft) | — | Till; dark gray, calcareous loam; more clayey and silty relative to till above (Vandalia). . | 10.0 |
| Kansan Stage<br>Banner Formation | | | | |
| | | | ***Yarmouth Soil*** | |
| VA1? | 0-5 | 12036 | Sand, clayey; yellowish brown (10YR 5/3-5/5) loam to clay loam with common gray mottles; massive breaking to angular, blocky structure; leached. | |
| VA2? | 5-10<br>10-15 | 12037<br>12038 | Sand, silty; yellowish brown (10YR 5/4-5/5) loam with common gray mottles; a few yellowish brown clay coatings; massive to weak, platy structure; leached. | |
| VB2 | 15-20 | 12039 | Sand, clayey; yellowish brown (10YR 5/4) loam with common gray mottles; few thick clay coatings; massive to weak, blocky structure; leached. | |
| VB3 | 20-26<br>26-32 | 12040<br>12041 | Sand; yellowish brown (10YR 5/8) loam to sandy loam with many thin, reddish brown clay coatings; a few dark stains; porous; massive to granular structure; beta horizon; leached. . . | 2.7 |

| Horizon | Depth (in.) | P-No. | | Thickness (ft) |
|---|---|---|---|---|
| VIC1 | 32-38 | 12042 | Till; yellowish brown (10YR 5/6) loam to clay loam with few brownish yellow and gray mottles; massive; leached. . . . . . . . . . . | 0.5 |
| VIC2 | 38-44<br>50-56 | 12043<br>12044 | Till; yellowish brown (10YR 5/4) loam with few dark gray and yellow stains; dense; brittle; indistinct color banding that tends to parallel horizontal cleavage; flow till(?); weak blocky to coarse platy structure; calcareous. . . . . . . . . . . . . . . . . . . . . | 1.5 |
| VIC2 | 56-120<br>(40.2-45.5 ft) | — | Till; locally covered with spoil; bottom of section in road ditch; Pennsylvanian bedrock exposed at base of north end of the section. . | 6.3 |
| | | | Total section | 45.5 |

END OF TRIP; turn around and go back to U.S. 40.

TABLE 6—HEAVY MINERALS DATA FROM YARMOUTH, SANGAMON, AND FARMDALE SOIL PROFILES

| Stratigraphic unit | Soil horizon | Depth (in.) | Sample no. | (0.062 mm-0.25 mm) Transparent heavy minerals (%) Garnet | Epidote | Zircon | Andalusite | Sillimanite | Muscovite | Biotite | Tourmaline | Staurolite | Sphene | Enstatite | Rutile | Hornblende | Augite | Hypersthene | Kyanite | Topaz | Opaque heavy minerals (% of total) | Garnet to epidote ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Profile A; Collison Section - Sangamon Soil | | | | | | | | | | | | | | | | | | | | | | |
| Roxana Silt | A | 0-3 | P-11747 | 5 | 33 | 4 | — | — | 46 | — | 2 | 1 | 2 | 2 | — | 6 | — | 1 | — | — | 39 | 0.1 |
| Roxana Silt | IIB1 | 9-12 | P-11749 | 12 | 36 | 3 | 1 | — | 12 | 1 | 3 | — | 3 | 2 | — | 17 | 1 | 7 | — | 1 | 55 | 0.3 |
| Radnor Till | IIIB2 | 15-18 | P-11751 | 19 | 37 | 4 | 2 | — | 4 | 2 | — | — | 1 | 3 | — | 24 | 1 | 4 | — | — | 54 | 0.5 |
| Radnor Till | IIIB3 | 33-36 | P-11757 | 17 | 19 | 3 | — | — | 14 | — | 1 | 2 | 3 | 5 | — | 33 | — | 1 | — | 1 | 94 | 0.9 |
| Radnor Till | IIIC2 | 51-54 | P-11763 | 17 | 22 | 1 | — | — | — | — | 3 | 1 | 3 | 7 | — | 32 | 4 | 7 | — | 2 | 40 | 0.8 |
| Profile B; School House Section - Yarmouth Soil | | | | | | | | | | | | | | | | | | | | | | |
| Banner Fm. | A | 5-10 | P-11765 | 27 | 20 | 3 | 3 | 5 | 2 | 2 | 1 | 3 | 4 | 5 | — | 20 | 2 | 4 | — | — | 42 | 1.3 |
| Banner Fm. | A | 15-20 | P-11767 | 24 | 19 | 2 | — | — | 13 | 1 | — | 1 | 5 | 4 | — | 23 | 3 | 7 | — | — | 21 | 1.3 |
| Banner Fm. | IIB | 30-35 | P-11770 | 33 | 18 | 2 | 1 | 4 | 4 | 1 | 1 | 2 | 3 | 4 | 1 | 19 | — | 7 | 1 | — | 24 | 1.9 |
| Banner Fm. | IIB2 | 50-54 | P-11774 | 43 | 8 | — | 1 | 1 | 4 | — | — | 2 | 5 | 7 | — | 19 | 3 | 8 | 2 | — | 44 | 5.7 |
| Tilton Till | IIIB3 | 66-72 | P-11777 | 33 | 15 | 3 | 4 | 2 | 3 | 1 | 3 | 2 | 5 | 3 | — | 23 | 1 | 4 | — | — | 30 | 2.2 |
| Tilton Till | IIIC2 | 110-115 | P-11785 | 19 | 14 | 3 | 2 | 1 | 1 | — | 6 | 2 | 8 | 10 | — | 25 | 5 | 3 | 1 | 2 | 11 | 1.4 |
| Profile D; Center School Section - Farmdale and Sangamon Soils | | | | | | | | | | | | | | | | | | | | | | |
| Robein Silt | 02 | 5-10 | P-11827 | 6 | 5 | 2 | — | 1 | 61 | 8 | — | — | — | — | — | 16 | — | 1 | — | — | 37 | 1.2 |
| Roxana Silt | IIBg | 17-20 | P-11829 | 11 | 30 | 4 | — | 2 | 8 | — | 1 | 1 | 6 | 2 | — | 28 | — | 7 | — | — | 32 | 0.4 |
| Roxana Silt | IIBg | 35-40 | P-11833 | 20 | 27 | 1 | — | 1 | 6 | 1 | 2 | 2 | 2 | 8 | 2 | 23 | 3 | 3 | 1 | — | 56 | 0.7 |
| Pearl Fm. | IIIA | 65-70 | P-11839 | 18 | 15 | 1 | 1 | 4 | 22 | — | 1 | — | 2 | 2 | 1 | 22 | — | 8 | 1 | 1 | 37 | 1.2 |
| Pearl Fm. | IIIBg | 90-95 | P-11844 | 18 | 19 | — | 3 | 3 | 15 | 3 | 1 | 1 | 4 | 4 | 1 | 21 | 1 | 6 | — | — | 65 | 1.0 |
| Vandalia Till | IVBg | 105-110 | P-11847 | 14 | 14 | 2 | 1 | 5 | 7 | 4 | — | — | 3 | 4 | 1 | 38 | 4 | 6 | — | — | 41 | 1.0 |
| Vandalia Till | IVC | 128-135 | P-11851 | 14 | 22 | 5 | 2 | 3 | 2 | 3 | 1 | 1 | 4 | 3 | — | 36 | 4 | 4 | — | — | 40 | 0.6 |

TABLE 7—GRAIN-SIZE DISTRIBUTION, CLAY MINERAL CONTENT, AND CARBONATE CONTENT OF DESCRIBED SECTIONS

| | | | Grain-size distribution | | | Carbonate minerals | | | Clay minerals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample number | Stratigraphic unit | Lithology | Sand (%) | Silt (%) | Clay (%) | Calcite (%) | Dolomite (%) | Total carbonate (%) | Expandable (%) | Illite (%) | Kaolinite plus chlorite (%) |
| | | | | | Higginsville Section | | | | | | |
| P-11870 | Snider Till Member | Till | 20 | 46 | 34 | 5 | 17 | 22 | 2 | 85 | 13 |
| P-11871 | Snider Till Member | Till | 23 | 49 | 28 | 6 | 17 | 23 | 3 | 83 | 14 |
| P-11872 | Snider Till Member | Till | 19 | 46 | 35 | 6 | 19 | 25 | 4 | 81 | 15 |
| P-11873 | Snider Till Member | Till | 8 | 46 | 46 | 8 | 16 | 24 | 3 | 82 | 15 |
| P-11874 | Snider Till Member | Till | 9 | 47 | 44 | 7 | 17 | 24 | 5 | 80 | 15 |
| P-11875 | Snider Till Member | Till | 9 | 56 | 35 | 7 | 17 | 24 | 5 | 79 | 16 |
| P-11876 | Snider Till Member | Till | 7 | 43 | 50 | 7 | 16 | 23 | 4 | 74 | 22 |
| P-5336 | Batestown Till Member | Till | 31 | 42 | 27 | 4 | 20 | 24 | 4 | 89 | 7 |
| P-5337 | Batestown Till Member | Till | 32 | 43 | 25 | 4 | 23 | 27 | 4 | 81 | 15 |
| P-5338 | Glenburn Till Member | Till | 32 | 38 | 30 | 6 | 20 | 26 | 10 | 73 | 17 |
| P-5339 | Glenburn Till Member | Till | 35 | 41 | 24 | 6 | 21 | 27 | 12 | 70 | 18 |
| P-5340 | Glenburn Till Member | Till | 33 | 38 | 29 | 5 | 21 | 26 | 8 | 73 | 19 |
| P-5341 | unnamed silt | Silt | 18 | 53 | 29 | — | — | — | 8 | 72 | 20 |
| P-5343 | unnamed silt | Silt | 7 | 88 | 5 | 1 | 20 | 21 | 8 | 71 | 21 |
| P-5345 | Radnor Till Member | Till | 42 | 40 | 18 | 5 | 23 | 28 | 6 | 86 | 8 |
| P-5346 | Radnor Till Member | Till | 36 | 41 | 23 | 4 | 24 | 28 | 5 | 81 | 14 |
| P-5347 | Radnor Till Member | Till | 34 | 43 | 23 | 4 | 24 | 38 | 5 | 77 | 18 |
| P-5348 | Radnor Till Member | Till | 47 | 40 | 13 | 4 | 29 | 33 | 5 | 75 | 20 |
| P-5349 | Radnor Till Member | Silt | 2 | 72 | 26 | 7 | 21 | 28 | 4 | 78 | 18 |
| P-5350 | Radnor Till Member | Till | 31 | 41 | 28 | 6 | 22 | 28 | 6 | 75 | 19 |
| P-5351 | Radnor Till Member | Till | 44 | 40 | 16 | 5 | 31 | 36 | 11 | 70 | 19 |
| P-5352 | Radnor Till Member | Till | 39 | 43 | 18 | 6 | 30 | 36 | 13 | 62 | 25 |
| P-11877 | Radnor Till Member | Till | 39 | 41 | 20 | 7 | 23 | 30 | 6 | 70 | 24 |
| P-11878 | Radnor Till Member | Till | 26 | 49 | 25 | 6 | 23 | 29 | 6 | 69 | 25 |
| P-11879 | Radnor Till Member | Till | — | 76 | 24 | 6 | 20 | 26 | 5 | 71 | 24 |

TABLE 7—Continued

| Sample number | Stratigraphic unit | Lithology | Grain-size distribution | | | Carbonate minerals | | | Clay minerals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sand (%) | Silt (%) | Clay (%) | Calcite (%) | Dolomite (%) | Total carbonate (%) | Expandable (%) | Illite (%) | Kaolinite plus chlorite (%) |
| | Higginsville Section (Concluded) | | | | | | | | | | |
| P-11880 | Radnor Till Member | Till | 34 | 51 | 15 | 7 | 29 | 36 | 6 | 63 | 31 |
| P-11881 | Radnor Till Member | Till | 17 | 66 | 17 | 6 | 25 | 31 | 3 | 67 | 30 |
| P-11882 | Radnor Till Member | Till | 38 | 52 | 10 | 7 | 30 | 37 | 9 | 62 | 29 |
| P-5353 | Roby Silt Member | Silt | 20 | 66 | 14 | 15 | 21 | 22 | 11 | 61 | 28 |
| P-5354 | Roby Silt Member | Silt | 1 | 88 | 11 | 7 | 35 | 42 | 19 | 64 | 17 |
| P-5355 | Vandalia Till Member | Till | 45 | 30 | 25 | 11 | 23 | 34 | 15 | 69 | 16 |
| P-5356 | Vandalia Till Member | Till | 44 | 34 | 22 | 11 | 22 | 33 | 16 | 69 | 15 |
| P-5357 | Vandalia Till Member | Till | 37 | 35 | 28 | 10 | 23 | 33 | 14 | 71 | 15 |
| | Collison Branch Section No. 1 | | | | | | | | | | |
| P-11883 | Snider Till Member | Till | 13 | 45 | 42 | 5 | 16 | 21 | 3 | 82 | 15 |
| P-11884 | Snider Till Member | Till | 7 | 42 | 51 | 4 | 18 | 22 | 2 | 81 | 17 |
| P-11885 | Snider Till Member | Till | 10 | 43 | 47 | 5 | 16 | 21 | 2 | 80 | 18 |
| P-11886 | Batestown Till Member | Till | 31 | 36 | 33 | 5 | 17 | 22 | 3 | 80 | 17 |
| P-11887 | Batestown Till Member | Till | 32 | 32 | 36 | 5 | 17 | 22 | 4 | 78 | 18 |
| P-11888 | Glenburn Till Member | Till | 34 | 32 | 34 | 8 | 19 | 27 | 12 | 68 | 20 |
| P-11889 | Glenburn Till Member | Till | 35 | 30 | 35 | 8 | 19 | 27 | 12 | 68 | 20 |
| | Emerald Pond Section | | | | | | | | | | |
| P-5387 | Snider Till Member | Till | 18 | 44 | 38 | 6 | 18 | 24 | 2 | 88 | 10 |
| P-5388 | Snider Till Member | Till | 21 | 41 | 38 | 4 | 18 | 22 | 3 | 86 | 11 |
| P-5389 | Snider Till Member | Till | 18 | 54 | 28 | 5 | 18 | 23 | 3 | 86 | 11 |
| P-5390 | Snider Till Member | Till | 18 | 53 | 29 | 8 | 15 | 23 | 3 | 85 | 12 |
| P-5391 | Snider Till Member | Till | 19 | 53 | 28 | 6 | 19 | 25 | 3 | 84 | 13 |

(Continued on next page)

TABLE 7—Continued

| Sample number | Stratigraphic unit | Lithology | Grain-size distribution: Sand (%) | Grain-size distribution: Silt (%) | Grain-size distribution: Clay (%) | Carbonate minerals: Calcite (%) | Carbonate minerals: Dolomite (%) | Carbonate minerals: Total carbonate (%) | Clay minerals: Expandable (%) | Clay minerals: Illite (%) | Clay minerals: Kaolinite plus chlorite (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Emerald Pond Section (Continued) | | | | | | |
| P-5392 | Snider Till Member | Till | 20 | 47 | 33 | 6 | 17 | 23 | 2 | 84 | 14 |
| P-5393 | Snider Till Member | Till | 20 | 41 | 39 | 7 | 19 | 26 | 4 | 82 | 14 |
| P-5394 | Snider Till Member | Till | 19 | 42 | 39 | 6 | 18 | 24 | 3 | 83 | 14 |
| P-5358 | Batestown Till Member | Till | 36 | 39 | 25 | 3 | 18 | 21 | 3 | 85 | 12 |
| P-5359 | Batestown Till Member | Till | — | — | — | 4 | 21 | 25 | 3 | 84 | 13 |
| P-5360 | Batestown Till Member | Till | 29 | 39 | 32 | 5 | 17 | 22 | 3 | 84 | 13 |
| P-5361 | Batestown Till Member | Till | 26 | 38 | 36 | 5 | 16 | 21 | 3 | 83 | 14 |
| P-5362 | Batestown Till Member | Till | 26 | 42 | 32 | 6 | 19 | 25 | 3 | 82 | 15 |
| P-5363 | Batestown Till Member | Till | 24 | 43 | 33 | 5 | 18 | 23 | 3 | 76 | 21 |
| P-5364 | Batestown Till Member | Till | 27 | 37 | 36 | 5 | 19 | 24 | 3 | 75 | 22 |
| P-5365 | Batestown Till Member | Till | 27 | 38 | 35 | 4 | 19 | 23 | 2 | 75 | 23 |
| P-5366 | Batestown Till Member | Till | 29 | 37 | 34 | 4 | 22 | 26 | 3 | 74 | 23 |
| P-5367 | Batestown Till Member | Till | 30 | 36 | 34 | 6 | 19 | 25 | 4 | 74 | 22 |
| P-5368 | Glenburn Till Member | Till | 40 | 34 | 26 | 6 | 17 | 23 | 10 | 66 | 24 |
| P-5369 | Glenburn Till Member | Till | 40 | 35 | 25 | 5 | 18 | 23 | 12 | 63 | 25 |
| P-5370 | Glenburn Till Member | Till | 40 | 39 | 21 | 4 | 18 | 22 | 11 | 65 | 24 |
| P-5371 | Glenburn Till Member | Till | 26 | 54 | 20 | 4 | 17 | 21 | 10 | 66 | 24 |
| P-5372 | Glenburn Till Member | Till | 39 | 40 | 21 | 4 | 19 | 23 | 13 | 63 | 24 |
| P-5373 | Glenburn Till Member | Till | 29 | 51 | 20 | 4 | 19 | 23 | 10 | 64 | 26 |
| P-5374 | Glenburn Till Member | Till | 39 | 41 | 20 | 2 | 20 | 22 | 14 | 61 | 25 |
| P-5375 | Glenburn Till Member | Till | 39 | 40 | 21 | 5 | 17 | 22 | 10 | 62 | 28 |
| P-5376 | Glenburn Till Member | Till | 41 | 39 | 20 | 4 | 15 | 19 | 10 | 64 | 26 |
| P-5377 | Glenburn Till Member | Till | 40 | 39 | 21 | 4 | 16 | 20 | 10 | 64 | 26 |
| P-5378 | Glenburn Till Member | Till | 27 | 53 | 20 | 4 | 18 | 22 | 10 | 64 | 26 |
| P-5379 | Glenburn Till Member | Till | 40 | 43 | 17 | 2 | 18 | 20 | 11 | 64 | 25 |

TABLE 7—Continued

| Sample number | Stratigraphic unit | Lithology | Grain-size distribution: Sand (%) | Silt (%) | Clay (%) | Carbonate minerals: Calcite (%) | Dolomite (%) | Total carbonate (%) | Clay minerals: Expandable (%) | Illite (%) | Kaolinite plus chlorite (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Emerald Pond Section (Concluded) | | | | | | |
| P-5380 | Glenburn Till Member | Till | 38 | 43 | 19 | 5 | 17 | 22 | 11 | 63 | 26 |
| P-5381 | Glenburn Till Member | Till | 26 | 55 | 19 | 3 | 17 | 20 | 15 | 60 | 25 |
| P-5382 | Glenburn Till Member | Till | 37 | 44 | 19 | 3 | 19 | 22 | 16 | 57 | 27 |
| P-5383 | Tilton Till Member | Till | 28 | 47 | 25 | 12 | 20 | 32 | 13 | 65 | 22 |
| P-5384 | Tilton Till Member | Till | 39 | 35 | 26 | 15 | 16 | 31 | 12 | 68 | 20 |
| P-5385 | Tilton Till Member | Till | 40 | 36 | 24 | 15 | 17 | 32 | 12 | 67 | 21 |
| P-5386 | Tilton Till Member | Till | 42 | 34 | 24 | 13 | 19 | 32 | 11 | 70 | 19 |
| | | | | | Harmattan Strip Mine Section No. 4 | | | | | | |
| P-10153 | Batestown Till Member | Till | 26 | 43 | 31 | 5 | 21 | 26 | 3 | 79 | 18 |
| P-10154 | Batestown Till Member | Till | 28 | 41 | 31 | 4 | 22 | 26 | 2 | 80 | 18 |
| P-10155 | Batestown Till Member | Till | 27 | 38 | 35 | 7 | 18 | 25 | 4 | 77 | 19 |
| P-10156 | Radnor Till Member | Till | 39 | 42 | 19 | 5 | 26 | 31 | 4 | 74 | 22 |
| P-10157 | Radnor Till Member | Till | 43 | 39 | 18 | 5 | 26 | 31 | 4 | 72 | 24 |
| P-10158 | Vandalia Till Member | Till | 42 | 35 | 23 | 11 | 23 | 34 | 22 | 60 | 18 |
| P-10159 | Vandalia Till Member | Till | 42 | 31 | 27 | 12 | 22 | 34 | 15 | 63 | 22 |
| P-10160 | Vandalia Till Member | Till | 45 | 29 | 26 | 12 | 24 | 36 | 12 | 66 | 22 |
| P-10161 | Vandalia Till Member | Till | 32 | 44 | 24 | 12 | 23 | 35 | 8 | 69 | 23 |
| P-11892 | Vandalia Till Member | Till | 35 | 37 | 28 | 10 | 25 | 35 | 8 | 67 | 25 |
| P-11893 | Tilton Till Member | Till | 41 | 32 | 27 | 12 | 20 | 32 | 13 | 64 | 23 |
| P-11894 | Tilton Till Member | Till | 41 | 35 | 24 | 11 | 19 | 30 | 15 | 62 | 23 |
| P-11895 | Tilton Till Member | Till | 34 | 36 | 30 | 12 | 19 | 31 | 18 | 63 | 19 |
| P-11896 | Hillery Till Member | Till | 28 | 41 | 31 | 12 | 15 | 27 | 4 | 72 | 24 |
| P-11897 | Hillery Till Member | Till | 26 | 41 | 33 | 10 | 14 | 26 | 4 | 72 | 24 |

(Continued on next page)

TABLE 7—Continued

| Sample number | Stratigraphic unit | Lithology | Grain-size distribution: Sand (%) | Silt (%) | Clay (%) | Carbonate minerals: Calcite (%) | Dolomite (%) | Total carbonate (%) | Clay minerals: Expandable (%) | Illite (%) | Kaolinite plus chlorite (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Harmattan Strip Mine Section No. 4 (Continued) | | | | | | | | |
| P-11898 | Batestown Till Member | Till | 23 | 32 | 45 | 4 | 17 | 21 | 3 | 77 | 20 |
| P-11899 | Glenburn Till Member | Till | 36 | 33 | 31 | 4 | 15 | 19 | 16 | 59 | 25 |
| P-11900 | Glenburn Till Member | Till | 28 | 39 | 33 | 4 | 17 | 21 | 13 | 63 | 24 |
| P-11901 | Oakland Till Member | Till | 36 | 33 | 31 | 2 | 10 | 12 | 26 | 51 | 23 |
| P-11902 | Oakland Till Member | Till | 33 | 35 | 32 | 2 | 10 | 12 | 28 | 51 | 21 |
| P-11903 | Oakland Till Member | Till | 35 | 35 | 30 | 3 | 11 | 14 | 28 | 51 | 21 |
| P-11904 | Oakland Till Member | Till | 15 | 48 | 37 | 3 | 12 | 15 | 25 | 52 | 23 |
| P-11905 | Oakland Till Member | Till | 5 | 54 | 41 | 4 | 13 | 17 | 11 | 62 | 27 |
| P-11906 | Oakland Till Member | Till | 8 | 53 | 39 | 4 | 12 | 16 | 20 | 54 | 26 |
| P-11907 | Oakland Till Member | Till | 7 | 49 | 44 | 3 | 12 | 15 | 15 | 56 | 29 |
| P-11908 | Oakland Till Member | Till | 11 | 55 | 34 | 3 | 14 | 17 | 17 | 55 | 28 |
| P-11909 | Oakland Till Member | Silt | 0 | 27 | 73 | 5 | 9 | 14 | 11 | 60 | 29 |
| P-11910 | Oakland Till Member | Silt | 2 | 73 | 25 | 5 | 18 | 23 | 18 | 54 | 28 |
| P-11911 | Harmattan Till Member | Till | 30 | 36 | 34 | 7 | 15 | 22 | 22 | 58 | 20 |
| P-11912 | Harmattan Till Member | Till | 31 | 34 | 35 | 8 | 17 | 23 | 29 | 52 | 19 |
| P-11913 | Harmattan Till Member | Till | 17 | 58 | 25 | 8 | 23 | 31 | 14 | 65 | 21 |
| P-11914 | Harmattan Till Member | Till | 21 | 46 | 33 | 6 | 11 | 17 | 8 | 65 | 27 |
| P-11915 | Harmattan Till Member | Till | 25 | 35 | 40 | 4 | 13 | 17 | 5 | 72 | 23 |
| P-11916 | Belgium Member | Silt | 0 | 83 | 17 | 0.5 | 9 | 9 | 18 | 44 | 38 |
| P-11917 | Banner Formation | Silt | 14 | 59 | 27 | 0.9 | 0.6 | 1.5 | 12 | 35 | 53 |
| P-11918 | Batestown Till Member | Till | 31 | 36 | 33 | 6 | 18 | 24 | 4 | 83 | 13 |
| P-11919 | Batestown Till Member | Till | 29 | 37 | 34 | 4 | 19 | 23 | 3 | 77 | 20 |
| P-11920 | Batestown Till Member | Till | 24 | 35 | 41 | 6 | 17 | 25 | 4 | 76 | 20 |
| P-11921 | Glenburn Till Member | Till | 29 | 43 | 28 | 3 | 12 | 15 | 30 | 50 | 20 |
| P-11922 | Oakland Till Member | Till | 3 | 54 | 43 | 4 | 12 | 16 | 21 | 55 | 24 |

TABLE 7—Continued

| Sample number | Stratigraphic unit | Lithology | Grain-size distribution: Sand (%) | Silt (%) | Clay (%) | Carbonate minerals: Calcite (%) | Dolomite (%) | Total carbonate (%) | Clay minerals: Expandable (%) | Illite (%) | Kaolinite plus chlorite (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Harmattan Strip Mine Section No. 4 (Concluded) | | | | | | |
| P-11923 | Radnor Till Member | Till | 42 | 36 | 22 | 7 | 21 | 28 | 4 | 75 | 21 |
| P-11924 | Batestown Till Member | Till | 28 | 35 | 37 | 8 | 18 | 26 | 6 | 73 | 21 |
| P-11925 | Glenburn Till Member | Till | 29 | 40 | 31 | 9 | 18 | 27 | 11 | 66 | 23 |
| P-11926 | Oakland Till Member | Till | 33 | 43 | 24 | 5 | 14 | 19 | 22 | 58 | 20 |
| P-11927 | Oakland Till Member | Till | 13 | 51 | 36 | 2 | 9 | 11 | 30 | 44 | 26 |
| P-11928 | Batestown Till Member | Till | 29 | 37 | 34 | 6 | 18 | 24 | 3 | 78 | 19 |
| P-11929 | Batestown Till Member | Till | 24 | 41 | 35 | 8 | 17 | 25 | 4 | 76 | 20 |
| P-11931 | Robein Silt | Silt | 0 | 89 | 11 | 5 | 26 | 31 | 10 | 68 | 22 |
| P-11932 | Robein Silt | Silt | 2 | 79 | 19 | 3 | 21 | 24 | 12 | 65 | 23 |
| P-11933 | Vandalia Till Member | Till | 56 | 29 | 15 | 13 | 21 | 34 | 14 | 62 | 24 |
| P-11934 | Vandalia Till Member | Till | 42 | 34 | 24 | 12 | 23 | 35 | 15 | 60 | 25 |
| P-11935 | Vandalia Till Member | Till | 42 | 28 | 30 | 12 | 20 | 32 | 8 | 65 | 27 |
| | | | | | School House Branch Section of Hungry Hollow | | | | | | |
| P-5461 | Vandalia Till Member | Till | 48 | 32 | 20 | 11 | 22 | 33 | 15 | 64 | 21 |
| P-5462 | Vandalia Till Member | Till | 41 | 40 | 19 | 9 | 24 | 33 | 14 | 64 | 22 |
| P-5463 | Vandalia Till Member | Till | 44 | 36 | 20 | 9 | 24 | 33 | 10 | 68 | 22 |
| P-5464 | Vandalia Till Member | Till | 44 | 35 | 21 | 8 | 25 | 33 | 8 | 70 | 22 |
| P-5465 | Vandalia Till Member | Till | 36 | 51 | 13 | 9 | 26 | 35 | 11 | 69 | 20 |
| P-5466 | Vandalia Till Member | Till | 18 | 63 | 19 | 7 | 27 | 34 | 10 | 69 | 21 |
| P-5475 | Mulberry Grove Member | Silt | 12 | 57 | 31 | 2 | 13 | 15 | 62 | 24 | 14 |
| P-5476 | Mulberry Grove Member | Silt | 2 | 79 | 19 | 1 | 21 | 22 | — | — | — |
| P-5477 | Mulberry Grove Member | Silt | 0 | 79 | 21 | 0 | 0 | 0 | 54 | 12 | 34 |
| P-5478 | Mulberry Grove Member | Clay | 16 | 42 | 42 | 0 | 0 | 0 | 80 | 9 | 11 |

(Continued on next page)

TABLE 7—Continued

| Sample number | Stratigraphic unit | Lithology | Grain-size distribution | | | Carbonate minerals | | | Clay minerals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sand (%) | Silt (%) | Clay (%) | Calcite (%) | Dolomite (%) | Total carbonate (%) | Expandable (%) | Illite (%) | Kaolinite plus chlorite (%) |
| School House Branch Section of Hungry Hollow (Concluded) | | | | | | | | | | | |
| P-5479 | Mulberry Grove Member | Clay | 16 | 56 | 28 | 0 | 0 | 0 | 79 | 11 | 10 |
| P-5480 | Mulberry Grove Member | Colluvium | 28 | 33 | 39 | 0 | 0 | 0 | 52 | 38 | 10 |
| P-5481 | Mulberry Grove Member | Colluvium | 28 | 35 | 37 | 0 | 0 | 0 | 69 | 21 | 10 |
| P-5482 | Mulberry Grove Member | Colluvium | 28 | 29 | 43 | 0 | 0 | 0 | 57 | 31 | 12 |
| P-5467 | Smithboro Till Member | Till | 17 | 57 | 26 | 3 | 14 | 17 | 47 | 37 | 16 |
| P-5468 | Smithboro Till Member | Till | 15 | 61 | 24 | 4 | 18 | 22 | 47 | 36 | 17 |
| P-5469 | Smithboro Till Member | Till | 16 | 61 | 23 | 4 | 19 | 23 | 43 | 39 | 18 |
| P-5470 | Smithboro Till Member | Till | 8 | 66 | 26 | 3 | 15 | 18 | 48 | 34 | 18 |
| P-5472 | Hillery Till Member | Till | 35 | 40 | 25 | 15 | 10 | 25 | 17 | 67 | 16 |
| P-5473 | Hillery Till Member | Till | 33 | 42 | 25 | 15 | 12 | 27 | 7 | 71 | 22 |
| Center School Section | | | | | | | | | | | |
| P-11936 | Glenburn Till Member | Till | 28 | 43 | 29 | 4 | 16 | 20 | 20 | 70 | 10 |
| P-11937 | Glenburn Till Member | Till | 26 | 47 | 27 | 7 | 18 | 25 | 19 | 69 | 12 |
| P-11938 | Glenburn Till Member | Till | 29 | 44 | 27 | 7 | 18 | 25 | 15 | 70 | 15 |
| P-11939 | Glenburn Till Member | Till | 27 | 45 | 28 | 8 | 18 | 26 | 13 | 71 | 16 |
| P-11940 | Glenburn Till Member | Till | 31 | 44 | 25 | 8 | 18 | 26 | 12 | 71 | 17 |
| P-11941 | Glenburn Till Member | Silt | 2 | 78 | 20 | 9 | 20 | 29 | — | — | — |
| P-11942 | Vandalia Till Member | Till | 37 | 41 | 22 | 9 | 17 | 26 | — | — | — |
| P-11943 | Vandalia Till Member | Till | 26 | 49 | 25 | 7 | 17 | 24 | 21 | 69 | 10 |
| P-11944 | Vandalia Till Member | Till | 27 | 49 | 24 | 7 | 17 | 24 | 19 | 62 | 19 |
| Jewett Section (west side of road) | | | | | | | | | | | |
| P-3456 | Vandalia Till Member | Till | 44 | 36 | 20 | 4 | 14 | 18 | 20 | 65 | 15 |
| P-3455 | Vandalia Till Member | Till | 46 | 34 | 20 | 7 | 14 | 21 | 20 | 65 | 15 |

TABLE 7—Continued

| Sample number | Stratigraphic unit | Lithology | Grain-size distribution: Sand (%) | Silt (%) | Clay (%) | Carbonate minerals: Calcite (%) | Dolomite (%) | Total carbonate (%) | Clay minerals: Expandable (%) | Illite (%) | Kaolinite plus chlorite (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jewett Section (Continued) | | | | | | | | |
| P-3454 | Vandalia Till Member | Till | 39 | 41 | 20 | 4 | 14 | 18 | 20 | 65 | 15 |
| P-3453 | Vandalia Till Member | Till | 44 | 37 | 19 | 11 | 15 | 26 | 17 | 68 | 15 |
| P-3452 | Vandalia Till Member | Till | 44 | 35 | 21 | 11 | 17 | 28 | 17 | 68 | 15 |
| P-3451 | Vandalia Till Member | Till | 45 | 35 | 20 | 16 | 15 | 31 | 16 | 63 | 21 |
| P-3450 | Vandalia Till Member | Till | 41 | 41 | 18 | 12 | 15 | 27 | 13 | 72 | 15 |
| P-3449 | Vandalia Till Member | Till | 36 | 44 | 20 | 8 | 15 | 23 | 16 | 66 | 18 |
| P-3448 | Vandalia Till Member | Till | 36 | 45 | 19 | 9 | 16 | 25 | 14 | 69 | 17 |
| P-3447 | Vandalia Till Member | Till | 37 | 45 | 18 | 8 | 15 | 23 | 16 | 65 | 19 |
| P-3446 | Vandalia Till Member | Till | 37 | 43 | 20 | 7 | 16 | 23 | 14 | 68 | 18 |
| P-3445 | Vandalia Till Member | Till | 36 | 44 | 20 | 7 | 15 | 22 | 21 | 55 | 24 |
| P-3444 | Vandalia Till Member | Till | 35 | 46 | 19 | 9 | 15 | 24 | 19 | 68 | 13 |
| P-3443 | Vandalia Till Member | Till | 37 | 43 | 20 | 8 | 18 | 26 | 17 | 69 | 14 |
| P-3442 | Vandalia Till Member | Till | 39 | 41 | 20 | 8 | 18 | 26 | 21 | 66 | 13 |
| P-3441 | Vandalia Till Member | Till | 38 | 42 | 20 | 9 | 19 | 28 | 18 | 65 | 17 |
| P-3440 | Vandalia Till Member | Till | 30 | 49 | 21 | 8 | 26 | 34 | 4 | 83 | 13 |
| P-3439 | Vandalia Till Member | Till | 33 | 40 | 27 | 10 | 20 | 30 | 3 | 78 | 19 |
| P-3438 | Smithboro Till Member | Till | 28 | 42 | 30 | 5 | 15 | 20 | 20 | 65 | 15 |
| P-3437 | Smithboro Till Member | Till | 27 | 44 | 29 | 5 | 15 | 20 | 21 | 59 | 20 |
| P-3436 | Smithboro Till Member | Till | 21 | 51 | 28 | 3 | 13 | 16 | 38 | 43 | 19 |
| P-3435 | Smithboro Till Member | Till | 25 | 54 | 21 | 5 | 24 | 29 | 11 | 63 | 26 |
| P-3434 | Smithboro Till Member | Till | 21 | 53 | 26 | 3 | 15 | 18 | 33 | 45 | 21 |
| P-3433 | Smithboro Till Member | Till | 21 | 52 | 27 | 3 | 14 | 17 | 38 | 40 | 22 |
| P-3432 | Yarmouth Soil in Banner Formation | Sand & gravel | 35 | 27 | 38 | — | — | — | 87 | 7 | 6 |
| P-3431 | Yarmouth Soil in Banner Formation | Sand & gravel | 35 | 29 | 36 | — | — | — | 85 | 9 | 6 |

(Concluded on next page)

TABLE 7—Concluded

| Sample number | Stratigraphic unit | Lithology | Grain-size distribution: Sand (%) | Silt (%) | Clay (%) | Carbonate minerals: Calcite (%) | Dolomite (%) | Total carbonate (%) | Clay minerals: Expandable (%) | Illite (%) | Kaolinite plus chlorite (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jewett Section (Concluded) | | | | | | | | |
| P-3430 | Yarmouth Soil in Banner Formation | Sand & gravel | 42 | 23 | 35 | — | — | — | 88 | 6 | 6 |
| P-3429 | Yarmouth Soil in Banner Formation | Sand & gravel | 41 | 26 | 33 | — | — | — | 82 | 9 | 9 |
| P-3428 | Yarmouth Soil in Banner Formation | Sand & gravel | 46 | 25 | 29 | — | — | — | 87 | 7 | 6 |
| P-3427 | Yarmouth Soil in Banner Formation | Sand & gravel | 49 | 24 | 27 | — | — | — | 84 | 10 | 6 |
| P-3426 | Yarmouth Soil in Banner Formation | Sand & gravel | 54 | 23 | 23 | — | — | — | 78 | 16 | 6 |
| P-3425 | Yarmouth Soil in Banner Formation | Sand & gravel | 78 | 10 | 12 | — | — | — | — | — | — |
| P-3424 | Banner Formation | Sand & gravel | 58 | 33 | 9 | 13 | 4 | 17 | — | — | — |
| P-3423 | Banner Formation | Sand & gravel | 71 | 22 | 7 | 10 | 20 | 30 | — | — | — |
| P-3422 | Banner Formation | Sand & gravel | 85 | 10 | 5 | 11 | 32 | 42 | — | — | — |
| P-3421 | Banner Formation | Sand & gravel | 54 | 33 | 13 | 3 | 10 | 13 | — | — | — |

TABLE 8—GRAIN-SIZE DISTRIBUTION, CLAY MINERAL CONTENT, AND CHEMICAL DATA FOR SOIL PROFILES

| Soil horizon | Depth (in.) | Sample number | Particle size: Gravel (> 2 mm) (%) | Sand (0.062-2 mm) (%) | Silt (2-62 μ) (%) | (< 31 μ) (%) | Medium silt (16-31 μ) (%) | Coarse silt (31-62 μ) (%) | Medium to coarse silt ratio 16-31 μ / 31-62 μ | Clay (< 2 μ) (%) | Fine clay (< 0.5 μ) (%) | Clay minerals (%): Expandable | Illite | Kaolinite plus chlorite | Chemical data: Total C (%) | Organic C (%) | Total $P_2O_5$ (%) | $Fe_2O_3$ (%) | $MnO_2$ (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Collison Branch Section No. 2: Profile A | | | | | | | | | | | | | | | | | | | |
| A | 0-3 | P-11747 | — | 27.2 | 57.8 | 54.6 | 12.3 | 18.2 | 0.67 | 15.0 | 9.6 | 41 | 40 | 19 | 0.22 | 0.09 | 0.02 | 0.03 | 0.004 |
| | 3-6 | P-11748 | 4.0 | 30.5 | 48.3 | 54.8 | 14.4 | 14.4 | 0.97 | 21.2 | 10.9 | 40 | 38 | 22. | 0.35 | 0.23 | 0.01 | 0.03 | 0.006 |
| IIB1 | 9-12 | P-11749 | 7.4 | 35.4 | 39.7 | 48.8 | 7.4 | 15.8 | 0.46 | 24.9 | 19.2 | 21 | 66 | 13 | 0.24 | 0.16 | 0.01 | 2.35 | 0.009 |
| | 12-15 | P-11750 | 3.0 | 37.8 | 38.4 | 48.6 | 11.0 | 13.4 | 0.83 | 23.8 | 18.6 | 24 | 64 | 12 | 0.08 | 0.03 | 0.01 | 0.36 | 0.005 |
| IIIB2 | 15-18 | P-11751 | 3.4 | 35.3 | 36.3 | 55.5 | 8.8 | 9.2 | 0.95 | 28.4 | 26.6 | 23 | 65 | 12 | 0.22 | 0.11 | 0.01 | 0.31 | 0.009 |
| | 18-21 | P-11752 | 5.1 | 41.0 | 35.8 | 45.9 | 7.6 | 13.1 | 0.58 | 23.2 | 18.2 | 21 | 69 | 10 | 0.19 | 0.03 | 0.01 | 0.28 | 0.083 |
| | 21-24 | P-11753 | 7.1 | 41.6 | 38.1 | 44.1 | 6.8 | 14.3 | 0.47 | 20.3 | 15.6 | 19 | 72 | 9 | 0.32 | 0.19 | 0.01 | 0.31 | 0.049 |
| | 24-27 | P-11754 | 5.0 | 42.8 | 36.0 | 47.6 | 8.5 | 9.6 | 0.88 | 21.2 | — | 21 | 71 | 8 | — | — | — | — | — |
| | 27-30 | P-11755 | 5.0 | 41.8 | 36.5 | 42.5 | 8.6 | 15.7 | 0.54 | 21.7 | 13.8 | 26 | 66 | 8 | 0.17 | 0.13 | 0.02 | 0.31 | 0.054 |
| IIIB3 | 30-33 | P-11756 | — | 45.7 | 37.4 | 38.7 | 6.1 | 15.6 | 0.39 | 16.9 | — | 22 | 70 | 8 | — | — | — | — | — |
| | 33-36 | P-11757 | 5.4 | 47.4 | 37.4 | 38.6 | 7.1 | 14.0 | 0.50 | 15.2 | 10.6 | 27 | 64 | 9 | 0.20 | 0.18 | 0.02 | 0.34 | 0.054 |
| | 36-39 | P-11758 | — | 43.6 | 36.9 | 44.8 | 6.6 | 11.6 | 0.56 | 19.5 | — | 29 | 63 | 8 | — | — | — | — | — |
| | 39-42 | P-11759 | 5.3 | 43.8 | 40.0 | 43.5 | 9.8 | 12.7 | 0.77 | 16.2 | 12.4 | 22 | 69 | 9 | 0.12 | 0.10 | 0.02 | 0.25 | 0.020 |
| | 42-45 | P-11760 | — | 44.3 | 37.1 | 42.4 | 5.8 | 13.3 | 0.43 | 18.6 | — | 23 | 69 | 8 | — | — | — | — | — |
| IIIC1 | 45-48 | P-11761 | 15.0 | 44.5 | 41.0 | 41.0 | 9.6 | 14.5 | 0.66 | 14.5 | 9.0 | 11 | 78 | 11 | 0 | 0 | 0.03 | 0.28 | 0.071 |
| | 48-51 | P-11762 | — | 46.2 | 41.5 | — | — | — | — | 12.3 | — | 8 | 76 | 16 | — | — | — | — | — |
| IIIC2 | 51-54 | P-11763 | 9.5 | 44.6 | 44.9 | 41.0 | 10.0 | 15.6 | 0.65 | 10.5 | 5.4 | 10 | 76 | 14 | 2.41 | 0.04 | 0.03 | 0.17 | 0.163 |
| School House Branch Section of Hungry Hollow: Profile B | | | | | | | | | | | | | | | | | | | |
| A | 0-5 | P-11764 | 0.5 | 22.9 | 56.6 | — | — | — | — | 20.6 | — | — | — | — | — | — | — | — | — |
| | 5-10 | P-11765 | 0.4 | 18.7 | 61.5 | 59.2 | 18.2 | 22.1 | 0.82 | 19.8 | 15.2 | 50 | 31 | 19 | 0.39 | 0.37 | 0.067 | 0.41 | 0.005 |
| | 10-15 | P-11766 | 0 | 17.0 | 61.7 | 65.4 | 9.1 | 17.9 | 0.50 | 21.3 | — | 46 | 34 | 20 | — | — | — | — | — |
| IIB | 15-20 | P-11767 | 0.2 | 22.3 | 51.7 | 64.5 | 13.8 | 12.7 | 1.08 | 26.0 | 22.6 | 59 | 25 | 16 | 0.43 | 0.42 | 0.057 | 0.34 | 0.002 |
| | 20-25 | P-11768 | 0 | 20.8 | 48.6 | 63.4 | 11.8 | 15.8 | 0.74 | 30.6 | 26.2 | 57 | 25 | 18 | 0.34 | 0.33 | 0.050 | 0.31 | 0.003 |
| | 25-30 | P-11769 | 0.4 | 28.1 | 42.5 | — | — | — | — | 29.4 | — | 58 | 25 | 17 | — | — | — | — | — |
| | 30-35 | P-11770 | 1.3 | 30.2 | 44.0 | 53.8 | 11.2 | 16.0 | 0.70 | 25.8 | 21.8 | 60 | 23 | 17 | — | — | — | — | — |
| | 35-40 | P-11771 | 1.1 | 31.7 | 38.7 | — | — | — | — | 29.6 | — | 60 | 23 | 17 | — | — | — | — | — |
| | 40-45 | P-11772 | 1.0 | 32.5 | 39.4 | 51.9 | 10.7 | 15.2 | 0.70 | 28.1 | 22.6 | 59 | 22 | 19 | 0.34 | 0.29 | 0.055 | 0.39 | 0.059 |
| IIB2 | 45-50 | P-11773 | 2.5 | 38.5 | 34.2 | 49.3 | 7.8 | 12.2 | 0.63 | 27.3 | 21.8 | 61 | 21 | 18 | — | — | — | — | — |
| | 50-54 | P-11774 | 3.9 | 46.7 | 29.7 | 37.4 | 5.5 | 15.9 | 0.34 | 23.6 | — | 63 | 20 | 17 | — | — | — | — | — |
| | 54-60 | P-11775 | 11.7 | 52.6 | 24.2 | — | — | — | — | 23.2 | — | 60 | 23 | 17 | — | — | — | — | — |
| | 60-66 | P-11776 | 40.7 | 40.3 | 35.9 | — | — | — | — | 23.8 | — | 57 | 25 | 18 | — | — | — | — | — |
| IIIB3 | 66-72 | P-11777 | 0.5 | 41.4 | 36.1 | 44.2 | 4.5 | 14.4 | 0.31 | 22.5 | 17.1 | 57 | 24 | 19 | 0.19 | 0.18 | 0.040 | 0.42 | 0.012 |
| | 72-78 | P-11778 | 1.5 | 53.2 | 28.4 | 39.9 | 11.0 | 21.0 | 0.52 | 18.0 | — | 63 | 29 | 14 | — | — | — | — | — |
| | 78-84 | P-11779 | 3.4 | 50.0 | 31.6 | — | — | — | — | 19.4 | — | 60 | 26 | 14 | — | — | — | — | — |
| | 84-91 | P-11780 | 10.9 | 49.1 | 29.1 | — | — | — | — | 21.8 | — | 62 | 23 | 15 | — | — | — | — | — |
| IIIC1 | 91-96 | P-11781 | 3.2 | 41.1 | 35.3 | — | — | — | — | 23.6 | — | 24 | 58 | 18 | — | — | — | — | — |
| | 96-101 | P-11782 | 3.2 | 42.0 | 36.1 | 45.2 | 7.1 | 12.8 | 0.55 | 21.9 | 9.9 | 24 | 58 | 18 | 0.28 | 0.25 | 0.135 | 0.31 | 0.006 |

(Continued on next page)

TABLE 8—Continued

| Soil horizon | Depth (in.) | Sample number | Particle size: Gravel (> 2 mm) (%) | Sand (0.062-2 mm) (%) | Silt (2-62 μ) (%) | (< 31 μ) (%) | Medium silt (16-31 μ) (%) | Coarse silt (31-62 μ) (%) | Medium to coarse silt ratio 16-31 μ / 31-62 μ | Clay (< 2 μ) (%) | Fine clay (< 0.5 μ) (%) | Clay minerals (%): Expandable | Illite | Kaolinite plus chlorite | Chemical data: Total C (%) | Organic C (%) | Total $P_2O_5$ (%) | $Fe_2O_3$ (%) | $MnO_2$ (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | School House Branch Section of Hungry Hollow: Profile B (Concluded) | | | | | | | | | | |
| IIIC2 | 101-105 | P-11783 | 8.8 | 37.9 | 45.8 | 47.7 | 13.1 | 14.4 | 0.90 | 16.3 | — | 24 | 57 | 19 | 3.51 | 0.23 | 0.095 | 0.11 | 0.205 |
| | 105-110 | P-11784 | 9.8 | 39.7 | 42.3 | 47.3 | 10.0 | 12.1 | 0.82 | 18.0 | 10.7 | 27 | 57 | 21 | — | — | — | — | — |
| | 110-115 | P-11785 | 8.9 | 40.6 | 41.3 | — | — | — | — | 18.1 | — | 20 | 58 | 22 | 3.84 | 0.30 | 0.086 | 0.14 | 0.086 |
| | | | | | | | | | Hutton Section: Profile C | | | | | | | | | | |
| A1 | 0-3 | P-11786 | — | 8.4 | 78.6 | 79.0 | 26.0 | 12.6 | 2.06 | 13.0 | 6.6 | — | — | — | 0.89 | 0.87 | 0.046 | 0.70 | 0.241 |
| A2 | 3-7 | P-11787 | — | 6.1 | 73.5 | 81.3 | 23.1 | 12.6 | 1.83 | 20.4 | 12.1 | 40 | 35 | 25 | 0.35 | 0.35 | 0.025 | 0.92 | 0.081 |
| B1 | 7-12 | P-11788 | — | 4.3 | 68.1 | 83.6 | 20.2 | 12.1 | 1.66 | 27.6 | 19.6 | 58 | 24 | 19 | 0.26 | 0.24 | 0.027 | 1.34 | 0.053 |
| | 12-16 | P-11789 | — | 2.1 | 66.1 | 83.2 | 17.8 | 14.7 | 1.21 | 31.8 | 25.1 | 62 | 22 | 16 | — | — | — | — | — |
| | 16-20 | P-11790 | — | 2.5 | 65.2 | 87.6 | 21.5 | 10.7 | 2.00 | 32.3 | — | 67 | 21 | 14 | 0.23 | 0.19 | 0.044 | 1.34 | 0.079 |
| B2 | 20-24 | P-11791 | — | 4.9 | 64.7 | 77.8 | 20.2 | 16.6 | 1.21 | 30.4 | 23.9 | 68 | 19 | 13 | — | — | — | — | — |
| | 24-28 | P-11792 | — | 8.2 | 63.7 | 78.8 | 23.8 | 13.0 | 1.83 | 28.1 | 25.1 | 69 | 20 | 11 | 0.40 | 0.37 | 0.035 | 1.29 | 0.054 |
| | 28-31 | P-11793 | — | 8.8 | 65.6 | 73.7 | 27.1 | 17.5 | 1.54 | 25.6 | 21.9 | 69 | 20 | 11 | — | — | — | — | — |
| B3 | 31-36 | P-11794 | — | 9.5 | 65.7 | 71.3 | 22.5 | 19.2 | 1.17 | 24.8 | 22.2 | 69 | 20 | 11 | 0.46 | 0.43 | 0.041 | 1.08 | 0.041 |
| | 36-40 | P-11795 | — | 7.4 | 68.5 | 75.8 | 22.6 | 16.8 | 1.34 | 24.1 | 19.8 | 69 | 20 | 11 | — | — | — | — | — |
| | 40-44 | P-11796 | — | 1.1 | 71.3 | 90.2 | 22.9 | 8.8 | 2.60 | 27.6 | — | 68 | 20 | 12 | — | — | — | — | — |
| C1 | 44-48 | P-11797 | — | 0.9 | 77.5 | 92.6 | 25.8 | 6.5 | 3.96 | 21.6 | 18.9 | 68 | 20 | 12 | 0.33 | 0.30 | 0.049 | 0.64 | 0.044 |
| | 48-53 | P-11798 | — | 2.5 | 73.8 | 86.0 | 20.6 | 11.5 | 1.79 | 23.7 | — | 73 | 17 | 10 | 0.10 | 0.09 | 0.039 | 1.01 | 0.043 |
| IIA | 53-59 | P-11799 | 1.0 | 27.8 | 47.6 | 57.7 | 14.1 | 13.0 | 1.08 | 24.6 | — | 72 | 17 | 11 | 0.18 | 0.14 | 0.027 | 0.69 | 0.016 |
| | 59-65 | P-11800 | 1.1 | 31.0 | 46.0 | 60.0 | 15.1 | 9.0 | 1.67 | 23.0 | 19.8 | 71 | 16 | 13 | 0.13 | 0.12 | 0.029 | 0.81 | 0.053 |
| IIB | 65-71 | P-11801 | 2.1 | 31.4 | 44.5 | — | — | — | — | 24.1 | — | 73 | 14 | 13 | — | — | — | — | — |
| | 71-77 | P-11802 | 2.4 | 30.7 | 43.0 | — | — | — | — | 26.3 | — | 69 | 17 | 14 | 0.09 | 0.09 | 0.055 | 0.64 | 0.053 |
| | 77-83 | P-11803 | 1.7 | 31.2 | 43.0 | 58.2 | 12.9 | 10.6 | 1.21 | 25.8 | 20.0 | 69 | 16 | 13 | — | — | — | — | — |
| | 83-89 | P-11804 | 1.7 | 36.8 | 37.2 | 55.2 | 11.9 | 8.0 | 1.48 | 26.0 | 23.0 | 68 | 16 | 16 | 0.07 | 0.07 | 0.040 | 0.70 | 0.049 |
| IIIA | 89-94 | P-11805 | 2.1 | 31.0 | 39.8 | 58.9 | 12.1 | 10.1 | 1.19 | 29.2 | 26.1 | 64 | 19 | 17 | 0.24 | 0.21 | 0.050 | 1.29 | 0.054 |
| | 94-99 | P-11806 | 2.9 | 33.4 | 36.8 | 57.8 | 10.4 | 8.8 | 1.18 | 29.8 | 27.0 | 70 | 14 | 16 | 0.25 | 0.22 | 0.050 | 0.92 | 0.088 |
| IIIB2 | 99-104 | P-11807 | 2.6 | 30.6 | 38.0 | 60.3 | 12.7 | 9.3 | 1.36 | 31.4 | 27.2 | 69 | 15 | 17 | 0.05 | 0.05 | 0.038 | 0.88 | 0.050 |
| | 104-109 | P-11808 | 1.9 | 32.8 | 32.9 | 59.8 | 9.4 | 6.2 | 1.51 | 34.3 | 29.7 | 66 | 18 | 16 | — | — | — | — | — |
| | 109-114 | P-11809 | 2.3 | 32.6 | 35.5 | 60.4 | 9.4 | 8.2 | 1.14 | 31.9 | 28.2 | 63 | 20 | 17 | 0.45 | 0.44 | 0.033 | 0.84 | 0.088 |
| | 114-119 | P-11810 | 2.4 | 38.1 | 31.8 | 55.1 | 8.2 | 6.8 | 1.20 | 30.1 | 25.5 | 66 | 16 | 18 | — | — | — | — | — |
| | 119-125 | P-11811 | 2.3 | 46.2 | 30.2 | 45.0 | 6.0 | 8.8 | 0.68 | 23.6 | 20.2 | 50 | 36 | 14 | — | — | — | — | — |
| | 125-131 | P-11812 | 2.6 | 41.1 | 35.2 | 46.9 | 7.3 | 12.0 | 0.60 | 23.7 | 18.2 | 40 | 45 | 15 | — | — | — | — | — |
| | 131-136 | P-11813 | 5.0 | 43.6 | 34.0 | 45.4 | 9.1 | 11.0 | 0.82 | 22.4 | 16.2 | 29 | 57 | 15 | — | — | — | — | — |
| IIIB3 | 136-142 | P-11814 | 4.0 | 41.0 | 35.4 | — | — | — | — | 23.6 | — | 28 | 59 | 13 | 0.23 | 0.19 | 0.074 | 1.40 | 0.037 |
| | 142-148 | P-11815 | 2.7 | 40.6 | 36.2 | 47.1 | 6.0 | 12.3 | 0.48 | 23.2 | 15.6 | 29 | 57 | 14 | 0.04 | 0.02 | 0.110 | 0.92 | 0.017 |
| | 148-154 | P-11816 | 6.0 | 44.0 | 35.3 | 46.7 | 6.6 | 9.3 | 0.70 | 20.7 | 14.8 | 19 | 70 | 11 | — | — | — | — | — |

TABLE 8—Continued

| Soil horizon | Depth (in.) | Sample number | Particle size: Gravel (> 2 mm) (%) | Sand (0.062-2 mm) (%) | Silt (2-62 μ) (%) | (< 31 μ) (%) | Medium silt (16-31 μ) (%) | Coarse silt (31-62 μ) (%) | Medium to coarse silt ratio 16-31 μ / 31-62 μ | Clay (< 2 μ) (%) | Fine clay (< 0.5 μ) (%) | Clay minerals (%): Expandable | Illite | Kaolinite plus chlorite | Chemical data: Total C (%) | Organic C (%) | Total $P_2O_5$ (%) | $Fe_2O_3$ (%) | $MnO_2$ (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Hutton Section: Profile C (Concluded) | | | | | | | | | | |
| IIIC1 | 154-162 | P-11817 | 1.8 | 45.8 | 35.3 | 44.8 | 8.4 | 9.4 | 0.89 | 18.9 | 13.1 | 29 | 60 | 11 | — | — | — | — | — |
| | 162-170 | P-11818 | 3.0 | 39.3 | 38.6 | 49.4 | 7.3 | 11.3 | 0.64 | 22.1 | 13.4 | 14 | 74 | 12 | 0.04 | 0.04 | 0.126 | 1.17 | 0.170 |
| IVC2 | 170-176 | P-11819 | 7.8 | 43.2 | 39.4 | 46.0 | 10.1 | 10.8 | 0.93 | 17.4 | 7.9 | 27 | 58 | 15 | 1.96 | 0.10 | 0.098 | 0.98 | 0.065 |
| | 190-196 | P-11820 | 5.6 | 38.8 | 43.1 | 49.1 | 10.7 | 12.3 | 0.86 | 18.1 | 11.7 | 28 | 58 | 14 | 3.13 | 0.44 | 0.081 | 0.06 | 0.019 |
| | 210-214 | P-11821 | 6.4 | 40.8 | 43.0 | 47.1 | 12.1 | 12.7 | 0.95 | 16.2 | 9.2 | 32 | 54 | 14 | 2.93 | 0.21 | 0.065 | 0.11 | 0.019 |
| | 228-232 | P-11822 | 7.5 | 42.1 | 42.4 | 46.7 | 7.1 | 11.2 | 0.63 | 15.5 | 8.3 | 29 | 55 | 16 | — | — | — | — | — |
| | 258-262 | P-11823 | — | 24.3 | 55.5 | 60.7 | 17.9 | 15.0 | 1.19 | 20.2 | — | 51 | 34 | 15 | — | — | — | — | — |
| | 282-286 | P-11824 | — | 34.4 | 47.2 | 56.1 | 16.0 | 9.5 | 1.68 | 18.4 | — | 32 | 51 | 16 | — | — | — | — | — |
| VBg | 298-310 | P-11825 | — | 21.7 | 41.4 | 68.8 | 10.4 | 9.5 | 1.09 | 36.9 | — | 66 | 17 | 17 | — | — | — | — | — |
| VIC | 310-315 | P-11826 | — | 17.9 | 62.8 | 63.2 | 21.4 | 18.9 | 1.13 | 19.3 | — | 45 | 34 | 21 | — | — | — | — | — |
| | | | | | | | | | Center School Section: Profile D | | | | | | | | | | |
| 02 | 0-10 | P-11827 | 0 | 1.7 | 80.1 | 86.9 | 25.1 | 11.4 | 2.20 | 18.2 | 12.7 | 21 | 52 | 27 | 4.60 | 4.10 | 0.122 | — | 0.063 |
| | 10-17 | P-11828 | 0 | 2.6 | 86.7 | 86.2 | 19.2 | 11.2 | 1.71 | 10.7 | 6.8 | 21 | 50 | 29 | 6.09 | 5.90 | 0.170 | — | 0.013 |
| IIBg | 17-20 | P-11829 | 1.2 | 25.0 | 55.6 | 65.1 | 18.7 | 9.2 | 1.88 | 19.4 | 15.6 | 64 | 17 | 18 | 0.65 | 0.63 | 0.069 | — | 0.002 |
| | 20-25 | P-11830 | 0.4 | 21.7 | 60.5 | 65.6 | 17.8 | 13.4 | 1.32 | 17.8 | 12.2 | 52 | 24 | 24 | 1.72 | 1.69 | 0.079 | — | 0.002 |
| | 25-30 | P-11831 | 1.1 | 26.7 | 55.6 | 58.6 | 15.3 | 13.8 | 1.10 | 17.7 | — | 60 | 18 | 22 | 0.84 | 0.83 | 0.064 | — | 0.008 |
| | 30-35 | P-11832 | 0.9 | 34.4 | 49.2 | 54.0 | 14.4 | 11.8 | 1.22 | 16.4 | — | 64 | 17 | 19 | — | — | — | — | — |
| | 35-40 | P-11833 | 1.4 | 38.9 | 45.7 | 49.6 | 14.0 | 11.5 | 1.21 | 15.4 | 12.8 | 59 | 19 | 22 | 0.31 | 0.27 | 0.042 | 0.60 | 0.023 |
| | 40-45 | P-11834 | 2.6 | 48.4 | 37.2 | — | — | — | — | 14.4 | — | 59 | 19 | 22 | — | — | — | — | — |
| | 45-50 | P-11835 | 2.2 | 43.0 | 39.7 | — | — | — | — | 17.3 | — | 65 | 13 | 22 | — | — | — | — | — |
| | 50-55 | P-11836 | 2.2 | 39.4 | 39.7 | 48.3 | 13.3 | 12.3 | 1.08 | 20.3 | — | 64 | 16 | 21 | 0.17 | 0.15 | 0.030 | — | 0.003 |
| | 55-61 | P-11837 | 2.4 | 37.6 | 39.3 | 52.3 | 13.3 | 10.1 | 1.31 | 23.1 | — | 67 | 11 | 22 | 0.26 | 0.23 | 0.018 | — | 0.004 |
| IIIA | 61-65 | P-11838 | 2.5 | 37.3 | 35.9 | 51.8 | 7.8 | 10.9 | 0.71 | 26.8 | 23.8 | 65 | 14 | 21 | 0.16 | 0.15 | 0.088 | — | 0.003 |
| | 65-70 | P-11839 | 1.5 | 35.0 | 35.4 | 54.5 | 12.6 | 10.2 | 1.23 | 29.6 | 25.8 | 66 | 16 | 18 | 0.20 | 0.15 | 0.032 | — | 0.004 |
| IIIBg | 70-75 | P-11840 | 1.3 | 38.9 | 33.9 | 49.0 | 8.8 | 12.0 | 0.73 | 27.2 | — | 64 | 16 | 20 | — | — | — | — | — |
| | 75-80 | P-11841 | 5.1 | 39.8 | 31.8 | 49.0 | 8.1 | 11.2 | 0.72 | 28.4 | 21.8 | 64 | 15 | 21 | 0.26 | 0.19 | 0.042 | 1.20 | 0.022 |
| | 80-85 | P-11842 | 3.4 | 41.5 | 31.5 | — | — | — | — | 27.0 | — | 62 | 19 | 19 | — | — | — | — | — |
| | 85-90 | P-11843 | 7.2 | 44.8 | 27.5 | — | — | — | — | 27.7 | — | 59 | 22 | 19 | — | — | — | — | — |
| | 90-95 | P-11844 | 2.6 | 40.7 | 33.6 | 49.7 | 9.6 | 10.1 | 0.95 | 25.7 | 21.6 | 58 | 21 | 21 | 0.20 | 0.17 | 0.029 | — | 0.024 |
| | 95-101 | P-11845 | 7.4 | 51.8 | 25.8 | 36.7 | 7.6 | 9.7 | 0.77 | 22.4 | — | 58 | 22 | 20 | — | — | — | — | — |
| | 101-105 | P-11846 | 34.7 | 52.5 | 25.7 | 38.4 | 5.6 | 9.8 | 0.57 | 21.8 | — | 41 | 36 | 23 | — | — | — | — | — |
| IVBg | 105-110 | P-11847 | 1.9 | 40.2 | 35.9 | 48.7 | 7.9 | 11.1 | 0.71 | 23.9 | 16.5 | 37 | 41 | 22 | 0.09 | 0.07 | 0.122 | 1.67 | 0.001 |
| | 110-115 | P-11848 | 3.2 | 40.8 | 36.3 | — | — | — | — | 22.9 | — | 38 | 39 | 23 | — | — | — | — | — |
| | 115-120 | P-11849 | 1.5 | 38.0 | 39.0 | 49.8 | 10.3 | 12.6 | 0.81 | 23.0 | — | 43 | 36 | 21 | — | — | — | — | — |
| | 120-128 | P-11850 | 1.5 | 34.0 | 45.9 | 54.8 | 11.3 | 11.4 | 0.99 | 20.1 | — | 54 | 29 | 18 | 0.13 | 0.12 | 0.063 | — | 0.001 |
| IVC | 128-135 | P-11851 | 4.2 | 39.7 | 41.9 | 47.5 | 9.3 | 12.8 | 0.72 | 18.4 | 11.8 | 30 | 50 | 20 | 2.51 | 0.16 | 0.042 | — | 0.088 |

(Continued on next page)

TABLE 8—Continued

| Soil horizon | Depth (in.) | Sample number | Particle size: Gravel (> 2 mm) (%) | Sand (0.062-2 mm) (%) | Silt (2-62 μ) (%) | (< 31 μ) (%) | Medium silt (16-31 μ) (%) | Coarse silt (31-62 μ) (%) | Medium to coarse silt ratio $\frac{16\text{-}31\ \mu}{31\text{-}62\ \mu}$ | Clay (< 2 μ) (%) | Fine clay (< 0.5 μ) (%) | Clay minerals (%): Expandable | Illite | Kaolinite plus chlorite | Chemical data: Total C (%) | Organic C (%) | Total $P_2O_5$ (%) | $Fe_2O_3$ (%) | $MnO_2$ (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Center School Section: Profile E | | | | | | | | | | |
| IIA1 | 0-6 | P-11852 | 0.9 | 39.1 | 45.7 | 55.4 | 18.3 | 5.5 | 3.32 | 15.2 | 12.6 | 64 | 25 | 11 | 0.37 | 0.35 | 0.069 | — | 0.047 |
| IIA2 | 6-12 | P-11853 | 1.4 | 34.6 | 52.3 | 53.7 | 17.2 | 11.7 | 1.47 | 13.1 | 9.8 | 68 | 17 | 15 | 0.21 | 0.17 | 0.058 | — | 0.017 |
| IIB1 | 12-18 | P-11854 | 1.6 | 36.0 | 50.4 | 45.7 | 11.4 | 18.3 | 0.62 | 13.6 | 11.6 | 71 | 16 | 13 | 0.22 | 0.20 | 0.048 | — | 0.022 |
| IIB2 | 18-24 | P-11855 | 1.3 | 40.6 | 45.3 | 45.4 | 11.8 | 14.8 | 0.79 | 14.1 | — | 71 | 16 | 13 | — | — | — | — | — |
| | 24-30 | P-11856 | 1.9 | 41.4 | 45.9 | 42.8 | 12.4 | 15.6 | 0.79 | 13.7 | 10.2 | 71 | 14 | 15 | 0.19 | 0.19 | 0.031 | — | 0.023 |
| IIB3 | 30-36 | P-11857 | 1.6 | 41.4 | 37.3 | — | — | — | — | 21.3 | — | 71 | 13 | 16 | — | — | — | — | — |
| | 36-42 | P-11858 | 2.6 | 41.2 | 37.2 | — | — | — | — | 21.6 | — | 70 | 12 | 17 | — | — | — | — | — |
| | 42-48 | P-11859 | 2.1 | 39.6 | 38.4 | — | — | — | — | 22.0 | — | 71 | 14 | 15 | 0.14 | 0.14 | 0.027 | — | 0.064 |
| | 48-52 | P-11860 | 1.7 | 37.8 | 41.7 | 51.4 | 10.2 | 10.8 | 0.94 | 21.5 | 12.1 | 74 | 12 | 14 | 0.58 | 0.52 | 0.026 | 1.12 | 0.019 |
| IIIA | 52-60 | P-11861 | 2.7 | 40.9 | 37.7 | 48.4 | 10.8 | 10.3 | 1.04 | 22.4 | 14.3 | 73 | 13 | 14 | 0.34 | 0.28 | 0.030 | — | 0.036 |
| IIIB1 | 60-66 | P-11862 | 15.6 | 41.2 | 37.8 | — | — | — | — | 21.0 | — | 73 | 13 | 14 | 0.12 | 0.10 | 0.036 | 3.59 | 0.273 |
| IIIB2 | 66-72 | P-11863 | 6.8 | 43.1 | 32.4 | 47.4 | 7.2 | 9.6 | 0.75 | 24.5 | 21.9 | 72 | 15 | 13 | 0.09 | 0.07 | 0.028 | — | 0.165 |
| | 72-78 | P-11864 | 2.7 | 45.1 | 33.1 | — | — | — | — | 21.8 | — | 72 | 15 | 13 | — | — | — | — | — |
| IIIB3 | 78-84 | P-11865 | 23.5 | 58.4 | 18.6 | 31.1 | 3.7 | 8.5 | 0.43 | 23.0 | 20.4 | 66 | 21 | 13 | 0.79 | 0.76 | 0.053 | 2.76 | 0.007 |
| | 84-90 | P-11866 | 25.3 | 63.1 | 16.1 | — | — | — | — | 20.8 | — | 62 | 25 | 13 | — | — | — | — | — |
| IVB3 | 90-96 | P-11867 | 3.0 | 47.3 | 29.6 | — | — | — | — | 23.1 | — | 57 | 30 | 13 | — | — | — | — | — |
| IVC1 | 96-104 | P-11868 | 3.3 | 47.2 | 33.2 | 40.1 | 5.4 | 12.7 | 0.42 | 19.6 | 12.1 | 40 | 48 | 12 | 0.26 | 0.26 | 0.074 | — | 0.004 |
| IVC2 | 104-110 | P-11869 | 3.7 | 41.2 | 40.0 | 45.6 | 10.6 | 13.2 | 0.80 | 18.8 | 14.1 | 38 | 51 | 11 | 2.28 | 0.12 | 0.063 | — | 0.200 |
| | | | | | | | | | Jewett Section: Profile F | | | | | | | | | | |
| | | | | | | | | | | | | | | | | Total Fe | | | |
| A1 | 0-3 | P-12009 | 0.3 | 9.1 | 79.4 | 74.2 | 23.2 | 16.6 | 1.39 | 11.5 | 7.0 | 16 | 53 | 31 | 1.14 | 2.19 | | 1.12 | |
| A2 | 3-7 | P-12010 | 0.3 | 5.1 | 82.0 | 79.3 | 22.5 | 15.6 | 1.44 | 12.9 | 7.1 | 17 | 57 | 26 | 0.79 | 2.24 | | 1.08 | |
| B1 | 7-13 | P-12011 | 0.1 | 2.2 | 79.2 | 88.6 | 22.6 | 9.2 | 2.45 | 18.6 | 12.0 | 33 | 29 | 28 | 0.59 | 2.93 | | 1.31 | |
| B2 | 13-18 | P-12012 | 0 | 0.9 | 66.4 | 91.7 | 20.3 | 7.4 | 2.74 | 32.7 | 26.2 | 47 | 31 | 23 | 0.59 | 5.14 | | 2.06 | |
| | 18-23 | P-12013 | 0 | 0.7 | 69.6 | 89.5 | 23.0 | 9.7 | 2.37 | 29.7 | 22.8 | 51 | 31 | 18 | 0.50 | 4.11 | | 2.00 | |
| B3 | 23-30 | P-12014 | 0 | 1.0 | 73.1 | 84.2 | 23.1 | 14.7 | 1.57 | 25.9 | 21.4 | 54 | 32 | 14 | 0.31 | 4.35 | | 2.14 | |
| B'2x | 30-36 | P-12015 | 0 | 1.7 | 65.0 | 82.2 | 18.3 | 16.0 | 1.14 | 33.3 | 29.1 | 62 | 27 | 11 | 0.24 | 5.54 | | 2.27 | |
| B'3x | 36-42 | P-12016 | 0 | 6.2 | 67.1 | 81.3 | 22.7 | 12.5 | 1.81 | 26.7 | 21.1 | 68 | 23 | 9 | 0.28 | 4.44 | | 1.64 | |

TABLE 8— Concluded

| Soil horizon | Depth (in.) | Sample number | Particle size: Gravel (> 2 mm) (%) | Sand (0.062-2 mm) (%) | Silt (2-62 μ) (%) | (< 31 μ) (%) | Medium silt (16-31 μ) (%) | Coarse silt (31-62 μ) (%) | Medium to coarse silt ratio $\frac{16\text{-}31\ \mu}{31\text{-}62\ \mu}$ | Clay (< 2 μ) (%) | Fine clay (< 0.5 μ) (%) | Clay minerals (%): Expandable | Illite | Kaolinite plus chlorite | Chemical data: Total C (%) | Total Fe (%) | $Fe_2O_3$ (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Jewett Section: Profile F (Concluded) | | | | | | | | | | |
| IIA1x | 42-48 | P-12017 | 0.1 | 18.6 | 66.2 | 67.1 | 20.4 | 14.3 | 1.42 | 15.2 | 12.8 | — | — | — | 0.20 | 3.28 | 1.23 |
| IIA2x | 48-54 | P-12018 | 0.1 | 26.9 | 62.0 | 54.0 | 16.4 | 19.1 | 0.85 | 11.1 | 8.7 | — | — | — | 0.38 | 2.44 | 1.10 |
| IIBx | 54-60 | P-12019 | 0.1 | 27.0 | 58.9 | 53.3 | 16.8 | 19.7 | 0.85 | 14.1 | 9.2 | 51 | 26 | 23 | 0.37 | 2.49 | 1.32 |
| | 60-66 | P-12020 | 0.2 | 34.2 | 55.4 | 49.7 | 16.5 | 16.2 | 1.01 | 10.4 | 7.0 | 51 | 26 | 23 | 0.26 | 2.54 | 1.11 |
| IIIA2 | 66-69 | P-12021 | 0.5 | 37.8 | 49.1 | 47.9 | 14.0 | 14.3 | 0.97 | 13.1 | 7.8 | 57 | 24 | 19 | 0.30 | 2.44 | 1.12 |
| | 69-72 | P-12022 | 1.5 | 34.2 | 53.6 | 45.8 | 13.0 | 20.1 | 0.64 | 12.2 | 7.5 | 56 | 24 | 20 | 0.13 | 2.05 | 1.08 |
| IIIB1 | 72-75 | P-12023 | 6.8 | 39.4 | 46.4 | 45.6 | 10.4 | 14.9 | 0.69 | 14.2 | 8.2 | 55 | 27 | 18 | 0.16 | 1.98 | 1.27 |
| | 75-78 | P-12024 | 17.9 | 34.4 | 45.6 | 47.4 | 10.1 | 18.2 | 0.55 | 20.0 | 12.6 | 55 | 26 | 19 | — | — | — |
| IIIB2 | 78-84 | P-12025 | 6.5 | 33.8 | 31.6 | 55.5 | 6.8 | 10.7 | 0.63 | 34.6 | 26.6 | 57 | 28 | 15 | 0.66 | 3.54 | 2.60 |
| | 84-90 | P-12026 | 5.5 | 31.7 | 26.8 | 58.7 | 5.1 | 9.5 | 0.53 | 41.5 | 34.4 | 54 | 30 | 16 | — | — | — |
| | 90-96 | P-12027 | 5.6 | 29.9 | 34.9 | 55.1 | 6.2 | 15.0 | 0.41 | 35.2 | 29.0 | 53 | 33 | 14 | 0.25 | 4.69 | 3.59 |
| IIIB31 | 96-102 | P-12028 | 4.3 | 41.4 | 30.6 | 46.5 | 6.0 | 12.1 | 0.49 | 28.0 | 22.4 | 55 | 33 | 12 | — | — | — |
| | 102-108 | P-12029 | 3.0 | 40.1 | 32.7 | 47.7 | 6.2 | 12.2 | 0.50 | 27.2 | 21.5 | 52 | 35 | 15 | 0.16 | 3.36 | 2.12 |
| IIIB32 | 108-114 | P-12030 | 10.9 | 56.1 | 28.9 | 25.0 | 7.5 | 18.9 | 0.39 | 15.0 | 13.1 | — | — | — | 0.21 | 3.18 | 2.50 |
| IIIC1 | 114-119 | P-12031 | 7.0 | 45.0 | 34.1 | 42.8 | 6.4 | 12.1 | 0.52 | 20.9 | 14.1 | 54 | 35 | 11 | — | — | — |
| | 119-124 | P-12032 | 3.6 | 42.2 | 37.5 | 43.8 | 7.1 | 14.0 | 0.50 | 20.3 | 13.2 | 50 | 38 | 12 | 0.11 | 3.20 | 1.76 |
| IIIC2 | 124-134 | P-12033 | 4.7 | 45.0 | 40.5 | 42.3 | 8.4 | 12.7 | 0.66 | 14.5 | 7.1 | 25 | 59 | 16 | 2.08 | 2.69 | 0.99 |
| | 160-164 | P-12034 | 6.2 | 41.9 | 43.0 | 42.6 | 8.4 | 15.6 | 0.53 | 15.1 | 8.6 | 16 | 65 | 19 | 2.76 | 2.26 | 0.90 |
| | 208-212 | P-12035 | 9.3 | 43.9 | 40.8 | 42.8 | 8.1 | 13.3 | 0.60 | 15.3 | 7.9 | 17 | 66 | 17 | — | — | — |
| | | | | | | | | Jewett Section: Profile G | | | | | | | | | |
| VA1? | 0-5 | P-12036 | 0.4 | 48.3 | 29.2 | 41.5 | 6.5 | 10.2 | 0.63 | 22.5 | 17.7 | 82 | 11 | 7 | 0.30 | 4.49 | 2.31 |
| VA2? | 5-10 | P-12037 | 0.6 | 54.2 | 26.0 | 36.1 | 5.9 | 9.7 | 0.60 | 19.8 | 16.0 | 83 | 10 | 7 | 0.24 | 2.84 | 2.34 |
| | 10-15 | P-12038 | 0.6 | 58.7 | 25.4 | 30.4 | 4.4 | 10.9 | 0.40 | 15.9 | 13.4 | 81 | 11 | 8 | 0.14 | 3.21 | 2.04 |
| VB? | 15-20 | P-12039 | 5.6 | 61.1 | 25.9 | 27.7 | 5.7 | 11.2 | 0.50 | 13.0 | 10.4 | 81 | 11 | 8 | 0.15 | 2.89 | 1.27 |
| VB3 | 20-26 | P-12040 | 8.2 | 67.7 | 24.4 | 22.4 | 4.0 | 9.9 | 0.40 | 7.9 | 4.8 | 20 | 58 | 22 | — | — | — |
| | 26-32 | P-12041 | 24.3 | 58:2 | 31.6 | 28.7 | 5.4 | 13.1 | 0.41 | 10.2 | 4.6 | 29 | 51 | 20 | 0.15 | 9.88 | 7.02 |
| VIC1 | 32-38 | P-12042 | 1.9 | 31.6 | 50.4 | 51.6 | 9.0 | 16.8 | 0.53 | 18.0 | 8.8 | 36 | 49 | 15 | 0.06 | 4.91 | 2.92 |
| VIC2 | 38-44 | P-12043 | 6.0 | 36.7 | 48.8 | 45.8 | 11.4 | 17.5 | 0.65 | 13.6 | 7.5 | 18 | 66 | 16 | 2.82 | 4.15 | 2.74 |
| | 50-56 | P-12044 | 7.6 | 44.1 | 45.1 | 40.1 | 9.9 | 15.8 | 0.62 | 10.8 | 4.4 | 17 | 68 | 15 | 2.82 | 4.35 | 2.43 |

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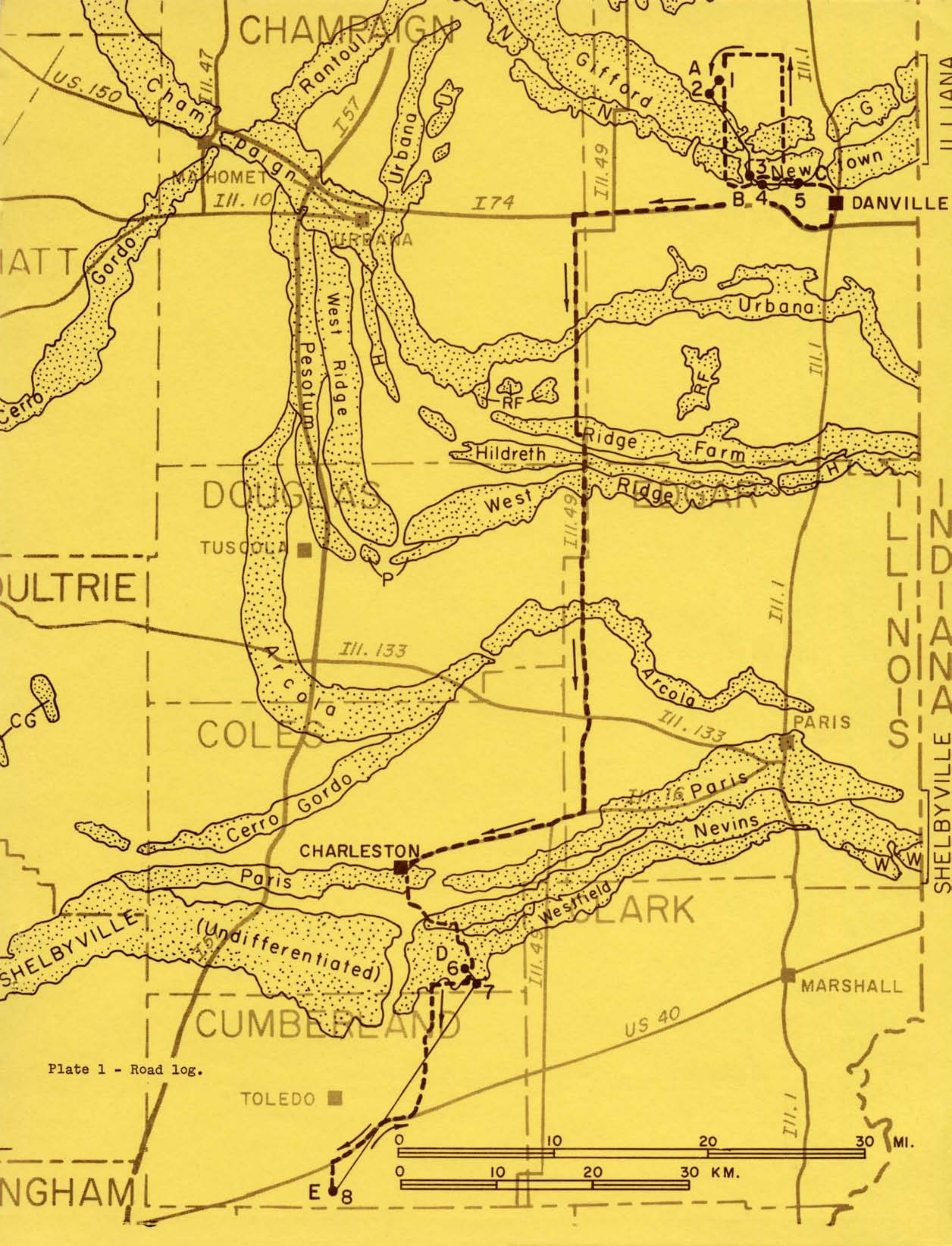


Plate 1 - Road log.