Guidebook 21

Wisconsinan and Sangamonian type sections of central Illinois

E. Donald McKay

Ninth Biennial Meeting, American Quaternary Association
University of Illinois at Urbana-Champaign, May 31-June 6, 1986

Sponsored by the Illinois State Geological and Water Surveys, the Illinois State Museum, and the University of Illinois Departments of Geology, Geography, and Anthropology

Wisconsinan and Sangamonian type sections of central Illinois

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Contents

This guidebook was prepared for the Ninth Biennial Meeting of the American Quaternary Association held in Urbana-Champaign, Illinois, May 31-June 6, 1986. Much of the material was taken from previous guidebooks, and new material was added to complete the tour itinerary for the AMQUA meeting. Our purpose in compiling this guidebook was to provide the newest information and interpretations and to stimulate discussion. The guidebook was reviewed internally, but not by outside reviewers; the articles reflect the thinking of the individual authors at the time of preparation of the guidebook, not necessarily the current opinions or positions of the Illinois State Geological Survey.

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INTRODUCTION

Geologic sections in central Illinois expose deposits that have had a profound influence on the development of concepts of continental glaciation in the midcontinent. Two principal exposures show these deposits much as they were viewed by early investigators late in the 19th century. The Farm Creek Section in Tazewell County east of Peoria, Illinois was first described by Frank Leverett in the 1890s. Intense study and restudy of the section since Leverett's work has been instrumental in the evolution of concepts of Wisconsinan and Sangamonian time and deposits.

In southern Menard County, the Athens Quarry Sections expose deposits and paleosols in the type region of the Sangamon Soil. The complex sedimentologic and pedologic processes recorded in the deposits in the quarry are similar to those first described by Worthen (1873) and later named the Sangamon Soil by Leverett (1898a).

Central Illinois also contains an important record of prehistoric human occupations. A visit to the Dickson Mounds Site and Museum will offer the opportunity to review the current knowledge in this area of active research.

Our field trip will follow a route from Champaign, Illinois, northwestward across late Wisconsinan landscapes to the Peoria area, south along the Illinois River valley to Dickson Mounds, southeastward across the broad outwash valley train of the Illinois River, and onto the Illinoian till plain north of Springfield, returning to Champaign (fig. 1). A road log is not included in this guidebook.

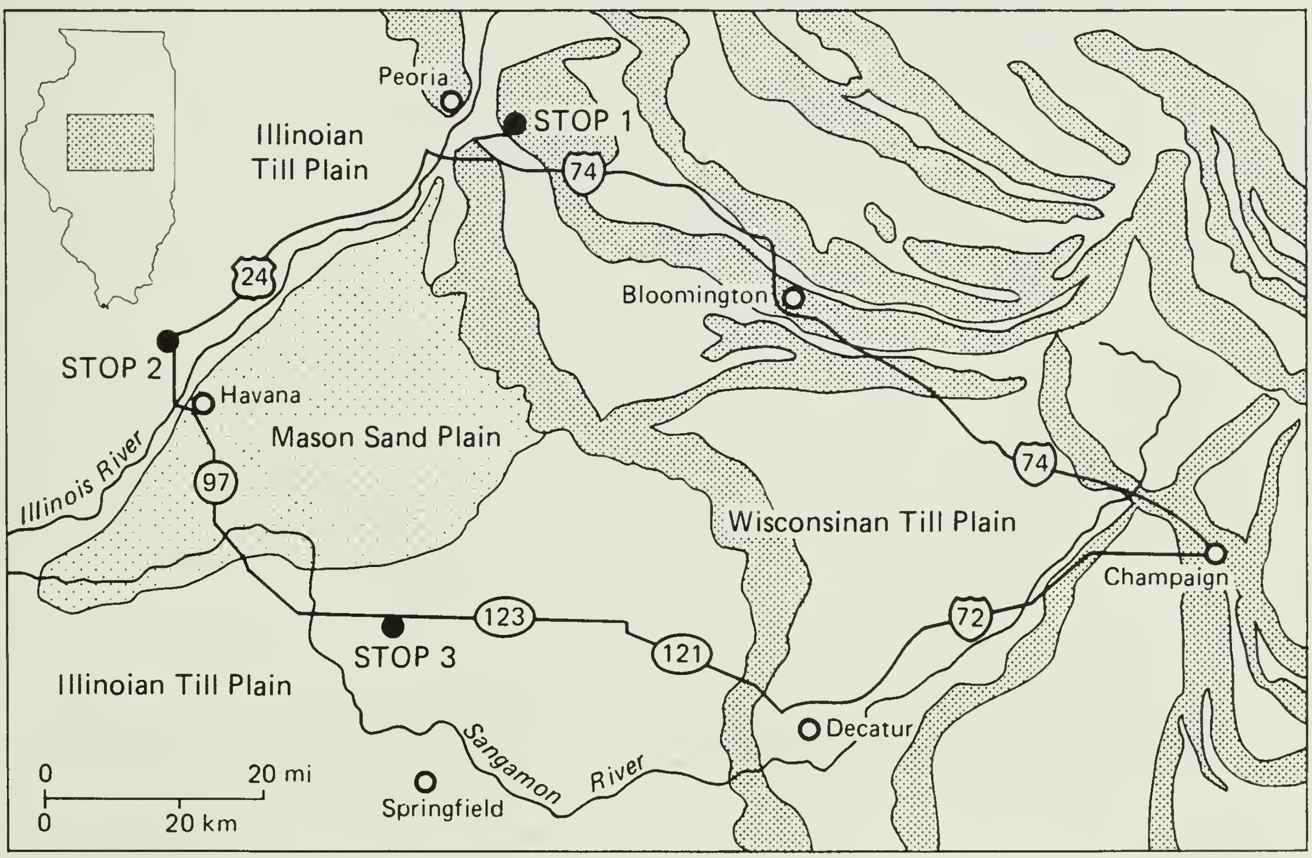


Figure 1. Route map for the field trip.

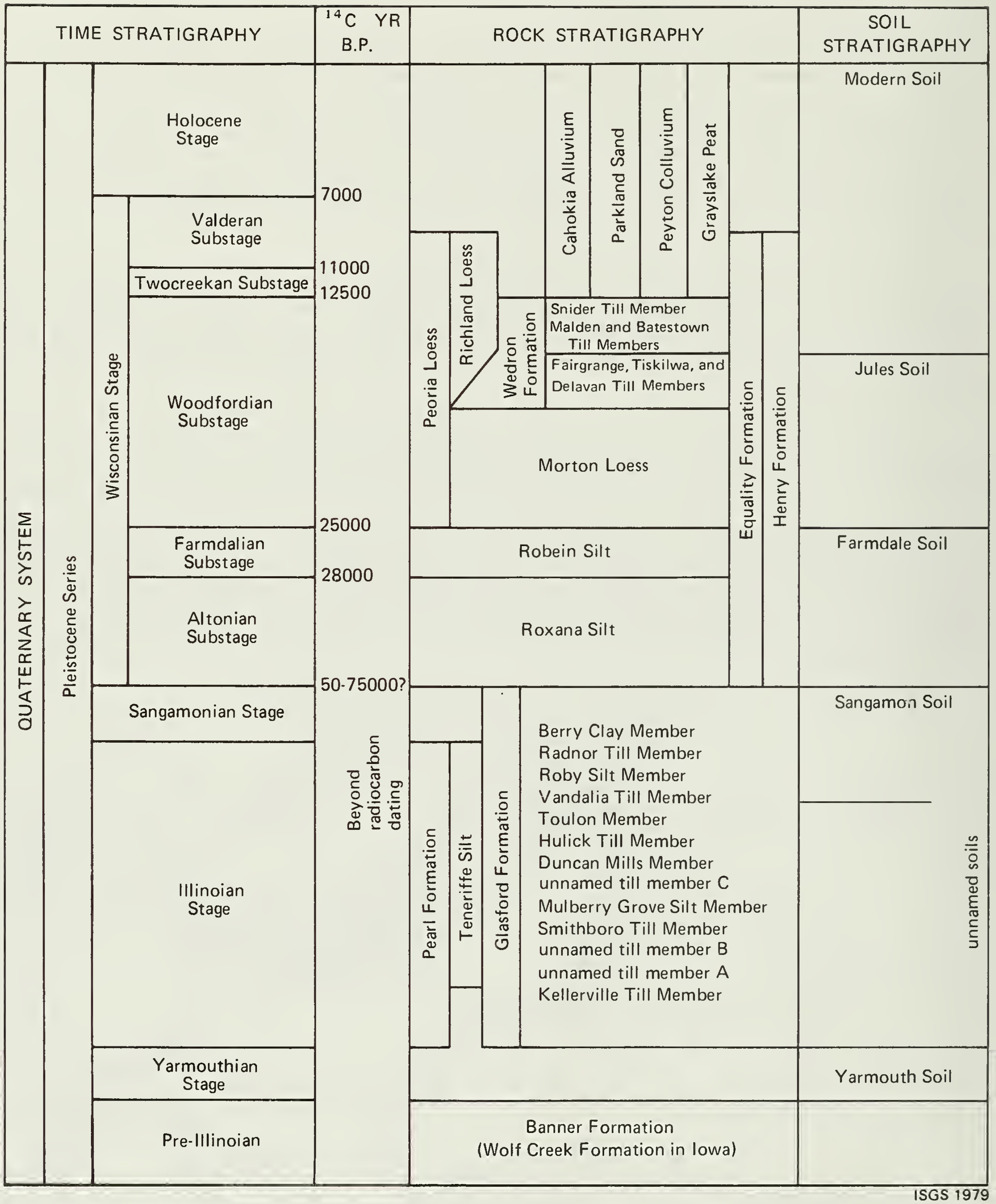


Figure 2. Time-stratigraphic, rock-stratigraphic, and soil-stratigraphic units and absolute dating of the Quaternary deposits in the Peoria-Springfield area.

The Farm Creek Section and the Athens Quarry Sections were both featured stops on the 1979 Midwest Friends of the Pleistocene Field Conference (Follmer et al., 1979). The following summary and discussion draws heavily on materials prepared for that conference.

The purpose of this field conference is (1) to reexamine the classic Farm Creek Section, which has been studied by geologists for nearly 90 years and has been used by many researchers as a type or reference section for several rock-, time-, and soil-stratigraphic classifications of the Quaternary; (2) to examine details of the development of the Sangamon Soil under varying environmental conditions in its type region; and (3) to consider some details of stratigraphic and compositional variations in the Wisconsinan loesses and their relation to Wisconsinan glaciation in Illinois.

The Peoria-Springfield, Illinois, region has been trodden by many well-known Quaternary geologists during the last century: Worthen, Leverett, Leighton, MacClintock, Horberg, Willman, and Frye, to name but a few, used sections in the region to develop concepts of Quaternary stratigraphy. Yet much remains to be done. Recently developed ideas on basic classification of the Quaternary, correlation of climatic changes with the marine record, soil development in the geologic past, and interpretation of proglacial loess deposits are based on studies in this classical region. We will examine these ideas during the field conference.

REGIONAL GEOLOGIC SETTING

Sheets of drift from the Illinoian and Wisconsinan Stages cover the Peoria-Springfield region. Older drift is found in places below the Illinoian. Time-, rock-, and soil-stratigraphic units used in the Peoria-Springfield region are summarized in figure 2. Two major preglacial valleys, the Ancient Mississippi and the Mahomet, meet just east of Mason County between Peoria and Springfield. These valleys were filled by glacial deposits during the Quaternary. Drift exceeds 130 m in thickness in parts of the valley system and thins to 15 m or less in places on the uplands west of the present Illinois River valley and south of the Sangamon River.

Various Illinoian glaciers advanced across the entire area. The late Wisconsinan glaciers advanced into the northeastern part of the region, crossing the Illinois River at Peoria. Extensive surficial deposits of glacial outwash and slack-water lake deposits resulting from the late Wisconsinan glaciation are found in the Illinois River valley and tributary valleys. Uplands were covered by thick deposits of Wisconsinan loess, and extensive areas of sand dunes developed on the valley-train deposits.

Pre-Illinoian drift

Pre-Illinoian drift is present in places below the Illinoian, but little is known of pre-Illinoian drift in the Peoria-Springfield area because of its limited exposure. Some drift previously thought to be pre-Illinoian may be better included in the Illinoian (Lineback, 1979). Where present, the pre-Illinoian drift is included in the Banner Formation (fig. 2). The Banner probably includes several till sheets of differing lithology and intercalated sand, gravel, silt, and clay deposits. Paleosols may be present within the pre-Illinoian succession, and in many places the sucession is capped by an often truncated but well-developed paleosol, the Yarmouth Soil.

Illinoian drift

The youngest known Illinoian glaciation in central Illinois--represented by the Radnor Till Member of the Glasford Formation (fig. 2)--advanced only a few kilometers farther than the later Wisconsinan glaciers. The upland beyond the Radnor in the Springfield area is underlain by the older Vandalia Till Member of the Glasford Formation. The Vandalia apparently did not extend west of the Illinois Valley where the Radnor overlies the Hulick Till Member. An extensive late Illinoian proglacial lake existed near Springfield during the Radnor advance (Bergstrom, Piskin, and Follmer, 1976). Deposits of this lake are included in the Teneriffe Silt (fig. 2).

The Illinoian drift contains several significant unnamed paleosols (Lineback, 1979) and is capped by the Sangamon Soil (fig. 2).

Wisconsinan drift

Tills of the Altonian Substage (early Wisconsinan) of the Wisconsinan are known only from northern Illinois, and recent studies have questioned their age (Berg et al., 1985); however, during the early Wisconsinan, meltwater and valley-train deposits extended southward down the Ancient Mississippi Valley. Loess (Roxana Silt) blown from the outwash was deposited on the uplands from Illinois to Mississippi. Regionally, the Roxana, most of which was deposited between about 45,000 and 30,000 years BP, can be divided into several mineralogical zones and related to Altonian glacial events (McKay, 1979).

The Robein Silt, commonly organic rich, lies between the Roxana Silt and the Morton or Peoria Loesses in many places. The weakly developed Farmdale Soil formed in the Robein or in the Roxana during the Farmdalian Substage, a minor interstadial in Illinois.

Woodfordian glaciers reached the Peoria area about 19,000 BP. Till and intercalated deposits of the Woodfordian Substage are included in the Wedron Formation. The basal Wedron till overlies the Morton Loess, a proglacial loess that correlates with the lower part of the Peoria Loess beyond the Wisconsinan glacial limit. An age of 25,000 RCYBP for the base of the Morton Loess indicates that glaciers reentered the Ancient Mississippi drainage basin 6,000 years before they reached the Peoria area. The basal Wedron tills are generally reddish gray, violet gray, reddish brown, brown, or gray, depending on the composition and degree of oxidization. The till is generally sandy, relatively high in illite, and dolomitic.

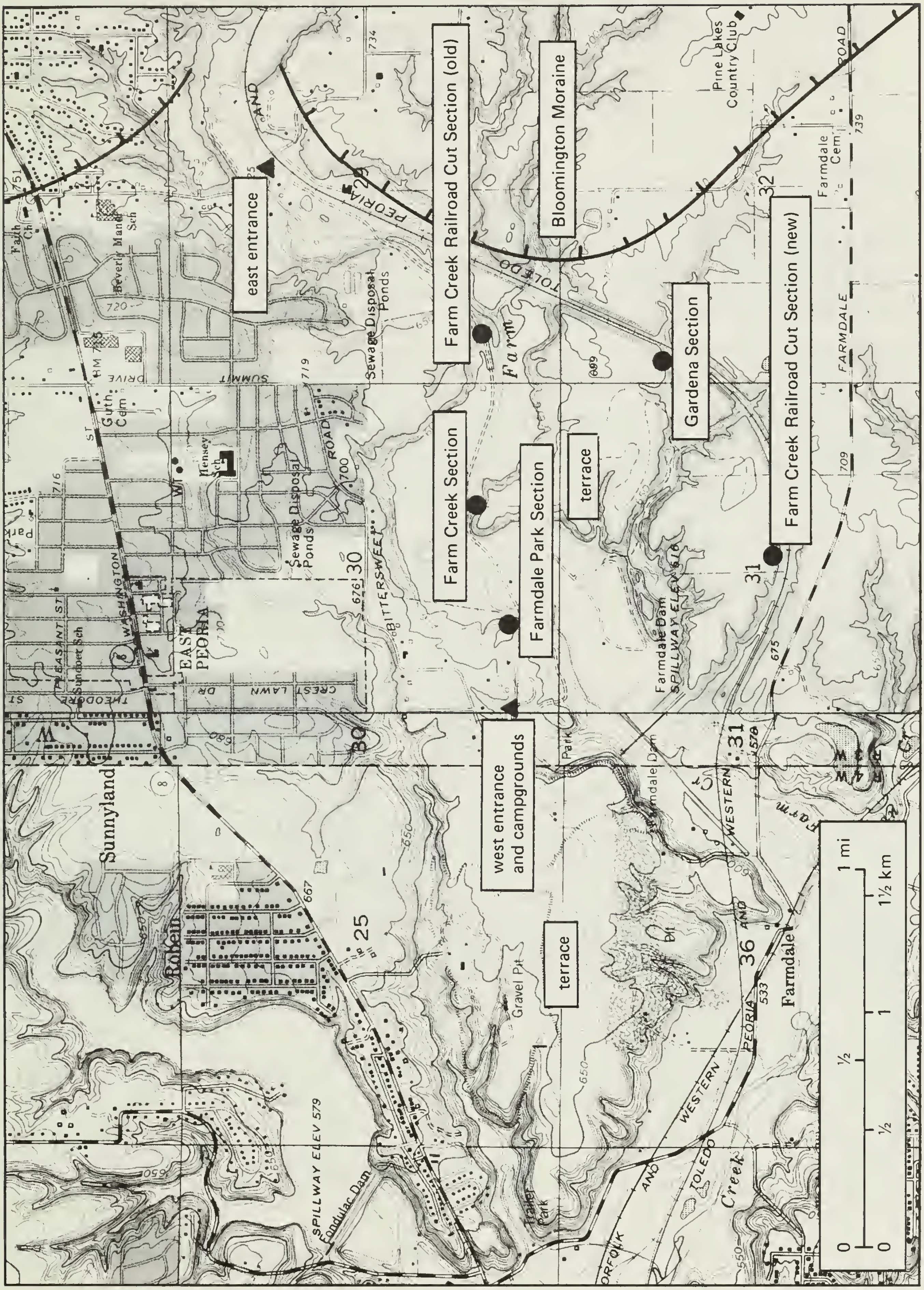
Three regional names have been applied to the basal Wedron: the Fairgrange Till Member in east-central Illinois, the Delavan Till Member in the area east and south of Peoria, and the Tiskilwa Till Member east and north of Peoria and in the area west of the Illinois River. In the East Peoria area, the name Delavan has been used at Farm Creek, Farmdale Park, and Gardena. The Tiskilwa has been mapped to the front of the Bloomington

Morainic System (Willman and Frye, 1970) and may represent an additional increment of the same kind of till on top of the Delavan. In any case, there are few data to allow separation of the Delavan from the Tiskilwa or Fairgrange in the region. East of Peoria, in Woodford and McLean Counties, younger Woodfordian tills are present. The Malden and Batestown Till Members are representative of a group of gray, silty tills that are in turn overlain by clay-rich till of the Snider Till Member.

With the advance of the Woodfordian glaciers, large volumes of meltwater were channeled into the Illinois River valley. A large area of outwash (Henry Formation) was deposited in a lowland where the two bedrock valleys join. A complex series of terraces now lies above the present floodplains in Mason County (fig. 1). Farther downstream, and up tributary valleys, lacustrine deposits formed in slackwater lakes (Equality Formation). Eolian deposition of fine sand took place on these valley-train deposits during the waning stages of glaciation and formed a complex system of sand dunes (Parkland Sand). Finer sediment was blown onto the uplands from the valley-train deposits forming the Peoria and Richland Loesses. Peat and organic-rich sediment were deposited in lakes that formed on the floodplains (Grayslake Peat) as the modern floodplain developed through the deposition of the Cahokia Alluvium. The Peyton Colluvium (fig. 2) is largely unsorted debris that accumulated on and at the base of steep slopes by creep and slope wash.

FARM CREEK: A NOTABLE PLEISTOCENE SECTION

E. Donald McKay and Leon R. Follmer



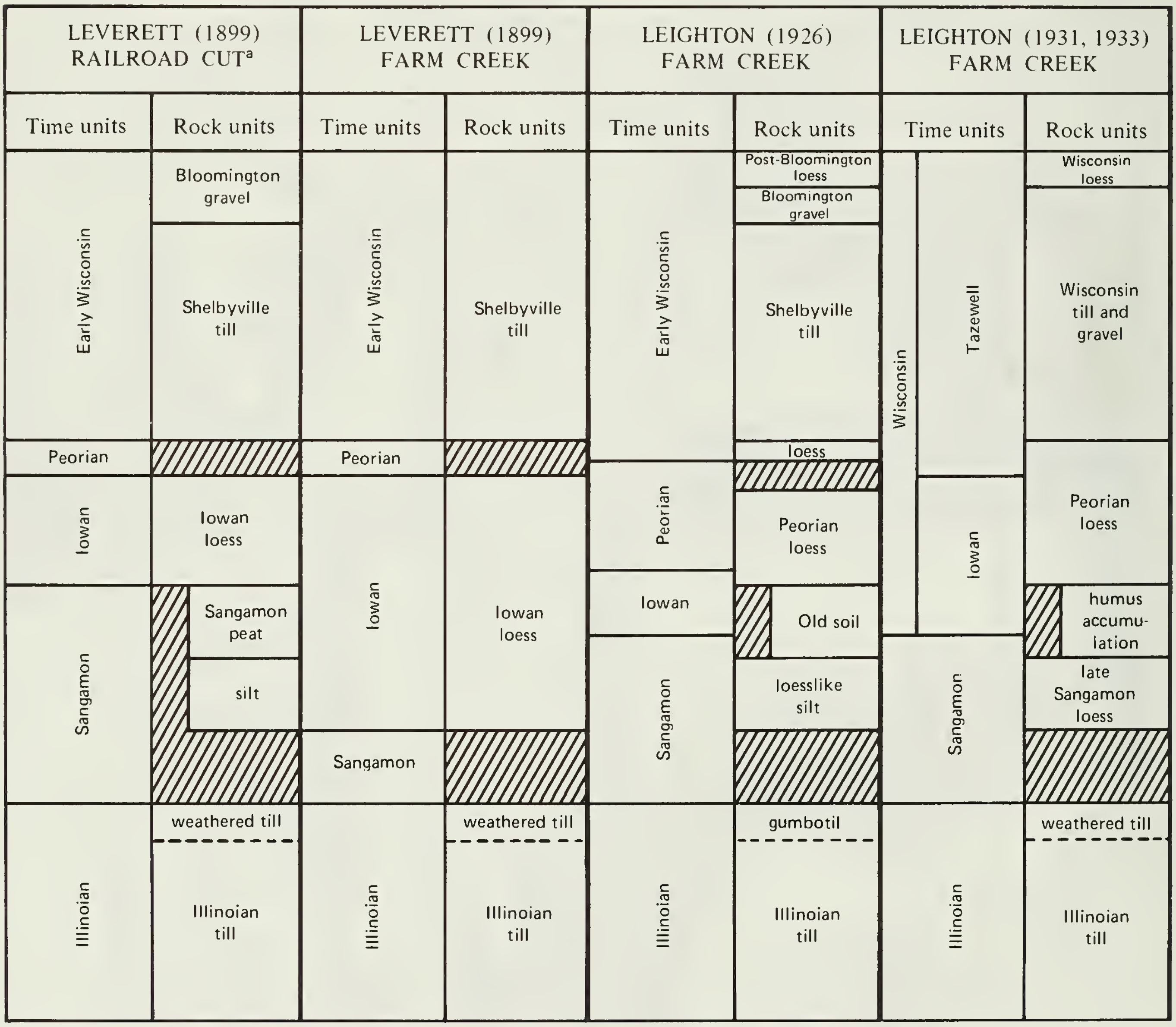
STOP 1. Farm Creek Section and adjacent sections

Sec. 30, 31, and 32, T26N, R3W, Tazewell County IL (Peoria East and Washington Quadrangles)

First described by Leverett in 1899, The Farm Creek Section has been much studied ever since by glacial geologists.

INTRODUCTION

The Farm Creek Section (page 7) is a classic Pleistocene exposure that has been studied by many geologists as a type or reference section for several different rock-, time-, and soil-stratigraphic units (fig. 4). It remains well exposed, and recent work has reaffirmed the importance of the exposure to stratigraphic studies (McKay, 1979).



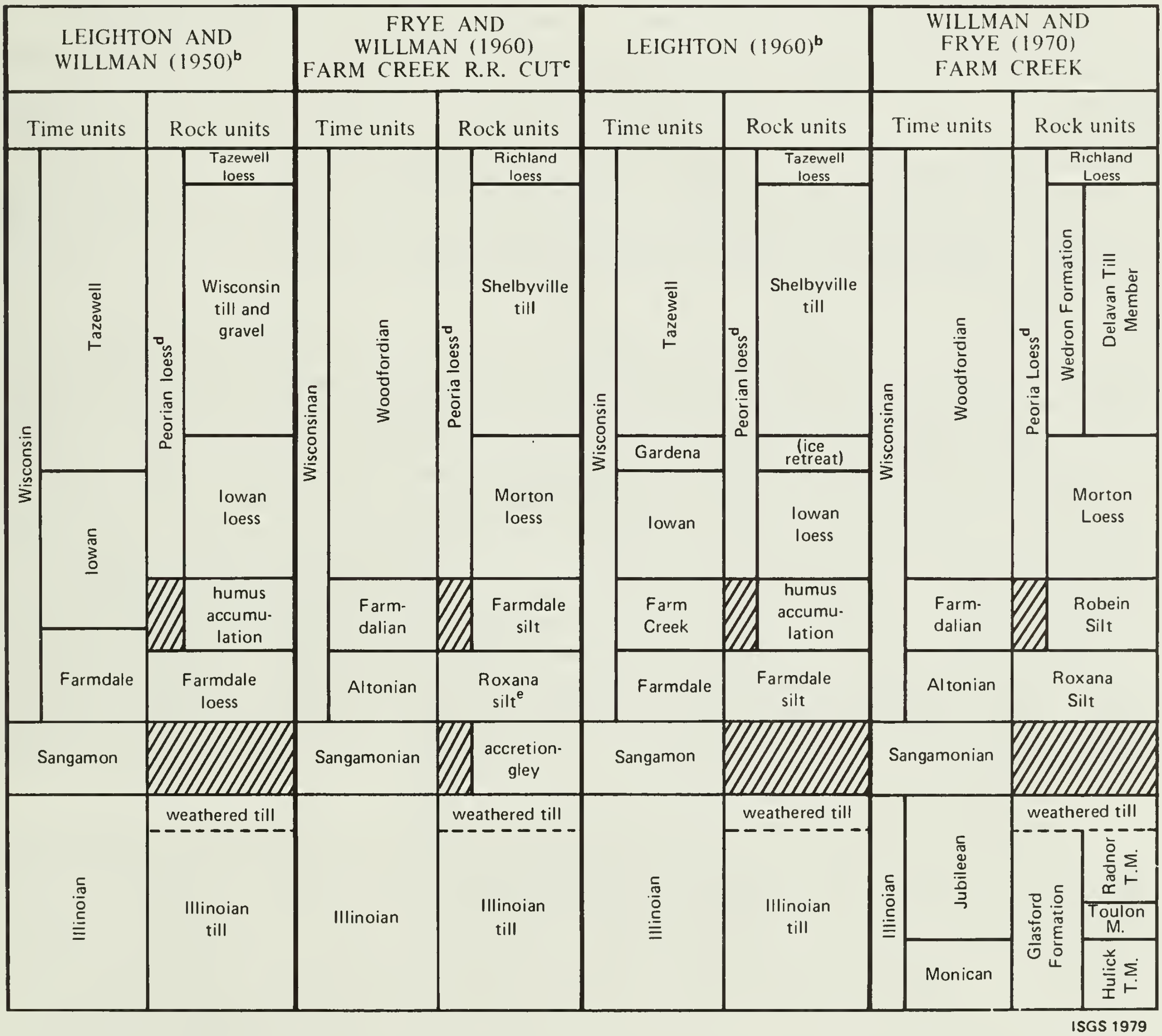
[a] Railroad cut about a half mile east of classic Farm Creek Section.
[b] No section in Farm Creek area specifically described.
[c] Railroad cut about three-quarters mile south of classic section.
[d] Used only outside the area of Wisconsinan drift.
[e] Absent at this locality.

Figure 4. Principal developments of the stratigraphic classification of Quaternary deposits exposed

In the 1970 classification of Pleistocene deposits in Illinois, Willman and Frye designated Farm Creek as the type section for the Farmdalian Substage, Robein Silt, and Farmdale Soil. Recent stratigraphic studies have suggested that careful reexamination of these units is necessary for a more complete understanding of their stratigraphic importance.

Background

Leverett (1899) first described and interpreted the Farm Creek Section in terms of the meaning of the organic soil and weathering zone on the Illinoian till. He related both features to the Sangamon Soil and considered them to be evidence for an interglacial stage (Follmer, 1978). Leighton (1926) was so impressed with the exposure that he referred to it as "a notable type Pleistocene section." His general interpretation of the sequence between the over-



in the Farm Creek area of central Illinois.

lying Wisconsinan till (Shelbyville) and the Illinoian till below agrees with Leverett's (fig. 4). Leverett's Farm Creek description indicates that he did not resolve the detail that was later found to be present. The terms Iowan and Peorian, first introduced by Leverett, have been confused or misinterpreted and have since been dropped (see McKay, 1979). The Iowan was thought to be a glacial event that occurred between the Illinoian and Wisconsinan, represented here by a calcareous loess; the Peorian was thought to be a loess deposited at the end of a glacial event and weathered during an interglacial event.

Leighton and Leverett agreed that the "Sangamon" (the organic zone) contains coniferous wood and overlies a loesslike silt. The boreal vegetation present caused interpretation problems because the Sangamon was thought to be a time of warmth similar to the present climate. They concluded that the cold-climate indicators reflected either the close of the Sangamon time or the result of the subsequent glaciation. By 1948, Leighton decided that the loesslike silt had been generated by glacial conditions and consequently renamed the unit the Farmdale loess. Leighton and Willman (1950) interpreted this loess as representing the Farmdale substage, the oldest part of the Wisconsin stage. They did not name the organic soil at this time but recognized it as a youthful profile of weathering not sufficient to be designated as an interglacial soil. This interpretation removed the confusion between the organic soil and the profile of weathering on till below the loess, both of which had been called Sangamon. This change brought the basic stratigraphic interpretations into alignment with present concepts, but no agreement on terminology was reached at this time.

In 1960 Frye and Willman proposed a major revision of the Wisconsinan terminology, because new data could not be reconciled with the old models. Much new information was developed from their study of the Farm Creek area. Their work culminated with the publication of a comprehensive study of the Pleistocene stratigraphy of Illinois (Willman and Frye, 1970). They correlated and renamed most stratigraphic units present at Farm Creek and designated the section as the type section for the Farmdale Soil, the Farmdalian Substage and the Robein Silt. A new railroad cut south of the Farm Creek Section (page 7) was designated the type section of the Morton Loess (Frye and Willman, 1960). Most of the changes resulted from the implementation of a system of multiple classification allowing litho-, chrono-, and pedostratigraphic units to be treated independently. In effect, the previous classification system was monotaxonomic, in that all aspects were considered interrelated. This led to confusion of the terms used for materials, time intervals, and paleosols.

The study of Follmer et al. (1979) provides the most recent information for the Farm Creek Section. In this study, the classic Farm Creek Section was described, using the terminology of Willman and Frye (1970); figure 5 shows a generalized sketch of the main section. Profiles A and C are in the general area that had been previously studied. The area where profile B was taken had probably not been studied before, but the materials present there appear to be similar to those which Leverett found in the old railroad cut about 0.8 km (0.5 mi) upstream (east). All profiles show the location of detailed sampling and description. The results are presented in Follmer et al. (1979) and are summarized here.

THE FARM CREEK SECTION

To characterize fully the units exposed at Farm Creek, six vertical profiles were described and sampled (fig. 5, 6, and 7). Two radiocarbon dates were run on the Robein Silt from profile B.

Profiles A and C

The section was measured near the middle of the classic exposure on the south side of Farm Creek in the NE SW SE Sec. 30, T26N, R3W, Washington 7 1/2-minute Quadrangle, Tazewell County.

Pleistocene Series
Wisconsinan Stage
Woodfordian Substage
Richland Loess — Modern Soil

Horizon	Depth (m)	Sample no.		Thickness (m)
B and C1	0 to 2.06	FCC1 to FCC8	Loess; leached, weathered, yellowish-brown (10YR 5/4) silty clay loam; moderate subangular blocky; overlain by silty A horizon to east; Typic Hapludalf soil profile......	2.06

Henry Formation

Horizon	Depth (m)	Sample no.		Thickness (m)
Beta and C2	2.30 2.60	FCC9 FCC10	Outwash; dolomitic, gravel, sandy, common cobbles, some rotten; reddish brown (9YR 3/6); upper 20 cm is grayish red (10R 4/2) beta horizon with many thick reddish argillans; somewhat coherent......................	0.60

Wedron Formation
Delavan Till Member

Horizon	Depth (m)	Sample no.		Thickness (m)
C2 and C3	2.70 to 10.00	FCC11 to FCC35	Till; calcareous loam, common pebbles, few cobbles; upper zone, 2.7 to 4.0 m, reddish brown (5YR 4/4), fine blocky, crumbly (exposure effect); zone 2, 4.0 and 5.0 m, mottled grayish brown (10YR 4/2), coarse blocky; zone 3, 5.0 to 6.0 m, reddish gray (5R 5/2); zone 4, 6.0 to 8.6 m, more gray than above, more gravel at 6.0 to 6.3 m; lower zone, 8.6 to 10.0 m, more brown (10YR 4/2) than above, more sand, fissile (coarse, platy in exposure)......................................	7.34

Morton Loess

Horizon	Depth (m)	Sample no.		Thickness (m)
C2	10.05 to 11.40	FCATZ1 to FCATZ28	Loess; dolomitic, brown to olive-brown (10YR-2.5Y 4/3-4/4) (2.5Y 7/2-7/3, dry) silt loam, few 5/6 mottles; traces of	

Horizon	Depth (m)	Sample no.		Thickness (m)
			brown organic staining, rare fragments of carbonized material; rare small iron-encrusted tubes; few reddish joint stains; few snail shells; rare secondary carbonates; massive, breaks into plates; compact, somewhat friable. Sampled at 5-cm intervals..................................	1.4
Altonian Substage Roxana Silt			Farmdale Soil	
C/A	11.46 to 13.10	FCATZ29 to FCATZ35	Loess; leached, dark brown (10YR 3/3) (upper part) and dark grayish brown (2Y 4/2) (lower part) silt loam, sand increases downward in lower part, few 5/8 mottles; degraded charcoal (manganese replacement) common in places; granular to massive, weak aggregation, largely healed; bleached silt masses in upper part; firm; very gradual lower boundary..........	1.65
Illinoian Stage Glasford Formation Radnor Till Member			Sangamon Soil	
C/A	13.30	FCATZ36 FCA17	Till; leached, grayish brown (2Y 4.5/2) loam, low sand, rare pebbles, common 5YR 5/8 stains (exposure effect); massive, no recognizable aggregation; few degraded charcoal-carbonized wood; firm............	0.25
B1	13.50	FCATZ37 FCA16	Till; leached, grayish brown (2Y 4.5/2) clay loam, low sand, rare pebbles, common 5YR 5/8 stains; nearly massive, weak aggregation, healed blocky; few 3/2 argillans outlining peds; bleached ped interiors, firm, somewhat plastic....................	0.20
B2tg	13.60 13.90	FCA15 FCA14	Till; leached; olive-brown (2Y 4/4 upper) and greenish gray (5GY 5/1 lower) clay, rare pebbles, common 10YR 5/8 (upper) and 5Y 4/4 (lower) mottles; many 5YR 5/8 stains (gley undergoing oxidation due to exposure); moderately fine angular blocky, strong aggregation, partly healed; few pores; many thick 3/1-3/2 and thin 4/1 argillans, some stained red, covering most peds; few slickensides; bleached ped interiors; firm, plastic when wet, hard when dry...........	0.45

Horizon	Depth (m)	Sample no.		Thickness (m)
B3g	14.20	FCA13	Till; leached; gray (5Y 5/1) clay loam, high clay, low sand, rare pebbles; rare 5/4 mottles, few 5YR 5/8 stains; weak blocky, largely healed; few pores; few thick 3/2 argillans; traces of carbonized roots; firm, plastic; clear lower boundary...............	0.30
C2	14.50 to 16.90 17.50	FCA12 to FCA4 FCA1	Till; calcareous, olive to light olive-brown (5Y-2.5Y 4/3-5/4) loam, common pebbles, few 5/8 mottles; few reddish stains (exposure-enhanced oxidation); few small manganese stains; few 5/8 concretions, few carbonate concretions; weak angular blocky to massive, common conchoidal fractures; few 3/2 argillans and secondary carbonates in upper 50 cm; traces of coal; firm when moist, hard and dense when dry. Base of exposure....................................	3.30
C4	17.80 18.10	FCA2 FCA3	Till; calcareous, dark gray (5Y 4/1) loam, common pebbles, uniform, no mottles; massive, breaks with conchoidal fracture; dense, hard................................	$\geq$0.50
			Total	18.05

Profile B

The section was measured in a fresh slump scarp exposure about 10 m east of the classic exposure in the NE SW SE Sec. 30, T26N, R3W , Washington Quadrangle, Tazewell County. Sampling starts in the Morton Loess about 15 m above stream level.

Pleistocene Series
Wisconsinan Stage
Woodfordian Substage
Morton Loess

Horizon	Depth (m)	Sample no.		Thickness (m)
C2	7.05 7.15 7.25 7.35 7.45	FCB1 FCB2 FCB3 FCB4 FCB5	Loess; dolomitic, olive-brown to light brownish gray (10YR 2.5Y 4/4-5/3-6/2) silt loam, variegated (due to exposure), few 5/8 and 6/1 mottles; nearly massive, very weak platy, essentially no aggregation; few pores; few roots and other plant remains; traces of degraded charcoal and carbonized organic remains, intercalated organic remains at base; friable; samples from lower third..........................	1.5

Horizon	Depth (m)	Sample no.		Thickness (m)
Farmdalian Substage Robein Silt			Farmdale Soil	
O	7.55 7.75 7.95	FCB6 FCB7 FCB8	Muck; leached, black (N 2/0-10YR 2/1) silty muck; massive, weakly aggregated; grayish appearance and hydrophobic after drying; little fibrous material, much humus; few charcoal or carbonized fragments; few joints filled with dolomitic silt; discontinuous degraded brown (3/3-4/4) zone at top; firm, punky; occasional secondary carbonate and gypsum; B6 and B8 sampled in upper and lower part of black zone, replicate samples (B9K and B3K) taken for dating (26,680±380 and 27,700±770 RCYBP [ISGS-533 and 535, respectively]). Additional samples collected for pollen analysis......	0.60
Altonian Substage Roxana Silt				
C/B	8.15 8.35 8.55 8.75 8.95 9.15	FCB9 FCB10 FCB11 FCB12 FCB13 FCB14	Loess; leached, dark brown, olive-brown, and dark grayish brown (10YR-2Y 3/3-4/4-4/2) silt loam, variegated, few 5/8 mottles and stains; few degraded charcoal fragments; massive to granular, weak aggregation; rare channels and pores; few bleached silt masses; traces of roots; occasional gypsum in joints; indistinct darker zone near middle; more coarse silt in upper half, more clay in lower half; noticeable sand in lower sample; somewhat friable; gradational boundaries................................	1.20
Illinoian Stage Glasford Formation Radnor Till Member			Sangamon Soil	
C/A	9.35 9.55	FCB15 FCB16	Till; leached, olive-brown to grayish brown (1Y 4/3-5/3 moist, 7/3-7/2 dry) loam, rare pebbles, common 10YR-5YR 5/8 mottles, few degraded charcoal particles; massive to granular, slightly platy, healed rounded aggregates; few pores; rare root traces; rare very small argillans; matrix more bleached than above; somewhat firm and brittle; probable A1 and A2 horizons.......	0.40

Horizon	Depth (m)	Sample no.		Thickness (m)
B1	9.80	FCB17	Till; leached, light olive-brown (1Y 5/4) clay loam, few pebbles, few 5/8 mottles; few degraded charcoal particles; massive; healed blocky, moderately aggregated; few pores, common 4/3 and 3/2 argillans in pores and outlining peds; bleached ped interiors; firm, somewhat plastic..........	0.25
B2t	10.15	FCB18	Till; leached, olive-brown (1Y 4/4) clay loam to clay, few pebbles, common 5/8 and few 5/2 mottles, few red stains along joints (exposure effect); moderate subangular blocky, largely healed, moderately aggregated; few pores; common thick 5Y 3/2 and 10YR 4/2 argillans; bleached ped interiors; plastic to firm when wet, hard and blocky when dry; base covered with slump................................	>0.30
			Total	4.25

DISCUSSION

Post-Sangamonian Stratigraphy

The Richland Loess at Farm Creek is approximately 2 m thick and overlies sand and gravel outwash of the Henry Formation. The Richland contains the profile of the Modern Soil and is leached throughout its entire thickness. The Illinois River valley in its present location was the source of Richland, which thickens to approximately 3 m at the bluff line. The Henry Formation is a high-level outwash on the tops of interfluves along the valley of Farm Creek. The source of the outwash was probably meltwater originating at a glacial margin at the Bloomington Morainic System approximately 2 km east of the Farm Creek Section. To the southeast of the section, the Henry Formation occupies an outwash plain 1 to 2 km wide along the Bloomington front. A Beta horizon is well developed in the upper part of the highly calcareous outwash in the exposure. The Henry Formation overlies the Delavan Till Member of the Wedron Formation.

The Delavan Till Member is oxidized to a reddish brown in its upper part and is reddish gray to gray in its unoxidized condition. The Delavan in profile C averages 26 percent sand and 35 percent clay. The unoxidized till between FCC 17 and 33 contains an average of 12 percent expandable clay minerals, 67 percent illite, and 21 percent kaolinite plus chlorite. On the basis of its carbonate minerals, the Delavan can be divided into two parts: above FCC 23 it averages 9 percent calcite and 20 percent dolomite, and between FCC 24 and 33 the calcite drops to 6 percent and the dolomite averages 21 percent. Samples FCC 34 and 35 at the base are gray, have a variable grain-size composition, and average only 3 percent calcite and 17 percent dolomite. Clay minerals in this zone average 14 percent expandables, 66 percent illite, and 20 percent kaolinite plus chlorite. These compositional differences in the lower part of the Delavan are probably caused by mixing with loess and other units below the Delavan.

Three rock-stratigraphic units--Morton Loess, the Robein Silt, and the Roxana Silt--are identified in the 3.2-m-thick loess and silt succession between the base of the Delavan Till Member and the top of the Sangamon Soil. If the base of the Wisconsinan Stage in Illinois is placed between 50,000 and 75,000 years BP, as suggested by a number of studies, then this succession contains the record of 70 to 80 percent of Wisconsinan time in Illinois.

The type section of the Morton Loess is the Farm Creek Railroad Cut Section located 1.3 km due south of the Farm Creek Section. That section has been overgrown for many years and was last examined in 1958 and 1959 by Frye and Willman (1960).

At the Farm Creek Section the Morton is a 1.5-1.75-m-thick, dolomitic, gray to brown loess that is overlain on an erosional contact by the Delavan Till Member (fig. 5). At the Gardena Section (see later discussion), the Morton is 0.4 to 0.5 m thicker, suggesting that about that much is missing at the main Farm Creek exposure. Streaks of plant debris and humus in the upper 0.5 m of the Morton accentuate shallow deformation caused by glacial overriding. The till-on-loess contact at the top of the Morton is nearly horizontal and is the most conspicuous boundary in the exposure. The Morton, dolomitic throughout its thickness, contains dolomite zones p-1, p-2, and p-3 (figs. 6 and 7). Radiocarbon dates of 20,340 ±750 (W-349) and 20,700 ±650 (W-399) RCYBP have been reported from the upper part of the Morton at this exposure (Rubin and Alexander, 1958; Frye and Willman, 1960). These dates are from the upper part of zone p-3 and are compatible with the proposed chronology of loess zonation in the area (McKay, 1979).

The base of the Morton Loess is gradational with the underlying silt unit, either Robein or Roxana Silt; the dolomitic composition and lighter

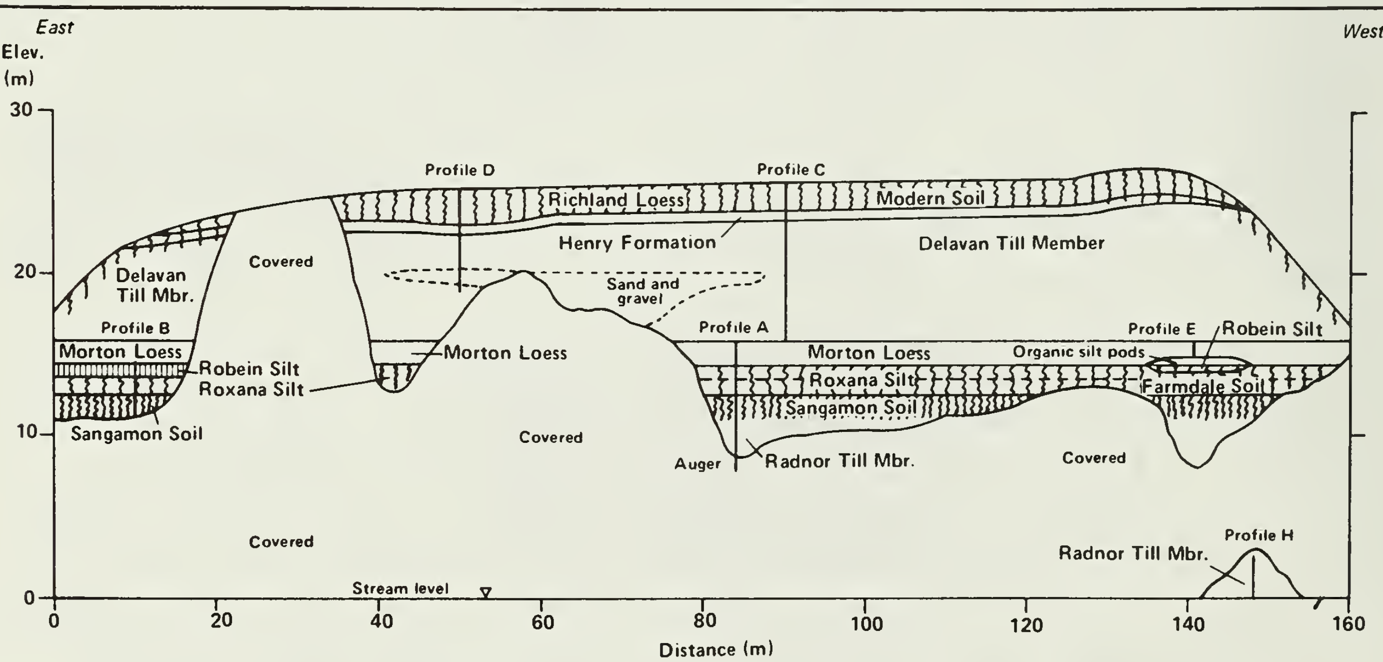


Figure 5. Diagram of the Farm Creek Section. Datum point is stream level.

brown or gray color of the Morton distinguish it from these units. Identification of the silt unit beneath the Morton at a given site has proved difficult. Willman and Frye (1970) described 4.5 ft (1.4 m) of Robein Silt and 3.5 ft (1.1 m) of Roxana Silt in this section. The total thickness of combined Robein and Roxana now exposed is only 1.8 m, 0.7 m less than they described.

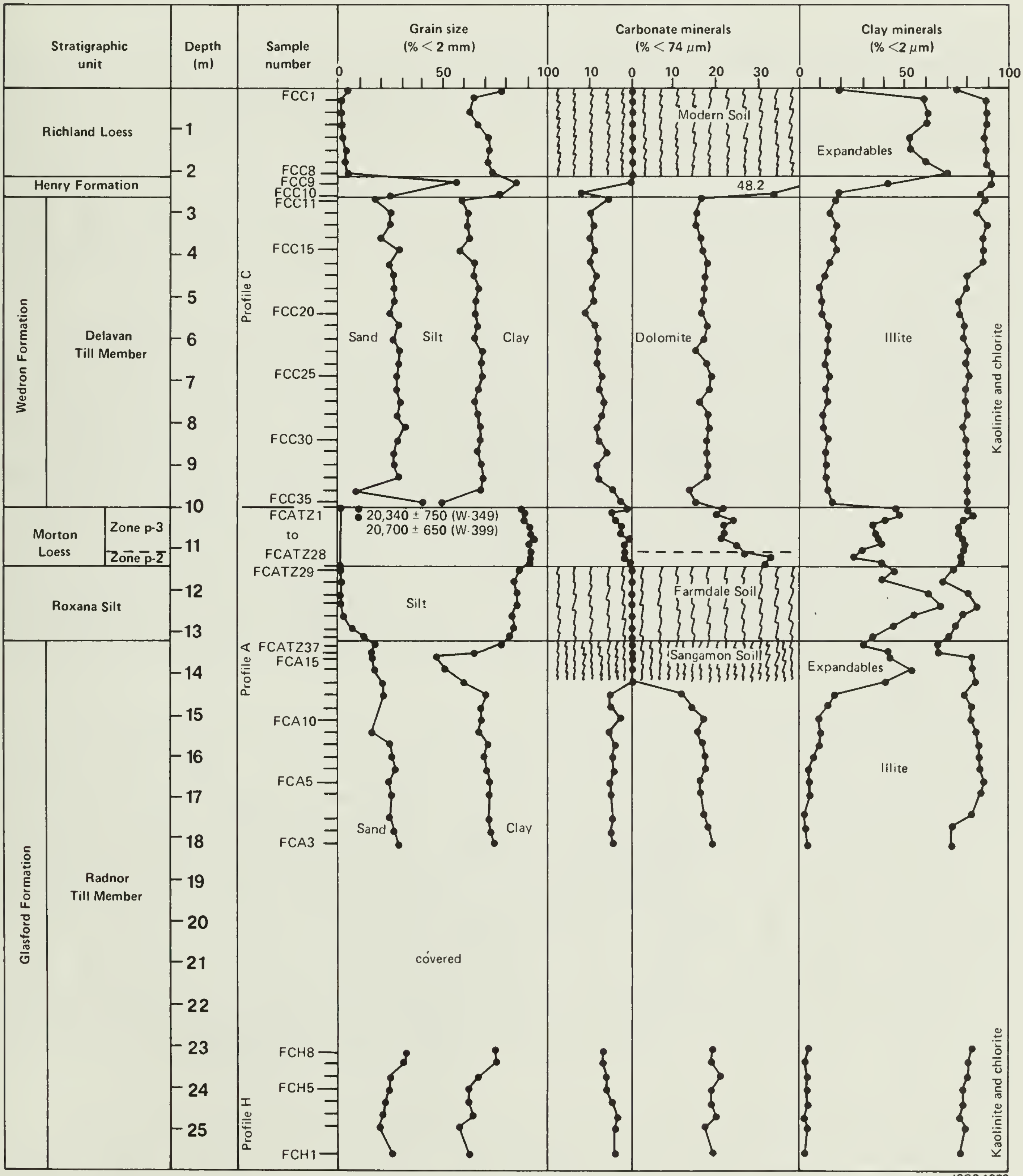


Figure 6. Grain sizes, carbonate-mineral content, and clay mineralogy of profiles A, C, and H of the Farm Creek Section.

To characterize and to help differentiate the Robein and Roxana, grain-size analyses with fractionation of the silt-sized fraction were run, using the pipette method. Samples from profiles A and B were selected for analysis. At profile A (fig. 6) and across much of the exposure, the Morton directly overlies a leached, brown, massive silt within which only one depositional unit can be distinguished in the field. In profile B, a 0.6-m-thick, leached, peaty muck occurs just beneath the Morton and overlies the leached brown silt.

The Robein Silt has been interpreted as being predominantly the accumulation of sediment derived by water and colluvial action from the older Roxana Silt (Frye and Willman, 1960). Therefore, pipette analyses, including silt fractions, were carried out to test for grain-size discontinuities in the Morton-Robein-Roxana sequence.

The grain-size data show significant differences in composition between the Morton and the underlying unit. In profile A, the Morton is a relatively uniform silt that averages 25 percent coarse silt (62 to 31 μm), 39 percent medium silt (31 to 16 μm), 19 percent fine silt (16 to 8 μm), 9 percent very fine silt (8 to 2 μm), and 8 percent clay. A ratio of coarse to medium (62 to 31 μm/31 to 16 μm) silt is a clay-free index that can be used to evaluate the uniformity of silty materials through weathering profiles. The Morton has an average silt ratio of 0.6. In the silt succession below the Morton in profile A, grain-size data identify only one unit. Within this unit are no discontinuities that can be identified as a contact of Robein Silt with Roxana Silt. The lower three samples (TZ33 to 35) show the effect of mixing of loessial sediments with materials from the underlying Sangamon Soil, a feature typical of the lower Roxana. The entire leached silt section from the base of

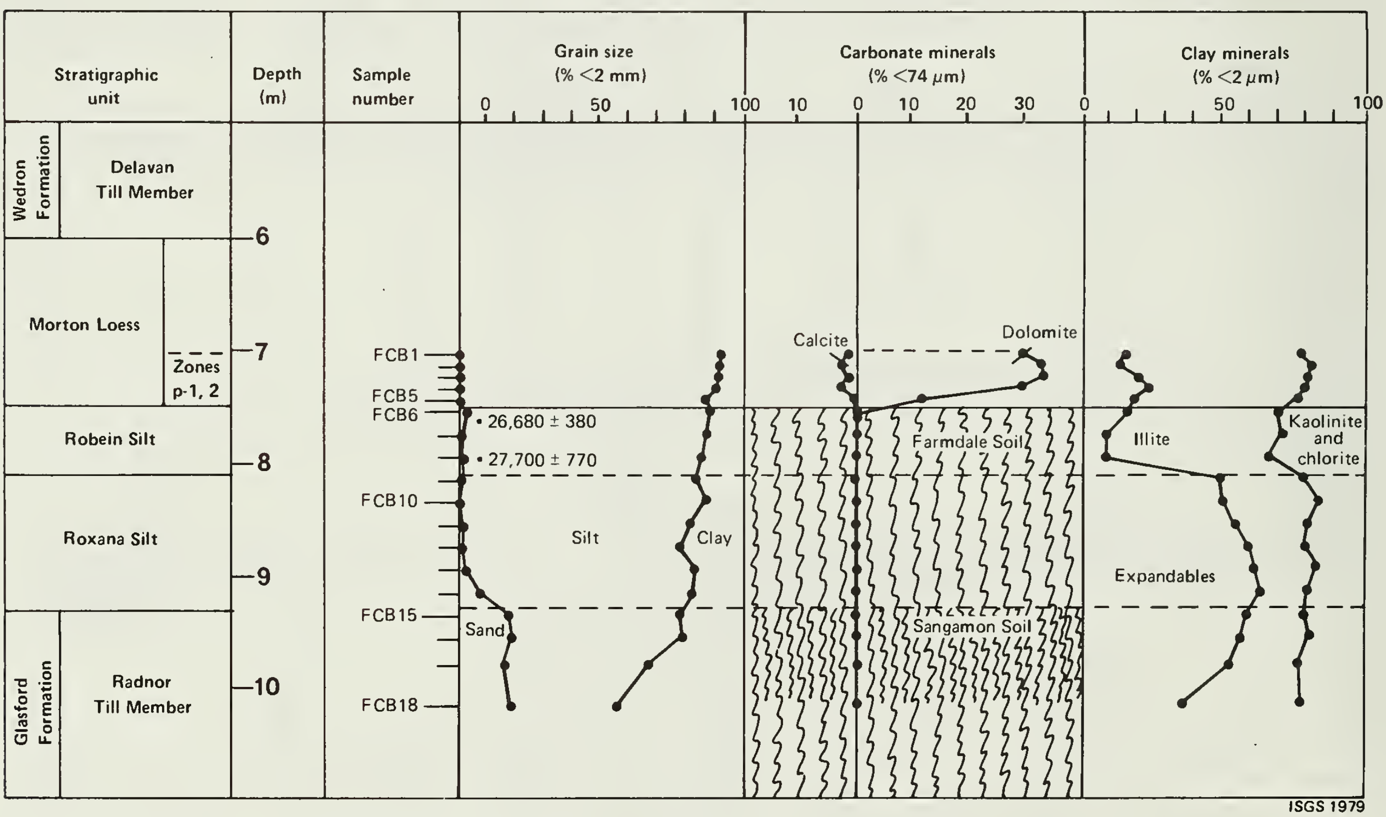


Figure 7. Grain sizes, carbonate-mineral content, and clay mineralogy of profile B of the Farm Creek Section.

the Morton to the Sangamon appears loessial in origin and is the Roxana Silt. The upper four samples of the Roxana are above the zone of mixing and have an average grain-size composition of 29 percent coarse silt, 34 percent medium silt, 16 percent fine silt, 8 percent very fine silt, and 13 percent clay. The Roxana contains more coarse silt, less medium silt, less fine silt, and more clay than the Morton and has a silt ratio of 0.9 as compared to the 0.6 of the Morton.

These differences in grain-size composition are the same as those between the Peoria Loess and Roxana Silt along the Mississippi Valley in southwestern Illinois. The grain-size differences may in part be pedogenic, but in comparisons of dolomitic Peoria Loess to dolomitic Roxana Silt, the same pattern of the finer textured Peoria over coarser textured Roxana has been found (McKay, 1977). These consistent grain-size differences between loesses probably relate to differences in the grain sizes available to wind erosion from the Altonian and Woodfordian valley trains. Because the grain-size compositions are consistent depositional features, they are useful in identifying contacts between the loess units.

In profile B, a 0.5-m-thick silty muck is correlated with the Robein Silt. Its grain-size composition closely resembles that of the Roxana beneath it: the silt ratio averages 1:2. The Morton above contains a coarse zone (samples B2 and B3). The remainder of the Morton has a grain-size composition like that in profile A. The Roxana in profile B above the zone of mixing with the Sangamon has an average grain-size composition nearly identical to that of the Roxana in profile A.

It is clear that a 4.5-ft- (1.4-m) thick Robein Silt, as described by Willman and Frye (1970), is not now exposed at Farm Creek and that the silt unit beneath the Morton Loess is the Roxana Silt. The Robein Silt in this report is restricted to the 0.5-m-thick silty muck exposed in the easternmost part of the Farm Creek Section and sampled in profile B. At Farm Creek, the Robein Silt is merely the O horizon of the Farmdale Soil.

The Farmdalian Substage is based on the Robein Silt in the Farm Creek Section and its boundaries have been placed at 22,000 and 28,000 RCYBP (Frye and Willman, 1960). Two radiocarbon dates from the upper and lower parts of the Robein Silt adjacent to profile B yielded ages of 26,680 ±380 (ISGS-533) and 27,700 ±770 (ISGS-535) RCYBP, respectively. The two dates fall within the early part of the Farmdalian, and the lower date seems to substantiate the boundary of the 28,000 RCYBP used by Frye and Willman; however, the radiocarbon age of a soil horizon reveals little about the age of the rock unit in which the soil is developed other than that the soil must be younger than the rock unit. The youngest date available in the upper Roxana below the Farmdale Soil profile is 30,980 ±400 (McKay, 1979). Thus, the deceleration of loess deposition that marked the end of the Altonian probably occurred between 31,000 and 28,000 RCYBP. More study is necessary to define precisely the timing of depositional events in this part of the record.

The age of the base of the Morton Loess cannot be determined precisely from evidence at Farm Creek. It has been estimated at 22,000 RCYBP by Frye and Willman (1960), but the upper date on the Robein Silt near the base of the Morton in profile B is nearly 27,000 RCYBP. Zone p-2 is present in the Morton and is older than about 23,400 RCYBP in southwestern Illinois (McKay, 1979).

Gardena Section

The Gardena Section, 1.0 km southeast of the Farm Creek Section, reveals stratigraphic relationships in the Morton Loess, Robein Silt, and Roxana Silt that aid in clarification of numerous stratigraphic problems raised at Farm Creek, particularly the age of the base of the Morton and the boundary of the Woodfordian and Farmdalian. The section is described below, and data for samples are plotted in figure 8. Pollen analyses for samples from Gardena are discussed by J. E. King (1979). The section is currently well exposed but too remote to be visited on the field trip.

At the Gardena Section, till of the Delavan Member is underlain by a thin lacustrine silt and clay that overlies an in situ moss layer at the top of the Morton Loess. The presence of moss indicates that there has been no erosive truncation of the Morton, and a radiocarbon date of 19,680 ±460 RCYBP (ISGS-532) on the moss dates the burial of the Morton by lacustrine sediments just prior to till deposition. At Gardena, the Morton is 2.13 m thick, 0.4 to 0.5 m thicker than at Farm Creek. A dolomite zone, p-5, is present in the upper 0.3 m of the Morton, and its contact with the underlying p-3 is the record of diversion of the Ancient Mississippi River (Glass, Frye, and Willman, 1964). The increase of dolomite from the middle of p-3 upward may record an increasing proportion of Lake Michigan Lobe outwash prior to diversion. Zone p-2 is present in the lower part of the Morton and contains muck and peat zones that have been dated. Sample G20 at the top of zone p-2 contained only a marginally sufficient amount of wood and yielded a radiocarbon date of 25,680 ±1,000 RCYBP (ISGS-530). Wood from sample G26 from the lower 10 cm of the Morton yielded a radiocarbon date of 25,370 ±310 RCYBP (ISGS-531). Wood from the upper 10 cm of the Robein Silt (sample G27) immediately below the base of the Morton yielded an age of 25,960 ±280 RCYBP (ISGS-529). These dates are the basis for a conservative estimate that the age of the base of the Morton Loess in the Farm Creek region is 25,000 RCYBP,

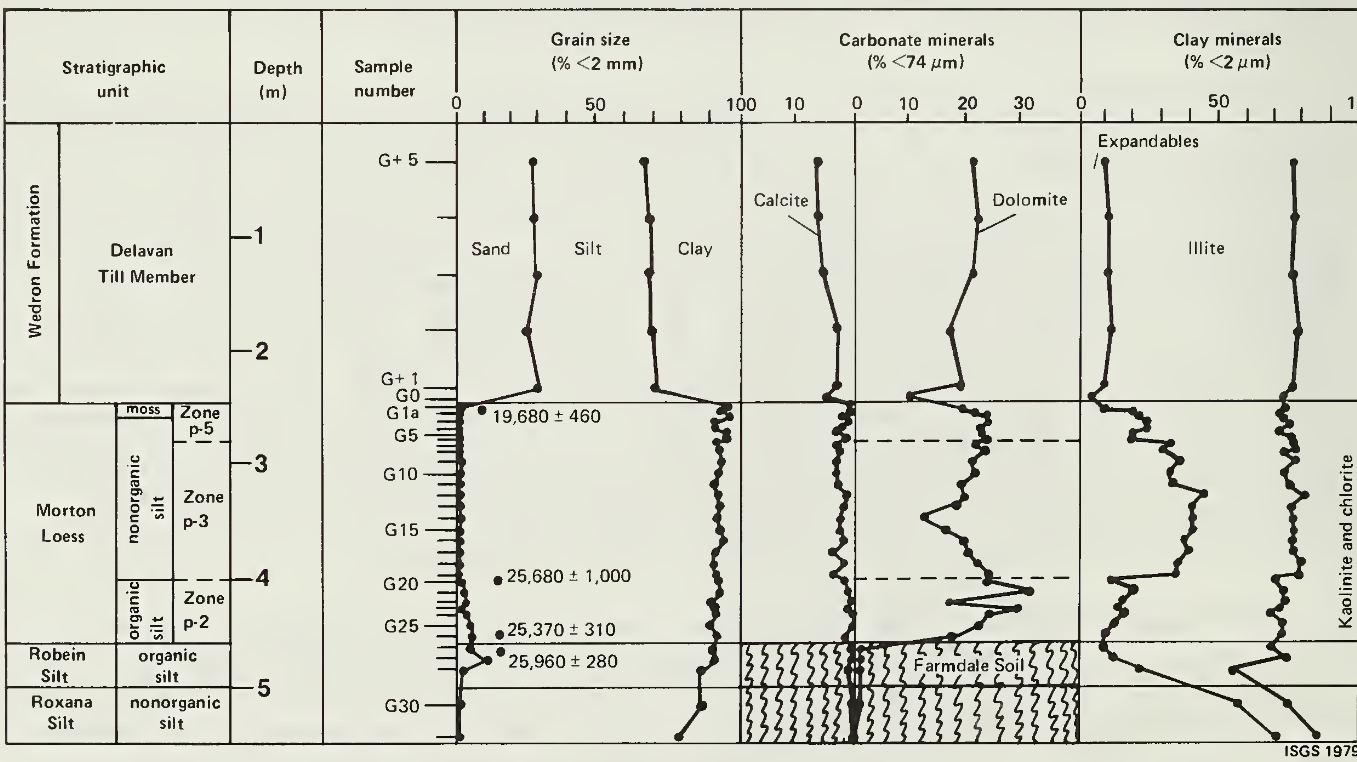


Figure 8. Grain sizes, carbonate-mineral content, and clay mineralogy of the Gardena Section.

and that the boundary of the Farmdalian and Woodfordian should be placed at 25,000 RCYBP.

Time-stratigraphic boundaries established in the rock record do not necessarily coincide with boundaries of climatic events. The age of the contact of the Morton Loess with the Robein Silt in the Farm Creek area is the basis for placement of the boundary between the Woodfordian and Farmdalian time at 25,000 RCYBP. The vegetational record of the climate of the region (J.King, 1979) indicates that the shift from cool spruce-pine interstadial vegetation toward the spruce-dominated stadial "full-glacial" climate did not begin in this region until after 23,000 RCYBP. Thus, the Farmdalian/Woodfordian boundary established in the rock succession does not mark an interstadial-to-stadial transition in the local climate, and the lower part of the Morton Loess, although Woodfordian in age, was deposited while interstadial conditions prevailed in central Illinois.

Although initiation of Woodfordian loess deposition along the Ancient Mississippi River in central Illinois does not coincide with changes in local climatic conditions, the onset of loess accumulation after the relatively loess-free Farmdalian Substage must record the renewal of glacial activity in the upper reaches of the Ancient Mississippi basin. To initiate loess deposition along much of the Ancient Mississippi, large volumes of meltwater and outwash must have been introduced into the basin about 25,000 BP. Thus, while the base of the Morton Loess does not coincide with local climatic trends in central Illinois, it does coincide with geologic events that affected a large region along the Ancient Mississippi Valley and which may, in fact, be related to climatic changes of a larger scale. Climatic conditions revealed by fossil insects at Gardena are discussed in Appendix 2.

Sangamon Soil

Many details of the history of studies on the Sangamon Soil at the Farm Creek Section have been reviewed by Follmer (1978, 1983). The Roxana Silt here rests on the Sangamon Soil developed in the Radnor Till Member of the Glasford Formation. A zone of mixing causes most characteristics of the boundary between the Roxana Silt and the Sangamon Soil in till to be very gradational. As a result, boundaries are difficult to distinguish; the characteristics of soil horizons in the contact zone are referred to as confounded soil characteristics.

To the extent possible, the top of the Sangamon Soil is restricted to coincide with the top of Sangamonian-aged deposits, Illinoian deposits, or older deposits, if Sangamonian or Illinoian deposits are missing. At the Farm Creek exposures, the evidence indicates that the material beneath the Roxana Silt is the Radnor Till of Illinoian age. The top of the till is largely blurred because of mixing with the Roxana by bioturbation and pedoturbation during formation of the Sangamon Soil.

The Sangamon Soil in Illinois is most often buried by Wisconsinan deposits, but occasionally it merges into the Modern Soil on post-Wisconsinan geomorphic surfaces. In the Peoria region, the Wisconsinan deposits are thick enough that the Sangamon is exposed only in deep stream cuts or excavations. At the Farm Creek Section, the Sangamon is about 13 m below the upland surface. As a consequence of burial, the Sangamon (or any buried soil) is removed from the forward forces of soil genesis and experiences some degree of retrogressive development or diagenesis. The weaker the soil profile expression, the more likely the soil horizon characteristics will be lost. In most cases, the retrogressive processes cause soil horizons to return to a state more like the parent material.

The best-preserved soil horizons are O horizons and Bt horizons. The Bt horizons are more useful because they are more widespread and are diagnostic of interglacial paleosols. Clay coatings (argillans) on peds are always preserved to some degree in Bt horizons. Clean silt accumulations (silans) that are sometimes present between peds provide the best evidence for recognizing genuine platy soil structures (aggregations) in the upper solum of buried soils. Compaction and subsequent release of confining pressure sometimes generate platy structures that have clean joint surfaces without silans or other coatings (cutans).

Many kinds of soil features are expressed in the Sangamon Soil at the Farm Creek Sections. The Sangamon in most places is a poorly drained, gleyed podzolic, in situ profile, formerly referred to as gumbotil. Because of its gleyed condition, it has been confused with accretion-gley (Follmer, 1978). In recent years, slow bluff erosion has exposed a reddish brown Sangamon Bt horizon near the center of the exposure. This permits us to see a Sangamon catena from a poorly drained to a moderately well drained profile. The poorly drained profile is being oxidized on the exposure. The resulting iron staining extends into the overlying A horizon along joints and up into the Roxana and Morton in places. This indicates that the iron staining is not a soil feature, but a geologic feature.

The upper part of the Sangamon B (B1) grades upward into an A (C/A) that is essentially massive in appearance except for joint staining; however, at profile B, internal fabrics show healed or compressed granular to platy aggregates. At profiles A and B, degraded charcoal or carbonized wood is in a C/A horizon that has a slightly "bleached look" (low chroma) in comparison to adjacent horizons. This zone has some characteristics of an A horizon, but, now in the buried state, it lacks many of the normal characteristics of an A. This horizon is interpreted to be a C/A horizon, that is, C horizon morphology imposed on a buried A horizon. The analytical data do not suggest any change of parent material between the C/A and B1 at either profile A or B (figs. 6 and 7). Grain-size and clay-mineral trends in the Sangamon Soil are pedologic features. The sand content is nearly constant, and a strong increase in clay content from the C/A to the B2t (abrupt at profile A--a 34% increase--and 22% at profile B) is clearly shown. Clay trends of this type are evidence for strongly developed soils. A vermiculitic characteristic of the C/A is evident by the high values of the kaolinite and chlorite at profile A. This characteristic is common in buried A horizons. The morphological and analytical results therefore confirm that a conformable sequence of deposits is present through the critical portions of both Sangamon profiles, so the Sangamon A must be present and must have undergone retrogressive morphologic changes.

Upward into the Roxana, the sand content shows a lithologic (geologic) discontinuity. The decreasing trend to the very low values of sand defines the zone of mixing with the Roxana. Generally, this matches decreasing characteristics of an A horizon upward into the Roxana. Together these features distinguish the zone of mixing between the Sangamon Soil and the Roxana at most localities. Old terminology referred to the zone of mixing as a part of the "Late Sangamon loess." In some sections, soil-stratigraphic boundaries described in this zone were defined as the upper boundaries of the Chapin (lower) and Pleasant Grove (upper) Soils (Willman and Frye, 1970).

Pedologic features in the Sangamon Bt horizons at Farm Creek are reasonably well expressed. Most pronounced is the blocky structure (or healed blocky aggregates) that is accentuated by dark (or reddish) clay separations (argillans). The strong degree of aggregation, including the segregation of materials with contrasting colors (mottles, stains, and concretions), is diagnostic of a strongly developed soil profile. This feature is common in the Sangamon Soil and other interglacial paleosols. The clay minerals in the Sangamon B here have been largely altered, as shown by the large depletion of illite (from about 75% to 30%) and by the gain of expandable minerals (from about 5% to 50%) as compared to underlying oxidized calcareous till at profile A. Because of exposure, the colors of the Sangamon profile are changing from gley colors (greenish and bluish gray) to oxidized colors (olive to brown). The degree of alteration and the abruptness of the B horizon suggests that the Sangamon Soil at profile A is an Albaquult (Ultisol). An alternate classification of Albaqualf (Alfisol) must be considered because of the lack of chemical, temperature, and other data required for classification.

No morphologic or laboratory data indicate any discontinuity with the underlying calcareous till. In most places the lower boundary of the soil appears to be gradual, although a B3 commonly overlies a C2 in most places. The absence of a C1 horizon may indicate a rapidly developing soil or a hydrogeologic control.

Illinoian Till

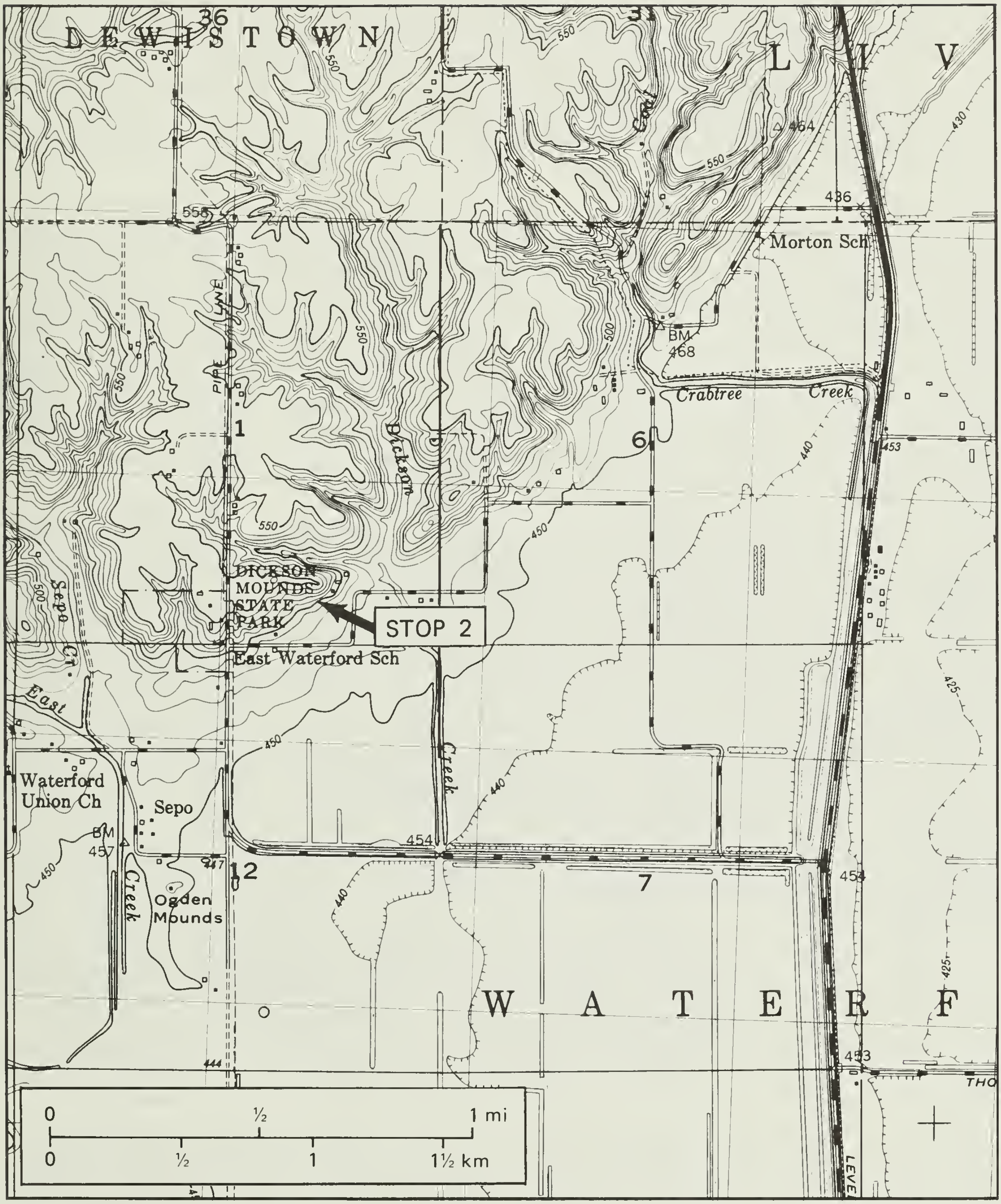
The till in which the Sangamon Soil developed at Farm Creek is Illinoian and is correlated to the Radnor Till Member of the Glasford Formation (Willman and Frye, 1970). The Radnor Till is largely covered with slump except for the upper part near the center of the section and a portion (profile H) at creek level near the old railroad structure at the west end. About 5 m of section could not be sampled.

The oxidized C2 under the Sangamon is exposed. It averages 24 percent sand and 29 percent clay (4 μm). The carbonates average 5 percent calcite and 17 percent dolomite. Clay minerals show a trend in this zone. The lower part averages about 80 percent illite and slowly decreases upward to the Sangamon B3t, where the illite content drops to about 45 percent. Values of expandables and kaolinite and chlorite gradually increase up through the C2. The unaltered, unoxidized C4 horizon (augered samples A2 and A3) contains about 2 percent expandables, 69 percent illite, and 29 percent kaolinite and chlorite. Upon oxidation of the C4, primary chlorites are altered, which causes the value for kaolinite and chlorite to drop. At this section the value drops to about 15 percent, which causes the relative illite value to increase from 69 percent to about 80 percent. The grain size and carbonate content of the C2 and C4 are the same.

The till exposed at profile H just above stream level was correlated to the Hulick Till Member of the Glasford Formation by Willman and Frye (1970). Work by Lineback (1979) has shown that this lower till is more like the Radnor.

DICKSON MOUNDS

Alan D. Harn



STOP 2. The Dickson Mounds Museum

Along the Illinois River, west of Havana, IL, Fulton County (Havana Quadrangle)

A modern museum has been developed in an area rich in remains of a Mississippian culture abandoned about A.D. 1300.

Dickson Mounds (page 25), a branch of the Illinois State Museum and a National Historic Site, is one of the few on-site archaeological museums in the Midwest. It developed as the result of a carefully planned private excavation undertaken nearly 60 years ago by Dr. Don F. Dickson on land owned by his family. First opened to the public in 1927, this excavation was operated as a private museum until 1945, when it was sold to the State of Illinois. Additional excavations and research by the Illinois State Museum over the last three decades have greatly increased knowledge of the site and its importance in interpreting Midwestern prehistory during the Woodland and Mississippian archaeological periods.

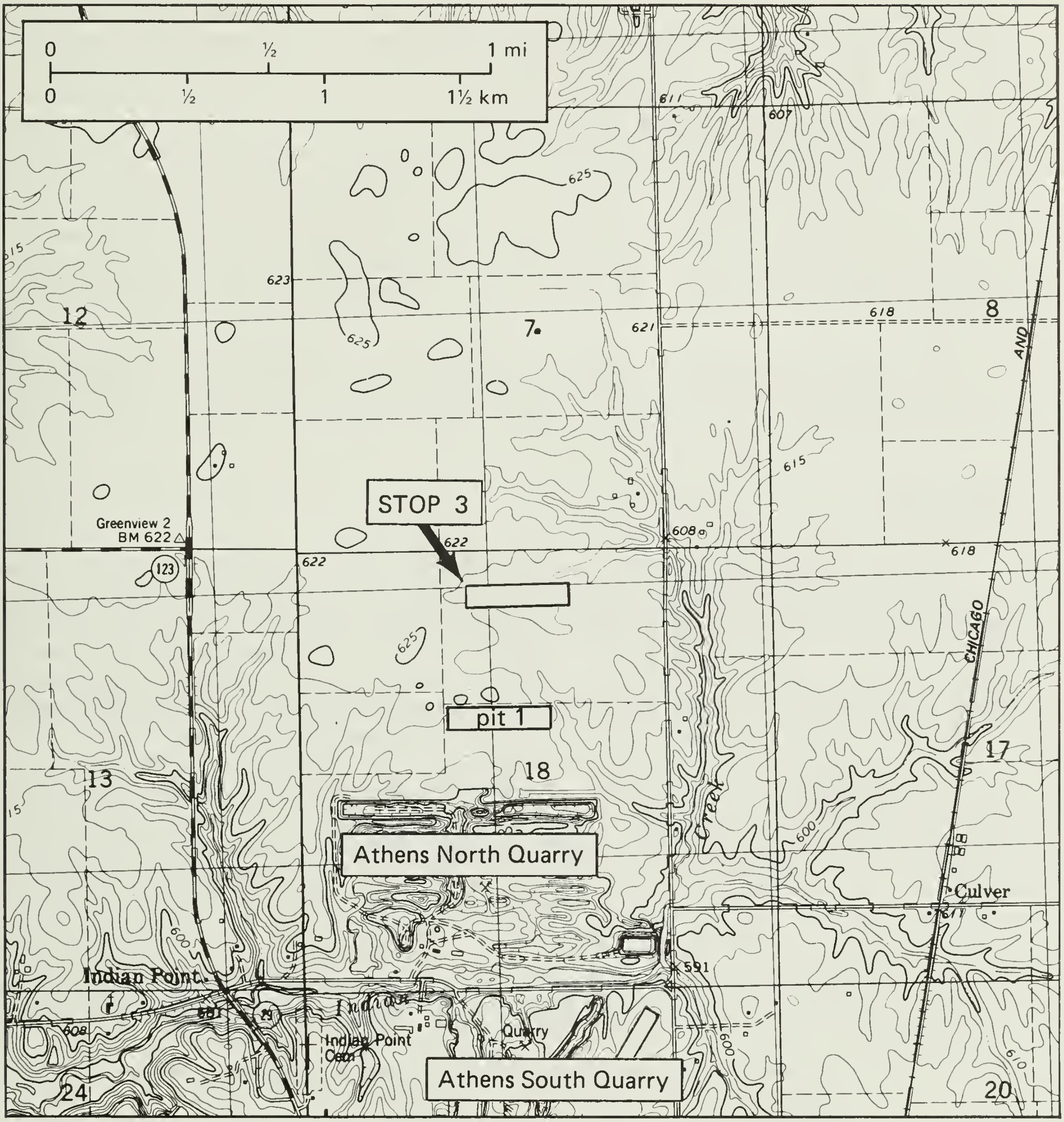
Between A.D. 800 and 1200, important changes were taking place in lifeways over a large area of North America. At the beginning of this time period, people lived in small, scattered settlements supported primarily by fishing, gathering, and hunting of large animals such as deer. Some wild, starchy seed plants also were being domesticated through cultivation. By the end of the period, people were concentrated around fortified towns and were part of a highly controlled, structured society partly dependent upon horticulture for its food. The development of such economically important crops as corn and beans can be attributed to these later groups. These innovations and changing lifestyles can be traced especially well at Dickson Mounds, which stands at the margins of several major culture areas.

A thousand years ago, bands of Late Woodland people in the Illinois River valley were beginning to come increasingly under the influence of a strong Mississippian culture that had developed downriver near the present East St. Louis. Within a century, Mississippian people had established a small habitation site (Eveland) on the terrace at the bluff base below Dickson Mounds. Here the Woodland and Mississippian populations merged, and by A.D. 1250 this settlement and the Dickson cemetery had become a part of a large Mississippian community of villages, camps, homesteads, and work stations extending for several miles along the river. Its center was a fortified town on the blufftop near Dickson Mounds. This grouping of more than 40 sites represented a seasonal interplay of human activity that articulated with the natural environment in a delicate attempt to support a rapidly expanding population. Growth in population and intensive exploitation of the environment gradually resulted in a depletion of resources, and by A.D. 1300 the inhabitants had abandoned the area.

The Dickson Mounds Museum offers a variety of learning experiences for the scientist as well as for the general public. In addition to its mandate of public education, the Museum serves as an active research center for Illinois State Museum archaeologists and as a repository for regional archaeological collections. Outside at the Eveland village site, remains of three original structures from an early Mississippian village are preserved for viewing. Within the museum complex at Dickson Mounds are the original 248 human burials and their accompanying possessions excavated by the Dickson family between 1927 and 1932. Modern museum displays and programs interpret the unique prehistory of the area and relate it to human cultural development in a regional perspective.

ATHENS QUARRY SECTIONS: TYPE LOCALITY OF THE SANGAMON SOIL

Leon R. Follmer, E. Donald McKay, James E. King, and Frances B. King



STOP 3. Athens Quarry Section

Sec. 18 and 19, T18N, R5W Menard County, IL (Greenview Quadrangle)

The sequence of materials in the overburden of this limestone quarry matches very closely Worthen's description (1873) of an organic-rich zone later named the Sangamon Soil.

INTRODUCTION

The limestone quarries north of Athens, Illinois (page 27) are located within the central portion of the type area of the Sangamon Soil. Type section concepts are not directly applicable to soils (pedostratigraphic units) as they are to lithostratigraphic and chronostratigraphic units because for soils all of the necessary information for establishing type section concepts is not available at one designated location. For soils, the necessary information for reference and definition involves a catena (a sequence of soil profiles ranging from well drained to poorly drained) in a minimum horizontal distance of generally 100 ft (30 m) or more. North Quarry provides the necessary information for a reference section and will continue to be an active quarry operation. The open pit exposures are generally more than 1,000 ft (300 m) long and serve well as a type locality exposure of the Sangamon Soil.

Most of the material used in the discussion of this stop is taken from a guidebook prepared for the 1979 Midwest Friends of the Pleistocene Field Conference (Follmer et al., 1979). New results from C-14 studies have been added.

BACKGROUND

Much of the study of glacial stratigraphy in Illinois has been directly or indirectly related to the Sangamon Soil. In a general sense, the Sangamon became known as a zone of weathering on glacial deposits about the same time that the drift upon which the Sangamon Soil developed was recognized as the Illinoian till sheet (Leverett, 1898a). Leverett and others recognized the need for a term to identify the interruption in the glacial record between the Illinoian and Iowan (Wisconsinan) Stages of glaciation.

The Sangamon Soil was first recognized as a soil by Worthen in 1873 in the fifth volume of his report to the Illinois General Assembly on the geology and paleontology of Illinois. Worthen had not recognized the existence of a buried soil until his fourth volume (Worthen, 1870), when he reported a soil zone or "bed resembling the surface soil was observed below the Drift" in a coal mine shaft in Adams County in western Illinois.

In his report on Sangamon County, Worthen summarized the common observations on the sequence of materials found in northwestern Sangamon County and

Table 1. Correlation of terminology in type locality of the Sangamon Soil.

Worthen (1873)	Present
Soil	Peoria Loess, A horizon
Yellow clay	Peoria Loess, B horizon
Whitish gray clay with shells	Peoria Loess, C horizon, calcareous
Black muck with wood	Peoria Loess, basal organic zone
	Robein Silt, Farmdale organic horizon
Bluish colored boulder clay	Diamicton, Sangamon Soil Bg horizon
Gray hard pan	Diamicton, calcareous Illinoian till
Soft blue clay	Undetermined paleosol, till or lacustrine material

the adjoining part of Menard County. All of the units described by Worthen can be seen in the Athens Quarries today (table 1).

Between 1873 and 1898, resolution of many complexities of the Quaternary progressed considerably. The idea of multiple glaciations separated by interglaciations and characterized by episodes of nonglacial erosion and weathering of the surficial materials had been largely accepted. The U.S. Geological Survey furthered progress with a program directed toward the study of the glacial formations of the Midwest, and USGS geologist Frank Leverett made a significant contribution to the Quaternary studies in Illinois.

During his work in the Midwest, Leverett discovered that one soil occurred above and another below a formation of glacial deposits that he named the Illinoian till sheet (Leverett, 1896). In 1897, Leverett gave these soils formal status by naming them the Sangamon soil and Yarmouth soil, respectively (Leverett, 1898a and 1898b). By 1898 the concept of the Sangamon Soil was reasonably well understood, as indicated in Leverett's paper introducing the Sangamon as "the weathering zone between the (Wisconsinian) loess and the Illinoian till sheet . . . found from central Ohio westward to southeastern Iowa, i.e., to the limits of the Illinoian till sheet" (1898a, p. 75). The first use of the term Sangamon soil by Leverett in 1898 restricted it to the black soil, muck, or peat that contains remains of coniferous wood occurring at the base of the loess. The purpose of naming the Sangamon was to formalize a term so that an interval of geologic time could be named "the Sangamon interglacial stage," to separate the "Illinoian and Iowan stages" of glaciation. The Iowan was later included in the Wisconsinan and eventually dropped as a time term (Ruhe, 1969).

Perhaps Leverett's most astute observation was that the type of organic matter in the "black soil," particularly the coniferous wood, is not characteristic of conditions during an interglacial climax, but of "the close of that stage when glacial conditions were being inaugurated." Probably all of the woody deposits that Leverett observed below the loess in central Illinois are post-Sangamonian by present definition, but were interpreted to be the Sangamon Soil by Leverett.

In 1930, Leighton and MacClintock published their classic paper on the "Weathered zones of the drift-sheets of Illinois." Leighton and MacClintock reached a very important point in the understanding of the Sangamon Soil. They recognized a type of catena: the gumbotil profile in poorly drained areas, the siltil profile in well-drained areas, and the mesotil profile in intermediate areas. They did not call them types of Sangamon Soil, but weathering profiles on Illinoian drift. They used the term Sangamon only in a time-stratigraphic sense.

In 1931, the stratigraphic position of the Sangamon Soil was adjusted when Leighton (1931) reinterpreted the loesslike silt described at the "Farm Creek exposure" (Leighton, 1926) to be the "Late Sangamon loess." This exposure was considered by Leighton to be a "type Pleistocene section," and, in effect, became the reference section for the Sangamon Soil. The inference that can be drawn from Leighton (1931) is that the Sangamon Soil transgresses from interglacial to glacial conditions and consists of two parts:
(1) Illinoian gumbotil (a product of intense weathering) in the lower part and (2) a youthful soil profile formed in the Late Sangamon loess, which may have developed during the "Iowan," the first glacial stage of the "Wisconsin."

After 1931, no significant modification of the two-part concept of the Sangamon Soil was made for about 20 years. Then Leighton eliminated the "upper Sangamon" by changing the name of the "Late Sangamon loess" to the Farmdale loess (Wascher, Humbert, and Cady, 1948) and placing it into the "Wisconsin" stage (Leighton and Willman, 1950). During the 1940s, Leighton and others came to realize that the Farmdale loess was a deposit related to glacial conditions. But the Sangamon peat described by Leverett (1899) at the "Farm Creek exposure" overlies the Farmdale loess. Therefore, by placing the peat and Farmdale loess into the Wisconsinan, the peat bed containing the boreal remains (coniferous wood) was deleted from the Sangamon Soil as conceived by Leverett.

The most controversial change in the concept of the Sangamon Soil occurred in 1960 when Frye and others published the paper, "Accretion-gley and the gumbotil dilemma." They criticized the dualism of the empirical and genetic definition of gumbotil and suggested that gumbotil be restricted to the truly in situ, gleyed soil. They reviewed the term gley, a product of reduction in a wet environment, and defined "accretion gley," a product of "slowly accumulating deposits of surficial clay" in a wet soil environment.

Shortly after publishing their paper on the gumbotil dilemma, Frye and others (1960) presented the first broad analysis of the physical features of the Sangamon Soil in Illinois, but they did not describe any soil profiles. The significant conclusions drawn by Frye and others (1960) are: (1) the degree of mineral decomposition in accretion-gley profiles is less than in the in situ profiles and much less than ascribed to the gumbotil, and (2) the term gumbotil is not a good scientific term and "should be used only in a general sense to refer to those plastic and sticky surficial clays resting on till." Leighton and MacClintock (1962) disputed much of the work of Frye and others but acknowledged that some deposits are accretion gleys.

Frye and Willman (1963) countered by commenting on what they considered to be archetypical gumbotil sections that "At every reported exposure that we have recently examined the 'gumbotil' is accretion-gley." The dilemma can be explained by considering a conceptual catena. Given a nearly level ground surface with an occasional rise and isolated depressions, an in situ, poorly drained gleyed soil can exist on the level ground between the accretion gley in the depression and the better-drained, in situ soil on the rise. In fact, this sequence is typical of a large part of the flat Illinoian till plain. In a soil-geomorphic sense, disregarding the chemical and mineralogic requirements, the in situ, gleyed profile could be called gumbotil; however, Willman and others (1966) did not approve of differentiating a poorly drained, in situ soil from the better drained, in situ soils because they did not consider it practical.

Because the Sangamon Soil is time-transgressive, its recognition in a sequence of deposits does not necessarily establish that the beginning of Wisconsinan time is marked by the top of the soil. The Wisconsinan time boundary commonly lies within the A horizon of the Sangamon Soil and has been determined in Illinois by detailed analyses of grain sizes (Follmer, 1970, summarized in Johnson and others, 1972) or by mineralogical analysis (Frye and others, 1974). The beginning of Wisconsinan time has been estimated by Frye and others to be about 75,000 years ago. Studies in Iowa (Ruhe, 1976) and in Indiana (Kapp and Gooding, 1964) suggest that the Wisconsinan begins at a younger age.

The fundamental question that arises concerns the basis for assigning the Wisconsinan-Sangamonian boundary in the continental record. Should the beginning of the Wisconsinan be based on the first Wisconsinan sediments on the Sangamon Soil in its type area (Frye and others, 1974) or on the introduction of, or some measure of, boreal remains into the Sangamon Soil profile?

A general evaluation of all known published descriptions of the Sangamon Soil in central Illinois has been summarized by Follmer (1978). Only 7 of the 88 described sections included detailed description of the Sangamon Soil. At 17 other sections, only the major horizons were noted. The general appearances of the profile were described at 52 sites; at the remaining 12 sites the Sangamon Soil was noted as occurring in the described section, but was not described. The type area of the Sangamon Soil had not been designated until the central portion of the Illinoian till plain was proposed by Follmer (1978).

The major concepts of the origin and stratigraphic position of the Sangamon Soil in Illinois have evolved into a reasonably clear picture in the 88 years since the introduction of the Sangamon Soil by Leverett (1898a). Some of the details remain to be resolved, however. The details pertaining to the Sangamon Soil and its age have become increasingly important as more precise correlations to other areas, particularly the oceanic record, are being attempted.

The need for more precise information has always been recognized. Leighton initially went to the Farm Creek Section in 1926 because he thought a "detailed examination" was needed. Even after the great amount of work Leighton accomplished himself, he described the need for a comprehensive study of the weathering profiles (1962) and made recommendations that the "Farm Creek Section should be opened up" and studied again (1965). In more recent work, Willman and Frye (1970) thought that paratype sections of two types of Sangamon Soil profiles were needed because none had existed before. At the present time the status of the Sangamon Soil in central Illinois can be generalized by the following: (1) It has been used successfully to separate the Wisconsinan and Illinoian deposits; (2) the mineralogy has been satisfactorily characterized; (3) its morphology and parent material have not been studied in sufficient detail; (4) its catenary members have been characterized at Athens North and South Quarries, but more work needs to be done; and (5) the top of one accretionary profile has been dated at 41,770 $\pm$ 1100 RCYBP (ISGS 684).

THE ATHENS NORTH QUARRY SECTION

The section was measured at the east end of the operating Material Services Indian Point limestone quarry, August 1978, in the SW SE NE Sec. 18, T18N, R5W, Mason City Southwest 7½-minute Quadrangle, Menard County.

Pleistocene Series
Wisconsinan Stage
Woodfordian Substange
Peoria Loess

Horizon	Depth (m)	Sample no.		Thickness (m)
C2	1.02 to 2.05	NQA43 to NQA35	Loess; dolomitic, light olive-gray (5Y 6/2) silt loam, common 10YR 6/8 mottles, common dark stains and small iron concretions; massive to weak platy, very weak aggregation; porous, common small channels with thin dark argillans; friable; upper 1.0 m disturbed..	2.1
Oa Oe A	2.18 to 3.28	NQA34 to NQA17	Silt, organic rich; dolomitic, very dark grayish brown to black (10YR 3/2 and 2/1) color-stratified muck and silt loam, few to common 5/6 mottles, few pipestem concretions in upper part; few continuous small channels; weak platy "bedded" structure with ragged vertical fracture faces and felted horizontal surfaces; well-preserved spruce needles and charred-carbonized wood fragments in upper part, zones of highly decomposed organic material between zones of moderately well preserved woody fragments, generally more decomposed downward; abundant wood remains in lower 5 cm (wood at 2.25 m, 22,170 ±450 RCYBP (ISGS-534).................................	1.2

Farmdalian Substage
Robein Silt

Farmdale Soil

Horizon	Depth (m)	Sample no.		Thickness (m)
Oa	3.37 3.40 3.47	NQA16 NQA15 NQA14	Muck; leached, black (10YR 2/1) mucky silt, rare 5/4 mottles in upper part; massive to very weak platy; firm when moist, hard and punky when dry (wood at 3.35m, 25,170 ±200 RCYBP (ISGS-536).............................	0.2
A	3.53 3.60	NQA13 NQA12	Silt; leached, black (10YR 2/1) silt loam; massive, very weak aggregation, fracture surface rough with small rounded forms; somewhat friable...........................	0.1
Bg Gley zone I	3.66 3.73 3.98 4.14 4.30	NQA11 NQA10 NQA9 NQA8 NQA7	Silt; leached, very dark gray to dark gray (5YR 3/1-4/1) silt loam, more sand at base; nearly massive, healed platy (bedding?); rare pores and small channels; few very thin argillans; few thin bleached silt lenses; traces of organic matter, stratiform light and dark layers; somewhat friable, hard when dry; occasional krotovina filled with 2/1 or 3/1 silt; common large-scale involu-	

Horizon	Depth (m)	Sample no.		Thickness (m)
			tions (differential compaction or cryoturbation?); very gradational boundaries (C-14 dates on muck from adjacent pits in lower half of unit, 35,750 ±620, 37,100 ±1200, RCYBP (ISGS 870 and 883 respectively)..........	0.7
Altonian Substage Roxana Silt				
Bg/A Gley zone II	4.46 to 5.27 4.45 to 5.25	NQA6 to NQA1 NQB22 to NQB18	Silt; leached, gray (5Y 5/1) heavy silt loam, rare 5/6-6/8 mottles; B horizon superimposed on A horizon, structures largely healed, breaks into blocks with rounded forms (welded aggregates) on fracture surfaces, distinct platyness and traces of degraded charcoal; few small channels, porous in places; few thin argillans in pores; rare silans separating platy forms; friable to plastic; occasional krotovina filled with Robein material; very gradational boundaries (C-14 date on humus from preserved Ab from top of unit from adjacent pit 38,900 ±654 RCYBP [ISGS 654])........................	1.0
Sangamonian Stage Glasford Formation Berry Clay Member			Sangamon Soil	
Bg Gley zone III	5.45 5.65 5.85 6.05 6.25 6.45 6.65	NQB17 NQB16 NQB15 NQB14 NQB13 NQB12 NQB11	Clayey silt; leached, dark gray to greenish gray (5Y 4/1 to 5GY 4/1), silty clay loam, some sand, few pebbles; few 7.5YR 6/6 mottles, few 2/1 stains and small concretions; rare degraded charcoal in upper sample; nearly massive when wet, weak blocky with irregular aggregate forms when dry; few thin to large dark argillans; few silans; few pores (channels, planar voids and vugs); more firm than above; plastic when wet, hard when dry; few krotovina; local masses of vivianite, white, turn blue on exposure; clear lower boundary (C-14 date on seeds, charcoal and humus from preserved Ab from top of unit from adjacent pit, 41,770 ±1100 RCYBP [ISGS 684]).........	1.4
Illinoian Stage Glasford Formation Vandalia Till Member				
Bg Gley zone IV	6.75 6.90	NQB10 NQB9	Till; leached, dark greenish-gray (5GY 4/1) loam, common pebbles, many 5Y 6/6 mottles; few stains and small concretions; nearly massive when wet, healed weak blocky with moderate aggregate expression when dry; few	

Horizon	Depth (m)	Sample no.		Thickness (m)
			5Y 4/1 argillans; firm to plastic; occasional krotovina; gradual irregular lower boundary..................................	0.3
B3 (BC) (C1)	7.05 7.20 7.35	NQB8 NQB7 NQB6	Till; leached, olive (5Y 5/4) loam, common pebbles, common 5G 6/1 and 10YR 6/8 mottles, few manganese concretions; weakly blocky with few argillans on healed ped surfaces, few pores; firm to plastic; gradual to distinct lower boundary..................................	0.4
C2	7.50 7.65 7.85 7.95 8.05	NQB5 NQB4 NQB1 NQB2 NQB3	Till; dolomitic, light olive-brown (2.5Y 5/4) loam, common pebbles, gravel-rich zone at base, common 10YR 5/8 and rare 5G 6/1 mottles; weak coarse platelike blocks; rare small argillans; brittle, hard somewhat friable; common vertical stained joints; gradual lower boundary..................................	0.4
C3 C4	9.20 to 10.10	NQBB9 to NQBB1	Till; dolomitic, pebbly loam, olive (5Y 5/4-5/3) grading down to dark gray (5Y 4/1), oxidizes to 4/2 on exposure, common 5/8 mottles at top and base; middle part uniform gray with coarse blocky to platy fracture pattern on drying, massive when wet: breaks with smooth to hackly conchoidal surfaces; dense, firm, brittle (dry), plastic (wet); rests upon glacially polished Pennsylvanian limestone in most places....................	2.1
			Total	9.9

EXPLANATION OF TERMINOLOGY

Geologists and pedologists have historically used different styles in describing weathering profiles in surficial materials. In this description the two styles are combined to illustrate relationships of terminology. The first word of the description is a lithogenetic term used by geologists; second is a term that describes a condition of leached (of carbonate minerals) or dolomitic ("unleached"). Much of the terminology, concepts and horizon designations is from "Soil Taxonomy" (Soil Survey Staff, 1975). Recent trends are replacing lithogenetic terms with simple descriptive terms, such as diamicton for till and silt for loess. When these descriptive terms are encountered, it is important to keep in mind the differences between generalizations made by geologists and specific definitions offered by the USDA "Soil Taxonomy". For example, what a geologist may call silt could include a range of textures from silt to loam or silty clay as defined by the USDA. In the main body of the description, the USDA definitions for texture have been followed. The C horizon has been differentiated on morphogenetic criteria and is explained in appendix 1.

DISCUSSION

The Peoria Loess at North Quarry is dolomitic and 3.3 m thick; it contains dolomite zones p-1, p-2, p-3, and p-5. The clay-mineral composition of the Peoria increases in expandable clay minerals and decreases in kaolinite and chlorite upward from the base (fig. 11).

The lower 1.2 m of the Peoria Loess (zones p-1, p-2, and the lower half of p-3) contains well-preserved spruce wood, needles, and other plant debris. Wood and muck at the base of the Peoria and at the top of the Oa horizon of the Farmdale Soil yielded a radiocarbon date of 25,170 ±200 RCYBP (ISGS-536). This date supports the interpretation that the age of the base of the Peoria Loess is about 25,000 years old. The upper part of the organic zone (sample NQA33) yielded a date on wood of 22,170 ±450 RCYBP (ISGS-534). This date is from just below the middle of zone p-3, which has been estimated to range from about 20,500 to about 24,000 years old. (McKay, 1979).

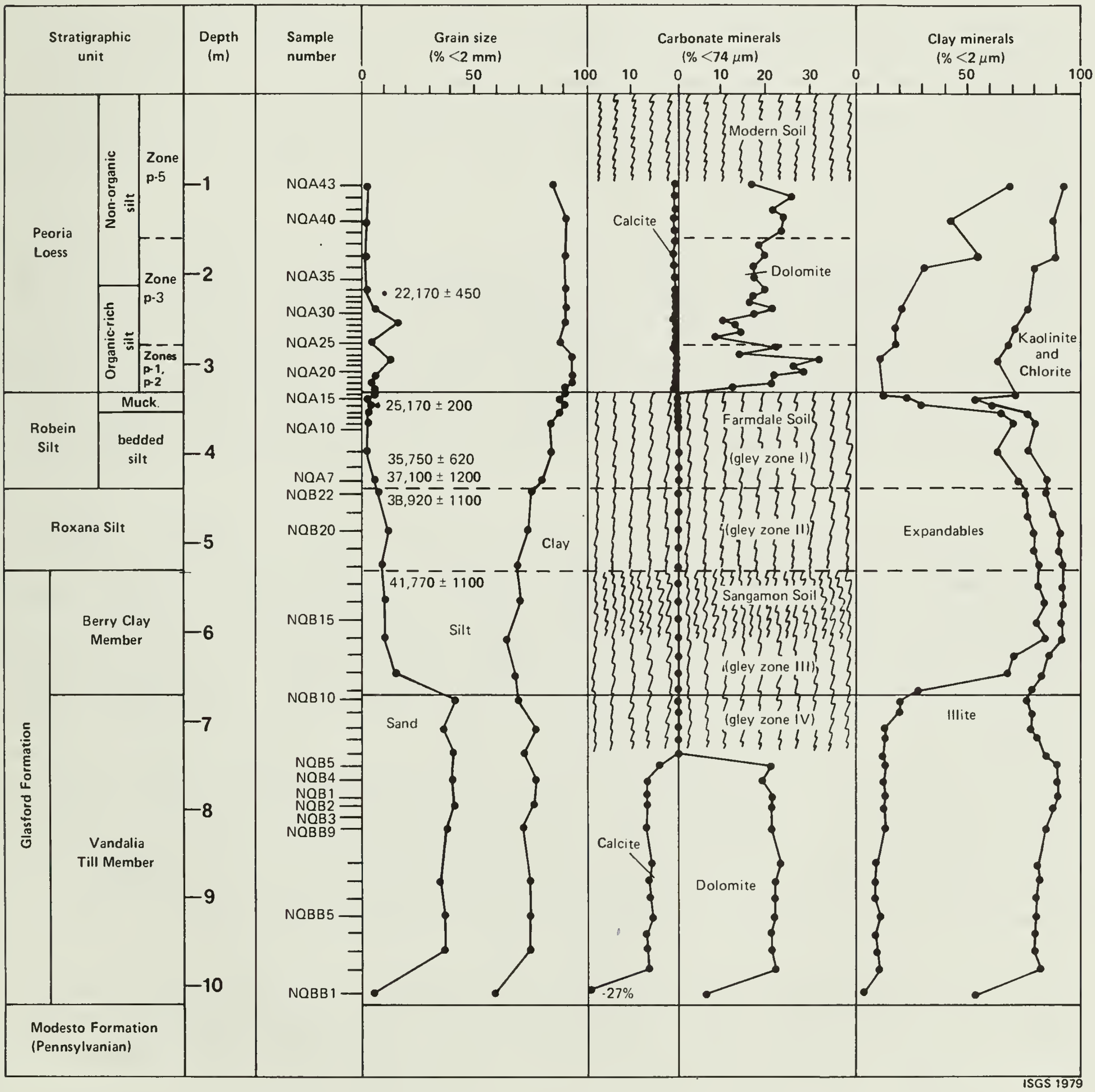


Figure 11. Grain sizes, carbonate-mineral content, and clay mineralogy of profiles A, B, and BB of the Athens North Quarry.

The Oa horizon of the Farmdale Soil is more compact than the overlying organic-rich zone and stands out in the exposure as a more resistant bed. As organic-rich as this horizon appears, it only contains 6.3 to 7.3 percent organic carbon. It is leached of carbonates and contains about 85 to 90 percent silt. This horizon has the greatest amount of vermiculite in the profile; the presence of vermiculite causes large reductions in the calculated values for expandable clay. An A horizon occurs below the Oa, and from that point downward, the clay-mineral trends change very little until the till is encountered. This indicates a similarity of the materials, or of the soil-forming environment, or both. The environmental conditions may be the more important of the two.

The parent material of the Farmdale Soil here is interpreted to be the Robein Silt. The upper part is organic-rich silt and the lower part is an involuted gleyed silt loam (gley zone I). This gley appears to have a wavy bedding and a few soft-sediment penetration structures. The clay content gradually increases downward and sand becomes noticeable in the lower part. The lower boundary is placed where the color becomes lighter and the apparent bedding stops. All other features are very gradational across the boundary into gley zone II.

Passing down into gley zone II, the small soil features change somewhat and become more granular or have a welded granular aggregation within a weak blocky or platy structure. Mottling becomes apparent and the clay and sand content continues to increase downward. Gley zone II is interpreted to be the Roxana Silt simply because no pedologic, stratigraphic, or geomorphic evidence was found to suggest that it is missing at this section. A reasonable alternative is to include the overlying material, up to the base of the Peoria, into the Roxana Silt. Even if an accretionary character can be demonstrated with certainty, the "Robein" material was clearly derived from the Roxana.

An equally difficult problem exists in identifying the boundary between gley zone II and III and the boundary is also very gradational, but structural and aggregation characteristics help distinguish the two zones. Blocky aggregates with argillans and internal granularity help distinguish zone III. Pebbles become apparent and texture becomes a silty clay loam in zone III. Traces of charcoal and other organic fragments are present in the upper sample of this zone, which indicates a ground surface. Therefore, gley zone III is interpreted to be the Berry Clay (accretion-gley) and the upper part of the Sangamon Soil. The principal argument for Berry Clay is based on the conformable relationships it has with the Vandalia Till below and the Roxana-derived material above. For practical purposes, the top of the Sangamon Soil is arbitrarily placed at the top of the Berry Clay. An alternative is to place the top of the Sangamon at the top of the Farmdale Soil, as did Leverett in 1898; however, Leverett did not realize that a glacial deposit (Roxana) separated the weathered till (Sangamon) from the Farmdale organic horizon.

A third alternative interpretation for gley zone III comes from the silt fraction data (Follmer et al., 1979). The medium silt content is about 10 percent higher than in the underlying till. This suggests that zone III has a loessial component; the admixture of some Roxana Silt in the Sangamon Soil is common in all profiles that have been examined.

The lower boundary of gley zone III with gley zone IV is clear in comparison to the other zone boundaries. Pebbles are more common, the sand content is higher, and the zone takes on the appearance of gleyed till. The boundary position is commonly gray with many "orange" mottles. The blocky aggregates are more distinctive, but in a fresh exposure the zone is usually wet and plastic, and appears massive, as in zone III. In places a coarse layer is found at the top of the till. The sand content of zone IV (about 40%) is the same as that of the till below. Also, the clay mineralogy shows a genetic relationship to the underlying till. The gleying has caused some increase in the values of the expandables and kaolinite and chlorite, and a decrease in illite values. Therefore, gley zone IV is interpreted to be the upper part of the Vandalia Till.

The olive B3 beneath the gley zone IV is a normal pedologic feature in gleyed soil profiles. The solum thickness of the Sangamon in this profile is 2.1 m, and the B3 is in sharp contact with a calcareous C2 horizon in the Vandalia in most places. Average carbonate content of the C2 is slightly lower (27.4 %) than the C4 (28.5 %). Grain size is essentially the same for both horizons, averaging 38 percent sand and 27 percent clay (20 % <2 μm). The C4 is an unaltered zone, whereas the C2 is oxidized. The C1 and C3 are transitional horizons (appendix 1). Unaltered chlorite is found in the C4 but is mostly destroyed in the C2. This causes the warp (depth, 9.8 to 10 m) in figure 11. The value for kaolinite and chlorite is about 20 percent in the C4. When oxidation alters the chlorite, the value for kaolinite and chlorite drops to about 10 percent, and the difference is largely made up by the apparent increase in illite from about 71 percent to 77 percent. This difference in illite content points to the value of recognizing subdivision of the C horizons so that the degree of weathering can be taken into account when till correlations are made.

NEW INFORMATION

Since 1979, the quarry operations have continued to work northward and have produced one or two new exposures each year. Each open pit is about 1000 to 1300 ft long with a width of 265 ft. Each new pit is parallel to the former pit and is separated by a 15-ft buffer zone. The pit sampled in 1978 was designated pit 1. The Midwest Friends of the Pleistocene (Follmer et al., 1979) examined pit 2.

After the Friends trip in 1979, a new exposure in pit 3 revealed an organic-rich A horizon in the top of the Roxana (fig. 12). The age of this horizon is 38,920 ±1100 RCYBP (ISGS-654). Later in 1980 a careful search for a preserved Sangamon A horizon revealed one isolated location in which dark, organic blotches containing seeds, plant fragments and carbonized wood were present. A combination of these materials with extracted humus gave an age of 41,770 ±1100 RCYBP (ISGS-684, Follmer, 1983). The humic acid yielded an age of 35,560 ±900 RCYBP (ISGS-688), which indicates that a small amount of contamination probably affected the age of the residue sample. This allows us to project the age of the top of the accretionary Sangamon Soil at this location to be about 45,000 years old.

In pit 4 and in all succeeding exposures up to the present, multiple couplets of A and Bg horizon have been found in the lower part of the Robein

Silt. Each A/Bg couplet is interpreted as a soil that developed in accreted silty material. Samples collected from the two most prominent A horizons, the lower one (5 cm thick) from the top of the Roxana and the upper one (15 cm thick) about 0.5 m above the Roxana, gave ages of 37,100 ±1200 (ISGS 883) and 35,750 ±620 (ISGS 870) RCYBP respectively. No formal name has been assigned to these soils, but they have been referred to as splits in the Indian Point geosol.

The greater thickness of the Peoria Loess in pit 3 (fig. 12) suggests that the Farmdale Soil in Roxana may have been lower on the paleolandscape and buried at an earlier time than the equivalent horizon in pit 4. Also, sampling from different stratigraphic levels could account for the apparent different age. The pit 1 profile was sampled nearer a modern drainage way that appears to be related to the thinner Peoria Loess at that location. The

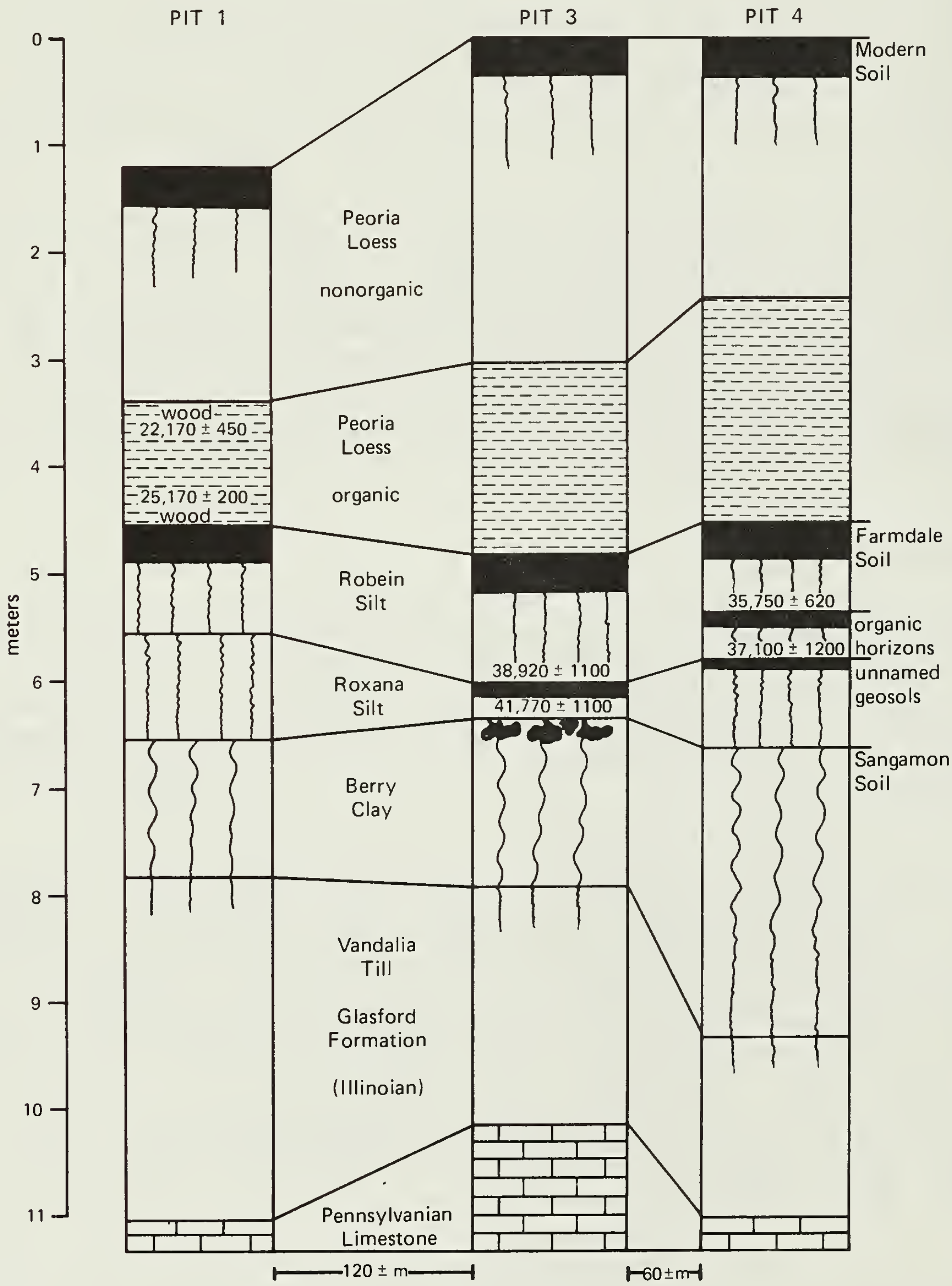


Figure 12. Stratigraphic correlations of North Quarry pit exposures.

C-14 dates from pit 1 indicate that the base of the Peoria is intact there and that headward erosion by the modern drainage way has eroded about 1 m or more of the younger parts of the Peoria Loess.

SUMMARY OF PALEOBOTANICAL STUDIES

Bulk samples for pollen and plant analyses were collected from the North Quarry pit exposures in 1978 (J. King, 1979). Because of continued quarrying operations, the same exposure is no longer present, but a similar exposure may be available in the future. The pollen samples were collected from a cleaned face at the east end of the north wall in pit 1 near the site of the profile description. At the east end of this pit, the upper horizon of the Farmdale Soil is a compact muck that grades upward into a 50-cm-thick, dark peatlike silty deposit in the lower part of the Peoria Loess. Abundant wood fragments, plant macrofossils, and small logs are present at the base of the Peoria (table 2).

Table 2. Macrofossils from Athens North Quarry (F. King, 1979)

Wood	*Picea*	spruce
	Pinus	pine
	Larix laricina	larch
Needles	*Picea*	spruce
	Abies balsemea	balsam fir
Cones	*Picea mariana*	black spruce
Seeds	*Cyperus*	sedge
	Hypericum	St. John's-wort
	Viola	violet

Pollen in the Athens North Quarry section was preserved only in a 50-cm section above the Farmdale Soil in the lower part of the organic-rich Peoria Loess (fig. 13). Spruce wood, at the Peoria Loess/Robein Silt contact (at the

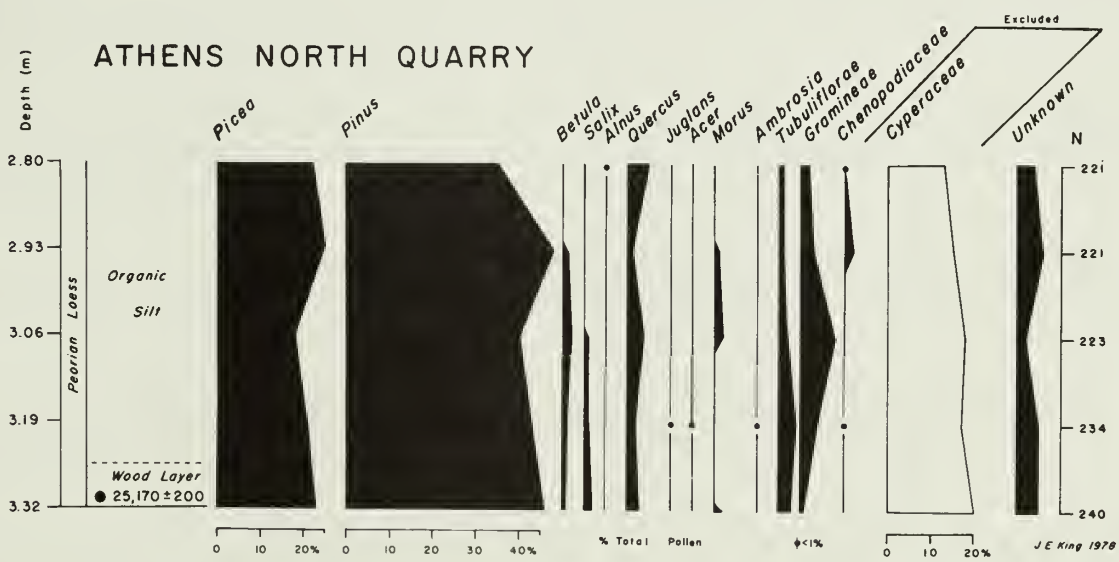


Figure 13. Relative frequency of pollen from Athens North Quarry.

base of the pollen column) was radiocarbon dated at 25,170 ±200 RCYBP. Wood from near the top of the organic-rich silt and 80 cm above the uppermost pollen sample is dated at 22,170 ±450 RCYBP. The dark organic-rich silt with the preserved pollen therefore dates between about 23,000 and 25,000 BP.

The pollen in this section is dominated by *Pinus* (pine) and *Picea* (spruce); together these two types comprise about 70 percent of the total pollen. Other taxa commonly present throughout the section include *Quercus* (oak), *Gramineae* (grass), and *Tubuliflorae* (the sunflower group). The variations in the percentages of individual taxa between samples is relatively small within the range of confidence limits of percentages based on *N* of 200 (Rohlf and Sokal, 1969). Thus, the fluctuations between levels of pine and spruce, the major plant types, are not statistically significant. A possible shift to slightly colder climatic conditions toward the top of this short pollen section may be suggested by the disappearance of *Betula* (birch), *Salix* (willow), and *Morus* (mulberry). Overall, however, the pollen evidence indicates rather stable vegetational conditions during the deposition of this portion of the lower Peoria Loess, which occurred over approximately a 2000-year period.

The pollen in the Athens North Quarry section appears to reflect a forest composed of pine and spruce with a grass and herb understory. The presence of <10% oak pollen indicates that it was not growing near the site; the oak pollen in the section apparently drifted in on the prevailing winds from source areas to the south and southwest. The pollen does not suggest any type of major climatic change between 23,000 and 25,000 years ago in this area.

REFERENCES

Berg, R. C., J. P. Kempton, L. R. Follmer, and D. P. McKenna, 1985, Illinoian and Wisconsinan stratigraphy and environments in northern Illinois: The Altonian revised: Illinois State Geological Survey Guidebook 19, 177 p.

Bergstrom, R. E., K. Piskin, and L. R. Follmer, 1976, Geology for planning in the Springfield-Decatur region, Illinois: Illinois State Geological Survey Circular 497, 76 p.

Chamberlin, T. C., 1896 [editorial], Journal of Geology, v. 4, p. 872-876.

Deere, D. V. and F. D. Patton, 1971, Slope stability in residual soils: Fourth Panamerican conference on soil mechanics and foundation engineering, San Juan, Puerto Rico, p. 87-170.

Follmer, L. R., 1970, Soil distribution and stratigraphy in the Mollic Albaqualf region of Illinois: Ph.D. thesis, University of Illinois, Urbana, 155 p.

Follmer, L. R., 1978, The Sangamon Soil in its type area--A review, in W. C. Mahaney [ed.], Quaternary soils: Geology Abstracts, Norwich, England, p. 125-165.

Follmer, L. R., 1983, Sangamon and Wisconsinan pedogenesis in the midwestern United States, in Porter, S. C. [ed.], The Late Pleistocene (vol. 1 of Wright, H. E. [ed.], Quaternary Environments of the United States): University of Minnesota Press, Minneapolis, p. 138-144.

Follmer, L. R., 1984, Soil--an uncertain medium for waste disposal: Seventh Annual Madison Waste Conference proceedings, p. 296-331.

Follmer, L. R., E. D. McKay, J. A. Lineback, and D. L. Gross, 1979, Wisconsinan, Sangamonian, and Illinoian stratigraphy in central Illinois: Illinois State Geological Survey Guidebook 13, 139 p.

Follmer, L. R., J. P. Tandarich, and R. G. Darmody, 1985, The evolution of pedologic and geologic profile concepts in the Midcontinent, USA: American Society of Agronomy Abstracts, p. 190.

Frye, J. C., and H. B. Willman, 1960, Classification of the Wisconsinan Stage in the Lake Michigan glacial lobe: Illinois State Geological Survey Circular 285, 16 p.

Frye, J. C., P. R. Shaffer, H. B. Willman, and G. E. Ekblaw, 1960, Accretion gley and the gumbotil dilemna: American Journal of Science, v. 258, n. 3, p. 185-190.

Frye, J. C., and H. B. Willman, 1963, Loess stratigraphy, Wisconsinan classification and accretion-gleys in central-western Illinois: Illinois State Geological Survey Guidebook 5, 37 p.

Frye, J. C., L. R. Follmer, H. D. Glass, J. M. Masters, and H. B. Willman, 1974, Earliest Wisconsinan sediments and soils: Illinois State Geological Survey Circular 485, 12 p.

Glass, H. D., J. C. Frye, and H. B. Willman, 1964, Record of Mississippi River diversion in the Morton Loess of Illinois: Illinois Academy of Science Transactions, v. 57, n. 1, p. 24-27.

Johnson, W. H., L. R. Follmer, D. L. Gross, and A. M. Jacobs, 1972, Pleistocene stratigraphy of east-central Illinois: Illinois State Geological Survey Guidebook 9, 97 p.

King, F. B., 1979, Plant macrofossils from Athens North Quarry, in Follmer, Leon R., E. D. McKay, J. A. Lineback, and D. L. Gross [eds.], Wisconsinan, Sangamonian and Illinoian stratigraphy in central Illinois: Illinois State Geological Survey Guidebook 13, p. 114-115.

King, J. E., 1979, Pollen analysis of some Farmdalian and Woodfordian deposits, central Illinois, in Wisconsinan, Sangamonian, and Illinoian Stratigraphy in central Illinois: Illinois State Geological Survey Guidebook 13, p. 109-113.

Kapp, R. O., and A. M. Gooding, 1964, Pleistocene vegetational studies in the Whitewater Basin, southeastern Indiana: Journal of Geology, v. 72, p. 307-326.

Leighton, M. M., 1926, A notable type Pleistocene section: The Farm Creek exposure near Peoria, Illinois: Journal of Geology, v. 34, p. 167-174.

Leighton, M. M., 1931, The Peorian loess and the classification of the glacial drift sheets of the Mississippi Valley: Journal of Geology, v. 39, p. 45-53.

Leighton, M. M., 1933, The naming of the subdivisions of the Wisconsin glacial age: Science, v. 77, n. 1989, p. 168.

Leighton, M. M., 1960, The classification of the Wisconsin glacial stage of north central United States: Journal of Geology, v. 68, p. 529-552.

Leignton, M. M., 1965, The stratigraphic succession of Wisconsin loesses in the Upper Mississippi River Valley: Journal of Geology, v. 73, p. 323-345.

Leighton, M. M., and Paul MacClintock, 1930, Weathered zones of the drift-sheets of Illinois: Journal of Geology, v. 38, p. 28-53.

Leighton, M. M., and Paul MacClintock, 1962, The weathered mantle of glacial tills beneath original surfaces in north-central United States: Journal of Geology, v. 70, p. 267-293.

Leighton, M. M., and H. B. Willman, 1950, Loess formations of the Mississippi Valley: Journal of Geology, v. 58, p. 599-623.

Leverett, Frank, 1898a, The weathered zone (Sangamon) between the Iowan loess and Illinoian till sheet: Journal of Geology, v. 6, p. 171-181.

Leverett, Frank, 1898b, The Peorian soil and weathered zone (Toronto Formation?): Journal of Geology, v. 6, p. 244-249.

Leverett, Frank, 1899, The Illinois glacial lobe: U.S. Geological Survey Monograph 38, 817 p.

Lindroth, C. H., 1961, The ground beetles of Canada and Alaska: Part 1, Opusc Entomol Supplement XX.

Lindroth, C. H., 1966, The ground beetles of Canada and Alaska: Part 4, Opusc. Entomol Supplement XXIX.

Lineback, J. A., 1979, The status of the Illinoian glacial stage, in Follmer, E. D. McKay, J. A. Lineback, and D. L. Gross, Wisconsinan, Sangamonian, and Illinoian stratigraphy in central Illinois: Illinois State Geological Survey Guidebook 13, p. 69-78.

McKay, E. D., 1977, Stratigraphy and zonation of Wisconsinan loesses in southwestern Illinois: Ph.D thesis, University of Illinois, Urbana, 242 p.

McKay, E. D., 1979, Wisconsinan loess stratigraphy of Illinois, in Follmer, L. R., E. D. McKay, J. A. Lineback, and D. L. Gross, Wisconsinan, Sangamonian, and Illinoian Stratigraphy in central Illinois: Illinois State Geological Survey Guidebook 13, p. 95-108

Morgan, A. V., and A. Morgan, 1979, The fossil Coleoptera of the Two Creeks Forest Bed, Wisconsin: Quaternary Research 12, p. 226-240.

Morgan, A. V., and A. Morgan, 1980, Faunal assemblages and distributional shifts of Coleoptera during the Later Pleistocene in Canada and the Northern United States: Canadian Ent. 112, p. 1105-1128.

Morgan, A. V., and A. Morgan, 1980, Paleontomological methods of reconstructing paleoclimate with reference to interglacial and interstadial insect faunas of southern Ontario, in Quaternary Paleoclimate, W. C. Mahaney [ed.]: Geo. Abstracts, U.K.

Rohlf, F. J., and R. R. Sokal, 1969, Statistical tables: W. H. Freeman and Company, San Francisco.

Rubin, M., and C. Alexander, 1960, U.S. Geological Survey radiocarbon supplement, v. 2, p. 129-185.

Ruhe, R. V., 1976, Stratigraphy of mid-continent loess, U.S.A., in W. C. Mahaney [ed.], Quaternary Stratigraphy of North America: Dowden, Hutchinson, and Ross, Inc., Stroudsbrug, PA, p. 197-211.

Soil Survey Staff, 1975, Soil taxonomy--A basic system of soil classification for making and interpreting soil surveys: U.S. Department of Agriculture, Soil Conservation Service, Agriculture Handbook No. 436, 754 p.

Wascher, H. L., R. P. Humbert, and J. G. Cady, 1948, Loess in the southern Mississippi Valley: Identification and distribution of the loess sheets: Soil Science Society of America Proceedings, 1947, v. 12, p. 389-399.

Williams, N. E., J. A. Westgate, D. D. Williams, A. Morgan, and A. V. Morgan, 1981, Invertebrate fossils (Insecta: Trichoptera, Diptera, Coleptera) from the Pleistocene Scarborough Formation at Toronto, Onatrio, and their paleoenvironmental significance: Quaternary Research 16, p. 146-166.

Willman, H. B., H. D. Glass, and J. C. Frye, 1966, Mineralogy of glacial tills and their weathering profiles in Illinois: Part 2, Weathering profiles: Illinois State Geological Survey Circular 400, 76 p.

Willman, H. B., and J. C. Frye, 1970, Pleistocene stratigraphy of Illinois: Illinois State Geological Survey Bulletin 94, 204 p.

Worthen, A. H., 1870, Geology and Paleontology: Geological Survey of Illinois, v. IV, 508 p.

Worthen, A. H., 1873, Geology and paleontology: Geological Survey of Illinois, v. V, 619 p.

APPENDIX 1. Comparison of the complete soil profile and a weathering profile in rock (from Follmer, 1984).

Soil profile (Follmer et al., 1979)			Weathering profile (Deere and Patton, 1971)	
	Horizon	Description	Zone	Description
	A	Zone of organic matter and resistant mineral accumula-ion; porous*	IA	Top soil; organic material; zone of leaching and eluvia-tion; may be porous*
	E	Zone of eluviation; porous, may be vesicular*		
(BC)	B B3	Zone of clay accumulation or gleying; blocky peds commonly coated with clay or secondary minerals; biological pores*	IB	Characteristically clay-enriched with accumulations of Fe, Al and Si; no relict structures*
(CB)	C1**	Zone of strong mineral alteration; oxidized or gleyed; clay coatings or stains on peds or joint blocks; common roots in joints; occasionally porous and massive	IC	Relict rock structure retained; <10% core stones; >90% soil-like material
(C)	C2	Zone of moderate mineral alteration; oxidized or gleyed; jointed; calcareous or equivalent; clay or secondary minerals in joints; geologic fabric within structural units		
(CD) (DC)	C3**	Zone of slight mineral alteration; variable; few joints with stains or veins of secondary minerals; unaltered "core stones" between joints	IIA IIB	Soil-like to rock-like; 10 to 90% core stones, highly variable Rock-like; altered or stained along joints
(D)	C4	Unweathered, unaltered, unoxidized, massive or stratified geologic material	III	Unweathered rock; no stains along joints

*Although descriptions are different, general agreement exists to use definitions of the Soil Survey Staff (1975) for the solum.
**Transitional horizon.
( )Designations proposed by Follmer et al. (1985) in a paper read at the American Society of Agronomy meeting in Chicago.

APPENDIX 2. A Preliminary Note on Fossil Insect Faunas from Central Illinois

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As part of a long-term paleoentomological project at the University of Waterloo, samples have been obtained from a number of sites close to the limit of Wisconsinan glaciation in Illinois, Indiana, Ohio, New York, and Pennsylvania. Preliminary samples from Illinois were first collected in 1972 (Morgan, unpublished) and established the foundation for further sampling in following years. This report provides comments on the insect faunas extracted from the Gardena and Clinton sites. The processing methods follow those outlined in Morgan and Morgan (1979).

Gardena Section

The site at the Gardena Section is well exposed on the banks of a tributary stream flowing into Farm Creek east of Peoria, Illinois (Follmer et al., 1979). The section exposes a sequence of 2.13 m of Morton Loess resting on Robein Silt and overlain by a gray, massive diamicton (the Delavan Till Member of the Wedron Formation). The top 1 to 3 cm of the Morton is a thin, continuous layer of compressed moss that is overlain by an 8- to 10-cm light gray lacustrine clay.

Wood taken from the base of the Morton near stream level (ca. 2.0 m below the contact with the till) has provided an age of 25,370 ± 310 RCYBP (ISGS-531). The moss layer (10 to 12 cm below the till) was dated at 19,680 ± 460 RCYBP (ISGS-532).

Samples for insect analyses were taken from two levels. In 1981, 28.1 kg were extracted from 1.85-2.0 m below the till, with an additional 76 kg from the same level in 1982. Also in 1981, 22.8 kg were taken from the moss and lacustrine clay layer and supplemented by an additional 121.8 kg in 1982. A consistent ecological picture emerged that permits some general comments about the paleoenvironments of the Peoria region prior to the advance of the late Wisconsinan ice.

The lower part of the Morton Loess in the Gardena Section contains a numerically rich but very poorly preserved insect fauna with a restricted number of taxa. The presence of water and muddy marginal substrates is indicated by a number of dytiscid and hydrophilid species including Hydroporus and Helophorus, the carabid Dyschirius, and staphylinid species such as Bledius and Stenus. The presence of conifer trees and other plants is indicated by at least two species of scolytids, Phloeotribus piceae and Scolytus piceae, along with several cuculionid (weevil) species. Other groups represented in the fauna include oribatid mites, ants (Formica sp.) and alder flies (Sialis sp.). This assemblage suggested boreal forest conditions, although without more specific identifications it is difficult to reconstruct the exact environmental regime.

The insect fauna recovered from the moss layer at the top of the Morton Loess contrasts markedly with the fauna from the base. Although the fauna is dominated by staphylinid (rove) beetles, it also contains some extremely interesting carabid species. Foremost among these is the ground beetle Diacheila polita, which was the first-found fossil in the southern mid-continent in the early Wisconsinan Scarborough Formation at Toronto. D. polita has subsequently been discovered in other early Wisconsinan sites in Ontario and Quebec (Morgan and Morgan, 1980; Williams et al., 1981). This highly distinctive species occurs (in some number) in the Gardena section and further east at the Clinton site. The modern distribution of D. polita is confined to Alaska, Northwest Territories and the Yukon. Lindroth (1961) describes D. polita as inhabiting peaty soil on the open tundra, although it is known that this species ranges down to the northern edge of conifers (Morgan and Morgan, 1981).

Several well-preserved specimens of Elaphrus lapponicus have been found. All coppery-green, they were identified from disarticulated pronota and elytra. E. lapponicus is an hydrophilous species that, according to Lindroth (1961) inhabits cold water areas near springs, where the vegetation mainly consists of mosses. He also reports that this species rarely ascends above timber limit and is not a true inhabitant of the tundra.

Staphylinids from the same stratigraphic level include Olophrum rotundicolle, a species with a typical boreal distribution and Acidota quadrata, also a boreal inhabitant. Additional staphylinid species include Arpedium, Stenus, and at least one other Olophrum.

The somewhat limited fauna from the top of the Gardena Section does give a simplistic environmental picture of an open ground area, treeless, but not a true tundra in the sense of the modern arctic tundra. Temperatures probably were warm enough for trees to grow, but either lack of sufficient moisture, or, more likely, winds blowing across the open environment, prevented forest growth.

Clinton Section

The fauna at the top of the Morton Loess in the Gardena Section is remarkably similar to an insect assemblage recovered from an equivalent stratigraphic section in excavations made for a nuclear power station at Clinton, Illinois, approximately 50 miles southeast of Peoria. The Clinton Section was sampled twice before the exposure was closed and a total 159 kg of sediment was removed for analysis. The organic horizon consisted of a thin (up to 5-cm) layer of compacted mosses overlain by an additional 5 to 10 cm of light gray lacustrine silty clay beneath Wedron Formation till. The moss bed has been dated at 20,670 ± 280 RCYBP (ISGS-828). The Clinton fauna contains Diacheila polita and Elaphrus lapponicus as two common carabids, as well as Agonum exaratum. A. exaratum is described by Lindroth (1966) as the most pronouncedly arctic North American species of Agonum, rarely occurring below forest limit. It has been found on soft, marshy ground at the margin of pools and ponds, commonly with carices and sometimes mosses. As in the case of the fauna at the top of the Morton Loess at Gardena, staphylinids including Stenus and Olophrum rotundicolle are fairly common. A hydrophilid beetle, Helophorus sempervarians, occurs commonly in the Clinton site. This is also a typical boreal species inhabiting the margins of permanent ponds or temporary water bodies. Non-beetle insect remains recovered from Clinton include Diptera (fly puparia and chironomids), Trichoptera (caddisflies), Hemiptera and Homoptera (bugs) and Archnidae (oribatid mites).

The general environmental picture at Clinton appears to be similar to that of the Peoria region at approximately 20,000 B.P. Both the top Gardena and Clinton faunas lack scolytids, and this suggests (albeit with the dangers of negative evidence well in mind) that trees were probably not present in the depositional catchment area. The carabids, staphylinids, and hydrophilids at these sites indicate open-ground conditions, although their modern boreal distribution suggests that the environment was probably marginally capable of supporting trees. If trees were not growing at Garden or Clinton 20,000 years ago, then they must surely have not been geographically far away--possibly at the most, 10-20 km. On the basis of insect requirements, July temperatures at maximum glaciation (20,000 - 18,000 BP) should have been about 11°C or 12°C, with a mean annual temperature possibly as low as -7°C to -9°C.

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