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Quaternary records of central and northern Illinois

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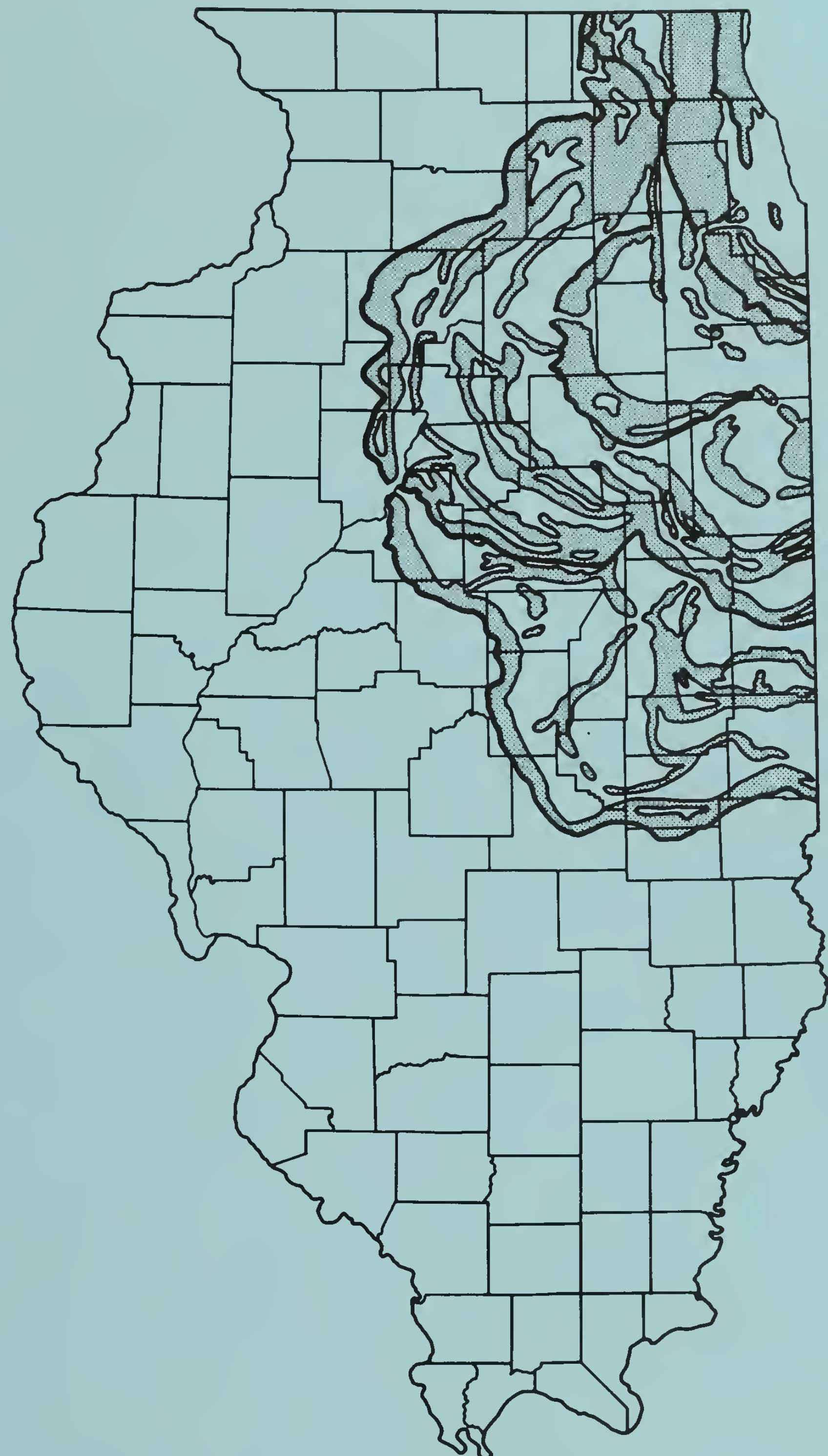

Ninth Biennial Meeting, American Quaternary Association
University of Illinois at Urbana-Champaign, May 31-June 6, 1986

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

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Quaternary records of central and northern Illinois

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American Quaternary Association
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ILLINOIS STATE GEOLOGICAL SURVEY
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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

Field trips are designed to allow us to view the scope and scale of the objects of interest and to develop an appreciation of the infinite number of surrounding factors. This trip is intended to focus on many aspects of Quaternary Science, a science that is concerned with surficial processes and human activities over the last several million years.

However, the range of interests of Quaternarists is very large and all topics cannot be equally addressed within the scope of a two-day trip. Therefore, we will concentrate on the geological aspects of the conference theme of Glacial Margins: Processes and Environments. Pedological, paleofloral and faunal, paleoclimatic and archaeological subjects have been worked in where practical.

On this trip we will see many parts of the classical Wisconsinan glacial margin of Illinois (see trip route map on back cover). At stop 1 the morphological expression of the moraine is one of the best that can be seen along the margin. In many other places the margin is subdued but can be easily determined from soil patterns and stratigraphic evidence. Stop 2 is the type locality of the Sangamon Soil, where the present-day exposures in limestone quarries reveal the sequence of silt deposits and buried soils that became the basis for naming the Sangamon Soil.

Stop 3 will be at the Illinois State Museum's Dixon Mounds park and museum, where features of early Mississippian culture can be seen in a natural setting. On the way to Stop 3 we will cross the Mason County sand plain where the ancestral "Ohio" and Mississippi Rivers once joined. Wisconsinan glaciofluvial and eolian sand deposits now cover this lowland (the "Havana" Strath"?).

Stop 4 is located at the original site of the Farm Creek Section, if the slope retreat of a cut bank on Farm Creek is taken into consideration. This section was one of the first exposures of late Pleistocene deposits to be described in Illinois and has been very useful to glacial geologists attempting to formulate stratigraphic concepts and interpret glacial history in the Midwest.

Stop 5 is in the Green River Lowland where Twocreekan wood has been recently found under "Holocene" alluvium. The ancient Mississippi River once crossed this lowland, which has a very complex history, including large-scale erosion linked to the building of the moraines at the Wisconsinan margin. End of first day.

Stop 6 is at one of the rare locations in northern Illinois where we can see a relatively complete stratigraphic record of Wisconsinan deposits overlying a Sangamon Soil developed in a reddish brown till. The extensive erosion on this till removed the Sangamon in most places and led many geologists to interpret this till as early Wisconsinan in age.

Stop 7 is a gravel pit on the Rockford Terrace, which was subjected to periglacial processes during late Illinoian time. Sangamon Soil development exploited fossil ice wedge casts and produced large pendants. The exact age of the gravel is uncertain, but the soil in it appears to be overlain in places by a complete sequence of Wisconsinan deposits.

Stop 8 is in a "till plain" area between the Wisconsinan margin and the Rock River where large-scale erosion greatly modified the landscape during the construction of the moraines of the Wisconsinan margin. The type of erosion is thought to include periglacial processes that removed the Sangamon Soil from most of the "Esmond Till plain" (except for rare sites of preservation such as at Stop 8).

Stop 9 is the Wedron type section, located within a series of quarry exposures in the St. Peter Sandstone. The quarry has been operating for more than 80 years and has provided excellent exposures for the study of late Wisconsinan glacial deposits designated as the Wedron Formation. Most of the concepts of the stratigraphic units in the Wedron in Illinois during about 1950 to 1970 were based on or directly related to features observed in the quarry exposures.

Stop 10 is a rare bog in central Illinois that formed in a kettle that by coincidence is crossed by a thalweg of a former glacial river that carried water from a stagnated Wisconsinan ice margin. Pollen studies on marl and organic deposits in the bog reveal a complete record back to about 14,000 years ago.

End of trip.

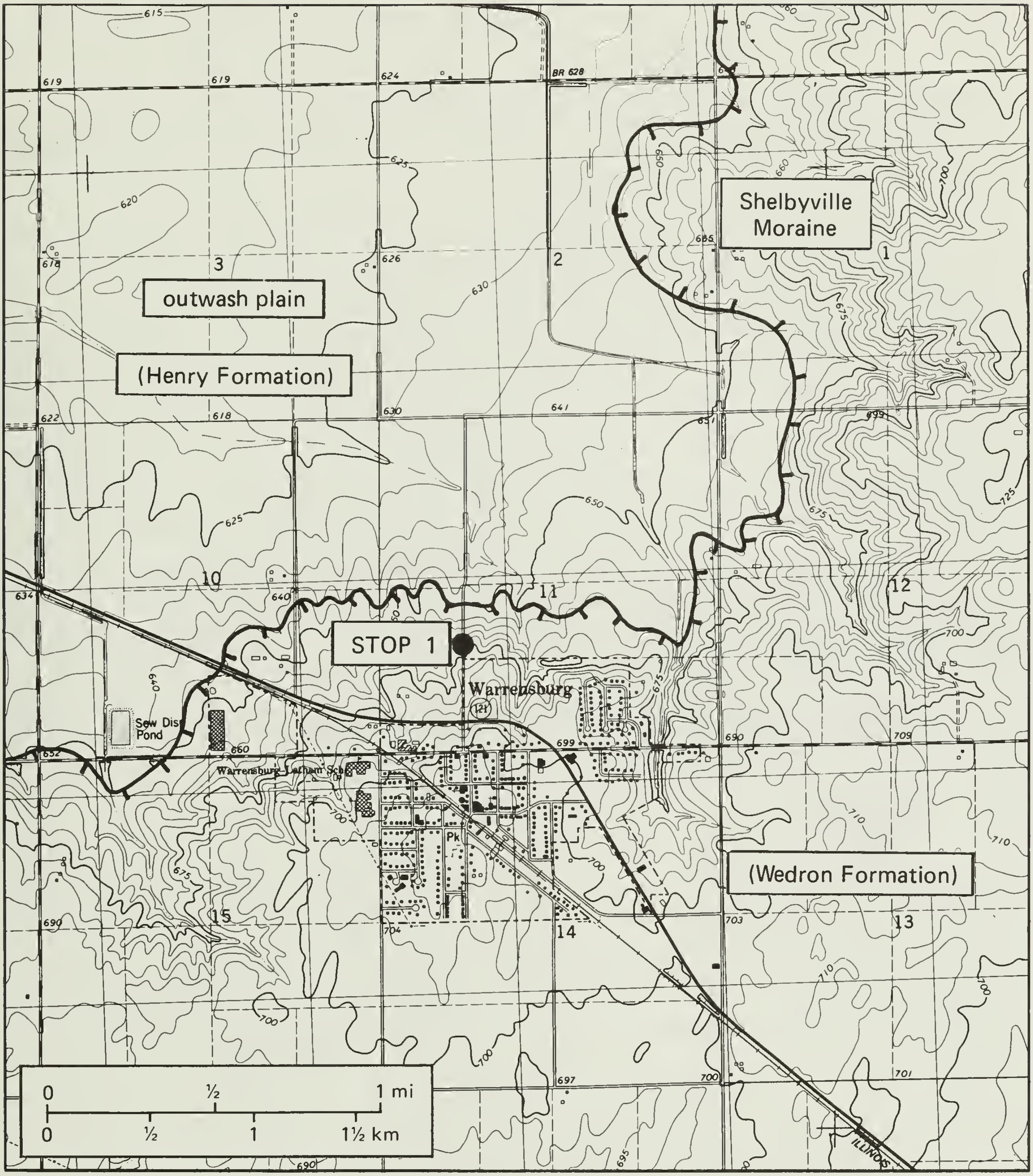
ACKNOWLEDGMENTS

During the preparation for this field trip, we received the cooperation and assistance from many landowners and organizations. We want to express our appreciation to Jack Brown, Superintendent of Indian Point Quarry, Material Service Corporation; Farmdale Park, Tazewell County; Porter Brothers, Inc.; Cooling and Sons Sod Farm; Dan Fisher, Rockford Blacktop Construction Company; Ronald Lentz; Charles Fowler and Spencer Zitka, Wedron Silica Company; Delmar Ford, Loren Hodgson and Roger Farney.

Faith Stanke, Jack Masters and Stephen Zu Hoene assisted us with field work and trip organization. Many staff members of the Illinois State Geological Survey assisted in the preparation: Herb Glass, clay mineralogy and interpretation; Mike Miller, Becky Roeper, and Bill Westcott, particle size analysis; Jack Liu and Barry Fisher radiocarbon analysis; Joanne Klitzing, Gloria Merrick, and Kathy Cooley, typing; Sandy Stecyk, drafting; and Gail Taylor, typesetting.

THE WISCONSINAN GLACIAL MARGIN

Leon R. Follmer



STOP 1. View of the Shelbyville Morainic System at Warrensburg

Sec. 10 and 11, T17N, R1E, Macon County IL (Warrensburg Quadrangle)

The crest of the outer moraine of the Shelbyville System at Warrensburg rises about 100 ft above the outwash plain to the west.

The city of Warrensburg is located on the crest of the Shelbyville Moraine, providing an excellent view of the outwash plain to the north and west. The Shelbyville Moraine was named by Leverett in 1897 and discussed in detail in his monograph (Leverett, 1899). The Shelbyville marks the margin of the classic or late Wisconsinan (Woodfordian) glaciation in this area. Because it is made up of multiple ridges in many places, Willman and Frye (1970) changed the formal name to Shelbyville Morainic System. The morainic system can be traced from Indiana to Peoria, Illinois, where it is overlapped by the Bloomington Morainic System.

At Warrensburg the moraine has about 90 ft (27 m) of relief in about a mile along a line to the northwest. On the basis of available water well records, most of the height of the moraine can be accounted for by the thickness of the Wedron Formation. The E-W alignment of the moraine at Warrensburg reflects a reentrant relationship of the multiple advances during the construction of the morainic system. In the regional view, a reorientation of the system occurs here. From Warrensburg south, a younger advance appears to have overridden the earlier margin. The younger advance deposited a gray drift that contains a relatively high amount of illite; it has been recognized as the Piatt Till Member of the Wedron Formation. The older deposits to the north are pinkish gray and have an intermediate content of illite; they have been mapped as the Fairgrange Till Member (Lineback, 1979).

The age of these advances has not been determined at this location but can be estimated to be in the range of 20,000 to 21,000 years old on the basis of radiocarbon dates on organic material at the base of the outer moraine in many other locations.

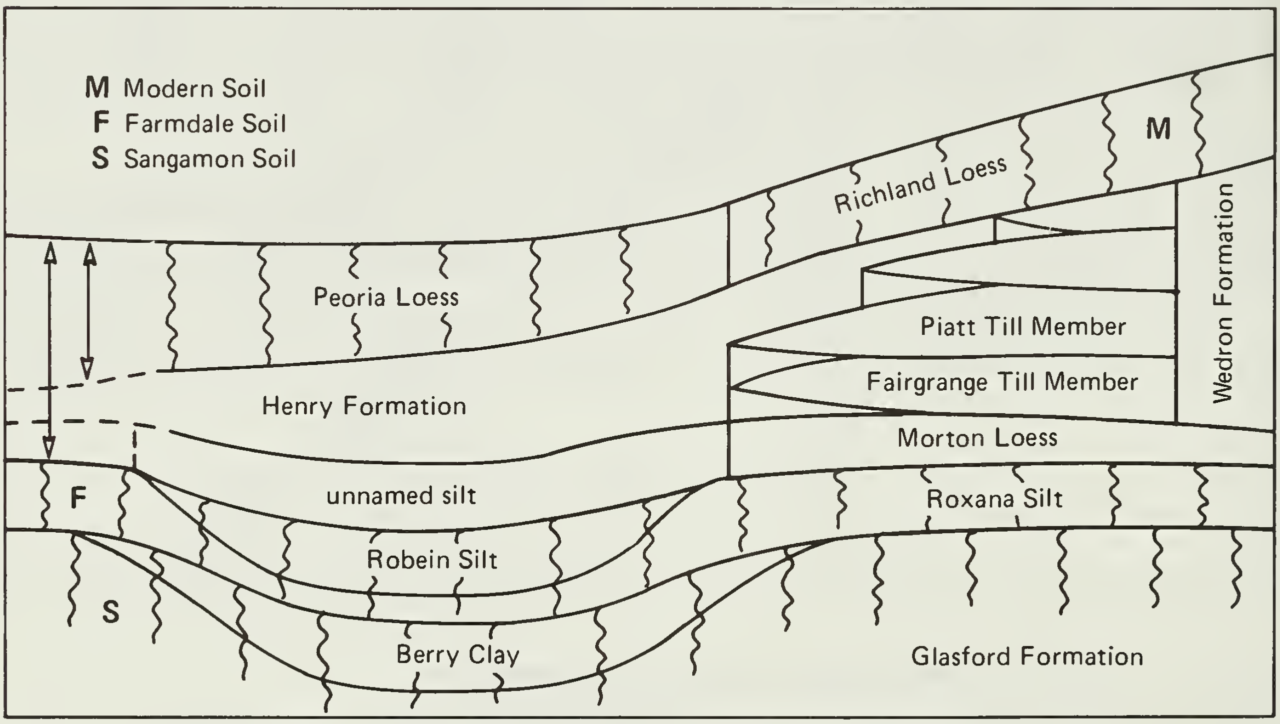


Figure 1-1. Stratigraphic units in region of Wisconsinan margin in central Illinois.

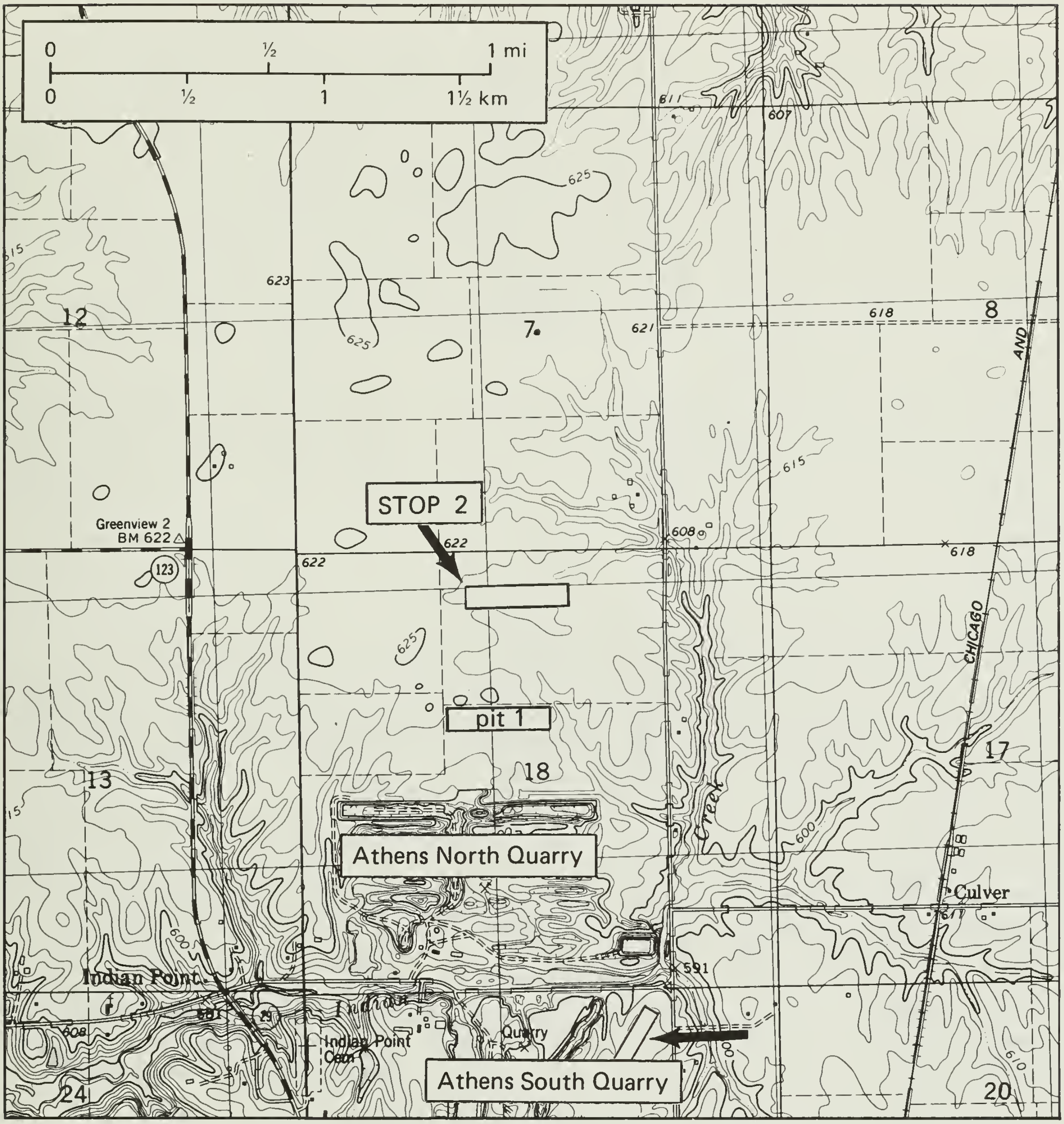
One of the largest and best developed Woodfordian outwash plains in Illinois is the lowland to the northwest of Warrensburg. All of the outwash of Woodfordian age occurring above Woodfordian tills or older deposits are included in the Henry Formation (Willman and Frye, 1970).

The stratigraphic relationships of the glacial deposits in the area are reasonably simple (fig. 1-1). For practical reasons, the surficial loess is divided by a vertical cutoff at the margin of the Wedron Formation. The part of the Woodfordian loess covered by the Wedron Formation is the Morton Loess. The overlying loess is the Richland Loess. Where these units converge beyond the limit of the Wedron Formation they become indistinguishable for mapping purposes and are grouped together to form the Peoria Loess. As a matter of convention the Woodfordian outwash is recognized as Henry Formation only if it overlies or extends beyond the Wedron Formation. Where intercalated with till, the outwash is included in the Wedron Formation. Where the Henry outwash overlies Woodfordian loess, the loess is treated as an unnamed silt (bed). Therefore, the Peoria Loess thickness depends on the presence or absence of the Henry Formation (fig. 1-1).

Under the Woodfordian deposits is a sequence of geosols (buried soils in a known stratigraphic sequence) developed in silt, organic deposits, and glacial diamictons. The Farmdale Soil, developed in a thin Roxana Silt (early Wisconsinan), underlies the Wedron Formation in most places. In low or depressional locations on the paleolandscape, the Farmdale is an organic soil that has developed on the Robein Silt, an accretionary deposit derived principally from the Roxana Silt. The Roxana conformably overlies the Sangamon Soil developed in accretionary deposits (post-Illinoian) and the glacial deposits of the Glasford Formation (Illinoian). The Roxana is commonly difficult to differentiate from the underlying deposits because of bioturbation (pedogenic mixing). The Sangamon Soil and complexities of the overlying deposits will be discussed in detail at the next stop.

TYPE LOCALITY OF THE SANGAMON SOIL

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



STOP 2. 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, 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 are 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 lateral distance of generally 100 ft (30 m) or more. North Quarry, an active quarry, provides the necessary information for a reference section. 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 the 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 the adjoining part of Menard County. All of the units described by Worthen can be seen in the Athens Quarries today (Table 2-1).

Table 2-1. 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

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 by Frank Leverett on the study of the glacial formations of the Midwest.

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" in 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 (1960b) presented the first broad analysis of the physical features of the Sangamon Soil in Illinois, but did not describe any soil profiles. The significant conclusions drawn by Frye and others (1960b) 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 on 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.

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 (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 Creen 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; (5) the top of one accretionary profile has been dated at 41,770 ± 1100 RCYBP (ISGS 684).

ATHENS NORTH QUARRY SECTION

The section was measured at the east end of the operating Material Services Indian Point limestone quarry, August 1978.

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

Horizon	Depth (m)	Sample no		Thickness (m)
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	
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; a few krotovina filled with 2/1 or 3/1 silt; common large-scale involutions (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 [ISGS 870 and 883], respectively).	0.7

Horizon	Depth (m)	Sample no		Thickness (m)
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 5Y 4/1 argillans; firm to plastic; occasional krotovina; gradual irregular lower boundary.	0.3

Horizon	Depth (m)	Sample no		Thickness (m)
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	10.2

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; the 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 the appendix.

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 (McKay, 1979). The clay-mineral composition of the Peoria increases in expandable clay minerals and decreases in kaolinite and chlorite upward from the base (fig. 2-1).

The lower 1.2 m of the Peoria Loess (zones p-1, p-2, and the lower half of p-3) contain 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).

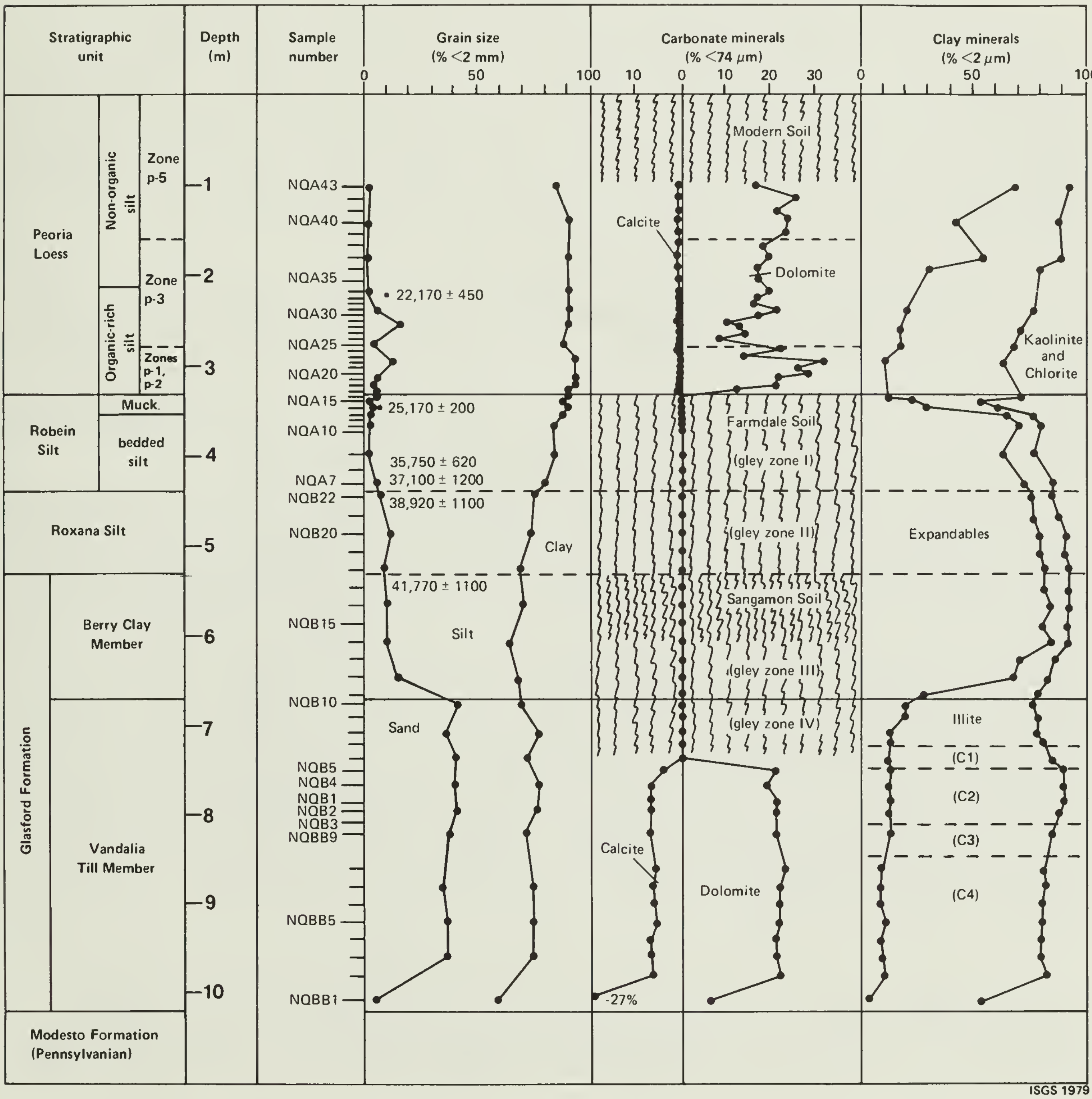


Figure 2-1. Grain sizes, carbonate-mineral content, and clay mineralogy of profiles A, B, and BB of the Athens North Quarry Section. Subdivisions of the C horizon are designated in the clay mineral column; see appendix 2 for explanation.

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. In more recent exposures an abrupt boundary with an organic horizon at the top of gley zone II has been found.

Passing down into gley zone II at the site of the original description, 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 because of the silt content and stratigraphic position. The Roxana (massive gleyed silt) appears to be the source for the overlying Robein (stratified gleyed silt).

The lower boundary of gley zone II with gley zone III is very gradational at most places. 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 present in the upper sample of this zone indicate a ground surface. In a more recent exposure, a distinguishable, dark-colored A horizon has been observed. 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 a loessial component is in zone III; 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 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, but is largely destroyed in the C2. This causes the warp in the illite to kaolinite and chlorite depth-function between 8 to 9 m (fig. 2-1). 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 shows the value of recognizing subdivisions of the C horizon so that the degree of weathering can be considered 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 studied 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. 2-2). 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 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 humus alone 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 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

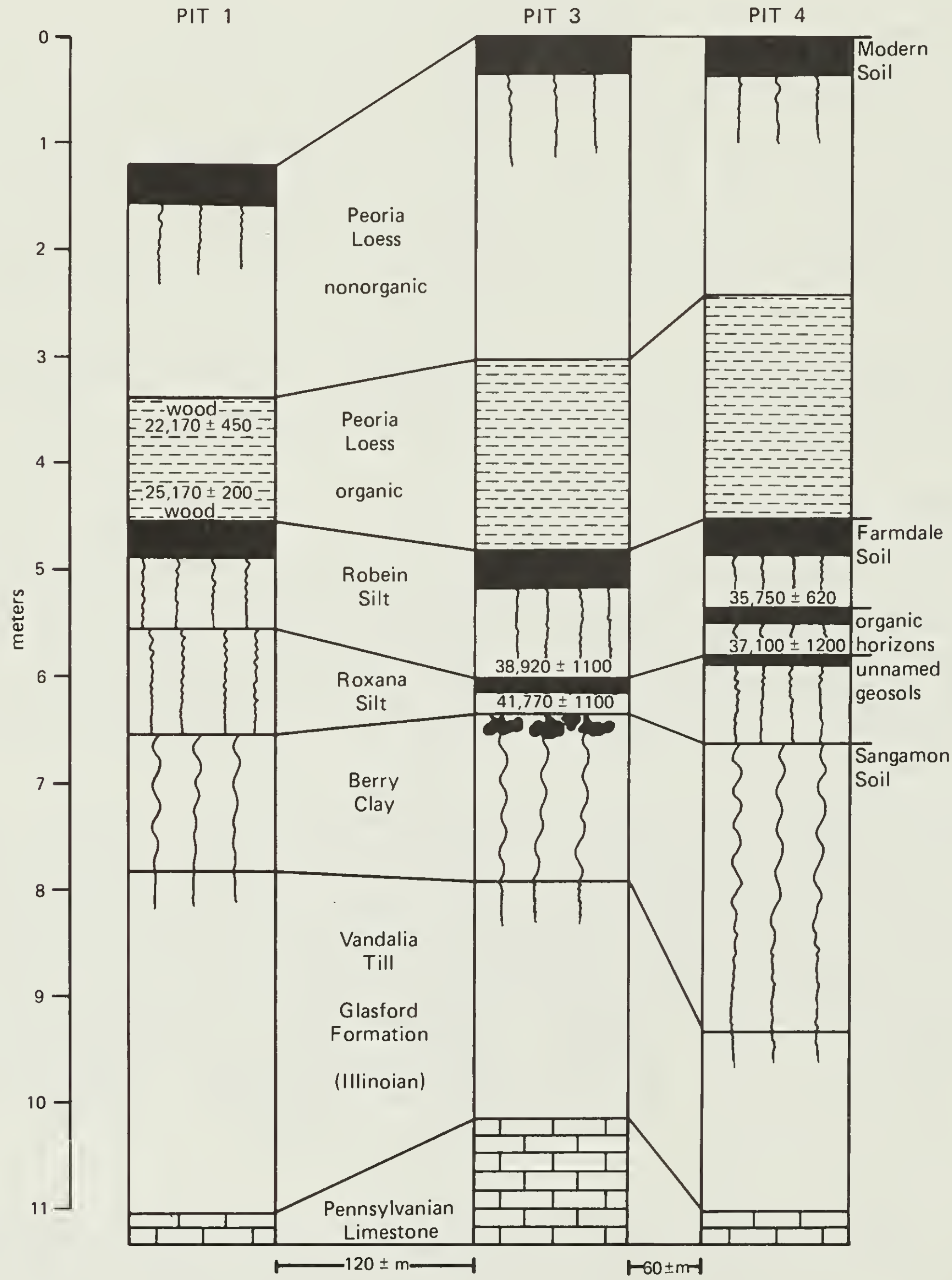


Figure 2-2. Stratigraphic correlations of North Quarry pit exposures.

related to the thinner Peoria Loess at that location. The 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 the continued quarrying operations the same exposure is no longer present, but a similar exposure is expected to be available in 1986. 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 2-2).

Table 2-1. 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. 2-3). Spruce wood at the Peoria Loess/Robein Silt contact (the base of the pollen column) was radiocarbon dated at 25,170 ± 200 RCYBP. Wood

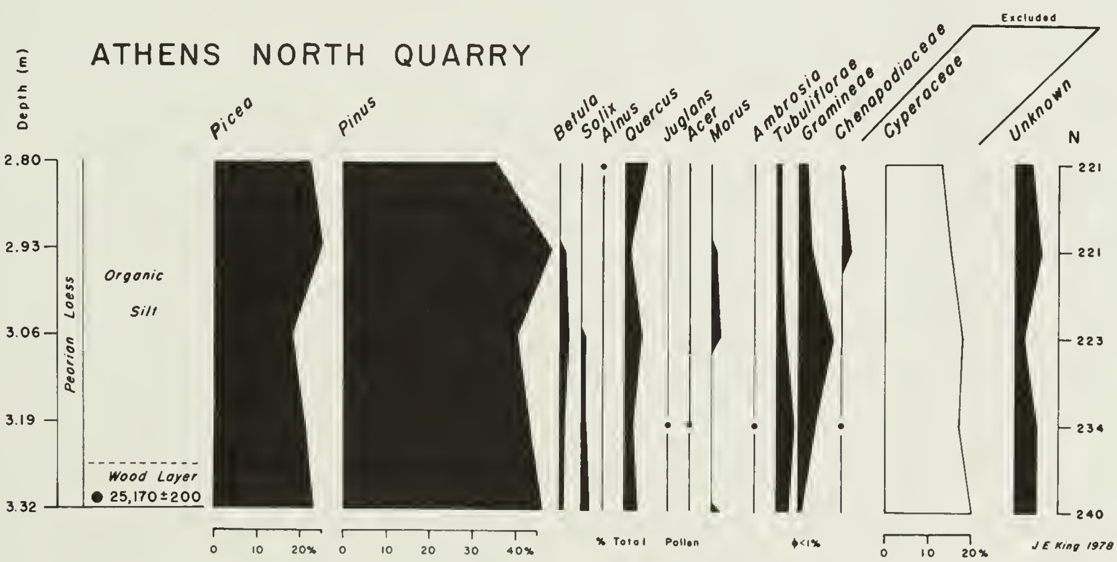


Figure 2-3. Relative frequency of pollen from Athens North Quarry.

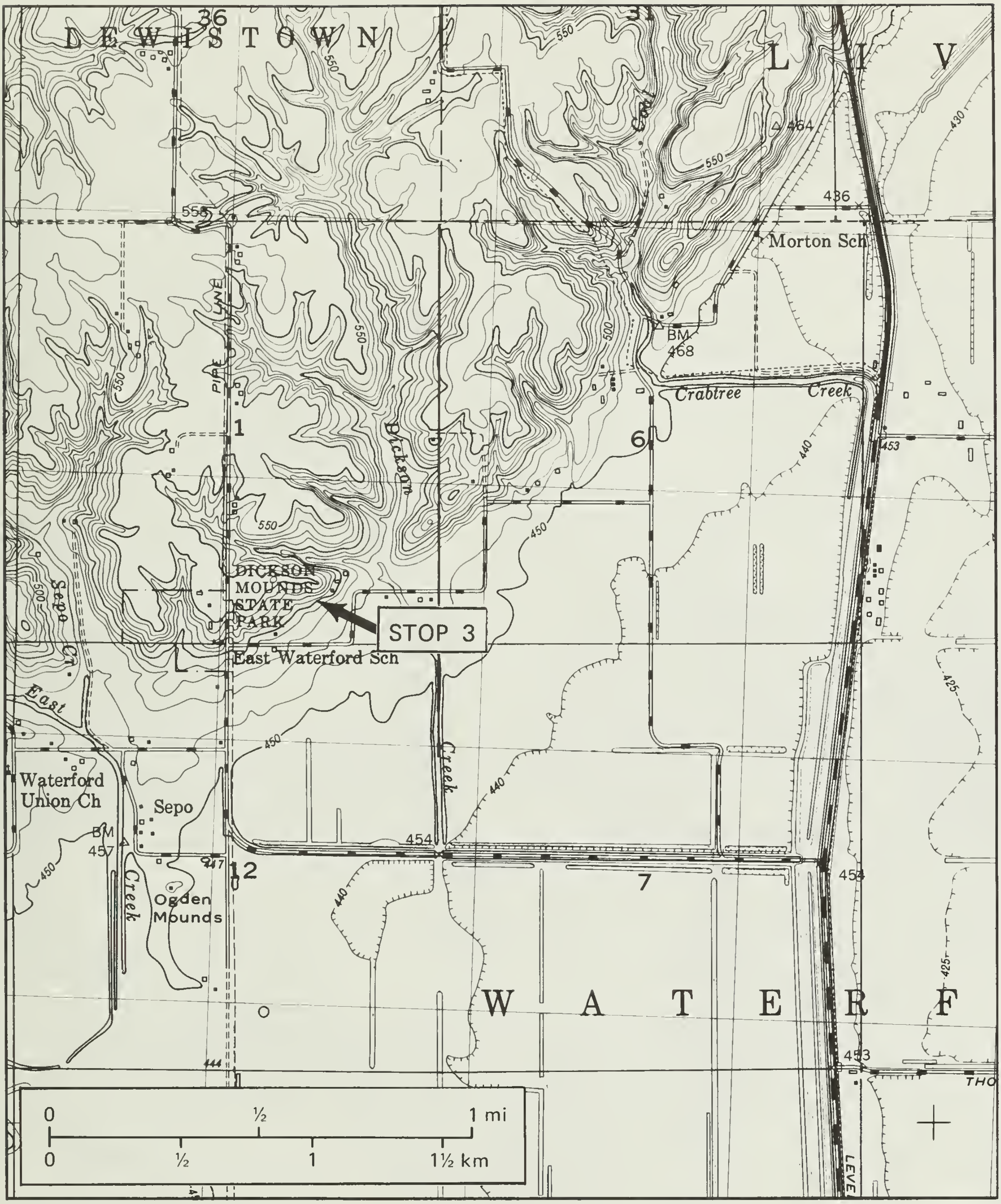
from near the top of the organic-rich silt and 80 cm above the uppermost pollen sample is dated at 22,170 ± 450 RCYBP. The dark organic-rich silt with the preserved pollen therefore dates between about 23,000 and 25,000 B.P.

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.

DICKSON MOUNDS

Alan D. Harn



STOP 3. 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, 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.

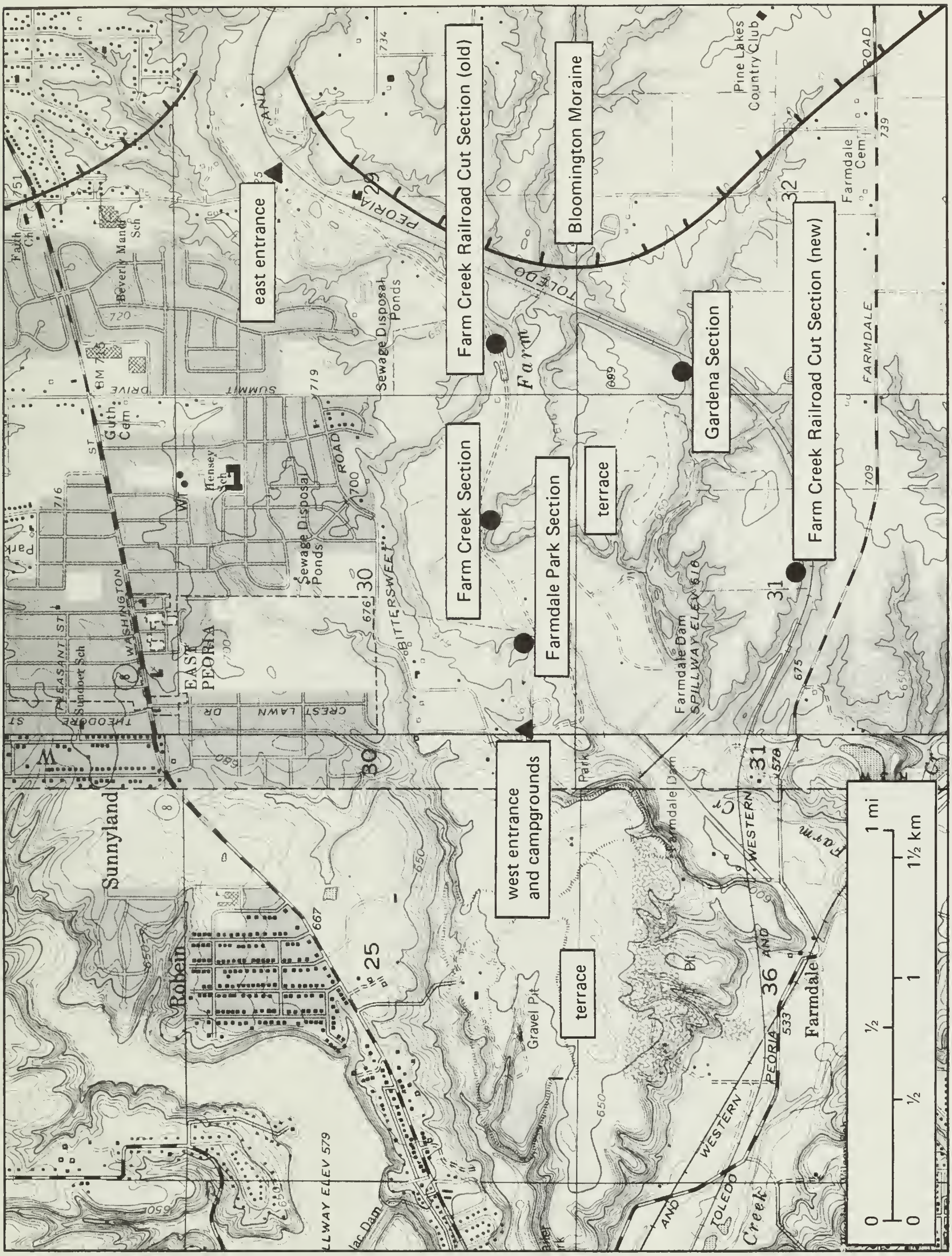
Between A.D. 800 and 1200, important changes were taking place in lifeways over a large area of North America. At the beginning of this time period, people lived in small, scattered settlements supported primarily by fishing, gathering, and hunting of large animals such as deer. Some wild, starchy seed 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 partially 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 which 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 over 40 sites represented a seasonal interplay of human activity which 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.

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 which were 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.

FARM CREEK: A NOTABLE PLEISTOCENE SECTION

Leon R. Follmer and E. Donald McKay



STOP 4. 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.

No exposure in Illinois has drawn more attention from glacial geologists than has the Farm Creek Section. Since Leverett's discovery of this creek bluff in 1897, this exposure has stimulated much research into the late glacial history of the area. The Farm Creek Section was one of the featured stops on the 1979 Midwest Friends of the Pleistocene Field Conference (Follmer et al., 1979). The following summary and discussion are modified from material prepared for the Geological Society of America Decade of North American Geology--Centennial Field Guides.

The Farm Creek Section, located east of Peoria near the margin of the late Wisconsinan (Woodfordian) glacial margin, is a large cut bank of Farm Creek in the Farmdale Recreation Area.

The Farm Creek Section and nearby exposures appear to be complete with respect to most stratigraphic elements of the late Pleistocene in central Illinois, and continue to be the best and most accessible exposures in the area. The Farm Creek Section is the type section for the Farmdale Soil, the Farmdalian Substage, and the Robein Silt. Many geologists have used this section as a type or reference section for litho-, chrono-, and pedostratigraphic units. A discontinuous organic paleosol within a sequence of loess that overlies Illinoian till and underlies Wisonsinan till is a principal reference point for Pleistocene researchers in Illinois. The organic soil was first thought to be the Sangamon Soil but later was determined to stratigraphically overlie the Sangamon Soil developed in Illinoian till.

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 overlying Wisconsinan till (Shelbyville) and the Illinoian till below agree with Leverett's (fig. 4-1). 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 in Follmer et al., 1979). The Iowan was interpreted as a glacial event 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 had decided that the loesslike silt had been generated by glacial conditions, and consequently he 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 (plate 4) 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 4-2 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 Leverett had 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 on table 4-1.

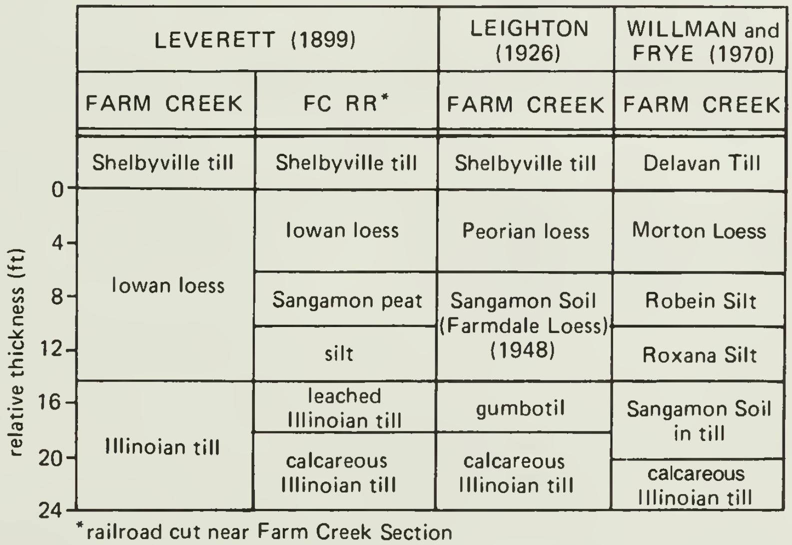


Figure 4-1. Development of stratigraphic classifications of Farm Creek Section.

FARM CREEK SECTION

The top of the Farm Creek Section is quite irregular and nearly vertical in places. A late Wisconsinan loess (Richland Loess), continuous across the top, ranges from 1 to 2 m (3 to 7 ft) thick. In most places a modern soil (Hapludalf) has developed through the loess into the underlying gravel of the Henry Formation. The alteration due to soil formation caused clay enrichment and reddening, particularly in the upper part of the gravel. The gravel is part of the terrace deposits formed by the outwash from the Bloomington Morainic System to the east. Under the gravel is the Delavan Till Member of the Wedron Formation, which is about 7 m (25 ft) thick; it contains large lenses of sand and gravel. The Delavan (the name for basal Woodfordian till in the area) forms the terminal Wisconsinan moraine south of Peoria.

Table 4-1. Averages of common lithologic parameters.

	Grain size			Carbonate		Clay minerals		
	(<2mm)*			(<74µm)**			(<2µm)†	
Section Unit Horizon	Sd (%)	Si (%)	C (%)	Cal (%)	Dol (%)	E (%)	I (%)	K+C (%)
Farm Creek								
Richland Loess	2	68	30	0	0	58	31	11
Henry (sand & gravel)	65	19	16	19	34	18	68	14
Delavan Till	26	39	35	8	21	12	67	21
Morton Loess	<1	92	8	2	23	37	43	20
"Robein Silt"	2	89	9	0	0	10	60	30††
Roxana Silt	2	85	13	0	0	54	26	20
Radnor Till								
E (C/A) horizon	17	65	18	0	0	30	35	35††
Bt horizon	16	32	52	0	0	47	34	19
C (oxidized)	24	47	29	5	17	6	80	14
C (unaltered)	27	46	27	5	19	2	75	23
Gardena								
Delavan Till	27	40	33	5	20	10	67	23
Morton Loess	<1	93	6	2	21	30	45	28
"Robein Silt"	5	86	9	1	1	18	50	32††
Roxana Silt	<1	84	15	0	0	62	16	22
Farmdale Park								
Radnor Till								
C2 (oxidized)	26	45	29	5	17	6	82	12
C4 (unaltered)	30	44	26	5	20	5	71	24
"Vandalia Till"								
C2 (oxidized)	38	43	19	6	23	7	82	11

*Gravel excluded, <4µm clay on tills, <2µm clay on silts and soil horizons.
**Weight percent of fine fraction (Chittick method).
†Percentages based on sum of three peak heights.
††High vermiculite causing K + C value to be relatively high.
Abbreviations: Sd = sand, Si = silt, C = clay; Cal = calcite, Dol = dolomite; E = expandable clay minerals (17A), I = illite (10A, K + C = kaolinite and chlorite (7A).

The gray Delavan Till forms a sharp contact with the underlying light colored Morton Loess that can be easily traced across the outcrop. The Morton is calcareous and appears to be undisturbed except for local, indistinct shear disturbances. Leverett (1899) and Leighton (1926) thought a soil surface or eroded soil surface might be present here. No evidence for a soil has been found in recent studies, but one can be seen at the Gardena Section about 1.0 km to the southeast of the Farm Creek Section. The Morton is an early (classic or late Wisconsinan) Woodfordian loess that was overridden by the advancing glacier. Beyond the margin of the late Wisconsinan moraine west of Peoria, the Richland and Morton Loess converge to form the Peoria Loess.

In the main section at Profile A, about 1.5 m (5 ft) of Morton Loess lies over a leached brown silt (the Roxana), which is about 5 feet thick and contains the fossil remnants of the Farmdale Soil. The main body of the Roxana Silt is eolian and can be traced across the upland of much of Illinois (McKay, 1979). The Roxana Silt is considered to represent the Altonian Substage or early Wisonsinan in Illinois. At Profile E the Morton-Roxana contact is somewhat masked by organic matter, including wood fragments, carbonized wood, and charcoal. Rounded pods form the organic-rich zone here. Over time, diagenic processes (biogeochemical degradation) eliminated the organic matter, leaving large bleached zones and segregations of secondary iron and manganese minerals. The organic-rich remnants in this occluded form indicate that the Morton was deposited on an organic-rich soil that continued to develop upwards. Therefore, it is likely that most of the Morton and Roxana at this section was initially humic-rich and that most of the humic material was removed by diagenic processes, leaving most of the Morton and Roxana exposed in the outcrop, free of humic material.

At Profile B much of the organic material of the O horizon of the Farmdale Soil has been preserved because of the environment of burial. Pollen is present in the richest portion, but it is poorly preserved. The pollen assemblage is dominated by pine and spruce, indicating a cool climate during

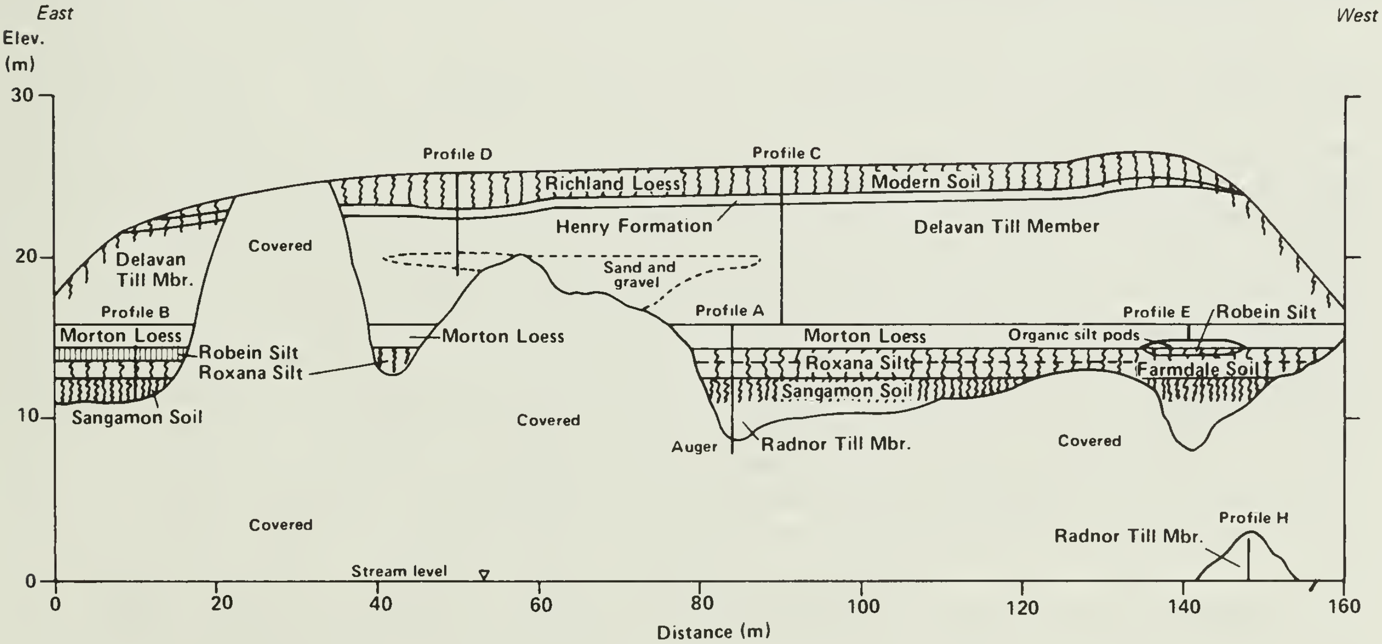


Figure 4-2. Diagram of the Farm Creek Section. Datum point is stream level.

the formation of the Farmdale Soil (see J. King, Stop 2). Radiocarbon analysis of samples near the top and bottom of the organic-rich zone, designated by Willman and Frye (1970) as Robein Silt, yielded ages of 26,680 ± 380 and 27,700 ± 770 RCYBP, respectively. The Robein Silt is defined as a resedimented silt derived from the Roxana, but no evidence for resedimentation was found in recent studies reported in Follmer et al. (1979). It appears that organic matter accumulated on the surface of the Roxana Silt during the formation of the Farmdale Soil; this presents a technical problem because although this is the type section for the Robein, no evidence for waterlain stratification can be demonstrated here. Because stratified Robein deposits are present in other localities, a new reference section needs to be designated.

The Roxana was calcareous when deposited, but is leached of its carbonate minerals in the present exposure. The base of the Roxana is gradational into the top (A horizon ?) of the Sangamon Soil developed in Illinoian till. The boundary is hard to identify because it has been blurred by bioturbation or pedogenic processes. The sand content increases downward and the color becomes lighter. Characteristics of fossil A horizons commonly are poorly preserved and organic matter (analogous to soft parts of fossils) is often not preserved. The distinguishing characteristics are the biogenic pores and structures in the probable A and underlying E horizon of the Sangamon Soil profile. The relative high porosity in a bleached (light-colored) matrix serves to identify the "topsoil" of many Sangamon Soil profiles as well as other soils that have developed in a deciduous forest environment. The E horizon overlies a greenish gray Bt horizon that is recognized by the abrupt increase in clay, changes in soil structures from small to large, and the abundant clay skins coating the soil structures. In most places in the outcrop the Sangamon Soil is poorly drained (gleyed); it was formerly referred to as gumbotil. Because of the gleyed condition, it has been confused with accretion-gley (Follmer, 1978). In recent years the relatively slow bluff erosion has exposed a reddish brown Sangamon Bt horizon near the center of the exposure, revealing a Sangamon catena from a poorly drained profile to a moderately-well drained profile.

The B-horizon characteristics of the Sangamon Soil fade with depth into unaltered calcareous, gray Radnor Till of the Illinoian age. The top of the Illinoian till must be placed at the top of the Sangamon Soil at this site because no sedimentologic unit can be demonstrated to exist between the Roxana and the till. Lithologic studies (Follmer et al., 1979) support the interpretation that the Sangamon soil is the highly altered portion of the till. Further study is needed to resolve some remaining problems concerning till correlations. The relationship of the till exposed at profile A to that at profile H is not yet clear. The clay content at H is about 10% higher than average (table 4-1), but the till contains the amount of illite characteristic of the Radnor. At profile A the texture of the C horizons is characteristic of the Radnor, but the illite content of the unaltered Radnor is about 5% lower than average (table 4-1). Two rows of data presented in Follmer et al. (1979) are misprinted; all parameters for samples FCA-1 and FCA-3 must be inverted in order to put them into correct stratigraphic order. Lower illite values and higher sand content are regional characteristics of the Vandalia Till Member, which occurs stratigraphically below the Radnor Till in this area and to the south. The till at profile H was at one time assigned to the Hulick, a middle Illinoian unit known in western Illinois (Willman and Frye, 1970); however, recent lithologic studies in the Farm Creek area suggest that the best correlation is with the Radnor, the youngest Illinoian till in Illinois. The differences between A and H raise the question of equivalency, but the till at both locations is more like Radnor than Hulick.

Farmdale Park Section

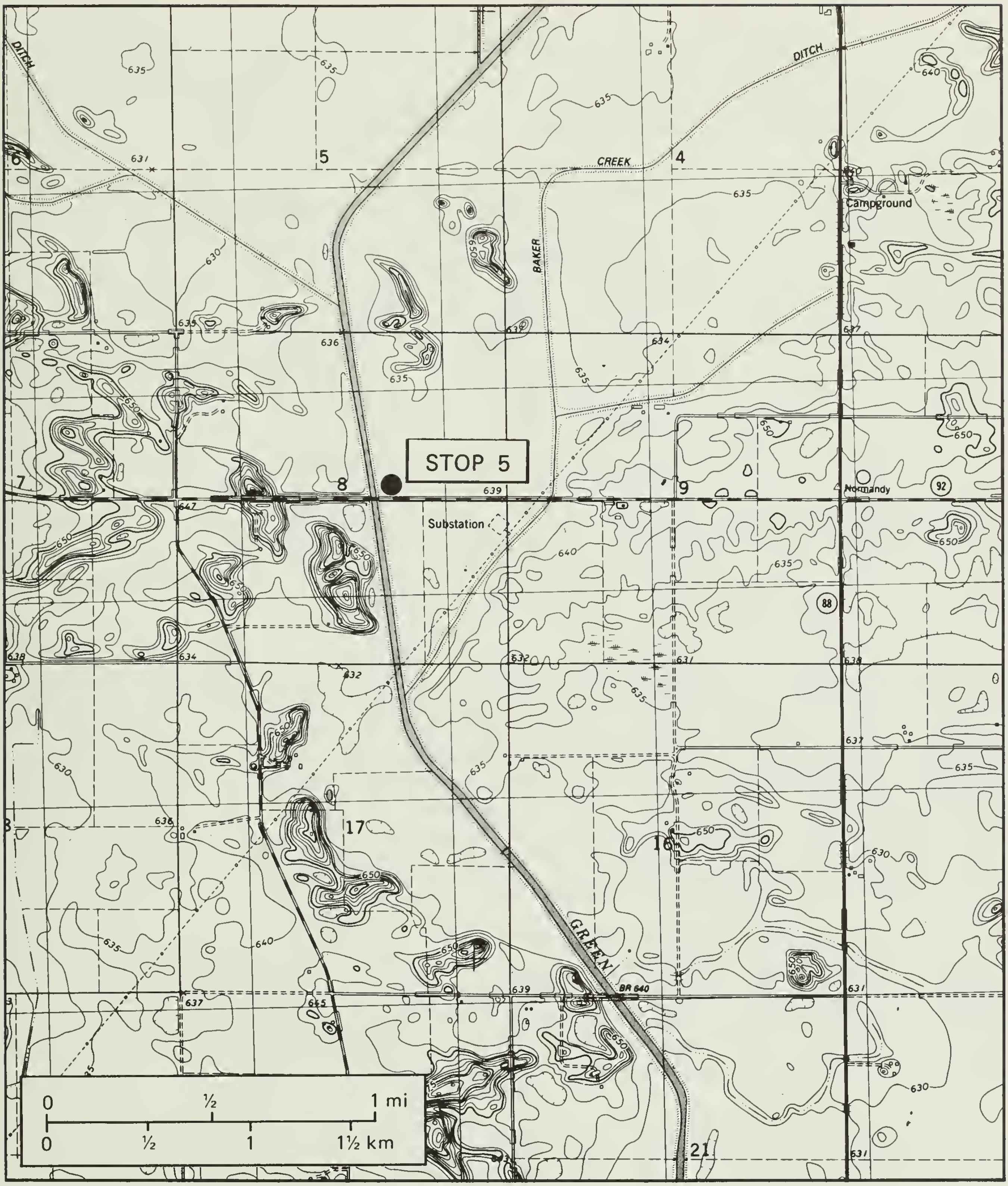
The Farmdale Park Section was studied near the west ford on the north side of the creek (Stop 4 map) and presented in Follmer et al. (1979). The same stratigraphic units seen at the Farm Creek Section are present here from the top of the section down to the Radnor Till. The Sangamon Soil here is a complete profile of an oxidized, well-drained soil developed in the Radnor Till. The redness of the Sangamon Soil contrasts with the greenish gray colors that dominate the Sangamon at the main section. Color and other physical characteristics indicate that the Sangamon landscape had topographically high (oxidized) and low (wet) landscape positions. This information is used to reconstruct paleolandscapes.

Two Illinoian tills are visible in the lower part of the exposure. The upper unit is correlated to the Radnor on the basis of stratigraphic position and lithologic characteristics. Most of the Radnor is calcareous and oxidized to a yellowish brown. At the north side of the exposure, the base of the Radnor is unoxidized and gray. Here the gray till forms a distinct boundary with an underlying oxidized, olive brown, calcareous, more sandy till. The textural boundary continues across the outcrop, but the color contrast disappears to the south because of oxidization. On the basis of texture and stratigraphic relationships, the lower till is correlated to the Vandalia Till Member. But the clay mineral assemblage of the lower unit is typical of oxidized Radnor Till; it is higher in illite than is typical for Vandalia Till to the south. The two units of Illinoian till at the Farmdale Park Section may represent a more complex sequence within the Radnor or the lower unit could be a till older than the Vandalia. Other exposures in the area have not been studied in detail and may contain the stratigraphic information that can resolve the question.

Gardena Section

One can hike across the park or along the new T.P. and W. Railroad track to this rare exposure of a soil developed in the top of the Morton Loess underlying the Delavan Till (Stop 4 map) described in Follmer et al., 1979. A moss layer at the top of the soil was dated 19,680 ± 460 RCYBP. Five species of mosses were found that now range from the northern United States to the Arctic. Spruce pollen was the dominant pollen in this soil, indicating that this short-lived soil formed during the coldest interval this area experienced during the advance of the Woodfordian (late Wisconsinan) glaciers (appendix 1). A few centimeters of lacustrine clay separate the Delavan Till from the moss layer. The lacustrine clay probably represents the derangement of drainage caused by the advancing glacier to form a lake that was soon overridden.

About 2.1 m (7 ft) of Morton is present west of the railroad bridge just above the creek level. The lower 0.6 m (2 ft) is dolomitic, and is black from all the decomposed organic matter it contains. The C-14 age of wood in the base of this zone is 25,370 ± 310 RCYBP. Under this is a leached organic zone that yielded an age of 25,960 ± 280 RCYBP and is interpreted to be Farmdale Soil developed in Robein Silt. Below water level is the gray (gleyed) horizon of the Farmdale Soil in Robein Silt. The ages of the organic samples and the litho- and pedostratigraphic relations confirm the interpretations drawn from the study of the Farm Creek Section. The analytical data (table 4-1) support the correlations between sections and illustrate the value of using lithic parameters in the correlation of glacial deposits. The contrasts within and between sections create problems and questions when geologists attempt to make litho-, chrono-, and pedostratigraphic correlations. Appropriate features at each section are correlated, using stratigraphic and pedologic principles, and lithologic similarities.



STOP 5. Normandy Profile Section
SE SW NE Sec. 8, T18N, R7E, Bureau County IL (New Bedford Quadrangle)

Wood found in a soil profile at 1.5 m depth was determined to be Twocreekan-age black ash underlying alluvium younger than 11,400 ± 90 RCYBP.

The route between Farm Creek (Stop 4) and the Green River Lowland site (Stop 5) is on the complex topography of the Bloomington Morainic System for about 50 miles (fig. 5-1). The Bloomington Moraine was first recognized by Leverett in 1897 and formally renamed a Morainic System by Willman and Frye (1970) because of its multiple ridge characteristics. Older deposits of the early Woodfordian (late Wisconsinan) are buried by the Bloomington advance along this portion of the Wisconsinan glacial margin.

The Green River Lowland area has been an area of interest over the years. The complex glacial history of the lowland has led to some unresolved issues and controversies. Most of the early interpretations concluded that the first advance of the classic (Woodfordian) Wisconsinan glaciation occupied some, part, or all of the lowland (Frye et al., 1969; Willman and Frye, 1970). Studies of terraces and drainage patterns in the Rock Island area support the interpretation of a glacier in the lowland that could explain the terraces along the Rock River and the abandoned channels of the Mississippi River (Anderson, 1968).

The age of glaciers occupying the lowland west of the Bloomington is still in doubt because of complexities and a dependence on physical correlation parameters. In recent work till in the lowland interpreted to be Woodfordian by Willman and Frye (1970), and formerly correlated to Shelbyville Drift, has been found to support Farmdale and Sangamon Soils in critical locations (Follmer and Kempton, 1985). The till has lithic characteristics of the Radnor Till, the youngest till under the Illinoian till plain.

South of Stop 5 we cross the former channel(s) of the Mississippi River that once traversed the Green River Lowland on a diagonal from the abandoned channels shown in the northwest part of figure 5-1 (between the loess hills) to the present Illinois River at the "big bend" (in the middle of the east edge of figure 5-1). The Woodfordian advance blocked the Mississippi and caused a large lake to form in the Green River Lowland. Ultimately, water found a passage to the west, which established the present-day course of the Mississippi. The release of lake water may have been catastrophic and related to evidence down the Mississippi for short-lived floods that produced clay beds in the lower part of the Peoria Loess near St. Louis.

The age of the construction of the Bloomington System and associated lake and flood features is about 20,000 BP. This was the time when severe landscape erosion occurred in the area adjacent to the Bloomington (Follmer et al., 1978), and this erosional event in Illinois correlates to the time of maximum erosion on the Iowan erosion surface (Ruhe, 1969). The discussion at Stop 8 will cover additional details of this event.

During the late Woodfordian large sand dunes up to 50 ft high were formed on many parts of the lowland. East of Stop 5 sand was blown up and over the dissected outer Bloomington Moraine to form sheet deposits on the back side of the moraine. Dominant winds appear to have been from the west. Stop 5 is located just east of a dune complex and adjacent to the present channelized Green River. Before the channel was created the Green River did not have a continuous channel, but passed through large areas of marsh.

During the mapping of soils in the area, wood was found in a test pit at Stop 5. The wood found was detrital fragments of black ash, which dated at

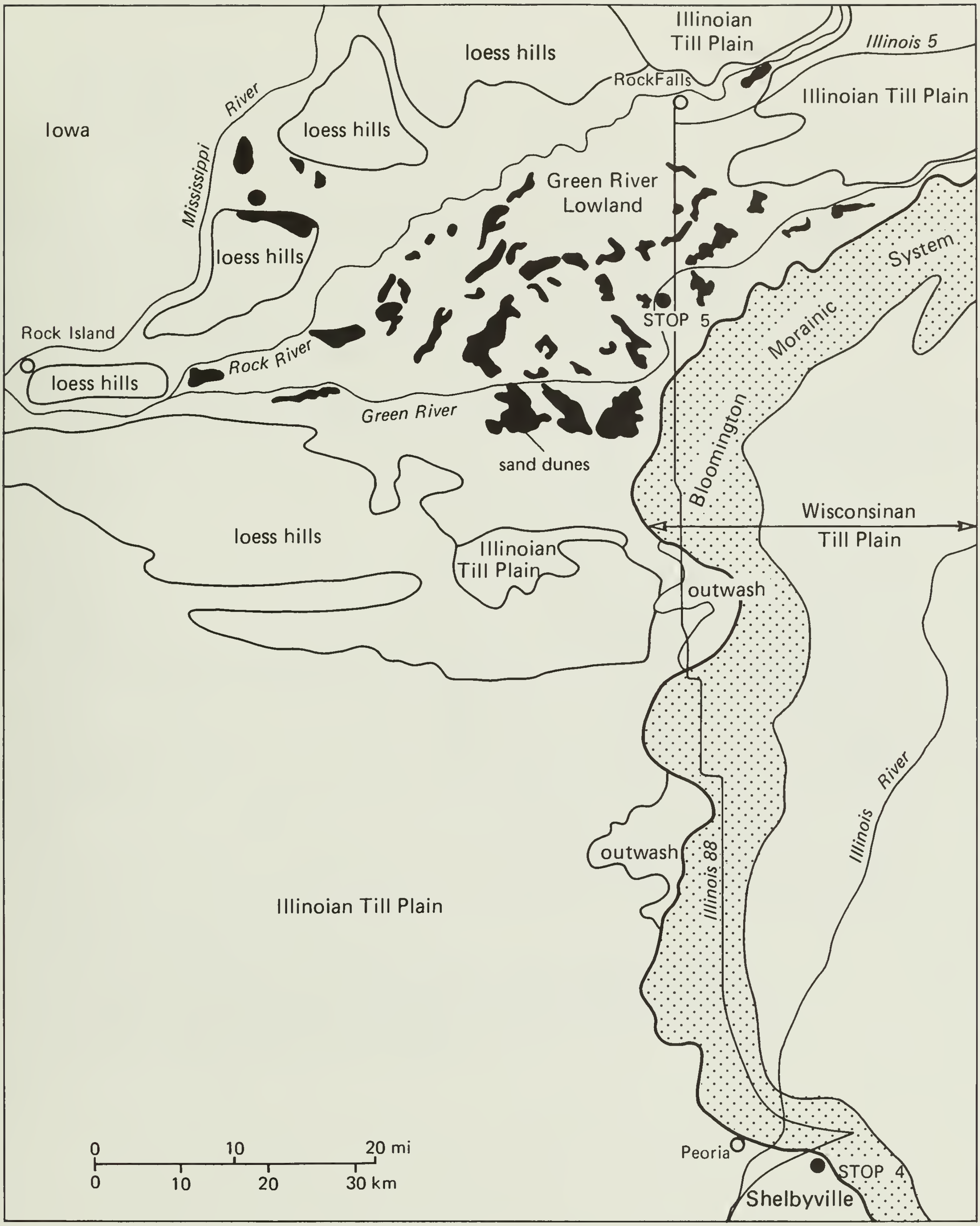


Figure 5-1. Surficial geology between Farm Creek and the Green River Lowland.

11,410 $\pm$ 90 RCYBP (ISGS 1112). The wood was collected from the upper part of a stratified sand at 1.5 m depth. The overlying silty alluvium contains a normal poorly-drained Haplaquoll of the area.

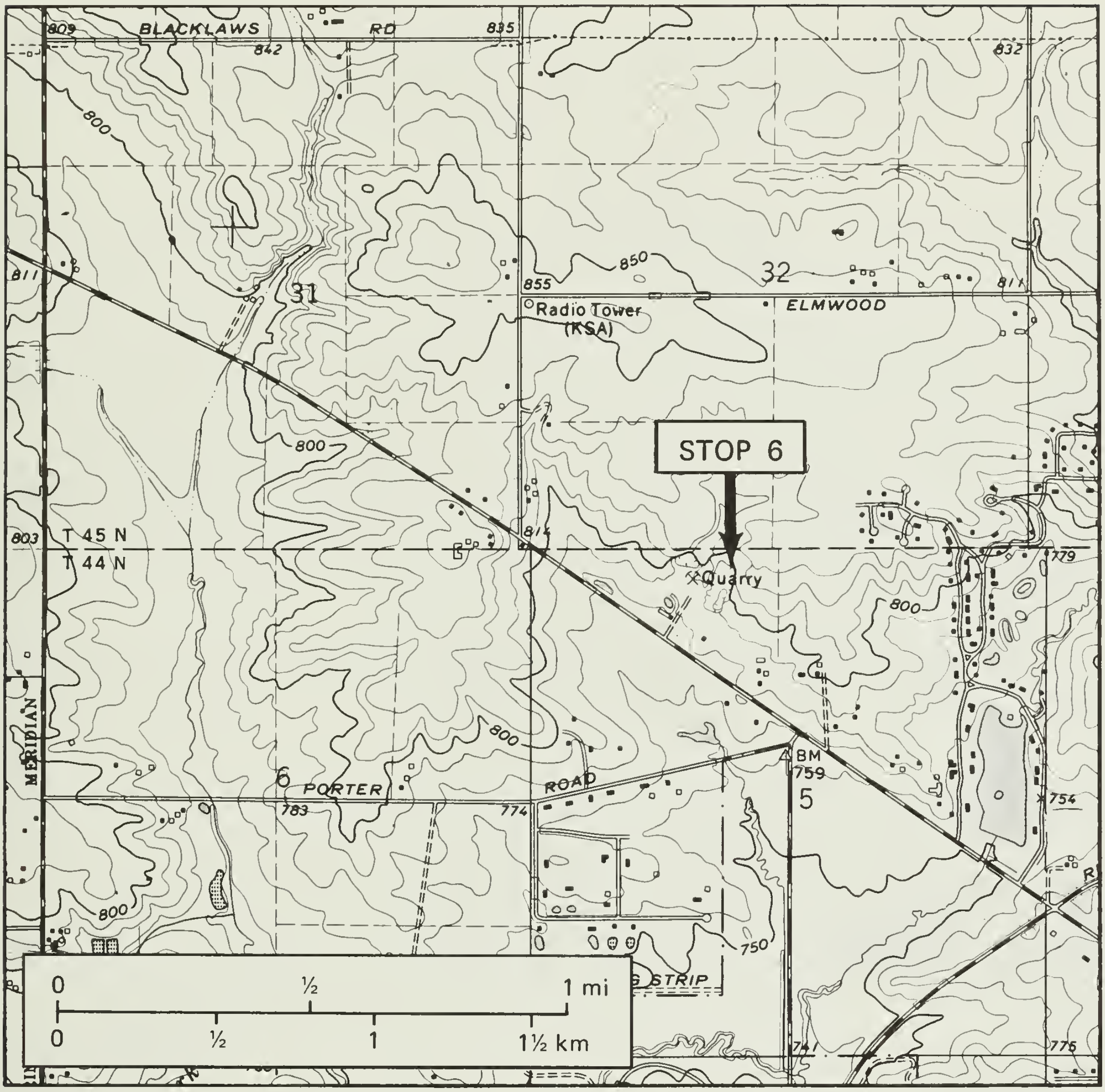
The alluvium appears to be one unit that shows slight evidence of a fining-upward sequence. For practical reasons the Holocene boundary for this area is placed at the contact of the silty alluvium with the stratified sand.

The age of the wood corresponds to Twocreekan, which means that this area did not experience any sedimentological impact of the younger glacial advance (Valderan/Greatlakean) in Wisconsin. Black ash is typically the first deciduous species to increase significantly after the decline of glacial conditions. Oak, elm, and hackberry wood has been found in alluvium near Mahomet, west of Champaign, which also date at about the same time. In the Chicago region, all of the wood of Twocreekan age found has been coniferous.

These observations, combined with data from pollen studies in the Midwest, indicate that when the conditions for vegetation change were met, the change was rapid.

FARMDALE AND SANGAMON SOILS AT THE WEMPLETOWN SOUTHEAST SECTION

Dennis P. McKenna and Leon R. Follmer



STOP 6. Wempletown Southeast Section

NW NW Sec. 5, T44N, R1E, Winnebago County, IL (Winnebago Quadrangle)

This section exposes a sequence of Peoria Loess and Roxana Silt over a Sangamon Soil developed in the Argyle Till Member of the Winnebago Formation. The Argyle Till is now thought to be Illinoian rather than early Wisconsinan.

INTRODUCTION

The Wempletown Southeast Section is an exposure in a quarry on the uplands above the North Fork of Kent Creek in Winnebago County. This stop was developed for the 1985 Midwest Friends of the Pleistocene Field Conference (Berg et al., 1985). The material is reproduced here with only a few modifications.

This section is the first described in the literature in which the Roxana Silt is recognized over a paleosol formed in a Winnebago Formation deposit. In earlier studies, the absence of the Roxana Silt and absent or "weakly developed" paleosols were often cited as reasons for assigning the Winnebago Formation tills to the Altonian Substage (early Wisconsinan) rather than to the Illinoian Stage (Shaffer, 1956; Leighton and Brophy, 1966; Willman and Frye, 1970). This section is the most complete stratigraphic section in the area previously considered to be underlain by early Wisconsinan deposits; it includes an unnamed organic soil dated at 20,150 ± 500 RCYBP (ISGS-1302) formed in the lower part of the Peoria Loess, a Farmdale Soil formed in the Roxana, and a Sangamon Soil formed in Argyle Till. From the evidence found at this section and at the Oak Crest Bog (McKenna, 1985), we conclude that the lower Winnebago Formation deposits are late Illinoian in age.

The following profile is measured in a vertical exposure in the northeast corner of the quarry. The upper portion of the section was apparently removed for sale as topsoil.

PROFILE DESCRIPTION

Pleistocene Series
Wisconsinan Stage
Woodfordian Substage
Peoria Loess

Modern Soil
(truncated Argiudoll)

Soil horizon	Depth cm	Sample no.		Thickness (cm)
Bt1	0-32	PB-1	Silt; dark yellowish brown (10YR 4/6) silty clay loam, subangular blocky structure, numerous roots, gradual lower boundary, leached	32
Bt2	32-87	PB-2	Silt; dark yellowish brown (10YR 4/6) silty clay loam with few pale brown (10YR 6/3) mottles, weak subangular blocky structure, few roots, abrupt lower boundary, leached	55
BC (B3)	87-110	PB-3	Silt; brown (7.5YR 3/4) silt loam, weak blocky structure, few small roots, abrupt lower boundary; leached	23

Soil horizon	Depth cm	Sample no.		Thickness (cm)
CB (C1)	110-120	PB-4	Silt; light yellowish brown (10YR 6/4) silt loam, massive to weak blocky structure, few lenses of fine sand, few small root channels, fairly porous, dolomitic	10
(C) (C2)	120-145	PB-5	Silt; alternating light gray (10YR 7/2) and yellowish brown (10YR 5/6) silt loam, massive to stratified, few root channels, some vertical fracturing, wavy abrupt lower boundary, dolomitic	25
				Unnamed Soil
2A/Cg	145-175	PB-6 PB-7	Silt; alternating dark grayish brown (10YR 4/2) organic-rich silt loam and light gray (10YR 7/1) dolomitic silt loam, massive structure, root channels, few thin oxidized layers of yellowish brown (10YR 5/6) silt, few snail shells, wavy abrupt lower boundary, organic-rich silt; leached	30
2A	175-187	PB-8	Silt; very dark brown (10YR 2/2) organic-rich silty clay loam, massive structure, few fine roots, slight oxidation around small channels, porous, wavy abrupt lower boundary, dolomitic (humic material dated 20,150 ± 500 RCYBP, ISGS-1302)	12
Altonian Substage				
Roxana Silt, sandy silt facies				Farmdale Soil
3E	187-207	PB-9	Silt; yellowish brown (10YR 5/4) silt loam, few light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6) mottles, granular, porous, gradual lower boundary; leached	20
3AE	207-257	PB-10	Silty sand; dark brown (7.5YR 3/4) loam, coarse pinkish gray (7.5YR 6/2) mottles and silans, granular to platy, porous, gradual lower boundary; leached	50

Soil horizon	Depth cm	Sample no.		Thickness (cm)
3-4AE	257-340	PB-11 PB-12	Diamicton; brown (7.5YR 4/4) loam to sandy loam; dries out very light, weak platy structure breaking to granular, highly porous, abrupt lower boundary, leached, fewer mottles than above but more black concretions, more brittle than above, few pebbles, stone line at bottom	83

The profile description continues 25 ft to the southwest at the silt contact with the stone line 200 cm below the new surface (depths in parentheses are a continuation of the original profile).

Illinoian Stage
Winnebago Formation
Argyle Till Member

Sangamon Soil

4EBt	200-215 (340-355)	PB-13	Stone line, zone of mixed material, disrupted strata of gray sandy loam and reddish loam	15
4Bt1	215-282 (355-422)	PB-14 Pb-15	Diamicton; strong brown (7.5YR 4/6) sandy loam, weak blocky structure, few roots, moderate porosity, few dark brown skins, few white spots (salts?), few pebbles, leached	67
4Bt2	282-360 (422-500)	PB-16 PB-17	Diamicton; strong brown (7.5YR 4/6) sandy loam, weak large blocky structure, few roots, few vertical fractures, few clay skins along macropeds, numerous rotten rocks, gradual lower boundary, leached	78
4Bt3	360-390 (500-530)	PB-18	Diamicton; strong brown (7.5YR 5/6) sandy loam, weak blocky structure, few roots, abrupt lower boundary, leached	30
4C1	390-450 (530-590)	PB-19	Diamicton; dark yellowish brown (10YR 4/6) sandy loam, coarse platy to blocky structure, gradual lower boundary, leached	60

Soil horizon	Depth cm	Sample no.		Thickness (cm)
4C2	450-510 (590-650)	PB20 PB21	Diamicton; light yellowish brown (10YR 6/4) sandy loam, numerous pebbles, dolomitic	60
Ordovician System				
5R	510+ (650+)		Ordovician dolomite, yellowish brown (10YR 7/4)	

RESULTS AND DISCUSSION

During our initial field investigation, we had concluded that this section consisted of a straightforward sequence of Peoria Loess, a Farmdale Soil in Robein Silt, Roxana Silt, and a Sangamon Soil formed in the Argyle Till. After determining the particle size, clay-mineral composition, and a radiocarbon date of the organic materials (fig. 6-1), we recognized (1) that there is an additional soil in the Peoria Loess, and (2) that the Roxana

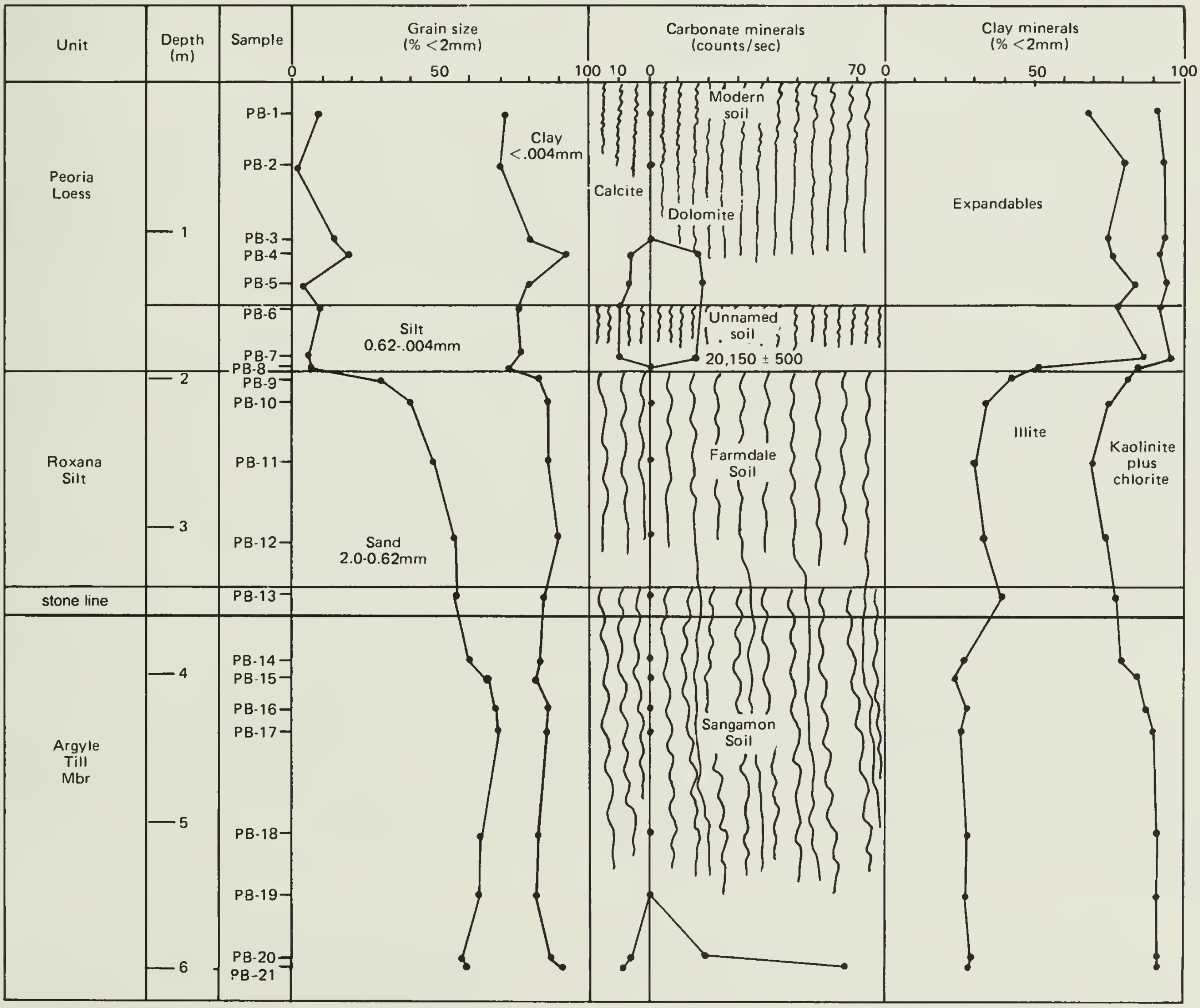


Figure 6-1 Grain-size distribution, clay-mineral composition, and carbonate data for the Wempletown Southeast Section.

pedogenically welded with the Sangamon Soil during formation of the Farmdale Soil.

Our field description had placed the lower boundary of the Peoria Loess at 120 cm, on the basis of the stratification in the 120- to 145-cm interval and an abrupt decrease in sand content and increase in clay. The marked change in clay-mineral composition indicates, however, that the boundary is between samples PB-7 and PB-8 at approximately 175 cm, and that all the overlying material has a clay-mineral composition characteristic of the Peoria Loess. Textural data further complicate the interpretation. Samples PB-5 through PB-8 (120 to 187 cm) have a significantly higher clay content than the samples immediately above or below; this suggests there were similar pedogenic or sedimentological conditions throughout the interval respresented by samples PB-5 to PB-8. Although the analytical data as well as the morphology of this unit are somewhat inconsistent, we consider the upper 187 cm of this profile to be Peoria Loess.

Humic material from the thickest and darkest organic-rich layer of the 2A horizon at 175 to 187 cm (PB-8) was dated at 20,150 $\pm$ 500 RCYBP (ISGS-1302). The fact that this date is slightly younger than expected may be due to contamination. There were modern roots in the sample and they may not have been completely removed during pretreatment; however, a 20,000-BP age is reasonable if the Peoria Loess is the parent material for this soil. This date also indicates that the soil formed just before the main body of the Peoria Loess was deposited. Deposition of the loess terminated the soil-forming processes. We have classified the soil within the interval represented by samples 6, 7, and 8 in the basal portion of the Peoria Loess as an unnamed soil after considering its morphological characteristics, organic content, stratigraphic position, and the radiocarbon date of 20,150 $\pm$ 500 RCYBP.

The source of the clayey silts and the causes of the alternating light and dark bands in the unnamed soil are uncertain. The apparent paleo-landscape position of this section would lead to the conclusion that the silty layers are primarily slopewash, although there was undoubtedly some eolian deposition. The organic-rich layers could either have formed in place or could have been derived from an A horizon of an adjacent soil. Both explanations suggest intervals of landscape stability alternating with intervals of erosion and deposition. The high clay content of this silt is also problematic. Preferential lateral transport of eroded clays and fine silt may explain this situation. There is no evidence that the clays formed in situ or were translocated from overlying horizons.

A distinct increase in sand content marks the upper boundary of the Roxana Silt; the boundary does not coincide with the boundary between materials with different clay-mineral compositions. The sample (PB-8) showing the change in clay-mineral content was taken above the sample (PB-9) showing the change in sand content. Sample PB-8 could be interpreted as a silty, uppermost layer of the Roxana but has been included here with the Peoria because of the physical similarities.

The Roxana is much sandier here than in other described sections of the Roxana in the area. However, it is similar to the Roxana sandy silt facies described by Johnson et al. (1972) in east-central Illinois. They interpreted the sandy silt facies as a pedogenic mixing of eolian silt with underlying

Sangamon Soil developed in a sandy parent material. We correlate the Roxana here to this sandy silt facies not only because of its stratigraphic position, but also because of its similar physical properties and evidence of pedogenic alteration. The increase in the kaolinite plus chlorite values in samples PB-10 through PB-12 actually reflects an increase in vermiculite. The abundant vermiculite in the Roxana reflects its A-horizon characteristics; the vermiculite is sometimes referred to as "soil chlorite" and is found in most soils.

In the Wempletown Southeast Section, a stone line serves as a marker for the base of the Roxana; however, it appears that soil development after deposition of the Roxana Silt welded the Roxana with the Sangamon Soil. Well developed characteristics of A and E horizons (granular and platy structure, pores, and light color) are present in the Roxana, and the particle-size data show only a gradual transition across the stone line into the Bt horizon of the Sangamon Soil. We have classified the soil interval above the stone line as the Farmdale Soil because it is buried by the Peoria Loess. It is likely, however, that the soil began to form in Altonian time.

The Sangamon Soil is morphologically less well developed than other Sangamon profiles on Winnebago Formation tills observed in recent studies in the area. Many types of buried soils have been observed during the soil survey of the area underlain by Argyle Till. Commonly, paleosol B-horizons contain 25 to 40 percent clay in soils mapped by the Soil Conservation Service (Grantham, 1980). The clay content in the Bt horizon is only 15 to 18 percent, which is lower than our field estimates of 25 to 30 percent. Whether this discrepancy is due to an overestimation of clay content relative to the high sand content or to the failure of our methods to completely disperse iron-bound clay aggregates is unknown.

The data on clay-mineral composition also do not agree with the data from other studies on the Sangamon Soil. The illite shows only a slight decrease upwards in the weathering profile in contrast to the 50 to 60 percent decrease reported by Frye et al. (1969) for typical profiles in Winnebago and Glasford Formation deposits in northwestern Illinois. However, in the upper portion of the Bt (samples 14, 15, and 16), the increase in kaolinite values is strong evidence that soil kaolinite was formed. In Illinois, soil kaolinite has never been observed in soil profiles younger than the Sangamon Soil (H. D. Glass, personal communication, 1985). The comparatively low clay content and the presence of only a few thin argillans may indicate that the Bt of the original Sangamon Soil is not preserved in this exposure. The horizon classified as Bt in this profile could be the BC(B3) or some lower horizon that survived the erosional event (late Sangamonian) and then re-formed into a Bt(B2) at a later time. On the basis of the evidence at the Oak Crest Bog (McKenna, 1985), there may have been as much as 25,000 years of a cool moist climate during which the Farmdale Soil was subject to weathering. Assuming those conditions, the morphology of the presently exposed polygenetic paleosol is more understandable.

The diamicton in which the Sangamon Soil has formed is the Argyle Till Member of the Winnebago Formation. The lowermost samples from the exposure (PB-20 and PB-21) are dolomitic. Their average grain sizes are 57 percent sand, 31 percent silt, and 12 percent clay; the average clay-mineral composition is 28 percent expandables, 63 percent illite, and 9 percent kaolinite plus chlorite.

CONCLUSIONS

This section and the surrounding hillslopes reflect three depositional events, three significant erosional intervals, and four soil-forming intervals (fig. 6-2). A transect in any direction from this section would likely encounter a variety of modern and paleo-soil profiles; the variations are primarily the results of erosion and deposition interrupting soil formation. The morphologies of modern soils formed in both thin and thick Peoria Loess are similar, a fact that supports an early post-Woodfordian time for the most recent erosional interval. The lack of both the Roxana Silt and a paleosol below thick Peoria Loess on many slopes throughout this region indicates that intensive erosion also occurred prior to deposition of the Peoria Loess. The

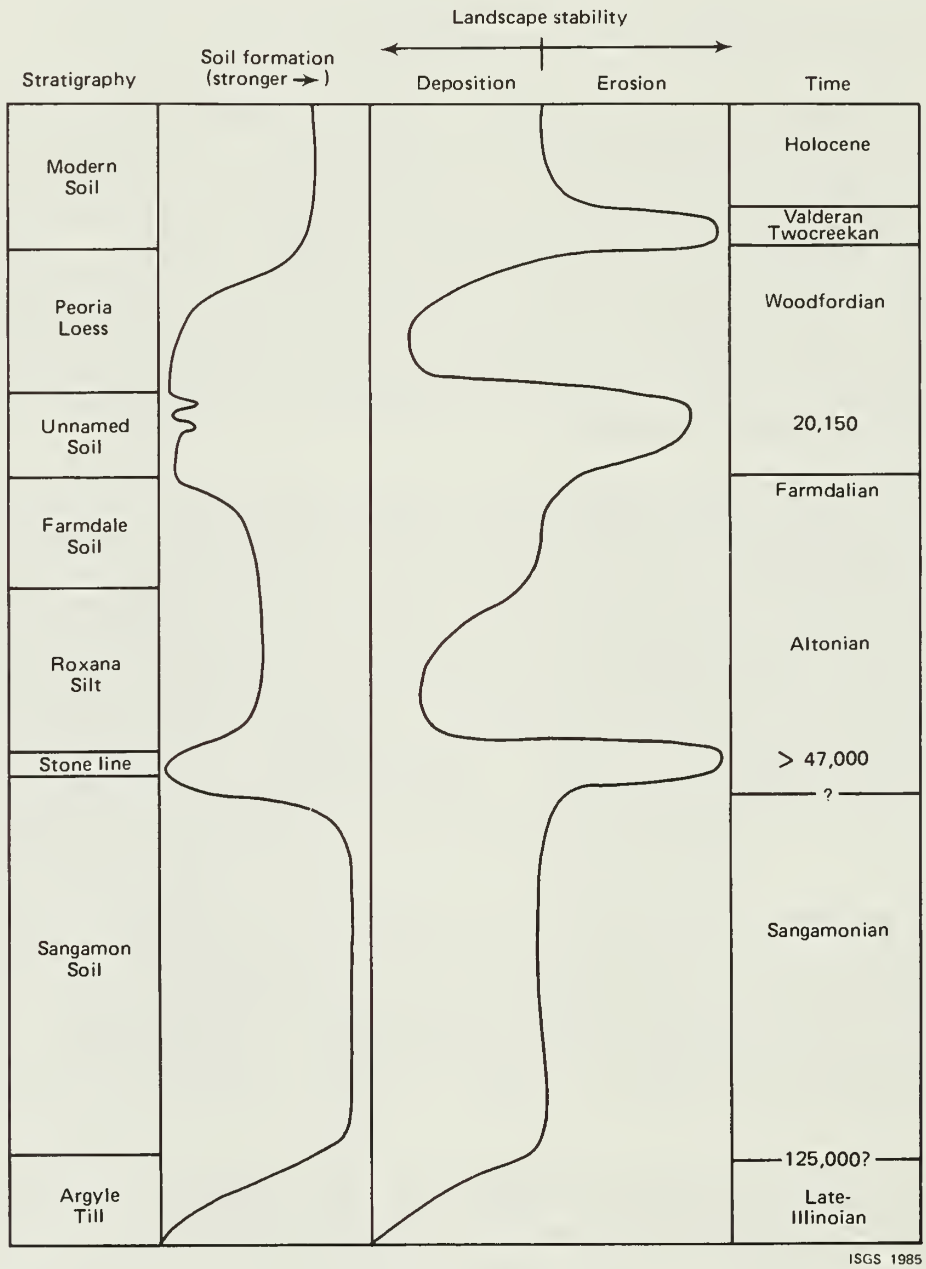


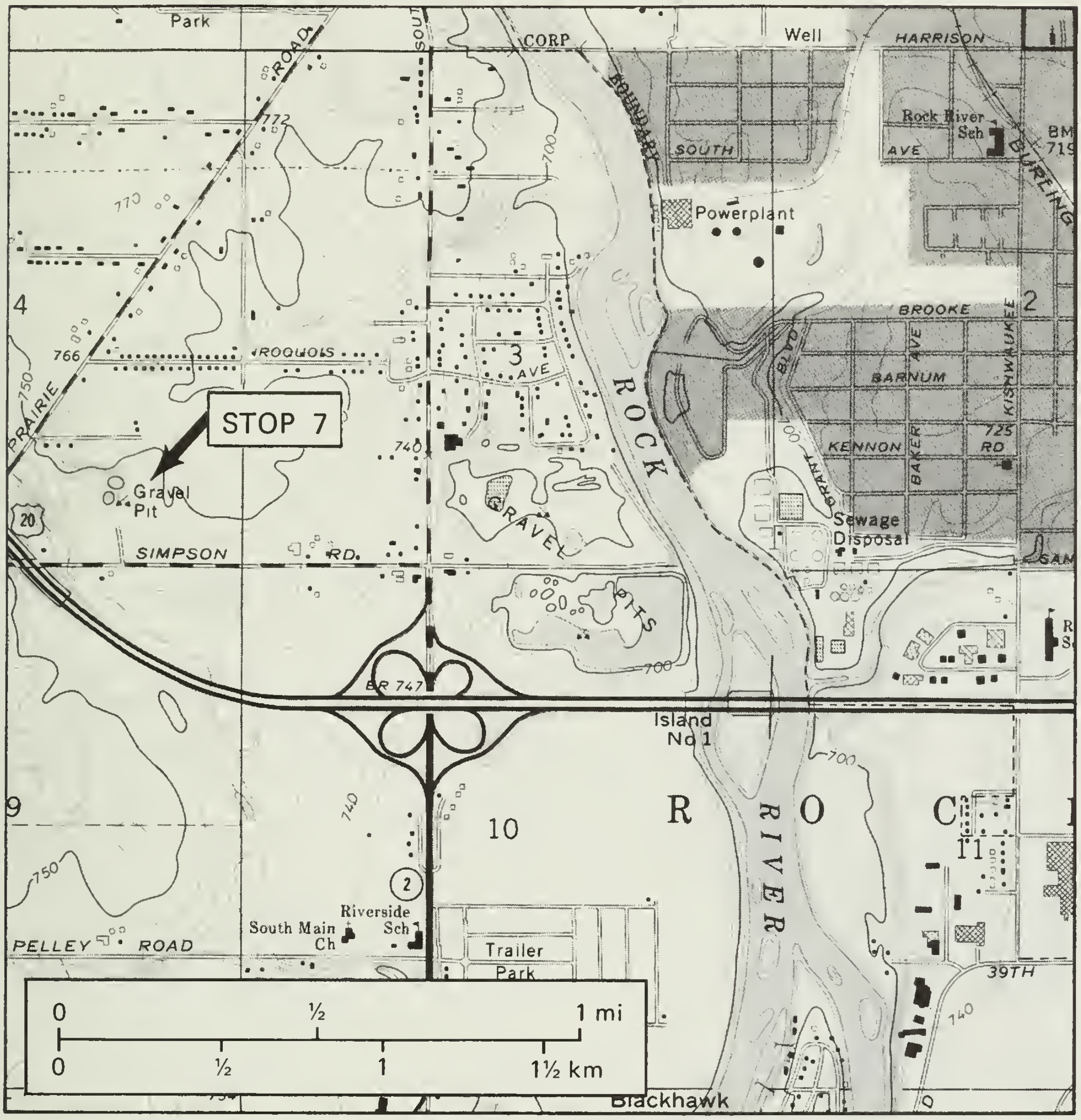
Figure 6-2. Duration and approximate dates of intervals of erosion, deposition, and soil formation since late Illinoian time in area of the Wempletown Southeast Section.

evidence at the Oak Crest Bog for erosion prior to 47,000 RCYBP (McKenna, 1985), in addition to the sandy silt facies of the Roxana Silt and the stone line at the top of the Sangamon Soil in this profile, suggest that the most intensive erosional event occurred in early Wisconsinan time. It is neccessary to reconize these erosional episodes to properly interpret the soil- and rock-stratigraphic record in this region.

In summary, the important observation at this section is that a distinct paleosol is present under early Wisconsinan silt and is developed in the upper part of the till. This sequence of materials and soil horizons is commonly found on the Illinoian till plain of Illinois; however, late Sangamonian and Wisconsinan erosional events have removed much or all of the argillic-type paleosol over large areas of northern Illinois. On the basis of the character of the paleosol and its stratigraphic position, we interpret the paleosol to represent soil formation of the last interglacial--the Sangamon Soil. Although the soil at this site appears to be an exception because of its low clay content, the regional stratigraphic equivalent is continuous throughout the areas of Glasford and Winnebago Formations. On this basis we interpret both formations to be Illinoian. At this time, we have no evidence for weathering profiles on the Glasford where it is overlain by the Winnebago Formation.

ROCKFORD TERRACE: A LATE ILLINOIAN OUTWASH SURFACE

Leon R. Follmer, Richard C. Berg, and John M. Masters



STOP 7. Simpson Road Sand and Gravel Pit
SE Sec. 4, T43N, R1E, Winnebago County IL (Rockford South Quadrangle)

The Rockford Terrance, buried by Wisconsinan loesses, is a rare occurrence of an Illinoian glaciofluvial surface. The outwash deposits contain ice-wedge casts that have been altered by Sangamon Soil formation.

INTRODUCTION

The information for Stop 7 has been taken from a guidebook prepared for the 1985 Midwest Friends of the Pleistocene Field Conference (Berg et al., 1985). The highest terrace-forming glaciofluvial deposit along the Rock River in northern Illinois is the Rockford Terrace. Anderson (1967) described its distribution, sedimentological, and geomorphic aspects, and Anderson and Masters (1985) formalized its name.

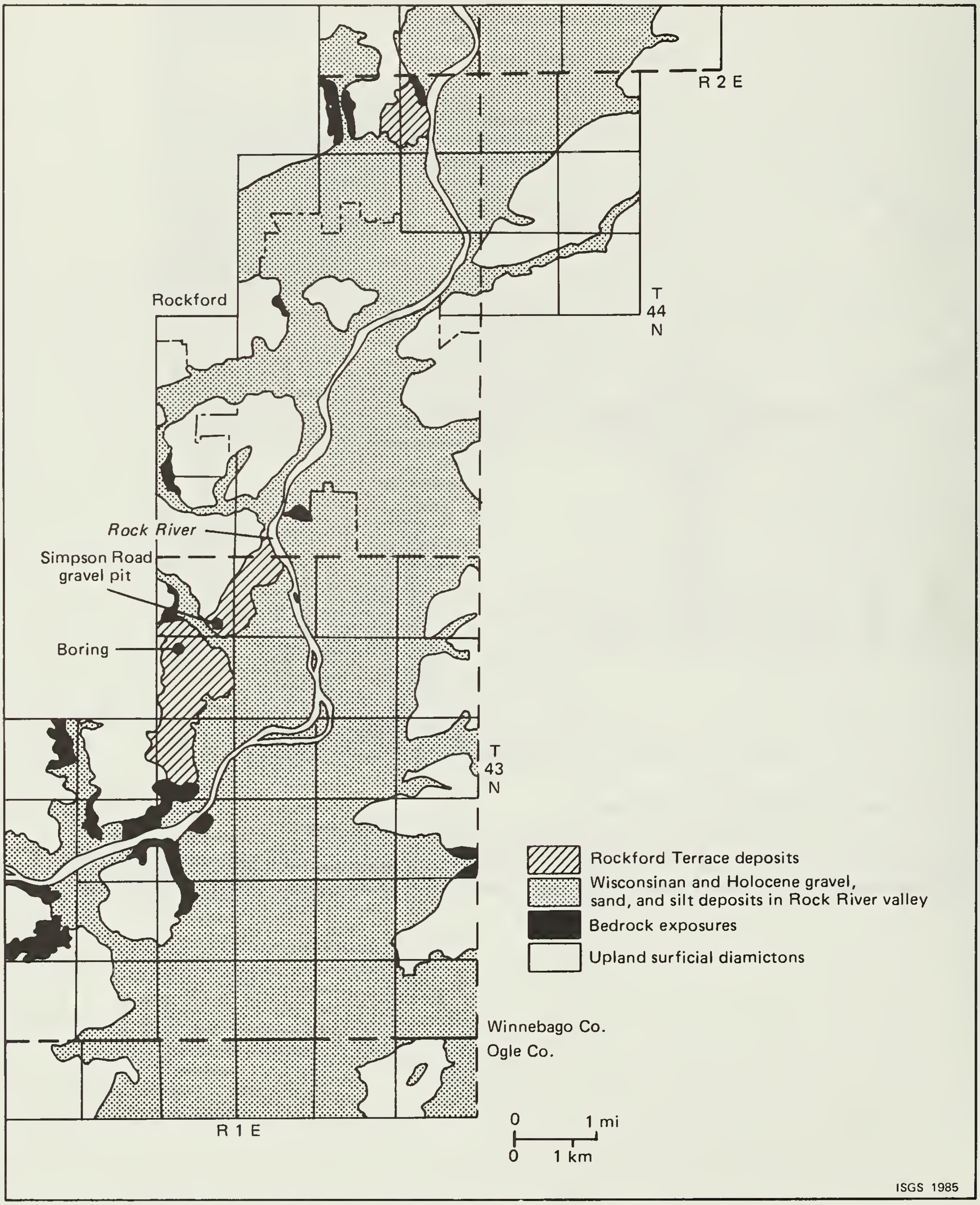


Figure 7-1. Distribution of the Rockford Terrace (modified from Anderson, 1967).

Two large and rare remnants of the Rockford Terrace are found near Rockford on the west side of the Rock River (fig. 7-1). These remnants nearly merge with the upland to the west and are about 5 to 9 m above the highest Wisconsinan age terrace. The Rockford Terrace is more hummocky and dissected than the Wisconsinan terraces. Soil maps of the area can be used to delineate the boundary between the uplands and the Rockford Terrace (Grantham, 1980). On the terrace, soils developed in sand and gravel predominate, whereas the uplands are dominated by loess underlain by paleosols that have formed in glacial diamictons.

SIMPSON ROAD GRAVEL PIT

The materials of the Rockford Terrace are best displayed at an exposure in a gravel pit (the Hoogie Pit) on the north side of Simpson Road (Stop 7 map). The Rockford Sand and Gravel Company operates the pit. Our discussion here emphasizes (1) the characterization of the deposits, (2) the fossil ice wedges in the gravel with a superimposed paleosol, (3) litho- and chronostratigraphic relationships and (4) depositional environments of the gravel.

North of Simpson Road, the terrace scarp has a local relief of about 3 m. West of the scarp is the small pit in the terrace gravel. The overburden of loess is at most times stripped from the gravel exposure or covered by vegetation. The noticeable feature at the pit is an irregular spacing of dark reddish brown pendants of a paleosol penetrating the upper part of the gravel (figure 7-2). The distribution of the pendants is irregular: some are large and singular; others have wide, complex, and multiple downward projections. The large individual pendants and complexes are numbered on figure 7-2 for convenience. In places the reddish horizon pinches out between pendants.

PROFILE DESCRIPTION

Pleistocene Series
Wisconsinan Stage
Woodfordian Substage
Peoria Loess — Modern Soil (Mollic Hapludalf)

Horizon	Depth (m)		Thickness (m)
AP	0-.29	Silt loam, very dark grayish brown (10YR 3/2), many roots, friable, abrupt lower boundary; leached	.29
A1	.29-.42	Silt loam, very dark grayish brown (10YR 3/2), few roots, fine thin platy structure, irregular lower boundary; leached	.13
E	.42-.63	Silt loam, dark brown (10YR 3/3), slight bleached appearance, few fine roots, very gradual lower boundary; leached	.21

Horizon	Depth (m)		Thickness (m)
Bt1	.63-1.07	Silty clay loam, brown (10YR 4/3), common roots, subangular blocky structure, gradual lower boundary; leached	.44
Bt2	1.07-1.60	Silty clay loam, brown (10YR 4/3), many yellowish-red (5YR 4/6) mottles, few sand grains on ped faces, few lower chroma mottles, strong subangular blocky structure, gradual lower boundary; leached	.53
BC	1.60-2.08	Silty clay loam, brown (10YR 4/3), many 2-chroma mottles, subangular blocky structure, siltier with depth, clayey silt at base; leached	.48
Illinoian Stage Pearl Formation		Sangamon Soil	
2BC	2.08-2.21	Medium sand mixed with silt, at top yellowish brown (10YR 5/4-5/6), lower part brown (7.5YR 4/3), few layers of pea gravel and coarse sand, abrupt lower wavy boundary, 18-cm diameter gray silt-clay ball (rip-up clast) at base of unit, few fine roots in joints; leached	.13
3Bt1	2.21-4.10	(Pendant #16 description) (infilling); alternating dark reddish brown (5YR 3/3) to yellowish red (5YR 4/6) sandy clay within wedges protruding downwards into sandy gravel; curved horizontal bands (lamellae) of clay and iron-rich sand, textural boundaries stained red and higher in clay content, some clay bands have wavy appearance and dip downward in the middle of the pendant, some bow up near the edges; abrupt lower boundary; leached	1.89
3Bt2	4.10-5.04	Diamicton; very dark reddish brown to black (5YR 3/3 to 2/1) clayey gravel, black clay accumulations at edges of pendant, some black clay passing into underlying and adjacent calcareous gravel, many rotten dolomite pebbles, abrupt lower boundary; leached	.94

Horizon	Depth (m)		Thickness (m)
4C	5.04-8.0±	Stratified layers of gravelly sand and sandy cobbly gravel, grayish brown to pale brown (10YR 5/2 to 6/3), calcareous, lower part covered by talus	2.96
Winnebago Formation Argyle Till Member			
5C	8.0	Diamicton; brown to pale brown (10YR 5/3-6/3) sandy loam with 5 to 15 percent gravel, exposed in base of pit; calcareous; probable basal till.	
		Total	8.0

DISCUSSION

A modern soil (Mollic Hapludalf) was described in the bank about 5 m east of the northeast corner of the exposure. For convenience we moved to pendant 16 to describe the lower part of the exposure (fig. 7-2). The modern soil here is typical of soils found on terraces and uplands. If it were well drained, as one might expect for a soil overlying gravel, it would be bright colored, without mottles. However, the iron-stained mottles in the lower part of the soil indicate prolonged wetness.

The bottom of the modern solum appears to terminate in horizon 2BC, which is a yellow to brown medium sand in most places. It is quite evident, however, that much reddish brown to black clay has moved down into the reddish clay horizons (3Bt). This illuvial clay amassed along boundaries, and in places, in the dolomitic gravel. The lower boundary of the 3Bt, which is very irregular, defines the pendant shapes. In most places, pendants have formed where sand has infilled a wedge-shaped area opening upwards. These forms are interpreted to be fossil ice-wedge casts, although they might be sand wedges. The main distinction between an ice wedge and a sand wedge is that ice wedges cause compressional upwarping of adjacent strata, and while sand wedges are fillings in cracks caused by tension.

The tops of the wedges flare out in a horn shape in most cases. A few have structures that indicate disruption or a spreading of the wedge and subsequent collapse. Most show a draping of sand layers above the outer parts of the wedges and a bowing downward of sand layers over the midsection of the wedge. This reflects the filling process and perhaps downwarping due to dissolution of underlying carbonate minerals. The layering is easily confused with "layers" of clay enrichment or subsoil lamellae. The clay enrichment either follows bedding planes or cuts across them. Pedogenic clay bands are also present in the wedges.

The flanks and bottoms of most wedges are filled with clay-enriched gravel. Some appear distinctly layered. The margins of the wedges are difficult to delineate because the outer parts of the infilling are derived from the wall material, and in most places, the reddish to black illuvial clay passes beyond the margin of the wedge into the gravel. The dolomite cobbles surrounded by the clay are soft and generally leached of their carbonate content (ghosts). Beyond the zone of clay enrichment, the cobbles may have softened rims, but are generally competent.

In 1983 an area in the northeast corner of the pit was stripped down to the top of the gravel, exposing polygonal tops of the wedges. The yellowish sand of the 2BC horizon appears to be the same sand that is permeated with reddish clay in the center of the wedges; this relationship, however, has not been studied in detail and remains uncertain.

The top of the gravel appears to be an erosion surface. The yellowish sand above the gravel is missing in places. A clayey silt and a sandy silt are frequently present above the gravel. The Peoria Loess uniformly overlies them both, and in places, directly overlies the gravel. The sandy silt has upper solum soil characteristics and is restricted to a position above a stone line at the top of the 3Bt in the gravel as well as above the reddish, sandy clay, wedge infilling. These relationships suggest that the sand predates the

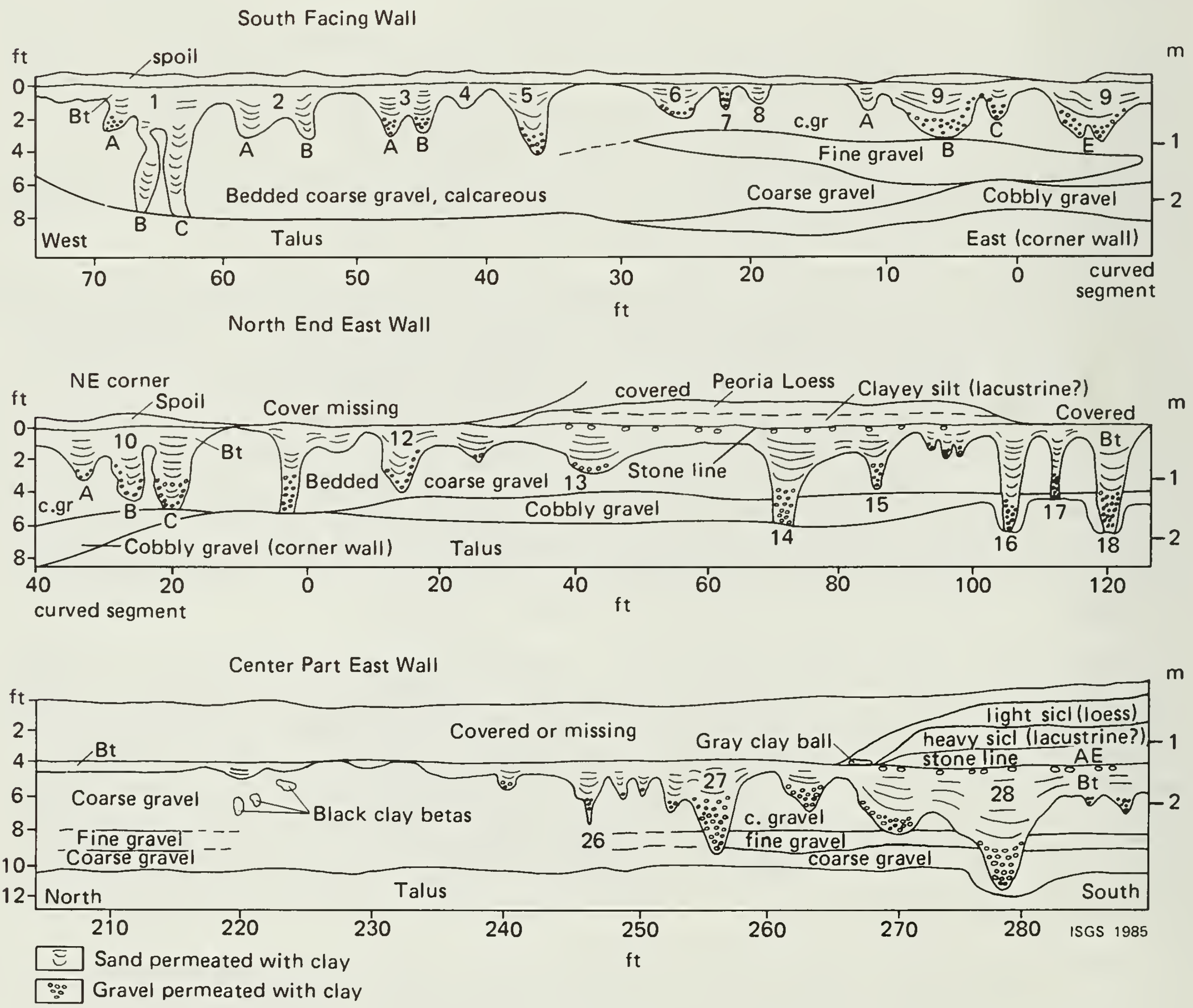


Figure 7-2. Sketch of soil pendants in highwall of Simpson Road gravel pit. Pendants are exaggerated up to 1.5 and numbered for convenience.

paleosol, while the sandy silt postdates it. This means that the gravel surface probably was subjected to at least two episodes of erosion.

About 54 m south of Pendant 16, above Pendant 28 (fig. 7-2), 10 to 20 cm of clayey silt (lacustrine) comformably underlies the Peoria Loess; this clayey silt is the same material that forms the "clay-ball clasts" described in a contact zone between loess and sand. Where the clayey silt is present, the paleosol has upper solum horizons (A, EA, and EB) overlying a stone line on the top of the clayey 3Bt. The upper solum horizons are sandy silt that can be correlated to the Roxana Silt; this sandy silt is comparable to the sandy silt facies at the Wempletown Southeast Section (McKenna and Follmer, Stop 6). The sequence here is interpreted to represent a late Sangamonian erosion followed by (1) early Wisconsinan deposition of a silt, (2) early to middle Wisconsinan pedogenesis, (3) late Wisconsinan deposition of lacustrine clayey silt, (4) fluvial scour, (5) covering by Peoria Loess, and (6) Holocene pedogenesis.

With the Wisconsinan events accounted for, the character and stratigraphic relationships of the materials here strongly suggest that the reddish paleosol is the Sangamon Soil developed in the top of the gravel.

Underlying the gravel is diamicton of the Argyle Till Member, a late Illinoian unit. The diamicton here is uniform in appearance and is interpreted to be basal till. It has an average grain size distribution of 65 percent sand, 30 percent silt, and 5 percent clay. Its clay-mineral composition averages 26 percent expandables, 63 percent illite, and 11 percent kaolinite plus chlorite. The diamicton at the Simpson Road gravel pit is somewhat more sandy than Argyle described elsewhere in the area (Berg et al., 1985).

The terrace deposits consist of a poorly sorted, coarse cobble and pebble gravel about 3 m thick, having crude horizontal bedding and cross strata. Clasts up to 20 cm in median diameter are common. About 70 percent of the cobble- to granule-size material is dolomite. Other rock types include about 10 percent chert, 10 percent other sedimentary rocks, and 10 percent igneous and metamorphic rocks. Many carbonate and crystalline cobbles are deeply weathered; some have completely disintegrated to sand. The gravel is a clast-supported deposit that varies from open-to-closed framework. Most of the matrix (silty sand) filling the interstices of the closed-framework gravel probably dropped out of the meltwater as flow decreased following gravel deposition.

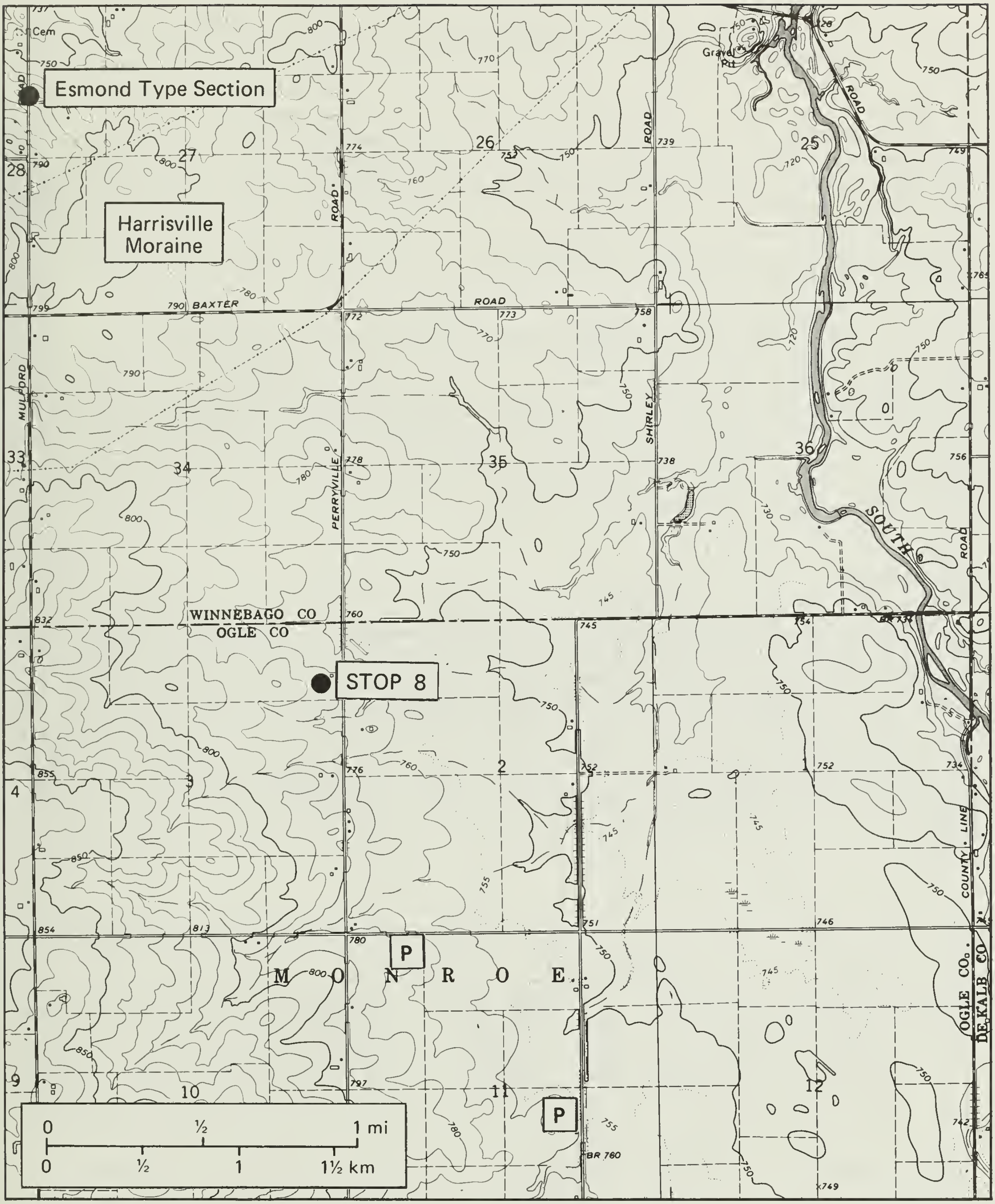
One of the beds is a poorly sorted cobble gravel about 1 meter thick. The underlying bed (about 1 m thick) contains low-angle crossbedding, and consists mostly of pebbles to fine cobbles; the crossbeds dip to the south of open framework, well graded, fining-upward deposits of pebble or pea gravel. Both of these beds were probably deposited in a high-velocity, braided stream system on an outwash plain or a kame terrace during peak melt-water discharge close to an ice margin.

INTERPRETATIONS

The exposure of the sand and gravel in the Rockford Terrace at the Simpson Road pit and the available subsurface information in the area show that these deposits are thin. We think that the high degree of weathering in the upper part of the terrace deposits represents the Sangamon Soil; thus, the sand and gravel correlates with the Illinoian age Pearl Formation, and makes the Rockford Terrace an Illinoian glaciofluvial landform.

A probable correlation of the Rockford Terrace gravel can be made to a site beyond the Rock River Valley 80 km northeast of Rockford. Near East Troy, Wisconsin, Schneider and Follmer (1983) described a Sangamon Soil in coarse gravel of Illinoian age that underlies the Tiskilwa Till of late Wisconsinan age. No ice-wedge casts or other evidence of periglacial conditions are present. The Sangamon profile described at the exposure contains an unusually large clay pendant (beta horizon development) that penetrates the dolomitic gravel. The appearance of the pendants and the red and clayey paleosols at both locations is similar; however, at the Simpson Road pit the pattern of soil horizons follows the structural feature (wedges in the gravel infilled with sand) interpreted to be ice wedge casts. In general the pendants at both locations cut across horizontal bedding planes in a similar manner.

The formation of the ice wedge casts observed at the Simpson Road pit would require that periglacial conditions existed at some time during the Illinoian Stage. These periglacial conditions could only have occurred prior to the Sangamonian, because the pedogenic features follow the form of the wedges. The age of the Rockford Terrace is still somewhat in question. Because the gravels overlie the Argyle Till, they may be closely associated with the Argyle deglaciation, or they may be the result of an event after the Argyle event but still during the Illinoian. However, the poorly sorted large boulders and cobbles in the terrace and lack of distinct stratification, plus the absence of fine-grained constituents, suggest proximity to an ice margin and deposition in a high-velocity, braided glacial stream system.



STOP 8. Monroe Profile Site

NE NE Sec. 3, T42N, R2E, Ogle County IL (Cherry Valley Quadrangle)

Recent work has shown that a Sangamon Soil in the Esmond Till at this site has been removed by large-scale erosion.

INTRODUCTION

The age of the Esmond Till has been reinterpreted many times because of incompatible arguments based on landform appearance, glacial history, paleosol relations and stratigraphy. Some geologists thought the Esmond was deposited during the Iowan, a glaciation between Illinoian and Wisconsinan; others considered it Illinoian, early Wisconsinan, or late Wisconsinan in age. Although many studies have been made of glacial deposits that included the Esmond, most appear unrelated to the Esmond because of nomenclatural and conceptual changes over the years. This paper will (1) review the history of the previous concepts of the Esmond; (2) present information concerning its age and stratigraphic relationships with paleosols and other glacial deposits in the region; and (3) discuss the Esmond at a rare site where the Sangamon Soil is preserved.

The Esmond Till was informally named by Frye et al. (1969) for the Village of Esmond in De Kalb County, Illinois. Their recognition of the Esmond Till was based on detailed study of the Greenway School cores taken near Esmond. Later, the Esmond was formalized by Willman and Frye (1970) as a member of the Wedron Formation (late Wisconsinan). Recent work has shown the Esmond to be late Illinoian. The background information for this stop is reproduced from a guidebook prepared for the Midwest Friends of the Pleistocene Field Conference (Berg et al., 1985).

BACKGROUND

In a study of the tills of northwestern Illinois, Frye et al. (1969) introduced the term Esmond Till to denote a loam to silty clay diamicton that they believed to be the oldest till member of the Wedron Formation. They showed the Esmond as the surface diamicton, extending westward as the Dixon Lobe from the Bloomington Morainic System to the vicinity of Dixon (fig. 8-1). They considered a region to the south to be an interlobate area dividing the

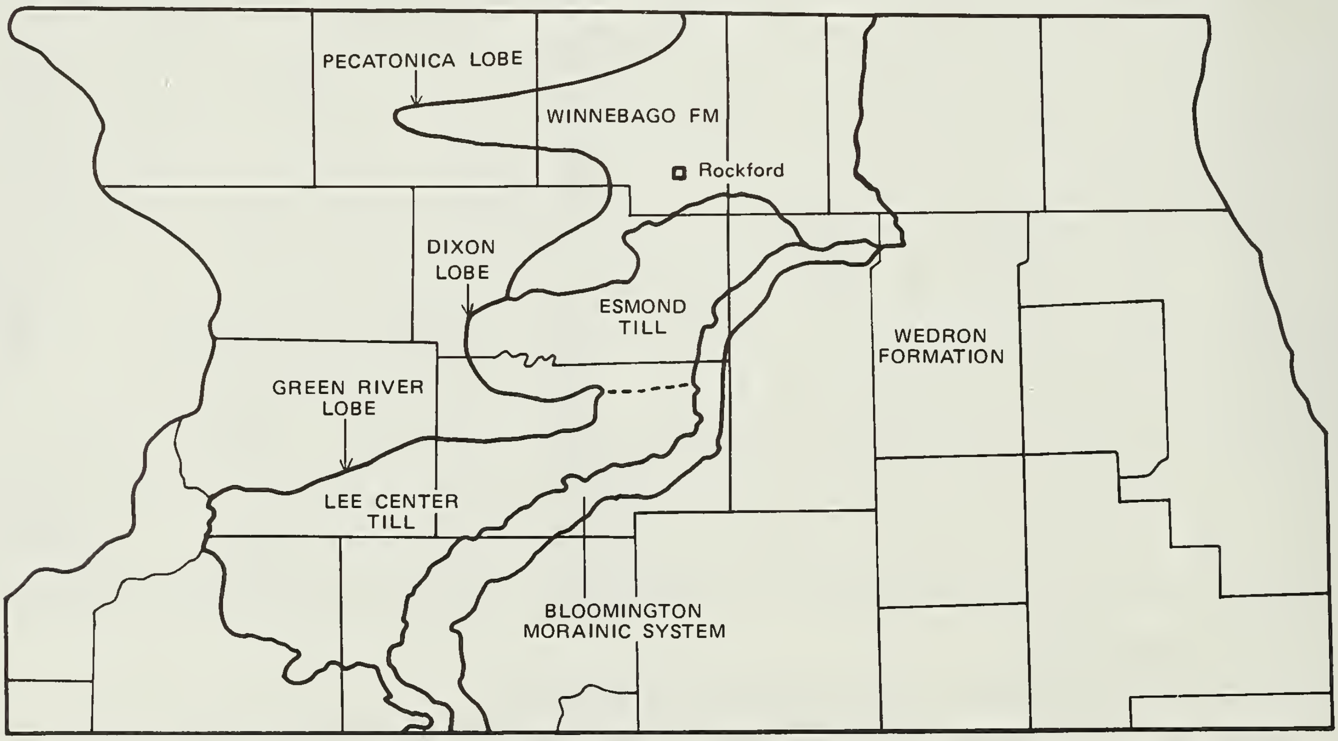


Figure 8-1. Glacial lobes of northern Illinois beyond the Bloomington Morainic System (modified from Frye et al., 1969).

Esmond from a time-equivalent unit they called Lee Center Till. According to Frye et al. (1969), the Lee Center forms the Green River Lobe that extends to the eastern border of Rock Island County covering the Green River Lowland. The drift of the Bloomington System overlaps both the Esmond and the Lee Center Tills, but at the present time the distribution of these materials in the subsurface is uncertain.

Frye et al. (1969) summarized the interpretations of many previous studies on the tills of northwestern Illinois. The interpretations are quite confusing because stratigraphic concepts and mapping criteria differ among the researchers. Examples include

- the presence or absence of a paleosol; a Sangamon Soil was required for recognition of Illinoian deposits. A weak paleosol (Farmdale) was conceptually associated with Farmdale deposits (Winnebago Formation) and no paleosol was allowed on deposits interpreted to be Shelbyville or Esmond.

- landscape characteristics; Illinoian areas were recognized where thick, weathered drift was dominant, Farmdale was conceptually associated with less weathering and less stream drainage development, and the Esmond and equivalents were recognized on "youthful landscapes."

- the presence or absence of a silt (Roxana, previously called Farmdale) below the Peoria Loess.

- stratigraphic position, the least developed but the most important theoretical criterion; stratigraphic concepts differed mainly on the number of glacial stages (fig. 8-2). Erosional events were recognized in most studies but were not integrated into the stratigraphic framework. Early workers were only able to recognize 'bundles' of Illinoian and Wisconsinan deposits separated by the Sangamon Soil.

Much of the confusion is eliminated when the stratigraphic concepts are separated from the mapping problems. Although the names and numbers of stratigraphic units, as well as the basis of definition, have been changed in several cases, the units fall into a relatively simple stratigraphic framework (fig. 8-2).

Stratigraphy and Lithology

The composition of the Esmond Till is relatively easy to distinguish from that of other surficial diamictons in the area. The Esmond belongs to the gray-olive family and oxidizes to a brown. Other diamictons in the area are gray brown in the subsurface and oxidize to a pinkish brown or yellowish brown. The pinkish hue indicates a distant source material while the yellowish brown indicates a local source. The underlying Galena-Platteville Dolomite is light yellowish brown.

The most diagnostic property of the Esmond Till is its clay-mineral composition. Its illite content is commonly about 76 to 80 percent, which contrasts with that of other diamictons in the area that generally have less than 70 percent. The grain-size characteristics of the Esmond are also relatively distinctive. In a complete sequence, the Esmond has a downward-fining texture. The Esmond is commonly a heavy loam, low in sand, that grades downward into a silty clay, clay, or a heavy clay loam (fig. 8-3).

In accretion-gley (gleyed accretionary soil) sites, lacustrine silt and clay commonly overlie Esmond diamicton. Under the Esmond diamicton a silt unit up to 3 m thick is common; it usually has a silt loam texture but becomes more clayey and stratified where thick. The silt loam appears to be eolian; the stratified portions are obviously waterlaid. This silt underlying the Esmond was recognized by previous researchers and correlated with the Morton Loess by Willman and Frye (1970). The time-stratigraphic placement of the Morton, however, is no longer valid because snails from this silt at the Byron Power Plant site 30 km to the southwest were dated >36,500 RCYBP (ISGS 378), (Follmer et al., 1978).

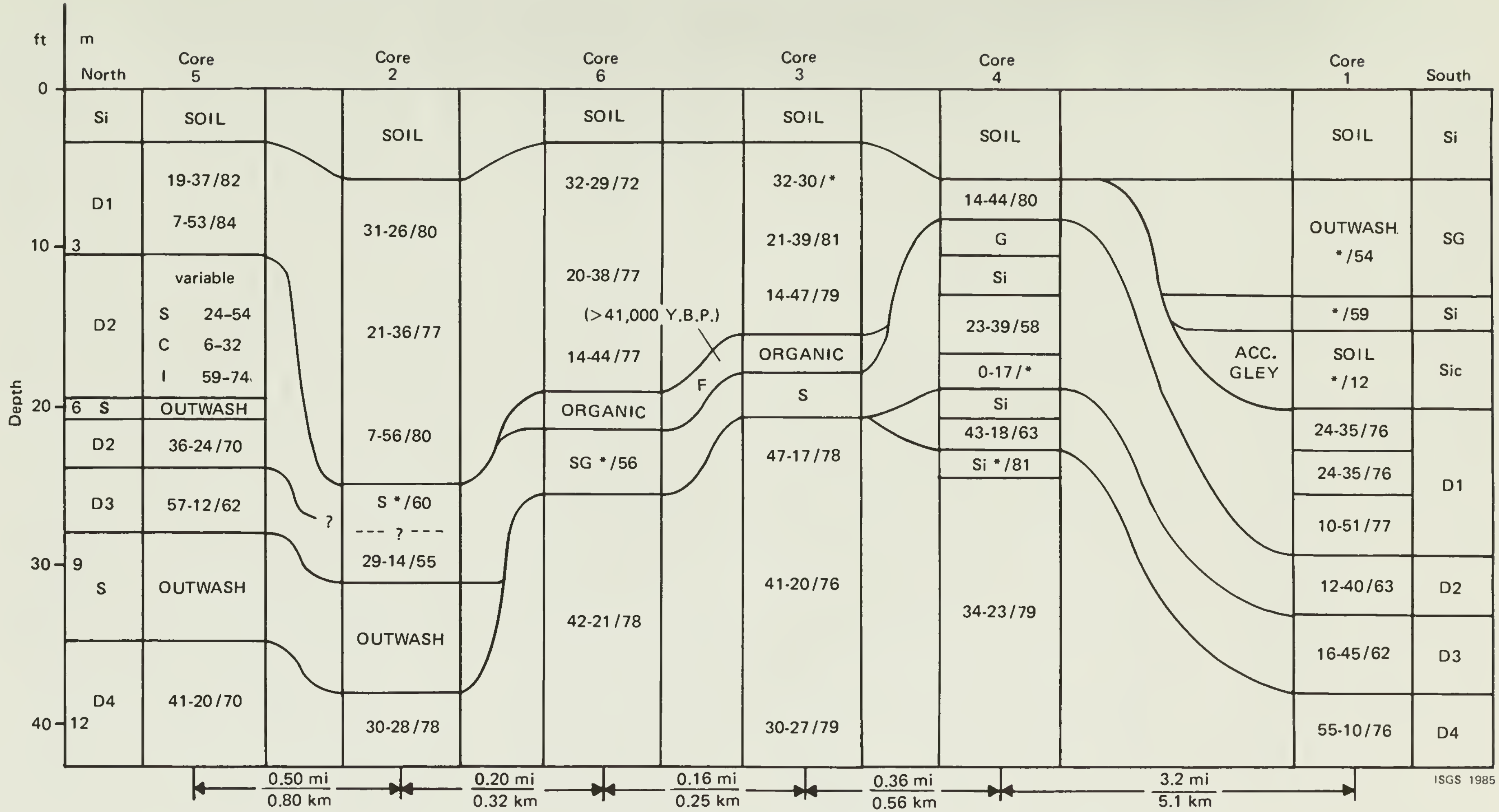
Soil Geomorphology

The soil geomorphology of the area was described by Follmer et al. (1978). Most of the soils are formed in eolian silt, sand, or loam over Esmond Till. The eolian silt is the Peoria Loess. The eolian material that ranges from loam to sand is designated the Parkland Sand. Several soil types (Acker et al., 1980) are developed into the silty upper Esmond; one soil that by definition requires a fine-textured parent material is found where the lower Esmond is within 1 m of the ground surface. Another group of soils is mapped where the underlying sandy diamicton outcrops on hill slopes. In a few

Leverett (1899)	Leighton (1923)	Shaffer (1956)	Leighton and Brophy (1961)	Frye et al. (1969)	Present
Wisconsin	Wisconsin	Wisconsin	Wisconsin	Wisconsinan	Wisconsinan
NR	Bloomington	Bloomington	Bloomington	Woodfordian	Woodfordian
NR	Belvidere Lobe Green River Lobe Shelbyville	Shelbyville	Shelbyville	Esmond Lee Center	NR
Iowan	Iowan	Iowan	Iowan	NR	NR
NR	NR	Farmdale	Farmdale	Altonian	Altonian
Sangamon	Sangamon	Sangamon	Sangamon	Sangamonian	Sangamonian
Illinoian	Illinoian	Illinoian	Illinoian	Illinoian	Illinoian
NR	NR	NR	NR	Sterling	Esmond

NR — Not Recognized

Figure 8-2. Relative order and correlation of important names used in discussion of the Esmond Till.



D1 to D4 — Diamictons
G—Gravel; S—Sand
Si—Silt; C—Clay
I—Illite; *—Not Available
19-37/82 — %S-%C/%I
Acc Gley — Accretion Gley Soil

Unit	Frey et al. (1969)	PRESENT
D1	Esmond Till Mbr	Esmond Till Member
D2	Capron Till Mbr	Oregon or Creston Till Mbr
D3	Argyle Till Mbr	Oregon Till Mbr
D4	Sterling Till Mbr	Herbert or older Till Mbr
F	Farmdale Soil	Unnamed geosol in unnamed silt
Acc.Gley	——	Sangamon Soil in Berry Clay

Figure 8-3. Correlation of the Greenway School Cores, Ogle County, Illinois.

places on high parts of the Harrisville Moraine (terminus of the Esmond. (page 51), soils are developed in the gravels of the ice-contact deposits. On gentle slopes south and east of lowlands, stratified layers of eolian sand, loam, and silt often attain thicknesses of more than 1.5 m.

The eolian loam originated from prograding sand moving onto a loess-covered surface (Follmer et al., 1978). Small eolian dunes are visible in the affected areas. A sandy lag material (pedisediment or solifluction debris), sometimes similar to the eolian loam, is present in places above Esmond.

Regional Relationships

Follmer et al. (1978) reported the Esmond in most of northeastern Ogle County; however, it was quite discontinuous within the areas mapped west of U.S. 251 and to the south. An early Woodfordian erosion surface under an eolian cover forms a band-shaped area paralleling the front of the Bloomington Morainic System. This erosion surface extends from eastern Ogle County northward into southeastern Winnebago and southern Boone Counties and southward to Lee County. Frye et al. (1969) mapped the Green River Lowland area to the south as Lee Center, a time equivalent and in some places, a lithic equivalent to the Esmond. Erosion in many places has removed the upper coarser textured Esmond, exposing its finer grained components; in many places to the west and south, the Esmond has been entirely removed by erosion. Thus, the substratum of the Modern Soil formed in eolian deposits and Esmond Till may vary from loam to clay. This is a factor that made soil mapping difficult in Ogle County.

Follmer et al. (1978) concluded that early Woodfordian erosion exposed a wide variety of older deposits and generally removed the paleosol (Sangamon Soil) from the top of the Esmond and Lee Center Tills. Generally, no stone line is present on the Esmond or Lee Center surface; however, a sand lag deposit is commonly found. The lack of a stone concentration above the truncated Esmond or Lee Center surface indicates a mass movement (solifluction) of the entire paleosol mantle, which was later covered in places by slope wash (lag or pedisediment).

In the areas east of the Rock River where maximum erosion occurred, sandy eolian deposits are found more or less continuously eastward to the Bloomington Morainic System. In places the sandy deposits terminate in low-lying sand-rich dunes. No dune crest is more than 1 m higher than the inter-dune areas; however, contrasting soil color patterns clearly reveal the dune positions (Acker et al., 1980). Beyond dune crests, the sand content drops to essentially zero; here loess-derived soils are found. Follmer et al. (1978) concluded that following the erosional event during Woodfordian time, the Peoria Loess was deposited on a barren landscape. Sand was then blown out of the Rock River valley, forming dunes that migrated across the loess-covered landscape. The migration of this dune sand entrained loess, locally producing large areas of loamy deposits that attain thicknesses of at least 150 cm. The loamy soils are always associated with dune-sand soils, indicating a clear genetic relationship. In places the upper horizons in the loamy soils are high in silt, suggesting that loess was deposited during the final phase of eolian activity. At the close of this event, the Modern Soil began to form. For classification purposes, the eolian loam is included in the Parkland Sand, a dune sand of Wisconsinan age.

Near Holcomb, 12 km southwest of Stop 8 and within the Esmond Till plain, a paleosol was studied by Follmer et al. (1978). On the basis of soil characteristics, this paleosol "outlier" was judged to be a Sangamon Soil. The area around Holcomb appears to be a ground moraine because of the smooth, gently rolling landscape; however, it would be quite anomalous for a wide variety of parent materials, including paleosols, to subcrop beneath the Peoria Loess on what appears to be a constructional geomorphic surface such as a ground moraine. The stratigraphy and geomorphology of the Holcomb site indicate that widespread erosion was associated with the building of the Bloomington Morainic System. A combination of solifluction, and fluvial and eolian activity resulted in a discontinuous distribution of Esmond Till, rare occurrences of a paleosol in or above the Esmond Till, and an outcropping of a variety of older deposits. These materials are now all covered by late Woodfordian eolian sediments.

Age and Correlation of the Esmond Till

For several reasons, Frye et al. (1969) interpreted the Esmond Till to be Woodfordian in age: (1) the landforms appear youthful; (2) Woodfordian eolian deposits commonly rests upon calcareous Esmond Till (i.e., no accretion-gley paleosol); (3) the apparent stratigraphic position is above the Altonian Winnebago Formation; and (4) one radiocarbon date of 23,750 ± 1000 RCYBP on material found beneath the Esmond was Farmdalian in age. The first two reasons can now be explained by erosion and eolian deposition. The stratigraphic problem has been resolved with the recognition of two similar diamictons overlying and underlying the Esmond (Berg et al., 1985). Thus the strength of the argument depends on one radiocarbon date.

The age of the Esmond was not seriously questioned until Frye et al. (1969) recognized the Illinoian-age Sterling Till adjacent to the Esmond to the west. They reported that the clay-mineral composition of both units was very much alike; (illite values of about 80%). Although they were unable to demonstrate stratigraphic relations between them, they concluded that the two units did not correlate because (1) the Roxana Silt and the Sangamon Soil were present above the Sterling but not above the Esmond; and (2) Winnebago Formation till members were recognized below the Esmond and above the Sterling.

The rare observations of the Sangamon Soil on the Esmond were not explainable using the old model. The strength of the old model rested on one radiocarbon date of 23,750 ± 1000 RCYBP (I-2784) from organic material beneath the Esmond Till in the Greenway School Cores (Frye et al., 1969). Because they expected the Esmond to be younger than Farmdalian (22,000 to 28,000 BP) and the age of the organic material fell into this range, the date appeared to confirm their model. Later a conceptual conflict arose between the growing pedo-stratigraphic evidence that a Sangamon surface was above the Esmond and the evidence for a younger interpretation.

On the basis of stratigraphic position and the lack of a paleosol, the units in cores 2 through 6 appeared to fit the young Esmond model (fig. 8-3). However, the accretion-gley (Sangamon) soil occurs above the Esmond in core 1. Cores 2 through 6 were taken in a close-spaced traverse with a length of about

2.0 km. Core 1 was located about 5.1 km to the south. Unfortunately, core 1 was excluded because it did not appear to relate to the other five cores.

The organic material below the Esmond was re-examined (Follmer and Kempton, 1985) to resolve the question of whether the Esmond is young (based on its youthful appearance and one radiocarbon date) or old (based on soil stratigraphy). To confirm or counter the significance of the single radiocarbon date, a reevaluation was undertaken. A sampling plan was designed to collect field replicates of the organic material. Five cores were made between the original cores 3 and 6; however, recovery of organic material was so small that the material from cores 2 and 3, and cores 4 and 5, were combined. The coarse fraction (e.g. twigs) was separated from the silt and the clay fraction; the clay fraction was discarded to ensure against contamination. The silt fraction and coarse organic fragments were combined, then leached with HCl and NaOH. The residue was burned to produce the carbon (benzene synthesis method) for dating. The results were >41,000 RCYBP for both samples (ISGS-722 and -724). The agreement between dates and the fact that both were equally dead (equal background activity) indicate success in avoiding contamination and the likelihood that the dates are valid. Thus, the Esmond Till does not have to be Woodfordian in age.

Summary of Background Material

The recognition that the Esmond Till belongs in the sequence of Illinoian till members rather than in the early Wisconsinan sequence was the key to the stratigraphic reorientation that separates till members of the Winnebago Formation from those of the Glasford Formation in northern Illinois. The occurrence of an "interglacial" soil on the Esmond, the realization that the youthful appearance of the Esmond Till plain was due to erosion and not to recent deposition, and two new radiocarbon dates of >41,000 RCYBP, all indicate an Illinoian age for the Esmond. In the regional perspective, the Esmond is believed to be correlative with the Sterling to the west and the Lee Center and Radnor to the south. On the basis of the widespread distribution and available information on the Radnor, Follmer and Kempton (1985) selected Radnor for the name of this correlated unit.

NEW INFORMATION

Soil mapping by the Soil Conservation Service in the early 1970s revealed the rare occurrences of a strongly developed paleosol on the Esmond till plain and led to the investigation by Follmer et al. (1978). On the basis of local stratigraphy and correlations the best interpretation of the paleosol is Sangamon. For this field trip, we attempted to find a better example of this paleosol than has previously been reported. An important factor in the old controversy was the uncertain relation of the Esmond Till at its type section (page 51) to the paleosol observed at other locations. Three sites were found a short distance to the south; we selected one for Stop 8; the others are designated with a "P" (see p. 51). The soil-geomorphic relationships behind the farmstead of Ronald Lentz at Stop 8 have many of the features that are associated with sites of Assumption soil (a Modern Soil that contains a poorly drained, accretion-gley paleosol in the present solum). Composites of many hand borings were used to sketch the stratigraphic relations around the Monroe Profile (fig. 8-4). Superposed on figure 8-4a is a reconstruction of the paleolandscape showing the position of former lithostratigraphic units that were stripped from the landscape during a major erosional event about 20,000 years ago. Relics of poorly drained paleosols in sites such as this indicate an inversion of topography that was caused by deeper erosion of the surrounding materials in comparison to the paleo-gley sites.

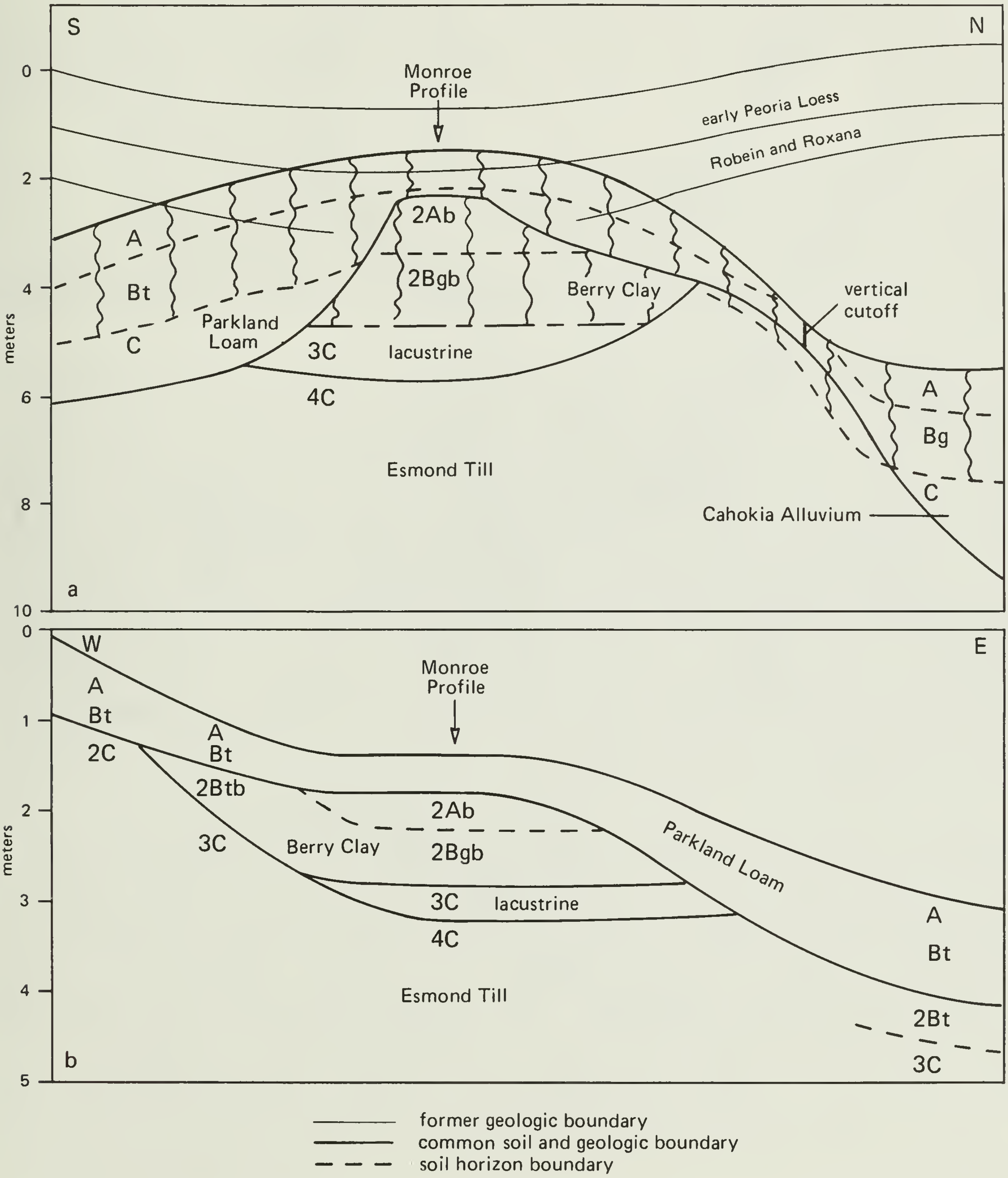


Figure 8-4. Idealized sketch of Monroe profile area stratigraphy.

The Sangamon Soil at this site is correlated to the 2Ab and 2Bgb horizons. The Roxana Silt (early Wisconsinan) and the Robein Silt (mid-Wisconsinan) may be contained in the 2Ab. The solum (2Ab and 2Bgb) is a fining-upward sequence representing slow accretion in a wet pedogenic environment. Pedogenic features effectively mask all but the textural trends. At one location the thickness of the dark gray 2Ab and the gray 2Bgb are each about 1 m thick. The 2Ab is a silty clay that grades downward to a clay loam with pebbles at the base of the 2Bgb. The underlying lacustrine deposits are thin-bedded silt loam and silty clay. Towards the base, the lacustrine unit contains thin lenses of diamicton from the Esmond Till, which indicates that at the close of Esmond glaciation (Illinoian) a lake existed at this location.

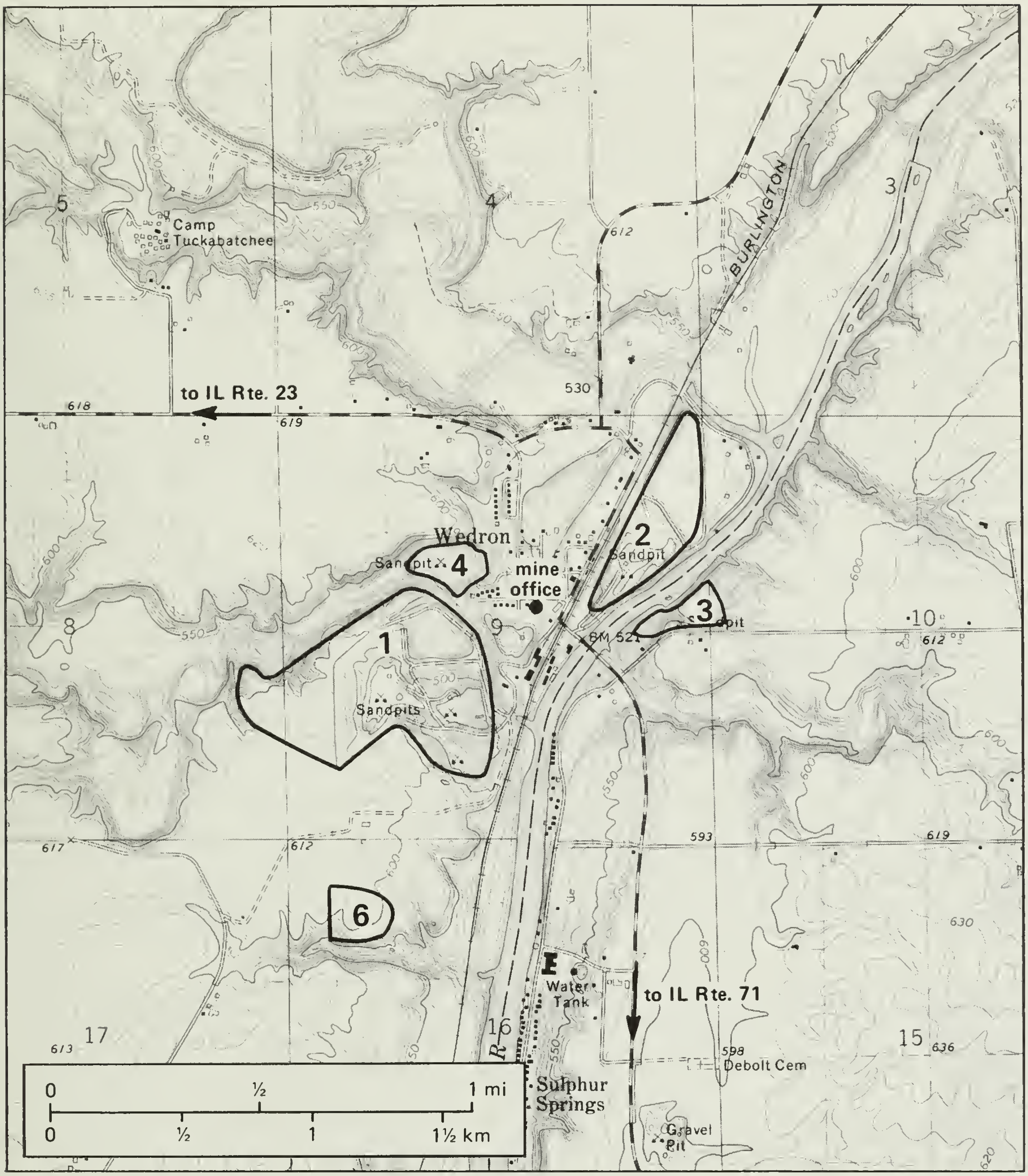
In many other locations to the west the Robein and Roxana overlie a paleosol that closely resembles the one here. Because the 2Ab is silty clay and contains much highly weathered material, the Robein and Roxana were probably removed by erosion. The same erosion event probably removed the early Peoria Loess that is commonly found in the area underlying the Parkland loam, a sand-silt facies of the Parkland Sand that is middle to late Woodfordian in age.

The landform expression here is close to ideal for this type of sequence. A bench observed on the lower part of the upland is caused by the relatively flat surface of the paleosol. The main erosion of this paleosol created two forms in front view (fig. 8-4a): one is where total removal of the solum occurred (left side); the other is a beveled surface (right side). In the side view (fig. 8-4b) both ends of paleosol are beveled. The bevelling can be caused by any type of overland erosion, whereas the whole profile removal next to a "scarp" indicates mass wasting. Here, mass wasting during a time of coldest climate can be interpreted as the result of solifluction processes. In many places on the Esmond Till plain the Sangamon Soil appears to have been "melted off" the landscape leaving little trace on a youthful appearing landscape. In support of the solifluction interpretation, many parts of the erosion surface do not have a stone line that would indicate a fluvial process. Instead, the late Woodfordian eolian silt, loam, or sand commonly rests directly on Esmond Till (usually calcareous). On the beveled surfaces a sandy lag deposit is relatively common.

Most of the Parkland loam is eolian in origin except for possible resedimentation in alluvial positions. The dominant wind direction was from the west-northwest, and dune forms were built on north facing slopes of east-west trending valleys and in lowlands between the Rock River valley and the Bloomington Morainic System. Here at Stop 8 the major landforms trend more north-south, and dune forms are absent or poorly formed. Some build-up is evident on the beveled surface, and blow-over covered the "scarp" area. The surface horizon of most Modern Soil in the region is relatively silty, which suggests that dune formation had slowed or ceased before the end of the Woodfordian. For all practical purposes, Modern Soil formation began at this time, estimated to be about 13,000 years ago.

WEDRON TYPE SECTION

W. Hilton Johnson, Ardith K. Hansel, and Leon R. Follmer, with contributions by R. G. Baker and A. E. Sullivan



STOP 9. Wedron Silica Company Quarry

Sec. 8, 9, 10, and 16, T34N, R4E, La Salle County IL (Wedron Quadrangle)

Studies of exposures in this quarry have led to the development of a detailed, evolving interpretation of the late Wisconsinan glacial history of the area.

INTRODUCTION

The Wedron Section is the type section of the Wedron Formation, which consists of glacial diamictons and intercalated stratified deposits of the late Wisconsinan (Woodfordian Subage) glaciation in Illinois, and of the Peddicord Formation. The exposures in the five pits at this quarry are the thickest, most complete exposures of the Wedron Formation in Illinois: they include complex succession of deposits representing multiple glacial events. Observations and interpretations of these deposits have been important in developing the history of the last glaciation.

Researchers have been studying at Wedron for more than 70 years. Early studies were focused on the stratigraphy of the multiple diamictons, originally all called tills, and their relationship with Woodfordian moraines down-ice to the west. These studies have led to the recent work on the sedimentology of the deposits, which has generated some new interpretations described in detail by Johnson et al. (1985).

The following summary and discussion is modified from material prepared for the Geological Society of America Decade of North American Geology--Centennial Field Guides. New information on the paleobotanical record has been added.

STRATIGRAPHY AND INTERPRETATIONS

Exposures in the quarry were first described by Sauer (1916), who recognized one main till unit and several units of sand and gravel, and silt and clay. The early work placed strong emphasis on morphology as a basis for subdividing and interpreting the glacial deposits. End moraines were interpreted as representing still-stands of an otherwise fluctuating ice margin, and it was assumed that each end moraine would have a sheet of till associated with it. The Wedron Section supported this concept because several till units of the last glaciation were exposed, and several end moraines of the last glaciation had been mapped to the west. Thus, the till units were named for the end moraine with which they were assumed to be related; for example, Willman and Payne (1942) recognized Shelbyville drift, Bloomington drift, Farm Ridge drift, and Marseilles drift at the Wedron Quarry.

Frye and Willman (1960), Frye et al. (1968), and Willman and Frye (1970) introduced formal lithostratigraphy into the classification of Pleistocene deposits in Illinois, revised the chronostratigraphic classification, and formalized the practice of morphostratigraphic classification. The Wedron Formation, as defined by Frye et al. (1968), includes the deposits of glacial till and intercalated outwash and silt of the Woodfordian Substage. Wedron was designated the type section, and three till members, Lee Center, Tiskilwa and Malden, were described in the section. Although the younger members are not present at the quarry, Wedron was selected by Willman and Frye (1970) as the best available exposure for the type section. The age of the Wedron Formation at the quarry is in the range of 15,000 to 25,000 BP. The top of the Wedron Formation is defined as bounded by the Two Creeks deposits in Wisconsin, which have an age of about 11,800 RCYBP. The youngest members were defined by Lineback et al. (1974).

Willman and Frye also formalized a system of morphostratigraphic classification in 1970. In the sequence at Wedron they recognized six morphostratigraphic units that are named after moraines and are called drifts. Nomenclature used in Willman and Frye (1970), as well as that used earlier (Frye et al., 1968) and in this guidebook, is summarized in table 9-1.

The quarry operation exposes the Starved Rock Sandstone Member of St. Peter Sandstone, a thick, quartz sandstone that is Champlainian Series middle Ordovician). The sandstone is medium grained, crossbedded, and friable except for an outer case-hardened surface. More than 30 m of St. Peter is exposed in Pit 1. Because it is almost pure SiO_2, the St. Peter is mined here and elsewhere in the area for silica sand.

Several pits have been worked in the quarry (page 61); Pits 1, 4, and 6 currently are active. Illinoian and pre-Illinoian deposits are exposed in

Table 9-1. Current and recent nomenclature used for Wisconsinan glacial deposits at Wedron Quarry.

1968 (Frey et al.)	1970 (Willman and Frye)	1985 (Johnson et al.)
Richland Loess	Richland Loess	Richland Loess
Wedron Formation Sand and gravel	Henry Formation Batavia Mbr.	Henry Formation
	Wedron Formation Malden Till Mbr.	Wedron Formation Malden Till Mbr.*
Till (Farm Ridge) Sand and gravel	Farm Ridge Drift (till) Sand and gravel	Unit 3
Till (Cropsey) Sand	Mendota Drift (till) Sand	
Till (Cropsey) Silt, some sand	Arlington Drift (till) Silt, some sand	Unit 2
Till (Normal) Sand and silt	Dover Drift (till) Sand and silt	Unit 1
Till (Bloomington)	Tiskilwa Till Mbr. Bloomington Drift (till)	Tiskilwa Till Mbr. Main Unit
Till (Shelbyville)	Lee Center Till Mbr. Atkinson Drift (till)	Lower unit
Sand and gravel (pro-Shelbyville)	Sand and gravel	Peddicord Formation Sand unit
Farmdale Silt	Farmdale Silt	Silt unit
---	---	Robein Silt

*Correlations between the Malden units of this guide and drift units of earlier workers are uncertain.

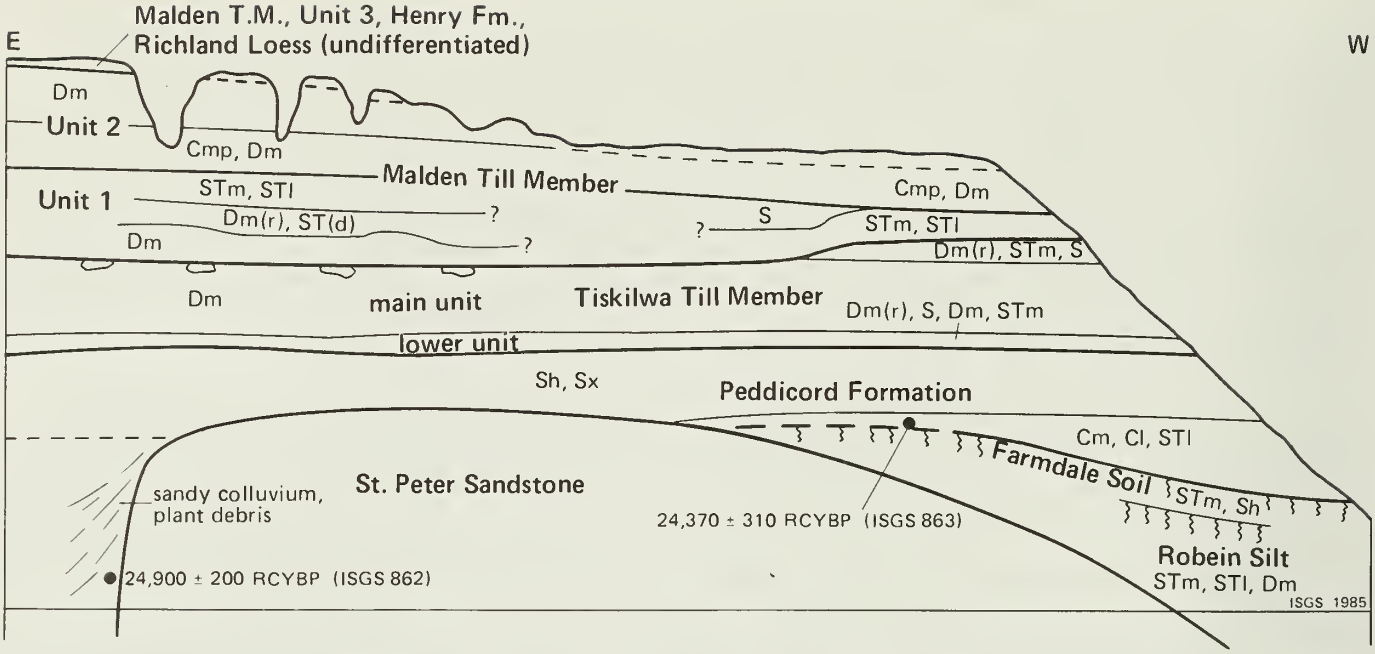


Figure 9-1. Sketch of southwestern corner of Pit 1, Wedron Quarry, 1984, destroyed in 1985 (not to scale).

Dm	diamicton, massive
Cm	clay, massive
Cmp	clay, massive, pebbly
Cl	clay, laminated
STm	silt, massive
STl	silt, laminated
Sh	sand, horizontal bedding
Sx	sand, crossbedding
Gh	gravel, horizontal bedding

evidence for
(p) pedogenesis
(d) soft sediment deformation
(r) resedimentation
(s) shearing

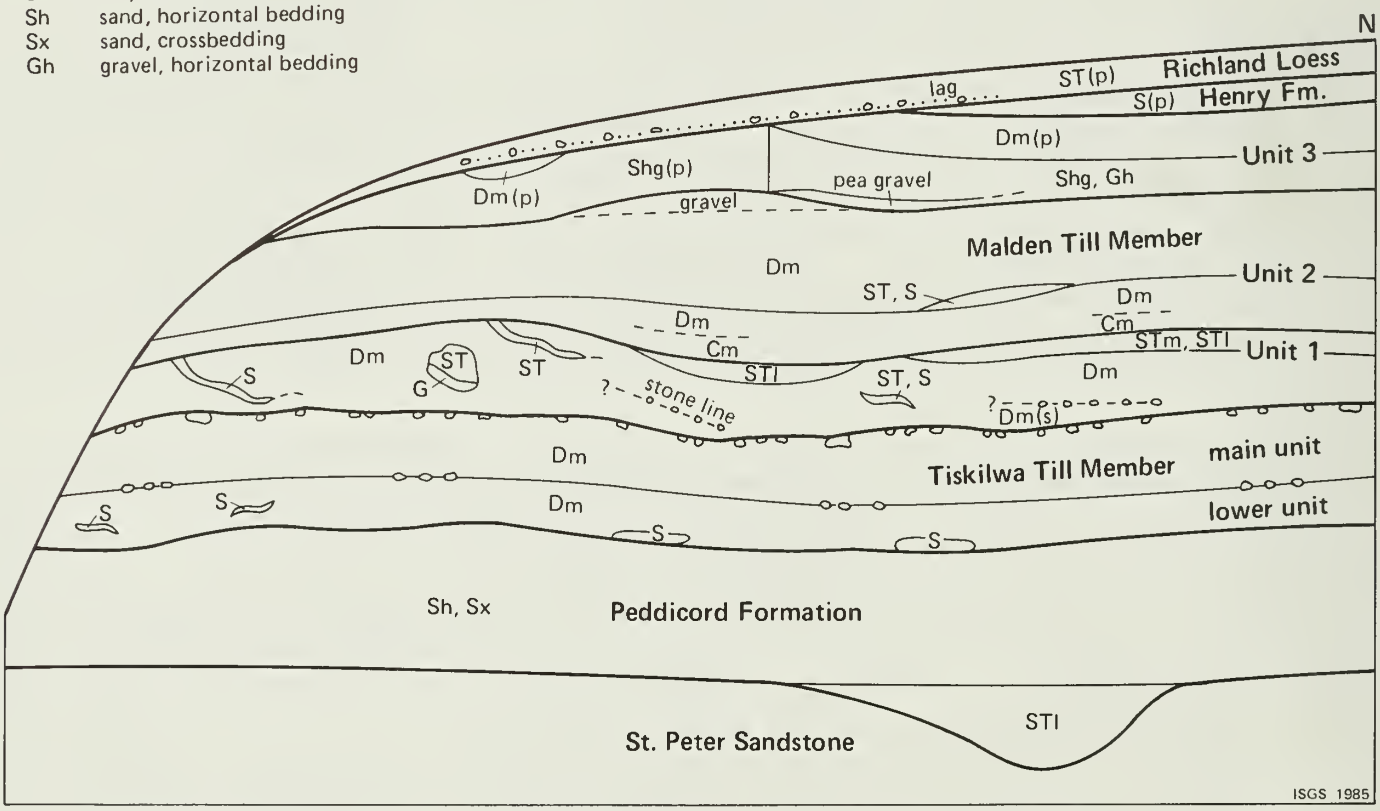


Figure 9-2. Sketch of west wall exposure of Pit 6, Wedron Quarry, 1984, destroyed 1985 (not to scale).

Pits 3 and 4. The following description and discussion focuses on Pits 1 and 6, and is organized by stratigraphic unit. The nongenetic term diamicton is used to describe poorly to unsorted deposits. The genetic term till is restricted to those diamictons that are interpreted to have been deposited directly from glacier ice with little or no modification after deposition. Other diamictons are interpreted to have been deposited from sediment (mud) flows in the glacial environment.

The bedrock surface contains several valleys that are tributaries of the Ticona Bedrock Valley (Willman and Payne, 1942). These are exposed in Pit 1 (Fig. 9-1) and are filled with Wisconsinan alluvial and lacustrine deposits. Although the alluvial deposits vary, they are silty for the most part and are included in Robein Silt. The Farmdale Soil, about 1.3 m thick, is developed in the top of Robein Silt (Fig. 9-1). The A horizon of the Farmdale is dark and cumulic, and contains abundant organic debris and wood. It overlies a weakly developed, gleyed B horizon.

Peddicord Formation

Willman, Leonard, and Frye (1971) defined the Peddicord Formation as including gray and pink silt that had accumulated in a Farmdalian lake confined to valleys of the Ticona drainage system. We recognized these deposits as a silt unit of the Peddicord, and also tentatively include in the Peddicord overlying sand deposits that we think are related to the same drainage system.

The silt unit consists of massive and laminated silt containing subordinate beds and laminae of clay and sand. These materials are calcareous and vary in color from gray to reddish brown. Coniferous wood fragments and organic-debris laminae are common, particularly near valley and gully margins. The unit varies in thickness; up to 13 m has been described at Wedron (Willman and Frye, 1970). It is particularly thick in buried canyons where the silt beds grade to and are interbedded with sandy colluvium derived from St. Peter Sandstone. The unit has the same clay mineral composition as the Tiskilwa Till Member. Radiocarbon dates on detrital wood from this facies are 24,370 $\pm$ 310 (ISGS 863), 24,900 $\pm$ (ISGS 862), 24,000 $\pm$ 700 (W-79) and 26,800 $\pm$ 700 (W-79) RCYBP.

The deposits are interpreted as typical proglacial lake beds that accumulated in a dammed drainage system during the initial Woodfordian glacial advance in northern Illinois. The color and clay mineral composition suggest that the system was dammed by the Tiskilwa ice margin or by outwash from that ice sheet. Lake Peddicord inundated the Farmdale Soil, which had formed in the valleys, and wood and organic debris were washed into the lake from valley sides and adjacent uplands. The lake probably existed in latest Farmdalian and earliest Woodfordian time.

Previous interpretations related the silt deposits either to Lake Kickapoo, interpreted as postdating the initial Woodfordian ice margin advance and hence to be younger (Willman and Payne, 1942), or to Lake Peddicord, interpreted as predating the earliest Woodfordian glaciation and thus older than the Farmdale Soil (Willman, Leonard, and Frye (1971). The latter interpretation of the age of the lake is rejected because of stratigraphic relationships at Wedron. Additional regional studies will be required to determine possible relationships between deposits of Lake Kickapoo and Lake Peddicord.

A sand unit comprising up to 6 m of relatively well-sorted sand and some fine gravel overlies the silt unit of the Peddicord Formation. The sands are calcareous and tan to yellow brown. Beds vary in thickness from about 0.2 to 1.0 m, and are planebedded and trough and planar crossbedded. The sand unit is more extensive than the silt unit and appears to be continuous across the bedrock surface at Wedron.

This unit is interpeted as representing glaciofluvial sedimentation that occured as the Woodfordian ice margin approached the quarry area. The proglacial origin agrees with earlier interpretations (table 1), except that we relate the unit to the ice sheet that deposited the Tiskilwa Till Member and not the Lee Center Till Member or Shelbyville till.

Wedron Formation

The Wedron Formation, which consists of glacial deposits, overlies the Peddicord Formation. Initially it was subdivided into three members at Wedron; currently, only two members are recognized, although both consist of multiple lithologic units. In addition, Willman and Frye (1970) recognized six morphostratigraphic units (table 1). The latter classification is not utilized in this guide because correlations to end moraines to the west are uncertain. The Wedron Formation is exposed in all pits, but currently is best exposed in Pits 1 and 6 (Figs. 9-1, 9-2).

Tiskilwa Till Member. The lower unit of diamicton and intercalated sand and silt is related here to the Tiskilwa glacial advance, not an earlier advance. The unit is thin, rarely more than 1 m thick, and discontinuous. It is highly variable in character. In most places it consists of thin diamicton layers interbedded with stratified sand or silt. The lenticular beds thicken and thin abruptly. In some places, the unit is uniform pebbly loam diamicton. The diamicton, which is generally oxidized, has a yellow-brown to pinkish color, similar to the pinkish diamicton in the main body of the Tiskilwa; where unoxidized, it is distinctly grayer. Its clay fraction contains slightly more illite than does the main part of the Tiskilwa. We interpret the unit to be till and material that has undergone resedimentation and deformation in the subglacial environment.

Willman and Frye (1970) included this unit in the Lee Center Till Member; earlier it had been called Shelbyville till (table 1). Subsequent work by Follmer and Kempton (1985) has demonstrated that the Lee Center Till in the type area is Illinoian; thus the name is inappropriate for this unit at Wedron. Although the contrasting color and composition suggested to earlier geologists that the unit had been deposited during an earlier glacial event, materials with these characteristics are not unusual in the lower portion of the Tiskilwa Till Member. We believe the unit was deposited by the Tiskilwa ice sheet and that the contrasting characteristics are the result of incorporation of older drift and local Paleozoic source material.

The lower unit is overlain by 2 to 4 m of typical Tiskilwa Till. The contact is distinct and locally marked by a concentration of boulders. The main body of the Tiskilwa is a massive, relatively uniform loam to clay loam diamicton that weathers to a distinct pinkish color. This unit is interpreted as till, but in some places the upper portion contains interbedded stratified sands, silts, and diamicton layers of sediment flow origin. In Illinois, the Tiskilwa is one of several reddish-brown till units; its color and composition reflect late Precambrian source materials that occur in the Lake Superior region north of Lake Michigan. The unit is extensive in northern Illinois and forms several large end moraines along the western margin of Woodfordian glaciation.

Malden Till Member. At Wedron the Malden Till Member is complex, consisting of various lithologic materials. Three main units, numbered upward, are tentatively recognized; each is variable.

Malden unit 1 is a gray to gray-brown diamicton that oxidizes to a reddish brown hue and has a variable color and clay mineral composition. The latter characteristics generally are intermediate between those of the main Tiskilwa and Malden unit 2. A discontinuous boulder pavement occurs at the lower contact, and azimuths of striae commonly range from 70° to 80°; a boulder pavement also is present within the unit. The diamicton has a pebbly loam texture and the upper part of the diamicton locally is interbedded with stratified deposits. These deposits are overlain by a bed of well-sorted silt to fine sand, that is laminated and continuous in exposures at Wedron. The unit is 1 to 3 m thick and consists primarily of till and sediment flow and lacustrine deposits.

Malden unit 2, about 3 m thick, consists of a lower silty clay that gradates upward to pebbly, silty clay diamicton, and an upper pebbly loam diamicton. The lower subunit ranges from massive to faintly laminated and is interpreted to be lacustrine in origin. The increased sand and sparse pebble content in the silty clay diamicton may be from ice-rafted material. The overlying gray, pebbly loam diamicton is about 2 m thick; it is generally massive, but locally contains thin streaks of fine sand, block inclusions of older pinkish and clayey diamicton, and interbedded sorted deposits of sand and silt. Although mainly gray, locally the upper part contains pinkish diamicton that has a lower illite content. The diamicton subunit is interpreted as consisting of basal till and deposits that have undergone resedimentation in the supraglacial environment.

Malden unit 3 consists of a lower sand subunit and a discontinuous, overlying fine-grained diamicton subunit. The sand unit is stratified and crossbedded, and locally it contains multiple coarsening-upward sequences. Local lenticular bodies of pea gravel are present at the base or within it. The sand is best exposed in Pit 6, where it is up to 2 m thick. The overlying diamicton, which contains few pebbles, has a clayey texture, its maximum thickness, observed in recent exposures, is 1.5 m. The upper surface of the diamicton has been truncated and locally is marked by a thin lag (a concentration of pebbles). The diamicton and subjacent sand and gravel are weathered and locally are part of the solum of the Modern Soil. The regional significance of unit 3 is not known; it may consist of outwash and sediment flow deposits derived from the Yorkville Till Member, which forms the Marseilles Morainic System located immediate east of the Fox River, or it may have been the result of a younger Malden ice margin advance that extended west of Wedron.

Henry Formation

Several deposits of sand and gravel found at or near the ground surface are assigned to in the Henry Formation: they include the sand of Malden unit 3, where it has been exhumed, and thin sand that locally overlies the clay diamicton of Malden unit 3. The deposits, interpreted as outwash, have been weathered in the Modern Soil.

Richland Loess

The uppermost unit at Wedron, Richland Loess, is weathered silt; it is thin (usually about 0.5 m thick), but locally approaches 1.0 m. This eolian deposit was derived from valley trains and drift surfaces during the middle and latter portions of the Woodfordian Subage. The A and locally the E and/or B horizons of the Modern Soil are developed in the loess. The soils, which developed in a well-drained position under forest or grass vegetation, are classified as Udalfs or Udolls, respectively.

PALEOBOTANICAL RECORDS FROM BIGGSVILLE AND WEDRON: NEW INFORMATION

Richard G. Baker and Amy E. Sullivan, Department of Geology, University of Iowa.

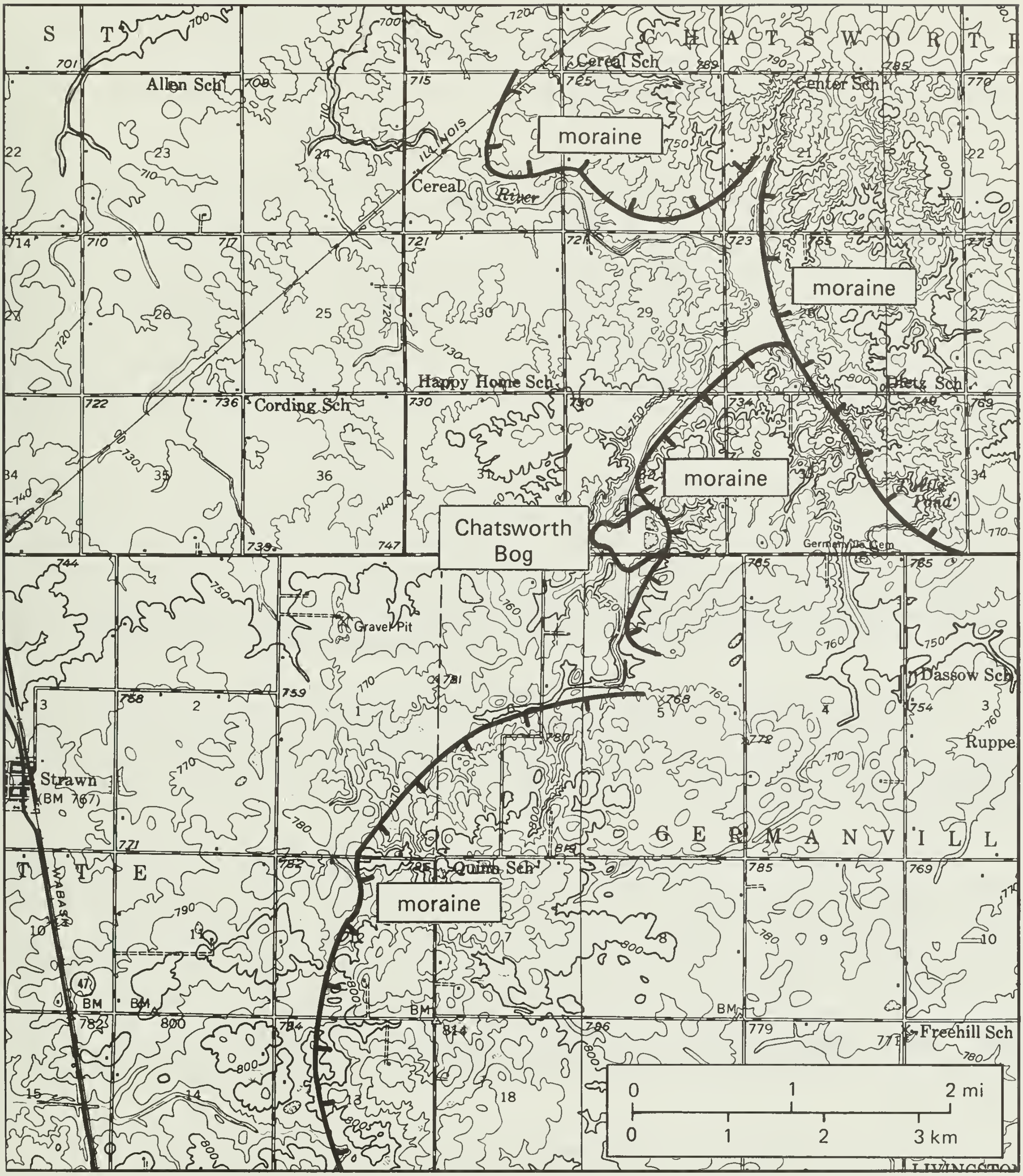
Pollen studies from several areas in Illinois and Iowa indicate that a spruce-pine forest that prevailed in the region from at least 28,000 to 25,000 BP gave way to a spruce-larch forest that lasted until about 22,500 BP (Baker et al., 1986; Hallberg, Baker, and Legg, 1980; Hallberg, Van Zant, and Baker, 1980; F.B. King, 1979; J.E.King, 1979; Mundt and Baker, 1979). Detailed pollen and plant macrofossil work from Biggsville in western Illinois, an area well beyond the Woodfordian glacial margin, indicates that spruce pollen percentages and influx drop off sharply between about 22,500 and 21,500 BP, and spruce needles disappear from the record. The pollen spectra are dominated by high percentages of spruce and sedge, with lesser amounts of pine. However, low pine pollen influx suggest that pine was already absent from the area. As spruce and larch disappear from the record, megaspores and microspores of the *Selaginella selaginoides* (spikemoss), a subarctic plant, appear for the first time. Loess deposition apparently mantled the entire landscape after 21,500 BP, and organic deposition ceased.

Preliminary pollen and plant macrofossil analysis of sediments in a small swale fill in the Wedron Quarry (Pit 6) indicates that the subarctic to arctic conditions existed as Woodfordian glaciers approached the Wedron area 21,400 $\pm$ 470 RCYBP, shortly after the record at Biggsville ended. The pollen spectrum consists of a spruce-pine-sedge assemblage, much like the uppermost samples at Biggsville dated at 21,410 RCYBP (Sullivan, 1985). Plant macrofossils of the arctic plants *Dryas intergrifolia* (arctic avens) and *Vaccinium uliginosum* var. *alpinum* (arctic blueberry), and the subarctic *Selaginella selaginoides* and *Betula glandulosa* (dwarf birch) indicate that the environment was very open and tundralike. Other plant macrofossils include a number of pioneer aquatic plants, wetland plants, and several taxa whose identification is still incomplete. This is the first arctic-plant assemblage from Illinois, and it is similar to the plant assemblage from the arctic biota at Conklin Quarry, dating from about 16,700 to about 18,000 BP (Baker et al., 1984; manuscript in review).

In summary, fossiliferous sediments of full-glacial age have seldom been found in Illinois. Data from new sites, especially the Wedron site, suggest that the full-glacial environment was much more open and tundralike than previously thought.

CHATSWORTH BOG: A WOODFORDIAN KETTLE

James E. King



STOP 10. Chatsworth Bog

SW¼ Sec. 32, T26N, R8E, Livingston County IL (Sibley Quadrangle)

The sediment record found in this rare bog in central Illinois provides significant information on the floral history from about 14,000 years ago to the present.

Chatsworth Bog is a marl bog situated within a roughly circular 25-ha depression dissected by an outwash channel that originated in the late Wisconsinan Chatsworth Moraine (Willman and Frye, 1970) 4 km to the north (see p. 51). A small permanent stream flows in the channel and through the bog. In the 1930s the organic-rich marl was commercially mined from the east half of the bog for agricultural lime, producing a pit that is now occupied by a small lake. Although the bog was probably surrounded by forest in the 19th century, the primary vegetation on the rolling morainic topography was tall-grass prairie (Anderson, 1970).

The fossil pollen in Chatsworth Bog was first investigated by John Voss (1937) who sampled the vertical walls of the open pit during the period of active mining at the site. He reported 60% spruce pollen at a depth of 11.2 m. This analysis included only the arboreal pollen types and was completed only on sediments below 6.5 m depth. Leonard (1974), who referred to the site as Strawn Northeast, studied the snails recovered from the fossiliferous marls at the edge of the basin in sediments dated younger than 9000 RCYBP and reported no evidence of climatic change. The snails indicated a uniform environment with some fluctuations in water levels. A pollen study of Turtle Pond, 3 km east of Chatworth Bog (Griffin, 1951), did not include herbaceous pollen types.

A 5-cm diameter continuous core, 1275 cm long, was collected from the southwestern side of the Chatsworth basin in the remaining unmined area. The stratigraphy is shown in figure 10-1. Volumetric pollen samples were recovered from the core at 20 cm intervals. Additional samples were later analyzed from selected parts of the core at 5 and 10 cm intervals in areas of rapid changes in pollen frequency and/or influx. The extraction methods and a detailed discussion of this and other Illinois pollen sites are described by King (1981).

Radiocarbon dates from the core are shown in figure 10-1 along with a plot of sedimentation rates throughout the sequence. The radiocarbon dates of 3370 ± 75 RCYBP from the top of the marl and 2640 ± 75 RCYBP (Leonard, 1974) from near the base of the overlying surface peat bracket the stratigraphic contact between the organic marl and the surface peat.

Pollen concentration, Figure 10-1, fluctuates widely below 1000 cm depth, then slowly declines in the upper portion. There is no appreciable change across the marl/peat stratigraphic boundary at 100 cm. Total pollen influx (Fig. 10-2) remains relatively low, about 2000 grains/sq cm/yr between 14,300 BP and 11,000 BP when it increases to 5000 grains/sq cm/yr. Between 10,200 and 9100 BP, it again declines to about 1000 grains/sq cm/yr. At 9100 BP the pollen influx begin a rapid increase to 28,000 grains/sq cm/yr, remains high until about 7500 BP when it declines to about 7000 grains/sq cm/yr, and then continues to decline to the top of the marl at 100 cm depth, about 3400 BP (fig. 10-2).

The pollen record from Chatsworth Bog, Figure 10-3, is dominated by spruce (*Picea*) in the lower Pleistocene levels and oak (*Quercus*) in the upper Holocene sections. The pollen record is divided into 4 assemblage zones.

ZONE I. Zone I is dominated by up to 76% spruce with lesser amounts of fir, larch, alder, birch and oak. Also present are grass and sage. Pollen influx

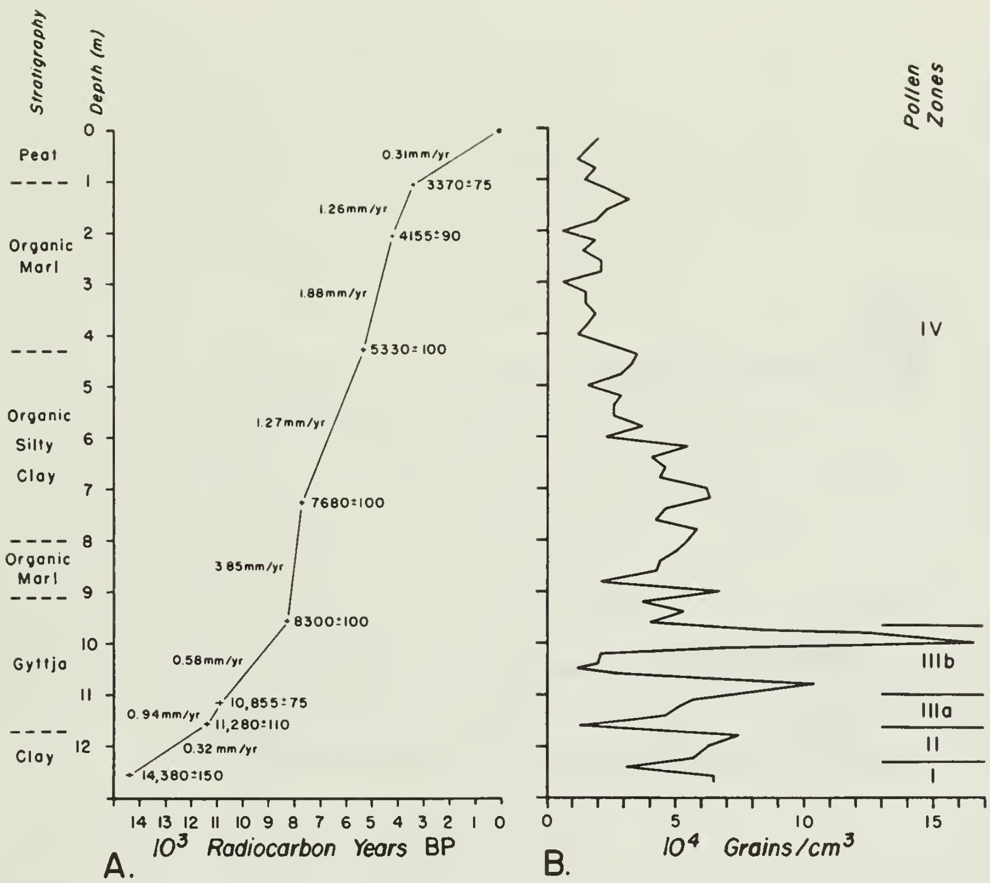


Figure 10-1. Stratigraphy, sedimentation rates, and pollen concentration for the Chatsworth Bog core: (A) sedimentation rates calculated from adjacent pairs of dates and the bog surface; (B) pollen concentration (grains/cu cm).

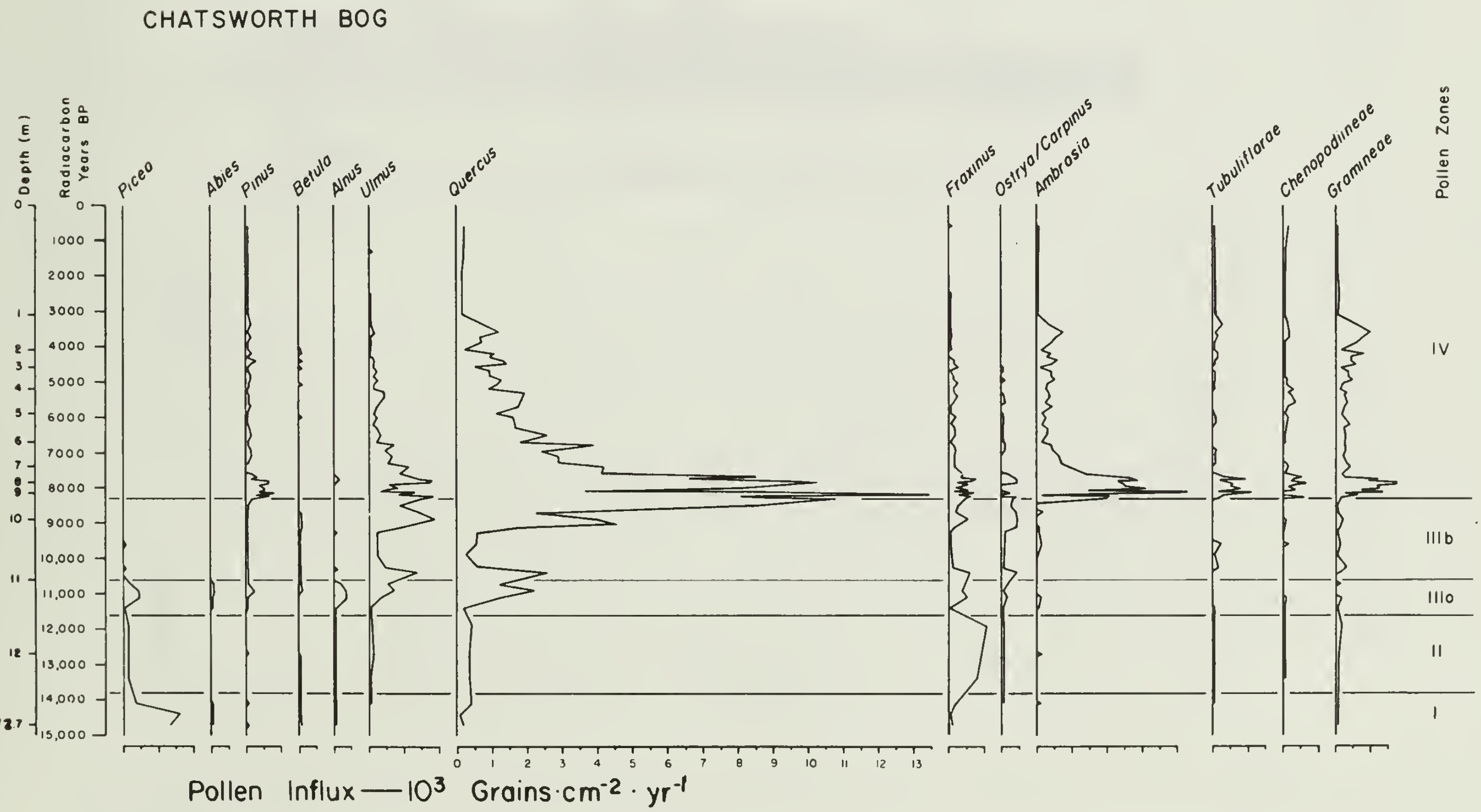


Figure 10-2. Pollen influx of selected taxa from Chatsworth Bog plotted as a function of years BP.

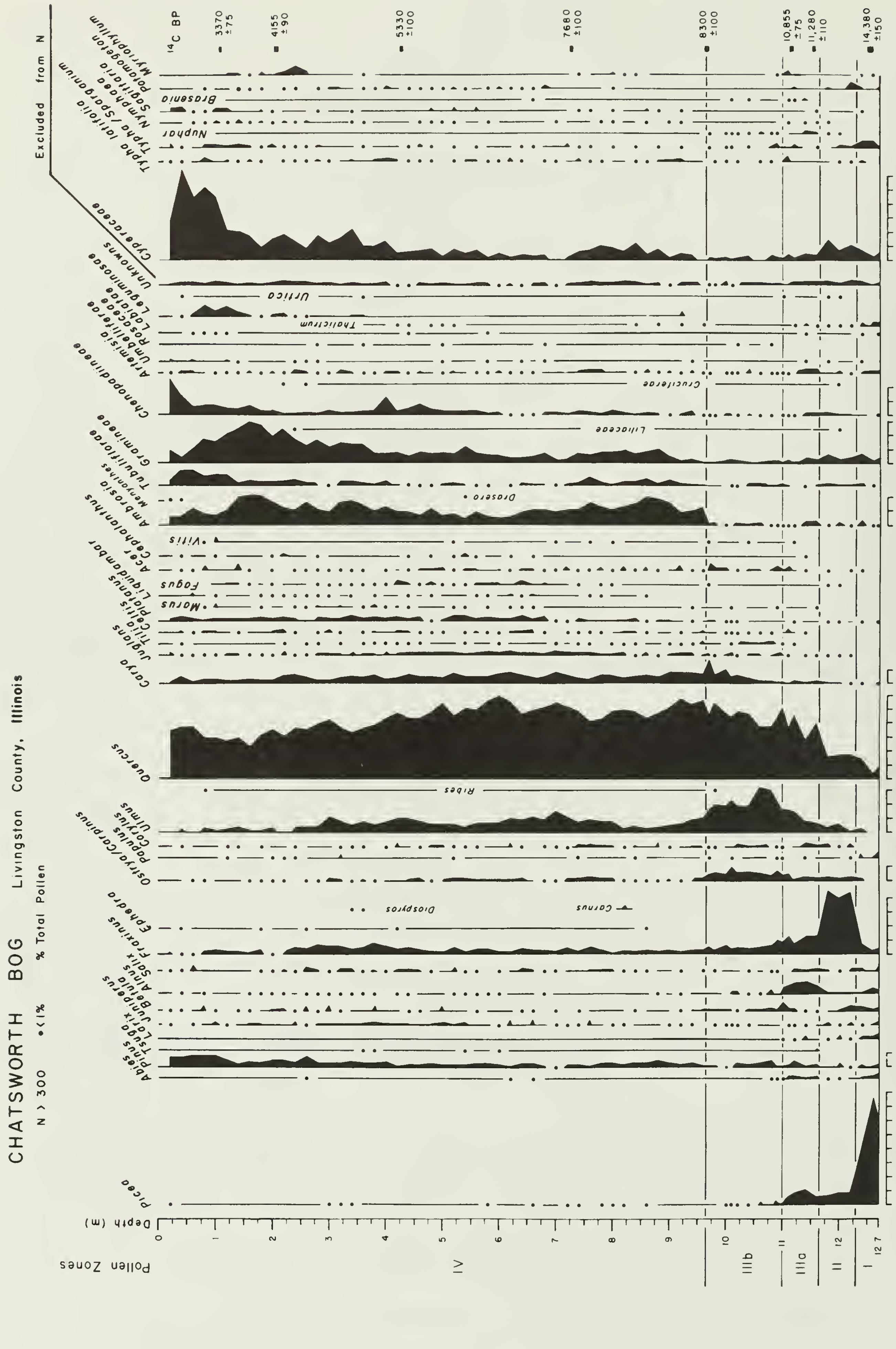


Figure 10-3. Percentage pollen diagram from Chatsworth Bog.

values range from 1000 to 2100 grains/sq cm/yr. Based on the sedimentation rate curve (Fig. 10-1), Zone I dates from the base of the core, about 14,700 BP to 13,800 BP. Although oak comprises up to 17% of the total pollen in Zone I, its influx ranges only from 80 to 400 grains/sq cm/yr. This is considerably less than the 2000-12,000 grains/sq cm/yr in areas where oak trees presently occur, indicating that the late Pleistocene oak component was from long-distance wind transport rather than from the presence of significant quantities of local oak trees. Zone I is interpreted as reflecting a mosaic of open spruce woodland and tundra, perhaps similar to the modern forest-trundra transition.

ZONE II. This zone contains much lower spruce percentages and increases in ironwood, elm, oak, and ash, particularly black ash. There is little pine pollen present, less than 2%. Pine is never prominent at Chatsworth Bog suggesting that pine did not occupy an important place in the late-glacial vegetation of central Illinois as it did in areas to the north. Total pollen influx increases slightly to maximums of 2400 grains/sq cm/yr. Most of this increase is due to ash pollen; oak remains about 500 grains/sq cm/yr. Zone II dates between 13,800 and 11,600 BP. This zone is interpreted as a rapid expansion of black ash in the wet lowlands in the vicinity of the bog while the surrounding uplands remained open and treeless. Spruce had been displaced by the ash with climatic warming.

ZONE III. This double zone is dominated by tree taxa. Zone IIIa, dominated by cool temperate species, contains a sharp decline in ash and increases in alder, elm, and oak. IIIa also contains the last major occurrence of spruce and fir; it is dated between 11,600 and 10,600 BP. In Zone IIIb the cool-temperate taxa are replaced by warm-temperate trees. Ash, fir, spruce, larch, alder decline further or disappear from the pollen record while elm, ironwood, hickory, and oak increase to maximums. Zone IIIb dates from 10,600 to 8300 BP and is interpreted as the culmination of the transition from tundra and boreal woodland to oak dominated deciduous forest. By the top of Zone IIIb, the dominant vegetation in the area was oak-hickory forest. The climate in central Illinois at this time was wetter than at present.

ZONE IV. At 8300 BP there was an abrupt increase in ragweed (Ambrosia) and shortly, after grass, Chenopods, and the sunflower group (Tubuliflorae) increased. The pollen of the deciduous trees declined at the same time. Between 970 and 860 cm depth the percentage of NAP (non-arboreal pollen) increases from 3% to 37%. The percentage increase in NAP is also apparent in the influx values. This increase in herb and grass pollen is interpreted as the first appearance of prairie in the Holocene on the broad upland of central Illinois. Oak pollen continues to dominate the pollen record, however, as small remnants of forest persisted along river and streams. Prairie produces small amounts of pollen because most of its constituent species, with the exception of grass and ragweed, are insect-pollinated. Because of the disproportionally large production of pollen by trees, small NAP increases are more significant than overriding percentages of trees. The shift from forest to grasslands in central Illinois 8300 years ago suggest that climatic conditions were becoming increasingly drier.

There is little vegetation change in the Chatsworth Bog pollen record after 8300 BP. Once the area became prairie is has remained that way to the present.

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APPENDIX 1. 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 has 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) bettles, 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 were coppery-green and 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 B.P) should have been about 11° or 12°C, with a mean annual temperature possibly as low as -7° to -9°C.

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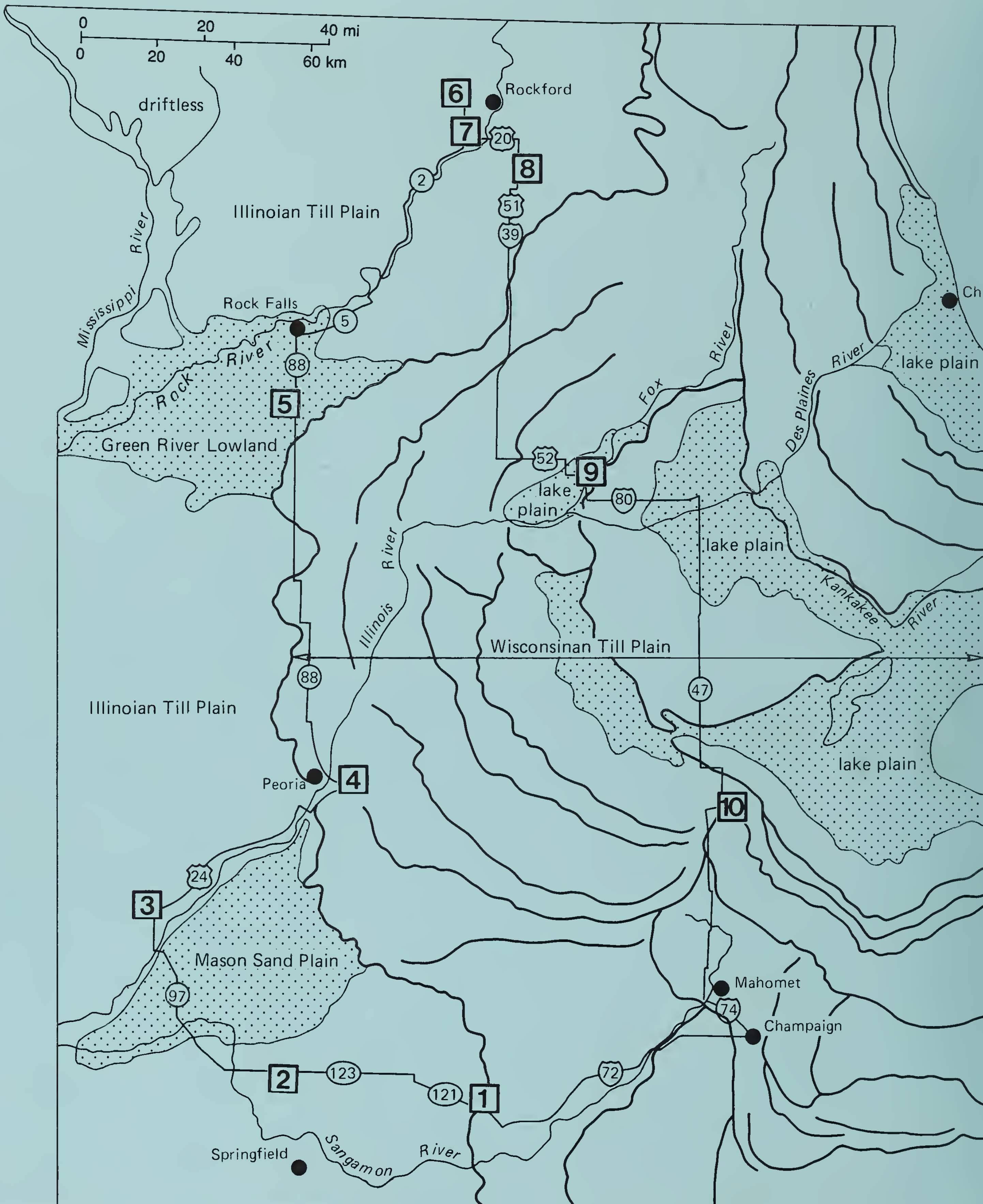
APPENDIX 2. **Comparison of the Complete Soil Profile and a Weathering Profile in Rock (from Follmer, 1984).**

Soil profile (Follmer et al., 1979)			Weathering profile (Deere and Patton, 1971)	
Horizon		Description	Zone	Description
A		Zone of organic matter and resistant mineral accumulaion; porous*	IA	Top soil; organic material; zone of leaching and eluviation; may be porous*
E		Zone of eluviation; porous, may be vesicular*		
B		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*
(BC)	B3			
(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)	C3**	Zone of slight mineral alteration; variable; few joints with stains or veins of secondary minerals; unaltered "core stones" between joints	IIA	Soil-like to rock-like; 10 to 90% core stones, highly variable
(DC)			IIB	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 ASA meeting in Chicago.



0 20 40 mi
0 20 40 60 km
driftless
Rockford
6
7
20
8
2
51
39
Illinoian Till Plain
Mississippi River
Rock Falls
5
Rock River
88
5
Green River Lowland
Chicago
lake plain
Des Plaines River
Fox River
52
9
lake plain
80
lake plain
Kankakee River
Illinois River
Wisconsinan Till Plain
88
47
Illinoian Till Plain
lake plain
Peoria
4
10
24
3
Mason Sand Plain
97
Mahomet
74
Champaign
2
123
121
1
72
Springfield
Sangamon River